MECHANICAL & ELECTRICAL

Volume 1 of 1
(METCON O&M is integrated into this manual)

OPERATION & MAINTENANCE MANUAL

IGLOOLIK
TRUCK FILL STATION

IGLOOLIK, Nunavut

Government of Nunavut #:
15230-00278

November 2017
Last revision: November 29, 2018

OWNER:	**GOVERNMENT OF NUNAVUT**
CONSULTING ENGINEER:	**CHIARELLI ENGINERRING**
GENERAL CONTRACTOR:	**KUDLIK CONSTRUCTION INC.**
MECHANICAL & ELECTRICAL CONTRACTOR:	**SIFEC NORTH INC.**

MECHANICAL & ELECTRICAL

VOLUME 1 OF 1

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Chapter 1 DOCUMENT VERSION

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Original Scope: **ELECTRICAL & MECHANICAL**

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20-09-2018	CO#12 Revision
18-09-2018	Operating sequence revision
05-11-2018	Last revision
12-11-2018	Revision (forms)
29-11-2018	Revision (Chapter 3.6)

MECHANICAL & ELECTRICAL

Project History

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Community Work Foreman:	

Chapter 2 INTRODUCTION

2.1 GENERAL INFORMATION

This project consists of the construction of a new Truck Fill Station, and chlorination system. The new filtration building includes two strainers (one for each pump), three new "Harmsco" filters and a 15,000-liter contact tank

Water is pumped from a storage reservoir that was built adjacent to the Truck Fill Station. Two intakes were installed. The pumps in the intakes are fed by a 120/208V, 3Ø line connected to the Qulliq Energy Corporation. There is an 80kWe back-up generator located in the building providing power to the existing truck fill station in case of a power failure.

2.2 PROCESS INFORMATION

The design of this water Truck Fill Station consists of the following features:

- Two skids mounted with 25 HP submersible pumps located inside a 12'' insulated casing, feeding a 3'' HDPE line up to the plant and placed at a low level in the water storage lake.
- Two 12-inch pipe casings with six heat traces each, three per pipe in service, are pump housing with a screen at intake and three spare heat trace cables per casing.
- One electronic heat trace controller per casing connected to 3 heat traces in parallel with an alarm in case of fault.
- At the highest point of the building entrance there is a 2" return insertion point on casing #2 for return water that is used for water sampling. Instrumentation is in the chlorination room. A sump pump ensures level compatibility.
- Similarly, at building casing inlet #1 we find a 2" return line from the truck fill arm, this water return point is used to empty the filling line at each truck fill.
- There is one VFD starter for each submersible pump.

- In the building at each pump outlet pipe, you will find a flow switch used for the pump sequencer control panel.
- Pump sequencer panel ensures pump alternation and flow supervision.
- One 200 MESH strainer with a 75 mircon insert per pump to capture debris and one differential pressure indicator for indication of a restricted strainer.
- One header for water capture and a flow meter feeder.
- At header output before the first metering there is a chlorine injector that receives a chlorine mixture from the injection pumps.
- One flow meter indicating the water speed in conduit, flow of water in liters per hour, and a cubic meter cumulative data, 4-20 ma programmable output proportional to flow. (flowmeter is programmable to suit your preference for example (gal/HR or liter /HR)
- At flow meter output there is a water sampling point feeding a sample of treated water to a chlorine analyzer probe and controller.
- Past the water sampling point there are two motorized valves connected in standard "C" arrangement. (One flow direction is possible at a time).
- In normal operation water passes through the filter and the 15,000-liter contact tank.
- In fire mode as initiated by truck operator at loading arm loaded water bypasses filtration and contact tank.
- In normal operation this filtration loop also includes 3 new in line filters with the following order of filtration 20 microns, 5 microns and LT2 followed by a 15,000-liter contact tank at filter output.
- The #2 chlorine injection point followed by a second flowmeter is found at the last filter outlet.

- Past the #2 flowmeter there is a second water sampling point feeding a second chlorine content measurement probe supplying information to chlorine analyzer #2.

- A 15,000-liter contact tank is located under the floor grating followed by 6'' rising piping to truck fill arm.

- Two truck fill arms and truck positions are available, each fill line position includes a motorized valve activated by a start and stop station located at eye level once on truck top.

- On each 4'' water supply line there is a 2'' motorized valve opening to return after truck filling the excess water to be returned to pump intake casing.

2.3 ELECTRICAL & CONTROL INFORMATION

- On the electrical side there is a 250-amp 3 phase 120/208-volt underground feeder connected to "QEC" - the electrical supplier.

- At the main breaker outlet there is a metering box with an outside cabinet for the meters.

- At the metering box outlet, there is a 400-amp 120/208-volt 3 phase automatic transfer switch that starts the generator upon power failure and transfers power from the building to the generator.

- At the transfer switch outlet, you will find the main power panel that feeds itself three Secondary panels, one for pump house distribution, one for the generator room and one for the old decommission pump house.

- At control and supervision level there are two panels

    - the main control panel which is capable of supervising multiple points, includes an auto dialer that informs by recorded telephone message the nature of the alarm and has the capacity to acknowledge at a distance a malfunction at the plant caused by faulty operation. It has the capacity to latch a transient alarm and run an amber strobe

on rooftop under alarm conditions. On the panel face there is an acknowledge push button to stop the telephone alarm emission, and strobe on the rooftop. The panel fault indication light remains on until fault is corrected.

- The pump sequencer panel, as its name implies changes the pump in usage at each truck fill.

2.4 PLAN OVERVIEW

2.4.1 Mechanical plans

Plan M1

Plan M2

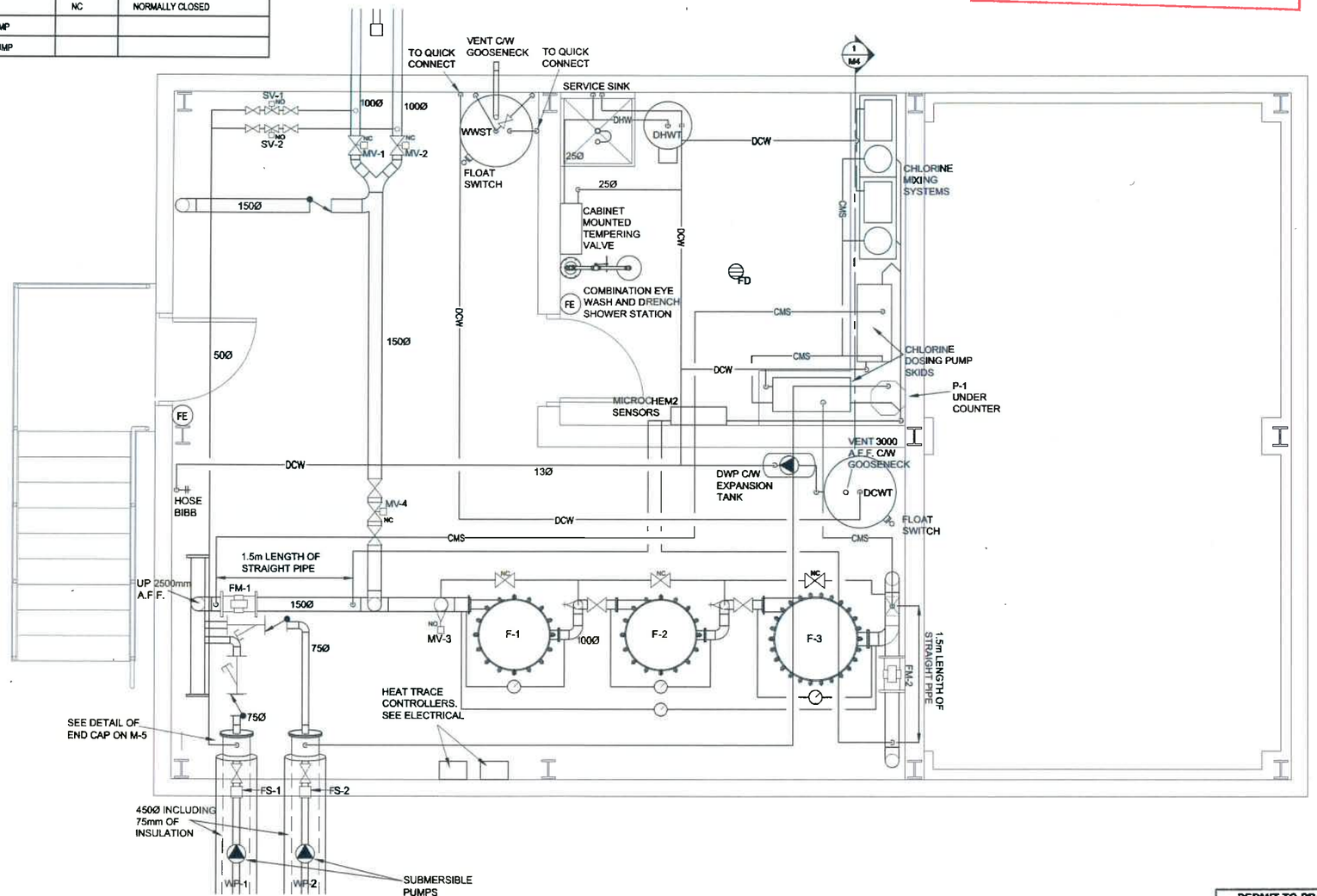
Plan M3

Plan M4

Plan M5

LEGEND			
CMS	CHEMICAL SUPPLY	DWP	DOMESTIC WATER PUMP
DHW	DOMESTIC HOT WATER	FS	FLOW SWITCH
DCW	DOMESTIC COLD WATER	F	FILTER TANK
SAN	SANITARY	MV	MOTORIZED VALVE
	BALL VALVE	SV	SOLENOID VALVE
	CHECK VALVE	DCWT	DOMESTIC COLD WATER TANK
	PUMP	WWST	WASTE WATER STORAGE TANK
	PRESSURE GAUGE	CS	CHLORINE SENSOR
FE	FIRE EXTINGUISHER	DHWT	DOMESTIC HOT WATER TANK
FM	FLOW METER	DP	DIFFERENTIAL PRESSURE GAUGE
CFM	CHEMICAL FLOW METER	NO	NORMALLY OPEN
SP	SUMP PUMP	NC	NORMALLY CLOSED
WP	SUBMERSIBLE PUMP		
CP	CHLORINATION PUMP		

AS-BUILT
DATE: November 5, 2018
BIG NORTH



1/M4

1/M1 PLUMBING PLAN - HIGH ELEVATION
1:25

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

Arktis piusitippaa

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NWT/NU

CONSULTANT: CEML
DRAWN BY: R.S.
DESIGNED BY: M.M.
APPROVED BY: M.M.
DATE: MARCH 2016

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DESIGNED BY:
APPROVED BY:
DATE:

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:

IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:

PLUMBING LAYOUT - HIGH ELEVATION

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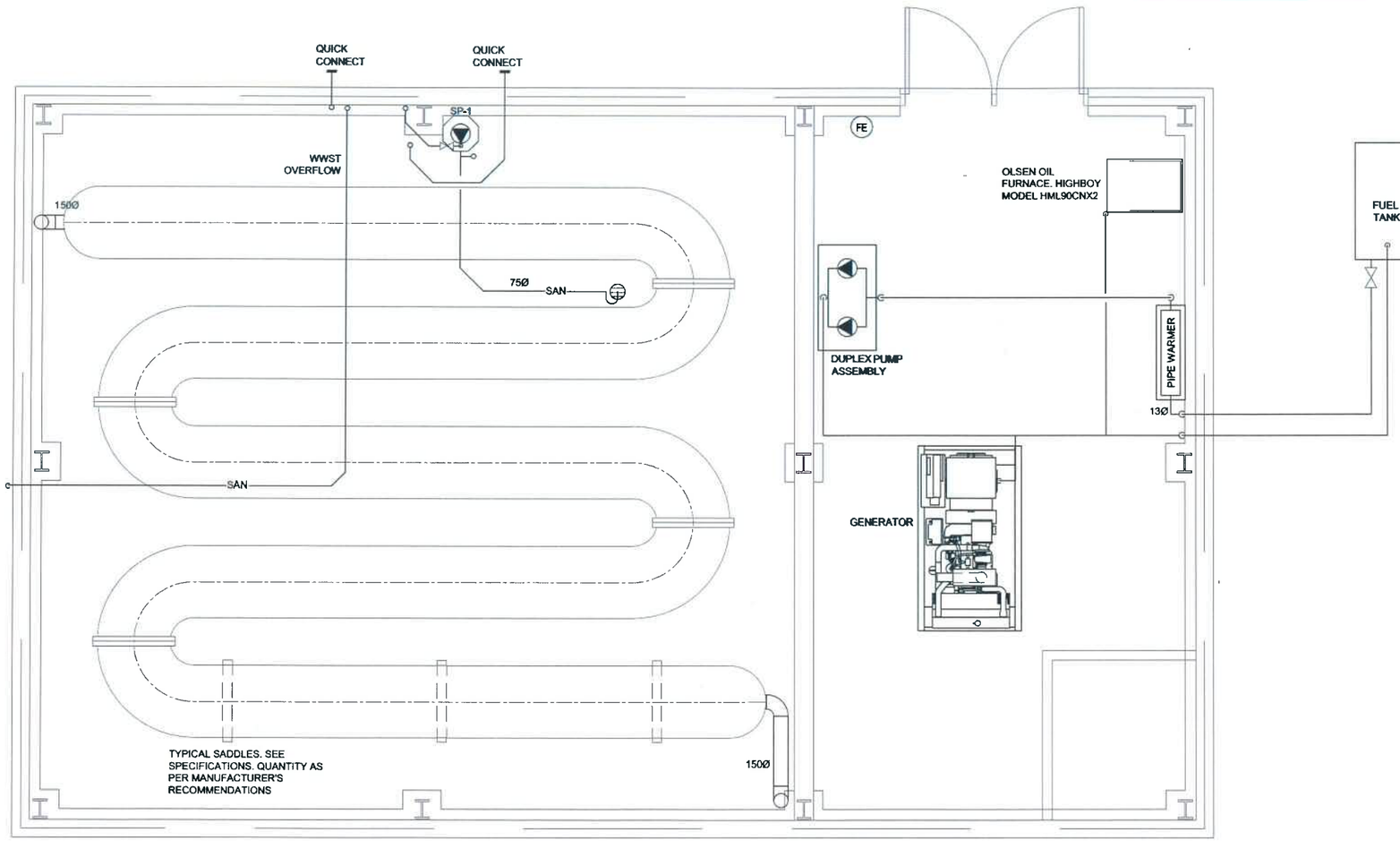

1/M2 PLUMBING PLAN - LOW ELEVATION

1:25

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APPROVED BY: M.M.
DATE: MARCH 2016
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DRAWN BY:
DESIGNED BY:
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LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:

IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:

PLUMBING LAYOUT - LOW ELEVATION

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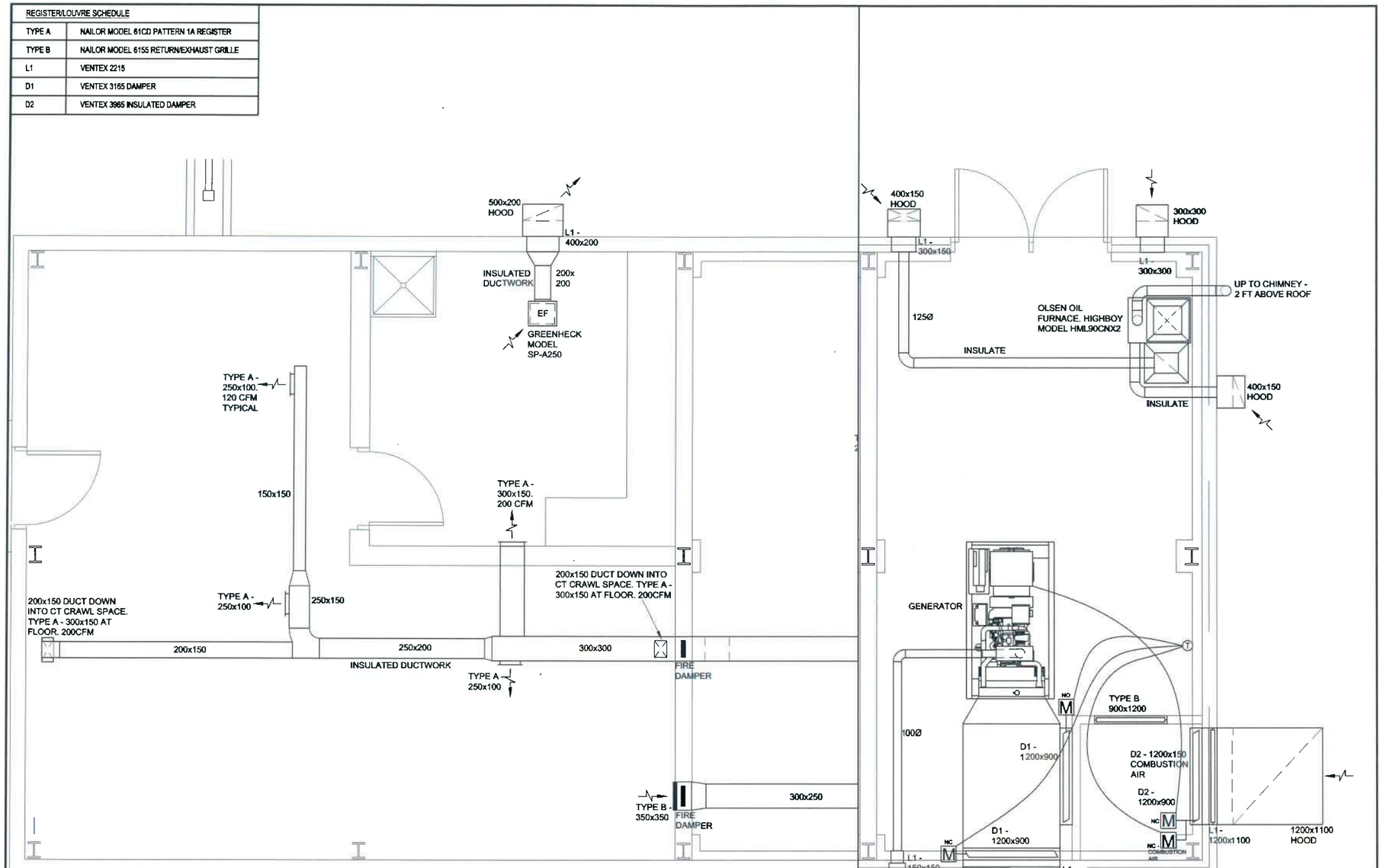
13–072	M2	5	AS NOTED

REGISTER/LOUVRE SCHEDULE	
TYPE A	NAILOR MODEL 61CD PATTERN 1A REGISTER
TYPE B	NAILOR MODEL 6155 RETURN/EXHAUST GRILLE
L1	VENTEX 2215
D1	VENTEX 3165 DAMPER
D2	VENTEX 3985 INSULATED DAMPER



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1/M3 UPPER HVAC PLAN
1:25

2/M3 LOWER HVAC PLAN - GENERATOR ROOM
1:25

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STAMP

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DESIGNED BY:
APPROVED BY:
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LOCATION

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PROJECT:

IMPROVEMENT OF WATER SUPPLY SYSTEM

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HVAC LAYOUTS

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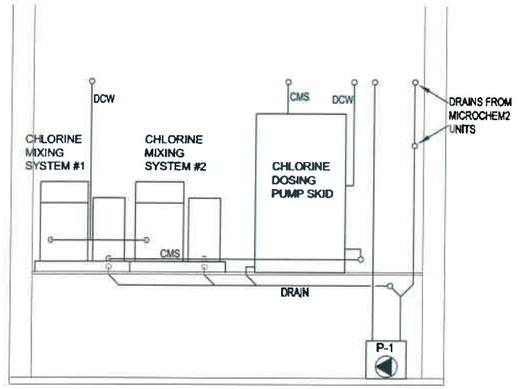
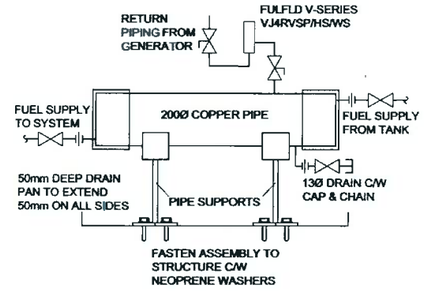


1 / M4 CHEMICAL TANK DETAIL
1:25



2 / M4 FUEL PIPE WARMER DETAIL
1:10

1. SEQUENCE OF OPERATION DOMESTIC WATER PUMP (DWP):

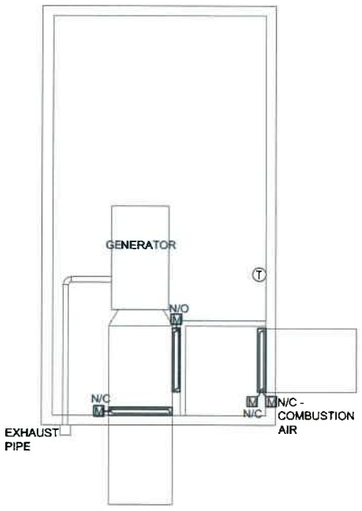
a. THE DOMESTIC STORAGE TANK WILL BE FILLED BY ONE OF THE WATER TRUCKS VIA AN OUTSIDE INLET THAT WILL PERMIT THE FILLING OF THE TANK. THERE WILL BE A LOW WATER ALARM TO ADVISE THE OPERATOR THAT THE TANK IS LOW.
b. UPON A DROP IN PRESSURE, THE PUMP WILL START AND PROVIDE WATER TO BOTH THE SINK AND THE TO THE DOMESTIC HOT WATER TANK.
c. ONCE THE SUPPLY FIXTURES ARE CLOSED, THE PRESSURE IN THE SYSTEM WILL INCREASE AND SHUT OFF AT 40 PSIG AND SHUT OFF.

2. SEQUENCE OF OPERATION SUMP PUMP (SP-1):

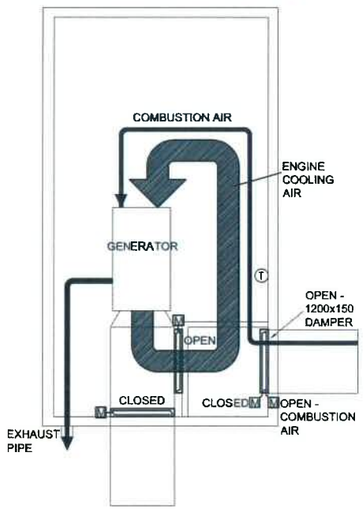
a. THE DRAIN FROM THE SERVICE SINK AND THE FLOOR DRAINS WILL DRAIN INTO A SUMP PUMP PACKAGE THAT WILL DISCHARGE INTO A WASTEWATER STORAGE TANK. THERE WILL BE A HIGH WATER ALARM TO ADVISE THE OPERATOR OF WHEN THE TANK IS TO BE DRAINED OR IF THE PUMP FAILED TO START.

AS-BUILT
DATE: November 5, 2018
SIRC NORTH

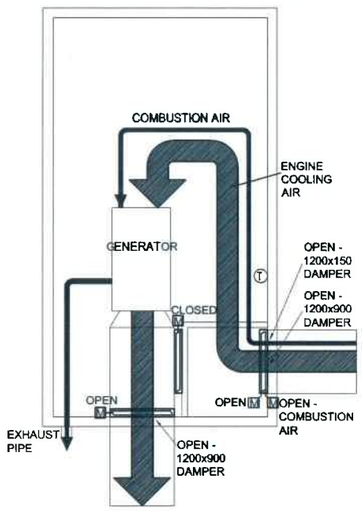
GENERATOR NOT RUNNING



GENERATOR RUNNING. ROOM IS COLDER THAN THERMOSTAT SET POINT



GENERATOR IS RUNNING. ROOM IS WARMER THAN THERMOSTAT SET POINT



3 / M4 GENERATOR SEQUENCE
NTS

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

Arktis piusitippaa

CONSULTANT NAME AND ADDRESS
CHIARELLI ENGINEERING MANAGEMENT LTD.
203-100 CRAIG HENRY DR.
NEPEAN, ONTARIO K2G 5W3
TEL. (613)225-1123
FAX. (613)225-7298
E-MAIL: info@cemlottawa.com
MECH. PROJECT No: 13-072

10			
9			
8			
7			
6			
5	28/03/16	RS.	REISSUED FOR TENDER
4	14/04/14	RS.	REISSUED FOR TENDER
3	13/02/14	RS.	ISSUED FOR TENDER
2	15/01/14	R.S.	ISSUED FOR 99% REVIEW
1	25/11/13	R.S.	ISSUED FOR 50% REVIEW
No.	DATE: dd/mm/yyyy	BY:	DESCRIPTION

STAMP

REGISTERED PROFESSIONAL ENGINEER NWT/NU MAR 2016

CONSULTANT: CEML
DRAWN BY: R.S.
DESIGNED BY: M.M.
APPROVED BY: M.M.
DATE: MARCH 2016

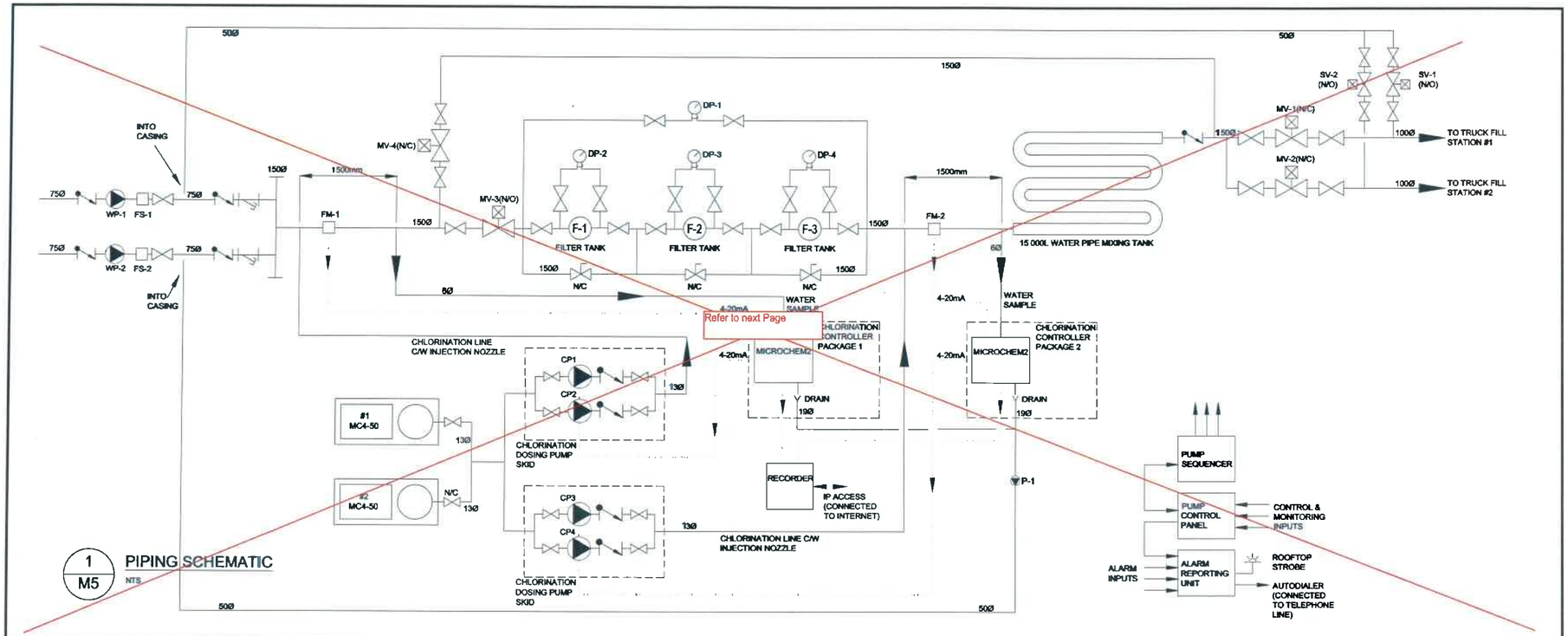
STAMP
CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATE:

LOCATION:
IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

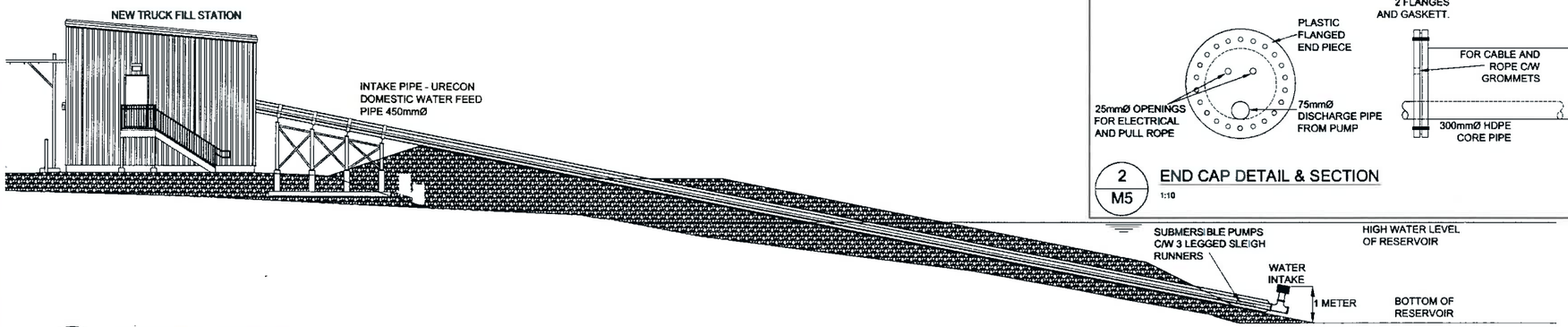
PROJECT:
IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:
MECHANICAL SECTIONS AND SCHEMATICS

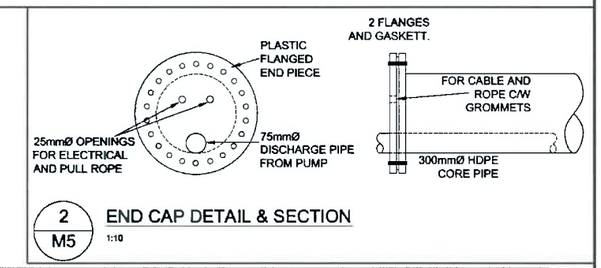
MECH FILE NAME	DWG NO	SHT	SCALE
13-072	M4	5	AS NOTED



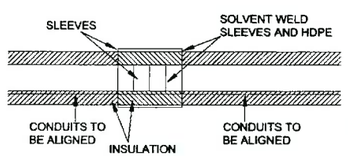
1 M5 **PIPING SCHEMATIC** NTS



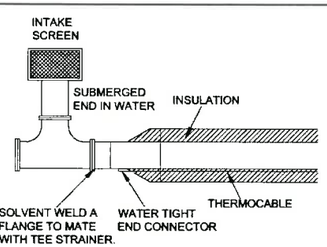
3 M5 **INTAKE PIPE SECTION** 1:100



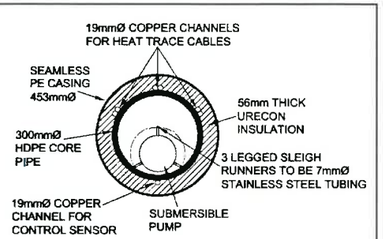
2 M5 **END CAP DETAIL & SECTION** 1:10



4 M5 **INTAKE PIPE JOINT - TYPICAL** 1:25



5 M5 **SUBMERGED END CAP DETAIL** 1:25



6 M5 **INTAKE CROSS SECTION** 1:10

AS-BUILT
DATE: November 5, 2018
GIC NORTH

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

Arktis piusitippaa

CONSULTANT NAME AND ADDRESS
CHIARELLI ENGINEERING MANAGEMENT LTD.
203–100 CRAIG HENRY DR.
NEPEAN, ONTARIO K2G 5W3
TEL. (613)225–1123
FAX. (613)225–7298
E–MAIL: info@cemlottawa.com
MECH. PROJECT No: 13–072

	DATE	BY	DESCRIPTION
10			
9			
8			
7			
6			
5			
4			
3	08/03/16	M.S.	REISSUED FOR TENDER
2	14/04/14	M.S.	REISSUED FOR TENDER
1	13/02/14	M.S.	ISSUED FOR TENDER

STAMP
CONSULTANT: C.E.M.L.
DRAWN BY: R.S.
DESIGNED BY: M.M.
APPROVED BY: M.M.
DATE: MARCH 2016

REGISTERED PROFESSIONAL ENGINEER NWT/NU M.M. CHIARELLI MARCH 2016

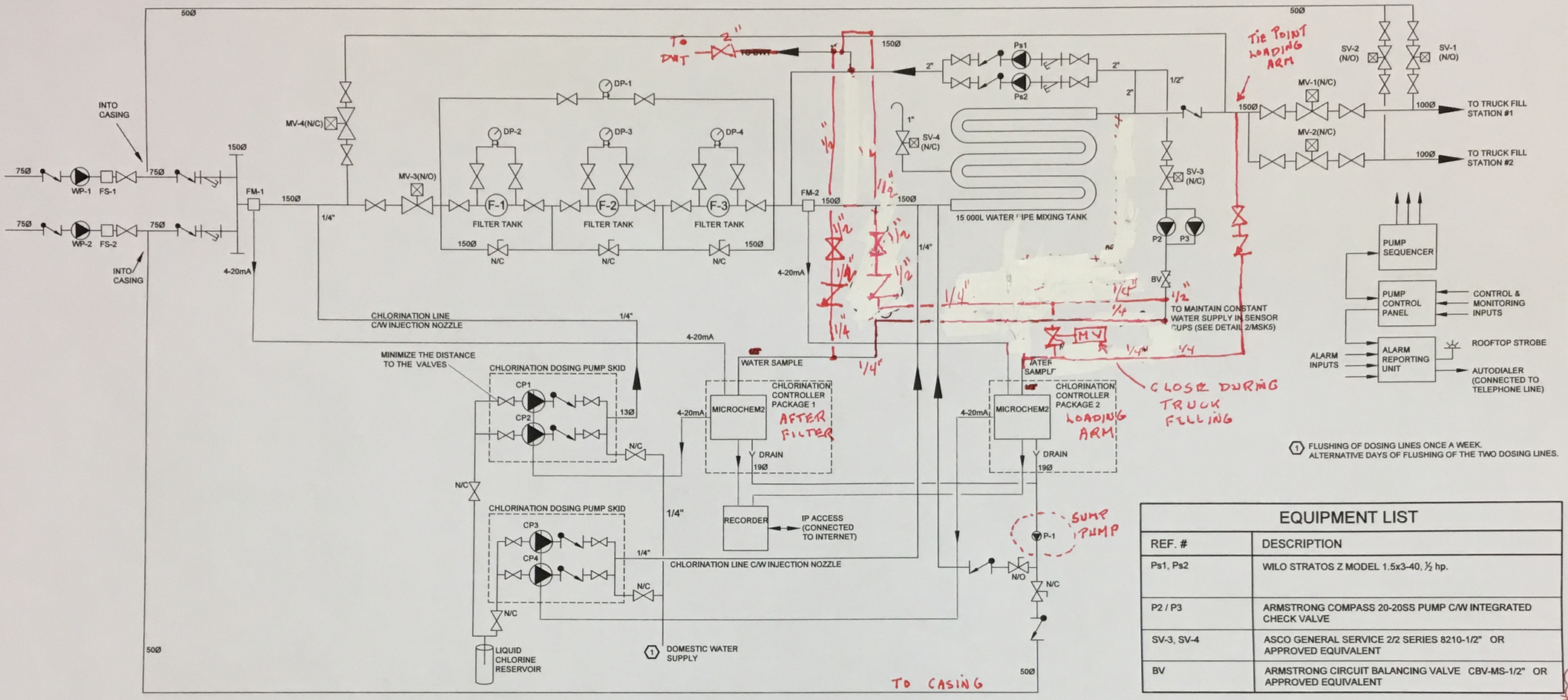
STAMP
CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATE:

LOCATION
IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:
IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:
MECHANICAL SECTIONS AND SCHEMATICS

MECH FILE NAME	DWG NO	SH.	SCALE
13–072	M5	5	AS NOTED

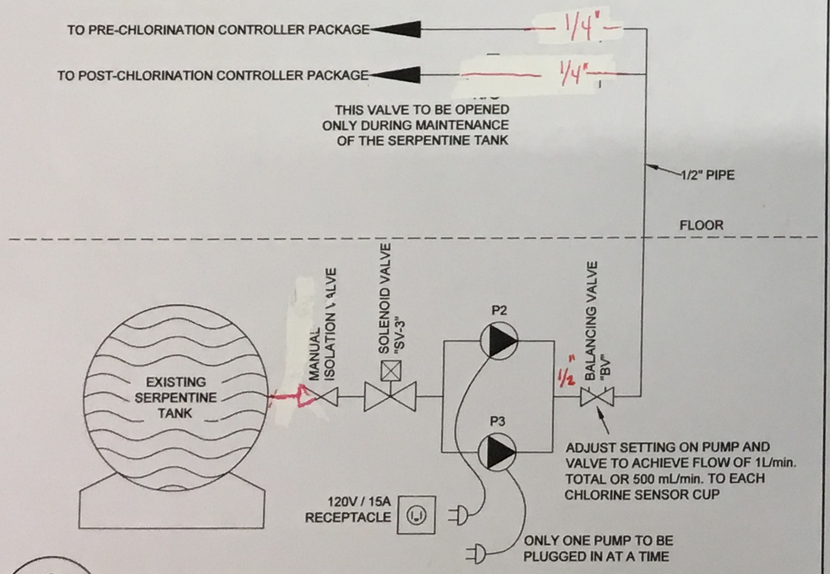


1 FLUSHING OF DOSING LINES ONCE A WEEK. ALTERNATIVE DAYS OF FLUSHING OF THE TWO DOSING LINES.

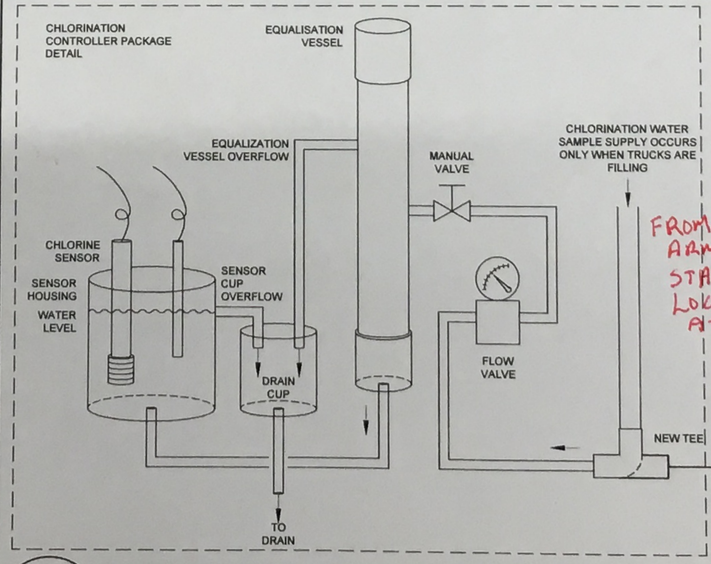
EQUIPMENT LIST

REF. #	DESCRIPTION
Ps1, Ps2	WILO STRATOS Z MODEL 1.5x3-40, ½ hp.
P2 / P3	ARMSTRONG COMPASS 20-20SS PUMP C/W INTEGRATED CHECK VALVE
SV-3, SV-4	ASCO GENERAL SERVICE 2/2 SERIES 8210-1/2" OR APPROVED EQUIVALENT
BV	ARMSTRONG CIRCUIT BALANCING VALVE CBV-MS-1/2" OR APPROVED EQUIVALENT

1 / MSK5 — CHLORINATION MODIFICATIONS SCHEMATIC
N. T. S.



2 / MSK5 — CHLORINATION MODIFICATIONS RISER DIAGRAM
N. T. S.



3 / MSK5 — CHLORINATION CONTROLLER PACKAGE DETAIL - MODIFICATIONS
N. T. S.

SEQUENCE OF OPERATIONS:

- WHEN WP1 AND/OR WP2 STOPS RUNNING AND AFTER TIME DELAY OF 1 MIN, OPEN "SV-3" AND "SV-4" AND TURN ON P2 OR P3 (ONLY ONE ACTIVE).
- WHEN DELIVERY OF WATER IS REQUESTED (WP-1 AND/OR WP-2 IS ON), TURN OFF "SV-3" AND "SV-4"AND P2/P3.
- NOTE: VENT TO BE AT HIGHEST POINT ON OUTLET PIPING TO TRUCK DELIVERY ARMS.

AS-BUILT
DATE: 01-11-2018
DIRECTION

PWGSC A2 (594x420)

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 2018-08-14
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

REGISTERED PROFESSIONAL ENGINEER
M.M. MATTLET
LICENSEE
NWT/NU

CEML
Chiarelli Engineering Management Ltd
210–2120 ROBERTSON RD.
NEPEAN, ONTARIO K2H 5Z1
TEL. (613) 225–1123
EMAIL: info@cemlottawa.com

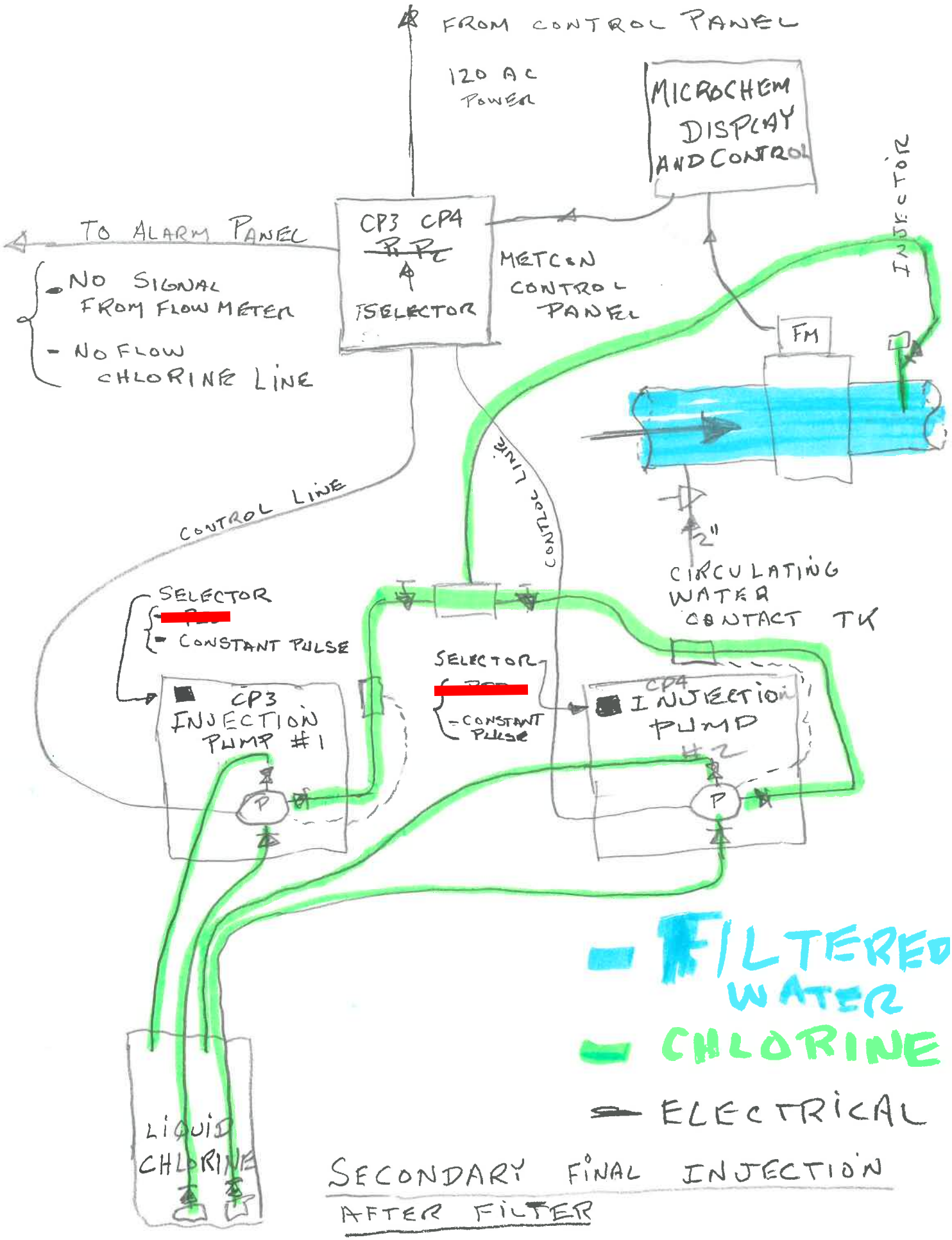
Contractor to verify all dimensions & conditions on site and immediately notify the engineer of all discrepancies.

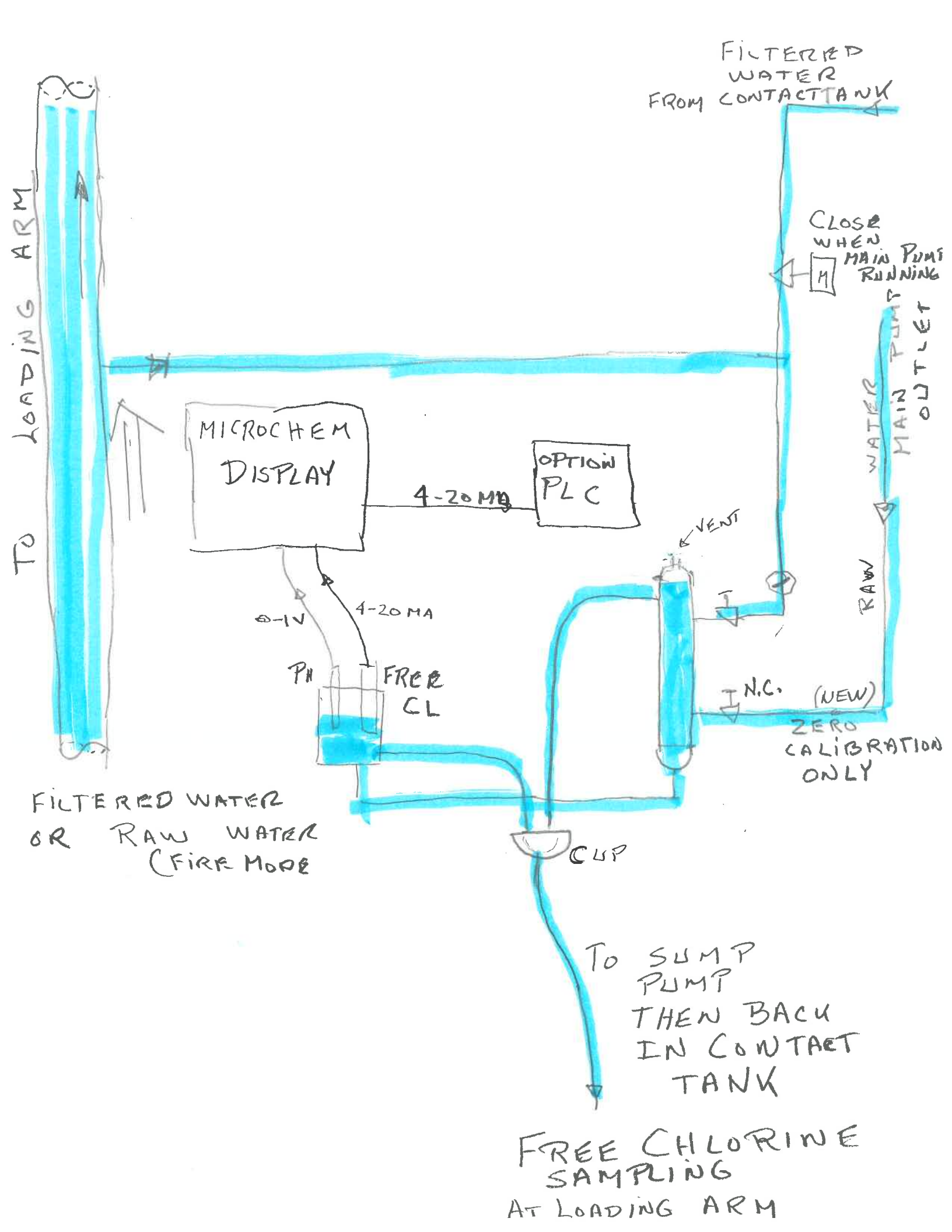
revisions	description	
2	Reissued for CCN# M&E 4	2018/08/14
1	Issued for CCN# M&E 4	2018/08/08

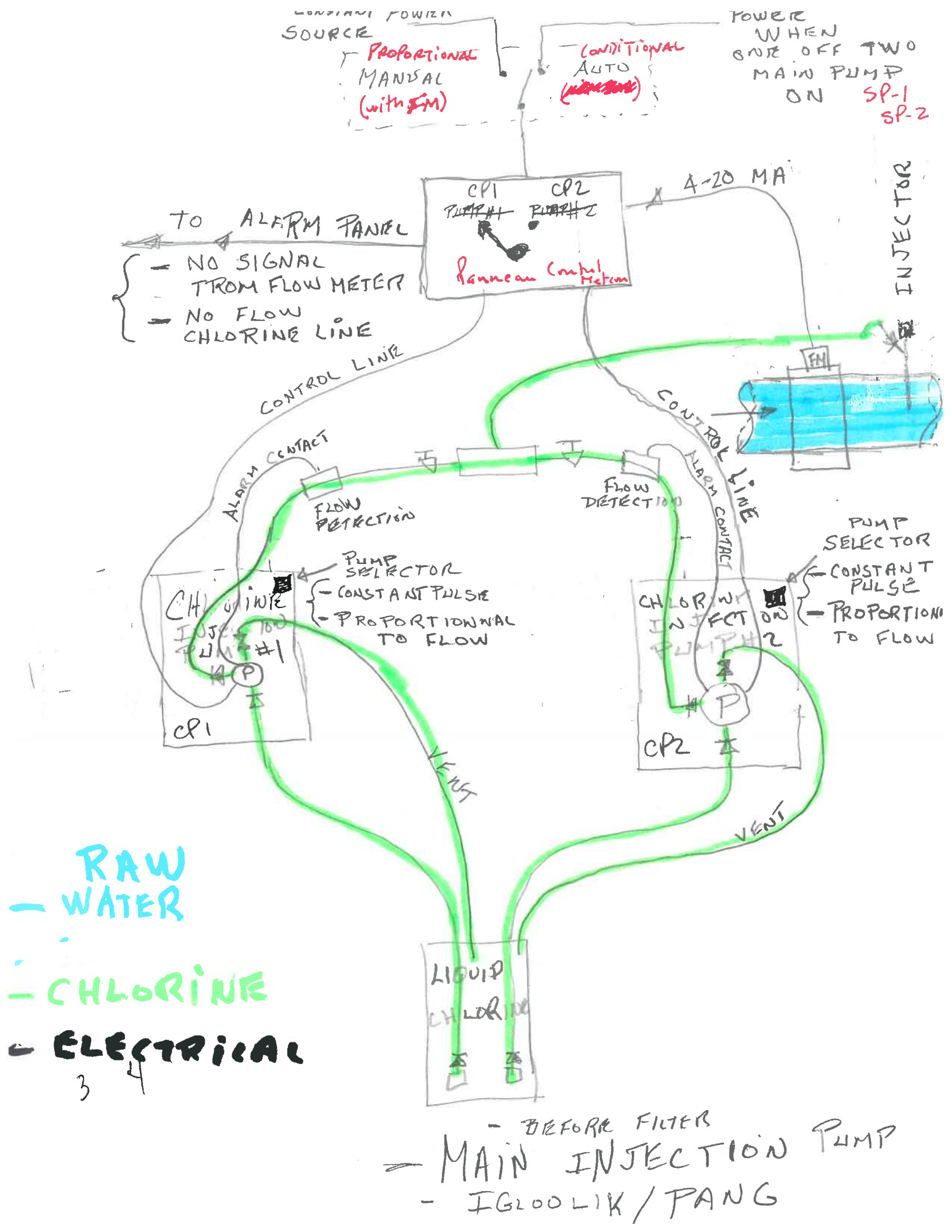
project / projet
IMPROVEMENT OF DRINKING WATER SUPPLY
IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0R0

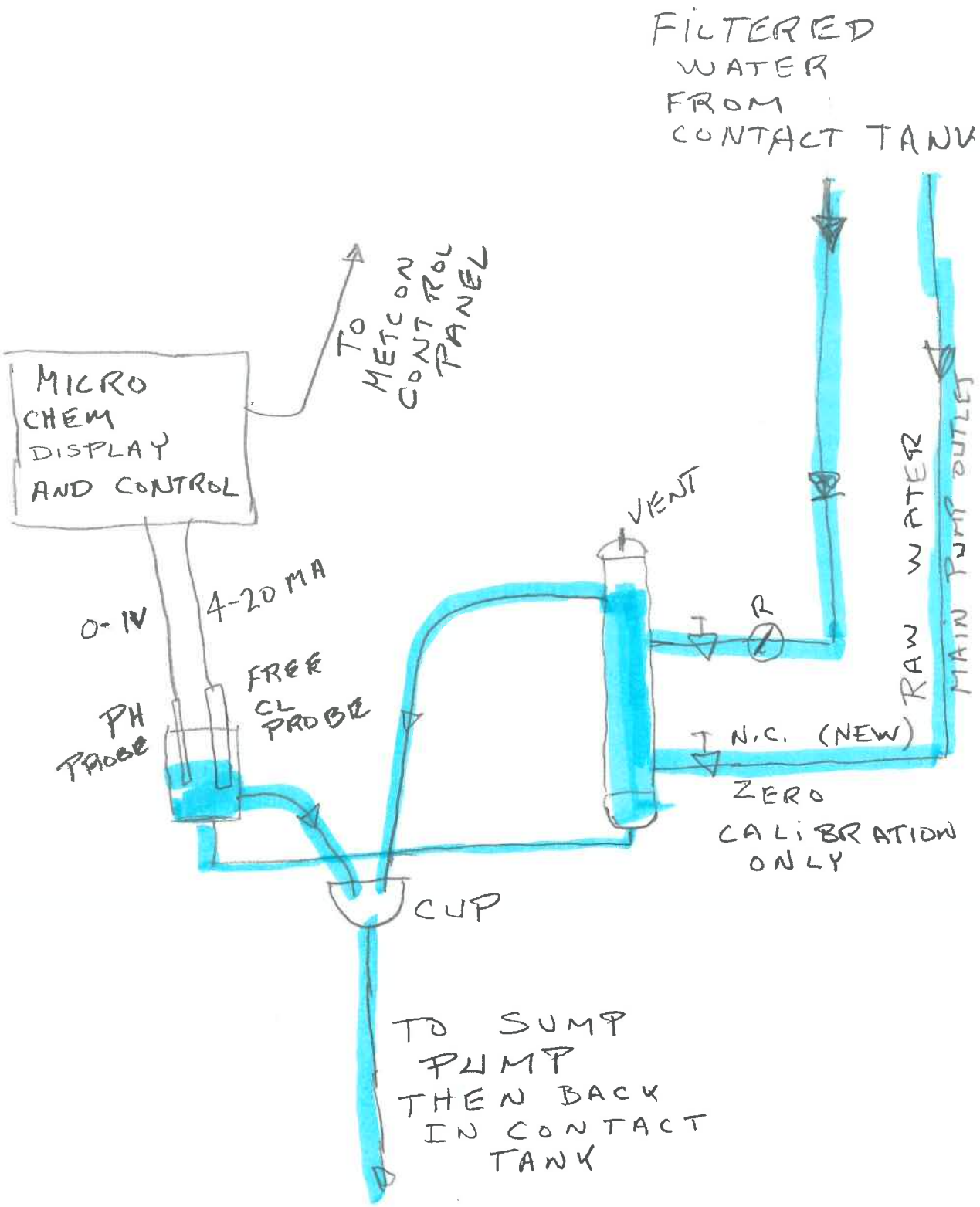
drawing / dessin
CHLORINATION SYSTEM MODIFICATIONS

Designed By	M.M.	Conçu par
Date	2018/08/14	(yyyy/mm/dd)
Drawn By	B.P.	Dessiné par
Date	2018/08/14	(yyyy/mm/dd)
Reviewed By	N.K.	Examiné par
Date	2018/08/14	(yyyy/mm/dd)
Approved By	M.M.	Approuvé par
Date	2018/08/14	(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets
Project no.	13-072	No. du projet
Drawing no.	MSK5	No. du dessin

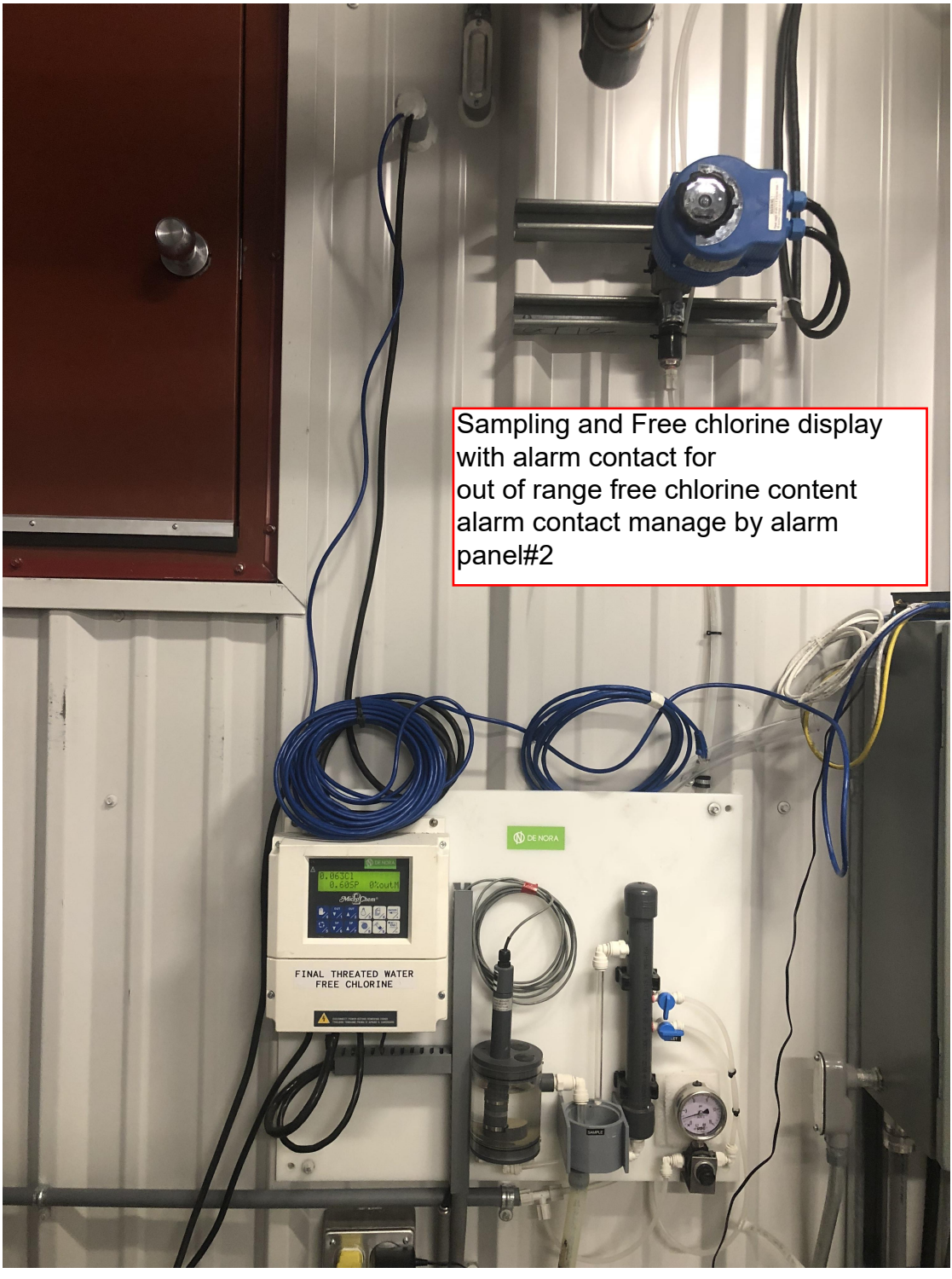

FROM CONTROL PANEL
120 AC POWER
MICROCHEM DISPLAY AND CONTROL
TO ALARM PANEL
CP3 CP4
SELECTOR
METCON CONTROL PANEL
NO SIGNAL FROM FLOW METER
NO FLOW CHLORINE LINE
INJECTION
FM
CONTROL LINE
CONTROL LINE
2"
CIRCULATING WATER CONTACT TK
SELECTOR
CONSTANT PULSE
SELECTOR
CONSTANT PULSE
CP3 INJECTION PUMP #1
CP4 INJECTION PUMP #2
P
P
FILTERED WATER
CHLORINE
ELECTRICAL
LIQUID CHLORINE
SECONDARY FINAL INJECTION
AFTER FILTER


FILTERED WATER FROM CONTACT TANK
CLOSE WHEN MAIN PUMP RUNNING
M
WATER MAIN PUMP OUTLET
TO LOADING ARM
MICROCHEM DISPLAY
4-20 MA
OPTION PLC
VENT
0-1V
4-20 MA
PH
FREE CL
RAW
N.C.
(NEW) ZERO CALIBRATION ONLY
FILTERED WATER OR RAW WATER (FIRE MODE
CUP
TO SUMP PUMP THEN BACK IN CONTACT TANK
FREE CHLORINE SAMPLING AT LOADING ARM


CONSTANT POWER SOURCE
PROPORTIONAL
MANUAL
(with FM)
CONDITIONAL
AUTO
POWER WHEN ONE OFF TWO MAIN PUMP ON
SP-1
SP-2
CP1
CP2
4-20 MA
INJECTOR
TO ALARM PANEL
- NO SIGNAL FROM FLOW METER
- NO FLOW CHLORINE LINE
CONTROL LINE
FM
ALARM CONTACT
FLOW DETECTION
PUMP SELECTOR
- CONSTANT PULSE
- PROPORTIONAL TO FLOW
VENT
LIQUID CHLORINE
- BEFORE FILTER
- MAIN INJECTION PUMP
- IGLOOLIK / PANG
RAW WATER
CHLORINE
ELECTRICAL



FREE CHLORINE SAMPLING FROM CONTACT TANK OUTLET


Sampling and Free chlorine display
with alarm contact for
out of range free chlorine content
alarm contact manage by alarm
panel#2
DE NORA
FINAL THREATED WATER
FREE CHLORINE

CONTACT FOR SERVICE, PARTS, AND REPAIRS:
metcon
SALES & ENGINEERING LTD.
CCP-2
FILTRED WATER
PUMP 1 -O- PUMP 2
Constant chlorine injection rate
at Contact tank inlet 15,000 litres
1) ajustable rate on pump
2) ajustable stroke lenth on pump
ProMinent
gamma/ X
STOP

CONTACT FOR SERVICE, PARTS, AND REPAIRS:
metcon
SALES & ENGINEERING LTD
CCP-1
RAW WATER
PUMP 1 -0- PUMP 2
Normal Operation with flow meter available
1) chlorine injection rate proportionnal to main pump flow
2) stroke lenth ajustable with knob
metcon
metcon

Back Pressure/ Relief Valves

CRN REGISTERED

1/2" to 2"

2-1/2" to 4"

SB12 Series – 1/2" to 4"

- SB12 Series Back Pressure/Relief valves feature a **built-in check valve function, desirable in dosing applications.** Inlet pressure acts upward against the disc allowing excess pressure flow upwards through the orifice.
- These valves are **recommended for dirty fluids.**
- Relief pressure settings are 5–150 psi for 1/2" to 3" and 5–90 psi for 4" sizes.
- FPM (Viton•) seat and seals are supplied as standard. EPDM is available special order.

True Union

Size	Item No.	PVC x=A Socket y=U	PVC x=A Threaded y=UT	PP x=B Socket y=U	PP x=B Threaded y=UT	PVDF x=K Socket y=UT	PVDF x=K Threaded y=UT	
1/2"	SB12x005Vy	*SB12A005VU* 278.00	*SB12A005VUT* 292.00	*SB12B005VU* 364.00	*SB12B005VUT* 398.00	*SB12K005VU* 930.00	*SB12K005VUT* 969.00	G
3/4"	SB12x007Vy	389.00	404.00	505.00	544.00	1,420.00	1,466.00	G
1"	SB12x010Vy	405.00	523.00	513.00	556.00	1,462.00	1,532.00	G
1-1/4"	SB12x012Vy	512.00	640.00	664.00	709.00	2,213.00	2,342.00	G
1-1/2"	SB12x015Vy	533.00	690.00	690.00	746.00	2,264.00	2,370.00	G
2"	SB12x020Vy	554.00	583.00	736.00	804.00	2,348.00	2,482.00	G

Spigot and ANSI 150 Flanged•

Size	Item No.	PVC x=A Flanged† y=F	PP x=B Metric Spigot (Blank)[1]	PP x=B Flanged† y=F	PVDF x=K Metric Spigot (Blank)[1]	PVDF x=K Flanged† y=F	
1/2"	SB12x005Vy	*SB12A005VF* 308.00	*SB12B005V* 319.00	*SB12B005VF* 436.00	*SB12K005V* 875.00	*SB12K005VF* 999.00	G
3/4"	SB12x007Vy	416.00	456.00	584.00	1,355.00	1,494.00	G
1"	SB12x010Vy	419.00	456.00	597.00	1,355.00	1,506.00	G
1-1/4"	SB12x012Vy	521.00	588.00	743.00	2,097.00	2,276.00	G
1-1/2"	SB12x015Vy	521.00	588.00	767.00	2,097.00	2,304.00	G
2"	SB12x020Vy	531.00	588.00	797.00	2,097.00	2,353.00	G
2-1/2"	SB12x025Vy	1,612.00	1,982.00	2,299.00	6,751.00	7,275.00	G
3"	SB12x030Vy	2,494.00	3,136.00	3,510.00	8,872.00	9,528.00	G
4"	SB12x040Vy	3,771.00	4,753.00	5,196.00	13,448.00	14,182.00	G

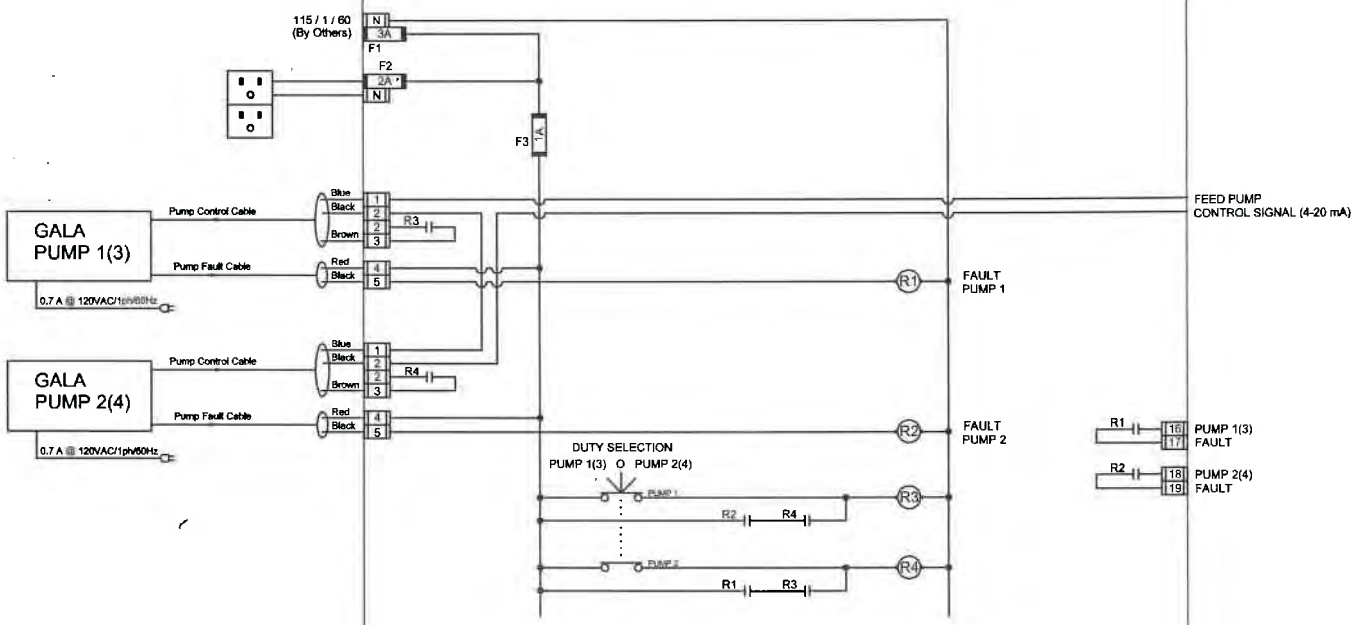
[1]Metric Spigot ends may be butt fused directly to metric pipe.

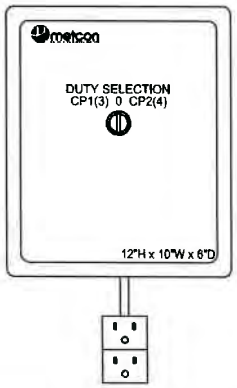
Socket and Threaded[2]•†

Size	Item No.	PVC x=A Socket y=S	PVC x=A Threaded y=T	PP x=B Threaded y=T	PVDF x=K Threaded y=T	
1/2"	SB12x005Vy	*SB12A005VS* 293.00	*SB12A005VT* 293.00	*SB12B005VT* 403.00	*SB12K005VT* 970.00	G
3/4"	SB12x007Vy	402.00	402.00	544.00	1,457.00	G
1"	SB12x010Vy	402.00	407.00	554.00	1,479.00	G
1-1/4"	SB12x012Vy	509.00	518.00	693.00	2,233.00	G
1-1/2"	SB12x015Vy	510.00	523.00	721.00	2,279.00	G
2"	SB12x020Vy	511.00	547.00	741.00	2,308.00	G

[2]Solid (no unions) socket and threaded ends are socket welded to spigot valves. Solid socket ends are available up to 4". P.O.A.

CHEMICAL PUMPS CONTRL PANEL





NOTES:

1. Two identical control panels, one for each chemical system
2. Selected duty pump will automatically start after selection from selector switch. Second pump will be the stand-by one.
3. If selected duty pump fails, the stand-by pump will automatically start. Please advise if this feature is not required.
4. If manual control is required, disconnect control cable from pump. On manual control, start/stop and speed adjustment from pump key pad.
5. Control panels will have CSA approval (general inspection).

REVISIONS:

No	Date	By	Description
1.			
2.			

BILL OF MATERIALS

#	Part #	Make	Description	Pcs
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

☐ PROPOSAL ONLY
☒ FOR APPROVAL
☐ FOR CONSTRUCTION
☐ AS BUILT

metcon SALES & ENGINEERING LTD.

Control Panel

Wiring and Layout

Date:	Mar 05, 2015
Job Number:	15-S010792
Job Name:	Pangnirtung
Dwg. #:	2
Approved by:	GM
Drawn by:	GT

Notes:
1. [✱] Indicates supplied by others.
2. Unit: Inches (mm). Do not scale this drawing. All dimensions, sizing, orientation of piping, wiring and equipment, are estimations and approximations and are not to be used in other related design.
3. The information contained on this drawing is of confidential nature and shall not be used or reproduced without written consent from Metcon Sales and Engineering Limited.

K14
120VAC

K15
120VAC

LOW OR HI CHLORINE 3Ø-STUP PUMP

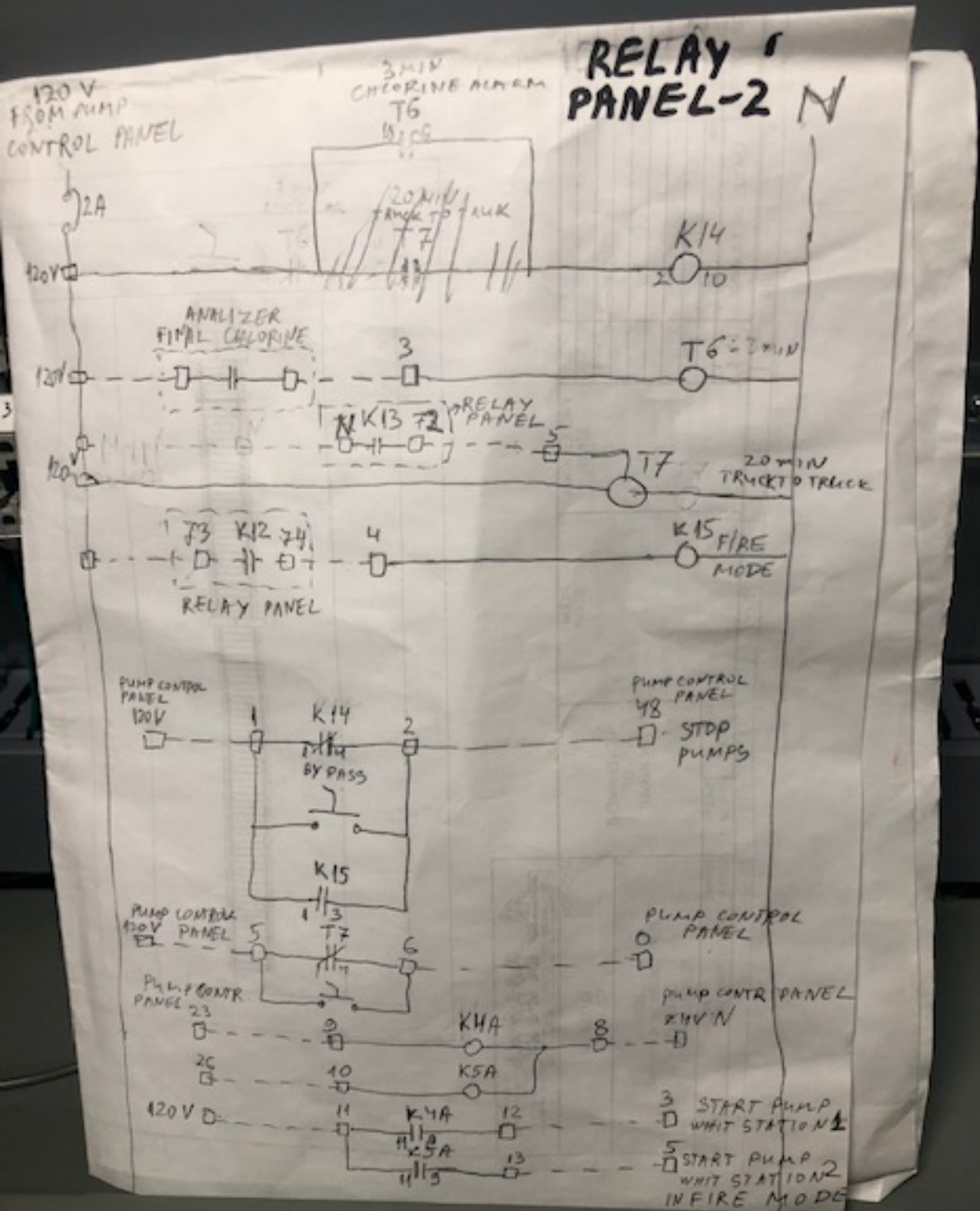
T6
120VAC

START-TO-START PUMPS 2Ø

T7
120VAC

K4A
24VAC

STOP PUMPS
ALARM
AUTO BY-PASS


RELAY PANEL-2
120 V FROM PUMP CONTROL PANEL
2A
3 MIN CHLORINE ALARM T6
20 MIN TRUCK TO TRUCK T7
K14
ANALIZER FINAL CHLORINE
3
T6 = 3 MIN
K13 T2 RELAY PANEL
T7
20 MIN TRUCK TO TRUCK
K12 T4
4
K15 FIRE MODE
RELAY PANEL
PUMP CONTROL PANEL 120V
K14
BY PASS
PUMP CONTROL PANEL 48
STOP PUMPS
K15
T7
KHA
K5A
START PUMP WHIT STATION 1
START PUMP WHIT STATION 2 IN FIRE MODE

2.4.2 Electrical plans

Plan E1

Plan E2

Plan E3

Plan E4

Plan E5

Plan E6

ELECTRICAL SCOPE OF WORK

ALL WORK SHALL BE CARRIED OUT IN ACCORDANCE WITH:

A) ELECTRICAL DRAWINGS 13-072 E1 THROUGH E6, NOTES AND SPECIFICATIONS
B) ALL APPLICABLE CODES, BYLAWS AND BEST-RECOMMENDED PRACTICES

FOR THE PURPOSES OF THIS PROJECT, 'PROVIDE' SHALL MEAN TO SUPPLY AND INSTALL.

FOR THE PURPOSES OF THIS PROJECT, 'DEMOLISH' SHALL MEAN MATERIALS AND EQUIPMENT ARE TO BE REMOVE THEIR INSTALLED LOCATION AND DISPOSED OF, UNLESS MATERIAL IS RECYCLABLE, IN WHICH CASE IT SHALL BE IN FERROUS AND NON-FERROUS CONTAINERS SUPPLIED BY CONTRACTOR. THE REMAINDER SHALL BE CONS GARBAGE. CONTRACTOR SHALL BE RESPONSIBLE FOR DISPOSAL OF GARBAGE IN ACCORDANCE WITH STANDARDS AND REGULATIONS, AND PROVIDE HIS OWN WASTE REMOVAL SERVICES

WHERE MATERIALS AND EQUIPMENT ARE IDENTIFIED AS 'SALVAGE', THEY SHALL BE REMOVED FROM THEIR INS LOCATION WITHOUT DAMAGE AND HANDED TO THE OWNER AT THE DESIGNATED DROP LOCATION WITHIN THE FACIL

MAKE PRIOR ARRANGEMENTS AND CAREFULLY PLAN THE DISCONNECTING AND SHUT-DOWN OF ANY EQUIPMEI OWNERS FACILITIES DEPARTMENT. GIVE MINIMUM 48 HOURS NOTICE OF ANY SHUT-DOWN.

IT IS THE RESPONSIBILITY OF THIS CONTRACTOR TO CAREFULLY COORDINATE HIS WORK WITH THAT OF OWNER'S FOR THE BEST SUCCESS OF THIS PROJECT.

CONTRACTOR TO:

A. VERIFY EQUIPMENT ROUTING.
B. VERIFY ALL DIMENSIONS PRIOR TO EQUIPMENT PURCHASE.
C. VERIFY ALL LIGHTING VOLTAGE PRIOR TO EQUIPMENT PURCHASE.
D. PROTECT BUILDING STRUCTURE FROM DAMAGE.
E. ENSURE ADJACENT AREAS ARE NOT AFFECTED BY ANY WORK ON THIS PROJECT.
F. RETURN ALL RECYCLABLE MATERIALS (COPPER, METAL, BUILDING WIRE, ETC) TO OWNER.
G. PROVIDE SEISMIC RESTRAINTS PER SPECIFICATION. PROVIDE STRUCTURAL DESIGN AND SHOP DR/ STAMPED BY STRUCTURAL ENGINEER.
H. SUBMIT FOUR (4) HARD COPIES OF EQUIPMENT SHOP DRAWINGS OR ELECTRONIC COPIES OF SHOP DR FOR APPROVAL BY THE ENGINEER PRIOR TO COMMENCING ANY WORK OR ORDERING OF ANY EQUIPMENT.
I. OBTAIN RELATED PERMITS TO CARRY OUT THE WORK OF THIS PROJECT.

THE NUMBERS INSIDE HEXAGONS SHOWN ON THE PLANS REFER TO THE NUMBERED POINTS BELOW. NOT ALL ARE SHOWN ON THE PLANS.

1. CONTRACTOR TO COORDINATE UPGRADE OF THE HIGH VOLTAGE LINE TO THE PUMPING STATION WITH ENERGY CORPORATION (LOCAL POWER UTILITY), INCLUDING:
   A. UPGRADING THE FEEDER TO 3 PHASE,
   B. RELOCATION OR MODIFICATION OF THE END OF THE LINE DUE TO CONSTRUCTION OF THE NEW PUMPING S AND/OR ACCESS ROAD,
   C. ENSURING TEMPORARY POWER TO THE EXISTING PUMPING STATION DURING THE CONSTRUCTION OF TI PUMPING STATION, AND
   D. REPLACEMENT OF THE SINGLE PHASE 25 KVA TRANSFORMER WITH 3x 25 KVA TRANSFORMERS.
2. PROVIDE BURIED CABLE AND CONDUIT BETWEEN EXISTING POWER POLE AND NEW TRUCK FILL STATIC BETWEEN NEW TRUCK FILL STATION AND OLD TRUCK FILL STATION; SIZED ACCORDING TO SINGLE LINE DIAGRA
3. PROVIDE MAIN 250A CIRCUIT BREAKER, CURRENT TRANSFORMER CABINET AND 13JAW REVENUE METER BASE.
4. PROVIDE MAIN PANELBOARD P-1 TO BE 120/208V/3PH/60CCT/400AF SURFACE MOUNT WITH 250A MAIN BREAKER. PROVIDE SUBPANEL P-2 TO BE 120/208V/3PH/30CCT/100AF SURFACE MOUNT TO BE PROTECTED BY 100A/3PH BREAKER IN PANEL P-1. PROVIDE TWO 120V/15A CIRCUIT BREAKERS IN PANEL P-2 AS SPARES.
5. PROVIDE GENSET FOR BACKUP EMERGENCY POWER. INCLUDED ARE GENSET CONTROLLER AND GENSET LOAD CENTRE. PROVIDE 260A-RATED AUTOMATIC TRANSFER SWITCH (ATS) TO SWITCH BETWEEN NORMAL GRID AND EMERGENCY BACKUP POWER. PROVIDE 208V/3P/30A CIRCUIT BREAKER IN PANEL P-2 FOR GENSET LOAD CENTRE.
6. PROVIDE WALL-MOUNTED THERMOSTAT (TS-1) TO CONTROL GENERATOR VENTILATION DAMPERS. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 AND PROVIDE WIRING TO DAMPER MOTORS.
7. PROVIDE COMBINATION BATTERY PACK/ PICTOGRAM EXIT SIGN/ DUAL-HEAD EMERGENCY LIGHT PACKS TO BE MOUNTED ABOVE DOORWAYS WHERE INDICATED. EMERGENCY LIGHTING CIRCUIT TO BE ON SAME CIRCUIT AS INTERIOR LIGHTING CIRCUIT ON PANEL P-2. PROVIDE 120V/15A DUPLEX RECEPTACLE ABOVE DOORWAY NEXT TO EACH COMBO PACK.
8. PROVIDE INTERIOR LIGHTING WHERE INDICATED. 'A' LUMINAIRES ARE TO BE SUSPENDED BY CHAINS AT 3m AFF. PROVIDE WALL-MOUNTED SWITCHES WHERE INDICATED. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 FOR INTERIOR LIGHTING.
9. PROVIDE EXTERIOR LIGHTING WHERE INDICATED. DESIGNATED 'B' LUMINAIRE ARE TO BE MOUNTED ADJACENT TO DOORWAY ENTRY AT TOP OF STAIRS. DESIGNATED 'C' LUMINAIRES ARE TO BE MOUNTED AT 4m AGL. OUTDOOR LIGHTS TO BE CONTROLLED BY COMBINATION OF PHOTOCELL AND TIMER. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 FOR EXTERIOR LIGHTING.
10. PROVIDE CONVENIENCE RECEPTACLES WHERE INDICATED, TO BE WALL-MOUNTED STANDARD 300mm AFF. PROVIDE TWO 120V/15A CIRCUIT BREAKERS IN PANEL P-2 FOR THE RECEPTACLE CIRCUITS. RECEPTACLES WITHIN 1.5m OF WATER ZONES TO BE GFCI PROTECTED.
11. PROVIDE DIRECT ELECTRICAL CONNECTION TO CEILING EXHAUST FAN (EF). EF TO BE CONNECTED TO SAME CIRCUIT AS INTERNAL LIGHTING AND ALWAYS POWERED 'ON'.
12. PROVIDE DIRECT ELECTRICAL CONNECTION TO BACKUP UNIT HEATERS UH-1 – 5; EACH UNIT TO BE PROTECTED BY ITS OWN 208V/3P/15A CIRCUIT BREAKER IN PANEL P-1. UNITS TO BE INDIVIDUALLY CONTROLLED BY INTERNAL THERMOSTATS, SET TO 5°C LOWER THAN FURNACE THERMOSTAT. EACH UNIT SPECIFIED TO HAVE INTEGRAL DISCONNECT SWITCHES. PROVIDE WALL-MOUNT BRACKETS AND MOUNT UNIT'S BELOW MAXIMUM HEIGHT OF 8'.
13. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 FOR OIL-FIRED FURNACE. PROVIDE WALL SWITCH IN GENERATOR ROOM BETWEEN EXIT DOORWAY AND FURNACE UNIT, SEPARATE FROM ANY OTHER CONTROLS, AND LABELED AS "FURNACE SHUTOFF".
14. PROVIDE 120V/1P/15A CIRCUIT BREAKER IN PANEL P-2 FOR DUPLEX OIL PUMP CONTROLLER (DPC) IN GENERATOR ROOM. PROVIDE DIRECT ELECTRICAL CONNECTION TO DPC, TO BE SPECIFIED AS HAVING INCLUDED DISCONNECT SWITCH.
15. PROVIDE 120V/25A CIRCUIT BREAKER IN PANEL P-2 FOR DOMESTIC WATER PUMP (DWP). PROVIDE DIRECT ELECTRICAL CONNECTION TO DWP.
16. PROVIDE 208V/3P/15A CIRCUIT BREAKER IN PANEL P-1 FOR DOMESTIC HOT WATER TANK (DHWT). PROVIDE DIRECT ELECTRICAL CONNECTION TO DHWT WHERE INDICATED.
17. PROVIDE TWO 120V/15A CIRCUIT BREAKERS IN PANEL P-2 FOR TWO PUMPS (SP-1, & P-1). PROVIDE DEDICATED WALL-MOUNTED 120V GFCI-PROTECTED DUPLEX OUTLETS AT EACH PUMP LOCATION.
18. PROVIDE 120V/20A CIRCUIT BREAKER IN PANEL P-2 AND DEDICATED CSA CONFIGURATION 5-20R RECEPTACLE FOR CHLORINE MIXING SYSTEM (CMS) SKID. A BACKUP UNIT IS TO BE PROVIDED BUT ONLY ONE POWERED AT A TIME.
19. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 FOR DIRECT ELECTRICAL CONNECTION TO CHLORINE DOSING PUMP (CDP) SKIDS. SKID INCLUDES QUAD RECEPTACLE FOR CONNECTION TO DOSING PUMPS AND CHLORINATION CONTROLLER PANELS (CCP).
20. PROVIDE TWO 208V/2P/30A CIRCUIT BREAKERS IN PANEL P-1 FOR HEAT TRACE CONTROLLERS (HTC-1 - 2). PROVIDE DEDICATED ELECTRICAL CONNECTION TO EACH HTC. EACH WATER INTAKE PIPE TO ALSO INCLUDE A THERMAL SENSOR KIT C/W 3 TEMPERATURE PROBES FOR CONTROL AND PROTECTION.
21. PROVIDE TWO 208V/3/80A TIME DELAY CIRCUIT BREAKERS IN PANEL P-1 FOR SUBMERSIBLE WATER PUMPS (WP-1 AND WP-2). PROVIDE DIRECT ELECTRICAL CONNECTION TO EACH PUMP. PUMPS ARE TO BE CONTROLLED BY PUMP SEQUENCER UNIT, LOCATED AS SHOWN.
22. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL P-2 FOR ALARM CONTROL PANEL. PROVIDE 120V/15A DUPLEX RECEPTACLE FOR CONNECTION TO INCLUDED AC ADAPTER.
23. PROVIDE WALL-MOUNTED TELEPHONE JACK FOR CONNECTION TO AUTODIALER OF ALARM REPORTING UNIT. WIRE PHONE JACK BACK TO TELEPHONE DEMARCATION POINT OF BUILDING.
24. PROVIDE AMBER STROBE WARNING LIGHT TO BE MOUNTED EXTERIOR ABOVE LEVEL OF OUTDOOR LUMINAIRE 'B' AT FRONT CORNER OF BUILDING AS SHOWN. UNIT WILL FLASH IF ALARM CONTROLLER DETECTS ANY ALARM CONDITION.
25. PROVIDE EXTERIOR RATED WARNING LIGHT TO INDICATE WASTE WATER STORAGE TANK IS FULL.
26. PROVIDE CEILING-MOUNTED HEAT-DETECTORS IN EACH ROOM AS SHOWN. PUMP ROOM AND CHEMICAL MIXING ROOM ARE TO HAVE FIXED TEMPERATURE 135F UNITS AND GENERATOR ROOM IS TO HAVE FIXED TEMPERATURE 200F UNIT. PROVIDE LOW-VOLTAGE CABLES FOR CONNECTION BACK TO ALARM PANELBOARD.
27. PROVIDE WALL-MOUNTED THERMOSTAT TS-2 FOR LOW-TEMPERATURE ALARM AT LOCATION SHOWN. PROVIDE LOW-VOLTAGE WIRING TO ALARM PANELBOARD.
28. PROVIDE WEATHERPROOF CONTROL BOXES TO BE MOUNTED AT TRUCK TOP HEIGHT. PROVIDE STOP AND START PUSHBUTTONS, IN-USE INDICATOR LIGHTS, FIRE PUSHBUTTON AND FIRE STROBE LIGHT AND LINE-VOLTAGE CONNECTIONS BACK TO PUMP CONTROL PANELBOARD.
29. PROVIDE ALL NECESSARY CONTROL DEVICES AS DESCRIBED IN E5-1 SCHEMATIC (LOW-VOLTAGE TRANSFORMER, RELAYS, PUSHBUTTONS, SWITCHES, MOTORIZED VALVES, INDICATOR LIGHTS) AND CONNECTIONS BETWEEN DEVICES, ALARM REPORTING UNIT, EXPANDER & POWER SUPPLY AND PUMP CONTROL PANEL.
30. ONCE NEW TRUCK FILL STATION HAS BEEN COMMISSIONED, DEMOLISH ALL ELECTRICAL EQUIPMENT, WIRING AND CONDUIT IN OLD FILL STATION BUILDING.
31. PROVIDE NEW PANELBOARD PA-1 IN OLD PUMP STATION TO BE 120/208V/3PH/24CCT/60AF SURFACE-MOUNT. PROVIDE BURIED CONNECTION BACK TO PANEL P-1 AND PROVIDE 208V/3P/60A BREAKER IN PANEL P-1. PROVIDE TWO 120V/15A CIRCUIT BREAKERS IN PANEL PA-1 AS SPARES.
32. PROVIDE INTERIOR LIGHTING OF LUMINAIRE TYPE 'A', TO BE CHAIN-SUSPENDED FROM CEILING AT 3m AFF. PROVIDE WALL-MOUNTED LIGHT SWITCHES WHERE INDICATED. PROVIDE 120V/15A CIRCUIT BREAKER IN PANEL PA-1 FOR INTERIOR LIGHTING.
33. PROVIDE COMBINATION BATTERY PACK/ PICTOGRAM EXIT SIGN, DUAL-HEAD EMERGENCY LIGHTS TO BE MOUNTED DIRECTLY ABOVE DOORWAYS. POWER TO BE ON SAME CIRCUIT AS INTERIOR LIGHTING. PROVIDE DUPLEX 120V RECEPTACLES TO BE WALL-MOUNTED NEXT TO EACH COMBO UNIT.
34. PROVIDE WALL-MOUNTED CONVENIENCE RECEPTACLES WHERE INDICATED, TO BE WALL-MOUNTED AT 300mm AFF. PROVIDE TWO 120V/15A CIRCUIT BREAKERS IN PANEL P-2 TO POWER RECEPTACLES IN EACH ROOM.
35. PROVIDE INTERNET CONNECTION, WALL JACK AND REQUIRED ETHERNET CABLING FOR DATA RECORDER.
36. TRACE ALL CIRCUITS OF PANELBOARDS RELATED TO THIS PROJECT AND PROVIDE NEATLY TYPED, UPDATED CIRCUIT DIRECTORIES IN A PLASTIC HOLDER ON THE INSIDE DOORS OF ALL PANELBOARDS, WITH COPY IN MANUAL.
37. IDENTIFY AND LABEL EACH DEDICATED RECEPTACLE FOR ITS INTENDED USE ONLY.
38. IDENTIFY ALL PULL BOXES, JUNCTION BOXES, FIXTURES, CONTROL PANELS, MOTOR STARTERS, AND DISCONNECT SWITCHES WITH PERMANENT MARKER IDENTIFICATION INDICATING PANEL AND CIRCUIT NUMBERS.
39. CLEAN AREA OF ANY DEBRIS CREATED DURING DEMOLITION WORK.
40. AFTER CONSTRUCTION COMPLETION, MARK UP DRAWINGS INDICATING ANY AND ALL DEVIATIONS FROM THE DRAWINGS AND PROVIDE TWO COPIES TO OWNER.

ELECTRICAL SYMBOL LEGEND

SYMBOL	DESCRIPTION
A	TYPE 'A' LIGHT FIXTURE ROUGH SERVICE CEILING/SUSPEND MOUNT 79W, 5725lm, 4100K, CRI65, ASYMMETRIC BEAM, MVOLT DRIVER
B	TYPE 'B' LIGHT FIXTURE EXTERIOR WALL-PACK 19W, 1017lm, 5000K, 120V, PHOTOELECTRIC CELL, DARK BRONZE FINISH
C	TYPE 'C' LIGHT FIXTURE EXTERIOR WALL-PACK 45W, 3149lm, 5000K, 120V, PHOTOELECTRIC CELL, DARK BRONZE FINISH
STROBE	PENDANT-MOUNT STROBE WARNING LIGHT, WEATHERPROOF 12W, 2Mcp, 60fl/min, 90-130VAC, 3/4" CONDUIT ENTRY, AMBER LENS
	COMBO ALUMINUM 6V 36W CAPACITY BATTERY UNIT W/ 2x PAR18 4W LED HEADS, LED BACKLIT PICTOGRAM SIGN, 120/347VAC INPUT
$	SINGLE POLE WALL-MOUNT SWITCH
	WALL-MOUNT DUPLEX RECEPTACLE CSA CONFIGURATION 5-15R
	WALL-MOUNT DUPLEX RECEPTACLE CSA CONFIGURATION 5-15R ON DEDICATED CIRCUIT
	WALL-MOUNT DUPLEX RECEPTACLE WITH INTEGRAL GFCI PROTECTION
	WALL-MOUNT DUPLEX RECEPTACLE WITH INTEGRAL GFCI ON DEDICATED CIRCUIT
	WALL-MOUNT QUAD RECEPTACLE CSA CONFIGURATION 5-15R
	WALL-MOUNT SPECIAL PURPOSE DIRECT CONNECTION TO EQUIPMENT VOLTAGE, NUMBER OF PHASES AND CIRCUIT BREAKER AMPERAGE AS STATED
	TELEPHONE JACK WALL-MOUNT
	DATA JACK WALL-MOUNT
	ELECTRICAL DISTRIBUTION PANEL
	ELECTRICAL POWER PANEL
	ELECTRICAL PANEL, LOW-VOLTAGE OR SPECIAL-PURPOSE
WH	WATT-HOUR REVENUE METER
G	EMERGENCY DIESEL ENGINE-GENERATOR SET 208V 3ϕ 60Hz 80kW 100kVA 278A
	AUTOMATIC TRANSFER SWITCH SOLID NEUTRAL, 3-POLE, 3ϕ, 260A, 208V, C/W WINDOW KIT
UF	UNFUSED DISCONNECT SWITCH
	MOTOR, SINGLE-PHASE
	MOTOR, THREE-PHASE
EF	EXHAUST FAN CEILING-MOUNTED
	HEAT DETECTOR CEILING-MOUNTED
T	THERMOSTAT, WALL-MOUNT
FS	FLOW SWITCH
	LEVEL SWITCH
	MOTORIZED VALVE
DP	DIFFERENTIAL PRESSURE METER
	FLOW METER
M	MOTORIZED DAMPER
M	MOTORIZED DAMPER PARALLEL BLADE
	HEAT TRACE CABLE
HTC	HEAT TRACE CONTROLLER
	UNIT HEATERS UH-1--5

EQUIPMENT LIST: IGLOOLIK

1. MB, MAIN BREAKER, 250 AMPS, 250V, 3 POLE BREAKER IN A NEMA 4 ENCLOSURE, IR PER SPEC
2. G, EMERGENCY GENERATOR, DIESEL ENGINE-GENERATOR, STANDBY, AIR CHARGED-AIR COOLED, 3 PHASE, 120/208 V, 80KW, 100 KVA, C/W MAIN BREAKER, LOAD CENTRE AND GFI RECEPTACLE, COMPLETE WITH AN INTEGRATED CONTROLLER, BATTERY CHARGER AND STARTING BATTERIES, BLOCK HEATER AND FIRE ALARM CAPABLE CONTROL PANEL WITH TROUBLESHOOTING AND MAINTENANCE ASSISTANCE CAPABILITIES. MONITORING THE FOLLOWING: VOLTAGES, FREQUENCY, CURRENTS, KILOWATTS AND THE FOLLOWING ALARMS AND FAULTS: LOW OIL PRESSURE, LOW OIL LEVEL, LOW COOLANT LEVEL, HIGH ENGINE TEMPERATURE, NO START UP, ENGINE OVER-SPEED, MIN./MAX. ALTERNATOR VOLTAGE, MIN./MAX. BATTERY VOLTAGE AND EMERGENCY STOP AND THE FOLLOWING ENGINE PARAMETERS: HOURS COUNTER, OIL PRESSURE, COOLANT TEMPERATURE, ENGINE SPEED, BATTERY VOLTAGE, BATTERY CHARGING AMPS, ROOM TEMPERATURE AND STATUS OF COOLANT HEATER (CURRENT)..
3. ATS, AUTOMATIC TRANSFER SWITCH, SOLID NEUTRAL, 3 POLE, 3 PHASE, 120/208 V, 260 AMPS, C/W WINDOW KIT, ASCO CAT. NUMBER: 300 3 260 C 1 C 123 120/208V, 60 HZ, OR EQUIVALENT, IR PER SPEC, MONITORING THE FOLLOWING: A.T.S. POSITION, VOLTAGES, FREQUENCY AND CURRENTS, KILOWATTS, ATS TROUBLE.
4. P1, PANEL BOARD, 120/208V, 3 PHASE, 4 WIRE, 400 AMP FRAME, SURFACE MOUNT, 60 CIRCUITS, NEMA 4 ENCLOSURE. C/W 250A/3P MAIN BREAKER AND THE FOLLOWING LOAD BREAKERS: 100A/3P, 2X 100A/3P TIME DELAY, 60A/3P, 2X 30A/2P, 7X 15A/3P. IRS PER SPEC.
5. P2, PANEL BOARD, 120/208V, 3 PHASE, 4 WIRE, 100 AMP FRAME, 30 CIRCUITS, SURFACE MOUNT, NEMA 4 ENCLOSURE. C/W THE FOLLOWING LOAD BREAKERS: 30A/2P, 25A/1P, 20A/1P AND 13X 15A/1P. IRS PER SPEC
6. PA-1, PANEL BOARD, 120/208V, 3 PHASE, 4 WIRE, 60 AMP FRAME, 24 CIRCUITS, SURFACE MOUNT, NEMA 4 ENCLOSURE. C/W THE FOLLOWING LOAD BREAKERS: 4X 15A/1P. IRS PER SPEC
7. UH-1 TO 5, 4kW 208V 3PHASE UNIT HEATER, C/W INTERNAL THERMOSTAT AND 40A DISCONNECT SWITCH. CHROMOLOX MODEL NUMBER: LUH-04-83-34-40-1. C/W WALL-MOUNT BRACKET MODEL NUMBER: WUH-01A
8. LIGHT 'A': SUSPEND MOUNT LED ROUGH SERVICE FIXTURE, LITHONIA LIGHTING MODEL NUMBER: VAP 79LED ASY, C/W 8' CHAIN MOUNT BRACKET MODEL: VAPCMB MSI8
9. LIGHT 'B': 19W 1017LM LED WALL LUMINAIRE C/W PHOTOCELL, LITHONIA LIGHTING MODEL NUMBER: TWS LED 1 50K 120 PE
10. LIGHT 'C': 45W 3149LM LED WALL LUMINAIRE C/W PHOTOCELL, LITHONIA LIGHTING MODEL NUMBER: TWP LED 20C 700 50K T3M 120 PE DDBXD
11. EXIT SIGNS: COMBO ALUMINUM LED PICTOGRAM EXIT SIGN, DUAL HEAD 4W PAR18 LED LIGHTS AND 36W BATTERY PACK, AIMLITE MODEL: CARPW0636 U M-2SM4LJ WHT/ATD
12. ALARM REPORTING UNIT: BARNETT ENGINEERING MODEL: B1290 PROTALK PLUS, C/W ONE EXPANDER UNIT MODEL: B1292 AND ONE BATTERY BACKUP POWER SUPPLY MODEL: OPTION 004
13. STROBE: PENDANT-MOUNT STROBE WARNING LIGHT, WEATHERPROOF, ¾" CONDUIT ENTRY, AMBER LENS. APPLIED STROBE TECHNOLOGY MODEL: AST-2-90-130-AC-AM
14. FIRE BEACON: RED, FLASHING LED, 24V AC/DC, WERMA SIGNALTECHNIK PART NUMBER: 22410075
15. HD-1 TO 2, FIXED TEMPERATURE 135F MOISTURE-PROOF HEAT DETECTOR, MIRCOM MODEL: CF-135MP
16. HD-3: FIXED TEMPERATURE 200F MOISTURE-PROOF HEAT DETECTOR, MIRCOM MODEL: CF-200MP
17. K0 TO 3: 4PDT, 120VAC COIL RELAY
18. K4 TO 5: 4PDT, 24VAC COIL RELAY
19. HTC-1 TO 2: HEAT TRACE CONTROLLER, URECON MODEL NUMBER: UTC-2030-11, WITH GROUND FAULT DETECTION CIRCUITRY, 120-240VAC, 30A, 2 POLES IN A NEMA 4 PAINTED STEEL ENCLOSURE. CONTROLS FACTORY SET @ 3°C AND HIGH LIMIT: 65°C FOR PROTECTION OF PLASTIC PIPING. EACH HTC TO CONTROL: 2 HEAT TRACE CABLES, AND 3 RTD TEMPERATURE SENSORS, PER INTAKE PIPE. FOR INSTALLATION DETAILS OF HEAT TRACE COMPONENTS SEE: SPEC 224201_13-072 REV PLUMBING SPECIALTIES AND ACCESSORIES, SECTION 2.8: INTAKE PIPES.
20. HEAT TRACE CABLES: THERMOCABLE MODEL# C13-240-COJ, 12AWG BUS WIRES WITH OUTPUT OF 9.75 W/m @ 208VAC AND MAXIMUM CIRCUIT LENGTH OF 220m. EACH INTAKE PIPE TO HAVE A REDUNDANT SET OF THREE SPARE HEAT TRACE CABLES PULLED UPON INSTALLATION.
21. 100 Ω RTD TEMPERATURE SENSOR URECON MODEL: ERTD-15-G WITH 15 m OF GREY PVC LEAD WIRE.
22. 100 Ω RTD TEMPERATURE SENSOR URECON MODEL: ERTD-15-R WITH 15 m OF RED PVC LEAD WIRE.
23. 100 Ω RTD TEMPERATURE SENSOR URECON MODEL: ERTD-30-G WITH 30 m OF GREY PVC LEAD WIRE.

PUMP STATION OVERVIEW:

MAJOR COMPONENTS:

1. PUMP SEQUENCER: ITS FUNCTION IS TO SEQUENCE THE 2 SUBMERSIBLE PUMPS (WP-1 AND WP-2), SO THAT EACH PUMP IS EXERCISED EQUALLY OVER TIME.
   IN CASE OF A PUMP FAILURE (DETERMINED BY THE RELEVANT FLOW SWITCH FS-1 OR FS-2), THE SEQUENCE SWITCHES TO THE NEXT AVAILABLE PUMP AND INITIATES AN ALARM CONDITION.
2. PUMP CONTROLLER: IT TIES ALL CONTROL DEVICES AND SENSORS TOGETHER. THE CONTROL LIGHTS INDICATE WHICH FILLING STATION IS IN USE AND WHICH PUMP IS RUNNING. IT ALSO INDICATES SOME OF THE ALARM CONDITIONS AND PROVIDES AN EMERGENCY POWER OFF AND RESET PUSHBUTTONS.
3. ALARM REPORTING UNIT: ITS FUNCTION IS TO TURN ON THE ROOFTOP STROBE AT ANY OF THE 10 ALARM CONDITIONS AND TO DIAL PRE-PROGRAMMED PHONE NUMBERS WITH A RECORDED MESSAGE WARNING OF THE ALARM CONDITION.

OPERATION:

4. DEPRESSING THE "ON" PUSHBUTTON OF FILLING STATION #1 LOCATED ON THE FILLING ARM WILL START THE CHLORINATION LOOP, CLOSE VALVE SV-1 AND OPEN MV-1. THIS OPERATION TAKES APPROX. 3 SECONDS. AFTER A 3 SECOND DELAY, THE PUMP SEQUENCER STARTS THE "NEXT" AVAILABLE PUMP. DEPRESSING THE SAME "ON" PUSHBUTTON AGAIN WILL HAVE NO IMPACT.
5. PUMPING MUST BE STOPPED BY DEPRESSING THE "OFF" PUSHBUTTON OF FILLING STATION #1. DEPRESSING THE "OFF" PUSHBUTTON WILL STOP THE CHLORINATION AND THE PUMP IT STARTED. IT ALSO CLOSES VALVE MV-1 AND OPENS VALVE SV-1 WHICH DRAINS THE OUTSIDE PORTION OF THE FILL ARM.
6. THE PROCESS IS IDENTICAL FOR FILL STATION #2 (EXCEPT IT WORKS WITH VALVES MV-2 AND SV-2).

THE CHLORINATION LOOP:

7. THE MICROCHEM2 CHLORINE CONTROLLER PACKAGE (CCP-1) IS THE CONTROLLING UNIT FOR THE PRIMARY CHLORINATION PROCESS. SINCE THE WATER FLOW IN THE MAIN 100mm WATER PIPE CAN VARY DEPENDING ON WHETHER 1 OR 2 WATER PUMPS ARE RUNNING, THE CONDITION OF THE FILTERS AND WATER LEVEL IN THE LAGOON, THE FLOW IS PRECISELY MEASURED BY THE FLOW METER (FM-1). THE CCP-1 SENDS A 4-20mA SIGNAL TO ITS CHLORINE DOSING PUMP (CDP-1) THAT IS PROPORTIONAL TO THE WATER FLOW MEASURED BY FM-1. A WATER SAMPLE IS TESTED CONTINUALLY BY CHLORINATION AND pH/TEMPERATURE PROBES CONNECTED TO CCP-1 AND CCP-1 WILL ADJUST THE AMOUNT OF CHLORINE PUMPED BY CDP-1 TO ENSURE THE REQUIRED LEVEL OF PRIMARY CHLORINATION.
8. CCP-2 IS A POST-CHLORINATION LOOP IDENTICAL TO CCP-1. ITS FUNCTION IS TO CHECK CHLORINATION LEVEL OF WATER DELIVERED TO TRUCKS AND ADD CHLORINE IF REQUIRED. THE FLOW IS PRECISELY MEASURED BY THE FLOW METER (FM-2). THE CCP-2 SENDS A 4-20mA SIGNAL TO ITS CHLORINE DOSING PUMP (CDP-2) THAT IS PROPORTIONAL TO THE WATER FLOW MEASURED BY FM-2. A WATER SAMPLE IS TESTED CONTINUALLY BY CHLORINATION AND pH/TEMPERATURE PROBES CONNECTED TO CCP-2 AND CCP-2 WILL ADJUST THE AMOUNT OF CHLORINE PUMPED BY CDP-2 TO ENSURE THE REQUIRED LEVEL OF POST-CHLORINATION.
9. THE INFORMATION GATHERED BY CCP-1 AND CCP-2 (WATER DELIVERY, CHLORINATION AND pH LEVELS, TEMPERATURE) CAN BE STORED IN THE DATA RECORDER AND ACCESSED THROUGH A USB PORT OR REMOTELY THROUGH AN IP ADDRESS.
10. ONLY ONE OF THE CDP SUBCOMPONENT DOSING PUMPS (CP-1 OR CP-2) IS "ON". THE SECOND PUMP IS A BACKUP IN CASE THAT THE ACTIVE PUMP HAS FAILED. THIS MUST BE SWITCHED MANUALLY. THE CDP DOSING PUMP SKID ALSO CONTAINS CALIBRATION AND CLEANING ACCESSORIES.
11. THE CHLORINE SOLUTION FOR THE DOSING PUMPS IS PREPARED BY AN "MC4-50" CHLORINE MIXING SYSTEM (CMS). HERE AGAIN THE SECOND SYSTEM IS A BACKUP IF THE ACTIVE ONE FAILS. IT IS RECOMMENDED TO KEEP THE BACKUP SYSTEM DRY & CLEAN AND ONLY ACTIVATE IT UNTIL IT IS REQUIRED.

SYSTEM FAILURES AND ALARMS:

12. THE ALARMS ARE LISTED IN THE ALARM REPORTING TABLE. THERE ARE 10 ALARMS CONNECTED TO THE ALARM REPORTING UNIT. IT ALSO CAN ACCOMMODATE ANOTHER 6 ALARM INPUTS IN THE FUTURE IF REQUIRED.
13. SOME OF THE ALARM LEVELS ARE SETTABLE: A). - THE LOW TEMPERATURE ALARM ON THERMOSTAT TS-1 LOCATED IN THE MAIN PUMPING ROOM, AND B).- PRESSURE DROPS ACROSS THE WATER FILTERS MEASURED BY DP-1. DP-1 HAS TWO ADJUSTABLE ALARM SETTINGS: HIGH (H) - WHEN ONE TRUCK IS BEING FILLED (ONE WATER PUMP IS RUNNING), AND HIGH/HIGH (H/H) WHEN TWO TRUCKS ARE BEING FILLED (TWO WATER PUMPS ARE RUNNING). THE SETTINGS OF DP-1 WILL NEED TO BE ESTABLISHED BY EXPERIENCE. HOWEVER, THE PRESSURE SHOULD NOT EXCEED 15LB ACROSS THE FILTER BANK WHEN TWO PUMPS ARE RUNNING (H/H). THE HIGHER THE ALLOWED PRESSURE DROP ACROSS THE FILTERS, OVER TIME IT WILL TAKE LONGER TO FILL THE TRUCKS AS THE FILTERS CATCH MORE SEDIMENT, BUT THE FILTERS WILL NEED TO BE CLEANED LESS FREQUENTLY.

Arktis piusitippaa

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MECH. PROJECT No: 13–072

NO.	DATE: (dd/mm/yy)	BY:	DESCRIPTION:
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5	28/03/16	B.P.	REISSUED FOR TENDER
4	14/04/14	B.P.	REISSUED FOR TENDER
3	13/02/14	B.P.	ISSUED FOR TENDER
2	15/01/14	B.P.	ISSUED FOR 99% REVIEW
1	25/11/13	B.P.	ISSUED FOR 50% REVIEW

STAMP

REGISTERED PROFESSIONAL ENGINEER — NWT/NU — M.M. VALLET — MAR 2016

CONSULTANT: CEML
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATE: MARCH 2016

STAMP

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature _____
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

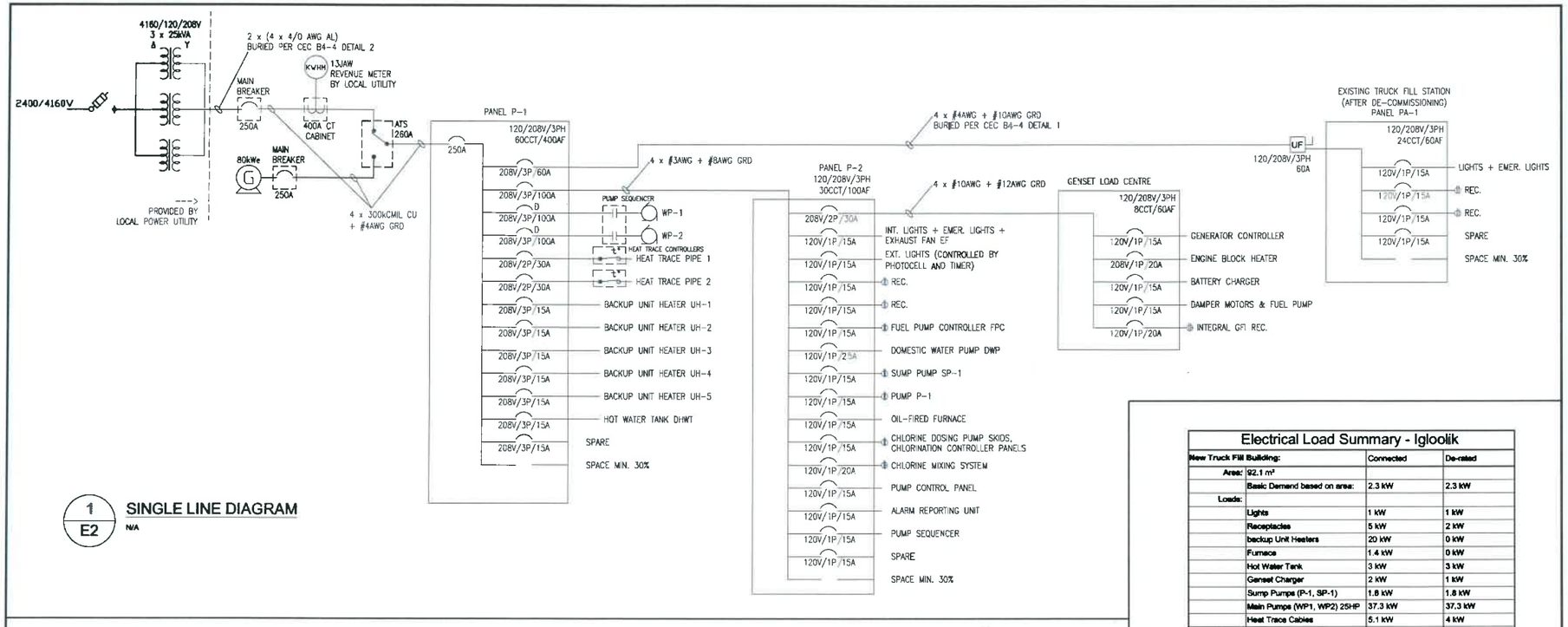
PROJECT:

IMPROVEMENT OF
WATER SUPPLY SYSTEM

DRAWING TITLE:

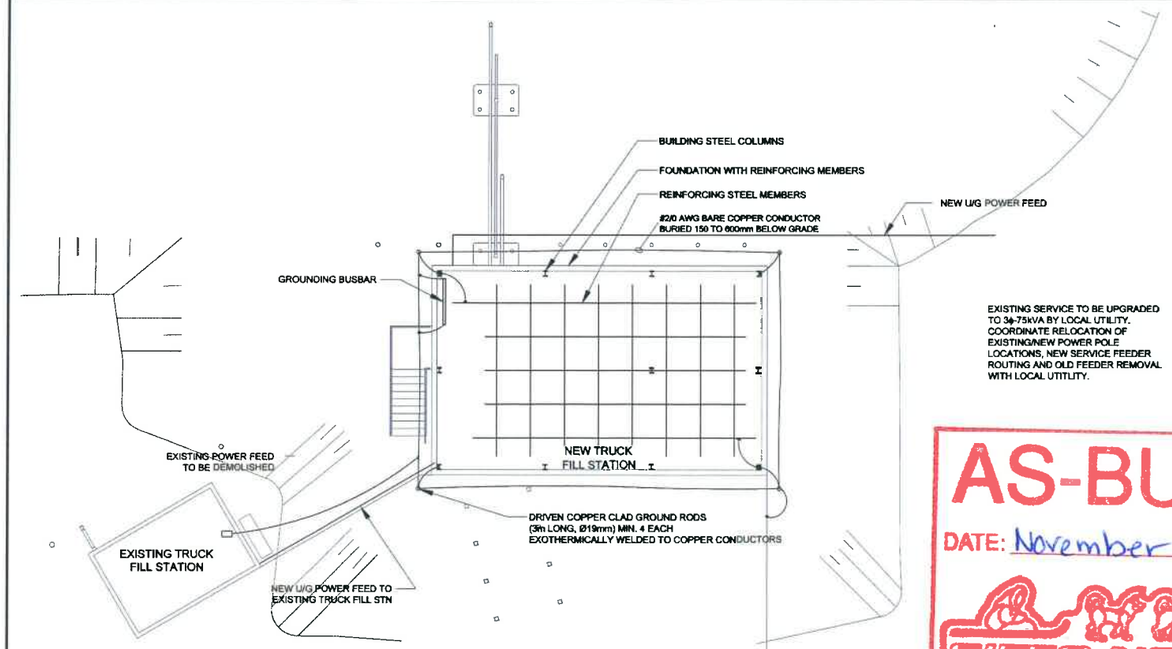
ELECTRICAL
SCOPE OF WORK, LEGEND AND
MAJOR EQUIPMENT SCHEDULE

MECH. FILE NAME:	DWG. NO:	OF:	SCALE:
13-072 E	E1	6	AS NOTED



1 / E2 **SINGLE LINE DIAGRAM**

N/A



2 / E2 **SITE PLAN - POWER DISTRIBUTION & GROUNDING SCHEME**

N/A

AS-BUILT
DATE: November 5, 2018
CIMC NORTH

Electrical Load Summary - Igloolik

		Connected	De-rated
New Truck Fill Building:			
Area:	**92.1 m²**		
	Basic Demand based on area:	**2.3 kW**	**2.3 kW**
Loads:			
	Lights	**1 kW**	**1 kW**
	Receptacles	**5 kW**	**2 kW**
	backup Unit Heaters	**20 kW**	**0 kW**
	Furnace	**1.4 kW**	**0 kW**
	Hot Water Tank	**3 kW**	**3 kW**
	Genset Charger	**2 kW**	**1 kW**
	Sump Pumps (P-1, SP-1)	**1.8 kW**	**1.8 kW**
	Main Pumps (WP1, WP2) 25HP	**37.3 kW**	**37.3 kW**
	Heat Trace Cables	**5.1 kW**	**4 kW**
	Domestic Water Pump (DWP)	**0.9 kW**	**0.9 kW**
Existing Truck Fill Building:			
Area:	**26.7 m²**		
	Basic Demand based on area:	**0.7 kW**	**0.7 kW**
Loads:	**Lights**	**0.3 kW**	**0.3 kW**
	Receptacles	**0 kW**	**0 kW**
	TOTAL Connected Load:	**80.8 kW**	
	TOTAL De-rated Load:		**54.4 kW**
	Minimum Service (at 125%)	**68 kVA**	**189 A**
	Required Service	**75 kVA fused at**	**250 A**

GROUNDING NOTES:

1. PERFORM COMPLETE INSTALLATION AND EQUIPMENT IN STRICT ACCORDANCE TO THE STRINGENT MOST REQUIREMENTS OF A) CSA C22.1-12 - 22ND EDITION OF THE CANADIAN ELECTRICAL CODE 2012 B) GN/CGS- PROTECTION SERVICES DIVISION-ELECTRICAL / MECHANICAL SAFETY SECTION -ELECTRICAL BULLETINS.
2. ALL GROUNDING EQUIPMENT SHALL BE CSA APPROVED. GROUNDING SHALL BE DONE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE 2012 AND INSPECTED BY ESA PRIOR TO BACKFILLING. EXCAVATION TO BE BACKFILLED AND COMPACTED TO 800 mm WITH THE BALANCE OF THE EXCAVATION TO REMAIN OPEN FOR GROUNDING INSTALLATION BY CONTRACTOR UNTIL INSPECTION IS COMPLETED.
3. PROVIDE MINIMUM FOUR DRIVEN COPPER CLAD GROUND RODS NOT LESS THAN 3 m LONG AND 19 mm IN DIAMETER, SPACED AT LEAST THE ROD LENGTH APART, LOCATED AROUND THE PERIMETER WALL OF THE BUILDING. INTERCONNECT THE GROUNDING RODS WITH NO. 2/0 AWG BARE COPPER CONDUCTOR AT A MINIMUM DEPTH OF 150 mm BELOW THE FINISHED GRADE OF THE BUILDING.
4. BOND THE REINFORCING STEEL OF THE FOUNDATION AND SLAB TO THE BURIED GROUNDING WIRES WITH AT LEAST IN 2 PLACES USING 2/0 AWG BARE COPPER CONDUCTORS.
5. BOND THE STEEL COLUMNS OF THE BUILDING TO THE BURIED GROUNDING SYSTEM AS SHOWN.
6. BOND THE EXISTING TRUCK FILL STATION AND THE CHAIN LINK FENCE TO THE NEW BURIED GROUNDING SYSTEM AS SHOWN.
7. CHECK RESISTANCE TO GROUND BEFORE ENERGIZING. TEST GROUND RESISTANCE FOR THE PROSPECTIVE FAULT CURRENT UNDER BOTH SHORT CIRCUITS AND EARTH FAULT CONDITIONS AND AT EVERY RELEVANT POINT OF THE COMPLETE INSTALLATION. PERFORM CONTINUITY TEST, INSULATION RESISTANCE TESTS AND POLARITY TEST FOR EARTH FAULT LOOP IMPEDANCE.
8. PROVIDE ADDITIONAL GROUNDING RODS IF THE MEASURED GROUNDING RESISTANCE IS HIGHER THAN 15 OHMS.
9. PROVIDE COPPER GROUND BUSBAR AT THE INCOMING ELECTRICAL SERVICE. CONNECT THE BUSBAR TO THE BURIED GROUNDING CONDUCTOR IN AT LEAST 2 PLACES AND GROUND ALL NON-CURRENT CARRYING METAL PARTS OF THE EQUIPMENT AND STRUCTURES IN THE BUILDING TO IT.

Arktis piusitippaa

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2	15/01/14	B.R.	ISSUED FOR 99% REVIEW
1	15/11/13	B.P.	ISSUED FOR 50% REVIEW

STAMP

REGISTERED PROFESSIONAL ENGINEER
M.M. MARLET
MAR 12 2016
NWT/NU

CONSULTANT: CEML
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATE: MARCH 2016

STAMP

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:

IMPROVEMENT OF
WATER SUPPLY SYSTEM

DRAWING TITLE:

SINGLE LINE DIAGRAM AND
SITE POWER DISTRIBUTION &
GROUNDING SCHEME

MECH FILE NAME	DWG NO	OF	SCALE
13-072 E	E2	6	AS NOTED

Truck Fill Station

Igloolik, NUNAVUT

PANEL P-1

120/208 VOLT, 3 PHASE, 4 WIRES

CKT. TRIP	DESCRIPTION	No BRKR.	PH	No BRKR.	DESCRIPTION	CKT. TRIP
3P-100	Water Pump - 1	1	A	2	Panel P2	3P-100
		3	B	4		
		5	C	6		
3P-100	Water Pump - 2	7	A	8	Old Station	3P-60
		9	B	10		
		11	C	12		
2P-30	Heat Trace - 1	13	A	14	Heat Trace - 2	2P-30
		15	B	16		
1P-15	Spare	17	C	18	Spare	1P-15
3P-15	Heater UH - 1	19	A	20	Heater UH - 2	3P-15
		21	B	22		
		23	C	24		
3P-15	Heater UH - 3	25	A	26	Heater UH - 4	3P-15
		27	B	28		
		29	C	30		
3P-15	Heater UH - 5	31	A	32	Hot Water	3p-15
		33	B	34		
		35	C	36		
1P-15	Spare	37	A	38	Spare	1P-15
1P-15	Spare	39	B	40	Spare	1P-15
		41	C	42		
		43	A	44		
		45	B	46		
		47	C	48		
		49	A	50		
		51	B	52		
		53	C	54		
		55	A	56		
		57	B	58		
		59	C	60		
		61	A	62		
2P-30	Spare	63	B	64		
		65	C	66		
2P-30	Spare	67	A	68		
		69	B	70		
		71	C	72		

Truck Fill Station

Igloolik, NUNAVUT

PANEL P-2

120/208 VOLT, 3 PHASE, 4 WIRES

CKT. TRIP	DESCRIPTION	No BRKR.	PH	No BRKR.	DESCRIPTION	CKT. TRIP
3P-30	Genset Panel	1	**A**	2	Light & Exit - Light & Fan	1P-15
		3	**B**	4	Exterior Light	1P-15
		5	**C**	6	Receptacle	1P-15
1P-15	Fuel Pump 1	7	**A**	8	Fuel Controller	1P-15
1P-15	Fuel Pump 2	9	**B**	10	Furnace	1P-15
1P-15	P-1	11	**C**	12	Receptacle (Gen Room)	1P-15
1P-15	SP-1	13	**A**	14	Receptacle (Chlorine Room)	1P-15
1P-15	Domestic Water Pump	15	**B**	16	Chlorine Dosing	1P-15
1P-15	Pump Control & Alarm Panel	17	**C**	18	Chlorine Mixing	1P-20
1P-15	Circulation Pump P2	19	**A**	20	Receptacle (Control Panel)	1P-20
1P-15	Circulation Pump P3	21	**B**	22	Analyzer Final	1P-15
1P-15	Sequencer	23	**C**	24	PLC	1P-15
1P-15	Receptacle Under Window	25	**A**	26	Water Pumps PS1 & PS2	2P-15
		27	**B**	28		
		29	**C**	30		
		31	**A**	32		
		33	**B**	34		
		35	**C**	36		
		37	**A**	38		
		39	**B**	40		
		41	**C**	42		

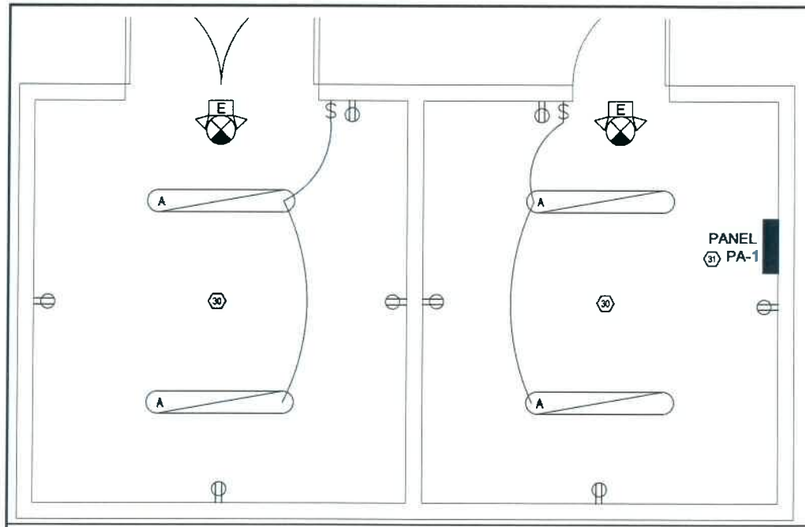
Truck Fill Station

Igloolik, NUNAVUT

Genset Load Panel

240/48 VOLT, 3 PHASE, 4 WIRES

CKT. TRIP	DESCRIPTION	No BRKR.	PH	No BRKR.	DESCRIPTION	CKT. TRIP
1P-15	Generator Dampers	1	**A**	2	Gen Run Damper	1P-15
1P-15	Receptacle Gen Panel	3	**B**	4	Battery Charger	1P-15
		5	**C**	6	Block Heater	1P-20
		7	**A**	8		
		9	**B**	10		
		11	**C**	12		
		13	**A**	14		
		15	**B**	16		
		17	**C**	18		

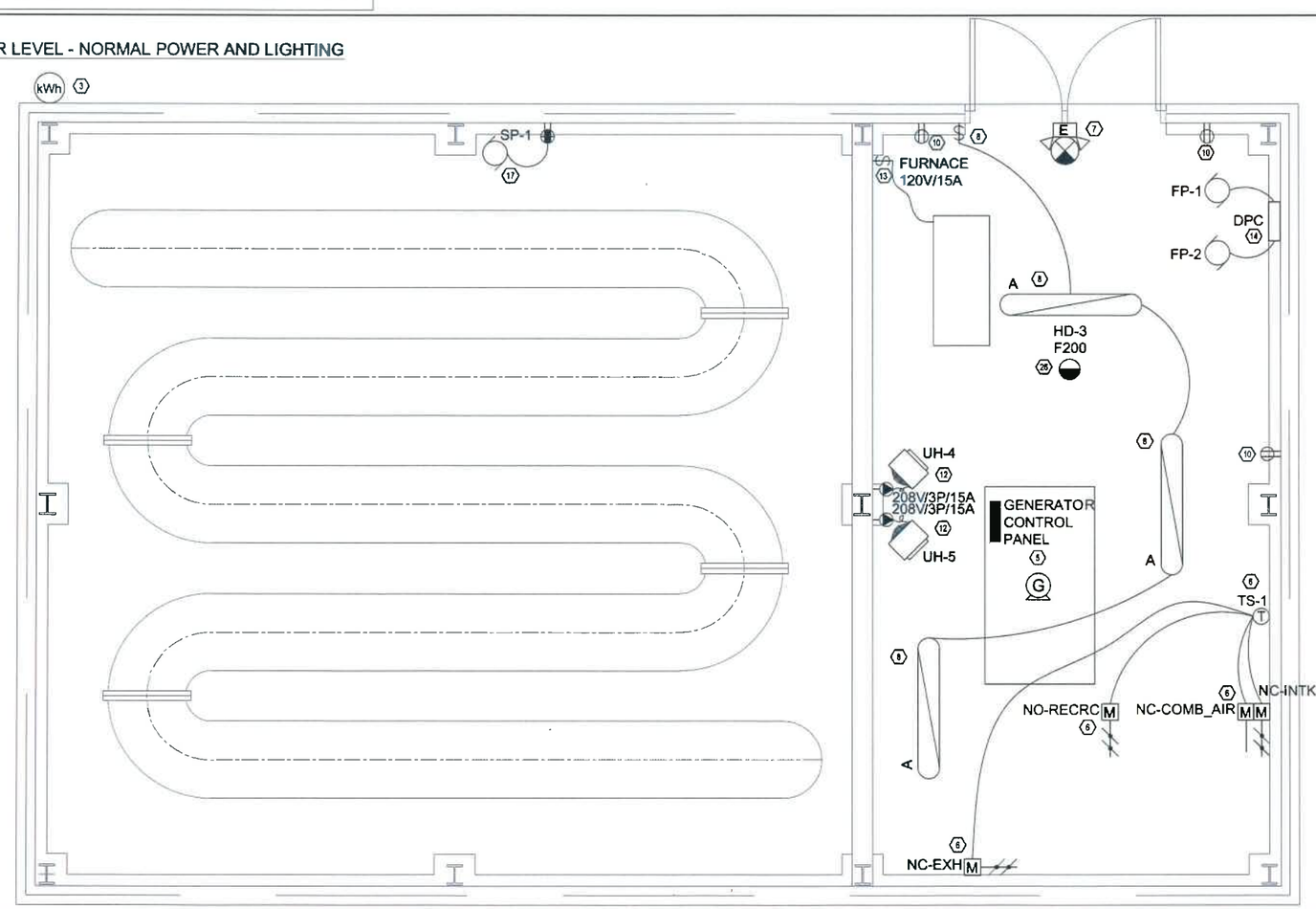


- DEMOLISH ALL EXISTING ELECTRICAL EQUIPMENT IN DECOMMISSIONED PUMP STATION.
- PROVIDE NEW PANEL PA-1 TO REPLACE OLD PANEL, AND PROVIDE NEW U/G FEED FROM NEW PUMP STATION.
- PROVIDE ONE DUPLEX CONVENIENCE RECEPTACLE AT EACH ENTRANCE AND ON EACH WALL.
- PROVIDE WALL-MOUNTED LIGHT SWITCHES AT EACH ENTRANCE AND SUFFICIENT LIGHTING FIXTURES 'A' TO PROVIDE 50LX ILLUMINATION FOR EACH ROOM.
- PROVIDE COMBINATION BATTERY PACK/ PICTOGRAM EXIT SIGN AND DUAL 4W LED EMERGENCY LIGHTS ABOVE DOORWAY TO EACH EXTERNAL DOOR.

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 march 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

2 / E3 ELECTRICAL LAYOUT - EXAMPLE DECOMMISSIONED PUMP STATION
N/A

1 / E3 ELECTRICAL LAYOUT - LOWER LEVEL - NORMAL POWER AND LIGHTING
1:25



AS-BUILT
DATE: November 5, 2018
BIG NORTH

Arktis piusitippaa

CONSULTANT NAME AND ADDRESS
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1	25/11/13	B.P.	ISSUED FOR 50% REVIEW
NO.	DATE: dd/mm/yy	BY	DESCRIPTION

STAMP
REGISTERED PROFESSIONAL ENGINEER NWT/NU MARK CHIARELLI M.M. 2016

CONSULTANT: C.E.M.L.
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATE: MARCH 2016

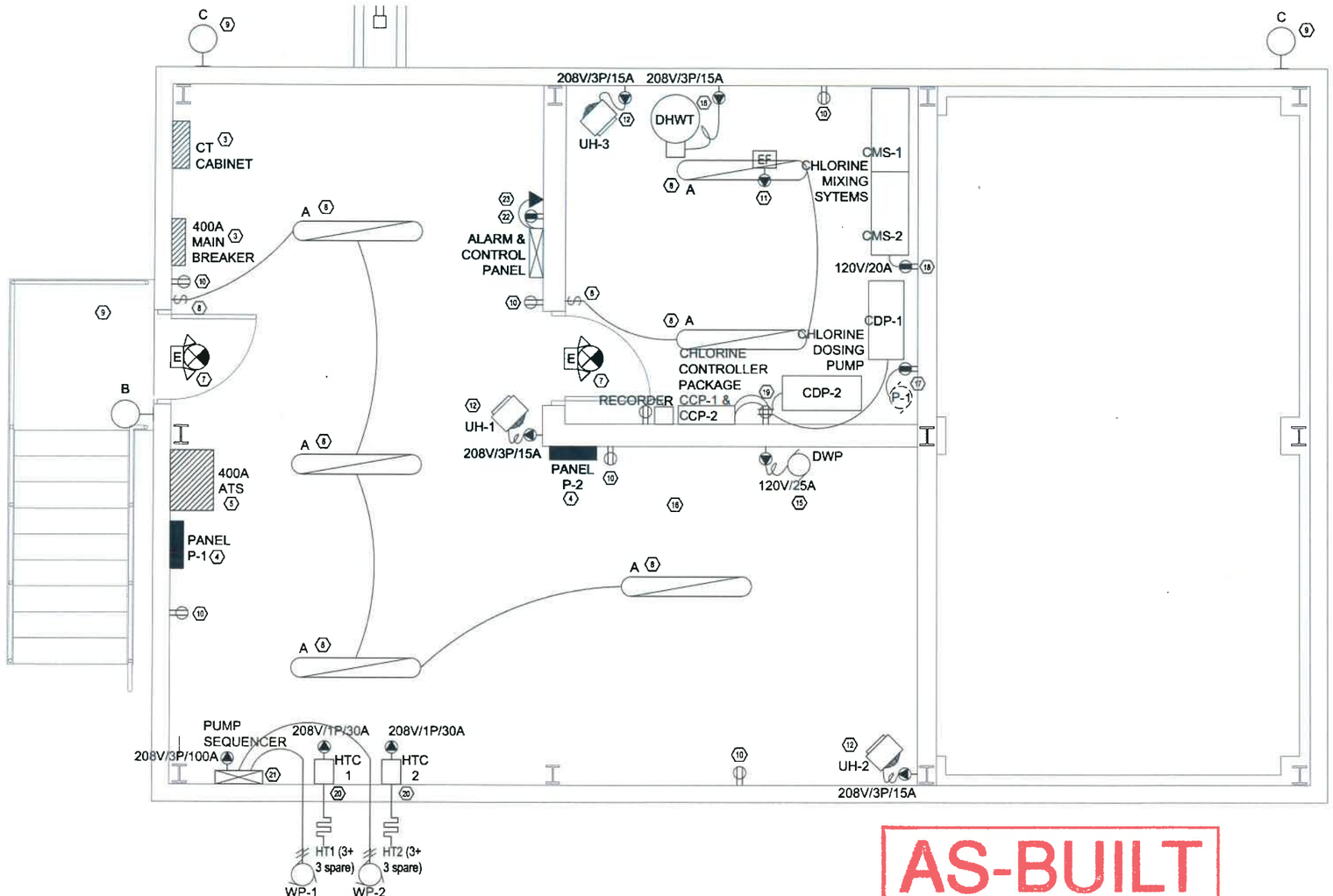
STAMP
CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATE:

LOCATION
IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:
IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE
ELECTRICAL POWER & LIGHTING LAYOUT LOWER LEVEL

MECH FILE NAME	DWG NO	QTY	SCALE
13-072 E	E3	6	AS NOTED



1/E4 ELECTRICAL LAYOUT - UPPER LEVEL - NORMAL POWER AND LIGHTING

1:25

AS-BUILT

DATE: November 5, 2018

DIEC NORTH

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

Arktis piusitippaa

CONSULTANT NAME AND ADDRESS

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STAMP

REGISTERED PROFESSIONAL ENGINEER M.M. CHIARELLI M.APR. 2016 NWT/NU

CONSULTANT: CEML
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATE: MARCH 2016

STAMP

CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATE:

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

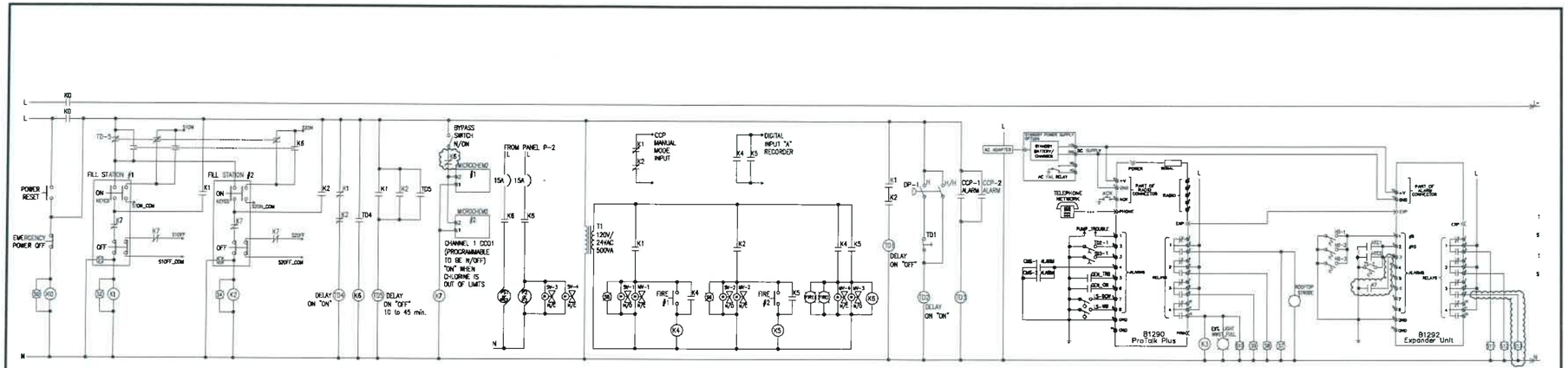
PROJECT:

IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:

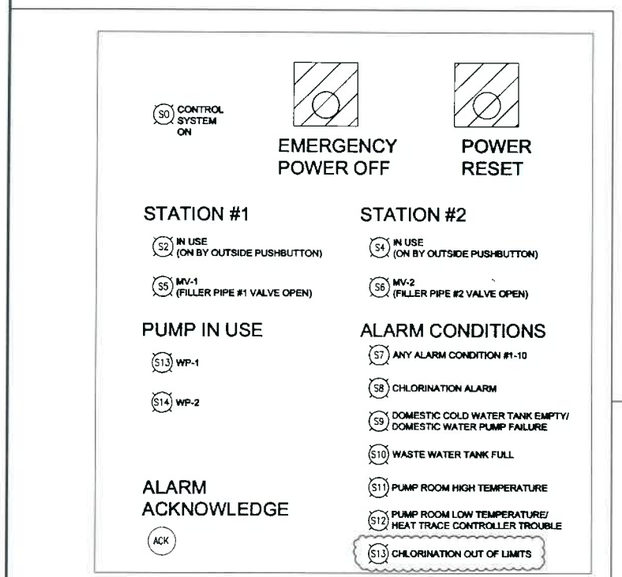
ELECTRICAL POWER & LIGHTING LAYOUT UPPER LEVEL

MECH FILE NAME	DWG NO	REV	SCALE
13-072 E	E4	6	AS NOTED



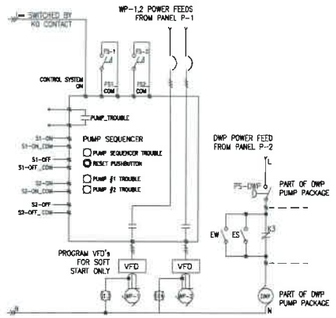
1 / E5 PUMP CONTROL SYSTEM & ALARM SYSTEM LADDER LOGIC DIAGRAM

N/A



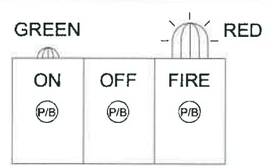
3 / E5 PUMP CONTROL SYSTEM PANELBOARD LAYOUT

N/A



2 / E5 PUMP C.S. LOGIC DIAGRAM CONT'D

N/A



CONTROLS TO BE PLACED ON FILL ARM IN MID-ROAD LOCATION FOR BOTH TRUCK FILL SPOTS

4 / E5 FILL ARM CONTROL BOX LAYOUT

N/A

ALARM REPORTING UNIT

ALARM #	ALARM DESCRIPTION	ALARM CONDITION	ALARM GENERATED BY
1	PUMP TROUBLE	NO FLOW OF WATER WHEN PUMP TURNED ON	PUMP SEQUENCER & WATER PUMP FLOW SWITCHES FS-1 – 2
2	FILTER BLOCKED	INSUFFICIENT FLOW OF WATER WHEN PUMP IS RUNNING	DIFFERENTIAL PRESSURE SWITCH DP-1
3	CHLORINATION STOPPED	INSUFFICIENT FLOW OF CHLORINE WHEN CCP-1 OR CCP-2 IS RUNNING	CHLORINATION CONTROLLER PANEL CCP-1 OR CCP-2
4	CHLORINE FEED TROUBLE	CHLORINE MIXING SYSTEM TROUBLE	CHLORINE MIXING SYSTEM CMS-1 OR CMS-2
5	EMERGENCY GENERATOR TROUBLE	ANY OUT-OF-SPEC CONDITION	GENERATOR CONTROLLER
6	EMERGENCY GENERATOR RUNNING	NORMAL GRID POWER LOST	AUTOMATIC TRANSFER SWITCH ATS
7	WATER STORAGE TANK EMPTY	LOW LEVEL IN DOMESTIC COLD WATER STORAGE TANK	FRESH WATER STORAGE TANK LOW LEVEL FLOAT SWITCH LS-DCW
8	WASTE WATER TANK FULL	HIGH LEVEL IN WASTE WATER STORAGE TANK	WASTE WATER STORAGE TANK HIGH LEVEL FLOAT SWITCH LS-WW
9	PUMP STATION HIGH TEMPERATURE	HIGH PUMP STATION ROOM TEMPERATURE	3 ROOM HEAT DETECTORS HD-1 – 3
10	PUMP STATION LOW TEMPERATURE	LOW PUMP STATION ROOM TEMPERATURE / HEAT TRACE TROUBLE	ROOM THERMOSTAT & 2 HEAT TRACE CONTROLLERS
11	CHLORINATION OUT OF LIMITS	CHLORINE IS LOWER THAN MIN. OR HIGHER THAN MAX. SETTINGS	MICROCHEM #1 OR MICROCHEM #2

ALARMS:

1. ALARM ACTIVATES IF A FLOW SWITCH (FS-1 OR FS-2) SENSES NO FLOW IN 15 (ADJUSTABLE) SECONDS AFTER ITS RELEVANT PUMP (WP-1 OR WP-2) IS TURNED ON.
   ACTION: CHECK THE PUMP CONTROLLER, DETERMINE WHICH PUMP FAILED AND WHY.
   REPAIR THE PROBLEM, RESET THE PUMP SEQUENCER AND ACKNOWLEDGE THE ALARM CONTROLLER.
2. ALARM ACTIVATES IF A DIFFERENTIAL PRESSURE SWITCH (DP-1) SENSES HIGHER THAN SET (H) (ADJUSTABLE) PRESSURE ACROSS FILTERS IN 15 SECONDS (ADJUSTABLE) AFTER ONE PUMP IS TURNED ON. ALARM ACTIVATES IF A DIFFERENTIAL PRESSURE METER (DP-1) SENSES HIGHER THAN SET H/H (ADJUSTABLE) PRESSURE ACROSS FILTERS IN 15 SECONDS (ADJUSTABLE) AFTER TWO PUMPS ARE TURNED ON.
   ACTION: CLEAN ALL 3 WATER FILTERS, ONE AT A TIME. ACKNOWLEDGE ALARM CONTROLLER.
3. ALARM ACTIVATES IF EITHER CHLORINATION CONTROLLER PANELS CCP1 OR CCP2 SENSES OUT-OF-SPEC CONDITIONS FOR 15 SECONDS (ADJUSTABLE).
   ACTION: DETERMINE THE REASON FOR THE CHLORINATION CONTROLLER ALARM.
   FIX THE PROBLEM AND RESET THE CHLORINATION CONTROLLERS AND ACKNOWLEDGE THE ALARM CONTROLLER.
4. ALARM ACTIVATES IF CHLORINE MIXING SYSTEM SENSES TROUBLE.
   ACTION: CHECK THE CHLORINE MIXING SYSTEM AND FIX THE PROBLEM.
   RESET THE CHLORINE MIXING SYSTEM AND ACKNOWLEDGE ALARM CONTROLLER.
5. ALARM ACTIVATES IF GENERATOR CONTROLLER SENSES OUT-OF-SPEC CONDITION WITH GENERATOR.
   ACTION: CHECK THE GENERATOR CONTROLLER AND DETERMINE THE CAUSE FOR THE ALARM.
   FIX THE PROBLEM AND RESET THE GENERATOR CONTROLLER AND ACKNOWLEDGE ALARM CONTROLLER.
6. ALARM ACTIVATES IF NORMAL GRID POWER IS LOST AND AUTOMATIC TRANSFER SWITCH ENGAGES EMERGENCY GENERATOR.
   ACTION: DETERMINE THE REASON WHY THE GENERATOR IS RUNNING.
   ENSURE THE GENERATOR HAS ENOUGH FUEL IF THE POWER OUTAGE IS PROLONGED. ACKNOWLEDGE ALARM CONTROLLER.
7. ALARM ACTIVATES IF DOMESTIC COLD WATER STORAGE TANK (DCWST) LOW LEVEL FLOAT SWITCH (LS-DCW) DETECTS LOW WATER LEVEL.
   ACTION: ARRANGE TO RE-FILL THE DCWST AND ACKNOWLEDGE THE ALARM.
8. ALARM ACTIVATES IF WASTE WATER STORAGE TANK (WWST) HIGH LEVEL FLOAT SWITCH (LS-WW) DETECTS HIGH WATER LEVEL.
   ACTION: ARRANGE TO PUMP OUT THE WWST AND ACKNOWLEDGE THE ALARM.
9. ALARM ACTIVATES IF ANY OF THE ROOM FIRE ALARM HEAT DETECTORS (HD-1, -2 OR -3) SENSES HIGH ROOM TEMPERATURE.
   ACTION: DETERMINE THE REASON FOR THE HIGH TEMPERATURE. FIX THE PROBLEM. ACKNOWLEDGE THE ALARM.
10. ALARM ACTIVATES IF THE ROOM THERMOSTAT (TS-2) SENSES LOW ADJUSTABLE ROOM TEMPERATURE OR IF ANY OF THE 2 HEAT TRACE CONTROLLERS SENSES TROUBLE WITH THE HEAT TRACE CABLES.
    ACTION: DETERMINE WHAT IS CAUSING THE ALARM. TAKE APPROPRIATE ACTION: (A) PROVIDE TEMPORARY HEAT SOURCE FOR THE PUMP ROOM IF THE ROOM TEMPERATURE FALLS BELOW SET POINT (10°C ADJUSTABLE), OR (B) DETERMINE WHICH HEAT TRACE CONTROLLER ALARMED AND TAKE ACTION TO FIX THE PROBLEM. ACKNOWLEDGE THE ALARM.
11. ALARM ACTIVATES WHEN CHLORINATION IS LOWER THAN MIN. OR HIGHER THAN MAX. SET TOLERANCES.

ALARM REPORTING UNIT RELAYS:

1. PROGRAMMED TO TURN "ON" WITH ANY OF THE 1-10 ALARM INPUTS. TURNS "ON" AN OUTDOOR STROBE BEACON LOCATED OUTSIDE THE PUMP STATION TO DISPLAY THAT THE PUMP STATION REQUIRES ATTENTION. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "ANY ALARM CONDITION #1-10"
2. PROGRAMMED TO TURN "ON" WITH EITHER ALARM INPUT #3 OR #4. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "CHLORINATION ALARM"
3. PROGRAMMED TO TURN "ON" WITH ALARM INPUT #7. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "FRESH WATER TANK EMPTY OR DWP PUMP FAILURE"
4. PROGRAMMED TO TURN "ON" WITH ALARM INPUT #8. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "WASTE WATER TANK FULL", TURNS "ON" AN OUTDOOR WARNING LAMP TO INDICATE FULL TANK REQUIRING SERVICE. FULL WWST WILL DISABLE (K3) DOMESTIC WATER PUMP TO PREVENT OVERFILL, UNLESS EMERGENCY EYEWASH (EW) OR EMERGENCY SHOWER (ES) IS USED.

ALARM EXPANDER UNIT RELAYS:

1. PROGRAMMED TO TURN "ON" WITH ALARM INPUT #9. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "PUMP ROOM HIGH TEMPERATURE"
2. PROGRAMMED TO TURN "ON" WITH ALARM INPUT #10. TURNS "ON" AN INDICATOR LIGHT ON THE MAIN PANEL LABELED "PUMP ROOM LOW TEMPERATURE / HEAT TRACE CONTROLLER TROUBLE"

PUMP SEQUENCER OPERATION:

BY DEPRESSING THE "ON" PUSHBUTTON AT FILL STATION #1 OR #2 (SEQUENCER INPUT CONTACTS S1-ON OR S2-ON) THE SEQUENCER STARTS THE "NEXT" PUMP WITH A DELAY OF 3 SECONDS.
DEPRESSING THE SAME "ON" PUSHBUTTON AGAIN WILL DO NOTHING UNTIL THE RELEVANT "OFF" BUTTON IS PRESSED.
ONCE THE PUMP IS RUNNING, IT CAN BE TURNED "OFF" BY DEPRESSING THE "OFF" PUSHBUTTON (SEQUENCER INPUT CONTACTS S1-OFF OR S2-OFF) AT THE INITIATING FILL STATION.
DEPRESSING THE SAME "OFF" PUSHBUTTON AGAIN WILL DO NOTHING.
BASED ON THE ABOVE, 1 OR 2 PUMPS CAN RUN SIMULTANEOUSLY.

THE SEQUENCE OF THE "NEXT PUMP" IS WP-1 -> WP-2 -> WP-1 -> WP-2 -> ETC...

FLOW SWITCHES WILL PROVIDE FEEDBACK SO THAT WHEN A PUMP IS TURNED "ON" IT ACTUALLY DELIVERS WATER.
IF THE FLOW SWITCH OF ITS RELEVANT PUMP IS NOT "ON" WITHIN 15 SECONDS, THE PUMP SEQUENCER WILL TURN THAT PUMP "OFF" AND TURN THE "NEXT" PUMP "ON".
THIS WILL CAUSE THE AFFECTED PUMP TO BE TAKEN OUT FROM THE SEQUENCE OF THE "NEXT PUMP". IT WILL ALSO TURN "ON" A "PUMP # TROUBLE" ALARM LIGHT AND TURN "ON" A SET OF DRY OUTPUT ALARM CONTACTS "PUMP TROUBLE".
LATCHING OF A FAILED PUMP "OFF" CAN BE RESET BY DEPRESSING A "RESET" BUTTON ON THE PUMP SEQUENCER.

AS-BUILT
DATE: November 5, 2018
ARCTIC NORTH

Arktis piusitippaa

CONSULTANT NAME AND ADDRESS:

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EMAIL: info@cemlottawa.com

NO.	DATE (YY/MM/DD)	BY	DESCRIPTION
10			
9			
8			
7	08/08/10	B.P.	ISSUED FOR CCNR MLE 4
6	15/07/08	B.P.	ISSUED FOR CONSTRUCTION
5	28/03/16	B.P.	REISSUED FOR TENDER
4	14/04/14	B.P.	REISSUED FOR TENDER
3	13/02/14	B.P.	ISSUED FOR TENDER
2	15/01/14	B.P.	ISSUED FOR 99% REVIEW
1	25/11/13	B.P.	ISSUED FOR 50% REVIEW

STAMP
REGISTERED PROFESSIONAL ENGINEER — MARC PELLET — AUG 2018 — NWT/NU

CONSULTANT: CEML
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATED: AUGUST 08 2018

STAMP
PERMIT TO PRACTICE — CHLORELL ENGINEERING MANAGEMENT LTD. — Signature — Date 2018-08-08 — PERMIT NUMBER: P 738 — NWT/NU Association of Professional Engineers and Geoscientists

CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATED:

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

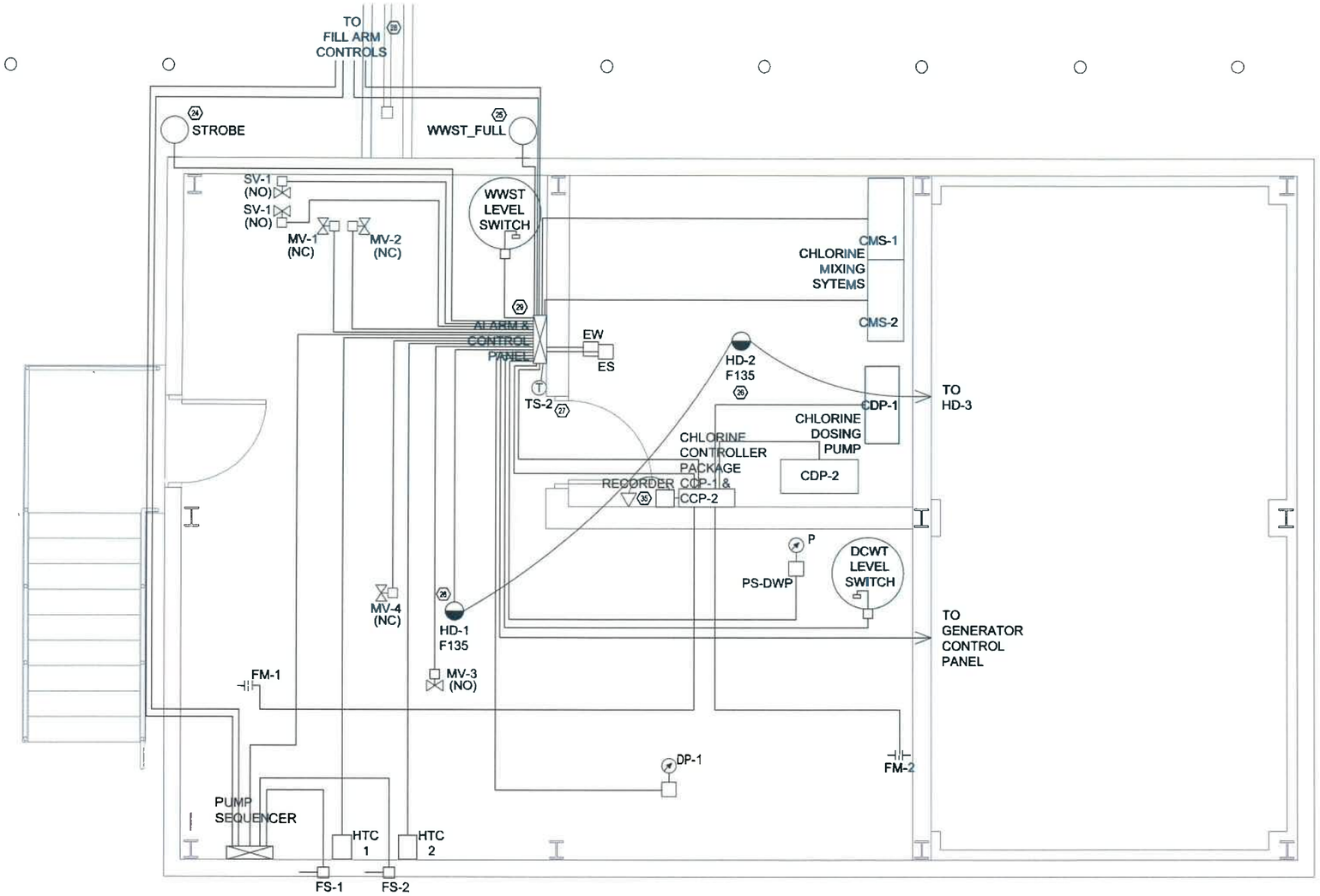
PROJECT:

IMPROVEMENT OF WATER SUPPLY SYSTEM

DRAWING TITLE:

PUMP CONTROL & ALARM SYSTEM SCHEMATIC AND SEQUENCE OF OPERATIONS

REDI TITLE NAME:	DWG NO.	OF:	SCALE:
13-072 E	E5	6	AS NOTED



1/E6 LOW-VOLTAGE ELECTRICAL LAYOUT - UPPER LEVEL - CONTROL AND MONITORING SYSTEM

1:25

AS-BUILT

DATE: November 5, 2018

DIC NORTH

PERMIT TO PRACTICE
CHIARELLI ENGINEERING MANAGEMENT LTD.
Signature
Date 30 March 2016
PERMIT NUMBER: P 732
NWT/NU Association of Professional Engineers and Geoscientists

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NO.	DATE (DD/MM/YY)	BY:	DESCRIPTION
10			
9			
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6			
5	28/03/16	B.P.	REISSUED FOR TENDER
4	14/04/14	B.P.	REISSUED FOR TENDER
3	13/02/14	B.P.	ISSUED FOR TENDER
2	15/01/14	B.P.	ISSUED FOR 99% REVIEW
1	25/11/13	B.P.	ISSUED FOR 50% REVIEW

STAMP

REGISTERED PROFESSIONAL ENGINEER
M.M. MALLET
MAR. 2016
NWT/NU

CONSULTANT: CEML
DRAWN BY: B.P.
DESIGNED BY: N.K.
APPROVED BY: M.M.
DATE: MARCH 2016

STAMP

CONSULTANT:
DRAWN BY:
DESIGNED BY:
APPROVED BY:
DATE:

LOCATION:

IGLOOLIK
QIKIQTAALUK REGION OF NUNAVUT
X0A 0L0

PROJECT:

IMPROVEMENT OF
WATER SUPPLY SYSTEM

DRAWING TITLE:

LOW-VOLTAGE
ELECTRICAL LAYOUT
UPPER LEVEL

REDM FILE NAME:	DWG. NO	BY:	SCALE:
13-072 E	E6	6	AS NOTED

Chapter 3 PROCESS SYSTEM OPERATION

3.1 GENERAL OPERATION

3.1.1 PUMP STATION OPERATION OVERVIEW:

Major components:

1. **Pump sequencer:** its function is to sequence the two submersible pumps, so that each pump is used equally over time. In case of a pump failure (determined by the relevant flow switch FS-1 or FS-2), the sequence switches to the next available pump and initiates an alarm signal.
2. **Pump controller:** ties all control devices and sensors together. The control lights indicate which filling station is in use and which pump is running. It also indicates some of the alarm conditions and provides an emergency power off and reset pushbuttons.
3. **Alarm reporting unit:** its function is to turn on the rooftop strobe at any one of the 10 alarm conditions and to dial pre-programmed phone numbers with a recorded message to give warning of the alarm condition.

Operation:

4. **Pumping one truck:** by pressing the “ON” pushbutton of filling station #1 located on the filling arm valve SV-1 will close and open MV-1. This operation takes approximately three seconds. After the three second delay, the pump sequencer starts the “NEXT” available pump. pressing the same “ON” pushbutton again will have no impact.
5. Pumping must be stopped by pressing the “OFF” pushbutton of filling station #1. Pressing the “OFF” pushbutton will stop the pump that was running. It also closes valve MV-1 and opens valve SV-1 which drains the outside portion of the fill arm.
6. The process is identical for fill station #2 (except it works with valves MV-2 and SV-2).
7. **Pumping two trucks:** the controls are set up so that only one of the two filling arms can be used at a time. This is to guarantee that the water delivered to the truck has enough contact time with the chlorine. The time delay between two fillings depends on the level

of desired chlorination. Higher the chlorination dosage, shorter the required contact time (CT.).

The controls will prevent initiation of the second truck filling until the required delay is not reached.

8. **Pumping water for fire fighting:** by pressing the "ON" pushbutton of filling station #1 located on the filling arm and the "FIRE" button valve SV-1 will close, MV-1 will open, MV-3 will close and MV-4 will open. This operation takes approximately three seconds. After the three second delay, the pump sequencer starts the "NEXT" available pump. Pressing the same "ON" pushbutton again will have no impact. This operation bypasses the water filters speeding up the filling process.
9. Pumping must be stopped by pressing the "OFF" pushbutton on filling station #1. Pressing the "OFF" pushbutton will stop the pump that was running. It also opens MV-3, closes MV-4, closes valve MV-1 and opens valve SV-1, which drains the outside portion of the fill arm.
10. The process is identical for fill station #2 (except it works with valves MV-2 and SV-2 in addition to MV-3 and MV-4).
11. **Pumping two trucks with water for fire fighting**: the process for the first truck requesting water for fire fighting is identical to the description in points 8 to 10 above. While the first truck is filling a second truck can request fire fighting water by pressing the relevant "ON" button. This will initiate closure of the second SV valve and open the unused MV-1 or MV-2 valve. After a three second delay, the second water pump will start doubling the pumping capacity of the station.
12. Pumping must be stopped by pressing the relevant "OFF" pushbutton on filling station. Pressing the "OFF" pushbutton will stop the first water pump. It also closes valve MV-1 (or MV-2) and opens valve SV-1 (or SV-2), which drains the outside portion of the fill arm.
13. Pressing the second "OFF' button will turn off the second water pump and closes valve MV-2 (or mMV-1) and opens valve SV-2 (or SV-1), which drains the outside portion of the fill arm and opens MV-3 and closes MV-4 which resets the station for delivery of drinking water

The chlorination loop:

14. The microchem2 chlorine controller package (CCP-1) is the controlling unit for the primary chlorination process. Since the water flow in the main 100mm water pipe can vary depending on whether one or two pumps are running, the condition of the filters and water level in the lagoon, the flow is precisely measured by the flow meter (FM-1). The CCP-1 sends a 4-20ma signal to its chlorine dosing pump (CP-1 and or CP-2) that is proportional to the water flow measured by fm-1. A water sample is tested continually by chlorination and PH/temperature probes connected to CCP-1 and CCP-1 will adjust the amount of chlorine pumped by CP-1/CP-2 to ensure the required level of primary chlorination. The setting of the CCP-1 loop is proportional
15. CCP-2 is a post-chlorination loop identical to CCP-1 except it is set to a constant flow. It's function is to maintain the chlorination level of water delivered to the trucks and add chlorine if required in time of prolonged inactivity of the station (nights, weekends). The flow is precisely measured by the flow meter (FM-2). The CCP-2 sends a 4-20ma signal to it's chlorine dosing pump (CP-3 and CP-4) that is proportional to the water flow measured by FM-2. A water sample is tested continually by chlorination and PH/temperature probes connected to CCP-2 and CCP-2 and will adjust the amount of chlorine pumped by cp-3 and/or cp-4 to ensure the required level of post-chlorination.
16. The information gathered by ccp-1 and ccp-2 (water delivery, chlorination and PH levels, temperature) is stored in the data recorder and accessed through a USB port or remotely through an IP address.
17. Only one of the CP subcomponent dosing pumps (CP-1 or CP-2) is "ON" the second pump is a backup in case the active pump has failed. This must be switched manually. The CP dosing pump skid also contains calibration and cleaning accessories.
18. The chlorine solution for the dosing pumps is prepared by an "mc4-50" chlorine mixing system (CMS). Once again, the second system is a backup in case the active one fails. It is recommended to keep the backup system dry & clean and only activate it once it is required. Alternatively, liquid chlorine can be used by one or both chlorination systems by reversing the manual valves in front of the dosing pumps. Switching the source of chlorine will also require adjusting the setting of the relevant dosing pumps as the two chlorination medias provide different concentrations of chlorine.

Note that when using MC4-50 chlorine mixers, that it is occasionally necessary to flush the chlorine injection lines with domestic water by closing the manual chlorine valves at both ends of the line and opening the water valves.

19. If the measured chlorine level gets below the set minimum, or higher than the set maximum measured by the two microchems, the pumping of drinking water will stop. This condition will require a station operator to investigate and fix the problem followed by a manual reset of the out of range chlorine condition. This condition will not affect pumping fire fighting water.

System failures and alarms:

1. The alarms are listed in the alarm reporting table on drawing E5. There are 11 alarms connected to the alarm reporting unit. It can also accommodate another five additional alarm inputs in the future if required.
2. **Some of the alarm levels are settable:** a). - the low temperature alarm on thermostat is-1 located in the main pumping room, and b). - pressure drops across the water filters measured by DP-1. DP-1 has two adjustable alarm settings: high (H) - when one truck is being filled (one water pump is running), and high/high (H/H) when two trucks are being filled (two water pumps are running). The settings of DP-1 will need to be established by experience. However, the pressure should not exceed 15lbs across the filter bank when two pumps are running (H/H). The highest the allowed pressure drop across the filters, over time it will take longer to fill the trucks as the filters catch more sediment, but the filters will need to be cleaned less frequently.

Alarm reporting unit relays:

Alarms:

1. Alarm activates if a flow switch (FS-1 or FS-2) senses no flow in 15 (adjustable) seconds after its relevant pump (WP-1 or WP-2) is turned on. Action: check the pump controller, determine which pump failed and why. Repair the problem, reset the pump sequencer and acknowledge the alarm controller.
2. Alarm activates if a differential pressure switch (DP-1) senses higher than set (H) (adjustable) pressure across filters in 15 seconds (adjustable) after one pump is turned on.

Alarm activates if a differential pressure meter (DP-1) senses higher than set H/H (adjustable) pressure across filters in 15 seconds (adjustable) after two pumps are turned on. Action: clean all three water filters, one at a time. Acknowledge the alarm controller.

3. Alarm activates if either chlorination controller panels CCP1 or CCP2 senses out-of-spec conditions for 15 seconds (adjustable). Action: determine the reason for the chlorination controller alarm. Fix the problem, reset the chlorination controllers and acknowledge the alarm controller.
4. Alarm activates if chlorine mixing system senses trouble. Action: check the chlorine mixing system and fix the problem. Reset the chlorine mixing system and acknowledge the alarm controller.
5. Alarm activates if generator controller senses out-of-spec conditions with generator. Action: check the generator controller and determine the cause for the alarm. Fix the problem and reset the generator controller and acknowledge the alarm controller.
6. Alarm activates if normal grid power is lost and automatic transfer switch engages emergency generator. Action: determine the reason why the generator is running. Ensure the generator has enough fuel if the power outage is prolonged. Acknowledge alarm the controller.
7. Alarm activates if domestic cold-water storage tank (DCWST) low level float switch (ls-DCW) detects low water level. Action: check why the DCWST is not topped up automatically and acknowledge the alarm.
8. Alarm activates if waste water storage tank (WWST) high level float switch (lS-WW) detects high water level. Action: arrange to pump out the WWST and acknowledge the alarm.
9. Alarm activates if any of the room fire alarm heat detectors (HD-1, -2 or -3) senses high room temperature. Action: determine the reason for the high temperature. Fix the problem. Acknowledge the alarm.
10. Alarm activates if the room thermostat (TS-2) senses a low adjustable room temperature or if any of the three heat trace controllers sense trouble with the heat trace cables. Action: determine what is causing the alarm. Take appropriate action: (a) provide temporary heat source for the pump room if the room temperature falls below set point

(10*c adjustable), or (b) determine which heat trace controller was activated and act to fix the problem. Acknowledge the alarm.

11. Alarm activates when the water chlorination level is lower that set minimum or higher that set maximum tolerance level.

Alarm reporting unit relays:

1. Programmed to turn "ON" with any of the 1-11 alarm inputs. Turns "ON" an outdoor strobe beacon located outside the pump station to display that the pump station requires attention.
2. Turns "ON" an indicator light on the main panel labeled "any alarm condition #1-11"
3. Programmed to turn "ON" with either alarm input #3 or #4. Turns "ON" an indicator light on the main panel labeled "chlorination alarm"
4. Programmed to turn "ON" with alarm input #7. Turns "ON" an indicator light on the main panel labeled "fresh water tank empty or DWP pump failure"
5. Programmed to turn "ON" with alarm input #8. Turns "ON" an indicator light on the main panel labeled "waste water tank full". Turns "ON" an outdoor warning lamp to indicate full tank requiring service. Full WWST will disable (K3) domestic water pump to prevent overfill, unless emergency eyewash (EW) or emergency shower (ES) is used.

Alarm expander unit relays:

1. Programmed to turn "ON" with alarm input #9. Turns "ON" an indicator light on the main panel labeled "pump room high temperature"
2. Programmed to turn "ON" with alarm input #10. Turns "ON" an indicator light on the main panel labeled "pump room low temperature / heat trace controller trouble"
3. Programmed to turn "ON" with alarm input #11. Turns "ON" an indicator light on the main panel labeled "water chlorination out of limits”.

Pump sequencer operation:

By depressing the "ON" pushbutton at fill station #1 or #2 (sequencer input contacts S1 on or S2 on) the sequencer starts the "next" pump with a delay of three seconds. Pressing the same "ON" pushbutton again will do nothing until the relevant "OFF" button is pressed. Once the pump is running, it can be turned "OFF" by pressing the "OFF" pushbutton (sequencer input contacts S1off or S2off) at the initiating fill station. Pressing the same "OFF" pushbutton again will not do anything. Based on the above, 1 or 2 pumps can run simultaneously but only in “fire” mode.

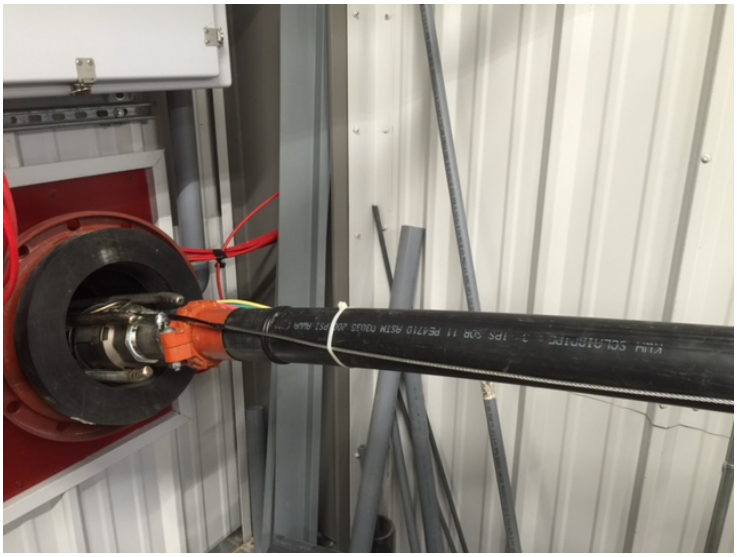
The sequence of the "next pump" is wp-1 -> wp-2 -> wp-1 -> wp-2 -> etc...

Flow switches will provide feedback so that when a pump is turned "ON" it delivers water. If the flow switch of its relevant pump is not "ON" within 15 seconds, the pump sequencer will turn that pump "OFF" and turn the "NEXT" pump "ON". This will cause the affected pump to be taken out of the sequence of the "next pump". It will also turn "ON" a "pump # trouble" alarm light and turn "ON" a set of dry output alarm contacts "pump trouble". Latching of a failed pump "off" can be reset by pressing a "reset" button on the pump sequencer.

3.2 WATER PUMPS

3.2.1 Description

When the trucker pushes the start button the control panel automatically starts one of the two 25HP water submersible pumps located in the raw water intake pipe. Both pumps can run simultaneously. The water pumps are alternating. The Control Panel changes automatically to switch to the other pump in case of failure or the need for maintenance. The operator can force the operation of a specific pump by turning off the other pump.



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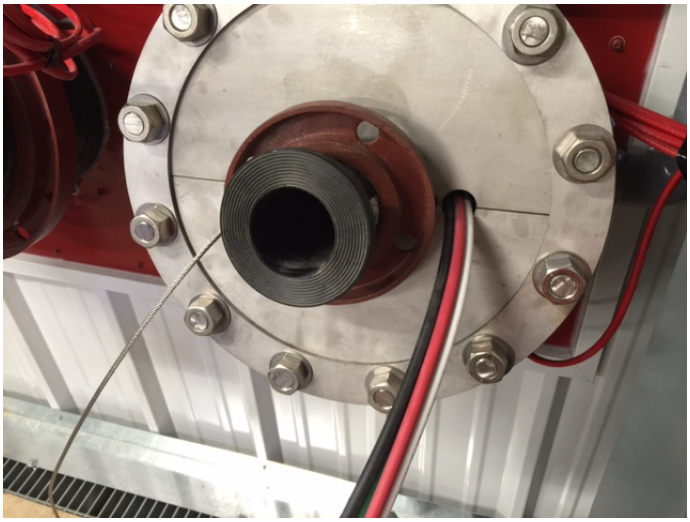


3.2.2 Operation

1. Check daily if the water pumps are working correctly by using the Control Panel.

2. No alarm shown on the control panel and/or the sequencer panel means everything is OK.

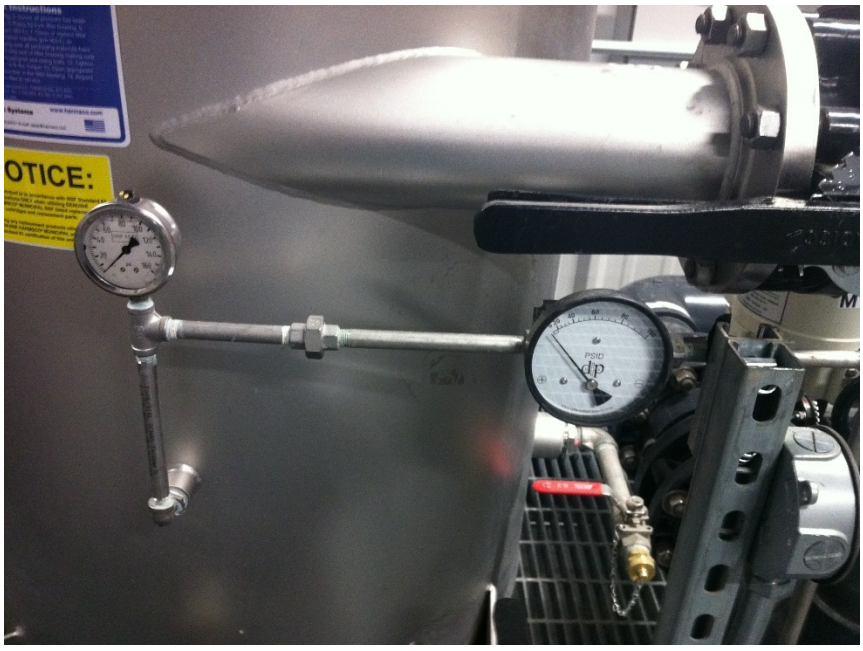
The rest of the system is automatic. No operations should be required. If the system fails to operate properly, go to **Chapter 7**, "trouble shooting". For more information, refer to **Chapter 16, Chapter 28 & Chapter 37**.

3.3 FILTERS

3.3.1 Description

The Filtration building is equipped with three filters housing and two strainers, one for each pump. The filters are positioned in a series for a filtration capacity going from a basket strainer with 75 microns holes to a 1 µm filter. In flow order, as below:

1. Strainer equipped with a basket filter with a 75 microns hole.
2. Filter Housing #1 – 20µm capacity (HC/170-20 Hurricane Fltr Cart) Contains 5 filters per housing.
3. Filter Housing #2 – 5µm capacity (HC/170-5 Hurricane Fltr Cart) Contains 5 filters per housing.
4. Filter Housing #3 – 1µm capacity (HC/170-LT2 Hurricane Fltr Cart) Contains 8 filters per housing.



3.3.2 Filter replacement

Filters need to be changed according to the water quality. Also, filters need to be cleaned, following Harmsco procedures**.**

Step 1

Open pump breaker in truck fill station, Pump P1 and P2. Make sure that the pumps are disabled.

Another option is to flip the filtration mode selector to bypass mode. In this case, the filtration building is bypassed by a motorised valves MV3 & MV4.

Another option with the filter butterfly valves is to isolate the filter that requires maintenance.

Step 2

Close the valves between filter Housing. **Refer to Harmsco for cleaning procedure and filter changes.**

Step 3

Always isolate and remove pressure from housing before servicing. Housing is to be shut off, drained of fluid by first opening the lower drain.

Step 4

Open filter housing by turning eye nuts counter-clockwise, disengaging swing bolts, and removing the lid.

Step 5

Remove the new cartridges from their packaging and make sure centre cores are clear of all obstructions, mainly from shipping materials.

Step 6

Install cartridge by lifting handle into cartridge.

Step 7

Insert cartridge into housing and stand-pipe, cartridge is to contact tube sheet of housing.

Step 8

Position housing O-ring seal in the groove housing.

Step 9

Position Lid onto housing and properly align on seal before applying swing bolts. Do not allow tilting or cocking of lid on gasket.

Step 10

Close filter housing by tightening Eye Nuts clockwise by hand. Use a star pattern several times to tighten all the eye nuts properly.

Step 11

Slowly open inlet valve to begin operation, allowing fluid to fill housing.

Step 12

Open filter housing outlet valve.

Step 13

It is recommended to flush the system by running water through the filter at the recommended rate for 10 minutes.

Step 14

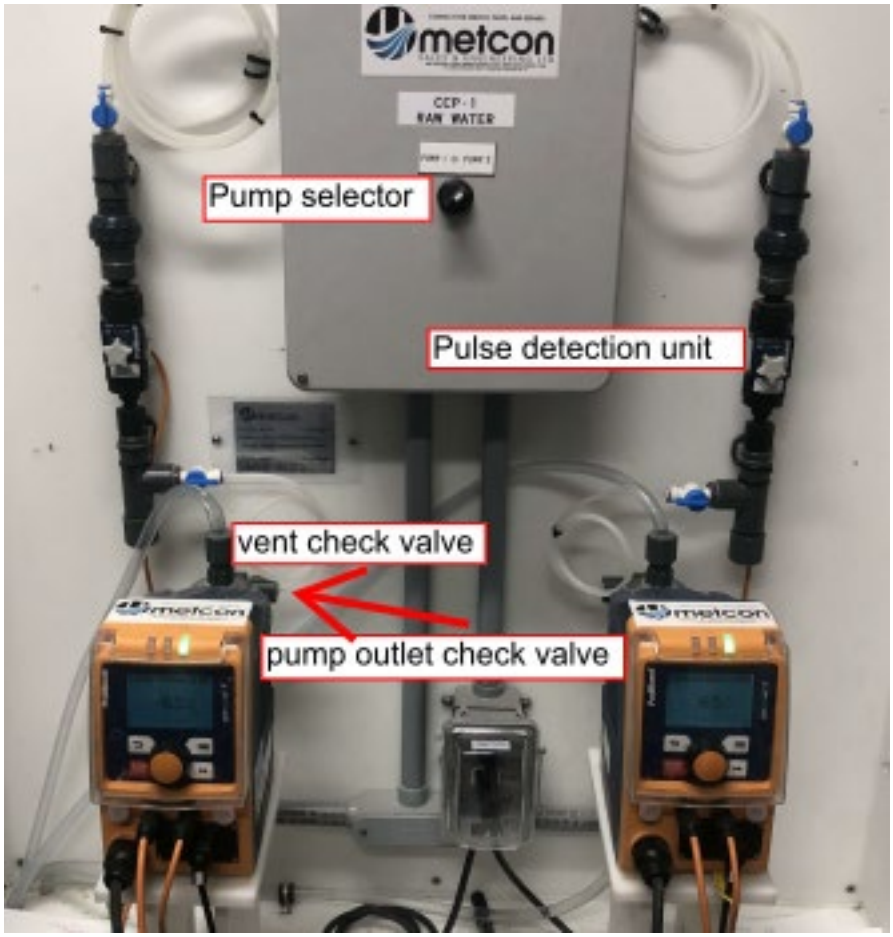
Start pump, if applicable, and operate filter.

Refer to **Chapter 36** for more details

3.4 CHLORINATION DOSING PUMPS (Prominent Solenoid Metering Pump)

3.4.1 Description

Operation of these pumps is the key to proper chlorine injection, Numerous training periods are required to obtain a satisfactory level of understanding of the injection process taking place.



3.4.2 Operation

For chlorine injection we find two distinct locations of injection with two different strategies of operation.

- Main injection located at pump outlet after the flow meter.
    1) In normal mode chlorine injection is proportionnal to water flow. Stroke pulse rate is automaticaly adjusted by the pump depending on the intensity of the 4-20 ma signal received by the flow meter feeding the injection pump .Stroke lenth is adjusted by the operator by turning the knob on the injection pump.Higher stroke lenths give more chlorine content.

2) In emergency mode (failure of flow meter detected by the injection pump) In this condition two actions must be taken by the operator to resume operation.
   a) Injection pump must be operated in manul mode giving a fixed pulse rate when main raw water pumsp are operating
   b) Selector located in the control panel located on the left side of the alarm panel must be turned to automatic position.

- Final injection is located at filter outlet before the 15,000 litre contact tank.

  At this position one only strategy of chlorine injection is available

  1) Selecting manual mode on the injection pump with a slow pulse rate ensures a slow constant injection.The pulse rate is selected by the operator to maintain chlorine level in contact tank overnight and between two truck fills.

3.5 CHLORINE CONTROLLER (Microchem 2 c/w CL4000 sensor)

3.5.1 Description

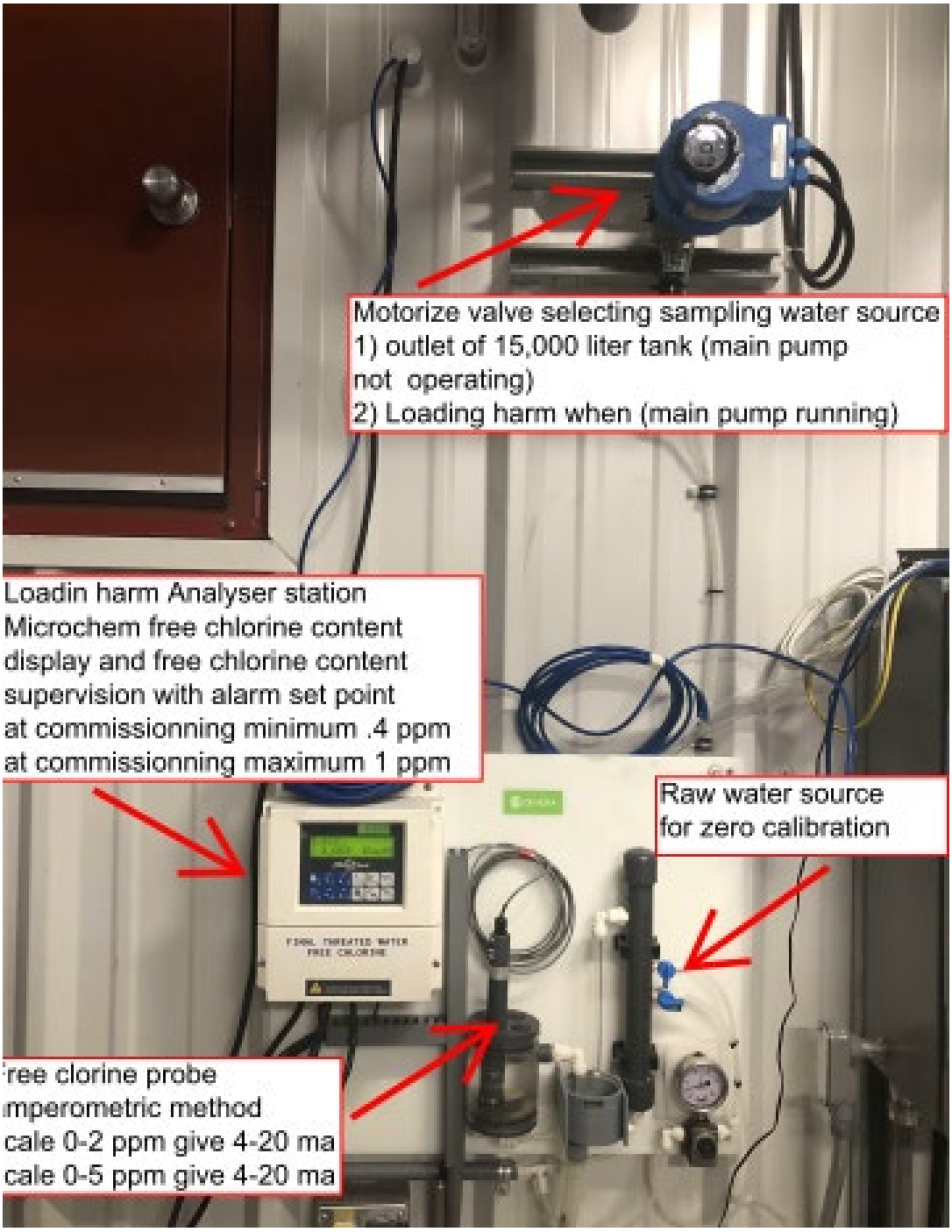
The controller is intended to read and display free chlorine content and ph.

In this installation readings are taken at two locations

- At 15,000 litre contact tank output with display located in chlorine room .

- At loading arm where trucks are loaded and located below loading arm outlet. In this location the controller signals an alarm when chlorine concentration is below .4 PPM and /or over 1 PPM.

Free Chlorine Measurement at Loading Arm



The two key components are the Free chlorine probes and PH probes.

1) The CL4000 (Free Chlorine Probe) supplies a 4-20ma signal to the Microchem controller and this method of reading the free chlorine content is called amperometric because the signal is obtained by circulating an electric current in the water solution for analyzation.

- CL4000 chlorine probes require 30 litres per hour of stable and continuous flow and require time to settle.

- After a water flow interruption numerous minutes are required for the chemical reaction to resume operation. Free chlorine Display value on the Microchem will be in alarm and flashing mode.

2) The PH probe on its side, provides a millivolts value proportional to PH to the Microchem controller.

The Microchem Controller display Free chlorine (CL) and PH value.

3.5.2 Operation

This system is not automatic. The Operator must continuously do a follow up.

-For the main chlorine injection point before filtering the amount of chlorine injected is proportional to water flow. Typically, main water pump supply 1,200 litres of water per minute.

For the main injection, the chlorine injector pump starts automatically once flow is detected in flow meter. Therefore, the P1 is set at 4.5 ma. (when flow reaches the engineering value of 4.5 ma the injection pump starts). Chlorine is added proportionally to the slope selected on P1 anP2 in the injection pump. The flow meter and injection pump are using following the set points.

- P1 4ma is zero flow zero stroke per minute on the injection pump.

- P2 20 ma is corresponding to 3000 litres per minute and 8000 strokes per minute on the injection pump.

- Recommended stroke length - not less than 30%

-For the final chlorination process a constant injection rate of typically 22 strokes per hour with stroke length no less than 30% is used to maintain the free chlorine level in contact tank.

3.6 LIQUIDE CHLORINATOR

3.6.1 Description

3.6.2 Operation

- New Chlorine Hypochlorite 12% barrels (55Litres) are transferd into the pellet mixer MC 4-50 as requested by the CEML engineer.
- The liquid chlorine is now distributed to the chlorine pump via a CPVC Pipe located at the bottom of the tank.
- The Control Panel only indicates if the liquid levels in the container are low.

3.6.3 Safety – Read Material Safety Data Sheets (MSDS)

It is crucial to read the MSDS (shown below) before attempting any Liquid Chlorine transfers to the MC-4-50 tank.

- **Wear the appropriate Facemask with Chlorine Cartrige Filters.**
- **Wear appropriate Gloves to handle Chlorine**
- **Wear appropriate coveralls**

GREAT NORTH CHEMICALS INC.
85 MALMO COURT, P.O. BOX 2, COMP 13 • MAPLE, ON L6A 1R4
(905) 832-2276 • FAX (905) 832-3701

Material Safety Data Sheet

Sodium Hypochlorite 12% - NSF

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Sodium Hypochlorite 12%
Synonyms: Sodium oxychloride; Soda bleach liquor; Javel water; Clorox; Javex.
Chemical Family: Hydrochlorous acid, sodium salt.
Application: Chemical intermediate. Laboratory reagent. Water treatment. Pulp and paper. Bleaching agent. Disinfectant.

Distributed By:
Great North Chemicals
85 Malmo Court
Maople, Ontario
L6A 1R4

Prepared By: Tony Roehrig
Preparation date of MSDS: January 2017
Telephone number of preparer: 1-905-832-2276

24-Hour Emergency Telephone Number (CANUTEC): (613) 996-6666

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	Percentage (W/W)	LD50s and LC50s Route & Species:
Water 7732-18-5	Balance	Oral LD50 (Rat) >90 mL/kg
Sodium Hypochlorite, Solution 7681-52-9	12-14	Oral LD50 (Rat) = 8200 mg/kg Dermal LD50 (Rabbit) > 10000 mg/kg

Note: Drug Identification Number (DIN) - 02265729

3. HAZARDS IDENTIFICATION

Potential Acute Health Effects:
Eye Contact: Corrosive to eye tissue and may cause severe damage and blindness.
Skin Contact: Corrosive. May cause severe skin irritation. Prolonged contact may lead to burns and blisters and may aggravate dermatitis. May cause whitening or bleaching of the skin.
Inhalation: Corrosive to the respiratory passage. Causes irritation of the mouth, nose and throat. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary edema (fluid build-up in lungs) and reduction of pulmonary function. If mixed with acids or warmed to temperatures greater than 40 degrees Celcius, Sodium hypochlorite solutions release chlorine gas. This gas can cause severe irritation of the nose and throat. Exposures to high levels of chlorine gas may result in severe lung damage.

3. HAZARDS IDENTIFICATION

Ingestion: Corrosive. Causes burns to the mouth, throat and stomach. Causes vomiting, nausea, and diarrhea. Coma, shock and death may occur.

4. FIRST AID MEASURES

Eye Contact: Wash eyes with water for a minimum of 30 minutes or until no evidence of the chemical remains. Hold eyelids open during flushing. Seek immediate medical attention.
Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 30 minutes. Get medical attention.
Inhalation: Remove person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, get immediate medical attention.
Ingestion: Rinse mouth with water. Do not induce vomiting. Do not give anything by mouth to an unconscious person. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Seek immediate medical attention.
Notes to Physician: Due to the severely irritating or corrosive nature of the material, swallowing may lead to ulceration and inflammation of the upper alimentary tract with hemorrhage and fluid loss. Also, perforation of the esophagus or stomach may occur, leading to mediastinitis or peritonitis and the resultant complications.

5. FIRE FIGHTING MEASURES

Flash Point: None.
Flash Point Method: Not applicable.
Autoignition Temperature: Not available.
Flammable Limits in Air (%): Not Available.
Extinguishing Media: Use extinguishing media appropriate for surrounding fire.
Special Exposure Hazards: Keep containers cool to prevent rupture and release of material. Closed containers may explode in fire. Spilled material may cause floors and contact surfaces to become slippery.
Hazardous Decomposition/Combustion Materials (under fire conditions): Chlorine. Oxygen. Oxides of sodium.
Special Protective Equipment: Fire fighters should wear full protective clothing, including self-contained breathing equipment.
NFPA RATINGS FOR THIS PRODUCT ARE: Not Available.
HMIS RATINGS FOR THIS PRODUCT ARE: Not Available.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures: Wear appropriate protective equipment.
Environmental Precautionary Measures: Prevent entry into sewers or streams, dike if needed. Consult local authorities.
Procedure for Clean Up: Ventilate area. Small spills: soak up with absorbent material and scoop into containers. Large spills : prevent contamination of waterways. Dike and pump into suitable containers. Clean up residual with absorbent material, place in appropriate container and flush with water. Spilled material may cause floors and contact surfaces to become slippery.

7. HANDLING AND STORAGE

Handling: For industrial use only. Handle and open containers with care. Avoid contact with eyes, skin and clothing. Do not ingest. Avoid inhalation of chemical. Empty containers may contain hazardous product residues. Keep the containers closed when not in use. Protect against physical damage. Use appropriate personnel protective equipment. When diluting, add this product to water in small amounts to avoid spattering. Never add water to this material.
Storage: Store in a cool, dry, well ventilated area, away from heat and ignition sources. Store below 29 °C. Do not freeze. Keep away from direct sunlight. Store away from organic chemicals, strong bases, metal powders, carbides, sulfides, and any readily oxidizable material. Storage area should be equipped with corrosion-resistant floors, sumps and should have controlled drainage to a recovery tank. Store in a sealed polyethylene lined container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:

Local exhaust ventilation as necessary to maintain exposures to within applicable limits. Make up air should always be supplied to balance air exhausted (either generally or locally). Ventilation required when spraying or applying in a confined area. Ventilation should be explosion proof. Eliminate ignition sources.

Respiratory Protection: Wear a Niosh approved full facepiece respirator for acid gases or a self-contained breathing apparatus for air concentration levels up to 5 ppm. NIOSH approved supplied air respirator when airborne concentrations exceed exposure limits.

Gloves:

Impervious gloves. Neoprene gloves. Nitrile gloves. Rubber gloves.

Skin Protection: Neoprene coated apron or chemical resistant clothing. Impervious boots.

Eyes: Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes.

Other Personal Protection Data: Ensure that eyewash stations and safety showers are proximal to the work-station location.

Ingredients	Exposure Limit - ACGIH	Exposure Limit - OSHA	Immediately Dangerous to Life or Health - IDLH
Water	Not available.	Not available.	Not Available.
Sodium Hypochlorite, Solution	0.5 ppm As For Chlorine.	Not available.	Not Available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Liquid.
Colour: Clear Green to yellow.
Odour: Chlorine.
pH 11.5 - 13
Specific Gravity: 1.21
Boiling Point: Decomposition at 40°C / 104°F
Freezing/Melting Point: -25°C / -12°F
Vapour Pressure: 17.5 mmHg
Vapour Density: Not Available.
% Volatile by Volume: Not Available.
Evaporation Rate: Not Available.
Solubility: Miscible in water.
VOCs: Not Available.
Viscosity: Not Available.
Molecular Weight: Not Available.
Other: Not Available.

10. STABILITY AND REACTIVITY

Chemical Stability: Unstable above 40°C / 104 °F.
Hazardous Polymerization: Will not occur.
Conditions to Avoid: High temperatures. Exposure to light.
Materials to Avoid: Acids. Ammonia. Strong oxidizers. Reducing agents. Metals.
Hazardous Decomposition Products: When heated to decomposition, it emits acrid smoke and irritating fumes. Chlorine. Oxides of sodium. Oxygen.

Additional Information:

Hypochlorites may react with primary amines to form nitrogen trichloride which explodes spontaneously in air. Hypochlorite bleach reacts with urea to form nitrogen trichloride whic explodes spontaneously in air. Some metals accelarate the decomposition of Sodium Hypochlorite. Nickel. Copper. Tin. Iron and its alloys. Manganese.

11. TOXICOLOGICAL INFORMATION

Principle Routes of Exposure

Ingestion: Corrosive. Causes burns to the mouth, throat and stomach. Causes vomiting, nausea, and diarrhea. Coma, shock and death may occur.

11. TOXICOLOGICAL INFORMATION

Skin Contact: Corrosive. May cause severe skin irritation. Prolonged contact may lead to burns and blisters and may aggravate dermatitis. May cause whitening or bleaching of the skin.
Inhalation: Corrosive to the respiratory passage. Causes irritation of the mouth, nose and throat. Repeated and/or prolonged exposures may cause productive cough, running nose, bronchopneumonia, pulmonary edema (fluid build-up in lungs) and reduction of pulmonary function. If mixed with acids or warmed to temperatures greater than 40 degrees Celcius, Sodium hypochlorite solutions release chlorine gas. This gas can cause severe irritation of the nose and throat. Exposures to high levels of chlorine gas may result in severe lung damage.
Eye Contact: Corrosive to eye tissue and may cause severe damage and blindness.

Additional Information: Aspiration may cause lung damage. Corrosive effects on the skin and eyes may be delayed, and damage may occur without the sensation or onset of pain.
Acute Test of Product:
Acute Oral LD50: Not Available.
Acute Dermal LD50: Not Available.
Acute Inhalation LC50: Not Available.

Carcinogenicity:

Ingredients	IARC - Carcinogens	ACGIH - Carcinogens
Water	Not listed.	Not listed.
Sodium Hypochlorite, Solution	Group 3	Not listed.

Carcinogenicity Comment: No additional information available.

Reproductive Toxicity/ Teratogenicity/ Embryotoxicity/ Mutagenicity: Not Available.

12. ECOLOGICAL INFORMATION

Ecotoxicological Information:

Ingredients	Ecotoxicity - Fish Species Data	Acute Crustaceans Toxicity:	Ecotoxicity - Freshwater Algae Data
Water	Not Available.	Not Available.	Not Available.
Sodium Hypochlorite, Solution	LC50 96 h (Pimephales promelas) 0.06-0.11 mg/L flow-through LC50 96 h (Pimephales promelas) 4.5-7.6 mg/L static LC50 96 h (Lepomis macrochirus) 0.4-0.8 mg/L static LC50 96 h (Lepomis macrochirus) 0.28-1 mg/L flow-through LC50 96 h (Oncorhynchus mykiss) 0.05-0.771 mg/L flow-through LC50 96 h (Oncorhynchus mykiss) >0.03-<0.19 mg/L semi-static LC50 96 h (Oncorhynchus mykiss) 0.18-0.22 mg/L static	Not Available.	EC50 24 h Skeletonema costatum 0.095 mg/L

Other Information:
Harmful to aquatic life at low concentrations. Toxicity is primarily associated with pH.

13. DISPOSAL CONSIDERATIONS

Disposal of Waste Method: Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations.
Contaminated Packaging: Empty containers should be recycled or disposed of through an approved waste management facility.

14. TRANSPORT INFORMATION

DOT (U.S.):
DOT Shipping Name: HYPOCHLORITE SOLUTION
DOT Hazardous Class 8
DOT UN Number: UN1791
DOT Packing Group: III
DOT Reportable Quantity (lbs): Not Available.
Note: No additional remark.
Marine Pollutant: No.

TDG (Canada):
TDG Shipping Name: HYPOCHLORITE SOLUTION
Hazard Class: 8
UN Number: UN1791
Packing Group: III
Note: No additional remark.
Marine Pollutant: No.

15. REGULATORY INFORMATION

U.S. TSCA Inventory Status: All components of this product are either on the Toxic Substances Control Act (TSCA) Inventory List or exempt.

Canadian DSL Inventory Status: All components of this product are either on the Domestic Substances List (DSL), the Non-Domestic Substances List (NDSL) or exempt.

Note: Not available.

U.S. Regulatory Rules

Ingredients	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Water	Not Listed.	Not Listed.	Not Listed.
Sodium Hypochlorite, Solution	Not Listed.	Listed	Not Listed.

California Proposition 65: Not Listed.
MA Right to Know List: Listed.
New Jersey Right-to-Know List: Listed.
Pennsylvania Right to Know List: Listed.

WHMIS Hazardous Class:
E CORROSIVE MATERIAL

16. OTHER INFORMATION

Additional Information: This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

Disclaimer: NOTICE TO READER:
Great North Chemicals, expressly disclaims all express or implied warranties of merchantability and fitness for a particular purpose, with respect to the product or information provided herein, and shall under no circumstances be liable for incidental or consequential damages.

Do not use ingredient information and/or ingredient percentages in this MSDS as a product specification. For product specification information refer to a Product Specification Sheet and/or a Certificate of Analysis.

All information appearing herein is based upon data obtained from the manufacturer and/or recognized technical sources. While the information is believed to be accurate, Great North Chemicals makes no representations as to its accuracy or sufficiency. Conditions of use are beyond Great North Chemicals' control and therefore users are responsible to verify this data under their own operating conditions to determine whether the product is suitable for their particular purposes and they assume all risks of their use, handling, and disposal of the product, or from the publication or use of, or reliance upon, information contained herein. This information relates only to the product designated herein, and does not relate to its use in combination with any other material or in any other process.

3.7 FLOW METER

Two flowmeters are present in this installation.

-One is at pump outlet before the valve set up (this meter all water is exiting the pumps.) (Including water when fire button is pressed on loading arm and valves bypass filters)

-One is at filter outlet. (Any water passing through filter is metered)

-Those flow meter supplies a 4-20 mA signal proportional to flow. present setting is

0 flow is 4mA and 3000 liters per minute is 20mA

-The level of this signal must be programmed by the commissioning engineer to suit proportional chlorine injection.

This signal is used by the two chlorine injection pumps used for the main injection proportional to flow. Analog mode on pump.

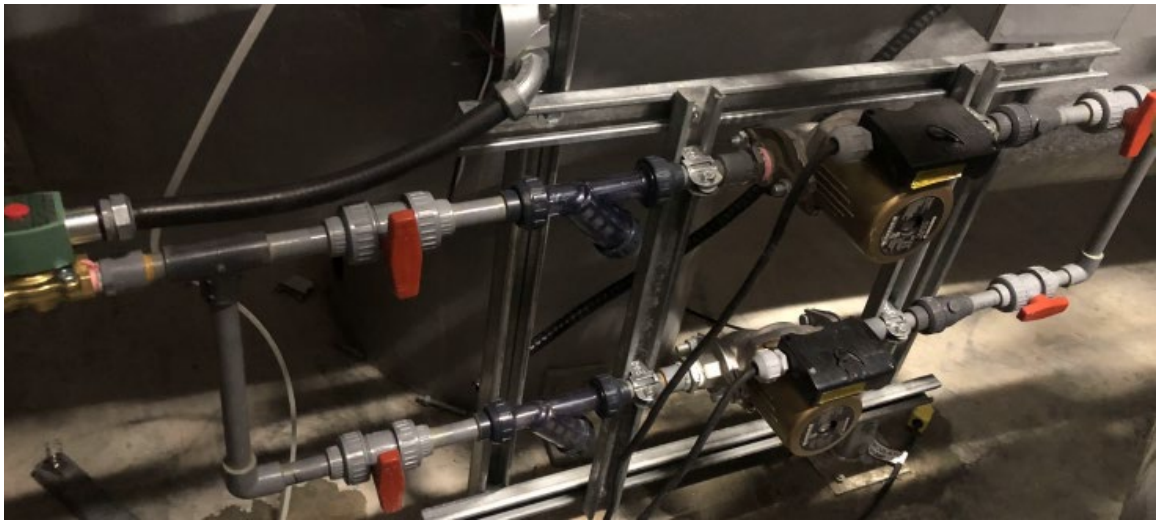
3.8 PROCESS WATER CAPTURE AND TANK FILLING

A simple filling valve is actuated by a float located at process water tank top.

To fill tank water is taken from the 2” circulating loop . Part of the circulated 225 liters is used to cap the tank

3.9 CIRCULATING PUMPS (P2 & P3) (New Circulating Pumps for Microchem2 Probes - Under CCN)

The circulating pumps are used to provide a constant treated water flow to both Microchem2 analysers to determine the Free Chlorine content and are controlled by the Control Panel.



pump stop during truck fill

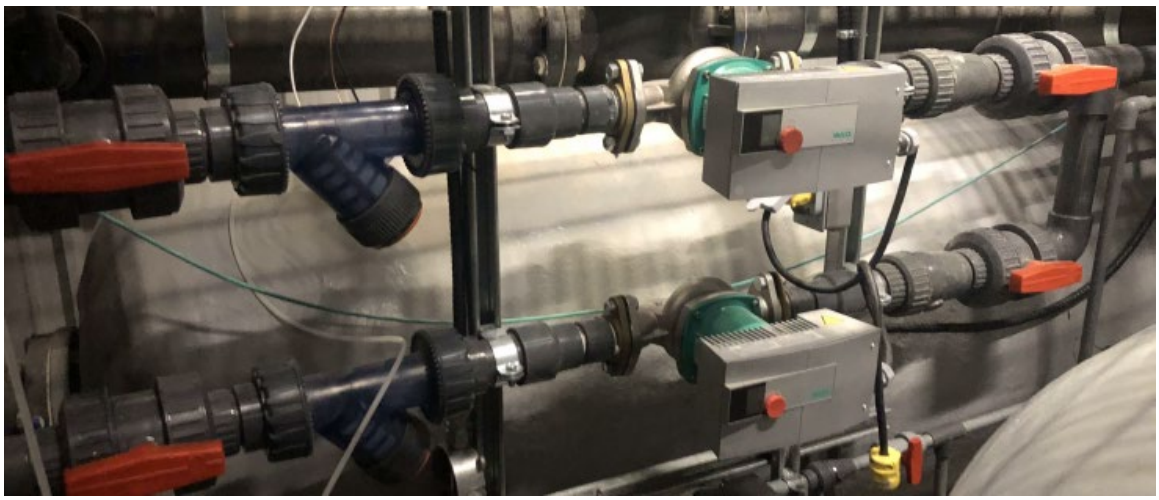
1. Refer to **Chapter 17** for more details

3.10 CIRCULATING PUMPS (PS1 & PS2) (Circulating Pumps for Chlorine Recirculation - Under CCN)

The circulating pumps are used to facilitate diffusion and maintain Free Chlorine level in the 15000 Litre main contact Tank.

Two-hundred and twenty-five liters of treated water are circulated from the 15,000-litre tank outlet to the filter outlet and contact tank inlet.

At all times including overnight and/or between truck filling, chlorine is injected to maintain chlorine level.



Following conditions STOP operation of pumps:

1. During Water Truck fill.
2. Refer to **Chapter 17** for more details

Chapter 4 BUILDING MECHANICAL SYSTEM OPERATION

4.1 Sump pump and Waste water pit

During service sink use, filter change, and floor cleaning, waste water is drained to the waste water pit. Integrated in the sump pump is a control float operating directly at 120 volts in the supply line of the sump pump. That pump expels excess waste water level to the waste water holding tank.

The 120-volt chlorine room sump pump's individual package returns to the 15,000-Liter tank inlet water coming from both analysers located in the chlorination room and at the loading arm free chlorine analyser.

Depending on isolation valve position water can also be returned to pipe casing water intake

4.2 Waste water tank and signal

Under high waste water conditions in tank, two actions are taking place:

1. Red outside indicating lamp is on (high waste water level in storage tank)
2. Domestic pump is blocked and not operating

Pump out is required to resume normal operation.

4.3 Domestic Water Tank

This tank is filled with the treated water circulating loop.

4.4 Domestic Water Pump

Domestic water pump is interlocked where found operating as per spec. (pump stop if drinkable water tank low and or waste water tank full). Domestic water pump is set at 40 PSI of pressure.

The domestic water pump is a self-contained automatic pump. When water is demanded, it maintains water pressure for service sink, cleaning hose, chlorine tank filling, etc.

The following conditions stop operation of pump:

1. Potable water tank is empty
2. Pump pressure outlet is satisfied and pump motor stop.
3. Waste water tank full thus preventing pump operation.

4.5 FUEL SYSTEM

4.5.1 General Operation

Fuel Control Panel has a strobe to horn in case of failure. The fuel control panel is located near the daily fuel tank. When this problem occurs, the operator must find the problem immediately.

4.5.2 Fuel Storage Tank

The purpose of this system is to provide fuel oil to the furnace and the back-up generator. The furnace, primary source of heating, runs all the time with fuel oil. Without fuel oil, the back-up unit heater will take on the heating with electrical input. Otherwise, the building and the pipes will freeze.

4.5.3 Description

Fuel is stored in a 4546 liter (1000 imp. Gal.) storage tank outside the building. When full, this tank holds enough fuel to run the building heating system.

A second, smaller tank 227Liters (50 Gallon imp.) is located near the boiler and holds enough fuel to supply the furnace and the back-up generator.

Refer to Chapter 25 & Chapter 26 for more information.

4.6 FUEL PUMPS

4.6.1 Description

Fuel pumps located in the building automatically draw fuel from the larger tank to fill the smaller tank. Fuel Control Panel (FCP) use Float switches in the smaller tank automatically turn on the pumps when the fuel level is low (40%) and shut the pumps off when the small tank is nearly full near (90%). The operator can manually fill up the day tank using the FCP panel and select ‘’HAND’’ mode. Important: after the operation move back the selector in AUTO mode.

If the level in the small tank gets too low or too high, a "fuel alarm" will show on the interface. If this happens, go to the "trouble shooting" Chapter 7.

4.6.2 Operation

- Every 4 days check the fuel level in the large storage tank outside by reading the gauge of the main tank. Located beside the fuel control panel.
- If the fuel level is low, phone the supplier for more fuel.
- The rest of the system is automatic. No operation should be required. If the system fails to operate properly, go to Chapter 7, "trouble shooting".

Refer to Chapter 25 & Chapter 26 for more information.

4.7 HVAC

4.7.1 General Description

Heating for the building is provided by an Oil-Fired Furnace.

For safety consideration there is a fan (EF-1) in Chlorination Room. This Fan is running constantly, and the Furnace Heating fan assures a negative pressure in chlorination room.

The entire system is self-directed. In case of building low temperature, the systems automatically dial-up the operator.

If any part of the system fails to work, go to the "trouble shooting" **Chapter 7.**

4.8 HEATING FURNACE

4.8.1 Description

The Oil Furnace sucks the fuel from fuel day tank. The Oil furnace supplied hot air to the three rooms via a series of air ducts: Chlorination Room, Generator Room & Filter Room. An independent Thermostat located in filter room is controlling the furnace. Refer to Olsen Chapter for more information about the furnace.

4.8.2 Operation

- Every day check if the Furnace is functioning properly.
- Furnace Fan must:

The rest of the system is automatic. No operation should be required. If the system fails to operate properly, go to **Chapter 7.** "Trouble shooting".

Refer to Chapter 25 for more information.

4.9 UNIT HEATERS (UH-1…)

4.9.1 Description

The Electrical Unit Heaters are only for Emergency Purpose. They kick-off only under low temperature set-point. Electrical Unit Heaters are suspended from the ceiling. Each Unit has their own internal thermostat. Refer to Chapter 27 for more information about the Unit Heater.

4.9.2 Operation

- Every day check if the Thermostat is set around 10°C.
- Every day check if there is no apparent malfunction.

The rest of the system is automatic. No operation should be required. If the system fails to operate properly, go to **Chapter 27**, "trouble shooting".

Chapter 5 ELECTRICAL OPERATION

5.1 Electrical power

The installation is powered by QEC new power line at 208 volts 3 phase with a 250amp 3 phase breaker.

There is always a backup generator 120/208 volts 3 phase of 80 kW capacity feeding an automatic transfer switch ready to start , in case of a QEC Power failure.

The 25 HP main power pumps are fed at 208 volts 3 phase.

Refer to As-built Plans in Chapter 1, for more details.

5.2 Submersible Pumps

A selector switch on control panel in the building allows pump selection. Two independent intakes with their own water reservoirs are available as water source. Pushing the start button located on the water loading arm, activates the selected 25 HP pump. Only one pump at a time can run in normal condition.
In case of ‘’High Flow Demand’’ (Fire in the Hamlet) the two submersible pumps work at the same time to provide maximum flow to loading arm.

Automatic motorised isolating valve assures maximum flow to the loading arm preventing water to back flow in the standby pump.

The selected pump can be stopped using the "Truck Fill Stop" button on the start/stop at arm level and or at ground level in a second station.

At all times, pumps can be started inside building directly on their respective starter by use of a selector mounted directly on the starter box. Turn the selector and manually start the pump. Return to off position or auto stop the pump.

For more information, refer to Chapter 16 & Chapter 28 & Chapter 37.

5.3 Heat Trace

Heat trace system is installed on each water intake. Heat trace and their respective control panel for pipe#1 and pipe #2 was tested and found conform to design. Freezing protection is more than adequate. Spare tubing is available for heat trace running.

Each HTC to control: two heat trace cables and three RTD temperature sensors. There are three sensors per intake pipe: at 15 meters and at 30 meters.

One control panel per intake controls and supervises heat trace operations.

In summary, each heat trace control panel keeps the following tasks under control;

a) To be code conform ground fault protection must always be guaranteed. This control monitors continuously leaks current to ground and gives an alarm on such a condition and cuts the electric circuit to the faulty heat trace.

b) Temperature control inside pump casing. With its probe inserted in the insulated intake casing the controller turns the heat trace on and off to adjust with set point.

c) Control always supervises the correct range of operation; following the alarm set point of operation given at installation. (For example, under heating demand if the controller detects no corresponding electrical current. This is a fault condition and controls fall in alarm condition).

d) For more information, refer to Chapter 38.

Chapter 6 CONTROL OPERATION

6.1 Main Control Panel (Alarm & Pump Control)

On outside Control Panel you can choose between ‘’ Filtration’’ mode or ‘’Fire mode, No Filtration’’ mode. The selector should always be on ‘’Filtration’’ mode. In case of fire flow demand, the operator needs to select ‘’No filtration’’ mode.

The main control panel inside the truck fill station has red indicating lights to warn of any trouble with the system. When one of these lights is on, the operator must acknowledge the problem, find and resolve the problem according to the alarm:

The control panel houses all necessary control relay and supervision relay for alarm purposes.

As long as the alarm condition is not acknowledged by the operator, the control panel sends an alarm condition to the auto-dialler.

The possible alarm conditions are as follows:

a. Generator Trouble

b. Chlorination Alarm

c. Domestic Cold-Water Tank Empty/Domestic Water Pump Failure

d. Water Tank Full

e. Pump Room High Temperature

f. Pump Room Low Temperature/Heat Trace Trouble.

g. Filter Block

h. Pump Trouble

The main control panel in truck fill station building also manages the following items:

2. Motorised Valve No.1
3. Motorised Valve No.2
4. Motorised Valve No.3
5. Motorised Valve No.4
6. Starter Pump No.1 (SS1)
7. Starter Pump No.2 (SS2)
8. Solenoid Valve No.1
9. Solenoid Valve No.2
10. Relay for outdoor Operator Stations (Start & Stop)
11. Selector for mode of operation.

6.1.1 Filtration Mode Selection

On the outside control panel, the operator must select the desired method of operation for the plant.

Following modes are available

1. -Operation with filtration plant (normal operation with filter line
2. -Operation without filtration plant (fire mode two truck can be filled at same time.

With filtration plant mode selected motorized valves MV3 and MV4 automatically divert water flow to the filtration building. Here are the other automatic actions that are undertaken.

If filtered water circulation is detected in the filtration loop by the flow meter, the chlorine injection pump is activated. As required, the process water tank fills up.

Following the selection of operation, if it is without filtration plant mode, the motorized valves MV3 and MV4 automatically isolate filtration plant.

6.2 Pump Sequencer

The pump sequencer's main goal is to alternate working pumps after each truck fill. In case of pump failure an alarm sounds off. If the flow switch of its relevant pump is not "ON" within 15 seconds, the pump sequencer will turn that pump ''OFF'' and turn the next pump ''ON''. This will cause the affected pump to be taken out from the sequence of the ''NEXT PUMP''. It will also turn ''ON'' a ''Pump Trouble No. X''. Latching of a failed pump ''OFF'' can be reset by pressing a ''RESET'' button on the pump sequencer.

The possible alarm conditions are as follows:

1) Pump No.1 No Flow
2) Pump No.2 No Flow
3) Water Pump No.1 Fail
4) Water Pump No.2 Fail

For more information, refer to **Chapter 38.**

Chapter 7 TROUBLESHOOTING

7.1 Submersible Pumps

Mechanically speaking, there is no periodic maintenance to do on these pumps.

If they are defective, they must be replaced as a unit. The pumps or electric motor cannot be repaired, just replace the complete unit motor and pump. The key to avoiding problems with the pumps or electrical motor is a good installation procedure.

The submersible pump motor needs a good, water tight electrical connection, especially for the underwater part of the wiring. This three-phase motor can run in either direction depending on how it is connected to the power supply. When the three cable leads are first connected to the power supply, there is only a 50 % chance that the motor will run in the proper direction.

During the replacement of a pump, special care must be taken to rebuild electrical connections with compressed lugs and heat shrink, following the instructions in this manual.

After replacing the pump, if it does not deliver the expected flow, check the direction of rotation. Rotation can be reversed by exchanging any of the three wires feeding the pump.

Great care must be taken to rebuild these connections. Failure to do so will result in faulty conditions listed below.

7.2 Truck Fill "Start button is pressed but does not start pump"

A) Is power present in building from NPC and/or Generator? (regular lighting is on and emergency lights are off?)

B) Is the corresponding pump insulation contactor beside the door live and red light on, if not, check the following: Is the selector on the insulating contactor on auto? Turn selector to run for trouble shooting purposes. If pump does not start, continue investigation.

1) Is there a ground fault indication on the VFD control push the reset button? If you are unable to reset the pump, the motor is defective to ground. Confirm with a 1000 volts megger insulation condition on pump. If test shows a resistance less than 1 meg ohms, pump motor needs to be replaced.

2) Is the red indicating light live on the contactor with the selector positioned to Run? If it is not:

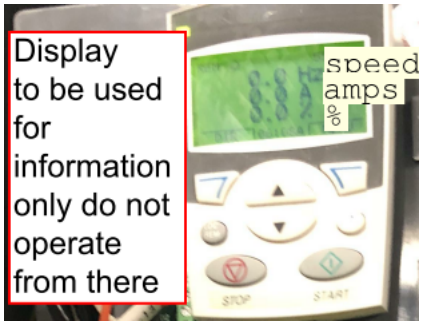
   - Try the other pump turn selector to run. If also dead, problem could be related to control panel 120 volts AC power source.
   - Check and replace fuses as required. If control continues to burn the fuses, find a control technician for repair.

7.3 Pump Soft start VFD

The main function of this electronic device is to start and stop the pumps. It provides the submersible pump with a progressively increasing frequency and current giving a smooth and gradual pressure increase at strainer inlet and filter inlet.

At pump stop speed will gradually and smoothly decrease.

Information on VFD status



7.4 Pump failure -Removal of Pumps for Servicing

If previous troubleshooting clearly indicates a pump malfunction, then we must plan to replace the pump.

Step 1: Call the Area Maintenance Officer.

Step 2: Disconnect the intake line from the building piping.

Step 3: The intake line is about 100 ft long., guide the pipe outside by pulling it out.

Step 4: Pull the pump into the building. Do not let the pump drop onto concrete floor.

7.5 GENERAL

7.5.1 Auto-Dialler Calls

- Fire Alarm.
- Panel Alarm

7.5.2 Alarm Interface is not working properly

- Verify the fuse on the main control panel.
- Validate if the interface is well connected behind the Interface door If it is not, connect it.
- If is still not working, call 855-437-4001 for Technical support.

7.5.3 Building Low temperature

- Verify thermostat settings for the individual Unit Heaters (UH-1 @ UH-5) and the furnace. If the temperature is below 10°C, boost thermostats to 20°C. Wait 10 minutes and validate. If they do not work properly refer to Chapter 27.Go to step 7.5.4.

7.5.4 The furnace does not work properly

- Validate if the fuel pumps are working properly.
- If the fuel pump's control panel displays LLA (low level alarm) check the main tank level.
- If the level ok check exterior supply valves on fuel line.
- If outside valve is closed push and hold for five minutes and start push button on control panel, after a delay, the tank filling will resume normal operation.
- Validate if the furnace is functioning properly, if not, go to Chapter 20.

7.5.5 The Fuel Pumps does not work properly

- Validate if Fuel Pumps are in AUTO mode. If not, select AUTO mode.
- Pumps should start and fill up day tank.
- Validate if fuel is available in the day tank. If not, validate if fuel is available in the main tank. If the fuel level is low, phone the supplier for more fuel.
- If fuel pumps are not pumping, Refer to the fuel pump manual Chapter 25.

7.5.6 Fire Alarm system does not work properly

- Fire heads are only connected to the alarm panel as a high temperature alarm, no supervision is available on these sensors

7.5.7 Unit Heater systems are not working properly

- If Unit Heater are not working properly, refer to Chapter 27

7.5.8 Damper Actuator is not working properly

- If Damper Actuator is not working properly, refer to Chapter 23

7.6 MAINTENANCE

The following outline for a maintenance program is general information and is an essential, effective, economic, and safe operation of mechanical equipment, systems and services.

The key to generally low maintenance costs for the system is a standard preventative maintenance program based upon the manufacturer's recommended procedures.

With the sophistication of mechanical systems for environmental control, there is a greater need for proper operation and maintenance of the systems to avoid costly breakdowns or failure in performance. The total cost of such breakdowns includes not only the cost of necessary repairs and the replacement of damaged parts, but also the loss of use, inconvenience, down time and possibly partial or even complete shutdown of the facility.

Sound operating procedures and maintenance programs as itemized below, can serve to achieve these benefits:

1 Become familiar with the manufacturer's information in the operating manuals,

2 Stocking an adequate supply of spare parts.

3 Develop a program and provide an adequately managed and trained staff to implement the program.

4 Consider an option of a service contract for all specialized systems such as refrigeration systems and automatic controls.

7.7 Preventive maintenance and Safety

To ensure uninterrupted use, equipment should be regularly inspected, tested and proper repairs made and recorded.

The objective is to minimize equipment operating problems and prevent failures by making minor or necessary repairs before major difficulties occur. The importance of record keeping cannot be over emphasized. Good maintenance protects the Owner's interest with manufacturer warranties, continuity of maintenance despite staff turnover and equipment reliability track record.

Environmental and operating conditions are key elements affecting proper and reliable operating of equipment.

Costly repairs can be minimized if the following items are attended to -

KEEP IT TIGHT
KEEP IT CLEAN

Day-to-day accumulation of normal atmospheric particles lint, metallic particles from mechanical equipment cause problems with equipment over a long period of time, as accumulation affects equipment reliability and operating life. **ALL equipment should be regularly cleaned.**

7.8 Keep it Tight

All dynamic equipment and control devices operate with high speed movement. This motion creates vibration that can loosen hardware and other parts. External vibration from equipment may cause the loosening of hardware and connections in any equipment. **All hardware and connections should be tightened regularly**. This simple procedure takes only a small amount of time and can save hours of searching for intermittent problems. All rotating equipment such as motors is affected by vibrations causing alignment problems resulting in bearing failures.

7.9 Renewal Parts

Availability of parts can be a major problem in **IGLOOLIK**.

Delivery can be delayed for many reasons including the weather. For this reason, local distributors should be contacted, and the availability of parts assessed. Any critical part affecting the reliability of the system should be ordered, recorded and stored.

7.10 Schedule Maintenance Program

Scheduled maintenance is an effective means to improve service from systems and equipment. Where failure of equipment can result in shut down, scheduled maintenance is an economical alternative.

Most maintenance can be done by average personnel, with a minimum need for specialized services.

7.11 Causes of equipment failure

An effective maintenance program will attempt to remove or reduce causes of equipment failure. Common causes of failure are:

1 Clogged filters

2 Improper lubrication and oiling or lack of

3 Persistent overloading

4 Above normal temperatures

5 Below normal temperatures

6 Obstruction of system by foreign objects or material (blockage or air, dirt on components -etc.)

7 Normal deterioration

8 Severe weather conditions.

7.12 Maintenance list

Refer to spare parts list

Chapter 8 CERTIFICATIONS

8.1 TESTING/TRAINING SHEET

SIFEC NORTH INC. COMMISSIONING TRAINING		
Revision Sifec – Rev 12-07-2018	***Training and Communication***	***Record of Training***

The purpose of this training is to ensure that plant operators are familiar with the functional operations of the equipment/process of a new plant and have demonstrated competency.

Community: **IGLOOLIK – TRUCKFILL STATION**	**Date Trained - Commissioned:**
Persons Being Trained - Name and Surname: _____ _____ _____ _____ _____ _____ _____	**Signatures:** _____ _____ _____ _____ _____ _____ _____

(To be signed when all training has been completed)

Training Day #	Equipment/Process	Reference Material/Notes O&M	Trainers Name Can be the contractor/supplier for equipment and the Project manager for processes	Trainers Signature	Date Completed Needs to reflect the actual day of training
1	**Stand-By Genset - MTU** Overview of the unit • Prestart up checks • Start • Rated and on line • Unload • Shutdown Filters and change out system				
1	**Ventilation** • Furnace Maintenance • Furnace Troubleshooting • T775 Controller • Damper • Actuators				
1	**Fuel** • Fuel Pumps				

	• Fuel Control Panel • Fuel Filter • Fuel Level Switch				
1	**Oil** • Oil filing system • Oil emptying system				
1	**Electrical** • Battery • Charger • Transfer Switch • Breaker Locations • Power Distribution • Lighting • Emergency Lighting				
1	**Electrical Unit Heater** • Operation • Troubleshooting Maintenance				
1	**Electrical Heat Trace** • Operations • Replace • Alarm Power Connections				
	==========	==========	==========	======	========
1-2	**Raw Water Submersibles Pumps** • Operations • Pump Sequencer • Replace • Alarm Power Connections				
1-2	**Harmsco Strainers** • Clean Strainers Daily				
1-2	**Water Filter – Harmsco Stainless Steel Housing** • Differential Pressure				

	• Replace 20 Microns Filters (5) • Replace 5 Microns Filters (5) • Replace LT2 Filters (8) • Consumables				
1-2	**Chlorine Mixer MC4-50** • Operation • Hooper Insert • Briquette Maintenance				
2-3	**CHLORINATION DOSING PUMPS (CP1 to CP4)** • Operation • Maintenance				
2-3	**CHLORINE CONTROLLER (Microchem 2)** • Operation • Maintenance • Probe Replacement • Probe Calibration • Control				
2 to 28	**PH Probe Replacement** • Operation • Maintenance • Probe Replacement • Probe Calibration • Control				
2 to 28	**Free Chlorine Probe Replacement** • Operation • Maintenance • Probe Replacement • Probe Calibration • Control				
2 to	**Hand Pocket Hach (Free Chlorine)** • Operation				

28	• Maintenance • Consumables				
2 to 28	**PH Pocket Tester** • Operation • Maintenance • Consumables				
2-28	**DATA RECORDER (Nanodac)** • Modem Troubleshooting • Programming • Recording • Maintenance				
3	**FLOW METER** • Operation • Troubleshooting • Maintenance				
3 to 28	**RE-CIRCULATION PUMPS (P2 & P3)** • Operation • Troubleshooting • Maintenance				
3 to 28	**RE-CIRCULATION PUMPS (PS1 & PS2)** • Operation • Troubleshooting • Maintenance				
4 to 28	**CONTROL PANEL (SV-1 to SV-4 and MV-1 to MV-4)** • Operation • Alarm • Troubleshooting • Maintenance				
4	**SUMP PUMP and WASTE WATER PIT** • Operation				

	• Troubleshooting • Maintenance				
4	**DOMESTIC WATER PUMP and WATER TANK** • Operation • Troubleshooting • Maintenance				
Notes:					

Project Manager Verification

Name:	**Signature:**

(To be signed when all training has been completed)

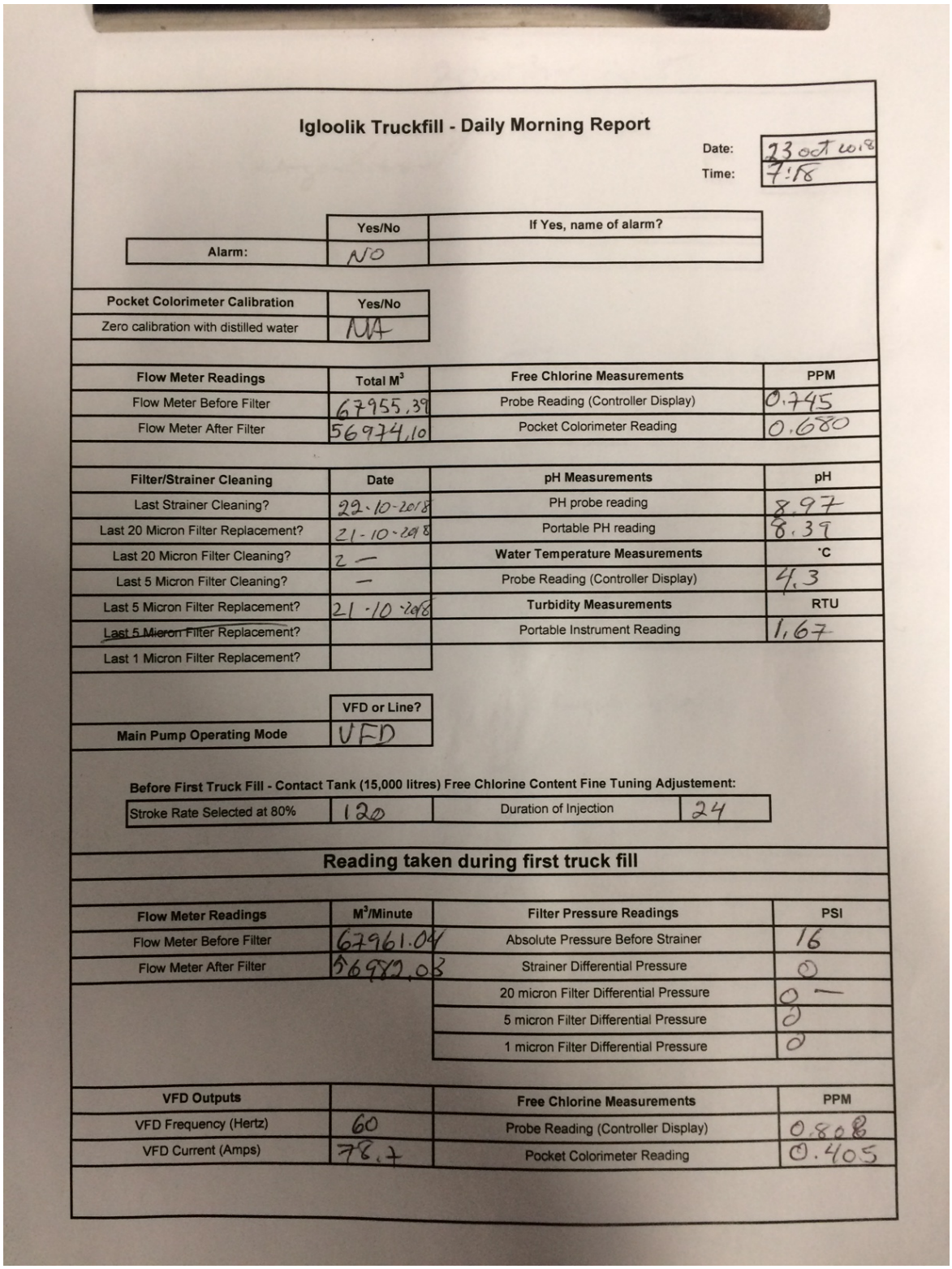
8.2 CONSUMMABLES LIST NECESSARY FOR 3 MONTHS OPERATION

Quantity	Product	Supplier
2	P/N 924595 - Injection Valve ½" x 3/8" x ½: MNPT, PVC/Viton -	Provan or Metcon
2	P/N 10-4002 – Maintenance Kit:	Provan or Metcon
2	P/N 29263 – Preventive Maintenance Kit:	Provan or Metcon
1	P/N 23183 – Chlorine Probe 2ppm:	Provan or Metcon
2	pH probe (part # 26189)	Provan or Metcon
1	H2635300_H2635300 - SpechCheck Secondary Gel Standards Set, DPD	Hach
3	H2105528_H2105528 - DPD Free Chlorine Reagent powder pillow	Hach
3	H2105628_H2105628 - DPD Total Chlorine reagent powder pillows 10ml	Hach
3	H2601300_H2601300 - pH Paper, 0 - 14 pH Range	Hach
5	H2427606_H2427606 - Sample Cell 25x60mm 10ml pk/6, w/cap used with pocket colorimeter	Hach
4	SAP340_SAP340 – Latex gloves Medium	Tenaquip
8	SAP341_SAP341 – Latex Gloves Large	Tenaquip
1	JB896_JB896 Garbage Bag	Tenaquip
36	PM1345751_PM1345751 – Industrial Paper towels - absorbent - resistant	Patrick Morin
7	ACG12_ACG12 - Hypochlorite de sodium 55litres	Distributions J.Y. St-Pierre Inc.
18	MultiFold Paper Towel Bounty S-16501 (Case of 8)	U-Line
15	HC17020WHF_HC17020WHF - Hurricane Fltr Cart	Dyna-Pro
15	HC1705WHF_HC1705WHF - Hurricane Fltr Cart	Dyna-Pro
24	HC170LT2_HC170LT2 - Hurricane Fltr Cart	Dyna-Pro

8.3 SPARE PARTS

Quantity	Make	Model	Description
2	Square D	QOB115	15A Breakers Bolt-on
2	Square D	QOB120	20A Breakers
2	Square D	QOB130	30A Breakers
10	Ferraz	GGC3	Fuses
10	Ferraz	GGM3	Fuses
10	Ferraz	GGC5	5A Fuses
4	GF	1A-30	Furnace Oil Filter
12	DAFCO	DAFSC16251	Furnace Air Filters
1	DELAVAN	DEL55X60W	Nozzle 0,55 gph for Becket NX 70lhhs
1	MTU	X57536400006	Generator Fuel Filter
1	MTU	ECB105002 DC168G A	Air Filter
1	MTU	OM924la	Generator Oil Filter #234644 PNR: 2084415371 AENT : A1153625
4	Willsup Gasket	custom	Gaskets 6'' ring 1/8''
2	Willsup Gasket	custom	Gaskets 4'' Ring 1/16''
1	Willsup Gasket	custom	Gaskets 2'' Ring 1/16''
1	Ipex		Ball Valve 3/8'' PVC SCH80
2	Ipex		Ball Valves 1/2'' C-PVC SCH80
2	Ipex		Ball Valves 1'' PVC SCH80
2	Ipex		Ball Valves 2'' PVC SCH80
2	Ipex		Ball Valve 2'' SCH40 PVC

8.4 DAILY LOG SHEET



Igloolik Truckfill - Daily Morning Report

Date: 23 oct 2018
Time: 7:18

	Yes/No	If Yes, name of alarm?
Alarm:	NO	

Pocket Colorimeter Calibration	Yes/No
Zero calibration with distilled water	NA

Flow Meter Readings	Total M^3	Free Chlorine Measurements	PPM
Flow Meter Before Filter	67955,39	Probe Reading (Controller Display)	0.745
Flow Meter After Filter	56974,10	Pocket Colorimeter Reading	0.680

Filter/Strainer Cleaning	Date	pH Measurements	pH
Last Strainer Cleaning?	22-10-2018	PH probe reading	8.97
Last 20 Micron Filter Replacement?	21-10-2018	Portable PH reading	8.39
Last 20 Micron Filter Cleaning?	2 —	**Water Temperature Measurements**	°C
Last 5 Micron Filter Cleaning?	—	Probe Reading (Controller Display)	4,3
Last 5 Micron Filter Replacement?	21-10-2018	**Turbidity Measurements**	RTU
~~Last 5 Micron Filter Replacement?~~		Portable Instrument Reading	1,67
Last 1 Micron Filter Replacement?			

	VFD or Line?
Main Pump Operating Mode	VFD

Before First Truck Fill - Contact Tank (15,000 litres) Free Chlorine Content Fine Tuning Adjustement:

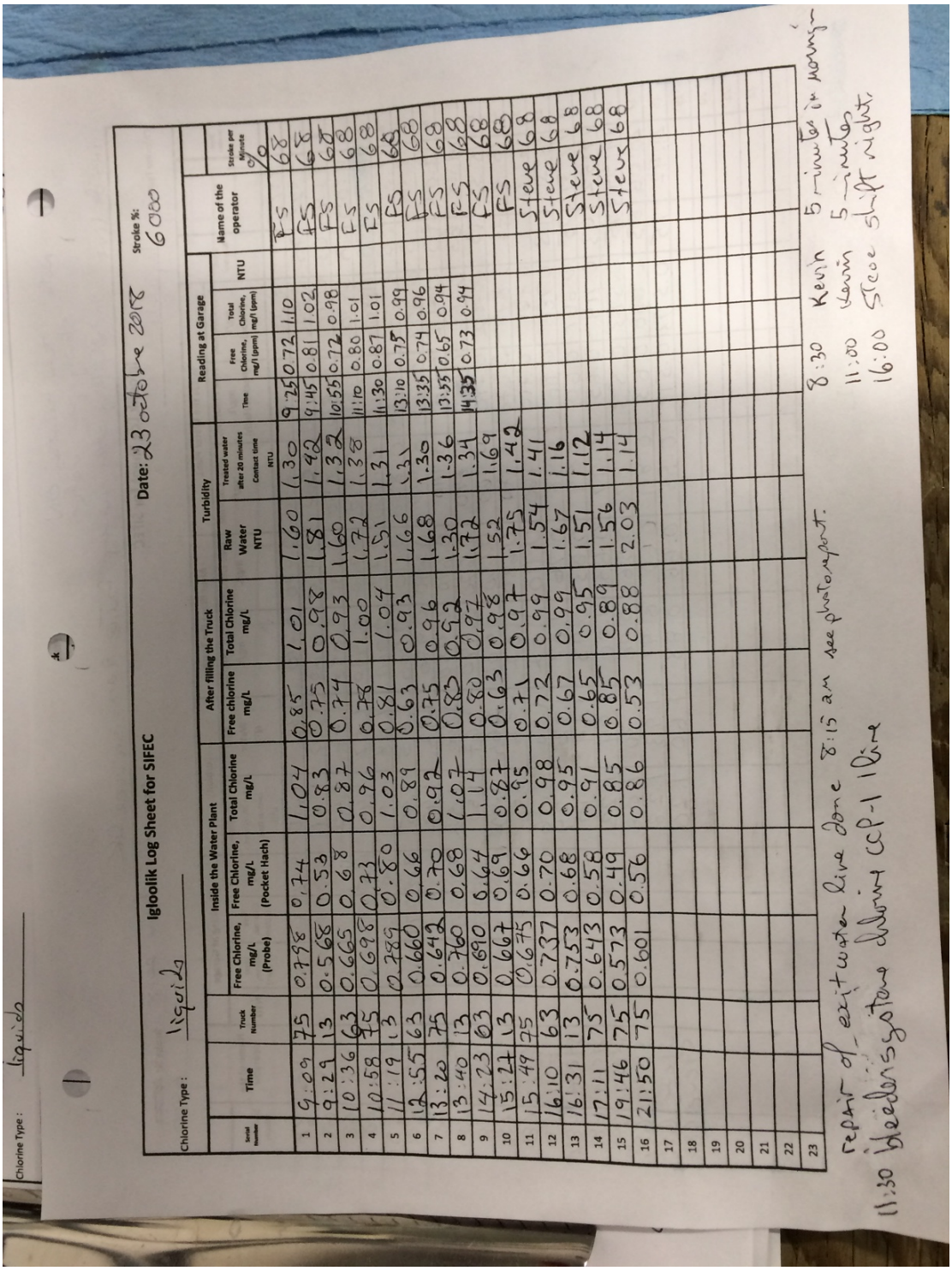
Stroke Rate Selected at 80%	120	Duration of Injection	24

Reading taken during first truck fill

Flow Meter Readings	M^3/Minute	Filter Pressure Readings	PSI
Flow Meter Before Filter	67961.04	Absolute Pressure Before Strainer	16
Flow Meter After Filter	56982.08	Strainer Differential Pressure	0
		20 micron Filter Differential Pressure	0 —
		5 micron Filter Differential Pressure	0
		1 micron Filter Differential Pressure	0

VFD Outputs		Free Chlorine Measurements	PPM
VFD Frequency (Hertz)	60	Probe Reading (Controller Display)	0.808
VFD Current (Amps)	78.7	Pocket Colorimeter Reading	0.405

8.5 DAILY LOG SHEET



Chlorine Type : liquids

Igloolik Log Sheet for SIFEC

Chlorine Type : liquids

Date: 23 octobre 2018

Stroke %: 6080

Load number	Time	Truck Number	Inside the Water Plant			After filling the Truck		Turbidity		Reading at Garage			Name of the operator	Stroke per Minute 68
			Free Chlorine, mg/L (Probe)	Free Chlorine, mg/L (Pocket Hach)	Total Chlorine mg/L	Free chlorine mg/L	Total Chlorine mg/L	Raw Water NTU	Treated water after 20 minutes Contact time NTU	Time	Free Chlorine, mg/l (ppm)	Total Chlorine, mg/l (ppm)	NTU		
1	9:09	75	0.758	0.74	1.04	0.85	1.01	1.60	1.30	9:25	0.72	1.10		FS	68
2	9:29	13	0.568	0.53	0.83	0.75	0.98	1.81	1.42	9:45	0.81	1.02		FS	68
3	10:36	63	0.665	0.68	0.87	0.74	0.93	1.60	1.32	10:55	0.72	0.98		FS	68
4	10:58	75	0.698	0.73	0.96	0.78	1.00	1.72	1.38	11:10	0.80	1.01		FS	68
5	11:19	13	0.789	0.80	1.03	0.81	1.04	1.51	1.31	11:30	0.87	1.01		FS	68
6	12:55	63	0.660	0.66	0.89	0.63	0.93	1.66	1.31	13:10	0.75	0.99		FS	68
7	13:20	75	0.643	0.70	0.92	0.75	0.96	1.68	1.30	13:35	0.74	0.96		FS	68
8	13:40	13	0.760	0.68	1.07	0.83	0.92	1.30	1.36	13:55	0.65	0.94		FS	68
9	14:23	63	0.690	0.64	1.14	0.80	0.97	1.72	1.34	14:35	0.73	0.94		FS	68
10	15:27	13	0.667	0.69	0.87	0.63	0.98	1.52	1.69					FS	68
11	15:49	75	0.675	0.66	0.95	0.71	0.97	1.75	1.42					Steve	68
12	16:10	63	0.737	0.70	0.98	0.72	0.99	1.54	1.41					Steve	68
13	16:31	13	0.753	0.68	0.95	0.67	0.99	1.67	1.16					Steve	68
14	17:11	75	0.643	0.58	0.91	0.65	0.95	1.51	1.12					Steve	68
15	19:46	75	0.573	0.49	0.85	0.85	0.89	1.56	1.14					Steve	68
16	21:50	75	0.601	0.56	0.86	0.53	0.88	2.03	1.14					Steve	68
17															
18															
19															
20															
21															
22															
23															

repair of exit water line done 8:15 am see photo report.

11:30 bleeders system during CCP-1 line

8:30 Kevin 5 minutes in morning

11:00 Kevin 5 minutes

16:00 Steve shift night

8.6 **NANODAC PROCEDURE & GRAPHIC EXAMPLE**

NANODAC ACCESS PROCEDURE

To transfer file from nanodac,

1. download the file: http://ftp.sifec.biz/

[ ] 6xxxTools5p7p1.exe ---- this is the program to view chart in the nanodac
[ ] TeamViewer_Setup.exe ----------team viewer is an application for remote assistance
[ ] WinSCP-5.13.3-Setup.exe --- this is a free FTP application to transfer file .

the address of the nanodac is : Pang-wtp.dyndns.org

in FTP , user: history

password: 100

this is the video to make it work, Review is not an easy application

https://www.youtube.com/watch?v=_bfw2SAxWWY

file:///C:/Users/Igloolik%20Truckfill/Desktop/nano%20chart/2018-10-23.pdf
Raw Wtr Flow L/Min
0.00 300.00 600.00 900.00 1200.00 1500.00 1800.00 2100.00 2400.00 3000.00
Filter Wtr PH PH
0.00 1.40 2.80 4.20 5.60 7.00 8.40 9.80 11.20 12.60 14.00
Final Treated Chl mg/l
Filter Wtr Chl mg/l
0.000 0.200 0.400 0.600 0.800 1.000 1.200 1.400 1.600 1.800 2.000
18/10/23 08:00:00
18/10/23 12:00:00
18/10/23 16:00:00
18/10/23 20:00:00
18/10/24 00:00:00
18/10/24 04:00:00
Filter Wtr Chl
Raw Wtr Flow
Final Treated Chl
Filter Wtr PH
18/10/23 07:00:00
2018-10-24 10:00:50 AM
Chart Nanodac
18/10/24 06:59:59
Page 1 of 1

8.7 WARRANTY LETTER

SIFEC NORTH

P.O. Box 556, Rankin Inlet, NU, X0C 0G0, Tel: 1-866-437-4001

October 29, 2018

C/O Greg Morash
Senior Administrative Officer
P.O. Box 30
Igloolik, Nunavut X0A 0L0
Tel: (867) 934-8830
Fax: (867) 934-8757
SAO@Igloolik.ca

Subject: Water and Wastewater Infrastructure Upgrade, Igloolik, NU
Substantial Completion Date – October 26, 2018

Dear Mr. Morash:

SIFEC NORTH INC. guarantees the mechanical and electrical systems as well as any related equipment according to **Contract #15230-00278** for a one (1) year period effective as of the date of the substantial completion, in this case as of October 26, 2018.

Best regards,

Rhea Fauteux, P.Eng.
Project Manager

RF/jp

Chapter 9 MECHANICAL IDENTIFICATION

MANUFACTURER/DISTRIBUTOR:

LUMEN ST-JÉRÔME
Richard Chamberland
Phone: (450) 436-3225
Fax: (450) 436-2537
Richard.chamberland@sonepardis.ca

Tenaquip Limited
20701, Chemin Sainte-Marie,
Sainte-Anne-de-Bellevue, QC
H9X 5X5
Phone: 514-457-7800
Call: 1-800-661-2400
Fax: 1-800-661-2212

9.1 BRADY PRINTER

BRADY
WHEN PERFORMANCE MATTERS MOST™

Brady B-7425 Workhorse® Series Thermal Transfer Labels

www.BradyID.com/lab

As part of Brady's Workhorse Label Series, the B-7425 thermal transfer labels are engineered to withstand the harshest environments across a wide variety of laboratory applications. These labels are constructed with durable polypropylene material to provide a tough and economical solution for improved identification and workflow tracking in the lab. They're ideal for a broad range of processes and applications, including samples, inventory, general tracking, and identification of vials, tubes, racks, flasks, bags and other sample containers.

Features:

- Economical solution for vials and tubes from 0.5ml to 50ml
- Use on tubes, vials, boxes, racks, slides, microplates, flasks, dishes, bags or other general needs
- Apply to dry room temperature samples with no overlap needed
- Adhere to stainless steel, glass and polypropylene
- Withstand temperature ranges from -196°C to 121°C (-320°F to 248°F)
- Use in LN2, freezers, autoclave, and hot water baths.
- Chemical resistance to ethanol, DMSO, IPS, short term xylene, 10% formalin, 50% acetic acid and toluene
- Prints best with R6400 black ribbon (can also use R4300 or R6200 black ribbon)
- Stock sizes available for Brady portable and benchtop thermal transfer printers, as well as 1" and 3" core rolls for other industry printers
- Custom label sizes and print automation options available

For more information, call a Brady Lab Specialist at 1-800-356-9951, contact your lab distributor or visit BradyID.com

Brady B-7425 Workhorse® Series Thermal Transfer Labels

Catalog #	Size	Core Size	Printer Compatibility
IP Printer, PR+ Printers			
THT-257-7425-2	0.825" x 0.250"	3" Core	IP Printer, PR+
THT-249-7425-2	1.000" x 0.375" w/ 0.375" dia top	3" Core	IP Printer, PR+
THT-251-7425-2	1.000" x 0.500" w/ 0.440" dia top	3" Core	IP Printer, PR+
THT-152-7425-2	1.000" x 0.375"	3" Core	IP Printer, PR+
THT-59-7425-2	1.000" x 0.500"	3" Core	IP Printer, PR+
THT-88-7425-2	1.000" x 0.750"	3" Core	IP Printer, PR+
THT-179-7425-2	1.000" x 1.000"	3" Core	IP Printer, PR+
THT-256-7425-2	1.300" x 0.600"	3" Core	IP Printer, PR+
THT-37-7425-2	1.500" x 0.500"	3" Core	IP Printer, PR+
THT-136-7425-2	1.500" x 0.750"	3" Core	IP Printer, PR+
THT-235-7425-2	1.500" x 1.000"	3" Core	IP Printer, PR+
THT-258-7425-2	1.500" x 1.750"	3" Core	IP Printer, PR+
THT-53-7425-2	2.000" x 0.500"	3" Core	IP Printer, PR+
THT-151-7425-2	2.000" x 0.250"	3" Core	IP Printer, PR+
THT-137-7425-2	2.000" x 1.000"	3" Core	IP Printer, PR+
BBP12 Printer			
THT-257-7425-2-SC	0.825" x 0.250"	1" Small Core	BBP12 only
THT-249-7425-2-SC	1.000" x 0.375" w/ 0.375" dia top	1" Small Core	BBP12 only
THT-251-7425-2-SC	1.000" x 0.500" w/ 0.440" dia top	1" Small Core	BBP12 only
THT-152-7425-2-SC	1.000" x 0.375"	1" Small Core	BBP12 only
THT-59-7425-2-SC	1.000" x 0.500"	1" Small Core	BBP12 only
THT-88-7425-2-SC	1.000" x 0.750"	1" Small Core	BBP12 only
THT-179-7425-2-SC	1.000" x 1.000"	1" Small Core	BBP12 only
THT-256-7425-2-SC	1.300" x 0.600"	1" Small Core	BBP12 only
THT-37-7425-2-SC	1.500" x 0.500"	1" Small Core	BBP12 only
THT-136-7425-2-SC	1.500" x 0.750"	1" Small Core	BBP12 only
THT-235-7425-2-SC	1.500" x 1.000"	1" Small Core	BBP12 only
THT-258-7425-2-SC	1.500" x 1.750"	1" Small Core	BBP12 only
THT-53-7425-2-SC	2.000" x 0.500"	1" Small Core	BBP12 only
THT-151-7425-2-SC	2.000" x 0.250"	1" Small Core	BBP12 only
THT-137-7425-2-SC	2.000" x 1.000"	1" Small Core	BBP12 only
BBP33 Printer			
B33-257-7425	0.825" x 0.250"	B33 Series Roll	BBP33
B33-249-7425	1.000" x 0.375" w/ 0.375" dia top	B33 Series Roll	BBP33
B33-251-7425	1.000" x 0.500" w/ 0.440" dia top	B33 Series Roll	BBP33
B33-152-7425	1.000" x 0.375"	B33 Series Roll	BBP33
B33-59-7425	1.000" x 0.500"	B33 Series Roll	BBP33
B33-88-7425	1.000" x 0.750"	B33 Series Roll	BBP33
B33-179-7425	1.000" x 1.000"	B33 Series Roll	BBP33
B33-256-7425	1.300" x 0.600"	B33 Series Roll	BBP33
B33-37-7425	1.500" x 0.500"	B33 Series Roll	BBP33
B33-136-7425	1.500" x 0.750"	B33 Series Roll	BBP33
B33-235-7425	1.500" x 1.000"	B33 Series Roll	BBP33
B33-258-7425	1.500" x 1.750"	B33 Series Roll	BBP33
B33-53-7425	2.000" x 0.500"	B33 Series Roll	BBP33
B33-151-7425	2.000" x 0.250"	B33 Series Roll	BBP33
B33-137-7425	2.000" x 1.000"	B33 Series Roll	BBP33
BMP21-Plus, BMP21-LAB Printers			
M21-375-7425	0.375" x 21'	Cartridge	BMP21
M21-500-7425	0.500" x 21'	Cartridge	BMP21
M21-750-7425	0.750" x 21'	Cartridge	BMP21

USA
Customer Service: 1-888-272-3946
Inside Sales: 1-888-311-0775
BradyID.com

Canada
Customer Service: 1-800-263-6179
BradyCanada.ca

Mexico
Customer Service: 1-800-262-7777
Inside Sales: 1-800-262-7777 ext 177
BradyLatinAmerica.com

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Chapter 10 HOT WATER TANK

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax: (514) 344-9341

10.1 DOMESTIC HOT WATER TANK A.O. SMITH DEL30D (HWT-1)

Commercial Electric Water Heaters

DHWT

™

Designed for use as a recovery heater having its own storage tank. Available in upright standard models (DEN) and lowboy models (DEL).

GLASSLINED TANK - Thirteen sizes; 6 thru 119 gallon capacity. Tank interior is coated with glass specially designed by A. O. Smith for water heater use.

ELEMENTS - Zinc plated copper sheaths for longer life. Medium watt density means lower surface temperature to minimize scale build-up and more surface to heat water. Element sizes from 1.5 to 6 KW. Maximum input 12 KW (see chart on back).

STANDARD VOLTAGES - 120, 277 single phase and 208, 240 and 480V unbalanced three-phase delta; easily converted to single-phase at terminal block (except 208V with 6000 watt elements). Single element heater, single-phase only.

TERMINAL BLOCK - Factory-installed. Just bring the service to heater and connect to block. Terminal block not supplied on 120V & 277 volt models. (No junction box on DEL6-20)

CONTROLS - Temperature control (adjustable through arange of 110° to 170°F on single element and 120° to 180°F on dual element) and manual reset high temperature cutoff per element (dual element models). Factory-wired for non-simultaneous operation; easily converted to simultaneous element operation (three phase models only).

CSA CERTIFIED AND ASME RATED T&P RELIEF VALVE

SIMPLIFIED CIRCUITRY, COLOR CODED FOR EASE OF SERVICE

ANODE ROD FOR MAXIMUM CORROSION PROTECTION

CABINET HAS BONDERIZED UNDERCOAT WITH BAKED ENAMEL FINISH

TOP INLET AND OUTLET OPENINGS

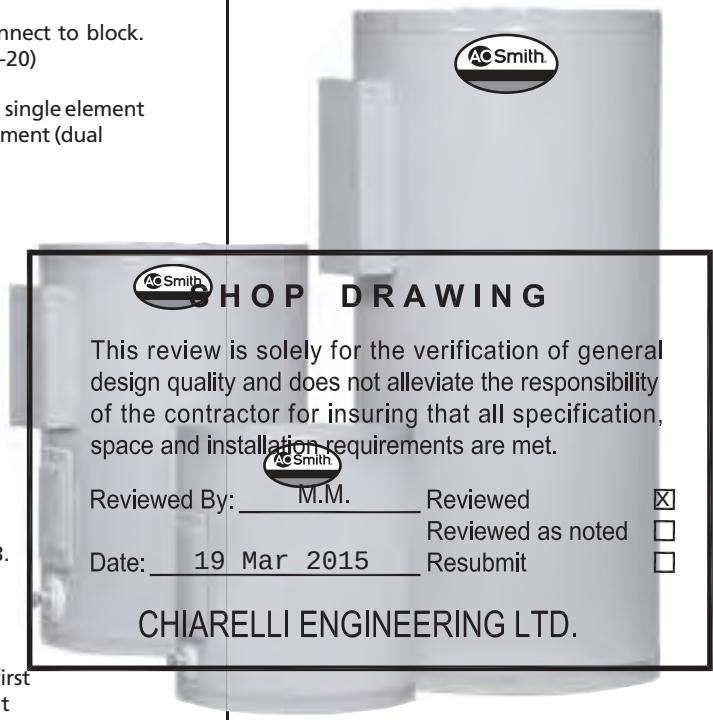
DRAIN VALVE (EXCLUDES DEL 6-20)

UL APPROVED FIELD CONVERSION PROGRAM - The 6 through 20 models are UL listed to UL 174 and the 30 through 120 models are listed to UL 1453.

COMPLIANCE - Meets the standby loss Requirements of the U.S. Department of Energy and current edition of ASHRAE/IESNA 90.1.

LIMITED WARRANTY OUTLINE - If the tank should leak any time during the first three years, under the terms of the warranty, A. O. Smith will furnish a replacement heater; installation, labor, handeling and local delivery extra. THIS OUTLINE IS NOT A WARRANTY. For complete information consult the written warranty or A. O. Smith Water Products Company.

DEN/DEL MODELS



SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

ELEMENT AVAILABILITY CHART

Input	120V	208V	240V	277V	480V
1,500	YES	YES	YES	YES	—-
2,000	YES	YES	YES	YES	YES
2,500	YES	YES	YES	YES	YES
3,000	YES	YES	YES	YES	YES
3,500	—-	—-	YES	—-	—-
4,000	—-	YES	YES	YES	YES
4,500	—-	YES	YES	YES	YES
5,000	—-	YES*	YES*	YES*	YES*
5,500	—-	—-	YES*	—-	—-
6,000	—-	YES**	YES	YES	YES

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

NOTE: DEL-6 not available in above 2.5 KW.
DEL-6 not available in 480V.

* Not available in DEL-10, DEL-15 and DEL-20.
** A6 non-simultaneous circuit only.

c UL us

Low Lead Content

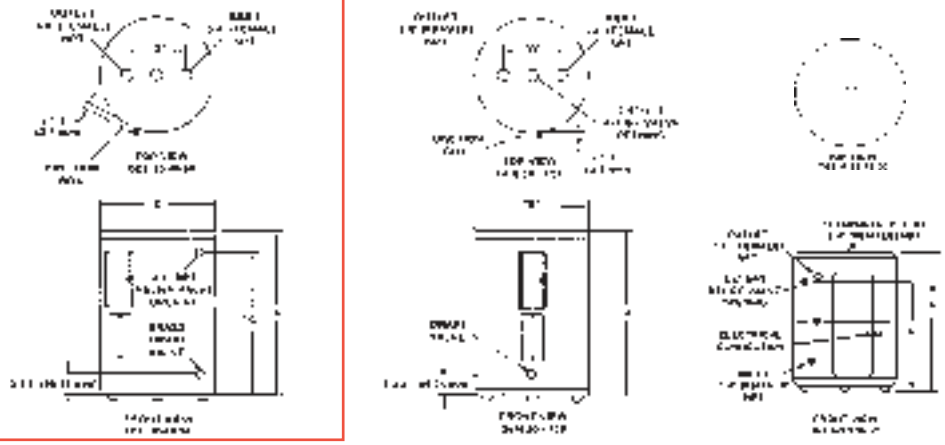
Revised April 2013

Commercial Electric Water Heaters

Dura-Power™

PRODUCT SPECIFICATIONS

DHWT



ROUGH-IN DIMENSIONS

Models Dimensions	No. of Elements	Tank Capacity US Gals.	Tank Capacity Litres	A inches	A mm	B inches	B mm	C inches	C mm	D inches	D mm	Shipping Weight. Lbs.	Shipping Weight. Kg.
DEL-6	1	6	23	15 1/2	394	14 1/4	362	11	279	-	-	35	15.9
DEL-10	1	10	38	18 1/4	464	18	457	12 1/2	318	-	-	54	24.5
DEL-15	1	15	57	26	660	18	457	20 1/2	521	-	-	58	26.3
DEL-20	1	20	76	22 1/4	565	21 3/4	552	15 3/8	391	-	-	73	33.1
DEL-30	2	30	114	30 7/8	784	21 3/4	552	24 1/8	613	8	203	100	45.4
DEL-40	2	40	151	32 1/4	819	24	610	25 9/16	649	8	203	125	56.7
DEL-50	2	50	189	32 1/4	819	26 1/2	673	25 1/8	638	8	203	166	75.3
DEN-30	2	30	114	34 1/2	876	20 1/2	521	-	-	8	203	98	44.5
DEN-40	2	40	151	45 1/8	1146	20 1/2	521	-	-	8	203	113	51.3
DEN-52	2	50	189	54 7/8	1394	20 1/2	521	-	-	8	203	131	59.4
DEN-66	2	66	250	60 3/4	1543	21 3/4	552	-	-	8	203	176	79.8
DEN-80	2	80	303	59 3/8	1508	24	610	-	-	8	203	211	95.7
DEN-120	2	119	450	62 7/16	1586	29 3/8	746	-	-	8	203	326	147.9

RECOVERY CAPACITIES

Element Wattage (Upper/Lower)	INPUT KW	U.S. Gallons/Hr and Litres/Hr at TEMPERATURE RISE INDICATED F°	36F°	40F°	54F°	60F°	72F°	80F°	90F°	100F°	108F°	120F°	126F°
		C°	20C°	22.2C°	30C°	33.3C°	40C°	44.4C°	50C°	55.5C°	60C°	66.6C°	70C°
NON-SIMULATANEOUS OPERATION													
/1500		GPH	17	15	11	10	8	8	7	6	6	5	5
	1.5	LPH	64	58	43	38	32	29	26	23	21	19	19
/2000		GPH	23	20	15	14	11	10	9	8	8	7	6
	2.0	LPH	85	77	57	51	43	38	34	31	28	26	24
/2500		GPH	28	25	19	17	14	13	11	10	9	8	8
	2.5	LPH	107	96	71	64	53	48	43	38	36	32	30
3000/3000		GPH	34	30	23	20	17	15	14	12	11	10	10
	3.0	LPH	128	115	85	77	64	58	51	46	43	38	37
4000/4000		GPH	45	41	30	27	23	20	18	16	15	13	13
	4.0	LPH	170	153	114	102	85	77	68	61	57	51	49
4500/4500		GPH	51	46	34	30	25	23	20	18	17	15	14
	4.5	LPH	192	173	128	115	96	86	77	69	64	58	55
5000/5000		GPH	56	51	38	34	28	25	23	20	19	17	16
	5.0	LPH	213	192	142	128	107	96	85	77	71	64	61
6000/6000		GPH	68	61	45	41	34	30	27	24	23	20	19
	6.0	LPH	256	230	170	153	128	115	102	92	85	77	73
SIMULATANEOUS OPERATION													
3000/3000		GPH	68	61	45	41	34	30	27	24	23	20	19
	6	LPH	256	230	170	153	128	115	102	92	86	77	73
4000/4000		GPH	90	81	60	54	45	41	36	32	30	27	26
	8	LPH	341	307	227	205	170	153	136	123	114	102	97
4500/4500		GPH	101	91	68	61	51	46	41	36	34	30	29
	9	LPH	384	345	256	230	192	173	153	138	128	115	110
5000/5000		GPH	113	101	75	68	56	51	45	41	38	34	32
	10	LPH	426	384	284	256	213	192	170	153	142	128	122
6000/6000		GPH	135	122	90	81	68	61	54	49	45	41	39
	12	LPH	511	460	341	307	256	230	205	184	170	153	146

Recovery capacities at 100° F rise equal: for non-simultaneous element operation = 4.1 gal. x kW of one element; for simultaneous element operation = 4.1 gal. x 2/3 kW of both elements. For other rises multiply element kW as previously explained by 410 and divide by temperature rise. Full load current for single phase = total watts ÷ voltage.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 19 Mar 2015

- ☐ Reviewed
- ☒ Reviewed as noted
- ☐ Resubmit

CHIARELLI ENGINEERING LTD.

SUGGESTED SPECS

The water heaters(s) shall be Dura-Power™ Model(s) No. _____ as manufactured by A. O. SMITH or an approved equal. Heater(s) shall be rated at _____kW, _____volts, _____ phase, 60 cycle AC, and listed by Underwriters' Laboratories. Models shall meet the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IESNA 90.1. Tank(s) shall be _____gallon capacity. Heater(s) shall have 150 psi working pressure and be equipped with extruded high density anode rod. All steel by firing at a temperature range of 1600°F. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacket shall be of backed enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panels and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided (except on 120V & 277V {no junction box on DEL-6 thru 20}). The drain value shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Fully illustrated instruction manual to be included.

Commercial Electric Water Heaters

DURA-POWER™

Designed for use as a recovery heater having its own storage tank. Available in upright standard models (DEN) and lowboy models (DEL).

GLASSLINED TANK

- Thirteen sizes; 6 thru 119 gallon capacity. Tank interior is coated with glass specially designed by A. O. Smith for water heater use.

ELEMENTS

- Zinc plated copper sheaths for longer life. Medium watt density means lower surface temperature to minimize scale build-up and more surface to heat water. Element sizes from 1.5 to 6 KW. Maximum input 12 KW (see chart).

STANDARD VOLTAGES

- 120, 277 single phase and 208, 240 and 480V unbalanced three-phase delta; easily converted to single-phase at terminal block (except 208V with 5500 watt elements). Single element heaters, single-phase only.

TERMINAL BLOCK

- Factory-installed. Just bring the service to heater and connect to block. Terminal block not supplied on 120V & 277 volt models. (No junction box on DEL6-20)

CONTROLS

- Temperature control (adjustable through a range of 110° to 170°F on single element and 120° to 181°F on dual element) and manual reset high temperature cutoff per element

CSA CERTIFIED AND ASME RATED T&P RELIEF VALVE

SIMPLIFIED CIRCUITRY, COLOR CODED FOR EASE OF SERVICE

ANODE ROD FOR MAXIMUM CORROSION PROTECTION

CABINET HAS BONDERIZED UNDERCOAT WITH BAKED ENAMEL FINISH

TOP INLET AND OUTLET OPENINGS

DRAIN VALVE (EXCLUDES DEL 6-20)

UL APPROVED FIELD CONVERSION PROGRAM

COMPLIANCE

- Meets the standby loss Requirements of the U.S. Department of Energy and current edition of ASHRAE/IES 90.1.

LIMITED WARRANTY OUTLINE

- If the tank should leak any time during the first three years, under the terms of the warranty, A. O. Smith will furnish a replacement heater; installation, labor, handling and local delivery extra. THIS OUTLINE IS NOT A WARRANTY. For complete information consult the written warranty or A. O. Smith Water Products Company.

DEN-40

DEL-30

Low Lead Content

AHRI CERTIFIED® www.ahridirectory.org

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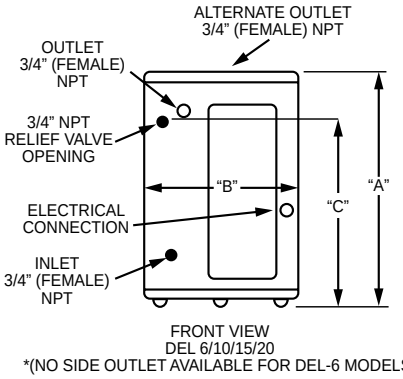
Commercial Electric Water Heaters

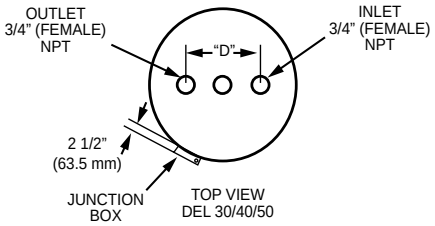


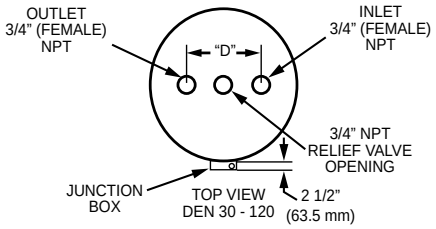
*(NO SIDE OUTLET AVAILABLE FOR DEL-6 MODELS)

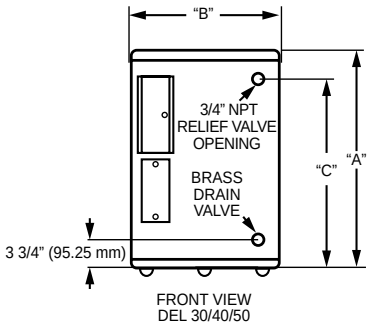
ROUGH-IN DIMENSIONS

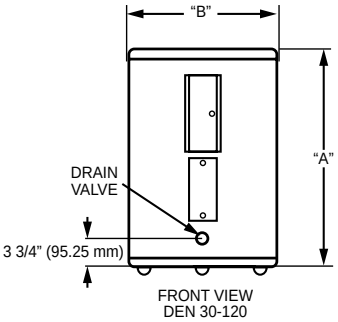
Model Number	No. of Elements	Tank Capacity		A		B		C		D		Shipping Weight	
		US Gals	Litres	Inches	mm	Inches	mm	Inches	mm	Inches	mm	lbs.	Kg.
DEL-6	1	6	23	15-1/2	394	14-1/4	362	11	279	N/A	N/A	35	15.9
DEL-10	1	10	38	18-1/4	464	18	457	12-1/2	318	N/A	N/A	54	24.5
DEL-15	1	15	57	26	660	18	457	20-1/2	521	N/A	N/A	58	26.3
DEL-20	1	20	76	22-1/4	565	21-3/4	552	15-3/8	391	N/A	N/A	73	33.1

* No side outlet available on DEL-6 Model









ROUGH-IN DIMENSIONS

Model Number	No. of Elements	Tank Capacity		A		B		C		D		Shipping Weight	
		US Gals	Litres	Inches	mm	Inches	mm	Inches	mm	Inches	mm	lbs.	Kg.
DEL-30	2	30	114	30-7/8	784	21-3/4	552	24-1/8	613	8	203	100	45.4
DEL-40	2	40	151	32-1/4	819	24	610	25-9/16	649	8	203	125	56.7
DEL-50	2	50	189	32-1/4	819	26-1/2	673	25-1/8	638	8	203	166	75.3
DEN-30	2	30	114	34-1/2	876	20-1/2	521	21	533	8	203	98	44.5
DEN-40	2	40	151	45-1/8	1146	20-1/2	521	N/A	N/A	8	203	113	51.3
DEN-52	2	50	189	54-7/8	1394	20-1/2	521	N/A	N/A	8	203	131	59.4
DEN-66	2	66	250	60-3/4	1543	21-3/4	552	N/A	N/A	8	203	176	79.8
DEN-80	2	80	303	59-3/8	1508	24	610	N/A	N/A	8	203	211	95.7
DEN-120	2	119	450	62-7/16	1586	29-3/8	746	N/A	N/A	8	203	326	147.9

ELEMENT AVAILABILITY CHART (LIGHT-DUTY COMMERCIAL ELECTRIC)

Models & Elements	Voltage	Wiring	kW Input Available									
6-Gallon Models Single-Element	120V	-	1.5	2	2.5	3						
	208V	-	1.5	2	2.5	3						
	240V	-	1.5	2	2.5	3						
	277V	-	1.5	2	2.5	3						
	480V	-		2	2.5	3						
10-Gallon through 20-Gallon Models Single-Element	120V	-	1.5	2	2.5	3						
	208V	-	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
	240V	-	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
	277V	-	1.5	2	2.5	3		4	4.5	5		6
	480V	-		2	2.5	3		4	4.5	5	5.5	6
30-Gallon through 120-Gallon Models Double-Element	120V	Interlock	1.5	2	2.5	3						
		Simultaneous	3	4	5	†						
	208V	Interlock	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
		Simultaneous	3	4	5	6	7	8	9	10**	11**	†
	240V	Interlock	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
		Simultaneous	3	4	5	6	7	8	9	10	11	12**
	277V*	Interlock	1.5	2	2.5	3		4	4.5	5		6
		Simultaneous	3	4	5	6		8	9	10		12
	480V	Interlock		2	2.5	3		4	4.5	5	5.5	6
		Simultaneous		4	5	6		8	9	10	11	12

6 gallon model not available above 3kW
6/10/15/20 gallon models all A6 circuit (2 wire) only
† Exceeds maximum amp draw.
** Simultaneous only in 3ph

ELECTRIC CHARACTERISTICS

Electric Characteristics											
Non Simultaneous and Single Element Operation 6 - 120 Gallon				Simultaneous Dual Element Operation (Single Phase Connection) 30 - 120 Gallon				Simultaneous Dual Element Operation (Unbalanced Three Phase connection) 30 - 120 Gallon			
Element Wattage	Full Load Current in Amperes (Terminals - L1, L2)			Element Wattage	Full Load Current in Amperes (Terminals - L1, L2)			Element Wattage	Full Load Current in Amperes (Terminals - L2 / Terminal L1 & L3)		
Upper / Lower	208V	240V	480V	Upper / Lower	208V	240V	480V	Upper / Lower	208V	240V	480V
1500	7.2	6.3	3.2	1500/1500	14.4	12.5	6.3	1500/1500	12.4/7.2	10.8/6.3	5.4/3.2
2000	9.6	8.3	4.2	2000/2000	19.2	16.6	8.3	2000/2000	16.6/9.6	14.4/8.3	7.2/4.2
2500	12.0	10.4	5.2	2500/2500	24	20.8	10.4	2500/2500	20.8/12.0	18.0/10.4	9.0/5.2
3000/3000	14.4	12.5	6.3	3000/3000	28.8	25	12.5	3000/3000	25.0/14.4	21.6/12.5	10.8/6.3
4000/4000	19.2	16.7	8.3	4000/4000	38.4	33.3	16.6	4000/4000	33.3/19.2	28.8/16.7	14.4/8.3
4500/4500	21.6	18.8	9.4	4500/4500	43.2	37.5	18.75	4500/4500	37.4/21.6	32.4/18.8	16.2/9.4
5000/5000	24.0	20.8	10.4	5000/5000	NA	41.6	20.8	5000/5000	41.6/24.0	36.0/20.8	18.0/10.4
6000/6000	28.8	25.0	12.5	6000/6000	NA	NA	25	6000/6000	NA	43.3/25.0	21.6/12.5

Commercial Electric Water Heaters

RECOVERY CAPACITIES

Element Wattage (Upper/ Lower)	Input	U. S. Gallons/Hr and Litres/Hr at Temperature Rise Indicated											
		F°	36	40	54	60	72	80	90	100	108	120	126
	kW	C°	20	22.2	30	33.3	40	44.4	50	55.5	60	66.6	70
Non-Simulataneous Operation													
/1500	1.5	GPH	17	15	11	10	8	8	7	6	6	5	5
		LPH	64	58	43	38	32	29	26	23	21	19	18
/2000	2	GPH	23	20	15	14	11	10	9	8	8	7	6
		LPH	85	77	57	51	43	38	34	31	28	26	24
/2500	2.5	GPH	28	25	19	17	14	13	11	10	9	8	8
		LPH	107	96	71	64	53	48	43	38	36	32	30
3000/3000	3	GPH	34	30	23	20	17	15	14	12	11	10	10
		LPH	128	115	85	77	64	58	51	46	43	38	37
4000/4000	4	GPH	45	41	30	27	23	20	18	16	15	14	13
		LPH	170	153	114	102	85	77	68	61	57	51	49
4500/4500	4.5	GPH	51	46	34	30	25	23	20	18	17	15	14
		LPH	192	173	128	115	96	86	77	69	64	58	55
5000/5000	5	GPH	56	51	38	34	28	25	23	20	19	17	16
		LPH	213	192	142	128	107	96	85	77	71	64	61
6000/6000	6	GPH	68	61	45	41	34	30	27	24	23	20	19
		LPH	256	230	170	153	128	115	102	92	85	77	73
Simulataneous Operation													
3000/3000	6	GPH	68	61	45	41	34	30	27	24	23	20	19
		LPH	256	230	170	153	128	115	102	92	85	77	73
4000/4000	8	GPH	90	81	60	54	45	41	36	32	30	27	26
		LPH	341	307	227	205	170	153	136	123	114	102	97
4500/4500	9	GPH	101	91	68	61	51	46	41	36	34	30	29
		LPH	384	345	256	230	192	173	153	138	128	115	110
5000/5000	10	GPH	113	101	75	68	56	51	45	41	38	34	32
		LPH	426	384	284	256	213	192	170	153	142	128	122
6000/6000	12	GPH	135	122	90	81	68	61	54	49	45	41	39
		LPH	511	460	341	307	256	230	205	184	170	153	146

Recovery capacities at 100° F rise equal: for non-simultaneous element operation = 4.1 gal. x kW of one element; for simultaneous element operation = 4.1 gal. x 2/3 kW of both elements.
For other rises multiply element kW as previously explained by 410 and divide by temperature rise. Full load current for single phase = total watts/voltage.

SPECIFICATION

The water heaters(s) shall be Dura-Power™ Model(s) No. _____ as manufactured by A. O. SMITH or an approved equal. Heater(s) shall be rated at _____kW, _____volts, _____-phase, 60 cycle AC, and listed by Underwriters' Laboratories. Models shall meet the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IES 90.1. Tank(s) shall be _____gallon capacity. Heater(s) shall have 150 psi working pressure and be equipped with extruded high density anode rod. All internal surfaces of the heater(s) exposed to water shall be glasslined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature range of 1400°F to 1600°F. Electric heating elements shall be medium watt density with zinc plated copper sheath. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacket shall be of backed enamel finish and shall enclose the tank with foam insulation. Electrical junction box with heavy duty terminal block shall be provided (except on 120V & 277V {no junction box on DEL-6 thru 20}). The drain valve shall be located in the front for ease of servicing. Heater tank shall have a three year limited warranty as outlined in the written warranty. Fully illustrated instruction manual to be included.

For technical information, call 800-527-1953. A. O. Smith Corporation reserves the right to make product changes or improvements without prior notice.

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www.hotwater.com | 800-527-1953 Toll-Free USA | A. O. Smith Corporation | 500 Tennessee Waltz Parkway | Ashland City, TN 37015

Instruction Manual

COMMERCIAL ELECTRIC WATER HEATERS

A.O. Smith®
500 Tennessee Waltz Parkway
Ashland City, TN 37015

Low Lead Content

AHRI CERTIFIED®
www.ahridirectory.org

MODELS DEL-6/10/15/20 Series 102
DEL-30/40/50 Series 110
& DEN-30/40/52/66/80/120 Series 110

INSTALLATION - OPERATION - SERVICE - MAINTENANCE - LIMITED WARRANTY

Thank you for buying this energy efficient water heater. We appreciate your confidence in our products.

⚠ WARNING

Read and understand this instruction manual and the safety messages herein before installing, operating, or servicing this water heater.

Failure to follow these instructions and safety messages could result in death or serious injury.

This manual must remain with the water heater.

⚠ WARNING

If the water heater becomes immersed in water up to or above the level of the bottom of the element doors, the heater should be examined by a qualified service agency before it is placed in operation, see Page 2.

PLACE THESE INSTRUCTIONS ADJACENT TO HEATER AND NOTIFY OWNER TO KEEP FOR FUTURE REFERENCE.

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SAFE INSTALLATION, USE, AND SERVICE

The proper installation, use and servicing of this water heater is extremely important to your safety and the safety of others.

Many safety-related messages and instructions have been provided in this manual and on your own water heater to warn you and others of a potential injury hazard. Read and obey all safety messages and instructions throughout this manual. It is very important that the meaning of each safety message is understood by you and others who install, use, or service this water heater.

	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER	**DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or injury.**
WARNING	**WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or injury.**
CAUTION	**CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.**
CAUTION	**CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, could result in property damage.**

All safety messages will generally tell you about the type of hazard, what can happen if you do not follow the safety message, and how to avoid the risk of injury.

The California Safe Drinking Water and Toxic Enforcement Act requires the Governor of California to publish a list of substances known to the State of California to cause cancer, birth defects, or other reproductive harm, and requires businesses to warn of potential exposure to such substances.

This product contains a chemical known to the State of California to cause cancer, birth defects, or other reproductive harm. This appliance can cause low level exposure to some of the substances listed in the Act.

IMPORTANT DEFINITIONS

- **Qualified Installer or Service Agency:**

  Installation and service of this water heater requires ability equivalent to that of a Qualified Agency (as defined by ANSI below) in the field involved. Installation skills such as plumbing, electrical supply are required in addition to electrical testing skills when performing service.

- **ANSI Z223.1 2006 Sec. 3.3.83:**

  “Qualified Agency” - “Any individual, firm, corporation or company that either in person or through a representative is engaged in and is responsible for (a) the installation, testing or replacement of gas piping or (b) the connection, installation, testing, repair or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction.”

GENERAL SAFETY INFORMATION

PRECAUTIONS

DO NOT USE THIS WATER HEATER IF ANY PART HAS BEEN EXPOSED TO FLOODING OR WATER DAMAGE. Immediately call a qualified service technician to inspect the water heater and to replace any part of the control system which has been under water.

If the unit is exposed to the following, do not operate heater until all corrective steps have been made by a qualified service technician.

1. External fire.
2. Damage.
3. Firing without water.

GROUNDING INSTRUCTIONS

This water heater must be grounded in accordance with the National Electrical Code and/or local codes. These must be followed in all cases. Failure to ground this water heater properly may also cause erratic control system operation on ELECTRONIC CONTROL models.

This water heater must be connected to a grounded metal, permanent wiring system; or an equipment grounding conductor must be run with the circuit conductors and connected to the equipment grounding terminal or lead on the water heater.

HYDROGEN GAS (FLAMMABLE)

⚠ WARNING

Explosion Hazard

- Flammable hydrogen gases may be present.
- Keep all ignition sources away from faucet when turning on hot water.

Hydrogen gas can be produced in a hot water system served by this heater that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To reduce the risk of injury under these conditions, it is recommended that the hot water faucet be opened for several minutes at the kitchen sink before using any electrical appliance connected to the hot water system. If hydrogen is present there will probably be an unusual sound such as air escaping through the pipe as the water begins to flow. THERE SHOULD BE NO SMOKING OR OPEN FLAME NEAR THE FAUCET AT THE TIME IT IS OPEN.

When servicing this unit, verify the power to the unit is turned off prior to opening the control cabinet door.

⚠ WARNING

Read and understand this instruction manual and the safety messages herein before installing, operating, or servicing this water heater.

Failure to follow these instructions and safety messages could result in death or serious injury.

This manual must remain with the water heater.

⚠ WARNING

- **Before removing any access panels or servicing the water heater, make sure the electrical supply to the water heater is turned "OFF."**
- **Failure to do this could result in death, serious bodily injury, or property damage.**

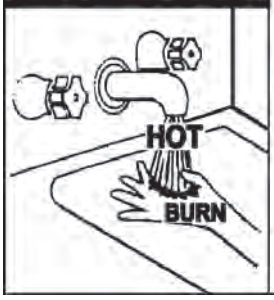
CAUTION

Improper installation, use and service may result in property damage.

- Do not operate water heater if any part has been exposed to flooding or water damage.
- Inspect anode rods regularly, replace when significantly depleted.
- Install in location with drainage.
- Fill tank with water before operation.
- Properly sized thermal expansion tanks are required on all closed water systems.

Refer to this manual for installation and service.

⚠ DANGER



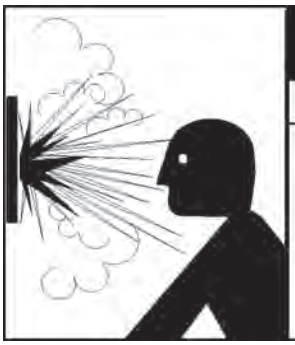
Water temperature over 125°F (52°C) can cause severe burns resulting in severe injury or death.

Children, the elderly, and the physically or mentally disabled are at highest risk for scald injury.

Feel water before bathing or showering.

Temperature limiting valves are available.

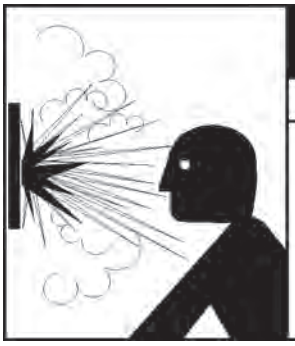
Read instruction manual for safe temperature setting.



⚠ WARNING

Explosion Hazard

- Flammable hydrogen gases may be present.
- Keep all ignition sources away from faucet when turning on hot water.



⚠ WARNING

Explosion Hazard

- Overheated water can cause water tank explosion.
- Properly sized temperature and pressure relief valve must be installed in opening provided.

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INTRODUCTION

Thank You for purchasing this water heater. Properly installed and maintained, it should give you years of trouble free service.

Abbreviations Found In This Instruction Manual:

- ANSI - American National Standards Institute
- AHRI - Air-Conditioning, Heating and Refrigeration Institute
- NEC - National Electrical Code
- NFPA - National Fire Protection Association
- UL - Underwriters Laboratory

PREPARING FOR THE INSTALLATION

1. Read the "General Safety Information" section of this manual first and then the entire manual carefully. If you don't follow the safety rules, the water heater may not operate safely. It could cause DEATH, SERIOUS BODILY INJURY AND/OR PROPERTY DAMAGE.

   This manual contains instructions for the installation, operation, and maintenance of the electric water heater. It also contains warnings throughout the manual that you must read and be aware of. All warnings and all instructions are essential to the proper operation of the water heater and your safety. **READ THE ENTIRE MANUAL BEFORE ATTEMPTING TO INSTALL OR OPERATE THE WATER HEATER.**

   Be sure to turn off power when working on or near the electrical system of the heater. Never touch electrical components with wet hands or when standing in water. When replacing fuses always use the correct size for the circuit. see page 12.

   The model and rating plates on page 6 interprets certain markings into useful information. Both of these references should be used to identify the heater, its components and optional equipment.

2. The installation must conform with these instructions and the local code authority having jurisdiction and the requirements of the power company. In the absence of local codes, the installation must comply with the latest editions of the National Electrical Code, NFPA 70 or the Canadian Electrical Code CSA C22.1. The National Electrical Code may be ordered from: National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269. The Canadian Electrical Code is available from the Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131.

3. If after reading this manual you have any questions or do not understand any portion of the instructions, call the toll free number listed on the back cover of this manual for technical assistance.

   A sample rating plate is shown on page 6 of this manual. In order to expedite your request, please have full model and serial number available for the technician.

4. Carefully plan your intended placement of the water heater. Examine the location to ensure the water heater complies with the "Locating the New Water Heater" section in this manual.

   Installation and service of this water heater requires ability equivalent to that of a licensed tradesman or qualified agency (page 2) in the field involved. Plumbing and electrical work are required.

DIMENSIONS AND CAPACITIES DATA

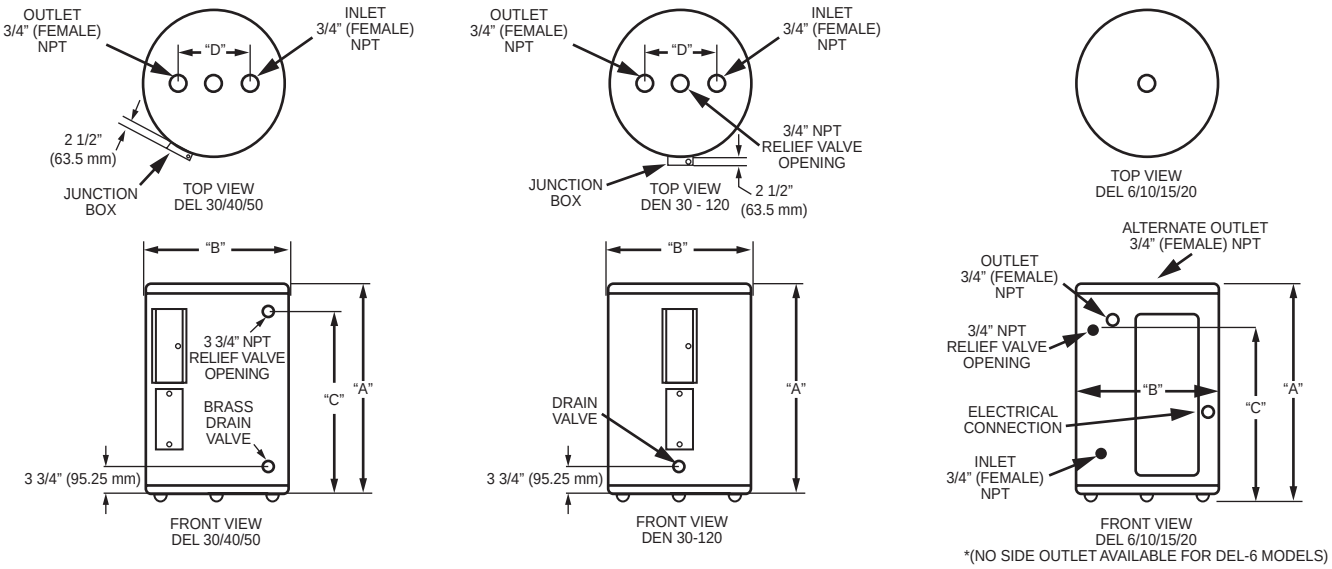


FIGURE 1

TABLE 1 - ROUGH-IN DIMENSIONS

Models Dimensions	No. of Elements	Tank Capacity		A		B		C		D		Approx. Shipping Weight	
		US Gals.	Litres	inches	mm	inches	mm	inches	mm	inches	mm	Lbs.	Kg.
DEL-6	1	6	23	15 1/2	394	14 1/4	362	11	279	-	-	35	15.9
DEL-10	1	10	38	18 1/4	464	18	457	12 1/2	318	-	-	54	24.5
DEL-15	1	15	57	26	660	18	457	20 1/2	521	-	-	58	26.3
DEL-20	1	20	76	22 1/4	565	21 3/4	552	15 3/8	391	-	-	73	33.1
DEL-30	2	30	114	30 7/8	784	21 3/4	552	24 1/8	613	8	203	100	45.4
DEL-40	2	40	151	32 1/4	819	24	610	25 9/16	649	8	203	125	56.7
DEL-50	2	50	189	32 1/4	819	26 1/2	673	25 1/8	638	8	203	166	75.3
DEN-30	2	30	114	34 1/2	876	20 1/2	521	-	-	8	203	98	44.5
DEN-40	2	40	151	45 1/8	1146	20 1/2	521	-	-	8	203	113	51.3
DEN-52	2	50	189	54 7/8	1394	20 1/2	521	-	-	8	203	131	59.4
DEN-66	2	66	250	60 3/4	1543	21 3/4	552	-	-	8	203	176	79.8
DEN-80	2	80	303	59 3/8	1508	24	610	-	-	8	203	211	95.7
DEN-120	2	119	450	62 7/16	1586	29 3/8	746	-	-	8	203	326	147.9

TABLE 2 - RECOVERY CAPACITIES

Element Wattage (Upper/Lower)	INPUT KW	U.S. Gallons/Hr and Litres/Hr at TEMPERATURE RISE INDICATED											
		F°	36F°	40F°	54F°	60F°	72F°	80F°	90F°	100F°	108F°	120F°	126F°
		C°	20C°	22.2C°	30C°	33.3C°	40C°	44.4C°	50C°	55.5C°	60C°	66.6C°	70C°
NON-SIMULATANEOUS													
/1500		GPH	17	15	11	10	8	8	7	6	6	5	5
	1.5	LPH	64	58	43	38	32	29	26	23	21	19	18
/2000		GPH	23	20	15	14	11	10	9	8	8	7	6
	2.0	LPH	85	77	57	51	43	38	34	31	28	26	24
/2500		GPH	28	25	19	17	14	13	11	10	9	8	8
	2.5	LPH	107	96	71	64	53	48	43	38	36	32	30
3000/3000		GPH	34	30	23	20	17	15	14	12	11	10	10
	3.0	LPH	128	115	85	77	64	58	51	46	43	38	37
4000/4000		GPH	45	41	30	27	23	20	18	16	15	14	13
	4.0	LPH	170	153	114	102	85	77	68	61	57	51	49
4500/4500		GPH	51	46	34	30	25	23	20	18	17	15	14
	4.5	LPH	192	173	128	115	96	86	77	69	64	58	55
5000/5000		GPH	56	51	38	34	28	25	23	20	19	17	16
	5.0	LPH	213	192	142	128	107	96	85	77	71	64	61
6000/6000		GPH	68	61	45	41	34	30	27	24	23	20	19
	6.0	LPH	256	230	170	153	128	115	102	92	85	77	73
SIMULATANEOUS OPERATION													
3000/3000		GPH	68	61	45	41	34	30	27	24	23	20	19
	6	LPH	256	230	170	153	128	115	102	92	85	77	73
4000/4000		GPH	90	81	60	54	45	41	36	32	30	27	26
	8	LPH	341	307	227	205	170	153	136	123	114	102	97
4500/4500		GPH	101	91	68	61	51	46	41	36	34	30	29
	9	LPH	384	345	256	230	192	173	153	138	128	115	110
5000/5000		GPH	113	101	75	68	56	51	45	41	38	34	32
	10	LPH	426	384	284	256	213	192	170	153	142	128	122
6000/6000		GPH	135	122	90	81	68	61	54	49	45	41	39
	12	LPH	511	460	341	307	256	230	205	184	170	153	146

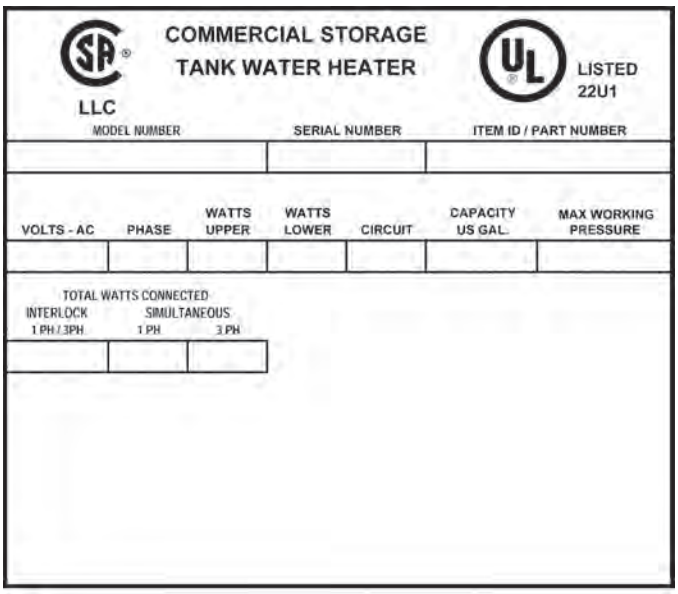
Recovery capacities at 100° F rise equal: for non-simultaneous element operation = 4.1 gal. x KW of one element; for simultaneous element operation = 4.1 gal. x 2/3 KW of both elements. For other rises multiply element KW as previously explained by 410 and divide by temperature rise. Full load current for single phase = total watts : voltage.

APPROVALS

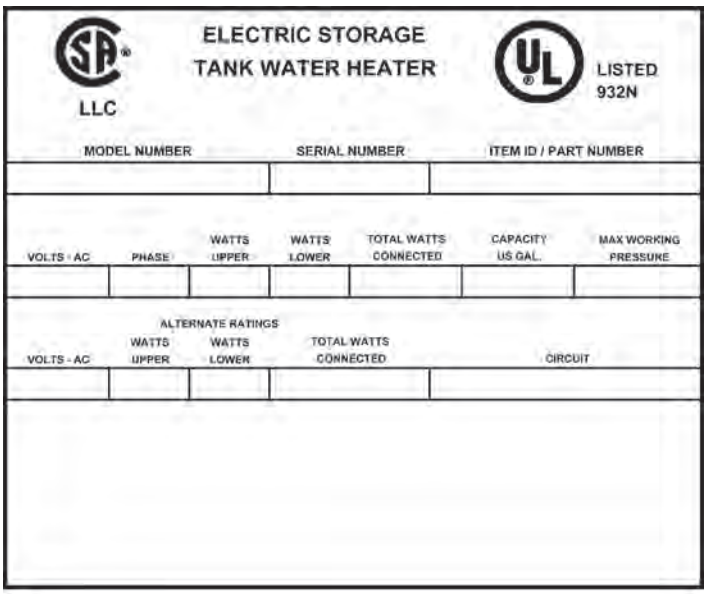
All models are listed by Underwriters Laboratories Inc.

Low Lead Content

MODEL AND RATING



DEL-30/40/50 & DEN-30/40/52/66/80/120



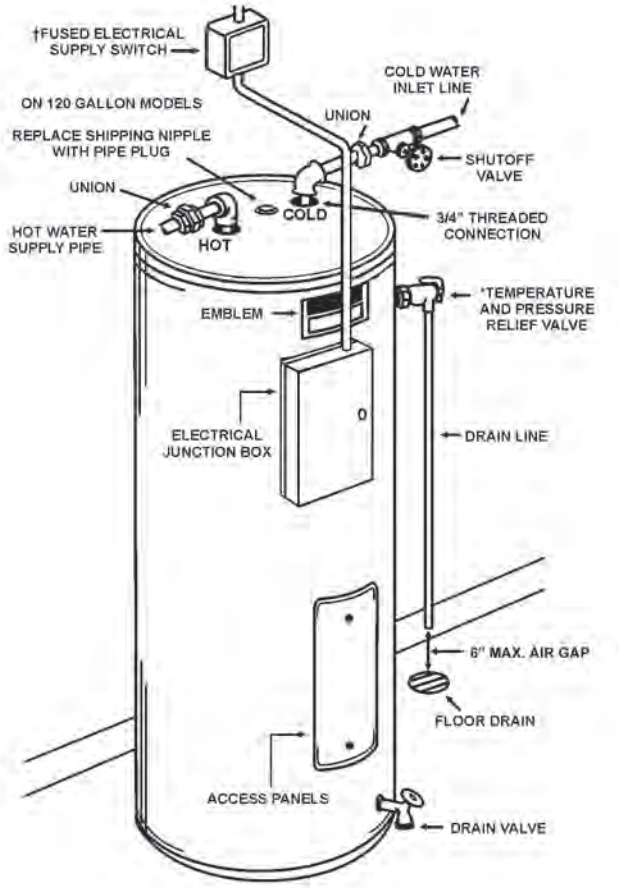
DEL-6/10/15/20

FEATURES AND COMPONENTS

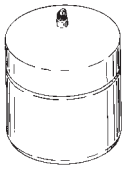
ELECTRONIC CONTROL MODELS

This page shows typical water heater installations by model designations.

DEN/DEL DUAL ELEMENT HEATER



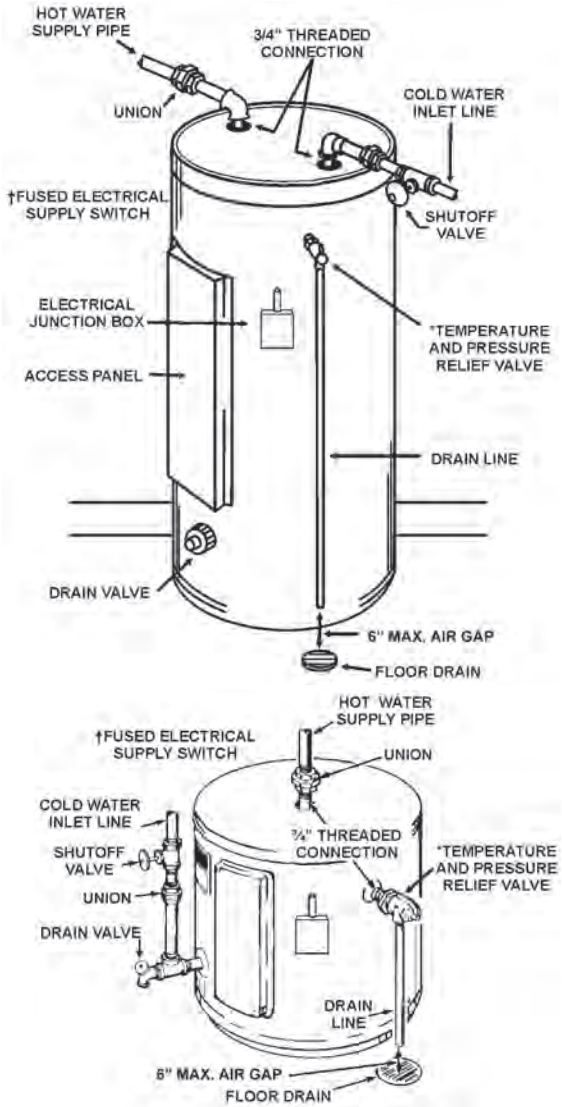
INSTALL SUITABLE DRAIN PANS UNDER WATER HEATERS TO PREVENT DAMAGE DUE TO LEAKAGE. REFER TO WATER HEATER LOCATION ON PAGE 8.



INSTALL THERMAL EXPANSION TANK IF CHECK VALVE OR PRESSURE REDUCING VALVE IS USED IN SUPPLY LINE.

INSTALL VACUUM RELIEF IN COLD WATER INLET LINE AS REQUIRED BY LOCAL CODES.

DEN/DEL SINGLE ELEMENT HEATER



† OVER CURRENT PROTECTION MUST BE SUPPLIED IN WATER HEATER CIRCUIT. CONSULT LOCAL CODE OR CURRENT EDITION OF NEC FOR PROPER INSTALLATION.

* INSTALL IN ACCORDANCE WITH ALL LOCAL CODES.

FIGURE 2

LOCATING THE NEW WATER HEATER

FACTS TO CONSIDER ABOUT THE LOCATION

CAUTION

Property Damage Hazard

- All water heaters eventually leak
- Do not install without adequate drainage.

The water heater should be located as close as possible to/or centralized to the water piping system. The water heater should be located in an area not subject to freezing temperatures.

The water heater should be located in an area where leakage of the tank or connections will not result in damage to the area adjacent to the heater or to lower floors of the structure.

When such locations cannot be avoided, a suitable drain pan should be installed under the heater.

Such pans should be at least two inches deep, have a minimum length and width of at least two inches greater than the diameter of the heater and should be piped to an adequate drain.

Drain pans suitable for these water heaters are available from your distributor or A.O. Smith Water Heater Parts Fulfillment, 125 Southeast Parkway, Franklin, TN 37068.

Water heater life depends upon water quality, water pressure and the environment in which the water heater is installed. Water heaters are sometimes installed in locations where leakage may result in property damage, even with the use of a drain pan piped to a drain. However, unanticipated damage can be reduced or prevented by a leak detector or water shut-off device used in conjunction with a piped drain pan. These devices are available from some plumbing supply wholesalers and retailers, and detect and react to leakage in various ways:

- Sensors mounted in the drain pan that trigger an alarm or turn off the incoming water to the water heater when leakage is detected.
- Sensors mounted in the drain pan that turn off the water supply to the entire home when water is detected in the drain pan.
- Water supply shut-off devices that activate based on the water pressure differential between the cold water and how water pipes connected to the water heater.
- Devices that will turn off the gas supply to a gas water heater while at the same time shutting off its water supply.

CLEARANCES

A minimum clearance of 4” must be allowed for access to replaceable parts such as thermostats, drain valve and relief valve.

Adequate clearance for servicing this water heater should be considered before installation, such as changing the anodes, etc.

INSTALLATION

REQUIRED ABILITY

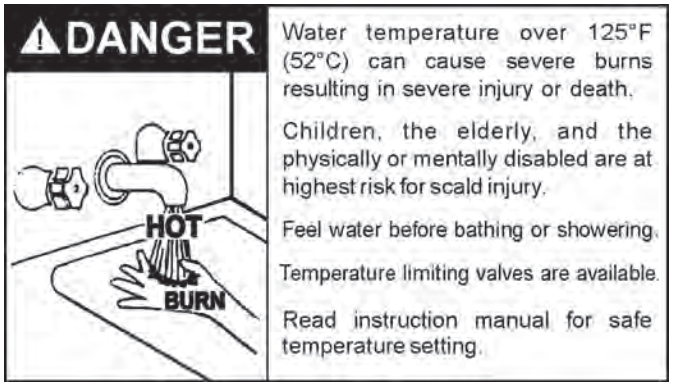
Installation and service of this water heater requires ability equivalent to that of a qualified installer or service agency (page 2) in the field involved. Plumbing and electrical work is required.

GENERAL

The installation must conform with these instructions and the local code authority having jurisdiction and the requirements of the power company. In the absence of local codes, the installation must comply with the latest editions of the National Electrical Code, NFPA 70 or the Canadian Electrical Code CSA C22.1. The National Electrical Code may be ordered from: National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269. The Canadian Electrical Code is available from the Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131.

Do **NOT** test electrical system before heater is filled with water, follow the START UP procedure in the OPERATION section of this manual.

The principal components of the heater are identified in the Features and Components illustrations on page 7.



MIXING VALVE USAGE:
Water heaters are intended to produce hot water. Water heated to a temperature which will satisfy space heating, clothes washing, dish washing, cleaning and other sanitizing needs can scald and permanently injure you upon contact. Some people are more likely to be permanently injured by hot water than others. These include the elderly, children, the infirm, or physically/developmentally disabled. If anyone using hot water in your home fits into one of these groups or if there is a local code or state law requiring a maximum water temperature at the hot water tap, then you must take special precautions. In addition to using the lowest possible temperature setting that satisfies your hot water needs, a means such as a **MIXING VALVE**, should be used at the hot water taps used by these people or at the water heater.

MIXING VALVES for reducing point of use temperature are available and are to be set at a maximum of 125 degree F. Consult a qualified installer or service agency. Follow all manufacturer's Instructions for installation of these valves. Before changing the factory setting on the thermostat, read the "Temperature Regulation" section in this manual.

CONTAMINATED WATER

This water heater shall not be connected to any heating system(s) or component(s) used with a non-potable water heating appliance.

Toxic chemicals, such as those used for boiler treatment shall not be introduced into this system.

CIRCULATING PUMP

Field installed circulating pumps should be of all bronze construction.

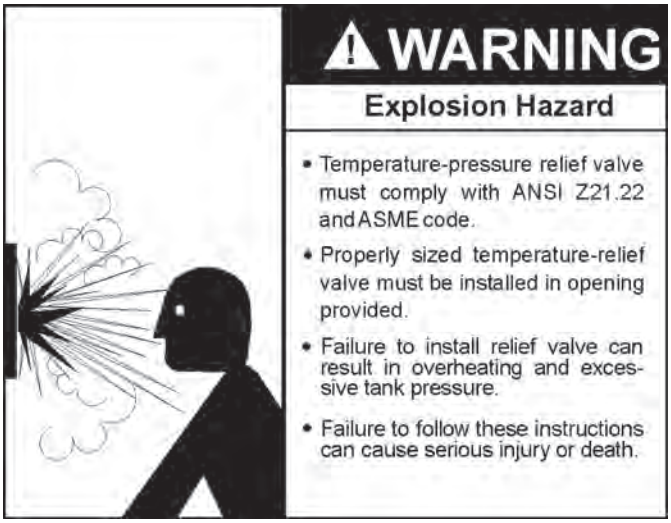
INSULATION BLANKETS

Insulation blankets are available to the general public for external use on electric water heaters but are not necessary with this product. The purpose of an insulation blanket is to reduce the standby heat loss encountered with storage tank heaters. Your water heater meets or exceeds the EPACT and ASHRAE/IES 90.1 standards with respect to insulation and standby loss requirements, making an insulation blanket unnecessary.

Should you choose to apply an insulation blanket to this heater, you should follow these instructions below. Failure to follow these instructions can result in fire, serious personal injury, or death.

- Do not cover the temperature and pressure relief (T & P) valve with an insulation blanket.
- Do not cover the instruction manual. Keep it on the side of the water heater or nearby for future reference.
- Do obtain new warning and instruction labels for placement on the blanket directly over the existing labels.

TEMPERATURE-PRESSURE RELIEF VALVE



This water heater is provided with a properly rated/sized and certified combination temperature - pressure relief valve by the manufacturer. The valve is certified by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment of materials as meeting the requirements for Relief Valves for Hot Water Supply Systems, ANSI Z21.22 • CSA 4.4, and the code requirements of ASME.

If replaced, the new valve must meet the requirements of local codes, but not less than a combination temperature and pressure relief valve rated/sized and certified as indicated in the above

paragraph. The new valve must be marked with a maximum set pressure not to exceed the marked hydrostatic working pressure of the water heater (150 psi = 1,035 kPa) and a discharge capacity not less than the water heater Btu/hr or KW input rate as shown on the water heater's model rating plate.

For safe operation of the water heater, the temperature and pressure relief valve must not be removed from its designated opening nor plugged. The temperature-pressure relief valve must be installed directly into the fitting of the water heater designed for the relief valve. Install discharge piping so that any discharge will exit only within 6 inches (15.2 cm) above, or at any distance below the structural floor. Be certain that no contact is made with any live electrical part. The discharge opening must not be blocked or reduced in size under any circumstances. Excessive length, over 30 feet (9.14 m), or use of more than four elbows can cause restriction and reduce the discharge capacity of the valve.

No valve or other obstruction is to be placed between the relief valve and the tank. Do not connect discharge piping directly to the drain unless a 6" (15.2 cm) air gap is provided. To prevent bodily injury, hazard to life, or property damage, the relief valve must be allowed to discharge water in adequate quantities should circumstances demand. If the discharge pipe is not connected to a drain or other suitable means, the water flow may cause property damage.

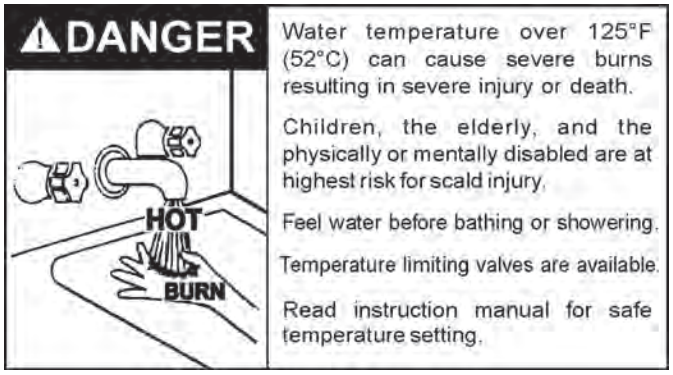
CAUTION

Water Damage Hazard

- Temperature-pressure relief valve discharge pipe must terminate at adequate drain.

The Discharge Pipe:

- Shall not be smaller in size than the outlet pipe size of the valve, or have any reducing couplings or other restrictions.
- Shall not be plugged or blocked.
- Shall be of material listed for hot water distribution.
- Shall be installed so as to allow complete drainage of both the temperature-pressure relief valve and the discharge pipe.
- Must terminate a maximum of six inches above a floor drain or external to the building. In cold climates, it is recommended that the discharge pipe be terminated at an adequate drain inside the building.
- Shall not have any valve or other obstruction between the relief valve and the drain.



The temperature-pressure relief valve must be manually operated at least once a year. Caution should be taken to ensure that (1) no one is in front of or around the outlet of the temperature-pressure relief valve discharge line, and (2) the water manually discharged can cause bodily injury or property damage because the water may be extremely hot. If after manually operating the valve, it fails to completely reset and continues to release water, immediately close the cold water inlet to the water heater, follow the draining instructions in this manual, and replace the temperature-pressure relief valve with a properly rated/sized new one.

If you do not understand these instructions or have any questions regarding the temperature-pressure relief valve call the toll free number listed on the back cover of this manual for technical assistance.

CLOSED WATER SYSTEMS

Water supply systems may, because of code requirements or such conditions as high line pressure, among others, have installed devices such as pressure reducing valves, check valves, and back flow preventers. Devices such as these cause the water system to be a closed system.

THERMAL EXPANSION

As water is heated, it expands (thermal expansion). In a closed system the volume of water will grow when it is heated. As the volume of water grows there will be a corresponding increase in water pressure due to thermal expansion. Thermal expansion can cause premature tank failure (leakage). This type of failure is not covered under the limited warranty. Thermal expansion can also cause intermittent temperature-pressure relief valve operation: water discharged from the valve due to excessive pressure build up. This condition is not covered under the limited warranty. The temperature-pressure relief valve is not intended for the constant relief of thermal expansion.

A properly sized thermal expansion tank should be installed on all closed systems to control the harmful effects of thermal expansion. Contact a local plumbing service agency to have a thermal expansion tank installed.

ELECTRICAL

⚠ WARNING

- Before removing any access panels or servicing the water heater, make sure the electrical supply to the water heater is turned "OFF."
- Failure to do this could result in death, serious bodily injury, or property damage.

GENERAL

The installation must conform with these instructions and the local code authority having jurisdiction and the requirements of the power company. In the absence of local codes, the installation must comply with the current editions of the National Electrical Code, NFPA 70 or the Canadian Electrical Code CSA C22.1.

An electrical ground is required to reduce risk of electrical shock or possible electrocution. The water heater should be connected to a separate grounded branch circuit with over-current protection and disconnect switch. The water heater should be grounded in accordance with national and local codes.

Voltage applied to the heater should not vary more than +5% to -10% of the model and rating plate marking for satisfactory operation.

DO NOT ENERGIZE THE BRANCH CIRCUIT FOR ANY REASON BEFORE THE HEATER TANK IS FILLED WITH WATER. DOING SO WILL CAUSE THE HEATING ELEMENTS TO BURN OUT AND VOID WARRANTY.

The factory wiring is attached to a terminal block within the external junction box unit. The branch circuit is connected to the terminal block within this junction box. The water heater should be connected to a separate, grounded, branch circuit with overcurrent protection and disconnect switch. The water heater should be grounded in accordance with national and local codes.

BRANCH CIRCUIT

The branch circuit wire size should be established through reference to the current edition of NFPA-70, the National Electrical Code or other locally approved source in conjunction with the heater amperage rating. For convenience, portions of the wire size tables from the Code are reproduced here. The branch circuit should be sized at 125 percent of the heater rating and further increase wire size as necessary to compensate for voltage drop in long runs.

CALCULATING AMPERAGE/OVERCURRENT PROTECTION

The heaters come from the factory in two configurations:

1. Two wire C-2 circuit for single element heater equipped with a high limit control, single phase power input.
2. Four wire A-8 circuit for dual element heater equipped with two high limit controls, single phase or three phase power input.

The heater with dual elements is factory wired for connection to a three wire, three-phase delta branch circuit, non-simultaneous operation. In addition a ground conductor is required.

Element connection is for non-simultaneous operation. This means only one element at a time operates. The wiring diagram, on page 12, shows the heater may be field converted to simultaneous element operation by moving the red wire on "J" terminal to L1. It is then possible for both elements to operate at once as determined by the thermostats. Regardless of element connection the heater operates in an "unbalanced" fashion.

The heater may be field converted to single-phase operation by moving the wire on L3 of the terminal block to L2. L3 is not used, see page 12.

The heater, now in single-phase non-simultaneous operation, may be field-converted to single phase simultaneous operation by moving the red wire on terminal "J" to L1, see page 12.

This is an example of calculating heater amperage for both types of element operation. From this, the branch circuit conductor and overcurrent protection sizing can be established.

The example is of a three-phase 240 volt unit with two, 6 kw elements. The notations are for units field converted to single-phase. Check the heater model and rating plate for actual specifications and substitute those values in the following.

TABLE 3

Non-simultaneous: (as factory wired)	Simultaneous: (Field conversion)
3000 : 240 = 12.5 amps*	3000 : 240 = 12.5 amps* 12.5 x 1.73 = 21.6 amps
*NOTE: as a single-phase non-simultaneous unit.	*NOTE: as a single-phase simultaneous unit the total is: 12.5 x 2 = 25 amps

The rating of the overcurrent protection should be computed on the basis of 125 percent of the total connected load amperage. Where the standard ratings and settings do not correspond with this computation, the next higher standard rating or setting should be selected.

Portion of Table 310-16 (NFPA-70) follows:
Allowable Ampacities of Insulated Copper Conductors. Not more than three conductors in Raceway or Cable or Direct Burial (Based on Ambient Temperature of 30° C, 86° F).

These ampacities relate only to conductors described in Table 310-13 in Code.

For ambient temperatures over 30° C (86° F), see Correction Factors, Note 13 in Code.

For ambient temperatures over 30° C (86° F), see Correction Factors, Note 13 in Code.

TABLE 4

Size	Temperature Rating of Conductor See Table 310-13 in Code	
AMG MCM	60°C (140°F)	75°C (167°F)
	Types: RUW, (14-2), T, TW, UF	Types: RH, RHW, RUH, (14-2), THW, THWN, XHHW, USE
18	- - -	- - -
16	- - -	- - -
14	15	15
12	20	20
10	30	30
8	40	45
6	55	65
4	70	85
3	80	100

Portion of Table 310-18 follows:
Allowable Ampacities of Insulated Aluminum and Copper -Clad Aluminum Conductors.

Not more than three conductors in Raceway or Cable or Direct Burial (Based on Ambient Temperature of 30° C, 86° F. These ampacities relate only to conductors described in Table 310-13 in Code.

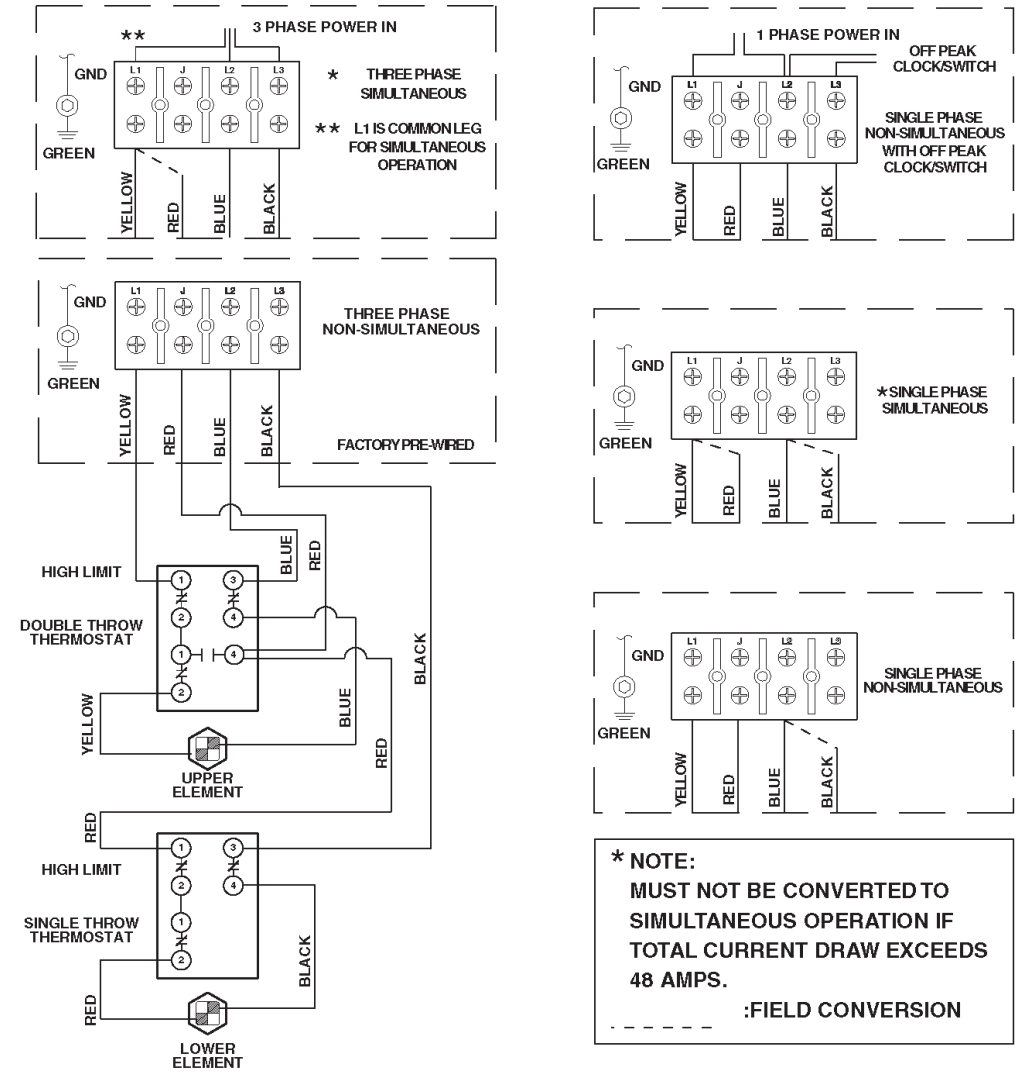
For ambient temperatures over 30° C (86° F), see Correction Factors, Note 13 in Code.

TABLE 5

Size	Temperature Rating of Conductor See Table 310-13 in Code	
AMG MCM	60°C (140°F)	75°C (167°F)
	Types: RUW, (12-2), T, TW, UF	Types: RH, RHW, RUH, (12-2), THW, THWN, XHHW, USE
12	15	15
10	25	25
8	30	40
6	40	50
4	55	65
3	65	75
2	75	90
1	85	100

WIRING DIAGRAMS

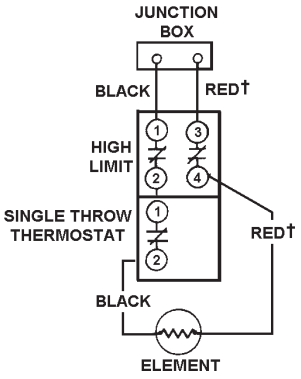
A-8 CIRCUIT FOR DUAL ELEMENT HEATER



* NOTE:
MUST NOT BE CONVERTED TO SIMULTANEOUS OPERATION IF TOTAL CURRENT DRAW EXCEEDS 48 AMPS.

\- - - - - - :FIELD CONVERSION

C-2 CIRCUIT FOR SINGLE ELEMENT HEATERS EQUIPPED WITH HIGH LIMIT CONTROL



——— FACTORY WIRED
---------- FIELD WIRING
† WHITE FOR 120V & 277V

FIGURE 3

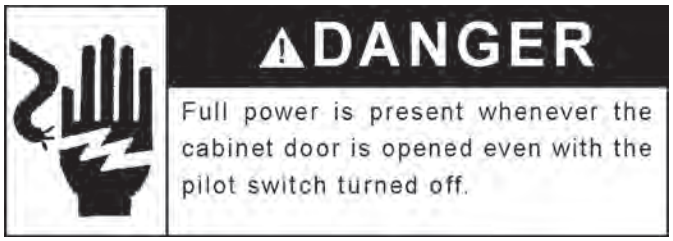
OPERATION

GENERAL

Refer to the Features and Components section of this manual (page 7) for the location of components mentioned in the instructions that follow.

NEVER turn on power to the water heater without being certain the water heater is filled with water and a temperature and pressure relief valve is installed in the relief valve opening.

DO NOT TEST ELECTRICAL SYSTEM BEFORE HEATER IS FILLED WITH WATER. FOLLOW FILLING AND START-UP INSTRUCTIONS IN OPERATION SECTION.



FILLING THE WATER HEATER

1. Turn off the electrical disconnect switch.
2. Close the water heater drain valve.
3. Open a nearby hot water faucet to permit the air in the system to escape.
4. Fully open the cold water inlet pipe valve allowing the heater and piping to be filled.
5. Close the hot water faucet as water starts to flow. The heater is now ready for STARTUP and TEMPERATURE REGULATION.

INITIAL START UP

The following checks should be made by the installer when the heater is placed into operation for the first time.

1. Turn off the electrical disconnect switch.
2. Open the front panel or top access cover, check all water and electrical connections for tightness. Also check connections on top and or sides of heater. Repair water leaks and tighten electrical connections as necessary.
3. Depress the red manual reset button on each Thermostat/ECO combination control. (See Figure 5, Figure 6, Figure 7, or Figure 8)
4. Turn on the electrical disconnect switch.
5. Observe the operation of the electrical components during the first heating cycle. Use care as the electrical circuits are energized.
6. Close the front panel or top access cover.

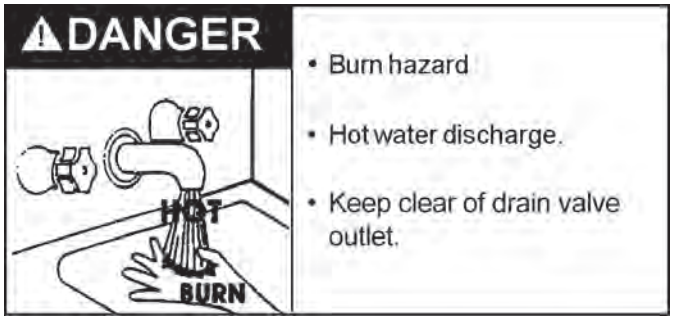
Temperature control and contactor operation should be checked by allowing heater to come up to temperature and shut off automatically. Use care as the electrical circuits are energized.

DRAINING THE WATER HEATER

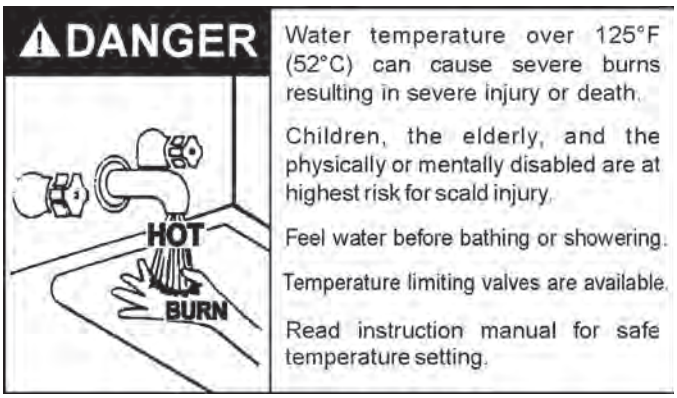
The water heater must be drained if it is to be shut down and exposed to freezing temperatures. Maintenance and service procedures may also require draining the heater.

1. Turn off the electrical disconnect switch.
2. Open a hot water valve until the water is cool, then close the supply water inlet valve to heater.
3. Attach hose to outlet opening of drain valve and direct end to drain.
4. Open a nearby hot water faucet and the heater drain valve.
5. If the heater is being drained for an extended shutdown, it is suggested the drain valve be left open during this period. The hose may be removed.

Follow FILLING instructions when restoring hot water service.



TEMPERATURE REGULATION



THE WATER HEATER IS EQUIPPED WITH AN ADJUSTABLE THERMOSTAT TO CONTROL WATER TEMPERATURE. HOT WATER AT TEMPERATURES DESIRED FOR AUTOMATIC DISHWASHER AND LAUNDRY USE CAN CAUSE SCALDS RESULTING IN SERIOUS PERSONAL INJURY AND/OR DEATH. THE TEMPERATURE AT WHICH INJURY OCCURS VARIES WITH THE PERSON'S AGE AND TIME OF EXPOSURE. THE SLOWER RESPONSE TIME OF CHILDREN , AGED OR DISABLED PERSONS INCREASES THE HAZARD TO THEM. NEVER ALLOW SMALL CHILDREN TO USE A HOT WATER TAP, OR TO DRAW THEIR OWN BATH WATER. NEVER LEAVE A CHILD OR DISABLED PERSON UNATTENDED IN A BATHTUB OR SHOWER.

It is recommended that lower water temperatures be used to avoid the risk of scalding. It is further recommended, in all cases, that the water temperature thermostats (See Figure 4) be set for the lowest temperature which satisfies your hot water needs. This will also provide the most energy efficient operation of the water heater.

Figure 4 shows the approximate time-to-burn relationship for normal adult skin. The thermostats on your water heater have a linear relationship between degrees of angular rotation and the corresponding change in temperature. Thus rotating the temperature adjustment indicator 30 angular degrees will result in a 10 degree Fahrenheit change in water temperature.

Water Temperature °F (°C)	Time for 1st Degree Burn (Less Severe Burns)	Time for Permanent Burns 2nd & 3rd Degree (Most Severe Burns)
110 (43)	(normal shower temp.)	
116 (47)	(pain threshold)	
116 (47)	35 minutes	45 minutes
122 (50)	1 minute	5 minutes
131 (55)	5 seconds	25 seconds
140 (60)	2 seconds	5 seconds
149 (65)	1 second	2 seconds
154 (68)	instantaneous	1 second
(U.S. Government Memorandum, C.P.S.C., Peter L. Armstrong, Sept. 15, 1978)		

FIGURE 4

TEMPERATURE ADJUSTMENT

The water heater is supplied with thermostats that may come from different manufactures and have different temperature indications as described below.

APCOM THERMOSTATS

A-8 Circuit thermostats have three designated set points; LO, MED and HI. (See Figure 5).The approximate equivalent temperatures for these three settings are: LO = 140°F (60°C), MED = 160°F (71°C) and HI = 181°F (83°C). These thermostats are set from the factory at the LO 140°F (60°C) setting. The over temperature device (ECO high limit) attached to each thermostat has a manual reset. The C-2 circuit thermostat is adjustable from approximately 130°F (54°C) to 170°F (77°C) (See Figure 6). These thermostats are set from the factory at approximately the 140°F (60°C) setting. The over temperature device (ECO high limit) attached to each thermostat has a manual reset.

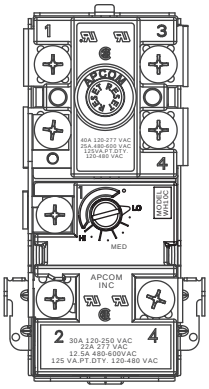


FIGURE 5

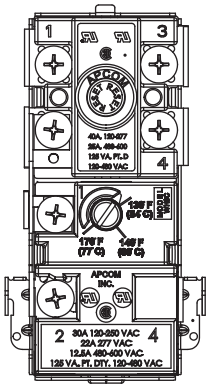


FIGURE 6

THERMODISC THERMOSTATS

A-8 circuit thermostats are adjustable from approximately 120°F (49°C) (lowest setting) to 181°F (83°C) (highest setting) (See Figure 7). The C-2 circuit thermostat is adjustable from approximately 110°F (43°C) to 170°F (77°C) (See Figure 8). These thermostats are set from the factory at approximately the 140°F (60°C) setting. The over temperature device (ECO high limit) attached to each thermostat has a manual reset.

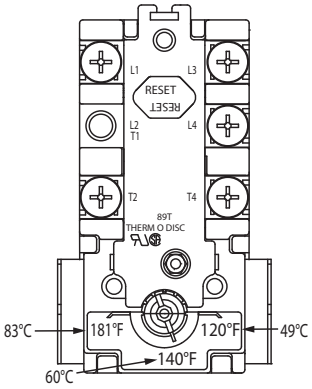


FIGURE 7

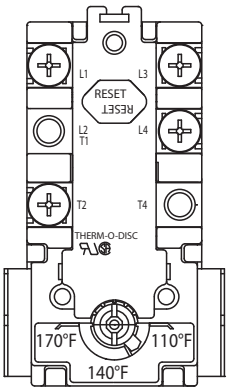


FIGURE 8

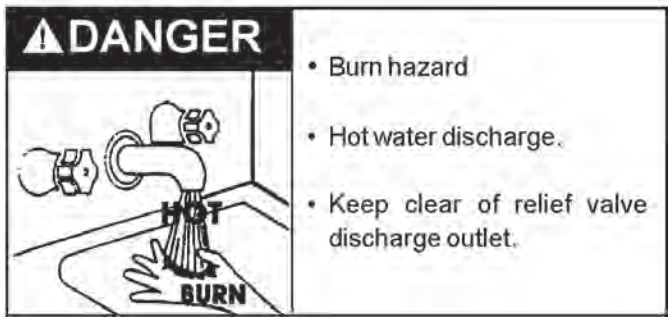
NOTE: It is not necessary to adjust the upper thermostat for a dual element unit. However, if it is adjusted above the factory set point 140°F (60°C) it is recommended that it not be set higher than the lower thermostat setting.

To change the temperature setting:

1. DANGER: Turn off the heater electrical supply. Do not attempt to adjust thermostat with power on.
2. Open the junction box door (for upper thermostat of dual element water heater only) and/or remove the (lower) thermostat access panel. Do not remove the plastic personnel protectors covering the thermostats. The thermostat is factory pre-set at 140°F (60°C).
3. Using a flat tip screwdriver, rotate the adjusting knob to the desired temperature setting.
4. Replace the covers and access panels, and turn on heater electrical supply.

MAINTENANCE

GENERAL



Periodically the drain valve should be opened and the water allowed to run until it flows clean. This will help to prevent sediment buildup in the tank bottom.

Periodically check the temperature and pressure relief valve to ensure that it is in operating condition. Lift the lever at the top of the valve several times until the valve seats properly and operates freely.

Water heater maintenance includes periodic tank flushing and cleaning, and removal of lime scale from the heating element.

The heater tank is equipped with an anode rod to aid in corrosion control.

ANODE ROD INSPECTION

CAUTION

Property Damage Hazard

- Avoid water heater damage.
- Inspection and replacement of anode rod required.

The anode rod is used to protect the tank from corrosion. Most hot water tanks are equipped with an anode rod. The submerged rod sacrifices itself to protect the tank. Instead of corroding tank, water ions attack and eat away the anode rod. This does not affect water's taste or color. The rod must be maintained to keep tank in operating condition.

Anode deterioration depends on water conductivity, not necessarily water condition. A corroded or pitted anode rod indicates high water conductivity and should be checked and/or replaced more often than an anode rod that appears to be intact. Replacement of a depleted anode rod can extend the life of your water heater. Inspection should be conducted by a qualified technician, and at a minimum should be checked annually after the warranty period.

Artificially softened water is exceedingly corrosive because the process substitutes sodium ions for magnesium and calcium ions.

The use of a water softener may decrease the life of the water heater tank.

The anode rod should be inspected after a maximum of three years and annually thereafter until the condition of the anode rod dictates its replacement.

NOTE: Artificially softened water requires the anode rod to be inspected annually.

TROUBLESHOOTING CHECKLIST

CHECKLIST

Before calling for service, check the following points to see if the cause of trouble can be identified and corrected.

Reviewing this checklist may eliminate the need of a service call and quickly restore hot water service. See Figure 2 on page 7 in this manual to identify and locate water heater components.

NOT ENOUGH OR NO HOT WATER

1. Be certain the electrical disconnect switch serving the water heater is in the ON position.
2. Check the fuses.
   - The electrical disconnect switch usually contains fuses.
3. If the water was excessively hot, and is now cold, the high limit switch may have activated.
   - See the Temperature Regulation section of this manual for more information on how to reset the ECO high limit controls.
4. The capacity of the heater may have been exceeded by a large demand for hot water.
   - Large demands require a recovery period to restore water temperature.
5. Cooler incoming water temperature will lengthen the time required to heat water to the desired temperature.
6. Look for hot water leakage.
7. Sediment or pipe scale may be affecting water heater operation.

ABNORMAL SOUNDS

1. Sediment or lime scale accumulations on the elements causes sizzling and hissing noises when the heater is operating.
   - The sounds are normal, however, the tank bottom and elements should be cleaned. See the Maintenance section of this manual.

WATER LEAKAGE IS SUSPECTED

Refer to Leakage Checkpoint on the following page 17.

1. Check to see if the heater drain valve is tightly closed.
2. If the outlet of the relief valve is leaking it may represent:
   - Excessive water temperature.
   - Faulty relief valve.
   - Excessive water pressure.
3. Excessive water pressure is the most common cause of relief valve leakage. It is often caused by a "closed system". See "Closed Water Systems" and "Thermal Expansion" in the Installation section of this manual for more information.
4. Examine the area around the element for gasket leakage.
   - Tighten the elements or, if necessary, follow the WATER AND LIME SCALE REMOVAL procedure to replace the gaskets.

IF YOU CANNOT IDENTIFY OR CORRECT THE SOURCE OF MALFUNCTION

1. Turn the power supply to the water heater off.
2. Close the supply water inlet valve to the heater.
3. Contact a Qualified Service Agency in your area. Call the toll free phone number on the back cover of this Instruction Manual for assistance in locating a service agency in your area.

REPLACEMENT PARTS

Call the toll free phone number on the back cover of this Instruction Manual for assistance in locating replacement parts.. When ordering parts, specify complete model no., serial no., (see rating plate), quantity and name of part desired. Standard hardware items should be purchased locally.

LEAKAGE CHECKPOINTS

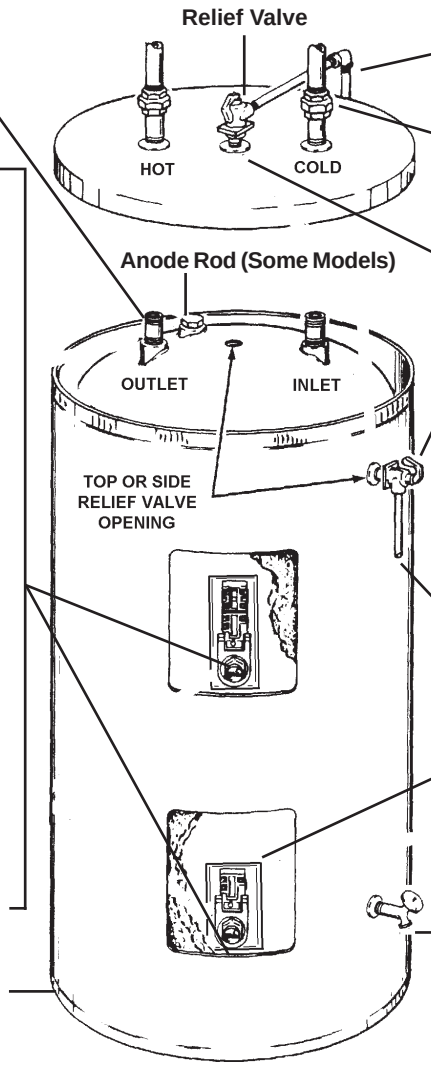
Instructions: Use this illustration as a guide when checking for sources of water leakage. You or your dealer may be able to correct what appears to be a problem. **NOTE: Cover and Insulation shown removed to reveal tank top.**

Where possible remove or lift top cover to examine threads of fittings installed into tank for evidence of leakage. Correct fitting leaks as necessary.

Water leaks at the elements may be due to:

1. **Defective element which leaks at terminals or thru flange. Replace element*.**
2. **Loose element/gasket leak:**
   - **(a) Screw-in type: tighten with 1-1/2" socket wrench. If leak continues, remove element*, discard gasket and clean thread areas. Apply nonhardening Permatex Number 2 to thread areas, install new gasket and screw element into fitting until it seats. Tighten 1/2 to 3/4 turn with wrench.**
   - **(b) Flange type: tighten screw with wrench. If leak continues remove element* and discard gasket. Clean gasket seating areas and re-install element with new gasket. A new element may be required where threads have become rusted or damaged, preventing tightening.**

All water which appears at the water heater bottom or on the surrounding floor may be caused by condensation, loose connections or relief valve operation and leakage. Do not replace the water heater until full inspection of all potential leak points is made and corrective steps taken to stop the leak. Leakage from other appliances, water lines or ground (see page 16) should also be suspected until proven otherwise.



To Open Drain

Condensation and dripping may appear on pipes when cold water temperature is low. Pipe fitting may be leaking.

Relief valve operation and leakage may be due to water expansion during heating cycle or foreign material on seat of valve. If the valve is not piped to an open drain the released water could be mistaken for a leaking heater. To check where threaded material between jacket opening and swab spud area. Remove valve* if indicated and repair with pipe joint compound.

To Open Drain

Water on the side of the tank may be condensation due to the panel or insulation not being in place.

Drain valve leakage could be from the valve itself.* To check for leakage where threaded portion enters tank, insert Q-tip or similar absorbent material between jacket opening and valve to swab spud area. Remove valve* if leak is indicated and repair with pipe joint compound.

*Contact your dealer as it is necessary to shut off electricity and drain tank to perform procedure.

FIGURE 9

COMMERCIAL WATER HEATER LIMITED WARRANTY

EFFECTIVE

For 3 Years, in the event of a tank leak, we will repair or, at our discretion, replace the defective water heater.

For 1 Year, in the event of part failure, we will repair or, at our discretion, replace the defective part.

We warrant this product against defects in materials or workmanship as described in this document if installed within the United States or Canada and provided the product remains at its original place of installation.

Warranty coverage begins the date of installation OR the date of manufacture if installation cannot be verified.

WHAT'S COVERED

Subject to these terms, in the event of defect in materials and/or workmanship resulting in a **tank leak** during the **first three years**, we will:

- Replace the water heater should the tank leak.

Subject to these terms, in the event of a defect in materials and/or workmanship appearing during the **first year**, we will:

- Repair or, at our discretion, replace any part of the water heater covered under this limited warranty excluding parts subject to normal maintenance (Example: non-electronic anode rod, filter, etc)

Service/labor, shipping, delivery, installation, handling or any other costs are not covered at any time under this warranty.

Any replacement part or product will be warranted only for the unexpired portion of the original water heater's limited warranty period.

If an identical model is no longer available due to a change in law, regulation, or standard, we will replace the product with one having comparable capacity and input. In these instances, the owner will have the option of paying the difference between what was paid for the original model and the new model with the additional features, or receiving a refund of the portion of the purchase price, on a pro-rata basis allocable to the unexpired portion of the warranty.

WHAT'S NOT COVERED

- Problems caused by improper: gas supply line sizing, gas type, venting, connections, combustion air, voltage, wiring, or fusing
- Failure to follow applicable codes
- Failure to follow printed instructions
- Abuse, misuse, accident, fire, flood, Acts of God
- Improper installation, sizing, delivery, or maintenance
- Claims related to rust, noise, smell, or taste of water
- Failure to conduct authorized factory start up if required
- Alterations to the water heater
- Non-outdoor heaters installed outdoors
- Damages due to a failure to allow for thermal expansion
- Heat exchanger failure due to lack of adequate / proper supply of water
- Heaters moved from their original location
- Service trips to explain proper installation, use, or maintenance of the product/unit or to describe compliance requirements under applicable codes and regulations
- Charges related to accessing your heater including but not limited to door/wall removal, equipment rental, etc.
- Replacement parts after expiration of this warranty

LIMITATIONS

NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, THIS IS YOUR SOLE AND EXCLUSIVE WARRANTY. ALL OTHER WARRANTIES INCLUDING A WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES. TOTAL LIABILITY ARISING AT ANY TIME SHALL NOT EXCEED THE PURCHASE PRICE PAID WHETHER BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER LEGAL THEORY.

SERVICE INQUIRIES:

For service inquiries call the telephone number listed below. Be prepared to provide the following information: name, address, and telephone number; the model and serial number of the water heater; proof of installation; and a clear description of the problem.

For your records, fill in the product:

Serial: _____
Model: _____

U.S. Customers:

A. O. Smith Corporation
500 Tennessee Waltz Parkway
Ashland City, Tennessee 37015
800-527-1953
www.hotwater.com

Canadian Customers:

P. O. Box 310 – 768 Erie Street
Stratford (Ontario) N5A 6T3
800-265-8520

NOTES

REPAIR PARTS LIST

Now that you have purchased this water heater, should a need ever exist for repair parts or service, simply contact the company it was purchased from or direct from the manufacturer listed on the rating plate on the water heater.

Selling prices will be furnished on request or parts will be shipped at prevailing prices and you will be billed accordingly.

The model number of your Water Heater will be found on the rating plated located above the lower access panel.

Be sure to provide all pertinent facts when you call or visit.

WHEN ORDERING REPAIR PARTS, ALWAYS GIVE THE FOLLOWING INFORMATION:

- MODEL NUMBER
- VOLTAGE AND ELEMENT WATTAGE
- SERIAL NUMBER
- PART DESCRIPTION

Del 6, 10, 15, 20 Series 102 (refer to repair parts table).

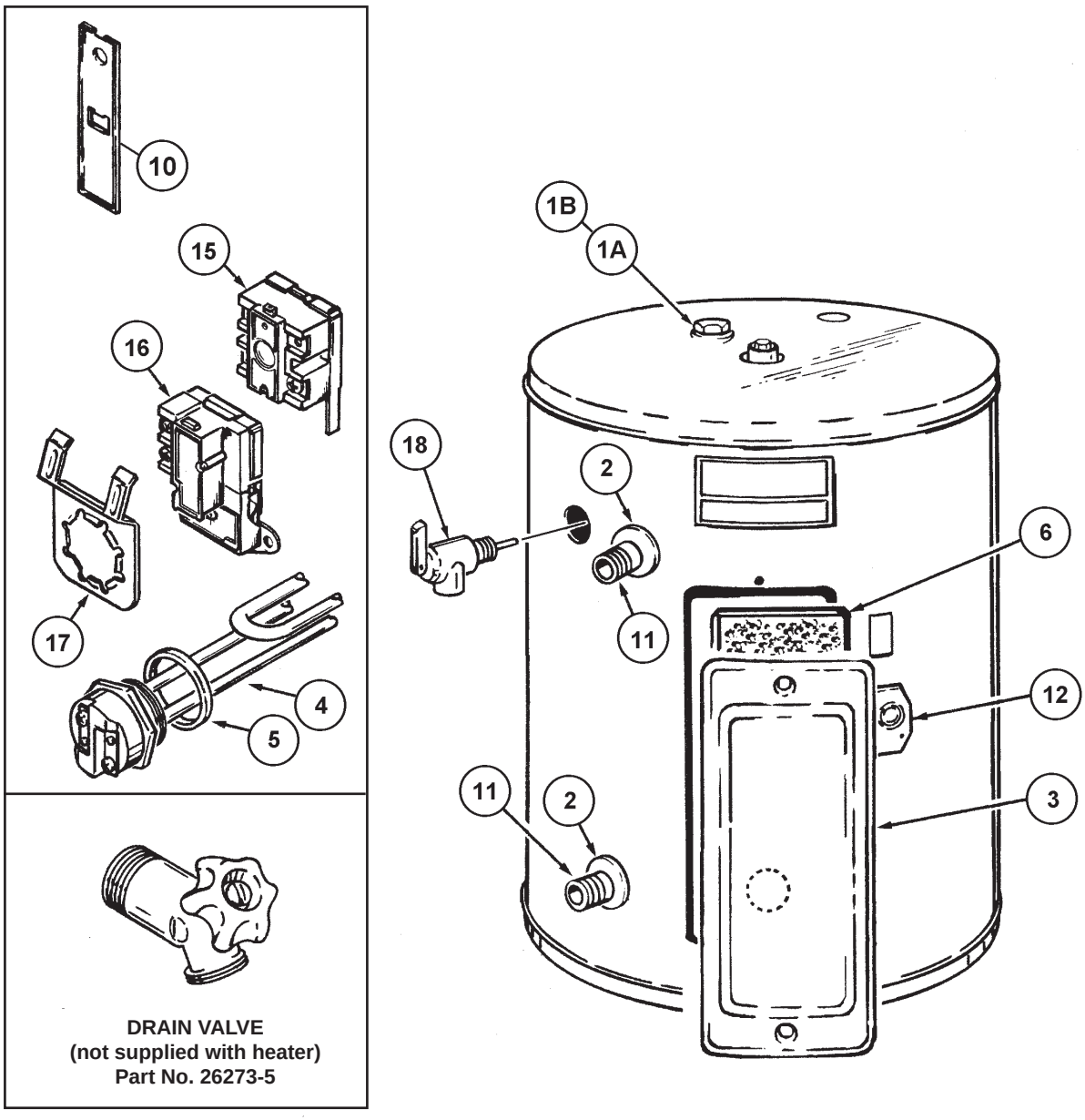


FIGURE 10

Item	Description	DEL-6 Series 102	DEL-10 Series 102	DEL-15 Series 102	DEL-20 Series 102
1A	Anode, Alum...	9003942005	9003942005	9003942005	9003944005
1B	Anode, Mag. (SMR P72 and S19)	9001909005	9001909005	9001909005	9003721005
2	Collar, Pipe	9004610115	9004610115	9004610115	9004610115
3	Cover, Front	9003900005	9003900005	9003900005	9003900005
4	ELEMENT, HEATING	SEE ELEMENT CHART ON PAGE 23			
5	Gasket, Element	9000308005	9000308005	9000308005	9000308005
6	Opening Insulation	043307-000	043307-000	043307-000	043307-000
7	*Instruction Manual	322055-0	322055-0	322055-0	322055-0
10	Personnel Protector	9003914015	9003914015	9003914015	9003914015
11	Pipe Nipple	194130	194130-3	194130-3	194130-3
12	Plate, Knockout	43293-1	43293-1	43293-1	43293-1
	PLUG				
15/16	Thermostat with High Limit Switch	9006586015	9006586015	9006586015	9006586015
17	Bracket, Thermostat	9003898015	9003898015	9003898015	9003898015
18	Valve, Relief	9003484005	9003741005	9003741005	9003741005

*Not Illustrated.
Standard Hardware Items May Be Purchased Locally. Underlined Parts Are Recommended For Emergency Replacement.

DEN 30, 40, 52, 66, 80 & 120, Series 110
(Refer to Repair Parts Table on page 22)

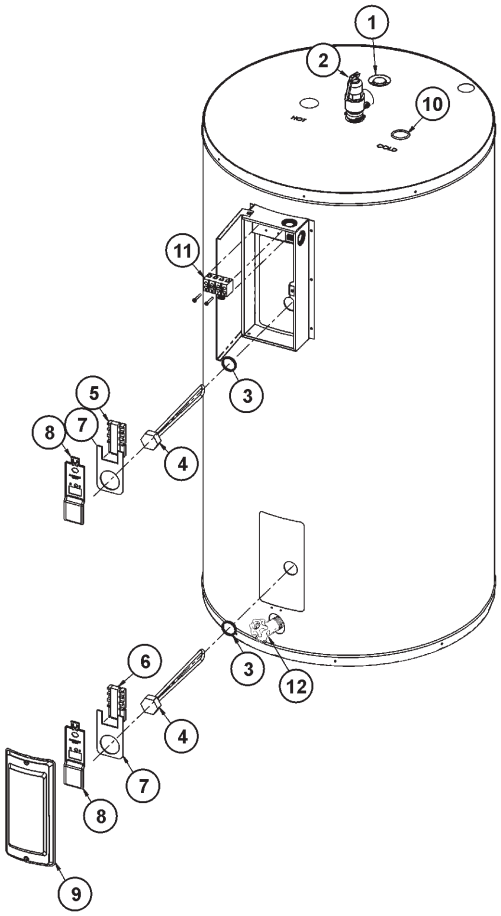


FIGURE 11

DEL 30, 40 & 50, Series 110
(Refer to Repair Parts Table on page 22)

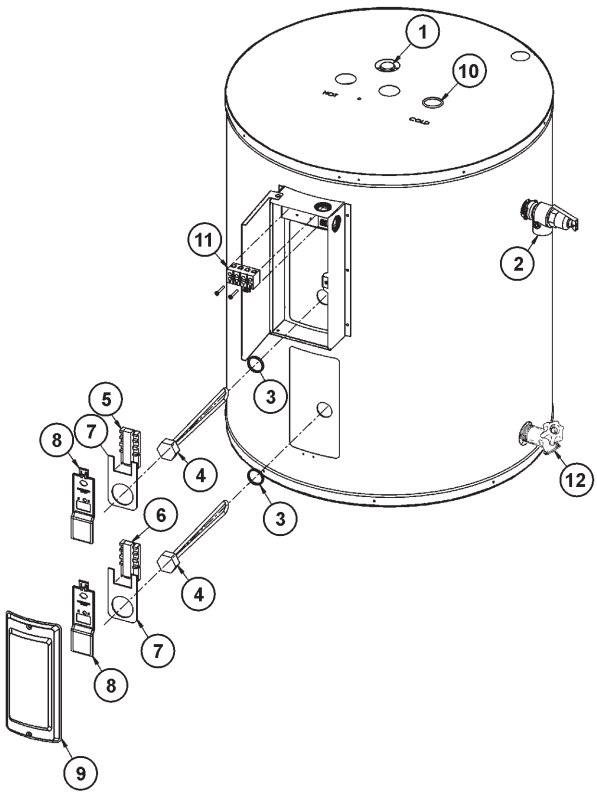


FIGURE 12

Item	Description	DEL-30 Series 110	DEL-40 Series 110	DEL-50 Series 110	DEN-30 Series 110	DEN-40 Series 110	DEN-52 Series 110	DEN-66 Series 110	DEN-80 Series 110	DEN-120 Series 110
1A	Anode, Alum.	9003944005	9003944005	9003944005	9003944005	9003944005	9003944005	9000029005	9003892005	9003892005
1B	Anode, Mag.(SMR P72)	9003721005	9003721005	9003721005	9003721005	9003721005	9003721005	9003721005	9001829005	9001829005
2	T&P Relief Valve	9003741005	9003741005	9003741005	9000071005	9000071005	9000071005	9000071005	9000071005	9000071005
3	Gasket, Element	9000308045	9000308045	9000308045	9000308045	9000308045	9000308045	9000308045	9000308045	9000308045
4	ELEMENT, each	(SEE ELEMENT & WATTAGE CHART page 23)								
5	Upper Thermostat w/Hi Limit	9002856015	9002856015	9002856015	9002856015	9002856015	9002856015	9002856015	9002856015	9002856015
6	Lower Thermostat w/Hi Limit	9002857015	9002857015	9002857015	9002857015	9002857015	9002857015	9002857015	9002857015	9002857015
7	Thermostat Bracket, each	9003898215	9003898215	9003898215	9003898215	9003898215	9003898215	9003898215	9003898215	9003898215
8	Personal Protector	9003914015	9003914015	9003914015	9003914015	9003914015	9003914015	9003914015	9003914015	9003914015
9	Lower Access Panel	9003900005	9003900005	9003900005	9003900005	9003900005	9003900005	9003900005	9003900005	9003900005
10	Dip Tube	9003902005	9003902005	9003902005	9003902005	9003903005	9003904005	9003905005	9003905005	9005709205
11	Power Terminal	9005719215	9005719215	9005719215	9005719215	9005719215	9005719215	9005719215	9005719215	9005719215
12	Drain Valve	9003906015	9003906015	9003906015	9003906015	9003906015	9003906015	9003906015	9003906015	9003906015
15*	Junction Box Assembly	195171	195171	195171	195171	195171	195171	195171	195171	195171
16*	Manual	322055-0	322055-0	322055-0	322055-0	322055-0	322055-0	322055-0	322055-0	322055-0

*Not Illustrated.

Standard Hardware Items May Be Purchased Locally.

Underlined Parts Are Recommended For Emergency Replacement.

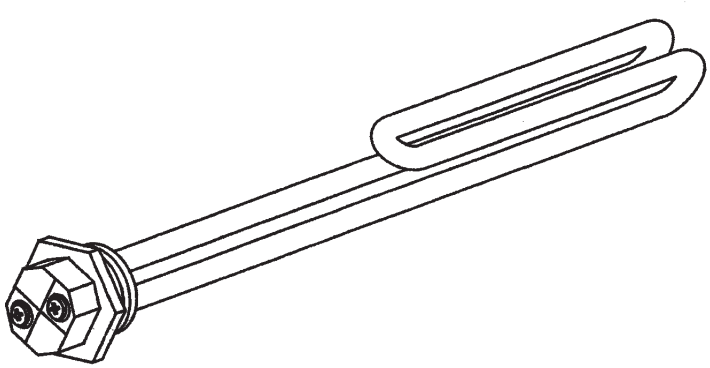


FIGURE 13

TABLE 6 - COPPER SHEATH ELEMENT AND WATTAGE CHART

K.W.	ELEMENT WATTAGE	120V	208V	240V	277V	480V
		PART NO.	PART NO.	PART NO.	PART NO.	PART NO.
1.0	1000W	- - -	9002863115	90001431005	- - -	- - -
1.5	1500W	9002963005	9000145005	9002864005	9001225115	- - -
2.0	2000W	9003947005	9002858005	9000145005	9004709115	- - -
2.5	2500W	9002859005	9004712105	9002860005	9002890005	9002861005
3.0	3000W	9002862005	9002868005	9003959005	9003958005	9003961005
3.5	3500W	- - -	9003950005	9004712105	- - -	- - -
MAX 3.5KW INPUT FOR 6 GALLON UNITS, ELEMENTS BELOW DOTTED LINE CANNOT BE USED ON 6 GALLON UNITS						
4.0	4000W	- - -	9002867005	9002868005	9001229005	9002869005
4.5	4500W	- - -	9003952005	9003950100	9003960005	9001225005
5.0	5000W	- - -	9001224005	9003957005	9001231005	9001236005
5.5	5500W	- - -	9002871005	9002867005	- - -	9002872005
6.0	6000W	- - -	9003953005	9003952005	9002874005	9002875005

TABLE 7 - INCOLOY SHEATH ELEMENT AND WATTAGE CHART (FOR SMR P72)

K.W.	ELEMENT WATTAGE	120 V	208 V	240 V	277 V	480 V
		PART NO.	PART NO.	PART NO.	PART NO.	PART NO.
1.5	1500 W	9004279005	9004283005	9004290005	9004736105	Not Available
2.0	2000 W	9004280005	9004284005	9004283005	9004290005	9004298005
2.5	2500 W	9004281005	9004285005	9004291005	9004295005	9004299005
INCOLOY ELEMENTS BELOW THIS LINE CANNOT BE USED ON 6 GALLON UNITS BECAUSE OF ELEMENT LENGTH						
3.0	3000 W	9004282005	9004751115	9000664005	9004296005	9004300005
3.5	3500 W	Not Available	9003210005	9004292005	Not Available	Not Available
4.0	4000 W	Not Available	9004294005	9004751115	9000664005	Not Available
4.5	4500 W	Not Available	9004287005	9003210005	9004297005	9004301005
5.0	5000 W	Not Available	9004753105	9004293005	Not Available	Not Available
5.5	5500 W	Not Available	9004288005	9004294005	Not Available	Not Available
6.0	6000 W	Not Available	9004289005	9004287005	Not Available	Not Available

www.hotwater.com
500 Tennessee Waltz Parkway, Ashland City, TN 37015
Tech Support: 800-527-1953
Parts: 800-433-2545

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Chapter 11 PLUMBING FIXTURES

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax: (514) 344-9341

11.1 **SERV-A-SINK LAUNDRY TUBS FIAT FL-1**

11.2 **SERVICE SINK FAUCET FIAT 830-AA**

11.3 **SINK WASTE ASSEMBLY KINDRED 1135**

11.4 **DRAIN ZURN ZXN-415-H6**

11.5 **EYE/FACE WASH GUARDIAN G1909SSH**

11.6 **TEMPERING VALVE GUARDIAN G3800**

11.7 **405 1/2 HP POMPE DRAIN 2 VENT LIBERTY, 120V/1/60**

11.8 **Liquid Level Regulators**

Emergency eyewash and shower

Guardian

Safety Stations with WideArea™ Eye/Face Wash

☐ **G1909** Safety Station with WideArea™ Eye/Face Wash, Stainless Steel Bowl
☐ **G1909P** Safety Station with WideArea™ Eye/Face Wash, Plastic Bowl

Application: Combination WideArea™ eye/face wash and shower safety station. Four GS-Plus™ spray-type outlet heads deliver a flood of water over a wide area of coverage for complete rinsing of eyes and face.

Shower Head: 10" diameter orange ABS plastic.

Shower Valve: 1" IPS chrome plated brass stay-open ball valve. Valve is US-made with chrome plated brass ball and Teflon® seals. Furnished with stainless steel actuating arm and 29" stainless steel pull rod.

Spray Head Assembly: Four GS-Plus™ spray heads. Each head has a "flip top" dust cover, internal flow control and filter to remove impurities from the water flow.

Eye/Face Wash Bowl: 11-1/2" diameter. Bowl is stainless steel (G1909) or orange ABS plastic (G1909P).

Eye/Face Wash Valve: 1/2" IPS chrome plated brass stay-open ball valve. Valve is US-made with chrome plated brass ball and Teflon® seals.

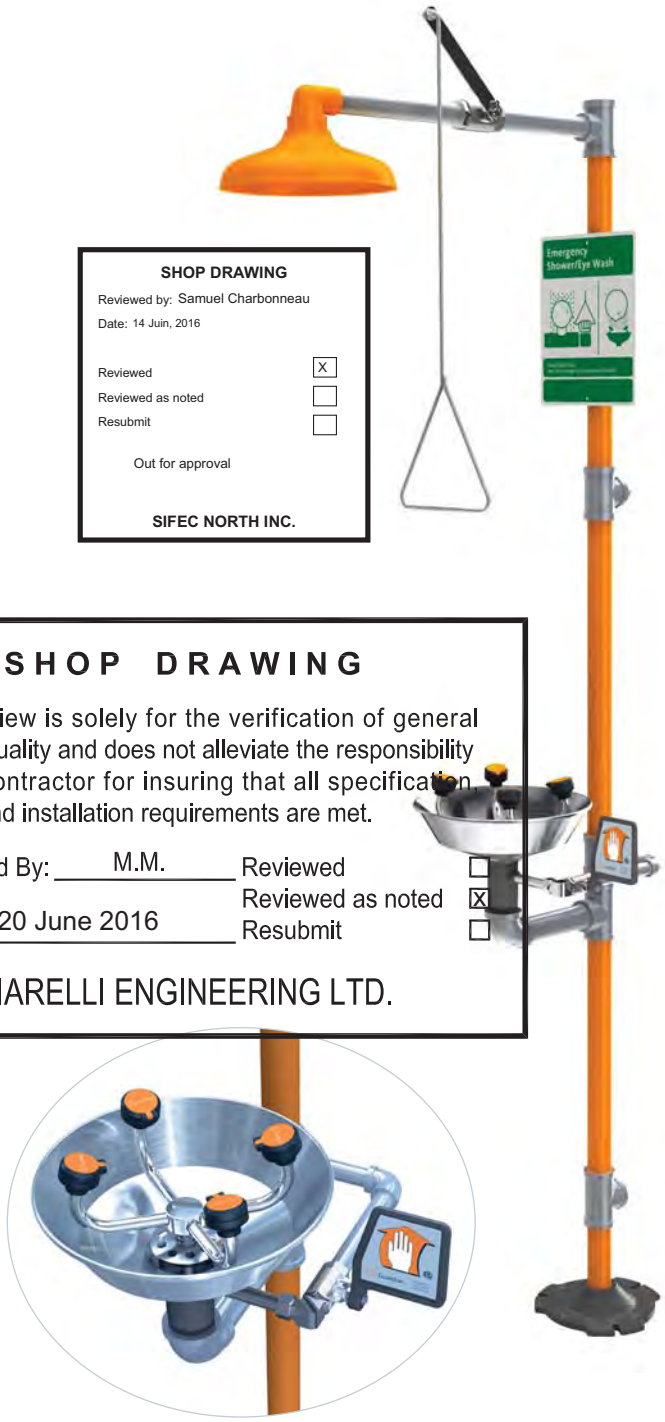
Pipe And Fittings: Schedule 40 galvanized steel. Furnished with orange polyethylene covers for vertical piping for high visibility and corrosion resistance.

Supply: 1-1/4" NPT female top or side inlet.

Waste: 1-1/4" NPT female outlet. Outlet can be positioned at either 9-1/4" or 19-5/8" above finished floor by reversing lower pipe nipples.

Sign: Furnished with ANSI-compliant identification sign.

Quality Assurance: Valve and spray head assemblies are factory assembled and water tested prior to shipment.



SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

SHOP DRAWING
This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification space and installation requirements are met.
Reviewed By: M.M.
Date: 20 June 2016
Reviewed [ ]
Reviewed as noted [X]
Resubmit [ ]
CHIARELLI ENGINEERING LTD.

Available Options

☐ **GC** Powder coated finish on galvanized pipe and fittings. Available colors include orange, yellow, red and green.

☐ **FC20** Regulates shower flow rate to 20 GPM.

☐ **GRN** Green ABS plastic shower head.

☐ **YEL** Yellow ABS plastic shower head.

☐ **SSH** Stainless steel shower head.

☐ **AP275-100 Electric Light and Alarm Horn**
Light and alarm horn summon assistance when eye/face wash or shower is activated.

☐ **AP250-015 Modesty Curtain**
Modesty curtain for mounting on safety station.

☐ **TMV** G3800 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1-2009.

Guardian Equipment
1140 N North Branch St
Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

Listed 8116. Units have been tested to and comply with ANSI Z358.1-2009 and the Uniform Plumbing Code.

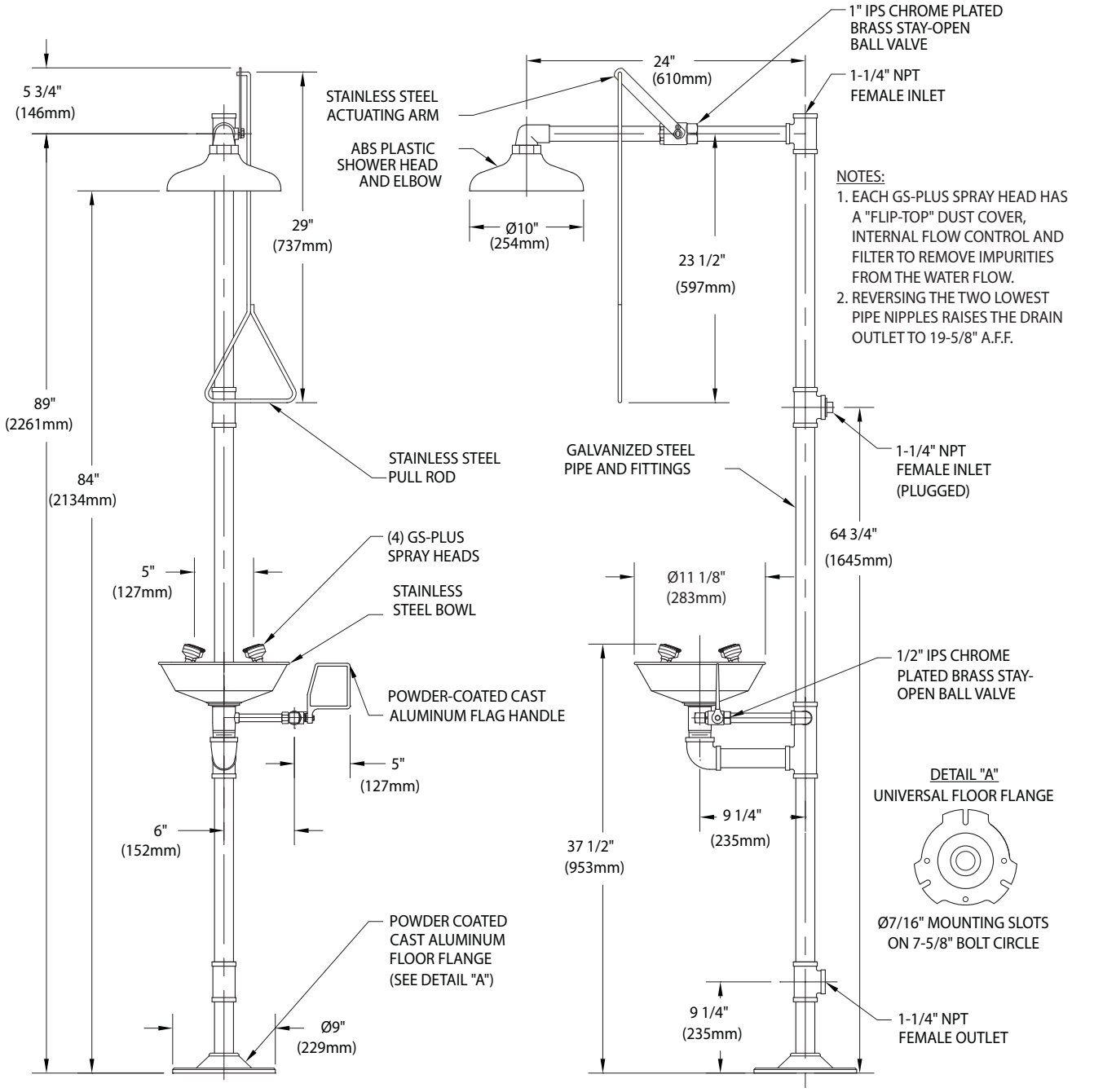
ETL Listed 101496. Units have been tested to and comply with ANSI Z358.1-2009.

Emergency eyewash and shower

Guardian

Safety Stations with WideArea™ Eye/Face Wash

☐ **G1909** Safety Station with WideArea™ Eye/Face Wash, Stainless Steel Bowl
☐ **G1909P** Safety Station with WideArea™ Eye/Face Wash, Plastic Bowl



Sign Included

THIS SPACE FOR ARCHITECT/ENGINEER APPROVAL

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4" (6mm). rev.10114

Guardian Equipment
1140 N North Branch St
Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

Listed 8116. Units have been tested to and comply with ANSI Z358.1-2009 and the Uniform Plumbing Code.

ETL Listed 101496. Units have been tested to and comply with ANSI Z358.1-2009.

HAYWARD®

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

SB Series Simplex Basket Strainers

1/2" TO 4" PVC, CPVC, GFPP AND EASTAR®

NSF
PVC and CPVC only

KEY FEATURES

- PVC, CPVC, GFPP and Eastar
- Ergonomic Hand-Removable Cover
- In-Line or Loop Connections
- External Cover Threads
- Integral Flat Mounting Bases
- NSF / ANSI 61 Listed

OPTIONS

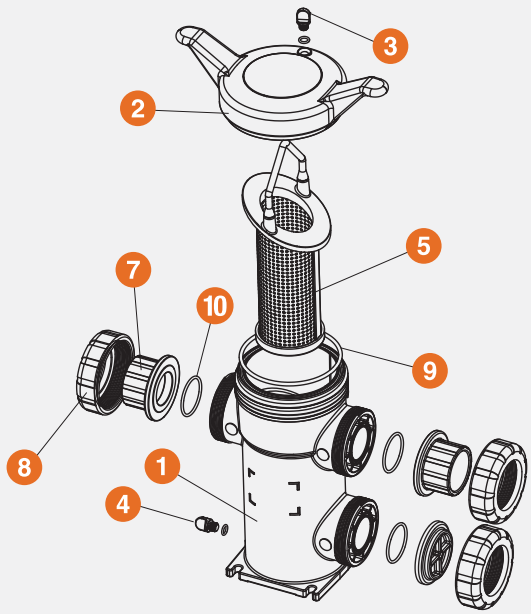
- Stainless Steel, Monel®, Hastelloy®, and Titanium Strainer Baskets
- Pressure Differential Gauge and Switch
- Baskets Available with Perforated or Mesh Liners

MATERIALS

- PVC Cell Class 12454 per ASTM D1784
- CPVC Cell Class 23447 per ASTM D1784
- GFPP Cell Class 85580 per ASTM D4101
- Eastar
- FPM and EPDM O-Ring Seals

TECHNICAL INFORMATION

EXPLODED VIEW



SELECTION CHART

SIZE	MATERIAL	END CONNECTION	SEALS	PRESSURE RATING
1/2" – 4" (DN15 – DN100)	PVC, CPVC and GFPP	Socket, Threaded or Flanged	FPM or EPDM	150 PSI @ 70°F Non-Shock
	Eastar*			100 PSI @ 70°F Non-Shock

* End connections and assembly nuts are PVC

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

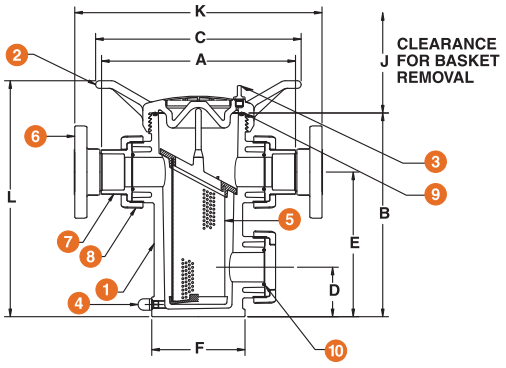
Reviewed By: M.M.
Date: 20 June 2016
Reviewed [ ]
Reviewed as noted [X]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

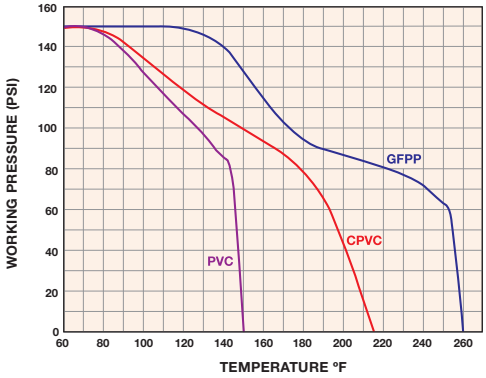
TECHNICAL INFORMATION, *CONTINUED*

PARTS LIST

1. Body
2. Cover
3. Vent Plug and O-Ring
4. Drain Plug and O-Ring
5. Basket
6. Flange (Optional)
7. End Connector
8. Nut
9. Cover O-Ring
10. End Connector O-Ring



OPERATING TEMPERATURE / PRESSURE



DIMENSIONS – INCHES / MILLIMETERS

SIZE in / DN	A in / mm	B in / mm	C in / mm	D in / mm	E in / mm	F in / mm	J in / mm	K in / mm	L in / mm	WEIGHT lbs / kg SOC / THD	WEIGHT lbs / kg FLANGED	VOLUME gal / LT
1/2 / 15	8.64 / 219	9.63 / 245	11.00 / 279	2.25 / 57	6.75 / 171	4.31 / 109	8.00 / 203	10.77 / 274	11.70 / 297	8.00 / 3.63	9.00 / 4.08	.20 / .76
3/4 / 20	8.64 / 219	9.63 / 245	11.00 / 279	2.25 / 57	6.75 / 171	4.31 / 109	8.00 / 203	11.02 / 280	11.70 / 297	8.00 / 3.63	9.00 / 4.08	.20 / .76
1 / 25	8.64 / 219	9.63 / 245	11.00 / 279	2.25 / 57	6.75 / 171	4.31 / 109	8.00 / 203	11.64 / 296	11.70 / 297	8.00 / 3.63	9.00 / 4.08	.20 / .76
1-1/4 / 32	12.75 / 324	13.38 / 340	13.50 / 343	3.25 / 83	9.50 / 241	6.13 / 156	12.86 / 327	15.63 / 397	15.50 / 394	14.00 / 6.35	16.50 / 7.48	.70 / 2.65
1-1/2 / 40	12.69 / 322	13.38 / 340	13.50 / 343	3.25 / 83	9.50 / 241	6.13 / 156	12.86 / 327	15.89 / 403	15.50 / 394	14.00 / 6.35	16.50 / 7.48	.70 / 2.65
2 / 50	12.75 / 324	13.38 / 340	13.50 / 343	3.25 / 83	9.50 / 241	6.13 / 156	12.86 / 327	16.29 / 413	15.50 / 394	14.00 / 6.35	16.50 / 7.48	.70 / 2.65
2-1/2 / 63	16.52 / 420	19.83 / 504	16.00 / 406	4.83 / 123	14.83 / 377	7.25 / 184	17.25 / 438	21.02 / 534	22.30 / 566	28.00 / 12.70	33.00 / 14.97	2.80 / 10.60
3 / 80	16.40 / 417	19.83 / 504	16.00 / 406	4.83 / 123	14.83 / 377	7.25 / 184	17.25 / 438	20.36 / 517	22.30 / 566	28.00 / 12.70	33.50 / 15.20	2.80 / 10.60
4 / 100	17.27 / 439	19.83 / 504	16.00 / 406	4.83 / 123	14.83 / 377	7.25 / 184	17.25 / 438	22.13 / 562	22.30 / 566	28.00 / 12.70	37.00 / 16.78	2.80 / 10.60

Dimensions are subject to change without notice – consult factory for installation information

PRESSURE DROP CALCULATIONS

BASKET PERFORATION CORRECTION FACTORS

For 1/2" to 4" Strainers

Plastic		Stainless Steel			
1/32"	1.05	1/32"	.82	20 Mesh	.79
1/16"	1.00	1/16"	.74	40 Mesh	1.01
1/8"	.58	1/8"	.58	60 Mesh	1.20
3/16"	.46	5/32"	.37	80 Mesh	1.16
		3/16"	.46	100 Mesh	1.20
		1/4"	.58	200 Mesh	1.09
		3/8"	.45	325 Mesh	1.22

PRESSURE LOSS CALCULATION FORMULA

The pressure drop across the strainer, for water or fluids with a similar viscosity, can be calculated using the formula at the right:

$$\Delta P = \left[\frac{Q}{Cv}\right]^2$$

ΔP = Pressure Drop

Q = Flow in GPM

Cv = Flow Coefficient

Cv VALUES

SIZE in / DN	Cv VALUES GPM	SIZE in / DN	Cv VALUES GPM
1/2 / 15	15	2 / 50	60
3/4 / 20	18	2-1/2 / 63	290
1 / 25	20	3 / 80	300
1-1/4 / 32	55	4 / 100	350
1-1/2 / 40	58		

The above Cv Values were determined using a 1/16" perforated plastic basket in 1/2" through 4" strainers.

To calculate pressure drop through vessels using other than 1/16" perforated baskets, first calculate the pressure drop using the listed Cv, and then multiply the result by the correction factor in the Correction Factors chart to the left.

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– Eastar is a registered trademark of Eastman.
– Hastelloy is a registered trademark of Haynes International Inc.
– Monel is a registered trademark of Special Metals Corporation.

FIAT PRODUCTS

SERV-A-SINK® LAUNDRY TUBS MODELS FL-1, L-1, DL-1

FL-1 FLOOR MOUNTED SERV-A-SINK®
L-1 WALL HUNG SERV-A-SINK®
DL-1 DROP-IN SERV-A-SINK®

Fiat Products uses a specialized SMC process (Molded Stone®) to manufacture all laundry tubs. Moldings are manufactured in matched metal dies under heat and pressure resulting in a homogeneous molded unit. Drain(s) with stopper(s) are furnished as standard equipment. Capacity shall be 76 litres (17 Imp gal) for the single tub sink and 152 litres (33 Imp gal) for the double tub sink. Laundry sinks available in white only.

- All single compartment laundry tubs are available in sixpacks (L-6 and FL-6) and bulk quantities.
- All products must be installed in accordance with installation instructions provided. Failure to do so may invalidate warranty at manufacturer's discretion.

FL-1 Floor Mounted Serv-A-Sink®

- **W**hite baked enamel angle legs that slip into molded sockets for rigid, friction-fit. (Included)
- Easy leveling devices are provided for fast, even planing. Tub is capable of handling 600 pounds.

Nominal Dimensions:
Overall Outside Dimensions:
20-1/4" x 17-1/4" x 13" (514 x 438 x 330mm)
Overall height from floor
34-3/4" (883mm) CSA Approved

L-1 Wall Hung Serv-A-Sink®

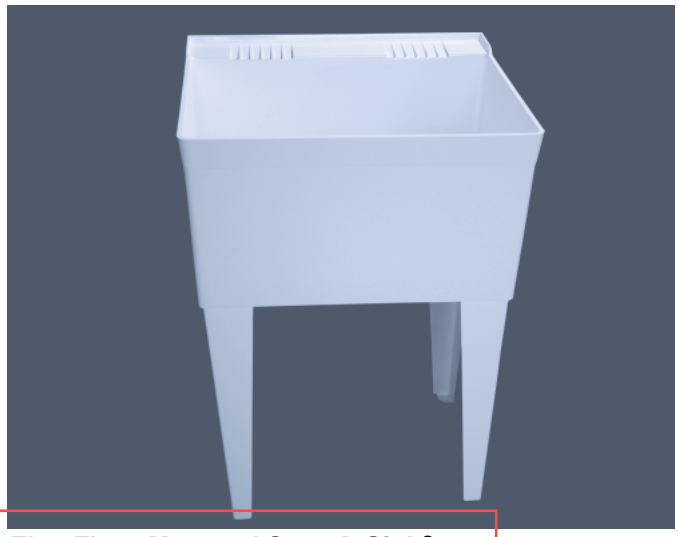
- **H**eavy gauge galvanized - steel bracket capable of withstanding 600 pounds. (Included)
- Side fillers and bottom tub support, which are assembled in field to the mounting brackets, are made of white molded plastic polymer.

Nominal Dimensions:
20-1/4" x17-1/4" x 13" (514 x 438 x 330mm)

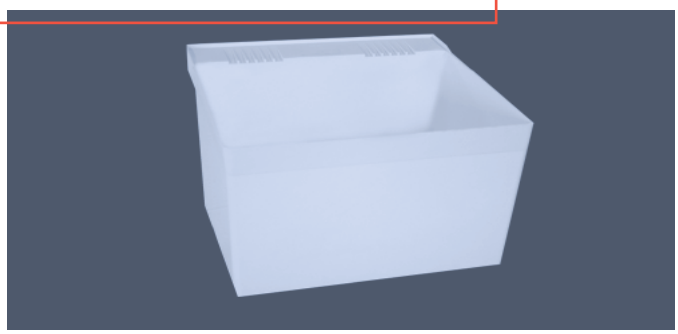
DL-1 Drop-In Serv-A-Sink®

- Designed for a countertop installation.
- Self-rimming flange, four locking corner bars and screws for fast tightening into integral molded mounting legs and against the underside of the countertop. (Included)

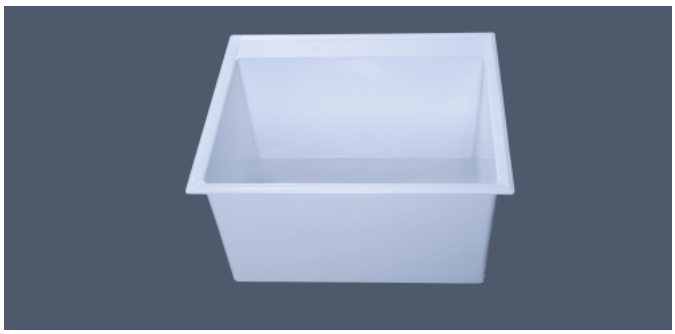
Nominal Dimensions:
22-1/8" x 17" x 12-3/7" (562 x 432 x 324mm)
Underside flange rim sealant for watertightness supplied by others.



FL-1 Floor Mounted Serv-A-Sink®



L-1 Wall Hung Serv-A-Sink®



DL-1 Drop-In Serv-A-Sink®

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

All products are UPC listed

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

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www.fiat.ca

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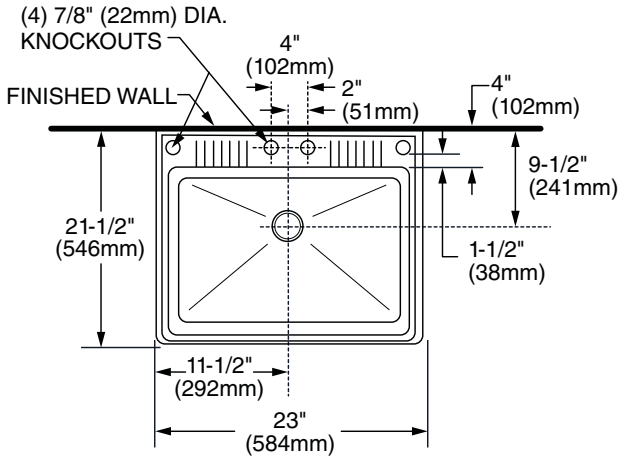
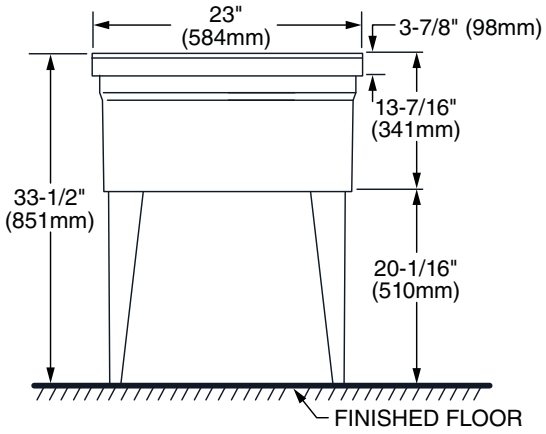
Revised 11/13

FIAT PRODUCTS

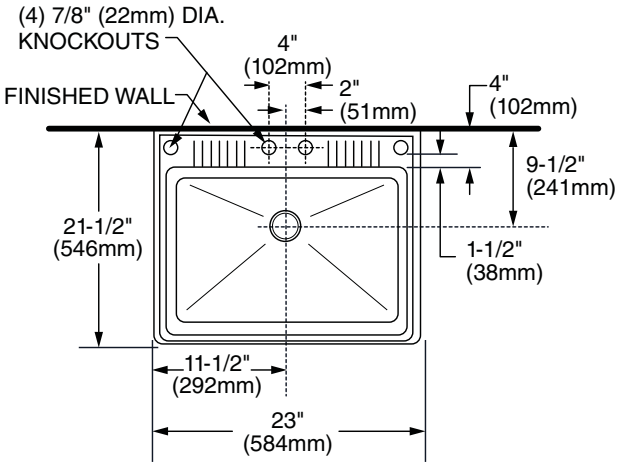
SERV-A-SINK® LAUNDRY TUBS
MODELS FL-1, L-1, DL-1

MODEL FL-1
FLOOR MOUNTED





MODEL L-1
WALL HUNG



IMPORTANT: Roughing-in dimensions may vary 1/2" and are subject to change or cancellation without prior notice.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

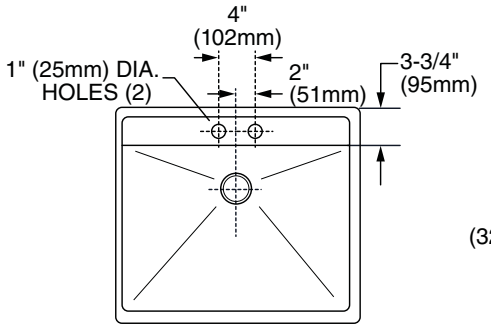
Reviewed By: M.M.

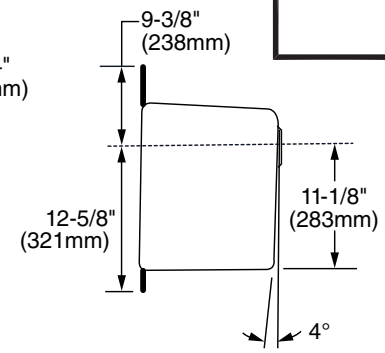
Date: 20 June 2016

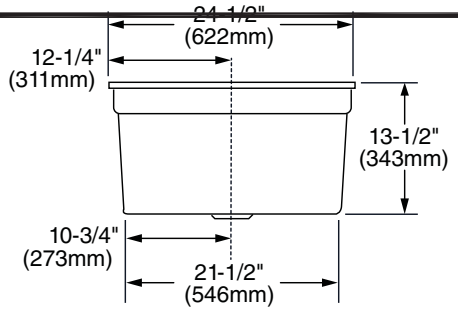
Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

MODEL DL-1
DROP-IN







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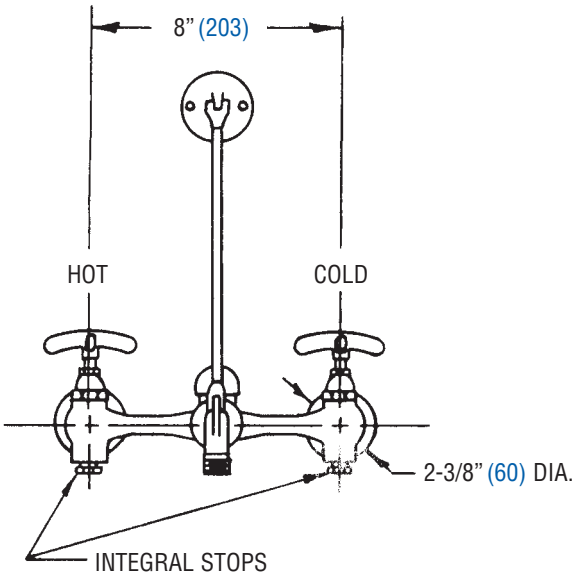
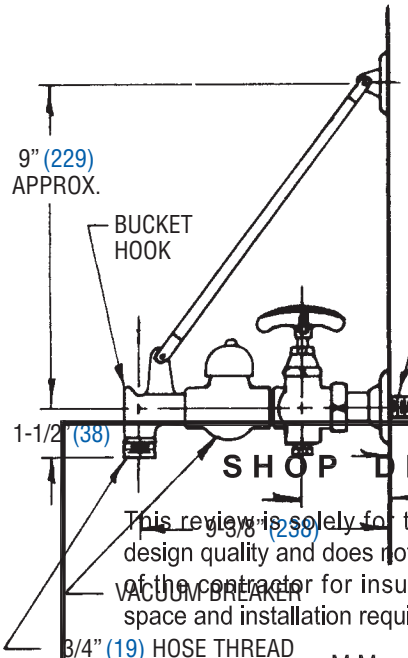
Service-Sink Faucet
Model: 830-AA

FIAT

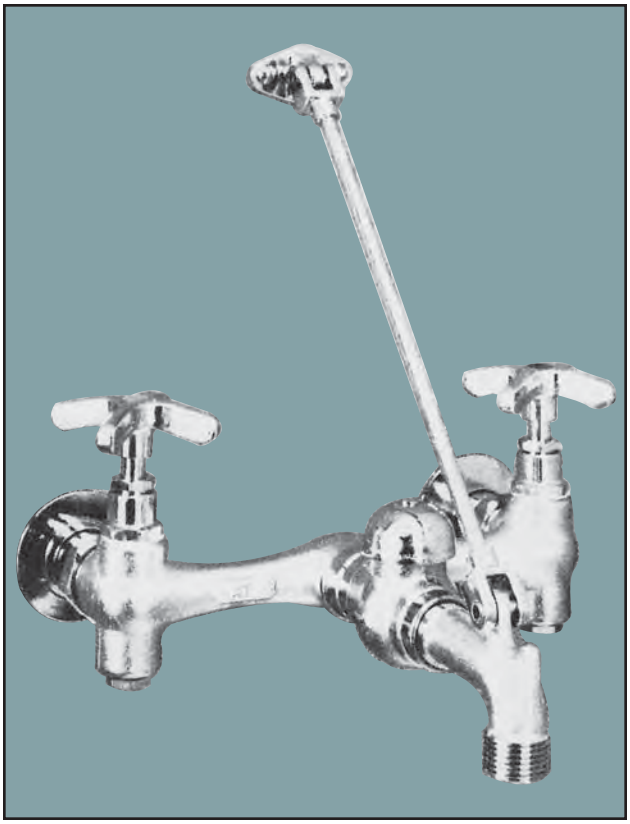
Service Sink and Faucet



FRONT VIEW



SIDE VIEW



General: 830-AA Service Faucet - Chrome plated with vacuum breaker, integral stops, adjustable wall brace, pail hook and 3/4" hose thread on spout. Body inlets 8" center to center, four arm handles. Valves contain renewable hub, renewable seats, swivel discs, encased washers and brass washer screws.

Material: Commercial red brass alloy casting-rough finish.

Finish: Chrome plating exceeding requirements of ANSI/ASTM B-456-71. Indicators cold (blue) and hot (red) are included.

Specifications and Codes: In the U.S.A., meets or exceeds requirements of ANSI-A112.18.1M-1979 for "Finished and Rough Brass Plumbing Fixture Fittings." In Canada, meets or exceeds the requirements of CSA standards B125 - "Plumbing Fittings," B64.1.1 - "Vacuum Breakers - Atmosphere Type" and B64.0 - "General Requirements for Backflow Preventers and Vacuum Breakers," and is approved under Product Class No. 6811 01 under Report #LM57412-1. Conforms to ASSE 1001.

NOTE: These roughing measurements may vary 1/4" (plus or minus).

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

FIAT PRODUCTS®
A CRANE PLUMBING COMPANY

255 Hutchings St. • Winnipeg, MB • R2X 2R4 • Ph. 800-665-7531 • 204-633-6122 • Fx. 2
e-mail: info@fiat.ca • website: www.fiat.ca

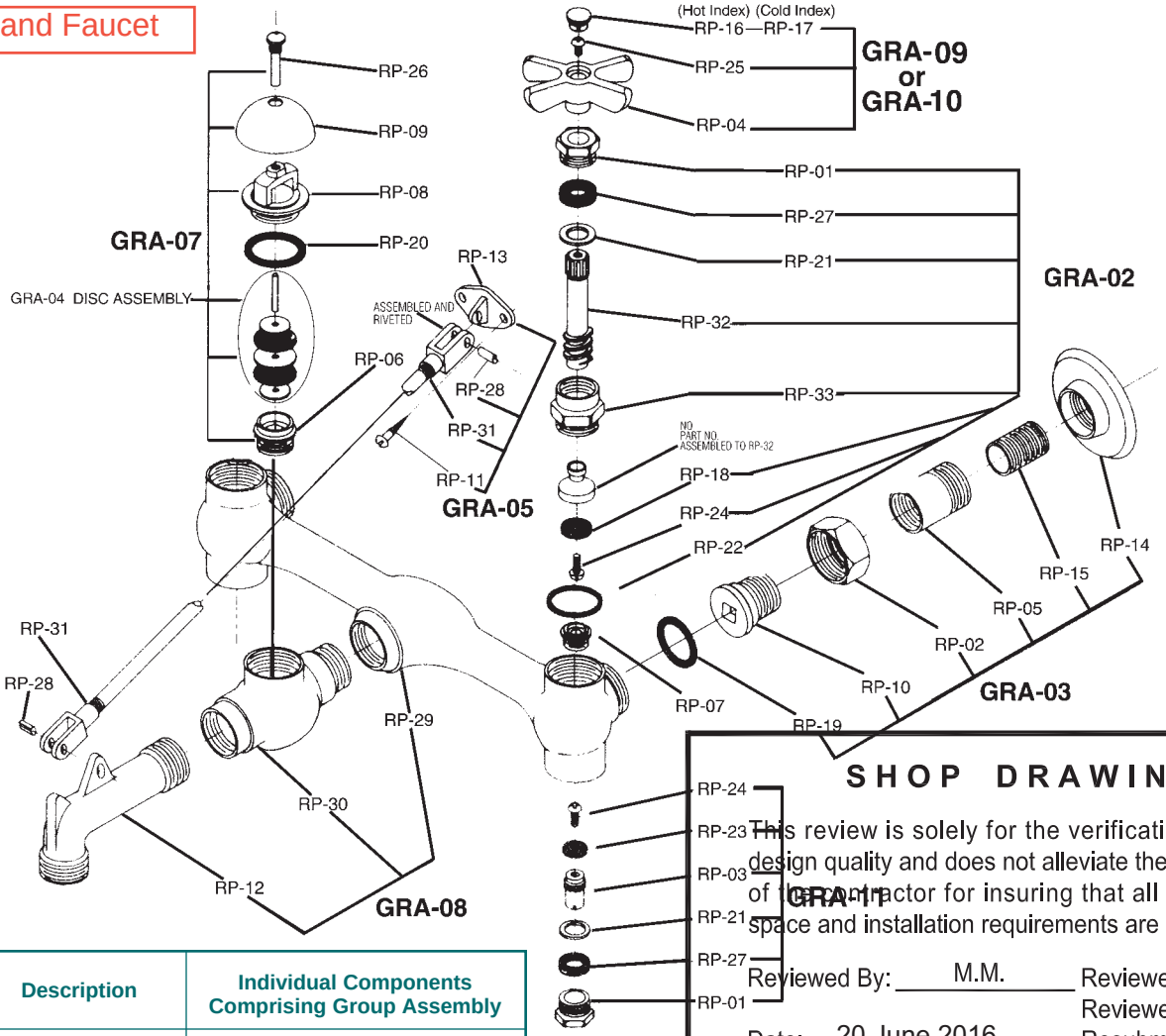
A subsidiary of CR/PL, L.L.C. Company – Evanston, IL

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

830-AA Group Replacement Assembly Parts List

FIAT

Service Sink and Faucet



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Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

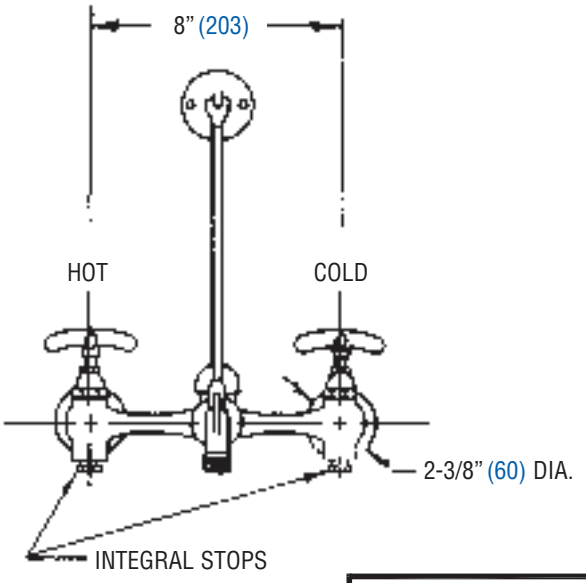
Group Assembly Part #	Description	Individual Components Comprising Group Assembly	
GRA-02	Handle Mounting Group Assembly	RP-01 RP-27 RP-21 RP-32 RP-33 RP-18 RP-24 RP-22	Packing Nut Packing Brass Washer Spindle Handle Hub Seat Washer Seat Washer Screw Hub Washer
GRA-03	Coupling Assembly	RP-14 RP-15 RP-05 RP-02 RP-10 RP-19	Wall Flange Nipple Bushing (socket) Coupling Nut Swivel Washer
GRA-05	Brace Assembly	RP-13 RP-28(2) RP-31 RP-11(2)	Brace Flange S.S. Roll Pin Wall Brace Rod Wood Screw
GRA-07	Vacuum Breaker & Disc Assembly	RP-26 RP-09 RP-08 RP-20 RP-06 GRA-04	V.B. Cap Screw Cap V.B Hub V.B Hub Washer Seat Vacuum Breaker Disc Assembly

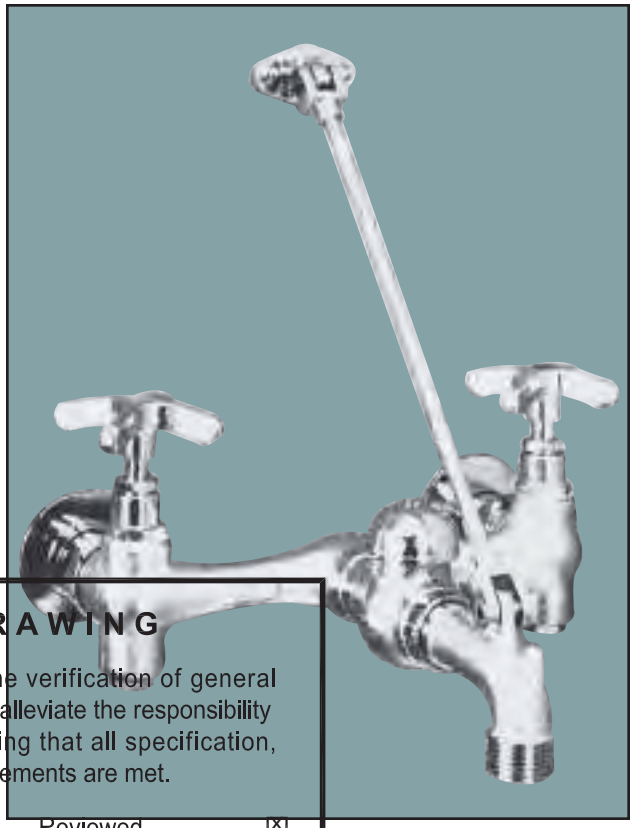
Group Assembly Part #	Description	Individual Components Comprising Group Assembly	
GRA-08	Complete Body Assembly	RP-29 RP-30 RP-12	Center Body V.B. Body Nozzle
GRA-09	Handle Assembly (Cold)	RP-17 RP-25 RP-04	Cold Index Handle Screw Handle
GRA-10	Handle Assembly (Hot)	RP-16 RP-25 RP-04	Hot Index Handle Screw Handle
GRA-11	Integral Stop Assembly	RP-24 RP-23 RP-03 RP-21 RP-27 RP-01	Seat Washer Screw Washer Spindle Brass Washer Packing Packing Nut
RP-07	(2 per package)	RP-07	Seat

Service-Sink Faucet
Model: 830-AA

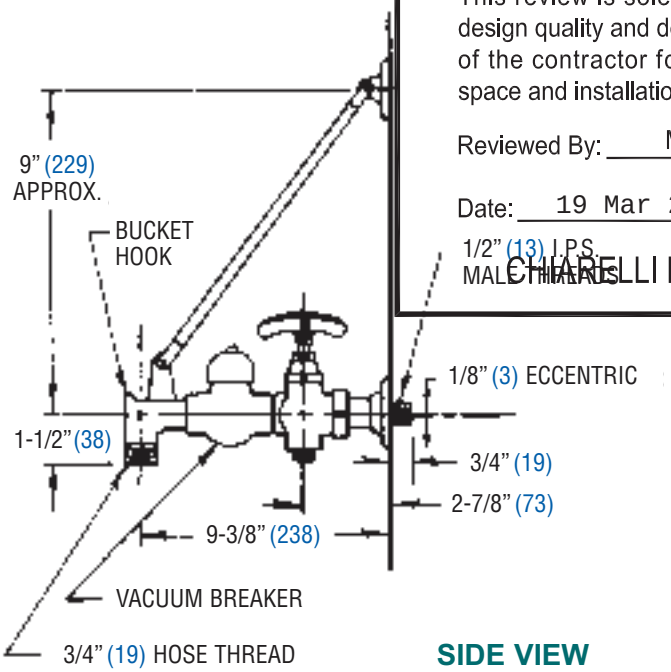
FIAT

Service Sink and Faucet





FRONT VIEW



SIDE VIEW

NOTE: These roughing measurements may vary 1/4" (plus or minus).

SHOP DRAWING

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Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

General: 830-AA Service Faucet - Chrome plated with vacuum breaker, integral stops, adjustable wall brace, pail hook and 3/4" hose thread on spout. Body inlets 8" center to center, four arm handles. Valves contain renewable hub, renewable seats, swivel discs, encased washers and brass washer screws.

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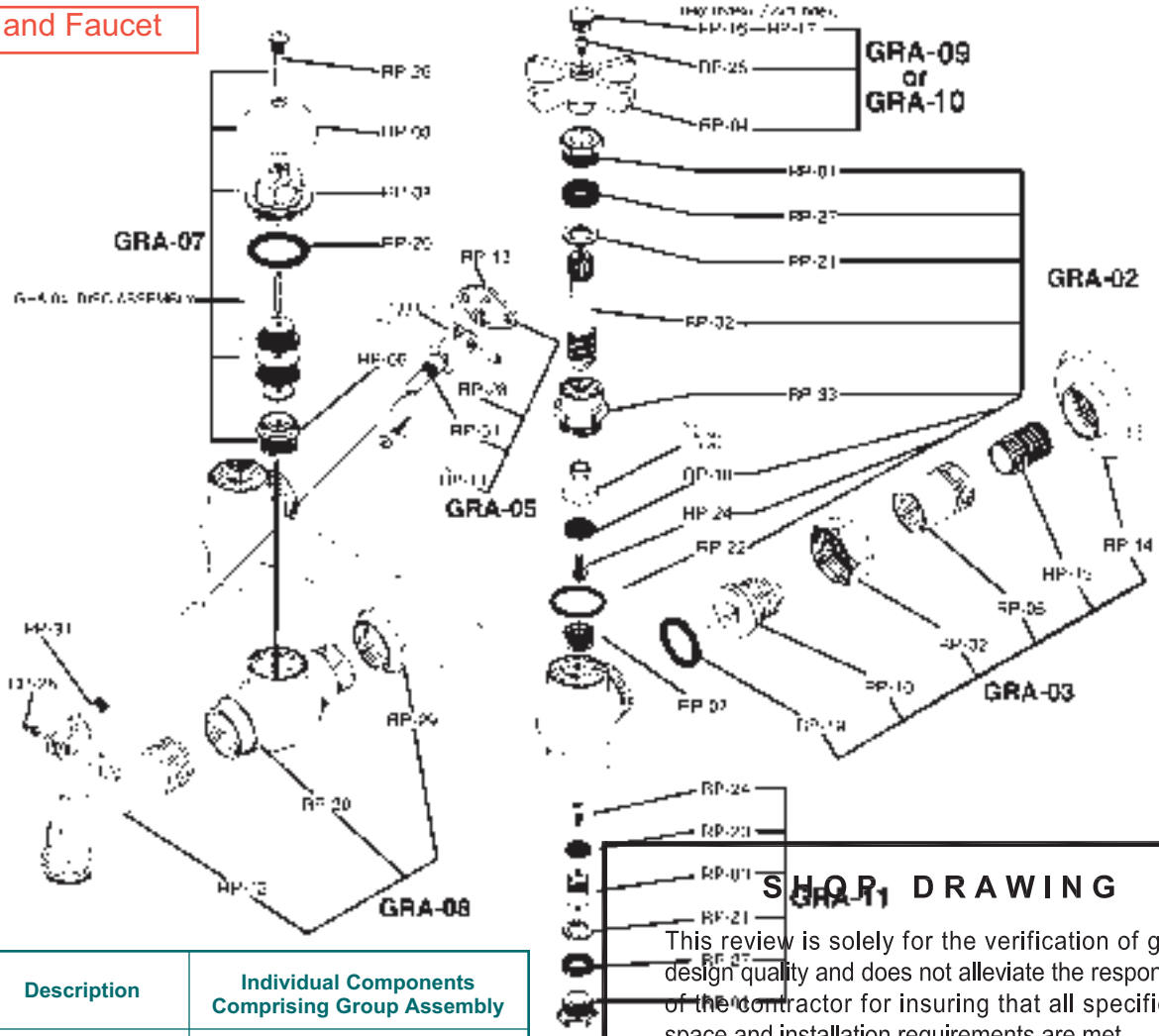
Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

830-AA Group Replacement Assembly Parts List

FIAT

Service Sink and Faucet



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SHOP DRAWING

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Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒

Reviewed as noted ☐

Resubmit ☐

CHIARELLI ENGINEERING LTD.

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RP-07	(2 per package)	RP-07	Seat

FIAT PRODUCTS

SERV-A-SINK® LAUNDRY TUBS MODELS FL-1, L-1, DL-1

FL-1 FLOOR MOUNTED SERV-A-SINK®
L-1 WALL HUNG SERV-A-SINK®
DL-1 DROP-IN SERV-A-SINK®

Fiat Products uses a specialized SMC process (Molded Stone®) to manufacture all laundry tubs. Moldings are manufactured in matched metal dies under heat and pressure resulting in a homogeneous molded unit. Drain(s) with stopper(s) are furnished as standard equipment. Capacity shall be 76 litres (17 Imp gal) for the single tub sink and 152 litres (33 Imp gal) for the double tub sink. Laundry sinks available in white only.

- All single compartment laundry tubs are available in sixpacks (L-6 and FL-6) and bulk quantities.
- All products must be installed in accordance with installation instructions provided. Failure to do so may invalidate warranty at manufacturer's discretion.

FL-1 Floor Mounted Serv-A-Sink®

- White baked enamel angle legs that slip into molded sockets for rigid, friction-fit. (Included)
- Easy leveling devices are provided for fast, even planing. Tub is capable of handling 600 pounds.

Nominal Dimensions:
Overall Outside Dimensions:
20-1/4" x 17-1/4" x 13" (514 x 438 x 330mm)
Overall height from floor
34-3/4" (883mm) CSA Approved

L-1 Wall Hung Serv-A-Sink®

- Heavy gauge galvanized - steel bracket capable of withstanding 600 pounds. (Included)
- Side fillers and bottom tub support, which are assembled in field to the mounting brackets, are made of white molded plastic polymer.

Nominal Dimensions:
20-1/4" x17-1/4" x 13" (514 x 438 x 330mm)

DL-1 Drop-In Serv-A-Sink®

- Designed for a countertop installation.
- Self-rimming flange, four locking corner bars and screws for fast tightening into integral molded mounting legs and against the underside of the countertop. (Included)

Nominal Dimensions:
22-1/8" x 17" x 12-3/7" (562 x 432 x 324mm)
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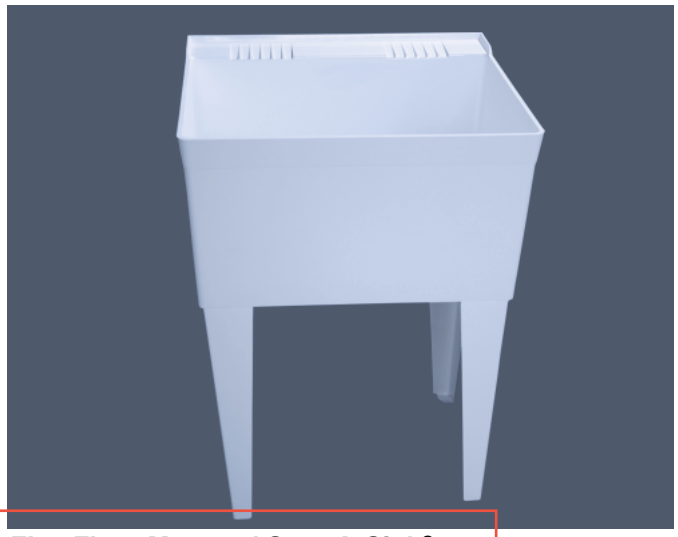
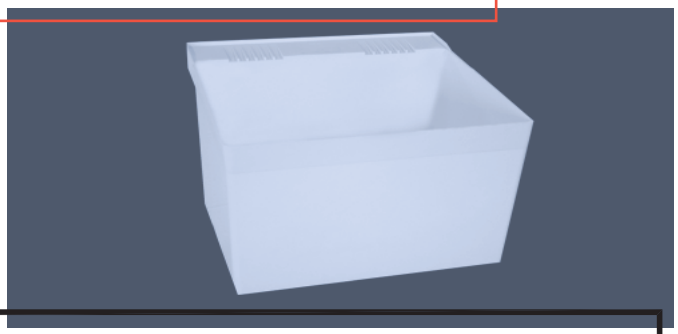
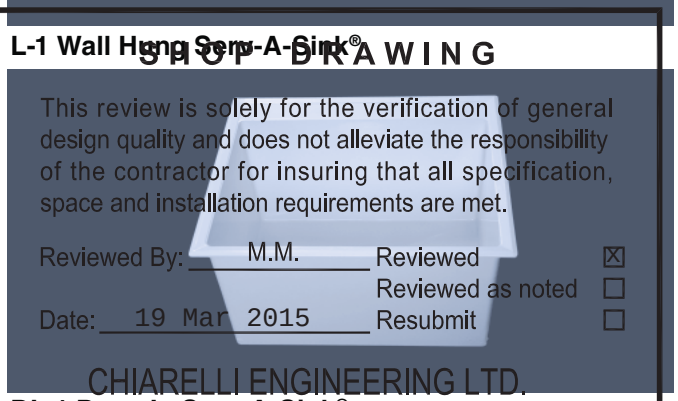


FL-1 Floor Mounted Serv-A-Sink®



L-1 Wall Hung Serv-A-Sink®



DL-1 Drop-In Serv-A-Sink®

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

All products are UPC listed

Customer Service Canada
1-800-387-0369
www.fiat.ca

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Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

FIAT QUALITY FOR LIFE

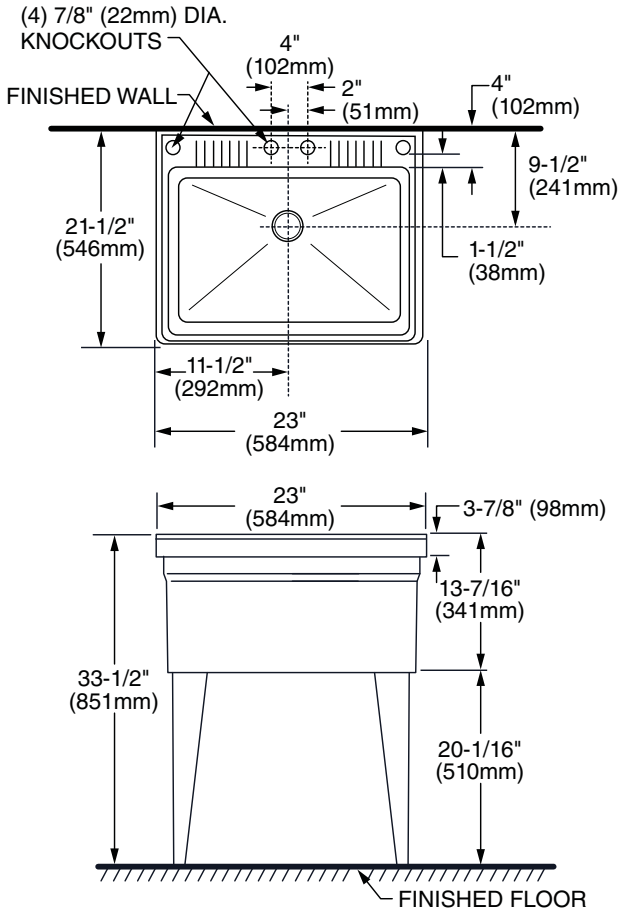
Customer Service United States
1-800-442-1902
www.fiatproducts.com

Revised 11/13
53/665

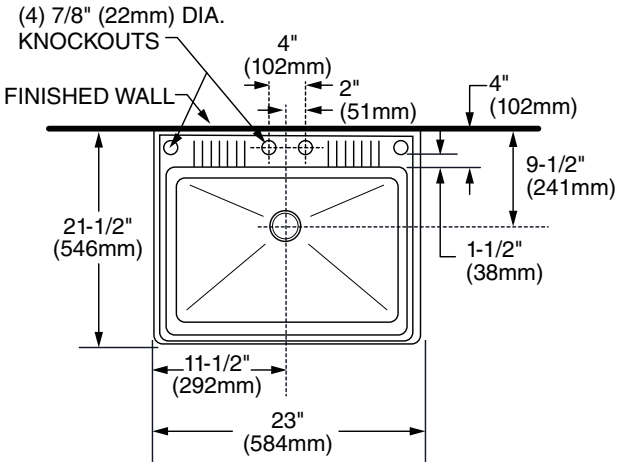
FIAT PRODUCTS

SERV-A-SINK® LAUNDRY TUBS
MODELS FL-1, L-1, DL-1

MODEL FL-1
FLOOR MOUNTED



MODEL L-1
WALL HUNG



SHOP DRAWING

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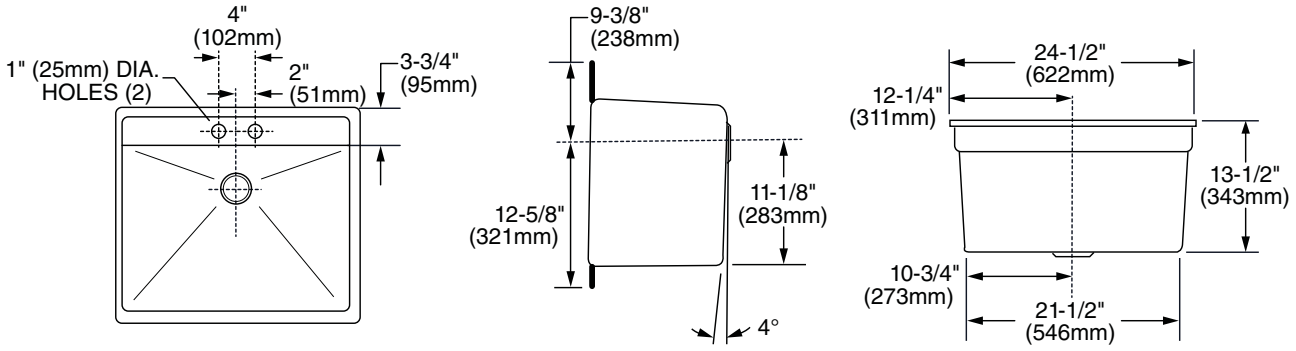
Reviewed By: M.M.

Date: 15 Mar 2015

- Reviewed ☒
- Reviewed as noted ☐
- Resubmit ☐

CHIARELLI ENGINEERING LTD.

MODEL DL-1
DROP-IN



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Revised 11/13
54/665

18-10 Stainless Steel Basket Strainer (replacement basket is 1135B)

Threaded Spindle

18-10 Stainless Steel Strainer Body

Foam Washer

PVC Gasket

Polypropylene Shell

Rubber Washer

Polypropylene Tailpiece

Certified

SPECIFICATION

1135: Stainless strainer assembly with polypropylene shell and tailpiece. Suitable to 18 and 20 gauge stainless steel product and granite product.

1135 FUN#112.0040.565
1135/60 FUN#112.0061.322
1135-CS FUN#112.0181.283 is the 1135 assembly packaged in a clam shell

Franke Kindred Canada Limited
P.O. Box 190, 1000 Franke Kindred Road, Midland, Ontario, Canada, L4R 4K9 Phone: 866-687-7465 Fax: 800-365-8408

Plumbing Fixture / Kitchen Sinks 15410

Franke Kindred Canada Limited Printed in Canada 61558 0316

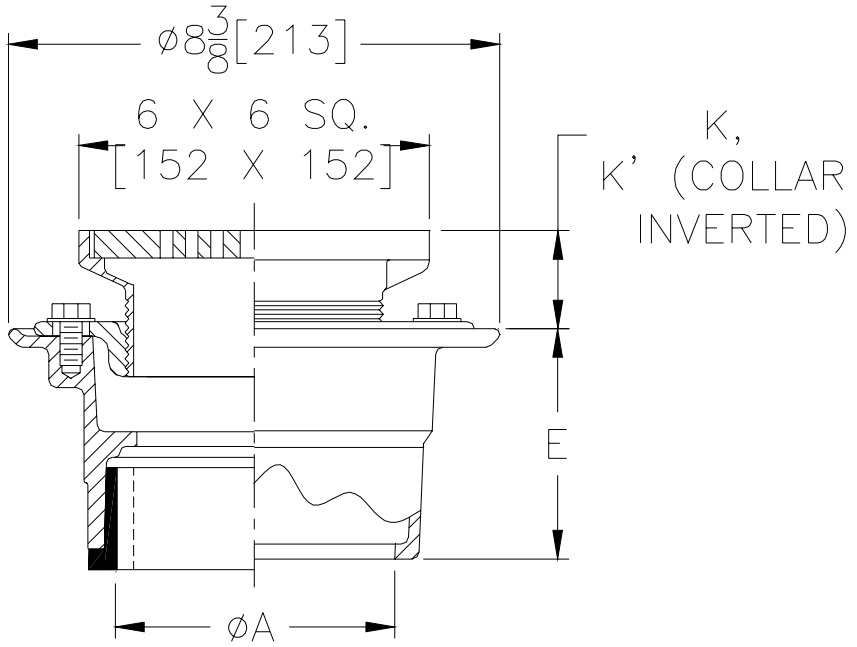
SPECIFICATION SHEET

ZXN-415-H

BODY ASSEMBLY WITH "TYPE H" STRAINER

TAG _____

Dimensional Data (inches and [mm]) are Subject to Manufacturing Tolerances and Change Without Notice



Str. Desig	Dimensions In Inches / [mm] A Pipe Size	Str. Dia.	K Min.	K Max.	K' Min.	K' Max.	Approx. Wt. Lbs. / (kg)	Strainer Open Area Sq. In. / [sq cm]
-H6	2-3-4-6 [51-76-102-152]	6 x 6 [152 x 152]	1-1/4 [32]	2 [51]	2-1/8 [54]	3-1/4 [83]	15 [7]	3 [19]

ENGINEERING SPECIFICATION: ZURN ZXN-415 Floor and Shower Drain, Dura-Coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with "TYPE H" heavy-duty polished nickel bronze strainer.

OPTIONS (Check/specify appropriate options)

PIPE SIZE	(Specify size/type) **OUTLET**		**'E' BODY HT. DIM.**
2 thru 4 [50 thru 100]	____ IC	Inside Caulk	3 7/8 [98]
2 thru 4 [50 thru 100]	____ IG	Inside Gasket	3 7/8 [98]
2 thru 4, 6 [50 thru 100, 152]	____ IP	Threaded	2 5/8 [67]
2 thru 4 [50 thru 100]	____ NH	No-Hub	3 7/8 [98]
2 thru 4 [50 thru 100]	____ NL	Neo-Loc	4 5/8 [117]

SUFFIXES

____	-AR	Acid Resisting Epoxy Coated Cast Iron
____	-G	Galvanized Cast Iron
____	-P	1/2" [13] Trap Primer Connection
____	-U	1" [25] - 3" [76] High Extension Adapter
____	-VP	Vandal Proof Secured Top
____	-X	Squeezin Backwater Valve
____	-Y	Sediment Bucket
____	-6NH	6" [152] No-Hub Outlet (6IP w/Z-1040)
____	-90	2" [51], 3" [76] or 4" [102] Side Outlet Body Assembly (IP or NH only)

*REGULARLY FURNISHED UNLESS OTHERWISE SPECIFIED

REV.	DATE: 11/15/99	C.N. NO. 83464
DWG. NO. 65032	PRODUCT NO. ZXN-415-H	

ZURN INDUSTRIES LIMITED ♦ 3544 Nashua Drive ♦ Mississauga, Ontario L4V 1L2 ♦ Phone: 905/405-8272 Fax: 905/405-1292
In the U.S.: ZURN INDUSTRIES, INC. ♦ SPECIFICATION DRAINAGE OPERATION ♦ 1801 Pittsburgh Ave. ♦ Erie, PA 16514
Phone: 814/455-0921 ♦ Fax: 814/454-7929 ♦ World Wide Web: www.zurn.com

Emergency eyewash and shower

Guardian

Safety Stations with WideArea™ Eye/Face Wash

☐ **G1909** Safety Station with WideArea™ Eye/Face Wash, Stainless Steel Bowl
☐ **G1909P** Safety Station with WideArea™ Eye/Face Wash, Plastic Bowl

Application: Combination WideArea™ eye/face wash and shower safety station. Four GS-Plus™ spray-type outlet heads deliver a flood of water over a wide area of coverage for complete rinsing of eyes and face.

Shower Head: 10" diameter orange ABS plastic.

Shower Valve: 1" IPS chrome plated brass stay-open ball valve. Valve is US-made with chrome plated brass ball and Teflon® seals. Furnished with stainless steel actuating arm and 29" stainless steel pull rod.

Spray Head Assembly: Four GS-Plus™ spray heads. Each head has a "flip top" dust cover, internal flow control and filter to remove impurities from the water flow.

Eye/Face Wash Bowl: 11-1/2" diameter. Bowl is stainless steel (G1909) or orange ABS plastic (G1909P).

Eye/Face Wash Valve: 1/2" IPS chrome plated brass stay-open ball valve. Valve is US-made with chrome plated brass ball and Teflon® seals.

Pipe And Fittings: Schedule 40 galvanized steel. Furnished with orange polyethylene covers for vertical piping for high visibility and corrosion resistance.

Supply: 1-1/4" NPT female top or side inlet.

Waste: 1-1/4" NPT female outlet. Outlet can be positioned at either 9-1/4" or 19-5/8" above finished floor by reversing lower pipe nipples.

Sign: Furnished with ANSI-compliant identification sign.

Quality Assurance: Valve and spray head assembly is pre-factory assembled and water tested prior to shipment.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 19 Mar 2015

Reviewed ☐
Reviewed as noted ☒
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Available Options

☐ **GC** Powder coated finish on galvanized pipe and fittings. Available colors include orange, yellow, red and green.

☐ **FC20** Regulates shower flow rate to 20 GPM.

☐ **GRN** Green ABS plastic shower head.

☐ **YEL** Yellow ABS plastic shower head.

☒ **SSH** Stainless steel shower head.

☐ **AP275-100 Electric Light and Alarm Horn**
Light and alarm horn summon assistance when eye/face wash or shower is activated.

☐ **AP250-015 Modesty Curtain**
Modesty curtain for mounting on safety station.

☒ **TMV** G3800 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1-2009.

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

Guardian Equipment
1140 N North Branch St
Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

Listed 8116. Units have been tested to and comply with ANSI Z358.1-2009 and the Uniform Plumbing Code.

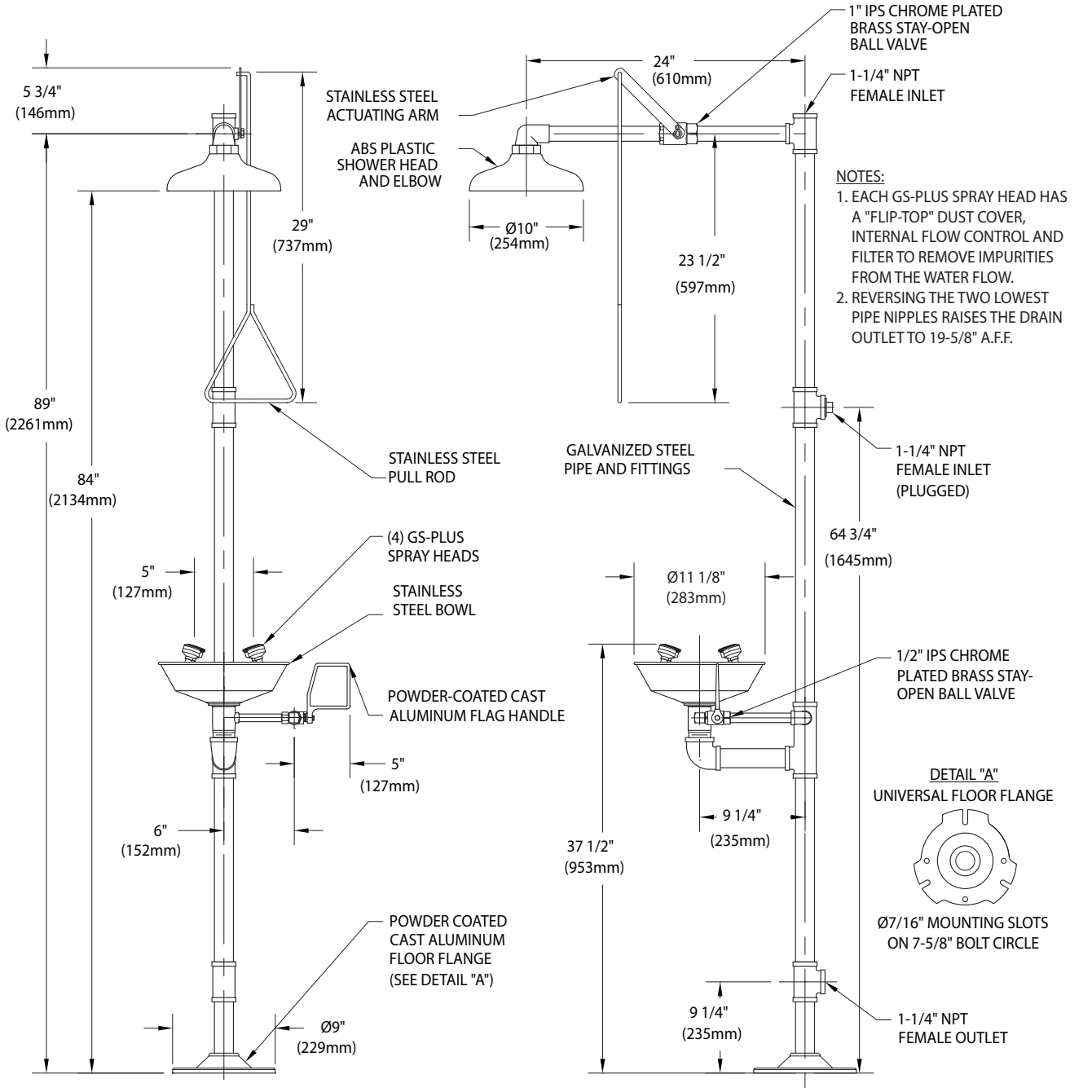
ETL Listed 101496. Units have been tested to and comply with ANSI Z358.1-2009.

Emergency eyewash and shower

Guardian

Safety Stations with WideArea™ Eye/Face Wash

☐ **G1909** Safety Station with WideArea™ Eye/Face Wash, Stainless Steel Bowl
☐ **G1909P** Safety Station with WideArea™ Eye/Face Wash, Plastic Bowl



THIS SPACE FOR ARCHITECT/ENGINEER APPROVAL

Sign Included

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4" (6mm). rev.10.14

Guardian Equipment
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Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

Listed 8116. Units have been tested to and comply with ANSI Z358.1-2009 and the Uniform Plumbing Code.

ETL Listed 101496. Units have been tested to and comply with ANSI Z358.1-2009.

Tempering Valve

Guardian

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 28 Apr 2015

Reviewed ☒

Reviewed as noted ☐

Resubmit ☐

CHIARELLI ENGINEERING LTD.

☐ G3700LF Tempering Valve, 34 Gallon Capacity

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Apr 23, 2015
SIFEC NORTH INC

Application: Tempering valve to blend hot and cold water to deliver tepid water. Valve has flow capacity of 3.0 to 34 gallons per minute (GPM). Valve can be used with emergency shower, safety station or multiple installations of eyewash, eye/face wash, dual purpose eyewash/drench hose and drench hose units.

Temperature Control: Valve has bimetallic thermostat that senses incoming water temperature and automatically blends water to 85°F (29°C). High temperature limit stop is set to 90°F (32°C). Valve has dial thermometer on outlet to monitor temperature of delivered water. *Note: Valve may need to be adjusted when installed based on incoming water temperature. Refer to "Installation Instructions" for further information.*

Fail Safe: In event of restriction or failure of hot water supply, internal bypass allows valve to deliver cold water to emergency unit. In bypass mode, valve will deliver 20 GPM of cold water at 30 PSI flow pressure. In event of loss of cold water supply, valve will close and not deliver water.

Flow Capacity: Refer to chart below for flow capacity of valve at specified pressure drops:

System Pressure Drop (PSI)	5	10	15	20	25	30	35	40
Flow Rate (GPM)	18	23	29	34	40	45	51	56

System Pressure Drop (Bar)	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8
Flow Rate (Liters per Minute)	68	87	110	129	151	170	193	212

Supply Temperature: Minimum hot water supply temperature is 140° F (60° C).

Supply Pressure: 30 PSI minimum supply pressure is required for proper operation of valve. Maximum supply pressure is 125 PSI. Maximum hot to cold water pressure differential is 5%.

Mounting: Furnished with heavy duty mounting bracket for securing valve to panel or wall.

Inlets: 3/4" NPT female hot and cold water inlets. Inlets can be rotated 360 degrees for top or bottom supply. Each inlet has integral water strainer, check valve and supply stop.

Outlet: 1" NPT female outlet.

Quality Assurance: Valve is completely assembled and water tested prior to shipment. Valve is certified to ASSE 1071. Valve is certified to meet low lead requirements of wetted surface area less than 0.25% lead by weight.

IMPORTANT: *Pursuant to ANSI Z358.1-2009, the water delivered by emergency equipment should be "tepid". Tepid is defined as moderately warm or lukewarm, and is generally considered to be between 60°F (15°C) and 90°F (32°C). However, in certain circumstances, a chemical reaction may be accelerated or otherwise affected by the water temperature. Please consult with a medical advisor to determine the optimum delivered water temperature prior to specifying, installing or using a tempering valve.*

Tempering valves will not deliver the appropriate water temperature if the system has not been sized correctly. Please refer to the flow capacities and supply pressure requirements listed above when designing the tempered water system and selecting tempering valves.

Tempering valves, like all emergency eyewash and shower equipment, must be installed in accordance with the manufacturer's instructions and maintained on a regular basis. Under ANSI Z358.1-2009, all emergency equipment should be activated weekly and inspected at least annually. Tempering valves should be treated the same and, in addition, must be regularly cleaned and cycled.

Additional Models

☐ **G3702LF** Same as above except valve is installed in surface mounted stainless steel cabinet.

☐ **G3707LF** Same as above except valve is installed in recess mounted stainless steel cabinet.

Guardian Equipment
1140 N North Branch St
Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

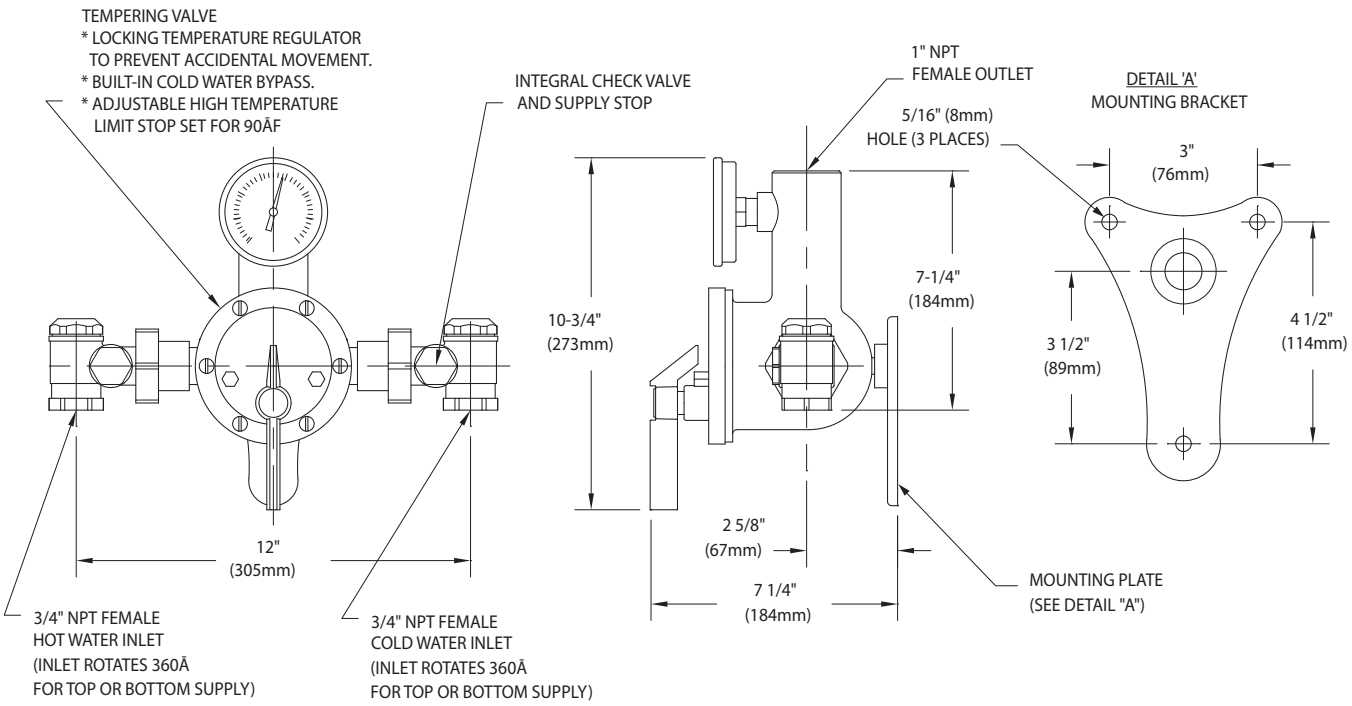
ASSE 1071 Certified

Meets low lead requirements

Tempering Valve

Guardian

☐ G3700LF Tempering Valve, 34 Gallon Capacity



1. As with all plumbing devices and emergency equipment, thoroughly flush supply lines prior to and after installation.
2. Install mounting bracket on panel or wall. Thread tempering valve securely onto mounting bracket. Valve must be installed in location where it is readily accessible for inspection, cleaning and maintenance.
3. Connect hot and cold water supply lines to valve. Connect outlet line to valve and then to inlet of emergency equipment.
4. Activate the water flow and check the temperature of the water delivered from the tempering valve and emergency equipment. Note that the temperature control knob on the tempering valve has been factory preset to deliver 85°F (29°C) tepid water and the high temperature limit stop has been factory preset at 90°F (32°C). These temperatures are based upon an incoming hot water supply at 140°F (60°C). If the incoming hot water temperature is higher than 140°F (60°C), the valve will deliver water that is warmer than 90°F (32°C). ***In this case, the high temperature limit stop must be reset by the installer.***
5. To reset the high temperature limit stop:
   - While the water is running, turn the adjusting knob counterclockwise to the maximum hot water position.
   - Remove the knob and retaining ring, loosen the set screw and remove the limit stop.
   - Replace the handle on the valve stem and rotate the valve stem until the desired outlet water temperature is reached. Confirm the outlet water temperature on the outlet thermometer.
   - Replace the limit stop on the valve stem, positioned so that the limit stop is against the web on the LEFT side of the valve cover (i.e. the valve stem cannot be turned any further counterclockwise).
   - Replace the retaining ring, tighten set screw and replace knob.

THIS SPACE FOR ARCHITECT/ENGINEER APPROVAL

SHOP DRAWING
This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.
Reviewed By: M.M.
Date: 28 Apr 2015
Reviewed ☒
Reviewed as noted ☐
Resubmit ☐
CHIARELLI ENGINEERING LTD.

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Apr 23, 2015
SIFEC NORTH INC

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4" (6mm). rev. 1214

Guardian Equipment
1140 N North Branch St
Chicago, IL 60642

312 447 8100 TELEPHONE
312 447 8101 FACSIMILE
gesafety.com

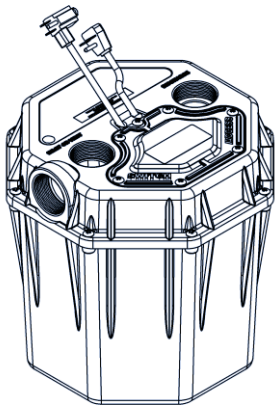
ASSE 1071 Certified

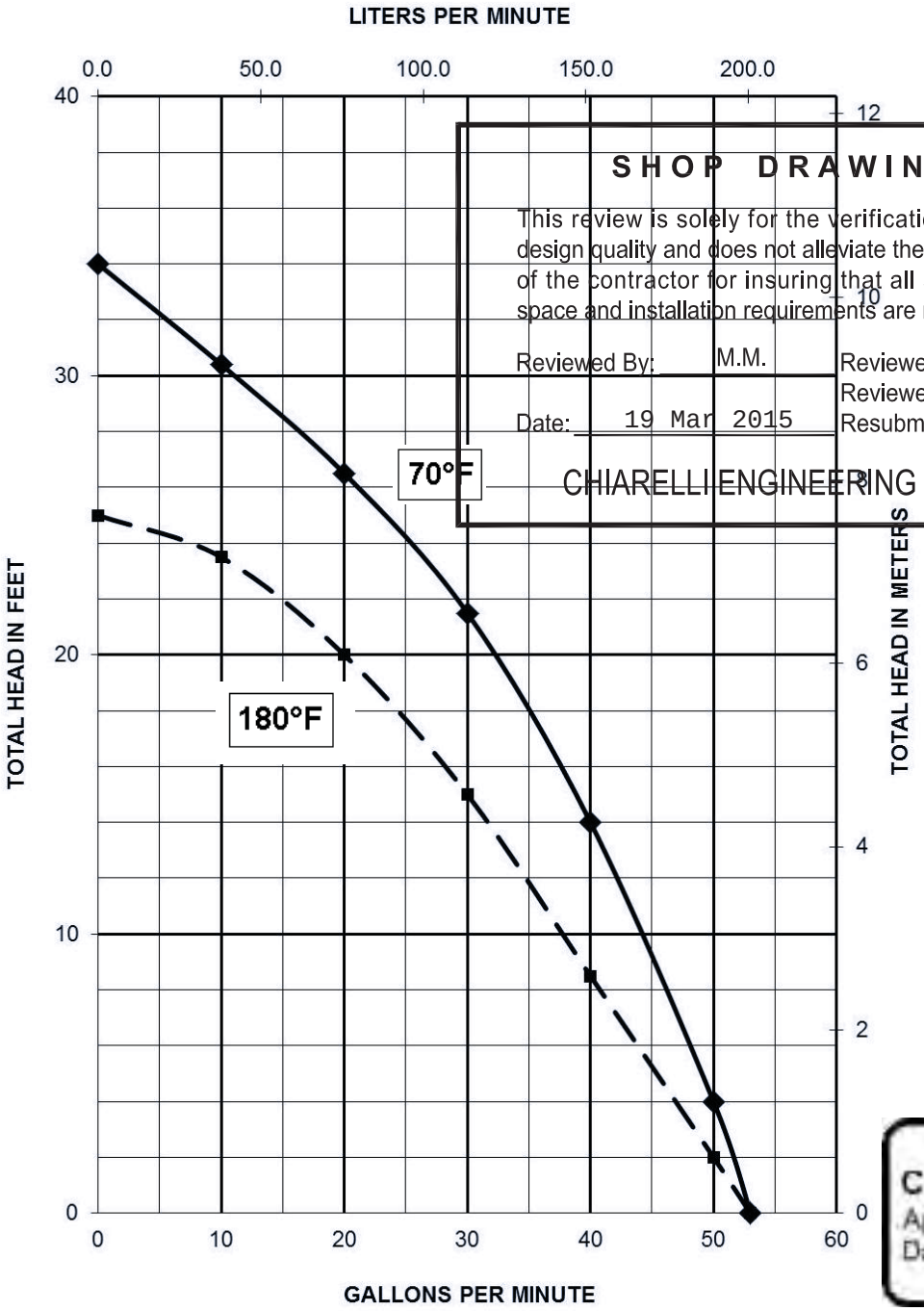
Meets low lead requirements

P-1/ SP-1

Pump Specifications

405 Series Commercial Drain Pump (High-Temp)





SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

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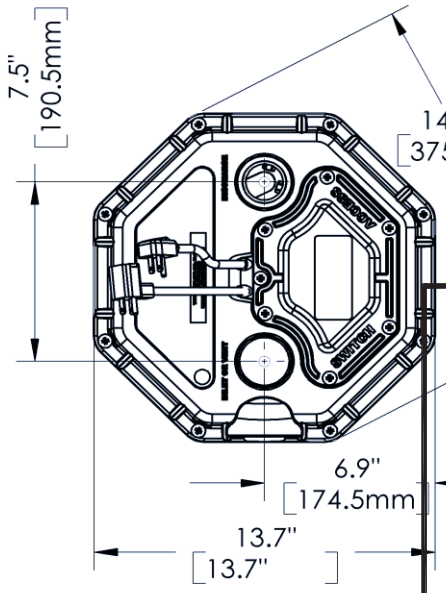
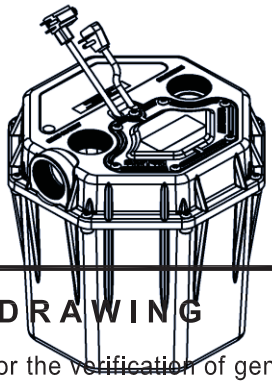
P-1/ SP-1





SHOP DRAWING

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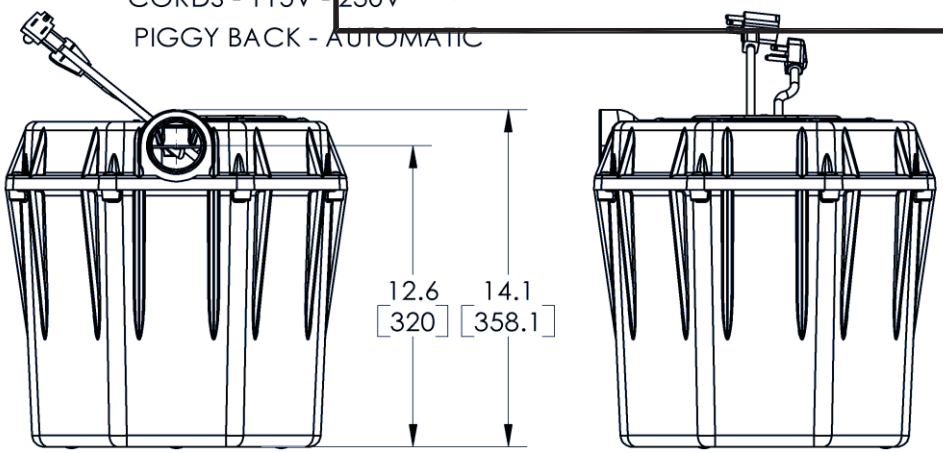
Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

CORDS - 115V - 230V
PIGGY BACK - AUTOMATIC



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APPLICATION | DO NOT SCALE DRAWING

405 SERIES DIMENSIONAL

SIZE A | JAN / 2007 | REV. A

SCALE:1:4 | WEIGHT: 23 LBS | SHEET 1 OF 1

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P-1/ SP-1

405-Series Electrical Data

MODEL	HP	VOLTAGE	PHASE	FULL LOAD AMPS	LOCKED ROTOR AMPS	THERMAL OVERLOAD TEMP	STATOR WINDING CLASS	CORD LENGTH FT	DISCHARGE	AUTOMATIC
405	1/2	115	1	7.3	16	140˚C / 284˚F	F	10	2”	YES
405-HV	1/2	208/230	1	3.5	7	140˚C / 284˚F	F	10	2”	YES

405-Series Technical Data

IMPELLER	VORTEX HIGH TEMPERATUER ENGINEERED POLYMER
SOLIDS HANDLING	3/8”
PAINT (PUMP)	POWDER COAT
MAX LIQUID TEMP	82˚C / 180˚F
MAX STATOR TEMP	CLASS F 155˚C/ 311˚F
THERMAL OVERLOAD	140˚C/ 284˚F
POWER CORD TYPE	SJTOOW
MOTOR HOUSING	DEEP FINNED POWDER COATED ALUMINUM
VOLUTE	ENGINEERED POLYMER
SHAFT	STAINLESS
HARDWARE	STAINLESS
ORINGS	BUNA N
SHAFT SEAL	ENGINEERED DOUBLE LIP WITH STAINLESS SPRINGS
WEIGHT	23 LBS
TANK MATERIAL	POLYPROPYLENE
INLET SIZE	2” FEMALE NPT
DISCHARGE SIZE	2” FEMALE NPT
VENT SIZE	2” FEMALE NPT

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

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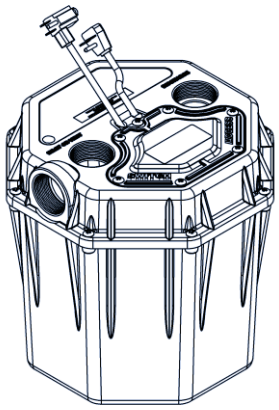
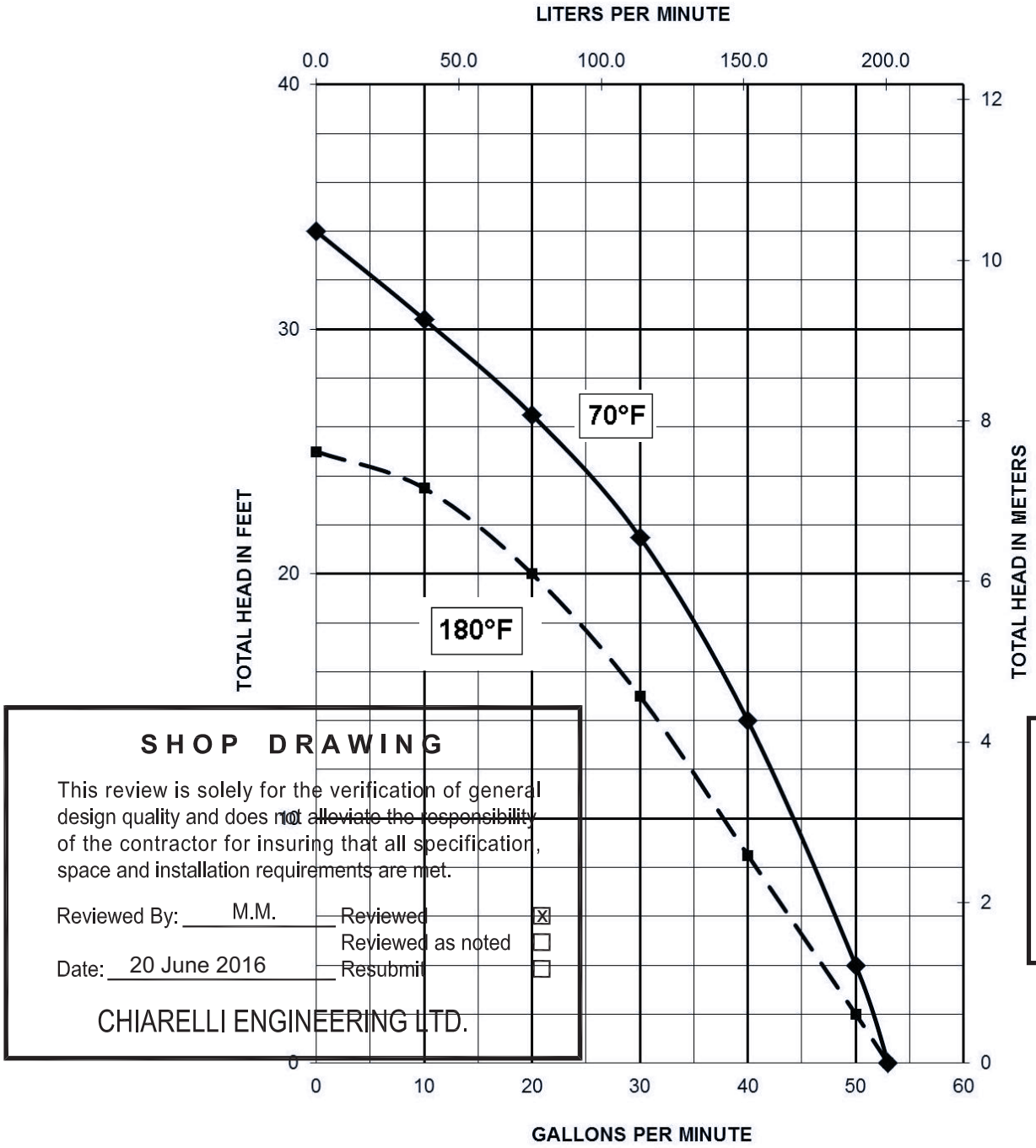
P-1/ SP-1

Pump Specifications

405 Series Commercial Drain Pump (High-Temp)





SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 14 Juin, 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

Out for approval

SIFEC NORTH INC.

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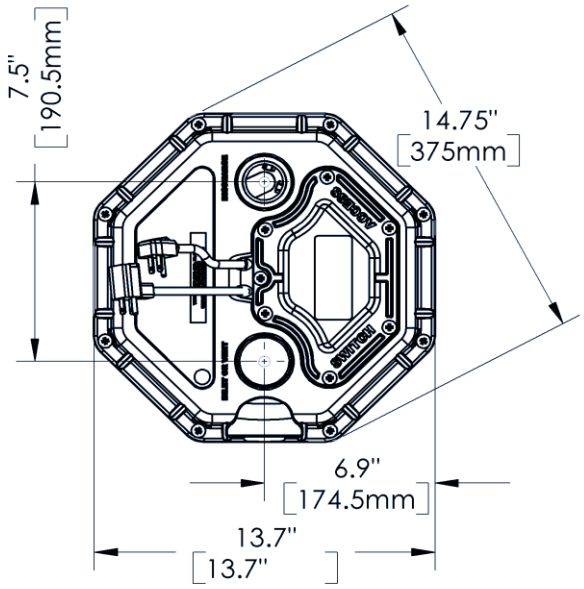
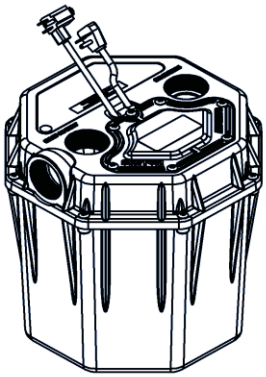
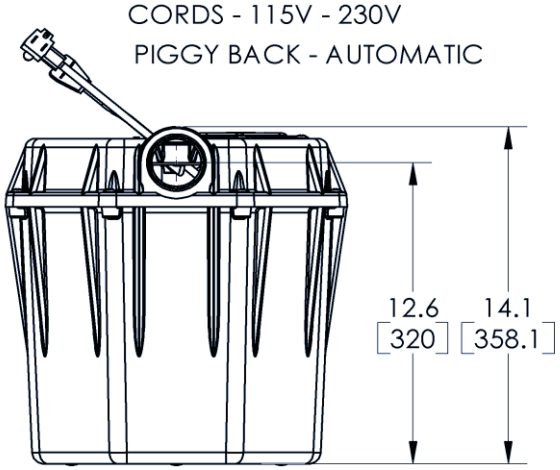
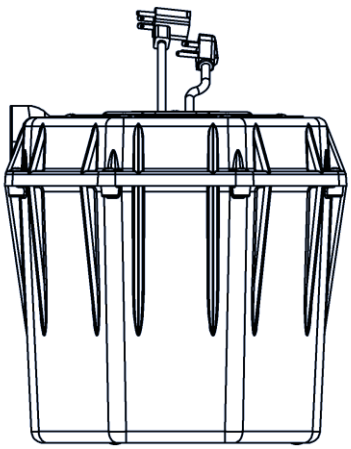
P-1/ SP-1





CORDS - 115V - 230V
PIGGY BACK - AUTOMATIC





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APPLICATION | DO NOT SCALE DRAWING

405 SERIES DIMENSIONAL

SIZE A | JAN / 2007 | REV. A

SCALE:1:4 | WEIGHT: 23 LBS | SHEET 1 OF 1

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P-1/ SP-1

405-Series Electrical Data

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Installation Manual

7212000D

Model 404 and 405 Automatic Drain Pump

MODEL 404 Residential
115 volt

MODEL 405 Commercial 115 volt
MODEL 405HV Commercial 230 volt

Contents

1.) General Information and Safety Guidelines

2.) Installation

3.) Maintenance and Troubleshooting

IMPORTANT:

Prior to installation, record Model, Serial Number, and Code Number from pump nameplate for future reference.

MODEL _____

SERIAL _____

CODE _____

INSTALLATION DATE _____

Liberty Pumps®
7000 Apple Tree Avenue
Bergen, NY 14416
Phone: (800) 543-2550
Fax: (585) 494-1839
www.libertypumps.com

C US
Contains Certified pump

SSPMA Certified PUMP MEMBER

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1. General Information and Safety Guidelines

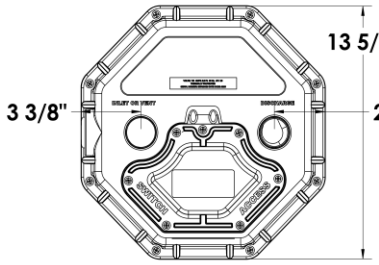
Before installation, read the following instructions carefully. Each Liberty pump is individually factory tested to insure proper performance. Closely following these instructions will eliminate potential operating problems, assuring years of trouble-free service.

⚠ WARNING

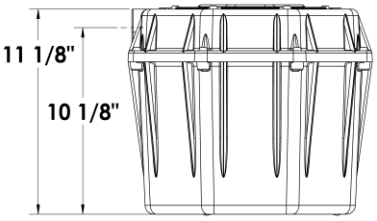
- **Risk of electric shock**. Always disconnect the pump from the power source before handling or making adjustments.
- The electrical connections and wiring for a pump installation should only be made by qualified personnel.
- **Explosion hazard during installation.** PVC cleaners, primers, and cements can release explosive vapors. These heavier than air vapors can accumulate in the tank. The heat of soldering or sweating copper or other metal pipe can ignite these vapors causing a violent explosion. If the unit is to be connected to copper discharge or vent piping, all solvent welded PVC joints must be allowed to cure a minimum of 24 hours. The access cover must be removed to allow the tank to be thoroughly ventilated prior to sweating copper pipe near the unit.
- This pump is supplied with a grounding conductor and grounding-type attachment plug. To reduce the risk of electric shock, be certain that it is connected to a Ground Fault Circuit Interrupter (GFCI) receptacle that meets the latest requirements per UL 943 including End of Life Provision and protection from Reverse Line-Load Miswire.
- Always wear rubber boots when water is on the floor and you must unplug the pump.
- DO NOT bypass grounding wires or remove ground prong from attachment plugs. DO NOT use an extension cord.
- This pump requires a separate, properly fused and grounded branch circuit. Make sure the power source is properly sized for the voltage and amperage requirements of the pump, as noted on the nameplate.
- The electrical outlet shall be within the length limitations of the pump power cord, and at least 4 feet above floor level to minimize possible hazards from flood conditions.
- The installation must be in accordance with the National Electric Code, Uniform Plumbing Code, International Plumbing Code, as well as all applicable local codes and ordinances.
- Keep clear of suction and discharge openings. To prevent injury, never insert fingers into pump while it is plugged in.
- DO NOT use this product for flammable or corrosive liquid.
- DO NOT use this product in applications where human contact with the pumped fluid is common (such as swimming pools, fountains, etc.)
- NEVER dispose of materials such as paint thinner or other chemicals down drains, as they can chemically attack and damage pump components, potentially causing product malfunction or failure.

⚠ CAUTION

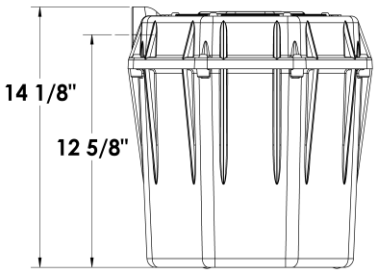
- ***Model 404 Do not use this pump in water over 140° F.***
- ***Model 405 Do not use these pumps in water over 180°F***
- DO NOT DO NOT use pumps in mud, sand, cement, oil or chemicals.
- DO NOT modify the pump in any way.
- DO NOT lift or carry pump by power cord.
- DO NOT remove any tags from pump or cords.
- If pump is installed during construction before power is available, it must be protected from the environment to prevent water from entering through the cord plug end, etc.



Top view
404 and 405



Side view
404

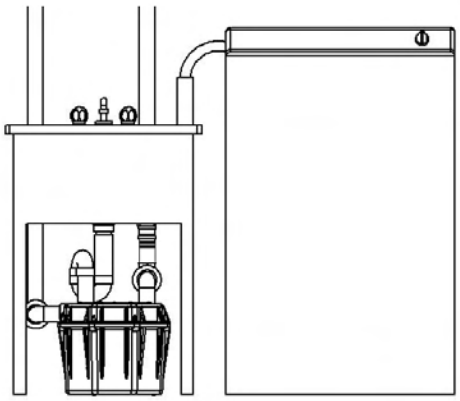


Side view
405

Dimensions are rounded to the nearest 1/8”

2. Installation

Fig. 1 – Typical Resident Installation
This is a recommended installation only.



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INLET: The pump has two ports: one on the top the other on the side, either can be used as a vent or inlet. Using the appropriate piping (1-1/2" on the model 404 and 2" on models 405, 405HV) connect the fixture to the pump. Note: a trap shall be used between the fixture and pump, a flange type is recommended. HAND-TIGHTEN TO PUMP. DO NOT OVERTIGHTEN OR CROSS-THREAD.

A. **DISCHARGE:** HAND-TIGHTEN ONLY. Install a union just above the pump to facilitate removal if necessary for cleaning or service. Install a check valve just above the union (as close to the pump as possible) to prevent the backflow of water after each pump cycle.

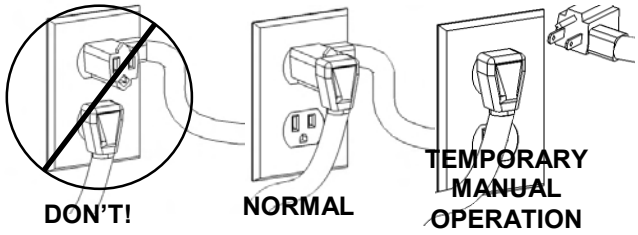
B. **VENT:** Provision is made for a vent stack to allow extra volume for high suds conditions, and to ensure proper drainage of the fixture. HAND-TIGHTEN ONLY. DO NOT CAP-OFF VENT. DO NOT use ONE-WAY QUICK-VENTS or AIR ADMITTENCE VALVES as they will not guarantee proper fixture performance. The vent pipe should have a union to facilitate removal if required and shall be connected directly to a building or house vent.

C. **POWER CORD:** The pump power cord is equipped with a grounding conductor and grounding-type 3-prong plug. It should be connected to a separately fused, grounded, 3-wire grounding-type receptacle of 15-amp capacity with the proper voltage for your model. Make sure all electrical wiring and connections are in accordance with the National Electric Code and all applicable local codes.
MODEL 404 - 115 volts
MODEL 405 - 115 volts
MODEL 405HV - 230 volts

⚠ WARNING

- **Risk of electric shock.** Always disconnect the pump from the power source before handling or making adjustments.
- DO NOT remove the plug or ground prong.
- DO NOT use an extension cord.

Fig. 1 Piggyback plug installation.



The 404 and 405-series pumps come factory-equipped with a float switch mounted within the tank. These models come with two cords - one to the float switch and the other to the pump motor. The switch cord has a series (piggyback) plug enabling the pump cord to be plugged into the back of it (see Fig. 4). The purpose of this design is to allow temporary manual operation of the pump.

For automatic operation using Liberty's supplied switch, the two cords should be interconnected and plugged into a separately fused, grounded outlet of proper amp capacity for your selected pump model. (See the pump's nameplate for electrical specifications of your model.) Both cords are equipped with 3-prong plugs and must be plugged into a properly grounded 3-wire receptacle. DO NOT REMOVE THE GROUND PRONGS.

For manual operation, or in the event of switch failure, the pump cord can be separated and plugged into the electrical outlet, directly bypassing the switch. 208-230V single phase pumps should only be operated without the float switch by using the circuit breaker or panel disconnect. Do not let the pump run dry for extended periods.

Application: The 404 and 405-series drain pumps are designed for use in gray wastewater applications. They will handle small debris and solids such as laundry lint (up to 3/8") associated with normal gray water drainage from a sink. Larger solids should be kept out of the pump system. The 405-series is designed for commercial applications where higher temperature drain water (up to 180 degrees F.) may be used.

3. Maintenance and Troubleshooting

Each unit is individually factory tested to ensure proper adjustment and operation. If the unit fails to operate properly, carefully re-read the instructions to see that they have been followed correctly. Routine maintenance is not required on the pump itself, but associated connections may require occasional attention. Lint and foreign objects should be removed from the trap periodically. The check valve on the discharge should also be checked for freedom of operation at the same time.

The pump is automatically turned on and off by use of a float switch mounted within the tank. This switch can be easily removed and checked for operation by removing the access cover located on top of the unit. Once the access cover has been removed a rubber plug must be lifted to free up the switch cord. The switch is mounted to a rod which can be removed by lifting or pulling upward. **IMPORTANT: Do not adjust the tether length. If replacing the switch, make sure to maintain the correct tether length for your model per the following diagram. (Tether length is the distance of cord measured between the clamp and top of float switch.)**

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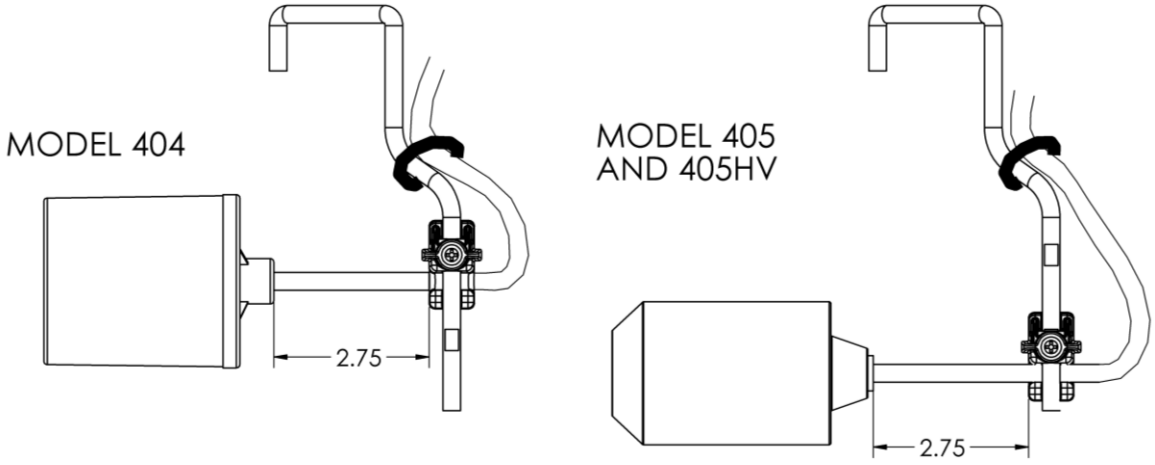
*__NOTE:__ Liberty Pumps, Inc. assumes no responsibility for damage or injury due to disassembly beyond float removal in the field. Disassembly, other than at Liberty Pumps or its authorized service centers, automatically voids warranty.



Problem	Cause	Correction
Pump will not turn on or shut off.	• Blown fuse or other interruption of power; improper voltage.	• Check that the unit is securely plugged in. Have an electrician check all wiring for proper connections and adequate capacity.
	• Plugged vent, or quick-vent in use.	• Be sure that an unrestricted vent at least 1-¼" in diameter is in use. Quick-vents shall not be used.
	• Defective switch or build-up on tank wall restricting free movement of float switch.	• *Remove access cover and check that float is free to move. If build-up restricts float, clean and reinstall. If defective, replace switch.
Pump runs or hums but does not pump.	• Discharge is blocked or restricted.	• Check the discharge line for blockage, including ice if the line passes through or into cold areas.
	• Check valve is stuck closed or installed wrong.	• Remove and examine for freedom of operation and proper installation.
	• Total lift height has been reached (see Fig. 2)	• Try routing pipe to a lower level. If not possible, another pumping station may be required at a level of roughly half the total lift.
	• Pump impeller is jammed.	• *Disassemble the receiver and bottom base of pump. Remove foreign material. Reassemble.
	• Trap or inlet piping is clogged.	• Check the trap and inlet piping for restrictions.
Pump short-cycles.	• Plugged vent, or quick-vent in use.	• Be sure that an unrestricted vent at least 1-¼" in diameter is in use. Quick-vents shall not be used.
	• Defective switch.	• *Remove access cover and check that float is free to move. If build-up restricts float, clean and reinstall. If defective, replace switch.
	• Check valve was not installed, is stuck open, or is leaking.	• Remove and examine for freedom of operation and proper installation.

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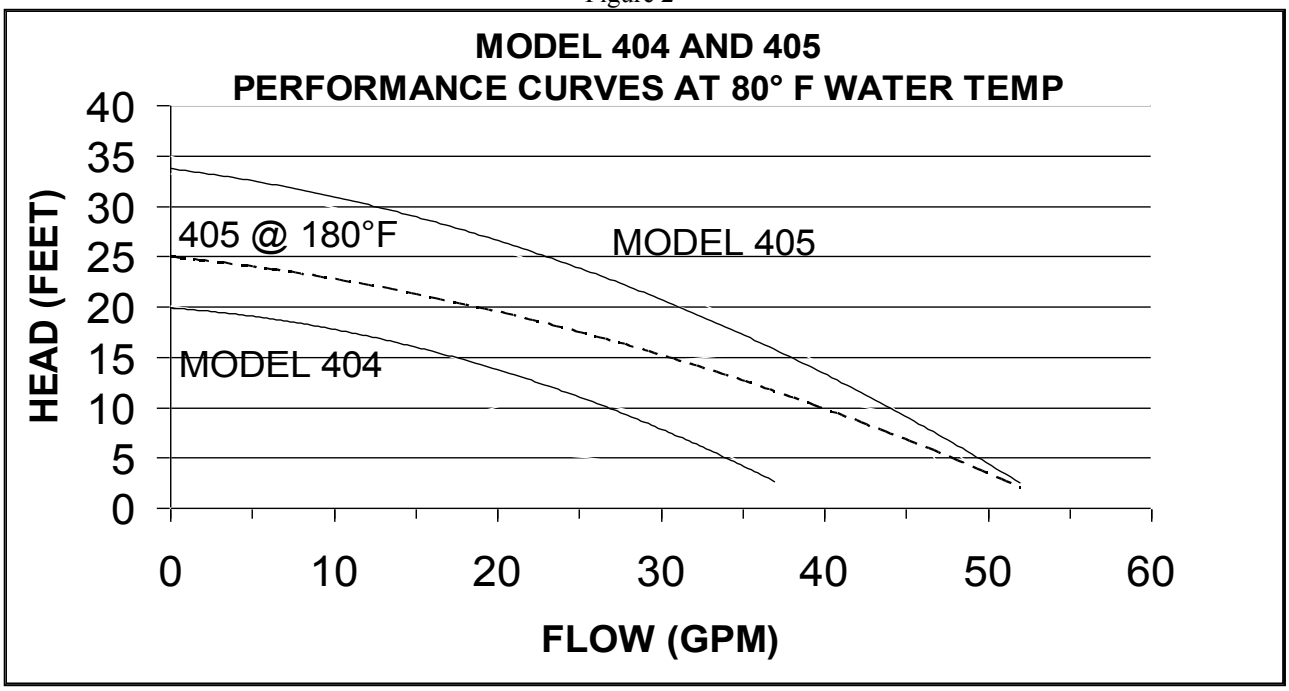
Pump runs periodically when fixtures are not in use.	• Check valve was not installed, is stuck open, or is leaking.	• Remove and examine for freedom of operation and proper installation.
	• Faucets are dripping.	• Repair faucets to eliminate dripping.
Water or soap suds come out of vent pipe.	• Vent pipe is too short or too small in diameter.	• Be sure that an unrestricted vent at least 1-¼" in diameter is in use.
	• Defective switch.	• *Remove tank cover and check that float is free to move. If build-up restricts float, clean and reinstall. If defective, replace switch.
	• Rate of in-flow exceeds pump output.	• Use valve on the inlet to reduce rate of inflow.
Pump operates noisily.	• Foreign objects in impeller cavity.	• *Disassemble the receiver and bottom base of pump. Remove foreign material. Reassemble.
	• Piping to house structure is too rigid.	• Replace a portion of the discharge pipe with rubber hose to absorb noise.

Figure 2



3 Year Limited Warranty

Liberty Pumps, Inc. warrants that pumps of its manufacture are free from all factory defects in material and workmanship for a period of 3 years from the date of purchase. The date of purchase shall be determined by a dated sales receipt noting the model and serial number of the pump. The dated sales receipt must accompany the returned pump if the date of return is more than 3 years from the "CODE" (date of manufacture) number noted on the pump nameplate.

The manufacturer's obligation under this Warranty shall be limited to the repair or replacement of any parts found by the manufacturer to be defective, provided the part or assembly is returned freight prepaid to the manufacturer or its authorized service center, and provided that none of the following warranty-voiding characteristics are evident.

The manufacturer shall not be liable under this Warranty if the product has not been properly installed; if it has been disassembled, modified, abused or tampered with; if the electrical cord has been cut, damaged or spliced; if the pump discharge has been reduced in size; if the pump has been used in water temperatures above the advertised rating, or water containing sand, lime, cement, gravel or other abrasives; if the product has been used to pump chemicals or hydrocarbons; if a non-submersible motor has been subjected to excessive moisture; or if the label bearing the serial, model and code number has been removed. Liberty Pumps, Inc. shall not be liable for any loss, damage or expenses resulting from installation or use of its products, or for consequential damages, including costs of removal, reinstallation or transportation.

There is no other express warranty. All implied warranties, including those of merchantability and fitness for a particular purpose, are limited to three years from the date of purchase.

This Warranty contains the exclusive remedy of the purchaser, and, where permitted, liability for consequential or incidental damages under any and all warranties are excluded.

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Low level float switch for DWT
High level float switch for WWT

Flygt ENM-10 liquid level regulators

TRIED-AND-TRUE SIMPLICITY

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

FLYGT
a xylem brand

Low level float switch for DWT
High level float switch for WWT

So simple, yet so reliable

Proper level regulation is critical for operational reliability. Lack of proper regulation can cause improper operation, pump damage or, in the worst case, overflow that results in environmental and economic consequences. With over a decade of experience and countless satisfied users, the natural choice for level regulation is the Flygt ENM-10.

Simple, reliable and effective

The Flygt ENM-10 level regulators are the ideal choice for most level control applications, such as wastewater pumping stations and ground water or drainage pumping. When the liquid level reaches the regulator, the bulb tilts, activating the internal microswitch, which starts or stops a pump or triggers an alarm device.

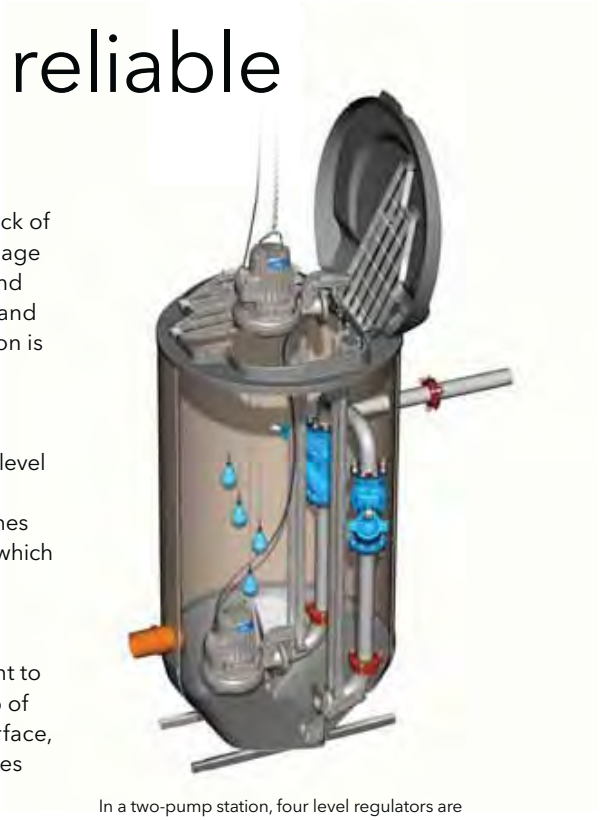
Practically maintenance free

The outer casing of Flygt ENM-10 level regulators are resistant to most aggressive liquids. The cable material prevents buildup of deposits and other impurities. Rather than floating on the surface, ENM-10 hangs immersed in the liquid. This prevents the cables from tangling when several regulators are used.

Xylem testing indicates Flygt ENM-10 level regulators last several times longer than most standard level regulators. This ensures reliable operation and a low degree of maintenance, thereby keeping service costs down to a minimum over the life cycle.

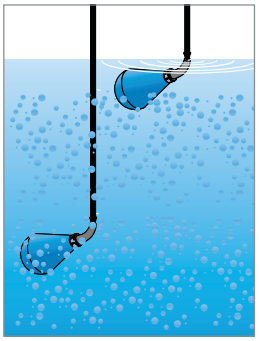
Environmentally friendly

The Flygt ENM-10 level regulator contains no harmful or toxic materials such as lead or mercury and does not require the use of any adhesives. All plastic components are welded and screwed together.

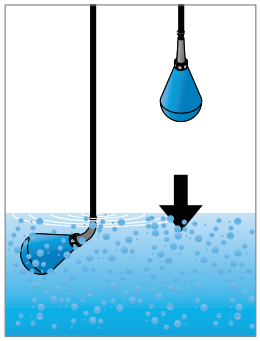


In a two-pump station, four level regulators are generally used. One is positioned at the stop level, one at each pump's start level, and the fourth regulator is used to trigger a high level alarm.

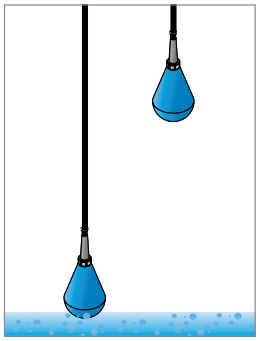
Operating principle



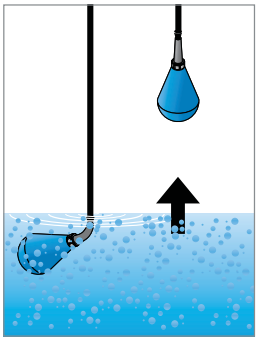
1. Media to be pumped reaches the pre-set level and tilts the upper regulator, which signals the start of the pumping process.



2. The pumping process drains the media.



3. The pumping process stops when the lower regulator returns to the vertical position and signals a stop.



4. The media level begins to rise, starting the process again.

Low level float switch for DWT
High level float switch for WWT

With a variety of installations in mind
The Flygt liquid level regulator comes in two main versions, standard and Ex-approved. Depending upon the media and type of installation, the Flygt ENM-10 is available for a broad range of liquid densities and with many cable lengths from which to choose.

Features

Standard

Ex

Watertight cable
Encases and protects power supply to the microswitch.

Operational mechanism
Initiates pump start and pump stop through the microswitch when the Flygt ENM-10 tilts or resumes its original position. Delivers reliable performance under all operating conditions including the slow movements often found in stormwater or rainwater installations.

Bending relief (protective sleeve)
Enables watertight, oil-resistant cable entry.

Microswitch
Provides proven quality, performance and reliability for all operating conditions, including switching low currents.

Accessories

Flygt ENM-10 cable holder
Dedicated accessory that reduces the cable wear. Sold separately or as package with the Flygt ENM-10.

Flygt Ex safety barrier
This two-channel safety barrier protects against overvoltage for liquid level regulators. Required when Flygt ENM-10s are to be used in Ex-installations.

Technical data

	Standard version	Ex-approved version
Cable lengths	6, 13, 20, 30 or 50 m* (20, 42, 65,100 or 167 ft.)	6, 13, or 20 m (20, 42 or 65 ft.)
Liquid density	Between 0.95 and 1.10 g/cm³*	Between 0.95 and 1.10 g/cm³
Materials	Body: Polypropylene Bending relief: EPDM rubber Cable: Special compound PVC & NBR/PVC	Body: Conductive polypropylene/carbon black Bending relief: NBR/PVC rubber Cable: NBR/PVC
Liquid temperature	Min. 0°C (32°F) Max. 60°C (140°F)	Min. 0°C (32°F) Max. 60°C (140°F)
Ingress protection	IP 68	IP 68
Electrical range (microswitch)	Interrupting capacity: AC: 250 V/10 A resistive load AC: 250 V/3 A inductive load at cosϕ = 0.5 DC: 24 V/ 10mA min., 6 A max. Note that local regulations may limit the voltage.	Interrupting capacity: AC: 250 V/10 A resistive load AC: 250 V/3 A inductive load at cosϕ = 0.5 DC: 24 V/ 10mA min., 6 A max. Note that local regulations may limit the voltage.
Approvals	CE, CSA, SEMKO, NEMKO, DEMKO	CE, SEMKO, NEMKO, DEMKO, ATEX/IECEX

*Other cable lengths and liquid densities available upon request.
The Flygt ENM-10 is a part of the Level Sensor product range from Xylem, covering most level measuring needs.

Low level float switch for DWT
High level float switch for WWT

Xylem [ˈzīləm]

1) The tissue in plants that brings water upward from the roots
2) A leading global water technology company

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com

xylem
Let's Solve Water

1319 . Flygt ENM 10 . 1 . Master . 1 . 20120103

Chapter 12 GAUGES

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax : (514) 344-9341

12.1 **TRERICE BIMETAL THERMOMETER B836-02-02**

12.2 **TRERICE BIMETAL THERMOWELL 76-4D2**

12.3 **TRERICE PRESSURE GAUGE 620B 45 02 L D 120**

12.4 **DIFFERENTIAL PRESSURE GAUGE 200DPG-G-S-4.0-4N-1-SS-F-V-0-(60 psid)**

12.5 **DIFFERENTIAL PRESSURE GAUGE 200DPG-GS-S-4.0-4N-1-SS-F-V-4-(100 psid)**

Adjustable Angle

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

BIMETAL THERMOMETERS

B836B shown

- 3", 5" Dial Size
- ± 1.0% Full Scale Accuracy
- Stainless Steel Case & Stem
- External Reset

Specifications

Models	Dial Sizes
B836	3"
B856	5"

Case	300 stainless steel, hermetically sealed
Stem	300 stainless steel 1/4" diameter
Coil	Bimetallic, silicone dampened on ranges to 300°F (148°C), above 300°F not dampened
Connection	Adjustable angle, 1/2 NPT
Window	Double strength glass
Pointer	Balanced, black finish
Dial Face	Aluminum, white background with black and blue graduations and markings
External Reset	Yes
Accuracy	±1.0 % Full Scale ASME B40.3 Grade A
Approximate Shipping Weight	B836: 1.1 lbs [0.5 kg] B856: 1.5 lbs [0.68 kg]

The Trerice **Adjustable Angle Bimetal Thermometer** can be configured to the most desirable viewing angle. This instrument has a hermetically sealed, stainless steel case designed to withstand the rigors of industrial environments, while producing an accurate, responsive measurement.

- Optional features available: Please consult the Options & Accessories Section for details.

Thermowell

- For corrosive or pressure applications, use of a thermowell is recommended to prevent damage to the thermometer and facilitate its removal from the process (refer to pages 155-161).

For correct use and application of all Bimetallic thermometers, please refer to the Bimetallic Actuated Thermometer Standard ASME B40.3.

HOW TO ORDER

Sample Order Number: B856 06 05

Model	Stem (Length)	Range Code
B836	02 2 1/2" Stem	See Standard Ranges
B856	04 4" Stem	
	06 6" Stem	
	09 9" Stem	
	12 12" Stem	
	15 15" Stem	
	18 18" Stem	
	24 24" Stem	

Other lengths available: Specify in inches (72" maximum)

SHOP DRAWING
This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.
Reviewed By: M.M.
Date: 8 July 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
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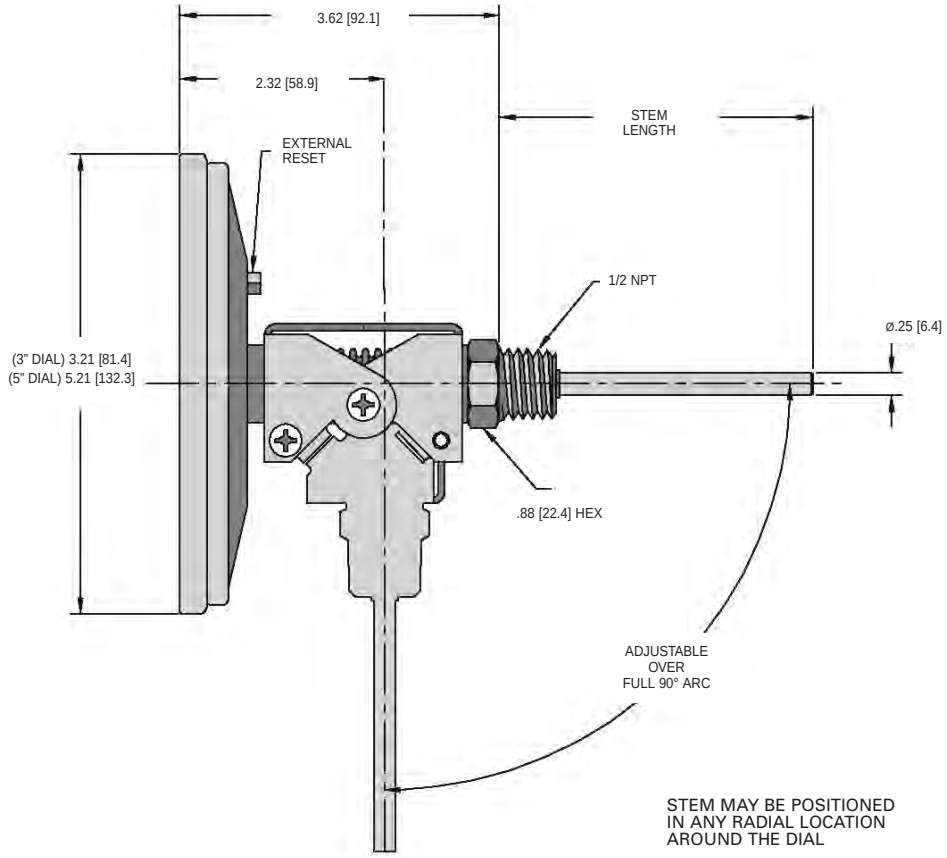
Adjustable Angle

All dimensions are nominal. Dimensions in [ ] are in millimeters.



Standard Ranges

Dual Scale (Fahrenheit & Celsius Range)		Fahrenheit only Range		Celsius only Range		Fahrenheit		Celsius	
Range Code	Range	Range Code	Range	Range Code	Range	Figure Intervals	Minor Divisions	Figure Intervals	Minor Divisions
01*†	-100° to 100°F & –75° to 40°C	01F*†	-100° to 100°F	01C*†	-75° to 40°C	20°	2°	10°	1°
02	-40° to 160°F & –40° to 70°C	02F	-40° to 160°F	02C	-40° to 70°C	20°	2°	10°	1°
12*†	0° to 100°F & -20° to 40°C	12F*†	0° to 100°F	12C*†	-20° to 40°C	10°	1°	10°	1°
03*†	25° to 125°F & –5° to 50°C	03F*†	25° to 125°F	03C*†	-5° to 50°C	10°	1°	5°	1/2°
04	0° to 200°F & –20° to 95°C	04F	0° to 200°F	04C	-20° to 95°C	20°	2°	10°	1°
05	20° to 240°F & –10° to 115°C	05F	20° to 240°F	05C	-10° to 115°C	20°	2°	10°	1°
27	0° to 250°F & –20° to 120°C	27F	0° to 250°F	27C	-20° to 120°C	50°	2°	20°	2°
06	50° to 300°F & 10° to 150°C	06F	50° to 300°F	06C	10° to 150°C	50°	2°	20°	2°
07	50° to 400°F & 10° to 200°C	07F	50° to 400°F	07C	10° to 200°C	50°	5°	50°	2°
08	50° to 500°F & 10° to 260°C	08F	50° to 500°F	08C	10° to 260°C	50°	5°	50°	2°
09*	150° to 750°F & 50° to 400°C	09F*	150° to 750°F	09C*	50° to 400°C	100°	10°	50°	5°
10*	200° to 1000°F & 100° to 550°C	10F*	200° to 1000°F	10C*	100° to 550°C	100°	10°	100°	5°

* Minimum stem length for these ranges is 4".
† Minimum insertion length for these ranges is 3".

Thermowells

DESIGN & OPERATION

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
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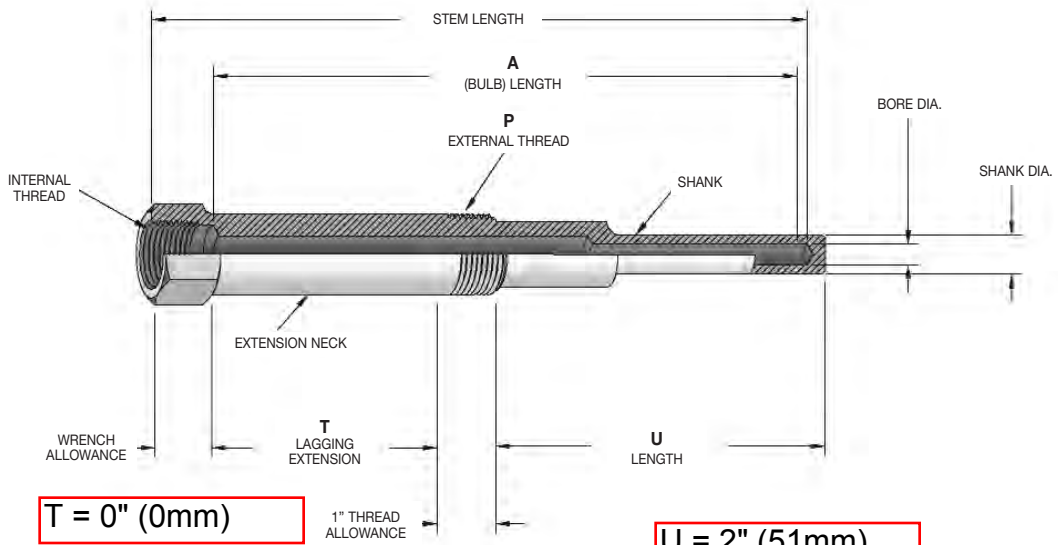
SIFEC NORTH INC.

Description

A thermowell is a pressure tight receptacle designed to accept a temperature sensing element and provide a means to insert that element into a vessel or pipe.



T = 0" (0mm)

U = 2" (51mm)

Principles of Operation

A thermowell acts as a barrier between a process medium and the sensing element of a temperature measuring device. It protects against corrosive process media, media contained under pressure, or media flowing at a high velocity. A thermowell also allows the sensing element to be removed from the application while maintaining a closed system.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 8 July 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

12950 W. Eight Mile Road • Oak Park, MI 48237-3288 • TEL:248/399-8000 • FAX: 248/399-7246 • www.TRERICE.com

Selecting a Thermowell

Temperature Instrumentation and Control Products, including: Thermometers, Thermocouples, RTDs, and Temperature Controllers.

All Trerice Thermowells should be carefully selected to meet the demands of the particular application. The information contained in this catalog is only offered as a guide to assist in making the proper selection. Improper application may cause failure of the thermowell, resulting in possible personal injury or property damage.

To ensure minimum response time, Trerice Heat Transfer Paste should be applied to the sensing portion of the instrument before installation into a thermowell. 1 oz. tube: Item No. 107-0001

Connection

Trerice Thermowells are available in a variety of process connection styles. Threaded connections in 1/2, 3/4 and 1 NPT are the most widely specified. Socket weld, weld-in, raised face flanged, Van Stone flanged, and sanitary (Tri-Clamp) connection styles are also available.

All Trerice Bimetal Thermowells are provided with a 1/2 NPSM instrument connection to allow for pressure relief within the thermowell.

U-Length

The U-length (insertion length) of a thermowell indicates its insertion depth into a process vessel or piping system and is measured from the tip of the thermowell to the underside of the threads. The U-length must equal or exceed the length of the sensitive portion of the temperature instrument's stem or bulb. Trerice Thermowells are available in U-lengths from 2" to 72".

Material

The material chosen must be compatible with the process medium to which it is exposed. In applications of high pressure or velocity, the material may be chosen for its strength or durability. Trerice offers thermowells in a variety of materials, including: brass, carbon steel, stainless steel, Monel, Carpenter 20, Hastelloy B or C, Inconel 600, Incoloy 800, Nickel and Titanium. Other alloys or compounds may also be available, please consult factory.

Threaded, welded and Van Stone flanged thermowells are made from forgings or bar stock. Raised face flanged and sanitary thermowells are of a two-piece welded construction.

Bore

The bore of each Trerice Thermowell is designed to fit the sensing element of a specific Trerice Temperature Instrument.

Shank

Trerice Thermowells are available in stepped, tapered, and straight shank configurations. Stepped shank thermowells are normally used on standard duty applications. Tapered shank thermowells are designed for use on heavy duty applications. Straight shank thermowells are designed for use with instruments that have wide stem diameters or short stem lengths.

Lagging Extension

Lagging extension thermowells are used on applications where insulation covers the vessel or piping system. The extension length (T-length) is the measurement between the instrument connection and process connection of the thermowell.

DIFFERENTIAL PRESSURE GAUGE

PISTON INSTRUMENTS

200 DPG

Piston Instruments

CE

SALIENT FEATURES

- Cost effective and reliable.
- Simple and compact design.
- Easy to read dial instrument eliminates accumulated errors of two instrument installations.
- **High operating pressure up to 200 bar.**
- **Differential pressure range up to 10 bar.**
- Over pressure safe from either side to maximum working pressure.
- Adjustable reed contact switching.
- Indicating mechanism isolated from pressure chamber.
- Only switch is also available.
- Wide applications in air, gas and liquid media.
- Manufactured in ISO certified plant.

These piston instruments can indicate small values of differential pressure even when used at high line pressures. They provide instantaneous and continuous information regarding system conditions helping in eliminating premature servicing of equipment, avoid unscheduled down time of costly processes and detect abnormal system conditions.

Switching Facility : Instruments can be supplied with reed switches to initiate alarms, activate other equipment, or shut the system down. Two switches are used when high and low limits are desired. Gauge-switch models provide the user with both, gauge readout and switch operation.

APPLICATIONS :

Filters, Hydraulic systems, Water treatment plants, Chemical plants, Natural gas processing, Heat exchangers, Gasoline / Diesel engine filters, Pumps and Valves, Compressors.

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 07 juillet 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 8 July 2016

Reviewed	X
Reviewed as noted	
Resubmit	

CHIARELLI ENGINEERING LTD.

Differential Pressure Plus, Inc.
16 Carriage Hill Drive
Branford, CT 06405
Phone : 203-481-2545
Fax : 203-483-7169
Email : DPGauge@AOL.com
Website : www.differentialpressure.com

MAGNETIC PRINCIPLE

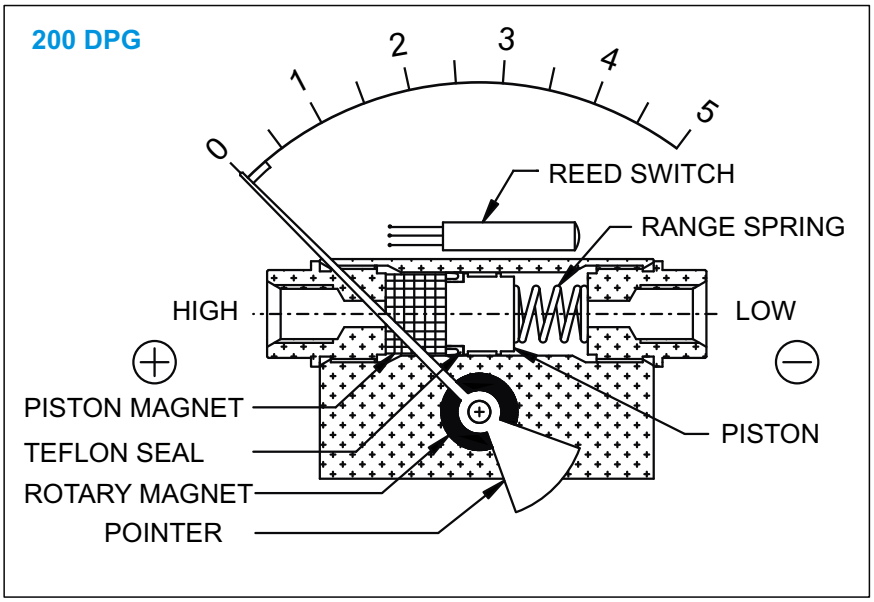
DIFFERENTIAL
PRESSURE GAUGE

OPERATING PRINCIPLE

High and Low pressures are separated by a sensor assembly consisting of a magnet, piston, Teflon seal and a range spring. The difference in pressure causes the sensor assembly to move in proportion to the change against a range spring.

A rotary magnet, located in a separate body cavity and isolated from the acting pressures, is rotated by magnetic coupling as per the linear movement of the sensor assembly. A pointer attached to the rotary magnet indicates differential pressure on the dial.

Switch : Reed switches are located adjacent to the pressure chamber and are activated by the magnetic field of the sensor assembly.



TECHNICAL DATA

Specifications

Accuracy	: ±2% of the FSD (Ascending)
Migration	: Minor from high to low port
Range	: 0-0.25 to 0-70 bar or equivalent range in other units
First marking on the scale	: 20% of the FSD
Sensing element	: Piston
Wetted parts	: Body material, SS 302 spring, Teflon, & ceramic magnet
Case material	: Stainless steel (SS 304)
Dial size in inch /mm	: 2”, 2.5”, 3.5”, 4”, 4.5”, 6”/ 50, 63, 80, 100, 115, 150
Mounting	: Direct, front flange & 2” pipe mounting
Max. working pressure	: 200/400 bar. 200 bar for Alu, Brass & 400 bar for SS body
Max process temperature	: 80° C / 175° F
Body material	: Aluminum, Brass, SS 316 & Monel
Seals	: Buna-N, Viton & EPDM ‘O’ rings
Window	: Float glass(Std.), toughened glass & acrylic on request.
Connection	: 1/4” NPT(F) Std. optional 1/4” BSP(F)
Porting	: In-line, rear, bottom
Over range protection	: Up to the max. working pressure from high & low side
Protection for gauge & switch	: IP 65 / NEMA-4

Options

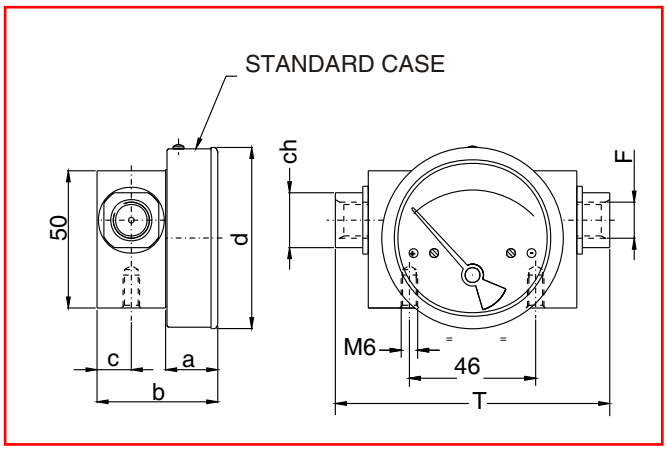
Glycerine filling
Red follower pointer (except 2" & 6")
Customer logo
Dual scale
Colour band
Filter mesh in (+) connection
Reverse port (Pointer moves from right to left)
Descending calibration

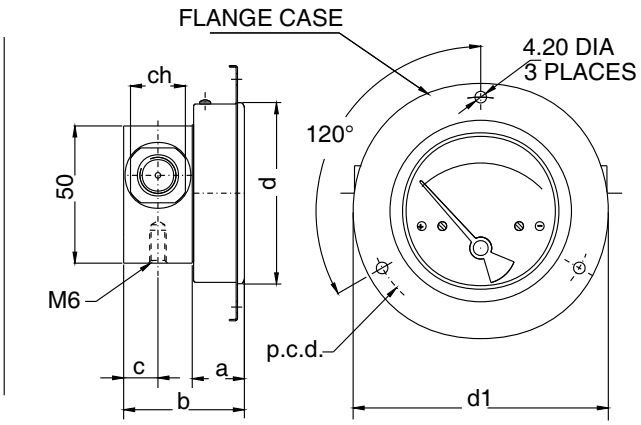
Switches (Adjustable in 20-100% of FSD)

1 or 2 SPSTs with a DIN plug
1 or 2 SPSTs with a terminal strip
1 or 2 SPSTs with a built in relay
1 or 2 SPDTs with a terminal strip
1 or 2 SPDTs with a DIN plug

DIFFERENTIAL
PRESSURE GAUGE

STANDARD DIMENSIONS (MODEL 200 DPG)

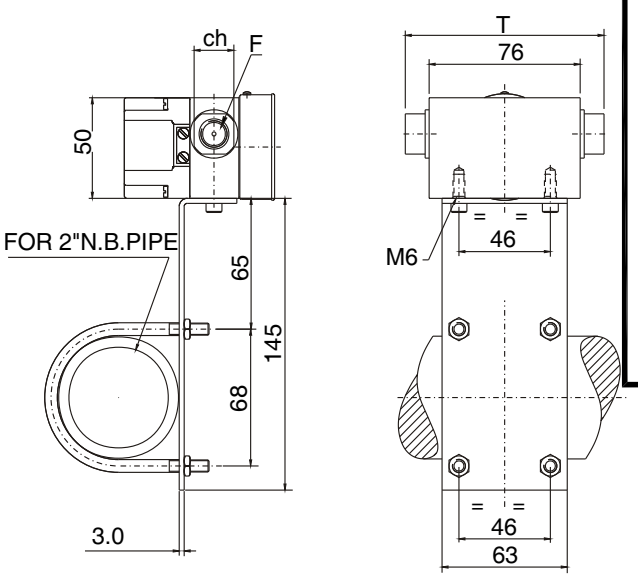




DIAL Ø	F	a	b	c	d	d1	T	ch	p.c.d.
50 (2")	1/4"BSP - 1/4"NPT	18	43	12.5	53	79	100	20	69
63 (2.5")	1/4"BSP - 1/4"NPT	19	44	12.5	66	93	100	20	83
80 (3.5")	1/4"BSP - 1/4"NPT	19	44	12.5	83	109	100	20	99
100 (4")	1/4"BSP - 1/4"NPT	19	44	12.5	104.3	131	100	20	121
115 (4.5")	1/4"BSP - 1/4"NPT	19	44	12.5	119.7	146	100	20	136
150 (6")	1/4"BSP - 1/4"NPT	19	44	12.5	154.3	181	100	20	171

* PANEL CUT OUT = d+ 1

MOUNTING BRACKETS (MODEL 200 DPG)



BRACKET MOUNTING FOR GAUGE+ SWITCH

SHOP DRAWING

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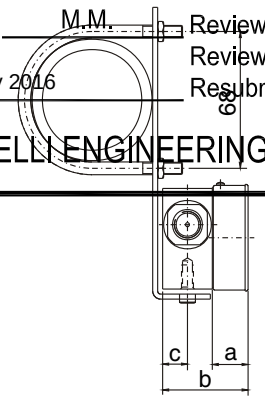
Reviewed By: M.M.

Date: 8 July 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.



BRACKET MOUNTING FOR GAUGE

DIAL Ø	F	a	b	c	T	ch
50 (2")	1/4"BSP - 1/4"NPT	18	43	12.5	100	20
63 (2.5")	1/4"BSP - 1/4"NPT	19	44	12.5	100	20
80 (3.5")	1/4"BSP - 1/4"NPT	19	44	12.5	100	20
100 (4")	1/4"BSP - 1/4"NPT	19	44	12.5	100	20
115 (4.5")	1/4"BSP - 1/4"NPT	19	44	12.5	100	20
150 (6")	1/4"BSP - 1/4"NPT	19	44	12.5	100	20

HOW TO ORDER A DIFFERENTIAL PRESSURE INSTRUMENT, MODEL 200 DPG

DIFFERENTIAL PRESSURE GAUGE

	Example	Code	Descriptions
Series	200 DPG		
Type	GS	G	Gauge
		S	Switch
		GS	Gauge + Switch
Body material	B	A	Aluminium *(anodized)*
		B	Brass
		S	SS-316
		H	Heavy duty Auminium. *(5000 psi) with 32mm thick body.*
		M	Monel
Dial size	3.5	2.0	2.0" (50 mm)
		2.5	2.5" (63 mm)
		3.5	3.5" (80 mm)
		4.0	4.0" (100 mm)
		4.5	4.5" (115 mm)
		6.0	6.0" (150 mm)
Connection	4N	4B	¼" BSP (Female)
		4N	¼" NPT (Female)
		ZZ	Special connection sizes using adaptor
Porting	1	1	In-line (Standard)
		2	Rear / Back
		3	Bottom
		6	In-line & Bottom
Case type	SS	SS	SS 304 with a rubber ring (standard)
		SF	SS 304 flange with a rubber ring (standard flange)
Window	A	F	Glass (standard)
		A	Acrylic
		T	Toughened glass
		L	Safety glass
Seal	B	B	Buna-N (standard)
		V	Viton
		E	EPDM
Switch	3	0	None
		1	One SPST, with a DIN plug*
		2	One SPST, with a terminal strip
		2A	One SPST, with built in relay
		3	Two SPSTs, with a DIN plug*
		4	Two SPSTs, with a terminal strip
		4A	Two SPSTs, with built in relay
		5	One SPDT, with a DIN plug*
		6	One SPDT, with a terminal strip
		7	Two SPDTs, with two DIN plugs*
		8	Two SPDTs, with a terminal strip

SPST Specifications :
10 VA AC or DC (max)
100 V AC or DC (max)
0.5 Amp AC or DC (max)

Built in relay :
230 V AC, 1 Amps.

SPDT Specifications :
3 VA AC or DC (max)
30 V AC or DC (max)
0.30 Amp AC or DC (max)

* ***DIN plug :*** *we mount it on the top, on the plastic switch cover. However we can give it at the back as a request.)*

Switch applicable for "S" & "GS" types only. Switches operate from 20 to 100% of the range & mounted at the back. Switches are in a plastic enclosure, they are factory set, field adjustable.

Standard Ranges 0-100 psi

Kg/cm²	0.25	-	0.5	0.75	1	-	1.6	2	2.5	3	3.5	4	5	-	6	7	9	10
bar	0.25	-	0.5	0.75	1	-	1.6	2	2.5	3	3.5	4	5	-	6	7	9	10
Mbar	250	-	500	750	1000	-	-	-	-	-	-	-	-	-	-	-	-	-
psi	-	5	8	-	15	20	25	30	-	40	50	60	-	80	-	100	-	-
Kpa	25	-	50	75	100	-	160	200	250	300	350	400	500	-	600	700	900	1000

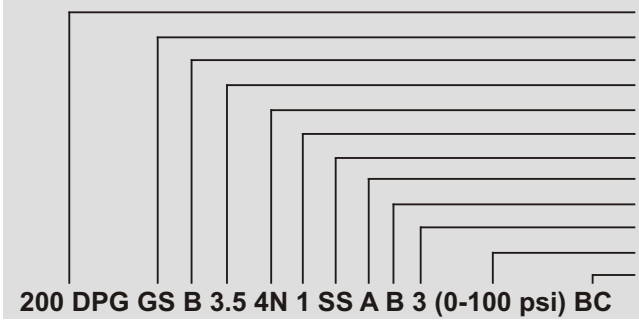
Other ranges on request.

Options	BC	0	None
		A	Glycerine*
		B	Red follower pointer on acrylic window
		C	Customer Logo
		D	Dual scale
		E	Colour band
		F	Strainer in (+) connection
		G	Reverse port**
		H	Descending calibration *(longer delivery time)*
		N	NACE

* Affects accuracy

** Pointer moves from right to left

Ordering Sequence Code (Example)



200 DPG GS B 3.5 4N 1 SS A B 3 (0-100 psi) BC

Limitations for making combinations:

- Glycerine filling will not have follower pointer.
- For bottom or back porting no mounting holes are given and hence can not be mounted using a bracket.
- Gauge with back porting cannot have a switch. (However, only switch with back porting is available.)
- Toughened glass and follower pointer not available in 2" (50 mm) dial.
- No follower pointer available in 6" (150 mm).

Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing, modifications may take place and materials specified may be replaced by others without prior notice.

Pressure gauge

620B

Stainless Steel Case

COMMERCIAL• CONTRACTOR GAUGES

620B shown

- **4 1/2" Dial Size**
- **±1.0% Accuracy**
- **Stainless Steel Case**
- **Recalibrator Screw**

The **620B** Trerice Contractor Gauge is designed to service the general pressure measurement requirements of the construction industry. The 620B offers high reliability at an economic price. This gauge features a corrosion resistant, stainless steel case and acrylic window. Wetted parts are brass.

- For correct use and application of all pressure gauges, please refer to: Pressure Gauge Standard ASME B40.100.

Specifications

Model	**620B**
Dial Size	4 1/2"
Wetted Parts	Bronze tube, brass socket
Movement	Brass
Connection	Lower male, 1/4 NPT
Case	304 stainless steel, stem-mounted flangeless
Ring	Friction type, 304 stainless steel
Window	Acrylic
Pointer	Plain, black finished Adjustable via screw on dial face
Dial Face	Aluminum, white background with black graduations and markings
Accuracy	±1.0% Full Scale, ASME B40.100 Grade 1A
Maximum Temperature	**212°F (100° C)**
Approximate Shipping Weight	0.8 lbs [0.36 kg]

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

SHOP DRAWING

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Reviewed By: M.M.
Date: 8 July 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

HOW TO ORDER

Sample Order Number: **620B 45 02 L D 140**

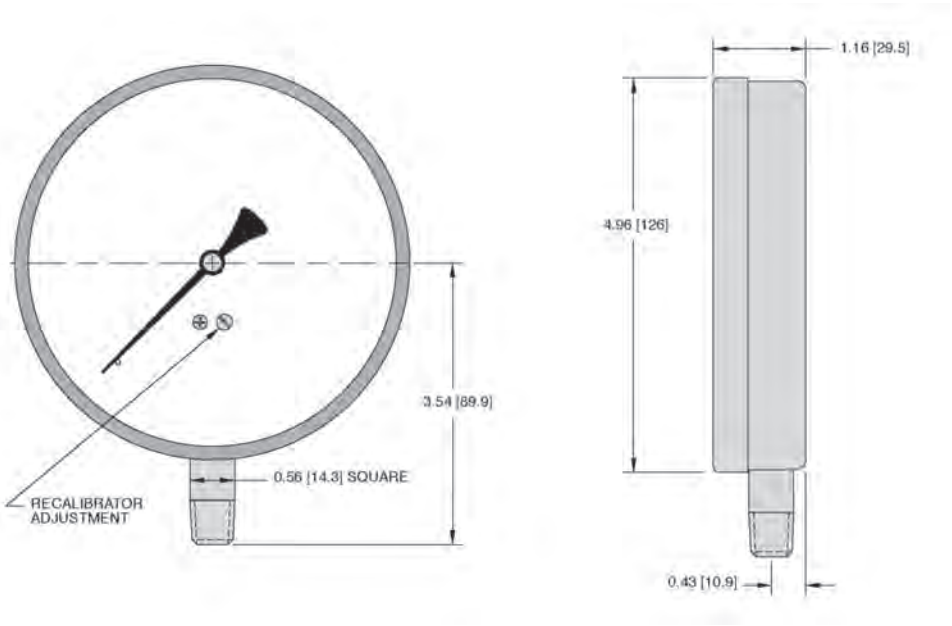
Model	Dial Size	Connection Size	Connection Location	Units of Measure	Range Code
620B	**45** 4 1/2"	**02** 1/4 NPT	**L** Lower	**A** psi **D** psi/kPa	See Standard Ranges

12950 W. Eight Mile Road • Oak Park, MI 48237-3288 • TEL:248/399-8000 • FAX: 248/399-7246 • www.TRERICE.com

620B

Stainless Steel Case

All dimensions are nominal. Dimensions in [ ] are in millimeters.



Standard Ranges

psi Ranges (A)				psi/kPa Ranges (D)					
						psi		kPa	
Range Code	Specific Range (psi)	Figure Intervals	Minor Divisions	Range Code	Specific Range	Figure Intervals	Minor Divisions	Figure Intervals	Minor Divisions
010	30" Hg to 0	5	0.5	010	30" Hg to 0 / –100 to 0 kPa	5	0.5	10	1
020	30" Hg to 15 psi	10/5	1/0.5	020	30" Hg to 15 psi / –100 to 100 kPa	10/5	1/0.5	20	2
030	30" Hg to 30 psi	10/5	1/–	030	30" Hg to 30 psi / –100 to 200 kPa	10/5	1/–	50	2
040	30" Hg to 60 psi	10/10	2/1	040	30" Hg to 60 psi / –100 to 400 kPa	10/10	2/1	50	5
050	30" Hg to 100 psi	30/20	2/2	050	30" Hg to 100 psi / –100 to 700 kPa	30/20	2/2	100	5
060	30" Hg to 150 psi	30/30	5/2	060	30" Hg to 150 psi / –100 to 1000 kPa	30/30	5/2	100	10
070	30" Hg to 300 psi	30/50	5/5	070	30" Hg to 300 psi / –100 to 2000 kPa	30/50	5/5	200	20
080	0 to 15 psi	3	0.2	080	0 to 15 psi / 0 to 100 kPa	3	0.2	10	1
090	0 to 30 psi	5	0.5	090	0 to 30 psi / 0 to 200 kPa	5	0.5	20	2
100	0 to 60 psi	10	1	100	0 to 60 psi / 0 to 400 kPa	10	1	50	5
110	0 to 100 psi	10	1	110	0 to 100 psi / 0 to 700 kPa	10	1	100	5
120	0 to 160 psi	20	2	120	0 to 160 psi / 0 to 1100 kPa	20	2	200	10
130	0 to 200 psi	20	2	130	0 to 200 psi / 0 to 1400 kPa	20	2	300	10
140	0 to 300 psi	50	5	140	0 to 300 psi / 0 to 2000 kPa	50	5	200	20
150	0 to 400 psi	50	5	150	0 to 400 psi / 0 to 2800 kPa	50	5	300	50
160	0 to 600 psi	100	10	160	0 to 600 psi / 0 to 4000 kPa	100	10	500	50

Chapter 13 DRAINAGE PIPING

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax : (514) 344-9341

13.1 DRAINAGE PIPING XFR DWV

SYSTEM XFR® DWV

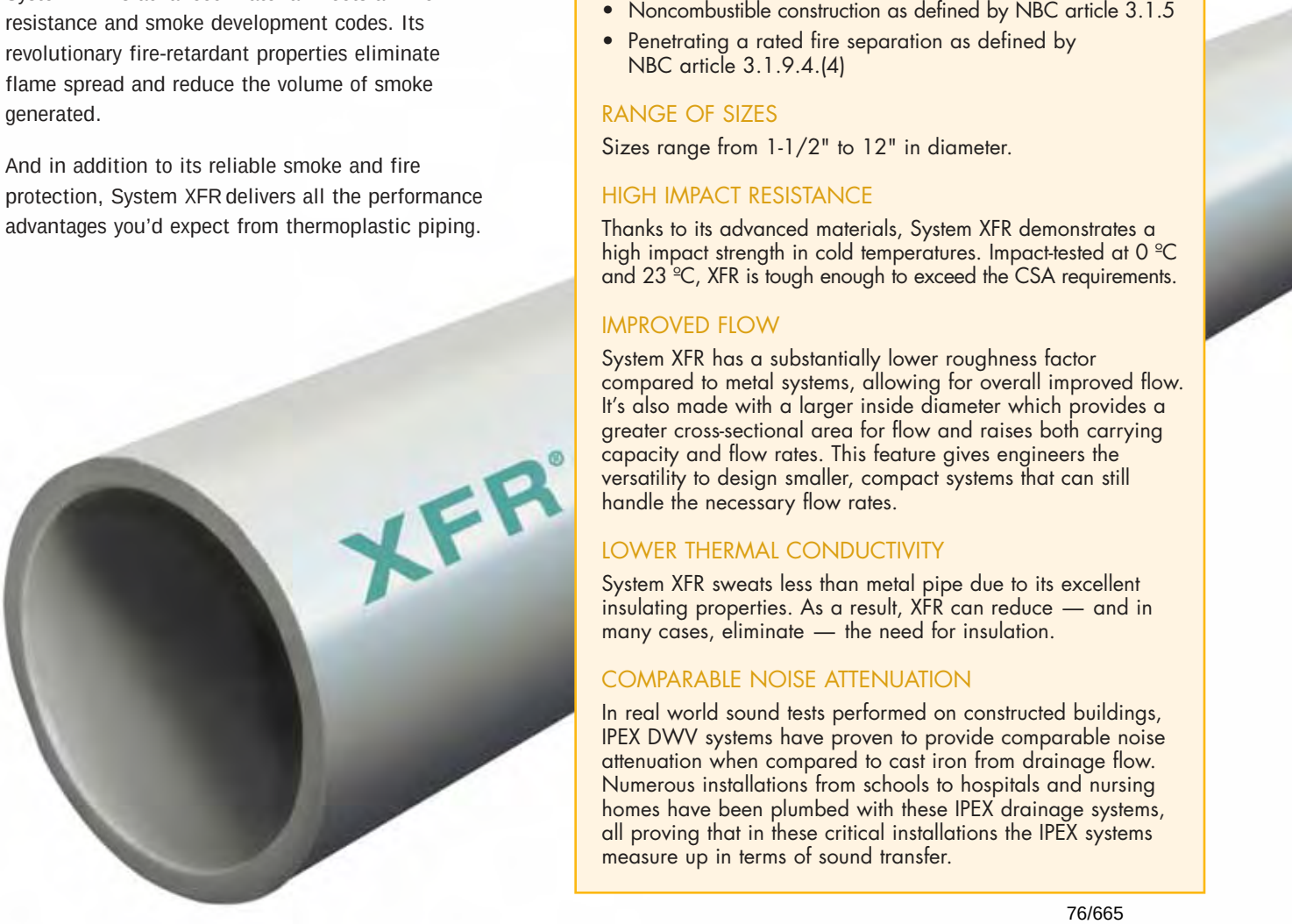
Drainage Systems for Noncombustible Buildings

THE WORLD'S FIRST PVC RATED FOR HIGH RISES & PLENUMS

Contractors installing DWV pipe in high-rises and plenums had few alternatives to heavy cast iron and copper. IPEX has changed that. System XFR® — the world's first PVC DWV system rated for high-rises and plenums where tighter fire and smoke regulations have previously limited the use of thermoplastic.

Suitable for use in noncombustible environments, System XFR's advanced material meets all fire-resistance and smoke development codes. Its revolutionary fire-retardant properties eliminate flame spread and reduce the volume of smoke generated.

And in addition to its reliable smoke and fire protection, System XFR delivers all the performance advantages you'd expect from thermoplastic piping.



FEATURES & BENEFITS

FLAME & SMOKE

System XFR possesses superior fire- and smoke- retardant capabilities. When tested to the CAN/ULC-102.2 Standard, System XFR achieved a Flame Spread Rating of not greater than 25 and a Smoke Developed Classification of not greater than 50.

CODE COMPLIANCE

Ideal for noncombustible applications, System XFR meets these national and provincial building codes:

- High-rise buildings as defined by NBC article 3.2.6
- Air plenums as defined by NBC article 3.6.4.3
- Noncombustible construction as defined by NBC article 3.1.5
- Penetrating a rated fire separation as defined by NBC article 3.1.9.4.(4)

RANGE OF SIZES

Sizes range from 1-1/2" to 12" in diameter.

HIGH IMPACT RESISTANCE

Thanks to its advanced materials, System XFR demonstrates a high impact strength in cold temperatures. Impact-tested at 0 °C and 23 °C, XFR is tough enough to exceed the CSA requirements.

IMPROVED FLOW

System XFR has a substantially lower roughness factor compared to metal systems, allowing for overall improved flow. It's also made with a larger inside diameter which provides a greater cross-sectional area for flow and raises both carrying capacity and flow rates. This feature gives engineers the versatility to design smaller, compact systems that can still handle the necessary flow rates.

LOWER THERMAL CONDUCTIVITY

System XFR sweats less than metal pipe due to its excellent insulating properties. As a result, XFR can reduce — and in many cases, eliminate — the need for insulation.

COMPARABLE NOISE ATTENUATION

In real world sound tests performed on constructed buildings, IPEX DWV systems have proven to provide comparable noise attenuation when compared to cast iron from drainage flow. Numerous installations from schools to hospitals and nursing homes have been plumbed with these IPEX drainage systems, all proving that in these critical installations the IPEX systems measure up in terms of sound transfer.

SYSTEM XFR DRAINAGE SYSTEMS

1-1/2" - 12" (40mm - 300mm)

SYSTEM XFR® DWV

Contractors installing DWV pipe in high-rises and plenums had few alternatives to heavy cast iron and copper. IPEX has changed that. System XFR® — the world's first PVC DWV system rated for high-rises and plenums where tighter fire and smoke regulations have previously limited the use of thermoplastic.

Suitable for use in noncombustible environments, System XFR's advanced material meets all fire-resistance and smoke development codes. Its revolutionary fire-retardant properties eliminate flame spread and reduce the volume of smoke generated.

And in addition to its reliable smoke and fire protection, System XFR delivers all the performance advantages you'd expect from thermoplastic piping.

APPLICATIONS

Drain Waste and Vent Piping in:

- Commercial
- Industrial
- Residential
- Above ground or underground

STANDARDS

CSA B181.2
CAN/ULC S102.2

ADVANTAGES

1. **Flame & Smoke**
System XFR possesses superior fire- and smoke- retardant capabilities. When tested to the CAN/ULC S102.2 Standard, System XFR achieved a Flame Spread Rating of not greater than 25 and a Smoke Developed Classification of not greater than 50.

2. **Code Compliance**
Ideal for noncombustible applications, System XFR meets these national and provincial building codes:
   - High-rise buildings as defined by NBC article 3.2.6
   - Air plenums as defined by NBC article 3.6.4.3
   - Noncombustible construction as defined by NBC article 3.1.5
   - Penetrating a rated fire separation as defined by NBC article 3.1.9.4.(4)

3. **High Impact Resistance**
Thanks to its advanced materials, System XFR demonstrates a high impact strength in cold temperatures. Impact-tested at 0 °C and 23 °C, XFR is tough enough to exceed the CSA requirements.

4. **Improved Flow**
System XFR has a substantially lower roughness factor compared to metal systems, allowing for overall improved flow. It's also made with a larger inside diameter which provides a greater cross-sectional area for flow and raises both carrying capacity and flow rates. This feature gives engineers the versatility to design smaller, compact systems that can still handle the necessary flow rates.

5. **Lower Thermal Conductivity**
System XFR sweats less than metal pipe due to its excellent insulating properties. As a result, XFR can reduce — and in many cases, eliminate — the need for insulation.

6. **Comparable Noise Attenuation**
In real world sound tests performed on constructed buildings, IPEX DWV systems have proven to provide comparable noise attenuation when compared to cast iron from drainage flow. Numerous installations from schools to hospitals and nursing homes have been plumbed with these IPEX drainage systems, all proving that in these critical installations the IPEX systems measure up in terms of sound transfer.

DID YOU KNOW?

SYSTEM XFR — the world's first uncoated PVC rated for high-rises and plenums where tighter fire and smoke regulations have previously limited the use of thermoplastic.

Suitable for use in noncombustible environments, System XFR's advanced material meets all fire-resistance and smoke development codes. Its revolutionary fire-retardant properties virtually eliminate flame spread and reduce the volume of smoke generated.

SHORT FORM SPECIFICATIONS

SYSTEM XFR DWV PIPE AND FITTINGS
IPEX System XFR Drain, Waste and Vent pipe and fittings shall be certified to CSA B181.2 and when used in noncombustible construction, high-rise buildings and air plenums, they shall be tested and listed in accordance with CAN/ULC S102.2 and clearly marked with the certification logo indicating a Flame Spread Rating not more than 25 and a Smoke Developed Classification not exceeding 50.

System XFR® pipe and fittings have been tested and certified by CSA to the CSA B181.2 standard. System XFR pipe and fittings are listed with ITS (Warnock Hersey) to exhibit Flame and Smoke values as per CAN/ULC S102.2-10.

Test Results

ITS (Warnock Hersey) conducted the testing in accordance with CAN/ULC S102.2 test standard. The following table summarizes the results of these tests.

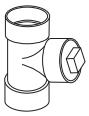
Component	Flame Spread Rating	Smoke-Developed Classification
System XFR®		
Pipe	≤ 25	≤ 50
Fittings	≤ 25	≤ 50
Fabricated PVC fittings with XFR Coating	≤ 25	≤ 50

PRODUCT SELECTION CHART - SYSTEM XFR

System XFR DWV Pipe

Dimension inches	Dimension mm	Product Code
1-1/2	40	110067
2	50	110068
3	75	110069
4	100	110070
6	150	110071
8	200	110072
10	250	110073
12	300	110074

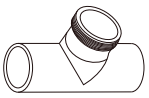
Line Cleanout H x H x Gasket Plug



Dimension inches	Dimension mm	Product Code
1-1/2	40	526040
2	50	526041
3	75	526103
4	100	526104
4 x 3 x 4	100 x 75 x 100	526105
6	150	526161
8	200	526162
10	250	526163
12	300	526164

Line Cleanout Sp x Sp x Threaded Plug

FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8	200	526766

Plug Cleanout MPT with gasket

Dimension inches	Dimension mm	Product Code
1-1/2	40	526401
2	50	526402
3	75	526403
4	100	526404
6	150	526405

Fitting Cleanout Sp x FPT

Dimension inches	Dimension mm	Product Code
1-1/2	40	526042
2	50	526046
3	75	526047
4	100	526048
6	150	426050

Fitting Cleanout Sp x Gasket Plug

Dimension inches	Dimension mm	Product Code
1-1/2	40	526345
2	50	526346
3	75	526347
4	100	526348
6	150	526349

Tube End Cleanout H x Gasket Plug

Dimension inches	Dimension mm	Product Code
1-1/2	40	526291
2	50	526298
3	75	526299
4	100	526300

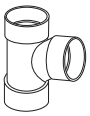
Tube End Cleanout H x Bolted Cover

Dimension inches	Dimension mm	Product Code
8	200	526000
10	250	526001
12	300	526002

Fitting Cleanout Sp x Bolted Cover

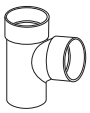
Dimension inches	Dimension mm	Product Code
8	200	526140
10	250	526141
12	300	526142

Sanitary Tee H x H x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	526081
2	50	526082
2 x 1-1/2 x 1-1/2	50 x 40 x 40	526058
2 x 1-1/2 x 2	50 x 40 x 50	526057
2 x 1-1/2	50 x 40	526056
3	75	526083
3 x 1½	75 x 40	526061
3 x 2	75 x 50	526060
4	100	526084
4 x 2	100 x 50	526064
4 x 3	100 x 75	526066
6	150	526377
6 x 4	150 x 100	526385
8	200	526810
8 x 4	200 x 100	526808
8 x 6	200 x 150	526809
10	250	526814
10 x 4	250 x 100	526811
10 x 6	250 x 150	526812
10 x 8	250 x 200	526813
12	300	526819
12 x 4	300 x 100	526815
12 x 6	300 x 150	526816
12 x 8	300 x 200	526817
12 x 10	300 x 250	526818

Sanitary Tee Sp x H x H

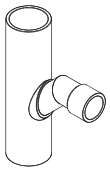


Dimension inches	Dimension mm	Product Code
1-1/2	40	526550
3 x 1-1/2	75 x 40	526552
4	100	426557

PRODUCT SELECTION CHART - SYSTEM XFR

Sanitary Tee Sp x Sp x H

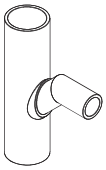
FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8 x 4	200 x 100	526926
8 x 6	200 x 150	526998
10 x 4	250 x 100	526997
10 x 6	250 x 150	526758
12 x 4	300 x 100	526761
12 x 6	300 x 150	526762

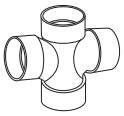
Sanitary Tee Sp x Sp x Sp

FOR USE WITH MJ GREY™



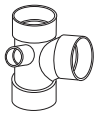
Dimension inches	Dimension mm	Product Code
8	200	526999
10 x 8	250 x 200	526759
10	250	526760
12 x 8	300 x 200	526763
12 x 10	300 x 250	526764
12	300	526765

Double Sanitary Tee H x H x H x H



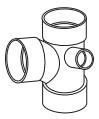
Dimension inches	Dimension mm	Product Code
1-1/2	40	526542
2	50	526543
2 x 1-1/2	50 x 40	526547
3	75	526544
3 x 1-1/2	75 x 40	526538
3 x 2	75 x 50	426539

Sanitary Tee Side Inlet (left hand) H x H x H x H SI



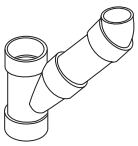
Dimension inches	Dimension mm	Product Code
3 x 3 x 3 x 1-1/2	75 x 75 x 75 x 40	526395
3 x 3 x 3 x 2	75 x 75 x 75 x 50	526396

Sanitary Tee Side Inlet (right hand) H x H x H SI x H



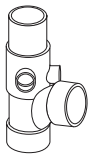
Dimension inches	Dimension mm	Product Code
3 x 3 x 3 x 1-1/2	75 x 75 x 75 x 40	526397
3 x 3 x 3 x 2	75 x 75 x 75 x 50	526398

Upright Extended Wye H x x H x Sp



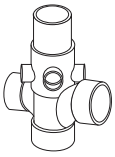
Dimension inches	Dimension mm	Product Code
3	75	526006

Single Apartment Fitting H x Sp x H



Dimension inches	Dimension mm	Product Code
3	75	526007

Double Apartment Fitting H x Sp x H x H



Dimension inches	Dimension mm	Product Code
3	75	526008

90º Elbow H x H

Dimension inches	Dimension mm	Product Code
1-1/2	40	526121
1-1/2 L	40 L	426024
2	50	526035
2 L	50 L	526122
3	75	526025
3 L	75 L	526123
4	100	526124
6	150	526125
8	200	526126
10	250	526127
12	300	526128

90º Elbow Sp x H

Dimension inches	Dimension mm	Product Code
1-1/2	40	526231
2	50	526232
3	75	526233
3 L	75 L	526230
4	100	526234
6	150	526235
8	200	526236
10	250	526237
12	300	526238

90º Elbow Sp x Sp

FOR USE WITH MJ GREY™

Dimension inches	Dimension mm	Product Code
8	200	526967
10	250	526968
12	300	526970

90º Reducing Elbow Closet Bend Reducing Sp x H

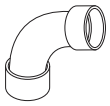
Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	426026

PRODUCT SELECTION CHART - SYSTEM XFR

90º Reducing Elbow H x H

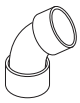
Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526155

90º Elbow Extra Long Sweep H x H



Dimension inches	Dimension mm	Product Code
2	50	426157

60º Elbow H x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	526261
2	50	526262
3	75	526253
4	100	526264

45º Elbow Short Turn H x H

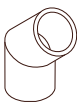
Dimension inches	Dimension mm	Product Code
1-1/2	40	526241
2	50	526242
3	75	526243
4	100	526244
6	150	526245
8	200	526246
10	250	526247
12	300	526248

45º Elbow Short Turn Sp x H

Dimension inches	Dimension mm	Product Code
1-1/2	40	526221
2	50	526071
3	75	526223
4	100	526072
6	150	526073
8	200	526226
10	250	526270
12	300	526271

45º Elbow Short Turn Sp x Sp

FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8	200	526971
10	250	526770
12	300	526771

45º Elbow Long Turn H x H

Dimension inches	Dimension mm	Product Code
6	150	426038

45º Elbow Long Turn Sp x H

Dimension inches	Dimension mm	Product Code
6	150	426225

22-1/2º Elbow H x H

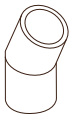
Dimension inches	Dimension mm	Product Code
1-1/2	40	526251
2	50	526252
3	75	526253
4	100	526254
6	150	526255
8	200	526256
10	250	526257
12	300	526258

22-1/2º Elbow Sp x H

Dimension inches	Dimension mm	Product Code
6	150	526651
8	200	526652
10	250	526653
12	300	526654

22-1/2º Elbow Sp x Sp

FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8	200	526972
10	250	526973
12	300	526908

11-1/4º Elbow H x H

Dimension inches	Dimension mm	Product Code
6	150	526671
8	200	526672
10	250	526673
12	300	526674

11-1/4º Elbow Sp x H

Dimension inches	Dimension mm	Product Code
6	150	526681
8	200	526682
10	250	526683
12	300	526684

PRODUCT SELECTION CHART - SYSTEM XFR

45° Wye H x H x H

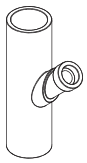
Dimension inches	Dimension mm	Product Code
1-1/2	40	526171
2	50	526172
2 x 1-1/2 x 1-1/2	50 x 40 x 40	526194
2 x 1-1/2	50 x 40	526195
3	75	526173
3 x 1-1/2	75 x 40	526201
3 x 2	75 x 50	526196
4	100	526174
4 x 2	100 x 50	526198
4 x 3	100 x 75	526197
6	150	526175
6 x 4	150 x 100	526199
8	200	526560
8 x 4	200 x 100	526606
8 x 6	200 x 150	526607
10	250	526706
10 x 4	250 x 100	526703
10 x 6	250 x 150	526704
10 x 8	250 x 200	526705
12	300	526711
12 x 4	300 x 100	526707
12 x 6	300 x 150	526708
12 x 8	300 x 200	526709
12 x 10	300 x 250	526710

45° Wye Sp x H x H

Dimension inches	Dimension mm	Product Code
3	75	426635
3 x 1-1/2	75 x 40	426638

45° Wye Sp x Sp x H

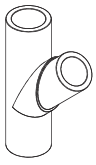
FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8 x 4	200 x 100	526985
8 x 6	200 x 150	526986
10 x 4	250 x 100	526988
10 x 6	250 x 150	526989
12 x 4	300 x 100	526992
12 x 6	300 x 150	526993

45° Wye Sp x Sp x Sp

FOR USE WITH MJ GREY™

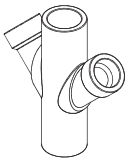


Dimension inches	Dimension mm	Product Code
8	200	526987
10 x 8	250 x 200	526990
10	250	526991
12 x 8	300 x 200	526994
12 x 10	300 x 250	526995
12	300	526996

Double 45° Wye H x H x H x H

Dimension inches	Dimension mm	Product Code
1-1/2	40	526637
2	50	526456
2 x 1-1/2	50 x 40	526642
3	75	526639
3 x 1-1/2	75 x 40	526643
3 x 2	75 x 50	526644
4 x 3	100 x 75	526457
6	150	426752
8	200	426755
8 x 4	200 x 100	426753
8 x 6	200 x 150	526754
10	250	426759
10 x 4	250 x 100	426756
10 x 6	250 x 150	426757
10 x 8	250 x 200	426758
12	300	426764
12 x 4	300 x 100	426760
12 x 6	300 x 150	426761
12 x 8	300 x 200	426762
12 x 10	300 x 250	426763

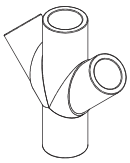
45° Double Wye Sp x Sp x H x H



Dimension inches	Dimension mm	Product Code
8 x 4	200 x 100	526769
8 x 6	200 x 150	526974
10 x 4	250 x 100	526976
10 x 6	250 x 150	526977
12 x 4	300 x 100	526980
12 x 6	300 x 150	526982

45° Double Wye Sp x Sp x Sp x Sp

FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
8	200	526975
10	250	526979
10 x 8	250 x 200	526978
12 x 8	300 x 200	526983
12 x 10	300 x 250	526984

PRODUCT SELECTION CHART - SYSTEM XFR

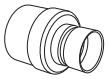
Increaser Coupling H x H

Dimension inches	Dimension mm	Product Code
2 x 1-1/2	50 x 40	526362
3 x 1-1/2	75 x 40	526363
3 x 2	75 x 50	526364
4 x 1-1/2	100 x 40	526369
4 x 2	100 x 50	526365
4 x 3	100 x 75	526366
5 x 3	125 x 75	526944
6 x 4	150 x 100	526860
8 x 4	200 x 100	526861
8 x 6	200 x 150	526867
10 x 4	250 x 100	526862
10 x 6	250 x 150	526868
10 x 8	250 x 200	526900
12 x 6	300 x 150	526869
12 x 8	300 x 200	526901
12 x 10	300 x 250	526907

Reducer Bushing Sp x H

Dimension inches	Dimension mm	Product Code
2 x 1-1/2	50 x 40	526282
3 x 1-1/2	75 x 40	526292
3 x 2	75 x 50	526284
4 x 2	100 x 50	526288
4 x 3	100 x 75	526286
6 x 4	150 x 100	526054
8 x 4	200 x 100	526446
8 x 6	200 x 150	526447

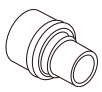
Reducer Bushing (Extended) Sp x H



Dimension inches	Dimension mm	Product Code
10 x 4	250 x 100	526296
10 x 6	250 x 150	526297
10 x 8	250 x 200	526962
12 x 4	300 x 100	526963
12 x 6	300 x 150	526964
12 x 8	300 x 200	526965
12 x 10	300 x 250	526966

Reducer Bushing (Extended) Sp x Sp

FOR USE WITH MJ GREY™



Dimension inches	Dimension mm	Product Code
10 x 8	250 x 200	526981
12 x 8	300 x 200	526767
12 x 10	300 x 250	526768

Male Adapter H x MPT

Dimension inches	Dimension mm	Product Code
1-1/2	40	526331
2	50	526332
3	75	526333
4	100	526334

Female Adapter H x FPT

Dimension inches	Dimension mm	Product Code
1-1/2	40	526341
2	50	526342
3	75	526343
4	100	526344

Coupling H x H

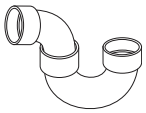
Dimension inches	Dimension mm	Product Code
1-1/2	40	526351
2	50	526352
3	75	526353
4	100	526354
6	150	526356
8	200	526358
10	250	526359
12	300	526360

Plastic MJ Spigot MJ Sp x H

Dimension inches	Dimension mm	Product Code
2	50	526522
3	75	526523
4	100	526524

Adapts M-J Cast Iron Pipe to Plastic DWV Pipe

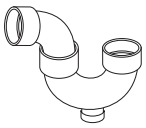
P Trap Solvent Weld H x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	526431
2	50	526432
3	75	526433
4	100	526434

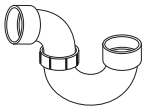
PRODUCT SELECTION CHART - SYSTEM XFR

P Trap Solvent Weld with Cleanout H x H



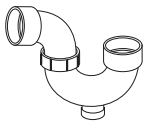
Dimension inches	Dimension mm	Product Code
1-1/2	40	526441
2	50	526442

P Trap Union Connection H x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	526443
2	50	526444

P Trap Union Connection with Cleanout H x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	526505

U Bend H x H

Dimension inches	Dimension mm	Product Code
4	100	526499
6	150	426503

Fitting Trap Adapter Sp x Slip Joint

Dimension inches	Dimension mm	Product Code
1-1/2	40	426304
2	50	426305

Plastic Nut & Washer

Pipe Trap Adapter H x Slip Joint

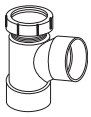
Dimension inches	Dimension mm	Product Code
1-1/2	40	526321
1-1/2 x 1-1/4	40 x 32	526329

Plastic Nut & Washer

90º Pipe Trap Adapter H x Slip Joint

Dimension inches	Dimension mm	Product Code
1-1/2 x 1-1/2	40 x 40	526330

Sanitary Tee Trap Adapter H x Slip Joint x H



Dimension inches	Dimension mm	Product Code
1-1/2	40	426179

Copper to DWV Pipe Adapter H x Slip Joint

Dimension inches	Dimension mm	Product Code
1-1/2	40	426320
1-1/2 x 1-1/4	40 x 32	426430
2	50	426510

Tail Piece Adapter Sp x Slip Joint

Dimension inches	Dimension mm	Product Code
1-1/2	40	526555
1-1/2 x 1-1/4	40 x 32	526556

Plastic Nut & Washer

Swivel Strainer Adapter H x Swivel Nut

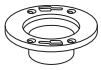
Dimension inches	Dimension mm	Product Code
1-1/2	40	426894

PRODUCT SELECTION CHART - SYSTEM XFR

Closet Flange One Piece Plastic Slip

Dimension inches	Dimension mm	Product Code
4	100	526573
4 x 3	100 x 75	526584

Closet Flange One Piece Plastic Slip w Spigot End

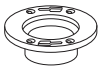


Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526592

Closet Flange One Piece Plastic Slip w Molded Test Plate

Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526591

Closet Flange One Piece Plastic Slip Flush Kit



Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	426594

Closet Flange One Piece Plastic Slip Flush Kit w Molded Test Plate

Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526595

Adjustable Closet Flange with Plastic Ring Slip

Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526586

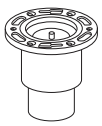
Adjustable Closet Flange w Plastic Ring Slip w Molded Test Plate

Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	526588

45º Discharge Closet Flange Adjustable w Plastic Ring

Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	426589

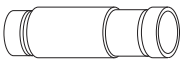
Closet Flange Kit for Concrete



Dimension inches	Dimension mm	Product Code
4 x 3	100 x 75	426593

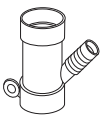
for use in Slab on Grade W.C. installations

Expansion Joint - Type 1 (Vertical & Horizontal Use) H x H



1-1/2	40	526485
2	50	526486
3	75	526487
4	100	526489
6	150	426209
8	200	426210
10	250	426211
12	300	426212

Dishwasher Wye H x H x Hose Barb



1-1/2 x 1-1/2 x 1/2	40 x 40 x 12	526495

Slip Cap H

1-1/2	40	526411
2	50	526412
3	75	526413
4	100	526414
6	150	526415
8	200	526416
10	250	526417
12	300	526418

The **Modern Age** of **DWV** is here

Mechanical engineers and contractors are converting from metal piping to System XFR® and System 15®

SYSTEM XFR® DWV
SYSTEM 15® DWV

PROVEN BENEFITS

IMPROVED FLOW – Larger inside diameter and smoother interior walls for more efficient waste removal

THERMAL PROPERTIES – Storm drains can often be used without insulation

LONGEVITY – Extremely durable, will not rust or corrode

JOINING METHODS – Solvent welding or MJ Grey™ mechanical joint coupling options

PLENUM/HIGH-RISE – System XFR® carries 25/50 Flame/Smoke requirements

LABOUR SAVINGS – Easy to handle, cut and assemble

ENVIRONMENTAL EFFECTS – Local manufacturing minimizes transport and reduces carbon footprint

Proven in noncombustible environments, the advanced material meets all Flame and Smoke code requirements.

A cost-effective “workhorse” designed for low-rise, light commercial and underground applications.

Chapter 14 WATER PIPING

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax: (514) 344-9341

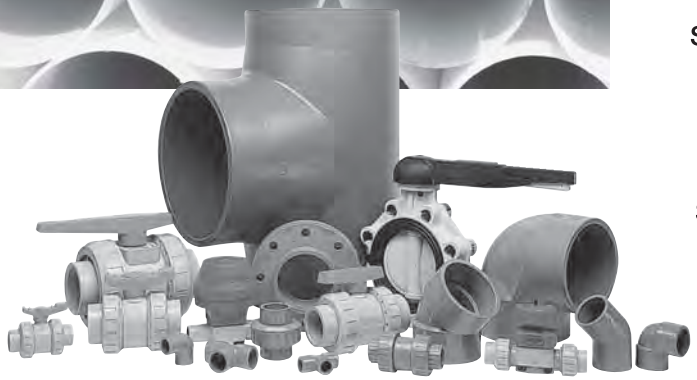
14.1 **DRINKABLE WATER PIPING PVC SCH80**

14.2 **PROCESSING PIPINC CPVC SCH80**

NOTE: ALL PIPE & FITTINGS SCH. 80 SOCKET WELD

CORZAN®

Submittal Data Sheet



Job or Customer: .....

Engineer: .....

Contractor: .....

Submitted by: ..... Date

Approved by: ..... Date

Order No: ..... Date

Specification: .....

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 27 june 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for Approval

SIFEC NORTH INC.

introduction

< STANDARDS >

ASTM D1784
ASTM F441
ASTM F439
ASTM F437
ASTM F1970

CAN/ULC S102.2

CPVC has physical properties similar to those of PVC and chemical resistance similar to or generally better than that of PVC. The design stress of CPVC is also 2,000psi at 73°F (23°C). The maximum service temperature is 200°F (93°C) under pressure with occasional exposure to boiling water (212°F, 100°C). CPVC has proved to be an excellent piping material for hot corrosive liquids, hot and cold water distribution and similar applications above the temperature range of PVC.

NSF 14
NSF 61

CSA 137.6

Please see our listing on agency websites for NSF and CSA compliant fittings.

www.nsf.org
www.CSAgroup.org

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 29 June 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

CHIARELLI ENGINEERING LTD.

IPEX

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CORZAN®

Submittal Data Sheet

material properties

Properties	CPVC	CPVC (High Impact)	Standards
Cell classification	23447	24448	ASTM D1784
Specific gravity	1.5	1.51	ASTM D792
Tensile strength, psi at 73°F	7,500	7,320	ASTM D638
Modulus of elasticity tensile, psi at 73°F	380,000	423,000	ASTM D638
Flexural strength, psi	11,400	13,200	ASTM D790
Izod impact, ft.lbs./in. at 73°F, notched	2.0	10.0	ASTM D256
Compressive strength, psi	10,100	10,100	ASTM D695
Poisson's ratio	0.33	0.33	
Working stress, psi at 73°F	2,000	2,000	
Coefficient of thermal expansion in./in./°F (x 10^{-5})	3.8	3.4	ASTM D696
Linear expansion, in./10°F per 100' of pipe	0.44 - 0.46	0.41	
Maximum operating temperature under pressure	200°F (93°C)	200°F (93°C)	
Deflection temperature under load, °F at 66 psi	n/a	n/a	ASTM D648
Deflection temperature under load, °F at 264 psi	212	239	ASTM D648
Thermal conductivity, BTU.in./hr.ft^2.°F	0.95	0.95	ASTM C177
Burning rate	Self extinguish	Self extinguish	ASTM D635
Burning class	V-0	V-0	UL-94
Flash ignition, °F	900	900	
Limited oxygen index (%)	60	60	ASTM D2863-70
Water absorption, %, (24 hrs. at 73°F)	0.03	0.03	ASTM D570

pipe availability

Pipe Size

Schedule 40 Grey	Schedule 80 Grey
1/2" - 16"	1/2" - 16"

CORZAN®

Submittal Data Sheet

molded fittings availability

Fittings	Size (inches) Schedule 80
Tee (Soc)	1/4" - 12"
Reducing Tee (Soc)	3/4" - 10" x 3/4" - 10" x 1/2" - 6"
Tee (Soc x Soc x Fpt)	1/2" - 2"
Tee (Fpt)	1/4" - 4"
90° Elbow (Soc)	1/4" - 12"
90° Elbow (Soc x Fpt)	1/4" - 2"
90° Elbow (Fpt)	1/4" - 4"
45° Elbow (Soc)	1/4" - 12"
45° Elbow (Fpt)	1/4" - 4"
22-1/2° Elbow (Soc)	2" - 4"
11-1/4° Elbow (Soc)	2" - 4"
30° Elbow (Soc)	6"
Cross (Soc)	1/4" - 4"
Coupling (Fpt)	1/4" - 4"
Coupling (Soc)	1/4" - 8"
Reducer Coupling (Soc)	3/4" - 8' x 1/2" - 6"
Female Adapter (Soc x Fpt)	1/4" - 4"
Female Adapter (Soc x Fpt SS Reinforced)	1/2" - 4"
Female Adapter (Spig x Fpt SS Reinforced)	1/2" - 4"
Male Adapter (Soc x Mpt)	1/2" - 4"
Reducer Bushing (Spig x Soc)	3/8" - 8" x 1/4" - 6"
Reducer Bushing (Spig x Fpt)	3/8" - 6" x 1/4" - 4"
Reducer Bushing (Mpt x Fpt)	3/8" - 4" x 1/4" 3"
Cap (Soc)	1/4" - 8"
Cap (Fpt)	1/4" - 4"
Plug (Mpt)	1/4" - 4"
Wye (Soc)	1/2" - 2"

CORZAN®

Submittal Data Sheet

fabricated fittings availability

Fittings	Size (inches) Schedule 80
Fabricated Tee (Soc)	14" - 16"
Fabricated Reducing Tee (Soc)	12" x 12" x 8"
Fabricated 90° Elbow (Soc)	14" - 16"
Fabricated 45° Elbow (Soc)	14" - 16"
Fabricated Coupling (Soc)	10" - 16"
Fabricated Reducer Bushing (Spig x Soc)	10" - 12" x 6" - 10"
Fabricated Cap (Soc)	10" - 16"
Fabricated Vanstone Flange (Soc)	14" - 16"
Blind Flange	10" - 12"
Heavy Duty Vanstone Flange (Soc)	16"
Vanstone Flange (Spig)	10" - 12"
Nipples	1/4" - 4"
Expansion Joints	1/2" - 4"

ASTM F1970 fittings availability

Fittings	Size (inches) Schedule 80
One Piece Flange (Soc)	1/2" - 8"
One Piece Flange (Fpt)	1/2" - 4"
Blind Flange	1/2" - 8"
Heavy Duty Vanstone Flange (Soc)	1/2" - 12"
Vanstone Flange (Fpt)	1/2" - 4"
Vanstone Flange (Spig)	1/2" - 8"
Union (Soc)	1/4" - 4"
Union (Fpt)	1/4" - 4"

PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

Tee Soc x Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code	
1/4	6	036768		059479	
3/8	9	036769		059480	
1/2	12	036770		059481	
3/4	20	036771		059482	
1	25	036772		059483	
1-1/4	32	036773		059484	
1-1/2	40	036774		059485	
2	50	036775		059486	
2-1/2	65	036776		059487	
3	75	036777		059488	
4	100	036778		059489	
6	150	036780		059490	
8	200	036781		059491	
10	250	036866	▮	059062	▮
12	300	036876	▮	059084	▮
10	250	036782	†	-	
12	300	036783	†	-	
14	350	036784	†	-	
16	400	036785	†	-	
18	450	036126	†	-	

Tee Soc x Soc x Fpt

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	036828	059942
3/4	20	036829	059943
1	25	036830	059518
2	50	036832	-

Tee Fpt x Fpt x Fpt

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036817	059507
3/8	9	036818	059508
1/2	12	036819	059509
3/4	20	036820	059510
1	25	036821	059511
1-1/4	32	036822	059512
1-1/2	40	036823	059513
2	50	036824	059514
2-1/2	65	036825	059515
3	75	036826	059516
4	100	036827	059517

90° Elbow Fpt x Fpt

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036197	059206
3/8	9	036198	059207
1/2	12	036199	059208
3/4	20	036200	059209
1	25	036201	059210
1-1/4	32	036202	059211
1-1/2	40	036203	059212
2	50	036204	059213
2-1/2	65	036205	059214
3	75	036206	059215
4	100	036207	059216

▮,†,◗ See page 5 for descriptions

Reducing Tee Soc x Soc x Soc

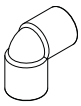
Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code	
3/4 x 3/4 x 1/2	20 x 20 x 12	036786		059492	
1 x 3/4 x 3/4	25 x 20 x 20	036790		-	
1 x 3/4 x 1	25 x 20 x 25	036791		059493	
1 x 1 x 1/2	25 x 25 x 12	036788		059494	
1 x 1 x 3/4	25 x 25 x 20	036789		-	
1-1/4 x 1 x 3/4	32 x 25 x 20	036792		-	
1-1/4 x 1 x 1-1/4	32 x 32 x 25	-		059495	
1-1/4 x 1-1/4 x 3/4	32 x 32 x 20	036793		-	
1-1/4 x 1-1/4 x 1	32 x 32 x 25	036794		-	
1-1/2 x 1-1/2 x 3/4	40 x 40 x 20	036795		059496	
1-1/2 x 1-1/2 x 1	40 x 40 x 25	036796		059497	
2 x 2 x 1/2	50 x 50 x 12	036797		059498	
2 x 2 x 3/4	50 x 50 x 20	036798		059499	
2 x 2 x 1	50 x 50 x 25	036799		059500	
2 x 2 x 1-1/2	50 x 50 x 40	036800		059501	
3 x 3 x 2	75 x 75 x 50	036802		059502	
3 x 3 x 2-1/2	75 x 75 x 65	036803		059504	
4 x 4 x 2	100 x 100 x 50	036804		059505	
4 x 4 x 3	150 x 100 x 75	036805		-	
6 x 6 x 3	150 x 150 x 75	036807		-	
6 x 6 x 4	150x150x100	036808	†	059506	
8 x 8 x 4	200x200x100	036809		-	
8 x 8 x 6	200x200x150	036810	†	059567	
10 x 10 x 4	250x250x100	036919	†	-	
10 x 10 x 6	250x250x150	036812	†	-	
10 x 10 x 8	250x250x200	036813	†	-	
12 x 12 x 8	300x300x200	036814	†	-	
12 x 12 x 10	300x300x250	036815	†	-	
14 x 14 x 10	350x350x250	036816	†	-	
14 x 14 x 12	350x350x300	-	†	-	
16 x 16 x 12	400x400x300	-	†	-	
16 x 16 x 14	400x400x350	-		-	

90° Elbow Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code	
1/4	6	036179		059192	
3/8	9	036180		059193	
1/2	12	036181		059194	
3/4	20	036182		059195	
1	25	036183		059196	
1-1/4	32	036184		059197	
1-1/2	40	036185		059198	
2	50	036186		059199	
2-1/2	65	036187		059200	
3	75	036188		059201	
4	100	036189		059202	
6	150	036191		059203	
8	200	036192		059204	
10	250	036864	▮	059085	▮
12	300	036865	▮	059086	▮
10	250	036193	†	-	
12	300	036194	†	-	
14	350	036195	†	-	
16	400	036196	†	-	
18	450	036132	†	-	

PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

90° Elbow Soc x Fpt



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	036172	059187
3/4	20	036173	059941
1	25	036174	059188
1-1/4	32	036175	059189
1-1/2	40	036176	059190
2	50	036177	059191

45° Elbow Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036142	059162
3/8	9	036143	059163
1/2	12	036144	059164
3/4	20	036145	059165
1	25	036146	059166
1-1/4	32	036147	059167
1-1/2	40	036148	059168
2	50	036149	059169
2-1/2	65	036150	059170
3	75	036151	059171
4	100	036152	059172
6	150	036154	059173
8	200	036155	059174
10	250	036862 ▮	059087 ▮
12	300	036863 ▮	059088 ▮
10	250	036156 †	-
12	300	036157 †	-
14	350	036158 †	-
16	400	036159 †	-

45° Elbow Fpt x Fpt

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036160	059176
3/8	9	036161	059177
1/2	12	036162	059178
3/4	20	036163	059179
1	25	036164	059180
1-1/4	32	036165	059181
1-1/2	40	036166	059182
2	50	036167	059183
2-1/2	65	036168	059184
3	75	036169	059185
4	100	036170	059186

30° Elbow Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
6	150	236003	059022

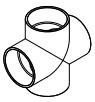
22-1/2° Elbow Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
2	50	036134	059614
3	75	036135	059615
4	100	036136	059616
6	150	036137 †	-
8	200	036138 †	-
10	250	036139 †	-
12	300	036140 †	-

11-1/4° Elbow Soc x Soc

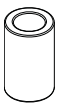
Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
2	50	-	059617
3	75	-	059618
4	100	-	059619

Cross Soc x Soc x Soc x Soc



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	-	059620
1/2	12	036116	059154
3/4	20	036117	059155
1	25	036118	059156
1-1/4	32	036119	059157
1-1/2	40	036120	059158
2	50	036121	059159
2-1/2	65	036122	059018
3	75	036123	059160
4	100	036124	059161
6	150	036125 †	-

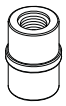
Coupling Soc x Soc



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036088	059130
3/8	9	036089	059131
1/2	12	036090	059132
3/4	20	036091	059133
1	25	036092	059134
1-1/4	32	036093	059135
1-1/2	40	036094	059136
2	50	036095	059137
2-1/2	65	036096	059138
3	75	036097	059139
4	100	036098	059140
6	150	036099	059141
8	200	036100	059142
10	250	036101 †	059033 †
12	300	036102 †	059043 †
14	350	036103 †	-
16	400	036889 †	-

▮,†,◗ See page 5 for descriptions

Coupling Fpt x Fpt



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/4	6	036104	059143
3/8	9	036105	059144
1/2	12	036106	059145
3/4	20	036107	059146
1	25	036108	059147
1-1/4	32	036109	059148
1-1/2	40	036110	059149
2	50	036111	059150
2-1/2	65	036112	059151
3	75	036113	059152
4	100	036114	059153

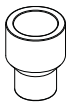
45º Wye Soc x Soc x Soc

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code	
1-1/2	40	036854	∎	059553.	∎
2	50	036855	∎	059536	∎
3	75	036856	∎	059537	∎
4	100	036857	∎	059538	∎
6	150	036858	∎	059539	∎
6 x 4	150 x 100	036861	∎	059541	∎
8	200	036859	†	-	
8 x 6	200 x 150	036884	†	-	

1/2" - 2" - 235 psi maximum internal pressure rating @ 73ºF
(12 - 50mm - 1 620 kPa maximum internal pressure rating @ 23°C)

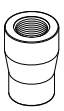
3" - 6" - 150 psi maximum internal pressure rating @ 73ºF
(75 - 150mm - 1 034 kPa maximum internal pressure rating @ 23°C)

Reducer Coupling Soc x Soc



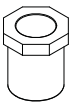
Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
3/4 x 1/2	20 x 12	036719	059460
1 x 1/2	25 x 12	036720	059461
1 x 3/4	25 x 20	036721	059462
1-1/4 x 3/4	32 x 20	036723	-
1-1/4 x 1	32 x 25	036724	059463
1-1/2 x 1/2	40 x 12	036725	-
1-1/2 x 3/4	40 x 20	036726	059464
1-1/2 x 1	40 x 25	036727	059465
1-1/2 x 1-1/4	40 x 32	036728	059466
2 x 1/2	50 x 12	036897	-
2 x 1	50 x 25	036729	059467
2 x 1-1/2	50 x 40	036731	059458
3 x 2	75 x 50	036735	059470
4 x 2	100 x 50	036736	059459
4 x 3	100 x 75	036738	059472
6 x 4	150 x 100	036740	059471
8 x 6	200 x 150	036743	059473

Reducer Coupling Fpt x Fpt



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2 x 1/4	12 x 6	036746	-
3/4 x 1/2	20 x 12	036748	-
1 x 1/2	25 x 12	036749	-
1 x 3/4	25 x 20	036750	-
1-1/4 x 3/4	32 x 20	036751	-
1-1/2 x 1	40 x 25	036754	-
2 x 1-1/2	50 x 40	036758	-

Reducer Bushing Spig x Soc (flushstyle)

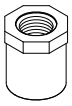


Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
3/8 x 1/4	9 x 6	036599	-
1/2 x 1/4	12 x 6	036600	059373
1/2 x 3/8	12 x 9	036601	059374
3/4 x 1/2	20 x 12	036604	059375
1 x 1/2	25 x 12	036605	059376
1 x 3/4	25 x 20	036606	059377
1-1/4 x 1/2	32 x 12	036607	059378
1-1/4 x 3/4	32 x 20	036608	059379
1-1/4 x 1	32 x 25	036609	059380
1- 1/2 x 1/2	40 x 12	036610	059381
1- 1/2 x 3/4	40 x 20	036611	059382
1-1/2 x 1	40 x 25	036612	059383
1-1/2 x 1-1/4	40 x 32	036613	059384
2 x 1/2	50 x 12	036614	059385
2 x 3/4	50 x 20	036615	059386
2 x 1	50 x 25	036616	059387
2 x 1-1/4	50 x 32	036617	059388
2 x 1-1/2	50 x 40	036618	059389
2 -1/2 x 1-1/4	65 x 32	036620	-
2-1/2 x 1-1/2	65 x 40	036621	-
2-1/2 x 2	65 x 50	036622	059392
3 x 1	75 x 25	036623	-
3 x 1-1/2	75 x 40	036624	059393
3 x 2	75 x 50	036625	059394
3 x 2-1/2	75 x 65	036626	059395
4 x 2	100 x 50	036628	059396
4 x 3	100 x 75	036630	059397
6 x 2	150 x 50	036632	059398
6 x 3	150 x 75	036633	059399
6 x 4	150 x 100	036634	059400
8 x 6	200 x 150	036638	059401
10 x 6	250 x 150	036922 †	-
10 x 8	250 x 200	036270 †	-
12 x 10	300 x 250	036208 †	-
12 x 6	300 x 150	036908	-
12 x 8	300 x 200	036645	-

∎,†,◗ See page 5 for descriptions

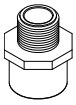
PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

Reducer Bushing Spig x Fpt (flushstyle)



Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
3/8 x 1/4	9 x 6	036679	-
1/2 x 1/4	12 x 6	036681	059428
1/2 x 3/8	12 x 9	036682	059429
3/4 x 1/4	20 x 6	036683	059430
3/4 x 1/2	20 x 12	036684	059431
1 x 3/8	25 x 9	036685	-
1 x 1/2	25 x 12	036686	059432
1 x 3/4	25 x 20	036687	059433
1-1/4 x 1/2	32 x 12	036688	059434
1-1/4 x 3/4	32 x 20	036689	059435
1-1/4 x 1	32 x 25	036690	059436
1-1/2 x 1/2	40 x 12	036691	059437
1-1/2 x 3/4	40 x 20	036692	059438
1-1/2 x 1	40 x 25	036693	059439
1-1/2 x 1-1/4	40 x 32	036694	059440
2 x 1/2	50 x 12	036695	059441
2 x 3/4	50 x 20	036696	059442
2 x 1	50 x 25	036697	059443
2 x 1-1/4	50 x 32	036698	059444
2 x 1-1/2	50 x 40	036699	059445
2-1/2 x 3/4	65 x 20	036700	059446
2-1/2 x 1	65 x 25	036701	059447
2-1/2 x 1-1/4	65 x 32	036702	059448
2-1/2 x 1-1/2	65 x 40	036703	059449
2-1/2 x 2	65 x 50	036704	059450
3 x 3/4	75 x 20	036705	-
3 x 1	75 x 25	036706	059547
3 x 1-1/4	75 x 32	036707	-
3 x 1-1/2	75 x 40	036708	059451
3 x 2	75 x 50	036709	059452
3 x 2-1/2	75 x 65	036710	059453
4 x 2	100 x 50	036711	059454
4 x 2-1/2	100 x 65	036712	059640
4 x 3	100 x 75	036713	059455
6 x 2	150 x 50	036714	-
6 x 3	150 x 75	036715	059641
6 x 4	150 x 100	036716	059456

Male Adapter Soc x Mpt

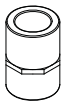


1/2	12	036420	059286
3/4	20	036421	059287
1	25	036422	059288
1-1/4	32	036423	059289
1-1/2	40	036424	059290
2	50	036425	059291
2-1/2	65	036426	059292
3	75	036427	059293
4	100	036428	059294
6	150	036887 †	-

T T Bushing Mpt x Fpt (flushstyle)

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
3/8 x 1/4	9 x 6	036647	059402
1/2 x 1/4	12 x 6	036648	059403
1/2 x 3/8	12 x 9	036649	059404
3/4 x 1/4	20 x 6	036651	059405
3/4 x 3/8	20 x 9	036652	059406
3/4 x 1/2	20 x 12	036653	059407
1 x 1/4	25 x 6	036654	059643
1 x 3/8	25 x 9	036655	-
1 x 1/2	25 x 12	036656	059408
1 x 3/4	25 x 20	036657	059409
1-1/4 x 1/2	32 x 12	036658	059410
1-1/4 x 3/4	32 x 20	036659	059411
1-1/4 x 1	32 x 25	036660	059412
1-1/2 x 1/2	40 x 12	036661	059413
1-1/2 x 3/4	40 x 20	036662	059414
1-1/2 x 1	40 x 25	036663	059415
1-1/2 x 1-1/4	40 x 32	036664	059416
2 x 1/2	50 x 12	036665	059417
2 x 3/4	50 x 20	036666	059418
2 x 1	50 x 25	036667	059419
2 x 1-1/4	50 x 32	036668	059420
2 x 1-1/2	50 x 40	036669	059421
2-1/2 x 2	65 x 50	036672	059422
3 x 1-1/2	75 x 40	036673	059423
3 x 2	75 x 50	036674	059424
3 x 2-1/2	75 x 65	036675	059425
4 x 2	100 x 50	036676	059426
4 x 3	100 x 75	036677	059427

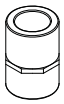
Female Adapter Soc x Fpt



1/4	6	036209	059217
3/8	9	036210	059218
1/2	12	036211	059219
3/4	20	036212	059220
1	25	036213	059221
1-1/4	32	036214	059222
1-1/2	40	036215	059223
2	50	036216	059224
2-1/2	65	036217	059225
3	75	036218	059226
4	100	036219	059227
6	150	036221 †	-

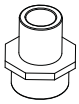
▮,†,◗ See page 5 for descriptions

Female Adapter Soc x Fpt (SS reinforced)



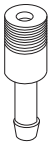
Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	036971	059951
3/4	20	036972	059952
1	25	036973	059953
1-1/4	32	036974	059954
1-1/2	40	036975	059955
2	50	036976	059956
2-1/2	65	036977	059646
3	75	036978	059957
4	100	036979	059958

Female Adapter Spig x Fpt (SS reinforced)



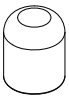
1/2	12	036965	059945
3/4	20	036966	059946
1	25	036967	059947
1-1/4	32	036968	059948
1-1/2	40	036969	059949
2	50	036970	059950
3	75	236000	059647
4	100	236001	059648

Hose Adapter Hose x Mpt



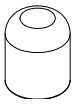
1/4	6	036394	†	-
3/8	9	036395	†	-
1/2	12	036396	†	-
3/4	20	036397	†	-
1	25	036398	†	-
1 1/4	32	036399	†	-
1 1/2	40	036400	†	-
2	50	036401	†	-
2 1/2	65	036402	†	-
3	75	036403	†	-
4	100	036404	†	-

Cap Soc



1/4	6	036056	059107
3/8	9	.036057	059108
1/2	12	036058	059109
3/4	20	036059	059110
1	25	036060	059111
1-1/4	32	036061	059112
1-1/2	40	036062	059113
2	50	036063	059114
2-1/2	65	036064	059115
3	75	036065	059116
4	100	036066	059117
6	150	036067	059118
8	200	036068	059029
10	250	036069 †	-
12	300	036070 †	-
14	350	- †	-
16	400	036071 †	-

Cap Fpt



1/4	6	036072	059119
3/8	9	036073	059120
1/2	12	036074	059121
3/4	20	036075	059122
1	25	036076	059123
1-1/4	32	036077	059124
1-1/2	40	036078	059125
2	50	036079	059126
2-1/2	65	036080	059127
3	75	036081	059128
4	100	036082	059129

Plug Mpt

1/4	6	036568	059361
3/8	9	036569	059362
1/2	12	036570	059363
3/4	20	036571	059364
1	25	036572	059365
1-1/4	32	036573	059366
1-1/2	40	036574	059367
2	50	036575	059368
2-1/2	65	036576	059369
3	75	036577	059370
4	100	036578	059371
6	150	036579	-

Plug Spig

2	50	036585	-

90º Radius Bends - 6D Spig x Spig

1/2	12	-	†	-
3/4	20	036027	†	-
1	25	036028	†	-
1-1/4	32	036029	†	-
1-1/2	40	036030	†	-
2	50	036031	†	-
2-1/2	65	036032	†	-
3	75	036033	†	-
4	100	036034	†	-
6	150	036035	†	-
8	200	036036	†	-
10	250	036868	†	-
12	300	-	†	-

▮,†,◗ See page 5 for descriptions

PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

45° Radius Bends - 6D Spig x Spig

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code
1/2	12	-	†	
3/4	20	036020	†	
1	25	036021	†	
1-1/4	32	-	†	
1-1/2	40	036022	†	
2	50	036023	†	
2-1/2	65	036867	†	
3	75	036024	†	
4	100	036025	†	
6	150	036026	†	
8	200	-	†	
10	250	-	†	
12	300	-	†	

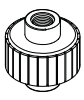
22-1/2° Radius Bends - 6D Spig x Spig

1/2	12	036012	†	-
3/4	20	-	†	-
1	25	036013	†	-
1-1/4	32	-	†	-
1-1/2	40	-	†	-
2	50	036014	†	-
2-1/2	65	036015	†	-
3	75	036016	†	-
4	100	036017	†	-
6	150	036018	†	-
8	200	036019	†	-
10	250	-	†	-
12	300	-	†	-

Union Soc x Soc (Viton® O-ring Seal)

1/4	6	036833	059519
3/8	9	036834	-
1/2	12	036835	059520
3/4	20	036836	059521
1	25	036837	059522
1-1/4	32	036838	059523
1-1/2	40	036839	059524
2	50	036840	059525
3	75	036842	059526
4	100	036843	059550

Union Fpt x Fpt (Viton® O-ring Seal)



1/4	6	036844	059527
3/8	9	036845	-
1/2	12	036846	059529
3/4	20	036847	059530
1	25	036848	059531
1-1/4	32	036849	059532
1-1/2	40	036850	059533
2	50	036851	059534
3	75	036852	059535
4	100	036853	059651

Union Soc x Fpt (Viton® O-ring Seal)

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code
1/2	12	036410		-
3/4	20	036411		-
1	25	036412		-
1-1/4	32	036413		-
1-1/2	40	036414		-
2	50	036415		-
3	75	236010		-
4	100	236011		-

Tank Adapter Soc x Fpt

1/2	12	036038		059100
3/4	20	036039		059101
1	25	036040		059102
1-1/4	32	036041		-
1-1/2	40	036042		059103
2	50	036043		059104
3	75	036045		059105
4	100	036046		059106
6	150	-	†	-

Tank Adapter Fpt x Fpt

1/2	12	036047		-
3/4	20	036048		-
1	25	036049		-
1-1/4	32	036050		-
1-1/2	40	036051		-
2	50	036052		-
3	75	036054		-
4	100	036055		-
6	150	-	†	-

Flange Soc (solid style)

1/2	12	036223		059228
3/4	20	036224		059229
1	25	036225		059230
1-1/4	32	036226		059231
1-1/2	40	036227		059232
2	50	036228		059233
2-1/2	65	036229		059234
3	75	036230		059235
4	100	036231		059236
5	125	036232		-
6	150	036233		059238
8	200	036234		059239
10	250	036235	†	-
12	300	036236	†	-
14	350	036237	†	-
16	400	036238	†	-
18	450	036870	†	-
20	500	-	†	-
24	600	036239	†	-

▮,†,◗ See page 5 for descriptions

Flange Fpt (solid style)

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code
1/2	12	036240		059240
3/4	20	036241		059241
1	25	036242		059242
1-1/4	32	036243		059243
1-1/2	40	036244		059244
2	50	036245		059245
2-1/2	65	036246		059246
3	75	036247		059247
4	100	036248		059248
6	150	036249		059249

Flange Blind

1/2	12	036250		059250
3/4	20	036251		059251
1	25	036252		059252
1-1/4	32	036253		059253
1-1/2	40	036254		059254
2	50	036255		059255
2-1/2	65	036256		059256
3	75	036257		059257
4	100	036258		059258
6	150	036259		059259
8	200	036260		059260
10	250	036261	†	-
12	300	036262	†	-
14	350	036263	†◆	-
16	400	036264	†◆	-
18	450	036265	†◆	-
20	500	-	†◆	-
24	600	036266	†◆	-

◆ Domed flange

No-Leak Flange Spig x Spig

1/2	12	036331	†	-
3/4	20	036332	†	-
1	25	036923	†	-
1-1/4	32	036333	†	-
1-1/2	40	036334	†	-
2	50	036335	†	-
2-1/2	65	036336	†	-
3	75	036337	†	-
4	100	036338	†	-
6	150	036339	†	-
8	200	036340	†	-
10	250	036341	†	-
12	300	036342	†	-
14	350	036915	†	-
16	400	036343	†	-
18	450	036871	†	-
20	500	-	†	-
24	600	036924	†	-

Heavy Duty Vanstone Flange Soc w Fibre-Loc Ring

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code
1/2	12	-		059262
3/4	20	-		059263
1	25	-		059264
1-1/4	32	-		059265
1-1/2	40	036323		059266
2	50	036324		059267
2-1/2	65	-		059268
3	75	036326		059269
4	100	036416		059270
6	150	036417		059271
8	200	036418		059272
10	250	036419	†	059273
12	300	036429	†	059569
14	350	036358	†▼	-
16	400	036359	†▼	-

▼ Molded hub, c/w coated metal rings

Vanstone Flange Soc w PVC Ring

1/2	12	036344		-
3/4	20	036345		-
1	25	036346		-
1-1/4	32	036347		-
1-1/2	40	036348		-
2	50	036349		-
2-1/2	65	036350		-
3	75	036351		-
4	100	036352		-
5	125	036353		-
6	150	036354		-
8	200	036355		-
10	250	036356	▼	-
12	300	036357	▼	-

▼ Molded hub, c/w coated metal rings

Vanstone Flange Soc w Steel Ring

18	450	036947	†	-
20	500	036913	†	-
24	600	036914	†	-

Note: these flanges are rated at 50 psi (345 kPa) maximum operating

▮,†,◗ See page 5 for descriptions

PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

Vanstone Flange Spig

Dimension inches	Dimension mm	PVC Sch 80 Product Code		CPVC Sch 80 Product Code
1/2	12	036374		059274
3/4	20	036375		059275
1	25	036376		059276
1-1/4	32	036377		059277
1-1/2	40	036378		059278
2	50	036379		059279
2-1/2	65	036380		059280
3	75	036381		059281
4	100	036382		059282
6	150	036383		059283
8	200	036384		059570
10	250	036321	†	-
12	300	036406	†	-

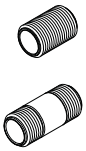
Vanstone Flange Fpt

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	036385	059656
3/4	20	036386	059657
1	25	036387	059658
1-1/4	32	036388	059284
1-1/2	40	036389	059659
2	50	036390	059660
2-1/2	65	036391	059661
3	75	036392	059285
4	100	036393	059662

1/8" Flange Gasket Neoprene

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	036296	-
3/4	20	036297	-
1	25	036298	-
1-1/4	32	036299	-
1-1/2	40	036300	-
2	50	036301	-
2-1/2	65	036302	-
3	75	036303	-
4	100	036304	-
5	125	036305	-
6	150	036306	-
8	200	036307	-
10	250	036308	-
12	300	036309	-
14	350	036310	-
16	400	036311	-
18	450	036312	-
20	500	036313	-
24	600	036314	-

Nipples



1/4" (6mm) diameter

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
7/8 close	22	036434	059296
1-1/2	40	036445	059306
2	50	036456	059316
2-1/2	65	036457	-
3	75	036458	059317
3 1/2	90	036459	-
4	100	036460	059318
4-1/2	115	036461	-
5	125	036462	059319
6	150	036463	059320
8	200	036464	-
10	250	236012	-
12	300	236013	-

3/8" (9mm) diameter

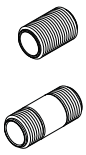
Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1 close	25	036435	059551
1-1/2	40	036446	059307
2	50	036466	059552
2-1/2	65	036467	-
3	75	036468	059939
3-1/2	90	036469	-
4	100	036470	059554
4-1/2	115	036471	-
5	125	036472	-
6	150	036473	-
8	200	036474	-

1/2" (12mm) diameter

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1-1/8 close	28	036436	059297
1-1/2	40	036447	059308
2	50	036475	059322
2-1/2	65	036476	-
3	75	036477	059321
3-1/2	90	036478	-
4	100	036479	059324
4-1/2	115	036480	-
5	125	036481	059325
5-1/2	140	036482	-
6	150	036483	059326
8	200	036484	-
10	250	036485	-
12	300	036486	-

▮,†,◗ See page 5 for descriptions

Nipples



3/4" (20mm) diameter

Dimension inches	mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1-3/8 close	35	036437	059298
1-1/2	40	036448	059309
2	50	036490	059327
2-1/2	65	036491	-
3	75	036492	059328
3-1/2	90	036493	-
4	100	036494	059329
4-1/2	115	036495	-
5	125	036496	059331
5-1/2	140	036497	-
6	150	036498	059332
8	200	036500	-
10	250	036501	-
12	300	036502	-

1" (25mm) diameter

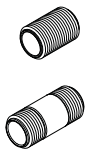
1-1/2 close	40	036438	059299
2	50	036449	059310
2-1/2	65	036504	-
3	75	036505	059333
3-1/2	90	036506	-
4	100	036507	059334
4-1/2	115	036508	-
5	125	036509	059335
5-1/2	140	036510	-
6	150	036511	059336
8	200	036512	-
10	250	036514	-
12	300	036515	-

1-1/4" (32mm) diameter

1-5/8 close	41	036439	059300
2	50	036450	059311
2-1/2	65	036516	-
3	75	036517	059338
3-1/2	90	036518	-
4	100	036519	059339
4-1/2	115	036520	-
5	125	036521	059340
6	150	036522	059341
8	200	036523	-
10	250	036524	-
12	300	036525	-

▮,†,◗ See page 5 for descriptions

Nipples



1-1/2" (40mm) diameter

Dimension inches	mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1-3/4 close	45	036440	059301
2	50	036451	059312
2-1/2	65	036526	-
3	75	036527	059342
3-1/2	90	036528	-
4	100	036529	059343
4-1/2	115	036530	-
5	125	036531	059344
5-1/2	140	036532	-
6	150	036533	059345
8	200	036534	-
10	250	036535	-
12	300	036536	-

2" (50mm) diameter

2 close	50	036441	059302
2-1/2	65	036452	-
3	75	036539	059346
3-1/2	90	036540	-
4	100	036541	059347
4-1/2	115	036542	-
5	125	036543	059348
5-1/2	140	036544	-
6	150	036545	059349
8	200	036546	-
10	250	036547	-
12	300	036548	-

2-1/2" (65mm) diameter

2-1/2 close	65	036442	059303
3	75	036549	-
4	100	036550	059351
6	150	036551	059352
8	200	036552	-
12	300	036553	-

3" (75mm) diameter

2-5/8 close	67	036443	059304
3	75	036554	059353
4	100	036555	059354
5	125	036556	059355
6	150	036557	059356
8	200	036558	-
10	250	036559	-
12	300	036560	-

4" (100mm) diameter

2-7/8 close	72	036444	059305
4	100	036562	-
5	125	036563	-
6	150	036564	059357
8	200	036565	-
10	250	036566	-
12	300	036567	-

PRODUCT SELECTION CHART - XIRTEC 140 PVC SCH. 80 & CORZAN CPVC SCH. 80 FITTINGS

Expansion Joint 6" (150mm) Travel EPDM

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	136115	059973
3/4	20	136117	059975
1	25	136119	059977
1-1/2	40	136121	059979
2	50	136123	059981
3	75	136125	059983
4	100	136127	059985

Expansion Joint 12" (1300mm) Travel EPDM

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	136116	059959
3/4	20	136118	059961
1	25	136120	059963
1-1/2	40	136122	059965
2	50	136124	059967
3	75	136126	059969
4	100	136128	059971

Expansion Joint 6" (150mm) Travel Viton®

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	136101	059974
3/4	20	136103	059976
1	25	136105	059978
1-1/2	40	136107	059980
2	50	136109	059982
3	75	136111	059984
4	100	136113	059986

Expansion Joint 12" (1300mm) Travel Viton®

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	136102	059960
3/4	20	136104	059962
1	25	136106	059964
1-1/2	40	136108	059966
2	50	136110	059968
3	75	136112	059970
4	100	136114	059972

Polypropylene Pipe Clamps

Dimension inches	Dimension mm	PVC Sch 80 Product Code	CPVC Sch 80 Product Code
1/2	12	035180	-
3/4	20	035181	-
1	25	035182	-
1-1/4	32	035183	-
1-1/2	40	035184	-
2	50	035185	-

Strut Base

-	-	035186	

Note: Strut Bases are sold individually, two Strut Bases are required to create one Strut Base Unit.
Example: If you require 10 complete Strut Base Units you must order 20 strut bases.

Pipe Straps 2 holes

1/2	12	036000	
3/4	20	036001	
1	25	036002	
1-1/4	32	036003	
1-1/2	40	036004	
2	50	036005	

Pipe Straps PVC Coated Steel 2 holes

2-1/2	65	036006	
3	75	036007	
3-1/2	90	036008	
4	100	036009	
5	125	036010	
6	150	036011	

"U" Bend 4" (100mm) O.C. for Ice Rink Piping

1	25	059019 Barbed end
1	25	- Plain End (Spigot)

Fits 1" (25mm) ID Poly Pipe

▮,†,◗ See page 5 for descriptions

Chapter 15 DOMESTIC TANK

MANUFACTURER/DISTRIBUTOR:

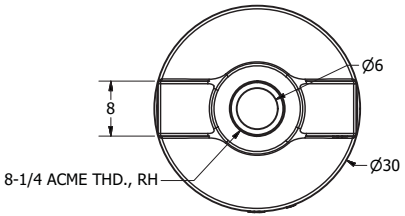
BRIMA
338, Grand Rang
La Présentation, QC, J0H 1B0
Phone: (450) 796-1818
Fax :(450) 796-2345
Email: admin@agbrima.com

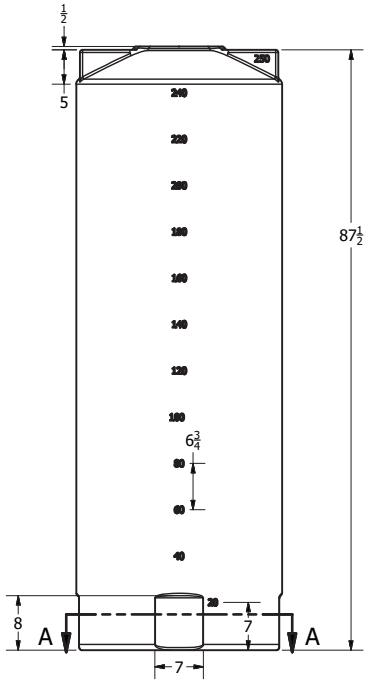
15.1 **DOMESTIC COLD WATER TANKNORWESCO WATER TANK 41854 (DCWT)**

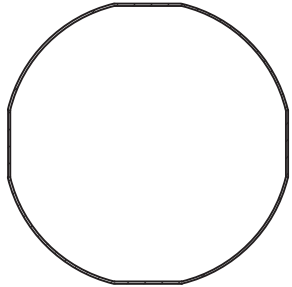
15.2 **WASTE WATER STORAGE TANK NORWESCO WATER TANK 41854 (WWST)**

15.3 **BURCAM EXPANSION TANK 503221S**

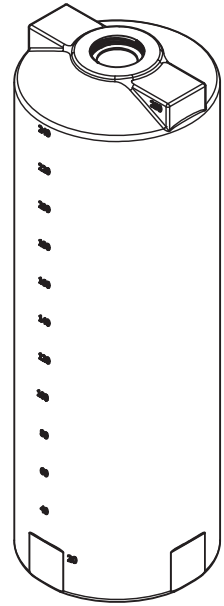
DCWT/ WWST







SECTION A-A
SCALE 1:10



SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Jun, 2016

Reviewed X
Reviewed as noted
Resubmit
Out for approval

SIFEC NORTH INC.

REVISION HISTORY

REV	DESCRIPTION	DATE	AUTHOR
A	REDRAWN	7/2/2013	Michael Holden

DRAWN	Jerry Paulson	8/7/2003
CHECKED		
QA		
MFG		
APPROVED		

NORWESCO, INC. SAINT BONIFACIUS, MN

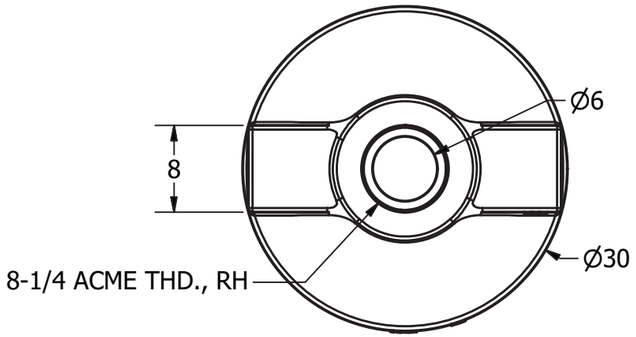
TITLE

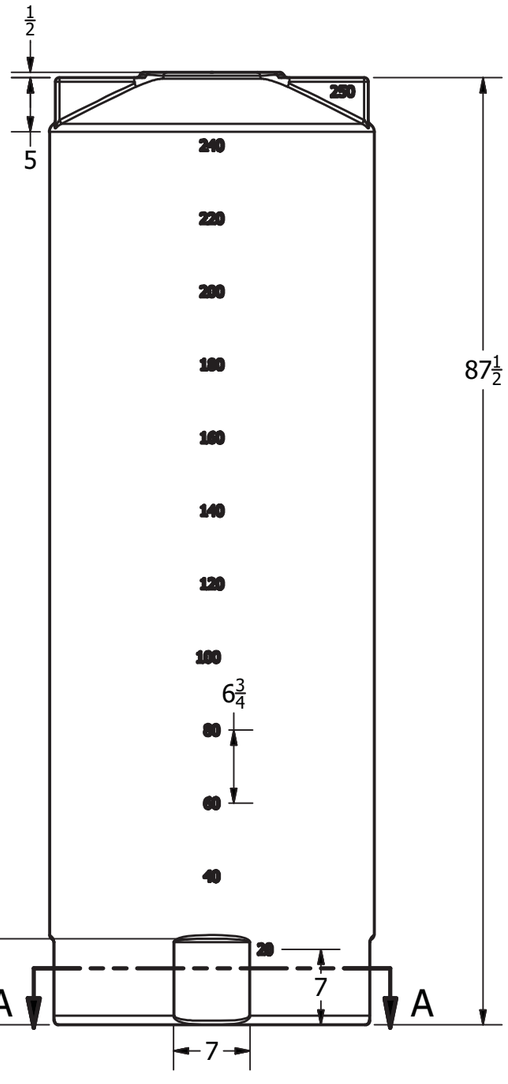
250 GALLON VERTICAL TANK X 30 DIA

SIZE	DWG NO	REV
B		A

SCALE: 1/16 SHEET 1 OF 1

DCWT/ WWST





SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

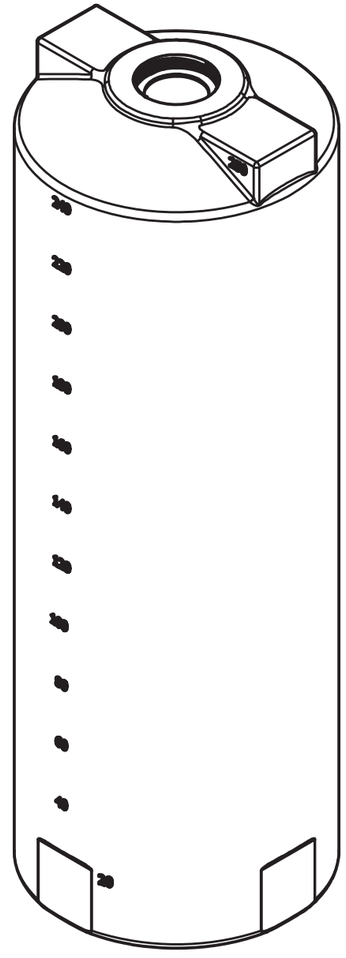
Reviewed By: M.M.

Date: 19 Mar 2015

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SECTION A-A
SCALE 1:10



Shop Drawings
Contractor Approval
Approved by:M.A.G., G. F.
Date:Mar 03, 2015
SIFEC NORTH INC

REVISION HISTORY			
REV	DESCRIPTION	DATE	AUTHOR
A	REDRAWN	7/2/2013	Michael Holden

DRAWN	Jerry Paulson	8/7/2003
CHECKED		
QA		
MFG		
APPROVED		

NORWESCO, INC. SAINT BONIFACIUS, MN

TITLE

250 GALLON VERTICAL TANK X 30 DIA

SIZE		DWG NO	REV
B			A

SCALE: 1/16

SHEET 1 OF 1 103/665

DWP

INSTALLATION INSTRUCTIONS MODELS 503121S/503221S AND BY- PRODUCTS LIKE 503127S, 503128S, 503228S, 503131S, 503231S, ETC.

JET PUMP

WWW.BURCAM.COM

2190 Boul. Dagenais West
LAVAL (QUEBEC)
CANADA
H7L 5X9

TEL: 514.337.4415
FAX: 514.337.4029
info@burcam.com

PROUDLY CANADIAN

Your pump has been carefully packaged at the factory to prevent damage during shipping. However, occasional damage may occur due to rough handling. **Carefully inspect your pump** for damages that could cause failures. Report any damage to your carrier or your point of purchase.

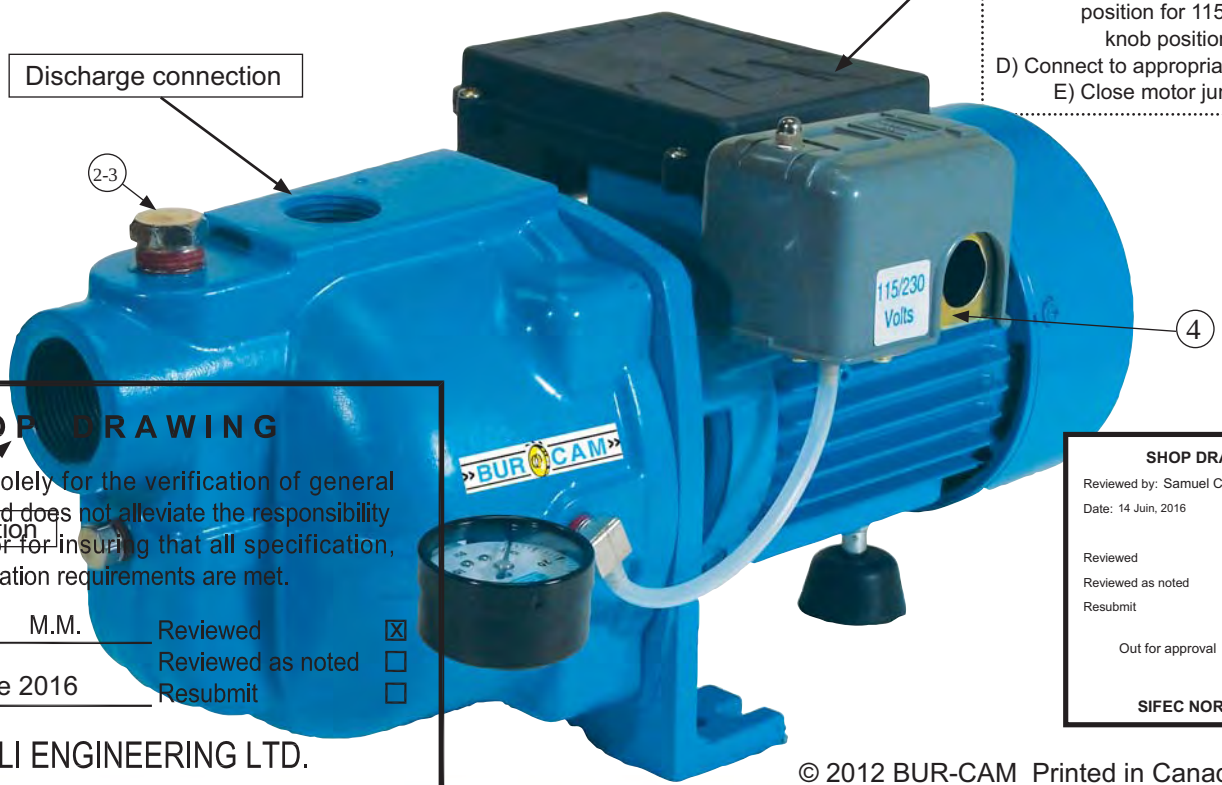
Please read these instructions carefully. **Failure** to comply to instructions and **designed** operation of this system, may **void** the warranty.

PRIMING PROCESS

Follow all these inside step by step instructions to install your pump. Use teflon tape on all threads. (1) Fill the suction line with water and connect it to the suction inlet. (2) Remove the priming plug and fill the pump body with water. (3) Screw the plug to the priming inlet. (4) Turn the power on. The pump should deliver water to the plumbing line within 30 seconds. If not, unplug the pump and repeat the process at step 2.

FACTORY SET VOLTAGE 115 V
CONNECTION VOLTAGE CHANGING:

Before changing the voltage connection:
A) Ensure the power to the pump is disconnected.
B) Open motor junction box cover.
C) Please select the up knob position for 115V or down knob position for 230V.
D) Connect to appropriate voltage.
E) Close motor junction box.



SHOP DRAWING

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Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 14 Juin, 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

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DWP

Safety Instructions:

This fine pump that you have just purchased is designed from the latest in material and workmanship. Before installation and operation, we recommend the following procedures:

A CHECK WITH YOUR LOCAL ELECTRICAL AND PLUMBING CODES TO ENSURE YOU COMPLY WITH THE REGULATIONS. THESE CODES HAVE BEEN DESIGNED WITH YOUR SAFETY IN MIND. BE SURE YOU COMPLY WITH THEM.

B WE RECOMMEND THAT A SEPARATE CIRCUIT BE LEAD FROM THE HOME ELECTRICAL DISTRIBUTION PANEL PROPERLY PROTECTED WITH A FUSE OR A CIRCUIT BREAKER. WE ALSO RECOMMEND THAT A GROUND FAULT CIRCUIT BE USED. CONSULT A LICENSED ELECTRICIAN FOR ALL WIRING.

C THE GROUND TERMINAL ON THE THREE PRONG PLUGS SHOULD NEVER BE REMOVED. THEY ARE SUPPLIED AND DESIGNED FOR YOUR PROTECTION.

D NEVER MAKE ADJUSTMENTS TO ANY ELECTRICAL APPLIANCE OR PRODUCT WITH THE POWER CONNECTED. DO NOT ONLY UNSCREW THE FUSE OR TRIP THE BREAKER, REMOVE THE POWER PLUG FROM THE RECEPTACLE.

Monthly Mandatory check-up:

1. Inspect the pump for any obvious condition that necessitates cleaning, correction, adjustement or repair.
2. Clear the surrounding of any paper, leaves or other debris.
3. Assure that the pump is secure for proper operation.
4. Assure that there is adequate clearance from any combustible materials or stucture. Stored materials must be kept away from the pump. Shelves or cabinet structures must not be in close proximity over the pump.
5. Assure that the motor is securely plugged into a proper GFCI electrical outlet.
6. Test the GFCI outlet by pressing its test switch. This should prove that the outlet is energized and will trip off to protect against a ground fault. Be sure to reset the GFCI by pressing its reset switch.
7. Observe that the plumbing can carry the water safely into the residence.

Material required for drilled well application **(indoor use only)**

Shallow well pump installation

- Desired length of polyethylene 1” pipe, 100 PSI, CSA or UL approved, to link up from pumping level to pump.
- 1 1” foot valve (750756 or 750752P).
- 1 well seal, as per well casing diameter (750929 6” x 1”).
- 1 1” well seal elbow (750860).
- 2 1” male adaptors (750865 or 750871).
- 8 1” stainless steel clamps (750885).
- Teflon tape.

Tank installation

- Desired length of 1” braided hose (750919) to link up from pump to tank. Keep tank as close as possible from pump.
- 1 tank T (650651).
- 1 drain valve (650659)
- 2 1” female adaptor.
- 1 1” male adaptor (750865 or 750871).
- 3 1” stainless steel clamps (750885).
- Teflon tape.

Tools

Screwdrivers, hacksaw to cut pipe, knife to assist in pipe cutting, round file to smooth pipe ends, pipe wrench, adjustable wrench to tighten fittings, propane torch and welding material.

DWP

APPLICATION

• This pump is designed for shallow well installation for water level up to 25 feet.

• CAPACITY:

	1/2 HP	3/4HP	
5’	815	865	US GPH
10’	715	755	US GPH
15’	630	665	US GPH
20’	550	575	US GPH
25’	500	530	US GPH

FRICTION LOSS IN PIPE NOT INCLUDED

FEATURES

• Easy tu prime pump body.

• Totally enclosed, fan cooled motor, bearing to bearing. Built for a continuous use.

• Full time connected run capacitor, to eliminate starting wear vs regular motor.

• Thermal and overload protection.

• Noryl impeller, built-in injector

• 1/2 HP, 115 / 230 VAC, 60 Hz, 8.6 A / 4.3 A (at start:15 A / 7.5 A).
• 3/4 HP, 115 / 230 VAC, 60 Hz, 8.8 A / 4.4 A. (at start:15 A / 7.5 A).

INSTALLATION STEPS

STEP 1

We recommend that you install your pump in a clean and dry location where there is adequate room for servicing at a later date. Protection from freezing temperatures and good ventilation should be considered as well, to provide the pump an environment for long life. Locating the pump as close as possible to the water source will reduce friction losses encountered in the suction pipe.

Friction losses in the suction pipe must be taken into consideration when the horizontal offset is greater than 50 feet. The suction pipes should be increased from 1” to 1 1/4”. This will reduce friction losses and allow the pump to give maximum performance.

A new well should be checked to determine that it is free from sand. Sand will damage the seal and the impeller. Have your well driller clean the well before your installation.

Never run the pump dry. Damage to the seal may occur. Fill pump body and suction pipe with water before turning on the power.

THE RUN OF HORIZONTAL PIPE FROM THE TOP OF YOUR WELL INTO THE HOUSE, WHERE YOUR PUMP WILL BE LOCATED, MUST BE INSTALLED IN A TRENCH, BELOW THE FROST LEVEL OF YOUR AREA.

DWP

SHALLOW WELL APPLICATION

SEE DIAGRAM ON PAGE 7

STEP 2

Cut the desired length of poly pipe to run from the top of the well to the pumping level. Smooth the pipe cuttings with your round file. (Check that no cut-out parts are left inside of pipe. This may block pump injector or impeller). Tape male adaptor threads with teflon tape and thread adaptor into the foot valve. Slide 2 stainless steel clamps over one end of pipe and use torch to soften pipe. Insert the male adaptor and foot valve into this pipe end. Tighten clamps with screwdriver when cool. **For security against leaks, we suggest to install 2 stainless steel clamps on each adaptor.**

STEP 3

Insert the well seal elbow thru the opening of the seal.
Slide 2 stainless steel clamps over the free end of the previously cut pipe and soften pipe with your torch. Attach pipe to the well seal elbow (end protruding at bottom of well seal). Tighten clamps with screwdriver when cool.

STEP 4

Install the well seal and piping assembly into your well casing. Tight down the well seal bolts using your adjustable wrench.

To facilitate servicing at a later date, you may use a pitless adaptor and a sealed well cap instead of an elbow and a well seal as describe in steps 3 and 4.

STEP 5

Install your pump in the house, on a sound foundation, as close as possible to the basement wall. Locate the suction inlet in the front of the injector. Thread an adaptor into inlet using teflon tape. Do not over tighten.

STEP 6

Cut the desired length of pipe from pump location to the well seal and connect both ends using the previous way, with stainless steel clamps and torch. **Do not fill in your trench to the house until you have checked for any leaks in your connections or trouble in your water system.**

STEP 7
for sand or well points

Sand or well points are limited to areas where water bearing sand or gravel lies below the surface, and where there are no boulders or rocks to interfere with the driving into the ground of the point.
The amount of water any “one” well point will supply is usually rather limited. Sometimes, it is necessary to use more than one point to increase the supply of water, entering to the pump’s suction.

THE IMPORTANT INSTALLATION STEP IN USING WELL POINTS IS THAT A CHECK VALVE MUST BE USED IN THE SUCTION PIPE LEADING TO THE SUCTION INLET, AS CLOSE TO THE PUMP AS POSSIBLE, TO KEEP SUCTION LINE AND PUMP WELL PRIMED.

CONTINUE ON PAGE 5 & 6 FOR TANKS AND ELECTRICAL INSTALLATION STEPS

STEP 8
for captive air tanks

Packaged systems have the pump mounted directly to the tank. The pump to tank plumbing fittings are pre-assembled in factory. You only have to connect the discharge line of your system to your home's plumbing distribution line. When using a separate tank from your pump, we recommend to install a captive air tank as shown in our typical installation diagram, that is air injected into the tank at the factory. This air, which is in addition to atmospheric pressure, increase the ability of the tank to deliver more water between on/off cycles, thus increasing the efficiency of your water system. Connect the pump discharge to the tank T, using adaptors and braided hose, then, connect the other side of tank T to your home's plumbing distribution line.

Make sure that the precharged air pressure (before connecting the tank) is 2 PSI less than the starting pressure setted on the pressure switch of your pump. If you adjust the air pressure after the installation, follow these steps:

- Check the starting pressure of the pump on the pressure gauge;
- Disconnect the power to the pump;
- Open nearest fawcet to the tank and relieve all pressure in tank, then close the fawcet;
- Adjust the air pressure of the tank (by pumping or removing air at the snifter valve) 2 PSI below pressure switch "ON" setting;
- Turn power back on to pump.

Your tank is now well precharged. Run the pump through a few cycles to verify that it works properly.

STEP 8
for epoxy or glass lined tanks

Other types of tanks may be used, as galvanized standard tanks, epoxy or glass lined tanks. These products do not achieve the benefits of the captive air tanks.

Epoxy or glass lined tanks with float have to be precharged by the installer. Assuming tank is plumbed to pump and all connections are checked for leaks, follow these steps:

- Run pump thru one complete cycle, until pump shuts off;
- Disconnect the power to the pump;
- Open nearest fawcet to the tank and relieve all pressure in tank, then close the fawcet;
- Close service line gate valve;
- With a car tire pump, inject air into the snifter valve located in tank. Watch pump pressure gauge and stop pumping air when pressure reachs 2 PSI below pressure switch "ON" setting;
- Return power back on to pump;
- Run pump through one complete cycle;
- Open service line gate valve.

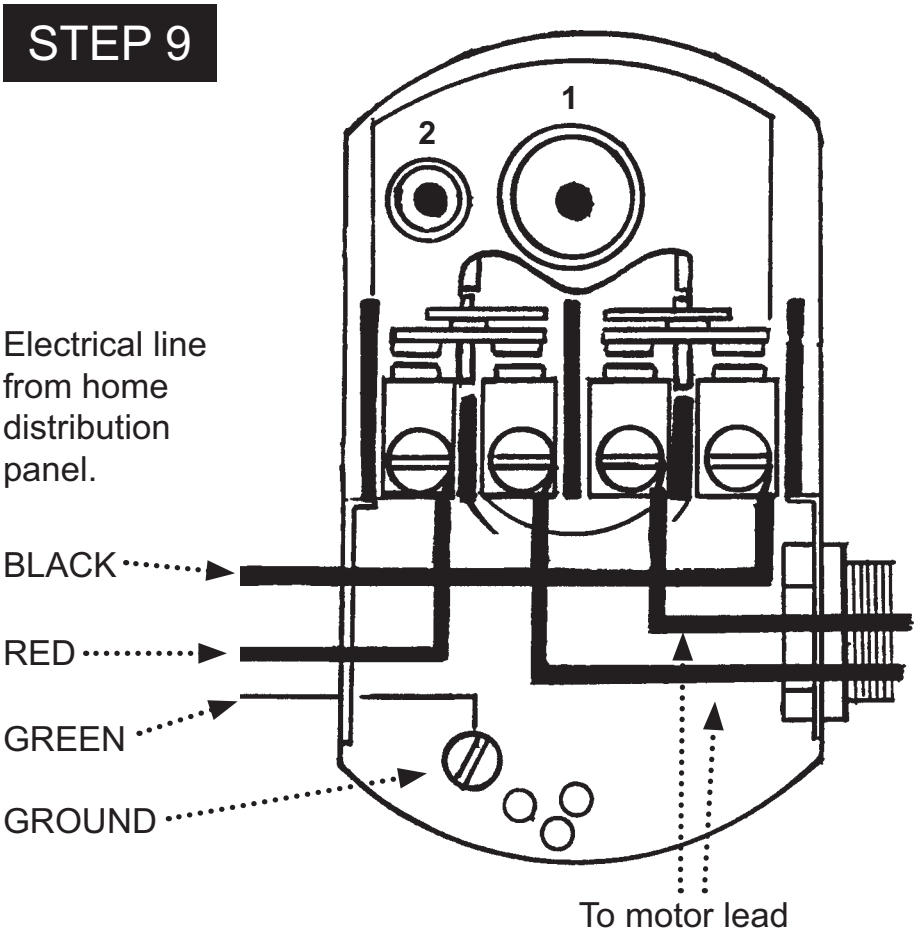
Your tank is now well precharged. Run the pump through a few cycles to verify that it works properly.

Not recommended for galvanized tanks

Galvanized standard tanks require an air volume control to be used with jet pump. We do not recommend the installation of this type of tank with your jet pump. This type of galvanized tank is recommended with piston pumps.

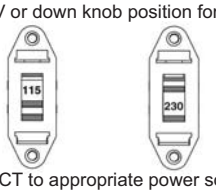
ELECTRICAL INSTALLATION

STEP 9



VOLTAGE SELECTION SWITCH

1. POWER off.
2. Please SELECT the up knob position for 115 V or down knob position for 230 V.



3. CONNECT to appropriate power source.

We recommend that a licensed electrician be employed to do the proper wiring to the pressure switch, and to permanently ground the motor in accordance to the electrical codes in your area.

Do not use an extension cord to connect your pump to the power source. From your distribution panel to the pressure switch, we recommend a wire gauge not smaller than 14 gauge.

This is a dual voltage 115/230 pump. The voltage selection switch is located inside the terminal box. The motor is factory wired on 115V. For 230V selection, please open the terminal cover and set the switch to the proper voltage. (See above drawing on right).

Pressure switch setting (start/stop 20/40 or 30/50) has been made at the factory. Adjustments may be done to give other operating pressures.

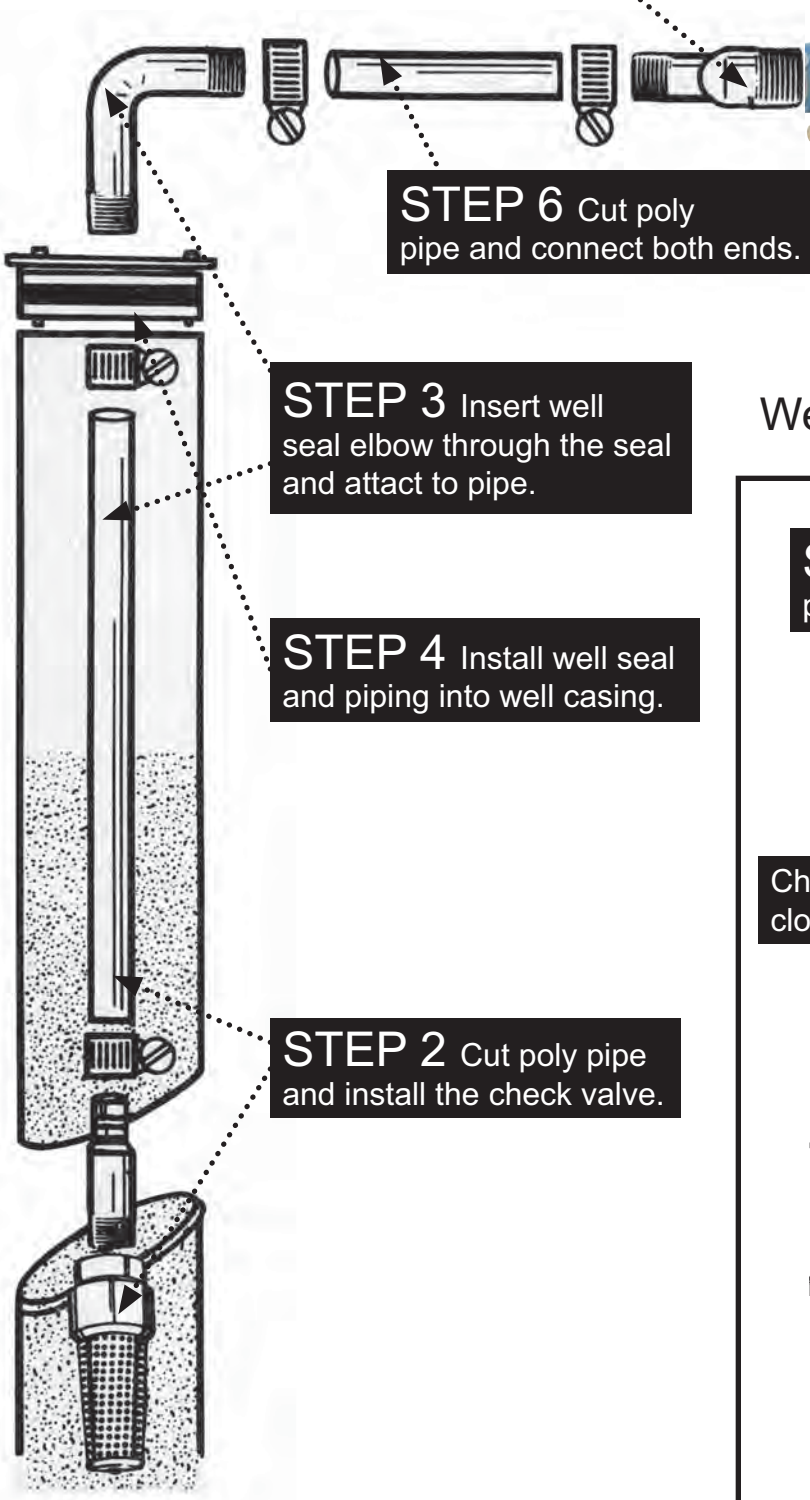
Adjustment or modification of start/stop setting of pressure switch have to be done carefully.
Turn adjustment nut half turn at a time.

Turn nut 1 clockwise to raise start and stop pressure setting. **Never turn nut 2. This will change the 20 PSI range between start and stop presssure and may damage your tank's bladder or modify the efficiency of your water system.** Check system operation after each adjustment.

SHALLOW WELL APPLICATION

STEP 5 Install your pump and thread an adaptor into inlet.

STEP 6 Cut poly pipe and connect both ends.



STEP 3 Insert well seal elbow through the seal and attact to pipe.

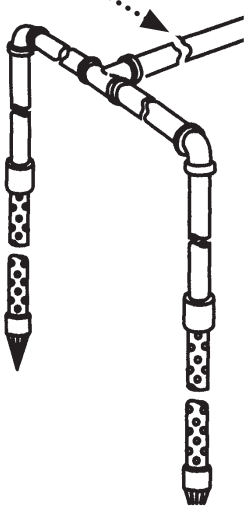
STEP 4 Install well seal and piping into well casing.

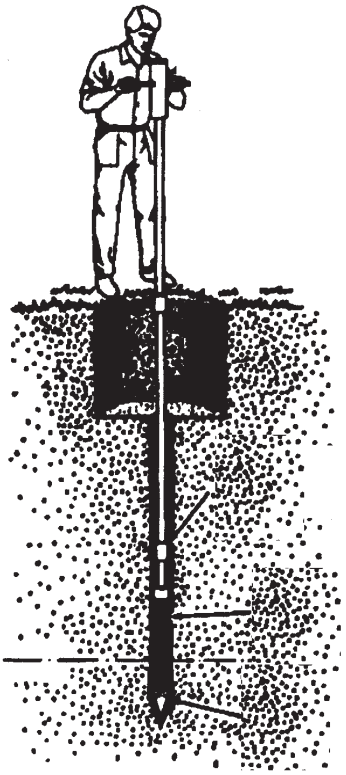
STEP 2 Cut poly pipe and install the check valve.

Well point optional installation

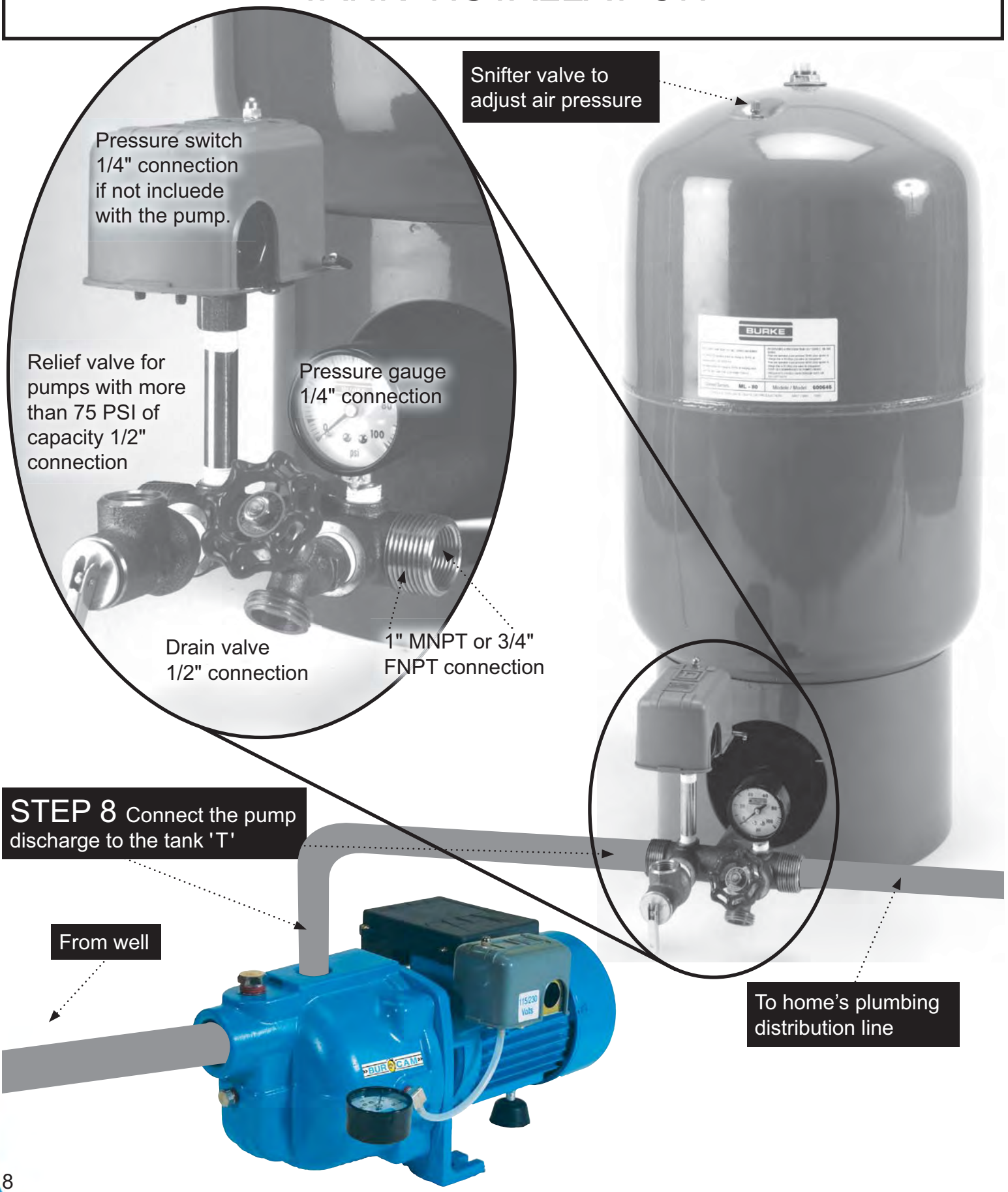
STEP 7 You may install one or more sand points to increase the supply of water.

Check valve, close to pump.



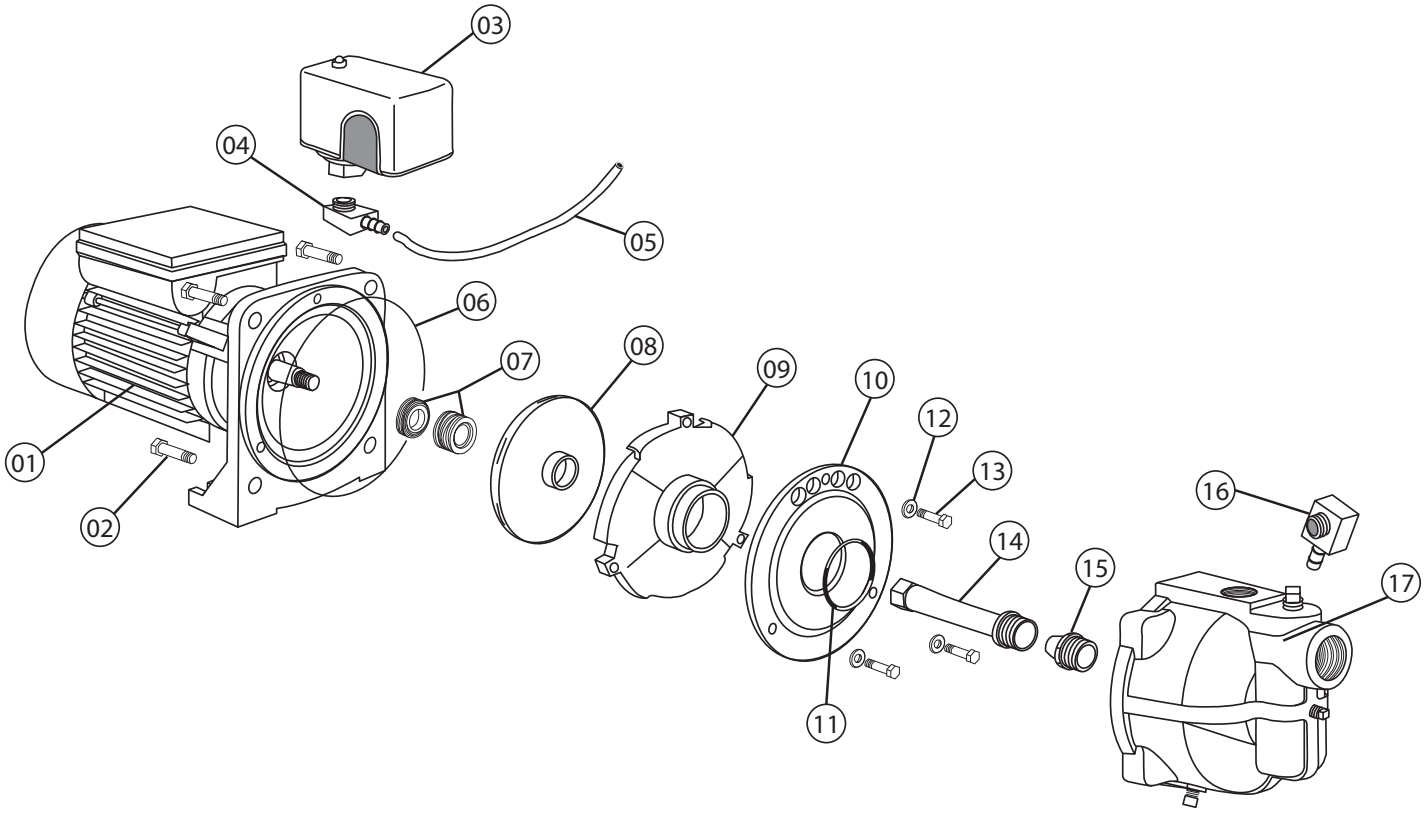


TANK INSTALLATION



REPAIR PARTS

Ref	Pieces	Descriptions	Ref	Pieces	Descriptions
1	510054	Motor 1/2 HP	10	510065	Diffuser Plate
1	510054-2	Motor 3/4 HP	11	510051	Diffuser Plate O-Ring
2	510055	Motor Screws (4)	12	510050	Diffuser Plate Washers (3)
3	750957S	Pressure Switch	13	510049	Diffuser Plate Screws (3)
4	510056	1/4" NPT 1/4" Barb Elbow	14	510069	Venturi
5	750748	Hose	15	510046	Nozzle
6	510053	Seal Plate O-Ring	16	510056	1/4" NPT 1/4" Barb Elbow
7	510052	Mecanical Seal	17	510045	Pump Body
8	510048	Impeller	18	750769	1/4" Pressure Gauge (not shown)
9	510047	Diffuser	19	510077	Capacitor (not shown)



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Repair parts may be ordered from your autorized point of sale or from

BUR-CAM PUMPS

DWP

TROUBLE SHOOTING GUIDE CHECKLIST

NEVER MAKE ADJUSTMENTS TO ANY ELECTRICAL APPLIANCE OR PRODUCT WITH THE POWER CONNECTED. DON'T JUST UNSCREW THE FUSE OR TRIP THE BREAKER, REMOVE THE POWER FROM THE RECEPTACLE.

TROUBLE	PROBABLE CAUSE	ACTION
Motor does not run.	Switch is off position	Turn switch to on position
	Blown fuse	Replace
	Tripped breaker	Reset
	Dirty pressure switch	Clean
	Defective pressure switch	Replace
	Defective motor	Replace
Motor runs but no water is delivered.	Pump not primed	Prime with clean water
	Leaky suction line	Check pipe and pipe connections
	Foot valve plugged	Clean
	Ejector nozzle clogged	Clean
	Water level below foot valve	Check foot valve level
	Suction lift to great	Water level lower than lift capacity
	Improper voltage	Check voltage
Pump does not deliver to full capacity.	Water level below foot valve	Check foot valve level
	Ejector nozzle clogged	Clean
	Excessive friction in pipe	Too small or dirty pipe
	Improper voltage	Check voltage
Pump does not shut off.	Leaky discharge line	Check all pipes for leak
	Motor not up to normal speed	Check power cable and voltage
	Improper setting of pressure switch	Reset or replace
	Ejector nozzle clogged	Clean
Pump starts and stop too often.	Pressure tank waterlogged	Drain tank and restart
	Leaky foot valve	Replace
	Leaky suction line	Check pipe and pipe connections
	Foot valve do not close properly	Clean or replace
	Pressure switch out of adjustment	Adjust on/off setting
	Leaky discharge line (toilet etc.)	Check all pipes for leak
Air spurts from fawcets.	Leaky suction line	Check pipe and pipe connections
	Gaz in water	Check and consult factory
	Airlogged tank (galvanized)	Replace air volume control

TO THE END CONSUMER

If you have any problems with the product, before advising the store, where you've purchased the pump, please contact us at 514 337-4415 , and ask for our sales department, and they will be pleased to help you with any questions you might have, concerning your installation.

Chapter 16 VALVES

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax :(514) 344-9341

16.1 **BUTTERFLY VALVE MAS L-D-4-A-E-LH 3" @ 6"**

16.2 **PVC CHECK VALVE IPEX 052289 & 052291**

16.3 **PVC CHECK VALVE SXE IPEX IPE052018**

16.4 **PVC BALL VALVE IPEX 353000 SERIE**

16.5 **BALL VALVE NPT STAINLESS STEEL G-2**

16.6 **BALL VALVE NPT MAS B3**

16.7 **NPT CHECK VALVE BRASS - Kitz#22**

16.8 **BALL VALVE CPVC**

16.9 **BALL VALVE JENKINS 4092J**

SV-1 @ SV-2

VKD Series Ball Valves

Submittal Data Sheet

Job or Customer: .....

Engineer: .....

Contractor: .....

Submitted by: ..... Date

Approved by: ..... Date

Order No: ..... Date

Specification: .....

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 29 June 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

introduction

IPEX VKD Series Ball Valves offer a variety of advanced features such as the patented seat stop carrier, a high quality stem and ball support system, and a multifunctional locking handle. Deep grooves, thick o-rings, and cushioned Teflon® seats contribute to strong seals at pressures up to 232 psi while an integral ISO mounting flange and support bracketing combine for simple actuation and anchoring. VKD Series Ball Valves are part of our complete systems of pipe, valves, and fittings, engineered and manufactured to our strict quality, performance, and dimensional standards.

< STANDARDS >

ASTM D1784
ASTM D2466
ASTM D2467
ASTM D2464
ASTM F1498
ASTM F439
ASTM F437

ANSI B1.20.1
ANSI B16.5

Valve Availability

Body Material:	PVC, CPVC, PP
Size Range:	3/8" through 4"
Pressure:	232 psi, 150 psi (PP)
Seats:	Teflon® (PTFE)
Seals:	EPDM or FPM
End Connections:	Socket (IPS), Threaded (FPT), Socket (Metric)

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 27 june 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for Approval

SIFEC NORTH INC.

CDN Toll Free: 866-473-9462
www.ipexinc.com

U.S. Toll Free: 800-463-9572
www.ipexamerica.com

IPEX

SV-1 @ SV-2

VKD Series Ball Valves

Valve Selection

Valve Size (inches)	Body Material	O-ring Material	IPEX Part Number IPS Socket	Pressure Rating at 73ºF
3/8	PVC	EPDM	253067	232 psi
		FPM	253068	
	CPVC	EPDM	253069	
		FPM	253070	
1/2	PVC	EPDM	053461	
		FPM	053467	
	CPVC	EPDM	053473	
		FPM	253008	
3/4	PVC	EPDM	053462	
		FPM	053468	
	CPVC	EPDM	053474	
		FPM	253009	
1	PVC	EPDM	053463	
		FPM	053469	
	CPVC	EPDM	053475	
		FPM	253010	
1-1/4	PVC	EPDM	053464	
		FPM	053470	
	CPVC	EPDM	053476	
		FPM	253011	
1-1/2	PVC	EPDM	053465	
		FPM	053471	
	CPVC	EPDM	053477	
		FPM	253012	
2	PVC	EPDM	053466	
		FPM	053472	
	CPVC	EPDM	053478	
		FPM	253013	
2-1/2	PVC	EPDM	053539	
		Viton®	053542	
	CPVC	EPDM	053545	
		Viton®	053548	
3	PVC	EPDM	053540	
		Viton®	053543	
	CPVC	EPDM	053546	
		Viton®	053549	
4	PVC	EPDM	053541	
		Viton®	053544	
	CPVC	EPDM	053547	
		Viton®	053550	

Body Material:

- ❑ PVC
- ❑ CPVC
- ❑ PP

Size:

- ❑ 3/8"
- ❑ 1/2"
- ❑ 3/4"
- ❑ 1"
- ❑ 1-1/4"
- ❑ 1-1/2"
- ❑ 2"
- ❑ 3"
- ❑ 4"

Seals:

- ❑ EPDM
- ❑ FPM

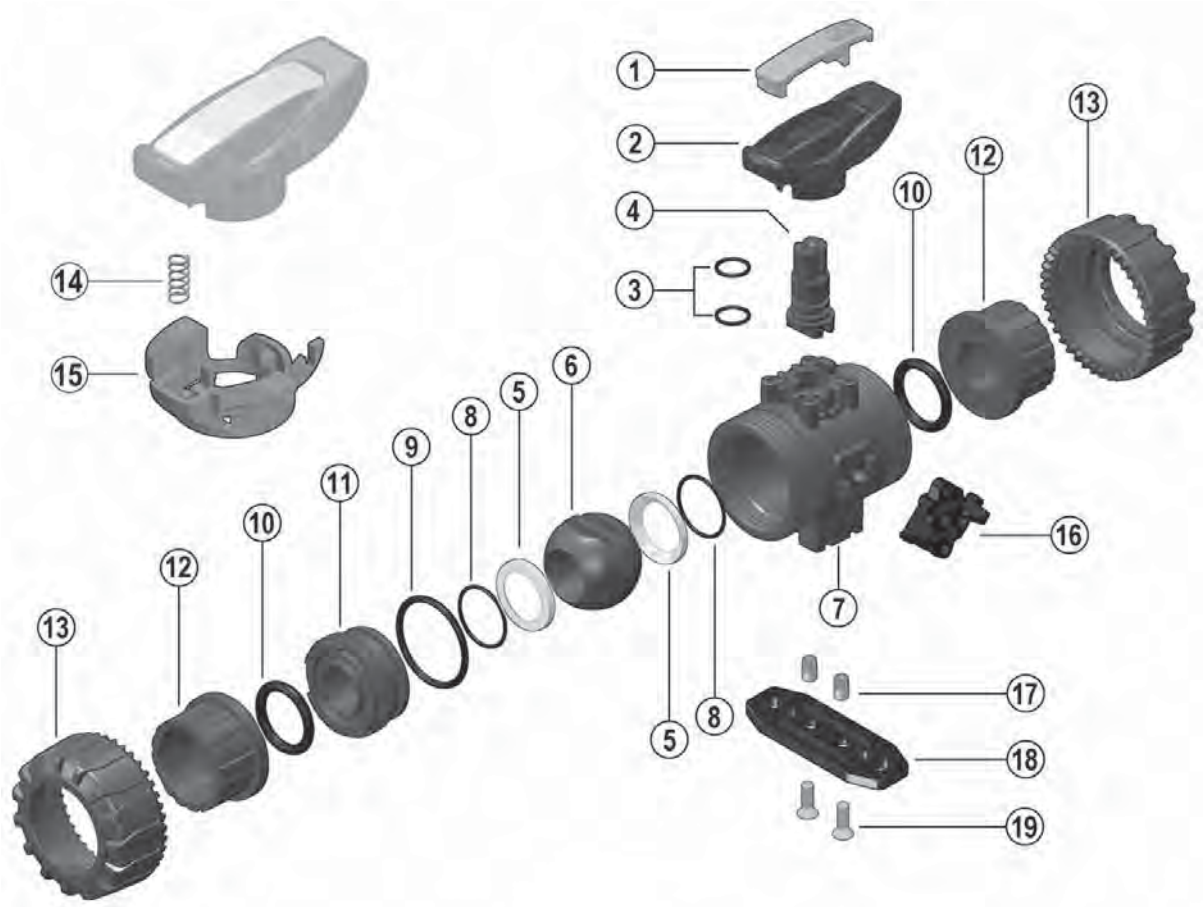
IPEX Part Number:

_____

VKD Series Ball Valves

Components

sizes 1/2" to 2"



#	Component	Material	Qty
1	insert	PVC / CPVC / PP	1
2	handle	PVC / CPVC / PP	1
3	stem o-ring	EPDM / Viton®	2
4	stem	PVC / CPVC / PP	1
5	ball seat	PTFE	2
6	ball	PVC / CPVC / PP	1
7	body	PVC / CPVC / PP	1
8	ball seat o-ring	EPDM / Viton®	2
9	body o-ring	EPDM / Viton®	1
10	socket o-ring	EPDM / Viton®	2

#	Component	Material	Qty
11	carrier with stop ring	PVC / CPVC / PP	1
12	end connector	PVC / CPVC / PP	2
13	union nut	PVC / CPVC / PP	2
14*	spring	SS	1
15*	handle lock	GRPP	1
16	DUAL BLOCK®	POM	1
17*	bracket bushing	SS / brass	2
18*	mounting plate	GRPP	1
19*	screw	SS	2

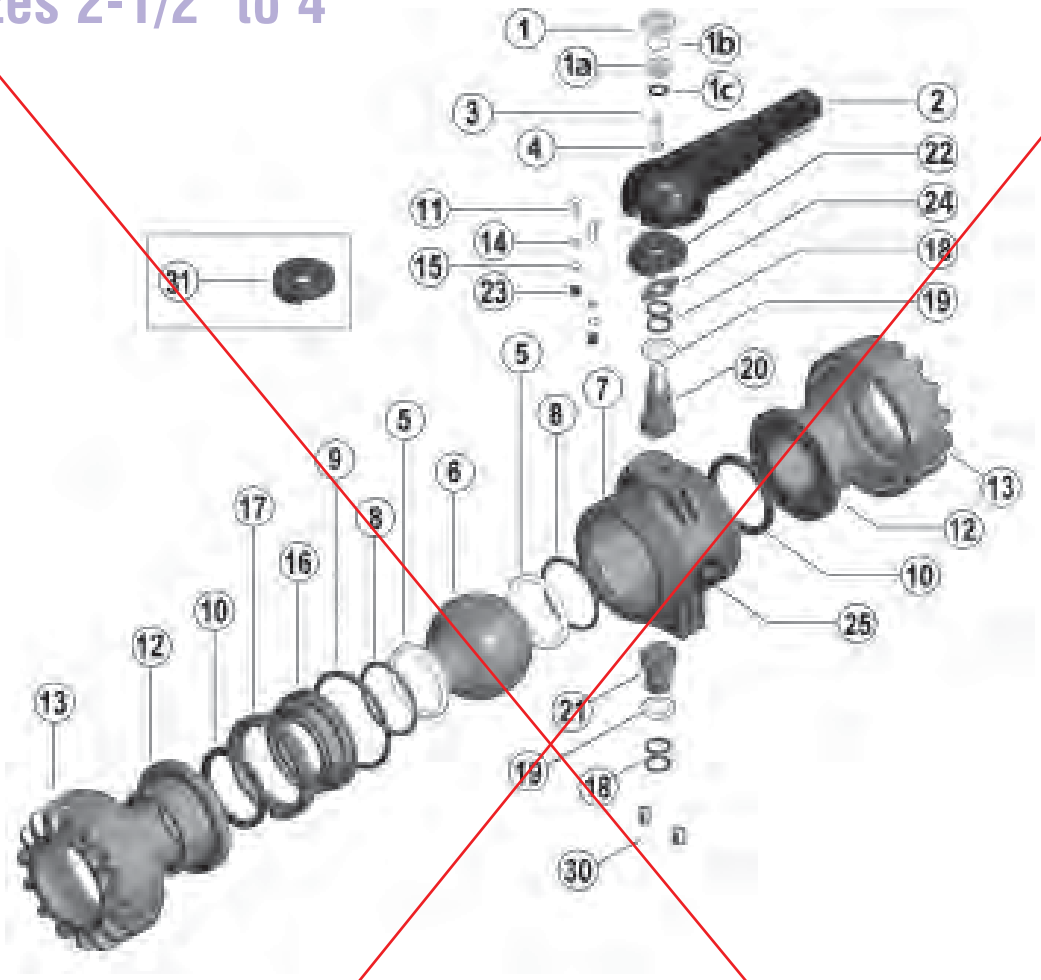
* Optional Accessories

SV-1 @ SV-2

VKD Series Ball Valves

Components

sizes 2-1/2" to 4"

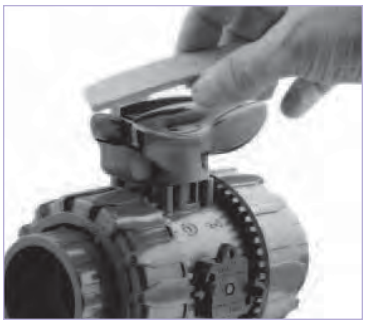


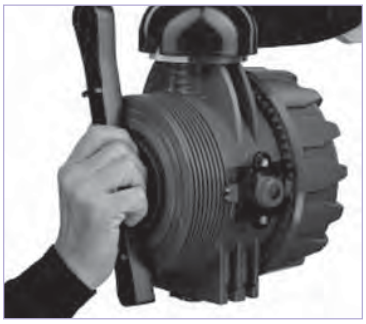
#	Component	Material	Qty
1 a,b,c	transparent service plug	PE	1
2	handle	PVC	1
3	bolt	SS	1
4	washer	SS	1
5	ball seat	PTFE	2
6	ball	PVC / CPVC	1
7	body	PVC / CPVC	1
8	ball seat o-ring	EPDM / Viton®	2
9	body o-ring	EPDM / Viton®	1
10	socket seal	EPDM / Viton®	2
11	bolt	SS	2
12	end connector	PVC / CPVC	2
13	union nut	PVC / CPVC	2
14	washer	SS	2
15	nut	SS	2
16	carrier	PVC / CPVC	1

#	Component	Material	Qty
17	stop ring	PVC / CPVC	1
18	stem o-ring	EPDM / Viton®	4
19	bushing	PTFE	2
20	upper stem	PVC / CPVC & SS	1
21	lower stem	PVC / CPVC	1
22	pad	GRPP	1
23	protective cap	PE	2
24	spring	SS	2
25	nut block	GRPP	2
26	cover	PP	1
27	nut block button	GRPP	1
28	protective cap	PE	1
29	screw	nylon	2
30	bracket bushing	brass	2
31	actuation pad	GRPP	1

VKD Series Ball Valves

Installation Procedures



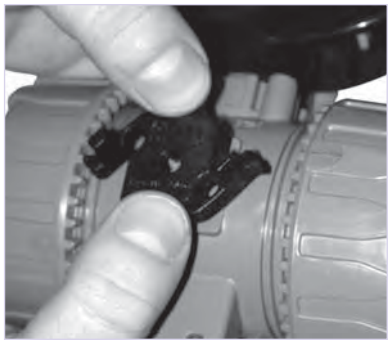


1. Remove the union nuts (part #13 on previous pages) and slide them onto the pipe.
2. Please refer to the appropriate connection style sub-section:
   a. For socket style, solvent cement or fuse the end connectors (12) onto the pipe ends. For correct solvent cementing procedure, please refer to the section entitled, "Joining Methods – Solvent Cementing" in the IPEX Industrial Technical Manual Series, "Volume I: Vinyl Process Piping Systems". **Be sure to allow sufficient cure time before continuing with the valve installation**.
   b. For threaded style, thread the end connectors (12) onto the pipe ends. For correct joining procedure, please refer to the section entitled, "Joining Methods – Threading" in the IPEX Industrial Technical Manual Series, "Volume I: Vinyl Process Piping Systems".
3. Open and close the valve to ensure that the carrier (11 or 16) is at the desired adjustment. If adjustment is required, ensure that the valve is in the closed position then remove the insert tool (1) from the handle (2). For sizes 2-1/2" to 4", use the tool that accompanies the valve. Line up the moldings on the tool with the slots in the carrier. Tighten or loosen to the desired position then replace the tool on the handle.
4. Ensure that the valve is in the closed position, and that the socket o-rings (10) are properly fitted in their grooves. If anchoring is required, insert the bracket bushings (17) into the bottom of the valve (sizes 1/2" to 2" only). Carefully place the valve in the system between the two end connections and fix if necessary.
5. Tighten the union nut on the side opposite to that which is marked "ADJUST". Hand tightening is typically sufficient to maintain a seal for the maximum working pressure. **Over-tightening may damage the threads on the valve body and/or the union nut, and may even cause the union nut to crack**.

VKD Series Ball Valves

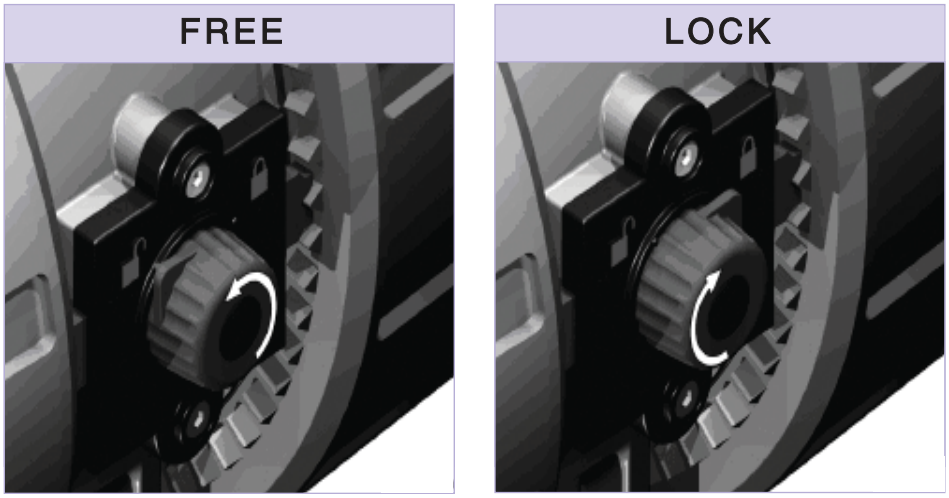
Installation Procedures

Size 1/2" - 2"



Size 2-1/2" – 4"

6. Tighten the union nut on the side marked "ADJUST". Tightening the union nuts in this order results in the best possible valve performance due to optimum positioning and sealing of the ball and seat support system.
7. Open and close the valve to again ensure that the cycling performance is adequate. If adjustment is required, place the valve in the closed position, loosen the union nuts, remove the valve from the system, and then continue from Step 3.
8. Engage the Dual Block® system by affixing the molded piece (16, sizes 1/2" to 2") to the side of the valve body or by turning the red knob (27, sizes 2-1/2" to 4") to the locked position. This feature will prevent back-off of the union nuts during operation.

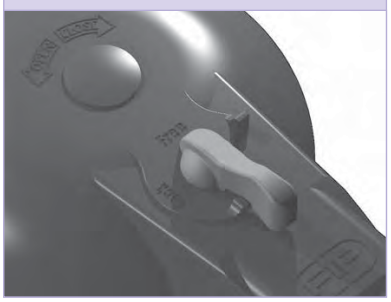


VKD Series Ball Valves

Testing and Operating

Size 2-1/2"

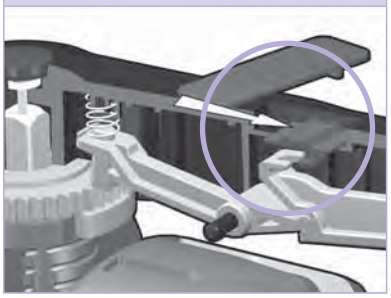
FREE



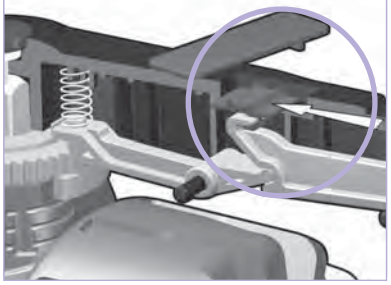
LOCK

Sizes 3" & 4"

FREE



LOCK



The purpose of system testing is to assess the quality of all joints and fittings to ensure that they will withstand the design working pressure, plus a safety margin, without loss of pressure or fluid. Typically, the system will be tested and assessed in sub-sections as this allows for improved isolation and remediation of potential problems. With this in mind, the testing of a specific installed valve is achieved while carrying out a test of the overall system.

An onsite pressure test procedure is outlined in the IPEX Industrial Technical Manual Series, *"Volume I: Vinyl Process Piping Systems"* under the section entitled, *"Testing"*. The use of this procedure should be sufficient to assess the quality of a valve installation. **In any test or operating condition, it is important to never exceed the pressure rating of the lowest rated appurtenance in the system.**

Important points:

- Never test thermoplastic piping systems with compressed air or other gases including air-over-water boosters.
- When testing, do not exceed the rated maximum operating pressure of the valve.
- Avoid the rapid closure of valves to eliminate the possibility of water hammer which may cause damage to the pipeline or the valve.

For safety reasons, please contact IPEX customer service and technical support when using volatile liquids such as hydrogen peroxide (H_2O_2) and sodium hypochlorite (NaClO). These liquids may vaporize causing a potentially dangerous pressure increase in the dead space between the ball and the valve body. Special VKD ball valves are available for these types of critical applications.

Note: The VKD handle incorporates a locking mechanism that prevents unintentional rotation. When engaged, the spring-loaded handle release is locked and the valve cannot be cycled. A padlock can be installed through this portion of the handle as an additional safety precaution.

Please contact IPEX customer service and technical support with regard to any concern not addressed in this data sheet or the technical manual.

VKD Series Ball Valves

About the IPEX Group of Companies

As leading suppliers of thermoplastic piping systems, the IPEX Group of Companies provides our customers with some of the world's largest and most comprehensive product lines. All IPEX products are backed by more than 50 years of experience. With state-of-the-art manufacturing facilities and distribution centers across North America, we have established a reputation for product innovation, quality, end-user focus and performance.

Markets served by IPEX group products are:

- Electrical systems
- Telecommunications and utility piping systems
- PVC, CPVC, PP, ABS, PEX, FR-PVDF and PE pipe and fittings (1/4" to 48")
- Industrial process piping systems
- Municipal pressure and gravity piping systems
- Plumbing and mechanical piping systems
- PE Electrofusion systems for gas and water
- Industrial, plumbing and electrical cements
- Irrigation systems

Products manufactured by IPEX Inc. and distributed in the United States by IPEX USA LLC.

This literature is published in good faith and is believed to be reliable. However, it does not represent and/or warrant in any manner the information and suggestions contained in this brochure. Data presented is the result of laboratory tests and field experience.

A policy of ongoing product improvement is maintained. This may result in modifications of features and/or specifications without notice.

Products manufactured by IPEX Inc. and distributed in the United States by IPEX USA LLC.

VKD SERIES BALL VALVE - TRUE UNION, PNEUMATIC - DOUBLE ACTING

PVC w PTFE Seats

End Connection	Size inches	EPDM Product Code	Viton® Product Code
S/T	1/2	253296	253305
S/T	3/4	253297	253306
S/T	1	253298	253307
S/T	1-1/4	253299	253308
S/T	1-1/2	253300	253309
S/T	2	253301	253310
Socket	2-1/2	253302	253311
Socket	3	253303	253312
Socket	4	253304	253313

Corzan® CPVC w PTFE Seats

End Connection	Size inches	EPDM Product Code	Viton® Product Code
S/T	1/2	253314	253323
S/T	3/4	253315	253324
S/T	1	253316	253325
S/T	1-1/4	253317	253326
S/T	1-1/2	253318	253327
S/T	2	253319	253328
Socket	2-1/2	253320	253329
Socket	3	253321	253330
Socket	4	253322	253331

Pneumatic - Spring Return, Normally Open

PVC w PTFE Seats

S/T	1/2	253368	253377
S/T	3/4	253369	253378
S/T	1	253370	253379
S/T	1-1/4	253371	253380
S/T	1-1/2	253372	253381
S/T	2	253373	253382
Socket	2-1/2	253374	253383
Socket	3	253375	253384
Socket	4	253376	253385

Pneumatic - Spring Return, Normally Open

Corzan® CPVC w PTFE Seats

S/T	1/2	253386	253395
S/T	3/4	253387	253396
S/T	1	253388	253397
S/T	1-1/4	253389	253398
S/T	1-1/2	253390	253399
S/T	2	253391	253400
Socket	2-1/2	253392	253401
Socket	3	253393	253402
Socket	4	253394	253403

Pneumatic - Spring Return, Normally Closed

PVC w PTFE Seats

S/T	1/2	253332	253341
S/T	3/4	253333	253342
S/T	1	253334	253343
S/T	1-1/4	253335	253344
S/T	1-1/2	253336	253345
S/T	2	253337	253346
Socket	2-1/2	253338	253347
Socket	3	253339	253348
Socket	4	253340	253349

Pneumatic - Spring Return, Normally Closed

Corzan® CPVC w PTFE Seats

S/T	1/2	253350	253359
S/T	3/4	253351	253360
S/T	1	253352	253361
S/T	1-1/4	253353	253362
S/T	1-1/2	253354	253363
S/T	2	253355	253364
Socket	2-1/2	253356	253365
Socket	3	253357	253366
Socket	4	253358	253367

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 29 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

VKD SERIES BALL VALVE - ELECTRIC - DOUBLE ACTING, 110 VAC

PVC w PTFE Seats

End Connection	Size inches
S/T	1/2
S/T	3/4
S/T	1
S/T	1-1/4
S/T	1-1/2
S/T	2
Socket	2-1/2
Socket	3
Socket	4

Corzan® CPVC w PTFE Seats

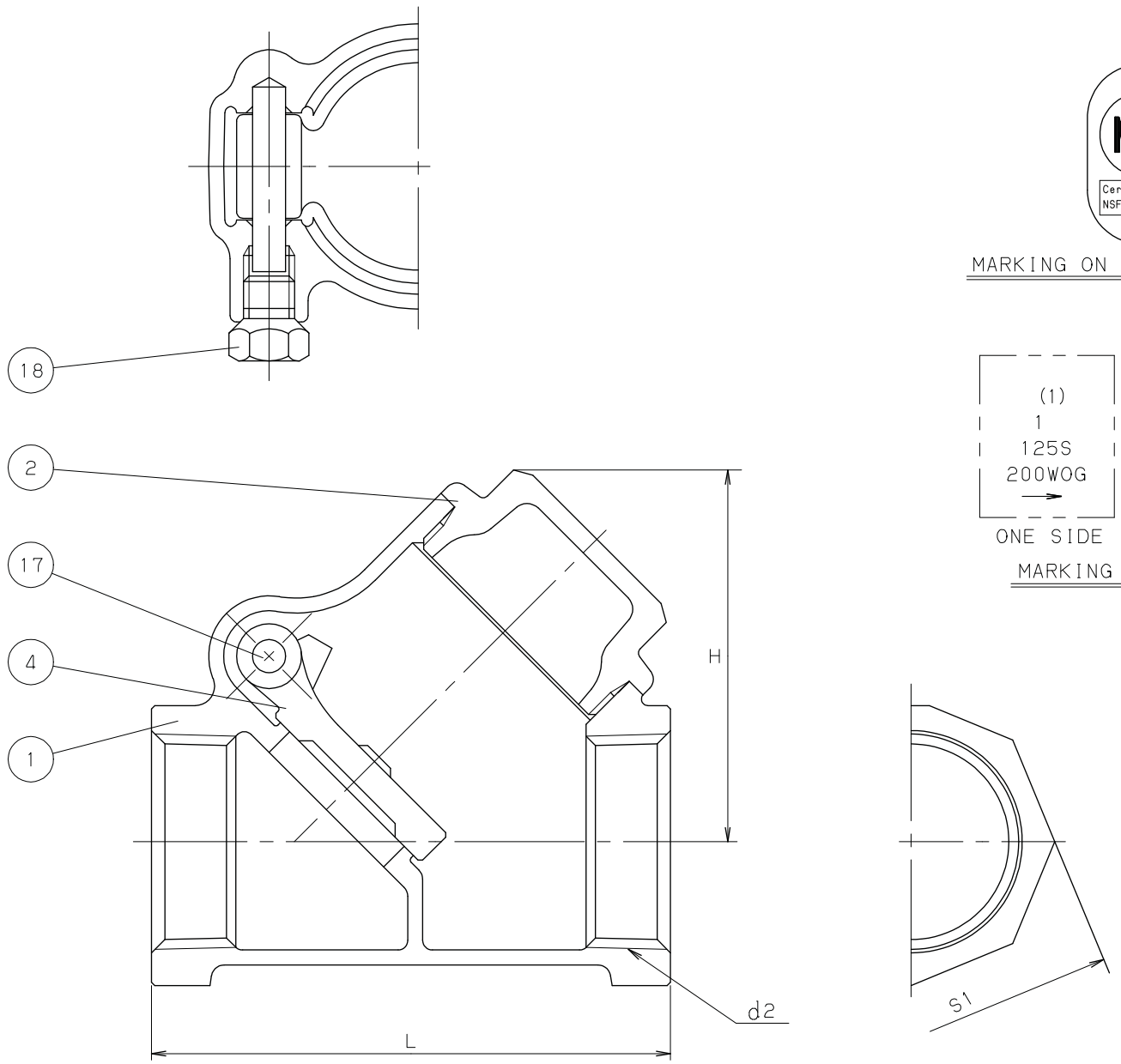
End Connection	Size inches
S/T	1/2
S/T	3/4
S/T	1
S/T	1-1/4
S/T	1-1/2
S/T	2
Socket	2-1/2
Socket	3
Socket	4

For electric valve actuation, you must order three separate components.

Contact IPEX Sales for assistance.

Check Valve 2 inches and less

236ALF



NSF Certified to NSF/ANS161-G

MARKING ON THE NAME PLATE

(1)
1
125S
200WOG

L F
RED-WHITE
TOYO

ONE SIDE THE OTHER SIDE

MARKING ON THE BODY

NO	NAME OF PARTS	QTY	MATERIALS	SPECIFICATIONS
1	BODY	1	CAST BRONZE	CDA No. C89530
			(CAC911 (2))	
2	CAP	1	FORGED BRASS	CDA No. C46750
			(KSB-4XA (3))	
4	DISC	1	CAST BRONZE	CDA No. C89530
			(CAC911 (2))	
17	HINGE PIN	1	COPPER	
18	PLUG	1	BRASS ROD	CDA No. C46750
			(KSB-4XC (3))	

SHOP DRAWING

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Reviewed By: M.M.
Date: 29 June 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

DIMENSIONS. UNIT:mm

NOMINAL SIZE	d2	H	L	S1		
1/2	NPT 1/2	40	56	28		
3/4	NPT 3/4	49	70	34		
1	NPT 1	58	80	41		
1.1/4	NPT 1.1/4	71	95	50		
1.1/2	NPT 1.1/2	80	110	57		
2	NPT 2	95	128	70		

NOTE (1) VALVE SIZE IDENTIFICATION.
(2) CAC911 IS LEAD FREE BRONZE.
(3) KSB-4XA AND KSB-4XC ARE LEAD FREE BRASS.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 27 june 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for Approval

SIFEC NORTH INC.

STANDARD		
	FACE TO FACE OR END TO END	TOYO STANDARD
	END CONNECTION	ASME B1.20.1
	WALL THICKNESS	TOYO STANDARD
	PRESSURE TEST	TOYO STANDARD
FIGURE		(RW02) AKYRN / No.236ALF

CLASS 125 LEAD FREE CAST BRONZE SWING CHECK VALVES

SCREW CAP, Y PATTERN, AND SCREW ENDS.

DATE APPD	JUN.18.'14	DRAWING NO	△		
APPD BY	T. KOYANAGI	813-000522	△		
CHKD BY	K. NAKAI		△		
DSGND BY	N. KAMA		△		
DRAWD BY	Y. WATANABE	REV-00	MARK	DATE	BY

TOYO VALVE CO., LTD.

TOYO

SC SERIES SWING CHECK VALVES

The SC combines superior flow rate with maximum versatility. With stainless wetted parts and hardware, top entry design, and extremely low back pressure requirements, these flanged valves are the perfect choice for back-flow prevention in large diameter lines, both vertical and horizontal. The SC is available in PVC with either EPDM or Viton® seals.

Pressure: up to 100 psi at 73°F depending on the size
Sizes: 3" – 8"

End Connection	Size inches	EPDM Product	Viton® Product Code
PVC			
Flanged	3	052289	053875
Flanged	4	052290	053876
Flanged	6	052291	053877
Flanged	8	052292	053878

SHOP DRAWING

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Reviewed By: M.M.
Date: 29 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 27 june 2016

Reviewed X
Reviewed as noted
Resubmit

Out for Approval

SIFEC NORTH INC.

VA SERIES AIR RELEASE VALVES - SINGL

The VA is one of only two such plastic valves in the industry, and the only one controlled by media and not pressure. Designed for tanks, slurries, or start-ups, the VA valve will economically and efficiently eliminate air or gas pockets as well as break potentially dangerous vacuums. This no-spill valve is offered in PVC with EPDM seals. Viton® sealing kits a also available.

Pressure: 232 psi
Sizes: 3/4", 1-1/4" and 2"

EPDM Product Code
053559
053560
053561

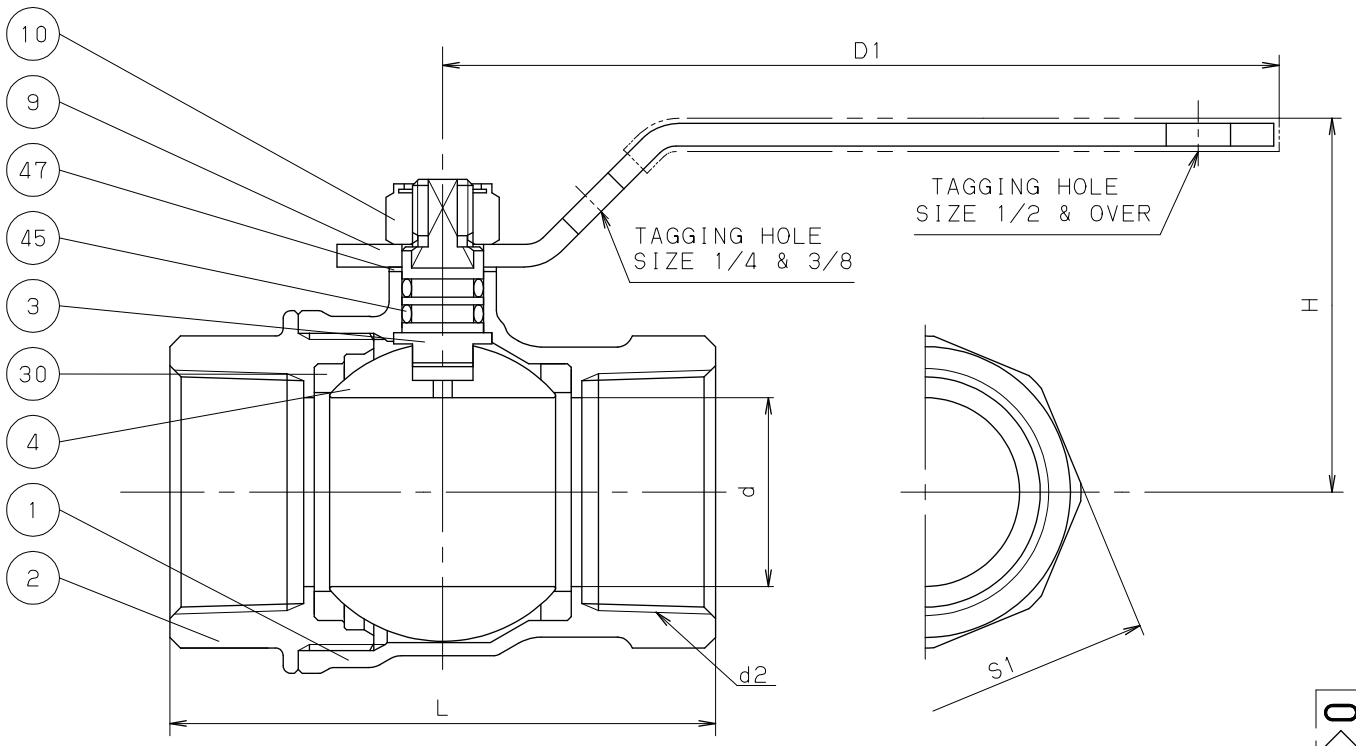
& threaded) end

connectors for the exhaust port

Size inches	Product Code
Viton® O-ring Set	
3/4	153845
1-1/4	153846
2	153847

Ball Valves 1/2 @ 1 inch

5044 ALF



SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 27 june 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for Approval

SIFEC NORTH INC.

NO	NAME OF PARTS	QTY	MATERIALS	SPECIFICATIONS
1	BODY	1	FORGED BRASS	CDA No. C46750
			(KSB-4XA (4))	
2	BODY CAP	1	FORGED BRASS	CDA No. C46750
			(KSB-4XA (4))	
3	STEM	1	BRASS ROD	CDA No. C46750
			(KSB-4XC (4))	
4	BALL	1	FORGED BRASS (2)	CDA No. C46750
			(KSB-4XA (4))	(UP TO SIZE 3/4)
		1	STAINLESS STEEL	A351 Gr. CF8
			(SCS13A)	(SIZE 1 & OVER)
9	HANDLE	1	CARBON STEEL (3)	
10	HANDLE NUT	1	CARBON STEEL	
30	BALL SEAT	2	PTFE	
45	O RING	2	FKM	
47	THRUST WASHER	1	PBT	

SHOP DRAWING

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Reviewed By: M.M.

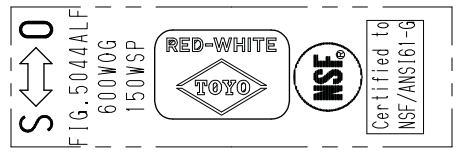
Date: 29 June 2016

Reviewed [X]

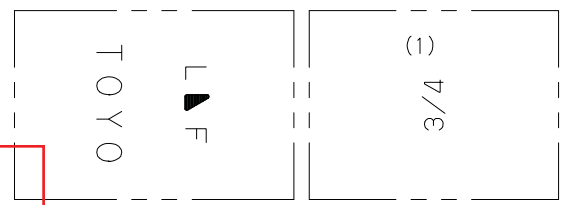
Reviewed as noted [ ]

Resubmit [ ]

CHIARELLI ENGINEERING LTD.



HANDLE MARKING



ONE SIDE THE OTHER SIDE

MARKING ON THE BODY

DIMENSIONS UNIT:inch

NOMINAL SIZE	d	d2	H	D1	L	S1		
1/4	0.39	NPT1/4	1.46	2.76	1.65	0.79		
3/8	0.39	NPT3/8	1.46	2.76	1.65	0.87		
1/2	0.59	NPT1/2	1.57	3.15	2.08	1.02		
3/4	0.79	NPT3/4	1.69	3.15	2.36	1.26		
1	0.98	NPT 1	1.97	4.33	2.83	1.54		
1.1/4	1.26	NPT1.1/4	2.16	4.33	3.31	1.89		
1.1/2	1.57	NPT1.1/2	2.52	5.90	3.62	2.17		
2	1.97	NPT 2	2.83	5.90	4.33	2.68		

NOTE (1) VALVE SIZE IDENTIFICATION.
(2) SnNi PLATING
(3) ZINC DICHROMATE PLATED AND PLASTIC COVERING.
(4) KSB-4XA AND KSB-4XC ARE LEAD FREE BRASS.

STANDARD		
	FACE TO FACE OR END TO END	TOYO STANDARD
	END CONNECTION	ASME B1.20.1
	WALL THICKNESS	TOYO STANDARD
	PRESSURE TEST	TOYO STANDARD
FIGURE		(TY) AKSZAN/NO.5044ALF

TYPE 600 LEAD FREE FORGED BRASS

BALL VALVES

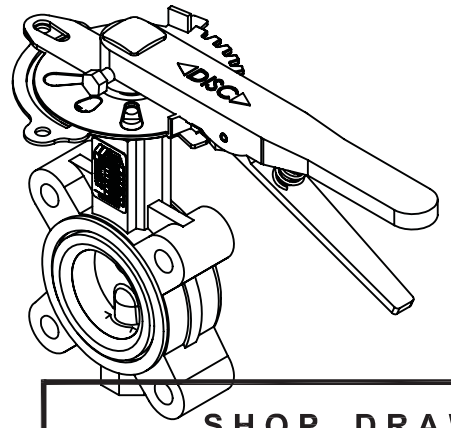
DATE APPD	JUN.20.'14	DRAWING NO	△		
APPD BY	T. KOYANAGI	825-001913	△		
CHKD BY	K. NAKAI		△		
DSGND BY	N. KAMA		△		
DRAWD BY	Y. WATANABE	REV-00	MARK	DATE	BY

TOYO VALVE CO., LTD.

TOYO

Butterfly Valves for use water pipe

in/mm									lbs/kgs
Size	L	∅D	n x M	h1	h2	A	B	Q	Assembly Weight
2"	1.69	4.75	4 x 5/8-11 UNC	2.60	5.12	8.7	1.3	1.13	6.5
DN50	42.9	121		66.0	130	221	33	28.7	3.0
2.5"	1.81	5.50	4 x 5/8-11 UNC	3.23	5.55	8.7	1.3	1.79	7.8
DN65	46.0	140		82.0	141	221	33	45.5	3.5
3"	1.81	6.00	4 x 5/8-11 UNC	3.54	5.83	8.7	1.3	2.45	8.6
DN75	46.0	152		89.9	148	221	33	62.2	3.9
4"	2.05	7.50	8 x 5/8-11 UNC	4.25	6.69	10.2	1.4	3.50	14.8
DN100	52.1	191		108	170	260	36	88.9	6.7
5"	2.20	8.50	8 x 3/4-10 UNC	4.84	7.36	10.2	1.4	4.55	19.2
DN125	55.9	216		123	187	260	36	116	8.7
6"	2.20	9.50	8 x 3/4-10 UNC	5.43	7.95	10.2	1.4	5.71	22.7
DN150	55.9	241		138	202	260	36	145	10.3
8"	2.36	11.75	8 x 3/4-10 UNC	6.69	9.37	14.2	1.7	7.77	36.6
DN200	59.9	299		170	238	360	43	197	16.6
10"	2.68	14.25	12 x 7/8-9 UNC	7.87	10.7	14.2	1.7	9.76	57.8
DN250	68.1	362		200	272	360	43	248	26.3
12"	3.07	17.00	12 x 7/8-9 UNC	9.29	12.0	14.2	1.7	11.7	79.5
DN300	78.0	432		236	305	360	43	298	36.1



#	MAS Part No.	Description
1	L-D-4-S-E-LH	Butterfly Valve
2	HANDLE XXX-XX	Lever - 10 pos throttle plate
3	MAS ID Plate	Identification tag w/ trim code
4	NSF-372 Tag	CSA/NSF-372 Compliance Tag

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 27 june 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for Approval

SIFEC NORTH INC.

SHOP DRAWING

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Reviewed By: M.M.

Date: 29 June 2016

Reviewed [X]

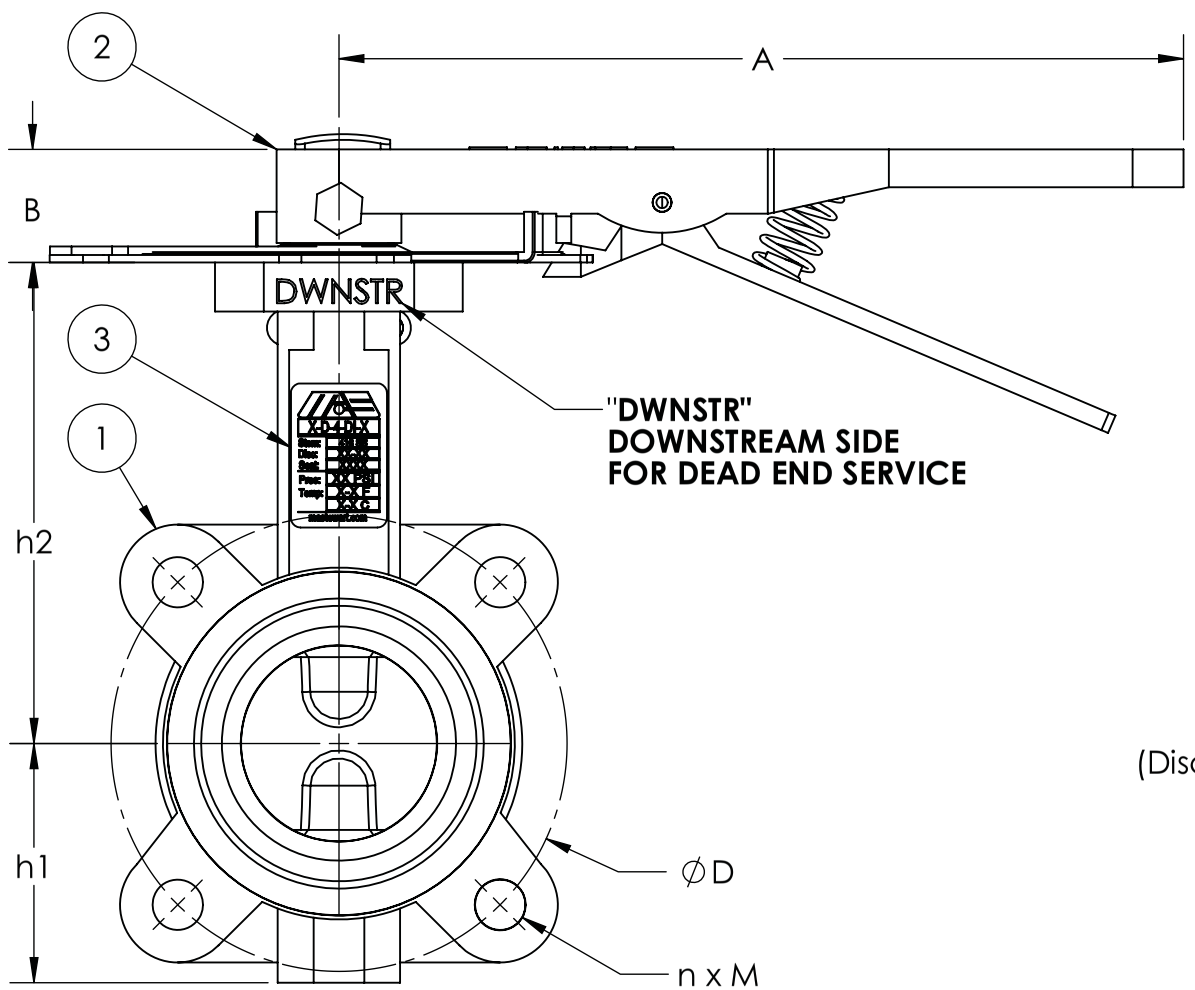
Reviewed as noted [ ]

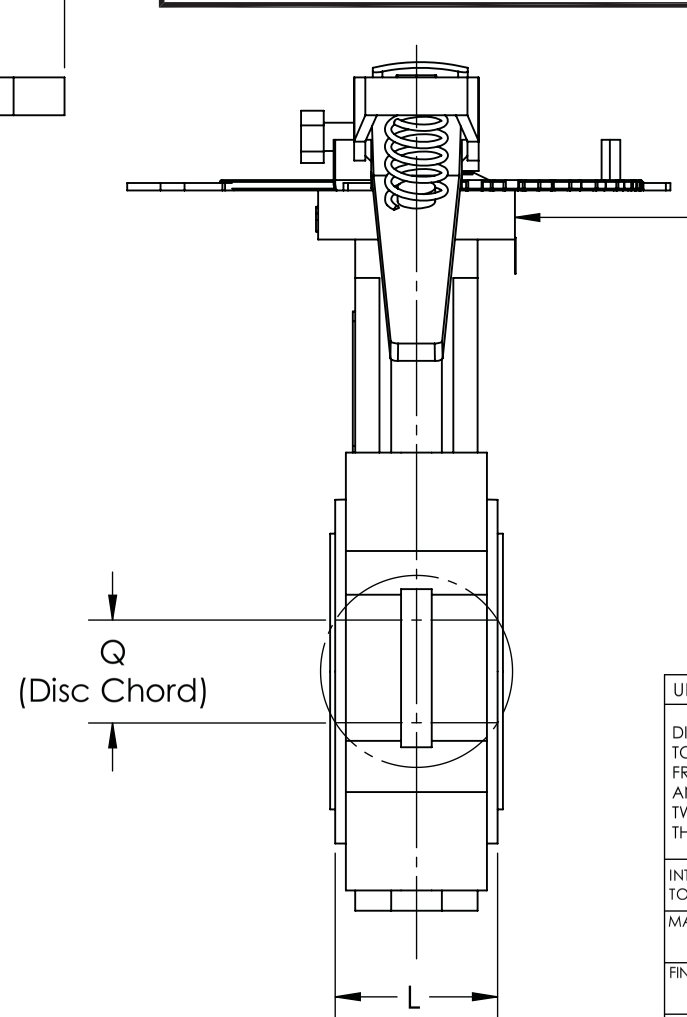
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

4 CSA/NSF-372 Compliance Tag:

NSF/ANSI 372
LOW LEAD CONTENT ONLY
MC#218481





Specifications	
Temp. Rating	-4-275°F (-20-135°C)
Press. Rating	200 PSI
Design to: MSS-SP-67 & API-609	
Markings to: MSS-SP-25	
NSF-372 Compliance: Low Lead Content Only	

Materials		
Valve	Body	Ductile Iron ASTM A536
	Stem	416 SS ASTM A582
	Disc	Stainless Steel ASTM A351 CF8M
	Seat	EPDM
Handle		Painted Malleable Iron w/ ABS Plug
Throttle plate		Zinc-Plated Steel

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	SE	5/3/13
	CHECKED		
	REVISIONS:	SE	11/18/13
		SE	5/13/14
INTERPRET GEOMETRIC TOLERANCING PER:	PROJECT:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

M.A. Stewart & Sons Ltd.
12900 - 87th Avenue
Surrey, B.C. V3W 3H9
Toll-Free: (800) 594-8431
Fax: (604) 594-4335
www.mastewart.com

TITLE:
MAS D Series Lug BFV
L-D-4-S-E-LH (2-12")

SIZE	DWG. NO.	REV
B	2-12in L-D-4-S-E-LH	2

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1

Chapter 17 PROCESS PUMPS

MANUFACTURER/DISTRIBUTOR:

Real-Jean
A/S Hugo Porier
8165-75 Lafrenaie
Montréal, Qc, H1P 2B1
Email: hpoirier@real-jean.com
Tel:(514)279-8592
Fax: (514)279-8595

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax :(514) 344-9341

17.1 **GRUNDFOS SUBMERSIBLE PUMP**

17.2 **GRUNDFOS SUBMERSIBLE PUMP MOTOR**

17.3 **ARMSTRONG COMPASS 20-20SS (P2 & P3)**

17.4 **Wilo Stratos Z 1.5 x 3 - 40 #2113420 (NSF61) (PS1 & PS2)**

WP-1 & WP-2

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
300S30-1B	A	3	4"	3" NPT	38.1	23.6	14.5	3.8	5.7	65
300S50-1	A	5	4"	3" NPT	44.1	29.6	14.5	3.8	5.7	82
300S50-2BB	A	5	4"	3" NPT	49.1	29.6	19.5	3.8	5.7	87
300S75-2	A	7 1/2	4"	3" NPT	43.5	24.0	19.5	3.8	5.7	113
300S75-2*	A	7 1/2	6"	3" NPT	49.1	29.6	19.5	5.4	5.7	104
300S100-3A	A	10	4"	3" NPT	67.8	43.9	23.9	3.8	5.7	154
300S100-3A	A	10	6"	3" NPT	49.3	25.4	23.9	5.4	5.7	130
300S150-3	A	15	6"	3" NPT	51.9	28.0	23.9	5.4	5.7	146
300S150-4AA	A	15	6"	3" NPT	56.4	28.0	28.4	5.4	5.7	161
300S150-4	A	15	6"	3" NPT	56.4	28.0	28.4	5.4	5.7	161
300S200-5AA	A	20	6"	3" NPT	63.4	30.6	32.8	5.4	5.7	172
300S200-5	A	20	6"	3" NPT	63.4	30.6	32.8	5.4	5.7	172
300S200-6B	A	20	6"	3" NPT	67.9	30.6	37.3	5.4	5.7	177
300S250-6	A	25	6"	3" NPT	70.4	33.1	37.3	5.4	5.7	192
300S250-7AA	A	25	6"	3" NPT	74.8	33.1	41.7	5.4	5.7	201
300S300-7	A	30	6"	4" NPT	74.8	33.1	41.7	5.4	5.7	220
300S300-8	A	30	6"	4" NPT	81.9	35.7	46.2	5.4	5.7	241
300S300-9B	A	30	6"	4" NPT	81.9	35.7	46.2	5.4	5.7	246
300S400-9*	A	40	6"	4" NPT	91.4	40.8	50.6	5.4	5.7	281
300S400-10*	A	40	6"	4" NPT	95.9	40.8	55.1	5.4	5.7	286
300S500-11*	A	50	6"	4" NPT	117.3	57.8	59.5	5.4	5.7	292
300S500-12*	A	50	6"	4" NPT	116.8	57.8	63.9	5.4	5.7	396
300S500-13*	A	50	6"	4" NPT	126.2	57.8	68.4	5.4	5.7	402
300S600-14*	A	60	6"	4" NPT	135.3	61.3	74.0	5.4	7.1	447
300S600-15*	A	60	8"	4" NPT	120.3	41.8	78.5	7.5	7.1	484
300S750-16	A	75	8"	4" NPT	130.3	47.4	82.9	7.5	7.1	540
300S750-17	A	75	8"	4" NPT	134.8	47.4	87.4	7.5	7.1	544
300S750-18	A	75	8"	4" NPT	139.2	47.4	91.8	7.5	7.1	626

NOTES: Models 2-15 Stgs. are suitable for use in 6" wells, 16-18 Stgs. are suitable for use in 8" wells.
Weights include pump end with motor in lbs.
* Alternate motor sizes available.

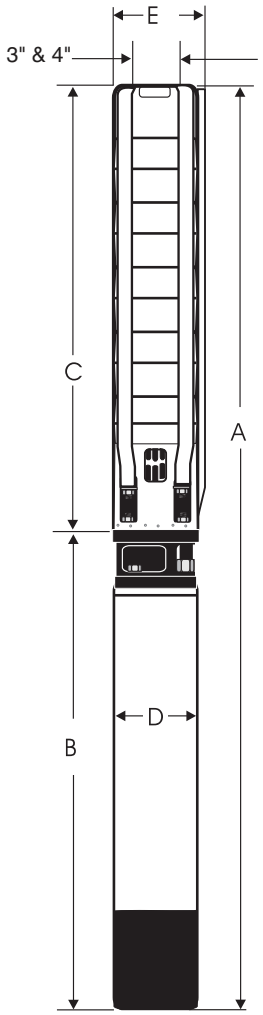


Fig. A

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016

Reviewed X
Reviewed as noted
Resubmit

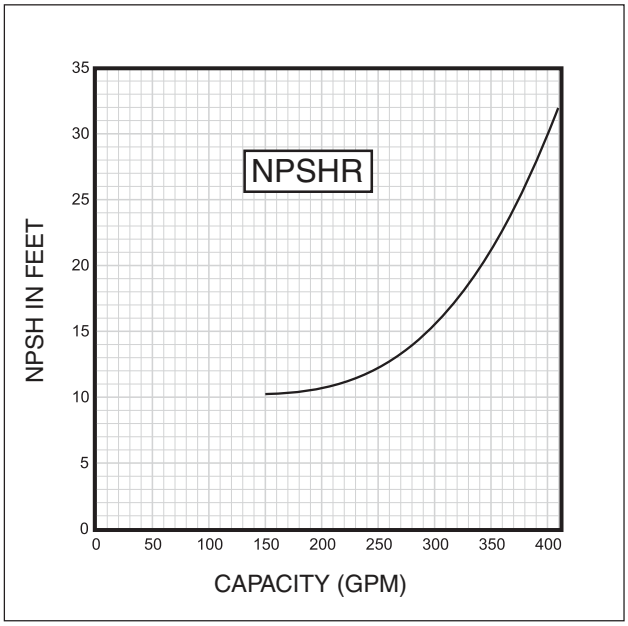
Out for approval

SIFEC NORTH INC.

MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (2-18 Stgs.)
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Split Cone Nut	304 Stainless Steel
Split Cone	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Coupling	316/329 Stainless Steel**
Pump Shaft	431 Stainless Steel
Intermediate Bearings	NBR
Impeller Seal Ring	NBR/304 Stainless Steel
Check Valve Seat	NBR/316 Stainless Steel
Top/Lower Bearing	NBR/316 Stainless Steel
8" Motor Adaptor Plate	304 Stainless Steel
Upthrust Washer	Carbon/Graphite HY22
Upthrust stop ring	304 S.S./Tungsten Carbide

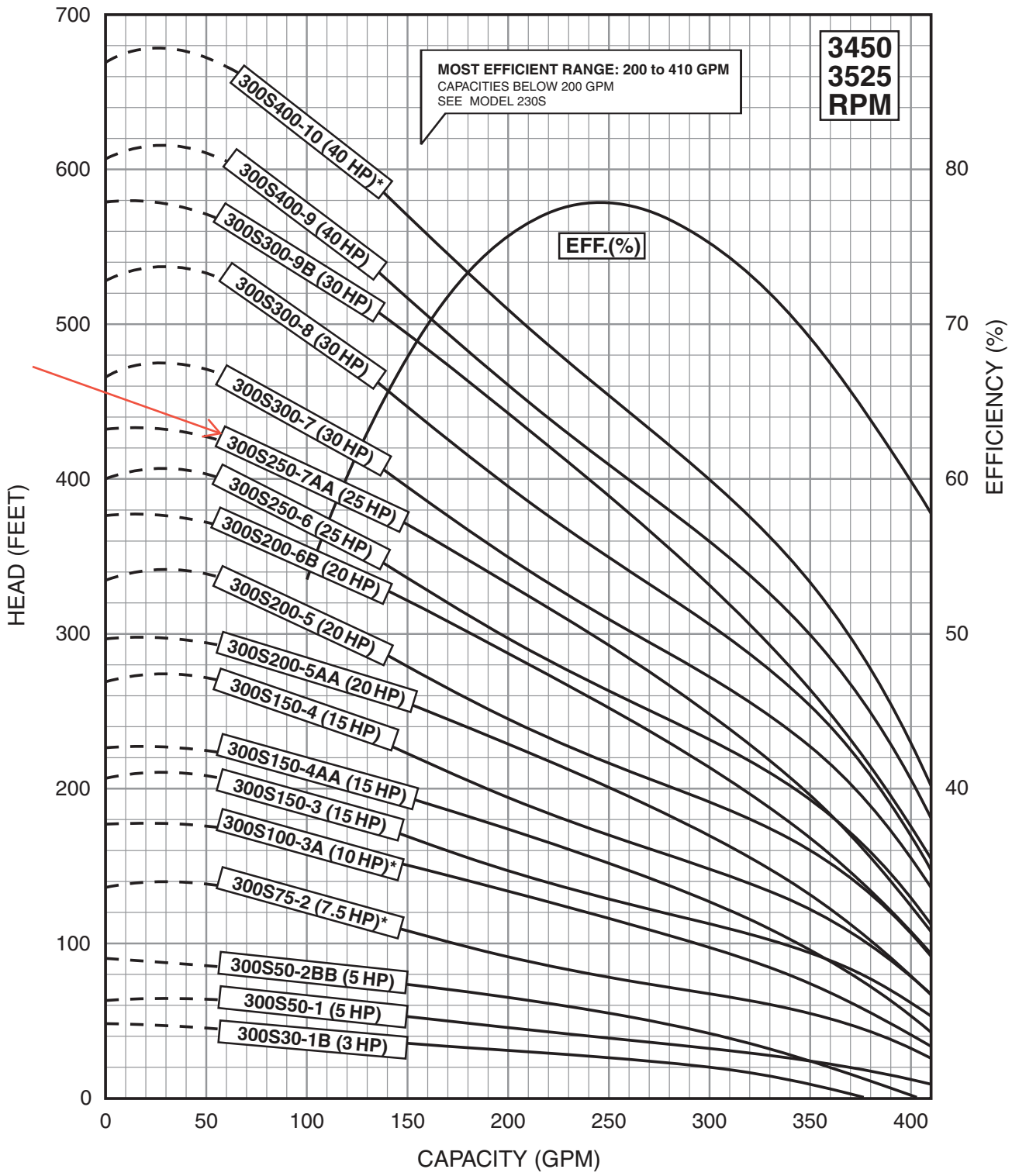
NOTES: Specifications are subject to change without notice.
***Stainless Steel options available.**
** 4" Coupling made of 316 Stainless Steel.



PERFORMANCE CURVES 300 GPM MODEL 300S

WP-1 & WP-2

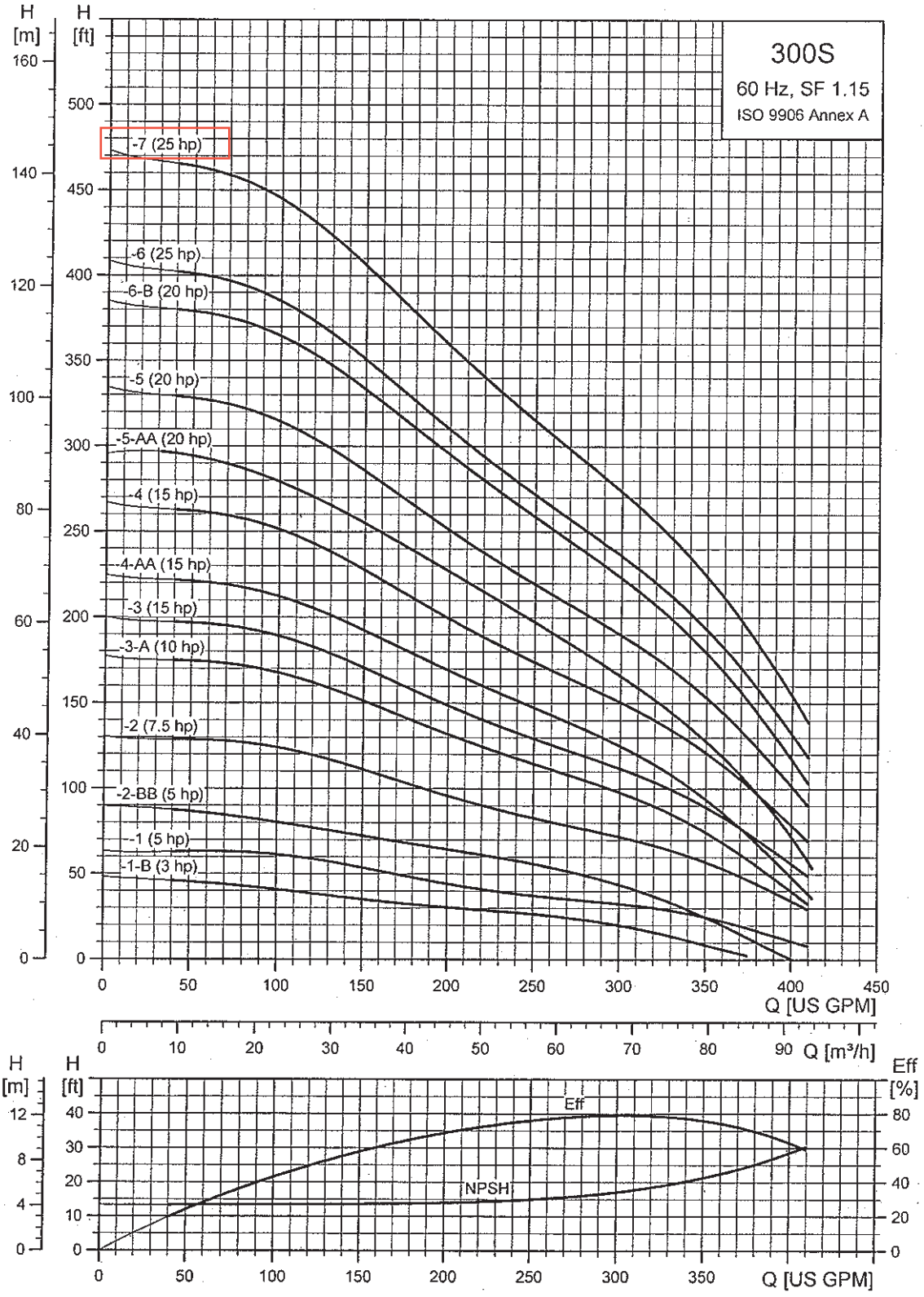
FLOW RANGE: 60 -410 GPM **OUTLET SIZE: 3"& 4" NPT*** **NOMINAL DIA. 6"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 7.5 HP/3450 RPM.
6" MOTOR STANDARD,15-60 HP/3450 RPM.
8" MOTOR STANDARD, 75 HP/3525 RPM.
* 3" NPT 2-6 STAGES, 4" NPT 7-18 STAGES.

Performance conforms to ISO 9906 Annex A
@ 8 ft. min. submergence.

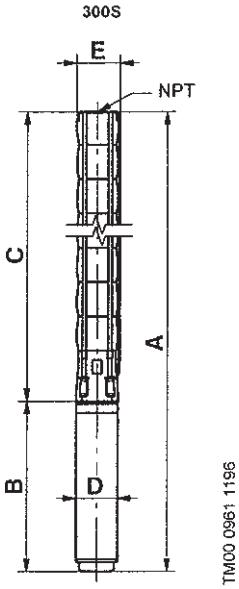
6" and larger wells - continued
SP 300S (300 gpm)



6" and larger wells - continued

SP 300S (300 gpm) / 6, 8 inch motor

Pump model	Nom. head [ft]	Ph	Volts [V]	Motor [Hp]		Dimensions A [in. (mm)]	B [in. (mm)]	C [in. (mm)]	D [in. (mm)]	E [in. (mm)]	Net weight (complete) [lb]
300S - Motor dia. 6 inch, 60 Hz, rated flow 300 gpm (4" NPT)											
300S250-7AA	249	3	230	25	▲	73.98 (1879)	31.78 (807)	42.21 (1072)	5.52 (140)	5.79 (147)	217.8
		3	460	25	▲	73.98 (1879)	31.78 (807)	42.21 (1072)	5.52 (140)	5.79 (147)	217.8
300S300-7	267	3	230	30	▲	76.34 (1939)	34.14 (867)	42.21 (1072)	5.52 (140)	5.79 (147)	217.8
		3	460	30	▲	76.34 (1939)	34.14 (867)	42.21 (1072)	5.52 (140)	5.79 (147)	217.8
300S300-8	307	3	230	30	▲	80.79 (2052)	34.14 (867)	46.66 (1185)	5.52 (140)	5.79 (147)	224.1
		3	460	30	▲	80.79 (2052)	34.14 (867)	46.66 (1185)	5.52 (140)	5.79 (147)	224.1
300S300-9B	329	3	230	30	▲	85.24 (2165)	34.14 (867)	51.11 (1298)	5.52 (140)	5.79 (147)	261.0
		3	460	30	▲	85.24 (2165)	34.14 (867)	51.11 (1298)	5.52 (140)	5.79 (147)	261.0
300S400-9	346	3	460	40	▲	90.36 (2295)	39.26 (997)	51.11 (1298)	5.52 (140)	5.79 (147)	296.0
300S400-10	385	3	460	40	▲	94.81 (2408)	39.26 (997)	55.56 (1411)	5.52 (140)	5.79 (147)	300.5
300S400-11	425	3	460	40	☼	99.26 (2521)	39.26 (997)	60.00 (1524)	5.52 (140)	5.79 (147)	352.0
300S500-12	464	3	460	50	☼	120.56 (3062)	56.11 (1425)	64.45 (1637)	5.67 (144)	5.79 (147)	348.8
300S500-13	504	3	460	50	☼	125.00 (3175)	56.11 (1425)	68.90 (1750)	5.67 (144)	5.79 (147)	355.1
300S600-14	543	3	460	60	*	-	-	73.35 (1863)	-	5.79 (147)	-
300S600-15	582	3	460	60	*	-	-	77.80 (1976)	-	5.79 (147)	-
SP 300S - Motor dia. 8 inch, 60 Hz, rated flow 230 gpm (4" NPT)											
300S600-14	543	3	460	60	*	125.12 (3178)	50.00 (1270)	75.12 (1908)	7.56 (192)	7.56 (192)	479.4
300S600-15	582	3	460	60	*	129.57 (3291)	50.00 (1270)	79.57 (2021)	7.56 (192)	7.56 (192)	519.4
300S750-16	622	3	460	75	*	137.17 (3484)	53.15 (1350)	84.02 (2134)	7.56 (192)	7.56 (192)	569.1
300S750-17	661	3	460	75	*	141.62 (3597)	53.15 (1350)	88.47 (2247)	7.56 (192)	7.56 (192)	575.4
300S750-18	701	3	460	75	*	146.07 (3710)	53.15 (1350)	92.92 (2360)	7.56 (192)	7.56 (192)	581.7



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
Performance conforms to ISO 9906 Annex A @ 8 ft. minimum submergence.

▲ MS 6000C motor.

☼ Takes MMS 6 motor; not available as complete.

* Takes MMS 8000 motor; not available as complete.

SP

Installation and operating instructions

Other languages

http://net.grundfos.com/qr/i/98074911

be
think
innovate

GRUNDFOS

Original installation and operating instructions.

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Warning

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

1. Symbols used in this document

Warning

If these safety instructions are not observed, it may result in personal injury.

Warning

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

Caution — If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

Note — Notes or instructions that make the job easier and ensure safe operation.

2. Introduction

These instructions apply to Grundfos submersible pumps, type SP, with submersible motors, types Grundfos MS/MMS or Franklin 4"-8".

If the pump is fitted with a motor of another motor make than Grundfos MS or MMS, note that the motor data may differ from the data stated in these instructions.

Note — The USB stick supplied with the product contains installation and operating instructions in various languages.

3. Delivery and storage

3.1 Delivery

Caution — The pump should remain in the packing until it is placed in vertical position during installation.

Handle the pump with care.

When the pump part and motor are supplied as separate units (long pumps), fit the motor to the pump as described in section *7.1 Fitting the motor to the pump*.

Note — The extra nameplate supplied with the pump should be fixed at the installation site.

Do not expose the pump to unnecessary impact and shocks.

3.2 Storage

Storage temperature

Pump: -20 °C to +60 °C.
Motor: -20 °C to +70 °C.

The motors must be stored in a closed, dry and well ventilated room.

Caution — If MMS motors are stored, the shaft must be turned by hand at least once a month. If a motor has been stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use.

The pump should not be exposed to direct sunlight.

If the pump has been unpacked, it should be stored horizontally, adequately supported, or vertically to prevent misalignment of the pump. Make sure that the pump cannot roll or fall over.

During storage, the pump can be supported as shown in fig. 1.

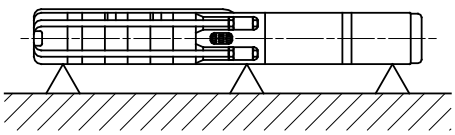

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Fig. 1 Pump position during storage

3.2.1 Frost protection

If the pump has to be stored after use, it must be stored on a frost-free location, or the motor liquid must be frost-proof.

4. Applications

Grundfos SP submersible pumps are designed for a wide range of water supply and liquid transfer applications, such as the supply of fresh water to private homes or waterworks, water supply in horticulture and agriculture, drawdown of groundwater and pressure boosting, and various industrial jobs.

The pump must be installed so that the suction interconnector is completely submerged in the liquid. The pump can be installed horizontally or vertically. See section *5.2 Positional requirements*.

4.1 Pumped liquids

Clean, thin, non-explosive liquids without solid particles or fibres.

The maximum sand content of the water must not exceed 50 g/m^3. A larger sand content will reduce the life of the pump and increase the risk of blockage.

Caution When pumping liquids with a density higher than that of water, motors with correspondingly higher outputs must be used.

If liquids with a viscosity higher than that of water are to be pumped, contact Grundfos.

The pump versions SP A N, SP A R, SP N, SP R and SPE are designed for liquids with higher aggressiveness than drinking water.

The maximum liquid temperature appears from section *5.4 Liquid temperatures/cooling*.

4.2 Sound pressure level

The sound pressure level has been measured in accordance with the rules laid down in the EC machinery directive 2006/42/EC.

Sound pressure level of pumps

The values apply to pumps submerged in water, without external regulating valve.

Pump type	$\overline{L}_{pA}$ [dB(A)]
SP 1A	< 70
SP 2A	< 70
SP 3A	< 70
SP 5A	< 70
SP 7	< 70
SP 9	< 70
SP 11	< 70
SP 14	< 70
SP 17	< 70
SP 30	< 70
SP 46	< 70
SP 60	< 70
SP 77	< 70
SP 95	< 70
SP 125	79
SP 160	79
SP 215	82

Sound pressure level of motors

The sound pressure level of Grundfos MS and MMS motors is lower than 70 dB(A).

Other motor makes: See installation and operating instructions for these motors.

5. Preparations before installation

Warning

Before starting work on the product, switch off the power supply. Make sure that the power supply cannot be accidentally switched on.

5.1 Checking the motor liquid

The motors are factory-filled with a special non-poisonous liquid which is frost-proof down to -20 °C.

Note Check the level of motor liquid and refill if required. Use clean water.

Caution If frost protection is required, special Grundfos liquid must be used to refill the motor. Otherwise clean water may be used for refilling (however, never use distilled water).

Refill liquid as described below.

5.1.1 Grundfos MS 4000 and MS 402 motors

The filling hole for motor liquid is placed in the following positions:

- MS 4000: in the top of the motor.
- MS 402: in the bottom of the motor.

1. Position the submersible pump as shown in fig. 2. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See fig. 2.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torques

- MS 4000: 3.0 Nm.
- MS 402: 2.0 Nm.

The submersible pump is now ready for installation.

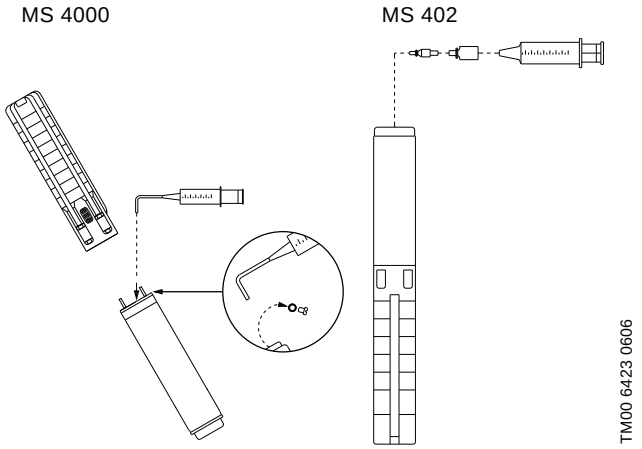

Fig. 2 Motor position during filling - MS 4000 and MS 402

5.1.2 Grundfos MS 6000 motors

- If the motor is delivered from stock, check the level of motor liquid before fitting the motor to the pump. See fig. 3.
- When pumps are delivered direct from Grundfos, the level has already been checked.
- Check the level in connection with service. See fig. 3.

The filling hole for motor liquid is placed at the top of the motor.

1. Position the submersible pump as shown in fig. 3. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See fig. 3.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torque: 3.0 Nm.

The submersible pump is now ready for installation.

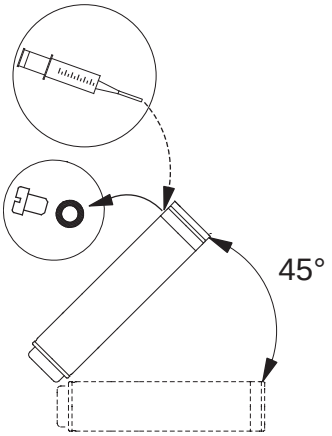

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Fig. 3 Motor position during filling - MS 6000

5.1.3 Grundfos MMS 6, MMS 8000, MMS 10000 and MMS 12000 motors

1. Place the motor at a 45 ° angle with the top of the motor upwards. See fig. 4.
2. Unscrew the plug A and place a funnel in the hole.
3. Pour tap water into the motor until the motor liquid inside the motor starts running out of A.

Caution Do not use motor liquid as it contains oil.

4. Remove the funnel and refit the plug A.

Caution Before fitting the motor to a pump after a long period of storage, lubricate the shaft seal by adding a few drops of water and turning the shaft.

The submersible pump is now ready for installation.

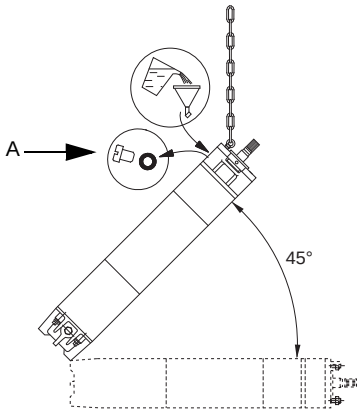

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Fig. 4 Motor position during filling - MMS

5.1.4 Franklin motors from 3 kW and up

Check the level of motor liquid in Franklin 4" and 6" motors by measuring the distance from the bottom plate to the built-in rubber diaphragm. The distance can be measured by inserting a rule or a small rod through the hole until it touches the diaphragm. See fig. 5.

Caution Take care not to damage the diaphragm.

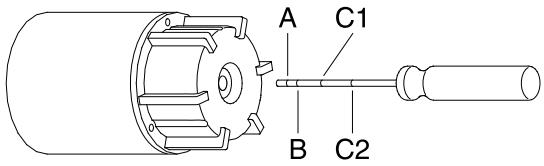

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Fig. 5 Measuring the distance from bottom plate to diaphragm

The table below shows the correct distance from the outside of the bottom plate to the diaphragm:

Motor	Dimension	Distance [mm]
Franklin 4", 0.25 - 3 kW (fig. 6a)	A	8
Franklin 4", 3 - 7.5 kW (fig. 6b)	B	16
Franklin 6", 4-45 kW (fig. 6c)	C1	35
Franklin 6", 4-22 kW (fig. 6d)	C2	59

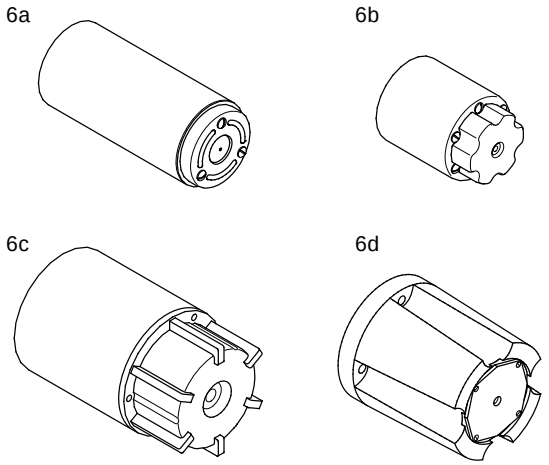

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Fig. 6 Franklin motors

If the distance is not correct, carry out an adjustment as described in section *5.1.5 Franklin motors*.

5.1.5 Franklin motors

Check the level of motor liquid in Franklin 8" motors as follows:

1. Press out the filter in front of the valve at the top of the motor using a screwdriver. If the filter is slotted, unscrew. Figure 7 shows the position of the filling valve.
2. Press the filling syringe against the valve and inject the liquid. See fig. 7. If the valve cone is depressed too far, it may be damaged thus causing the valve to leak.
3. Remove any air in the motor by pressing the point of the filling syringe lightly against the valve.
4. Repeat the process of injecting liquid and releasing air until the liquid starts running out or the diaphragm is in its correct position (Franklin 4" and 6").
5. Refit the filter.

The submersible pump is now ready for installation.

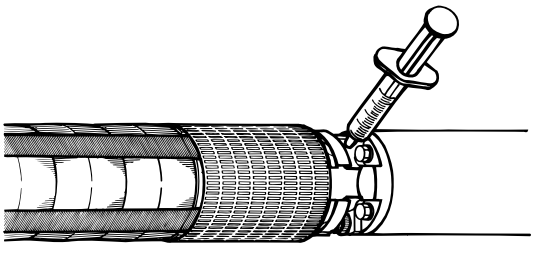


Fig. 7 Position of filling valve

5.2 Positional requirements

Warning

If the pump is to be installed in a position where it is accessible, the coupling must be suitably isolated from human touch. The pump can for instance be built into a flow sleeve.

Depending on motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section *5.2.1 Motors suitable for horizontal installation*.

If the pump is installed horizontally, the discharge port should never fall below the horizontal plane. See fig. 8.

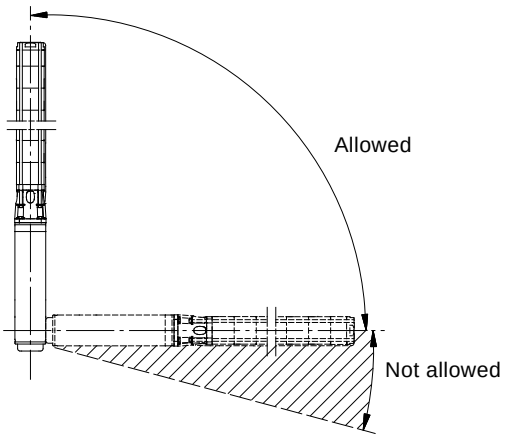


Fig. 8 Positional requirements

If the pump is installed horizontally, e.g. in a tank, we recommend that you fit it in a flow sleeve.

5.2.1 Motors suitable for horizontal installation

Motor	Output power 50 Hz	Output power 60 Hz
	[kW]	[kW]
MS	All	All
MMS 6	5.5 - 37	5.5 - 37
MMS 8000	22-110	22-110
MMS 10000	75-190	75-190
MMS 12000	147-250	147-250

When Franklin 4" motors up to and including 2.2 kW are started more than 10 times a day, we recommend that you incline the motor at least 15 ° above the horizontal plane in order to minimise wearing of the upthrust disc.

Caution During operation, the suction interconnector of the pump must always be completely submerged in the liquid. Make sure that the NPSH values are fulfilled.

Warning

If the pump is used for pumping hot liquids (40 to 60 °C), make sure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

5.3 Pump/motor diameter

We recommend that you check the borehole with an inside calliper to ensure unobstructed passage.

5.4 Liquid temperatures/cooling

The maximum liquid temperature and the minimum flow velocity past the motor appear from the table below.

We recommend that you install the motor above the well screen in order to achieve proper motor cooling.

Caution In cases where the stated flow velocity cannot be achieved, a flow sleeve must be installed.

If there is a risk of sediment build-up, such as sand, around the motor, use a flow sleeve in order to ensure proper cooling of the motor.

5.4.1 Maximum liquid temperature

Out of consideration for the rubber parts in pump and motor, the liquid temperature must not exceed 40 °C (~ 105 °F). See also the table below.

The pump can operate at liquid temperatures between 40 °C and 60 °C (~ 105 °F and 140 °F) provided that all rubber parts are replaced every third year.

Motor	Installation		
	Flow past the motor	Vertical	Horizontal
Grundfos MS 402 MS 4000 MS 6000	0.15 m/s	40 °C (~ 105 °F)	40 °C (~ 105 °F)
Grundfos MS 4000I*	0,15 m/s	60 °C (~ 140 °F) Flow sleeve recommended	60 °C (~ 140 °F) Flow sleeve recommended
Grundfos MS 6000I*	1.00 m/s		
Grundfos MMS	0.15 m/s	25 °C (~ 77 °F)	25 °C (~ 77 °F)
	0.50 m/s	30 °C (~ 86 °F)	30 °C (~ 86 °F)
Franklin 4"	0.08 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)
Franklin 6" and 8"	0.16 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)

* At an ambient pressure of minimum 1 bar (1 MPa).

Note 37 kW MMS 6, 110 kW MMS 8000 and 170 kW MMS 10000: The maximum operational liquid temperature is 5 °C lower than the values stated in the above table.

190 kW MMS 10000: The temperature is 10 °C lower.

5.5 Pipe connection

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

Note We recommend plastic pipes for 4" pumps only.

When using plastic pipes, secure the pump by an unloaded straining wire.

Warning

Make sure that the plastic pipes are suitable for the actual liquid temperature and the pump pressure.

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

6. Electrical connection

Warning

During electrical installation, make sure that the power supply cannot be accidentally switched on.

Warning

The electrical installation should be carried out by an authorised person in accordance with local regulations.

The supply voltage, rated maximum current and cos φ appear from the loose data plate which must be fitted close to the installation site.

The required voltage quality for MS and MMS motors, measured at the motor terminals, is - 10 %/+ 6 % of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

Check also that there is voltage symmetry in the power supply lines, i.e. same difference of voltage between the individual phases. See section *11. Checking motor and cable*, item 2.

Warning

The pump must be earthed.

The pump must be connected to an external mains switch with a minimum contact gap of 3 mm in all poles.

If MS motors with a built-in temperature transmitter (Tempcon) are not installed together with a MP 204 or similar Grundfos motor protection, they must be connected to a 0.47 µF capacitor approved for phase-phase operation (IEC 384-14) to meet the EC EMC directive (2004/108/EC). The capacitor must be connected to the two phases to which the temperature transmitter is connected. See fig. 9.

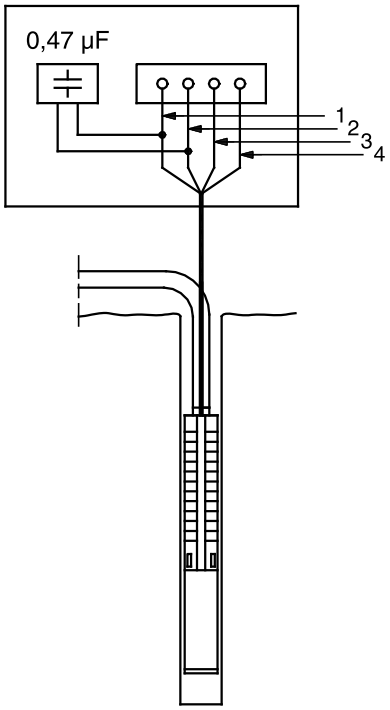


Fig. 9 Connection of capacitor

Colours of the leads		
Lead	**Flat cable**	**Single leads**
1 = L1	Brown	Black
2 = L2	Black	Yellow
3 = L3	Grey	Red
4 = PE	Yellow/green	Green

The motors are wound for direct-on-line starting or star-delta starting, and the starting current is between four and six times the rated current of the motor.

The run-up time of the pump is only about 0.1 second. Direct-on-line starting is therefore normally approved by the power supply company.

6.1 Frequency converter operation

6.1.1 Grundfos motors

Three-phase Grundfos motors can be connected to a frequency converter.

Caution

If an MS motor with temperature transmitter is connected to a frequency converter, a fuse incorporated in the transmitter will melt and the transmitter will be inactive. The transmitter cannot be reactivated. This means that the motor will operate like a motor without a temperature transmitter.

If a temperature transmitter is required, Grundfos offers a Pt100 or Pt1000 sensor for the submersible motor.

Caution

The motor should not run at a frequency higher than the rated frequency (50 or 60 Hz) during frequency converter operation. In connection with pump operation, never reduce the frequency (and consequently the speed) to such a level that the necessary flow of cooling liquid past the motor is no longer ensured.

To avoid damage to the pump part, the motor must stop when the pump flow falls below 0.1 x nominal flow.

Depending on the frequency converter type, it may expose the motor to detrimental voltage peaks.

Warning

MS 402 motors for supply voltages up to and including 440 V (see motor nameplate) must be protected against voltage peaks higher than 650 V (peak value) between the supply terminals.

We recommend that you protect other motors against voltage peaks higher than 850 V.

The above disturbance can be abated by installing an RC filter between the frequency converter and the motor.

Possible increased acoustic noise from the motor can be abated by installing an LC filter which will also eliminate voltage peaks from the frequency converter.

We recommend that you install an LC filter when using a frequency converter. See section *6.7.6 Frequency converter operation*.

For further details, contact your frequency converter supplier or Grundfos.

6.1.2 Other motor makes than Grundfos

Contact Grundfos or the motor manufacturer.

6.2 Motor protection

6.2.1 Single-phase motors

Single-phase MS 402 motors incorporate a thermal switch and require no additional motor protection.

Warning

When the motor has been thermally switched off, the motor terminals are still live. When the motor has cooled sufficiently, it will restart automatically.

Single-phase MS 4000 motors must be protected. A protective device can either be incorporated in a control box or be separate.

Franklin 4" PSC motors must be connected to a motor-protective circuit breaker.

6.2.2 Three-phase motors

MS motors are available with or without a built-in temperature transmitter.

The following motors must be protected by a motor-protective circuit breaker with thermal relay, or a MP 204 and contactor(s):

- motors with a built-in and intact temperature transmitter
- motors with or without a defective temperature transmitter
- motors with or without a Pt100 sensor.

MMS motors have no built-in temperature transmitter.
The Pt100 and the Pt1000 sensor are available as an accessory.

6.2.3 Required settings of motor-protective circuit breaker

For cold motors, the tripping time of the motor-protective circuit breaker must be less than 10 seconds at 5 times the rated maximum current of the motor. During normal operating conditions the motor must be running at full speed in less than 3 seconds.

Caution

If this requirement is not met, the motor warranty will be invalidated.

In order to ensure optimum motor protection, the motor-protective circuit breaker should be set as follows:

1. Set the motor-protective circuit breaker to the rated maximum current of the motor.
2. Start the pump and let it run for half an hour at normal performance.
3. Slowly grade down the scale indicator until the motor trip point is reached.
4. Increase the setting by 5 %.

The highest permissible setting is the rated maximum current of the motor.

For motors wound for star-delta starting, the motor-protective circuit breaker should be set as above, but the maximum setting should be rated maximum current x 0.58.

The highest permissible startup time for star-delta starting or autotransformer starting is 2 seconds.

6.3 Lightning protection

The installation can be fitted with a special overvoltage protective device to protect the motor from voltage surges in the power supply lines when lightning strikes somewhere in the area. See fig. 10.

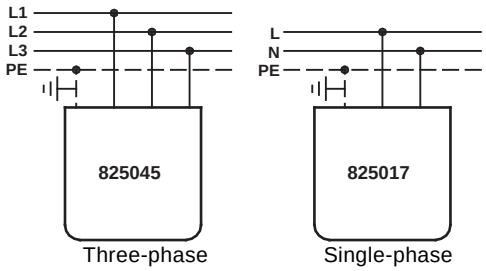


Fig. 10 Fitting an overvoltage protective device

The overvoltage protective device will not, however, protect the motor against a direct stroke of lightning.

The overvoltage protective device should be connected to the installation as close as possible to the motor and always in accordance with local regulations. Ask Grundfos for lightning protective devices.

MS 402 motors, however, require no further lightning protection as they are highly insulated.

A special cable termination kit with a built-in overvoltage protective device is available for Grundfos 4" motors (product No 799911 or 799912).

6.4 Cable sizing

Caution Submersible motor cables are dimensioned for submersion in liquid, and will not necessarily have sufficient cross-section to be in free air.

Make sure that the submersible drop cable can withstand permanent submersion in the actual liquid and at the actual temperature.

The cross-section (q) of the cable must meet the following requirements:

The submersible drop cable must be sized to the rated maximum current (I_n) of the motor.

The cross-section must be sufficient to make a voltage drop over the cable acceptable.

Grundfos supplies submersible drop cables for a wide range of installations. For correct cable sizing, Grundfos offers a cable sizing tool on the USB stick supplied with the motor.

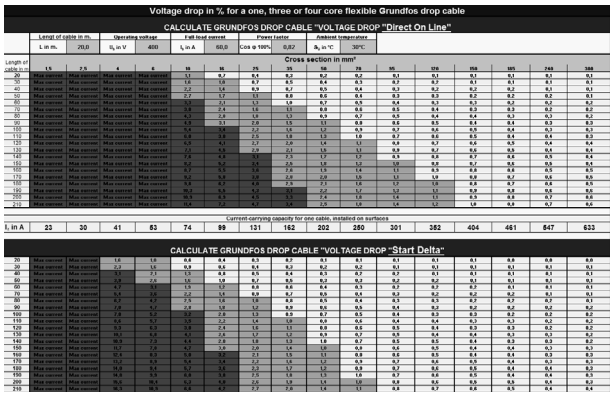


Fig. 11 Cable sizing tool

The sizing tool provides an accurate calculation of the voltage drop at a given cross-section on the basis of the following parameters:

- cable length
- operating voltage
- full-load current
- power factor
- ambient temperature.

You can calculate the voltage drop both for direct-on-line and star-delta starting.

In order to minimise operating losses, the cable cross-section may be increased. This is only cost-efficient if the borehole provides the necessary space, and if the operating time of the pump is long. The cable sizing tool also provides a power loss calculator that shows the potential savings of an increased cross-section.

As an alternative to the cable sizing tool, select the cross-section on the basis of the current values of the given cables.

The cross-section of the submersible drop cable must be large enough to meet the voltage quality requirements specified in section *6. Electrical connection*.

Determine the voltage drop for the cross-section of the submersible drop cable by means of the diagrams on pages 17 to 20.

Use the following formula:

I = Rated maximum current of the motor.

For star-delta starting, I = rated maximum current of the motor x 0.58.

Lx = Length of cable converted to a voltage drop of 1 % of the nominal voltage.

$$Lx = \frac{\text{length of drop cable}}{\text{permissible voltage drop in \%}}$$

q = Cross-section of submersible drop cable.

Draw a straight line between the actual I-value and the Lx-value. Where the line intersects the q-axis, select the cross-section that lies right above the intersection.

The diagrams are made on the basis of the formulas:

Single-phase submersible motor

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times XI\right)}$$

Three-phase submersible motor

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times XI\right)}$$

L = Length of submersible drop cable [m]
U = Rated voltage [V]
ΔU = Voltage drop [%]
I = Rated maximum current of the motor [A]
cos φ = 0.9
ρ = Specific resistance: 0.02 [Ωmm^2/m]
q = Cross-section of submersible drop cable [mm^2]
sin φ = 0.436
XI = Inductive resistance: 0.078 x 10^{-3} [Ω/m].

6.5 Control of single-phase MS 402 motors

Warning

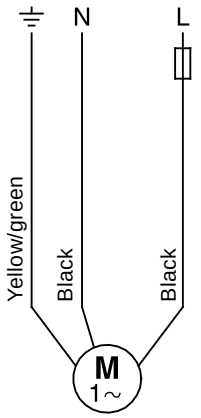
The single-phase MS 402 motor incorporates motor protection which cuts out the motor in case of excessive winding temperatures while the motor is still supplied with voltage. Allow for this, when the motor forms part of a control system.

If a compressor is included in a control system together with an ochre filter, the compressor will run continuously once the motor protection has cut out the motor, unless other special precautions have been taken.

6.6 Connection of single-phase motors

6.6.1 2-wire motors

MS 402 2-wire motors incorporate motor protection and a starter device and can therefore be connected direct to the mains.
See fig. 12.



TM00 1358 5092

Fig. 12 2-wire motors

6.6.2 PSC motors

The PSC motors are connected to the mains via a run capacitor which should be sized for continuous operation.

Select the correct capacitor size from the table below:

Motor [kW]	Capacitor [µF] 400 V, 50 Hz
0.25	12.5
0.37	16
0.55	20
0.75	30
1.10	40
1.50	50
2.20	75

MS 402 PSC motors incorporate motor protection and should be connected to the mains as shown in fig. 13.

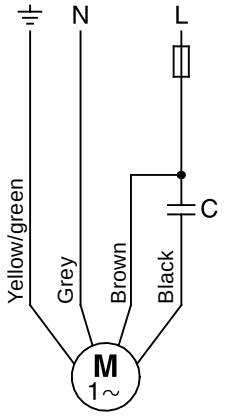


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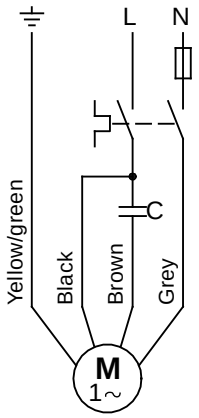
Fig. 13 PSC motors

See www.franklin-electric.com and fig. 14.



TM00 1361 1200

Fig. 14 Franklin motors

6.6.3 3-wire motors

MS 4000 3-wire motors must be connected to the mains via a Grundfos SA-SPM 5 (60 Hz), 7 or 8 (50 Hz) control box incorporating motor protection.

MS 402 3-wire motors incorporate motor protection and should be connected to the mains via a Grundfos control box SA-SPM 2, 3 or 5 (60 Hz), 7 or 8 (50 Hz) without motor protection.

6.7 Connection of three-phase motors

Three-phase motors must be protected.
See section *6.2.2 Three-phase motors*.

For electrical connection via the MP 204, see the separate installation and operating instructions for this unit.

When a conventional motor-protective circuit breaker is being used, the electrical connection should be carried out as described below.

6.7.1 Checking the direction of rotation

Caution The pump must not be started until the suction interconnector has been completely submerged in the liquid.

When the pump has been connected to the power supply, check the direction of rotation:

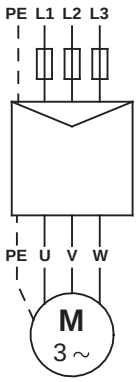
1. Start the pump and measure quantity of water and head.
2. Stop the pump and interchange two phases.
3. Start the pump and measure quantity of water and head.
4. Stop the pump.
5. Compare the two results. The connection giving the larger quantity of water and the higher head is the correct one.

6.7.2 Grundfos motors - direct-on-line starting

The connection of Grundfos motors wound for direct-on-line starting appears from the table below and fig. 15.

Mains	Cable/connection
	Grundfos 4" and 6" motors
PE	PE (yellow/green)
L1	U (brown)
L2	V (black)
L3	W (grey)

Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.



TM03 2099 3705

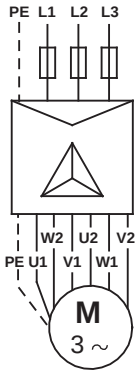
Fig. 15 Grundfos motors - direct-on-line starting

6.7.3 Grundfos motors - star-delta starting

The connection of Grundfos motors wound for star-delta starting appears from the table below and fig. 16.

Connection	Grundfos 6" motors
PE	Yellow/green
U1	Brown
V1	Black
W1	Grey
W2	Brown
U2	Black
V2	Grey

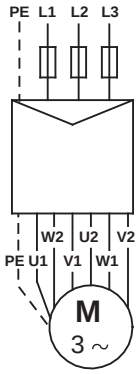
Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.



TM03 2100 3705

Fig. 16 Grundfos motors wound for star-delta starting

If direct-on-line starting is required, the motors should be connected as shown in fig. 17.



TM03 2101 3705

Fig. 17 Grundfos motors wound for star-delta starting - direct-on-line starting

6.7.4 Connection in the case of unidentified cable marking/connection (Franklin motors)

If you do not know where the individual leads are to be connected to the mains in order to ensure the correct direction of rotation, proceed as follows:

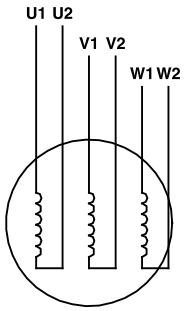
Motors wound for direct-on-line starting

Connect the pump to the mains as is expected to be right.

Then check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

Motors wound for star-delta starting

Determine the windings of the motor by means of an ohmmeter and name the lead sets for the individual windings accordingly: U1-U2, V1-V2, W1-W2. See fig. 18.



TM00 1367 5092

Fig. 18 Unidentified cable marking/connection - motors wound for star-delta starting

If star-delta starting is required, connect the leads as shown in fig. 16.

If direct-on-line starting is required, connect the leads as shown in fig. 17.

Then check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

6.7.5 Soft starter

We only recommend the use of soft starters which control the voltage on all three phases and which are provided with a bypass switch.

Ramp times: Maximum 3 seconds.

For further details, contact your soft starter supplier or Grundfos.

6.7.6 Frequency converter operation

Three-phase MS motors can be connected to a frequency converter.

Note To enable the monitoring of the motor temperature, we recommend that you install a Pt100/Pt1000 sensor together with a PR5714 or CU 220 (50 Hz).

Permissible frequency ranges: 30-50 Hz and 30-60 Hz.

Ramp times: Maximum 3 seconds for start and stop.

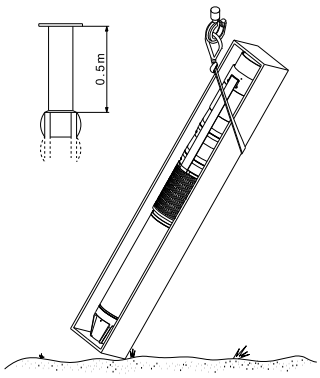
Depending on the type, the frequency converter may cause increased acoustic noise from the motor. Furthermore, it may expose the motor to detrimental voltage peaks. This can be abated by installing an LC filter between the frequency converter and the motor.

For further details, contact your frequency converter supplier or Grundfos.

7. Installation

We recommend that you first fit a 50 cm long pipe to the pump to facilitate handling of the pump during installation.

Caution Lift the pump to vertical position before removing it from the wooden box.



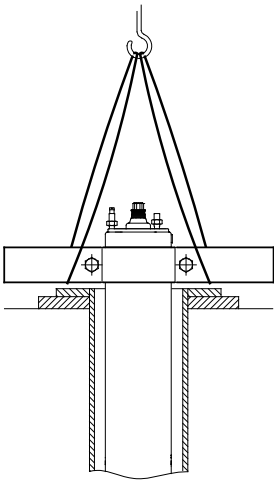
TM05 1617 3311

Fig. 19 Lifting the pump into vertical position

7.1 Fitting the motor to the pump

When the pump part and the motor are supplied as separate units (long pumps), fit the motor to the pump as follows:

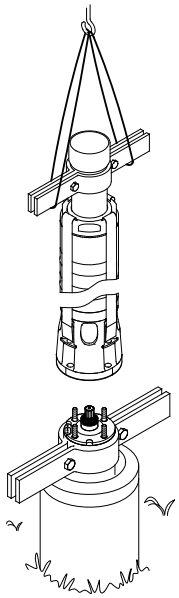
1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the borehole seal. See fig. 20.



TM00 5259 2402

Fig. 20 Motor in vertical position

3. Lift the pump part by means of pipe clamps fitted to the extension pipe. See fig. 21.



TM02 5263 2502

Fig. 21 Lifting the pump into position

4. Place the pump part on top of the motor.
5. Fit and tighten the nuts. See table below.

Caution Make sure that the coupling between the pump and motor engages properly.

The bolts and nuts securing the straps to the pump must be cross-tightened to the following torques:

Bolt/nut	Torque [Nm]
M8	18
M10	35
M12	45
M16	120
SP 215, 50 Hz, with more than 8 stages SP 215, 60 Hz, with more than 5 stages	150

When fitting the motor to the pump part, cross-tighten the nuts to the following torques:

Staybolt diameter	Torque [Nm]
5/16 UNF	18
1/2 UNF	50
M8	18
M12	70
M16	150
M20	280

Caution Make sure that the pump chambers are aligned when assembly has been completed.

7.2 Removing and fitting the cable guard

If the cable guard is screwed on to the pump, it should be removed and fitted by means of screws.

Caution Make sure that the pump chambers are aligned when the cable guard has been fitted.

7.3 Connecting the submersible drop cable

7.3.1 Grundfos motors

Before connecting the submersible drop cable to the motor, make sure that the cable socket is clean and dry.

To facilitate the connection of the cable, lubricate the rubber parts of the cable plug with non-conducting silicone paste.

Tighten the screws holding the cable to these torques [Nm]:

MS 402: 2.0
MS 4000: 3.0
MS 6000: 4.5
MMS 6: 20
MMS 8000: 18
MMS 10000: 18
MMS 12000: 15

7.4 Riser pipe

If a tool, e.g. a chain pipe wrench, is used when the riser pipe is fitted to the pump, the pump must only be gripped by the pump discharge chamber.

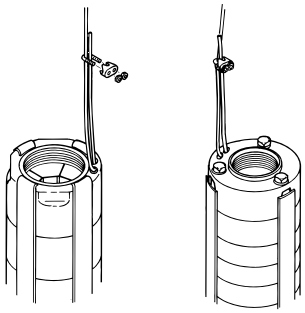
The threaded joints on the riser pipe must all be well cut and fit together to ensure that they do not work loose when subjected to torque reaction caused by the starting and stopping of the pump.

The thread on the first section of the riser pipe which is to be screwed into the pump should not be longer than the threads in the pump.

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

Note We recommend plastic pipes for 4" pumps only.

When plastic pipes are used, secure the pump by an unloaded straining wire to be fastened to the discharge chamber of the pump. See fig. 22.



TM00 1368 2298

Fig. 22 Fixing the straining wire

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

Where flanged pipes are used, the flanges should be slotted to take the submersible drop cable and a water indicator hose, if fitted.

7.5 Maximum installation depth below water level [m]

Grundfos MS 402: 150
Grundfos MS 4000: 600
Grundfos MS 6000: 600
Grundfos MMS: 600
Franklin motors: 350

7.6 Cable clips

Fit cable clips every 3 metres to fix the submersible drop cable and the straining wire, if fitted, to the riser pipe of the pump.

Grundfos supplies cable clip sets on request.

1. Cut off the rubber band so that the piece with no slit becomes as long as possible.
2. Insert a button in the first slit.
3. Position the wire alongside the submersible drop cable as shown in fig. 23.

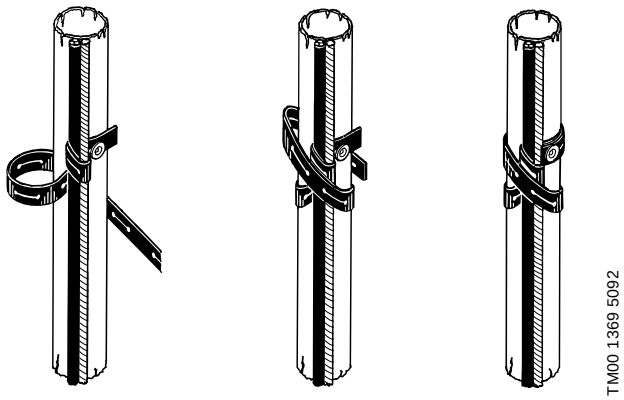


Fig. 23 Fitting the cable clips

4. Wind the band once around the wire and the cable. Then wind it tightly at least twice around the pipe, wire and the cable.
5. Push the slit over the button and cut off the band.

Where large cable cross-sections are used, it will be necessary to wind the band several times.

Where plastic pipes are used, some slackness must be left between each cable clip as plastic pipes expand when loaded.

When flanged pipes are used, the cable clips should be fitted above and below each joint.

7.7 Lowering the pump

We recommend that you check the borehole by means of an inside calliper before lowering the pump to ensure unobstructed passage.

Lower the pump carefully into the borehole, taking care not to damage the motor cable and the submersible drop cable.

Caution Do not lower or lift the pump by means of the motor cable.

7.8 Installation depth

The dynamic water level should always be above the suction interconnector of the pump. See section *5.2 Positional requirements* and fig. 24.

Minimum inlet pressure is indicated in the NPSH curve for the pump. The minimum safety margin should be 1 metre head.

We recommend that you install the pump so that the motor part is above the well screen in order to ensure optimum cooling. See section *5.4 Liquid temperatures/cooling*.

When the pump has been installed to the required depth, the installation should be finished by means of a borehole seal.

Slacken the straining wire so that it becomes unloaded and lock it to the borehole seal by means of wire locks.

Note For pumps fitted with plastic pipes, the expansion of the pipes when loaded should be taken into consideration, when deciding on the installation depth of the pump.

8. Startup and operation

8.1 Startup

When the pump has been connected correctly and it is submerged in the liquid to be pumped, it should be started with the discharge valve closed off to approximately 1/3 of its maximum volume of water.

Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

If there are impurities in the water, open the valve gradually as the water becomes clearer. Do not stop the pump until the water is completely clean, as otherwise the pump parts and the non-return valve may become blocked.

As the valve is being opened, check the drawdown of the water level to ensure that the pump always remains submerged.

The dynamic water level should always be above the suction interconnector of the pump. See section *5.2 Positional requirements* and fig. 24.

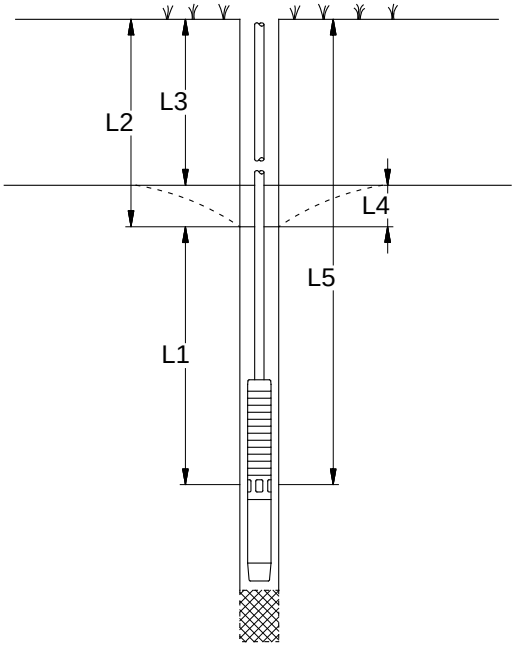


Fig. 24 Comparison of various water levels

L1: Minimum installation depth below dynamic water level. We recommend minimum 1 metre.

L2: Depth to dynamic water level.

L3: Depth to static water level.

L4: Drawdown. This is the difference between the dynamic and the static water levels.

L5: Installation depth.

If the pump can pump more than yielded by the well, we recommend that you install the Grundfos MP 204 motor protector or some other type of dry-running protection.

If no water level electrodes or level switches are installed, the water level may be drawn down to the suction interconnector of the pump and the pump will then draw in air.

Caution Long time of operation with water containing air may damage the pump and cause insufficient cooling of the motor.

8.2 Operation

8.2.1 Minimum flow rate

To ensure the necessary cooling of the motor, the pump flow rate should never be set so low that the cooling requirements in section *5.4 Liquid temperatures/cooling* cannot be met.

8.2.2 Frequency of starts and stops

Motor type		Number of starts
MS 402		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 4000		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 6000		• Minimum 1 per year is recommended. • Maximum 30 per hour. • Maximum 300 per day.
MMS6	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 40 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 10 per hour. • Maximum 70 per day.
MMS 8000	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 30 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 8 per hour. • Maximum 60 per day.
MMS 10000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 20 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 6 per hour. • Maximum 50 per day.
MMS 12000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 15 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 5 per hour. • Maximum 40 per day.

9. Maintenance and service

All pumps are easy to service.

Service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service centre.

Warning

If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

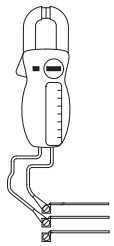
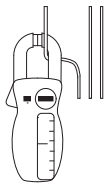
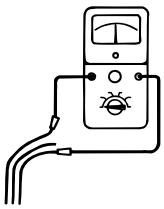
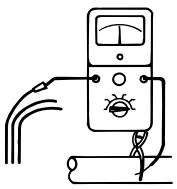
If Grundfos is requested to service the pump, Grundfos must be contacted with details about the pumped liquid, etc. before the pump is returned for service. Otherwise Grundfos can refuse to accept the pump for service.

Possible costs of returning the pump are paid by the customer.

10. Fault finding

Fault	Cause	Remedy
1. The pump does not run.	a) The fuses are blown.	Replace the blown fuses. If the new ones blow too, check the electric installation and the submersible drop cable.
	b) The ELCB or the voltage-operated ELCB has tripped.	Cut in the circuit breaker.
	c) No power supply.	Contact the power supply company.
	d) The motor-protective circuit breaker has tripped.	Reset the motor-protective circuit breaker (automatically or possibly manually). Check the voltage if it trips again. If the voltage is okay, see items 1e to 1h.
	e) The motor-protective circuit breaker/contactor is defective.	Replace the motor-protective circuit breaker/contactor.
	f) Starter device is defective.	Repair or replace the starter device.
	g) The control circuit has been interrupted or is defective.	Check the electric installation.
	h) The dry-running protection has cut off the power supply to the pump due to low water level.	Check the water level. If it is okay, check the water level electrodes/level switch.
	i) The pump/submersible drop cable is defective.	Repair or replace the pump/cable.
2. The pump runs but gives no water.	a) The discharge valve is closed.	Open the valve.
	b) No water or too low water level in borehole.	See item 3a.
	c) The non-return valve is stuck in closed position.	Pull out the pump and clean or replace the valve.
	d) The suction strainer is blocked.	Pull out the pump and clean the strainer.
	e) The pump is defective.	Repair or replace the pump.
3. The pump runs at reduced performance.	a) The drawdown is larger than anticipated.	Increase the installation depth of the pump, throttle the pump or install a pump with a smaller performance.
	b) Wrong direction of rotation.	See section *6.7.1 Checking the direction of rotation*.
	c) The valves in the discharge pipe are partly closed/blocked.	Clean or replace the valves.
	d) The discharge pipe is partly blocked by impurities (ochre).	Clean or replace the pipe.
	e) The non-return valve of the pump is partly blocked.	Pull out the pump and clean or replace the valve.
	f) The pump and the riser pipe are partly blocked by impurities (ochre).	Pull out the pump and clean or replace it. Clean the pipes.
	g) The pump is defective.	Repair or replace the pump.
	h) Leakage in the pipework.	Check and repair the pipework.
	i) The riser pipe is defective.	Replace the pipe.
4. Frequent starts and stops.	a) The differential of the pressure switch between the start and stop pressures is too small.	Increase the differential. The stop pressure must not exceed the operating pressure of the pressure tank, and the start pressure should be high enough to ensure sufficient water supply.
	b) The water level electrodes or level switches in the reservoir have not been installed correctly.	Adjust the intervals of the electrodes/level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See installation and operating instructions for the electrodes/level switches. If the intervals between stop/start cannot be changed via the automatics, the pump performance may be reduced by throttling the discharge valve.
	c) The non-return valve is leaking or stuck half-open.	Pull out the pump and clean or replace the valve.
	d) The tank precharge pressure is too small.	Adjust the tank precharge pressure in accordance with its installation and operating instructions.
	e) The tank is too small.	Increase the capacity of the tank by replacing or supplementing with another tank.
	f) The diaphragm of the tank is defective.	Check the diaphragm tank.

11. Checking motor and cable

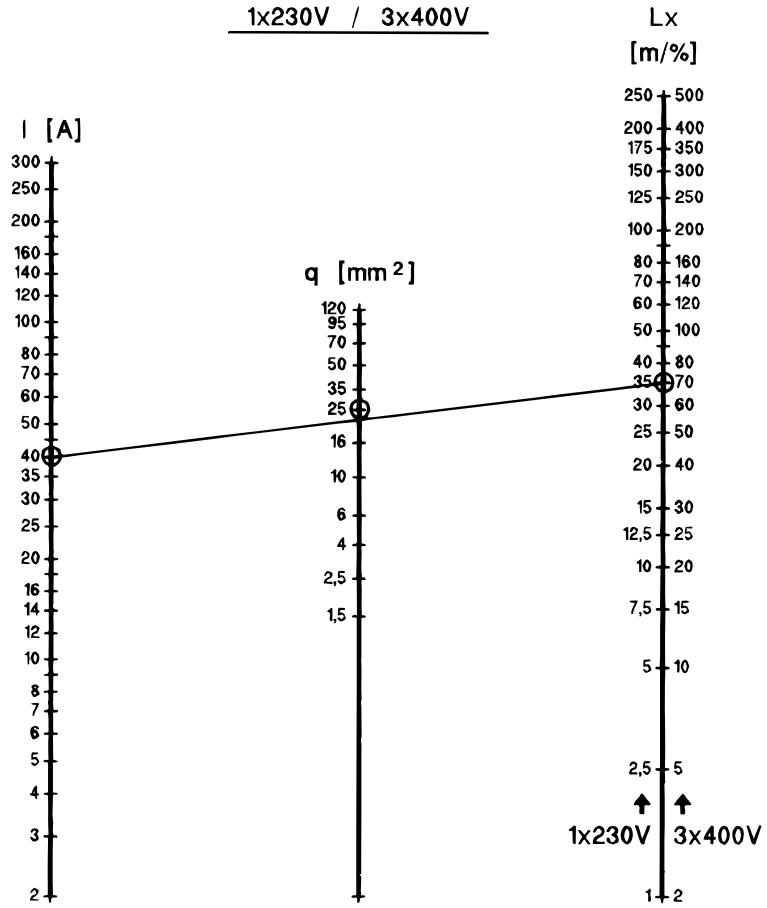
1. Supply voltage  TM00 1371 5092	Measure the voltage between the phases by means of a voltmeter. On single-phase motors, measure between phase and neutral or between two phases, depending on the type of supply. Connect the voltmeter to the terminals in the motor-protective circuit breaker.	The voltage should, when the motor is loaded, be within the range specified in section *6. Electrical connection*. The motor may burn if there are larger variations in voltage. Large variations in voltage indicate poor power supply, and the pump should be stopped until the defect has been remedied.
2. Current consumption  TM00 1372 5092	Measure the amps of each phase while the pump is operating at a constant discharge head (if possible, at the performance where the motor is most heavily loaded). For maximum operating current, see nameplate.	On three-phase motors, the difference between the current in the phase with the highest consumption and the current in the phase with the lowest consumption should not exceed 5 %. If so, or if the current exceeds the rated current, there are the following possible faults: • The contacts of the motor-protective circuit breaker are burnt. Replace the contacts or the control box for single-phase operation. • Poor connection in leads, possibly in the cable joint. See item 3. • Too high or too low supply voltage. See item 1. • The motor windings are short-circuited or partly disjointed. See item 3. • Damaged pump is causing the motor to be overloaded. Pull out the pump for overhaul. • The resistance value of the motor windings deviates too much (three-phase). Move the phases in phase order to a more uniform load. If this does not help, see item 3.
Items 3 and 4: Measurement is not necessary when the supply voltage and the current consumption are normal.		
3. Winding resistance  TM00 1373 5092	Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the winding resistance between the leads of the drop cable.	For three-phase motors, the deviation between the highest and the lowest value should not exceed 10 %. If the deviation is higher, pull out the pump. Measure motor, motor cable and drop cable separately, and repair or replace defective parts. **Note:** The operating winding of single-phase 3-wire motors will assume the lowest resistance value.
4. Insulation resistance  TM00 1374 5092	Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the insulation resistance from each phase to earth (frame). Make sure that the earth connection was made carefully.	If the insulation resistance is less than 0.5 MΩ, the pump should be pulled out for motor or cable repair. Local regulations may specify other values for the insulation resistance.

12. Disposal

This product or parts of it must be disposed of in an environmentally sound way:

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Subject to alterations.

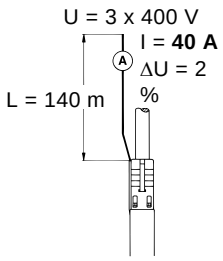


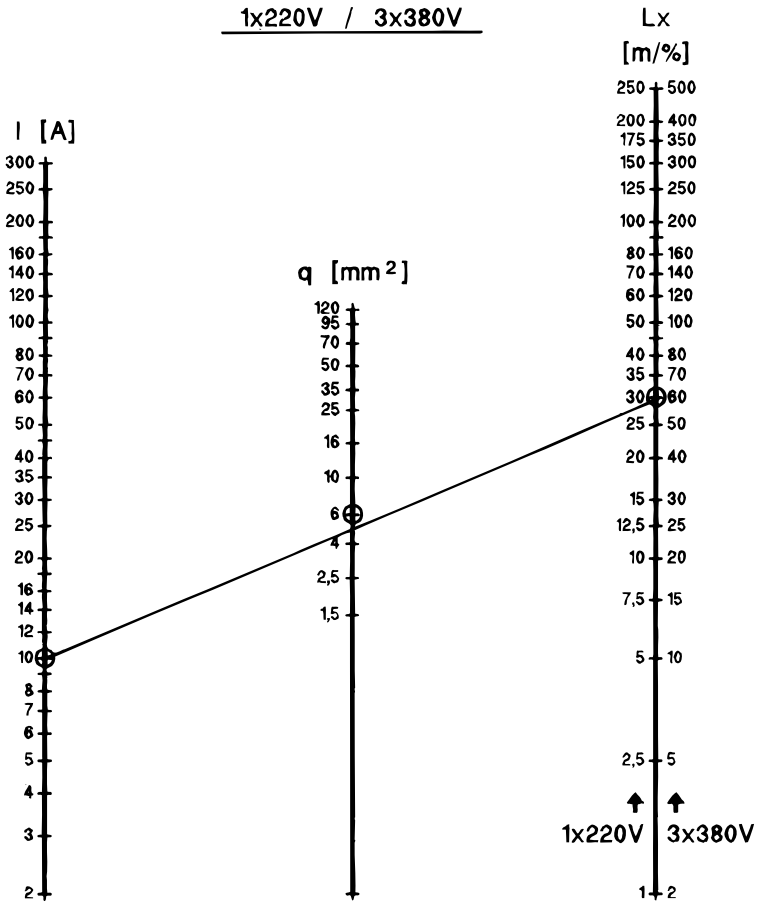
TM00 1346 5092

Example:

U = 3 x 400 V
I = **40 A**
L = 140 m
ΔU = 2 %

$Lx = \frac{L}{\Delta U} = \frac{140}{2\,\%} =$ **70 m** = q ⇒ 25 mm²



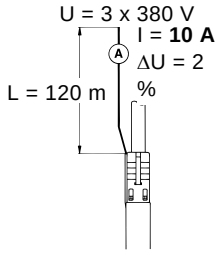


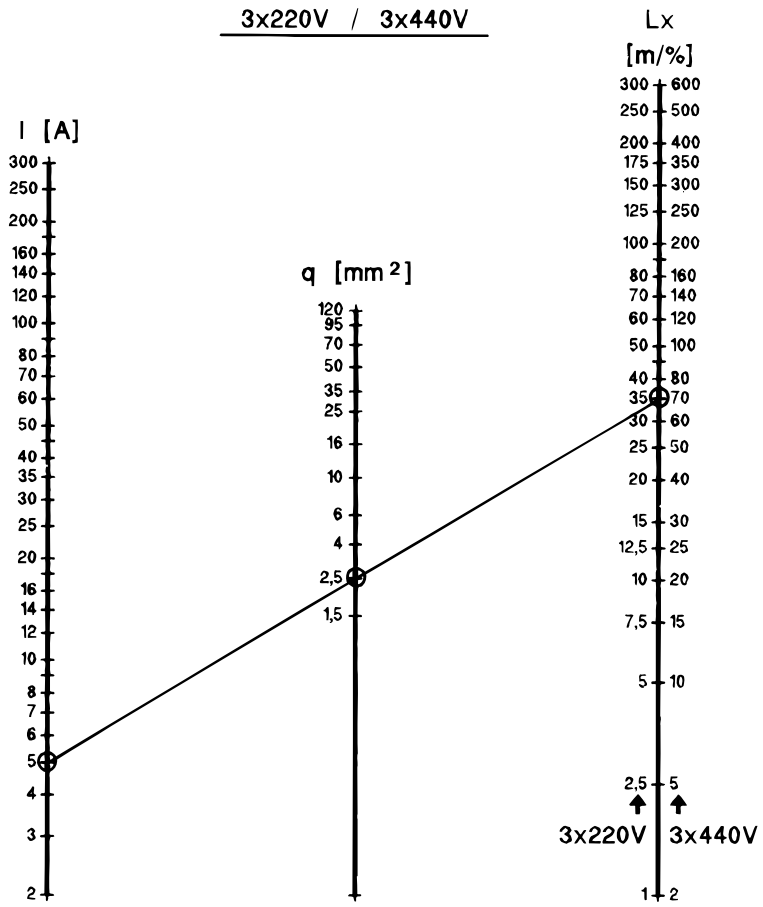
TM00 1345 5092

Example:

U = 3 x 380 V
I = **10 A**
L = 120 m
ΔU = 2 %

$Lx = \frac{L}{\Delta U} = \frac{120}{2\,\%} =$ **60 m** = q ⇒ 6 mm²

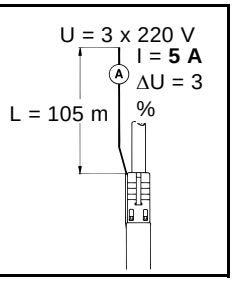




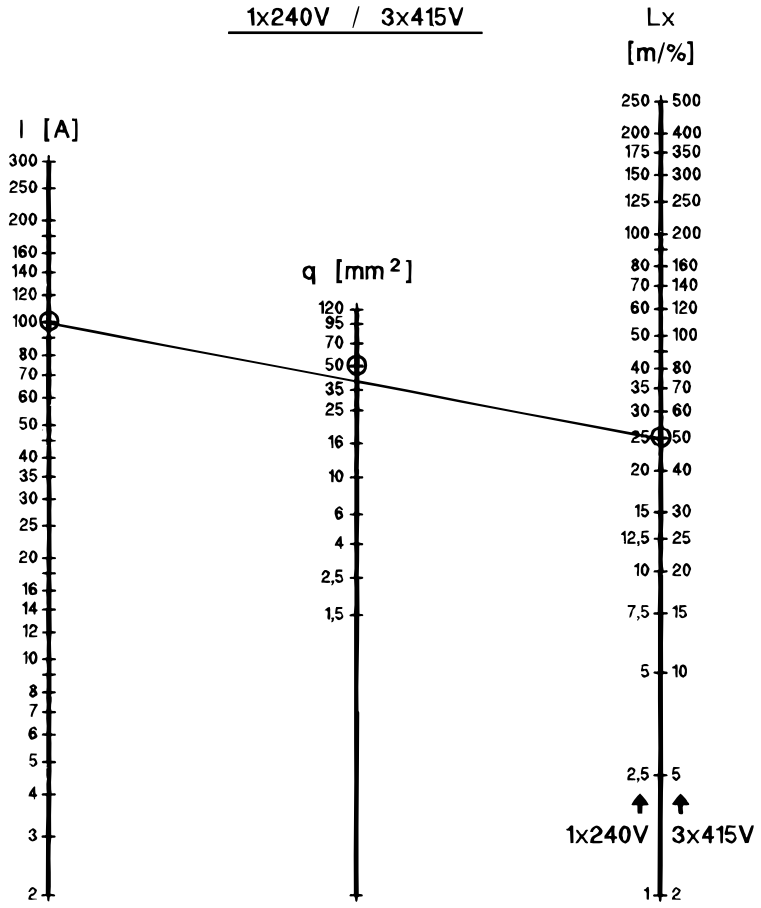
Example:

U = 3 x 220 V
I = **5 A**
L = 105 m
ΔU = 3 %

$$Lx = \frac{L}{\Delta U} = \frac{105}{3\,\%} = \mathbf{35\ m} = q \Rightarrow 2{,}5\ mm^2$$



TM00 1348 5092

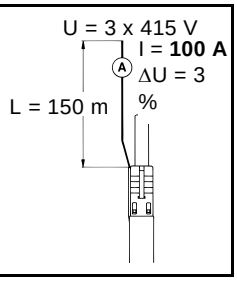


TM00 1347 5092

Example:

U = 3 x 415 V
I = **100 A**
L = 150 m
ΔU = 3 %

$Lx = \frac{L}{\Delta U} = \frac{150}{3\,\%} =$ **50 m** = q ⇒ 50 mm²



SP1 - SP 2 - SP 3 - SP 5

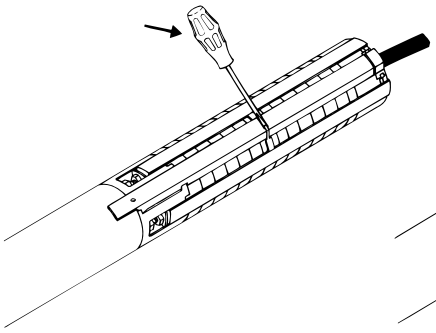


Fig. 1

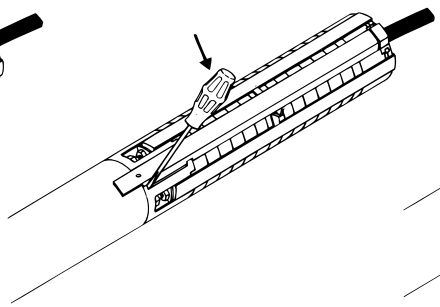


Fig. 2

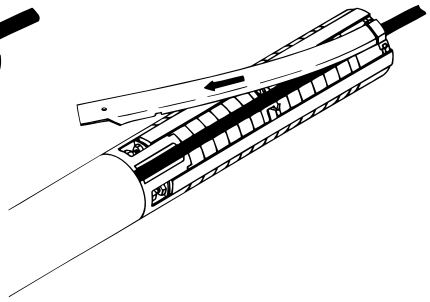


Fig. 3

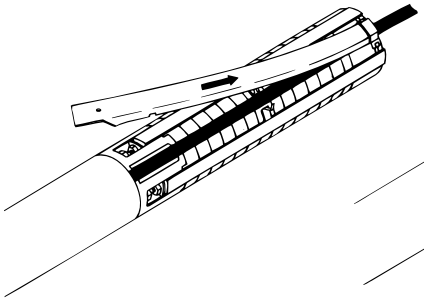


Fig. 1

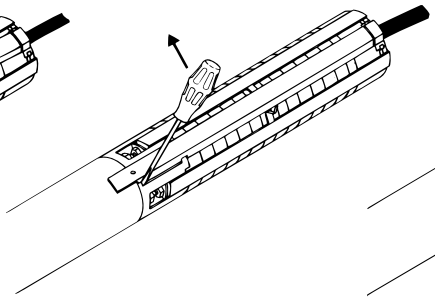


Fig. 2

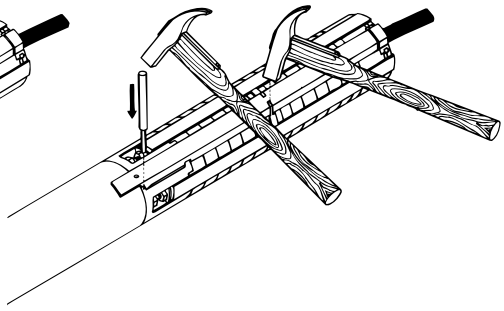


Fig. 3

TM00 1323 5092

SP 7 - SP 9 - SP 11 - SP 14 - SP 17 - SP 30 - SP 46 - SP 60

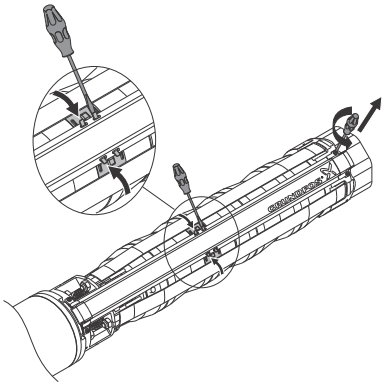


Fig. 1

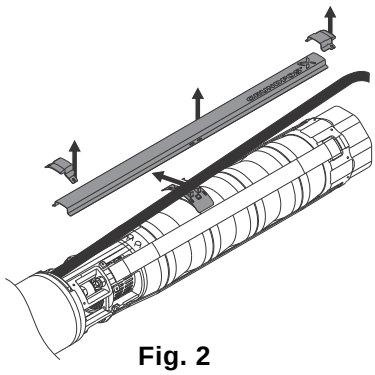
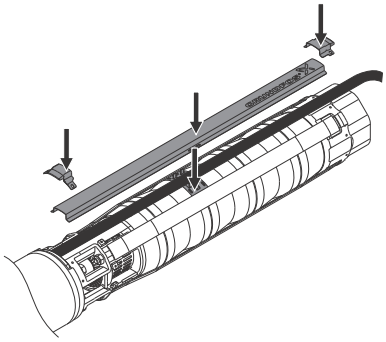


Fig. 2



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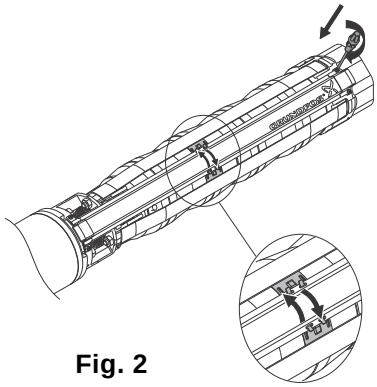

Fig. 2

TM06 0693 0814

SP 77 - SP 95 - SP 125 - SP 160 - SP 215

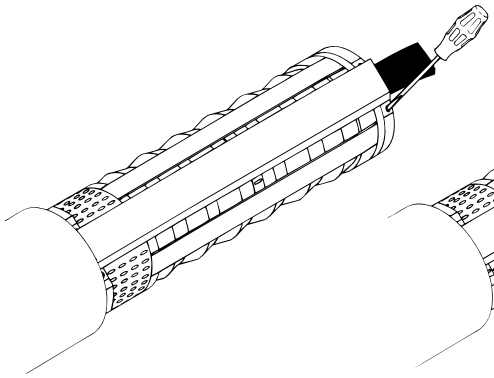

Fig. 1

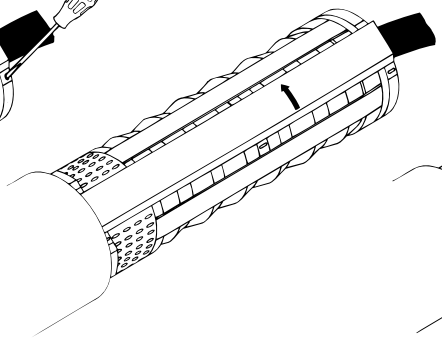

Fig. 2

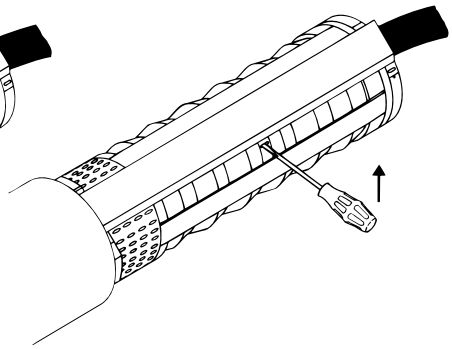

Fig. 3

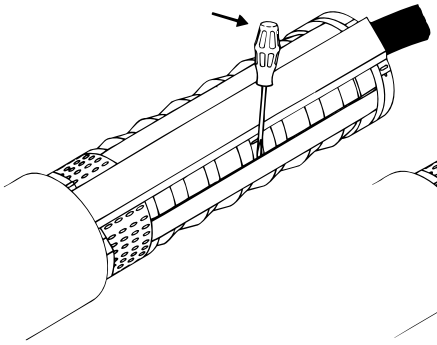

Fig. 1

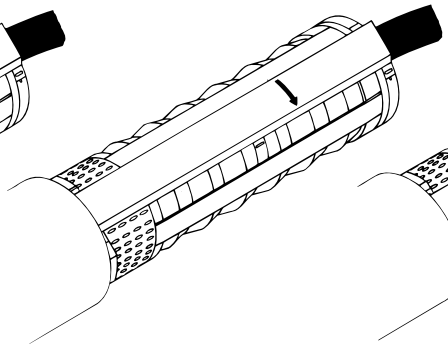

Fig. 2

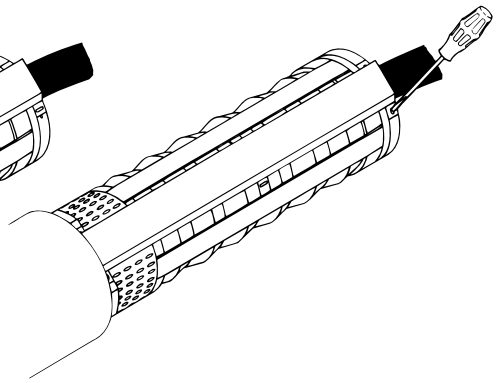

Fig. 3

TM00 1326 5092

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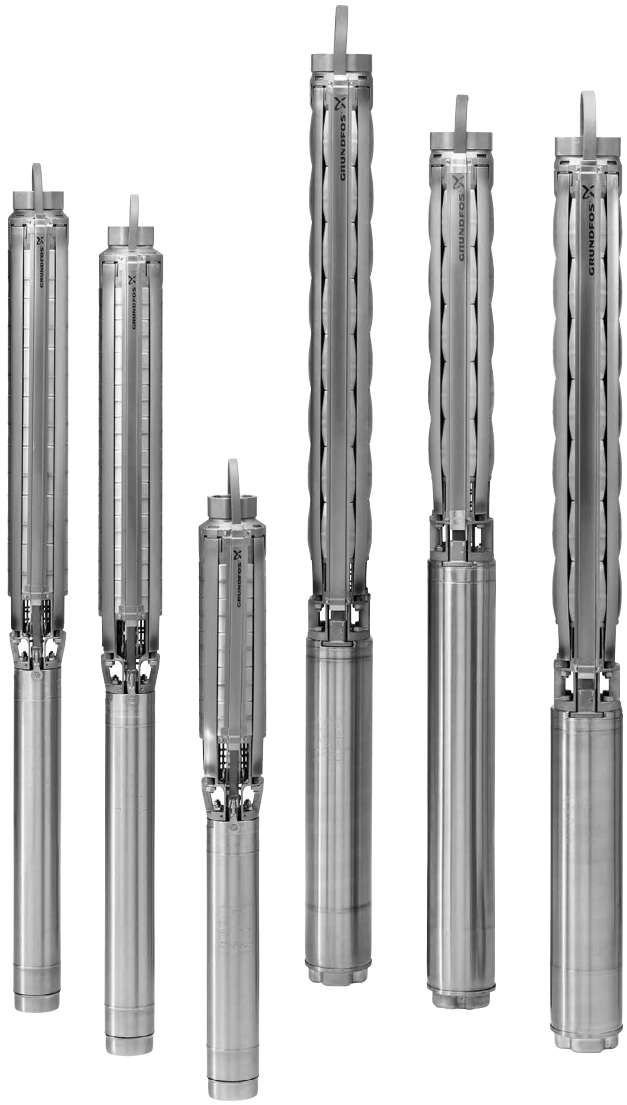
SP

Installation and operating instructions



Other languages

http://net.grundfos.com/qr/i/98074911

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GRUNDFOS

Original installation and operating instructions.

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Warning

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

1. Symbols used in this document

Warning

If these safety instructions are not observed, it may result in personal injury.

Warning

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

Caution — If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

Note — Notes or instructions that make the job easier and ensure safe operation.

2. Introduction

These instructions apply to Grundfos submersible pumps, type SP, with submersible motors, types Grundfos MS/MMS or Franklin 4"-8".

If the pump is fitted with a motor of another motor make than Grundfos MS or MMS, note that the motor data may differ from the data stated in these instructions.

Note — The USB stick supplied with the product contains installation and operating instructions in various languages.

3. Delivery and storage

3.1 Delivery

Caution — The pump should remain in the packing until it is placed in vertical position during installation.

Handle the pump with care.

When the pump part and motor are supplied as separate units (long pumps), fit the motor to the pump as described in section *7.1 Fitting the motor to the pump*.

Note — The extra nameplate supplied with the pump should be fixed at the installation site.

Do not expose the pump to unnecessary impact and shocks.

3.2 Storage

Storage temperature

Pump: -20 °C to +60 °C.
Motor: -20 °C to +70 °C.

The motors must be stored in a closed, dry and well ventilated room.

Caution — If MMS motors are stored, the shaft must be turned by hand at least once a month. If a motor has been stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use.

The pump should not be exposed to direct sunlight.

If the pump has been unpacked, it should be stored horizontally, adequately supported, or vertically to prevent misalignment of the pump. Make sure that the pump cannot roll or fall over.

During storage, the pump can be supported as shown in fig. 1.

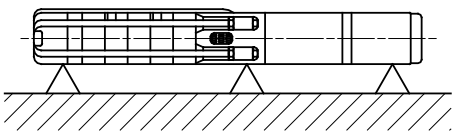

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Fig. 1 Pump position during storage

3.2.1 Frost protection

If the pump has to be stored after use, it must be stored on a frost-free location, or the motor liquid must be frost-proof.

4. Applications

Grundfos SP submersible pumps are designed for a wide range of water supply and liquid transfer applications, such as the supply of fresh water to private homes or waterworks, water supply in horticulture and agriculture, drawdown of groundwater and pressure boosting, and various industrial jobs.

The pump must be installed so that the suction interconnector is completely submerged in the liquid. The pump can be installed horizontally or vertically. See section *5.2 Positional requirements*.

4.1 Pumped liquids

Clean, thin, non-explosive liquids without solid particles or fibres.

The maximum sand content of the water must not exceed 50 g/m^3. A larger sand content will reduce the life of the pump and increase the risk of blockage.

Caution When pumping liquids with a density higher than that of water, motors with correspondingly higher outputs must be used.

If liquids with a viscosity higher than that of water are to be pumped, contact Grundfos.

The pump versions SP A N, SP A R, SP N, SP R and SPE are designed for liquids with higher aggressiveness than drinking water.

The maximum liquid temperature appears from section *5.4 Liquid temperatures/cooling*.

4.2 Sound pressure level

The sound pressure level has been measured in accordance with the rules laid down in the EC machinery directive 2006/42/EC.

Sound pressure level of pumps

The values apply to pumps submerged in water, without external regulating valve.

Pump type	$\overline{L}_{pA}$ [dB(A)]
SP 1A	< 70
SP 2A	< 70
SP 3A	< 70
SP 5A	< 70
SP 7	< 70
SP 9	< 70
SP 11	< 70
SP 14	< 70
SP 17	< 70
SP 30	< 70
SP 46	< 70
SP 60	< 70
SP 77	< 70
SP 95	< 70
SP 125	79
SP 160	79
SP 215	82

Sound pressure level of motors

The sound pressure level of Grundfos MS and MMS motors is lower than 70 dB(A).

Other motor makes: See installation and operating instructions for these motors.

5. Preparations before installation

Warning

Before starting work on the product, switch off the power supply. Make sure that the power supply cannot be accidentally switched on.

5.1 Checking the motor liquid

The motors are factory-filled with a special non-poisonous liquid which is frost-proof down to -20 °C.

Note Check the level of motor liquid and refill if required. Use clean water.

Caution If frost protection is required, special Grundfos liquid must be used to refill the motor. Otherwise clean water may be used for refilling (however, never use distilled water).

Refill liquid as described below.

5.1.1 Grundfos MS 4000 and MS 402 motors

The filling hole for motor liquid is placed in the following positions:

- MS 4000: in the top of the motor.
- MS 402: in the bottom of the motor.

1. Position the submersible pump as shown in fig. 2. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See fig. 2.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torques

- MS 4000: 3.0 Nm.
- MS 402: 2.0 Nm.

The submersible pump is now ready for installation.

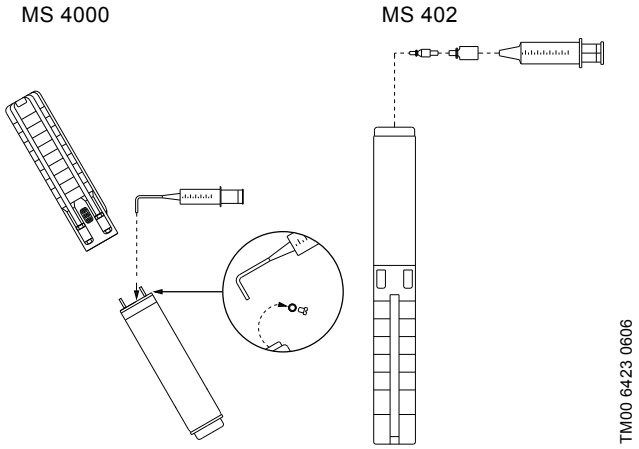

Fig. 2 Motor position during filling - MS 4000 and MS 402

5.1.2 Grundfos MS 6000 motors

- If the motor is delivered from stock, check the level of motor liquid before fitting the motor to the pump. See fig. 3.
- When pumps are delivered direct from Grundfos, the level has already been checked.
- Check the level in connection with service. See fig. 3.

The filling hole for motor liquid is placed at the top of the motor.

1. Position the submersible pump as shown in fig. 3. The filling screw must be at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe until the liquid runs back out of the filling hole. See fig. 3.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torque: 3.0 Nm.

The submersible pump is now ready for installation.

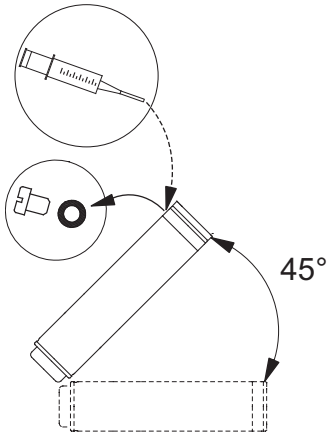

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Fig. 3 Motor position during filling - MS 6000

5.1.3 Grundfos MMS 6, MMS 8000, MMS 10000 and MMS 12000 motors

1. Place the motor at a 45 ° angle with the top of the motor upwards. See fig. 4.
2. Unscrew the plug A and place a funnel in the hole.
3. Pour tap water into the motor until the motor liquid inside the motor starts running out of A.

Caution Do not use motor liquid as it contains oil.

4. Remove the funnel and refit the plug A.

Caution Before fitting the motor to a pump after a long period of storage, lubricate the shaft seal by adding a few drops of water and turning the shaft.

The submersible pump is now ready for installation.

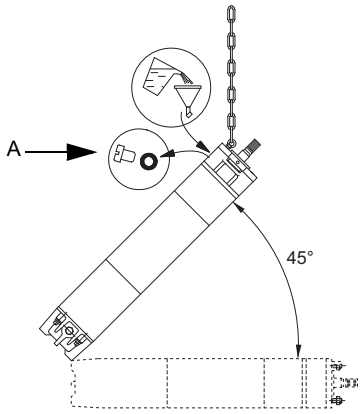

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Fig. 4 Motor position during filling - MMS

5.1.4 Franklin motors from 3 kW and up

Check the level of motor liquid in Franklin 4" and 6" motors by measuring the distance from the bottom plate to the built-in rubber diaphragm. The distance can be measured by inserting a rule or a small rod through the hole until it touches the diaphragm. See fig. 5.

Caution Take care not to damage the diaphragm.

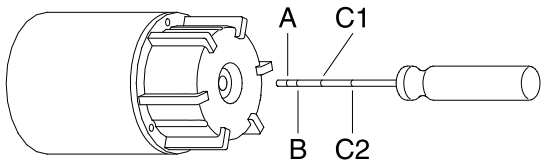

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Fig. 5 Measuring the distance from bottom plate to diaphragm

The table below shows the correct distance from the outside of the bottom plate to the diaphragm:

Motor	Dimension	Distance [mm]
Franklin 4", 0.25 - 3 kW (fig. 6a)	A	8
Franklin 4", 3 - 7.5 kW (fig. 6b)	B	16
Franklin 6", 4-45 kW (fig. 6c)	C1	35
Franklin 6", 4-22 kW (fig. 6d)	C2	59

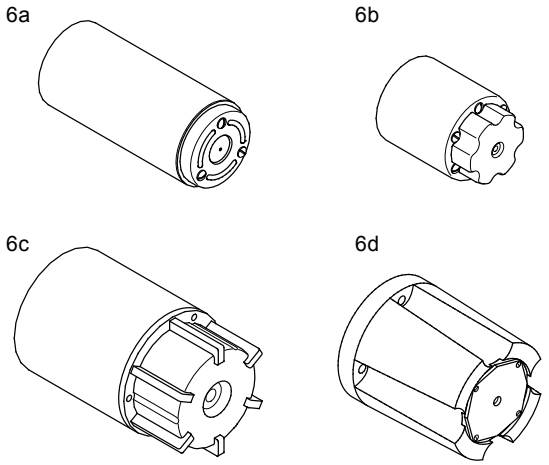

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Fig. 6 Franklin motors

If the distance is not correct, carry out an adjustment as described in section *5.1.5 Franklin motors*.

5.1.5 Franklin motors

Check the level of motor liquid in Franklin 8" motors as follows:

1. Press out the filter in front of the valve at the top of the motor using a screwdriver. If the filter is slotted, unscrew. Figure 7 shows the position of the filling valve.
2. Press the filling syringe against the valve and inject the liquid. See fig. 7. If the valve cone is depressed too far, it may be damaged thus causing the valve to leak.
3. Remove any air in the motor by pressing the point of the filling syringe lightly against the valve.
4. Repeat the process of injecting liquid and releasing air until the liquid starts running out or the diaphragm is in its correct position (Franklin 4" and 6").
5. Refit the filter.

The submersible pump is now ready for installation.

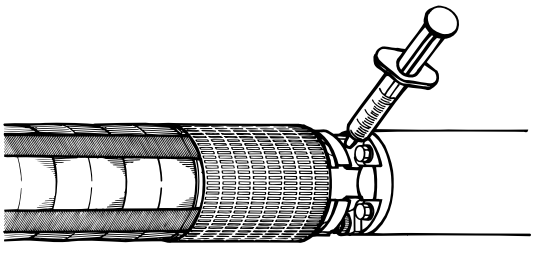

Fig. 7 Position of filling valve

5.2 Positional requirements

Warning

If the pump is to be installed in a position where it is accessible, the coupling must be suitably isolated from human touch. The pump can for instance be built into a flow sleeve.

Depending on motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section *5.2.1 Motors suitable for horizontal installation*.

If the pump is installed horizontally, the discharge port should never fall below the horizontal plane. See fig. 8.

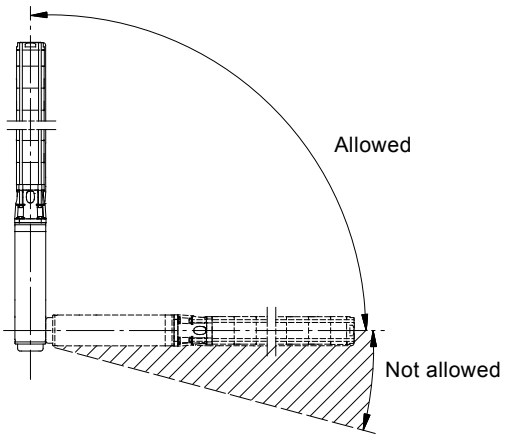

Fig. 8 Positional requirements

If the pump is installed horizontally, e.g. in a tank, we recommend that you fit it in a flow sleeve.

5.2.1 Motors suitable for horizontal installation

Motor	Output power 50 Hz	Output power 60 Hz
	[kW]	[kW]
MS	All	All
MMS 6	5.5 - 37	5.5 - 37
MMS 8000	22-110	22-110
MMS 10000	75-190	75-190
MMS 12000	147-250	147-250

When Franklin 4" motors up to and including 2.2 kW are started more than 10 times a day, we recommend that you incline the motor at least 15 ° above the horizontal plane in order to minimise wearing of the upthrust disc.

Caution During operation, the suction interconnector of the pump must always be completely submerged in the liquid. Make sure that the NPSH values are fulfilled.

Warning

If the pump is used for pumping hot liquids (40 to 60 °C), make sure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

5.3 Pump/motor diameter

We recommend that you check the borehole with an inside calliper to ensure unobstructed passage.

5.4 Liquid temperatures/cooling

The maximum liquid temperature and the minimum flow velocity past the motor appear from the table below.

We recommend that you install the motor above the well screen in order to achieve proper motor cooling.

Caution In cases where the stated flow velocity cannot be achieved, a flow sleeve must be installed.

If there is a risk of sediment build-up, such as sand, around the motor, use a flow sleeve in order to ensure proper cooling of the motor.

5.4.1 Maximum liquid temperature

Out of consideration for the rubber parts in pump and motor, the liquid temperature must not exceed 40 °C (~ 105 °F). See also the table below.

The pump can operate at liquid temperatures between 40 °C and 60 °C (~ 105 °F and 140 °F) provided that all rubber parts are replaced every third year.

Motor	Installation		
	Flow past the motor	Vertical	Horizontal
Grundfos MS 402 MS 4000 MS 6000	0.15 m/s	40 °C (~ 105 °F)	40 °C (~ 105 °F)
Grundfos MS 4000I*	0,15 m/s	60 °C (~ 140 °F) Flow sleeve recommended	60 °C (~ 140 °F) Flow sleeve recommended
Grundfos MS 6000I*	1.00 m/s		
Grundfos MMS	0.15 m/s	25 °C (~ 77 °F)	25 °C (~ 77 °F)
	0.50 m/s	30 °C (~ 86 °F)	30 °C (~ 86 °F)
Franklin 4"	0.08 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)
Franklin 6" and 8"	0.16 m/s	30 °C (~ 85 °F)	30 °C (~ 85 °F)

* At an ambient pressure of minimum 1 bar (1 MPa).

Note 37 kW MMS 6, 110 kW MMS 8000 and 170 kW MMS 10000: The maximum operational liquid temperature is 5 °C lower than the values stated in the above table.

190 kW MMS 10000: The temperature is 10 °C lower.

5.5 Pipe connection

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

Note We recommend plastic pipes for 4" pumps only.

When using plastic pipes, secure the pump by an unloaded straining wire.

Warning

Make sure that the plastic pipes are suitable for the actual liquid temperature and the pump pressure.

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

6. Electrical connection

Warning

During electrical installation, make sure that the power supply cannot be accidentally switched on.

Warning

The electrical installation should be carried out by an authorised person in accordance with local regulations.

The supply voltage, rated maximum current and cos φ appear from the loose data plate which must be fitted close to the installation site.

The required voltage quality for MS and MMS motors, measured at the motor terminals, is - 10 %/+ 6 % of the nominal voltage during continuous operation (including variation in the supply voltage and losses in cables).

Check also that there is voltage symmetry in the power supply lines, i.e. same difference of voltage between the individual phases. See section *11. Checking motor and cable*, item 2.

Warning

The pump must be earthed.

The pump must be connected to an external mains switch with a minimum contact gap of 3 mm in all poles.

If MS motors with a built-in temperature transmitter (Tempcon) are not installed together with a MP 204 or similar Grundfos motor protection, they must be connected to a 0.47 µF capacitor approved for phase-phase operation (IEC 384-14) to meet the EC EMC directive (2004/108/EC). The capacitor must be connected to the two phases to which the temperature transmitter is connected. See fig. 9.

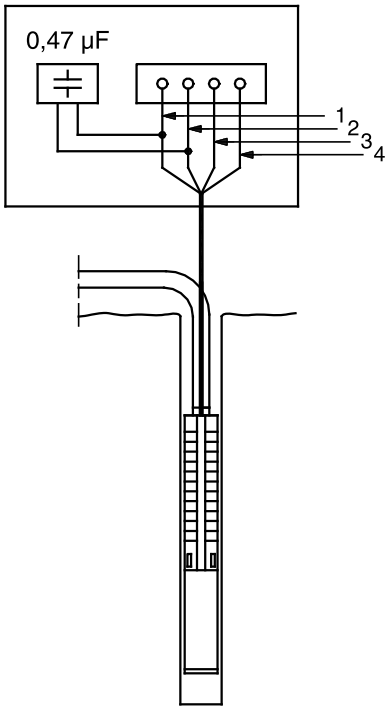

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Fig. 9 Connection of capacitor

Colours of the leads		
Lead	**Flat cable**	**Single leads**
1 = L1	Brown	Black
2 = L2	Black	Yellow
3 = L3	Grey	Red
4 = PE	Yellow/green	Green

The motors are wound for direct-on-line starting or star-delta starting, and the starting current is between four and six times the rated current of the motor.

The run-up time of the pump is only about 0.1 second. Direct-on-line starting is therefore normally approved by the power supply company.

6.1 Frequency converter operation

6.1.1 Grundfos motors

Three-phase Grundfos motors can be connected to a frequency converter.

Caution

If an MS motor with temperature transmitter is connected to a frequency converter, a fuse incorporated in the transmitter will melt and the transmitter will be inactive. The transmitter cannot be reactivated. This means that the motor will operate like a motor without a temperature transmitter.

If a temperature transmitter is required, Grundfos offers a Pt100 or Pt1000 sensor for the submersible motor.

Caution

The motor should not run at a frequency higher than the rated frequency (50 or 60 Hz) during frequency converter operation. In connection with pump operation, never reduce the frequency (and consequently the speed) to such a level that the necessary flow of cooling liquid past the motor is no longer ensured.

To avoid damage to the pump part, the motor must stop when the pump flow falls below 0.1 x nominal flow.

Depending on the frequency converter type, it may expose the motor to detrimental voltage peaks.

Warning

MS 402 motors for supply voltages up to and including 440 V (see motor nameplate) must be protected against voltage peaks higher than 650 V (peak value) between the supply terminals.

We recommend that you protect other motors against voltage peaks higher than 850 V.

The above disturbance can be abated by installing an RC filter between the frequency converter and the motor.

Possible increased acoustic noise from the motor can be abated by installing an LC filter which will also eliminate voltage peaks from the frequency converter.

We recommend that you install an LC filter when using a frequency converter. See section *6.7.6 Frequency converter operation*.

For further details, contact your frequency converter supplier or Grundfos.

6.1.2 Other motor makes than Grundfos

Contact Grundfos or the motor manufacturer.

6.2 Motor protection

6.2.1 Single-phase motors

Single-phase MS 402 motors incorporate a thermal switch and require no additional motor protection.

Warning

When the motor has been thermally switched off, the motor terminals are still live. When the motor has cooled sufficiently, it will restart automatically.

Single-phase MS 4000 motors must be protected. A protective device can either be incorporated in a control box or be separate.

Franklin 4" PSC motors must be connected to a motor-protective circuit breaker.

6.2.2 Three-phase motors

MS motors are available with or without a built-in temperature transmitter.

The following motors must be protected by a motor-protective circuit breaker with thermal relay, or a MP 204 and contactor(s):

- motors with a built-in and intact temperature transmitter
- motors with or without a defective temperature transmitter
- motors with or without a Pt100 sensor.

MMS motors have no built-in temperature transmitter.
The Pt100 and the Pt1000 sensor are available as an accessory.

6.2.3 Required settings of motor-protective circuit breaker

For cold motors, the tripping time of the motor-protective circuit breaker must be less than 10 seconds at 5 times the rated maximum current of the motor. During normal operating conditions the motor must be running at full speed in less than 3 seconds.

Caution

If this requirement is not met, the motor warranty will be invalidated.

In order to ensure optimum motor protection, the motor-protective circuit breaker should be set as follows:

1. Set the motor-protective circuit breaker to the rated maximum current of the motor.
2. Start the pump and let it run for half an hour at normal performance.
3. Slowly grade down the scale indicator until the motor trip point is reached.
4. Increase the setting by 5 %.

The highest permissible setting is the rated maximum current of the motor.

For motors wound for star-delta starting, the motor-protective circuit breaker should be set as above, but the maximum setting should be rated maximum current x 0.58.

The highest permissible startup time for star-delta starting or autotransformer starting is 2 seconds.

6.3 Lightning protection

The installation can be fitted with a special overvoltage protective device to protect the motor from voltage surges in the power supply lines when lightning strikes somewhere in the area. See fig. 10.

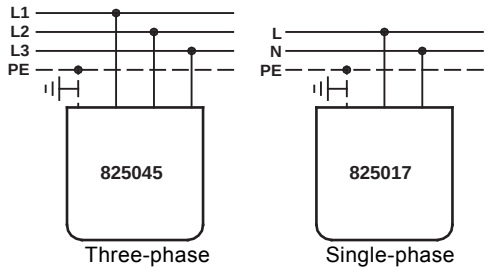


Fig. 10 Fitting an overvoltage protective device

The overvoltage protective device will not, however, protect the motor against a direct stroke of lightning.

The overvoltage protective device should be connected to the installation as close as possible to the motor and always in accordance with local regulations. Ask Grundfos for lightning protective devices.

MS 402 motors, however, require no further lightning protection as they are highly insulated.

A special cable termination kit with a built-in overvoltage protective device is available for Grundfos 4" motors (product No 799911 or 799912).

6.4 Cable sizing

Caution Submersible motor cables are dimensioned for submersion in liquid, and will not necessarily have sufficient cross-section to be in free air.

Make sure that the submersible drop cable can withstand permanent submersion in the actual liquid and at the actual temperature.

The cross-section (q) of the cable must meet the following requirements:

The submersible drop cable must be sized to the rated maximum current (I_n) of the motor.

The cross-section must be sufficient to make a voltage drop over the cable acceptable.

Grundfos supplies submersible drop cables for a wide range of installations. For correct cable sizing, Grundfos offers a cable sizing tool on the USB stick supplied with the motor.

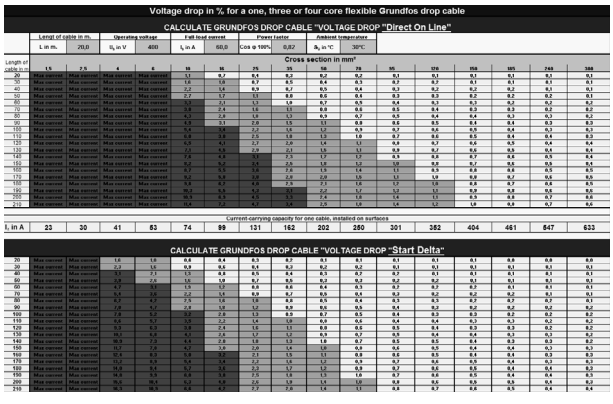


Fig. 11 Cable sizing tool

The sizing tool provides an accurate calculation of the voltage drop at a given cross-section on the basis of the following parameters:

- cable length
- operating voltage
- full-load current
- power factor
- ambient temperature.

You can calculate the voltage drop both for direct-on-line and star-delta starting.

In order to minimise operating losses, the cable cross-section may be increased. This is only cost-efficient if the borehole provides the necessary space, and if the operating time of the pump is long. The cable sizing tool also provides a power loss calculator that shows the potential savings of an increased cross-section.

As an alternative to the cable sizing tool, select the cross-section on the basis of the current values of the given cables.

The cross-section of the submersible drop cable must be large enough to meet the voltage quality requirements specified in section *6. Electrical connection*.

Determine the voltage drop for the cross-section of the submersible drop cable by means of the diagrams on pages 17 to 20.

Use the following formula:

I = Rated maximum current of the motor.

For star-delta starting, I = rated maximum current of the motor x 0.58.

Lx = Length of cable converted to a voltage drop of 1 % of the nominal voltage.

$$Lx = \frac{\text{length of drop cable}}{\text{permissible voltage drop in \%}}$$

q = Cross-section of submersible drop cable.

Draw a straight line between the actual I-value and the Lx-value. Where the line intersects the q-axis, select the cross-section that lies right above the intersection.

The diagrams are made on the basis of the formulas:

Single-phase submersible motor

$$L = \frac{U \times \Delta U}{I \times 2 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times XI\right)}$$

Three-phase submersible motor

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times XI\right)}$$

L = Length of submersible drop cable [m]
U = Rated voltage [V]
ΔU = Voltage drop [%]
I = Rated maximum current of the motor [A]
cos φ = 0.9
ρ = Specific resistance: 0.02 [Ωmm^2/m]
q = Cross-section of submersible drop cable [mm^2]
sin φ = 0.436
XI = Inductive resistance: 0.078 x 10^{-3} [Ω/m].

6.5 Control of single-phase MS 402 motors

Warning

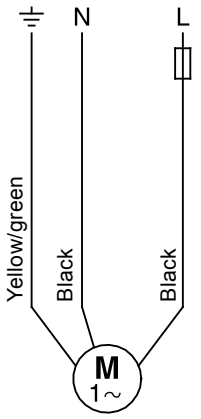
The single-phase MS 402 motor incorporates motor protection which cuts out the motor in case of excessive winding temperatures while the motor is still supplied with voltage. Allow for this, when the motor forms part of a control system.

If a compressor is included in a control system together with an ochre filter, the compressor will run continuously once the motor protection has cut out the motor, unless other special precautions have been taken.

6.6 Connection of single-phase motors

6.6.1 2-wire motors

MS 402 2-wire motors incorporate motor protection and a starter device and can therefore be connected direct to the mains. See fig. 12.



TM00 1358 5092

Fig. 12 2-wire motors

6.6.2 PSC motors

The PSC motors are connected to the mains via a run capacitor which should be sized for continuous operation.

Select the correct capacitor size from the table below:

Motor [kW]	Capacitor [µF] 400 V, 50 Hz
0.25	12.5
0.37	16
0.55	20
0.75	30
1.10	40
1.50	50
2.20	75

MS 402 PSC motors incorporate motor protection and should be connected to the mains as shown in fig. 13.

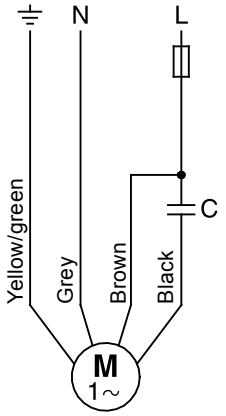


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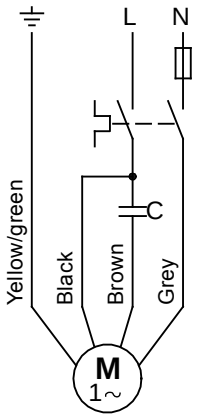
Fig. 13 PSC motors

See www.franklin-electric.com and fig. 14.



TM00 1361 1200

Fig. 14 Franklin motors

6.6.3 3-wire motors

MS 4000 3-wire motors must be connected to the mains via a Grundfos SA-SPM 5 (60 Hz), 7 or 8 (50 Hz) control box incorporating motor protection.

MS 402 3-wire motors incorporate motor protection and should be connected to the mains via a Grundfos control box SA-SPM 2, 3 or 5 (60 Hz), 7 or 8 (50 Hz) without motor protection.

6.7 Connection of three-phase motors

Three-phase motors must be protected.
See section *6.2.2 Three-phase motors*.

For electrical connection via the MP 204, see the separate installation and operating instructions for this unit.

When a conventional motor-protective circuit breaker is being used, the electrical connection should be carried out as described below.

6.7.1 Checking the direction of rotation

Caution The pump must not be started until the suction interconnector has been completely submerged in the liquid.

When the pump has been connected to the power supply, check the direction of rotation:

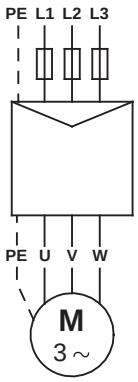
1. Start the pump and measure quantity of water and head.
2. Stop the pump and interchange two phases.
3. Start the pump and measure quantity of water and head.
4. Stop the pump.
5. Compare the two results. The connection giving the larger quantity of water and the higher head is the correct one.

6.7.2 Grundfos motors - direct-on-line starting

The connection of Grundfos motors wound for direct-on-line starting appears from the table below and fig. 15.

Mains	Cable/connection
	Grundfos 4" and 6" motors
PE	PE (yellow/green)
L1	U (brown)
L2	V (black)
L3	W (grey)

Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.



TM03 2099 3705

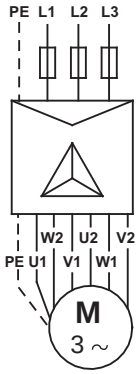
Fig. 15 Grundfos motors - direct-on-line starting

6.7.3 Grundfos motors - star-delta starting

The connection of Grundfos motors wound for star-delta starting appears from the table below and fig. 16.

Connection	Grundfos 6" motors
PE	Yellow/green
U1	Brown
V1	Black
W1	Grey
W2	Brown
U2	Black
V2	Grey

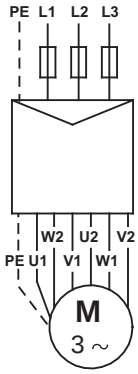
Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.



TM03 2100 3705

Fig. 16 Grundfos motors wound for star-delta starting

If direct-on-line starting is required, the motors should be connected as shown in fig. 17.



TM03 2101 3705

Fig. 17 Grundfos motors wound for star-delta starting - direct-on-line starting

6.7.4 Connection in the case of unidentified cable marking/connection (Franklin motors)

If you do not know where the individual leads are to be connected to the mains in order to ensure the correct direction of rotation, proceed as follows:

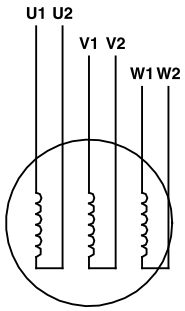
Motors wound for direct-on-line starting

Connect the pump to the mains as is expected to be right.

Then check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

Motors wound for star-delta starting

Determine the windings of the motor by means of an ohmmeter and name the lead sets for the individual windings accordingly: U1-U2, V1-V2, W1-W2. See fig. 18.



TM00 1367 5092

Fig. 18 Unidentified cable marking/connection - motors wound for star-delta starting

If star-delta starting is required, connect the leads as shown in fig. 16.

If direct-on-line starting is required, connect the leads as shown in fig. 17.

Then check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

6.7.5 Soft starter

We only recommend the use of soft starters which control the voltage on all three phases and which are provided with a bypass switch.

Ramp times: Maximum 3 seconds.

For further details, contact your soft starter supplier or Grundfos.

6.7.6 Frequency converter operation

Three-phase MS motors can be connected to a frequency converter.

Note To enable the monitoring of the motor temperature, we recommend that you install a Pt100/Pt1000 sensor together with a PR5714 or CU 220 (50 Hz).

Permissible frequency ranges: 30-50 Hz and 30-60 Hz.

Ramp times: Maximum 3 seconds for start and stop.

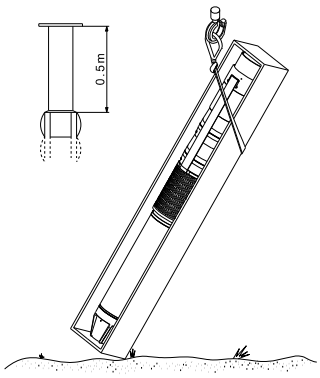
Depending on the type, the frequency converter may cause increased acoustic noise from the motor. Furthermore, it may expose the motor to detrimental voltage peaks. This can be abated by installing an LC filter between the frequency converter and the motor.

For further details, contact your frequency converter supplier or Grundfos.

7. Installation

We recommend that you first fit a 50 cm long pipe to the pump to facilitate handling of the pump during installation.

Caution Lift the pump to vertical position before removing it from the wooden box.



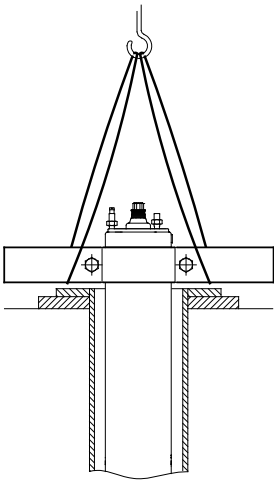
TM05 1617 3311

Fig. 19 Lifting the pump into vertical position

7.1 Fitting the motor to the pump

When the pump part and the motor are supplied as separate units (long pumps), fit the motor to the pump as follows:

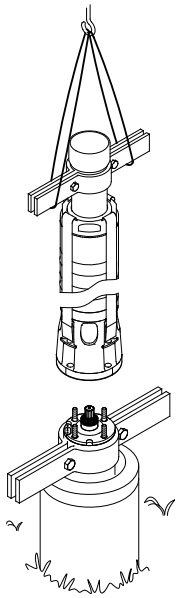
1. Use pipe clamps when handling the motor.
2. Place the motor in vertical position at the borehole seal. See fig. 20.



TM00 5259 2402

Fig. 20 Motor in vertical position

3. Lift the pump part by means of pipe clamps fitted to the extension pipe. See fig. 21.



TM02 5263 2502

Fig. 21 Lifting the pump into position

4. Place the pump part on top of the motor.
5. Fit and tighten the nuts. See table below.

Caution Make sure that the coupling between the pump and motor engages properly.

The bolts and nuts securing the straps to the pump must be cross-tightened to the following torques:

Bolt/nut	Torque [Nm]
M8	18
M10	35
M12	45
M16	120
SP 215, 50 Hz, with more than 8 stages SP 215, 60 Hz, with more than 5 stages	150

When fitting the motor to the pump part, cross-tighten the nuts to the following torques:

Staybolt diameter	Torque [Nm]
5/16 UNF	18
1/2 UNF	50
M8	18
M12	70
M16	150
M20	280

Caution Make sure that the pump chambers are aligned when assembly has been completed.

7.2 Removing and fitting the cable guard

If the cable guard is screwed on to the pump, it should be removed and fitted by means of screws.

Caution Make sure that the pump chambers are aligned when the cable guard has been fitted.

7.3 Connecting the submersible drop cable

7.3.1 Grundfos motors

Before connecting the submersible drop cable to the motor, make sure that the cable socket is clean and dry.

To facilitate the connection of the cable, lubricate the rubber parts of the cable plug with non-conducting silicone paste.

Tighten the screws holding the cable to these torques [Nm]:

MS 402: 2.0
MS 4000: 3.0
MS 6000: 4.5
MMS 6: 20
MMS 8000: 18
MMS 10000: 18
MMS 12000: 15

7.4 Riser pipe

If a tool, e.g. a chain pipe wrench, is used when the riser pipe is fitted to the pump, the pump must only be gripped by the pump discharge chamber.

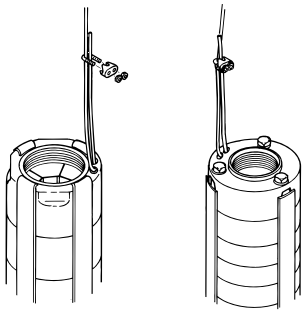
The threaded joints on the riser pipe must all be well cut and fit together to ensure that they do not work loose when subjected to torque reaction caused by the starting and stopping of the pump.

The thread on the first section of the riser pipe which is to be screwed into the pump should not be longer than the threads in the pump.

If noise may be transmitted to the building through the pipework, we recommend that you use plastic pipes.

Note We recommend plastic pipes for 4" pumps only.

When plastic pipes are used, secure the pump by an unloaded straining wire to be fastened to the discharge chamber of the pump. See fig. 22.



TM00 1368 2298

Fig. 22 Fixing the straining wire

When connecting plastic pipes, use a compression coupling between the pump and the first pipe section.

Where flanged pipes are used, the flanges should be slotted to take the submersible drop cable and a water indicator hose, if fitted.

7.5 Maximum installation depth below water level [m]

Grundfos MS 402: 150
Grundfos MS 4000: 600
Grundfos MS 6000: 600
Grundfos MMS: 600
Franklin motors: 350

7.6 Cable clips

Fit cable clips every 3 metres to fix the submersible drop cable and the straining wire, if fitted, to the riser pipe of the pump.

Grundfos supplies cable clip sets on request.

1. Cut off the rubber band so that the piece with no slit becomes as long as possible.
2. Insert a button in the first slit.
3. Position the wire alongside the submersible drop cable as shown in fig. 23.

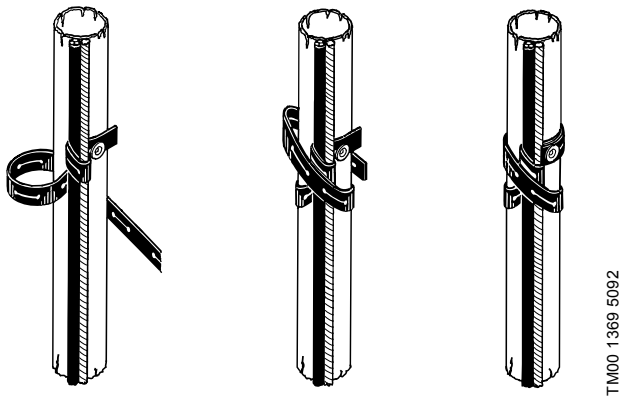


Fig. 23 Fitting the cable clips

4. Wind the band once around the wire and the cable. Then wind it tightly at least twice around the pipe, wire and the cable.
5. Push the slit over the button and cut off the band.

Where large cable cross-sections are used, it will be necessary to wind the band several times.

Where plastic pipes are used, some slackness must be left between each cable clip as plastic pipes expand when loaded.

When flanged pipes are used, the cable clips should be fitted above and below each joint.

7.7 Lowering the pump

We recommend that you check the borehole by means of an inside calliper before lowering the pump to ensure unobstructed passage.

Lower the pump carefully into the borehole, taking care not to damage the motor cable and the submersible drop cable.

Caution Do not lower or lift the pump by means of the motor cable.

7.8 Installation depth

The dynamic water level should always be above the suction interconnector of the pump. See section *5.2 Positional requirements* and fig. 24.

Minimum inlet pressure is indicated in the NPSH curve for the pump. The minimum safety margin should be 1 metre head.

We recommend that you install the pump so that the motor part is above the well screen in order to ensure optimum cooling. See section *5.4 Liquid temperatures/cooling*.

When the pump has been installed to the required depth, the installation should be finished by means of a borehole seal.

Slacken the straining wire so that it becomes unloaded and lock it to the borehole seal by means of wire locks.

Note For pumps fitted with plastic pipes, the expansion of the pipes when loaded should be taken into consideration, when deciding on the installation depth of the pump.

8. Startup and operation

8.1 Startup

When the pump has been connected correctly and it is submerged in the liquid to be pumped, it should be started with the discharge valve closed off to approximately 1/3 of its maximum volume of water.

Check the direction of rotation as described in section *6.7.1 Checking the direction of rotation*.

If there are impurities in the water, open the valve gradually as the water becomes clearer. Do not stop the pump until the water is completely clean, as otherwise the pump parts and the non-return valve may become blocked.

As the valve is being opened, check the drawdown of the water level to ensure that the pump always remains submerged.

The dynamic water level should always be above the suction interconnector of the pump. See section *5.2 Positional requirements* and fig. 24.

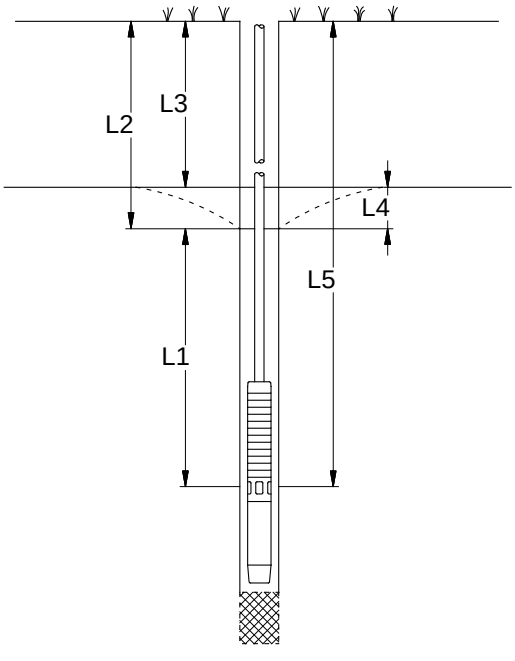


Fig. 24 Comparison of various water levels

L1: Minimum installation depth below dynamic water level. We recommend minimum 1 metre.

L2: Depth to dynamic water level.

L3: Depth to static water level.

L4: Drawdown. This is the difference between the dynamic and the static water levels.

L5: Installation depth.

If the pump can pump more than yielded by the well, we recommend that you install the Grundfos MP 204 motor protector or some other type of dry-running protection.

If no water level electrodes or level switches are installed, the water level may be drawn down to the suction interconnector of the pump and the pump will then draw in air.

Caution Long time of operation with water containing air may damage the pump and cause insufficient cooling of the motor.

8.2 Operation

8.2.1 Minimum flow rate

To ensure the necessary cooling of the motor, the pump flow rate should never be set so low that the cooling requirements in section *5.4 Liquid temperatures/cooling* cannot be met.

8.2.2 Frequency of starts and stops

Motor type		Number of starts
MS 402		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 4000		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 6000		• Minimum 1 per year is recommended. • Maximum 30 per hour. • Maximum 300 per day.
MMS6	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 40 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 10 per hour. • Maximum 70 per day.
MMS 8000	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 30 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 8 per hour. • Maximum 60 per day.
MMS 10000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 20 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 6 per hour. • Maximum 50 per day.
MMS 12000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 15 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 5 per hour. • Maximum 40 per day.

9. Maintenance and service

All pumps are easy to service.

Service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service centre.

Warning

If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

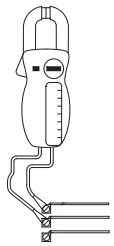
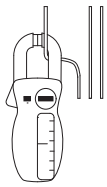
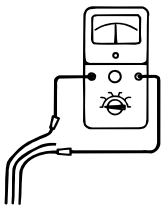
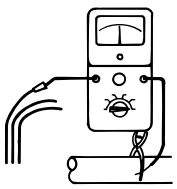
If Grundfos is requested to service the pump, Grundfos must be contacted with details about the pumped liquid, etc. before the pump is returned for service. Otherwise Grundfos can refuse to accept the pump for service.

Possible costs of returning the pump are paid by the customer.

10. Fault finding

Fault	Cause	Remedy
1. The pump does not run.	a) The fuses are blown.	Replace the blown fuses. If the new ones blow too, check the electric installation and the submersible drop cable.
	b) The ELCB or the voltage-operated ELCB has tripped.	Cut in the circuit breaker.
	c) No power supply.	Contact the power supply company.
	d) The motor-protective circuit breaker has tripped.	Reset the motor-protective circuit breaker (automatically or possibly manually). Check the voltage if it trips again. If the voltage is okay, see items 1e to 1h.
	e) The motor-protective circuit breaker/contactor is defective.	Replace the motor-protective circuit breaker/contactor.
	f) Starter device is defective.	Repair or replace the starter device.
	g) The control circuit has been interrupted or is defective.	Check the electric installation.
	h) The dry-running protection has cut off the power supply to the pump due to low water level.	Check the water level. If it is okay, check the water level electrodes/level switch.
	i) The pump/submersible drop cable is defective.	Repair or replace the pump/cable.
2. The pump runs but gives no water.	a) The discharge valve is closed.	Open the valve.
	b) No water or too low water level in borehole.	See item 3a.
	c) The non-return valve is stuck in closed position.	Pull out the pump and clean or replace the valve.
	d) The suction strainer is blocked.	Pull out the pump and clean the strainer.
	e) The pump is defective.	Repair or replace the pump.
3. The pump runs at reduced performance.	a) The drawdown is larger than anticipated.	Increase the installation depth of the pump, throttle the pump or install a pump with a smaller performance.
	b) Wrong direction of rotation.	See section *6.7.1 Checking the direction of rotation*.
	c) The valves in the discharge pipe are partly closed/blocked.	Clean or replace the valves.
	d) The discharge pipe is partly blocked by impurities (ochre).	Clean or replace the pipe.
	e) The non-return valve of the pump is partly blocked.	Pull out the pump and clean or replace the valve.
	f) The pump and the riser pipe are partly blocked by impurities (ochre).	Pull out the pump and clean or replace it. Clean the pipes.
	g) The pump is defective.	Repair or replace the pump.
	h) Leakage in the pipework.	Check and repair the pipework.
	i) The riser pipe is defective.	Replace the pipe.
4. Frequent starts and stops.	a) The differential of the pressure switch between the start and stop pressures is too small.	Increase the differential. The stop pressure must not exceed the operating pressure of the pressure tank, and the start pressure should be high enough to ensure sufficient water supply.
	b) The water level electrodes or level switches in the reservoir have not been installed correctly.	Adjust the intervals of the electrodes/level switches to ensure suitable time between the cutting-in and cutting-out of the pump. See installation and operating instructions for the electrodes/level switches. If the intervals between stop/start cannot be changed via the automatics, the pump performance may be reduced by throttling the discharge valve.
	c) The non-return valve is leaking or stuck half-open.	Pull out the pump and clean or replace the valve.
	d) The tank precharge pressure is too small.	Adjust the tank precharge pressure in accordance with its installation and operating instructions.
	e) The tank is too small.	Increase the capacity of the tank by replacing or supplementing with another tank.
	f) The diaphragm of the tank is defective.	Check the diaphragm tank.

11. Checking motor and cable

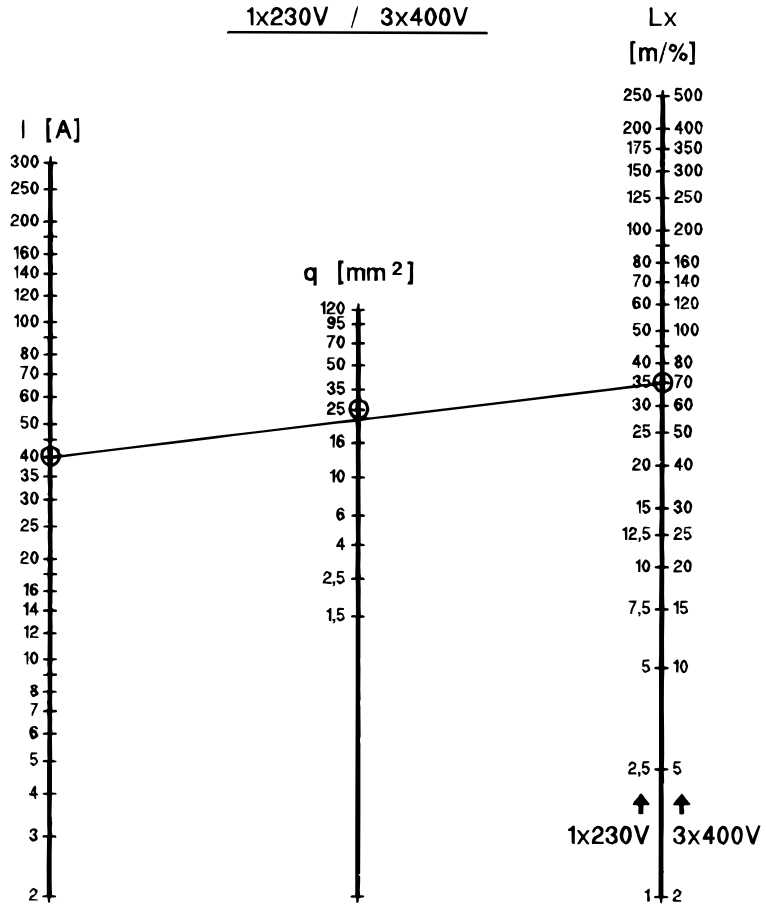
1. Supply voltage  TM00 1371 5092	Measure the voltage between the phases by means of a voltmeter. On single-phase motors, measure between phase and neutral or between two phases, depending on the type of supply. Connect the voltmeter to the terminals in the motor-protective circuit breaker.	The voltage should, when the motor is loaded, be within the range specified in section *6. Electrical connection*. The motor may burn if there are larger variations in voltage. Large variations in voltage indicate poor power supply, and the pump should be stopped until the defect has been remedied.
2. Current consumption  TM00 1372 5092	Measure the amps of each phase while the pump is operating at a constant discharge head (if possible, at the performance where the motor is most heavily loaded). For maximum operating current, see nameplate.	On three-phase motors, the difference between the current in the phase with the highest consumption and the current in the phase with the lowest consumption should not exceed 5 %. If so, or if the current exceeds the rated current, there are the following possible faults: • The contacts of the motor-protective circuit breaker are burnt. Replace the contacts or the control box for single-phase operation. • Poor connection in leads, possibly in the cable joint. See item 3. • Too high or too low supply voltage. See item 1. • The motor windings are short-circuited or partly disjointed. See item 3. • Damaged pump is causing the motor to be overloaded. Pull out the pump for overhaul. • The resistance value of the motor windings deviates too much (three-phase). Move the phases in phase order to a more uniform load. If this does not help, see item 3.
Items 3 and 4: Measurement is not necessary when the supply voltage and the current consumption are normal.		
3. Winding resistance  TM00 1373 5092	Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the winding resistance between the leads of the drop cable.	For three-phase motors, the deviation between the highest and the lowest value should not exceed 10 %. If the deviation is higher, pull out the pump. Measure motor, motor cable and drop cable separately, and repair or replace defective parts. **Note:** The operating winding of single-phase 3-wire motors will assume the lowest resistance value.
4. Insulation resistance  TM00 1374 5092	Disconnect the submersible drop cable from the motor-protective circuit breaker. Measure the insulation resistance from each phase to earth (frame). Make sure that the earth connection was made carefully.	If the insulation resistance is less than 0.5 MΩ, the pump should be pulled out for motor or cable repair. Local regulations may specify other values for the insulation resistance.

12. Disposal

This product or parts of it must be disposed of in an environmentally sound way:

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Subject to alterations.

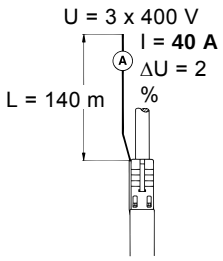


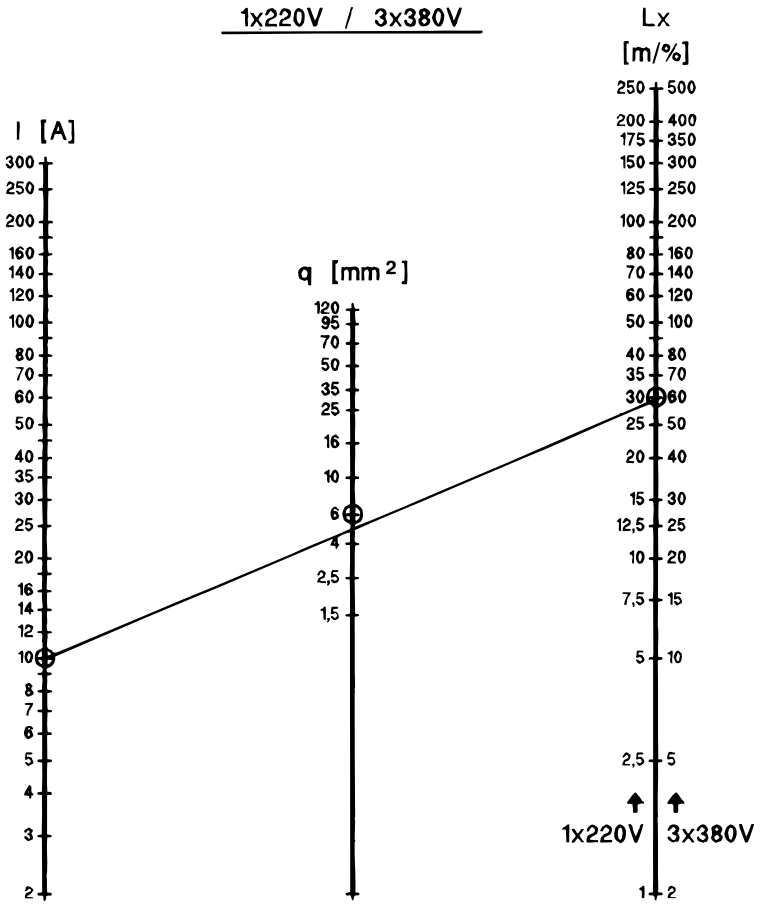
TM00 1346 5092

Example:

U = 3 x 400 V
I = **40 A**
L = 140 m
ΔU = 2 %

$Lx = \frac{L}{\Delta U} = \frac{140}{2\,\%} =$ **70 m** = q ⇒ 25 mm²



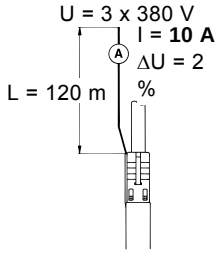


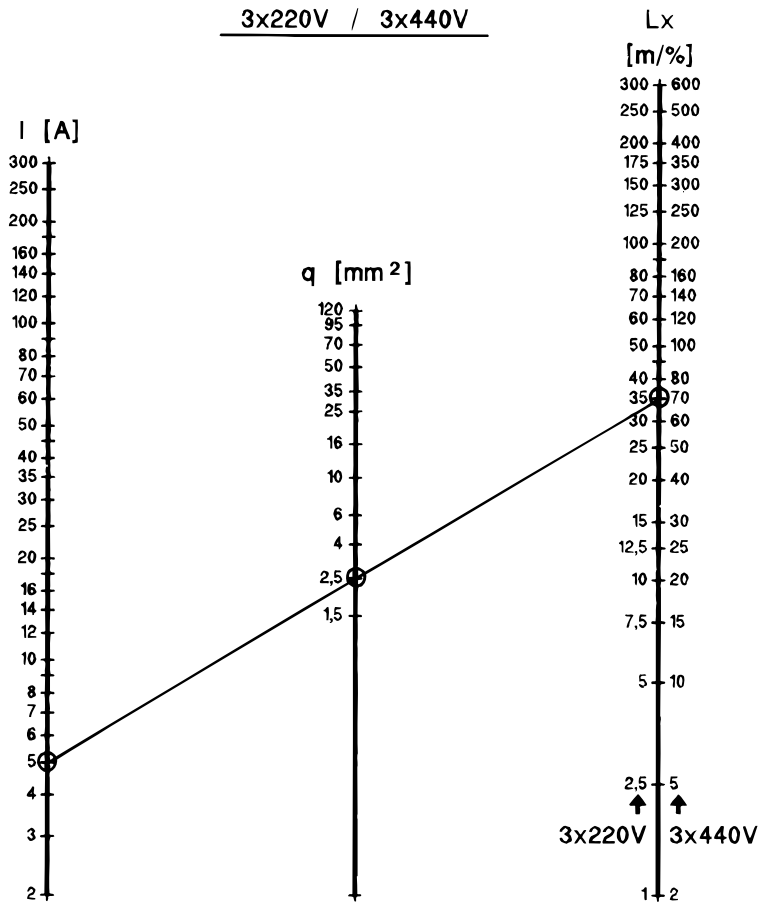
TM00 1345 5092

Example:

U = 3 x 380 V
I = **10 A**
L = 120 m
ΔU = 2 %

$Lx = \frac{L}{\Delta U} = \frac{120}{2\,\%} =$ **60 m** = q ⇒ 6 mm²



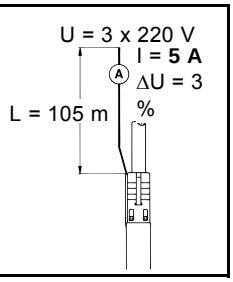


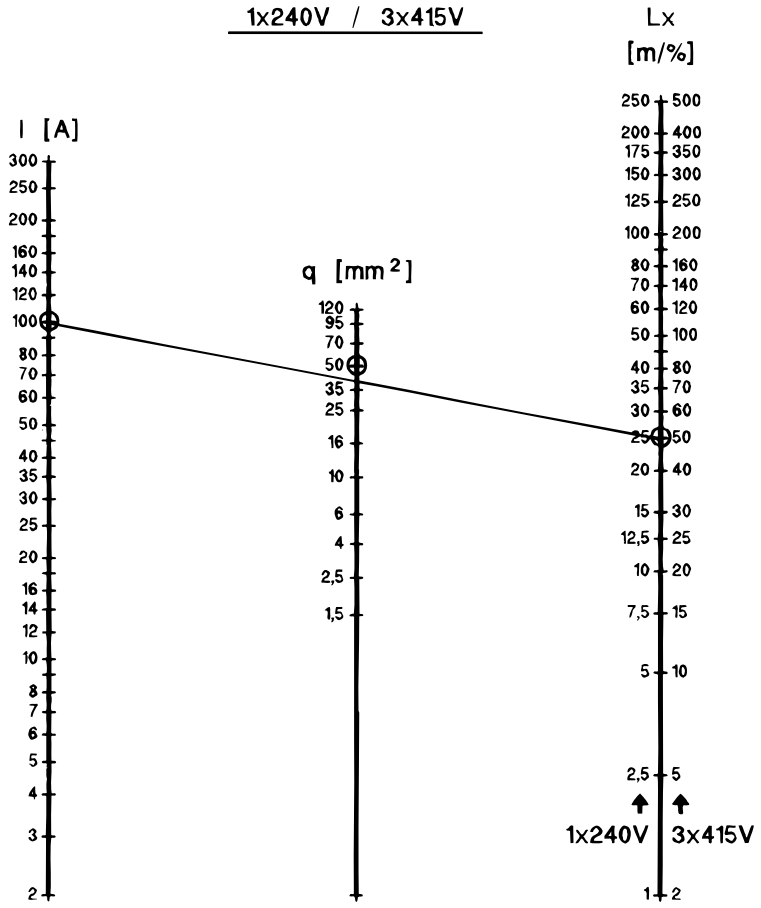
TM00 1348 5092

Example:

U = 3 x 220 V
I = **5 A**
L = 105 m
ΔU = 3 %

$$Lx = \frac{L}{\Delta U} = \frac{105}{3\,\%} = \mathbf{35\ m} = q \Rightarrow 2{,}5\ mm^2$$



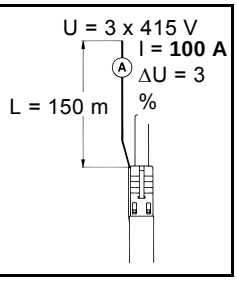


TM00 1347 5092

Example:

U = 3 x 415 V
I = **100 A**
L = 150 m
ΔU = 3 %

$$Lx = \frac{L}{\Delta U} = \frac{150}{3\,\%} = \mathbf{50\ m} = q \Rightarrow 50\ mm^2$$



SP1 - SP 2 - SP 3 - SP 5

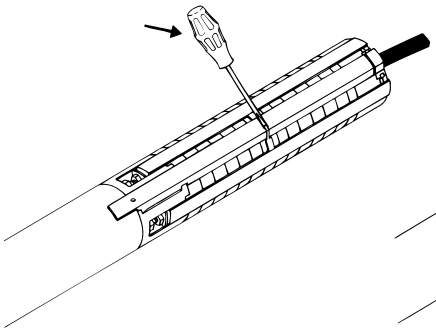


Fig. 1

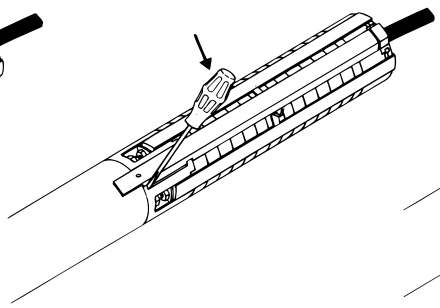


Fig. 2

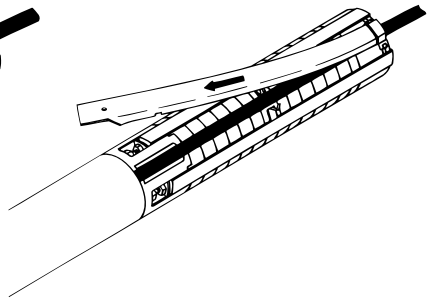


Fig. 3

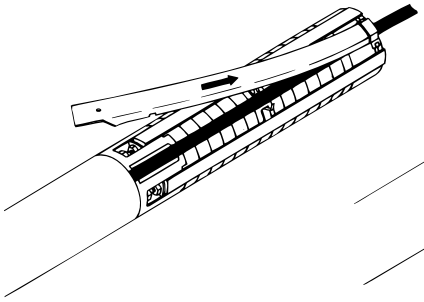


Fig. 1

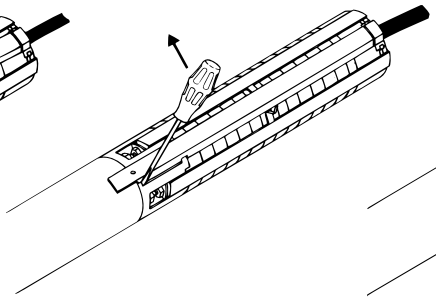


Fig. 2

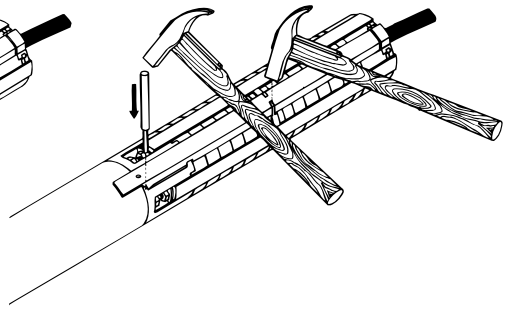


Fig. 3

TM00 1323 5092

SP 7 - SP 9 - SP 11 - SP 14 - SP 17 - SP 30 - SP 46 - SP 60

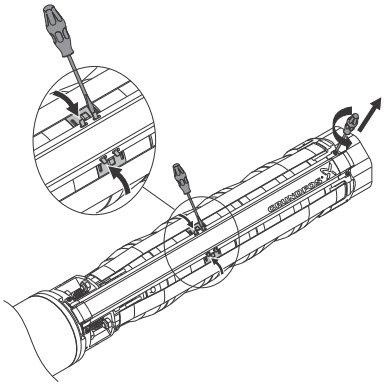


Fig. 1

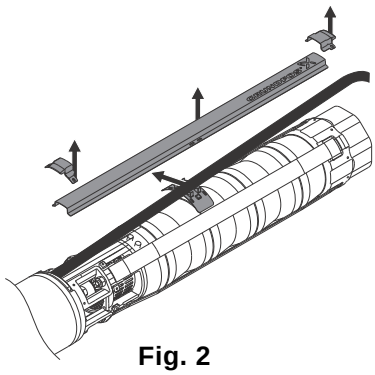


Fig. 2

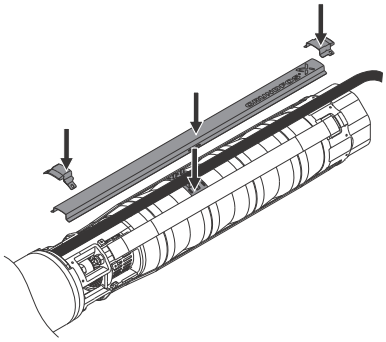


Fig. 1

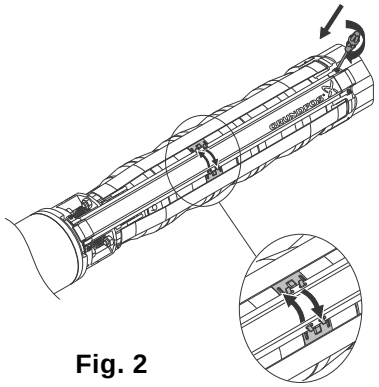


Fig. 2

TM06 0693 0814

SP 77 - SP 95 - SP 125 - SP 160 - SP 215

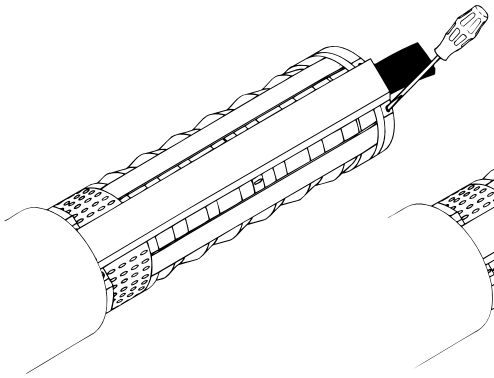


Fig. 1

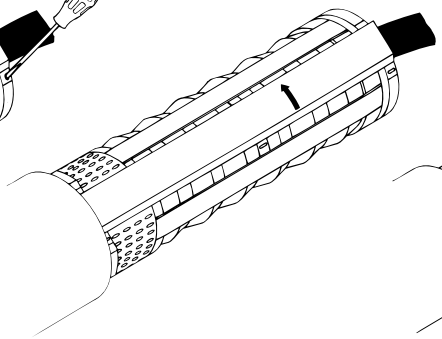


Fig. 2

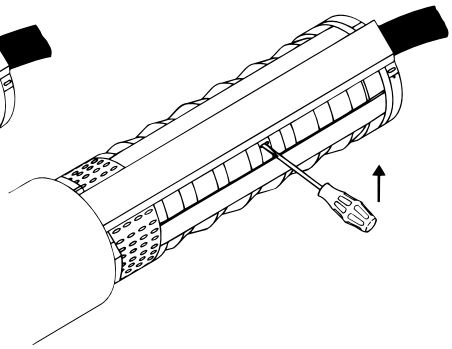


Fig. 3

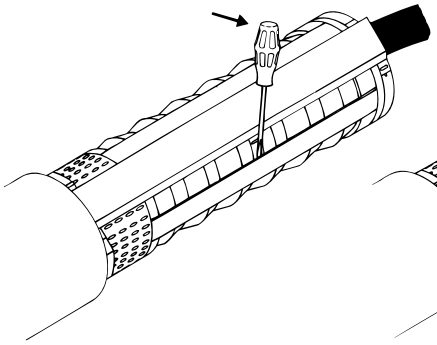


Fig. 1

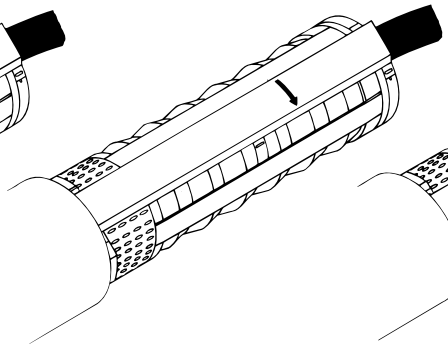


Fig. 2

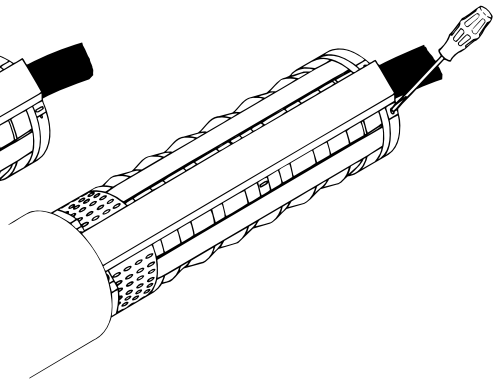


Fig. 3

TM00 1326 5092

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ARMSTRONG

DESIGN ENVELOPE

COMPASS
high-efficiency wet-rotor circulators

NSF®-372* | COMPLIES WITH EEI ≤ 0.22

3 YEAR WARRANTY

SOLUTION OUTLINE

FILE NO: 10.19
DATE: SEPTEMBER 2017
SUPERSEDES: 10.19
DATE: MAY 2016

Your choice of circulator has a surprisingly large effect on your building project.

Easy access for wiring the terminal block

The right circulator will generate energy savings for years. Advanced variable speed technology increases circulator efficiency; even though the circulator and motor are small, the energy savings can add up. Homeowners will appreciate the reduced operating costs and reduced carbon footprint.

For contractors, a well-designed circulator is easy to install and will reduce or eliminate customer complaints. For wholesalers and contractors, a circulator that covers a broad range of operating requirements makes the selection process easier, leaving more time for serving customers.

Inventory costs are also important. The right choice of circulator lets you serve more customers and installations with only one model. Keeping fewer circulator models on your shelf, or in your trucks, cuts your inventory investment and your operating costs.

ENERGY SAVINGS

UP TO 70%

FOR DETAILS ON

- Design Envelope selections
- Demand-based variable speed operation
- Sensorless technology

please see the Design Envelope solution outline
(FILE NO. 100.11)

kWh

DESIGN ENVELOPE

Design Envelope is a revolutionary technology pioneered by Armstrong that offers simplified circulator selection, lowest installed cost, expanded application flexibility and optimized energy efficiency. Armstrong Design Envelope technology, previously offered in Armstrong pumps from one horsepower to 450 hp, is now available in Armstrong circulators. Design Envelope technology augments the value of Armstrong circulators through increased operating range and sensorless, demand-based control.

KEY BENEFITS

Responding to the need for a better circulator, Armstrong offers COMPASS, an advanced solution that benefits everyone involved in a heating system project. By selecting the right circulator, wholesalers, homeowners, and contractors can all come out ahead.

COMPASS circulators incorporate advanced functionality to assist with your construction and service projects and improve the long-term enjoyment of the building spaces you help create.

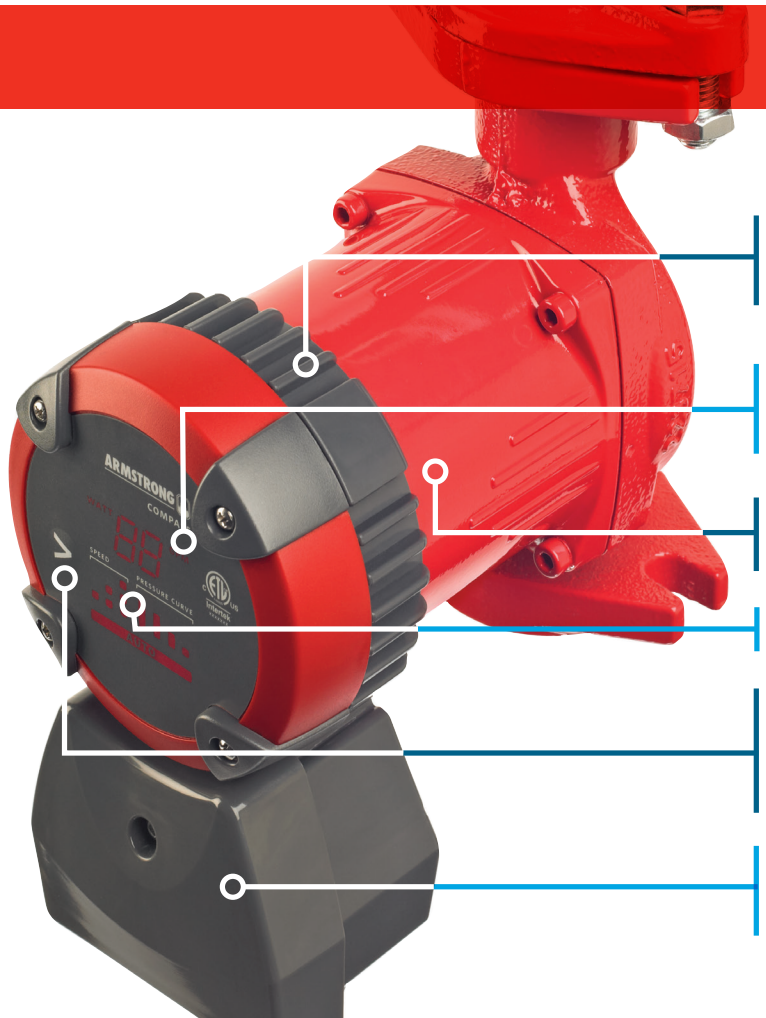
Easy sizing and selection of the COMPASS circulator simplifies your job as a wholesaler or contractor and reduces your inventory requirements.

In the field, the front mounted terminal block reduces installation time.

The COMPASS "auto" algorithm intelligently adapts to system demand, so you get the right setup every time and your customers enjoy comfortable room temperatures.

Ultimately, COMPASS circulators provide reliable performance, backed by a three-year warranty, with noticeable reductions in energy consumption and operating costs.

KEY FEATURES



Broad operating range, producing up to 20 feet of head and 20 USgpm flow

Design Envelope technology providing sensorless demand-based control

Efficient motor technology and intelligent variable speed operation

Easy to read display

Eight different modes of operation providing versatility to cover the performance of a wide range of fixed speed circulators

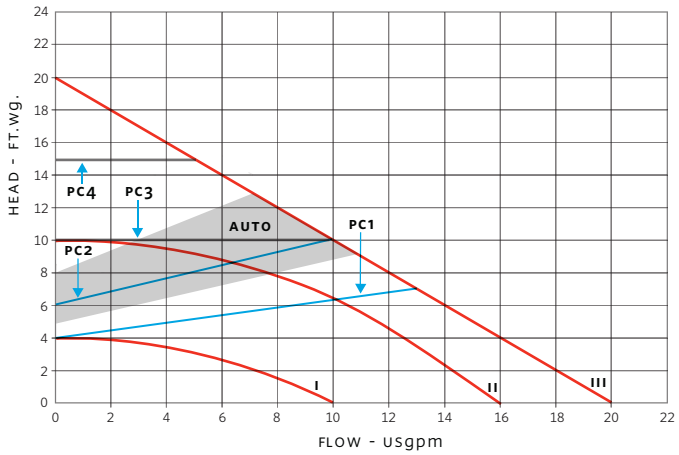
Large wiring chamber and front-mounted terminal block

PERFORMANCE

POWER RANGE	5W-45W
MAX FLOW RATE	20 USgpm
MAX HEAD PRESSURE	20 ft

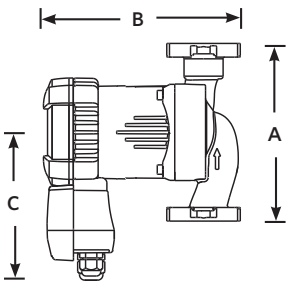
MODEL	ITEM NO.	
COMPASS 20 -20CI	180203-606	(flange)
*COMPASS 20-20SS	180203-607	(flange)
COMPASS 20-20SSU	180203-604	(union)

COMPASS PERFORMANCE CURVES

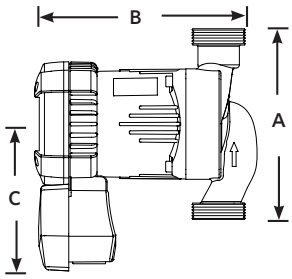


EIGHT MODE OPTIONS

AUTO	Circulator adapts to system demand over time.
PC1	Lowest proportional-pressure curve
PC2	Highest proportional-pressure curve
PC3	Lowest constant-pressure curve
PC4	Highest constant pressure curve
III	Highest constant speed
II	Medium constant speed
I	Lowest constant speed



A = 6.375"
B = 7.08"
C = 4.61"



A = 6"
B = 7.08"
C = 4.61"

SSU model

For more information, contact your Armstrong representative or visit us at:
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ARMSTRONG

COMPASS | HIGH-EFFICIENCY WET-ROTOR CIRCULATORS |
INSTALLATION AND OPERATING INSTRUCTIONS

File No: 10.895
Date: MARCH 28, 2014
Supersedes: 10.895
Date: DECEMBER 10, 2013

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WARNING

- Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.
- The use of this product requires experience with and knowledge of the product. Only licensed or trained installers should install this product.
- For supply Connection, use wires acceptable for at least 90°C (194°F).
- **Risk of shock:** this pump has not been tested for use in swimming pools or marine areas.
- To reduce risk of electric shock: Unplug before servicing, see instructions for proper installation, connect to a properly grounded, grounding type receptacle only.
- For indoor use only.
- Use copper conductors only.
- Do not install with motor above or below pump body.
- Do not submerge.
- Do not run pump dry.

1.0 SYMBOLS USED IN THIS DOCUMENT

WARNING

The safety instructions must be followed to prevent potential personal injury.

CAUTION

The safety instructions must be followed to prevent potential malfunction or damage to the equipment.

HINT

Hints or instructions that make the setup easier and ensure safe operation

2.0 GENERAL INSTALLATION

2.1 THE ARMSTRONG COMPASS CIRCULATOR

The Armstrong Compass circulator is designed for circulating water in closed hydronic heating systems or potable water systems.

Model

- Compass 20-20 CI
- Compass 20-20 SS**

The Armstrong Compass includes operating modes suitable for systems with constant or variable flows, such as:

- Underfloor heating systems
- One-pipe (series) systems
- Two-pipe (parallel) systems

Armstrong Compass circulators incorporate Armstrong patented Design Envelope variable speed control technology with an ECM motor, enabling optimum energy efficiency and occupant comfort, with built-in control algorithms that can adapt to continuously changing system requirements.

The Armstrong Compass features a user-friendly front-mounted control panel (see section 6) and wiring box for ease of installation.

2.2 BENEFITS OF INSTALLING AN ARMSTRONG COMPASS CIRCULATOR

Eight different modes of operation to suit different system requirements:

- Easily selectable from the front mounted display.
- Modes include Sensorless demand-based control – Auto.
- Power consumption and flow rate clearly displayed.

Broad operating range, producing up to 20 feet of head and 20 US GPM of flow, provide versatility to cover the performance of a wide range of fixed speed or variable speed circulators.

- Flange to flange compatibility with existing Armstrong circulators and many competing models.

Front mounted wiring box for ease of installation and service.

3.0 INSTALLATION

3.1 MOUNTING

Note:
For convenience in future servicing, isolation flanges can be used in place of standard flanges.

CORRECT INSTALLATIONS **INCORRECT INSTALLATIONS**

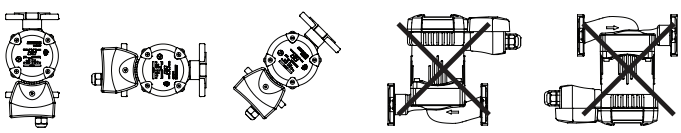


FIG. 2 Mounting the Armstrong compass

Arrows on the pump housing indicate the liquid flow direction through the pump.

1. Fit the two gaskets supplied when the pump is mounted in the pipe.
2. Install the pump with the motor shaft horizontal (see **FIG. 2**).

3.2 CONTROL BOX POSITIONS

The orientation of the display can be adjusted by removing four screws that attach the motor to the pump housing. Pump must be isolated from the system as this will open the system to the atmosphere.

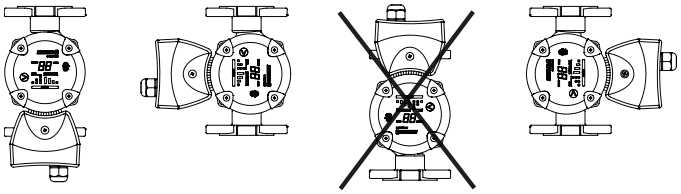


FIG. 3 Control box positions

WARNING

The pumped liquid may be scalding hot and under high pressure. Drain the system or close the isolating valves on either side of the pump before the screws are removed.

CAUTION

After the position of the control box has been rotated, refill the pump with system liquid before startup.

3.3 CHANGING THE WIRING BOX POSITION

Always install the circulator with the wiring box below or beside the motor. To change the wiring box position, remove the motor mounting screws and rotate the motor (see **FIG. 3**).

Ensure the gasket is intact and seated before evenly retightening the mounting screw to 4.5 - 5.5 lb/ft (6 - 7.5 Nm).

4.0 ELECTRICAL CONNECTION

The electrical wiring must be installed strictly in accordance with national electrical codes, local codes and regulations.

1. Electrical installation should be conducted by a qualified electrician.
2. Always make sure electric power is disconnected before wiring the circulator.

The motor is designed for 60 Hz, 1 phase, 115 volt power.

Wire shall be 14 to 16 gauge solid wire or 16 to 18 gauge stranded wire.

To wire, loosen the screw from the wiring box cover and remove the screw and cover.

Insert wires through supplied liquid-seal connector (installed) or other strain relief connector (not provided).

Select to use the installed liquid-seal connector or included ½" NPT connector. To install the NPT connector, loosen the existing connector and screw on the NPT connector using the existing lock nut.

(Connect other strain relief connector (not provided)to the NPT connector.)

Insert wires through the connector(s).

Strip 3⁄16" of insulation from the ends of the three wires to be connected.

To insert the wires into the terminal strip, press the terminal lever downward firmly. Insert the stripped wire into the opening and release the lever (see **FIG. 4**). Tug on the wire gently to ensure it is secured.

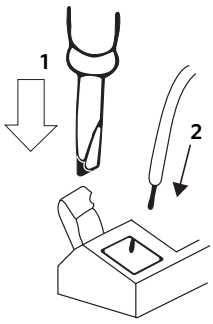


FIG. 4 Terminal strip

Connect the hot wire to terminal 'L', the neutral wire to terminal 'N', and the ground wire to terminal ⏚ (see **FIG. 5**).

Place the terminal box cover and tighten screw.

The motor is thermally protected so overload protection is not necessary. All that is required is a fused plug or circuit breaker in the power line. Electrical information can be found on the side of the terminal box.

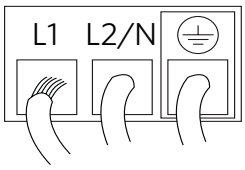


FIG. 5 Electrical connection

The electrical connections and protection must be carried out in accordance with local regulations.

WARNING

The pump must be connected to ground.

5.0 CONTROL PANEL

5.1 ELEMENTS ON THE CONTROL PANEL

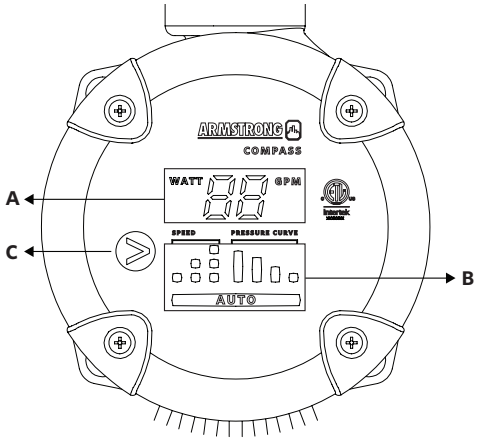


FIG. 6 Armstrong compass control panel

The control panel on the Armstrong compass includes:

POSITION	DESCRIPTION
A	Display showing the actual pump power consumption in Watt and reference flow in USgpm. Display alternates between Watt and GPM every 5 seconds.
B	Eight light fields indicating the pump setting
C	**Mode Select** button for changing pump setting

Note

GPM value is a flow indicator only, not calibrated.

5.2 FIRST POWER-UP

The display is on and in Auto mode (position 0 in **FIG. 7**) when the electricity has been switched on.

The display shows the actual pump power consumption in Watts and reference flow in USgpm during operation.

Note

Display shows "E#" when the pump is not operating properly (see section 10). (# is between 0 to 4)

5.3 DISPLAY

The Armstrong Compass has eight pump settings which can be selected with the press button.

Every time the Mode button is pressed (see **FIG. 6**, **C**) the pump setting is changed to the next option.

A full cycle is eight button presses.

The selected pump setting is indicated by one of eight different light fields (see **FIG. 7**).

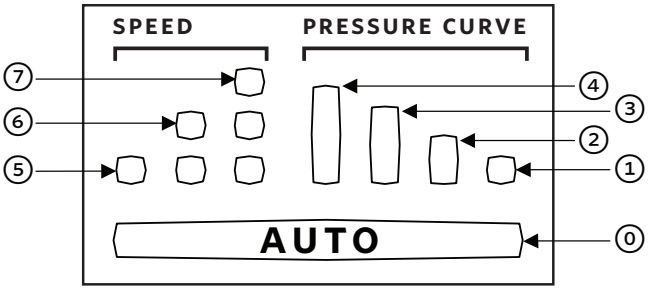


FIG. 7 Eight light fields

See section 9, Pump settings and pump performance, for information about the function of each setting.

POSITION	DESCRIPTION
⓪	AUTO (factory setting)
①	PC1 Lowest proportional-pressure curve
②	PC2 Highest proportional-pressure curve
③	PC3 Lowest constant-pressure curve
④	PC4 Highest constant-pressure curve
⑤	Constant curve, speed I
⑥	Constant curve, speed II
⑦	Constant curve, speed III

6.0 SETTING THE PUMP

6.1 PUMP SETTING FOR SYSTEM TYPE

Note
Optimum energy savings & comfort can be achieved by careful selection of the correct operation mode.

Recommended and alternative pump settings according to **FIG. 8**:

IMAGE	SYSTEM TYPE	RECOMMENDED SETTING	ALTERNATIVE SETTING
A	Underfloor heating	**AUTO**	Highest constant-pressure curve (PC4)* OR Lowest constant-pressure curve (PC3)*
B	Two-pipe (parallel) systems	**AUTO**	Highest proportional-pressure (PC2)*
C	One-pipe (series) systems	Lowest proportional-pressure curve (PC1)*	Highest proportional-pressure (PC2)*

* See pump settings and pump performance (section 9).

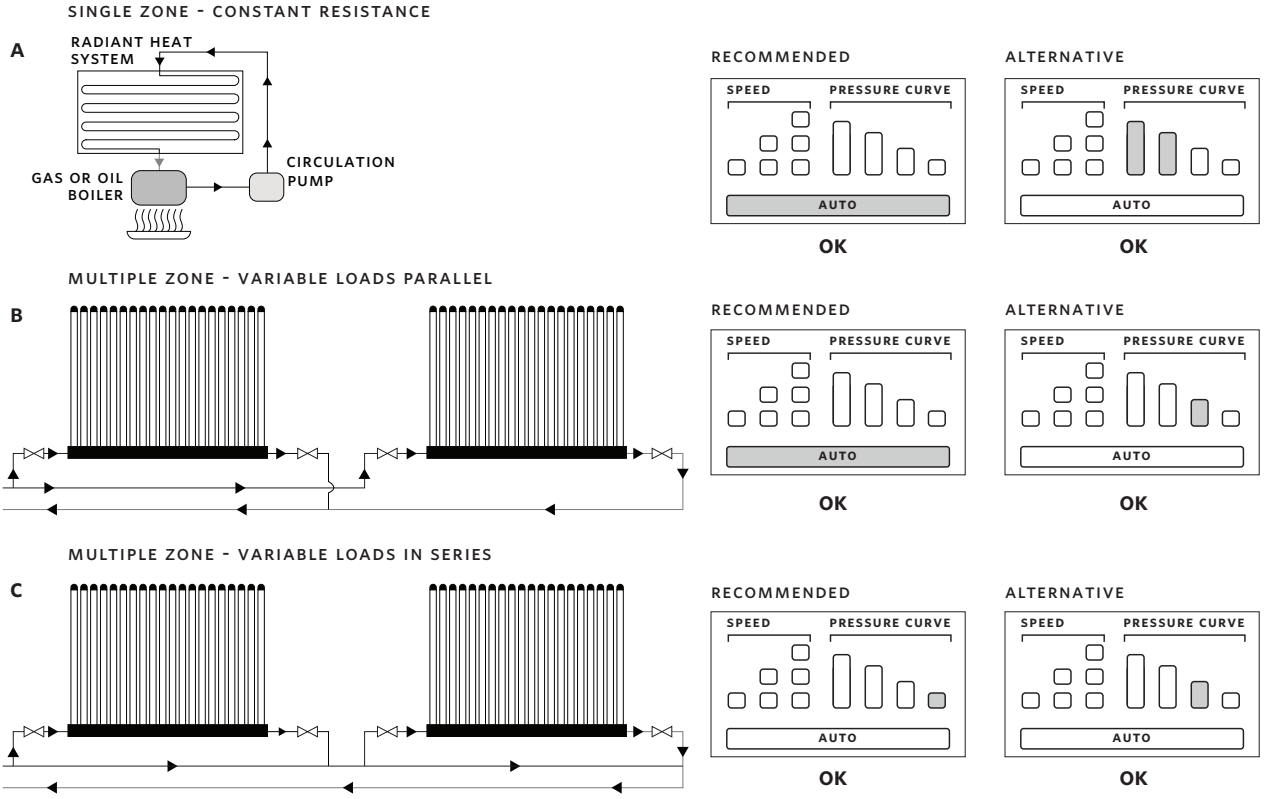


FIG. 8 Selection of pump setting for system type

AUTO (underfloor heating and two-pipe (parallel) systems)
AUTO function observes and adjusts the pump performance to satisfy the system requirement. The pump adapts to the system over time, it is recommended to leave the pump in the **AUTO** position at least one week before selecting other pump settings.

Changing from recommended (AUTO) to alternative pump setting:
Heating systems are 'slow' systems that cannot be set to the optimum operation within minutes or hours.

If the recommended pump setting does not give the desired comfort in some areas of the building, change the pump setting to the shown alternative.

See pump settings and pump performance (section 9) for more details.

7.0 SYSTEMS WITH BYPASS VALVE BETWEEN FLOW AND RETURN PIPES

7.1 PURPOSE OF BYPASS VALVE

The purpose of a differential pressure bypass valve is to ensure that the heat from the boiler can be distributed when all valves in the underfloor-heating circuits and/or thermostatic radiator valves are closed. These valves were commonly applied in multi zone systems with traditional fixed speed pumps.

A Compass circulator can eliminate the need for a differential bypass valve when used in Auto or proportional pressure modes, because the circulator will reduce speed when the valves in the system close and the heat demand is reduced.

If you are servicing an existing system with a bypass valve and you are replacing a fixed speed circulator with a Compass circulator, there is no need to remove the bypass valve.

8.0 START-UP

8.1 BEFORE START-UP

Fill the system with liquid and properly vent the system before starting the pump. The required minimum inlet pressure in relation to liquid temperature must be available at the pump inlet (see section 11).

8.2 VENTING THE PUMP

Even with system vented, air may be still be present in the pump. The air in the pump may cause noise but the noise should cease after a few minutes running.

The venting process can be shortened by setting the pump to run at speed III for a short period of time (20 seconds).

Once the pump is vented (the noise has ceased), set the pump mode according to the recommendations (see section 6).

CAUTION

The pump must not run dry.

9.0 PUMP SETTINGS AND PUMP PERFORMANCE

9.1 RELATION BETWEEN PUMP SETTING AND PUMP PERFORMANCE

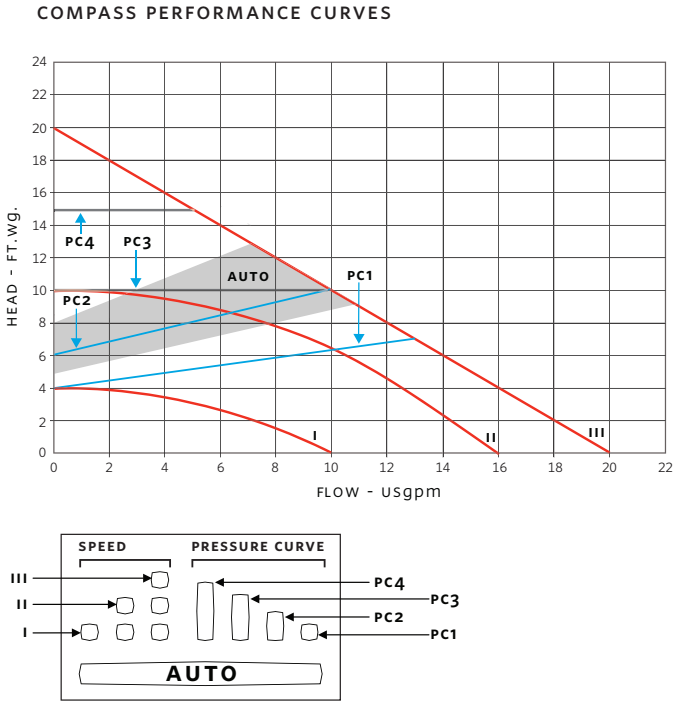


FIG. 10 Pump setting in relation to pump performance

Select the optimum setting:

The Compass circulator comes with 8 modes of operation.

There are three fixed speed curve options which will operate just like traditional fixed speed circulators, except that compass motor technology is far more energy efficient than traditional fixed speed circulators.

The proportional pressure curves operate as Sensorless differential pressure circulators. These curves follow pre-selected performance curves and will reduce flow and energy consumption when the valves in the system close and the flow requirements are reduced.

The constant pressure curves maintain pre-selected pressure ratings at the circulator.

AUTO mode operates on the sensorless differential pressure principle, but will **Learn** usage patterns and adjust circulator performance over time to optimize energy efficiency.

SETTING	PUMP CURVE	FUNCTION
AUTO (factory setting)	Operating within the defined range	The **AUTO** function controls the pump performance automatically within a defined performance range (see **FIG. 10**). • Adapt to the size of the system. • Adapt to system demand over time. In **AUTO**, Compass is set to proportional-pressure curve control.
PC1	Lowest proportional pressure curve	The operation point of the pump will follow the lowest proportional-pressure curve (see **FIG. 10**) depending on the load demand. The head (pressure) is reduced during low demand and increased during high demand until the maximum wattage is reached, then the pump will run on the speed III curve.
PC2	Highest proportional pressure curve	The operation point of the pump will follow the highest proportional-pressure curve (see **FIG. 10**) depending on the load demand. The head (pressure) is reduced during low demand and increased during high demand until the maximum wattage is reached, then the pump will run on the speed III curve.
PC3	Lowest constant pressure curve	The operation point of the pump will follow the lowest constant-pressure curve (see **FIG. 10**) depending on the load demand. The head (pressure) is kept constant, regardless of the load demand until the maximum wattage is reached, then the pump will run on the speed III curve.
PC4	Highest constant pressure curve	The operation point of the pump will follow the highest constant-pressure curve (see **FIG. 10**) depending on the load demand. The head (pressure) is kept constant, regardless of the load demand until the maximum wattage is reached, then the pump will run on the speed III curve.
III	Speed III	Speed III is the highest constant speed performance curve of Compass and it also presents the max performance capability of the pump (see **FIG. 10**). Speed III can also be used to vent the pump (see section 8.2).
II	Speed II	Speed II is the medium constant speed performance curve of Compass (see **FIG. 10**).
I	Speed I	Speed I is the lowest constant speed performance curve of Compass (see **FIG. 10**).

10.0 TROUBLESHOOTING

WARNING

Before starting any work on the pump, make sure that the electricity supply has been switched off and that it cannot be accidentally switched on.

FAULT	CONTROL PANEL	CAUSE	REMEDY
The pump does not run	Light off	A fuse in the installation is blown.	Replace the fuse.
		The circuit breaker has tripped out.	Switch the circuit breaker on.
		The pump is defective.	Replace the pump.
	Shows "E0" or "E1"	Electricity supply failure. Voltage may be too low or too high.	Check voltage level of the electricity supply.
	Shows "E2"	The impeller is locked.	Unlock the impeller/rotor.
	Shows "E3"	No liquid in system	Fill up the system
	Shows "E4"	Voltage may be too low	Check voltage level of the electricity supply.
		Control (internal circuit) is broken	Replace the pump.
Noise in the system	Shows wattage and gpm	Air in the system.	See section 8.2 Venting of the pump system.
		The flow is too high.	Select a lower speed or pressure curve (see section 9). Pump settings and pump performance.
		Pump may be running dry. No liquid in system	Fill up the system
Noise in the pump	Shows wattage and gpm	Air in the pump.	Let the pump run. It vents itself over time (see section 8.2) venting the pump.
		The inlet pressure is too low.	Increase the inlet pressure or check the air volume in the expansion tank, if installed.
Insufficient heat in space	Shows wattage and gpm	The pump performance setting may be too low.	Select a higher speed or pressure curve setting (see section 9). Pump settings and pump performance.
			Confirm that the system requirement can be met by this pump capacity or larger pump may be required.

11.0 TECHNICAL DATA AND INSTALLATION DIMENSIONS

11.1 TECHNICAL DATA

Supply voltage: 1 × 115 V – 10%/+ 6%, 60 Hz

	MINIMUM	MAXIMUM
Amp	0.05	0.65
Watt	5	45

Motor protection: The pump requires no external motor protection.

Maximum working temperature: 230°F (110°C) maximum

Maximum working pressure: 150 psi (10 bar).

Maximum relative air humidity (rh): 95%.

Enclosure class: Type 2

Insulation class: H

Certification: ETL listed for US and Canada (conforms to ULSTD.778 certified to CSA STD. C22.2 NO.108-01)

** NSF 372 (for stainless steel models)

INLET PRESSURE

Minimum inlet pressure in relation to liquid temperature:

LIQUID TEMPERATURE	MINIMUM INLET PRESSURE
150°F (65°C)	3.0 ft (0.91 m)
167°F (75°C)	4.4 ft (1.34 m)
194°F (90°C)	9.2 ft (2.8 m)
230°F (110°C)	36.1 ft (11.0 m)

Sound pressure level: The sound pressure level of the pump is lower than 43 dB(A).

Ambient temperature: 32°F (0°C) – 104°F (40°C)

Pumped liquids: Water or water Glycol mix.

WARNING

No flammable liquids such as diesel oil, petrol or similar liquids

Liquid temperature: 36°F (2°C) – 230°F (110°C)

To avoid condensation in the control box and stator, the liquid temperature must always be higher than the ambient temperature.

AMBIENT TEMPERATURE	LIQUID TEMPERATURE	
	MIN.	MAX.
32°F (0°C)	35.6°F (2°C)	230°F (110°C)
50°F (10°C)	50°F (10°C)	230°F (110°C)
68°F (20°C)	68°F (20°C)	230°F (110°C)
86°F (30°C)	86°F (30°C)	230°F (110°C)
95°F (35°C)	95°F (35°C)	194°F (90°C)
104°F (40°C)	104°F (40°C)	158°F (70°C)

CAUTION

Since water conditions can vary with geographical location (i.e. amount and type of dissolved solids) it is recommended that the operating temperature of the liquid for open (potable) systems be kept as low as possible (i.e. below 150°F or 65°C) to avoid precipitation of calcium.

VOLUTE MATERIAL

Cast iron: For closed systems (boiler loops)

Stainless steel:** Open or closed systems (potable hot water or boiler loops)

** Certified <0.25 weighted average percent lead (NSF 372) and complies with California Health and Safety code section 116875 (commonly known as AB1953).

SPARE PARTS

SPARE PART	ITEM NO.
Check valve 1"	810223-104

Pumpen Intelligenz.

Wilo Stratos Z

High Efficiency DHW Circulators

Product Brochure

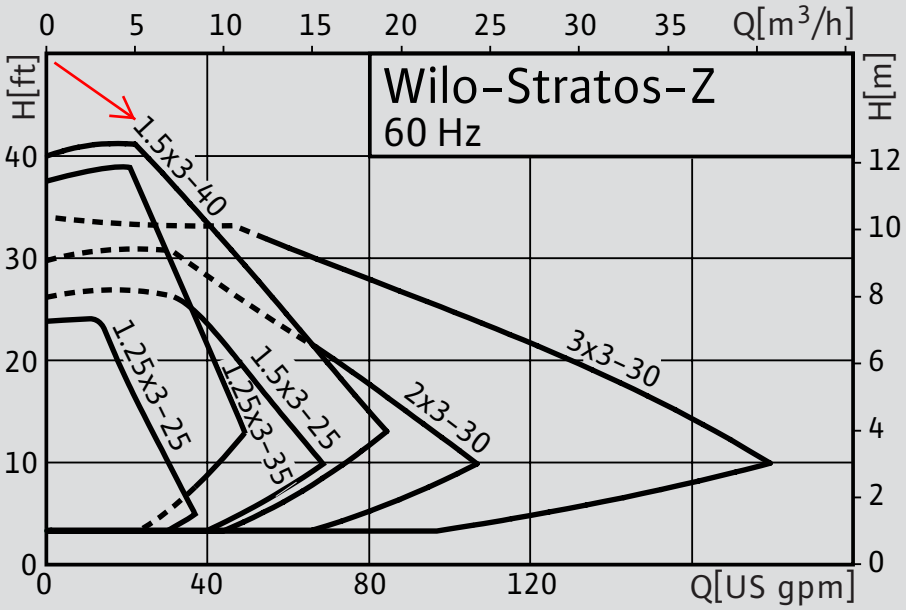
Wilo Stratos Z

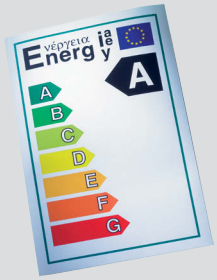
High Efficiency DHW Circulators

Applications Include:

- » **Domestic Hot Water**
- » **HVAC Systems**
- » **Closed Cooling Circuits**
- » **Industrial Circulation**
- » **Solar**
- » **Geothermal**

Wilo Stratos Z





Up to 80% Energy Savings!*

*Compared to an uncontrolled circulator.

- » Maximum efficiency with ECM technology
- » Quick and easy installation, Wilo “Red Button” technology, position adjustable LCD viewing screen
- » Lead free construction, Stainless Steel volute, NSF 61 Annex G certified
- » Optional interface modules available including: LONworks, BACnet, 0–10 Vdc, Ext Off, Ext Min and SBM Run Signal)
- » Remote control and access to data logger via optional infra-red device
- » Built in overload fault contacts (opens on over/under voltage, dry run, locked rotor, overload and over temperature)

WILO USA LLC

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GERMAN QUALITY since 1872.

WILO
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10-34-002-0612

Wilo-Stratos

Installation and operating instructions

Notice de montage et de mise en service

Instrucciones de instalación y funcionamiento

2085563-Ed.01 / 2007-05-Kothes!

Fig. 1:

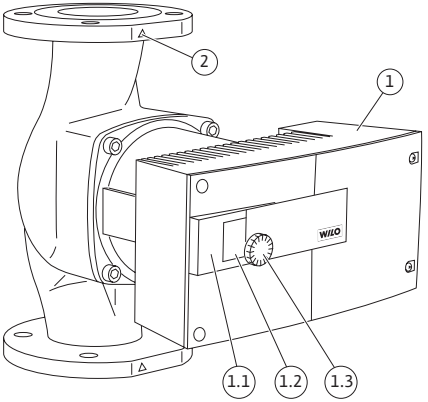


Fig. 2:

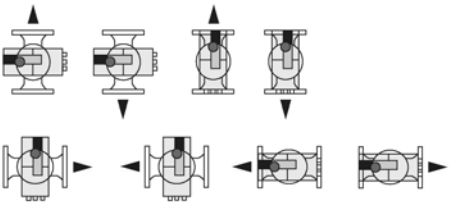
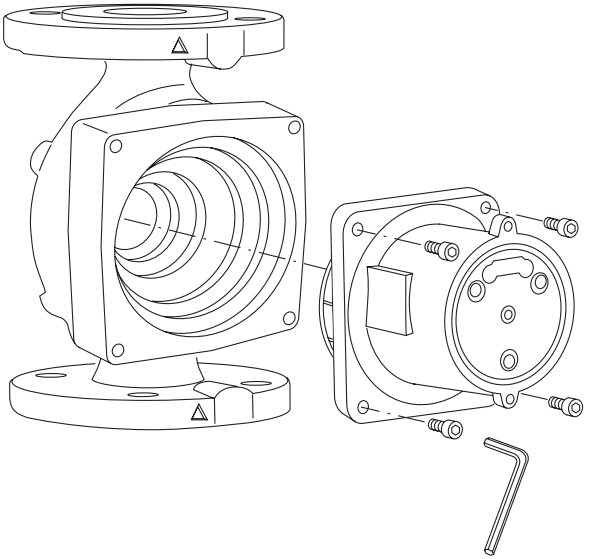


Fig. 3:



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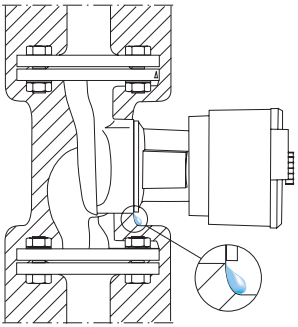

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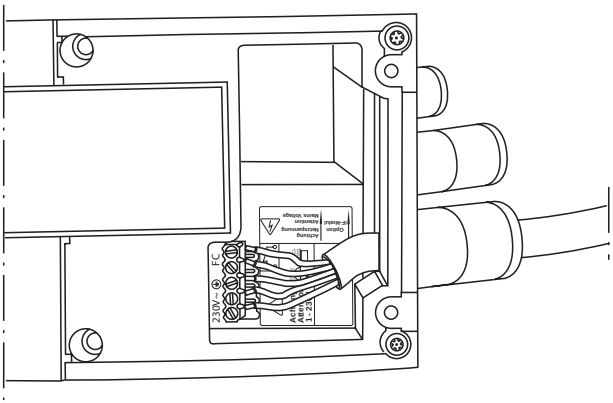

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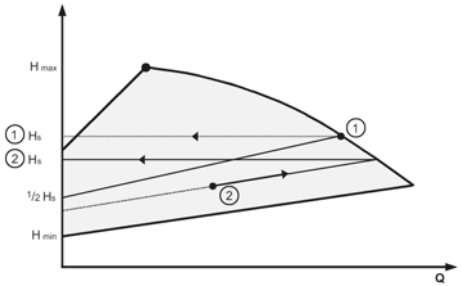

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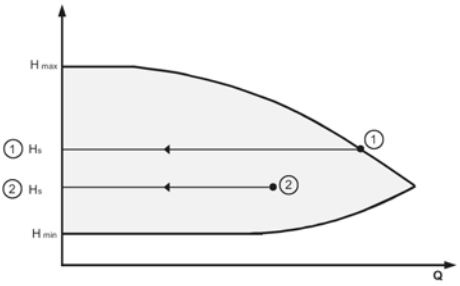


Fig. 8:

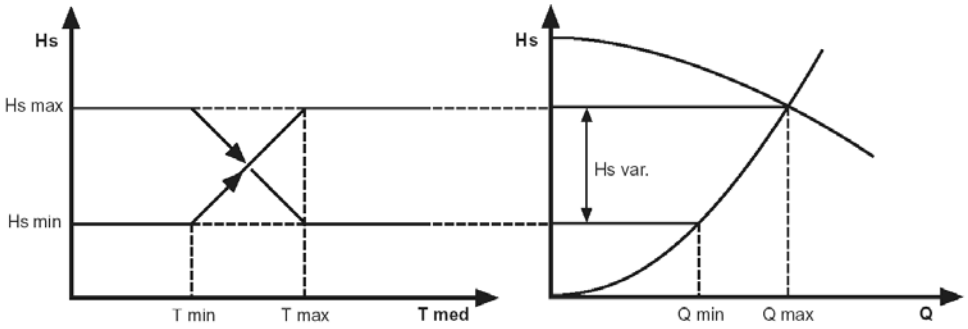


Fig. 9:

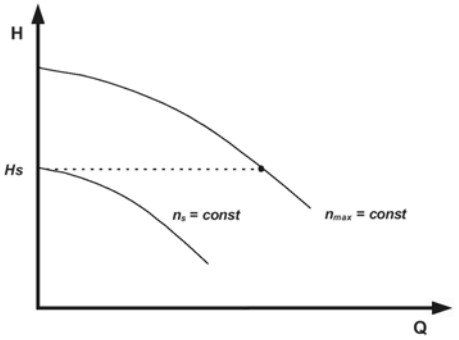
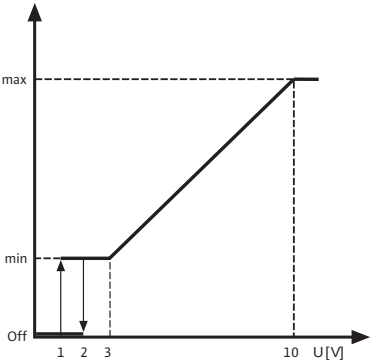


Fig. 10:



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1 General

1.1 About this document

These Installation and Operating Instructions form an integral part of the product. They must be kept close to the product and in readiness whenever required. Precise observance of these instructions is a pre-condition for use of the product for the intended purpose and for its correct operation.
These Installation and Operating Instructions conform to the relevant version of the equipment and the underlying safety standards valid at the time of going to press.

2 Safety

These instructions contain important information which must be followed when installing and operating the pump. It is therefore imperative that they be read by both the installer and the operator before the circulator is installed or started up.
Both the general safety instructions in the 'Safety precautions' section and those in subsequent sections indicated by danger symbols should be carefully observed.

2.1 Symbols and signal words used in these operating instructions

Symbols:

General Safety symbol

Hazards from electrical causes

NOTE:

Signal words:

DANGER!
Imminently hazardous situation.
Will result in death or serious injury if not avoided.

WARNING!
The user can be exposed to (severe) injury. 'Warning' refers that harm to the user when the user is neglecting the procedure.

CAUTION!
The product is at risk of damage. 'Caution' refers to the product when the user is neglecting the procedures.

NOTE: A notice with useful information for the user in relation to the product. It attends the user to possible problems.

2.2 Qualified Personnel

The personnel installing the pump must have the appropriate qualifications for this work.

2.3 Risks incurred by failure to comply with the safety precautions

Failure to comply with the safety precautions could result in personal injury or damage to the pump or installation. Failure to comply with the safety precautions could invalidate warranty and/or damage claims.
In particular, failure to comply with these safety precautions could increase the possibility of the following risks:

- the failure of important parts of the pump or installation,
- personal injury due to electrical and mechanical causes,
- material damage.

2.4 Safety precautions for the operator

Existing regulations for the prevention of accidents must be observed.
National Electrical Codes, local codes and regulations must be followed.

2.5 Safety precautions for inspection and installation

The operator must ensure that all inspection and installation work is carried out by authorized and qualified specialists who have carefully reviewed these instructions.
Work on the pump/unit must be carried out only with the pump disconnected (locked out) from the electrical supply and at complete standstill.

2.6 Unauthorized alterations and manufacture of spare parts

Alterations to the pump or installation may only be carried out with the manufacturer's consent. The use of original spare parts and accessories authorized by the manufacturer will ensure safety. The use of any other parts

may invalidate claims involving the liability of the manufacturer for any consequences.

2.7 Improper use

The operational safety of the pump or installation supplied can only be guaranteed if it is used in accordance with paragraph 4 of the operating instructions. The limits given in the catalogue or data sheet must under no circumstances be exceeded.

3 Transport and interim storage

When receiving the material, check that there has been no damage during the transport. If shipping damage has occurred, take all necessary steps with the carrier within the allowed time.

CAUTION! Outside influences may cause damages

If the delivered material is to be installed later on, store it in a dry place and protect it from impacts and any outside influences (humidity, frost etc.).

Handle the pump carefully so as not to damage the unit prior to installation.

4 Intended use (Application)

CAUTION! Possible damage of the pump

This pump is intended for use with water and water/glycol only.

The circulating pumps are used to circulate liquids in

- Warm and hot water heating systems,
- Cooling and cold water circuits,
- Closed circulation systems.

WARNING! Health hazard

The materials are not designed for drinking water supply.

Permissible liquids and requirements:

- Heating water according the requirements of accepted standards of water quality in heating systems.
- Water and water/glycol mixtures in a maximum ratio up to 1:1. High glycol concentration and low temperature systems may require a reassessment of the hydraulic data to compensate for the increased viscosity (please contact your WILO representatives for more information). Use of additives (corrosion inhibitors, oxygen scavengers etc.) must be in compliance with the manufacturer instructions.
- If other fluids or additives are used, please contact WILO for proper authorization.

5 Specification about the product

5.1 Model identification

Example: Stratos 1.5x3-40	
Stratos	**High-efficiency pump** Wet-rotor circulating pump
1.5	Pipe connection [inch]
3-40	Infinitely variable nominal pump head 3 to 40 [ft] H_{min}: 3.3 ft, H_{max}: 39.4 ft

5.2 Technical Data	
Power supply	1~230 V ± 10%
Frequency	60 Hz
Degree of protection	Enclosure 2
Insulation class	H
Motor protection	Standard built-in full motor protection
Maximum sound pressure level	54 dB(A)
Liquid temperature	14°F (-10°C) to 230°F (+110°C)
Max. ambient temperature	104°F (40°C)
Max. working pressure at the pump	145 psi

Min. pump inlet pressure [psi] at the suction side during operation by Wilo-Stratos model:

	At these liquid temps T_{Med}		
	14°F...122°F (- 10°C...+50°C)	203°F (+95°C)	230°F (+110°C)
1.25 inch	4.4 (psi)	14.5 (psi)	23.2 (psi)
1.5 and 2 inch	7.3 (psi)	17.4 (psi)	26.1 (psi)
3 inch	10.2 (psi)	21.8 (psi)	33.4 (psi)

The values apply up to 984 ft above sea level, add-on for higher altitudes: 0.15 psi/328 ft increase in height

5.3 Scope of Supply

- Complete pump
- Installation and operating instructions
- 2 flange gaskets (only for 1.25, 1.5 and 2 inch flange pumps)

5.4 Accessories

- Accessories such as companion flanges must be ordered separately.
- Companion flanges (included bolts, nuts and gaskets) for flange-pipe connection.
- IR (infra-red) module for special setup and diagnostics.
- IF (interface) Module Stratos Ext. Off/SBM, Ext.Min

6 Description and function

6.1 Pump description (fig. 1)

The Wilo-Stratos high efficiency pump (fig. 1) is a series of glandless pumps with **E**lectronic **C**ommutated **M**otor (ECM) technology and built-in differential pressure control.
On the motor housing there is in axial mounting form a **control module** (fig. 1, pos. 1) which sets the pump's differential pressure to a set value that can be varied within the control range. Depending on the control system involved, the differential pressure is subject to different criteria. However, regardless of the control system the pump constantly adapts to changing system power requirements, as it is especially the case when using thermostatic valves or mixers.

The main benefits of electronic control are:

- it saves energy while reducing operating costs,
- it reduces noise caused by the excess flow,
- it does not require pressure bypass valves.

This wet rotor pump is designed to have all rotating parts surrounded by the liquid being pumped. The pump is maintenance free and requires no further maintenance after the air bleeding procedure during the initial start-up (no after start-up maintenance).

6.1.1 Differential-pressure control systems

The **control systems** which can be selected are:

- Δ**p-v**: (Factory default setting) The electronics increase the pump's differential pressure set point in a straight line between ½ Hs and Hs. The differential pressure set point Hs increases or decreases in accordance with the required flow rate (fig. 6).
- Δ**p-c**: The electronics keep the differential pressure generated by the pump at a constant differential pressure set point Hs over the entire operation range of the pump (fig. 7).
- Δ**p-T**: The electronics alter the nominal differential pressure set point dependant on the fluid temperature measured. This control system can only be adjusted with the IR module. There are two possible settings (fig. 8):
  - Positive control: As the system temperature rises, the nominal differential pressure set point is **increased** linearly between Hsmin and Hsmax. (setting on IR module: $Hs_{max} > Hs_{min}$).
    Used e.g. with standard boilers with sliding flow temperature.
  - Negative control: As the system temperature rises, the nominal differential pressure set point is **decreased** linearly between Hsmin and Hsmax (setting on IR module: $Hs_{max} < Hs_{min}$).
    Used e.g. with condensing boilers where a specific maxium return water temperature must be maintained to achieve as much condensing as possible to insure maxium boiler effeciency. To do this, the pump must be installed in the system's return flow section.

6.1.2 Other energy-saving operating modes

- Speed regulation mode operation: The speed of the pump is kept at an externally set constant speed between minimum and maximum speeds (fig. 9). The speed regulation mode deactivates the differential pressure control.
- In the "auto" operating mode (factory default setting) the pump is able to recognize a minimum system heat output requirement due to a sustained drop in the system temperature and then automitically switch to **"Autopilot" night setback mode**. If the heat output requirement rises, the pump automatically switches to standard mode. This setting ensures that the pump's energy consumption is reduced to a minimum and in most cases is the optimum setting.

6.1.3 General pump functions

- The pumps are fitted with an electronic **overload protection system** which switches the pump off should it become overloaded.
- The control module is equipped with a non-volatile memory for **data storage**. What this means is that data is saved, even during long periods of down time. Once the voltage returns the pump starts operating again with the values set before the power outage.
- **Pump kick**: If the pump has been switched off externally by the IF (interface) device (Ext.Off, 0...10 V) or IR module it will automatically run for a short time once every 24 hours to exercise the pump.

Connections to the building management system (BMS)

- **FC**: A collective fault contact FC (potential-free closed contact) can be connected to a control point (building management system) as standard. The internal contact is closed if the pump is turned off, or there are no problems or failures on the part of the control module. The faults are described in detail in chapter 10.
- **IF**(**I**nter**f**ace) **modules (accessory)**:
  Analog interfaces are available in the form of add-on IF modules for connecting to external control system (e.g. DDC/BMS).

6.1.4 Double pump mode

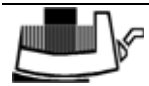
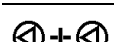
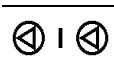
Two corresponding single pumps in a parallel pump installation can be fitted with built-in double-pump management.

- **Stratos IF module**: Two IF modules connected via the DP (double pump) interface are required for communication between pumps. In addition to double pump management, the IF modules provide other interfaces for the double pump.
  This double pump management has the following functions:
- **Master/Slave**: Both pumps are controlled by the master. All settings are made by the master.

- **Optimum-efficiency peak-load operation**: Two corresponding single pumps can be run in a low/high flow application where if the lead pump can not keep up with the flow demand the lag pump will operate automatically. At partial load, the hydraulic capacity is provided by one pump only. The second pump is switched on at optimum efficiency, when the sum of power consumptions P_1 of both pumps is less than the power consumptions P_1 of one pump. Both pumps are then adjusted upwards simultaneously to max. speed if necessary. In relation to the conventional peak load operation (load controlled switch on and off) a further energy saving is reached by this mode of operation.
- **Duty/Standby mode**: Each of the two pumps produces the design delivery rate. The other pump can be used in the event of the first pump malfunctioning or following a pump swap. Only one pump operates at a time.
- In the event that one pump experiences a **failure/problem**, the other will run as a single pump in standard mode as instructed by the master.
- In the event of a **break in communication**: The slave pump runs at the last set value of the master prior to the interruption.
- **Pump swap**: If only one pump is operational (duty/standby, peak- or low-load operation), the pumps are swapped after every 24 hrs' of actual operating time.
- **FC**: The collective fault contact (FC) of the master can be connected to a central control point. In this case, contact is only established with the master. The reading is valid for both pumps.
  As an option, the error message contacts of master and slave can be programmed as single fault signal with the IR module. For the single fault signals, contact must be established with each pump.

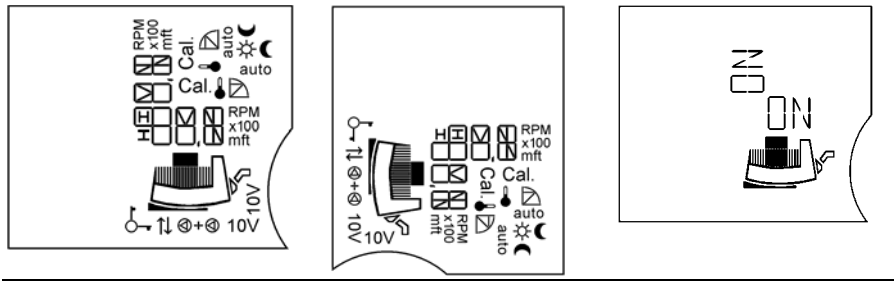
6.2 Operating the pump

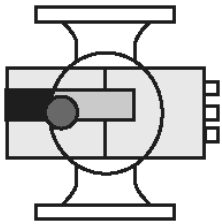
The electronic module (fig. 1, pos. 1) houses the **IR window** (infrared window, pos. 1.1) for communication with an **IR module** and the **LC display** (pos. 1.2) with the **tuning button** (pos. 1.3) for operating the pump. The IR receiver and sender surface must be located in such a way as to be able to communicate with the IR module. If the connection to the IR module has been made, the **green LED** lights up in the IR window to confirm the IR communication of all pumps that were connected to the IR module at the same time. The LED on the pump with which the IR module communicates blinks. It stops blinking 5 minutes after the connection to the IR module has been interrupted. A red **Error LED** in the IR window lights up when a fault is registered. Information on how to operate the IR module can be obtained in its installation and operating instructions.
LC display: The LC display shows the pump's setting parameters using symbols and numerical values. The display can be selected according to the position of the module, i.e. horizontal or vertical, at a readable angle (face to face).
The display is constantly lit up. The table below explains the meaning of the LC display's symbols:

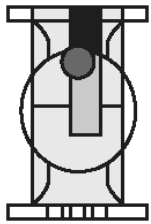
Symbol	Description of possible operating conditions
auto ☼	Standard mode; automatic switch-over to night setback mode is enabled. Night-time mode is activated at minimum heat output requirement (default).
auto ☾	Pump runs in night-time mode (night setback operation) at min. speed.
(no symb.)	Automatic switch-over to night setback mode blocked, i.e. pump runs in standard mode only.
☾	Night setback mode activated via interface Ext.Min, regardless of the system temperature.
	Pump switched on (default).
	Pump switched off.
H 18.0 ft	Differential pressure set value set to H = 18.0 ft. (example)
	Control system Δp-v, regulated to variable differential pressure set value (fig. 6) (default).
	Control system Δp-c, regulated to constant differential pressure set value (fig. 7).
	The regulator mode control system deactivates the module pressure variations. The speed of the pump is kept at a constant level. The speed is set internally using the tuning button (fig. 9).
26.0 RPM x100	Pump set to a constant speed (2.600 rpm example shown) - regulator mode.
10 V	In regulator mode, the speed or nominal lift of operating mode Δp-c or Δp-v of the pump is set via input 0...10 V of the Stratos IF module Ext.Min. The button then has no set value input function. (fig. 10)
	Control system Δp-T, regulated to temperature dependent differential pressure set value (fig. 8). The maximum set value Hsmax is displayed. This control system can only be activated via the IR module.
	All settings on module except "acknowledge error" blocked. Settings locked out by IR module. Settings can only be altered using IR .
SL	Pump runs as slave pump. No changes can be made to the position setting of the display.
	Two single pumps as double pump running in peak load mode (master + slave)
	Two single pumps as double pump running in duty / standby mode (master or slave)

Operating the tuning button: (fig. 1, pos. 1.3) Starting from the basic setting, the setting menus are selected one after the other in a fixed order by pressing the button (in 1st menu: press for more than 1 second). The relevant symbol blinks. By turning the button to the left or to the right the parameters on the display can be altered up or down. The symbol which has just been set blinks. The new setting is stored by pressing the button. At the same time the system advances to the next setting option.
The set value (differential pressure or speed) in the basic setting can be altered by turning the tuning button. The new value blinks. The new setting is stored by pressing the button.
If the new setting is not confirmed, after 30 seconds the old value is restored and the display returns to the basic setting.
Settings of the display position: For the layout of the control module, whether installed horizontally or vertically, the position of the display can be rotated through 90°. The position setting can be entered in menu point 3. The display position specified by the basic setting flashes by “ON“ (for horizontal position). The display can be rotated by turning the selector button. “ON“ flashes for the vertical position. The setting is confirmed by pressing the selector button.

Display position:



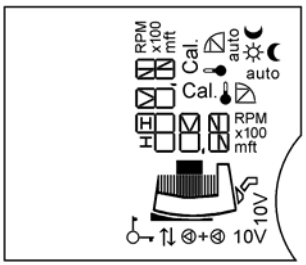
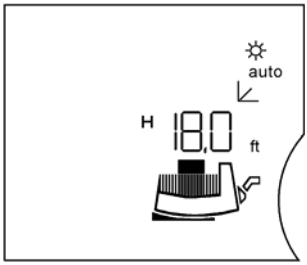


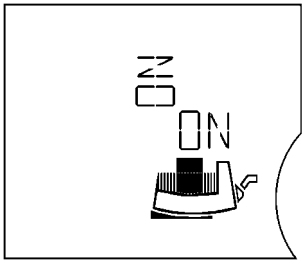
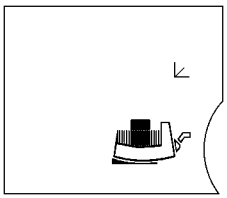
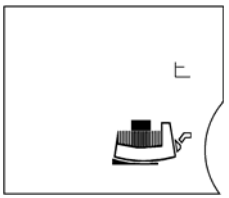
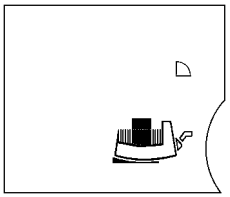
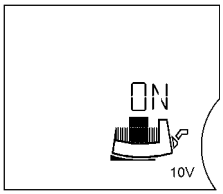
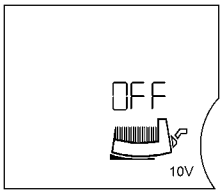


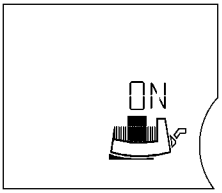
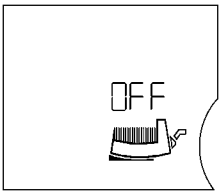
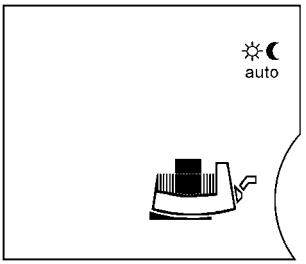
Position setting
in menu point 3

The following menus appear in succession on the pump display:
(horizontal representation of display)

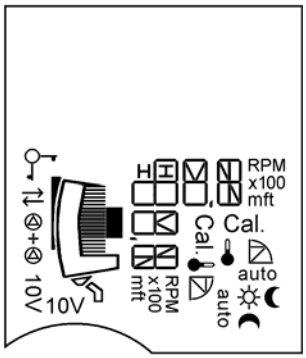
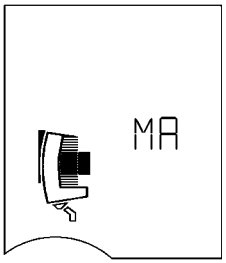
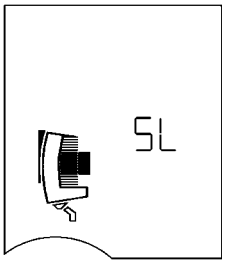
Single pump mode: Setting when first used / Menu order during standard use

	LC display	Setting
①		After switching on the module, **all symbols** appear on the display for 2 seconds. The current setting ② then engages.
②		**Current (basic) setting (factory default):** auto ☼ • automatic night setback enabled, Pump runs in standard mode e.g. **H 18.0 ft** • present differential pressure setpoint H_S = 18.0 ft at same time ½ H_S max (factory setting depending on pump type) • Control system Δp-v The differential pressure set point can be altered by turning the tuning button. The new differential pressure set point blinks. The new setting is stored by pressing the button briefly. If no button is pressed, the previously set blinking differential pressure set point returns to the previous value after 30 seconds. Press tuning button for > 1 second. The next menu point ③ appears.
	If no setting is made in the subsequent menus for 30s, the basic setting ② re-appears in the display.	

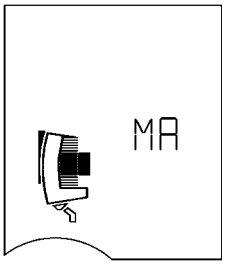
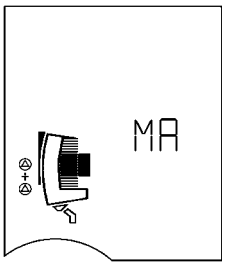
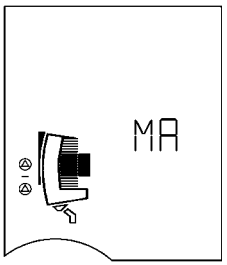
	LC display	Setting
③		Position setting of display vertical / horizontal The set position of the display is shown by the flashing “ON“. By turning the tuning button the other position can be selected. Setting stored.
④	  	The currently set **control system** blinks. By turning the tuning button other control systems can be selected. The new selected control system blinks. Pressing the button stores the new control system and switches to the next menu.
⑤	 	**Menu point ⑤ only appears if a Stratos IF module was inserted with input 0...10 V.** **Switch input 0...10 V on/off** **Activate input 0...10 V: “ON”** and the **“module motor symbol”** appears in the display. The setting can be altered by turning the tuning button. **Deactivate input 0...10 V: “OFF”** appears in the display and the **“motor symbol”** disappears. Setting stored. If the input was switched on, the menu manager jumps to menu point ⑦a.

	LC display	Setting
⑥		**Switch pump on/off.**
		Switch on pump, "**ON**" and the **"module motor symbol"** appear in the display
		The setting can be altered by turning the tuning button.
		**Switch off pump,** "**OFF**" appears in the display and the **"motor symbol"** disappears.
		Setting stored.
⑦		Menu point ⑥ is skipped if regulator mode was selected Either flash
		auto ☾ • **automatic night setback** Pump runs in standard mode Menu point ② then shows "auto ☼" during autom. standard mode or "auto ☾" during automatic night-setback
		☼ • normal **standard mode**, automatic night-setback disabled**.** Menu point ② does not contain any symbol.
		call up one of the two settings
		and store. Display jumps to the next menu.
		Menu point ⑦ is skipped if: • regulator mode was selected, • the input 0...10 V was activated
⑦a		In single-pump mode the display returns to basic setting ②. **In the event of an error the error menu ⑩ appears** before the basic setting ②. **In double pump mode (two single pumps) the display jumps to menu ⑧.**

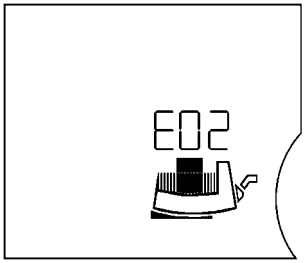
Double pump mode (as two single pump mode): Setting when starting up for the first time
(vertical display)

	LC display	Setting
①		When the module is switched on **all symbols** appear in the display for 2 seconds. Menu ⑴a then appears.
⑴a	 	The symbol **MA** = Master blinks on the display of both pumps. Should the settings not be altered, both pumps will run at a constant speed (HS = ½ Hmax. where Q = 0). By ↓ on the master pump tuning button the setting mode menu ⑼ appears on the display. **SL** = Slave appears automatically on the slave pump display. The configuration: left pump Master, right pump Slave is thus selected. The tuning button on the slave pump is deactivated. No more settings can be made here. A position setting for the display cannot be made on the slave pump. Position setting on the slave pump is taken over from the settings of the master pump.

Double pump mode: Menu order during normal use:
After switching on the module, **all symbols** (1) appear on the display for 2 seconds. The current setting (2) then sets itself. When "scrolling" in the MA display the same menu order (2)...(7) appears as for the single pump. Then the **MA** menu appears and remains on the screen permanently.

	LC display	Setting
(8)		**ATTENTION!** Use to confirm MA at the left pump. No change must be made in this menu item. It is always: MA = left pump, SL = right pump.
(9)		Setting **Peak load and duty / standby mode**
		The other setting blinks.
		Setting stored. Display returns to basic setting (2).
		

Error display

	LC display	Setting
⑩		In the event of an error the current error is displayed by **E** = Error, the **code no.** and by the flashing of the error source motor, control module or mains connection. **For code numbers and their meaning see chapter 10**

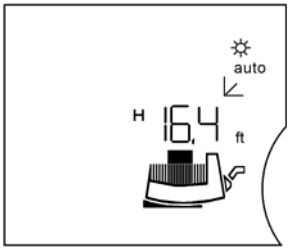
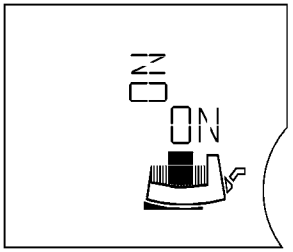
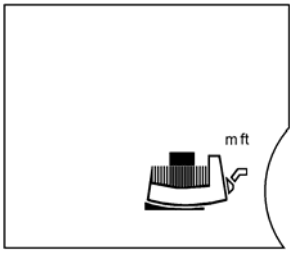
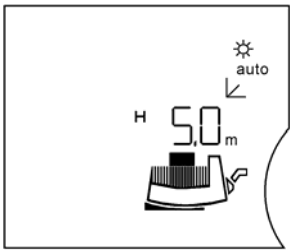
6.3 Priorities on the operation of the pump, IR module

The display of errors (menu 10) incl. error acknowledgment has the highest priority. This means that errors precedence on the pump's display and that they must be acknowledged and removed.

If settings are made on the control module or from the IR module and not confirmed by pressing the button, the setting will return to the previous position 30 seconds after the last entry.

- **Pump ↔ IR** without lockout function: The last command, whether from the IR monitor or control module, is stored by the pump.
- **Pump ↔ IR** with lockout function: When the "Key function on" command is received, the control module's current settings remain in place. The display shows . The pump is now blocked and cannot be operated.

Changing the display setting from feet [ft] to meters [m]

	LC display	Setting
①		Press and hold in the red button at the initial start up menu (level one) for a period of approximately 6 seconds.
		During this time there will be access to the second menu level (menu item display orientation) after approximately 1 second.
		After another 5 seconds there will be access to the third menu level. The display "m ft" appears, with [ft] flashing (factory default is [ft]). By turning the red button the display can be changed over to [m]. (m is flashing)
②		By pressing the red button the selection is confirmed. The display immediately returns to the first menu display.

7 Installation and electrical connection

Installation and electrical work in compliance with any local codes and by qualified personnel only!

WARNING! Bodily injury

Existing regulations for the prevention of accidents must be observed.

WARNING! Electrical shock hazard

Dangers caused by electrical energy must be excluded.
National Electrical Codes, local codes and regulations must be followed.

7.1 Pump installation

- The pump must be installed in a dry, well-ventilated and frost-free place.

CAUTION! Possible damage of the pump

Dirt and solder drops in the pump body can effect the pump operation.

- **It is recommended that any welding and soldering work be done before installing the pump.**
- **Thoroughly flush the system prior to installing and operating the pump.**
- **Foreign material in the system resulting from construction may damage the pump and is not warrantable.**

- The pump must be installed in an easily accessible position to facilitate inspection or replacement.
- The pump should never be located at the lowest point of the piping system, where dirt and sediment collect. Nor should it be located at the highest point of the piping system, where air accumulates. Please ensure at least a minimum of three pipe diameters of straight on the suction side of the pump.
- It is recommended that isolation valves be installed on the suction and discharge side of the pump.
  This will save having to drain and refill the system if the pump / pump head needs exchange-service. The valves are to be installed so that any water that escape cannot drip onto the pump motor or terminal box.
- An arrow on the pump housing indicates the direction of water flow (fig.1, pos.2).
- Install the pump in an easily accessible place, so that subsequent servicing work can easily be carried out.
  Installation is to be carried out such that dripping water cannot drip onto the pump motor or control module.
- Pump must be installed with the shaft in the horizontal position in such a way that it is not stressed by the pipework. (Installation positions in fig. 2). When installing in confined spaces, for example in compact distributors, the control module can be placed in a vertical position by rotating the motor, see chapter 7.1.1.

- In order to obtain the correct terminal box position the motor housing can be turned after removing the four allen screws (fig. 3).

WARNING! Risk of scalding

If the pump is already installed in the system, the system must be drained or the isolating valves on both sides of the pump must be closed before the allen screws are removed as the pumped liquid may be scalding hot and/or under pressure.
Do not start the pump until the system has been filled with liquid and vented.

- Permitted terminal box positions see fig. 2

CAUTION! Possible damage of the pump

When rotating the motor housing, ensure the O-ring between the cartridge and pump housing (volute) does not become damaged.

- Carefully lift the pump head and rotate it so the terminal box is in the desired position. Replace the pump head onto the pump housing and thighten the allen screws evenly in a diagonal method.
  Torque to:
  - M6 ..... 7 ft lb
  - M10 ..... 22 ft lb

WARNING! Electrical shock hazard

If the pump is operated by means of a generator, a dangerous voltage is created at the motor terminals after the control module is removed. The motor terminals are designed as VDE-approved bushings, so that there is no danger if simply touched with the finger. However, there would be a danger if a pointed object (nail, screwdriver, wire) were poked into one of the bushings.

7.1.1 Removing/installing the motor head unit

If the control module is to be moved into a different position, the motor does not need to be completely removed from the pump housing. The motor can be turned to the desired position in the pump housing.

CAUTION! Possible damage of the pump

Be careful not to damage the O-ring situated between the motor head and the pump housing. The O-ring must lie untwisted in the bevel of the end shield pointing to the impeller.

CAUTION! Possible damage of the pump

The impeller is permemtantly attached to the shaft, the end shield and the rotor. As the rotor has extremely strong rare earth magnets, if the rotor is removed from the rotor can, it has a considerable potential for danger e.g. by suddenly attracting objects made from iron/steel, influencing electrical equipment (risk to people with pacemakers), destroying magnetic cards, etc.

To remove the motor, (4x) M6 or (4x) M10 hexagon socket screws must be loosened. These screws can be reached with the following tools (fig. 3):

- 90° offset socket-head screwdriver
- spherical head socket-head screwdriver
- ¼" reversing ratchet with suitable bit

7.1.2 Insulating the pump in refrigerating/air-conditioning systems

The Wilo-Stratos series is suitable for use in refrigeration and air-conditioning systems with flow medium temperatures down to 14°F (-10°C).
When using the pumps in refrigerating and air-conditioning systems, diffusion-proof insulation is to be provided by the customer.

CAUTION! Possible damage of the pump

The pump housing may only be insulated up to the interstice with the motor, so that the condensation vents remain free and any condensation produced in the motor can run off without hindrance (fig. 4).

To protect it from corrosion, the pump housing is cataphoretically coated.

7.2 Electrical connection

Warning! Electrical shock hazard

Dangers caused by electrical energy must be excluded.

- **Electrical work by a qualified electrician only!**
- **National Electrical Codes, local codes and regulations must be strictly followed.**
- **All electrical connections must be performed after the electrical supply has been switched off and secured against unauthorized switching.**
- **For safe installation and operation a proper grounding of the pump to the power supply's grounding terminals is required.**

- Suitable mains fuse is required to protect the motor per local electrical codes.
- The operating voltage and frequency are marked on the rating plate.
- The pump must be connected with a power supply equipped with a grounded plug-connection and a main power switch.
- A minimum cable size of 14 AWG should be used (refer to the local code for wiring restrictions).

CAUTION! Possible damage of the pump

All conductors must be for at least 167°F (75°C).

- The electrical cable must be installed so that it never touches the pipework and/or the pump and motor housing.
- The connecting cable can be fed through the cable entry below or beside the terminal box, depending on it's orientation. It is advisable to install the screwed cable glands with the entrance of the conduit pointing downwards. The cable entry which is not used must be closed by a blind plug (fig. 5).
- Watertight screwed cable glands and conduit connections must be used to prevent any entrance of water to the terminal box.
- Connect power as shown in fig. 5.
- Mains fuse: see rating plate
- Pump/installation must be grounded in compliance with regulations.

CAUTION! Possible damage of the pump

In insulation tests with a high-voltage generator the pump is to be disconnected on all poles from the mains in the control module. The free cable ends are to be insulated in accordance with the voltage of the high-voltage generator.

7.2.1 Electrical pump connection (fig. 5)

- **230 V~, ⏚ :** Mains voltage, single-phase current 1~230 V AC ±10%, 60 Hz
  Voltage across terminals “230V~” must be total 230 volt
  either
  - 230 volt “hot” lines and neutral line

  or
  - two 230 volt “hot” lines.
- **FC:** A built-in collective fault signal is available on the FC (fault contact) terminals as a potential-free closed contact.
  Permissible contact load:
  - minimum: 12 V DC, 10 mA,
  - maximum: 250 V AC, 1 A.

  Max. tightening torque of the connecting terminal screws (230 V~, ⏚, FC): 2.2 lb inch
- **Two single pumps as double pump:** Both motors in the parallel pump installation are to be provided with a separate mains cable and a separate mains fuse protection.

ⓘ NOTE: If a single motor in a parallel pump installation is switched off-load, the built-in double-pump management is deactivated.

- **Switching frequency:**
  - On-/Off switching by mains supply ≤ 20 times / 24 h
  - On-/Off switching by Ext. Off or 0...10 V Signal ≤ 20 times/ h
- **Assignment of supply terminals:** The following table shows the possibilities for which combinations of circuits the individual cable glands in a cable can be assigned.

	Cable gland ½”	Cable gland ¼”	Cable gland PG 7
Function Cable type	Mains cable FC 5x14 AWG		
Function Cable type	Mains cable 3x14 AWG 3x14 AWG	FC 2-core cable	
Function Cable type	Mains cable 3x14 AWG 3x14 AWG 3x14 AWG	FC / Ext.Off / SBM or FC / 0...10 V / Ext.Min multicore control cable, number of cores in acc. with number of circuits, if nec. shielded	DP-management 2-core cable (l ≤ 2.5 m)

8 Start up

8.1 System filling - Venting

- Proper fill and pressurize the system with liquid.

CAUTION! Possible damage of the pump

Never operate the pump dry.
The system must be filled before starting the pump. Ensure that all isolation valves are open.

- The pump is normally vented automatically after a short operational period.

WARNING! Risk of burning

Depending on the operating condition of the pump and/or installation (fluid temperature) the entire pump can become very hot.
Avoid touching the pump owing to the risk of burning.
The temperature at the heat sink can be up to 158°F (+70°C) within the permissible operating conditions.

8.2 Setting the pump power

The unit is set to a specific operating point (point of maximum load, calculated maximum heating requirements). When starting up for the first time, the pump capacity (delivery head) is to be set in accordance with the system operating point. The factory presetting does not correspond to the pumping capacity required for the system. It is calculated on the basis of the performance curve of the selected pump (from the catalogue/data sheet). See also figs. 6 to 8.

Control systems Δp-c, Δp-v and Δp-T:

	Δp-c (fig. 7)	Δp-v (fig. 6)	Δp-T (fig. 8)
Operating point on max. speed curve	Draw a line from the operating point to the left. Read set value Hs and set the pump in accordance with this value.		Settings are to be made by the infrared device.
Operating point in control range	Draw a line from the operating point to the left. Read set point Hs and set the pump in accordance with this value.	Continue the standard line until it meets the max. speed curve, then continue horizontally to the left, read set point Hs and set the pump in accordance with this value.	
Setting range	H_{min}, H_{max} see type key (chapter 5.1)		T_{min}: 68...212°F (+20...+100°C) T_{max}: 86...230°F (+30...+110°C) $\Delta T = T_{max} - T_{min} \geq$ 50°F (10°C) Increase: $\Delta HS/\Delta T \leq$ 3.3 ft/50°F (10°C) H_{min}, H_{max}

8.3 Selecting the control system

Unit type	System conditions	Recommended control system
Heating-/ventilation- and air conditioning systems with a system friction loss (heating radiator + thermostatic valve) ≤ 25% of the total resistance	1. Two-pipe systems with thermostatic/ zone valves • Flow head > 13.1 ft (high head systems) • Very long distribution lines • Heavily throttled branch shut-off valves • Branch differential pressure regulator • High pressure losses in those system parts through which the total volume flows (boilers/ refrigerating machines, poss. heat exchangers, distribution line) 2. Primary circuits with high pressure losses	**Δp-v**
Heating-/ventilation- and air conditioning systems with a system friction loss in the generator/distributor circuit ≤ 25% of the resistance in the transfer part (heating radiator + thermostatic valve)	1. Two-pipe systems with thermostatic/ zone valves and high consumer authority • Flow head ≤ 6.6 ft (low head systems) • Converted gravity systems • Retrofitting to large temperature spread (e.g. long-distance energy) • Low pressure losses in the system parts through which the total volume flows (boilers/refrigerating machines, poss. heat exchangers, distribution line) 2. Primary circuits with low pressure losses 3. Underfloor heating systems with thermostatic or zone valves 4. Single-pipe systems with thermostatic or branch shut-off valves	**Δp-c**

Unit type	System conditions	Recommended control system
Heating systems	1. Two-pipe systems • Pump installed in the supply pipe. • Flow temperature controlled by atmospheric conditions. With increasing flow temperature the flow rate will be increased. 2. Single-pipe systems • Pump installed in the return pipe. • Constant flow temperature. With increased return temperature the flow rate will be lowered. 3. Primary circuits with condensing boiler • Pump installed in the return pipe. With increased return temperature the flow rate will be lowered.	**Δp-T**
Heating-/ventilation- and air conditioning systems Circulation systems for drinking water	1. Constant flow rate	**Regulator mode**
Heating systems	1. All systems • Pump installed in the supply pipe. • Flow temperature will be lowered in light loads periods (e.g. night). • Pump runs 24h without external control.	**Night setback mode “Autopilot“**

9 Maintenance/service

All servicing should be performed by an authorized service representative!

Warning! Electrical shock hazard

Dangers caused by electrical energy must be avoided.
All electrical work must be performed after the electrical supply has been disconnected and secured against unauthorized switching.

WARNING! Risk of scalding

At high water temperatures and system pressure close isolating valves before and after the pump.
First allow pump to cool down.

These pumps are maintenance free, self-lubricated by the system fluid, and have no seals to leak or couplings to break.

CAUTION! Possible damage of the pump

If the motor head is separated from the pump housing for servicing or repair work, the O-ring situated between the motor head and pump housing must be replace by a new one. When refitting the motor head, make sure the O-ring is positioned correctly.

10 Faults, causes and remedies

For faults, causes, and remedies see "Error / Warning Messages" flow chart and the tables below.
The first column in the table lists the code numbers shown by the display in the event of an error.
Most error displays disappear automatically once the cause of the error has been remedied.

10.1 Error messages

An error has occurred. The pump shuts down, the error LED (red permanent light) comes on. After 5 minutes the pump switches on automatically. Only when the same error occurs for the 6th time within 24 hours does the pump shut down permanently, the FC relay opens. Manual reset is necessary.
NOTE: **Exception**: With blocking code no. "E10" and “E25” the unit immediately shuts down on the first occurrence.

10.2 Warning messages

The problem (only **W**arning) is displayed, but the FC relay does not come into action. The pump continues to run. The error can occur an infinite number of times. The indicated operating condition should not be ignored for long periods of time. The cause of the error must be removed.
NOTE: **Exception**: If errors "E04", and "E05" remain for more than 5 minutes, these are passed on as error readings (see diagram).

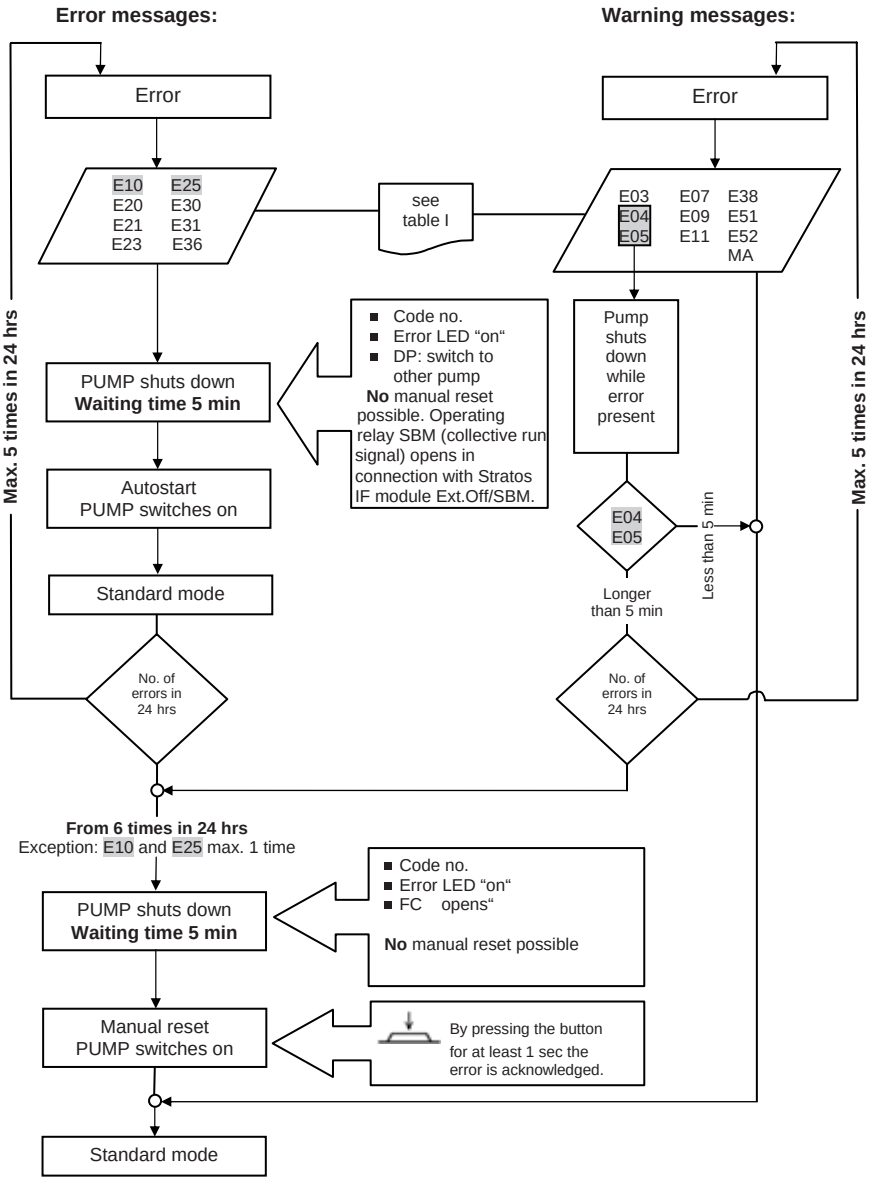

Error messages:
Warning messages:
Error
Error
E10 E25
E20 E30
E21 E31
E23 E36
see table I
E03 E07 E38
E04 E09 E51
E05 E11 E52
MA
Max. 5 times in 24 hrs
Max. 5 times in 24 hrs
Code no.
Error LED "on"
DP: switch to other pump
No manual reset possible. Operating relay SBM (collective run signal) opens in connection with Stratos IF module Ext.Off/SBM.
PUMP shuts down
Waiting time 5 min
Pump shuts down while error present
Autostart
PUMP switches on
E04
E05
Less than 5 min
Standard mode
Longer than 5 min
No. of errors in 24 hrs
No. of errors in 24 hrs
From 6 times in 24 hrs
Exception: E10 and E25 max. 1 time
Code no.
Error LED "on"
FC opens"
PUMP shuts down
Waiting time 5 min
No manual reset possible
Manual reset
PUMP switches on
By pressing the button for at least 1 sec the error is acknowledged.
Standard mode

Table I

Problem	cause	remedies
Pump does not run with switched on power	Electric fuse faulty,	Check fuse
	Pump has no power	Rectify interruption to power
Noisy pump operation	Cavitation due to insufficient admission pressure	Increase system admission pressure within permissible range

10.3 Error messages: Error LED “permanent light“

Code No.	Symbol flashing	Problem	cause	remedies
E04	Supply terminal	Mains undervoltage	Mains overloaded	Check electrical installation
E05	Supply terminal	Mains overvoltage		Check electrical installation
E10	Motor	Pump blocked	e.g. sedimentation	De-blocking routine starts automatically. Should this not remove the blockage, the pump switches off after 10 sec. Call customer services
E20	Motor	winding overheated	Motor overloaded	Let motor cool down, check the settings
			Ambient temperature to high	Reduce water temperature
E21	Motor	Motor overload	Sediment in the pump	Call customer services
E23	Motor	Short circuit/contact fault	Motor defect	Call customer services
E25	Motor	Contact error	Module not correctly installed	Reinstall module
E30	Module	Excess temperature module	Air intake to module heat sink is blocked	Free air intake
E31	Module	Excess temperature power component	Ambient temperature to high	Improve ventilation in room
E36	Module	Module faulty	Electronic components faulty	Call customer service / swap module

10.4 Warning messages: Error LED “off“

Code No.	Symbol flashing	Problem	cause	remedies
E03		Water temperature > 110°C	Heating control incorrectly set	Set to lower temperature
E04		Mains undervoltage	Mains overloaded	Check electrical installation
E05		Mains overvoltage		Check electrical installation
E07		Generator operation	Driven by admission pressure pump	Balance pump capacity regulation
E09		Generator operation	Driven by reverse flow through “off” pump	Check circulation direction. Fit a check valve at the pressure side
E11		Pump idling	Air in the pump	Vent pump and unit
E38	Motor	Temp. sensor medium faulty	Motor faulty (automatic night setback)	Call customer services
E51		non-permissible combination	Different pumps	
E52		Master/slave communication error Pump switches from standard mode to fixed characteristic (depending on chosen set value, see fig. 9)	Stratos IF module not correctly positioned, cable faulty	After 5 min. the modules switch to single-pump mode. Reinstall modules, check cable
MA		Master/slave not set		Specify master and slave

If the fault cannot be remedied, please contact your local heating specialist or Wilo customer services.

Chapter 18 MODULATING VALVES

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax :(514) 344-9341

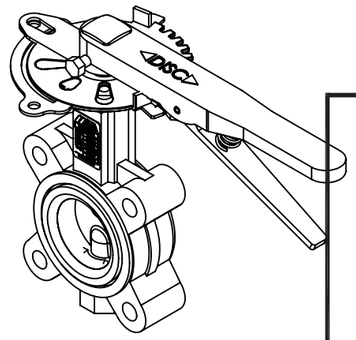
18.1 **BALL VALVE IPEX 053137 MV-1, MV-2, MV-3, MV-4**

18.2 **SOLENOID VALVE SV-01, SV-02**

18.3 **FLOW SWITCH FS4-3 MCDONNELL & MILLER**

MV-1 @ MV-4

in/mm									lbs/kgs
Size	**L**	**∅D**	**n x M**	**h1**	**h2**	**A**	**B**	**Q**	**Assembly Weight**
2"	1.69	4.75	4 x 5/8-11 UNC	2.60	5.12	8.7	1.3	1.13	6.5
DN50	42.9	121		66.0	130	221	33	28.7	3.0
2.5"	1.81	5.50	4 x 5/8-11 UNC	3.23	5.55	8.7	1.3	1.79	7.8
DN65	46.0	140		82.0	141	221	33	45.5	3.5
3"	1.81	6.00	4 x 5/8-11 UNC	3.54	5.83	8.7	1.3	2.45	8.6
DN75	46.0	152		89.9	148	221	33	62.2	3.9
4"	2.05	7.50	8 x 5/8-11 UNC	4.25	6.69	10.2	1.4	3.50	14.8
DN100	52.1	191		108	170	260	36	88.9	6.7
5"	2.20	8.50	8 x 3/4-10 UNC	4.84	7.36	10.2	1.4	4.55	19.2
DN125	55.9	216		123	187	260	36	116	8.7
6"	2.20	9.50	8 x 3/4-10 UNC	5.43	7.95	10.2	1.4	5.71	22.7
DN150	55.9	241		138	202	260	36	145	10.3
8"	2.36	11.75	8 x 3/4-10 UNC	6.69	9.37	14.2	1.7	7.77	36.6
DN200	59.9	299		170	238	360	43	197	16.6
10"	2.68	14.25	12 x 7/8-9 UNC	7.87	10.7	14.2	1.7	9.76	57.8
DN250	68.1	362		200	272	360	43	248	26.3
12"	3.07	17.00	12 x 7/8-9 UNC	9.29	12.0	14.2	1.7	11.7	79.5
DN300	78.0	432		236	305	360	43	298	36.1



#	MAS Part No.	Description
1	L-D-4-S-E-LH	Butterfly Valve
2	HANDLE XXX-XX	Lever - 10 pos throttle plate
3	MAS ID Plate	Identification tag w/ trim code
4	NSF-372 Tag	CSA/NSF-372 Compliance Tag

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

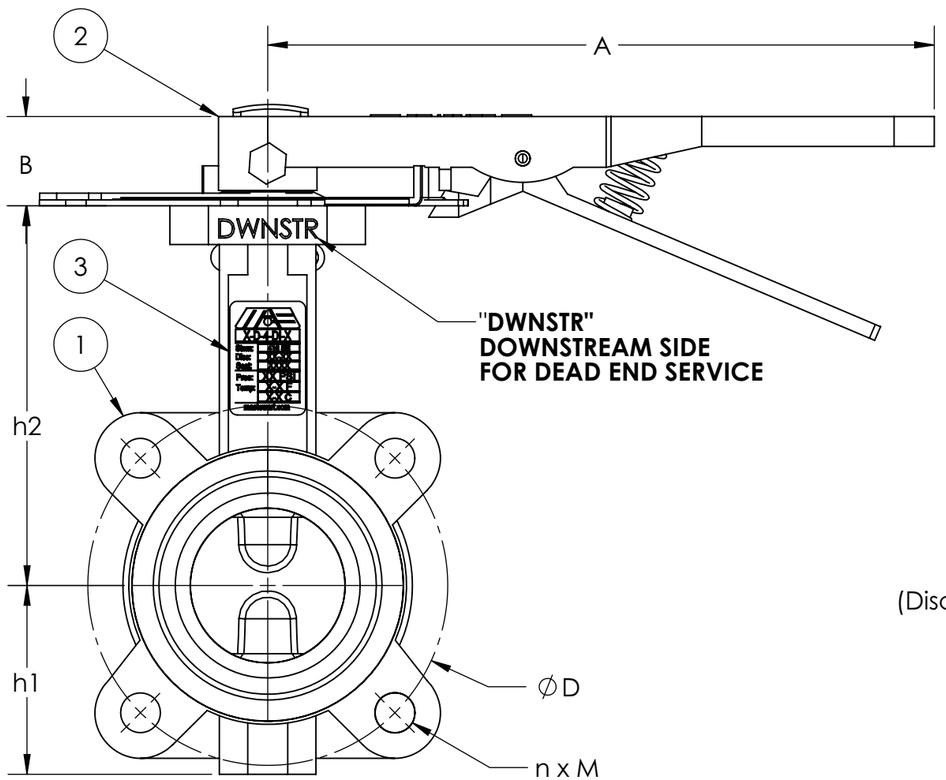
Reviewed By: M.M.

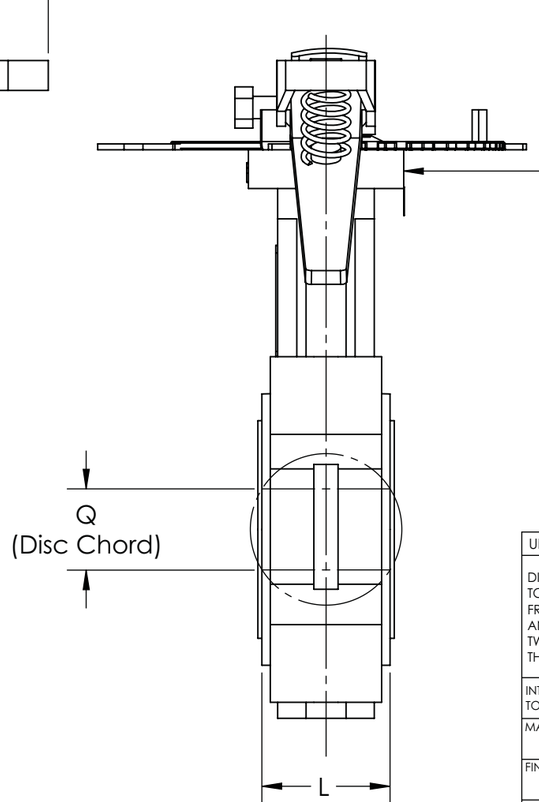
Date: 29 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 27 june 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for Approval
SIFEC NORTH INC.





4 CSA/NSF-372 Compliance Tag:

NSF/ANSI 372
LOW LEAD CONTENT ONLY
MC#218481

Specifications	
Temp. Rating	-4-275°F (-20-135°C)
Press. Rating	200 PSI
Design to: MSS-SP-67 & API-609	
Markings to: MSS-SP-25	
NSF-372 Compliance: Low Lead Content Only	

Materials		
Valve	Body	Ductile Iron ASTM A536
	Stem	416 SS ASTM A582
	Disc	Stainless Steel ASTM A351 CF8M
	Seat	EPDM
Handle		Painted Malleable Iron w/ ABS Plug
Throttle plate		Zinc-Plated Steel

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN	SE	5/3/13
	CHECKED		
	REVISIONS:	SE	11/18/13
		SE	5/13/14
INTERPRET GEOMETRIC TOLERANCING PER:	PROJECT:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

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12900 - 87th Avenue
Surrey, B.C. V3W 3H9
Toll-Free: (800) 594-8431
Fax: (604) 594-4335

TITLE:
MAS D Series Lug BFV
L-D-4-S-E-LH (2-12")

SIZE	DWG. NO.	REV
B	2-12in L-D-4-S-E-LH	2

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 27 june 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for Approval
SIFEC NORTH INC.

MV-1 @ MV-4

PROMATION ENGINEERING

Precision Actuation for Industry
...Partners, Above and Beyond

Data Sheet

P2/3 DC Series

On/Off/Jog/Proportional

ISO5211 F07 8P22

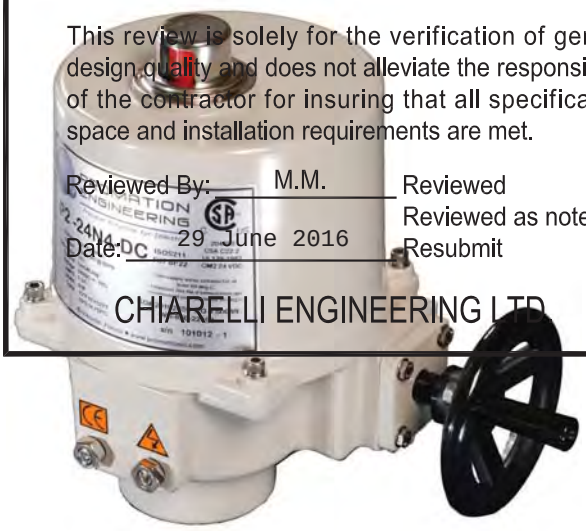
SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 29 June 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.



Actuator Specifications	P2 800"lbs/90Nm		P3 1335"lbs/150Nm	
Torque lb/Nm				
Supply Voltage	12vdc	24vdc	12vdc	24vdc
Max Inrush Current	5.0A	5.0A	5.0A	5.0A
Running Current	3.4A	3.0A	3.4A	3.0A
Runtime (90°)	15sec		22sec	
Weight	25lbs/11kg			
Mechanical Connections	ISO5211 F07 8 pt 22mm			
Electrical Entry	(2) 3/4" NPT			
Electrical Terminations	12 - 18 Ga.			
Environmental Rating	4, 4X			
Manual Override	5" HandWheel			
Control	On/Off/Jog/Proportional			
Duty Cycle	See Graph Below			
Case material	Aluminum Alloy, Powder Coated			
Motor Protection 12/24VDC Operation	DC Brush Type 275ºF/135ºC Thermal F Class			
Ambient Temperature Operating Range	-22ºF to +150ºF -30ºC to +65ºC			

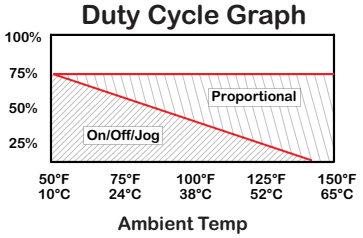
An electric actuator designed for load requirements ranging from 800 to 1335"lbs. The actuator comes standard with two auxiliary switches (Form C), an internal low power heater, a NEMA 4X environmental rating, and in 12VDC or 24VDC supply voltages. The P2/3 mechanical connections are ISO5211 compliant. The P2/3 DC Series is available as an on/off or two position model that can also be used in bump/jog applications. Additionally, a proportional control is available to accept 0-5vdc, 0-10vdc, 1-5vdc or 4-20mA input signals.

P2-24-N4DC
P3-24-N4DC

P 2 - 12 - N 4 DC

- **2** — 800"lbs / 90Nm, 15 seconds 90°, Weight = 25lbs / 11kg
- **3** — 1335"lbs / 150Nm, 22 seconds 90°, Weight = 25lbs / 22kg
- **12** — 12vdc ±10%, 5.0A Inrush, 3.4A Running
- **24** — 24vdc±10%, 5.0A Inrush, 3.0A Running
- **-** — On/Off, 25-50% Duty Cycle*
- **P** — Proportional, 75% Duty Cycle*
- **N** — Non-Spring Return
- (blank) — NEMA 4X
- **DC** — DC Supply

* Duty cycle is defined as the ratio of run time vs. off time and is a function of ambient temperature. (see graph at left)



C SA US
File 204450

See Pg 4 for Options

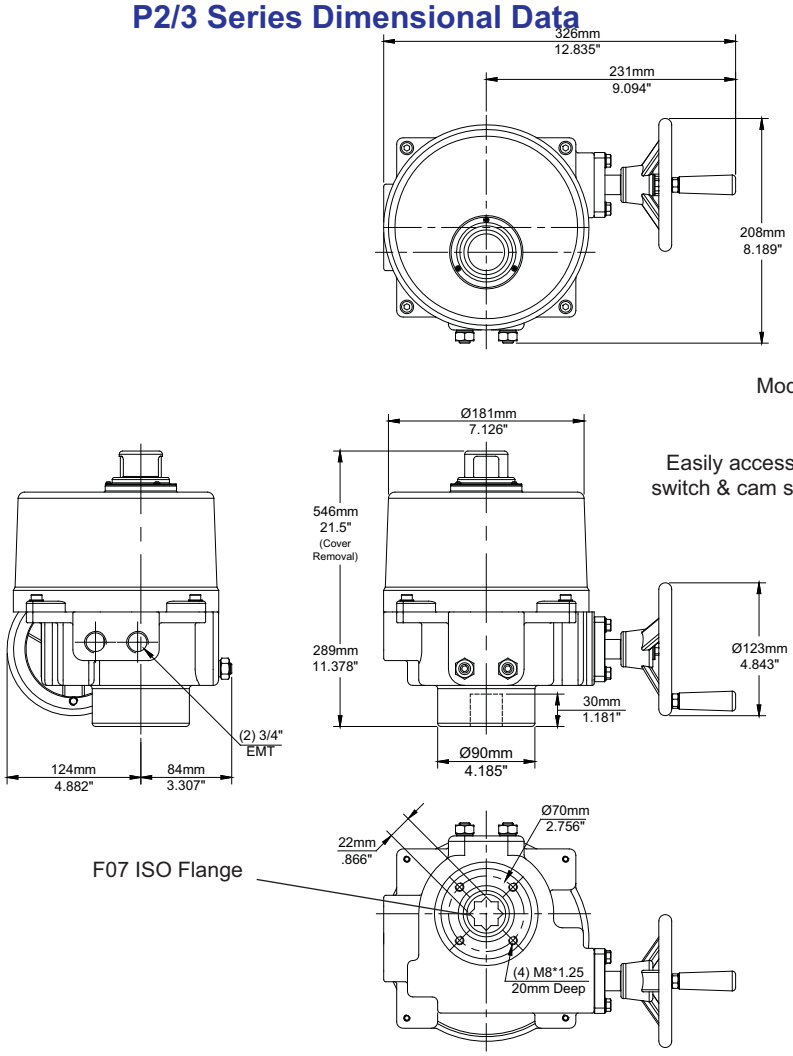
Also available in 12V & 24V AC operation,120v & 230v single phase operation, and in 3 phase models for 230/3/60, 380/3/60 & 480/3/60 supplies.Separate spec sheets are available for these configurations.

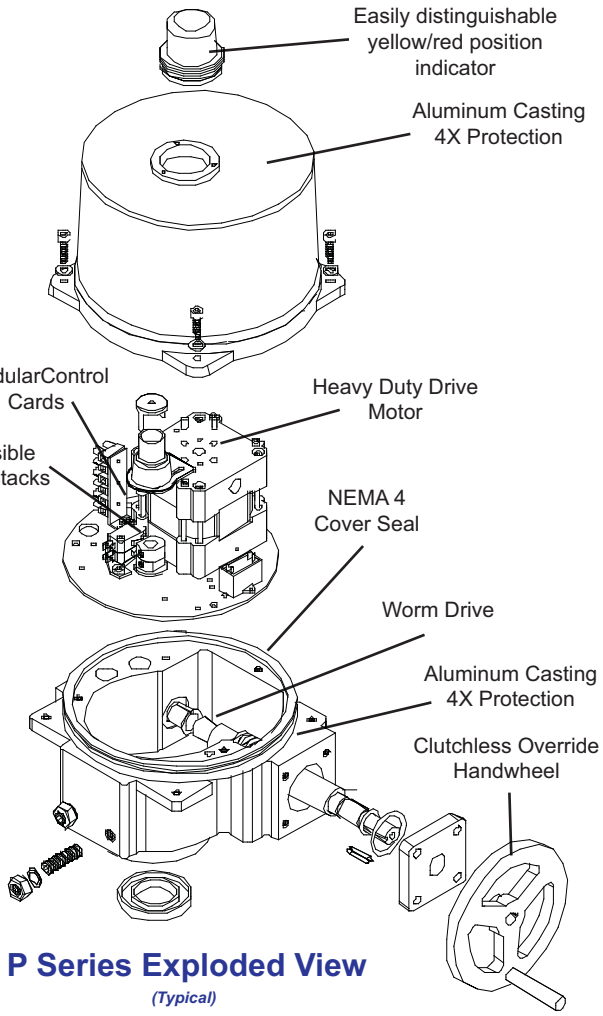
SD11_P23_DC_F078P22_Ver C_061511

Application Notes:

1. These actuators are designed to be used in either a horizontal or upright position. Do NOT mount the actuator with the top below a horizontal position.
2. When installing conduit, use proper techniques for entry into the actuator. Use drip loops to prevent conduit condensate from entering the actuator.
3. Both NPT conduit ports MUST use proper equipment to protect the NEMA 4x integrity of the housing.
4. The internal heater is to be used in ALL applications.
5. Do NOT install or store the actuator outdoors or in humid environments unless it is powered up and the heater is functioning.
6. Use proper wire size to prevent actuator failure (see chart below for proper wire sizing).
7. Mechanical travel stops are factory calibrated for 90 degree operation. These stops are NOT designed to adjust mechanical rotation by more than +/- 3 degrees.

P2/3 Series Dimensional Data





P Series Exploded View
(Typical)

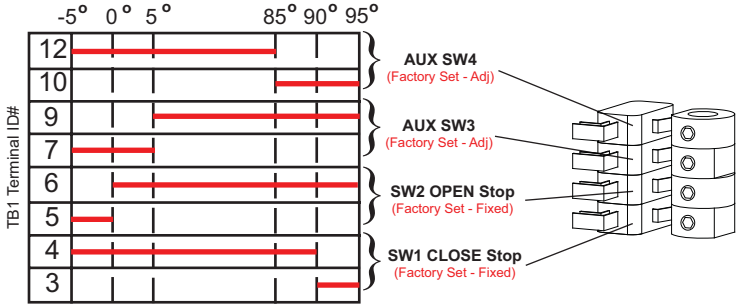
Wire sizing data is provided in the table below to assist in the selection of the proper wire size for ProMation P2/3 series actuators using various wire sizes over distance. Please make sure to reference the correct voltage and do not exceed the indicated length of the wire run for each model.

Wire Sizing Data

MAX distance between Actuator and Supply (feet)		
Wire Gage	P2/3-12DC 5.0A	P2/3-24DC 5.0A
18		
16	26	52
14	42	84
12	64	128
10	109	218
8	163	326

Switch sequencing data is provided in the table below to show the change-of-state points during the rotation of the actuator from OPEN to CLOSED and back again. Switches for terminals 3 thru 6 are set at the factory and should NOT be changed. The INCLUDED auxiliary switches SW3 & SW4 are for terminals 7 thru 12 and those setpoints may be modified if need be. When so optioned, SW5 & SW6 auxiliary switches are initially set to function the same as auxiliary switches SW3 & SW4.

Switch Logic Map and Switch/Cam Arrangement



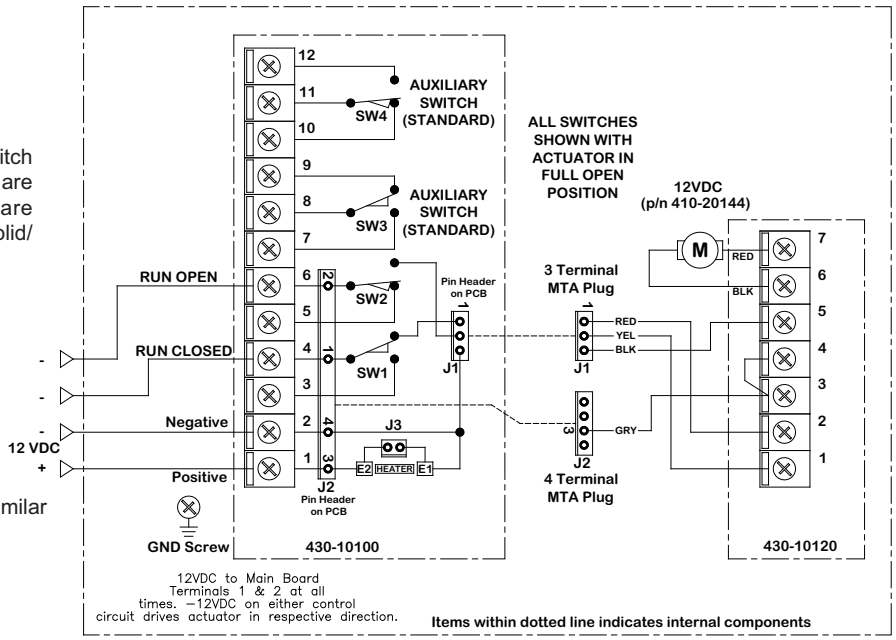
SD11_P23_DC_F078P22_Ver C_061511

Wiring Diagrams for P Series -

On/Off/Jog Control

Field Control Device may be relay contact or switch type. Pilot device 10A MAX. Auxiliary switches are rated 10A @ 250vac MAX. Terminals 7-12 are dry type Form C. Terminals accept 12-18ga solid/ stranded wire.

12vdc shown, 24vdc similar



Proportional Control

Control Signal Input: 4-20mA ONLY

Input impedance: 250 ohms (4-20mA)

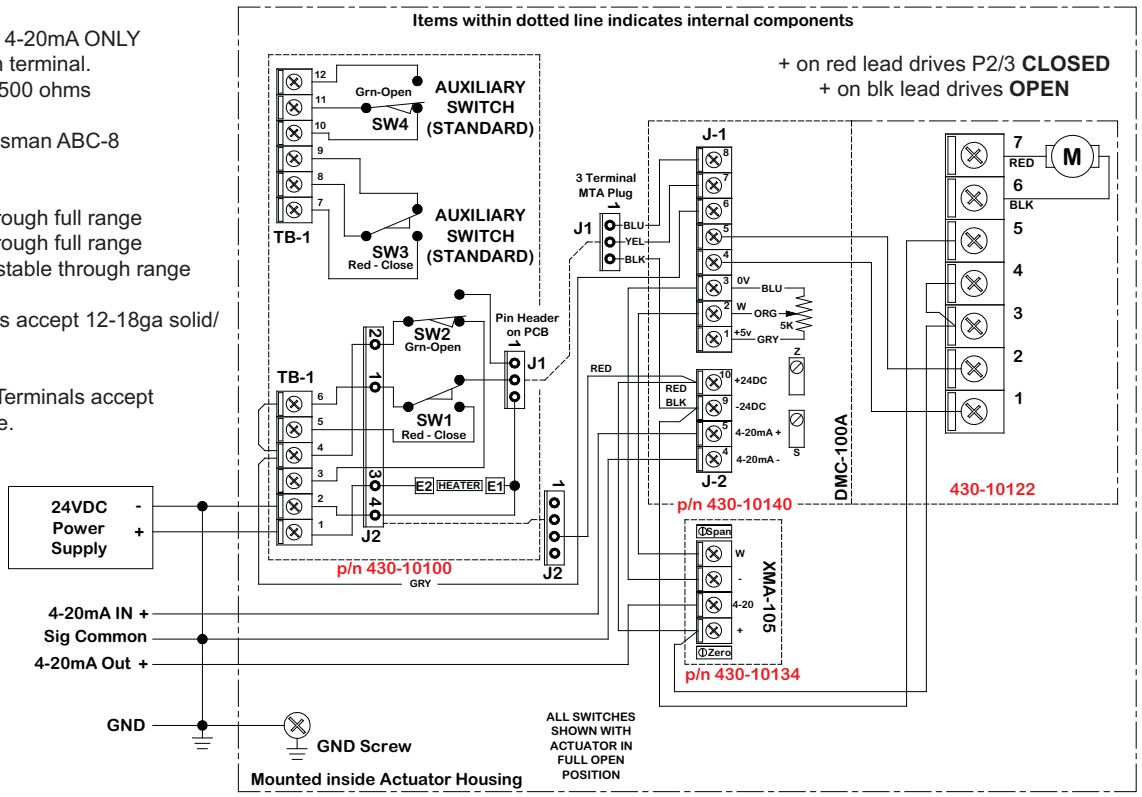
Feedback Signal Output: 4-20mA ONLY
Referenced to the common terminal.
Max Load: 500 ohms

Control Card Fuse: 8A Bussman ABC-8

Control Adjustments:
Zero: Adjustable through full range
Span: Adjustable through full range
Deadband: Linearly adjustable through range

Main Switch Card Terminals accept 12-18ga solid/ stranded wire.

Proportional Control Card Terminals accept 14-22ga solid/stranded wire.



Note: The GND line MUST be installed AT the control point of origin (signal generator). Do NOT use Sig Common and DC supply Negative as a common wire between actuator and controller. GND should be EARTH ground as well for noise cancellation.

SD11_P23_DC_F078P22_Ver C_061511

AVAILABLE OPTIONS

- Advanced Proportional Controller Kit. Includes Electronic Torque Monitor And Alarm. Converts 2 position to proportional control.
- Basic Proportional Controller Kit. Converts 2 position to proportional control.
- Extended Duty Motor - 75% Duty Cycle
- 0-45-90 degree rotation kit. Mid-point is center-off position.
- 0-90-180 degree rotation kit. Mid-point is center-off position.
- 0-180 degree rotation kit. No Mid-point position is offered. (On/Off/Jog only)
- Auxiliary Switch set. Provides 3rd and 4th auxiliary switches (Form C x 2).
- 1k ohm position feedback potentiometer.
- 5k ohm position feedback potentiometer.
- 10k ohm position feedback potentiometer.
- Single Wire Control Relay (Internal) Units operate NORMALLY CLOSED - ENERGIZE TO OPEN
- Single Wire Control Relay (Internal) Units operate NORMALLY OPEN- ENERGIZE TO CLOSED
- Adjustable Timer, Dual Set Point Timer (Duration and Frequency) (Contact factory for application assistance)
- Proportional Control Signal override capability (OPEN OR CLOSED).
- Integral Thermostat for Heater Control - turns on at +32 deg F, turns off at +50 deg F
- Cold weather auxiliary heater kit. Thermostatically controlled, On 32F, Off 50F, auto reset, hermetically sealed, 120/230vac On/Off/Jog type actuators. 175W Internal Heater, 2A power consumption.
- Kit, 4-20mA feedback generator for On/Off/Jog actuators.
- Local Control Unit offers “HAND/OFF/AUTO” Switch and OPEN/OFF/CLOSE Switch, No Indicator Lights. (See catalog for additional Local Control Selections)
- Mechanical Torque Switch Assembly (2 Position Jog only)
- Motor Control Center for 3 Phase models (Includes Local Control P/N: LCS-D)

ProMation Product Line

PL Series Linear Drive

Up to 4400lbs down/ up force and up to 100mm (4”) stem travel for globe valves, gate valves and linear travel devices. With override handwheel. Available with On/Off/Jog or Proportional control for 24vac, 120vac & 230vac supplies.

P Series Non-Spring Return

50”lbs through 40,500”lbs. Quarter-Turn, w/ manual Override Available with On/Off/Jog or Proportional control for 12vac/dc, 24vac/dc, 120vac, 230vac, 230v/3 phase, 380v/3 phase & 460v/3phase supplies.

D Series Spring Return

90”lbs through 450”lbs. Quarter-Turn, w/ manual Override Available with On/Off/Jog or Proportional control for 24...230vac/dc

PA~PD Series Spring Return

450”lbs through 2300”lbs. Quarter-Turn, both with and w/o manual override handwheel. Spring either CW or CCW Available with On/Off or Proportional control for 24vac/dc, 120vac & 230vac supplies. Stepdown for 3ph available.

PBU Battery Back-Up Systems

Provides power sufficient to drive P Series actuators to field-selectable fail-safe positions. For P Series & PL Series actuators in On/Off and Proportional control modes Available for 24/120vac actuators. Requires 120vac supplly.

SD11_P23_DC_F078P22_Ver C_061511

PROMATION ENGINEERING

Precision Actuation for Industry

...Partners, Above and Beyond

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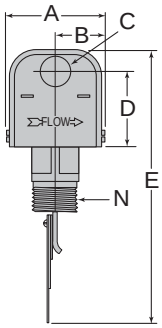
Flow Switches – Liquid

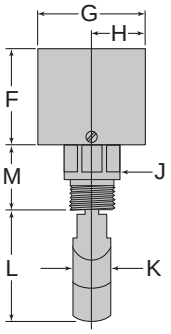
Series FS4-3
General Purpose Liquid Flow Switches

(for specified models)

- Universal design serves the widest variety of applications
- For starting or stopping electrically operated equipment such as signal lights, alarms, motors, automatic burners, metering devices and others
- Replacement for common flow switches from Johnson/Penn, Potter/Taco, Watts, Hydrolevel and other manufacturers
- 1" NPT
- Two electrical knock-outs allows connection from either end
- Sensitivity adjusting screw makes flow adjustment easy
- Single pole, double throw snap switch
- Hardened stainless steel bearings minimize friction
- Sealed Monel bellows
- Four stainless steel paddles included - 1", 2", 3" & 6" (25, 50, 80, & 150mm)
- Optional features
  – Two SPDT switches to make or break two separate circuits
  – Materials of construction suitable for corrosive liquids
  – BSPT threads
- Minimum temperature (fluid or ambient) 32°F (0°C)
- Maximum temperature 300°F (149°C)
- Maximum pressure 160 psi (11.3 kg/cm²)

Series FS4-3





SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 29 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 27 june 2016

Reviewed X
Reviewed as noted ☐
Resubmit ☐

Out for Approval

SIFEC NORTH INC.

Electrical Ratings

Voltage	Motor Switch Rating (Amperes)		Pilot Duty
	Full Load	Locked Rotor	
120 VAC	7.4	44.4	125 VA at 120 or 240 VAC 50 or 60 cycles
240 VAC	3.7	22.2	

Dimensions, in. (mm)

A	B	C	D	E	F	G
3 (76)	1½ (38)	⅞ (22)	2 7/32 (56)	8 7/16 (211)	2 15/16 (75)	3⅜ (86)

H	J	K	L	M	N NPT
1 11/16 (43)	1 7/16 (37)	1⅛ (29)	3 7/16 (87)	2 1/16 (52)	1

Flow Switches Liquid

Series FS4-3 (continued)
General Purpose Liquid Flow Switches

Flow Rates

Pipe Size NPT in.	Settings	Mode of Operation		Max. Flow Rate gpm (lpm) w/o Paddle Damage
		Flow gpm (lpm)	No Flow gpm (lpm)	
1	Factory or Minimum	6 (22.7)	3.6 (13.6)	27
	Maximum	10.2 (38.6)	9.2 (34.8)	(102.2)
1¼	Factory or Minimum	9.8 (37.1)	5.6 (21.2)	47
	Maximum	16.8 (63.6)	15 (56.8)	(177.9)
1½	Factory or Minimum	12.7 (48.1)	7 (26.5)	63
	Maximum	23 (87.1)	19.5 (73.8)	(238.5)
2	Factory or Minimum	18.8 (71.2)	9.4 (35.6)	105
	Maximum	32.8 (124.1)	24 (90.8)	(397.4)
2½	Factory or Minimum	24.3 (92)	11.6 (43.9)	149
	Maximum	42.4 (160.5)	37.5 (141.9)	(564)
3	Factory or Minimum	30 (113.6)	12 (45.4)	230
	Maximum	52.1 (197.2)	46.1 (174.5)	(870.6)
4	Factory or Minimum	39.7 (150.3)	19.8 (74.9)	397
	Maximum	73.5 (278.2)	64.2 (242)	(1502.7)
5	Factory or Minimum	58.7 (222.2)	29.3 (110.9)	654
	Maximum	115 (435.3)	92 (348.2)	(2415.4)
6	Factory or Minimum	79.2 (300)	39.6 (150)	900
	Maximum	166 (628.3)	123 (465.6)	(3406.5)

alues are 10%

NOTE DO NOT USE LI UID FLOW SWITCHES ON S STEMS WITH FLOW GREATER THAN 1 FEET (3M) PER SECOND.

Ordering In ormation

Model Number	Part Number	Description	Weight lbs. (kg)
FS4-3	114400	General purpose flow switch	1.9 (0.9)
FS4-3J	114610	FS4-3 w/BSPT connections	1.9 (0.9)
FS4-3-RPT	114639	FS4-3 w/test button	1.9 (0.9)
FS4-3Z	114410	FS4-3 w/ANSI terminal connections	1.9 (0.86)
FS4-3D	114550	FS4-3 w/2 SPDT switches	2.3 (1.0)
FS4-3S	114641	FS4-3 w/SS body, monel bellows	1.9 (0.9)
FS4-3SJ	176216	FS4-3S w/BSPT connections	1.9 (0.9)
FS4-3DS	114642	FS4-3S w/2 SPDT switches	3.3 (1.5)
FS4-3J-E	114611	FS4-3J-CE conformance rated	1.9 (0.9)
FS4-3D-E	114552	FS4-3D-CE conformance rated	1.9 (0.9)
FS4-3S-E	114646	FS4-3S-CE conformance rated	1.9 (0.9)

See pa e 120 or CE Con ormance in ormation

Chapter 19 INSULATION

MANUFACTURER/DISTRIBUTOR:

CrossRoads C&I Inc.
c/o Liette Larose
5760 Côte de Liesse
Ville Mont-Royal, Quebec H4T 1B1
Phone: 514-738-1916 Ext.2706
Fax: (514) 738-2058
800-738-2058
llarose@glasscellisofab.com

19.1 **PLUMBING INSULATION**

19.2 **VENTILATION INSULATION**

Foamglas

Used on the 3" intake pipe inside the building

FOAMGLAS®

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Pittsburgh Corning

Protecting Companies and Their People Worldwide

INDUSTRIAL PIPING, DUCTS AND EQUIPMENT

FOAMGLAS® insulation is a lightweight, rigid material composed of millions of completely sealed glass cells. Each cell is an insulating entity. FOAMGLAS® insulation's all-glass, closed-cell structure provides the following benefits:

- Constant Insulating Efficiency
- Zero Water Vapor Permeability
- Moisture Resistance
- Fire Protection
- Corrosion Resistance
- Long-Term Dimensional Stability
- Vermin Resistance
- CFC and HCFC Free

These benefits result in FOAMGLAS® Insulation Systems that are long-lasting, require little maintenance and are ideal for:

- Low temperature pipe, equipment, tanks and vessels
- Medium and high temperature pipes and equipment
- Hot oil and hot asphalt storage tanks
- Heat transfer fluid systems
- Hydrocarbon processing systems
- Chemical processing systems
- Above ground and underground steam and chilled water piping
- Commercial piping and ductwork

Manufactured to comply with ASTM C552-07.

FOAMGLAS® insulation is manufactured by Pittsburgh Corning in a basic block form. Blocks are fabricated into a wide range of shapes, thicknesses and sizes to satisfy industrial insulation requirements.

PHYSICAL AND THERMAL PROPERTIES OF FOAMGLAS® ONE™ INSULATION

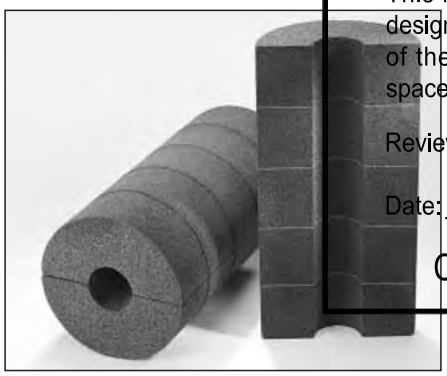
PHYSICAL PROPERTIES	SI	ENGLISH	ASTM STANDARD	EUROPEAN STANDARD
Absorption of Moisture (% by Volume)	0.2%	0.2%	C 240	EN 1609
	Only moisture retained is that adhering to surface cells after immersion			
Water-Vapor Permeability	0.00 perm-cm	0.00 perm-cm	E96 Wet Cup, Procedure B	EN ISO 10456
Acid Resistance	Impervious to common acids and their fumes except hydrofluoric acid			
Capillarity	None	None		EN 1609
Combustibility	Noncombustible, will not burn.		E 136	EN ISO 1182 (Class A1)
Composition	Soda-lime silicate glass — inorganic with no fibers or binders.			
Compressive Strength Average for Standard Material (+/-10%)	600 kPA	90 psi	C 165 C 240 C 552	EN 826
	Strength for flat surfaces capped with hot asphalt. For curved surfaces and pipe supports, contact PCC.			
Density, Average	120 kg/m^3	7.5 lb/ft^3	C 303	
Dimensional Stability	Excellent — does not shrink, swell or warp.			EN 1604
Flexural Strength, Block Average	480 kPa	70 psi	C 203 C 240	
Hygroscopicity	No increase in weight at 90% relative humidity.			EN 12089
Linear Coefficient of Thermal Expansion 25°C to 300°C (75°F to 575°F)	9.0 x 10^{-6}/°K	5.0 x 10^{-6}/°F	E 228	EN 13571
Maximum Service Temperature	480°C	+900°F		EN 14706
Modulus of Elasticity, Approx.	900 MPa	1.3 x 10^5 psi	C 623	
Thermal Conductivity	W/mK 0.039 @ 0°C 0.040 @ 10°C	Btu-in/hr•ft^2•°F 0.29 @ 75 °F 0.28 @ 50 °F	C 177 C 518	EN 12667 EN 12939
Specific Heat	0.84 kJ/kg•°K	0.20 Btu/lb•°F		
Thermal Diffusivity	4.2 x 10-7m^2/sec	0.016 ft^2/hr		

Notes: Measurements were collected using ASTM guidelines and, unless otherwise specified, properties were collected at 24°C (75°F). Properties may vary with temperature. The measurements listed in the table are average or typical values recommended for design purposes, and are not intended as specification or limit values.

Foamglas

FOAMGLAS® ONE™ INSULATION SYSTEMS FOR INDUSTRIAL APPLICATIONS

Pittsburgh Corning has developed insulation systems for a wide range of piping and equipment applications—above ground or underground, indoors or outdoors—at operating temperatures from -450°F to +900°F (-268°C to +482°C).



With the patented StrataFab® System, blocks of FOAMGLAS® insulation are laminated into billets using a special high temperature adhesive. These billets are fabricated into the desired shapes and sizes for pipe, tank, vessels, flanges and valves—practically any industrial insulation application.

SHOP DRAWING

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Reviewed By: M.M.

Date: 24 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHARELLI ENGINEERING LTD.

Totally Impermeable

Long Term Performance
Because it consists of closed glass cells, FOAMGLAS® insulation resists moisture in both liquid and vapor forms. When tested in accordance with ASTM E96, it has a permeability rating of 0.00 perm-in.

Noncombustible
FOAMGLAS® insulation is 100% glass and contains no binders or fillers—it cannot burn. FOAMGLAS® insulation will not absorb flammable liquids or vapors. If a fire does occur, FOAMGLAS® insulation will help contain it.

Corrosion-Resistant
All-glass FOAMGLAS® insulation is unaffected by common chemicals and by most corrosive plant atmospheres. It does not promote metal corrosion and its moisture resistance will help keep water from reaching equipment and piping.

Dimensionally Stable
FOAMGLAS® insulation is unaffected by temperature differentials and humidity. It will not swell, warp, shrink or otherwise distort. The insulation system's integrity remains intact.

High Compressive Strength
FOAMGLAS® insulation can withstand loads which crush most other insulating materials. In a properly designed piping system, FOAMGLAS® insulation eliminates the need for special treatment at pipe cradles. It also provides a firm base for roof membranes, jacketing or vapor retarders, prolonging their life.

Technical Service
Pittsburgh Corning's Technical Service Staff provides product, application and materials testing—standardized and customized specifications—on-site customer assistance and installation guidance.

For complete data on FOAMGLAS® Insulation Systems, please visit our Web site at www.foamglas.com, or contact Pittsburgh Corning at any of the following locations:

Pittsburgh Corning USA
(Corporate Headquarters)
800 Presque Isle Drive
Pittsburgh, PA 15239
Tel: 1-724-327-6100
Fax: 1-724-387-3807

Pittsburgh Corning Corporation Asia
(Asia Headquarters)
Pittsburgh Corning Corporation
3-7-4-304 Hikarigaoka
Nerima-ku, Tokyo, Japan 179-0072
Tel & Fax: 011 81-3-5997-0248

Pittsburgh Corning Europe NV
(Europe / Middle East Africa
Headquarters)
Albertkade, 1
B-3980 Tessenderlo
Belgium
Tel: +32-13-66-17-21
Fax: +32-13-66-78-54

GreenSpec® LISTED
www.GreenSpec.com

ISO 9001:2000
KEMA CERTIFICATE
Accredited by ANSI-RAB NAP
Accredited by the Dutch Council for Accreditation (RvA)

BCCA ISO 9001:2000

The information contained herein is accurate and reliable to the best of our knowledge. But, because Pittsburgh Corning Corporation has no control over installation worksmanship, accessory materials or conditions of application, NO EXPRESSED OR IMPLIED WARRANTY OF ANY KIND, INCLUDING THOSE OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS MADE as to the performance of an installation containing Pittsburgh Corning products. In no event shall Pittsburgh Corning be liable for any damages arising because of product failure, whether incidental, special, consequential or punitive, regardless of the theory of liability upon which any such damages are claimed. Pittsburgh Corning Corporation provides written warranties for many of its products, and such warranties take precedence over the statements contained herein.

STANDARDS, CERTIFICATIONS* AND APPROVALS

FOAMGLAS® insulation can be certified to conform to the requirements of:

- ASTM C 552 "Specification for Cellular Glass Thermal Insulation"
- Military Specification MIL-I-24244C, "Insulation Materials, Thermal, with Special Corrosion and Chloride Requirement"
- Nuclear Regulatory Guide 1.36, ASTM C 795, C 692, C 871
- Flame Spread 5, Smoke Developed 0 (UL 723, ASTM E 84), R2844; also classified by UL of Canada, CR1957
- ISO 9001:2000
- UL 1709
- For a listing of UL Through Penetration Fire Stop Approved Systems please search the UL Database at http://www.ul.com/ Once on this page click on CERTIFICATIONS on the left hand side. Under General Search click on UL FILE NUMBER and type in R15207 and then SEARCH
- Board of Steamship Inspection (Canada) Certificate of Approval No. 100/F1-98
- General Services Administration,PBS (PCD): 15250, Public Building Service Guide Specification, "Thermal Insulation (Mechanical)"
- New York City Dept. of Bldgs., MEA #138-81-M FOAMGLAS® insulation for piping, equipment, walls and ceilings
- New York State Uniform Fire Prevention and Building Code Dept. of State (DOS) 07200-890201-2013
- City of Los Angeles General Approval RR22534

FOAMGLAS insulation is identified by Federal Supply Code for Manufacturers (FSCM 08869)

***Written request for certificate of compliance must accompany order.**

FOAMGLAS®

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Used on the 3" intake pipe inside the building

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

GCI
GLASSCELL ISOFAB INC.

TECHNICAL DAT

FABRICATED METAL PRODUCTS

ALUMACLAD ROLLS AND CUT AND ROLLED

DESCRIPTION	GCI's Alumaclad Roll Jacketing is manufactured from Series 3000 alloys to meet the requirements of ASTM B-209. The BLUE coated interior offers moisture protection while the acrylic exterior finish offers better resistance in corrosive environments than a mill finish type. This combination has provided excellent protection for over 25 years. Rolled Jacketing is supplied in rolls that allow the installer to cut desired lengths to suit a particular application. Standard rolls are supplied in either 36" or 48" (918 mm or 1218 mm) widths and are available with or without a factory applied moisture barrier. The rolls are supplied in cardboard cartons for easy identification and storage. To increase job site efficiency, jackets are also offered pre-cut and rolled to fit standard insulated pipes.
AVAILABLE TYPES	Aluminum (Alumaclad) rolled jacketing and cut and rolled jacketing are pre-painted and available in smooth (SM), stucco embossed (SE) or cross crimped (CC. Thicknesses range from .006" to .050" in aluminum. Standard rolll lengths are 100 ft. in aluminum. These rolls are available with a clear epoxy coating for corrosion protectionand with or without factory applied moisture barrier. Moisture barriers are available as Polykraft, Painted acrylic “Blue Barrier” or Polysurlyn film. * Non standard roll lengths are available upon request.
ADVANTAGES	Rolled Jacketing in standard length rolls allows the installer the convenience of cutting desired length pieces as required in the field. Rolls may be inventoried for convenience and quick response times. They may be used to cover insulated piping, tanks and other mechanical equipment. Cut and rolled jackets are pre-cut to length and are economical to use on most job sites as the premium paid for the service is significantly less than the labor involved in cutting the jacket on site and the additional handling of large rolls.
APPLICATIONS	Rolled Jacketing may be fastened with either bands, screws or pop rivets depending on the application. Rolled Jacketing looks good and provides a neat finish to any insulated system. All laps should be arranged to shed water and edges caulked with an approved sealant where required.

0.16

SHOP DRAWING
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Reviewed By: M.M.
Date: 24 June 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
CHIARELLI ENGINEERING LTD.

CONTINUED

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

GCI
GLASSCELL ISOFAB INC.

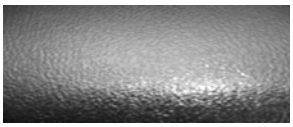
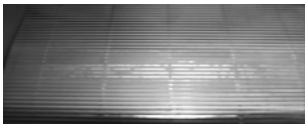
TECHNICAL DATA

FABRICATED METAL PRODUCTS

FABRICATED METALS ROLLS AND CUT AND ROLLED - 2

WIDTHS :	LENGTHS :
36" Standard, 48" on Special order.	100' Standard or Cut & Rolled to Length.

THICKNESSES:	USAGE:
.016”	Use in areas subject to traffic and abuse. Use on insulated lines up to 36” O.D.
.020”	Use on larger lines and large equipment up to 8’ in diameter.
.024”	Use in applications where extra thickness and protection is required.
.032”	Use where severe mechanical abuse or special fabricating requirements such as flat ducts or precipitators. Also in very windy areas.
.040” (Special Order)	

FINISHES:	PLAIN	PEBBLED (STUCCO)	CORRUGATED 3/16”:
			
	Use where minimum abuse is expected.	Use where some abuse is expected.	Use where maximum abuse is expected.

FEATURES	BENEFITS
Recycled content	Produced from 99% scrap. 80% of the scrap is from post-consumer sources.
Excellent emittance	Contributes to lower heat losses and personnel protection.
Coated Moisture Barrier	Eliminates possibility of delaminating in Lock formers. Coverage is full roll width.
Fire Protection	Coatings contribute less to a fire than Kraft or poly films.
Tensile & yield	Conforms to Aluminum Association standards for tensile & yield properties for each temper.
Bending	Meets Aluminum Association specifications for bending.

DUCT insulation

sustainable insulation

Specification Sheet

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

CertainTeed
SAINT-GOBAIN

SoftTouch™ Duct Wrap Insulation

Product Name	CertainTeed SoftTouch™ Duct Wrap Insulation
Manufacturer	CertainTeed Corporation
Address	P.O. Box 860 Valley Forge, PA 19482-0105
Phone	610-341-7000 • 800-233-8990
Fax	610-341-7571
Website	www.certainteed.com/insulation

PRODUCT DESCRIPTION

Basic Use: SoftTouch™ Duct Wrap Insulation is used to insulate rectangular and round heating, ventilating and air conditioning ductwork.

Benefits: SoftTouch Duct Wrap Insulation provides thermal efficiency that reduces unwanted heat loss or gain from equipment and ductwork. When properly installed in the correct thickness, this product virtually eliminates condensation problems on cold duct surfaces.

Composition and Materials: SoftTouch Duct Wrap is a blanket-type insulation composed of tan, uniformly textured, inorganic fibrous glass formed with a formaldehyde-free plant-based binding agent. It is available unfaced or with FSK, gray PSK or white PSK vapor retarder facing. On faced products, a stapling/taping tab is provided on one edge.

Limitations: The product should be kept clean and dry from the time of manufacture through job site installation and system operation.

SoftTouch Duct Wrap is suitable for use with most heating, ventilating and air conditioning ductwork operating at temperatures from 35°F to 250°F (1.7°C to 121°C) for faced SoftTouch Duct Wrap, and from 35°F to 450°F (1.7°C to 232°C) for unfaced SoftTouch Duct Wrap.

Sizes: See table on back for available sizes. Contact CertainTeed for other sizes and minimum order quantities.

INSTALLATION

Sheet metal ducts must be clean, dry and sealed tightly prior to insulating with CertainTeed SoftTouch Duct Wrap.

To ensure installed thermal performance, CertainTeed SoftTouch Duct Wrap must be cut to "stretch-out" dimensions. This requires measurement of the duct perimeter, then cutting the duct wrap to the dimensions (perimeter + add-on) indicated in the stretch-out table on the other side. A 2" piece of insulation is removed from the facing at the end of the piece of insulation to form an overlapping stapling and taping flap.

CertainTeed SoftTouch Duct Wrap is installed by wrapping the insulation around the perimeter of the duct with the facing out. Adjacent sections of duct wrap are tightly butted with the 2" taping flap overlapping. Seams must be stapled with outward-clinching staples on approximately 6" centers. When a vapor retarder is required, all seams, joints, tears, punctures and/or other penetrations of the duct wrap must be sealed with a pressure sensitive vapor retarder tape that matches the facing, or a suitable mastic system.

Where rectangular ducts are 24" in width or greater, CertainTeed SoftTouch Duct Wrap must be additionally secured to the bottom of the duct with mechanical fasteners spaced 18" on center to prevent sagging.

For additional installation details, consult the National Commercial and Industrial Insulation Standards (current edition) published by the Midwest Insulation Contractors Association (MICA).

AVAILABILITY AND COST

Manufactured in U.S.A. Available in select Western U.S./Canada regions. For availability and cost contact your local distributor, or call CertainTeed Sales Support Group in Valley Forge, PA at 800-233-8990.

WARRANTY

Refer to CertainTeed's Limited One-Year Warranty for Fiber Glass Duct Wraps (30-29-047).

MAINTENANCE

An inspection and preventative maintenance program for the HVAC system is recommended to ensure optimum performance.

TECHNICAL DATA

Applicable Standards

- Model Building Codes:
  – ICC
- Material Standards:
  – ASTM C1290
    Type I, Unfaced
    Type II, PSK – Grey
    Type III, FSK & PSK – White
  – ASTM C553
    Type I, Type 75 Duct Wrap
    Type II, Type 100 & 150 Duct Wrap
    Type III, Type 150 Duct Wrap
  – CAN/CGSB-51.11-92
  – ASTM C1136: FSK & White PSK, Type II, Gray PSK, Type IV
- Fire Safety Standards:
  – NFPA 90A, NFPA 90B

Fire Resistance

- Fire Hazard Classification:
  – UL 723, ASTM E84, CAN/ULC-S102
    Max. Flame Spread Index: 25
    Max. Smoke Developed Index: 50
- Non-Combustible: ASTM E136 / Meets test requirements

Physical/Chemical Properties

- Thermal Performance: See table on other side
- Operating Limits:
  – Temperature: ASTM C411
    Faced: Max. 250°F / 121°C
    Unfaced: Max. 450°F / 232°C
- Water Vapor Sorption: ASTM C1104 / < 5% by weight
- Water Vapor Transmission – Facing:
  – ASTM E96, Desiccant Method
    FSK and white PSK: Max. 0.02 perms (1.15×10^{-9} g/Pa•s•m²)
    Gray PSK: Max. 0.09 perms (5.17×10^{-9} g/Pa•s•m²)
- Corrosiveness: ASTM C665
  – Pass test requirements
- Fungi Resistance: ASTM C1338
  – Pass test requirements
- Odor Emission: ASTM C1304
  – Pass test requirements

Quality Assurance

CertainTeed's commitment to quality and environmental management has ensured the registration of the Athens, Chowchilla and Kansas City plants to ISO 9001:2000 and ISO 14001:2004 standards. The GREENGUARD® Environmental Institute has certified SoftTouch Duct Wrap Insulation for low emissions of total particle, formaldehyde and other Volatile Organic Compounds (VOCs).

DUCT insulation

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

www.certainteed.com/insulation

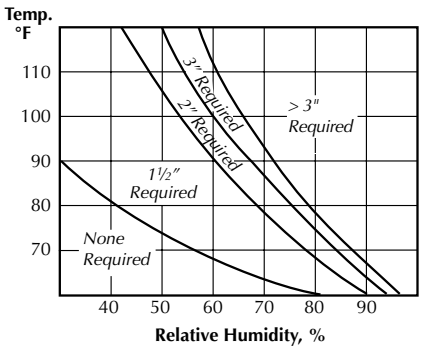
TECHNICAL SERVICES

Technical assistance can be obtained either from your local CertainTeed sales representative, or by calling CertainTeed Sales Support Group in Valley Forge, PA at 800-233-8990.

FILING SYSTEMS

- CertainTeed Pub. No. 30-36-081
- Sweet's Catalog Files, 230700
- Additional product information available upon request.

CONDENSATION CONTROL



This chart is based on indoor conditions so far as wind and other factors are concerned.

To determine thickness to prevent condensation, based on installed thickness at 75% of nominal (out-of-package) thickness and a duct internal air temperature of 55°F, refer to the condensation control chart.

To use: 1) Select maximum relative humidity (%) on lower axis; 2) Read up vertically until that line intersects the maximum ambient air temperature; 3) Select the thickness indicated at the point of intersection.

THERMAL PERFORMANCE

Product Type	Thickness in.	Thickness mm	R-Value h•ft²•°F/Btu	R-Value m²•°C/W	Installed R-Value h•ft²•°F/Btu	Installed R-Value m²•°C/W	K-Value Btu•in/h•ft²•°F	K-Value W/m²•°C	Installed K-Value Btu•in/h•ft²•°F	Installed K-Value W/m²•°C
75 (0.75 pcf*)	1	25	3.8	0.67	3.0	0.53	0.26	0.038	0.25	0.036
	1½	38	5.2	0.92	4.2	0.74	0.29	0.042	0.27	0.039
	2	51	6.9	1.22	5.7	1.00	0.29	0.042	0.26	0.038
	2⅛	54	7.3	1.29	6.0	1.06	0.29	0.042	0.27	0.038
	2½	64	8.6	1.51	7.1	1.25	0.29	0.042	0.26	0.037
	3	76	10.2	1.80	8.3	1.46	0.29	0.42	0.27	0.039
	4	102	13.5	2.38	11.0	1.94	0.30	0.043	0.27	0.039
100 (1.0 pcf*)	1	25	3.8	0.67	3.0	0.53	0.26	0.038	0.25	0.036
	1½	38	5.7	1.00	4.5	0.79	0.26	0.038	0.25	0.036
	2	51	7.6	1.34	6.1	1.07	0.26	0.038	0.25	0.035
150 (1.5 pcf*)	1	25	4.1	0.72	3.2	0.56	0.24	0.035	0.23	0.034
	1½	38	6.2	1.09	4.8	0.85	0.24	0.035	0.23	0.034
	2	51	8.3	1.46	6.4	1.13	0.24	0.035	0.23	0.034

Tested in accordance with ASTM C518 and/or ASTM C177 at 75°F (24°C) mean temperature. R means resistance to heat flow. The higher the R-value, the greater the insulating power. The installed R-value and K-value based upon 25% compression of the product thickness during installation. To get the installed R-value, it is essential that this insulation be installed properly. If you do it yourself, follow the installation instructions carefully.

*pcf. is pounds per square foot

INSTALLATION STRETCH-OUT DIMENSIONS

Product Label Thickness in.	Product Label Thickness mm	Average Installed Thickness in.	Average Installed Thickness mm	Stretch-Out Dimensions[1] perim.	Round Duct in.	Round Duct mm	Square Duct in.	Square Duct mm	Rectangular Duct in.	Rectangular Duct mm
1	25	0.75	19	P+	7.0	178	6.0	152	5.0	127
1.5	38	1.13	29	P+	9.5	241	8	203	7	178
2	51	1.50	38	P+	12	305	10	254	8	203
2.125	54	1.59	40	P+	12.6	321	10.4	270	8.4	213
2.5	64	1.875	48	P+	14.5	368	12.5	318	9.5	241
3	76	2.25	57	P+	17	432	14.5	368	11.5	292
4	106	3.00	76	P+	22.0	559	18.5	470	14.5	368

[1] The stretch-out dimension is equal to the duct perimeter (P) plus the add-on factor for the type of duct being installed.

AVAILABLE SIZES

Product Type	Facing	Thickness in.	Thickness mm	Length in.	Length m	Width in.	Width mm
75 (0.75 pcf)	UNFACED	1	25	150	45.7	9 - 72	229 - 1829
		1½	38	150	45.7		
		2	51	75	22.9		
		2½	64	75	22.9		
		3	76	50	15.2		
	FSK/PSK	1½	38	100	30.5	48	1219
		2	51	75	22.9		
		2⅛	54	75	22.9		
		2½	64	75	22.9		
		3	76	50	15.2		
		4	102	50	15.2		
100 (1.0 pcf)	Unfaced	1	25	150	45.7	9 - 72	229 - 1829
	FSK/PSK	1	25	100	30.5	48	1219
		1½	38	100	30.5		
		2	38	75	22.9		
150 (1.5 pcf)	FSK/PSK	1½	38	75	22.9	48	1219
		2	51	50	15.2		

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 24 June 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

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SAINT-GOBAIN

Chapter 20 OLSEN FURNACE

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax :(514) 344-9341

20.1 OLSEN FURNACE HML80CNX2

Fuel fired furnace

Olsen
Heating & Cooling Products

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

oil furnaces

Lowboy

BCL, BFL, BML, BMLV
60,000 – 224,000 BTU

Highboy

HML, HMLV, HTL, HTLV
60,000 – 140,000 BTU

Multiposition

WML, WMLV, MPL
60,000 – 123,000 BTU

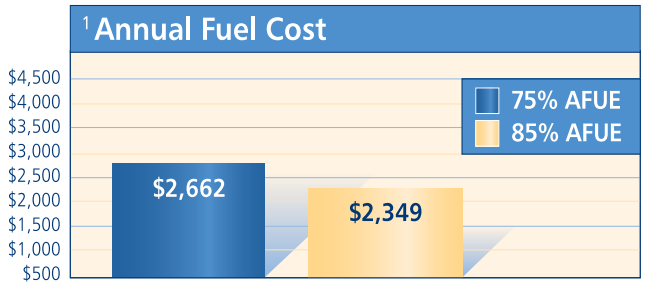
keeping families warm for more than 60 years

Fuel fired furnace

Higher AFUE translates into significantly lower fuel bills

(AFUE = Annual Fuel Utilization Efficiency)

If your furnace is 25 years old or older, chances are that it is only 55% or 65% efficient. Refer to the chart at right to see the savings you could realize by installing an Olsen today.



Higher AFUE = More heat for every dollar spent. AFUE works much like the miles-per-gallon rating on a car – the higher the rating, the lower the fuel costs. Installing a higher AFUE furnace can also equal cash back – energy-efficiency rebates or incentives may be available from the government or utility in your area.

Superior heat exchanger design delivers higher AFUE!

Double pass heat exchanger – Constructed of heavy-gauge metal, the Olsen high-efficiency heat exchanger has a large surface area to maximize heat transfer into your home. The two paths create added flue gas turbulence, which increases efficiency.

Dual clean outs – Easily-accessible dual clean outs allow for quick and efficient routine maintenance of the heat exchanger.

Cabinet vestibule protects burner and controls while reducing noise

Virtually all Olsen furnaces come standard with a vestibule or it is available as an option. The vestibule protects the controls and burner from accidental contact and reduces the operational noise of the furnace.

[1] This chart depicts potential energy costs. Data used for this example was 80,000 BTU heat load, 6000 Degree Days F per annum, fuel cost @ $3 per gallon or $0.79 per litre. Actual costs may vary, depending on your local weather patterns and fuel rates, lifestyle and the air infiltration integrity of your building envelope. This chart is for demonstration purposes only and does not constitute a guarantee of performance for any product.

Fuel fired furnace

oil furnace selection guide

FURNACE MODEL

FEATURES	LOWBOY				HIGHBOY				MULTIPOSITION		
	BML	BMLV	BCL	BFL	HML	HMLV	HTL	HTLV	WML	WMLV	MPL
Burner											
Beckett burner	•	•	•	•	•	•	•	•	•	•	•
Beckett NX burner											
Riello burner	•	•	•	•	•	•	•	•	•	•	•
Clean cut oil pump & flame retention burner head	•	•	•	•	•	•	•	•	•	•	•
Heat Exchanger											
Two-pass heavy gauge exchanger	•	•	•	•	•	•	•	•	•	•	•
Ceramic fibre combustion chamber	•	•	•	•	•	•	•	•	•	•	•
Foil-faced cabinet insulation	•	•	•	•	•	•	•	•	•	•	•
Air Flow Management											
Single-speed belt drive motor	•		•	•							
Multiple-speed direct drive PSC motor	•		•	•	•		•		•		•
Variable-speed direct drive ECM		•				•		•		•	
5-ton cooling model available			•	•			•	•			
Noise Reduction											
Ceramic fibre combustion chamber	•	•	•	•	•	•	•	•	•	•	•
Dynamically balanced blower assembly	•	•	•	•	•	•	•	•	•	•	•
Variable speed blower motor		•				•		•		•	
Installation & Maintenance											
Chimney vent	•	•	•	•	•	•	•	•	•	•	•
Direct side wall vent	•	•	•	•	•	•			•	•	•
Upflow	•	•	•	•	•	•	•	•			
Downflow/horizontal									•	•	•
Breech	Rear	Rear	Rear	Front	Front	Front	Front	Front	Front	Front	Front
Dual clean-out ports	•	•	•	•	•	•	•	•	•	•	•
Warranty											
*5-year parts warranty	•	•	•	•	•	•	•	•	•	•	•
*Limited lifetime heat exchanger warranty	•	•	•	•	•	•	•	•	•	•	•

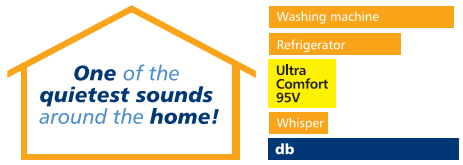
*As per the limitations set out in the warranty.

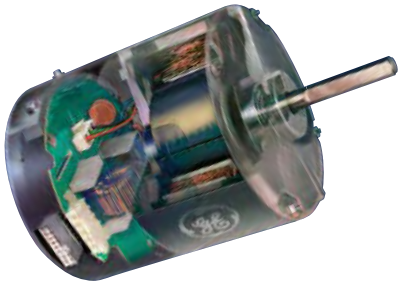
ECR's home comfort products are designed to provide years of **trouble-free** operation

The "Comfort Plus" Extended Warranty program complements ECR's Standard Product Warranty by providing labour coverage and additional years of parts coverage depending on the plan purchased. If you sell your home, the "Comfort Plus" warranty can be transferred to the purchaser, adding to the value of your home. Ask your installer for details on the "Comfort Plus" Extended Warranty program.

Fuel fired furnace

Variable speed (ECM) technology
uses less electricity





ECM (Electronically Commutated Motor) = Lower operating costs. At full load the ECM motor is 20% more efficient than a conventional motor. On continuous fan speed, the ECM motor consumes 60-80 watts compared to 400 watts for a conventional motor.

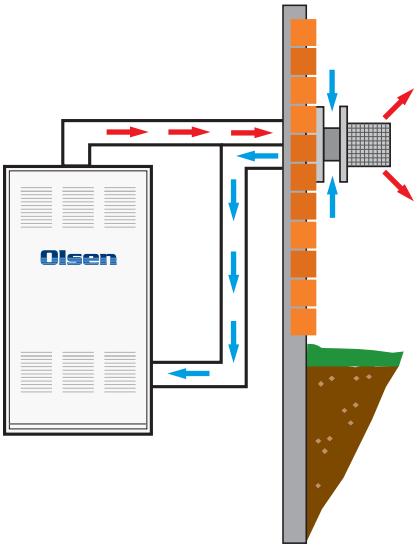
Soft start and stop = Less noise and increased overall comfort. The variable speed motor ramps up gradually until it reaches the required air flow and ramps down slowly before shutdown. The operation is so quiet you will rarely notice when your furnace turns on and off.

In heating mode, the initial rush of cold air and noise created by conventional motors is eliminated. Reduced temperature swings and gradual heat gain increase the overall comfort delivered by the system.

In cooling mode, the motor speed is reduced during the first several minutes of operation. This increases the system's ability to remove maximum humidity from the airflow, increasing comfort in your home.

DIRECT VENT SIDEWALL

Direct Sidewall Venting is an effective alternate method of venting combustion products through an outside wall of the house, rather than up a traditional chimney. This method utilizes the burner to efficiently exhaust products of combustion from the heating equipment.



FEATURES AND BENEFITS

- Direct Sidewall Vent allows for overall increase in installed appliance efficiency.
- The Olsen Direct Sidewall Vent kit has been designed for flexibility in installation. All vent-to-appliance adapters are included.
- Every Direct Sidewall Vent installation requires an Olsen Vent Terminal in addition to the venting kit described above. The Olsen Vent Terminal utilizes a two-pipe combustion air/exhaust gas configuration. Because outside air is used for combustion, the system provides greater efficiency and safety in new, tightly sealed houses.
- Only one wall opening is required for concentric vent.
- The burner provides the necessary pressure for adequate venting of flue products – no additional motors or controls are required.

oil furnace specifications

PERFORMANCE

Description Glossary

B2U = direct sidewall vent Beckett; RBU = direct sidewall vent Riello; RF = Riello burner; NX = Beckett NX burner; .5 = air conditioning ready; .2 = heating only; DD = direct drive; SS = belt drive; TS = 5-ton model; ECM = variable speed motor

	Model	Vent	AFUE %	Nozzle Factory Standard	**Firing Rate USGPH	Output BTU/h	***Optional Output (000) BTU/h	Burner Model	Blower	Max CFM @ 0.5 WC
	Lowboy									
CHIMNEY VENT	BML 80B .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	76,500	59-98	Beckett AF	PSC Direct Drive	1462
	BML 80B .2 1/2 SS	Chimney	83	0.65 / 80°A	0.65	76,500	59-98	Beckett AF	*Belt Drive	*
	BML 80B RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	76,500	59-87	Riello 40F3	PSC Direct Drive	1462
	BCL 100S RF .5 1/2 DD	Chimney	85.5	0.75 / 60°W	0.85	101,000	79-117	Riello 40F3	PSC Direct Drive	1585
	BCL 120S .5 1/2 DD TS	Chimney	85	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	PSC Direct Drive	1585
	BCL 120S .2 1/3 SS	Chimney	85	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	*Belt Drive	*
	BCL 120ST .5 1.0 DD	Chimney	85	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	PSC Direct Drive	2016
	BCL 145S .5 1/2 DD TS	Chimney	83.5	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	PSC Direct Drive	1585
	BCL 145S .2 1/2 SS	Chimney	83.5	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	*Belt Drive	*
	BCL 145ST .5 1.0 DD	Chimney	83.5	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	PSC Direct Drive	2016
	BCL 190 .25 COMPLETE	Chimney	78	1.65 / 70°B	1.65	188,000	166-188	Beckett AF	*Belt Drive	*
	BCL 190/225 .5 COMPLETE	Chimney	78	1.75 / 70°B	1.75	224,000	196-224	Beckett AF	*Belt Drive	*
	BFL 100 RF .5 1/2 DD	Chimney	85	0.75 / 60°W	0.85	101,000	79-117	Riello 40F3	PSC Direct Drive	1585
	BFL 120 .5 1/2 DD TS	Chimney	83	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	PSC Direct Drive	2016
	BFL 120 .2 1/3 SS	Chimney	83	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	*Belt Drive	*
	BFL 120T .5 1.0 DD	Chimney	83	1.00 / 80°A	1.00	117,000	79-117	Beckett AF	PSC Direct Drive	2016
	BFL 145 .2 1/2 DD	Chimney	83	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	PSC Direct Drive	1585
	BFL 145 .2 1/2 SS	Chimney	83	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	*Belt Drive	*
	BFL 145T .5 1.0 DD	Chimney	83	1.20 / 60°A	1.20	143,000	130-143	Beckett AF	PSC Direct Drive	2016
DIRECT VENT	BML 80B B2U .5 1/2 DD	Direct	83.5	0.60 / 60°A	0.65	76,500	59-87	Beckett AF II 85	PSC Direct Drive	1462
	BML 80B RBU .5 1/2 DD	Direct	85	0.60 / 60°W	0.65	76,500	59-87	Riello 40BF3	PSC Direct Drive	1462
	BCL 100S B2U .2 1/2 DD	Direct	85	0.85 / 80°A	0.85	101,000	79-117	Beckett AF II 150	PSC Direct Drive	1585
	BFL 100 B2U .2 1/2 DD	Direct	84	0.85 / 80°A	0.85	101,000	79-117	Beckett AF II 150	PSC Direct Drive	1585
ECM VARIABLE SPEED	BMLV 80B .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	76,500	59-98	Beckett AF	ECM Direct Drive	1380
	BMLV 80B RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	76,500	59-98	Riello 40F3	ECM Direct Drive	1380
	BMLV 80B B2U .5 1/2 DD	Direct	83.5	0.60 / 60°A	0.65	76,500	59-87	Beckett AF II 85	ECM Direct Drive	1380
	BMLV 80B RBU .5 1/2 DD	Direct	85	0.60 / 60°W	0.65	76,500	59-87	Riello 40BF3	ECM Direct Drive	1380
	Highboy									
CHIMNEY VENT	HML 80C .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	75,000	59-95	Beckett AF	PSC Direct Drive	1476
	HML 80C RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	75,000	59-86	Riello 40F3	PSC Direct Drive	1476
	HTL 115DRF 1/2 DD	Chimney	85	0.85 / 60°W	0.95	114,600	90-115	Riello 40F3	PSC Direct Drive	1440
	HTL 120D 1/2 DD	Chimney	83	1.00 / 60°W	1.00	117,600	89-117	Beckett AF	PSC Direct Drive	1440
	HTL 140DT 3/4 DD	Chimney	83	1.20 / 60°W	1.20	139,400	129-140	Beckett AF	PSC Direct Drive	1924
DIRECT VENT	HML 80C B2U .5 1/2 DD	Direct	83.5	0.60 / 60°A	0.65	75,000	63-86	Beckett AF II 85	PSC Direct Drive	1476
	HML 80C RBU .5 DD	Direct	85	0.60 / 60°W	0.65	75,000	59-86	Riello BF3	PSC Direct Drive	1476
ECM VARIABLE SPEED	HMLV 80C .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	75,000	59-95	Beckett AF	ECM Direct Drive	1380
	HMLV 80C RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	75,000	59-86	Riello 40F3	ECM Direct Drive	1380
	HTLV 115DRF 1/2HP ECM	Chimney	85	0.85 / 60°W	0.95	114,600	90-115	Riello 40F3	ECM Direct Drive	1380
	HMLV 80C B2U .5 1/2 DD	Direct	83.5	0.60 / 60°A	0.65	75,000	63-86	Beckett AF II 85	ECM Direct Drive	1380
	HMLV 80C RBU .5 DD	Direct	85	0.60 / 60°W	0.65	75,000	59-86	Riello BF3	ECM Direct Drive	1380

* Unit shipped as heating only. Field modifications and additional controls required for air conditioning.

** Additional firing rates available. See installation and operation manual for details.

*** Firing range available. Burner nozzle change required in the field. AFUE will change when the firing rate is changed. Go to www.olsenhvac.com for additional AFUE data.

Fuel fired furnace

oil furnace specifications

PERFORMANCE

	Model	Vent	AFUE %	Nozzle Factory Standard	** Firing Rate USGPH	Output BTU/h	*** Optional Output (000) BTU/h	Burner Model	Blower	Max CFM @ 0.5 WC
	Multiposition									
CHIMNEY VENT	WML 80C .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	75,000	58-86	Beckett AF	PSC Direct Drive	1291
CHIMNEY VENT	WML 80C RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	75,000	59-86	Riello 40F3	PSC Direct Drive	1291
CHIMNEY VENT	MPL 120B .5 3/4 DD	Chimney	82	1.00 / 60°A	1.00	112,000	86-123	Beckett AF	PSC Direct Drive	1331
CHIMNEY VENT	MPL 120B RF .5 DD 40F5	Chimney	84	0.85 / 70°A	1.00	112,000	86-123	Riello 40F5	PSC Direct Drive	1331
DIRECT VENT	WML 80C B2U .5 1/2 DD	Direct	83	0.65 / 60°A	0.65	75,000	63-86	Beckett AF II 85	PSC Direct Drive	1291
DIRECT VENT	WML 80C RBU .5 DD	Direct	85	0.60 / 60°W	0.65	75,000	59-86	Riello BF3	PSC Direct Drive	1291
DIRECT VENT	MPL 120B B2U .5 3/4 DD	Direct	83	0.85 / 70°A	1.00	112,000	85-112	Beckett AF	PSC Direct Drive	1331
ECM VARIABLE SPEED	WMLV 80C .5 1/2 DD	Chimney	83	0.65 / 80°A	0.65	75,000	58-86	Beckett AF	ECM Direct Drive	1291
ECM VARIABLE SPEED	WMLV 80C RF .5 1/2 DD	Chimney	85	0.60 / 60°W	0.65	75,000	59-86	Riello 40F3	ECM Direct Drive	1291
ECM VARIABLE SPEED	WMLV 80C B2U .5 1/2 DD	Direct	83	0.65 / 60°A	0.65	75,000	63-86	Beckett AF II 85	ECM Direct Drive	1291
ECM VARIABLE SPEED	WMLV 80C RBU .5 DD	Direct	85	0.60 / 60°W	0.65	75,000	59-86	Riello BF3	ECM Direct Drive	1291

** Additional firing rates available. See installation and operation manual for details.

*** Firing range available. Burner nozzle change required in the field. AFUE will change when the firing rate is changed. Go to www.olsenhvac.com for additional AFUE data.

DIMENSIONS All measurements in inches

Model	CABINET Width	CABINET Depth	CABINET Height	PLENUM OPENING Supply Air	PLENUM OPENING Return Air	Flue Dia.	Shipping Weight (lbs.)
Lowboy							
BML/BMLV	22	51 1/2	32	20 1/2 x 19	20 1/2 x 18 5/8	5	240
BCL/BFL	22	51 1/2	41	20 1/2 x 18 5/8	20 1/2 x 18 5/8	6	280
BCL 190/225	26	49	56	24 x 22	24 x 22	7	390
Highboy							
HML/HMLV	22	31	49 5/8	20 1/2 x 20	14 x 22	5	250
HTL/HTLV	22	31	58	20 1/2 x 20	14 x 22	6	270
Multiposition							
WML/WMLV	22	22 1/8	55 1/4	18 x 18	18 x 18	5	265
MPL	22 1/4	22 1/4	62	20 1/2 x 20 1/2	18 x 18	6	292

Ask your installer about our central air conditioners and heat pumps!

All product specifications reflect available information at the time of printing. ECR reserves the right to revise or modify products without notice.

YOUR ASSURANCE OF QUALITY

Olsen furnaces are designed, tested, and assembled to ensure that you get the very best in home heating comfort and value. Each furnace meets or exceeds all recognized safety, performance efficiency standards.

ecr

C US
Complies with ANSI/UL 727
CSA B140.4

2210 Dwyer Avenue, Utica NY 13504-4729
Phone: (315) 797-1310 • Fax: (866) 432-7329
e-mail: info@ecrinternational.com
web site: www.ecrinternational.com

Fuel fired furnace

Olsen
Heating & Cooling Products

oil furnaces

keeping families warm for more than 60 years

Reliable, Efficient Home Heating:

- Variable Speed Technology
- Easy Installation & Maintenance
- Optional Cooling Up to 5 Tons

Lowboy

BCL, BFL, BML, BMLV
59,000 - 237,000 BTU

Highboy

HML, HMLV, HTL, HTLV
59,000 - 113,000 BTU

Multiposition

WML, WMLV, MPL
59,000 - 128,000 BTU

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

Olsen Home Heating Economics 101

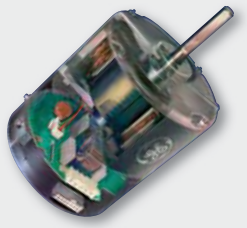
Fuel fired furnace

An oil furnace uses two energy sources, oil to produce heat and electricity to power the fan motor but there's more to consider than just that.

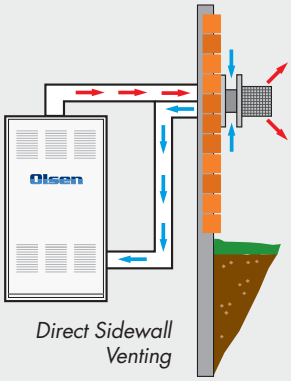
FEATURE:	BENEFIT:	ADDITIONAL BENEFITS:
OIL COSTS		
Higher Olsen AFUE Ratings (Annual Fuel Utilization Efficiency)	= Lower Fuel Costs	+ Bonus Cash Back (Through energy efficiency rebates).*
ELECTRICITY COSTS		
Olsen Variable Speed Technology An oil furnace with an ECM (Electronically Commutated Motor) can reduce electricity consumption up to †80%.	= Lower Electric Costs	+ Bonus Cash Back (Through energy efficiency rebates).*
OTHER COSTS AND CONSIDERATIONS		
DIRECTVENT SIDEWALL **Olsen Direct Sidewall Venting** As homes age, the chimney can become costly to maintain or repair.	– Eliminates Chimney Costs + Increases Combustion Efficiency	Requires only one wall opening, an Olsen Direct Sidewall Vent Kit (includes all connections from the furnace) and an Olsen concentric vent. (The Olsen vent terminal utilizes a two-pipe combustion air/exhaust gas configuration. Outside air is used for combustion resulting in greater efficiency and safety. The burner provides the necessary pressure for venting of flue products – no additional motors or controls are needed).
Superior Heat Exchanger Design	+ Delivers Higher AFUE	Double Pass Heat Exchanger (Heavy-gauge construction and large surface area maximize heat transfer) Dual Clean Outs (Provide easy access for quick, efficient routine maintenance)
Service & Maintenance Equipped for easy service and maintenance.	= Lower Costs of Good Design	Features like the slide out blower tray on high-boy models provide technicians easy access to critical components. Full length rails eliminate annoying/time consuming remounting of blower and motor housings, saving time and money on service.
Quiet Operation	= Better Quality Comfort	Most high-boy and low-boy Olsen furnaces come standard with a vestibule which provides sound attenuation, reducing operating noise. The vestibule also provides added protection for the burner.
Warranty & Peace of Mind Olsen furnaces are designed to provide years of trouble-free operation.	+ Limited Lifetime Warranty (Heat Exchanger), 5 Years Parts	

**(Check with your local government agencies and/or utilities regarding the availability of rebates and incentives).*
†Individual savings may vary.

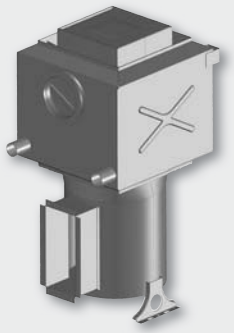
Calculate Your Savings



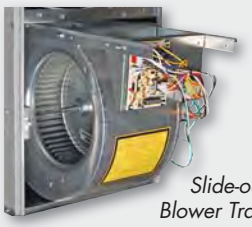
ECM Fan Motor



Direct Sidewall Venting



Superior Heat Exchanger



Slide-out Blower Tray

LOWBOY MODELS

BREECH	FURNACE DIMENSIONS (INCHES) HEIGHT	WIDTH	DEPTH	MODEL	FIRING RATE GPH	INPUT/ OUTPUT MBH[1]	AFUE EFFICIENCY % RATING — CHIMNEY VENT: BECKETT	BECKETT NX	RIELLO F	DIRECT VENT: BECKETT AFII	RIELLO BF
REAR FLUE MODEL	41	22	51½	BCL90S2	0.75	105/90	85.5%				
				BCL90S2							
				BCL90S2							
				BCL90ST2							
				BCL100S2	0.85	119/100	83.2%				
				BCL100S2							
				BCL100S2							
				BCL100ST2							
				BCL120S2	1.00	140/118	84.4%				
				BCL120S2							
				BCL120S2							
				BCL120ST2							
				BCL130S2	1.10	154/130	84.5%				
				BCL130S2							
				BCL130ST2							
				BCL145S2	1.20	168/141	84.0%				
				BCL145S2							
				BCL145ST2							
	56	26	49	BCL170-2	1.50	210/177	83.3%				
				BCL190	1.65	231/194	83.7% T				
				BCL200	1.75	245/205	83.7% T				
				BCL225	2.00	280/237	84.6% T				
	41	22	51½	BCL90SRF2	0.75	105/91	Chimney Vented with Riello F		87.2%		
				BCL100SRF2	0.85	119/102			86.2%		
				BCL90SB2U2	0.75	105/91					87.1%
				BCL100SB2U2	0.85	119/102	Direct Vented with Beckett AF II				86.0%
				BCL120SB2U2	1.00	140/119					85.1%
FRONT FLUE MODEL	41	22	51½	BFL90-2	0.75	105/88	83.8%				
				BFL90-2							
				BFL90-2							
				BFL90T2							
				BFL100-2	0.85	119/100	83.6%				
				BFL100-2							
				BFL100-2							
				BFL100T2							
				BFL120-2	1.00	140/114	83.0%				
				BFL120-2							
				BFL120-2							
				BFL120T2							
				BFL130-2	1.00	154/128	82.4%				
				BFL130-2							
				BFL130T2							
				BFL145-2	1.20	168/139	81.8%				
				BFL145-2							
				BFL145ST2							
				BFL145NX2	1.20	168/139	Chimney Vented with Beckett NX	83.1%			
				BFL145NX2							
				BFL145TNX2							
				BFL90RF-2	0.75	105/90	Chimney Vented with Riello F		85.6%		
				BFL100RF2	0.85	119/102			85.3%		
				BFL90B2U2	0.75	105/90					86.4%
				BFL100B2U2	0.85	119/101	Direct Vented with Beckett AF II				85.4%
				BFL120B2U2	1.00	140/117					83.7%

Fuel fired furnace

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 22 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

GREEN TINTED AREA indicates models sold in Canada only. **BOLD TYPE** indicates factory equipped firing rate. Other firing rates shown utilize field supplied nozzles. T = Thermal Efficiency

Fuel fired furnace

AVAILABLE MOTOR DRIVES			AC RANGE IN TONS BASED ON 400 CFM PER TON AIR FLOW @ 0.50" W.C. (CFM RANGE)	COOLING COILS SELECTION
ECM (V) VARIBLE FAN SPEED	PSC DIRECT DRIVE	PSC BELT DRIVE		
		1/3 HP		**BCL 90 to 145 Cased Cooling Coils** 2 ton CC24A3G-220R-066 2.5 ton CC30C3G-220R-066 3 ton CC36B3G-220R-066 3.5 ton CC42C3G-220R-066 4 ton CC48B3G-220R-066 5 ton CC60D3G-260R-066
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/3 HP		
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/3 HP		
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP		3 to 4 tons (1000 - 1600)	
	1 HP		3 to 5 tons (1300 - 2000)	
		3/4 HP	3 to 4 tons (1300 - 1550)	**BCL 170 to 225 Cased Cooling Coil** 3 to 4 ton N/A 5 ton CC60D3G-260R-066
		3/4 HP		
		1 HP	3 to 5 tons (1600 - 2200)	
		1 HP		
	1/2 HP		3 to 4 tons (1000 - 1600)	**BCL 90 to 120 Cased Cooling Coils** 2 ton CC24A3G-220R-066 3 ton CC36B3G-220R-066 3.5 ton CC42C3G-220R-066
		1/3 HP		**BFL Cased Cooling Coils** 2 ton CC24A3G-220R-066 2.5 ton CC30C3G-220R-066 3 ton CC36B3G-220R-066 3.5 ton CC42C3G-220R-066 4 ton CC48B3G-220R-066 5 ton CC60D3G-260R-066
		1/2 HP	3 to 4 tons (1000 -1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/3 HP		
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/3 HP		
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/2 HP	3 to 4 tons (1000 - 1600)	
	1/2 HP			
	1 HP		3 to 5 tons (1300 - 2000)	
		1/2 HP	3 to 5 tons (1300 - 2000)	
	1/2 HP			
	1 HP			
	1/2 HP		3 to 4 tons (1000 -1600)	

Ratings and specifications are subject to change without notice.

Common Features:

All Olsen Oil Furnaces:

- **Heat Exchanger –** Proven heat exchanger design featuring 100% welded construction for maximum performance. Large accessible clean out ports.
- **Radiator –** "Wrap-around" style for maximum heat transfer.
- **Insulation –** Spun glass and aluminum foil for "hand-cool" cabinet.
- **Burner –** Equipped with industry leading Beckett or Riello oil burners which include oil solenoid valve, PSC motor and solid state controls. Factory assembled, wired and tested. Ready to connect to fuel line.
- **Barometric Draft Control –** Included with all chimney vent models.
- **Blower –** Direct drive or belt drive type. Permanently lubricated, resilient mounted.
- **Blower Assembly –** Entire unit can be easily removed for servicing.
- **Filter Racks & Washable Air Filters –** Included with all models.
- **Alternate firing rates** to fit a wide variety of applications (alternate nozzles are field supplied).

Made in North America, Dunkirk, NY Plant.

Additional Features:

Fuel fired furnace

BCL/BCL-S/BFL Lowboy Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP direct drive models. Three-speed is standard with 1 HP direct drive models. Single speed with adjustable motor pulley is standard with belt drive models.
- **Controls –** (UTEC) Electronic fan timer is standard on all 1/3 HP and 1/2 HP models. (Honeywell or White Rodgers) Fan and limit control is standard on all 3/4 HP and 1 HP models.
- **Air conditioning –** Fan timer control is AC ready. Prewired fan center relay is standard on fan and limit equipped models with 1 HP direct drive blower.
- **Direct Vent Models –** Include Beckett AFII-150 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

BML/BMLV Compact Lowboy Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor (BML Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with ½ HP direct drive models. Single speed with adjustable motor pulley is standard with belt drive models.
- **ECM Variable Speed Blower Motor (BMLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 or Riello 40BF3 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

HML/HMLV/HTL/HTLV Highboy Upflow Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor (HML/HTL Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP direct drive models.
- **ECM Variable Speed Blower Motor (HMLV/HTLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 or Riello 40BF3 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

WML/WMLV/MPL Highboy Downflow/Horizontal Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. WML/WMLV models may be factory equipped with vestibule compartment to enclose burner & controls. Vestibule compartment for WML/WMLV also available as an after-market kit for non-factory equipped units.
- **PSC Blower Motor (WML/MPL Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP (WML) and 3/4 HP (MPL) direct drive models.
- **ECM Variable Speed Blower Motor (WMLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 (WML/WMLV) or Beckett AFII-150 (MPL) or Riello 40BF3 (WML) oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

model is to be as specified on the plan.
Highboy.

Olsen Oil-Fired Furnace

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 07 juillet 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Olsen
Heating & Cooling Products

oil furnaces

keeping families warm for more than 60 years

Reliable, Efficient Home Heating:

- Variable Speed Technology
- Easy Installation & Maintenance
- Optional Cooling Up to 5 Tons

Lowboy

BCL, BFL, BML, BMLV
59,000 - 237,000 BTU

Highboy

HML, HMLV, HTL, HTLV
59,000 - 113,000 BTU

Multiposition

WML, WMLV, MPL
59,000 - 128,000 BTU

Olsen Home Heating Economics 101

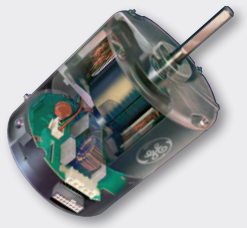
Olsen Oil-Fired Furnace

An oil furnace uses two energy sources, oil to produce heat and electricity to power the fan motor but there's more to consider than just that.

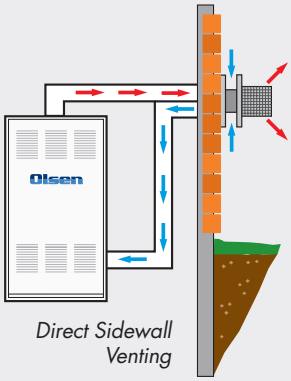
FEATURE:	BENEFIT:	ADDITIONAL BENEFITS:
OIL COSTS		
Higher Olsen AFUE Ratings (Annual Fuel Utilization Efficiency)	= Lower Fuel Costs	+ Bonus Cash Back (Through energy efficiency rebates).*
ELECTRICITY COSTS		
Olsen Variable Speed Technology An oil furnace with an ECM (Electronically Commutated Motor) can reduce electricity consumption up to †80%.	= Lower Electric Costs	+ Bonus Cash Back (Through energy efficiency rebates).*
OTHER COSTS AND CONSIDERATIONS		
DIRECTVENT SIDEWALL **Olsen Direct Sidewall Venting** As homes age, the chimney can become costly to maintain or repair.	– Eliminates Chimney Costs + Increases Combustion Efficiency	Requires only one wall opening, an Olsen Direct Sidewall Vent Kit (includes all connections from the furnace) and an Olsen concentric vent. (The Olsen vent terminal utilizes a two-pipe combustion air/exhaust gas configuration. Outside air is used for combustion resulting in greater efficiency and safety. The burner provides the necessary pressure for venting of flue products – no additional motors or controls are needed).
Superior Heat Exchanger Design	+ Delivers Higher AFUE	Double Pass Heat Exchanger (Heavy-gauge construction and large surface area maximize heat transfer) Dual Clean Outs (Provide easy access for quick, efficient routine maintenance)
Service & Maintenance Equipped for easy service and maintenance.	= Lower Costs of Good Design	Features like the slide out blower tray on high-boy models provide technicians easy access to critical components. Full length rails eliminate annoying/time consuming remounting of blower and motor housings, saving time and money on service.
Quiet Operation	= Better Quality Comfort	Most high-boy and low-boy Olsen furnaces come standard with a vestibule which provides sound attenuation, reducing operating noise. The vestibule also provides added protection for the burner.
Warranty & Peace of Mind Olsen furnaces are designed to provide years of trouble-free operation.	+ Limited Lifetime Warranty (Heat Exchanger), 5 Years Parts	

**(Check with your local government agencies and/or utilities regarding the availability of rebates and incentives).*
†Individual savings may vary.

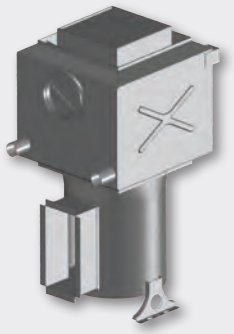
Calculate Your Savings



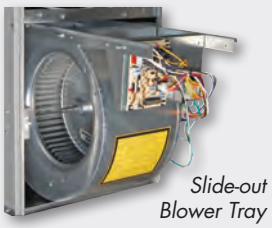
ECM Fan Motor



Direct Sidewall Venting



Superior Heat Exchanger



Slide-out Blower Tray

HIGHBOY MODELS

Olsen Oil-Fired Furnace

BREECH	FURNACE DIMENSIONS (INCHES) HEIGHT	WIDTH	DEPTH	MODEL	FIRING RATE GPH	INPUT/ OUTPUT MBH[1]	AFUE EFFICIENCY % RATING — CHIMNEY VENT BECKETT	BECKETT NX	RIELLO F	DIRECT VENT BECKETT AFII	RIELLO BF
FRONT FLUE MODEL	49⅝	22	30¾	HML60C2	0.50	70/59	83.1%				
				HMLV60C2							
				HML80C2	0.65	91/76	83.3%				
				HMLV80C2							
				HML90C2	0.75	105/85	81.5%				
				HMLV90C2							
				HML100C2	0.85	119/96	79.1%				
				HMLV100C2							
				HML60CNX2	0.50	70/60		86.4%			
				HMLV60CNX2							
				HML80CNX2	0.65	91/76	Chimney	85.7%			
				HMLV80CNX2			Vented with				
				HML90CNX2	0.75	105/88	Beckett NX	84.3%			
				HMLV90CNX2							
				HML100CNX2	0.85	119/98		83.4%			
				HMLV100CNX2							
				HML60CRF2	0.50	70/60			86.3%		
				HMLV60CRF2							
				HML80CRF2	0.65	91/77	Chimney Vented		85.2%		
				HMLV80CRF2			with Riello F				
				HML90CRF2	0.75	105/87			83.2%		
				HMLV90CRF2							
				HML60CB2U2	0.55	77/65				84.6%	
				HMLV60CB2U2							
				HML80CB2U2	0.65	91/77	Direct Vented with Beckett AF II			83.9%	
				HMLV80CB2U2							
				HML90CB2U2	0.75	105/88				83.3%	
				HMLV90CB2U2							
				HML60CRBU2	0.50	70/61					86.7%
				HMLV60CRBU2							
				HML80CRBU2	0.65	91/77	Direct Vented with Riello BF				85.4%
				HMLV80CRBU2							
				HML90CRBU2	0.75	105/88					84.5%
				HMLV90CRBU2							
	58	22	30¾	HTL90D2	0.75	105/84	83.4%				
				HTL100D2	0.85	119/101	84.0%				
				HTL120D2	1.00	140/117	83.0%				
				HTL90DRF2	0.75	105/91			86.5%		
				HTLV90DRF2							
				HTL100DRF2	0.85	119/102	Chimney Vented		85.3%		
				HTLV100DRF2			with Riello F				
				HTL115DRF2	0.95	133/113			84.1%		
				HTLV115DRF2							

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 8 July 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

GREEN TINTED AREA indicates models sold in Canada only. **BOLD TYPE** indicates factory equipped firing rate. Other firing rates shown utilize field supplied nozzles.

AVAILABLE MOTOR DRIVES			AC RANGE IN TONS BASED ON 400 CFM PER TON AIR FLOW @ 0.50" W.C. (CFM RANGE)	COOLING COILS SELECTION
ECM (V) VARIBLE FAN SPEED	PSC DIRECT DRIVE	PSC BELT DRIVE		
(V) 1/2 HP ECM motor 600 – 1200 cfm @ 0.5" w.c.	½ HP		2 to 3.5 Tons (690-1500)	**HML& HMLV Cased Cooling Coils** 2 ton CC24A3G-220R-066 2.5 ton CC30C3G-220R-066 3 ton CC36B3G-220R-066 3.5 ton CC42C3G-220R-066
(V) 1/2 HP ECM motor 600 – 1200 cfm @ 0.5" w.c.	½ HP		2 to 3.5 Tons (650-1400)	**HTL & HTLV Cased Cooling Coils** 2 ton CC24A3G-220R-066 2.5 ton CC30C3G-220R-066 3 ton CC36B3G-220R-066 3.5 ton CC42C3G-220R-066

Ratings and specifications are subject to change without notice.

Common Features:

All Olsen Oil Furnaces:

- **Heat Exchanger –** Proven heat exchanger design featuring 100% welded construction for maximum performance. Large accessible clean out ports.
- **Radiator –** "Wrap-around" style for maximum heat transfer.
- **Insulation –** Spun glass and aluminum foil for "hand-cool" cabinet.
- **Burner –** Equipped with industry leading Beckett or Riello oil burners which include oil solenoid valve, PSC motor and solid state controls. Factory assembled, wired and tested. Ready to connect to fuel line.
- **Barometric Draft Control –** Included with all chimney vent models.
- **Blower –** Direct drive or belt drive type. Permanently lubricated, resilient mounted.
- **Blower Assembly –** Entire unit can be easily removed for servicing.
- **Filter Racks & Washable Air Filters –** Included with all models.
- **Alternate firing rates** to fit a wide variety of applications (alternate nozzles are field supplied).

Made in North America, Dunkirk, NY Plant.

Additional Features:

Olsen Oil-Fired Furnace

BCL/BCL-S/BFL Lowboy Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP direct drive models. Three-speed is standard with 1 HP direct drive models. Single speed with adjustable motor pulley is standard with belt drive models.
- **Controls –** (UTEC) Electronic fan timer is standard on all 1/3 HP and 1/2 HP models. (Honeywell or White Rodgers) Fan and limit control is standard on all 3/4 HP and 1 HP models.
- **Air conditioning –** Fan timer control is AC ready. Prewired fan center relay is standard on fan and limit equipped models with 1 HP direct drive blower.
- **Direct Vent Models –** Include Beckett AFII-150 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

BML/BMLV Compact Lowboy Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor (BML Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with ½ HP direct drive models. Single speed with adjustable motor pulley is standard with belt drive models.
- **ECM Variable Speed Blower Motor (BMLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 or Riello 40BF3 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

HML/HMLV/HTL/HTLV Highboy Upflow Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. Access door easily removed to access enclosed burner & controls.
- **PSC Blower Motor (HML/HTL Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP direct drive models.
- **ECM Variable Speed Blower Motor (HMLV/HTLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 or Riello 40BF3 oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

WML/WMLV/MPL Highboy Downflow/Horizontal Models

- **Cabinet construction –** 22 gauge steel cabinet ensures strength and quiet operation. WML/WMLV models may be factory equipped with vestibule compartment to enclose burner & controls. Vestibule compartment for WML/WMLV also available as an after-market kit for non-factory equipped units.
- **PSC Blower Motor (WML/MPL Models) –** Designed for heavy duty continuous operation. Thermally protected. Four-speed is standard with 1/2 HP (WML) and 3/4 HP (MPL) direct drive models.
- **ECM Variable Speed Blower Motor (WMLV Models) –** Maximizes air conditioner efficiencies, reduces electrical operating costs and enhances comfort with programmed ramp up and ramp down operation. Available on 1/2 HP direct drive models.
- **Controls –** (UTEC) Electronic fan timer control is standard on all models.
- **Air conditioning –** Fan timer control is AC ready.
- **Direct Vent Models –** Include Beckett AFII-85 (WML/WMLV) or Beckett AFII-150 (MPL) or Riello 40BF3 (WML) oil burner with pressure switch system for proving airflow, intake air collar and vent adapter. Vent pipe kits sold separately.

Olsen Oil-Fired Furnace

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Morden National Sales
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Fax: 866-835-6667

PN 240009878 Rev. 4/14

Olsen Oil-Fired Furnace

Olsen
Heating & Cooling Products

Airco
Heating & Cooling Products

HML
(Up-Flow Model)
HMLV
(Up-Flow Model with ECM)
Series C
Oil Fired Warm Air Furnaces

INSTALLATION, OPERATION & MAINTENANCE MANUAL

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 8 July 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

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An ISO 9001-2008 Certified Company

C SA US

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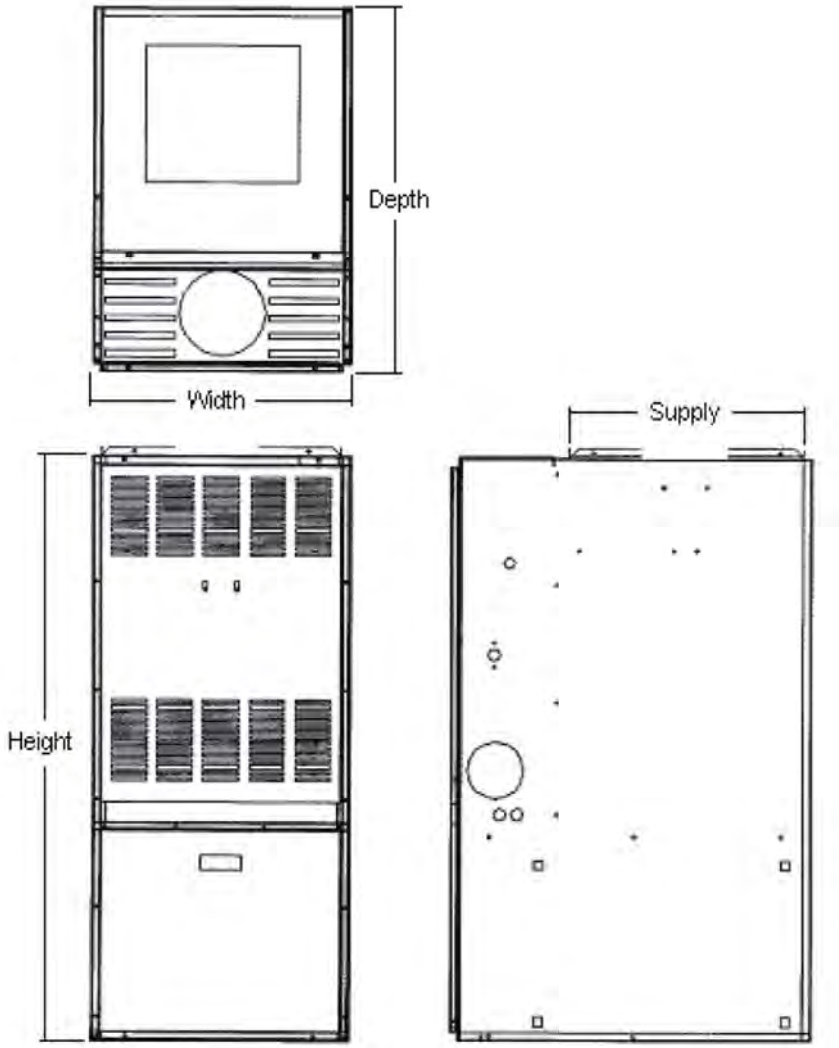
P/N# 30173, Rev. E [06/2013]

Dimensions



Furnace Model	Cabinet			Plenum Openings			Flue Diameter	Filter		Shipping Weight (LB)
	Width	Depth	Height	Supply	Return			Type	Size	
					Side	Bottom				
HML HMLV	22"	30¾"	49⅝"	20½"W x 20"D	14" x 22"	14" x 22"	5"	Permanent	16" x 25" x 1"	210 LB
	55.9 cm	78.1 cm	126.7 cm	52 cm x 52.8 cm	35.6 cm x 55.9 cm	35.6 cm x 55.9 cm	12.7 cm		40.6 cm x 63.5 cm x 2.5 cm	95.3 Kg

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Information and specifications outlined in this manual in effect at the time of printing of this manual. Manufacturer reserves the right to discontinue, change specifications or system design at any time without notice and without incurring any obligation, whatsoever.

1. General

Furnace installation shall be completed by qualified agency. See glossary for additional information.

⚠ WARNING

Fire, explosion, asphyxiation and electrical shock hazard. Improper installation could result in death or serious injury. Read this manual and understand all requirements before beginning installation.

⚠ WARNING

Fire, burn, asphyxiation hazard. Do not use gasoline, crank case oil, or any oil containing gasoline. Failure to follow these instructions could result in death or serious injury.

2. Safety Symbols

Become familiar with symbols identifying potential hazards.

This is the safety alert symbol. Symbol alerts you to potential personal injury hazards. Obey all safety messages following this symbol to avoid possible injury or death.

⚠ DANGER

Indicates a hazardous situation which, if not avoided, WILL result in death or serious injury

⚠ WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Used to address practices not related to personal injury.

3. Introduction Models HML And HMLV

Models HML and HMLV are oil fired forced air up-flow furnaces with an output capacity range of 59,000 btu/hr. To 96,000 btu/hr.

- HML models are equipped with 1/2 HP PSC 4 speed blower motor.
- HMLV models are equipped with 1/2 HP ECM variable speed blower motor.

Furnace models are either factory equipped for chimney venting or factory equipped for direct venting.

Chimney vent models and direct vent models are not field convertible. Direct vent installation instructions are included with the direct vent models.

Installation shall conform to requirements of authority having jurisdiction or in absence of such requirements:

- Canada - CAN/CSA - B139, Installation Code for Oil-Burning Equipment.
- United States - National Electrical Code, NFPA31, Standard for the Installation of Oil-Burning Equipment.

Models are CSA listed, (NRTL/C) for use with No. 1 (Stove) and No. 2 (Furnace) Oil.

Refer to tables in Appendix A for performance data.

4. Heat Loss

Maximum hourly heat loss for each heated space shall be calculated in accordance with the procedures described in the manuals of:

- Canada - The Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), or by other means prescribed, or approved by the local authority having jurisdiction.
- United States - Manual J. titled, "Load Calculation" published by the Air Conditioning Contractors of America, describes a suitable procedure for calculating maximum hourly heat loss.

5. Locating the Unit - [See Figure 1 and Table 1]

- Locate furnace so flue connection to chimney is short, direct and consists of as few elbows as possible.
- Centralize furnace location with respect to supply and return air ductwork. Central location minimizes trunk duct sizing.
- All models may be installed on combustible floors.

6. Furnace Used In Conjunction With Air Conditioning

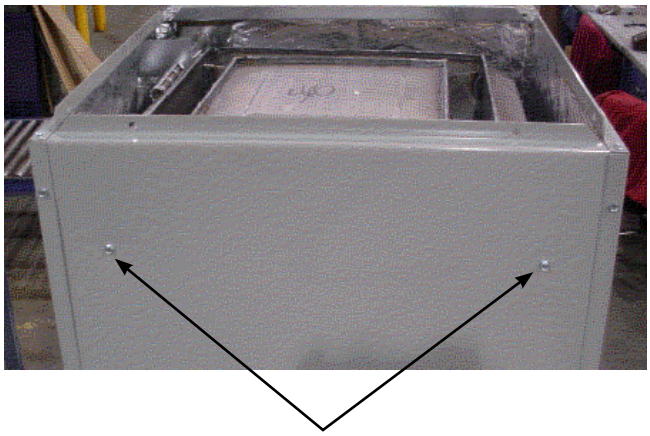
- Install furnace in parallel with or upstream from evaporator coil to avoid condensation in heat exchanger.
- When installed in parallel, prevent chilled air from entering furnace by use of dampers or air controlling.
- Manually operated dampers must have a control to prevent operation of either system unless dampers are in full heat or full cool position.
- Air heated by the furnace shall not pass through evaporator coil unless coil is specifically approved for such service.
- Check and adjust blower speed to compensate for pressure drop caused by evaporator coil.

Table 1: Minimum Installation Clearances

Location	Clearance to Combustibles
	HML and HMLV
	Up flow
Top	1" (26 mm)
Bottom	0"
S/A Plenum	1" (26 mm)
Rear	1" (26 mm)
Sides	1" (26 mm)
Front	1"** (26 mm)
Flue Pipe	9"* (229 mm)
Enclosure	Closet

*18 in. (458 mm) USA
** 24 in. (610 mm) Service Clearance

Figure 1 - Heat Exchanger Support Screw Location



Heat Exchanger Support Screws

- Remove heat exchanger support screws before final placement of the furnace.
- Preferable if furnace rear panel is inaccessible after installation.
- Screws must be removed if heat exchanger is to be removed from the cabinet.

7. Combustion Air

- Furnace installed in a closet or utility room, provide two openings connecting to well-ventilated space (full basement, living room or other room opening, not a bedroom or bathroom).
  A. One opening shall be located above level of upper vent opening.
  B. One opening below combustion air inlet opening in front of furnace.

  Each opening shall have a minimum free area of 1½ square inches per 1,000 Btu/h of total input rating of all appliances installed in the room.
- For furnaces located in buildings of unusually tight construction, such as those with high quality weather stripping, caulking, windows and doors, or storm sashed windows, or where basement windows are well sealed, a permanent opening communicating with a well ventilated attic or with the outdoors shall be provided, using a duct if necessary. The duct opening shall have a free area of 1½ square inches per 1,000 Btu/h of total input rating of all appliances to be installed.
- Furnace installed in a full basement, infiltration is normally adequate to provide air for combustion and draft operation.
- Furnace rooms under 65m³ (700 ft³) should automatically be treated as confined space.

8. Chimney Venting

- Flue pipe should be as short as possible with horizontal pipes sloping upward toward the chimney at a rate of one-quarter inch per foot.
- Flue pipe should not be smaller in cross sectional area than flue collar on the furnace.
- Flue pipe should connect to chimney so the flue pipe extends into, and terminates flush with the inside surface of chimney liner. Seal the joint between pipe and lining.
- Chimney outlet should be at least two feet above highest point of peaked roof.
- All unused chimney openings should be closed.
- Chimneys must conform to local, provincial or state codes, or in the absence of local regulations, to the requirements of the National Building Code.

NOTICE

This furnace is approved for use with Type L vent or equivalent.

⚠ WARNING

Asphyxiation hazard. Chimney vented versions of furnace must be connected to flue having sufficient draft at all times. Failure to follow these instructions could result in death or serious injury.

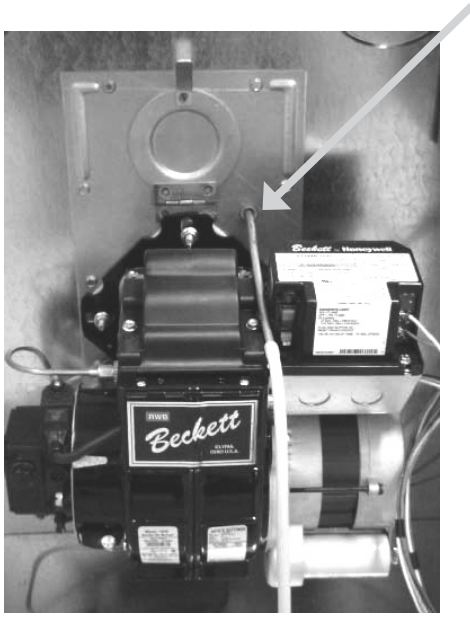
Manufacturer recommends overfire draft of -0.02 in. w.c. See figure 2.

Flue pipe must not pass through any floor or ceiling, may pass through a wall where suitable fire protection provisions have been installed.

- Refer to CAN/CSA B-139 for rules governing the installation of oil burning equipment.
- United States, refer to NFPA 31 for regulations governing the installation of oil burning equipment.

See appendix A for burner set-up.

Figure 2 - Check Over-Fire Draft



Over-fire draft access port.

9. Barometric Damper Control

Barometric damper control, also known as draft regulator, is used on conventional chimney venting only. Control automatically maintains constant negative pressure. Ensures proper pressures are not exceeded. If chimney does not develop sufficient draft, draft control does not function properly.

- Install draft regulator in same room or enclosure as furnace. Draft regulator should not interfere with combustion air supplied to the burner.
- Locate control near furnace flue outlet.
- Install per instructions supplied with regulator.
- Set overfire draft, measured at oil burner mounting plate over-fire draft access port, to -0.02 in. w.c. See Figure 2 page 6.

10. Optional Side Wall Venting

Certain HML and HMLV furnace models are manufactured as sidewall vented units. Refer to Direct Venting Instructions, P/N 240006979 included with Vent Kit for details.

Sidewall Venting (*Direct Venting*) requires use of specific oil burners; Beckett AFII, or Riello 40BF.

Refer to Appendix A, Tables A2, and A4.

11a. Fan Timer Board And Limit Control (HML) See Figure 3, page 15.

Electronic Fan Timer integrates control of burner and circulator fan operations. Control is central wiring point for most of furnace electrical components.

- United Technologies 1158-120 (HML) has an adjustable fan on time set by selecting dipswitch combination displayed in Chart 1. Fan on delay can be set at 30, 60, 90 or 120 seconds. Provides a delay between burner ignition and blower start-up to eliminate excessive flow of cold air when blower comes on.
- United Technologies 1158-120 (HML) has an adjustable fan off time of 2, 3, 4 or 6 minutes as displayed in Chart 1. Fan off delay time starts when burner motor is de-energized at end of call for heat. Blower shutdown is delayed to remove any residual heat from heat exchanger.
- Electronic fan timer board works in conjunction with snap disc limit controls, performing a safety function, and breaks power to oil burner primary control, shutting off burner if furnace over-heats.
- Limit control is thermally operated and automatically resets. Limit control is factory installed, pre-set and is not adjustable.
- If limit control opens with United Technologies 1158-120 (HML) electronic fan control**,** circulating fan will energize. When limit closes, fan off timer begins. At the end of fan off time cycle burner is energized, initiating normal burner cycle.

Chart 1- United Technologies 1158-120 (HML)

Dip Switch Position				Blower Delay Times	
1	2	3	4	On Seconds	Off Minutes
Off	Off			30	
On	Off			60	
Off	On			90	
On	On			120	
		Off	Off		2
		On	Off		3
		Off	On		4
		On	On		6

11b. Fan Timer Board And Limit Control (HMLV) [See Figure 4, page 15]

United Technologies 1168-1 ECM (HMLV) tap board has an adjustable fan on/off delay and airflow settings that must be adjusted in accordance with furnace input rating (nozzle size). Refer to Table A-9, page 17 for ECM blower set-up.

12. Electrical Connections

- Furnace is listed by Canadian Standards Association under NRTL (North American) Standard.
- All field wiring shall conform to CAN/CSA C22.1 Canadian Electrical Code, Part 1, and by local codes, where they prevail.
- United States, wiring shall conform to National Fire Protection Association NFPA-70, National Electrical Code, and with local codes and regulations.
- Wire furnace to separate dedicated circuit in main electrical panel.
- Suitably located circuit breaker can be used as service switch, separate service switch is advisable.
- Service switch is necessary if circuit breaker is close to the furnace, or furnace is located between circuit breaker and entry to furnace room.
- Clearly mark service switch. Install in accessible area between furnace and furnace room entry. Locate so as to reduce possibility it can be mistaken as light switch or similar device.
- Power requirement for HML and HMLV models is: 120 VAC, 1 Ø, 60 Hz., 12A.
- Accessory equipment such as electronic air cleaners and humidifiers may be included on furnace circuit.
- Accessories requiring 120 VAC power sources such as electronic air cleaners and humidifier transformers may be powered from electronic fan timer board where provisions have been made for connections, but should have their own controls.
- Do not use direct drive motor connections as a power source, there is risk of damaging accessories.

- Thermostat wiring connections are shown in wiring diagrams in Appendix B. Some micro-electronic thermostats require additional controls and wiring. Refer to thermostat manufacturer's instructions.
- Locate thermostat approximately 5 feet above floor, on inside wall, and where thermostat is exposed to average room temperatures. Avoid locations where thermostat is exposed to cold drafts, heat from nearby lamps and appliances, exposure to sunlight, heat from inside wall stacks, etc.
- Adjust thermostat heat anticipator to amperage draw of heating control circuit as measured at "R" and "W" terminals of thermostat. Do not measure current with thermostat connected to the circuit. Measure amperage by connecting ammeter between two wires which connect to thermostat "R" and "W" terminals.

13. Humidifier

- Humidifier is optional accessory available through most heating supplies outlets.
- Follow humidifier manufacturer's installation instructions
- Protect furnace heat exchanger from water or water droplets from humidifier.
- Do not use direct drive motor connections as source of power for 120 VAC humidifiers and humidifier transformers.

14. Piping Installation

- Install fuel system in accordance with requirements of CAN/CSA B-139, and local regulations.
- United States installation shall conform to NFPA No. 31 and local codes and authorities.
- Use only approved fuel oil tanks, piping, fittings and oil filter.
- Install oil filter as close to burner as possible.
- Refer to instructions and illustrations in oil burner and oil pump instructions shipped with the furnace.

15. Oil Filter

Install oil filter between fuel oil storage tank and oil burner. When using oil burner nozzle smaller than 0.65 U.S. Gallons Per Hour, install additional 7 to 10 micron filter as close as possible to oil burner.

16. Oil Burner Nozzles

Furnaces are certified for multiple firing rates. Furnace may be fired at ideal rate for wide range of structures by manipulating oil burner nozzle, flame retention head, and temperature rise. Refer to Table A-1 thru A-5, and furnace rating plate to determine proper combinations.

17. Oil Burner Adjustment

- Adjust burner air supply to maintain fuel to air ratio to obtain ideal combustion conditions.
- Lack of air causes "soft" and "sooty" flames, resulting in soot build-up throughout heat exchanger passages.
- Excess combustion air causes bright roaring fire and high stack temperatures resulting in poor fuel efficiency.
- HML and HMLV operate most efficiently with No. 1 smoke spot on Bacharach Scale. Dust will eventually build up on air moving components of oil burner assembly resulting in decreased air supply with potential soot build up in flue gas passageways of heat exchanger. Soot behaves as insulator and impairs good heat transfer. Stack temperature increases, and efficiency decreases. To avoid this problem, adjust the air supply to provide no more than trace smoke spot on Bacharach Scale.
- See Venting Instructions included in Vent Kits for set-up details for sidewall vented furnaces.

NOTICE

Set up sidewall vented models to deliver zero (0) smoke.

NOTICE

Before operating furnace check burner alignment with combustion chamber. End cone of air tube must be centred to accommodating ring of combustion chamber. Adjust as necessary.

18. Burner Electrodes

Correct positioning of electrode tips with respect to each other, fuel oil nozzle, and burners is essential for smooth light ups and proper operation.

Refer to oil burner instructions provided with furnace and Appendix A Section A.2 in this manual for electrode specifications.

NOTICE

Do not tamper with furnace controls they are sensitive. If problems persist, call your service contractor.

19. Burner Primary (Safety) Control

Furnace is equipped with primary combustion control, also referred to as burner relay or burner protector relay, which uses a cad cell located in burner housing, to monitor and control combustion.

Dust or combustion residuals can build up on lens of cad cell impairing its response to flame. Check cad cell for cleanliness and proper alignment if primary control frequently shuts down combustion.

20. Combustion Chamber

Furnace is equipped with cerafelt combustion chamber, held in place by a retaining bracket.

Check the alignment of the combustion chamber and oil burner before firing. It is possible for the combustion chamber to shift if subjected to rough handling during transit.

Inspect combustion chamber for damage or carbon build up whenever oil burner is removed for repairs or routine maintenance.

⚠ WARNING

Fire, burn, asphyxiation hazard. Do not start the burner unless blower access door is secured in place. Failure to follow these instructions could result in death or serious injury.

21a. CIRCULATING AIR BLOWER (HML)

- HML and HMLV furnace models are equipped with direct drive blower systems.
- HML models are equipped with PSC motors.
- HMLV models are equipped with electronically commutated motors (ECM).
- Direct drive blower speed adjustments are not normally required in properly sized extended plenum duct systems. Motor RPM and air CFM delivery will vary automatically to accommodate conditions within usual range of external static pressures typical of residential duct systems.
- Under-sized duct systems may require higher blower speed to obtain system temperature rise.
- Some older duct systems were not designed to provide static pressure. They typically feature special reducing fittings at each branch run and lack block ends on the trunk ducts. These systems may require modification to provide some resistance to the airflow to prevent over-amping of direct drive blower motor. Selecting a lower blower speed may correct this problem.
- Direct drive blower speeds are adjusted by changing "hot" wires to motor winding connections. Refer to wiring diagrams in Appendix B or wiring diagram label affixed to furnace.
- ***Do not move neutral wire (normally white wire) to adjust blower speed.***
- Single blower speed for both heating and cooling modes may be used. Use a "piggy-back connector" accommodating both wires on a single motor tap.
- It is also acceptable to connect selected motor speed with a pigtail joined to both heating and cooling speed wires with a wire nut.
- Safety precaution against accidental disconnection of wires by vibration, secure wire nut and wires with few wraps of electricians tape.
- ***Do not connect power leads between motor speeds. Always connect neutral wire to motor's designated neutral terminal.***
- If joining blower speed wiring is done in furnace junction box, tape off both ends of unused wire.
- ***Do not use blower speed wires as source of power to accessories as electronic air cleaners and humidifier transformers. Unused motor taps auto-generate sufficiently high voltages to damage accessory equipment.***

⚠ WARNING

Electrical shock hazard. Turn OFF electrical power supply at service panel before opening blower access door. Failure to do so could result in death or serious injury.

21b. Circulating Air Blower (HMLV)

HMLV furnace models are equipped with electronically commutated motors (ECM).

Setting Blower Speed and "ON" and "OFF" Timings

Blower speed and on/off time delays are handled by ECM motor programming and are set via dipswitches per Table A-9 on page 17. Heating airflow rate is SW1 and on/off delay is SW4, both are set according to firing rate. Cooling airflow rate is SW2 and if used is set according to installed cooling capacity. SW3 can be used to adjust airflow rate by (+) or (-) 15%. Features of this ECM variable speed motor are that it will deliver a constant airflow within a wide range of external static pressures, and also includes:

- **Soft Start:** ECM will slowly ramp up to required operating speed. In heating cycle allows heat exchanger to reach operating temperature before set heat speed, minimizes noise and increases comfort.
- **Soft Stop:** At end of heating cycle, ECM will slowly ramp down. Allows increased energy efficiency and reduced noise levels.
- **Dehumidification:** Dehumidification feature is programmed into the variable speed motor. At start of each cooling cycle, variable speed motor will run at 82% of rated airflow for 7.5 minutes. After 7.5 minutes has elapsed, motor will increase to 100% of rated airflow. Used to provide dehumidification and improve system efficiency.
- **Continuous Fan Operation:** When thermostat continuous fan (G) switch is on without call for heating or cooling, indoor fan is immediately energized up to 50% of cooling speed. Allows continuous circulation of air between calls for heating or cooling. If call for heat (W) or cool (Y) occurs during continuous fan, blower remains energized.

22. Maintenance And Service

Routine Maintenance By Home Owner

- Arrange for professional servicing of furnace by the service or installation contractor annually.
- Homeowner is to maintain air filter or filters. A dirty filter can cause furnace to over-heat, fail to maintain indoor temperature during cold weather, increase fuel consumption and cause component failure.
- Inspect, clean or replace filter monthly.
- Furnace is supplied with semi-permanent type filter. If filter is damaged, replace with filters of same size and type.
- During monthly filter inspection, inspect general condition of furnace. Watch for signs of oil leaks in vicinity of oil burner, soot forming on any external part of furnace, soot forming around joints in vent pipe, etc. If any of these conditions are present, please advise your service or installation contractor.

Annual Service By Contractor

NOTICE

Combustion chamber (firepot) is fragile. Use care when inspecting and cleaning this area

- Inspect heat exchanger periodically and clean if necessary.

⚠WARNING

Electrical shock hazard. Turn OFF electrical power supply at service panel before service or maintenance Failure to do so could result in death or serious injury.

- If cleaning is necessary, shut off oil supply, shut off power to the furnace and remove burner.
- Use stiff brush with wire handle, brush off scale and soot from inside drum and flue pipe.
- Clean radiator, remove clean-out cap screws. Remove caps carefully to avoid tearing gaskets.
- Wire brush can be used to loosen dirt and debris on the inside surfaces of radiator. Clean out all accumulated dirt, soot and debris with a wire handled brush and an industrial vacuum cleaner.
- Before replacing clean-out caps, inspect gaskets. If gaskets are broken, remove remnants and replace with new gaskets.
- Blower motor is factory oiled and permanently sealed. ***Do not lubricate.*** Excess oil causes premature electric motor failure.
- Inspect blower fan. Clean if necessary.
- Oil Burner Maintenance: Follow oil burner manufacturer instructions.
- Change oil burner nozzle and oil filter annually.
- Clean and inspect venting system for signs of deterioration. Replace pitted or perforated vent pipe and fittings.
- Barometric damper should open and close freely.
- Check electrical connections to ensure tight connections. Safety controls such as the high limit controls should be tested for functionality.
- Check fan control to ensure fan on and off delay function continues to start and stop blower fan at optimal settings.

⚠ WARNING

Fire, burn, explosion, asphyxiation hazard.

- Do not start burner when excess oil has accumulated, furnace is full of vapor, or combustion chamber is very hot.
- Do not burn garbage or paper in furnace.
- Do not leave paper or rags around furnace.

Failure to follow these instructions could result in death or serious injury.

23. OPERATING INSTRUCTIONS (HML)

Before Lighting

1. Open all supply and return air registers and grilles.
2. Open all valves in oil pipes.
3. Turn on electric power supply

To Light Unit

1. Set thermostat above room temperature to call for heat. Burner should start. It may be necessary to press RESET button on primary combustion control relay.
2. There is a fan on time delay before circulating fan is energized. United Technologies 1158-120 has adjustable fan on time set by selecting dipswitch combination displayed in Chart 1. Fan on delay can be set at 30, 60, 90 or 120 seconds.
3. Set the thermostat below room temperature. Oil burner stops.
4. Air circulation blower continues to operate until time off setting selected on electronic fan timer control times out. United Technologies 1158-120 has adjustable fan off time of 2, 3, 4 or 6 minutes. Fan timer control adjustments may be altered if air at room registers is high upon blower start up or shutdown.
5. Restore thermostat setting to comfortable temperature.

To Shut Down Unit

1. Set thermostat to lowest possible setting.
2. Set manual switch (if installed) in electrical power supply line to "OFF".

24. Operating Instructions (HMLV)

Before Lighting

1. Open all supply and return air registers and grilles.
2. Open all valves in oil pipes.
3. Turn on electric power supply.

To Light Unit

1. Set thermostat above room temperature to call for heat. Burner should start. It may be necessary to press RESET button on primary combustion control relay.
2. There is a fan on time delay before circulating fan is energized. United Technologies 1168-1 has adjustable fan on/off time delay programmed into ECM motor, and is set by selecting SW4 DIP switch combination displayed in Table A-9 page 17. Adjust Fan on/off delay according to input (nozzle size).
3. Set thermostat below room temperature. Oil burner stops.
4. Air circulation blower continues to operate until blower off delay setting programmed into ECM motor times out.
5. Restore thermostat setting to comfortable temperature.

NOTICE

If furnace is to be shut down for extended period of time, close oil supply valve to burner.

Check out and adjustments

HML and HMLV furnaces may be used with following oil burners.

Beckett AF, Beckett NX and Riello 40F oil burners are for applications using indoor air for combustion only.

Sidewall venting applications utilizing outdoor air for combustion, use Beckett AFII or Riello 40BF (Balanced Flue) oil burners only.

Table A-1 Beckett AF Oil Burner Set-Up

Beckett AF Series Oil Burners (For use with chimney vented units only)							
Furnace Model	**Output BTU/Hr**	**Burner Model**	**Delavan Nozzle**	**Pump Pressure**	**Flow Rate**	**Head [1]**	**Static Plate**
HML60C2 [2] HMLV60C2[2]	59,000	AF76BNHS	0.50 / 80°A	100 PSIG	0.50 USGPH	F3	3- ⅜ in.
HML80C2 HMLV80C2	76,000	AF76BNHS	0.65 / 80°A	100 PSIG	0.65 USGPH	F3	3- ⅜ in.
HML90C2[3] HMLV90C2[3]	85,000	AF76BNHS	0.75 / 80°A	100 PSIG	0.75 USGPH	F3	3- ⅜ in.
HML100C2[3] HMLV100C2[3]	96,000	AF76BNHS	0.85 / 70°A	100 PSIG	0.85 USGPH	F3	3- ⅜ in.

[1] Head is shielded by ceramic insulator.

[2] Low Firing Rate Baffle required when using 0.50-gallon nozzle.

[3] These models do not meet U.S. government requirements for minimum efficiency. They are intended for Canada only.

Table A-2 Beckett AFII Oil Burner Set-Up

Beckett AFII Series Oil Burners (For use with sidewall vented units with outdoor combustion air)						
Furnace Model	**Output BTU/Hr**	**Burner Model**	**Delavan Nozzle**	**Pump Pressure**	**Flow Rate**	**Head**
HML60CB2U2 HMLV60CB2U2	65,000	AFII-85	0.50 / 60°A	145 PSIG	0.55 USGPH	FB0
HML80CB2U2 HMLV-80CB2U2	77,000	AFII-85	0.60 / 60°A	115 PSIG	0.65 USGPH	FB3
HML90CB2U2 HMLV90CB2U2	88,000	AFII-85	0.70 / 60°A	115 PSIG	0.75 USGPH	FB3

Table A-3 Riello 40F Series Oil Burner Set-Up

Riello 40F Series Oil Burners (For use with chimney vented units)							
Furnace Model	**Output BTU/Hr**	**Burner Model**	**Delavan Nozzle**	**Pump Pressure**	**Flow Rate**	**Air Gate**	**Turbulator Setting**
HML60CRF2 HMLV60CRF2	60,000	40F3	0.50 / 60°W	105 PSIG	0.50 USGPH	2.6	1.0
HML80CRF2 HMLV80CRF2	77,000	40F3	0.60 / 60°W	115 PSIG	0.65 USGPH	2.6	1.5
HML90CRF2 HMLV90CRF2	87,000	40F3	0.65 / 60°W	135 PSIG	0.75 USGPH	3.6	2.0

Table A-4 Riello Balanced Flue (40BF) Burner Set-Up

Riello 40BF Balanced Flue Series Oil Burners (For use with sidewall vented units using outdoor combustion air)						
Furnace Model	**Output BTU/Hr**	**Burner Model**	**Delavan Nozzle**	**Pump Pressure**	**Flow Rate**	**Turbulator Setting**
HML60CRBU2 HMLV60CRBU2	61,000	40BF3	0.50 / 60°W	105 PSIG	0.50 USGPH	1.0
HML80CRBU2 HMLV80CRBU2	77,000	40BF3	0.60 / 60°W	115 PSIG	0.65 USGPH	1.5
HML90CRBU2 HMLV90CRBU2	88,000	40BF3	0.65 / 60°W	135 PSIG	0.75 USGPH	2.0

NOTE: Air gate setting may vary for sidewall vented units where air gate must be adjusted to achieve zero smoke.

Table A-5 Beckett NX Oil Burner Set-Up

Beckett NX Series Oil Burners (For use with chimney vented units)							
Furnace Model	**Output BTU/Hr**	**Burner Model**	**Delavan Nozzle**	**Pump Pressure**	**Flow Rate**	**Retention Head**	**Air Setting**
HML60CNX2 HMLV60CNX2	60,000	NX70LHSS	0.40 / 70°W	150 PSIG	0.50 USGPH	6-Slot	2.00
HML80CNX2 HMLV80CNX2	76,000	NX70LHSS	0.55 / 60°W	140 PSIG	0.65 USGPH	6-Slot	3.50
HML90CNX2 HMLV90CNX2	88,000	NX70LHSS	0.65 / 60°W	140 PSIG	0.75 USGPH	6-Slot	4.00
HML100CNX2 HMLV100CNX2	98,000	NX70LHSS	0.75 / 60°W	140 PSIG	0.85 USGPH	6-Slot	4.25

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 8 July 2016

Reviewed ☒

Reviewed as noted ☐

Resubmit ☐

CHIARELLI ENGINEERING LTD.

A.1 OIL BURNER AIR ADJUSTMENT

Consult oil burner instructions provided in furnace documents envelope for specific information concerning burner adjustments, operation and troubleshooting.

Beckett AF Burner (Chimney Vent)

Adjust air shutter by loosening locking screws. Moving air shutter, and if necessary, bulk air band.

Beckett AFII Burner (Direct Vent)

Adjust burner air supply. Loosen locking screw located on black dial to right of burner. Turn black dial clockwise to increase combustion air and counter-clockwise to decrease combustion air. Re-tighten locking screw after obtaining proper setting.

Beckett NX Burner (Chimney Vent)

Turn adjusting screw to setting 1/2 number higher than proper set point, turn adjusting screw counter clockwise to proper setting.

Riello 40F3 Burner (Chimney Vent)

Combustion air is adjusted by removing burner cover. Loosen screws that secure air adjustment plate. Move adjusting plate to either increase or decrease combustion air. When proper air setting is achieved, retighten fixing screws.

Riello 40BF3 Burner (Direct Vent)

Combustion air can be adjusted with burner cover on. Remove plastic cover on top right hand side of burner cover. With phillips head screw driver, turn adjustment screw clockwise to increase combustion air or counter-clockwise to decrease combustion air. When combustion air is set, re-insert plastic cover.

A.2 Burner Electrodes

Adjustment of electrode tips with respect to each other, nozzle, burner head is very important to ensure smooth start-ups and to permit efficient combustion.

Beckett AF and AFII Burners

- Electrode gap: 5/32 inch.
- Distance above horizontal center-line: 5/16 inch. Older instruction sheets specify 7/16 inch. Current specification is 5/16 inch.
- Distance ahead of nozzle: 1/16 inch.
- “Z” dimension, distance from front of end cone (head) to face of nozzle should be 1-1/8 inches. If ceramic head is used, distance from end cone to nozzle face is increased to 1-3/8 inches.

Beckett NX Burners

- Electrode gap: 5/32 inch
- Distance above horizontal centerline: 1/4 inch
- Distance ahead of nozzle: 3/32 inch
- Check /adjust zero calibration per Beckett NX Oil Burner Manual supplied with furnace.

Riello 40F, & BF Burners

- Electrode gap: 5/32 inch.
- Distance above horizontal center-line: 13/64 inch.
- Distance ahead of nozzle: 5/64 to 7/64 inch.

A.3 Start Up

Use following instructions to set the burner:

1. Shut off electrical power to the furnace.
2. Install oil pressure gauge to pressure port on oil pump. (Refer to oil pump specification sheet included with burner instructions).
3. Restore electrical power to furnace.
4. Start furnace and bleed all air from fuel oil lines.
5. Close purge valve and fire the unit.
6. Allow furnace to warm up to normal operating temperatures. During this time, set pump pressure in accordance with data provided in Appendix A, Table A-1 thru A-4.
7. ***Chimney vented units*** - Drill 1/4" test port in venting between furnace flue outlet and draft regulator (barometric damper) to take smoke readings.
8. ***Sidewall vented units*** - Do not drill. Use test port in the supplied appliance connector to take smoke readings.
9. When furnace has reached "*steady state*" (after approximately 10 minutes). Set combustion air damper to get TRACE of smoke for chimney vented units and ZERO smoke for sidewall vented units.
10. Check system temperature rise. *Temperature rise is the difference between return air temperature measured at a point near return air inlet, and supply air temperature measured near furnace outlet*.

    System temperature rise is listed on furnace rating plate. If temperature rise is too high, airflow must be increased. If temperature rise is too low, slow fan down.
11. After air adjustments have been completed, recheck the overfire draft at test port on burner mounting plate shown in Figure 2. Overfire draft should be adjusted to -0.02 inches w.c.
12. Turn burner off. Observe duct thermometer in supply air stream, note temperature blower fan stops. Fan adjustments can be made by moving dipswitch settings on timer control board for fan off delay.

13. Check operation of limit switch.

A. Shut off power to furnace.

B. Temporarily remove neutral wire from PSC blower motor or remove 5 pin power connector from ECM blower motor. Isolate AC line voltage pins on 5 pin power connector with electrical tape to prevent electric shock hazard.

C. Restore electrical power to furnace.

D. Set thermostat above room temperature.

E. After three or four minutes of burner operation, limit control should turn burner off.

F. When limit function test is complete, shut off electrical power to furnace, replace neutral wire to PSC blower motor or 5 pin power connector to ECM blower motor. Restore power.

G. Blower fan will start up immediately. Once temperature has dropped and limit control has reset, fan will operate until fan off time is reached.

H. Oil burner will resume operation and continue until thermostat is satisfied.

I. Restore thermostat setting to comfortable temperature.

14. Set heat anticipator adjustment in thermostat (if so equipped), by removing "R" or "W" wire to thermostat. Read amperage draw between the two wires. Failure to remove one of the wires from thermostat while performing this test could burn out heat anticipator. Set heat anticipator to amperage measured.

15. Run furnace through at least three full cycles before leaving the installation, to ensure all controls are operating properly.

16. Check all joints in any positive pressure venting system for leaks before leaving the installation site

A.4 Special Instructions For Units Equipped With Riello Burners

Riello specifications are listed in Tables A-3 and A-4. Consult Riello Installation Instructions supplied with Burner for specific information concerning burner adjustments, operation, and trouble-shooting.

A.5 Final Check Out

Verify all safety devices and electrical components have been set for normal operation.

Verify all electrical connections are tight and wiring is secure.

Verify homeowner is informed and understands:

Where circuit breaker or fuse is located in main electrical panel.

Where furnace switch is located, and switch "on" and "off" positions if not obvious.

Where oil shut-off valve from oil storage tank is located.

Thermostat operation, and other related accessories.

How to operate manual reset button on primary control, and when not to push the reset button.

How and where to visually inspect venting system for leaks or other problems.

How to inspect, clean and replace air filter, and other homeowner maintenance procedures.

Who to call for emergency service and routine annual service.

FIGURE 3: UNITED TECHNOLOGIES 1158-120 FAN TIMER BOARD (HML)

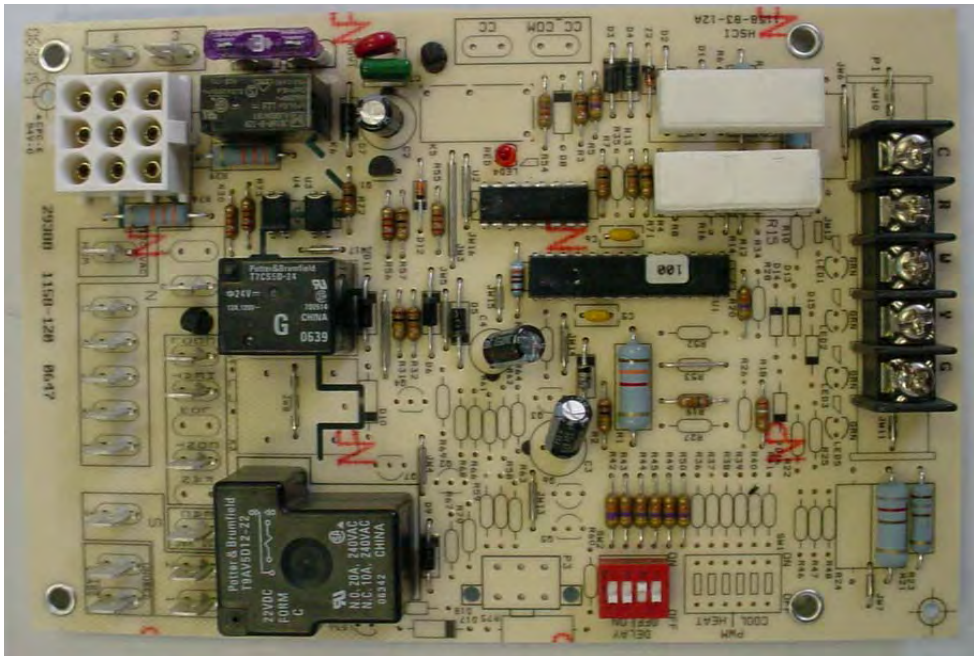


FIGURE 4: UNITED TECHNOLOGIES 1168-1 ECM TAP BOARD (HMLV)

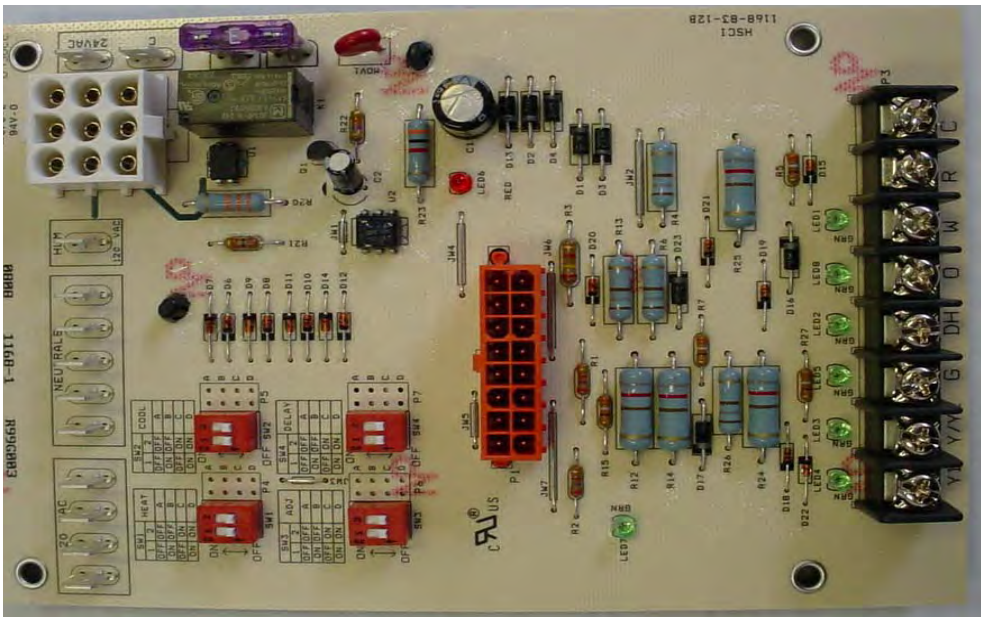


Table A-6 Direct Drive Blower Set-Up PSC Motor

Furnace Model	Blower	Blower Set-Up				Cooling Capacity		
		0.20 in. w.c.		0.50 in. w.c.		Tons	Power	CFM Range
		Speed	Motor	Speed	Motor			
HML-60	100-10T DD	Low	1/2 HP	Med-Low	1/2 HP	3	1/2 HP	690 – 1500
HML-80	100-10T DD	Med-Low	1/2 HP	Med-High	1/2 HP	3	1/2 HP	690 – 1500
HML-90	100-10T DD	Med-High	1/2 HP	High	1/2 HP	3	1/2 HP	690 – 1500
HML-100	100-10T DD	Med-High	1/2 HP	High	1/2 HP	3	1/2 HP	690 – 1500

Table A-7 Direct Drive Blower Characteristics PSC Motor

Furnace Model	Blower	Motor HP	Motor FLA	ΔT	Speed	CFM				
						External Static Pressure – Inches w.c.				
						0.20	0.30	0.40	0.50	0.60
HML 60 – 100	100-10T DD	1/2 HP	7.0	60°F	High	1741	1651	1556	1476	1369
					Med-High	1557	1497	1434	1369	1278
					Med-Low	1063	1051	1037	1037	1011
					Low	697	697	687	672	646

Table A-8 Direct Drive Blower Characteristics ECM Motor

Furnace Model	Blower	Motor HP	Motor FLA	ΔT	CFM RANGE		
					Continuous Fan	Heating	Cooling
						0.38 - 0.48 inches w.c.	0.5 inches w.c.
HMLV 60 – 100	100-10T DD	1/2 HP ECM	7.7	60°F	445 - 605	625 - 1500	600 - 1200

TIP

Formulas will assist with design of duct-work and determination of air flow delivery.

CFM = Bonnet Output / (1.085 x System Temperature Rise (ΔT)

System Temperature Rise (ΔT) = Bonnet Output / (1.085 x CFM)

Table A-9 ECM Blower Set-Up (HMLV)

Dip Switch Adjustment Chart

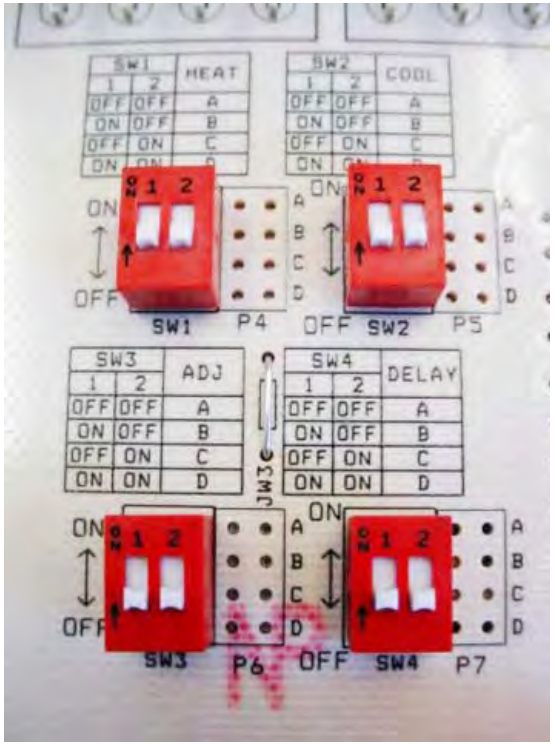
For Input 0.50 USGPH TO 0.85 USGPH

SW1 - HEAT DIP Switch Position 1	SW1 - HEAT DIP Switch Position 2	POS.	INPUT USGPH
OFF	OFF	A	0.65
ON	OFF	B	0.85
OFF	ON	C	0.75
ON	ON	D	0.50

SW2 - COOL DIP Switch Position 1	SW2 - COOL DIP Switch Position 2	POS.	AC Size (TON)
OFF	OFF	A	3
ON	OFF	B	2.5
OFF	ON	C	2
ON	ON	D	1.5

SW3 - ADJUST DIP Switch Position 1	SW3 - ADJUST DIP Switch Position 2	POS.	CFM
OFF	OFF	A	0%
ON	OFF	B	(+)15%
OFF	ON	C	(-)15%
ON	ON	D	N/A

SW4 - DELAY DIP Switch Position 1	SW4 - DELAY DIP Switch Position 2	POS.	INPUT USGPH
OFF	OFF	A	0.65
ON	OFF	B	0.85
OFF	ON	C	0.75
ON	ON	D	0.50



NOTE:

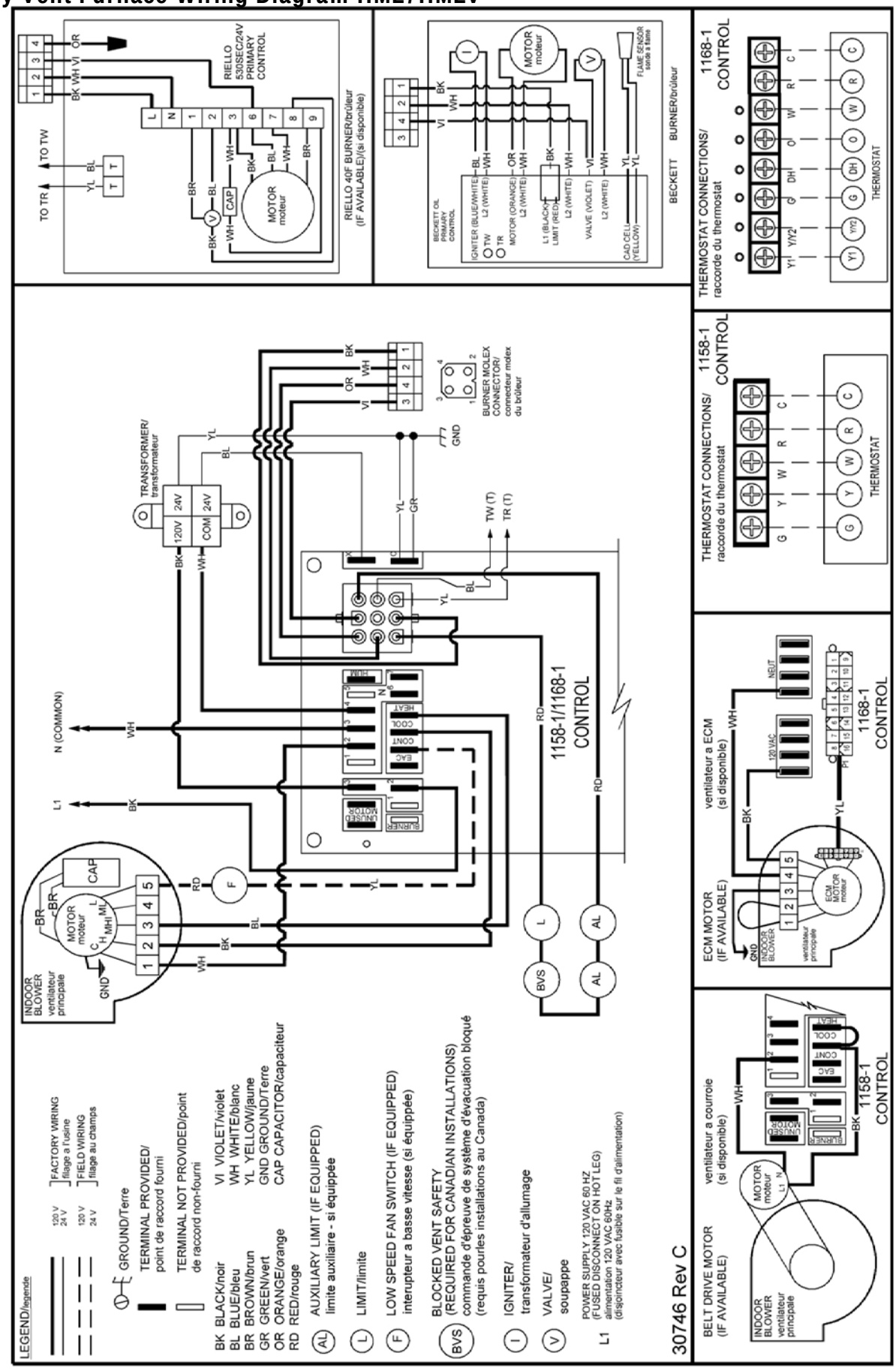
SW1 (HEAT) AND SW4 (DELAY) DIP SWITCHES MUST BOTH BE ADJUSTED ACCORDING TO INPUT (NOZZLE SIZE).

SW2 (COOL): 1 TON is approximately equal to 400 CFM

SW3 (ADJUST): (Heating Mode) Increase OR decrease temperature rise respectively

(Cooling Mode) Increase OR decrease CFM respectively

Chimney Vent Furnace Wiring Diagram HML/HMLV



Direct Vent Furnace Wiring Diagram HML/HMLV

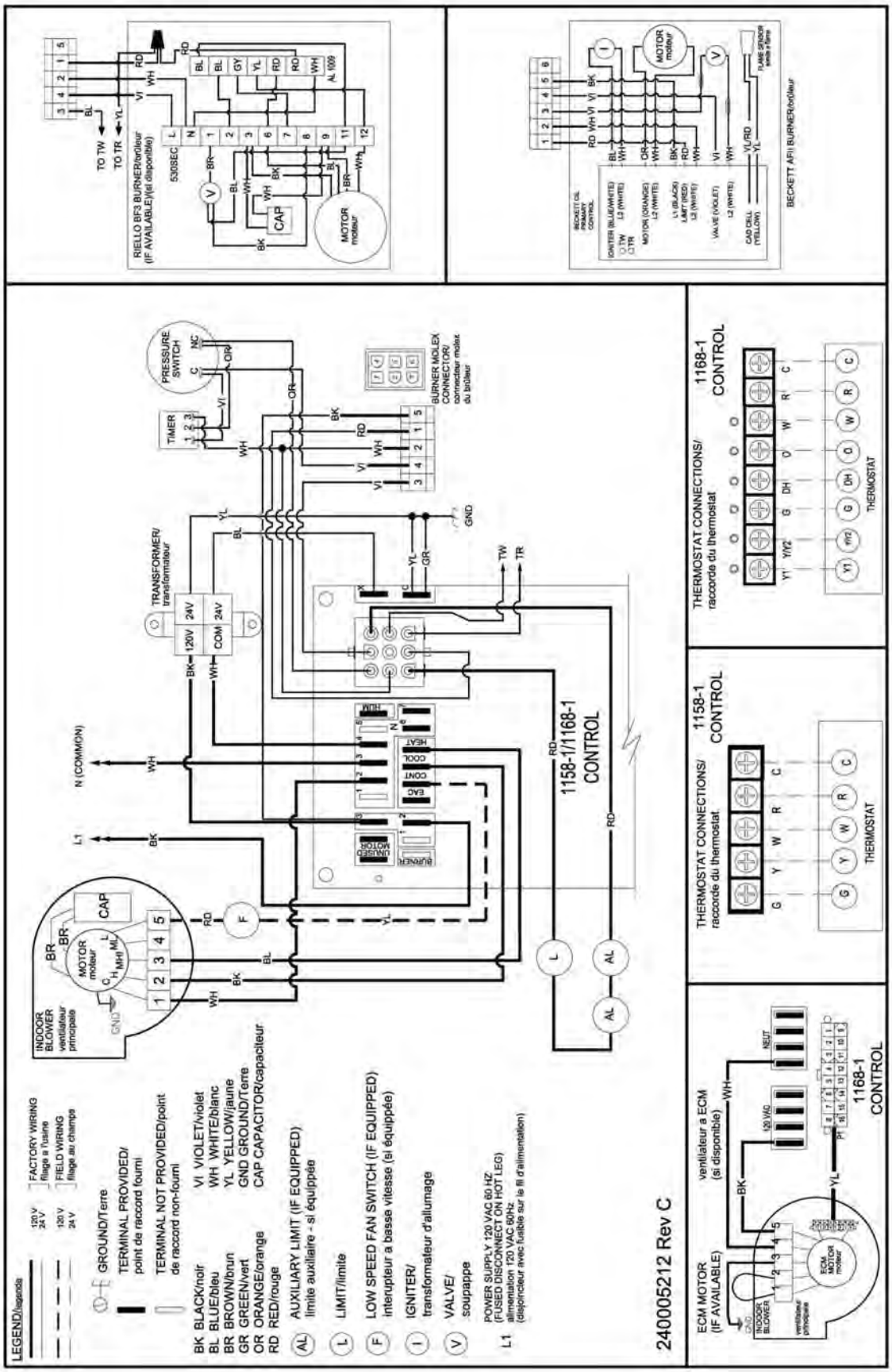


Table C-1: 1158-120 Electronic Fan Timer Board (EFT) Detailed Sequence Of Operation (HML)

Mode	Action	System Response
HEAT	Thermostat calls for heat. ("W" terminal is energized).	EFT closes the oil primary control T - T connections. Ignition system and the oil primary control start the furnace. Oil flows as long as the oil primary control senses flame. Burner motor is energized and heat "fan on" delay timing begins. When timing is complete, the circulator fan is energized at heat speed.
	Thermostat ends call for heat. ("W" terminal is de-energized).	The oil primary control is de-energized, terminating the burner cycle. Heat "fan off" delay timing begins. Length of delay depends on EFT dipswitch settings. When timing is complete, the circulator fan is de-energized. EFT returns to standby mode, (Oil primary control and circulator fan are off, unless continuous fan operation is selected at the thermostat).
	Burner fails to light.	Oil primary control locks out within lockout timing, (15 seconds). Burner motor is de-energized. (Even though thermostat is still calling for heat). If circulator fan has started, it continues through the selected heat “fan off” delay period.
	Established flame fails.	Burner motor is de-energized and oil primary control goes into recycle mode. If the selected heat “fan off” delay timing is longer than the recycle delay timing, the circulator fan continues to run through the next trial for ignition.
COOL	Thermostat begins call for cool. (G and Y terminals are energized).	Cooling contactor is energized immediately. Circulator fan is energized at cool speed.
	Thermostat ends call for cool. (G and Y terminals are de-energized).	Cooling contactor is de-energized immediately. Circulator fan turns off immediately.
FAN	Thermostat begins call for fan. (G terminal is energized).	Circulator fan is energized immediately at cooling speed.
	Thermostat ends call for fan. (G terminal is de-energized).	Circulator fan is de-energized immediately.
LIMIT	Limit switch string opens.	Oil primary control shuts off burner. Circulator fan is energized immediately at heat speed. EFT opens the oil primary control T - T connections. Circulating fan runs as long as limit string stays open. If there is a call for cooling or fan, the circulating fan switches from heating to cooling speed.
	Limit switch string closes (with existing call for heat).	EFT begins heat “fan off” delay sequence. Circulating fan turns off after the selected heat “fan off” timing. EFT re-closes the oil primary control T - T connections. Oil primary control is energized, initiating burner light off.
	Limit switch string closes (without existing call for heat).	Circulator fan turns off when heat “fan off” delay time is complete. Normal operation resumes; EFT control is in standby mode awaiting next thermostat command.
FAN	Continuous circulating fan is connected.	Circulating fan is energized when there is no call for heat, cool, or fan. If fan operation is required by a call for heat, cool, or fan, the EFT switches off the continuous fan speed tap before energizing the other fan speed.

EAC	Electronic Air Cleaner is connected.	Electronic air cleaner (EAC) connections are energized when the heat or cool speed of the circulator fan is energized. EAC connections are not energized when the optional continuous fan terminal is energized.
HUM	Humidity control is connected.	Humidifier connections are energized when the oil burner motor is energized.

1168-1 Electronic Fan Timer Board (EFT) Detailed Sequence Of Operation (HMLV)

Thermostat Input LEDs (LED1-5, LED8)

Six green LEDs are placed behind their respective thermostat connections (Y1, Y/Y2, G, DH, O, and W) and operate whenever a call is present.

Thermostat calls for heat “W”. The 24VAC input signal is passed to pin 2 of P1 and will drive the K1 relay that provides dedicated contacts to the T-T input of the Oil Primary Control. **Thermostat calls for cool “Y1”**. The 24VAC input signal is passed to pin 6 of P1. **Thermostat calls for fan “G”**. The 24VAC input signal is passed to pin 15 of P1. **Thermostat calls for dehumidification “DH”**. The 24VAC input signal is passed to pin 10 of P1. **Thermostat calls for reversing valve “O”**. The 24VAC input signal is passed to pin 9 of P1.

C.1 Troubleshooting

⚠WARNING

Electrical shock hazard. Only a trained, experienced service technician should perform troubleshooting procedure. Failure to do so could result in death or serious injury.

C.2 Preliminary Steps:

Consult Beckett or Riello instruction manuals provided with oil burner for specific information regarding oil burner primary control sequence of operation, diagnostics and troubleshooting.

Check diagnostic light for indications of burner condition.

NOTICE

When simulating call for heat at oil primary control, disconnect at least one thermostat lead wire from T - T terminals to prevent damage to thermostat. Neglecting this procedure may burn out heat anticipator of standard 24 vac thermostat, or cause harm to components within micro-electronic thermostat.

Before checking oil primary control, perform these preliminary checks, repair or replace controls as necessary:

- Check power supply, fuse box or breaker, any service switches, all wiring connections, and burner motor reset button (if equipped).
- Check limit switches to ensure switch contacts are closed.
- Check electrode gap and position.
- Check contacts between oil primary control and electrodes.
- Check oil supply (tank gauge).
- Check oil nozzle, oil filter, and oil valves.
- Check piping or tubing to oil tank.
- Check oil pump pressure.

C.3 Check Oil Primary Control

If the trouble does not appear to be in the burner or ignition hardware, check the oil primary control per manufacturer's instructions inlcuded with oil burner.

APPENDIX C - SEQUENCE OF OPERATION AND TROUBLESHOOTING

⚠WARNING

Electrical shock hazard. Only a trained, experienced service technician should perform troubleshooting procedure. Failure to do so could result in death or serious injury.

Table C2: System and General Troubleshooting

Problem	Possible Cause	Remedy
Furnace will not start.	Thermostat not calling for heat	Check thermostat and adjust. Check thermostat for accuracy; if mercury switch type, it might be off level.
	No power to furnace	Check furnace switch, main electrical panel furnace fuse or circuit breaker. Look for any other hand operated switch, such as old poorly located furnace switch, which was not removed during furnace replacement.
	Thermostat faulty	Remove thermostat wires from oil primary control terminals T-T. Place a jumper across T-T. If furnace starts, replace thermostat, thermostat sub-base (if equipped), or both.
	Oil primary control faulty	Check reset button on oil primary control. Remove thermostat wires from oil primary control terminals T - T. Check for 24V across T -T. If no voltage is present, check for 115V to oil primary control. If 115V is present, refer to oil primary control documentation provided with oil burner.
	Photo Cell wiring shorted or room light leaking into photo cell compartment	Check photo cell (cad cell) wiring for short circuits. Check for room light leaking into cad cell compartment. Repair light leak if necessary.
	Open safety switch	Check for open limit or auxiliary limit. Check internal wiring connections; loose connectors, etc.
Furnace will not start without first pushing oil primary control reset button. (Happens on frequent basis)	No fuel oil	Check fuel oil supply. Check all hand operated fuel oil valves are in open position. Fill oil storage tank if necessary.
	Clogged nozzle	Replace nozzle with high quality replacement. Use rating plate or Tables in Appendix A as a guide.
	Clogged oil filter	Replace oil tank filter or in-line filter if used.
	Low oil pump pressure	Connect pressure gauge to oil pump. Adjust pump pressure, or replace oil pump if necessary. Verify erratic pressure readings are not caused by defective fuel oil line.
	Air getting into fuel oil lines, or fuel oil line dirty, clogged, or in some manner defective	Check fuel oil lines. Replace any compression fittings found with high quality flared fittings. Check for signs of oil leaks. Any oil leak is potential source of air or contaminants.
	Defective burner motor	Check burner motor. If burner motor is cutting out on over-load, determine why. Replace if neces-sary.

Table C-2: System and General Troubleshooting continued

Problem	Possible Cause	Remedy
Furnace starts, but cuts out requiring manually re-setting oil protector reset button.	Photo Cell (Cad Cell) defective.	If cad cell is dirty, clean it. Determine why cad cell is getting dirty. If cad cell is poorly aimed, realign it. NOTE: Photocell should have resistance of 100 KΩ in absence of light; maximum of 1500 Ω in presence of light. Verify room light is not leaking into the cad cell compartment. (See diagnostic light section).
Furnace starts, but cuts out requiring manually re-setting oil protector reset button.	No fuel oil.	Check fuel oil supply. Check that all hand operated fuel oil valves are in the open position. Fill oil storage tank if necessary.
	Clogged nozzle.	Replace nozzle with high quality replacement. Use rating plate or Tables in Appendix A as a guide.
	Clogged oil filter.	Replace oil tank filter or in-line filter if used.
	Low oil pump pressure.	Connect pressure gauge to oil pump. Adjust pump pressure, or replace oil pump if necessary. Verify erratic pressure readings are not caused by defective fuel oil line.
	Air getting into fuel oil lines, or fuel oil line dirty, clogged, or in some manner defective.	Check fuel oil lines. Replace any compression fittings found with high quality flared fittings. Check for any signs of oil leaks. Any oil leak is a potential source of air or contaminants.
	Defective burner motor.	Check burner motor. If burner motor is cutting out on over-load, determine why. Replace if necessary.
	Water or contaminants in oil.	Drain fuel oil storage tank; replace fuel oil. (Consult with fuel oil supplier).
	Frozen oil line.	Gently warm oil line. Insulate oil line. (Outdoor piping size may require increased diameter).
Oil burner sputtering at nozzle	Electrodes out of adjustment or defective.	Check electrode settings. Check electrodes for dirt build-up or cracks in porcelain.
	Poor igniter connections or defective igniter.	Check contacts between the igniter and electrodes. If OK, replace the igniter
	Fuel oil filter clogged.	Replace fuel oil storage tank filter and / or fuel oil in-line filter.
	Defective oil pump.	Check burner motor and / or fuel oil pump coupling. Check oil pump pressure. Replace fuel oil pump if necessary.
	Fuel oil line partially clogged or contains air.	Bleed air from oil line. If problem persists, replace oil line.
Excessive fuel oil consumption.	System temperature rise too high.	System temperature rise should not exceed 75°F. Check for clogged air filters. Check blower fan for excess dirt build-up or debris. Speed up blower fan if necessary.
	Poor “fan off” delay timing selection, (fan stops too soon).	Check “fan off” delay timing setting. Use duct thermometer in supply air plenum take-off or first few inches of supply air trunk duct. Fan should shut off at 90° - 100°F. Manipulate dip switch settings to come as close as possible to this “fan off” temperature.
	Fuel oil leak.	Check fuel oil line for leaks. Repair or replace if necessary.
	Stack temperature too high.	Check stack temperature. Stack temperatures will normally range from 400° to 500°F. Check draft regulator. Draft should be set to -0.02 in. w.c.
	Thermostat improperly adjusted or in poor location.	Check thermostat heat anticipator setting against measured amperage draw. Increase heat anticipator setting if necessary. If thermostat is being influenced by drafts, sunlight, duct work, etc., relocate to suitable location.

Table C-2: System and General Troubleshooting continued

Problem	Possible Cause	Remedy
Too much smoke.	Insufficient combustion air adjustment at oil burner, or improper draft pressure.	Adjust oil burner combustion air band and draft regulator to gain highest practical CO2 or lowest practical O2 content in flue gases. See Burner Set Up.
	Heat exchanger partially clogged.	Check for soot build-up in heat exchanger flue passages, especially in outer radiator.
Soot building up on blast tube (end coning).	Poor alignment between oil burner blast tube and fire pot.	Check alignment. Blast tube should be centered with fire pot burner opening. Oil burner head should be ¼ inch back from inside surface of fire pot.
	Flame impingement caused by Incorrect nozzle angle.	Check nozzle size and angle. (See Appendix A). Check distance from head to inside surface of fire pot.
	Defective fire-pot	Check fire-pot. Repair or replace.
Furnace will not warm home to desired temperature.	Airflow blocked or dirty air filter.	Clean or replace air filter.
	Thermostat adjustments or location.	Check thermostat heat anticipator setting against measured amperage draw. Increase heat anticipator setting if necessary. If thermostat is being influenced by drafts, sunlight, duct work, etc., relocate to suitable location.
	Insufficient airflow.	Check all dampers. Open closed dampers including registers in unused rooms. Check system temperature rise. If temperature rise is too high, speed up blower fan.
	Defective high limit control.	Test high limit function of all limit switches. Use duct thermometer to verify accuracy of limit control. Check for obstructions to airflow around limit switch bimetal elements. Replace control if necessary.
	Under-sized nozzle.	Check nozzle. If problem is not caused by air flow problems, use larger nozzle, if permitted by rating plate.
	Blower fan motor stopping intermittently on overload.	Check blower fan motor amperage draw. Check motor ventilation ports, clean if necessary. Replace motor if necessary.
	Burner motor stopping intermittently on overload.	Check burner motor. Replace if necessary.
Home does not heat evenly	Improper distribution of heat.	This is not likely to be a furnace problem. Balance duct system.
Supply air temperature too hot.	Airflow blocked or dirty air filter.	Clean or replace air filter.
	Insufficient airflow.	Check all dampers. Open closed dampers including registers in unused rooms. Check system temperature rise. If temperature rise is too high, speed up blower fan.
Supply air temperature too cool.	Excess airflow.	Check system temperature rise. Slow down blower fan if necessary.
	Excessive duct losses.	Check supply air ductwork. Seal leaky joints and seams. Insulate ductwork if necessary.
Supply air temperature too cool during first moments of furnace cycle.	Fan control "fan on" setting too low.	Increase "fan on" dipswitch settings on EFT if control has this option. Register air deflectors may help.
	Excessive duct losses.	Check supply air ductwork. Seal leaky joints and seams. Insulate ductwork if necessary.

APPENDIX D - HOMEOWNER'S REFERENCE TABLE

Model No.	
Serial No.	
Date Installed	
Contractor	
Contact	
Address	
Postal Code	
Telephone No.	
After Hours No.	

Fuel Supplier

Fuel Oil Supplier	
Contact	
Telephone No.	
After Hours No.	

Parts Listing: Chimney Vent Models HML80(C2,CRF2, CNX2) and HMLV80(C2,CRF2, CNX2)

Ref. No.	Description	Part No.
1	Left Side Panel Assembly	29130AD
2	Right Side Panel Assembly	29129AD
3	Rear Panel	29131AD
4	Blower Division Assembly	29189
5	Base Panel	26216
6	Inner Front Panel	30066
7	Blower Access Panel	27721AD
8	Top Panel	21437AD
9	Heat Exchanger Assembly	550001636
10	Combustion Chamber Retainer Bracket	27068
11	Replacement Combustion Chamber	27000WP
12	Oil Burner Mounting Plate Assembly	109007674
	Sight Glass Cover Plate	29850
	Sight Glass Gasket (2 per unit)	29870
	Sight Glass	29876
13	Flue Connector	29005
14	Pouch Gasket	2080175
15	Flue Collar Gasket	21994
16	Insulation Retainer	20602
17	Radiator Clean-out Cover (2 per unit)	240007841
	Radiator Clean-out Cover Gasket (2 per unit)	240006333
18	Clean-out Gasket Retainer	29161
	Clean-out Tube Gasket	29163
19	Filter Frame 16” X 25”	18020
20	Filter Frame End Support	5592B2
21	Filter 16” X 25” X 1” Permanent	2180023
24	Control Box	29362
25	Upper Door Panel	30164AD
	Logo Bezel	28479
	Logo Label	28563
26	Limit Disc 60T11 BOF 155°F	30071
27	Fan Timer Control 1158-120 UTEC Fan Timer Control 1168-1 ECM UTEC	29388 240007048
28	Wire Harness, Controls Fan Timer	29364
29	Wire Harness PSC, Blower	29365
30	Wire Harness, Fan Timer Board, Transformer	29751
31	Wire Harness, ECM Blower Control	240006438
	Wire Harness, ECM Blower Supply	240005742
32	Transformer	240005330
33	Draft Regulator	27494 (5”)
34	Oil Burner Assembly, Beckett AF76BNHS	30067
	Oil Burner Assembly, Beckett NX70LHSS	240010182
	Burner Motor 1/7 HP 3450 RPM PSC	29689
	Beckett Clean-Cut Oil Pump A2EA6520	29688
	Solid State Ignitor	29522
	Oil Primary Combustion Control 7505P1515	240008818
	Flame Retention Head (F3 for AF burner)	1050002
	Low Fire Kit (0.50 GPH for AF burner)	29880
	Low Firing Rate Baffle (for AF burner)	25521101
34	Oil Burner, Riello 40F3	29568

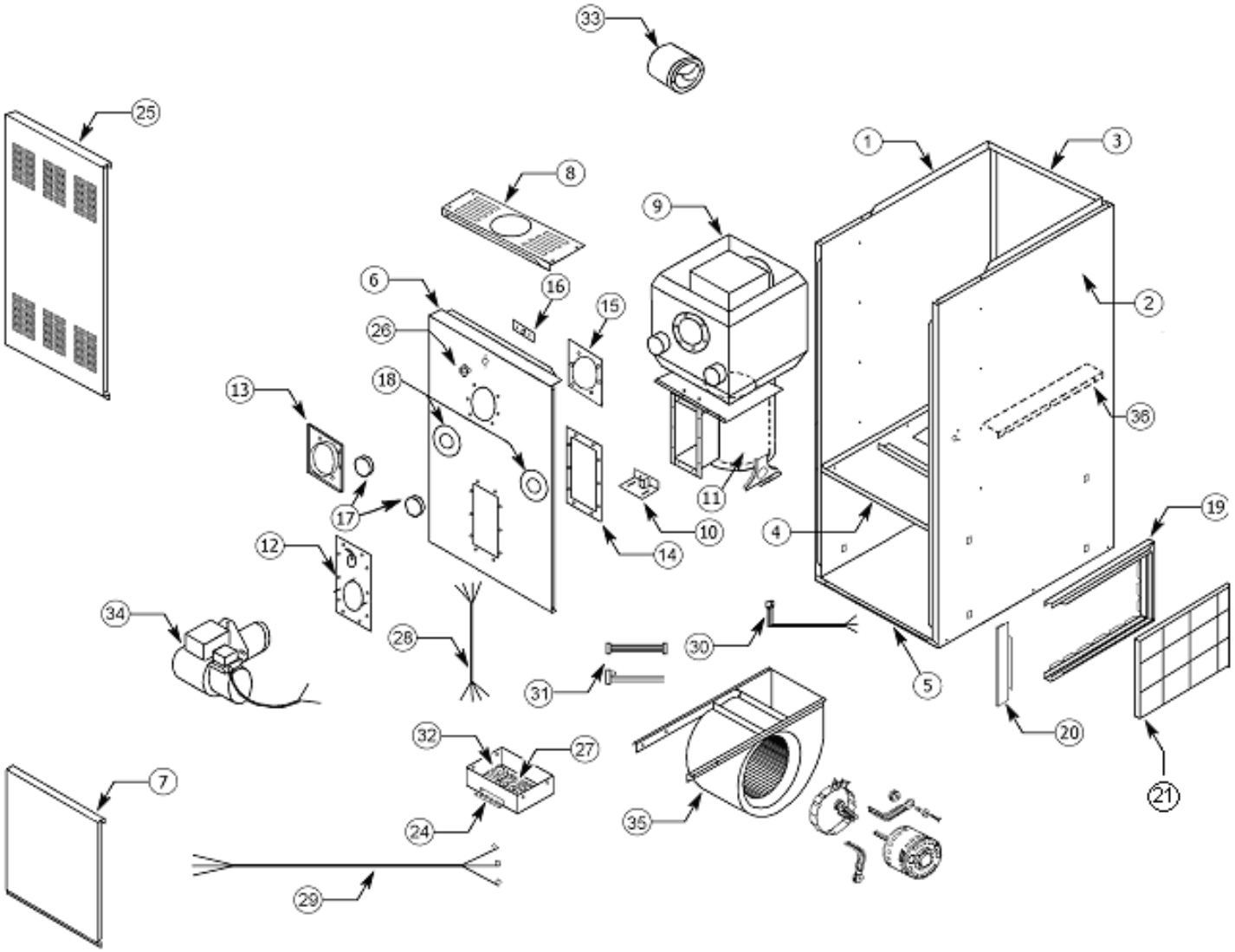
Parts Listing: Chimney Vent Models HML80(C2,CRF2,CNX2) and HMLV80(C2,CRF2,CNX2)

Ref. No.	Description	Part No.
35	Blower Assembly Direct Drive	30146
	Blower Assembly Direct Drive ECM	109007271
	Blower Housing and Wheel, 100-10T DD (HML and HMLV)	30626
	Blower Motor, 1/2 hp, 4-Speed	102000131
	Blower Motor, 1/2 hp, ECM Programmed	109007272
	Motor Mounting Band TR5868	17811
	Motor Mount Arms – 10-10 DD Blower (3 per unit)	26251
	Motor Run Capacitor, 10 mfd @ 370 Vac	27743
	Capacitor Strap	27761
	Blower Slide Rail 2 Per	27733
36	Right Side Panel, Air Baffle HML- 80C and HMLV-80C	27731
*	Blocked Vent Safety Switch Kit Complete	30693
*	Blocked Vent Safety Switch - Replacement Switch Only	30660

Parts Listing: Direct Vent Models HML80(CB2U2,CRBU2) and HMLV80(CB2U2,CRBU2)

Ref. No.	Description	Part No.
All parts are the same as listed on previous pages for chimney vent except where noted below.		
13	Flue Connector Assembly 6” to 4” 90º Elbow	240008224
14	Pouch Gasket (Second gasket required for Direct Vent)	2080175
15	Flue Collar Gasket (Second gasket required for Direct Vent)	21994
28	Wire Harness, Controls, Fan timer, Direct Vent	30745
34	Beckett Oil Burner AFII 85	30069
	Burner Motor 1/7 HP 3450 RPM PSC	28907
	Beckett Clean-cut Oil Pump A2EA6520	29688
	Solid State Ignitor	28558
	Oil Primary Combustion Control 7505P1530	
	Air Tube Combination FBX80HGXS	28561
	Flame Retention Head (FB3)	28533
34	Riello Oil Burner 40BF3	30427
*	Pressure Switch -0.28" WC	30700
*	10 Second Bypass Timer GPS00C9X10 (Use with Beckett AFII)	30699
*	25 Second Bypass Timer GPS00C9X25 (Use with Riello 40BF3))	240005182

Model HML and HMLV Diagram



Olsen Oil-Fired Furnace

ECR International
2210 Dwyer Avenue, Utica NY 13501
web site: www.ecrinternational.com

Chapter 21 CHIMNEYS

MANUFACTURER/DISTRIBUTOR:

CHEMINEE LINING
Denis Caron & Simon Champagne
Technical Representative
T (450) 625-6060 # 6226
F (450) 625-8170
C 514-946-1770
dcaron@chemineelining.com

21.1 **IPPL2 STAINLESS STEEL 304 CHEMINEE LINING INSIDE INSULATED 2" WITH MINERAL WOOL**

21.2 **EXHAUST THIMBLE 3MDC-20-C-450-29 type C**

Chimney

CHEMINÉE Lining

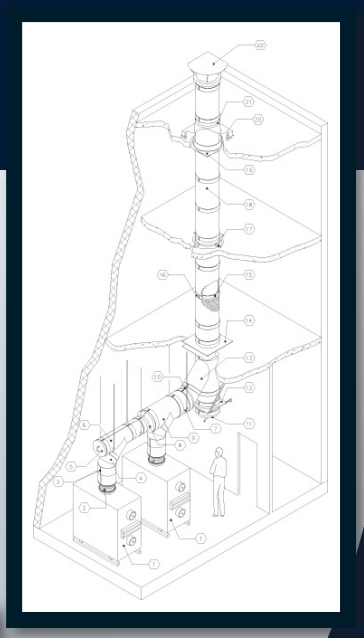
BOILER AND ENGINE EXHAUST

Industrial Positive Pressure Piping Systems

Complete Guide for Parts Identification and Selection

MODELS

IPPL • IPPL2 • IPPL2F • IPPL4F



SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 07 juillet 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Chimney

Our mission is to become the supplier of choice for gas venting products and solutions.

Company Profile

Cheminée Lining started out as a sales company that provided customers with quality products and installation. Our manufacturing arose from the certitude that we could supply superior products and services at a reasonable price.
With more than 15 years experience, our principles based on business integrity, first class customer service, reliable delivery and engineering services have established our reputation as a market leader for the supply of chimneys, grease duct and gas venting products.

Personnel

Cheminée Lining can count on qualified and highly professional employees. We are continually seeking to develop superior quality products at a competitive price.
Our engineering department will supply the answers you need – either for a project involving our standard line of products or a uniquely designed response to a specific requirement. We have developed specialized design systems for highly efficient results on sizing analysis and CAD design.
Our capabilities not only encompass the design and manufacturing of gas venting products, but also include full range engineering expertise to assist you in your projects, from specification to installation.
Cheminée Lining sales personnel work in an environment that promotes entrepreneurship. Their experience in the field allows them to utilize their resources to provide our clients with the best technical and economical solutions.

Manufacturing

Cheminée Lining combines the craftsmanship of a seasoned labor force with state of the art fabrication, delivering the highest quality products in the industry.
Our stainless steel precision cut using state of the art equipment for quality, speed and accuracy resulting in reduced manufacturing lead times.
An innovative engineering staff ensures continuing research and design, so that Cheminée Lining can offer the latest in gas venting products.

Chimney

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SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 8 July 2016

Reviewed ☒

Reviewed as noted ☐

Resubmit ☐

CHIARELLI ENGINEERING LTD.

LISTING AND APPLICATIONS

LISTINGS

CHEMINEE LINING.E inc. venting systems models IPPL, IPPL2, IPPL2F and IPPL4f are listed by Underwriters Laboratories, inc. (UL) under file MH26661 and tested in accordance with UL 103 Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances and the Canadian Standard for 540°C (1000°F) and 760°C (1400°F) industrial Chimneys CAN/ULC-C959. These models are also suitable for use in positive pressure applications up to 60" water column. Listings include the following chimney product categories and diameters.

c UL us LISTED

UL 103

MODELS IPPL, IPPL2, IPPL2F AND IPPL4F	TEMPERATURE	SIZE
Building Heating Appliance Type Chimney	1000°F continuous	6'' to 48'' I.D.
1400°F Chimney (IPPL, IPPL2, IPPL2F et IPPL4F)	1400°F continuous	6'' to 48'' I.D.

CAN/ULC C-959

MODELS IPPL, IPPL2, IPPL2F AND IPPL4F	TEMPERATURE	SIZE
Building Heating Appliance Type Chimney	1000°F continuous	6'' to 48'' I.D.
1400°F Chimney (IPPL, IPPL2, IPPL2F et IPPL4F)	1400°F continuous	6'' to 48'' I.D.

APPLICATIONS

1. Building Heating Appliance Chimney Listing (1000°F Chimney Listing) – under this category, models IPPL, IPPL2, IPPL2F and IPPL4F, have been determined suitable for venting flue gases at a temperature not exceeding 540°C (1000°F) under continuous operating conditions, from gas, liquid, oil or solid fuel fired appliances.
2. Building Heating Appliance Chimneys are suitable for use with Building Heating Appliances and Low Heat Appliances as described in the Chimney Selection Chart of National Fire Protection Association (NFPA) Standard No. 211.
3. 1400°F Chimney Listing – under this category, models IPPL, IPPL2F and IPPL4F, have been determined suitable for venting flue gases at a temperature not exceeding 760°C (1400°F) under continuous operating conditions. As such, they are suitable for use with ovens and furnaces as described in the Chimney Selection Chart of NFPA No. 211, in addition to other applications.

Other products and applications

CRITERIA	GREASE DUCT	BHA CHIMNEY	1400°F CHIMNEY
Application	Cooking appliances ventilation hoods restaurant grease ducts pizza oven exhausts.	• Low and high pressure steam boilers • Diesel and turbine exhausts • Building heating equipment	• Industrial furnaces • Processing equipment • Kilns and ovens • Diesel and turbine exhausts
Continuous operating temperature	500°F	1000°F	1400°F
IPPL, GDPL	Yes	Yes	Yes
IPPL2	Yes	Yes	N/A
IPPL2F, GDPL2F	N/A	Yes	Yes
IPPL4F, GDPL4F	Yes	Yes	N/A

DESIGN AND SPECIFICATION

DESIGN

All our double wall chimney systems are part of a large family of IPP (Industrial Positive Pressure) products for industrial and commercial applications. The components of each model are made using the same continuous laser welding stainless steel inner wall. Since all components have the same small and large ends, the parts of all models fit into one another, thus eliminating the need for all kinds of adapters and providing an incomparable flexibility in selecting models of flues and chimneys.

IPP, GDP: Single wall
(see Chimney Breechings and Liners Catalogue)

IPPL, GDPL : Double wall
with 2" air space

IPPL2: Double wall
with 2" mineral fiber insul.

IPPL2F, GDPL2F: Double wall
with 2" ceramic fiber insul.

IPPL4F, GDPL4F: Double wall
with 4" ceramic fiber insul.

This unique method for jointing components together is very efficient either in horizontal or in vertical installations. Our simple jointing concept along with the wide variety of components and accessories allows for a quick and simple installation, thus permitting you to save both time and money.

Cheminée Lining is proud of their industrial positive pressure piping systems. Recognized for being high quality products, they are also the easiest to install on the market!

These chimney systems are designed for exhaust of combustion gases, under positive, negative or neutral pressure, emanating from a variety of appliances including but not limited to:

- Diesel Engine and Gas Turbine Exhaust
- Restaurant Grease Duct
- Incinerator
- Coffee Roaster
- Air and Product containment
- Industrial Oven Exhaust
- Boiler Negative and Positive Pressure
- Unit Heater
- Heat Recovery

Models IPPL, IPPL2, IPPL2F and IPPL4F provide a wide variety of components and accessories, suitable for all kinds of site conditions, thus allowing for quick and simple installation. Each component is packed and shipped complete, with (1) one assembly band and (1) one finishing band for those having large ends. Sufficient tubes of appropriate sealant are also included in the shipment for completing the assembly.

SAMPLE SPECIFICATION (boiler Exhaust)

The chimney and flue must meet ULC (Underwriters Laboratories of Canada) and UL-103 (Underwriters Laboratories Inc.) section 22A for positive pressure exhaust system up to 60" water column and carry the appropriate approval labels. The chimney shall be listed by UL as a "B.H.A." (Building heating appliance) chimney for continuous operation up to 1000°F (540°C) maximum. For applications above 1000°F (540°C), the chimney shall be listed by UL as a "1400°F chimney" for continuous operation up to 1400°F (760°C) maximum.

The chimney and flue components must be of double wall construction and properly designed for positive pressure exhaust. The inner wall must be of 20 gauge (18 gauge – 42" to 48" diameter) 304 stainless steel, with continuous laser welding. The outer wall must be of 24 gauge (20 gauge – 42" to 48" diameter) 304 stainless steel. A high temperature insulation must be installed between walls. The jointing must be made using an assembly band, a finishing band and an appropriate sealing material, as supplied by the manufacturer. Quality required : Model IPPL2.

All components must be installed according to the manufacturer recommendations and must meet the NFPA and local safety code requirements.

MATERIALS

MODEL IPPL

Inner wall: 316L or 304 2B stainless steel (20 ga - 6" (152mm) to 40" (1016mm) diameter; 18 ga - 42" (1067mm) to 48" (1219mm) diameter)
Outer wall: 301,316L, 304 2B stainless steel, 430 or galvalume(24 ga - 6" (152mm) to 40" (1016mm) diameter; 20 ga - 42" (1067mm) to 48" (1219mm) diameter)
Insulation: 2" (51mm) air space

MODEL IPPL2

Inner wall: 316L or 304 2B stainless steel (20 ga - 6" (152mm) to 40" (1016mm) diameter; 18 ga - 42" (1067mm) to 48" (1219mm) diameter)
Outer wall: 301,316L, 304 2B stainless steel, 430 or galvalume(24 ga - 6" (152mm) to 40" (1016mm) diameter; 20 ga - 42" (1067mm) to 48" (1219mm) diameter)
Insulation: 2" (51mm) high temperature mineral fiber

MODEL IPPL2F

Inner wall: 316L or 304 2B stainless steel (20 ga - 6" (152mm) to 40" (1016mm) diameter; 18 ga - 42" (1067mm) to 48" (1219mm) diameter)
Outer wall: 301,316L, 304 2B stainless steel, 430 or galvalume (24 ga - 6" (152mm) to 40" (1016mm) diameter; 20 ga - 42" (1067mm) to 48" (1219mm) diameter)
Insulation: 2" (51mm) high temperature ceramic fiber

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Reviewed [X]
Reviewed as noted [ ]
Date: 8 July 2016
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

MODEL IPPL4F

Inner wall: 316L or 304 2B stainless steel (20 ga - 6" (152mm) to 40" (1016mm) diameter; 18 ga - 42" (1067mm) to 48" (1219mm) diameter)
Outer wall: 301,316L, 304 2B stainless steel, 430 or galvalume (24 ga - 6" (152mm) to 40" (1016mm) diameter; 20 ga - 42" (1067mm) to 48" (1219mm) diameter)
Insulation: 4" (51mm) high temperature ceramic fiber

SUPPORTS & ACCESSORIES

Galvanized steel, hot-galvanized steel, 316 L or 304 2B stainless steel

COMPONENTS	Internal walls		external walls		materials	
	STANDARD	AVAILABLE	STANDARD	AVAILABLE	STANDARD	AVAILABLE
ANCHOR PLATE	2	1	2	1	3	1, 2 and 4
ASSEMBLY BAND	2	1	---	---	--	---
COLLARS, FLASHING	---	---	---	---	--	1 and 2
DRAIN SECTION	2	1	2	1	--	---
ELBOWS	2	1	2	1	--	---
EXHAUST CONE, MITER SECTION	2	1	2	1	--	---
EXPANSION JOINT	2	1	2	1	--	---
FAN ADAPTER	2	1	2	1	---	---
FINISHING BAND	---	---	2	1	--	---
FIRESTOP, WALL FIRESTOP	---	---	---	---	3	1 and 2
HANGER BRACKET	---	---	---	---	3	1, 2 and 4
INCREASER / REDUCER	2	1	2	1	---	---
INSULATED SLEEVE, INSULATED WALL FIRESTOP	---	---	---	---	3	1 and 2
LENGTH, ADJUSTABLE LENGTH, VARIABLE LENGTH	2	1	2	1	---	---
RADIANT FIRESTOP	---	---	---	---	3	1 and 2
RAIN CAP, RAINSHEILD, CLOSURE SECTION	2	1	2	1	---	---
ROOF BAND, GUYWIRE BAND	---	--	---	--	2	1, 3 and 4
ROOF SUPPORT, GUIDING SPACER	---	--	---	--	3	1, 2 and 4
STARTING ADAPTER, DRAIN ADAPTER	2	1	---	--	3	1, 2 and 4
STARTING SLEEVE	2	1	---	--	3	1, 2 and 4
TEES	2	1	2	1	--	---
TEE CAPS	2	1	2	1	--	---
WALLS BAND, SUSPENSION BAND	---	---	---	---	3	1, 2 and 4
WALL / FLOOR GUIDES	--	---	---	---	3	--
WALL / HORIZONTAL SUPPORTS	2	1	2	1	3	1, 2 and 4

1: 316 L stainless steel **2:** 304 2B stainless steel **3:** Galvanized steel **4:** Hot-galvanized steel

WEIGTHS AND CLEARANCES

IPPL ● IPPL2 ● IPPL2F ● IPPL4F				LINEAR WEIGHT							
I.D.		AREA		IPPL		IPPL2		IPPL2F		IPPL4F	
in	mm	in^2	$1000mm^2$	lb/ft	kg/m	lb/ft	kg/m	lb/ft	kg/m	lb/ft	kg/m
6	152	28	18.2	5.7	8.5	8.8	13.1	8.8	13.1	14.6	21.8
8	203	50	32.4	7.2	10.8	11.1	16.5	11.1	16.5	17.7	26.3
10	254	79	50.7	8.8	13.0	13.4	19.9	13.4	19.9	20.7	30.8
12	302	113	73.0	10.3	15.3	15.6	23.3	15.6	23.3	23.8	35.4
14	356	154	99.3	11.8	17.5	17.9	26.7	17.9	26.7	26.8	39.9
16	406	201	129.7	13.3	19.8	20.2	30.1	20.2	30.1	29.9	44.4
18	457	254	164.2	14.8	22.0	22.5	33.4	22.5	33.4	32.9	49.0
20	508	314	202.7	16.3	24.3	24.7	36.8	24.7	36.8	35.9	53.5
22	559	380	245.2	17.8	26.5	27.0	40.2	27.0	40.2	39.0	58.0
24	610	452	291.9	19.3	28.7	29.3	43.6	29.3	43.6	42.0	62.5
26	660	531	342.5	20.8	31.0	31.6	47.0	31.6	47.0	45.1	67.1
28	711	616	397.3	22.3	33.2	33.9	50.4	33.9	50.4	48.1	71.6
30	762	707	456.0	23.8	35.5	36.1	53.8	36.1	53.8	51.6	76.1
32	813	804	518.9	25.4	37.7	38.4	57.2	38.4	57.2	54.2	80.7
34	864	908	585.8	26.9	40.0	40.7	60.5	40.7	60.5	57.3	85.2
36	914	1018	656.7	28.4	42.2	43.0	64.9	43.0	64.9	60.3	89.7
38	965	1134	731.7	29.9	44.5	45.2	67.3	45.2	67.3	63.3	94.3
40	1016	1257	810.7	31.4	46.7	47.5	70.7	47.5	70.7	66.3	98.8
42	1067	1385	893.8	46.2	68.7	63.1	93.9	63.1	93.9	83.3	124.0
44	1118	1521	981.0	48.3	71.9	66.0	98.2	66.0	98.2	87.0	129.4
46	1067	1662	1072.2	50.4	75.0	68.9	102.5	68.9	102.5	90.6	134.9
48	1219	1810	1167.5	52.5	78.2	71.7	106.8	71.7	106.8	94.3	140.3

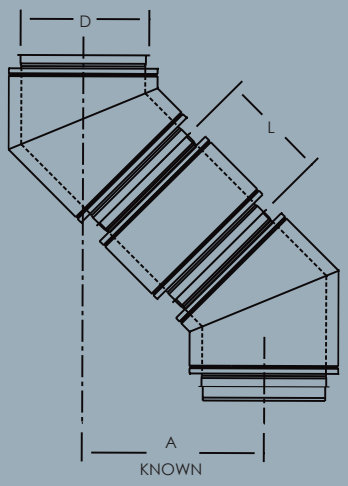
Minimum clearance air space to combustible construction									
Model IPPL						Model IPPL2		Model IPPL2F & IPPL4F	
Inside diameter		Clearance (1000°F to 1400°F)		Inside diameter		Clearance (1000°F)		Clearance (1000°F to 1400°F)	
in	mm	in	mm	in	mm	in	mm	in	mm
6'' to 12''	152-305	4''	102	6'' to 12''	152-305	1''	25	1''	25
14''	355	5''	127	14''	355	1.5''	38	1.5''	38
16'' to 18''	406-457	6''	152	16'' to 18''	406-457	2''	51	2''	51
20'' to 24''	508-610	7''	178	20'' to 22''	508-610	3''	76	3''	76
30'' to 34''	762-864	9''	229	28'' to 32''	762-864	5''	127	5''	127
36'' to 38''	914-965	10''	254	34'' to 36''	864-914	6''	152	6''	152
40'' to 48''	1016-1219	11''	279	38'' to 40''	965-1016	7''	178	7''	178
				42'' to 48''	1067-1219	8''	203	8''	203

Minimum opening when installing a chimney through a floor or wall made of combustible construction.
O.D. + 2 X (min. clearance air space) Ex. : IPPL2, B.H.A., I.D. = 8" ⇨ 12" + (2 X 1") = 14"

Minimum opening when installing a chimney through a floor or wall made of non combustible construction.
O.D. + 1" Ex. : IPPL2, B.H.A., O.D. = 12" ⇨ 12" + 1" = 13"

OFFSETS

OFFSET CALCULATIONS



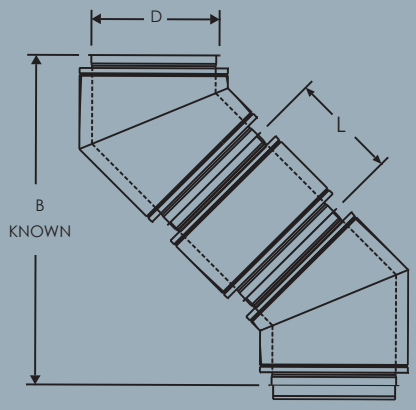
EFFECTIVE LENGTH CALCULATIONS

- OFFSET dimension is known
- Effective length is to be determined using equation 1, 2 or 3 depending on elbows used

1.	L(A) = 3.864(A) - 0.132D - 13"	15° elbows
2.	L(A) = 2(A) - 0.268D - 13"	30° elbows
3.	L(A) = 1.414(A) - 0.414D - 13"	45° elbows

EXAMPLE: An 8" ID IPPL2 chimney with a known offset width of 44.75"(A)using 2-45° elbows.

3. L(A) = 1.414(A) - 0.414D - 13''
   L(A) = 1.414(44.75'') - 0.414(8'') - 13''
   L(A) = 47'' in effective length choose a 48'' length (48L)



EFFECTIVE LENGTH CALCULATIONS

- HEIGTH dimesnion is known
- Effective length is to be determined using equation 4, 5 or 6 depending on elbows used

4.	L(B) = 1.035(B) - 0.268D - 26.459"	15° elbows
5.	L(B) = 1.155(B) - 0.577D - 28.011"	30° elbows
6.	L(B) = 1.414(B) - D - 31.385"	45° elbows

EXAMPLE: A 10" ID chimney with a known offset height of 55"(B) using 2- 45° elbows

6. L(B) = 1.414(B) - D - 31.385''
   L(B) = 1.414(55'') - 10'' - 31.385''
   L(B) = 36.385'' in effective length choose a 24'' length (24L) + adjustable length (AL)

Refer to the elbows specific table for minimum offsets and heights of two matched elbows. For special conditions, we can manufacture one piece offset.

LENGTHS

STRAIGHT LENGTHS • 48L • 36L • 24L • 12L

Available in 22 diameters from 6 to 48" (152 to 1219mm). Standard lengths: 48" (1219mm), 36" (914mm), 24" (610mm) and 12" (305mm).

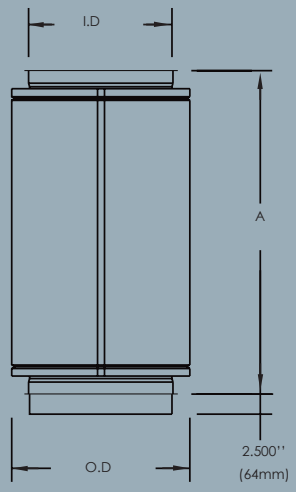
Includes:
1 Assembly band (AB)
1 Finishing band (FB)

K = 0.30 L/D

Where L = Pipe length in feet
D = Pipe diameter in inches

IPPL ● IPPL2 ● IPPL2F			
I.D.		O.D.	
in	mm	in	mm
6	152	10	254
8	203	12	305
10	254	14	356
12	305	16	406
14	356	18	457
16	406	20	508
18	457	22	559
20	508	24	610
22	559	26	660
24	610	28	711
26	660	30	762
28	711	32	813
30	762	34	864
32	813	36	914
34	864	38	965
36	914	40	1016
38	965	42	1067
40	1016	44	1118
42	1067	46	1168
44	1118	48	1219
46	1168	50	1270
48	1219	52	1321

IPPL4F			
I.D.		O.D.	
in	mm	in	mm
6	152	14	356
8	203	16	406
10	254	18	457
12	305	20	508
14	356	22	559
16	406	24	610
18	457	26	660
20	508	28	711
22	559	30	762
24	610	32	813
26	660	34	864
28	711	36	914
30	762	38	965
32	813	40	1016
34	864	42	1067
36	914	44	1118
38	965	46	1168
40	1016	48	1219
42	1067	50	1270
44	1118	52	1321
46	1168	54	1372
48	1219	56	1422



LENGTHS	EFFECTIVE LENGTHS "A"	
	in	mm
12'' (305 mm)	11.000	279
24'' (610 mm)	23.000	584
36'' (914 mm)	35.000	889
48'' (1219 mm)	47.000	1194

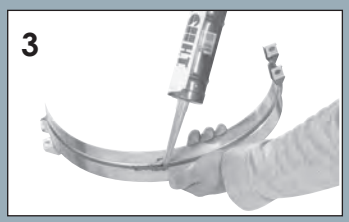
INSTALLATION GUIDE

Guide to Component Parts

MATERIALS	CODE	PAGE
ADJUSTMENT / EXPANSION		
Adjustable Length	AL	10
Expansion Joint	EJ	10
Increaser	I	19
Reducer	R	19
Variable Length	VL	10
COMPONENT		
Drain Section	DS	10
Drain -Tee Cap	DC	20
Tee Cap	TC	20
CONNECTING THE FLUE		
Drain Starting Adapter	SAD	21
Starting Adapter	SA	21
Starting Sleeve	SS	21
CONNECTION / OFFSET		
5° Elbow	E5	14
15° Elbow	E15	15
30° Elbow	E30	16
45° Elbow	E45	17
90° Elbow	2 x E45	18
90° Short Radius Elbow	E90	18
45° Tee	T45	12
90° Tee	T90	13
FIRE PROTECTION		
Firestop	FS	25
Insulated Sleeve	IS	26
Insulated Wall Firestop	IFS	27
Radiant Firestop	RFS	25
Wall Firestop	WFS	25
JOINTING		
Assembly Band	AB	20
Finishing Band	FB	20

MATERIALS	CODE	PAGE
LENGTH		
12" Length	12L	9
24" Length	24L	9
36" Length	36L	9
48" Length	48L	9
RELIEF VALVE	RV	34
SEALING AT ROOF		
Adjustable Flashing	AF	29
Flashing for Flat Roof	F	32
Ventilated Flashing	VF	33
SIDE STABILITY		
Guy Wire Band	GWB	28
Roof Band	RB	28
Wall Band	WB	28
SUPPORT / GUIDE		
Anchor Plate	AP	23
Floor Guide	FG	23
Guiding Spacer	GS	25
Hanger Bracket	HB	21
Horizontal Support	HS	22
Roof Support	RS	23
Suspension Band	SB	28
Wall Guide	WG	24
Wall Support	WS	22
TERMINATIONS		
Closure Section	CS	30
Exhaust Cone	EC	31
Fan Adapter	FA	29
Miter Section	MS	30
Rain Cap	RC	30
Rainshield	RSH	30

PIPE AND FITTING JOINT ASSEMBLY, STEP BY STEP



1. All components have a male and a female end. The orientation is indicated on the labelling of each section with an arrow. The arrow indicates the direction of the flue.
2. Before fitting the large and small ends into one another, a sealant (LTS or HTS) is applied on the male end, at the gap between the inner flange and the inner pipe.
3. Assemble both sections by sliding one section into the other until the flanges meet. A layer of sealant is applied inside the V-Groove of the Assembly band (AB) prior to it's installation over the joint.
4. The Assembly Band (AB) is installed and clamped in place with 4 nuts and bolts (supplied).
5. Insert the insulation strip around the inner joint assembly of insulated models IPPL2, IPPL2F and IPPL4F.
6. The Finishing Band (FB) is installed by slipping the edges of the band into the outer pipe edges and clamping them with 3 nuts and bolts (supplied).

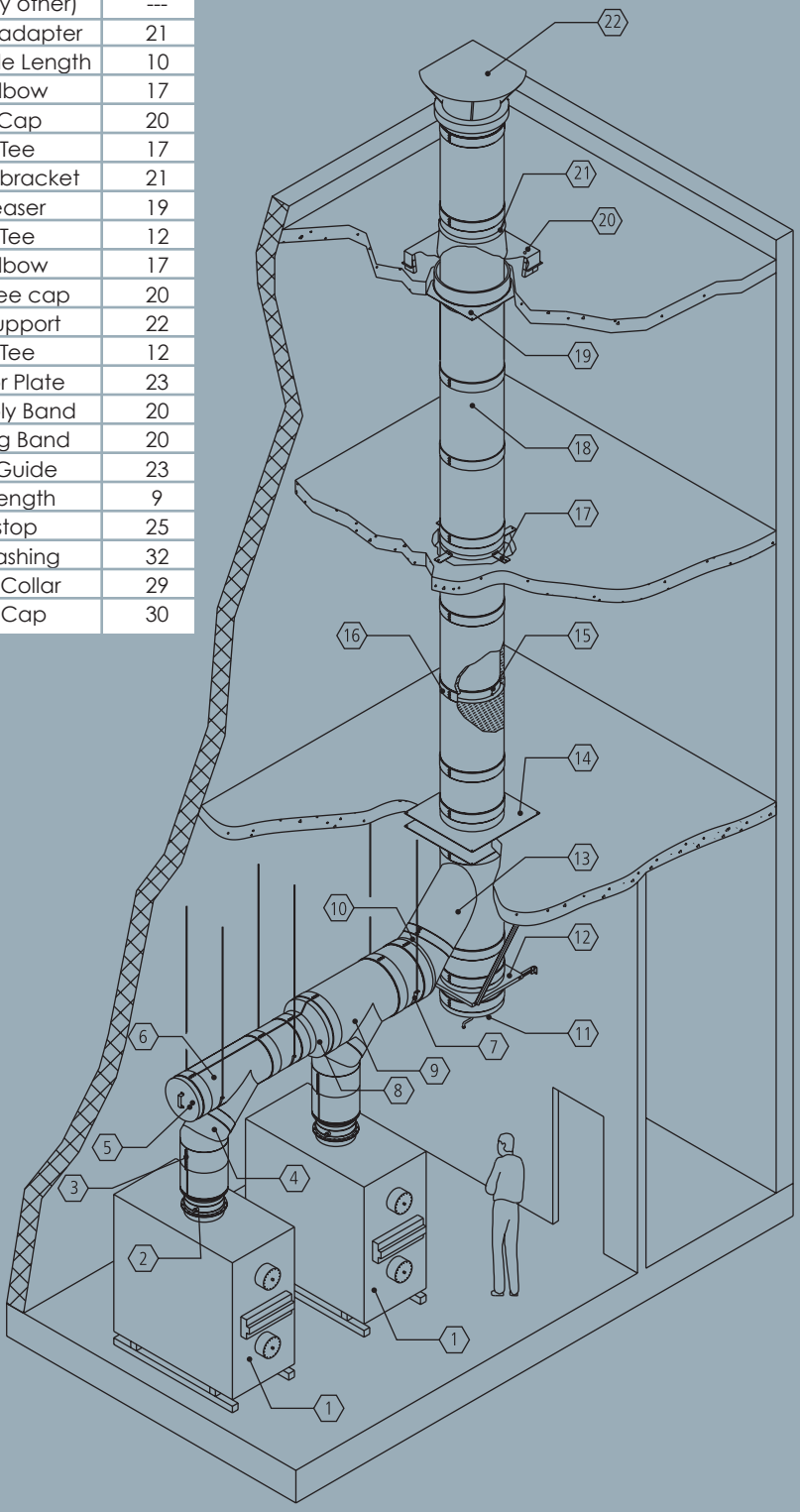
LTS: Low Temperature Sealant. 600˚F maximum flue gas temperature
HTS: High Temperature Sealant. Up to 2000˚F flue gas temperature
ES: Exterior Sealant. Outer sealant weather proof

7. FOR OUTDOOR INSTALLATION AND BAD WEATHER PROTECTION, AN EXTERIOR SEALANT (ES) IS APPLIED AT THE JOINT BETWEEN THE FINISHING BAND (FB) AND THE OUTER WALL OF THE CHIMNEY.

SAMPLE DRAWINGS

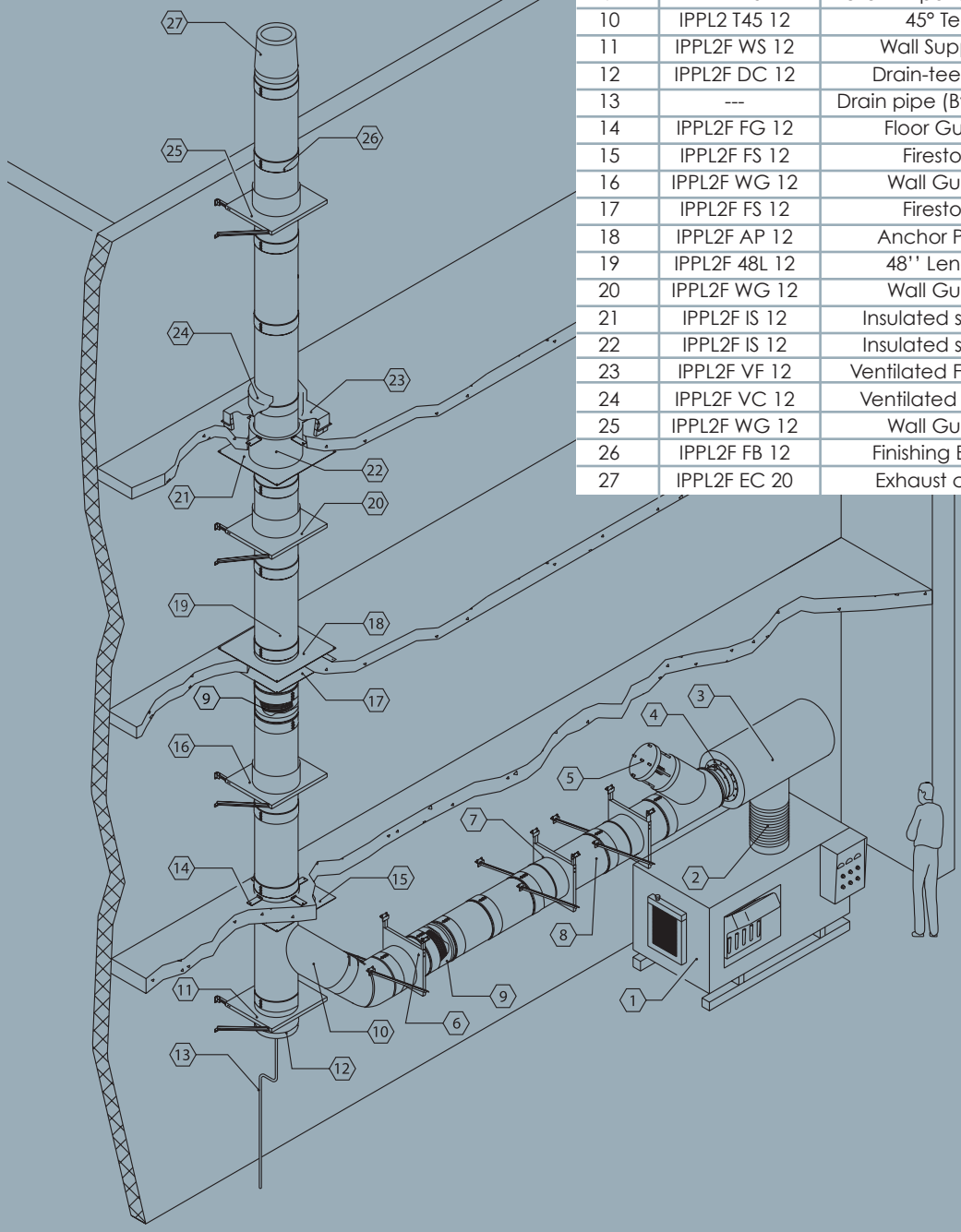
Sample Drawings

No.	Part No.	Descrption	Page
1	---	Boiler (By other)	---
2	IPPL2 SA 16	Starting adapter	21
3	IPPL2 AL 16	Adjustable Length	10
4	IPPL2 E45 16	45° Elbow	17
5	IPPL2 TC 16	Tee Cap	20
6	IPPL2 T45 16	45° Tee	17
7	IPPL2 HB 16	Hanger bracket	21
8	IPPL2 I 16	Increaser	19
9	IPPL2 T45 20	45° Tee	12
10	IPPL2 E45 20	45° Elbow	17
11	IPPL2 DC 20	Drain-tee cap	20
12	IPPL2 WS 20	Wall support	22
13	IPPL2 T45	45° Tee	12
14	IPPL2 AP 20	Anchor Plate	23
15	IPPL2 AB	Assembly Band	20
16	IPPL2 FB 20	Finishing Band	20
17	IPPL2 FG 20	Floor Guide	23
18	IPPL2 48L 20	48'' Length	9
19	IPPL2 FS 20	Firestop	25
20	IPPL2 F 20	Flat Flashing	32
21	IPPL2 SC 20	Storm Collar	29
22	IPPL2 RC 20	Rain Cap	30



ENGINE EXHAUST

Sample Drawings



No.	Part No.	Descrption	Page
1	---	Boiler (By other)	---
2	---	Adapter (By others)	---
3	---	Muffler (By others)	---
4	IPPL2F SA 12	Starting adapter	21
5	IPPL2F RV 12	Relief Valve	24
6	IPPL2F HS 12	Horizontal Support	22
7	IPPL2F WG 12	Wall Guide	22
8	IPPL2F 48L 12	48'' Length	9
9	IPPL2F EJ 12	Bellow Expansion Joint	17
10	IPPL2 T45 12	45° Tee	17
11	IPPL2F WS 12	Wall Support	22
12	IPPL2F DC 12	Drain-tee cap	20
13	---	Drain pipe (By others)	---
14	IPPL2F FG 12	Floor Guide	23
15	IPPL2F FS 12	Firestop	25
16	IPPL2F WG 12	Wall Guide	22
17	IPPL2F FS 12	Firestop	25
18	IPPL2F AP 12	Anchor Plate	23
19	IPPL2F 48L 12	48'' Length	9
20	IPPL2F WG 12	Wall Guide	22
21	IPPL2F IS 12	Insulated sleeve	25
22	IPPL2F IS 12	Insulated sleeve	25
23	IPPL2F VF 12	Ventilated Flashing	33
24	IPPL2F VC 12	Ventilated Collar	29
25	IPPL2F WG 12	Wall Guide	22
26	IPPL2F FB 12	Finishing Band	20
27	IPPL2F EC 20	Exhaust cone	31

Chimney

1-YEAR STANDARD WARRANTY

Models IPPL, IPPL2, IPPL2F and IPPL4F

All components of our models IPPL, IPPL2, IPPL2F and IPPL4F chimney system have been inspected in our workshop in accordance with our quality standards. Cheminée Lining.e inc. warrants the chimney/exhaust system and components against defects in material and workmanship for a period of (1) one year from date of delivery to the purchaser. During this period, any system or component supplied by Cheminée Lining.e inc. failing to perform its intended function of exhausting, without adverse leakage, combustion by-products from engine or heating appliance will be repaired or replaced at the manufacturer option.

This warranty is limited to repair or replacement of any component which has been proven defective by a factory-authorized inspector by Cheminée Lining.e inc. This warranty does not cover any labour cost or freight charge for removal or replacement of the defective product, nor does this warranty cover any system component not furnished by Cheminée Lining.e inc. and installed as part of the system. The warranty on any repaired or replacement component shall be for a duration no longer than the remaining or unexpired term of the original warranty.

This standard warranty is subject to the following conditions:

a) Generally accepted engineering practices have been followed to determine that sizing and material specifications are suitable for the application and environment involved.
b) The undamaged components have been correctly installed in accordance with the installation instructions published by Cheminée Lining.e inc. at the time of shipment.

The standard warranty is extended to a **15-YEAR LIMITED WARRANTY** provided the following conditions are satisfied:

a) The chimney must have been connected to an appliance listed by a testing authority recognized by the federal government. Also, this warranty is void if the appliance was not installed, used and maintained according to the manufacturer instructions.
b) The chimney system must have been designed and sized by the engineering department of Cheminée Lining.e inc. All design and operating parameters provided to Cheminée Lining.e inc. must meet the standards of Cheminée Lining.e inc. and must be accurately representative of the operating conditions.
c) The undamaged components must have been correctly installed, used and maintained in accordance with the instructions published by Cheminée Lining.e inc. at the time of shipment.
d) Air used in combustion must be free from any solvent or refrigerant vapor and from any halogenated compound which might generate acid condensate within the flue or chimney.
e) Cheminée Lining.e inc. has supplied the entire chimney or exhaust system from the appliance outlet to the stack termination.
f) Prior to start-up and thereafter, exposed galvanized and aluminized steel surfaces are at all times protected with a minimum of one base coat primer and one finish coat of heat and corrosion resistant paint.

In no event shall Cheminée Lining.e inc. be liable for any incidental or consequential damages of any kind or for any damage resulting in whole or in part from misuse, improper installation, removal and/or reuse of components or inadequate maintenance of the system or any component part thereof. In no event shall Cheminée Lining.e inc. be liable for any cost of installation, removal and reinstallation. Cheminée Lining.e inc. assumes no liability in case of fire, chimney fire, lightning or act of God. This warranty is in lieu of all other express warranties or guarantees of any kind. All implied warranties, including merchantability and fitness, are limited to the duration of the express warranty contained herein. Cheminée Lining.e inc. neither assumes nor authorizes any other person to assume on its behalf any other liability in connection with products sold. No agent is authorized to make any modification to this warranty or additional warranties, even if in writing, binding Cheminée Lining.e inc.

The purchaser or complainant must send all claims under this warranty in writing to Cheminée Lining.e inc. Customer Service Department.

warranty

CHEMINÉE Lining

Chapter 22 GRILLES & DIFFUSERS

MANUFACTURER/DISTRIBUTOR:

VENTIL-X-PERT
Jean-Paul Jobin
9855 Boul, L,- H. Lafontaine
Anjou, QC, H1J 2A3
Email: jpjobin@ventil-x-pert.com
Tel: 514-355-4540

22.1 **NAILOR -- 61CD PATTERN 1A REGISTER**

22.2 **NAILOR -- 6155 RETURN / EXHAUST GRILLE**

22.3 **VENTEX – 2215**

22.4 **VENTEX -- 3165 DAMPER**

22.5 **VENTEX -- 3965 INSULATED DAMPER**

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 21 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

SECTION 1:

GRILLES ET DIFFUSEURS

Nailor Industries, Inc.

Type A & B

Q.A.T.
Qualité Air Totale • Total Air Quality
3049 Peugeot, Laval, Québec, H7L 5C4, tel: (450) 681-5355, mtl: (514) 990-0566, fax: (450) 681-5834

CÉDULE POUR GRILLES ET DIFFUSEURS

CLIENT : LES ENTREPRISES SIFEC NORD INC.

INGÉNIEURS :

BON DE COMMANDE : #YGT12

NOTRE RÉFÉRENCE : #58794

PROJET : IGLOOLIK WATER & WASTERWATER

DATE: mercredi, 15 juin 2016

Légende sur plan	No. Modèle Nailor	Dimensions du conduit (POUCES) L X H	Description	No. de Dessin	Qté
	61CD-S-AW-A-1A-AB	10X4	G.R.	61C-1	3
	61CD-S-AW-A-1A-AB	12X6	G.R.	61C-1	3
	6155H-S-AW-A	14X14	G.R.	6100-8	1
	6155V-S-AW-A	48X36	G.R.	6100-8	1

NOMENCLATURE

G.A.:	Grille d'alimentation	G.T.:	Grille de transfert	R.E.:	Registre d'évacuation
R.A.:	Registre d'alimentation	G.P.:	Grille de porte	R.L.:	Registre de plancher
G.R.:	Grille de retour	G.E.:	Grille d'évacuation	Diff.:	Diffuseur
R.R.:	Registre de retour	G.L.A:	Grille linéaire d'alim.	D.L.A:	Diffuseur linéaire d'alim.
V.C.F.:	Volet coupe-feu	G.L.R:	Grille linéaire de retour	D.L.R.:	Diffuseur linéaire de retour
C.C.F:	Clapet coupe-feu	C.T.:	Couverture thermique	ACC. :	Accessoires

NOTE : L'ENTREPRENEUR DOIT NOUS FOURNIR LES DIMENSIONS EXACTES (CONDUITS, COLLETS, ETC.) COULEUR (FINITION), ET LA CONFIGURATION (T-BAR, GYPSE, ETC.), LORS DE LA RELÂCHE

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 24 June 2016

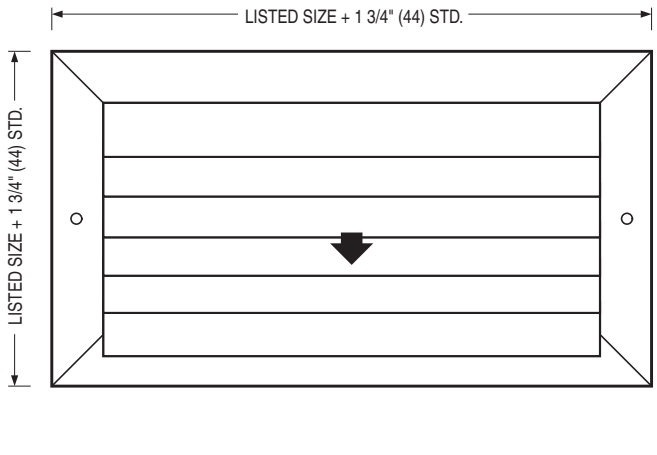
Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Type A

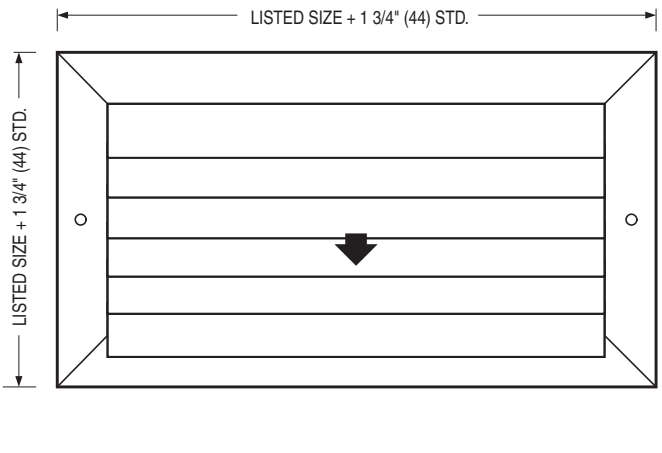
Nailor® Industries Inc.

STEEL CURVED BLADE GRILLES & REGISTERS
ONE-WAY DISCHARGE PATTERN
MODELS: 61C(-O) AND 61CD(-O) TYPE S



❑ **MODEL 61C**
Curved Blade Grille
1-Way Discharge Pattern

❑ **MODEL 61C-O**
Curved Blade Register
1-Way Discharge Pattern
(Includes O. B. Damper)



❑ **MODEL 61CD**
Curved Blade Grille with
rear directional vanes
1-Way Discharge Pattern

❑ **MODEL 61CD-O**
Curved Blade Register with
rear directional vanes
1-Way Discharge Pattern
(Includes O. B. Damper)

DESCRIPTION:

1. Construction: Corrosion-resistant steel. Curved vanes on 1" (25) centers. Frame is mechanically inter-locked for strength with hairline miters. Rear adjustable equalizing vanes on 61CD models are "teardrop" on 3/4" (19) centers. Roll-formed steel opposed blade damper on registers has screwdriver slot operator.
2. The min. size is 6" x 4" (152 x 102). The maximum size is 36" x 36" (914 x 914).
3. **Discharge Pattern Selection:**
   ☐ 1A ☐ 1B

4. Type S Surface mount frame has a 1 1/4" (32) face border and a 1" (25) overlap margin.
5. Curved blades are individually adjustable and regulate angle of discharge.
6. Standard fastening is Type A countersunk screwholes.
7. Standard finish is AW Appliance White.

OPTIONS:

1. Finish:
   ❑ SP Special _____ .
2. Fastening:
   ❑ Type C Concealed mounting straps
   ❑ Type D Concealed screwholes in neck
   ❑ Type N None
3. ❑ Type FB Fixed Curved Blades
4. ❑ PF Plaster sub-frame
5. ❑ IS Insect screen
6. ❑ Other _____ .

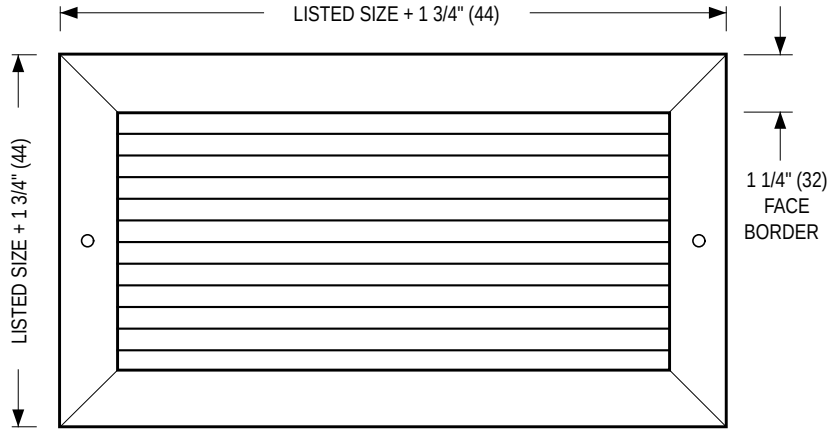
SCHEDULE TYPE:				
PROJECT:				
ENGINEER:	**DATE**	**B SERIES**	**SUPERSEDES**	**DRAWING NO.**
CONTRACTOR:	**2 - 1 - 11**	**6100**	**6100-6/13-10-00R**	**61C-1**

Dimensions are in inches (mm).

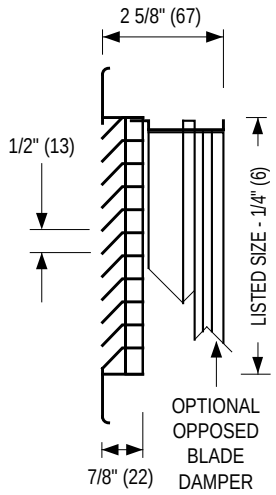
Nailor Industries Inc. reserves the right to change any information concerning product or pricing without notice.

Type B

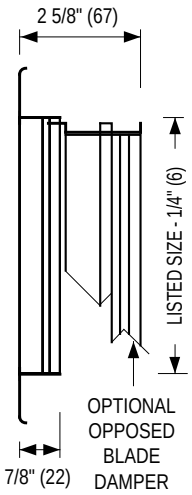
STEEL RETURN GRILLES & REGISTERS
FIXED BLADES • 1/2" (13) CENTERS
MODELS: 6155H(-O) AND 6155V(-O) TYPE S



Model 6155H



MODEL 6155H
Horizontal Blades



MODEL 6155V
Vertical Blades

❑ **MODEL 6155H**
Single Deflection Grille
Fixed 45° Horizontal Blades

❑ **MODEL 6155H-O**
Single Deflection Register
Fixed 45° Horizontal Blades
(Includes O. B. Damper)

❑ **MODEL 6155V**
Single Deflection Grille
Fixed 45° Vertical Blades

❑ **MODEL 6155V-O**
Single Deflection Register
Fixed 45° Vertical Blades
(Includes O. B. Damper)

DESCRIPTION:

1. Construction: Corrosion resistant steel. Roll-formed frame mechanically interlocked with reinforced mitered corners for strength. Streamlined shaped blades on 1/2" (13) centers are fixed at 45 degrees. Concealed reinforcing mullions on maximum 16" (406) centers. No see through when viewed from straight ahead.
2. Optional roll-formed steel opposed blade damper has a concealed lever operator.
3. Minimum size is 4" x 4" (102 x 102). Maximum size is 48" x 36" (1219 x 914).
4. Type S surface mount frame has a 1 1/4" (32) face border and a 1" (25) overlap margin.
5. Standard fastening is Type A countersunk screw holes.
6. Standard finish is AW Appliance White.

OPTIONS:

1. Finish:
   ❑ SP Special _____ .
2. Fastening:
   ❑ Type N None.
3. ❑ PF Plaster frame
4. ❑ IS Insect screen
5. ❑ Other _____ .

SCHEDULE TYPE:				
PROJECT:				
ENGINEER:	**DATE**	**B SERIES**	**SUPERSEDES**	**DRAWING NO.**
CONTRACTOR:	**2 - 7 - 11**	**6100**	**6100-3B/17-10-00**	**6100-8**

Dimensions are in inches (mm).

Nailor Industries Inc. reserves the right to change any information concerning product or pricing without notice.

Ventex

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

SECTION 3:

CÉDULE POUR VOLETS MOTORISÉS

ALUMAVENT

Ventex

Q.A.T.
Qualité Air Totale • Total Air Quality
3049 Peugeot, Laval, Québec, H7L 5C4, tel: (450) 681-5355, mtl: (514) 990-0566, fax: (450) 681-5834

CÉDULE POUR VOLETS MOTORISÉS

CLIENT: LES ENTREPRISES SIFEC NORD INC.

INGÉNIEURS:

BON DE COMMANDE : #YTG12

NOTRE RÉFÉRENCE : #58794

PROJET: IGLOOLIK WATER & WASTERWATER

DATE: mercredi, 15 juin 2016

Légende sur plan	No. Modèle ALUMAVENT	Dimensions du conduit (POUCES) L X H	Description	No. de dessin	Qté
	3165, EN ALUMINIUM NON-ISOLÉ	48X36	V.M.	VM/1@2	2
	3965, EN ALUMIMINUM ISOLÉ	48X6	V.M.	VM/3@5	1
	3965, EN ALUMIMINUM ISOLÉ	48X36	V.M.	VM/3@5	1

NOTES :

x

24 June 2016

S.V.P. NOUS CONFIRMER SI LES VOLETS SEONT DE TYPE INSÉRÉS AU CONDUIT (MODÈLE #3161/3961) OU À BRIDES (MODÈLE #3165/3965)

S.V.P. NOUS CONFIRMER SI LES LAMES SERONT PARALLÈLES OU À LAMES OPPOSÉES

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: _____

Reviewed ☐
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

D1

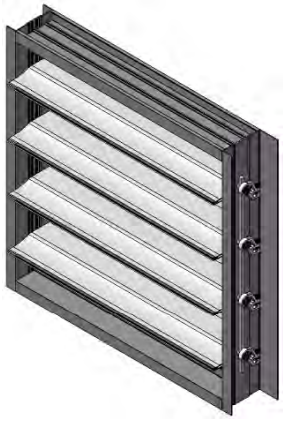
ALUMAVENT

VOLETS MOTORISÉS & VOLETS COUPE FEU

3100 SERIES

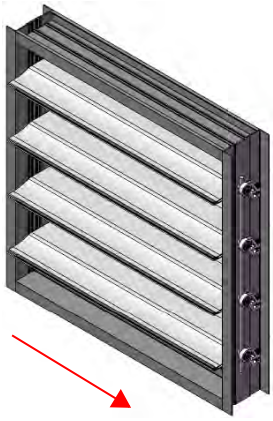
VOLETS MOTORISÉS NON-ISOLÉ

3160 | 3161 | 3165



3160
Inséré au conduit

3161 Quick 'N' Stall
Inséré au conduit



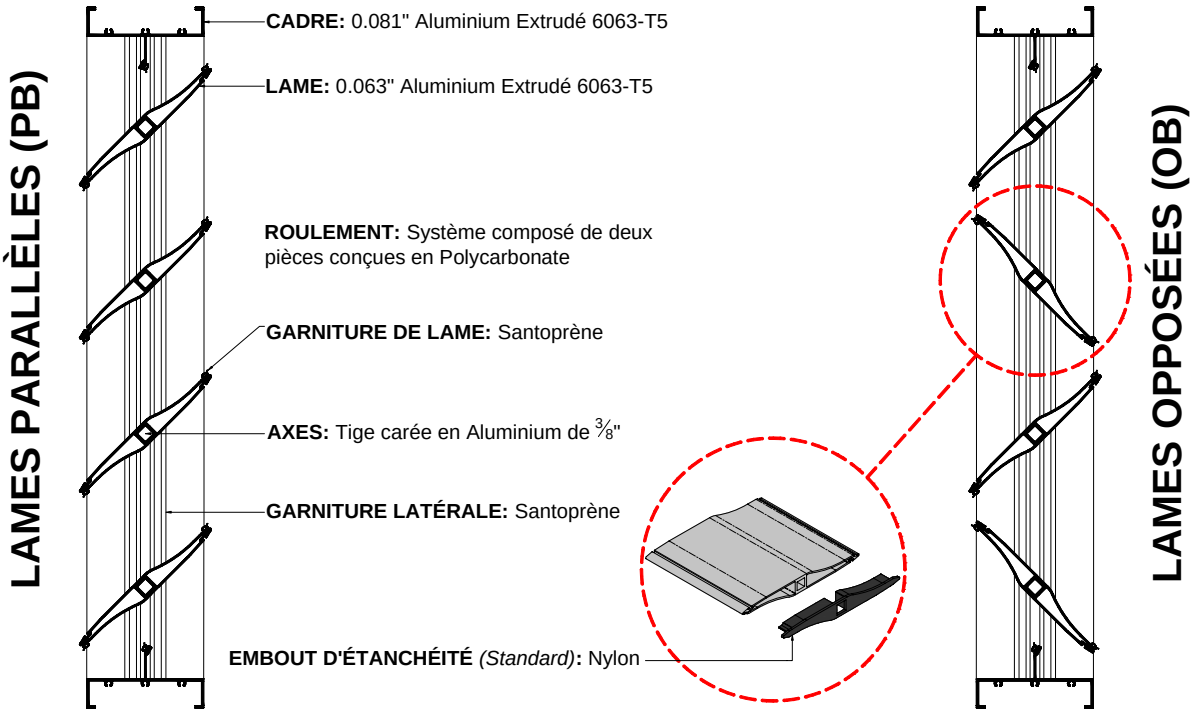
3165
Attaché au conduit

CONSTRUCTION STANDARD

Cadre: 4" *(101 mm)* – 3160/3165
5.25" *(133 mm)* – 3161
Profondeur lames ouvertes: 6.125" *(156 mm)*
Hauteur minimum: 8" *(203 mm)* – Lame simple
15" *(381 mm)* – Lame Multiple
Largeur maximum par panneau: 48" *(1219 mm)*
Hauteur maximum par panneau: 60" *(1524 mm)*
Pied^2 maximum par panneau:: 20 pi^2
Pression maximum du système : 4" w.g. *(1 kPa)*
Température d'opération: -40° to +180° F
Fini standard: Aluminium Naturel
Entrainement standard: Direct avec tige téléscopique de 6''
Tringlerie: - Disimulée en dehors du flux d'air (3160/3161)
- En dehors du cadre (3165)
Embout d'étanchéité: En Nylon standard sur toutes les lames

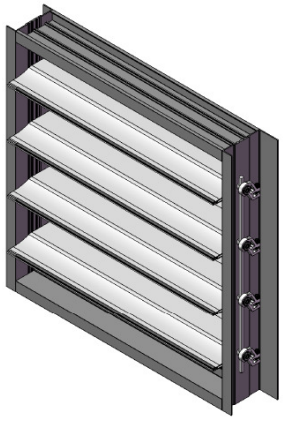
ACCESSOIRES DISPONIBLES

- **Actuateurs [Honeywell, Belimo]**
- **Interrupteur de fin de course**
- **Axes de renvois avec ou sans roulement à billes**
- **Quadrants à main**
- **Opération par chaîne avec ressort de rappel**
- **Garniture en silicone (3100 *SS*)**
- **Construction eau salé – (3100 *SW*)**

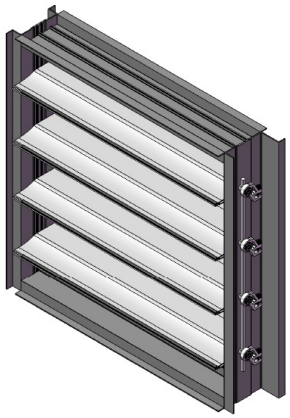


DWG. 3160-3161-3165-FR APRIL 2009

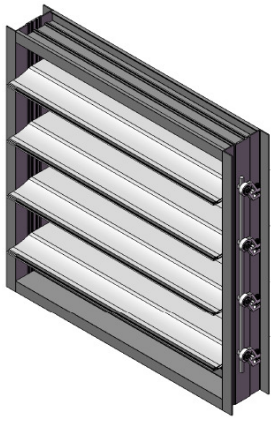
3100 SERIES
NON-INSULATED CONTROL DAMPERS
3160 | 3161 | 3165



3160
Duct-Mount



3161 Quick 'N' Stall
Duct-Mount



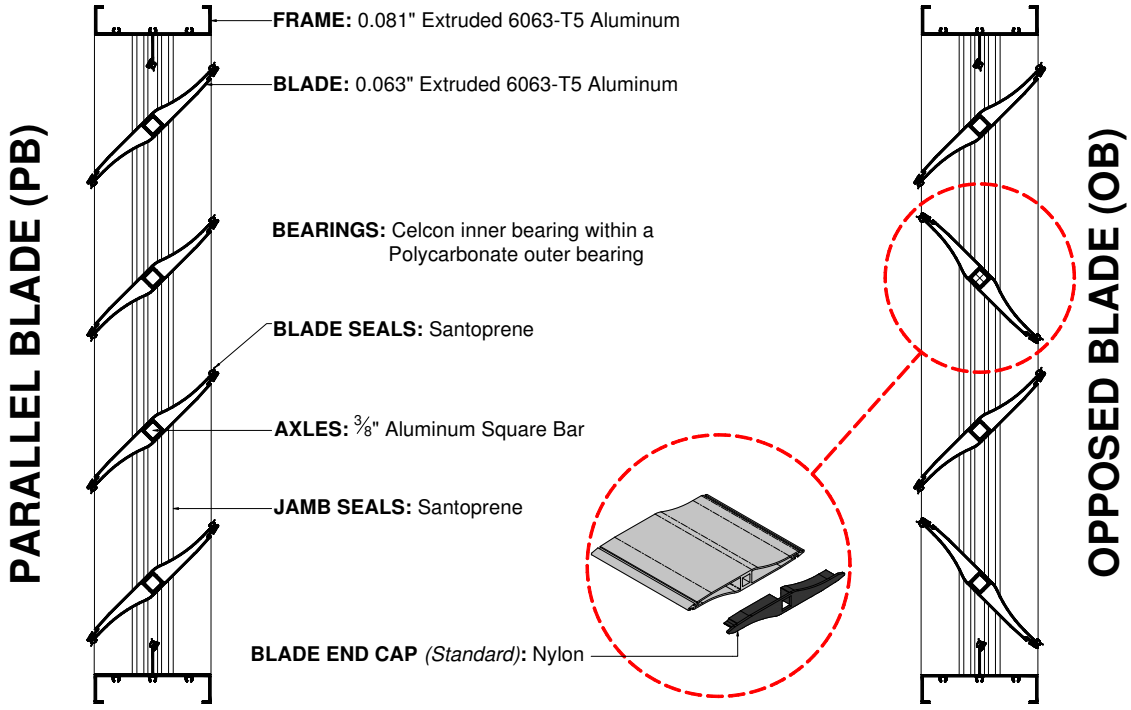
3165
Flanged-to-Duct

STANDARD CONSTRUCTION

Depth: 4" *(101 mm)* – 3160/3165
5.25" *(133 mm)* – 3161
Depth with Blades Open: 6.125" *(156 mm)*
Minimum Height: 8" *(203 mm)* - Single Blade
15" *(381 mm)* - Multiple Blade
Maximum Panel Width: 48" *(1219 mm)*
Maximum Panel Height: 60" *(1524 mm)*
Maximum Panel Size: 20 Sq.Ft.
Maximum System Pressure: 4" w.g. *(1 kPa)*
Operating Temperature Range: -40° to +180° F
Standard Finish: Mill
Standard Motor Installation: 6" Side Shaft Direct Drive
Linkage: Concealed in Frame (3160/3161)
Outside of Frame (3165)
Blade End Cap: Nylon

AVAILABLE ACCESSORIES

- **Actuators [Honeywell, Belimo]**
- **End Switch for signaling peripheral devices**
- **Jack Shaft**
- **Hand Quadrants**
- **Chain Operation for manual operation spring closed**
- **Silicone Blade and Jamb Seals – Specify 3100 *SS***
- **Salt Water Construction – Specify 3100 *SW***
- **Available finish: Clear Anodized**
- **4" Blade Construction**



DWG. 3160-3161-3165 *MARCH 2011*

D1

ALUMAVENT

VOLETS MOTORISÉS & VOLETS COUPE FEU

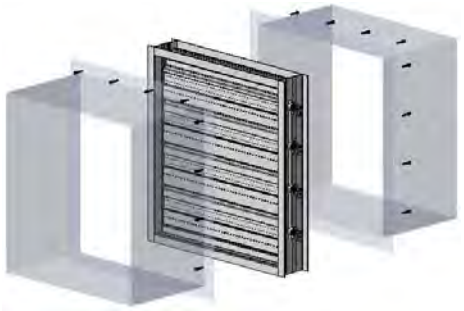
3100 SERIES

VOLETS MOTORISÉS NON-ISOLÉ

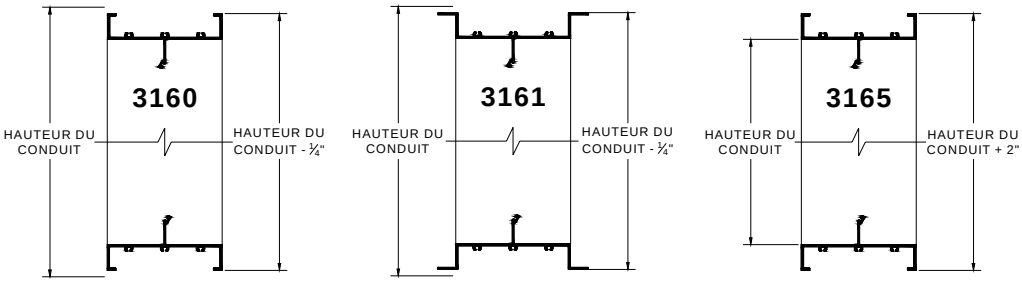
3160 | 3161 | 3165

3160 – Inséré au conduit

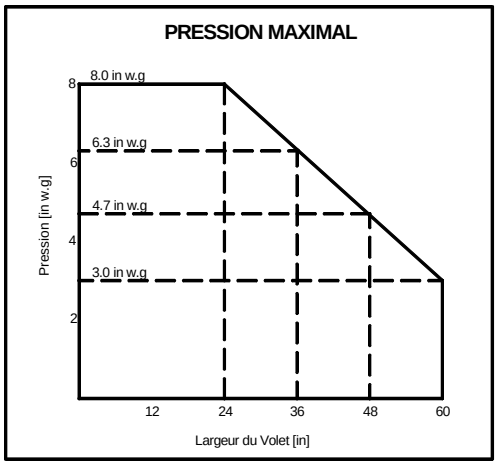
3161 – Inséré au conduit

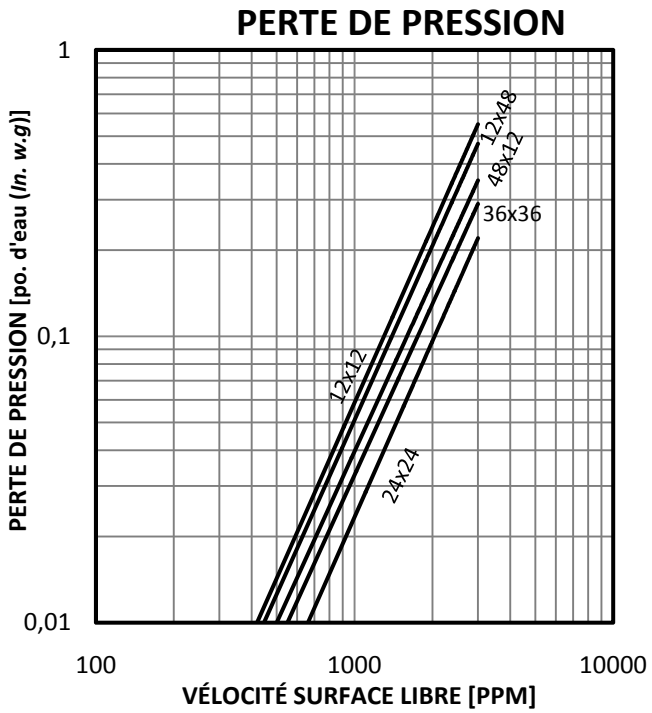


3165 – Attaché au conduit



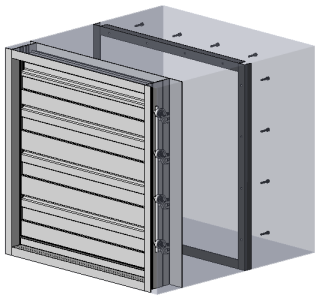
Configuration Inséré: *3160 / 3161*
Configuration Attaché: *3165*



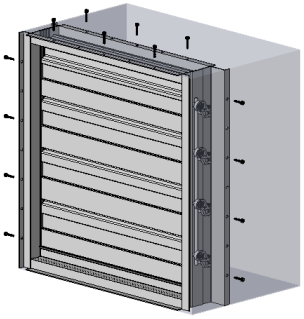


SPÉCIFICATION RECOMMANDÉES

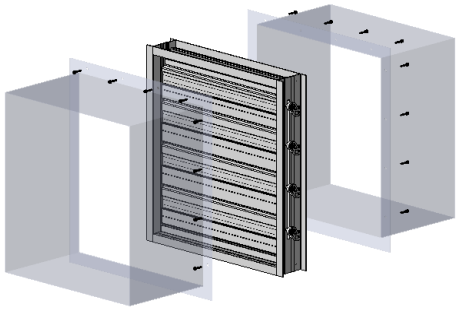
Fournir et installer les volets motorisés Alumavent, modèle 3160/3161/3165. Les volets seront d'une profondeur de 4" (101 millimètres) et n'excèdent pas 6.125'' (156 mm) lorsqu'en position ouverte. Les cadres de 4'' (101mm) seront d'un alliage d'aluminium d'au moins 0.081"(2.06 mm) et les lames d'au moins 0.063". Chaque lame est conçue avec des embouts d'étanchéités en Nylon. Les garnitures coupe-froid sur les lames et les cadres seront en résine de vinyle du type 'Santoprène' et seront intégrées aux extrusions. Le transfert des charges sera effectué par des coussinets conçus en thermoplastique d'acétal fixés à une tige d'aluminium d'alliage 6063-T5 d'au moins 0.375" (9.53 mm) et d'une tige maîtresse en acier traitée. La tringlerie sera cachée en dehors du flux d'air permettant un bon fonctionnement dans des conditions d'opération variant entre -40°F (-40°C) à 180°F (82°C) . L'étanchéité d'un volet de 48'' (1220 mm) x 48'' (1220 mm) n'excédera pas 8 PCM/pi^2 (*40.6 l/s/m²*) contre une pression de 4" w.g. (1 kPa). L'installation des volets de contrôle devra satisfaire les exigences émises par le manufacturier.



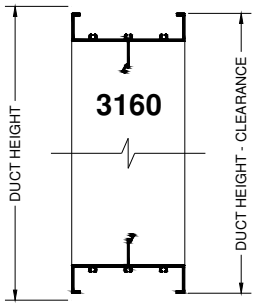
3160 – Duct-Mount

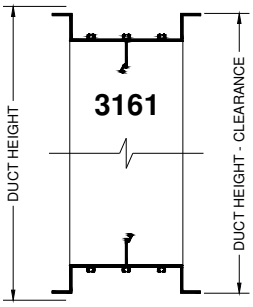


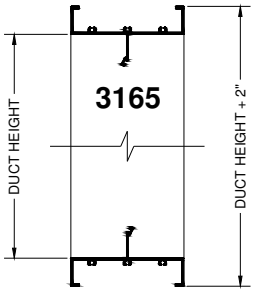
3161 – Duct-Mount



3165 – Flanged-to-Duct

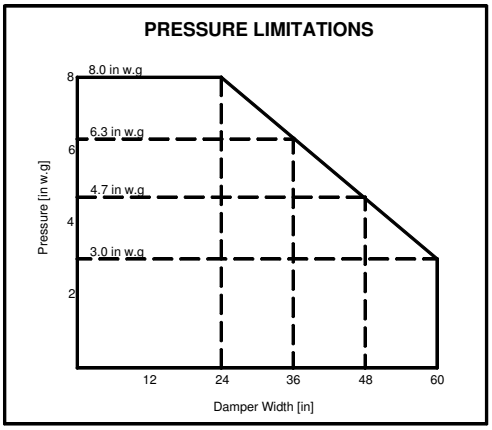




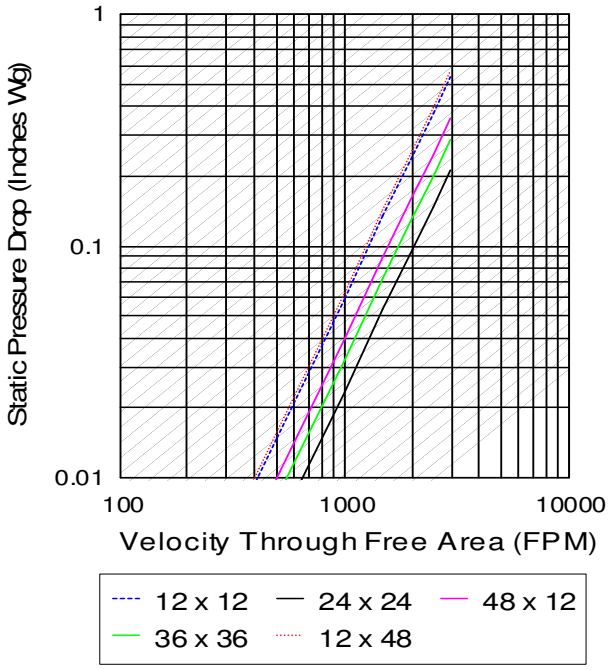


For Duct-Mount Frame specify: *3160 / 3161*
For Flanged-to-Duct Frame specify: *3165*

**For Models 3160 and 3161:*
Clearance = 1/4" Overall for Single Panel Construction
Clearance = 1/2" Overall for Multiple Panel Construction



Pressure Drop



RECOMMENDED SPECIFICATION

Furnish and install control damper models 3160 / 3161 / 3165 as manufactured by Alumavent, Bolton Ontario. Dampers shall be 4" *(101 mm)* deep. Blades shall be 0.063" *(1.60 mm)* thick, hollow airfoil shape. Frames shall be 0.081" *(2.06 mm)* thick. Axles shall be 0.375" *(9.53 mm)* thick, Aluminum square bar. Blade and Jamb seals shall be Santoprene. Linkage is concealed in frame for models 3160 / 3161 and outside of frame for model 3165. Air leakage through a 48"x48" damper shall not exceed 8 CFM/ ft^2 *(40.6 L/s/m^2)* against 4" w.g *(1 kPa)* static pressure at standard air. Operating temperature range shall be -40° to +180° F.

DWG. 3160-3161-3165 *MARCH 2011*

D2

ALUMAVENT

VOLETS MOTORISÉS & VOLETS COUPE FEU

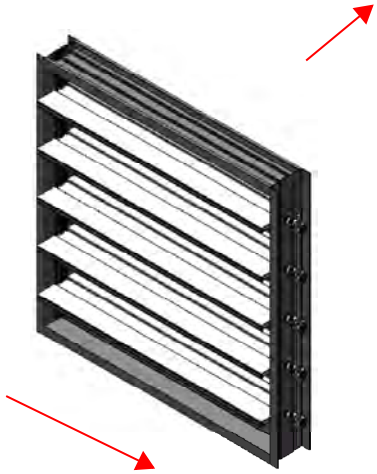
3900 SERIES

VOLETS MOTORISÉS ISOLÉS

3960 | 3961 | 3965

3960
Inséré au conduit

3961 Quick 'N' Stall
Inséré au conduit



3965
Attaché au conduit

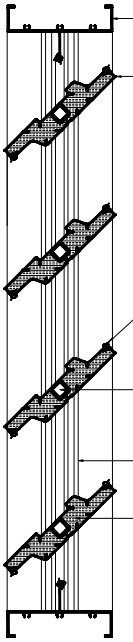
CONSTRUCTION STANDARD

Cadre: 4" ***(101 mm)*** – 3960/3965
5.25" ***(133 mm)*** – 3961
Profondeur lames ouvertes: 6.125" ***(156 mm)***
Hauteur minimum: 8" ***(203 mm)*** – Lame simple
15" ***(381 mm)*** – Lame Multiple
Largeur maximum par panneau: 48" ***(1219 mm)***
Hauteur maximum par panneau:: 60" ***(1524 mm)***
Pied^2 maximum par panneau:: 20 pi^2
Pression maximum du système : 4" w.g. ***(1 kPa)***
Température d'opération: -40° to +180° F
Fini standard: Aluminium Naturel
Entrainement standard: Direct avec tige téléscopique de 6''
Tringlerie: - Disimulée en dehors du flux d'air (3960/3961)
- En dehors du cadre (3965)

ACCESSOIRES DISPONIBLES

- **Actuateurs [Honeywell, Belimo]**
- **Interrupteur de fin de course**
- **Axes de renvois avec ou sans roulement à billes**
- **Quadrants à main**
- **Opération par chaîne avec ressort de rappel**
- **Garniture en silicone (3900 *SS*)**
- **Construction eau salé – (3900 *SW)***
- **Cadre isolé: polystyrène sur 3 côtés lorsqu' insérés et 4 côtés lorsqu'attachés**

LAMES PARALLÈLES (PB)



CADRE: 0.081" Aluminium Extrudé 6063-T5

LAME: 0.063" Aluminium Extrudé 6063-T5

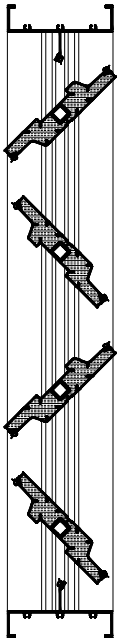
ROULEMENT: Système composé de deux pièces conçues en Polycarbonate

GARNITURE DE LAME: Santoprène

AXES: Tige carrée en Aluminium de $^3/_8$"

GARNITURE LATÉRALE: Santoprène

ISOLATION DES LAMES: Polyurethane à haute densité moussé sans CFC-(R-2.25)

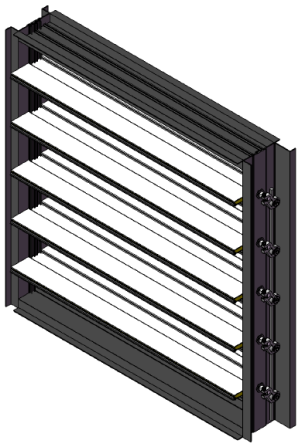


LAMES OPPOSÉES (OB)

DWG. 3960-3961-3965-FR AUGUST 2010

3900 SERIES
INSULATED CONTROL DAMPERS
3960 | 3961 | 3965

3960
Duct-Mount



3961 Quick 'N' Stall
Duct-Mount

3965
Flanged-to-Duct

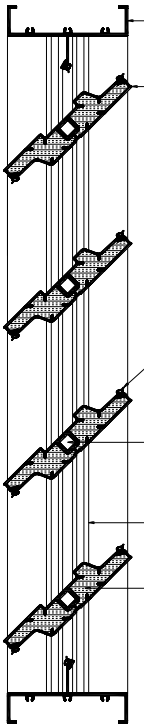
STANDARD CONSTRUCTION

Depth: 4" *(101 mm)* – 3960/3965
5.25" *(133 mm)* – 3961
Depth with Blades Open: 6.125" *(156 mm)*
Minimum Height: 8" *(203 mm)* - Single Blade
15" *(381 mm)* - Multiple Blade
Maximum Panel Width: 48" *(1219 mm)*
Maximum Panel Height: 60" *(1524 mm)*
Maximum Panel Size: 20 Sq.Ft.
Maximum System Pressure: 4" w.g. *(1 kPa)*
Operating Temperature Range: -40° to +180° F
Standard Finish: Mill
Standard Motor Installation: 6" Side Shaft Direct Drive
Linkage: Concealed in Frame (3960/3961)
Outside of Frame (3965)

AVAILABLE ACCESSORIES

- **Factory Supplied/Installed Actuators**
- **End Switch for signaling peripheral devices**
- **Jack Shaft**
- **Hand Quadrants**
- **Chain Operation for manual operation spring closed**
- **Silicone Blade and Jamb Seals – Specify 3900SI**
- **Salt Water Construction – Specify 3900SW**
- **Available finish: Clear Anodized**
- **Frame Insulation: Polystyrene Insulation**

PARALLEL BLADE (PB)



FRAME: 0.081" Extruded 6063-T5 Aluminum

BLADE: 0.063" Extruded 6063-T5 Aluminum

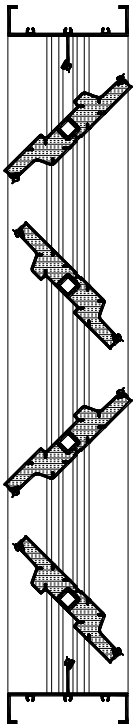
BEARINGS: Celcon inner bearing within a Polycarbonate outer bearing

BLADE SEALS: Santoprene

AXLES: 3⁄8" Aluminum Square Bar

JAMB SEALS: Santoprene

BLADE INSULATION: High density polyurethane non-CFC foam (R-2.25) - Blades are thermally broken



OPPOSED BLADE (OB)

DWG. 3960-3961-3965 *AUGUST 2010*

ALUMAVENT

VOLETS MOTORISÉS & VOLETS COUPE FEU

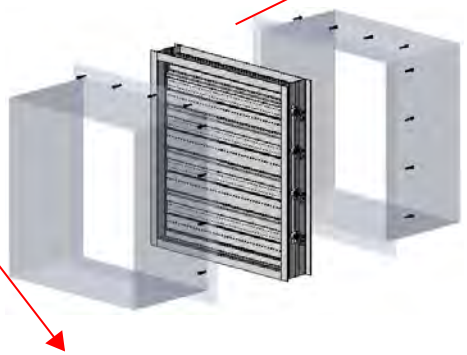
3900 SERIES

VOLETS MOTORISÉS ISOLÉS

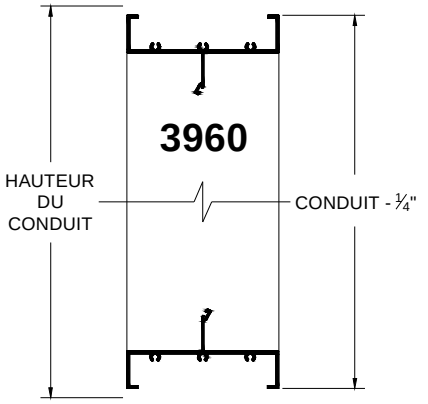
3960 | 3961 | 3965

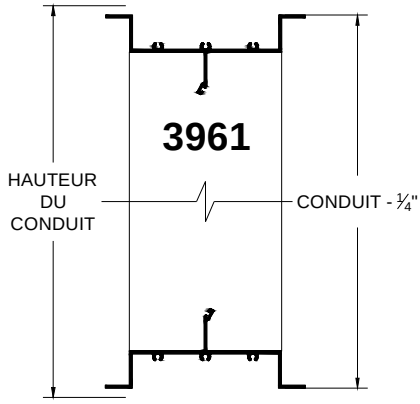
3960 – Inséré au conduit

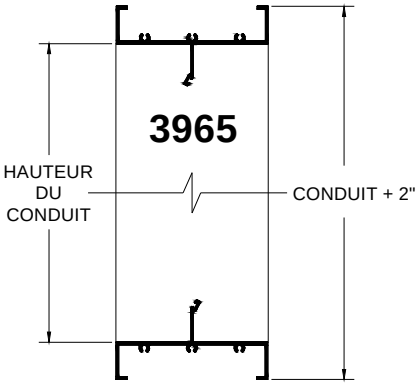
3961 – Inséré au conduit



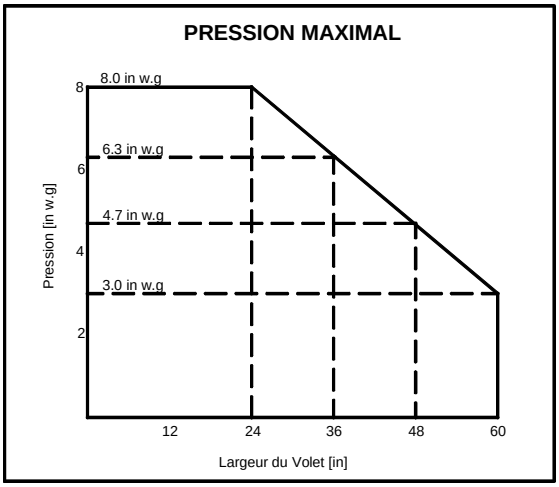
3965 – Attaché au conduit







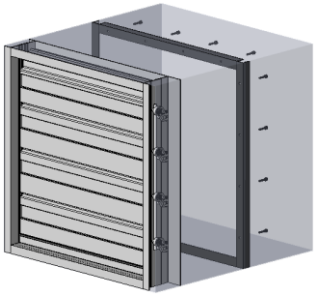
Configuration Inséré: 3960 / 3961
Configuration Attaché: 3965



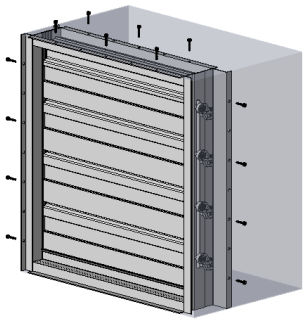
SPÉCIFICATION RECOMMANDÉES

Fournir et installer les volets motorisés Alumavent, modèle 3960/3961/3965. Les volets doivent portés le sceau de certification **AMCA**. Ils seront d'une profondeur de 4" (101 millimètres) et n'excèdent pas 6.125'' (156 mm) lorsqu'en position ouverte. Les cadres de 4'' (101mm) seront en aluminium d'au moins 0.081"(2.06 mm). Les lames seront d'un alliage d'aluminium d'au moins 0.063" ***(1.60 mm)*** avec bris thermique, injectées de polyuréthane haute densité sans CFC. Les garnitures coupe-froid sur les lames et les cadres seront en résine de vinyle du type 'Santoprène' et seront intégrées aux extrusions. Le transfert des charges sera effectué par des coussinets conçus en thermoplastique d'acétal fixés à une tige d'aluminium d'alliage 6063-T5 d'au moins 0.375" (9.53 mm) et d'une tige maîtresse en acier traitée. La tringlerie sera cachée en dehors du flux d'air permettant un bon fonctionnement dans des conditions d'opération variant entre -40°F (-40°C) à 180°F (82°C) . L'étanchéité d'un volet de 36'' (914 mm) x 36'' (914 mm) n'excédera pas 3 PCM/pi^2 (15.2 l/s/m²) contre une pression de 4" w.g. (1 kPa), tel que les tests effectués par AMCA. L'installation des volets motorisés devra satisfaire les exigences émises par le manufacturier.

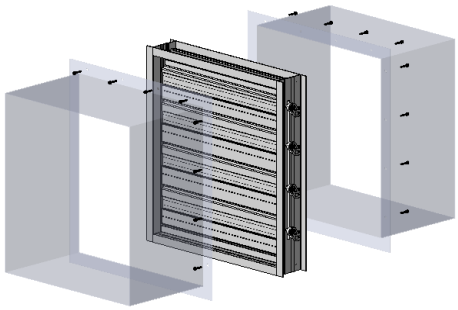
195 HEALEY ROAD | BOLTON, ON. L7E 5B2 | TEL (905) 857-4700 | FAX (905) 857-4730 | 1-800-668-7214 | ***www.ventexinc.com***



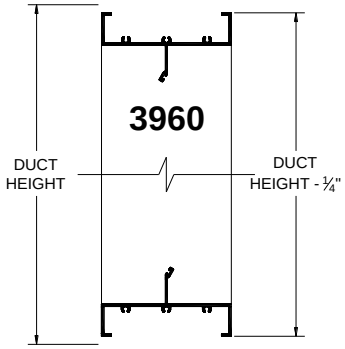
3960 – Duct-Mount

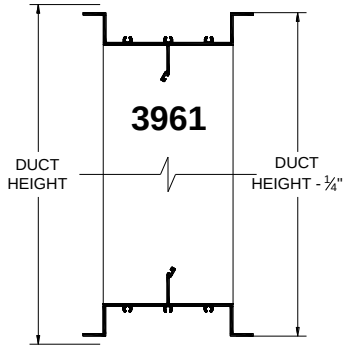


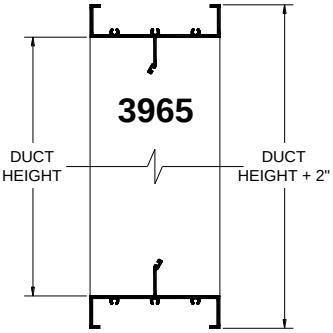
3961 – Duct-Mount



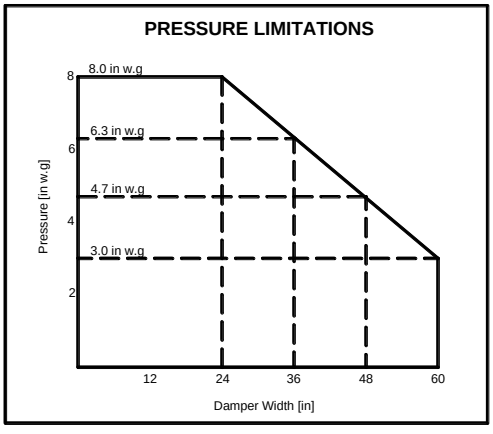
3965 – Flanged-to-Duct







For Duct-Mount Frame specify: *3960 / 3961*
For Flanged-to-Duct Frame specify: *3965*



RECOMMENDED SPECIFICATION

Furnish and install control damper models 3960 / 3961 / 3965 as manufactured by Alumavent, Bolton Ontario. Dampers must be licensed to bear the AMCA seal. Dampers shall be 4" *(101 mm)* deep. Blades shall be 0.063" *(1.60 mm)* thick, thermally broken with high density Polyurethane non-CFC injected foam insulation. Frame shall be 0.081" *(2.06 mm)* thick, with polystyrene insulation. Axles shall be 0.375" *(9.53 mm)* thick, Aluminum square bar. Blade and Jamb seals shall be Santoprene. Linkage is concealed in frame for models 3960 / 3961 and outside of frame for model 3965. Air leakage through a 36"x36" *(914 mm x 914 mm)* damper shall not exceed 3 CFM/ft^2 *(15.2 L/s/m^2)* against 4" w.g *(1.0 kPa)* static pressure at standard air (as per AMCA testing). Operating temperature range shall be -40° to +180° F.

195 HEALEY ROAD | BOLTON, ON. L7E 5B2 | TEL (905) 857-4700 | FAX (905) 857-4730 | 1-800-668-7214 | *www.ventexinc.com*

D2

ALUMAVENT

VOLETS MOTORISÉS & VOLETS COUPE FEU

3900 SERIES

VOLETS MOTORISÉS ISOLÉS

3960 | 3961 | 3965

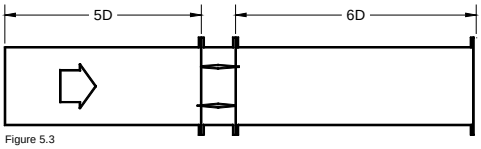
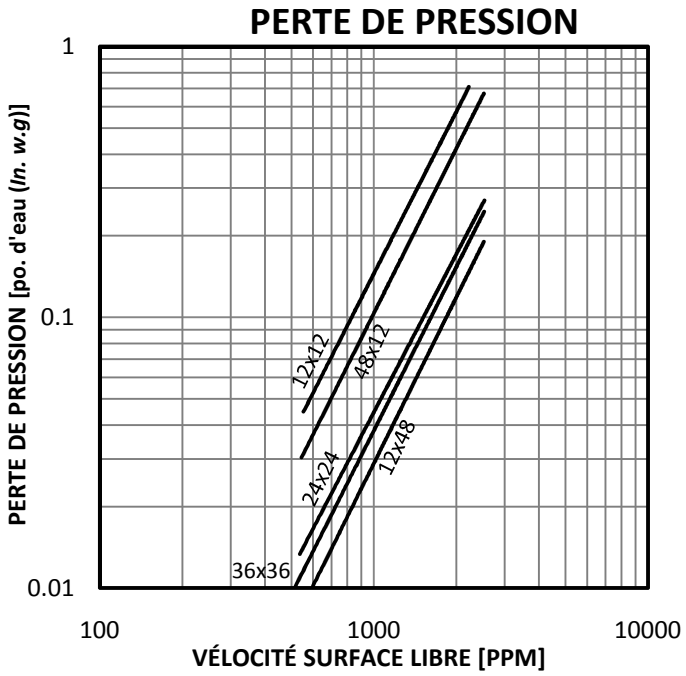


Figure 5.3

CERTIFICATION AMCA

Alumavent Inc. certifie que les volets de la série 3900 isolé sont licenciés et peuvent porter le sceau AMCA. Tous les résultats des tests sont fondés sur la procédure de la publication 511 de l'AMCA et ont remplis les exigences du programme de certification des performances de l'AMCA. Ce sceau ne s'applique qu'aux résultats des performances en matière de l'aération et de l'étanchéité.

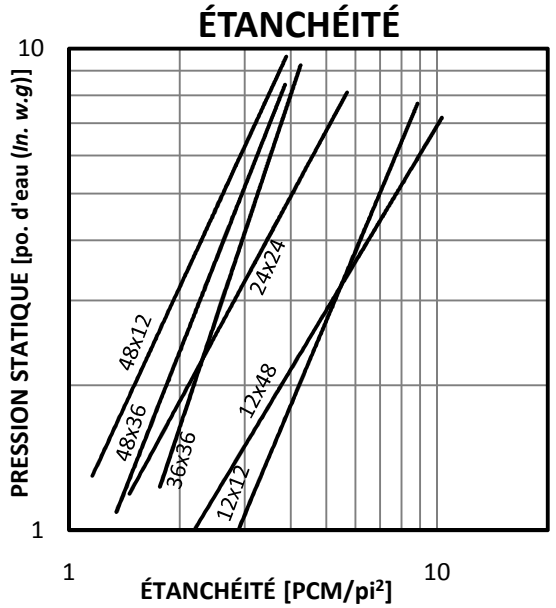
VOLETS MOTORISÉS SERIE 3900 – PERTE DE PRESSION	
Vélocité [PPM]	**Perte de Pression [po d'eau]**
12x12 (po)	
553.6	0.044
891.4	0.119
1051.9	0.161
2021.4	0.554
2221.7	0.740
24x24 (po)	
536.8	0.014
776.9	0.025
1101.1	0.056
2066.3	0.182
2530.1	0.272
36x36 (po)	
500.4	0.01
750.6	0.021
1006.1	0.036
2019.5	0.161
2526.6	0.249
12x48 (po)	
545	0.008
772.8	0.018
1095.3	0.035
2055.5	0.126
2519.2	0.187
48x12 (po)	
544.6	0.029
772.2	0.064
1094.4	0.1228
2053.1	0.439
2516	0.661



Résultats : selon AMCA Standard 500-D Configuration du test Voir Figure 5.3

DÉFINITION DES CLASSES D'ÉTANCHÉITÉ				
CLASS	**ÉTANCHÉITÉ pi³/min/pi² *(L/s/m²)***			
	1" *(0.25 kPa)*	**4" *(1.0 kPa)***	**8" *(2.0 kPa)***	**12" *(3.0 kPa)***
1A	3 ***(15.2)***	N/A	N/A	N/A
1	4 ***(20.3)***	8 ***(40.6)***	11 ***(55.9)***	14 ***(71.1)***
2	10 ***(50.8)***	20 ***(102)***	28 ***(142)***	35 ***(178)***
3	40 ***(203)***	80 ***(406)***	112 ***(569)***	140 ***(711)***

CLASSIFICATIONS D'ÉTANCHÉITÉ DU VOLETS MOTORISÉ DE LA SÉRIE 3900			
Dimension de volet Largeur x Hauteur	**PRESSION po d'eau (kPa)**		
	1" *(0.25 kPa)*	**4" *(1.0 kPa)***	**8" *(2.0 kPa)***
12"x12" *(305x305 mm)*	1A	1	1
24"x24" *(610x610 mm)*	1A	1	1
36"x36" *(914x914 mm)*	1A	1	1
12"x48" *(305x1219 mm)*	1A	1	1
48"x12" *(1219x305 mm)*	1A	1	1
48"x36" *(1219x914 mm)*	1A	1	1



Les tests ont été effectués selon le standard AMCA 500-D-98. Le couple de rotation appliqué est de 6 po.-lbs./pi² avec un volet à lames parallèles. Ce standard AMCA stipule que l'étanchéité est basée sur une utilisation à des températures variant entre 50°F ***(10°C)*** and 104°F ***(40°C)***.

DWG. 3960-3961-3965-FR AUGUST 2010

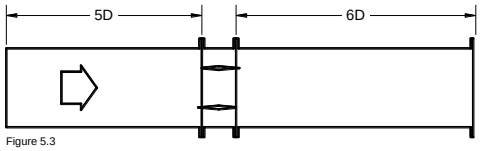
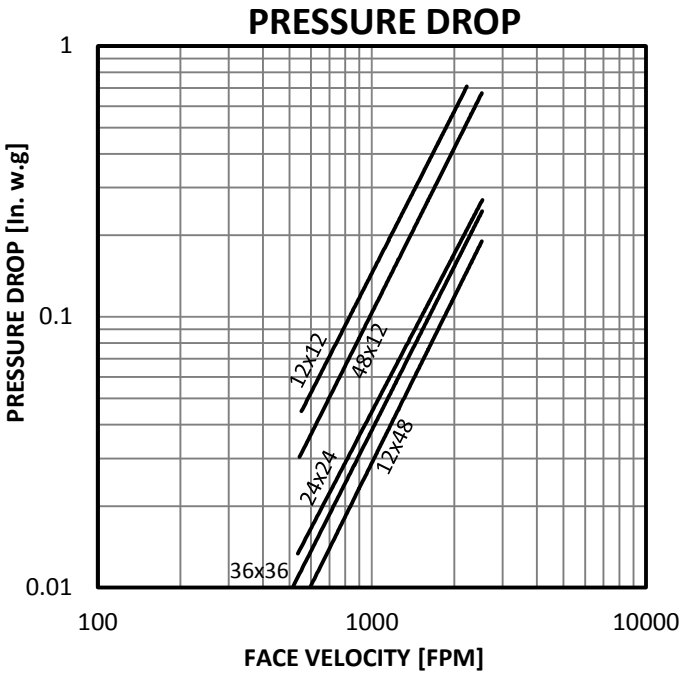


Figure 5.3

3900 SERIES CONTROL DAMPER PRESSURE DROP	
Velocity [FPM]	**Pressure Drop [in. w.g]**
12x12 (inches)	
553.6	0.044
891.4	0.119
1051.9	0.161
2021.4	0.554
2221.7	0.740
24x24 (inches)	
536.8	0.014
776.9	0.025
1101.1	0.056
2066.3	0.182
2530.1	0.272
36x36 (inches)	
500.4	0.01
750.6	0.021
1006.1	0.036
2019.5	0.161
2526.6	0.249
12x48 (inches)	
545	0.008
772.8	0.018
1095.3	0.035
2055.5	0.126
2519.2	0.187
48x12 (inches)	
544.6	0.029
772.2	0.064
1094.4	0.1228
2053.1	0.439
2516	0.661

CERTIFIED RATINGS

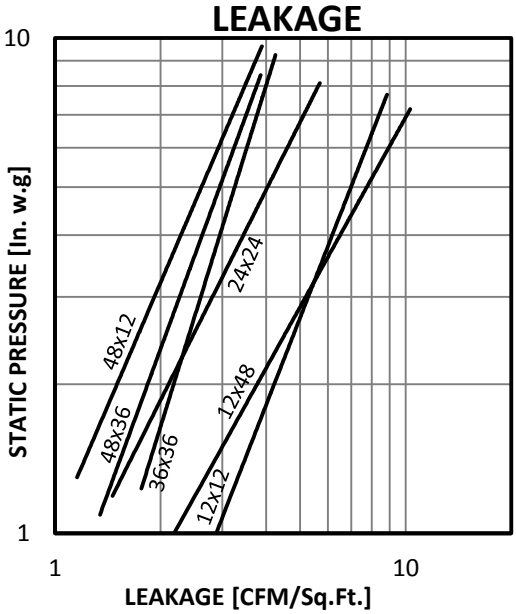
Alumavent Inc. certifies that the 3900 Series Insulated Control Dampers shown here are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Program. The AMCA Certified Ratings Seal applies to air performance ratings and air leakage ratings.



Ratings Based on: AMCA Standard 500-D Intake Ducted Test Figure 5.3 Setup

DEFINITION OF LEAKAGE CLASSIFICATION				
CLASS	**LEAKAGE $ft^3/min/ft^2$ *(L/s/m^2)***			
	1" *(0.25 kPa)*	**4" *(1.0 kPa)***	**8" *(2.0 kPa)***	**12" *(3.0 kPa)***
1A	3 *(15.2)*	N/A	N/A	N/A
1	4 *(20.3)*	8 *(40.6)*	11 *(55.9)*	14 *(71.1)*
2	10 *(50.8)*	20 *(102)*	28 *(142)*	35 *(178)*
3	40 *(203)*	80 *(406)*	112 *(569)*	140 *(711)*

3900 SERIES CONTROL DAMPER LEAKAGE RATING			
DAMPER SIZE Width x Height	**PRESSURE in w.g (kPa)**		
	1" *(0.25 kPa)*	**4" *(1.0 kPa)***	**8" *(2.0 kPa)***
12"x12" *(305x305 mm)*	1A	1	1
24"x24" *(610x610 mm)*	1A	1	1
36"x36" *(914x914 mm)*	1A	1	1
12"x48" *(305x1219 mm)*	1A	1	1
48"x12" *(1219x305 mm)*	1A	1	1
48"x36" *(1219x914 mm)*	1A	1	1



Leakage test was conducted in accordance with AMCA Standard 500-D-98. Holding torque applied was 6 in.-lbs./sq.ft on parallel blade dampers. AMCA Standard 500-D-98 states that air leakage is based on operation between 50°F *(10°C)* and 104°F *(40°C)*.

DWG. 3960-3961-3965 *AUGUST 2010*

L1

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 21 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

SECTION 4:

CÉDULE POUR PERSIENNES

VENTEX INC

LOUVERS & BACKDRAFT DAMPERS

L1

Q.A.T.
Qualité Air Totale • Total Air Quality
3049 Peugeot, Laval, Québec, H7L 5C4, tel: (450) 681-5355, mtl: (514) 990-0566, fax: (450) 681-5834

CHARTE DES DIMENSIONS POUR PERSIENNES

CLIENT : LES ENTREPRISES SIFEC NORD INC.

INGÉNIEURS :

BON DE COMMANDE : #YTG12

NOTRE RÉFÉRENCE : #58794

PROJET : IGLOOLIK WATER & WASTERWATER

DATE : mercredi, 15 juin 2016

Modèle	Accessoires	Dimensions (POUCES)		No. de dessin	Qté
		Largeur	Hauteur		
2215	*C/A Pare-Oiseaux en acier*	6	6	PERS/1-2	1
2215	*C/A Pare-Oiseaux en acier*	12	6	PERS/1-2	2
2215	*C/A Pare-Oiseaux en acier*	12	12	PERS/1-2	1
2215	*C/A Pare-Oiseaux en acier*	16	8	PERS/1-2	1
2215	*C/A Pare-Oiseaux en acier*	48	36	PERS/1-2	1
2215	*C/A Pare-Oiseaux en acier*	48	44	PERS/1-2	1

NOTES:

x

24 June 2016

S.V.P. INDIQUER LA COULEUR ET LE NUMERO DU FABRIQUANT DE LA PEINTURE REQUISE.

SVP NOUS INDIQUER SI LES PERSIENNES SONT REQUISES AVEC CADRE EN FLANGE « L » (MODÈLES 2215) OU AVEC CADRE EN « U » (MODÈLE 2210)

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: _____

Reviewed ☐
Reviewed as noted ☐
Resubmit ☐

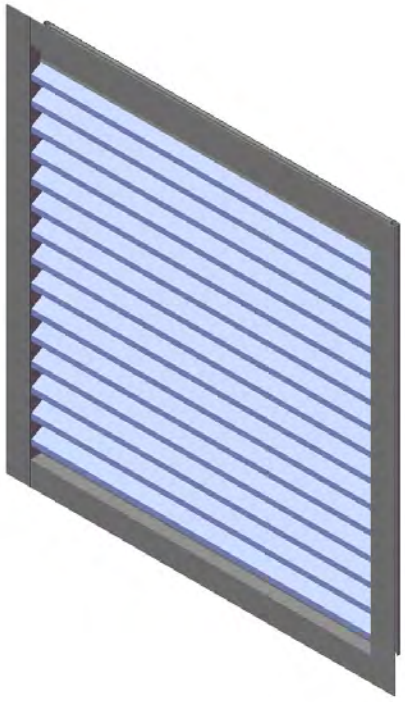
CHIARELLI ENGINEERING LTD.

L1

PERSIENNES & VOLETS

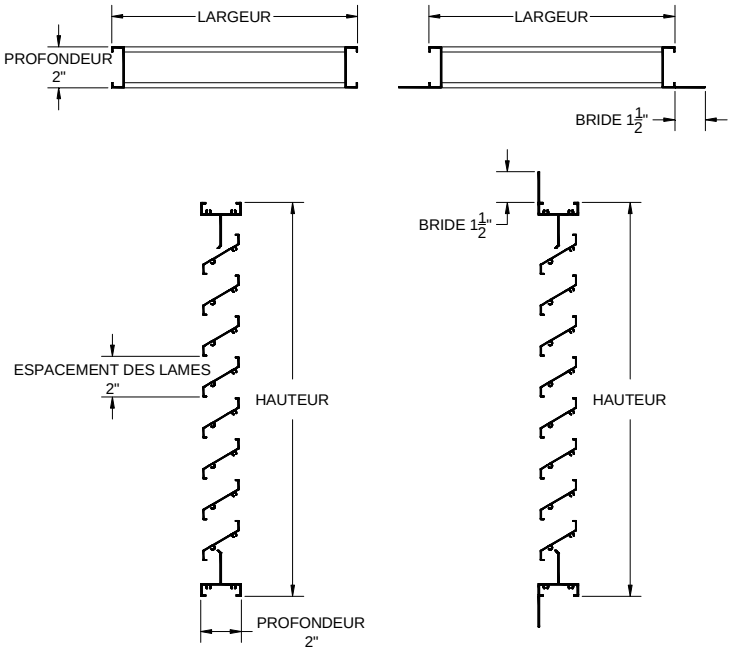
2210 / 2215

PERSIENNE D'ÉVACUATION 2"



MODÈLE 2210
CADRE: EN "U"
INSÉRÉ (DM)

MODÈLE 2215
CADRE: EN "L"
À BRIDE (FM)



PERFORMANCE			
PERSIENNE DE	**SURFACE TOTALE**	**SURFACE LIBRE pi²**	**SURFACE LIBRE %**
48" x 48"	16 pi²	8.51 pi²	***53.2%***
(1219 x 1219 mm)	*(1.49 m²)*	*(0.79 m²)*	
POINT INITIAL D'ENTRAINEMENT D'EAU POUR 0.01 oz./PI² EN SURFACE LIBRE:			***478 FPM***

CONSTRUCTION STANDARD

PROFONDEUR:	2" *(51 mm)*
MATÉRIEL:	ALUMINIUM EXTRUDÉ- 6063-T5
ÉPAISSEUR CADRE:	0.062" *(1.57 mm)*
ÉPAISSEUR LAMES:	0.062" *(1.57 mm)*
INCLINAISON LAMES:	30°
ESPACEMENT LAMES:	2" *(51 mm)*
GRILLAGE AVIAIRE:	ACIER GALVANISÉ 19 GA. - ½" x ½"
FINI:	ALUMINIUM NATUREL

LIMITATION: SECTION DE PERSIENNE SIMPLE

	MINIMUM	MAXIMUM
LARGEUR	12" *(305 mm)*	72" *(1829 mm)*
HAUTEUR	8" *(203 mm)*	72" *(1829 mm)*
SURFACE	0.67 pi² *(0.06 m²)*	36 pi² *(3.34 m²)*

* POUR PERMETTRE UN DÉGAGEMENT LES PERSIENNES SERONT FABRIQUÉES COMME SUIT (À MOINS D'INDICATION CONTRAIRE): - SECTION SIMPLE -*1/4" (6.4 mm)*
- SECTION MULTIPLE -*1/2" (12.7 mm)*

ACCESSOIRES DISPONIBLES

FINI:
- PEINTURE ÉLÉCTROSTATIQUE
- DURANAR
- ANODISÉ
  - *CLAIR*
  - *BRONZE 'LIGHT'*
  - *BRONZE 'MEDIUM'*
  - *BRONZE FONCÉ*
  - *ANODISÉ NOIR*
- SEUIL SPÉCIAL
- BARREAUX ANTI-VANDALES
- SUPPORT À FILTRES
- ATTACHES EN ACIER INOXYDABLE
- PORTE D'ACCÈS SUR CHARNIÈRE
- CONSTRUCTION SOUDÉE
- FORMES GÉOMETRIQUES
- CONSTRUCTION ROBUSTE
- CONSTRUCTION À LAMES CONTINUES

GRILLAGES:
- DU TYPE AVIAIRE
  - *1/2" x 1/2" EN ALUMINIUM*
  - *CADRAGE EN ALUMINIUM*
- MOUSTIQUAIRE
  - *18 x 14 'MESH'*

PANNEAU OBTURATEUR (ALUMINIUM):
- PANNEAU NON ISOLÉ
- PANNEAU ISOLÉ
  - *ISOLATION 1" (25.4 mm)*
  - *ISOLATION 2" (50.8 mm)*

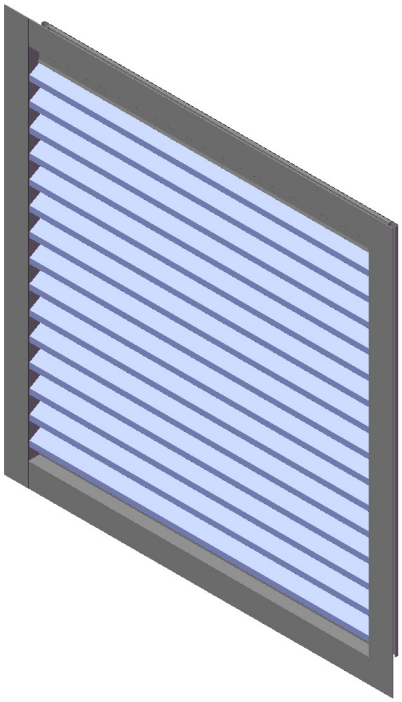
DWG. 2210 / 2215 *MARCH 2010*

VENTEX

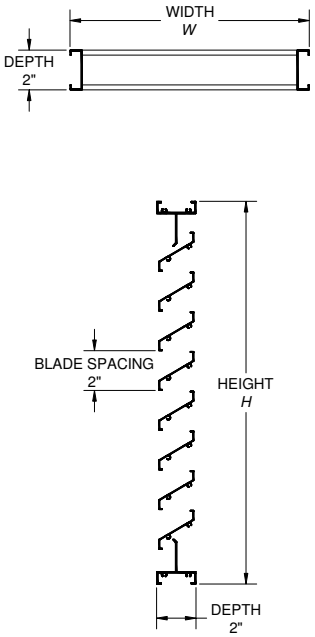
LOUVERS & BACK DRAFT DAMPERS

2210 / 2215

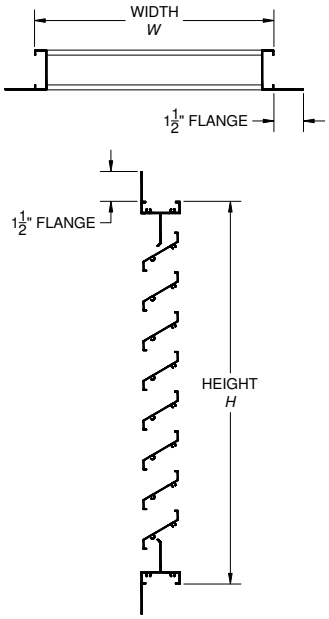
2" DEEP EXHAUST LOUVER



MODEL: *2210*
FRAME: CHANNEL FRAME
DUCT-MOUNT *(DM)*



MODEL: *2215*
FRAME: FLANGE FRAME
FLANGE-MOUNT *(FM)*



PERFORMANCE			
LOUVER UNIT SIZE	**TOTAL AREA**	**FREE AREA**	**FREE AREA**
48" x 48"	16 ft²	8.51 ft²	***53.2%***
(1219 x 1219 mm)	*(1.49 m²)*	*(0.79 m²)*	
BEGINNING POINT OF WATER PENETRATION AT 0.01 oz./ft² FREE AREA			***478 FPM***

STANDARD CONSTRUCTION	
DEPTH:	2" *(51 mm)*
MATERIAL:	EXTRUDED ALUMINUM - 6063-T5 ALLOY
FRAME THICKNESS:	0.062" *(1.57 mm)*
BLADE THICKNESS:	0.062" *(1.57 mm)*
BLADE ANGLE:	30°
BLADE CENTRES:	2" *(51 mm)*
BIRDSCREEN:	19 GA. GALVANIZED BIRDSCREEN - ½" x ½" OPENINGS
FINISH:	MILL

SIZE LIMITATIONS: SINGLE SECTION LOUVER		
	MINIMUM	**MAXIMUM**
WIDTH	12" *(305 mm)*	72" *(1829 mm)*
HEIGHT	8" *(203 mm)*	72" *(1829 mm)*
AREA	0.67 ft² *(0.06 m²)*	36 ft² *(3.34 m²)*

*LOUVER WILL BE MANUFACTURED 1/4" *(6.4 mm)* SMALLER (SINGLE SECTION) AND 1/2" *(12.7 mm)* SMALLER (MULTIPLE SECTION) THAN GIVEN OPENING DIMENSIONS UNLESS OTHERWISE SPECIFIED

AVAILABLE ACCESSORIES

FINISH:
- BAKED ENAMEL FINISH
- DURANAR FINISH
- ANODIZED FINISH
  - *CLEAR ANODIZED*
  - *LIGHT BRONZE*
  - *MEDIUM BRONZE*
  - *DARK BRONZE*
  - *BLACK ANODIZED*

SCREENS:
- BIRDSCREEN
  - *1/2" x 1/2" INTER CRIMPED ALUMINUM*
  - *ALUMINUM BIRDSCREEN WITH FRAME*
- INSECT SCREEN
  - *18 x 14 MESH*

BLANK-OFF PANELS (ALUMINUM): VARIOUS GAUGES
- NON-INSULATED BLANK-OFF PANELS
- INSULATED BLANK-OFF PANELS
  - *1" (25.4 mm) INSULATION*
  - *2" (50.8 mm) INSULATION*

- EXTENDED SILLS
- SECURITY BARS
- FILTER RACKS
- STAINLESS STEEL FASTENERS
- HINGED ACCESS DOORS
- ALL WELDED CONSTRUCTION
- CUSTOM GEOMETRIC SHAPES
- CONTINUOUS LINE CONSTRUCTION WITH HIDDEN MULLIONS TO PROVIDE AN UNINTERRUPTED APPEARANCE

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L1

2210 / 2215
PERSIENNE D'ÉVACUATION 2”

SURFACE LIBRE (PI²)

LARGEUR (PO)

HAUTEUR (PO)	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72
8	0.17	0.23	0.29	0.36	0.42	0.48	0.54	0.61	0.67	0.73	0.79	0.86	0.92	0.98	1.05	1.11
12	0.35	0.48	0.61	0.73	0.86	0.99	1.12	1.25	1.38	1.51	1.64	1.77	1.90	2.03	2.16	2.29
16	0.53	0.72	0.92	1.11	1.31	1.50	1.70	1.90	2.09	2.29	2.48	2.68	2.88	3.07	3.27	3.46
20	0.70	0.97	1.23	1.49	1.75	2.02	2.28	2.54	2.80	3.07	3.33	3.59	3.85	4.11	4.38	4.64
24	0.88	1.21	1.54	1.87	2.20	2.53	2.86	3.19	3.51	3.84	4.17	4.50	4.83	5.16	5.49	5.82
28	1.06	1.46	1.85	2.25	2.64	3.04	3.44	3.83	4.23	4.62	5.02	5.41	5.81	6.20	6.60	6.99
32	1.24	1.70	2.17	2.63	3.09	3.55	4.01	4.48	4.94	5.40	5.86	6.32	6.79	7.25	7.71	8.17
36	1.42	1.95	2.48	3.01	3.53	4.06	4.59	5.12	5.65	6.18	6.71	7.23	7.76	8.29	8.82	9.35
40	1.60	2.19	2.79	3.38	3.98	4.57	5.17	5.76	6.36	6.96	7.55	8.15	8.74	9.34	9.93	10.53
44	1.78	2.44	3.10	3.76	4.42	5.09	5.75	6.41	7.07	7.73	8.39	9.06	9.72	10.38	11.04	11.70
48	1.96	2.69	3.41	4.14	4.87	5.60	6.33	7.05	7.78	8.51	9.24	9.97	10.70	11.42	12.15	12.88
52	2.14	2.93	3.73	4.52	5.31	6.11	6.90	7.70	8.49	9.29	10.08	10.88	11.67	12.47	13.26	14.06
56	2.31	3.18	4.04	4.90	5.76	6.62	7.48	8.34	9.21	10.07	10.93	11.79	12.65	13.51	14.37	15.23
60	2.49	3.42	4.35	5.28	6.21	7.13	8.06	8.99	9.92	10.84	11.77	12.70	13.63	14.56	15.48	16.41
64	2.67	3.67	4.66	5.66	6.65	7.64	8.64	9.63	10.63	11.62	12.62	13.61	14.61	15.60	16.59	17.59
68	2.85	3.91	4.97	6.03	7.10	8.16	9.22	10.28	11.34	12.40	13.46	14.52	15.58	16.64	17.70	18.77
72	3.03	4.16	5.29	6.41	7.54	8.67	9.80	10.92	12.05	13.18	14.31	15.43	16.56	17.69	18.82	19.94

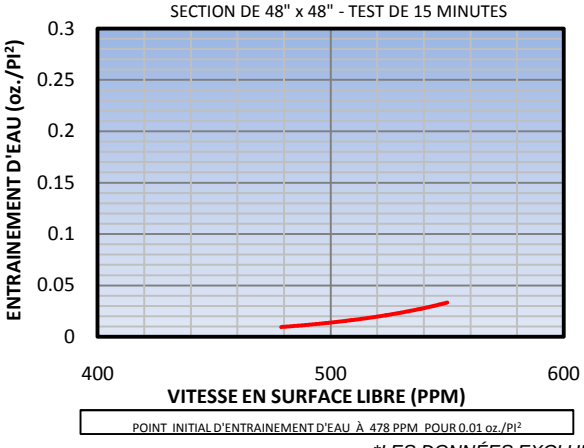
SURFACE LIBRE (%)

LARGEUR (PO)

HAUTEUR (PO)	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72
8	25.3%	26.0%	26.4%	26.7%	26.9%	27.1%	27.2%	27.3%	27.4%	27.5%	27.5%	27.6%	27.6%	27.6%	27.7%	27.7%
12	34.7%	35.7%	36.3%	36.7%	37.0%	37.2%	37.4%	37.5%	37.7%	37.7%	37.8%	37.9%	38.0%	38.0%	38.0%	38.1%
16	39.5%	40.6%	41.3%	41.7%	42.1%	42.3%	42.5%	42.7%	42.8%	42.9%	43.0%	43.1%	43.1%	43.2%	43.2%	43.3%
20	42.3%	43.5%	44.3%	44.8%	45.1%	45.4%	45.6%	45.7%	45.9%	46.0%	46.1%	46.2%	46.2%	46.3%	46.3%	46.4%
24	44.2%	45.5%	46.2%	46.8%	47.1%	47.4%	47.6%	47.8%	47.9%	48.0%	48.1%	48.2%	48.3%	48.4%	48.4%	48.5%
28	45.5%	46.9%	47.7%	48.2%	48.6%	48.9%	49.1%	49.3%	49.4%	49.5%	49.6%	49.7%	49.8%	49.8%	49.9%	50.0%
32	46.6%	47.9%	48.7%	49.3%	49.7%	49.9%	50.2%	50.3%	50.5%	50.6%	50.7%	50.8%	50.9%	51.0%	51.0%	51.1%
36	47.3%	48.7%	49.5%	50.1%	50.5%	50.8%	51.0%	51.2%	51.4%	51.5%	51.6%	51.7%	51.8%	51.8%	51.9%	51.9%
40	48.0%	49.4%	50.2%	50.8%	51.2%	51.5%	51.7%	51.9%	52.0%	52.2%	52.3%	52.4%	52.4%	52.5%	52.6%	52.6%
44	48.5%	49.9%	50.8%	51.3%	51.7%	52.0%	52.3%	52.4%	52.6%	52.7%	52.8%	52.9%	53.0%	53.1%	53.1%	53.2%
48	48.9%	50.3%	51.2%	51.8%	52.2%	52.5%	52.7%	52.9%	53.1%	53.2%	53.3%	53.4%	53.5%	53.5%	53.6%	53.7%
52	49.3%	50.7%	51.6%	52.2%	52.6%	52.9%	53.1%	53.3%	53.5%	53.6%	53.7%	53.8%	53.9%	53.9%	54.0%	54.1%
56	49.6%	51.0%	51.9%	52.5%	52.9%	53.2%	53.4%	53.6%	53.8%	53.9%	54.0%	54.1%	54.2%	54.3%	54.4%	54.4%
60	49.9%	51.3%	52.2%	52.8%	53.2%	53.5%	53.7%	53.9%	54.1%	54.2%	54.3%	54.4%	54.5%	54.6%	54.6%	54.7%
64	50.1%	51.6%	52.4%	53.0%	53.4%	53.8%	54.0%	54.2%	54.3%	54.5%	54.6%	54.7%	54.8%	54.8%	54.9%	55.0%
68	50.3%	51.8%	52.7%	53.2%	53.7%	54.0%	54.2%	54.4%	54.6%	54.7%	54.8%	54.9%	55.0%	55.1%	55.1%	55.2%
72	50.5%	52.0%	52.9%	53.4%	53.9%	54.2%	54.4%	54.6%	54.8%	54.9%	55.0%	55.1%	55.2%	55.3%	55.3%	55.4%

ENTRAINEMENT D'EAU - 2210 / 2215

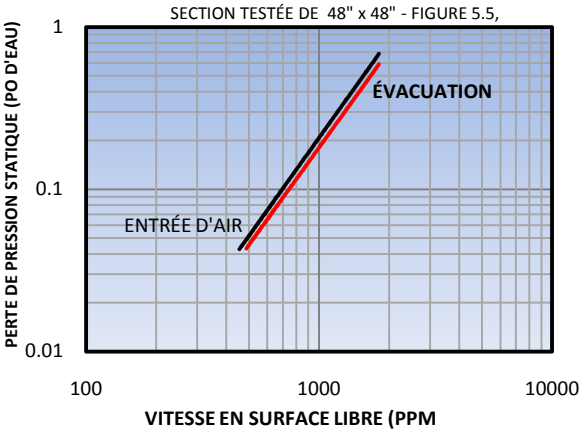
SECTION DE 48" x 48" - TEST DE 15 MINUTES



POINT INITIAL D'ENTRAINEMENT D'EAU À 478 PPM POUR 0.01 oz./PI²

PERTE DE PRESSION 2210 / 2215

SECTION TESTÉE DE 48" x 48" - FIGURE 5.5,



**LES DONNÉES EXCLUENT L'EFFET DU GRILLAGE AVIAIRE*

SPÉCIFICATION RECOMMANDÉES

Fournir et installer les persiennes fixes modèle 2210 / 2215 fabriquées par Ventex inc, Bolton (On). Elles seront d'une profondeur de 2" (50 mm). Les lames et les cadres seront d'un alliage d'aluminium 6063-T5 d'au moins 0.062" *(1.57 mm*).Les persiennes seront fournies avec un grillage en acier galvanisé ½" x ½" de 19 ga. Fini couleur en usine par un procédé environnementale à base de poudre électrostatique. Choix de couleur parmi la charte Ventex inc.

DWG. 2210 / 2215 *MARCH 2010*

FREE AREA (Sq. Ft.)

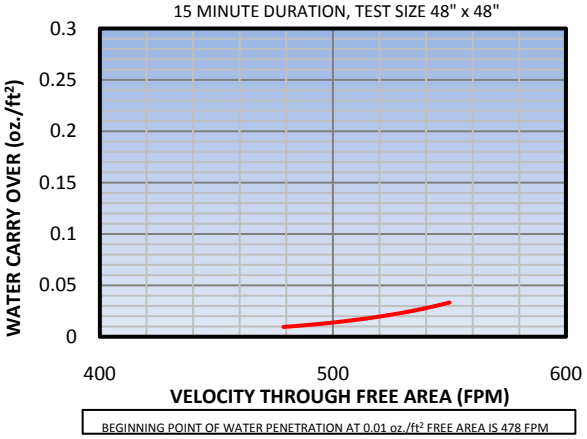
HEIGHT (INCHES) \ WIDTH (INCHES)	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72
8	0.17	0.23	0.29	0.36	0.42	0.48	0.54	0.61	0.67	0.73	0.79	0.86	0.92	0.98	1.05	1.11
12	0.35	0.48	0.61	0.73	0.86	0.99	1.12	1.25	1.38	1.51	1.64	1.77	1.90	2.03	2.16	2.29
16	0.53	0.72	0.92	1.11	1.31	1.50	1.70	1.90	2.09	2.29	2.48	2.68	2.88	3.07	3.27	3.46
20	0.70	0.97	1.23	1.49	1.75	2.02	2.28	2.54	2.80	3.07	3.33	3.59	3.85	4.11	4.38	4.64
24	0.88	1.21	1.54	1.87	2.20	2.53	2.86	3.19	3.51	3.84	4.17	4.50	4.83	5.16	5.49	5.82
28	1.06	1.46	1.85	2.25	2.64	3.04	3.44	3.83	4.23	4.62	5.02	5.41	5.81	6.20	6.60	6.99
32	1.24	1.70	2.17	2.63	3.09	3.55	4.01	4.48	4.94	5.40	5.86	6.32	6.79	7.25	7.71	8.17
36	1.42	1.95	2.48	3.01	3.53	4.06	4.59	5.12	5.65	6.18	6.71	7.23	7.76	8.29	8.82	9.35
40	1.60	2.19	2.79	3.38	3.98	4.57	5.17	5.76	6.36	6.96	7.55	8.15	8.74	9.34	9.93	10.53
44	1.78	2.44	3.10	3.76	4.42	5.09	5.75	6.41	7.07	7.73	8.39	9.06	9.72	10.38	11.04	11.70
48	1.96	2.69	3.41	4.14	4.87	5.60	6.33	7.05	7.78	8.51	9.24	9.97	10.70	11.42	12.15	12.88
52	2.14	2.93	3.73	4.52	5.31	6.11	6.90	7.70	8.49	9.29	10.08	10.88	11.67	12.47	13.26	14.06
56	2.31	3.18	4.04	4.90	5.76	6.62	7.48	8.34	9.21	10.07	10.93	11.79	12.65	13.51	14.37	15.23
60	2.49	3.42	4.35	5.28	6.21	7.13	8.06	8.99	9.92	10.84	11.77	12.70	13.63	14.56	15.48	16.41
64	2.67	3.67	4.66	5.66	6.65	7.64	8.64	9.63	10.63	11.62	12.62	13.61	14.61	15.60	16.59	17.59
68	2.85	3.91	4.97	6.03	7.10	8.16	9.22	10.28	11.34	12.40	13.46	14.52	15.58	16.64	17.70	18.77
72	3.03	4.16	5.29	6.41	7.54	8.67	9.80	10.92	12.05	13.18	14.31	15.43	16.56	17.69	18.82	19.94

FREE AREA (%)

HEIGHT (INCHES) \ WIDTH (INCHES)	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72
8	25.3%	26.0%	26.4%	26.7%	26.9%	27.1%	27.2%	27.3%	27.4%	27.5%	27.5%	27.6%	27.6%	27.6%	27.7%	27.7%
12	34.7%	35.7%	36.3%	36.7%	37.0%	37.2%	37.4%	37.5%	37.7%	37.7%	37.8%	37.9%	38.0%	38.0%	38.0%	38.1%
16	39.5%	40.6%	41.3%	41.7%	42.1%	42.3%	42.5%	42.7%	42.8%	42.9%	43.0%	43.1%	43.1%	43.2%	43.2%	43.3%
20	42.3%	43.5%	44.3%	44.8%	45.1%	45.4%	45.6%	45.7%	45.9%	46.0%	46.1%	46.2%	46.2%	46.3%	46.3%	46.4%
24	44.2%	45.5%	46.2%	46.8%	47.1%	47.4%	47.6%	47.8%	47.9%	48.0%	48.1%	48.2%	48.3%	48.4%	48.4%	48.5%
28	45.5%	46.9%	47.7%	48.2%	48.6%	48.9%	49.1%	49.3%	49.4%	49.5%	49.6%	49.7%	49.8%	49.8%	49.9%	50.0%
32	46.6%	47.9%	48.7%	49.3%	49.7%	49.9%	50.2%	50.3%	50.5%	50.6%	50.7%	50.8%	50.9%	51.0%	51.0%	51.1%
36	47.3%	48.7%	49.5%	50.1%	50.5%	50.8%	51.0%	51.2%	51.4%	51.5%	51.6%	51.7%	51.8%	51.8%	51.9%	51.9%
40	48.0%	49.4%	50.2%	50.8%	51.2%	51.5%	51.7%	51.9%	52.0%	52.2%	52.3%	52.4%	52.4%	52.5%	52.6%	52.6%
44	48.5%	49.9%	50.8%	51.3%	51.7%	52.0%	52.3%	52.4%	52.6%	52.7%	52.8%	52.9%	53.0%	53.1%	53.1%	53.2%
48	48.9%	50.3%	51.2%	51.8%	52.2%	52.5%	52.7%	52.9%	53.1%	53.2%	53.3%	53.4%	53.5%	53.5%	53.6%	53.7%
52	49.3%	50.7%	51.6%	52.2%	52.6%	52.9%	53.1%	53.3%	53.5%	53.6%	53.7%	53.8%	53.9%	53.9%	54.0%	54.1%
56	49.6%	51.0%	51.9%	52.5%	52.9%	53.2%	53.4%	53.6%	53.8%	53.9%	54.0%	54.1%	54.2%	54.3%	54.4%	54.4%
60	49.9%	51.3%	52.2%	52.8%	53.2%	53.5%	53.7%	53.9%	54.1%	54.2%	54.3%	54.4%	54.5%	54.6%	54.6%	54.7%
64	50.1%	51.6%	52.4%	53.0%	53.4%	53.8%	54.0%	54.2%	54.3%	54.5%	54.6%	54.7%	54.8%	54.8%	54.9%	55.0%
68	50.3%	51.8%	52.7%	53.2%	53.7%	54.0%	54.2%	54.4%	54.6%	54.7%	54.8%	54.9%	55.0%	55.1%	55.1%	55.2%
72	50.5%	52.0%	52.9%	53.4%	53.9%	54.2%	54.4%	54.6%	54.8%	54.9%	55.0%	55.1%	55.2%	55.3%	55.3%	55.4%

WATER PENETRATION - 2210 / 2215

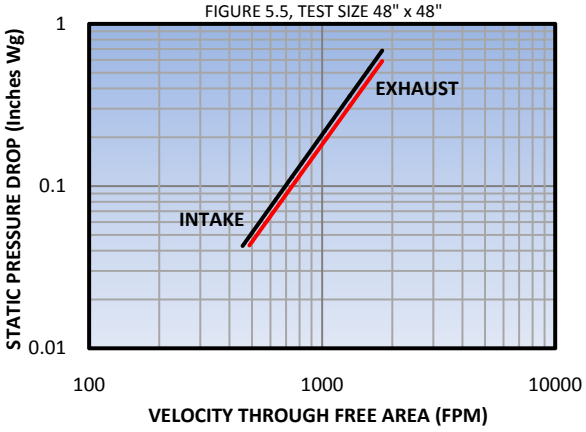
15 MINUTE DURATION, TEST SIZE 48" x 48"



BEGINNING POINT OF WATER PENETRATION AT 0.01 oz./ft² FREE AREA IS 478 FPM

PRESSURE DROP- 2210 / 2215

FIGURE 5.5, TEST SIZE 48" x 48"



**TEST RESULTS DO NOT INCLUDE THE EFFECTS OF BIRDSCREEN*

RECOMMENDED SPECIFICATION

Furnish and install stationary louver models 2210 / 2215 as manufactured by Ventex Inc, Bolton, Ontario. Louvers must be licensed to bear the AMCA seal. Louvers shall be 2" *(51 mm)* deep. Blades shall be 0.062" *(1.57 mm)* extruded 6063-T5 aluminum alloy and frame shall be 0.062" *(1.57 mm)* extruded 6063-T5 aluminum alloy. Louvers shall have 19 gauge galvanized ½" x ½" birdscreen. All materials shall be factory finished after assembly with Polyester Powder Coat in a color selected from the Ventex Color Chart.

CERTIFIED RATINGS

Ventex Inc. certifies that the models 2210 / 2215 shown here are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Program. The Certified Ratings Seal applies to air performance and water penetration ratings.

DWG. 2210 / 2215 *MARCH 2010*

Chapter 23 DAMPER ACTUATOR

MANUFACTURER/DISTRIBUTOR:

S.C.I. Montréal Inc.
3311, boul. Industriel
Laval Qc H7L 4S3
T : 450-668-8866
T : 514-990-8866
1-800-667-8866
info@scimtl.ca

23.1 **BELIMO NFB24-SR MODULING ACTUATOR**

23.2 **BELIMO LF24 MODULING ACTUATOR**

NFB and NFX Series Spring Return Direct Coupled Actuator

DAMPER
ACTUATOR

Minimum 90 in-lb Torque

- For damper areas up to 22 sq-ft*

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

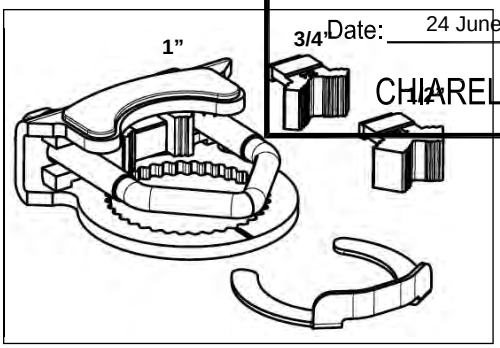
Date: 24 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

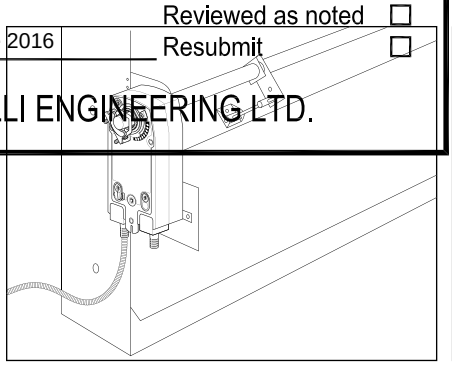
CHIARELLI ENGINEERING LTD.

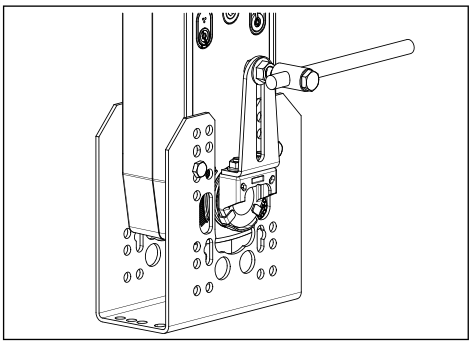
SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 21 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

Applications



New standard clamp fits standard 1/2” shafts to 1.05” jackshafts.


Mount directly to 1.05” jackshafts.


Linkage solutions are available when direct coupling is not possible.

Actuators in bold have BDCM

NFB, NFX Series – At A Glance

		NFB24, NFX24 (p. 105)	NFB24 N4(H), NFX24 N4 (p. 107)	NFB24-S, NFX24-S (p. 105)	NFB24-S N4(H), NFX24-S N4 (p. 107)	NFBUP, NFXUP (p. 109)	NFBUP N4(H), NFXUP N4 (p. 111)	NFBUP-S, NFXUP-S (p. 109)	NFBUP-S N4(H), NFXUP-S N4 (p. 111)	NFB24-SR, NFX24-SR (p. 113)	NFB24-SR N4(H), NFX24-SR N4 (p. 115)	NFB24-SR-S, NFX24-SR-S (p. 113)	NFB24-SR-S N4(H), NFX24-SR-S N4 (p. 115)	NFB24-MFT, NFX24-MFT (p. 117)	NFB24-MFT N4(H), NFX24-MFT N4 (p. 119)	NFB24-MFT-S, NFX24-MFT-S (p. 117)	NFB24-MFT-S N4(H), NFX24-MFT-S N4 (p. 119)
Torque:	90 in-lb	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Power supply:	24 VAC/DC	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	120 VAC					●	●	●	●								
	230 VAC					●	●	●	●								
Control signal:	On/Off	●	●	●	●	●	●	●	●								
	Proportional 2 to 10 VDC									●	●	●	●				
	Multi-function**													●	●	●	●
Feedback signal:	2 to 10 VDC									●	●	●	●				
	VDC variable**													●	●	●	●
Running time motor:	<75 seconds	●	●	●	●	●	●	●	●								
	95 seconds constant									●	●	●	●				
	Adj. 40 to 220 seconds***													●	●	●	●
	spring: <20 seconds	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Brushless DC Motor										●	●	●	●	●	●	●	●
External direction of rotation switch										●	●	●	●	●	●	●	●
Manual override		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Appliance rated cable, 18 GA (default)		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Plenum rated cable, 18 GA (optional)		●								●				●			
Built-in auxiliary switch, Two SPDT				●	●			●	●			●	●			●	●
NEMA 4 rated housing			●		●		●		●		●		●		●		●

Installation instructions.....(p. 121-127) General wiring.....(p. 129) Start-up and checkout.....(p. 130) Electrical operations.....(p. 128)

*Based on 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals. **Default 2 to 10 VDC. ***Default 150 seconds.

N40103 - 09/11 - Subject to change. © Belimo Aircontrols (USA), Inc.

DAMPER
ACTUATOR

A CLOSER LOOK...

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable fail-safe.
- Mount for clockwise or counterclockwise fail-safe.
- Check damper position easily with clear position indicator.
- Don't worry about actuator burn-out.
  Belimo is overload-proof throughout rotation.
- Built-in mechanical stop to adjust angle of rotation.
- Manual override crank speeds installation
- Need to change control direction?
  Do it easily with a simple switch (modulating actuators).
- Incorporated breather membrane optimizes
  performance in harsh airstream environments.
- Built-in auxiliary switches are easy to use, offers feedback or
  signal for additional device (-S models).
- Microprocessor-controlled brushless DC motor increases
  actuator life span and reliability, provides constant running
  time (modulating actuators).
- Rugged metal on plastic housing withstands rough
  handling in the mechanical room.
- Standard 3 ft. appliance rated cable and
  conduit connector eases installation.
- Added flexibility to select clamp, electrical connection, and running
  time to fit your specific application with Belimo's customized line of
  actuators (NFX).

ISO 9001

5 YEAR WARRANTY

The Belimo Difference

- *Customer Commitment.*
  Extensive product range. Application assistance.
  Same-day shipments. Free technical support. Five year warranty.
- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

CE

LISTED
94 D5
TEMP. IND. & REG. EQUIP.
c UL us

BRUSHLESS dc motor ©

N40103 - 09/11 - Subject to change. © Belimo Aircontrols (USA), Inc.

NFB24, NFB24-S, NFX24, NFX24-S

On/Off, Spring Return, 24 V

DAMPER ACTUATOR

- **Torque min. 90 in-lb, for control of air dampers**

Application

For On/Off, fail-safe control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications. Control is On/Off from an auxiliary contact, or a manual switch.

The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation

The NFB and NFX series actuators provide true spring return operation for reliable fail-safe application and positive close off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator.

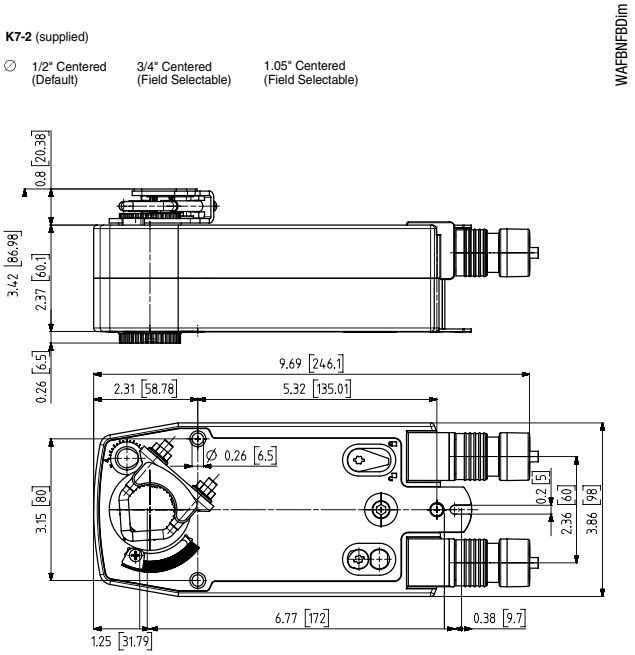
The NFB and NFX series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The NFB24-S and NFX24-S versions are provided with two built-in auxiliary switches. These SPDT switches are provided for safety interfacing or signaling, for example, for fan start-up. The switching function at the fail-safe position is fixed at +10°, the other switch function is adjustable between +10° to +90°. The NFB24, NFB24-S, NFX24 and NFX24-S actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off.

Technical Data		NFB24, NFB24-S, NFX24, NFX24-S
Power supply		24 VAC ± 20% 50/60 Hz 24 VDC +20% / -10%
Power consumption	running	6 W
	holding	2.5 W
Transformer sizing		8.5 VA (class 2 power source)
Electrical connection		
NFB24...		3 ft, 18 GA appliance cable, 1/2" conduit connector **-S models:** two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
NFX24...		3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector **-S models:** two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables, with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Control		on/off
Torque		90 in-lb [10 Nm] minimum
Direction of rotation	spring	reversible with CW/CCW mounting
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	motor	< 75 seconds
	spring	20 seconds @ -4°F to 122°F [-20°C to 50°C]; < 60 seconds @ -22°F [-30°C]
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3⁄16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		zinc coated metal and plastic casing
Agency listings †		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		<50dB(A) motor @ 75 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.15 lbs (1.9 kg); 4.4 lbs (2.0 kg) with switches
† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.		
NFB24-S, NFX24-S		
Auxiliary switches		2 x SPDT 3A (0.5A) @ 250 VAC, UL approved one set at +10°, one adjustable 10° to 90°

Dimensions (Inches [mm])



N40103 - 09/11 - Subject to change. © Belimo Aircontrols (USA), Inc.

Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05" dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

Note: When using NFB24, NFB24-S, NFX24, NFX24-S actuators, only use accessories listed on this page.

For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

Typical Specification

On/Off spring return damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall be protected from overload at all angles of rotation. If required, two SPDT auxiliary switch shall be provided having the capability of one being adjustable. Actuators with auxiliary switches must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

1 Provide overload protection and disconnect as required.

2 ***CAUTION** Equipment Damage!*
Actuators may be connected in parallel.
Power consumption and input impedance must be observed.

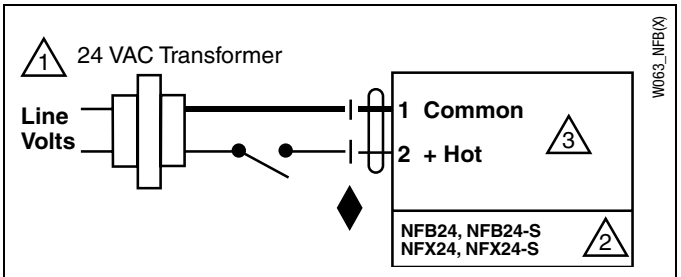
3 Actuators may also be powered by 24 VDC.

4 For end position indication, interlock control, fan startup, etc., NFB24-S and NFX24-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.

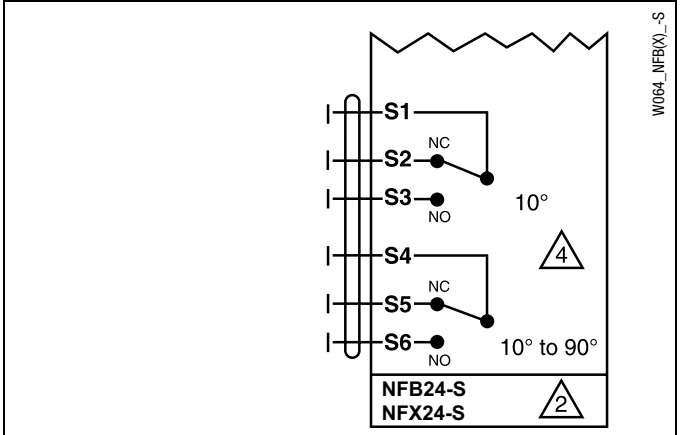
APPLICATION NOTES

Meets cULus requirements without the need of an electrical ground connection.

***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



On/Off wiring for NFB24, NFX24



Auxiliary Switches for NFB24-S, NFX24-S

N40103 - 09/11 - Subject to change. © Belimo Aircontrols (USA), Inc.

Chapter 24 HVAC FANS

MANUFACTURER/DISTRIBUTOR:

E.H. Price
Montreal - Samuel Thomas
4645 rue Louis-B-Mayer
Laval
T: 514-334-9804 etx.235
F: 514-745-3159

24.1 **GREENHECK EXHAUST FAN SP-A250**

24.2 **FIRE DAMPER FD-A-S -- 3 HR RATING, 14" LG SLEEVE 20 GA., VERTICAL**

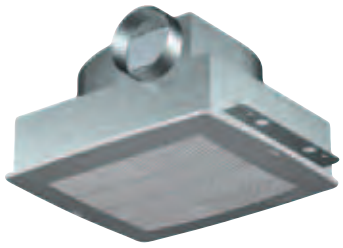
Inline, Ceiling and Sidewall Exhaust

GREENHECK
Building Value in Air.

Ceiling Exhaust - SP

Model SP ceiling exhaust fans are designed for clean air applications where low sound levels are desired. Low sound levels are achieved through quiet running forward-curved wheels.

SP-A



SP-B

SP-C

SP FANS A	SP FANS B	SP FANS C	STANDARD FEATURES
✓	✓	✓	Backdraft Damper - Prevents unwanted backdrafts.
✓			Spring Loaded Aluminum Backdraft Damper - Eliminates rattling or unwanted backdrafts (sizes 110 and up).
✓			Outlet - Both square and round outlets are field rotatable from horizontal to vertical discharge.
✓	✓	✓	Round Outlet (4 or 6 in.) - up to size A90. Versatile for quick, easy connections.
✓	✓		Power Assembly - Removes quickly for maintenance.
✓			External Electrical Access - Eliminates removing motor pack, saving installation time.
✓	✓		Electrical Knockout - Eliminates drilling holes.
✓	✓	✓	Disconnect (Plug Type) - Servicing is quick and safe.
✓	✓		Electrical Junction Box - Large for easy wiring.
✓	✓		Attractive Designer Grille - Concealed attachment screws securely to fasten grille to housing for quiet, rattle free operation.
✓	✓	✓	Mounting Brackets - Fully adjustable for multiple installation types.
✓	✓		Housing - Embossed galvanized steel for rigidity and low-profile for height restricted areas.
✓	✓	✓	PSC Compatible Motors - 50 cycle, 220v, and 240v options. 60 cycle, 115v, 208v, 220v, 230v, and 277v options. (Check factory for availability)
✓	✓	✓	3 Year Warranty
✓	✓	✓	UL listed for above showers w/ GFCI branch protected circuit

SERVICE CHART	IN STOCK	3 DAY	10 DAY
Standard Construction	✓	✓	✓
Speed Control, Mounted & Wired		✓	✓
Light, SP-A50, 70, 90, 110, 125 SP-B50, 80, 150		✓	✓
Light, SP-B70, 90, 110		✓	✓
Fan/CRD UL Listed Assembly		✓	✓
277 volt SP-A 110, 125, 190		✓	✓
277 volt SP-B 110, 150, 200		✓	✓
Contractor 4-Packs		✓	✓
Contractor Packs-Housings (sizes B70-B110) - Miami	✓	✓	✓
Motion Sensor - Grille Mounted			✓

PERFORMANCE

Models SP-A, SP-B, and SP-C are compact exhaust fans with performance capabilities of 29 cfm to 1600 cfm and up to 1 in. wg.

OPTIONS AND ACCESSORIES

- Grilles
- Lights
- Ceiling radiation dampers (CRD)
- Vibration isolation kits
- Speed controls
- Motion detectors
- Time delays
- Roof discharge accessories
- Wall discharge accessories
- Transitions
- Filters
- Contractor paks

Note: See pages 44-47 for full stock accessory listing

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 21 juin 2016

Reviewed [X]

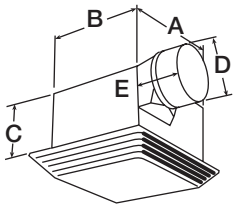
Reviewed as noted [ ]

Resubmit [ ]

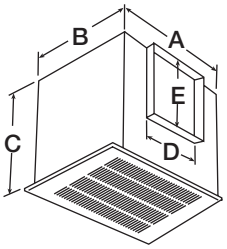
Out for approval

SIFEC NORTH INC.

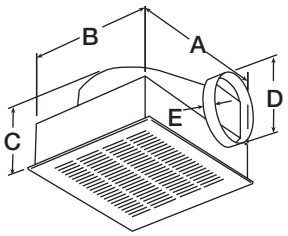
Ceiling Exhaust - SP



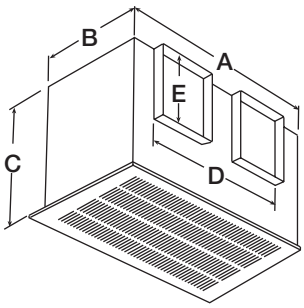
SP-C50



SP-A110 through SP-A510 and SP-A710 & SP-A780



SP-B50 through SP-B200



SP-A700, SP-A900 & SP-A1550

SP PERFORMANCE & DIMENSIONAL DATA - IN STOCK

MODEL	A	B	C	OUTLET D	OUTLET E	RPM	AMPS	WATTS	SONES @ 0 IN.	GRILLE SIZE	PERFORMANCE IN INCHES WG 0.00	.100	.125	.250	.375	.500	.625	.750	1.00
SP-C50-QD	7½	7½	3⅝	3 dia. x 1⅝		1680	0.80	46	2.9	9¼ x 9	52	49	48	47	44	38	29		
SP-B50-QD	13⅞	11½	6¹⁵⁄₁₆	4 dia. x ¾		625	0.50	38	1.7	14⅞ x 13¼	67	54	51	41	30				
SP-B70-QD	13⅞	11½	6¹⁵⁄₁₆	4 dia. x ¾		675	0.53	45	1.7	14⅞ x 13¼	77	71	68	57	50	40			
SP-B80-QD	13⅞	11½	6¹⁵⁄₁₆	4 dia. x ¾		900	0.60	54	2.9	14⅞ x 13¼	87	80	78	69	61	54	44	30	
SP-B90-QD	13⅞	11½	7¹⁵⁄₁₆	6 dia. x 1¼		700	0.65	50	1.9	14⅞ x 13¼	102	93	89	75	59	45	30		
SP-B110-QD	13⅞	11½	7¹⁵⁄₁₆	6 dia. x 1¼		950	1.14	80	2.0	14⅞ x 13¼	133	114	111	98	96	94	92	85	51
SP-B150-QD	13⅞	11½	7¹⁵⁄₁₆	6 dia. x 1¼		1050	1.70	129	3.0	14⅞ x 13¼	160	156	156	154	152	150	147	139	92
SP-B200-QD	13⅞	11½	7¹⁵⁄₁₆	6 dia. x 1¼		1100	2.20	173	4.4	14⅞ x 13¼	197	195	195	191	188	184	181	166	128
SP-A50-QD	13¼	10⅝	11⅝	6	6	700	0.31	18	0.7	14⅞ x 13¼	76	51	48	30					
SP-A70-QD	13¼	10⅝	11⅝	6	6	850	0.27	20	1.1	14⅞ x 13¼	83	70	67	42					
SP-A90-QD	13¼	10⅝	11⅝	6	6	900	0.34	29	1.1	14⅞ x 13¼	99	88	85	62	25				
SP-A110-QD	13¼	10⅝	10½	8	6	950	0.58	49	1.3	14⅞ x 13¼	119	110	106	89					
SP-A125-QD	13¼	10⅝	10½	8	6	1100	0.62	53	1.4	14⅞ x 13¼	135	123	121	105					
SP-A190-QD	13¼	10⅝	10½	8	6	1400	1.30	113	3.2	14⅞ x 13¼	216	197	192	167	134				
SP-A200-QD	14	11⅞	11¼	8	8	900	0.43	48	2.0	14⅞ x 13¼	247	226	220	197	172	142	105	68	
SP-A250-QD	14	11⅞	11¼	8	8	1000	0.77	83	2.9	14⅞ x 13¼	272	252	246	228	211	186	158	119	
SP-A290-QD	14	11⅞	11¼	8	8	1050	0.72	81	3.2	14⅞ x 13¼	315	293	287	258	232	207	176	125	
SP-A390-QD	14	11⅞	11¼	8	8	1350	1.34	135	5.4	14⅞ x 13¼	410	395	392	369	345	325	308	280	
SP-A410-QD	18	14⅜	14½	8	8	1000	1.74	121	4.1	19⅜ x 16⅜	443	413	405	351	306				
SP-A510-QD	18	14⅜	14½	8	8	1070	3.30	224	6.0	19⅜ x 16⅜	557	512	501	439	392	325			
SP-A700-QD	23⅝	11⅝	11⅝	19½	8	1100	3.20	350	6.1	25⅛ x 13½	757	730	723	700	680	650	613	560	397
SP-A710-QD	18	14⅜	14½	10	8	1080	4.40	285	7.4	19⅜ x 16⅜	752	714	701	653	588	486	320		
SP-A780-QD	18	14⅜	14½	10	8	1600	3.30	348	10.2	19⅜ x 16⅜	812	783	776	741	704	655	604	538	
SP-A900-QD	23¾	14⅜	14½	18¾	8	950	4.00	285	5.2	25 x 16⅜	955	907	897	842	774	701			
SP-A1050-QD	23¾	14⅜	14½	18¾	8	1095	6.30	420	7.2	25 x 16⅜	1125	1059	1043	964	886	797	663		
SP-A1410-QD	23¾	14⅜	14½	18¾	8	1450	7.40	786	11.6	25 x 16⅜	1455	1415	1404	1354	1308	1263	1219	1174	
SP-A1550-QD	23¾	14⅜	14½	18¾	8	1610	8.60	818	12.4	25 x 16⅜	1697	1599	1558	1517	1449	1408	1366	1323	

All dimensions in inches. Grille dimensions are for the designer grille except on model SP-C50 where the dimensions are shown for the decorative grille. Performance certified is for installation type B: Free inlet, Ducted outlet. Performance ratings include the effects of an inlet grille and backdraft damper. Speed (RPM) shown is nominal. Performance is based on actual speed of test. The sound ratings shown are loudness values in fan sones at 5 ft. (1.5 m) in a hemispherical free field calculated per AMCA Standard 301. Values are for installation type B: free inlet sone levels. The AMCA Certified Ratings Sound Seal applies to sone ratings only.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: MM Reviewed ☒
Date: 24 June 2016 Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

UL/cUL 507
E33599
Ceiling Exhaust Fans are also UL Listed for sizes 50 through 390 for above bathtub/shower with GFCI branch protected circuit. File No. E33599

c UL US LISTED

Tub & Shower

PLUG-IN

Greenheck Fan Corporation certifies that the SP models shown herein are licensed to bear the AMCA seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

For complete product information refer to catalog Models SP and CSP, or contact your local representative.

DESSINS D'ATELIER

3049 Peugeot
Laval, Qc
H7L-5C4
Tél: 450-681-5355
Fax: 450-681-5834

Veuillez trouver ci-inclus les dessins d'atelier pour:

APPROBATION

À:	**Les Entreprises Sifec Nord Inc.** 595, boul. de l'Aéroparc Lachute, Québec J8H 3R8	**Date:**	**15-06-16**
		Votre Commande:	**#YTG12**
		Notre Référence:	**#58794**
		Projet:	**IGLOOLIK WATER & WASTERWATER**
Att:	**Monsieur Samuel Charbonneau**	**Ingénieur:**	

S.V.P. Retourner 1 copie(s) approuvée(s) à:

Qualité Air Totale ● Total Air Quality

3049 Peugeot ● Laval Qc ● H7L-5C4

Quantité	Section	Description
1	1	**Dessins pour Grilles & Diffuseurs (NAILOR)** **(Livraison présentement 4@5 semaines ouvrables après approbation)**
1	2	**Dessins pour Volets Coupe-Feu (NAILOR)** **(Livraison présentement 1@2 semaines ouvrables après approbation)**
1	3	**Dessins pour Volets Motorisés (ALUMAVENT)** **(Livraison présentement 3@4 semaines ouvrables après approbation)**
1	4	**Dessins pour Persiennes (VENTEX)** **(Livraison présentement 3@4 semaines ouvrables après approbation)**

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 24 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 21 juin 2016

Reviewed X
Reviewed as noted ☐
Resubmit ☐

Out for approval

SIFEC NORTH INC.

** Les délais de livraison sont basé sur les cédules en vigueur au moment où ce document a été produit**

Par: Maria Marano

Pour: Cynthia Chartrand

QAT
Qualité Air Totale
Total Air Quality

DESSINS D'ATELIER

Vapac	Humidificateur
ROSEMEX	Unité de ventilation sur mesure
SPINNAKER	Filtration d'odeur, échangeurs de chaleur air/air
seresco	Déshumidificateurs de piscine commerciale
delta 2000 inc.	Serpentins de chauffage électrique sur mesure
ecosaire	Unités de climatisation de précision pour salle informatique
GRADA INTERNATIONAL	Diffuseurs haute induction et canons d'air
IQAir Air Cleaning Perfection	Filtration à particule haute efficacité (hyper Hepa)
Nailor Industries Inc.	Grilles, diffuseurs, volets, persiennes et boites VAV
aéromatic	Unité de ventilation avec échangeur à roue thermique
VENTEX	Persiennes; cabanons et volet motorisés
JencoFan A Tradition of Quality	Ventilateur

SECTION 2:

CÉDULE POUR VOLETS COUPE FEU

Nailor Industries, Inc.

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 21 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Q.A.T.
Qualité Air Totale • Total Air Quality
3049 Peugeot, Laval, Québec, H7L 5C4, tel: (450) 681-5355, mtl: (514) 990-0566, fax: (450) 681-5834

CÉDULE POUR VOLETS COUPE-FEU

CLIENT: LES ENTREPRISES SIFEC NORD INC. **INGÉNIEURS :**

BON DE COMMANDE : #YGT12 **NOTRE RÉFÉRENCE : #58794**

PROJET : IGLOOLIK WATER & WASTERWATER **DATE:** mercredi, 15 juin 2016

No. Modèle Nailor	Dimensions du conduit (POUCES) L X H	Description	No. de dessin	Qté
TYPE AV, MODÈLE 0110V	12X12	V.C.F.	0100-1	1
TYPE AV, MODÈLE 0110V	14X14	V.C.F.	0100-1	1
CHARTE DE DIMENSIONS			SC1	
INSTRUCTION D'INSTALLATION			1.050 @ 1.053	

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 24 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Fire Damper

STATIC CURTAIN TYPE FIRE DAMPER

1 1/2 HR. LABEL • VERT. OR HORIZ.
FOR USE IN STATIC SYSTEMS
MODELS: 0110V AND 0110H (TYPE A)

Nailor Industries Inc.

CLASSIFIED C UL US

QUALIFICATIONS:

- **UL 555 & CAN/ULC-S112 CLASSIFIED FIRE DAMPER. 1 1/2 hr. label (File # R9492).**
- **Meets all the requirements of UL and NFPA 80, 90A and 101 for fire dampers in static HVAC systems, as well as IBC and NBC (Canada) Building Code requirements.**
- **City of New York Board of Standards and Appeals. Cal. No. 460-88-SA.**
- **California State Fire Marshal: Fire Damper Listing No. 3225-0935:0100.**

Model 0110 curtain fire damper is UL approved for use where local building codes require the protection of HVAC ductwork penetrations in walls, partitions or floors that have a fire resistance rating of up to 2 hours. The 0110 is classified for use only in static "fans off" systems where the HVAC system is automatically shut down in the event of a fire alarm.

STANDARD CONSTRUCTION:

Frame: 4 1/4" (108) wide, 22 ga. (0.85) roll-formed G60 galvanized steel.

Blades: Curtain type interlocking blades, 22 ga. (0.85) roll-formed G60 galvanized steel.

Fusible Link: 165°F (74°C) standard. UL Listed. 212°F (100°C) available.

Blade Closure: Vertical mount model; gravity. Horizontal mount models are equipped with stainless steel closure springs and galvanized steel locking ramps.

Sizes (Duct W x H):

Minimum	Maximum		
Single Section	Single Section	Multiple Section	
Vertical/Horizontal	Vertical/Horizontal	Vertical	Horizontal
4" x 4" (102 x 102).	60" x 60" (1524 x 1524)	120" x 120" (3048 x 3048)	① 102" x 60" (2591 x 1524)

① Maximum individual sections not to exceed 34" x 60" (684 x 1524).

OPTIONS:

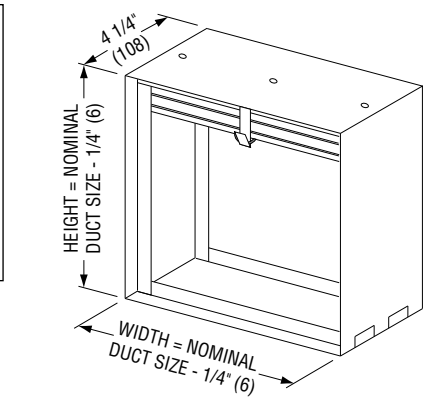
❑ Non-standard temperature fusible link. Specify _____ .

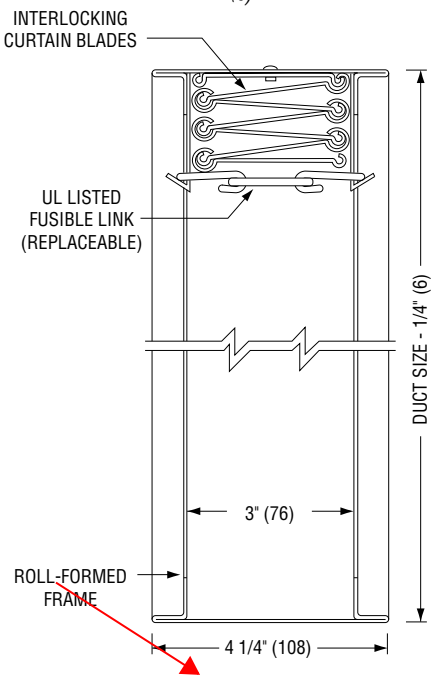
❑ **PT** Pull Tab Release. Permits simple reset of horizontal damper when access door is located below damper. (See dwg. ACC-PTR for details).

❑ Factory Sleeve. Available in 10 (3.5) through 22 ga. (0.85) galvanized steel and in lengths required for application. Specify: _____ length. _____ ga.

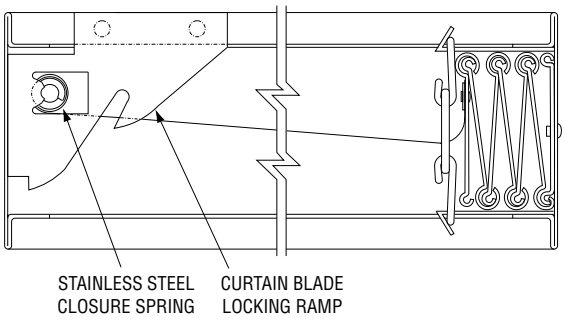
NOTES:

1. Units are manufactured 1/4" (6) under nominal duct size.





MODEL 0110V – VERTICAL MOUNT



MODEL 0110H – HORIZONTAL MOUNT

For installation instructions, see IOM-FDINST.

Dimensions are in inches (mm).

SCHEDULE TYPE:				
PROJECT:				
ENGINEER:	**DATE**	**B SERIES**	**SUPERSEDES**	**DRAWING NO.**
CONTRACTOR:	**4 - 28 - 14**	**FD**	**10 - 6 - 06**	**0100-1**

Nailor Industries Inc. reserves the right to change any information concerning product or pricing without notice.

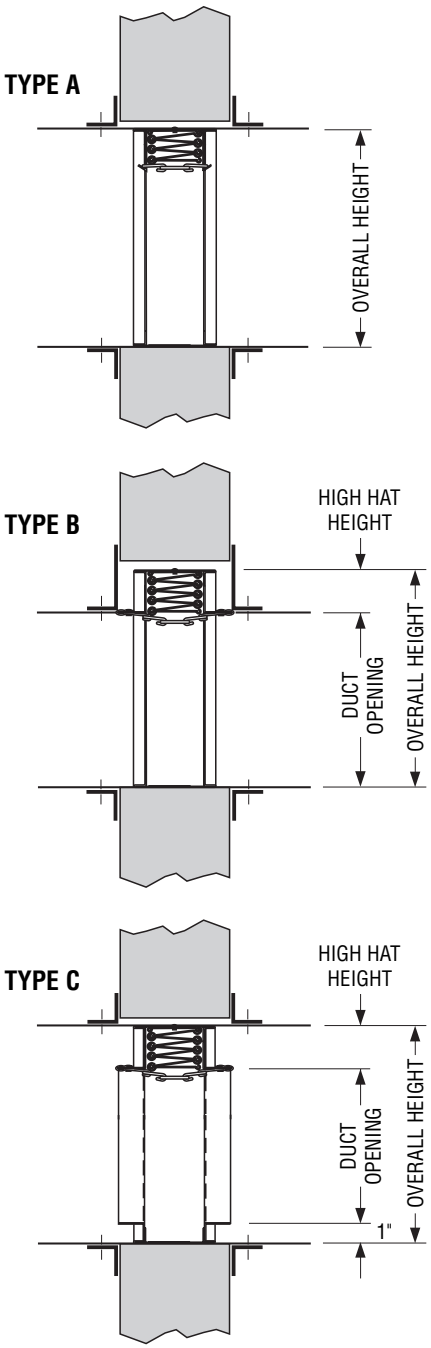
Nailor Industries Inc.

FIRE DAMPER SIZING CHART • IMPERIAL
STANDARD FRAME (4 1/4" WIDE)
MODEL SERIES 0100, 0500

DUCT OPENING HEIGHT (inches)	TYPE "A" OVERALL HEIGHT (inches)	TYPE "B" OVERALL HEIGHT (inches)	TYPE "C" OVERALL HEIGHT (inches)
4	3 3/4	6 1/8	5 3/4
5	4 3/4	7 1/8	6 3/4
6	5 3/4	8 1/8	8 3/4
7	6 3/4	9 1/8	9 3/4
8	7 3/4	10 1/8	10 3/4
9	8 3/4	11 1/8	11 3/4
10	9 3/4	12 1/8	12 3/4
11	10 3/4	13 1/8	13 3/4
12	11 3/4	14 1/8	14 3/4
13	12 3/4	15 1/8	15 3/4
14	13 3/4	16 1/8	16 3/4
15	14 3/4	17 1/8	17 3/4
16	15 3/4	18 1/8	18 3/4
17	16 3/4	19 1/8	19 3/4
18	17 3/4	21 1/8	21 3/4
19	18 3/4	22 1/8	22 3/4
20	19 3/4	23 1/8	23 3/4
21	20 3/4	24 1/8	24 3/4
22	21 3/4	25 1/8	25 3/4
23	22 3/4	26 1/8	26 3/4
24	23 3/4	27 1/8	27 3/4
25	24 3/4	28 1/8	28 3/4
26	25 3/4	29 1/8	29 3/4
27	26 3/4	30 1/8	30 3/4
28	27 3/4	32 1/8	32 3/4
29	28 3/4	33 1/8	33 3/4
30	29 3/4	34 1/8	34 3/4
31	30 3/4	35 1/8	35 3/4
32	31 3/4	36 1/8	36 3/4
33	32 3/4	37 1/8	37 3/4
34	33 3/4	38 1/8	38 3/4
35	34 3/4	39 1/8	39 3/4
36	35 3/4	40 1/8	40 3/4
37	36 3/4	42 1/8	42 3/4
38	37 3/4	43 1/8	43 3/4
39	38 3/4	44 1/8	44 3/4
40	39 3/4	45 1/8	45 3/4
41	40 3/4	46 1/8	46 3/4
42	41 3/4	47 1/8	47 3/4
43	42 3/4	48 1/8	48 3/4
44	43 3/4	49 1/8	49 3/4
45	44 3/4	50 1/8	50 3/4
46	45 3/4	52 1/8	52 3/4
47	46 3/4	53 1/8	53 3/4
48	47 3/4	54 1/8	54 3/4
49	48 3/4	55 1/8	55 3/4
50	49 3/4	56 1/8	56 3/4
51	50 3/4	57 1/8	57 3/4
52	51 3/4	58 1/8	58 3/4
53	52 3/4	59 1/8	59 3/4
54	53 3/4	60 1/8	
55	54 3/4		
56	55 3/4		
57	56 3/4		
58	57 3/4		
59	58 3/4		
60	59 3/4		

DAMPER WIDTH OVERALL
Type "A" = Duct Opening - 1/4".
Type "B" = Duct Opening - 1/4".
Type "C" = Duct Opening + 1 3/4".

Important Note: Type "B" and "C" overall height dimensions only apply to sizes that are single section high. For overall height dimensions for sizes that are multi-section in height, please contact factory. Refer to individual model submittal drawings for maximum single section heights.



Dimensions are in inches (mm).

SCHEDULE TYPE:				
PROJECT:				
ENGINEER:	**DATE**	**B SERIES**	**SUPERSEDES**	**DRAWING NO.**
CONTRACTOR:	**1 - 24 - 06**	**FD**	**2 - 25 - 02R**	**SC1**

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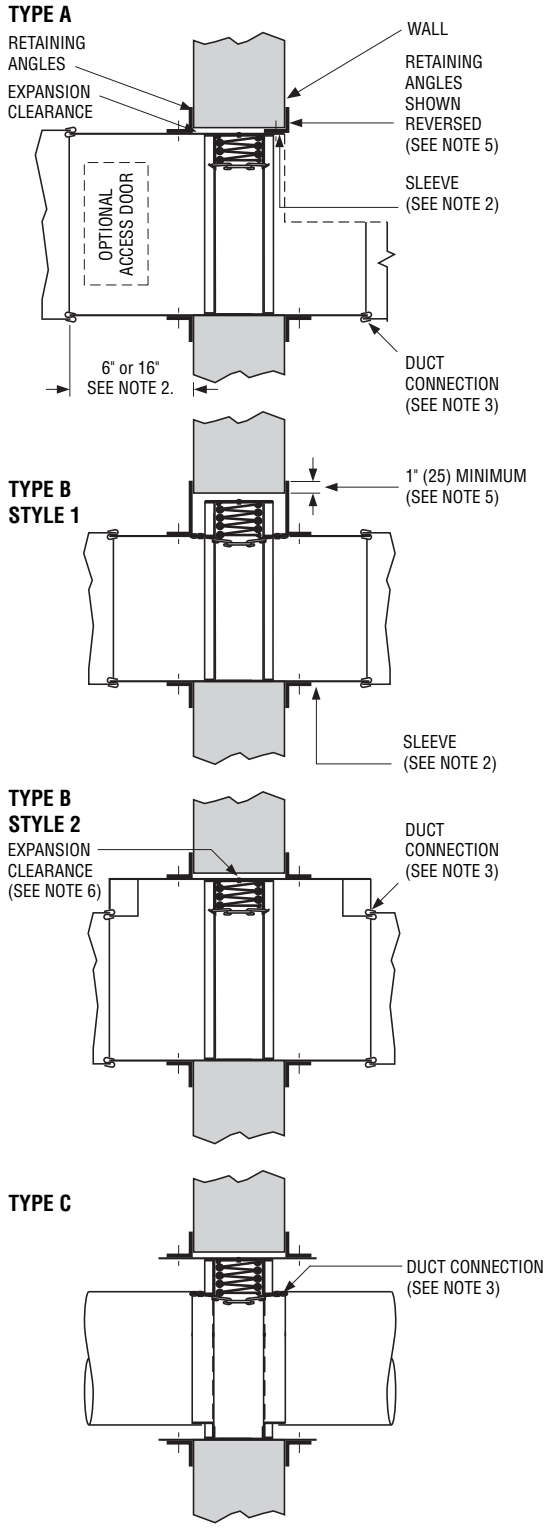
Nailor® Industries Inc.

INSTALLATION INSTRUCTIONS
CURTAIN TYPE FIRE DAMPERS • STANDARD & WIDE FRAME
1 1/2 & 3 HR. LABEL • VERTICAL & HORIZONTAL MOUNT
MODEL SERIES: (D) 0100, 0300, (D) 0500



QUALIFICATIONS:

Refer to the UL Classification Marking on the Product

- **Meets all the requirements of UL 555 and CAN/ULC-S112.**
- **Meets the requirements for NFPA 80, 90A and 101, as well as IBC and NBC (Canada) building codes.**
- **California State Fire Marshal Listing No. 03225-0935:0113.**
- **City of New York Board of Standards and Appeals. Cal. No. 460-88-SA.**

NOTES:

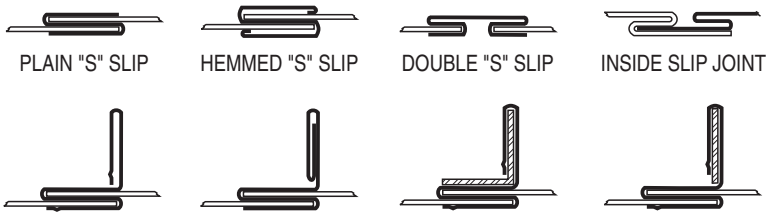
1. Installation shall be in accordance with the appropriate requirements of the National Fire Protection Association Standard NFPA 90A latest edition.

2. Damper Sleeve: Sleeve thickness must be equal to or thicker than the duct connected to it. Sleeve gauge requirements are listed in the SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems and in NFPA 90A. If a break-away style duct/sleeve connection is not used, damper sleeves up to 36" wide by 24" (914 x 610) high of not less than 16 gauge (1.61) coated steel, or larger sleeves of not less than 14 gauge (1.99) thick coated steel may be attached to the duct with screws or other types of mechanical fasteners. The maximum sleeve thickness for such rigid joints is 10 gauge (3.51) for coated steel.

The connecting duct shall not be continuous thru the wall or floor opening but shall terminate at the sleeve. Sleeves shall extend a maximum of 6" (152) on either side of the wall or floor opening or 16" (406) on one side when incorporating a factory installed access door.

3. Break-away duct/sleeve connections:

a. Rectangular ducts must use one or more of the following connections if the gauge is less than the requirement in note 2 for rigid connections:



In addition:

- A maximum of two #10 sheet metal screws on each side and on the bottom, located in the center of the slip pocket and penetrating both sides of the slip pocket may be used.
- One of the above connections on the top and bottom joints with flat drive slip connections on the side joints may be used for dampers up to 20" (508) in height.

FLAT DRIVE SLIP

b. Round and oval duct may be attached to the round or oval collar which is part of the damper/sleeve in the following manner:

- Duct diameters 22" (559) and smaller must use three #10 sheet metal screws equally spaced around the circumference.
- Duct diameters over 22" (559) up to and including 36" (914) may use five #10 sheet metal screws equally spaced around the circumference.
- Duct diameters larger than 36" (914) wide or diameter may use eight #10 sheet metal screws equally spaced around the circumference.

Dimensions are in inches (mm).

Nailor Industries Inc. reserves the right to change any information concerning product or specification without notice or obligation.

Note: When optional sealing of these break-away connections is desired, the duct sealant shall be PA2084T Duct Sealant by Precision or water based DP1010 by Design Polymetrics.

c. For the use of approved alternative Ductmate or TDC/TDF break-away connections, refer to the supplements noted on page 4.

4. **Damper/sleeve attachment:** Damper shall be secured to sleeve with 1/4" (6) long welds, spot welds, 3/16" (4.76) steel rivets, 1/4" (6.35) dia. bolts and nuts, #8 sheet metal screws, or 3/16" (4.76) dia. buttonloks on both sides at 6" (152) on center and a maximum of 2" (51) from the corners of the damper on all four sides. For field assembled sleeves, the inner dimensions of the sleeve shall be equal to the outer dimensions of the damper.
5. **Retaining angles** shall be a minimum of 1 1/2" x 1 1/2" x 16 gauge (38 x 38 x 1.61) for dampers up to 90" (2286)in width and up to 90" (2286) in height. For dampers exceeding these dimensions, the angles shall be a minimum of 2" x 2" x 10 gauge (51 x 51 x 3.51). Secure the retaining angles to the sleeve with 1/2" (12.7) long welds, 1/4" (6.35) dia. bolts and nuts, 3/16" (4.76) dia. steel rivets or #8 sheet metal screws 8" (203) on center and 2" (51) maximum from corner of sleeve on all four sides. The retaining angles must lap the structural opening by 1" (25.4) minimum. When the ductwork terminates at the wall or floor, the retaining angles may be turned inwards, providing the opening size is increased by an amount equal to twice the combined thickness of the angle and the height of the screw or bolthead to maintain the required expansion clearance. Field fabricated retaining angles are not to be mechanically fastened at the corners.
6. **Expansion clearance** between the sleeve and wall or floor shall be a minimum of 1/8" per foot (3.18 per 305) of width or height of the sleeve. The maximum size of the opening shall be 2" (50.8) larger in either dimension than the allowable minimum size. For example; a sleeve dimension of 36" x 36" (914 x 914) shall have an opening size of 36 3/8" x 36 3/8" (924 x 924) minimum and 38 3/8" x 38 3/8" (975 x 975) maximum.
7. The maximum Type A fire damper sizes are as follows:

Model Series				Single Section	Multiple Section
0100	Static	Vertical	(1 1/2 hr. label)	60" x 60" (1524 x 1524) *	120" x 120" (3048 x 3048)
		Horizontal	(1 1/2 hr. label)	60" x 60" (1524 x 1524)	102" x 60" (2591 x 1524) **
0300	Static	Vertical	(1 1/2 hr. label)	60" x 48" (1524 x 1219)	–
		Horizontal	(1 1/2 hr. label)	48" x 48" (1219 x 1219)	–
D0100	Dynamic	Vertical	(1 1/2 hr. label)	36" x 36" (914 x 914)	36" x 48" (914 x 1219) OR **** 72" x 24" (1829 x 610)
		Horizontal	(1 1/2 hr. label)	24" x 24" (610 x 610)	–
0500	Static	Vertical	(3 hr. label)	48" x 48" (1219 x 1219)	108" x 72" (2743 x 1829) ***
		Horizontal	(3 hr. label)	36" x 36" (914 x 914)	72" x 36" (1829 x 914)
0540	Static	Vertical	(3 hr. label)	60" x 48" (1524 x 1219) or 24" x 60" (610 x 1524)	–
D0500	Dynamic	Vertical	(3 hr. label)	36" x 36" (914 x 914)	36" x 48" (914 x 1219) OR **** 72" x 24" (1829 x 610)
		Horizontal	(3 hr. label)	24" x 24" (610 x 610)	–

* Type B and C dampers have the same overall damper size but the connecting ducts are smaller due to the B or C enclosures. See Type B and Type C specification drawings for maximum duct sizes.

** Maximum individual sections not to exceed 34" x 60" (864 x 1524).

*** Maximum individual sections not to exceed 36" x 36" (914 x 914).

**** Maximum individual sections not to exceed 24" x 24" (610 x 610), up to 48" x 24" (1219 x 610). Assemblies larger than 48" x 24" (1219 x 610) will be made up of individual sections not to exceed 18" x 24" (457 x 610).

8. **Multiple Section Assemblies.** Individual dampers may be joined together to make multiple section damper assemblies (see Figure 1). The frames shall be fastened together using 1/4" (6) long welds, 3/16" (4.76) steel rivets, 1/4" (6.35) bolts and nuts, #8 sheet metal screws or 3/16" (4.76) buttonloks on both sides of the damper at 6" (152) max. on center and 2" (51) max. from the corner of the damper on all 4 sides. The following additional requirements shall be met:
   Vertical dampers, 1 1/2 hr. label over 84" (2134) in width require a 12 ga. x 4 1/4" (2.75 x 108) wide steel mullion plate placed between adjacent vertical damper frames and the frames fastened together through this with 1/4" (6.35) bolts and nuts, 12" (305) max. on center. Dampers over 84" (2134) in height require a full length 2" x 2" x 10 ga. (51 x 51 x 3.51) steel angle bolted along horizontal joints on both sides of the assembly using 1/4" (6.35) bolts and nuts, 12" (305) max. on center (see Figure 2).
   Horizontal dampers, 1 1/2 hr. label over 84" (2134) wide require a 14 ga. x 4 1/4" (1.99 x 108) wide steel mullion plate placed between adjacent damper frames and the frames fastened together through this using 1/4" (6.35) bolts and nuts, 1/4" (6) long welds or #8 sheet metal screws, 4" (102) max. on center.
   Vertical dampers, 3 hr. label multiple sections require a 16 ga. x 6" (1.61 ga. x 152) wide "Z" mullion with 7/8" (22) flanges shall be placed between any horizontal joints (see Figure 3). The frames shall be joined together using 3/16" (4.76) bolts and nuts, 1/4" (6) long welds or #8 sheet metal screws, 6" (152) max. on center.

Dimensions are in inches (mm).

Nailor Industries Inc. reserves the right to change any information concerning product or specification without notice or obligation.

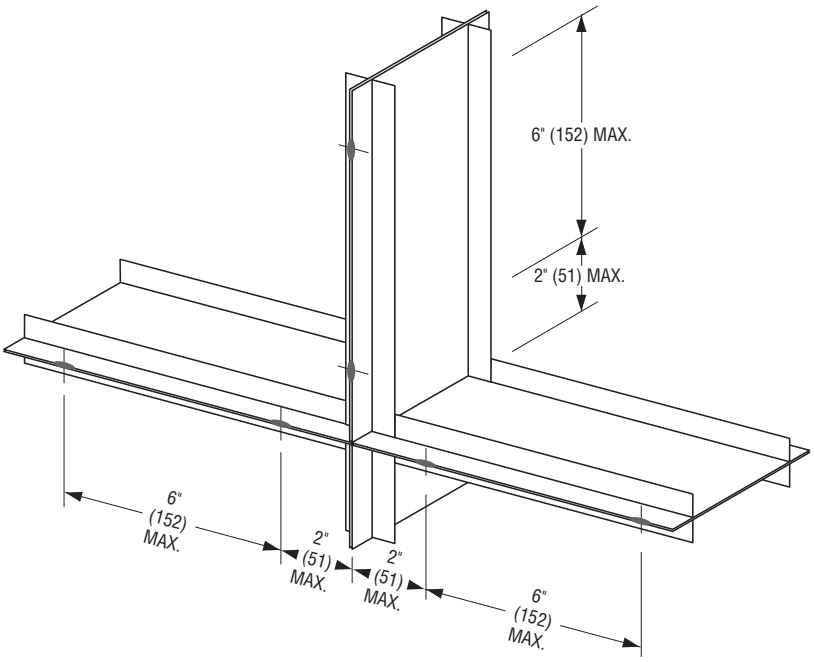


Figure 1.
Fastening of damper frames (see note 8).

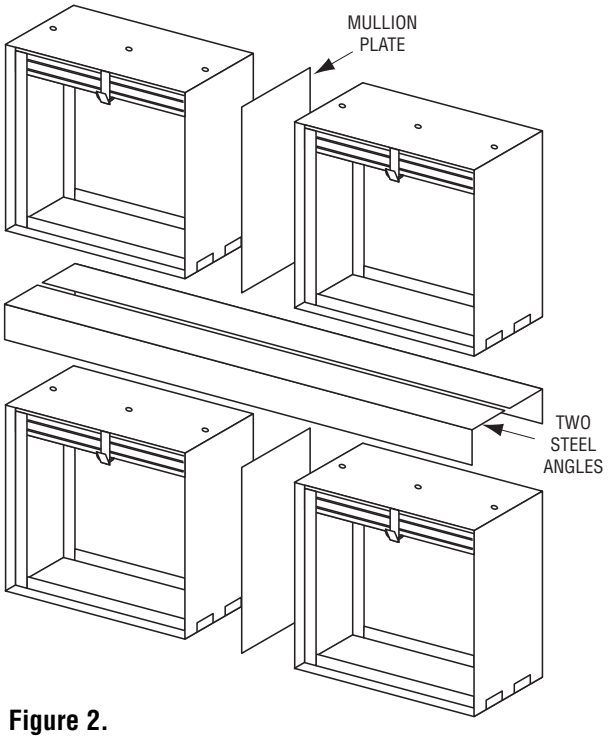


Figure 2.
1 1/2 hr. label vertical installation over 84" x 84" (2134 x 2134) (see note 8).

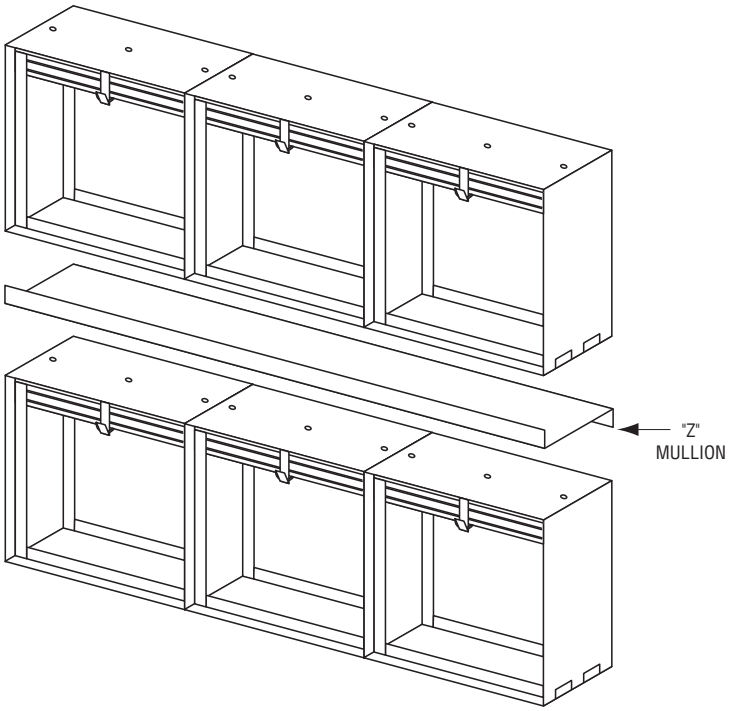


Figure 3.
3 hr. label vertical installation multiple section (see note 8).

Dimensions are in inches (mm).

Nailor Industries Inc. reserves the right to change any information concerning product or specification without notice or obligation.

9. In cases where the openings are larger than specified in note 7, a UL tested and qualified steel mullion must be provided between assemblies (refer to supplementary installation sheet FDSMINST).

IMPORTANT

DO NOT CAST DAMPER IN PLACE.
DO NOT FASTEN RETAINING ANGLES OR DAMPER DIRECTLY TO WALL OR FLOOR.
DO NOT INSTALL DAMPER OUT OF SQUARE OR OUT OF FLAT.
VERTICAL MOUNTING SHOWN ON MASONRY WALL.
FOR INSTALLATION IN DRYWALL FRAMING, SEE DOC. FDSWSFINST.
HORIZONTAL MOUNTING SIMILAR FOR MASONRY FLOOR.

REFER TO THE APPROPRIATE NAILOR INSTALLATION INSTRUCTION SUPPLEMENTS FOR THE FOLLOWING SPECIAL REQUIREMENTS:

STEEL MULLIONS (for dampers in oversized wall openings)	FDSMINST
SINGLE SIDED RETAINING ANGLES	FDSSRAINST
STEEL AND WOOD STUD FRAMING	FDSWSFINST
CAVITY SHAFT WALL PARTITIONS	FDCSWINST
FLANGED TYPE ALTERNATIVE BREAKAWAY CONNECTIONS	FDFABC
TDC/TDF FLANGED DUCT CONNECTION	FDTDCFINST
QUICK-SET RETAINING ANGLES	FDQSRA

Dimensions are in inches (mm).

Nailor® Industries Inc.

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Fax: 281-590-3086

Las Vegas, Nevada
Tel: 702-648-5400
Fax: 702-638-0400

Toronto, Canada
Tel: 416-744-3300
Fax: 416-744-3360

Calgary, Canada
Tel: 403-279-8619
Fax: 403-279-5035

Chapter 25 FUEL-OIL SYSTEM

MANUFACTURER/DISTRIBUTOR:

Wolseley Canada Inc
A/S M. Lacasse
4200 Hickmore
Saint-Laurent, Qc
Email: Mario.Lacasse@wolseleyinc.ca
Tel:(514) 344 9378
Fax:(514) 344 9341

25.1 FUEL PUMPS VIKING DUPLEX SYSTEM SG-0510X-DUP-O

See RFI 4 for justification on the use of this pump. Viking Pump does not offer a pump of 10GPH as specified in the tender. Will be used to full the day tank.

FP-1 / FP-2

VIKING PUMP CANADA

Viking Duplex Fuel Oil Pump Package - Quotation

Company:	Sifec North Inc.	Project:	Igloolik Improvement of Water Supply System
Address:	595 boulevard de l'Aéroparc		
City & Province:	Lachute, Québec	Quote #:	160876
Postal Code:	J8H 3R8	Date:	June 16, 2016
Contact:	Samuel Charbonneau	**FCA:**	Viking Pump, Windsor, Ontario
Phone:	(855) 437-4001	**Terms:**	1%10 days, net 30 days O.A.C.
Fax:		**Delivery:**	4 - 6 weeks after receipt of a purchase order
Email address:	scharbonneau@sifec.ca	**Validation:**	Quote is valid for 60 days

Required Conditions	Capacity			Pressure			Liquid	Viscosity	Temperature	
	2.4	144.0	9.0	9.2	25.0	0.63	No. 2 Fuel Oil	38	76	24
	USGPM	USGPH	L/min	PSIG	Feet	Bar	SG 0.85	SSU	°F	°C

We are pleased to offer the following:

Viking Duplex Fuel Oil Pump Package:

Quantity: **1**

Consisting of:

Quantity: **1** Viking DFO part number: SG-0510X-DUP-O

Quantity : **2** Motors Part Number: 350E.50-60-113TC

0.5 hp 1 ph 60 Hz 120 Volt 1150 rpm 56C Frame size

• Motors shall be Totally Enclosed Fan Cooled, C-Faced, NEMA Frame, CSA, fractional motor

Control Panel for Viking Duplex Fuel Oil Pump Package

Quantity **1**

Viking Control Panel part number: CPA05-160876

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 07 juillet 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for approval

SIFEC NORTH INC.

Best Regards,

Jerome Bouchard
Applications Engineering
519-259-4259

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M. Reviewed [X]

Reviewed as noted [ ]

Date: 8 July 2016 Resubmit [ ]

CHIARELLI ENGINEERING LTD.

FP-1 / FP-2

VIKING PUMP CANADA

Specifications
Viking Duplex Fuel Oil Pump Package

The Duplex Fuel Oil Pump Set shall be Viking # **SG-0510X-DUP-O** complete with the following equipment.

• (2) SG-0510X Spur Gear Pump in cast iron construction, UL-Listed, heat treated steel gears, case-hardened shafts, carbon graphite bushings, lip seal, plain head, 1/2" NPT ports.

• (2) M-drive adaptor to mount the pump on the motor

Pump 1 P/N: Pump 2 P/N: Bracket P/N: **6-05-755-51-0006**

The pumps shall deliver:

Capacity	*Liquid*	*Differential Pressure*	*Viscosity/Sp. Gr.*
2.4 USGPM	No. 2 Fuel Oil	9.2 PSIG	38 SSU
144.0 USGPH		25.0 Feet	3 cPs
9.0 L/min		0.63 Bar	0.85 Sp. Gravity

• Motors shall be Totally Enclosed Fan Cooled, C-Faced, NEMA Frame, CSA, fractional motor

0.5 hp 1 ph 60 Hz 120 Volt 1150 rpm 56C Frame

Motor P/N: **350E.50-60-113TC**

• **Common Base** shall be made of heavy gauge steel plate with 1 1/2" high drip-lip and 1/2" NPT drain.

• **Suction Line Equipment** shall consist of the following components in 1" Header Size

- (2) Lid-Ease Basket Strainers w/40 mesh
- (2) Ball valve, 1" NPT, 600 PSI pressure rated, full port, two piece brass body, PTFE seat, UL-Listed
- (2) 30"Hg-0-30 PSI, Compound gauges, 2.5" face, brass internals, liquid filled
- (2) Gage Valve - Ball valves, 1/4" NPT, 600 PSI, full port, two piece brass body, PTFE seat, UL-Listed
- Sch. 40 cbn stl piping and nipples,150 PSI malleable iron scrd fittings; Class 125/150 Flanges where applicable. N/American fittings std.

• **Discharge Line Equipment** shall consist of the following components in 1/2" Header Size

- (3) Spring Check Valve, 1/2" NPT, 400 PSI pressure rated, bronze body, PTFE poppet
- (2) Ball valve, 1/2" NPT, 600 PSI pressure rated, full port, two piece brass body, PTFE seat, UL-Listed
- (2) In-Line Relief Valve - continuous bypass type, cast iron body, stainless steel spring
- (2) Pressure Gauge, 2.5" dial, brass internals, liquid filled, 0-160 Range
- (2) Gage Valve - Ball valves, 1/4" NPT, 600 PSI, full port, two piece brass body, PTFE seat, UL-Listed
- Sch. 40 cbn stl piping and nipples,150 PSI malleable iron scrd fittings; Class 125/150 Flanges where applicable. N/American fittings std.
- Pump Set to be leak tested with 100 PSI air and soapy water.
- Unit to be coated with Vinyl Toluene Alkyd, Quick Dry Enamel
- Magnetic Float Switch with Alarm for Drip Tray Leak Detection
- Pressure Switch - Dual Stage - High and Low, 6-200 PSI (41.4 to 1379.3 kPa) in EEMAC1 enclosure, installed

Note: Specifications subject to change, consult factory

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FP-1 / FP-2

VIKING PUMP CANADA

Specifications
Control Panel for Viking Duplex Fuel Oil Pump Package

The Control Panel for the Viking Duplex Fuel Oil Pump Set shall be Viking part number: **CPA05-160876**

Duplex Control Panel 0.5 HP, 1/60/120V:

- NEMA 1 enclosure
- Individual disconnect switches, motor protectors and transformer c/w through the door operation and control circuit fuse (1 phase - 120 Volt)
- Magnetic motor starters (2)
- Hand-Off-Auto selector switches (2)
- Power on pilot light (white) (1)
- Run pilot lights (green) (2)
- Terminal Strip
- Provision to connect 3 float switches (normally closed)
- Control circuit fuse
- P1 - Auto - P2 alternating selector switch
- Lead pump failure pilot light & manual reset, lag pump start (automatic transfer to non operating pump in case of motor overload or short circuit)
- High pressure cut out - red pilot light & manual reset
- Low pressure cut out - red pilot light & override timers (2) (manual reset)
- High pressure alarm signal
- Low pressure alarm signal
- Low level alarm signal & red pilot light
- High level alarm signal & red pilot light
- Critical High Level Alarm Signal & red pilot light
- Provision to connect valve (each)
- Redundant Contactors (Back-up to Primary Contactors)
- Drip tray leak detection alarm signal & red pilot light
- Type ADB - 2 float switches, signal from generator & high level red light
- Buzzer and silence push button

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 8 July 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

Important Notes: When quoting an electrical control panel for the DFO set, please check any Federal, State, or Local requirements under the electrical code. Consult our Applications Engineering Department at 1-888-VIK-PUMP for options not listed above

Disclaimer: Any on-site modification needed to meet Federal, State, or Local electrical codes not specified on the order will be the responsibility of the Distributor or End-User and not Viking Pump, Inc. or Viking Pump of Canada Inc.

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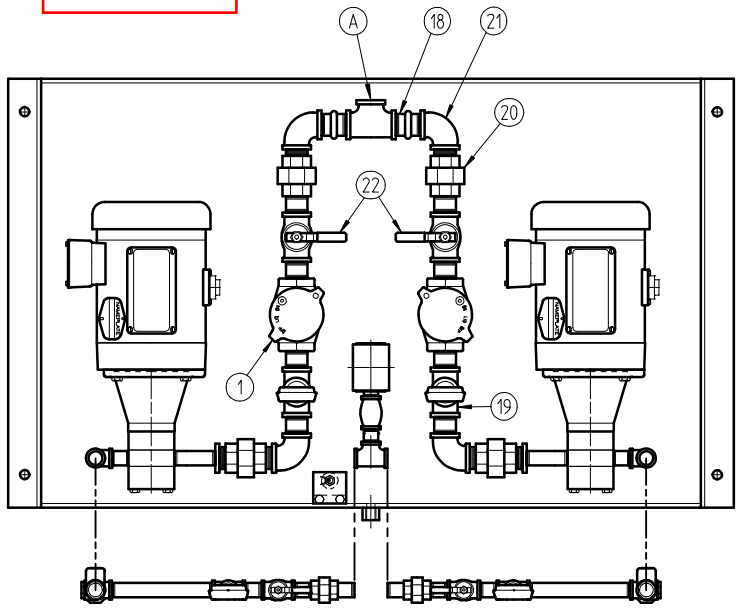
DIMENSIONAL DRAWING SG0510X-DUP-O DUPLEX UNIT

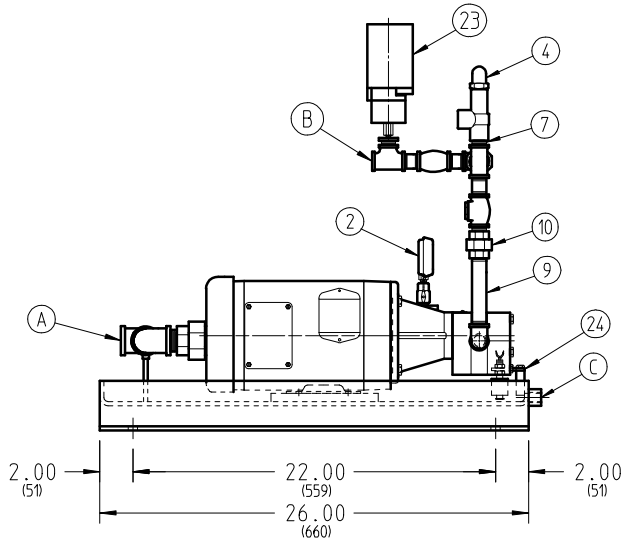
ITEM	DESCRIPTION
1	F1010 1.0" NPT LID EASE SIMPLEX BASKET STRAINER c/w 40 MESH S.S. BASKET
2	COMPOUND GUAGE 30"-0-30 PSI LIQUID FILLED 2.5" FACE X .25" NPT
3	PRESSURE GUAGE 0-100 PSI LIQUID FILLED 2.5" FACE X .25" NPT
4	FULFLO R.V. .50" NPT c/w GREEN-WS SPRING 30 - 100 PSI
5	.25" NPT X 1.5" PIPE NIPPLE
6	.25" NPT BALL VALVE
7	.50" NPT X 1.5" PIPE NIPPLE TBE
8	.50" NPT X 3.0" LONG NIPPLE
9	.50" NPT X 6.0" LONG NIPPLE
10	.50" NPT UNION
11	.50" NPT TEE
12	.50" NPT 90 DEG STREET ELBOW
13	.50" NPT CHECK VALVE
14	.50" NPT BALL VALVE
15	.50" MALE X .25" FEMALE NPT HEX REDUCING BUSHING
16	1.0" MALE X .25" FEMALE NPT HEX REDUCING BUSHING
17	1.0" MALE X .50" FEMALE NPT HEX REDUCING BUSHING
18	1.0" NPT X 2" PIPE NIPPLE
19	1.0" NPT TEE
20	1.0" NPT UNION
21	1.0" NPT 90 DEG STREET ELBOW
22	1.0" NPT BALL VALVE
23	PRESSURE SWITCH - DUAL STAGE
24	MAGNETIC FLOAT SWITCH

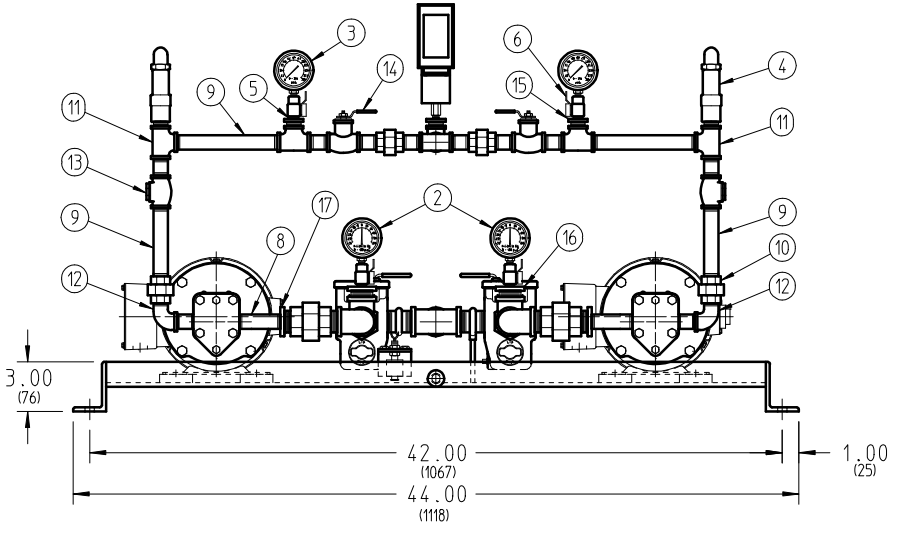
A	1.0" NPT COMMON SUCTION
B	.50" NPT COMMON DISCHARGE
C	.50" NPT DRAIN CONNECTION
D	9/16" DIA. 4-HOLES

NOTES
1) PIPES AND NIPPLES ARE CARBON STEEL SCH.40
2) ALL MALLEABLE IRON FITTINGS AND STEEL PIPING ARE MANUFACTURED IN USA/CANADA
3) PUMP SET IS LEAK TESTED WITH 100 PSI AIR AND SOAPY WATER

FP-1 / FP-2







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DIMENSIONAL DRAWING FOR VIKING DUPLEX FUEL OIL PACKAGE MODEL SG-0510X-DUP-O WITH SG-0510X PUMPS AND M DRIVE BRACKETS TO SUIT 56C FRAME MOTORS.

VIKING PUMP

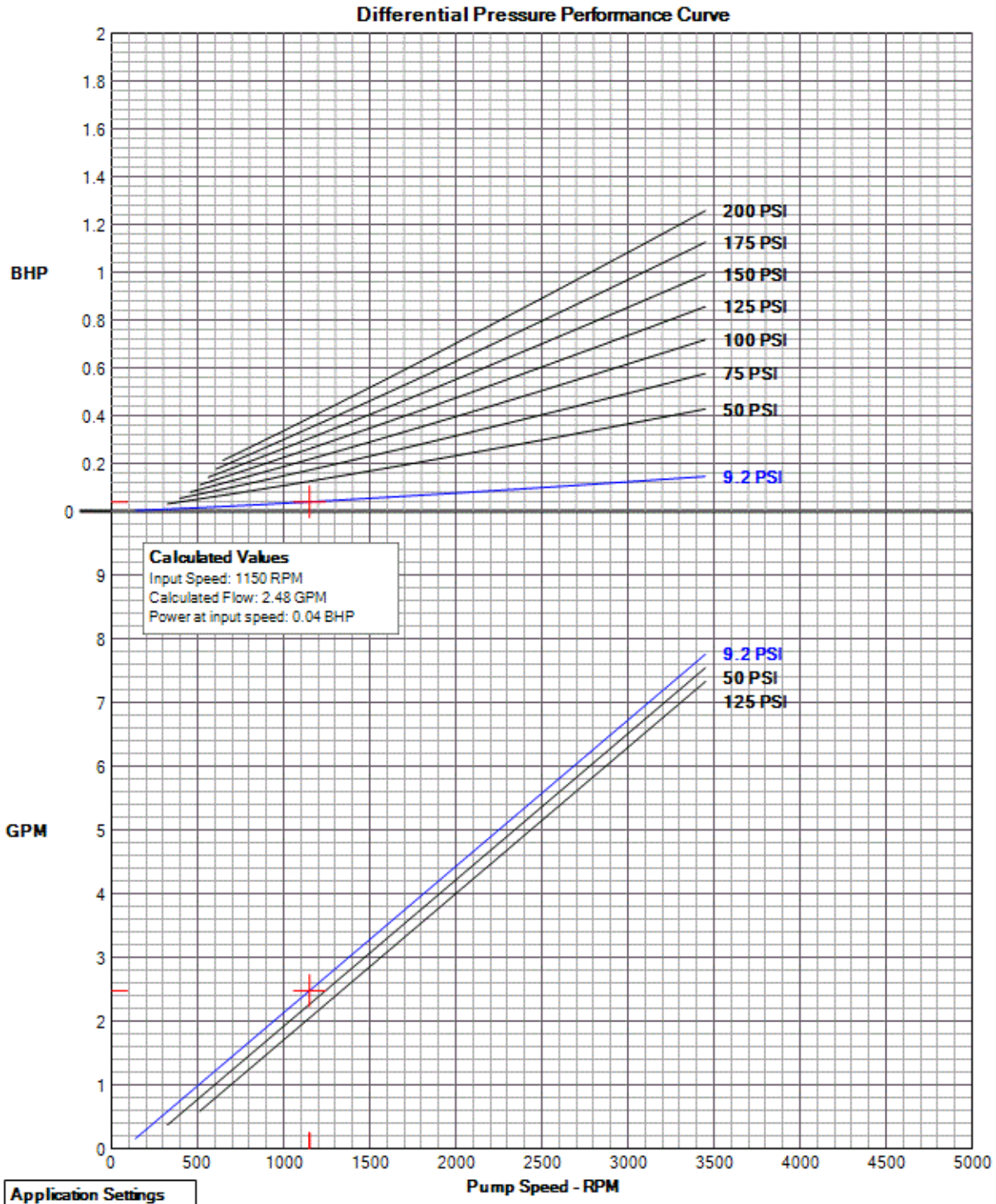
VIKING PUMP OF CANADA INC.
A Unit of IDEX Corporation
Windsor, Ontario N9A 6M3
CANADA

ARR. DRAWING

DRG. SIZE B

DRAWING NUMBER 800-SG-0510X-DUPLEX-O

FP-1 / FP-2



Application Settings
Model: SG-0510
Viscosity: 38 SSU
Diff. Pressure: 9.2 PSI
Temperature: 70 F
Specific Gravity: 0.85

Viking Pump, A Unit of IDEX Corporation, 406 State Street, Cedar Falls, Iowa, USA, 50613,

FP-1/FP-2

VIKING PUMP

A Unit of IDEX Corporation

Viking® Duplex Fuel Oil Systems and Control Panels

Factory Built and Tested Solutions for Simple Installation Startup and Operation

DFO

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☐
Reviewed as noted ☒
Resubmit ☐

CHIARELLI ENGINEERING LTD.

- **25 Years experience**
- **Single source responsibility**
- **Compact integrated system**
- **Mounting flexibility**
- **Ease of Selection**
- **Factory-Built / Local Support**

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 14 Juin, 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

Capacity to 284 LPM (75 GPM)
Pressure to 3,448 kPa (500 PSI)
Viscosity 1 to 500 cSt (38 to 2,500 SSU)
Temperature -20°C to +82°C (-4°F to +180°F)

Shop Drawings
Contractor Approval
Approved by: M.A.G., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

IDEX CORPORATION

FP-1/FP-2

Duplex Fuel Oil Systems Applications

The Viking Advantages

Viking Duplex Fuel Oil systems:

Factory engineered and built to order Duplex Fuel Oil systems and control panels for oil transfer applications like:

- Fueling diesel generators for backup electrical power generation
- Boosting low pressure fuel oil on oil-fired boilers and oil-fired furnaces
- Oil filtration/recirculation to ensure clean and / or water-free oil
- Fuel oil transfer from storage to day tank.

Viking Advantages

- Experience – Viking Pump have been worldwide leaders of PD pumping solutions since 1911 and have over 25 years of engineering and manufacturing DFO systems.
- One Source-One Responsibility – With a Viking DFO set we pre-engineer, pre-plumb, and with available pre-wiring give you a complete “plug-n-play” system so you don’t have to worry about sourcing and assembling the components.
- Compact – The Viking DFO set provides you with a compact integrated system that allows you mounting flexibility.
- Ease of Selection – With Viking’s easy select software, you can design, specify, and order standard and custom DFO systems to suit your application.
- Factory-Built / Local Support – With Viking’s extensive Distributor network we can provide you with local support and start-up assistance for you Viking DFO set.

Customer Benefits:

- Reliable fuel delivery with plumbed-and-wired standby pump
- Alternate pumps automatically minimize run time on any one pump
- Proven, factory manufactured sets built custom to your order
- UL-CSA electrical control panels
- Available with standard or UL rated pumps
- Quick access comparison sheets, specification sheets and illustration drawings
- Easily requested CAD submittal drawings
- Over 25 years experience engineering and manufacturing duplex fuel oil systems
- Easy sizing with 8-Step Selection Program
  (CD available, through your local authorized Viking Distributor)

Typical Applications:

Emergency Generators

Turbine Generators

Boilers

Standard Equipment - Pump Sets

Standard Equipment

Viking Heavy Duty Positive Displacement Rotary Gear or Spur Gear Pumps (2)

Flexible couplings with Orange Peel OSHA guards (2)

Motors - Totally Enclosed Fan Cooled, foot mounted, NEMA, UL, CSA (2)

Common steel baseplate shall be made of heavy gauge steel plate with 1 1/2" high drip-lip and 1/2" NPT drain (1)

Suction Line Equipment

- Viking Lid-Ease Basket Strainers, cast iron body, 40 mesh stainless steel basket (2)
- Ball valves, 600 PSI pressure rated, full port, two piece bronze body, PTFE seat (2)
- Compound Gauges, 30" Hg-0-30 PSI 2.5" dial, bronze internals, stainless steel case, liquid filled (2)
- Gauge Valves - bronze ball valves, 600 PSI rated (2)

Discharge Line Equipment

- Spring Check Valves, 400 PSI pressure rated, bronze body, PTFE poppet (3)
- Ball valves, 600 PSI pressure rated, full port, two piece bronze body, PTFE seat (2)
- Relief Valves - continuous bypass type, cast iron body, stainless steel spring (2)
- Pressure Gauges, 0-200 PSI, 2.5" dial, bronze internals, stainless steel case, liquid filled (2)
- Gauge Valves - bronze ball valves, 600 PSI rated (2)

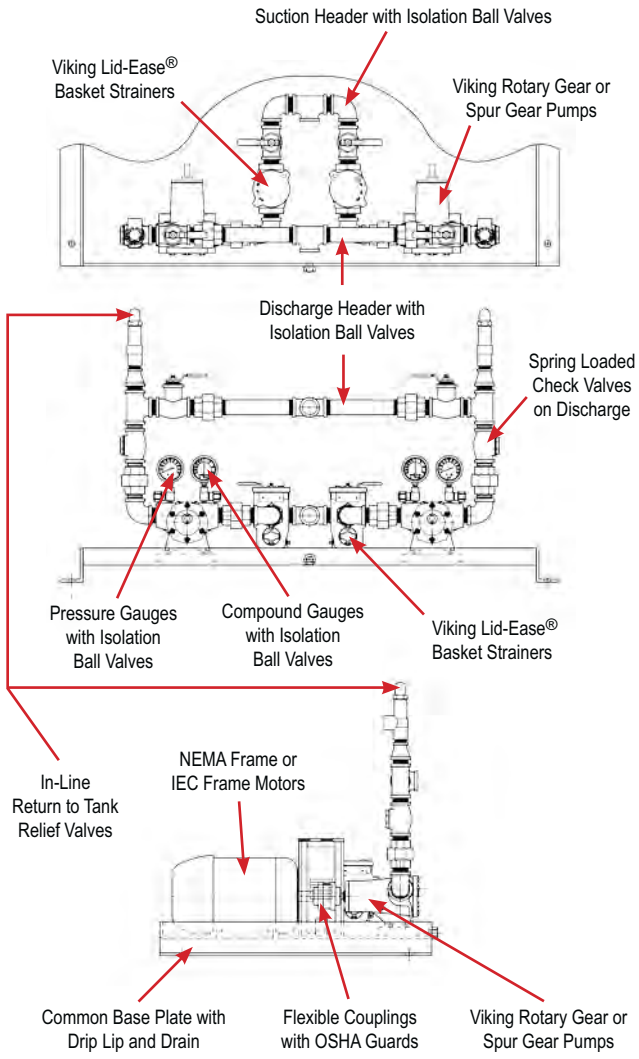
Suction and Discharge Piping

- Schedule 40 carbon steel piping and nipples, 150 PSI malleable iron screwed fittings

Unit to be coated with Vinyl Toluene Alkyd, quick dry enamel.

Duplex pump set to be leak tested with 100 PSI air and soap water.

Typical Standard Equipment Example



Suction Strainers

Viking Lid-Ease® Simplex Basket Strainer (2)
Duplex Basket Strainer (1)
Y-Strainers (2)
UL-Listed Simplex Basket Strainer (2)
UL-Listed Duplex Basket Strainer (1)

Standard equipment is Viking Lid-Ease Strainer w/40 mesh.
All strainers offerred in 20, 40 or 60 mesh.

Phase-Cycle-Voltage

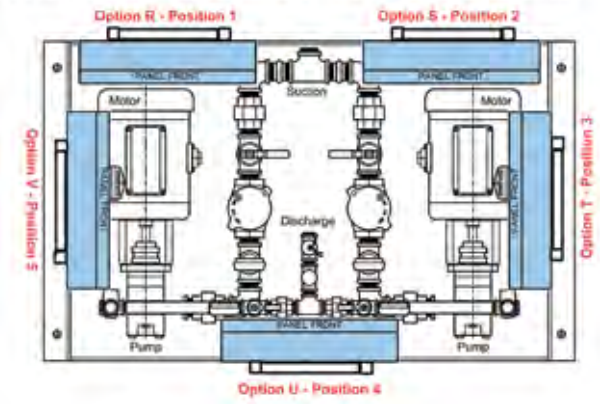
1 ph 60 Hz 115 Volt
1 ph 60 Hz 230-240 Volt
3 ph 60 Hz 208-230-460 Volt
3 ph 60 Hz 575 Volt
3 ph 50 Hz 380-415 Volt

Optional Equipment - Pump Sets

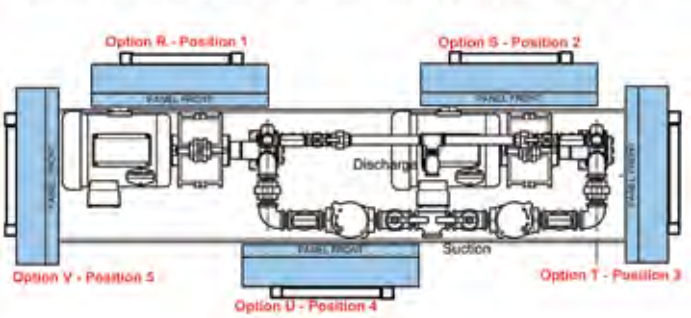
"A" or "B"	A	Pressure Switch - Single Stage, 20-200 PSI (41.4 to 1379.3 kPa) in EEMAC1 enclosure, installed
	B	Pressure Switch - Dual Stage - High and Low, 6-200 PSI (41.4 to 1379.3 kPa) in EEMAC1 enclosure, installed
	C	Pressure Control Valve Bronze body, Buna-N diaphragm, 0 to 75 PSI (0 to 517.2 kPa) c/w two shut off and one by-pass valve, installed
"D" or "E"	D	Flow Switch - Low Pressure to 100 PSI , NEMA 1, brass housing, SS vane, with junction box, c/w 120VAC, SPDT switch, installed
	E	Flow Switch - High Pressure to 1450 PSI , NEMA 7, brass housing, SS vane, less junction box, c/w 120VAC, SPDT switch, installed
"F" or "G"	F	Thermometer, industrial , bi-metal type, 3" round dial, 1/2"NPT mount -5° to 115°C (20° to 240°F), installed
	G	Thermometer, 91T100 industrial , 9" long Valox case with glass lens, 3/4"NPT mount, 0° to 115°C (30° to 240°F), installed
	H	Flexible Connectors: (1) suction header, (1) discharge header, (1) return-to-tank Relief Valve, SS hose, steel nipples, supplied loose
	J	Water Removal Filter, spin-on type cartridge filter, 200 PSI, c/w disposable 10 micron element and visual indicator, installed
	K	Galvanized Base Plate
	L	4" Dial Guages - (2) Compound 30"Hg-0-30PSI & (2) Pressure 0-200 PSI
"M" or "N"	M	UL-Listed Ball Valves, Strainer(s), and Relief Valves
	N	Stainless Steel Ball Valves and Check Valves (instead of standard bronze)
	O	Turbine Flow Meter - installed
	P	Viton® Seals in Pumps (instead of Buna-N)
	Q	High Efficiency Motors (Available for 3 phase 1 HP and larger)
"R" or "S" or "T" or "U" or "V"	R	Control Panel Mounted & Wired on Pump Set - Position 1
	S	Control Panel Mounted & Wired on Pump Set - Position 2
	T	Control Panel Mounted & Wired on Pump Set - Position 3
	U	Control Panel Mounted & Wired on Pump Set - Position 4
	V	Control Panel Mounted & Wired on Pump Set - Position 5
	W	Hand Priming Pump - Piped c/w isolation valves
	X	Magnetic Float Switch w/Alarm for Drip Tray Leak Detection
	Y	Header for Return-to-Tank Relief Valves

UL Listed Pumps
Cast Steel Pumps (4193 Series)
Consult factory for other options not listed

Control Panel Mounting and Wiring to Pump Set - (Side-by-Side Units)



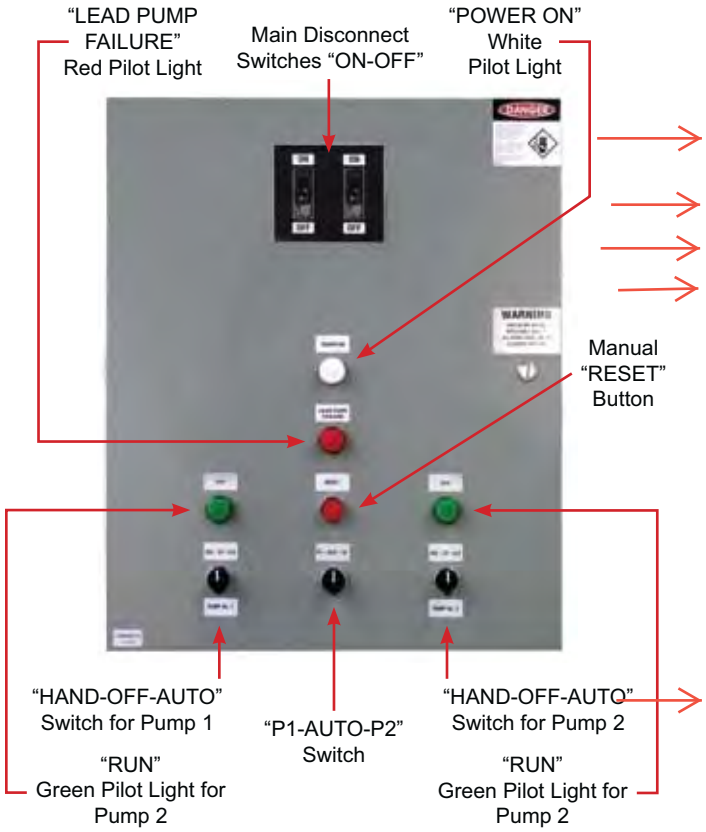
Control Panel Mounting and Wiring to Pump Set - (F & FH In-Line Units Only)



Standard Equipment - Control Panels

Standard Equipment:

- NEMA/CSA 1 enclosure
- Single pole circuit breaker (2) c/w through the door operation (120 volt) or individual disconnect switches, motor protectors and transformer (208-575 volt)
- Magnetic motor starters (2)
- Hand-Off-Auto selector switches (2)
- Power on pilot light (white)
- Run pilot light (green) (2)
- Terminal Strip
- Provision to connect 3 float switches (normally closed)
- Control circuit fuse
- Lead pump failure pilot light & manual reset, lag pump start
- P1 - Auto - P2 alternating selector switch



Standard control panel for Duplex Fuel Oil Pump Set is NEMA1 enclosure / CSA Listed. For USA customers, the panel is standard with UL508 Listing (see option Q in optional equipment)

Customized Packages to Your Specifications

Consult our Factory Applications Engineers to help us build the fuel oil system to meet your applications needs, with specific brands or specifications of:

• Motors	• Special Painting	• Filtration
• Valves	• Custom Nameplates	• Gauges
• Piping and Fittings	• Solenoid Valves	• Controls

Optional Equipment: Control Panel Chart

A	Motor run signal NO/NC - 1 per pump
B	Motor tripped red lights (2)
C	Motor tripped NO/NC signals (2)
D	High pressure cut out - red pilot light and manual reset
E	Low pressure cut out - red pilot light and override timers (2) (manual reset)
F	High pressure alarm signal
G	Low pressure alarm signal
H	Type ADB - 2 float switches, signal from generator and high level red light
I	Buzzer and silence push button
J	NEMA / CSA 2 enclosure - drip proof
K	NEMA / CSA 12 enclosure - oil & dust tight
L	NEMA / CSA 4 enclosure - water tight
M	Low flow signal to start lag pump c/w timers (2), red pilot lights and reset push button
N	Low level alarm signal and red pilot light
O	High level alarm signal and red pilot light
P	Low flow alarm signals (2)
Q	UL508 Listed Panel (Standard on USA Panel - Optional for Canadian panel)
R	Stop pump level main tank alarm signal and red pilot light
S	Low-level alarm signal and red pilot light (specify function)
T	High-level alarm signal and red pilot light (specify function)
U	Momentary test button
V	Key lock
W	Provision to connect valve (each)
X	Main disconnect for single phase controller
Y	Overload reset push-button (or handle)
Z	No alternator
1	NEMA 3R double door enclosure
2	Emergency push button shut-off switch
3	Time delay on Magnetrol contact (each, specify contact)
4	Main disconnect for three phase controller in lieu of pump disconnect

Consult Factory for other control panel options.

FP-1/FP-2

VIKING PUMP
A Unit of IDEX Corporation

Worldwide Leader Since 1911 for Positive Displacement Pumping Solutions for Industrial, OEM, and Sanitary Applications.

Innovation and Experience

Viking Pump has been a pump industry leader and innovator since its founding in 1911. We continue to build on our ever growing experience delivering innovative new pumping solutions, including custom designs, to many thousands of customers who use millions of Viking® pumps in some of the world's toughest applications.

Broad Performance Range

Capacity:
0.5 to 360 M³/Hr (0.1 to 1600 GPM)
Pressure:
0 to 172 Bar (0 to 2500 PSI)
Temperature:
-40°C to 370°C (-40°F to 700°F)
Viscosity:
0.5 to 1,000,000 cSt (28 to 4,500,000 SSU)

Ultimate in Sealing Solutions

Viking's offering of packing, component mechanical seals, cartridge seals, and sealless Mag Drive technology provides the best choices for sealing flexibility needed to provide your application a customized sealing solution every time - saving you money, time, and unplanned downtime.

Material Options Matched to Application

Viking's dedicated iron and alloys foundries provide pump construction materials from cast iron to Alloy C. Application-specific materials of construction extend pump life significantly, while reducing maintenance and unplanned downtime, which enables increased production and a better bottom line.

Liquid Integrity Protection

Viking has developed multiple positive displacement pump principles to protect shear-sensitive liquids, and low-shear options to prevent damage to fibers, polymers, and solids. Full-jacketing options provide precise temperature control throughout the pump. The Viking Mag Drive® and other seal options prevent fluid contact with air, assuring liquid integrity.

Local Applications and Engineering Support

Over 245 Authorized Viking Pump Distributors in 68 countries provide local application support and service, backed by Viking Application Engineers and Viking Region Managers strategically located around the world.

Quality Manufacturing

Viking uses ISO9001-2000, ISO14001, Six-Sigma, and Lean/Kaizen in its worldwide manufacturing and assembly processes to remove waste, reduce development costs, and deliver superior products on schedule. Dedicated Viking foundries and manufacturing facilities utilize state-of-the-art CNC equipment to assure unmatched quality is built into every pump.

Custom Designed Solutions

Viking has provided custom designed pumps to end-users and OEMs since its first pump in 1911, when Viking invented the gear-within-a-gear pumping principle to remove water from a rock quarry. Today, enabled by Viking's engineering staff, extensive applications experience, and in-house foundries, more than 20% of Viking's sales are new Viking designs, or pumps designs derived from more than 1000 Viking catalog pumps with more than 40,000 active configurations. So, whether you are an end-user or an OEM, Viking can provide custom designed pumping solutions to meet your specific needs.

IDEX CORPORATION

For more information, contact your local authorized Viking Pump Distributor or contact Viking at:

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A Unit of IDEX Corporation
406 State Street
Cedar Falls, Iowa 50613-0008 U.S.A.
Telephone: (319) 266-1741
Fax: (319) 273-8157
Email: info.viking@idexcorp.com
Web site: www.vikingpump.com

VIKING PUMP OF CANADA INC.
A Unit of IDEX Corporation
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Windsor, Ontario N9A 6M3 Canada
Telephone: (888) 845-7867
Fax: (519) 256-5070
E-mail: cinfo@idexcorp.com
Web site: www.vikingpumpcanada.com

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 20 June 2016

Reviewed ☐
Reviewed as noted ☒
Resubmit ☐

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FP-1/FP-2

VIKING PUMP CANADA

Specifications
Viking Duplex Fuel Oil Pump Package

The Duplex Fuel Oil Pump Set shall be Viking # **SG-0510X-DUP-O** complete with the following equipment.

• (2) SG-0510X Spur Gear Pump in cast iron construction, UL-Listed, heat treated steel gears, case-hardened shafts, carbon graphite bushings, lip seal, plain head, 1/2" NPT ports.

• (2) M-drive adaptor to mount the pump on the motor

Pump 1 P/N: Pump 2 P/N: Bracket P/N: **6-05-755-51-0006**

The pumps shall deliver:

10 usgpm @ 25'

Capacity	*Liquid*	*Differential Pressure*	*Viscosity/Sp. Gr.*
2.5 USGPM	No. 2 Fuel Oil	10.0 PSIG	38 SSU
9.5 l/min		0.68 Bar	3 cPs
0.15 l/sec		68.9 kPa	0.85 Sp. Gravity

• Motors shall be Totally Enclosed Fan Cooled, C-Faced, NEMA Frame, CSA, fractional motor

0.5 hp 1 ph 60 Hz 115 Volt 1150 rpm 56C Frame

Motor P/N: **350E.50-60-113TC**

• **Common Base** shall be made of heavy gauge steel plate with 1 1/2" high drip-lip and 1/2" NPT drain.

• **Suction Line Equipment** shall consist of the following components in 1" Header Size

- (2) Lid-Ease Basket Strainers w/40 mesh
- (2) Ball valve, 1" NPT, 600 PSI pressure rated, full port, two piece brass body, PTFE seat, UL-Listed
- (2) 30"Hg-0-30 PSI, Compound gauges, 2.5" face, brass internals, liquid filled
- (2) Gage Valve - Ball valves, 1/4" NPT, 600 PSI, full port, two piece brass body, PTFE seat, UL-Listed
- Sch. 40 cbn stl piping and nipples,150 PSI malleable iron scrd fittings; Class 125/150 Flanges where applicable. N/American fittings std.

• **Discharge Line Equipment** shall consist of the following components in 1/2" Header Size

- (3) Spring Check Valve, 1/2" NPT, 400 PSI pressure rated, bronze body, PTFE poppet
- (2) Ball valve, 1/2" NPT, 600 PSI pressure rated, full port, two piece brass body, PTFE seat, UL-Listed
- (2) In-Line Relief Valve - continuous bypass type, cast iron body, stainless steel spring
- (2) Pressure Gauge, 2.5" dial, brass internals, liquid filled, 0-160 Range
- (2) Gage Valve - Ball valves, 1/4" NPT, 600 PSI, full port, two piece brass body, PTFE seat, UL-Listed
- Sch. 40 cbn stl piping and nipples,150 PSI malleable iron scrd fittings; Class 125/150 Flanges where applicable. N/American fittings std.
- Pump Set to be leak tested with 100 PSI air and soapy water.
- Unit to be coated with Vinyl Toluene Alkyd, Quick Dry Enamel
- Magnetic Float Switch with Alarm for Drip Tray Leak Detection
- Pressure Switch - Dual Stage - High and Low, 6-200 PSI (41.4 to 1379.3 kPa) in EEMAC1 enclosure, installed

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FD-1/FD-2

VIKING PUMP CANADA

Specifications
Control Panel for Viking Duplex Fuel Oil Pump Package

The Control Panel for the Viking Duplex Fuel Oil Pump Set shall be Viking part number: **CPA05-DUP-STD**

Duplex Control Panel 0.5 HP, 1/60/115V:

- NEMA 1 enclosure
- Individual disconnect switches, motor protectors and transformer c/w through the door operation and control circuit fuse (1 phase - 115 Volt)
- Magnetic motor starters (2)
- Hand-Off-Auto selector switches (2)
- Power on pilot light (white) (1)
- Run pilot lights (green) (2)
- Terminal Strip
- Provision to connect 4 float switches and 1 redundant float switch (normally closed)
- Control circuit fuse
- P1 - Auto - P2 alternating selector switch
- Lead pump failure pilot light & manual reset, lag pump start (automatic transfer to non operating pump in case of motor overload or short circuit)
- High pressure cut out - red pilot light & manual reset
- Low pressure cut out - red pilot light & override timers (2) (manual reset)
- High pressure alarm signal
- Low pressure alarm signal
- Low level alarm signal & red pilot light
- High level alarm signal & red pilot light
- Critical High Level Alarm Signal & red pilot light
- Provision to connect valve (each)
- Redundant Contactors (Back-up to Primary Contactors)
- Drip tray leak detection alarm signal & red pilot light

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☐
Reviewed as noted ☒
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Electronic copies of the most current TSM issue can be found on the Viking Pump website at www.vikingpump.com

INSTALLATION, START UP, TROUBLESHOOTING, PREVENTIVE MAINTENANCE, DO'S & DON'TS SERIES SG-04, SG-05 & SG-07 SPUR GEAR PUMPS

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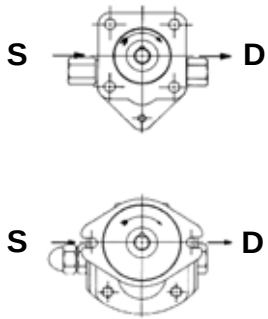


FIGURE 1

INSTALLATION

General

The following items must be considered prior to pump installation:

1. Location - locate the pump as close as possible to the liquid supply. If possible locate the pump below the liquid supply. Viking pumps are self-priming; but the better the suction conditions, the better the pump will perform.
2. Accessibility – the pump must be accessible for inspection, maintenance and repair.
3. Suction/Discharge - SG Series pumps are designed for clockwise rotation as standard (viewed from end of shaft). Refer to Figure 1.
4. Pressure Relief Valve - the SG Series is a positive displacement pump and requires some form of over pressure protection. Without pressure protection, if the discharge line is blocked or becomes closed, pressure will build up until the motor stalls, drive equipment fails, a pump part breaks, or the piping and/or other equipment in the system bursts. To prevent the possibility of any one or more of the above from occurring, the use of a pressure relief valve is recommended.
5. Storage - drain the pump and apply a light coat of non-detergent SAE 30 weight oil to all internal pump parts. Apply grease to the pump shaft extension. Viking suggests rotating the pump shaft by hand one complete revolution every 30 days to circulate the oil.

MOUNTING

1. Surfaces to which the pump mounts must be clean and flat.

2. Use SAE Grade 5 or better capscrews to mount pump.

3. The 4 mounting capscrews for the SG-04 and SG-05 pumps must have a minimum of ½ inch thread engagement, and must be torqued evenly to 12-15 ft-lbs.

4. The 2 mounting capscrews for the SG-07 pumps must have a minimum of ½ inch thread engagement, and be evenly torqued to 50-55 ft-lbs.

5. Standard SG Series pumps are designed to be used with jaw type couplings that do not induce axial thrust on the pump shaft. If an improper type of coupling is used, internal damage may result.

6. Do not strike or press the pump drive coupling to install. Internal pump damage will result. If the coupling does not slide onto the shaft, inspect the coupling, shaft and key for nicks or burrs and remove.

7. If the pump is to be belt or gear driven, the overhung load option must be specified.

8. Once the pump has been mounted and the coupling installed, it is recommended to put lube oil into the suction port and turn the pump by hand to make sure it turns freely.

Alignment

Check alignment after mounting.

1. If the unit has a flexible coupling, remove any coupling guards or covers and check alignment of coupling halves. A straight edge (piece of key stock will work) across the coupling must rest evenly on both rims at the top, bottom and sides. See Figure 3.

2. Make a final check on alignment after the piping is hooked up.

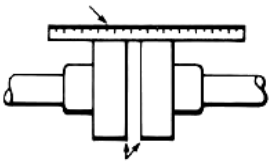


FIGURE 3

Piping/Hose

The cause of many pumping problems can be traced to the suction piping. It should always be as large in diameter and as short in length as possible.

Before starting the layout and installation of your piping system, consider the following points:

1. Never use piping smaller than the pump port connections. Piping larger in diameter than the port connection is sometimes required to reduce friction losses.

2. Be sure the inside of the pipe is clean before installing.

3. When approaching an obstacle to the suction line, go around instead of over it. Going over an obstacle can create an air pocket. Where practical, slope the piping so no air or liquid pockets will be formed. Air pockets in the suction line make it hard for the pump to prime.

4. A strainer on the suction side of the pump should always be considered in any pumping system. The strainer will keep foreign matter from entering the pump. The strainer mesh or perforation size should be large enough so that it does not cause excessive pressure drop, but fine enough to protect the pump. Use of a strainer is particularly important at start up to help clean the system of weld beads, pipe scale and other foreign objects.

5. A pressure relief valve is required in the discharge line. See Pressure Relief Valves, General page 1 item 4.

6. The pump must not be used to support the piping. Hangers, supports, stands, etc. must carry the weight of the pipes.

7. When fastening piping to the pump do not impose any strain on the pump casing. “Springing” or “drawing” the piping up to the pump will cause distortion, possible misalignment and probable rapid wear of the pump. Do not use the pump to correct errors in piping layout or assembly.

8. All joints of piping system must be tight; liquid thread sealant will help assure leak free threaded joints. Loose joints result in liquid leaks or suction side leaks. Air leaks make the pump noisy and reduce flow. **CAUTION:** Be careful not to over tighten fittings as this can cause cracked joints. Do not use PTFE tape. Reduced friction makes over tightening very easy and will result in cracked ports. Leaks in the suction line can permit air to be drawn in, and will cause a noisy pump and reduction in capacity.

9. Drive alignment must be checked after piping is hooked up.

10. Provide a pressure relief device in any part of a pump and piping system that can be valved off and, thus, completely isolated. A rise in temperature will cause a liquid to expand. If there is no provision for pressure relief in the closed off section, there is a chance that the pump or piping will rupture.

Danger !

Before starting pump, be sure all drive equipment guards are in place. Failure to properly mount guards may result in serious injury or death.

START UP

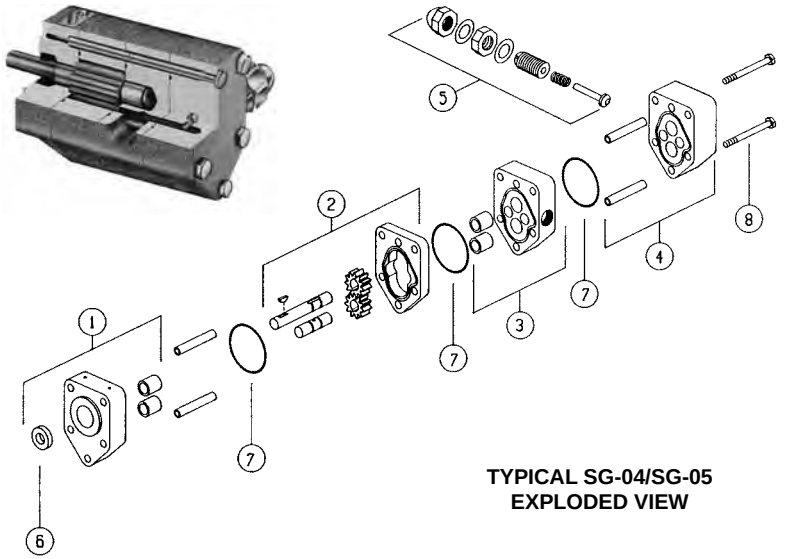
Before pushing “start” button, check the following:

1. Are vacuum and pressure gauges (liquid filled) mounted on or near the pump? Gauges are the quickest and most accurate way of finding out what is happening in the pump.

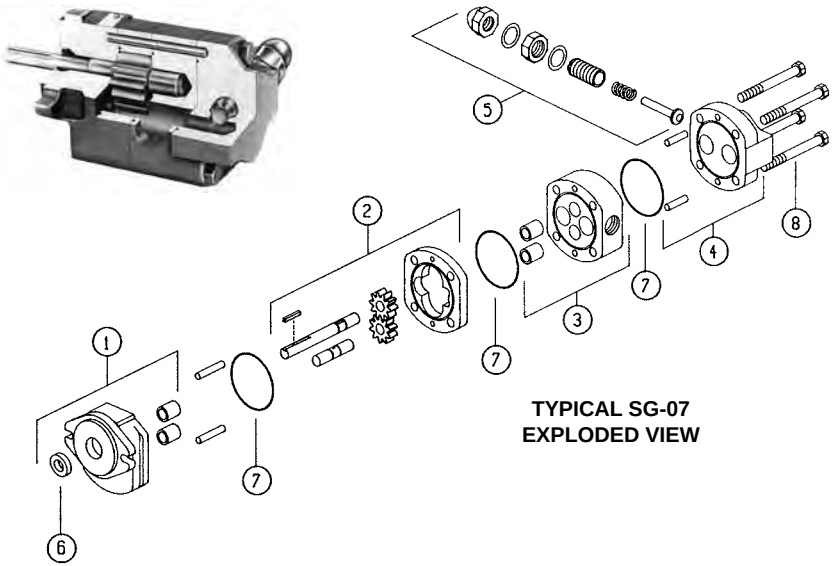
2. Is the pump is correctly aligned with the drive equipment?

3. Make sure there is no pipe strain on the pump ports.

4. Rotate the pump shaft by hand to be sure it turns freely.



TYPICAL SG-04/SG-05
EXPLODED VIEW



TYPICAL SG-07
EXPLODED VIEW

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1.	Bracket, lipseal & bearing section	**5.**	Relief valve kit
2.	Match ground casing & (2) gears, driver & driven shafts	**6.**	Lipseal
3.	Separation plate & bearing assy.	**7.**	O-ring
4.	Head and alignment sleeve assy.	**8.**	Assembly capscrews

5. Before connecting to the motor, jog it to be sure it is running in the correct direction. Refer to **"General"** on page 1.

6. Is the pressure relief valve installed properly?

7. Make sure suction piping is properly connected and sealed, and valves are open.

8. Make sure the discharge piping is properly connected and sealed, valves are open, and there is a place for the liquid to go.

9. Make sure all guards are in place.

10. The above checklist is a general guideline to be used prior to starting the pump. Since Viking Pump cannot foresee every application for our product and possible system design, the final responsibility is with the user. The pump must be utilized within the catalog specifications and the pump system must be designed to provide safe working conditions.

The "start" button may now be pushed.

The pump should begin to deliver liquid within 15 seconds! If not, push the stop button. Do not run the pump without liquid flow longer than 30 seconds or the pump may be ruined.

Review **Startup** steps 1 through 10. Consider what the suction and discharge gauges may indicate. If everything appears in order, re-prime pump. Refer to **Mounting,** page 2, item 8.

Push the "start" button. If nothing is flowing within 30 seconds, stop the pump. The pump is not a compressor, it will not build up much air pressure. It may be necessary to vent discharge line until liquid begins to flow.

If pump still does not deliver, consider one or more of the following:

1. The suction line has air leaks.

2. The end of the suction pipe is not submerged deeply enough in the liquid.

3. The suction lift is too great or the suction piping is too small.

4. Liquid is vaporizing in the suction line before it gets to the pump.

If after consideration of these points, the pump still does not deliver liquid, review all points given under **START UP** and read through the **TROUBLESHOOTING** guide and try again. If pump still will not deliver liquid, contact your Viking Pump supplier.

TROUBLESHOOTING

A Viking pump that is properly installed and maintained will give long satisfactory performance.

If trouble does develop, one of the first steps toward finding the difficulty is to install a vacuum gauge in the suction line and a pressure gauge in the discharge line. Readings on these gauges often give a clue on where to start looking for trouble.

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting etc.) be sure:

1. **That any pressure in chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**

2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on the pump.**

3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow the above listed precautionary measures may result in serious injury or death.

Vacuum Gauge - Suction Port

High vacuum reading would indicate:

1. The suction line is blocked, valve closed, a strainer is plugged or a pinched suction line.
2. The suction line is too small.
3. The liquid is too viscous to flow through the piping.
4. The lift required is too high.

Low reading would indicate:

1. There may be an air leak in the suction line.
2. The end of the pipe is not in the liquid.
3. The pump is worn.
4. The pump is dry and should be primed.

Fluttery, jumping or erratic reading would indicate:

1. The liquid is vaporizing.
2. Liquid is coming in to the pump in slugs, possibly an air leak or insufficient liquid above the end of the suction pipe.
3. Vibration from cavitation, misalignment, or damaged parts.

Pressure Gauge - Discharge Port

High reading would indicate:

1. High viscosity and small diameter and/or lengthy discharge line.
2. The strainer or filter is plugged.
3. The pressure relief valve is set too high.
4. Valve in the discharge line partially closed.
5. Line partially plugged from build up on inside of pump, solidified product or foreign object.
6. Liquid in the pipe not up to temperature.

Low reading would indicate:

1. Pressure relief valve set too low.
2. Pressure relief valve poppet not seating properly.
3. Pump mounting capscrews into torqued to specifications (GP-04 and GP-05 Series 12-15 ft.-lbs.).
4. Pump assembly bolts not torqued into specifications (GP-07 Series 50-55 ft.- lbs.).
5. The bypass around pump partially open.
6. Pump is damaged or worn.
7. The pump has too much internal clearance.

Fluttery, jumping or erratic reading would indicate:

1. Cavitation.
2. Liquid is coming to the pump in slugs.
3. Air leak in the suction line.
4. Vibrating from misalignment or mechanical problems.

MISCELLANEOUS

Pump does not pump:

1. The pump has lost its prime from air leak or low level in tank.
2. The suction lift is too high.
3. Rotating in the wrong direction.
4. The motor does not come up to speed.
5. The strainer is clogged.
6. The bypass valve is open, pressure relief valve set too low or pressure relief valve poppet stuck open.
7. The pump is worn out.
8. Any changes in liquid, system or operation that would help explain the trouble, e.g. new liquid, additional lines or process changes.

Pump starts, then looses its prime:

1. The supply tank is empty.
2. The liquid is vaporizing in the suction line.
3. There is an air leak or air pockets in the suction line.
4. The pump is worn out.

Pump is noisy:

1. The pump is cavitating (liquid vaporizing in suction line) or being starved (heavy liquid cannot get to pump fast enough). Increase the suction pipe size and/or reduce the length, or decrease the pump speed. If the pump is above the liquid, raise the liquid level closer to the center line of the inlet port. If the liquid is above the pump, increase the head of the liquid.
2. Check alignment.
3. Anchor the base or piping to eliminate vibration.

Pump not delivering up to capacity:

1. The pump is starving or cavitating – see **Pump is noisy**, item 1.
2. The strainer partially clogged.
3. Air leak somewhere in the suction line.
4. Running too slow. Is the motor the correct speed and wired up correctly?
5. Pressure relief valve is set too low, stuck open or has damaged poppet seat.
6. The bypass line around the pump partially opened.
7. The pump is worn out.

Pump takes too much power (stalls motor):

1. The pump sequence valve set too high.
2. Liquid is more viscous than the is unit sized to handle.
3. The system pressure relief valve set too high.
4. The pump is misaligned.

DO'S AND DON'TS

Do's and Don'ts for installation, operation and maintenance of Viking pumps to assure safe, long, trouble free operation.

Installation:

1. **DO** install the pump as close to supply tank as possible.
2. **DO** leave working space around the pumping unit.
3. **DO** use large, short and straight suction port.
4. **DO** install a strainer in the suction line.
5. **DO** a double check of alignment after unit is mounted and piping is hooked up.
6. **DO** provide pressure relief valve for discharge side of pump.
7. **DO** check for proper rotation.
8. **DO** use a return line filter.
9. **DO** use an industrial grade hydraulic oil.
10. **DO** use piping, hose and fittings rated for maximum system pressure.

Operation

1. **DON'T** run the pump at speeds faster than 3600 RPM.
2. **DON'T** allow the pump to develop pressure higher than those shown in catalog at that size.
3. **DON'T** operate pumps at temperatures above or below limits shown in catalog for model.
4. **DON'T** operate unit without all guards in place.
5. **DON'T** operate pump without pressure relief valve in discharge piping; be sure valve is mounted and set correctly.
6. **DON'T** stick fingers in ports of pump!!! Fingers may be pinched between gears.
7. **DON'T** work on the pump unless driver has been "locked out" so it cannot be started while work is being done on the pump.

Maintenance:

1. **DO** record pump model number and serial number and file for further use.
2. **DO** have spare parts, pump or stand by units available, particularly if pump is essential part of key operation process.
3. **DO** obtain, read and keep all maintenance instructions furnished with pump.
4. **DO** make sure any pump that has residual system pressure in it or that has handled high vapor pressure liquids, has been vented through the suction or discharge lines or other openings provided for this purpose.
5. **DO** make sure that if the pump is still hooked to the driver while maintenance is being performed that the driver has been "locked out" so that it cannot be inadvertently started while work is being done on the pump.
6. **DO** make sure any pump that has handled a corrosive, flammable, hot or toxic liquid has been drained, flushed, vented and/or cooled before it is disassembled.

INSTALLATION, START UP, TROUBLESHOOTING, PREVENTIVE MAINTENANCE, DO'S & DON'TS
SERIES SG-04, SG-05 & SG-07 SPUR GEAR PUMPS

VIKING PUMP

IDEX CORPORATION

WARRANTY

Viking warrants all products manufactured by it to be free from defects in workmanship or material for a period of one (1) year from date of startup, provided that in no event shall this warranty extend more than eighteen (18) months from the date of shipment from Viking. The warranty period for Universal Seal series pumps ONLY (Universal Seal models listed below) is three (3) years from date of startup, provided that in no event shall this warranty extend more than forty-two (42) months from the date of shipment from Viking.

UNDER NO CIRCUMSTANCES SHALL VIKING BE LIABLE UNDER THIS WARRANTY OR OTHERWISE FOR SPECIAL, INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, LOST OR UNREALIZED SALES, REVENUES, PROFITS, INCOME, COST SAVINGS OR BUSINESS, LOST OR UNREALIZED CONTRACTS, LOSS OF GOODWILL, DAMAGE TO REPUTATION, LOSS OF PROPERTY, LOSS OF INFORMATION OR DATA, LOSS OF PRODUCTION, DOWNTIME, OR INCREASED COSTS, IN CONNECTION WITH ANY PRODUCT, EVEN IF VIKING HAS BEEN ADVISED OR PLACED ON NOTICE OF THE POSSIBILITY OF SUCH DAMAGES AND NOTWITHSTANDING THE FAILURE OF ANY ESSENTIAL PURPOSE OF ANY PRODUCT.

THIS WARRANTY IS AND SHALL BE VIKING'S SOLE AND EXCLUSIVE WARRANTY AND SHALL BE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ALL WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT ALL OF WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED.

See complete warranty at www.vikingpump.com.

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Chapter 26 FACILITY FUEL-OIL

MANUFACTURER/DISTRIBUTOR:

WOLSELEY Inc.
4200, Hickmore
St-Laurent, QC, H4T 1K2
Phone: (514) 344-9378
Fax :(514) 344-9341

26.1 **OUTSIDE GREY DOUBLE WALL TANK 1000 GALL 30464222-08**

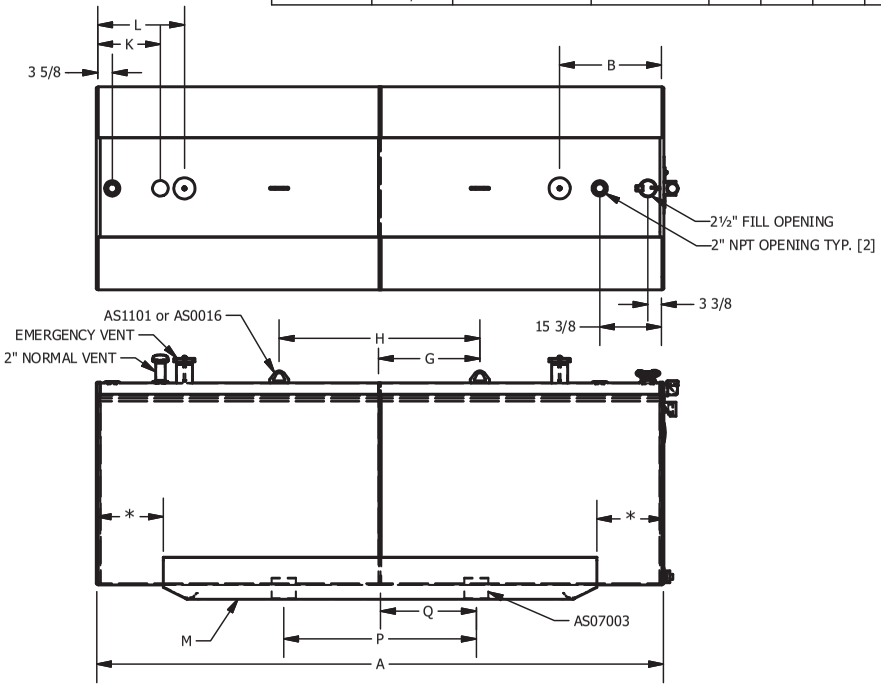
26.2 **K-TECH FLOAT SWITCH FS301E-1**

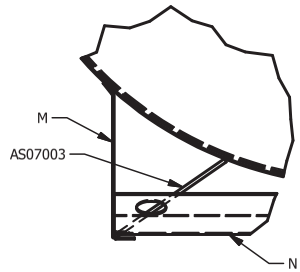
26.3 **K-TECH FLOAT SWITCH FS301E-1**

26.4 **MIDGET 277 LEVEL-O-METER (4550L – 50”D X 140”)**

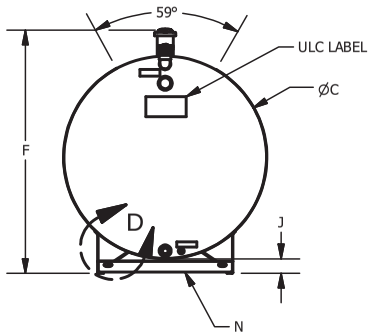
Oil storage tank

PRODUCT #	VOLUME (L,GAL)	PRIMARY STEEL NOMINAL THK.	SEC. STEEL NOMINAL THK.	A	B	C	F	G	H	J	K	L	M	N	P	Q
30064222	570,125	2.5 mm	2.5 mm	49		30¼	41½	0		4¾	12	18	AS07112	AS07009		0
30114222	1135,250	2.5 mm	2.5 mm	60		38¼	49½	0		4½	15	21	AS07122	AS07012		0
30144222	1360,300	2.5 mm	2.5 mm	72		38¼	49½	0		4½	15	21	AS07153	AS07012		0
30204232	1915,420	2.5 mm	2.5 mm	60		50¼	60½	0		3½	15	21	AS07122	AS07014		0
30234242	2275,500	2.5 mm	2.5 mm	72		50¼	61	0		3½	15	21	AS07153	AS07014		0
30394222	3800,835	2.5 mm	2.5 mm	120	25	50¼	61	25	50	3½	15	21	AS07274	AS07014		0
30394322	3800,835	3.0 mm	2.5 mm	120	25	50¼	61	25	50	3½	15	21	AS07274	AS07014		0
30464222	4550,1000	2.5 mm	2.5 mm	142	25	50¼	61	25	50	3½	15	21	AS07274	AS07014	48	24
30464322	4550,1000	3.0 mm	2.5 mm	142	25	50¼	61	25	50	3½	15	21	AS07274	AS07014	48	24





DETAIL D



* : Equal distance

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TOLÉRANCES LINÉAIRES, LINEAR STD TOLERANCES
0 OR FRAC. (X/X) -> ±0.5" 0.00 -> ±0.125"
0.0 -> ±0.25" 0.000 -> ±0.0625"

TOLÉRANCES ANGULAIRES, ANGULAR STD TOLERANCES
0 -> ± 2 DEG. 0.00 -> ± 0.1 DEG.
0.0 -> ± 0.5 DEG.

Les soudures doivent respecter la spécification SI-0039.
Tank welds must respect SI-0039 specifications.

Matériau / Material :

Description de la révision / Revision description

Dessiné par / Drawn by: E Bourassa — 2011-12-19

Approuvé par / Approved by : E Bourassa — 2011-12-19

Unités / Units: INCHES | Échelle / Scale: .03 : 1 | Feuille / Sheet: 1 / 1

Réservoirs d'Acier Granby,
Granby Steel Tanks
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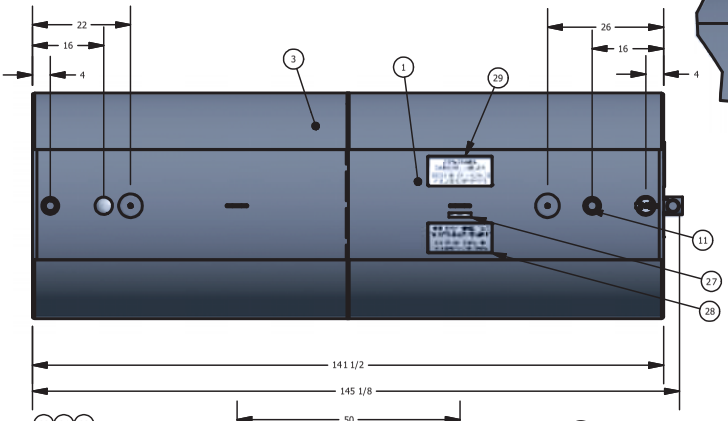
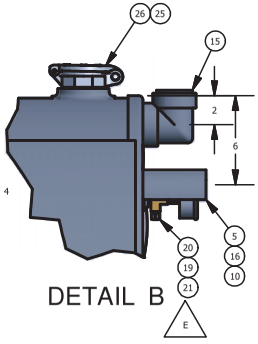
Format / Size: A | No de la pièce / Part no.: SI0071 | REV: C

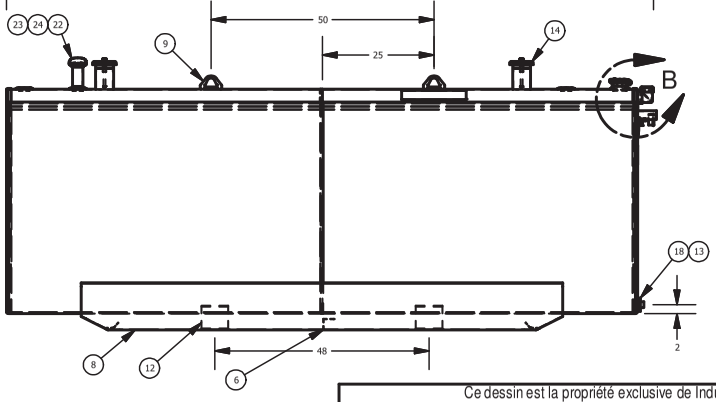
Description / Title
GENERIC DRAWING FOR CYLINDRICAL HORIZONTAL DOUBLE WALLED ULC-S601 UTILITY TANKS

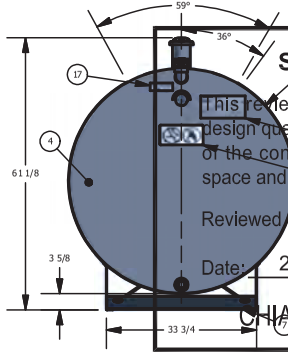
D-TANK_TMPLT-C

Oil storage tank









Parts List

ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	FA27184403	HR STEEL 0.093"min x 70½" x 158½"
2	2	CR27128	COUVERCLE ROND - 12ga 50" DIA - ROUND TANK HEAD
3	2	FA27184338	HR STEEL 0.093" min x 70½" x 133"
4	2	CR34130	COUVERCLE ROND - 10ga 50½" DIA. - ROUND TANK HEAD
5	1	AS0025	PROTECTEUR DE CADRAN DE SURVEILLANCE VAC.- GAUGE PROTECTOR FOR VAC. MONITOR
6	1	AS07004	RENFORT DE LISSE - 11Ga 2 3/8" x 33½" LONG - SKID STRENGTHENER
7	2	AS07014	RENFORT DE LISSE - 11Ga X 33½"LRG - SKID STRENGTHENER
8	2	AS07274	LISSE - 11Ga x 108" LONG - SKID
9	2	AS1101	OEILLET DE MANUTENTION RHC - LIFTING LUG
10	1	BF00006	BRIDE FORGÉE - ¼" NPT - FORGED FLANGE
11	2	BE00051CAP	BRIDE EMBOUTIE COURBÉE CAPÉE - 2" NPT- CURVED STAMPED FLANGE CAPPED
12	4	AS07003	RENFORT DE LISSE RÉS. D./-P ULC-S601 - SKID STRENGTHENER FOR D./W. ULC-S601 TANKS
13	1	BO00051	BOUCHON FILETÉ - 2" NPT - PIPE PLUG
14	2	CA02004G	EVENT D'URGENCE 4" S601 (MDL 6" HAUT)
15	1	CA02005	ELFENT 2" INTERSTITIAL VENT ELBOW (ULC LISTED)
16	1	CP02006	2½" DIA GLYCERIN FILLED SS VACUUM GAUGE (30" Hg)
17	1	EP0126	VACUUM MONITORING & INSTERTITIAL VENT STICKER
18	1	MD02051	DEMI-MANCHON - 2" NPT - HALF COUPLING
19	1	RL01006	RACORD LAITON - F,F,M ¼" NPT - BRASS TEE
20	1	VD01006	VALVE DIRECTIONELLE LAITON - 1/4"M x 1/8"F - BRASS CHECK VALVE
21	1	BO01003	BOUCHONS À PANS CREUX - 1/8" NPT - BRASS HEX SOCKET PLUG
22	1	E107-999	EVENT FORME CHAMPIGNON AVEC MOUSTIQUAIR - 2" NPT - MUSHROOM VENT CAP WITH SCREEN
23	1	BE00051	BRIDE EMBOUTIE COURBÉE - 2" NPT - CURVED STAMPED FLANGE
24	1	MC01051152	MANCHON MALE - 2" NPT x 6" - NIPPLE
25	1	BF00064	BRIDE FORGÉE COURB. - 2½" NPT - FORGED & CURVED FLANGE
26	1	CA01004	BOUCHON DE REMPLISSAGE EN ALU. - 2 ½" NPT - ALUMINUM FILL CAP
27	1	EP0314-2	AUTOCOLLANT PIÈCE - PART NUMBER STICKER
28	1	EP0246	COLLANT DISTANCE DU BÂTIMENT - DISTANCE FROM BUILDING STICKER
29	1	EP0245	COLLANT NE PAS SOULEVER - DO NOT LIFT TANK STICKER
30	1	EP0314-1	AUTOCOLLANT- ULC-S601 - LISTING MARK
31	1	EP0247	COLLANT - NO SMOKING OR OPEN FLAME - STICKER

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

Date: 20 June 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

NOTES:
1. AIR / SOAP TEST TO 35 KPa (5 PSI) MAX.
2. INTERIOR FINISH: CLEAN OF DEBRIS ETC.
3. EXTERIOR FINISH: PHOSPHATE CLEAN AND APPLY GRAY URETHANE ENAMEL 300 (PE0059ET AND PE0062ET)

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TOLÉRANCES LINÉAIRES, LINEAR STD TOLERANCES
0 OR FRAC. (X/X) -> ±0.5" 0.00 -> ±0.125"
0.0 -> ±0.25" 0.000 -> ±0.0625"

TOLÉRANCES ANGULAIRES, ANGULAR STD TOLERANCES
0 -> ± 2 DEG.
0.0 -> ± 0.5 DEG. 0.00 -> ± 0.1 DEG.

Les soudures doivent respecter la spécification SI-0039.
Tank welds must respect SI-0039 specifications.

Matériau / Material :

Description de la révision / Revision description

Dessiné par / Drawn by: E Bourassa — 2013-03-18

Approuvé par / Approved by : E Bourassa — 2013-03-18

Unités / Units: INCHES | Échelle / Scale | Feuille / Sheet 1 / 1

Réservoirs d'Acier Granby, Granby Steel Tanks
© 2009 Industries Granby , SEC. Granby Industries LP

Format / Size: A | No de la pièce / Part no.: 30464222 | REV: E .

Description / Title

RES. SUR LISSE GRIS - 4550L 2.5mm D/W V/M ULC-S601 - TANK ON SKID GREY

D-TANK_TMPLT-C

Chapter 27 BACKUP UNIT HEATER

MANUFACTURER/DISTRIBUTOR:

CDE
a/s Shaun Rouleau
298, Rue De Martigny Ouest
Saint-Jérôme, QC, J7Y 4C9
Tel: 450-438-1263
Email: srouleau@cde.qc.ca

27.1 **SHU0483CT Aerotherme Industrial TH/INT 4000W 208V 1/3PH**

27.2 **SHUDIS Switch**

Unit Heaters

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

COMMERCIAL & INDUSTRIAL UNIT HEATER

SHU SERIES

THE POWER OF DISPERSION

°STELPRO designs heaters for all circumstances. Take the SHU, the large volume heater that is distinguished by its appealing appearance, its manufacturing and its sturdy composition. It is usually installed in large garages, but it is not uncommon for it to be seen in warehouses or any other kind of commercial construction site requiring a generous volume of heat. The SHU works with great ease and has an incredible power scale from 2 kW to 60 kW. What could be better!

3 YEAR WARRANTY

INSTANT HEAT

PERMANENTLY LUBRICATED MOTOR

WIDE RANGE OF POWER: 2 KW TO 60 KW

THERMALLY PROTECTED

WALL OR CEILING INSTALLATION
BRACKET INCLUDED

IDEAL FOR:
WAREHOUSE, FACTORY, INDOOR PARKING GARAGE, LARGE INDUSTRIAL AND COMMERCIAL AREAS

ACCESSORIES

PRODUCT	DESCRIPTION	PRICE
SHUT1	built-in single pole thermostat (capillary)	58.75
SHUT2	built-in double pole thermostat (capillary)	70.25
SHUFS*	fan switch	52.50
SHUDIS*	disconnect switch [80 A]	146.00
SHUC24RX*	relay kit without transformer 24 V	90.00
SHUFS-RCV*	remote control circuit for ventilation mode 240 V	52.50

* Factory installed

COLOUR
almond

FINISH
epoxy-polyester powdercoat

MANUFACTURING
- heavy-duty, 18-gauge steel cabinet
- adjustable louvers and protective screen
- thermal protection with automatic reset

MOTOR
permanently enclosed lubricated ball bearing motor for long-lasting operation

ELEMENT
nichrome element produces instant heat

CONTROL
connection of multiple units to the same thermostat is possible with a relay kit without transformer (optional) and an external transformer (not provided)

INSTALLATION
- wall or ceiling mounted with universal mounting bracket (included)
- minimum distance from adjacent walls: 6 in. (2 kW to 30 kW units), 12 in. (40 kW to 60 kW units)
- maximum mounting heights: 8 ft. (2 kW to 10 kW units), 10 ft. (15 kW to 30 kW units), 15 ft. (40 kW to 60 kW units)

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 8 July 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

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For all the latest models and updated prices, please refer to our web site at www.stelpro.com.

TECHNICAL SPECIFICATIONS

WITHOUT CONTROL		BUILT-IN THERMOSTAT		240 V CONTROL		24 V CONTROL				
CODE	PRICE	CODE	PRICE	CODE	PRICE	CODE	PRICE	VOLTS	KW	CFM
SHU0281	805.00	SHU0281T	863.00	SHU0281C	874.00	SHU0281C24	910.00	208	2	250
---	---	SHU0283CT*	933.00	SHU0283C*	874.00	SHU0283C24*	910.00	208	2	250
SHU0221	805.00	SHU0221T	863.00	SHU0221C	874.00	SHU0221C24	910.00	240	2	250
SHU0271	964.00	SHU0271T	1023.00	SHU0271C	1034.00	SHU0271C24	1069.00	277	2	250
---	---	SHU0231CT	1092.00	SHU0231C	1034.00	SHU0231C24	1069.00	347	2	250
---	---	SHU0251CT	1092.00	SHU0251C	1034.00	SHU0251C24	1069.00	480	2	250
---	---	SHU0253CT*	1092.00	SHU0253C*	1034.00	SHU0253C24*	1069.00	480	2	250
---	---	SHU0261CT	1092.00	SHU0261C	1034.00	SHU0261C24	1069.00	600	2	250
---	---	SHU0263CT*	1092.00	SHU0263C*	1034.00	SHU0263C24*	1069.00	600	2	250
SHU0381	805.00	SHU0381T	863.00	SHU0381C	874.00	SHU0381C24	910.00	208	3	250
---	---	SHU0383CT*	933.00	SHU0383C*	874.00	SHU0383C24*	910.00	208	3	250
SHU0321	805.00	SHU0321T	863.00	SHU0321C	874.00	SHU0321C24	910.00	240	3	250
SHU0371	997.00	SHU0371T	1055.00	SHU0371C	1067.00	SHU0371C24	1102.00	277	3	250
---	---	SHU0331CT	1125.00	SHU0331C	1067.00	SHU0331C24	1102.00	347	3	250
---	---	SHU0351CT	1125.00	SHU0351C	1067.00	SHU0351C24	1102.00	480	3	250
---	---	SHU0353CT*	1125.00	SHU0353C*	1067.00	SHU0353C24*	1102.00	480	3	250
---	---	SHU0361CT	1125.00	SHU0361C	1067.00	SHU0361C24	1102.00	600	3	250
---	---	SHU0363CT*	1125.00	SHU0363C*	1067.00	SHU0363C24*	1102.00	600	3	250
SHU0481	813.00	SHU0481T	871.00	SHU0481C	882.00	SHU0481C24	918.00	208	4	250
---	---	SHU0483CT*	941.00	SHU0483C*	882.00	SHU0483C24*	918.00	208	4	250
SHU0421	813.00	SHU0421T	871.00	SHU0421C	882.00	SHU0421C24	918.00	240	4	250
SHU0471	1023.00	SHU0471T	1081.00	SHU0471C	1092.00	SHU0471C24	1128.00	277	4	250
---	---	SHU0431CT	1151.00	SHU0431C	1092.00	SHU0431C24	1128.00	347	4	250
---	---	SHU0451CT	1151.00	SHU0451C	1092.00	SHU0451C24	1128.00	480	4	250
---	---	SHU0453CT*	1151.00	SHU0453C*	1092.00	SHU0453C24*	1128.00	480	4	250
---	---	SHU0461CT	1151.00	SHU0461C	1092.00	SHU0461C24	1128.00	600	4	250
---	---	SHU0463CT*	1151.00	SHU0463C*	1092.00	SHU0463C24*	1128.00	600	4	250
---	---	SHU0581T	1003.00	SHU0581C	1015.00	SHU0581C24	1049.00	208	5	450
---	---	SHU0583CT*	1073.00	SHU0583C*	1015.00	SHU0583C24*	1049.00	208	5	450
SHU0521	944.00	SHU0521T	1003.00	SHU0521C	1015.00	SHU0521C24	1049.00	240	5	450
SHU0571	1060.00	SHU0571T	1118.00	SHU0571C	1130.00	SHU0571C24	1165.00	277	5	450
---	---	SHU0531CT	1188.00	SHU0531C	1130.00	SHU0531C24	1165.00	347	5	450
---	---	SHU0551CT	1188.00	SHU0551C	1130.00	SHU0551C24	1165.00	480	5	450
---	---	SHU0553CT*	1188.00	SHU0553C*	1130.00	SHU0553C24*	1165.00	480	5	450
---	---	SHU0561CT	1188.00	SHU0561C	1130.00	SHU0561C24	1165.00	600	5	450
---	---	SHU0563CT*	1189.00	SHU0563C*	1131.00	SHU0563C24*	1166.00	600	5	450
---	---	SHU0781CT	1511.00	SHU0781C	1453.00	SHU0781C24	1488.00	208	7.5	700
---	---	SHU0783CT*	1511.00	SHU0783C*	1453.00	SHU0783C24*	1488.00	208	7.5	700
---	---	SHU0721CT	1511.00	SHU0721C	1453.00	SHU0721C24	1488.00	240	7.5	700
---	---	SHU0771CT	1697.00	SHU0771C	1638.00	SHU0771C24	1674.00	277	7.5	700
---	---	SHU0731CT	1697.00	SHU0731C	1638.00	SHU0731C24	1674.00	347	7.5	700
---	---	SHU0751CT	1697.00	SHU0751C	1638.00	SHU0751C24	1674.00	480	7.5	700
---	---	SHU0753CT*	1697.00	SHU0753C*	1638.00	SHU0753C24*	1674.00	480	7.5	700
---	---	SHU0761CT	1697.00	SHU0761C	1638.00	SHU0761C24	1674.00	600	7.5	700
---	---	SHU0763CT*	1697.00	SHU0763C*	1638.00	SHU0763C24*	1674.00	600	7.5	700

TECHNICAL SPECIFICATIONS

BUILT-IN THERMOSTAT		240 V CONTROL		24 V CONTROL				
CODE	PRICE	CODE	PRICE	CODE	PRICE	VOLTS	KW	CFM
SHU1081CT	1587.00	SHU1081C	1529.00	SHU1081C24	1564.00	208	10	700
SHU1083CT*	1587.00	SHU1083C*	1529.00	SHU1083C24*	1564.00	208	10	700
SHU1021CT	1587.00	SHU1021C	1529.00	SHU1021C24	1564.00	240	10	700
SHU1071CT	1718.00	SHU1071C	1659.00	SHU1071C24	1695.00	277	10	700
SHU1031CT	1718.00	SHU1031C	1659.00	SHU1031C24	1695.00	347	10	700
SHU1051CT	1718.00	SHU1051C	1659.00	SHU1051C24	1695.00	480	10	700
SHU1053CT*	1718.00	SHU1053C*	1659.00	SHU1053C24*	1695.00	480	10	700
SHU1061CT	1718.00	SHU1061C	1659.00	SHU1061C24	1695.00	600	10	700
SHU1063CT*	1718.00	SHU1063C*	1659.00	SHU1063C24*	1695.00	600	10	700
SHU1581CT	2116.00	SHU1581C	2058.00	SHU1581C24	2128.00	208	15	1300
SHU1583CT*	2116.00	SHU1583C*	2058.00	SHU1583C24*	2128.00	208	15	1300
SHU1521CT	2116.00	SHU1521C	2058.00	SHU1521C24	2128.00	240	15	1300
SHU1571CT	2116.00	SHU1571C	2058.00	SHU1571C24	2128.00	277	15	1300
SHU1531CT	2116.00	SHU1531C	2058.00	SHU1531C24	2128.00	347	15	1300
SHU1551CT	2116.00	SHU1551C	2058.00	SHU1551C24	2128.00	480	15	1300
SHU1553CT*	2116.00	SHU1553C*	2058.00	SHU1553C24*	2128.00	480	15	1300
SHU1561CT	2116.00	SHU1561C	2058.00	SHU1561C24	2128.00	600	15	1300
SHU1563CT*	2116.00	SHU1563C*	2058.00	SHU1563C24*	2128.00	600	15	1300
SHU2081CT	2322.00	SHU2081C	2264.00	SHU2081C24	2334.00	208	20	1300
SHU2083CT*	2322.00	SHU2083C*	2264.00	SHU2083C24*	2334.00	208	20	1300
SHU2021CT	2322.00	SHU2021C	2264.00	SHU2021C24	2334.00	240	20	1300
SHU2071CT	2322.00	SHU2071C	2264.00	SHU2071C24	2334.00	277	20	1300
SHU2031CT	2322.00	SHU2031C	2264.00	SHU2031C24	2334.00	347	20	1300
SHU2051CT	2322.00	SHU2051C	2264.00	SHU2051C24	2334.00	480	20	1300
SHU2053CT*	2322.00	SHU2053C*	2264.00	SHU2053C24*	2334.00	480	20	1300
SHU2063CT*	2322.00	SHU2063C*	2264.00	SHU2063C24*	2334.00	600	20	1300
SHU2583CT*	2675.00	SHU2583C*	2617.00	SHU2583C24*	2687.00	208	25	1300
SHU2553CT*	2675.00	SHU2553C*	2617.00	SHU2553C24*	2687.00	480	25	1300
SHU2563CT*	2675.00	SHU2563C*	2617.00	SHU2563C24*	2687.00	600	25	1300
SHU3083CT*	2724.00	SHU3083C*	2665.00	SHU3083C24*	2735.00	208	30	1400
SHU3053CT*	2724.00	SHU3053C*	2665.00	SHU3053C24*	2735.00	480	30	1400
SHU3063CT*	2724.00	SHU3063C*	2665.00	SHU3063C24*	2735.00	600	30	1400
SHU4053CT*	3573.00	SHU4053C*	3515.00	SHU4053C24*	3632.00	480	40	2100
SHU4063CT*	3573.00	SHU4063C*	3515.00	SHU4063C24*	3632.00	600	40	2100
SHU5053CT*	3804.00	SHU5053C*	3745.00	SHU5053C24*	3862.00	480	50	2100
SHU5063CT*	3804.00	SHU5063C*	3745.00	SHU5063C24*	3862.00	600	50	2100
SHU6053CT*	4178.00	SHU6053C*	4119.00	SHU6053C24*	4236.00	480	60	2100
SHU6063CT*	4178.00	SHU6063C*	4119.00	SHU6063C24*	4236.00	600	60	2100

* Three-phase unit that can be field-converted to a single phase unit
* Three-phase unit
--- not available

THROW DISTANCE AND HEAT RISE

UNITS	THROW DISTANCE		HEAT RISE	
KW	M	FT.	°C	°F
2	8.5	28	17	31
3	8.5	28	35	62
4	8.5	28	52	93
5	9.4	31	55	99
7.5	9.4	31	54	97
10	9.4	31	85	153
15	10.7	35	52	93
20	11.3	37	89	160
25	10.2	33'6"	133	240
30	10.7	35	135	243
40	10.7	35	132	237
50	10.7	35	141	254
60	10.7	35	156	280

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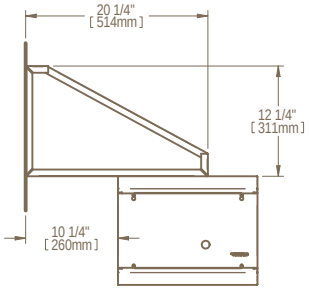
Unit Heaters

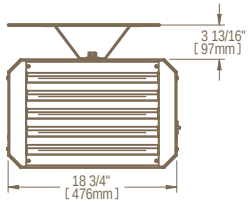
TECHNICAL DRAWINGS

2 KW TO 10 KW UNITS

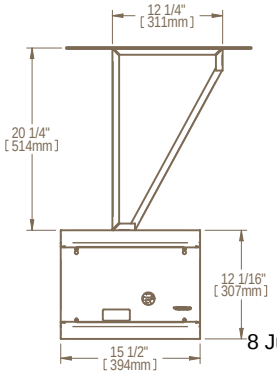
weight: approx. 40 lb (18 kg)



LEFT SIDE



FRONT



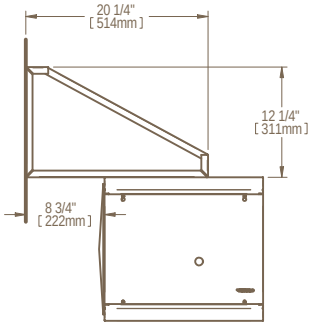
RIGHT SIDE

8 July 2016

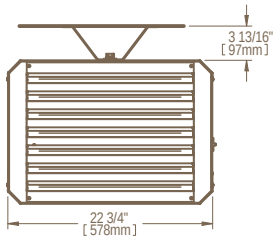
x

15 KW TO 30 KW UNITS

weight: approx. 67 lb (30 kg)



LEFT SIDE



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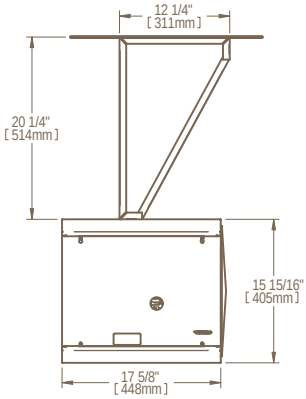


RIGHT SIDE

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.

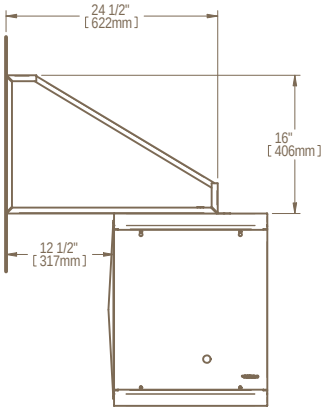
Date: _____

Reviewed ☐
Reviewed as noted ☐
Resubmit ☐

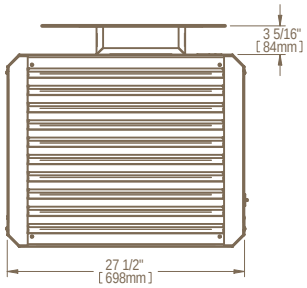
CHIARELLI ENGINEERING LTD.

40 KW TO 60 KW UNITS

weight: approx. 100 lb (45 kg)



LEFT SIDE



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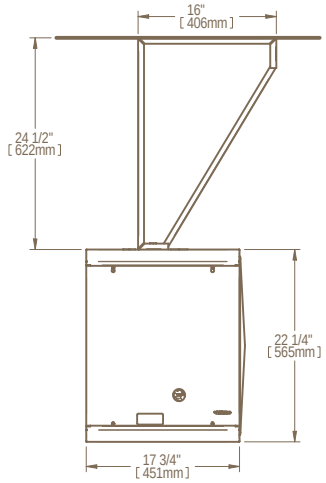

RIGHT SIDE

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For all the latest models and updated prices, please refer to our web site at www.stelpro.com.

Chapter 28 ELECTRICAL PANELS

MANUFACTURER/DISTRIBUTOR:

CDE
298, Rue De Martigny Ouest
Saint-Jérôme (Québec)
J7Y 4C9
Phone.: (450) 438-1263
Fax: (450) 438-3728
Courriel : cde@cde.qc.ca

28.1 **PANELS**

28.2 **MAIN CIRCUIT BREAKER**

28.3 **MAIN DISTRIBUTION PANEL**

28.4 **AUTOMATIC TRANSFER SWITCH**

28.5 **ENTRY BREAKER HYD_SFC703PW 7 INSERT.**

Product data sheet
Characteristics

JJL36250
3P, 600V, 250A MCCB

Main Breaker (250A)

Main

AC Magnetic Trip Setting	1250A - 2500A Adjustable Trip
Ampere Rating	250A
Approvals	UL Listed - CSA Certified - IEC Rated
Catalog Reference Number	0611CT0401
Circuit Breaker Type	Standard
Depth	5.00 Inches
For Use With	Industrial Enclosures and Switchboards
Frame Type	J-Frame
General Application	Provides overload and short circuit protection
HACR Rated	Yes
Height	7.52 Inches
Marketing Trade Name	Powerpact
Mounting Type	Unit Mount
Number of Poles	3-Pole
Short Circuit Current Rating	100kA@240VAC - 65kA@480VAC - 25kA@600VAC
Terminal Type	Line: Lug - Load: Lug
Type	JJ
Voltage Rating	600VAC/250VDC
Weight	5 Pounds
Width	4.12 Inches
Wire Size	#3/0-350 AWG/kcmil(Al/Cu)

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for approval

SIFEC NORTH INC.

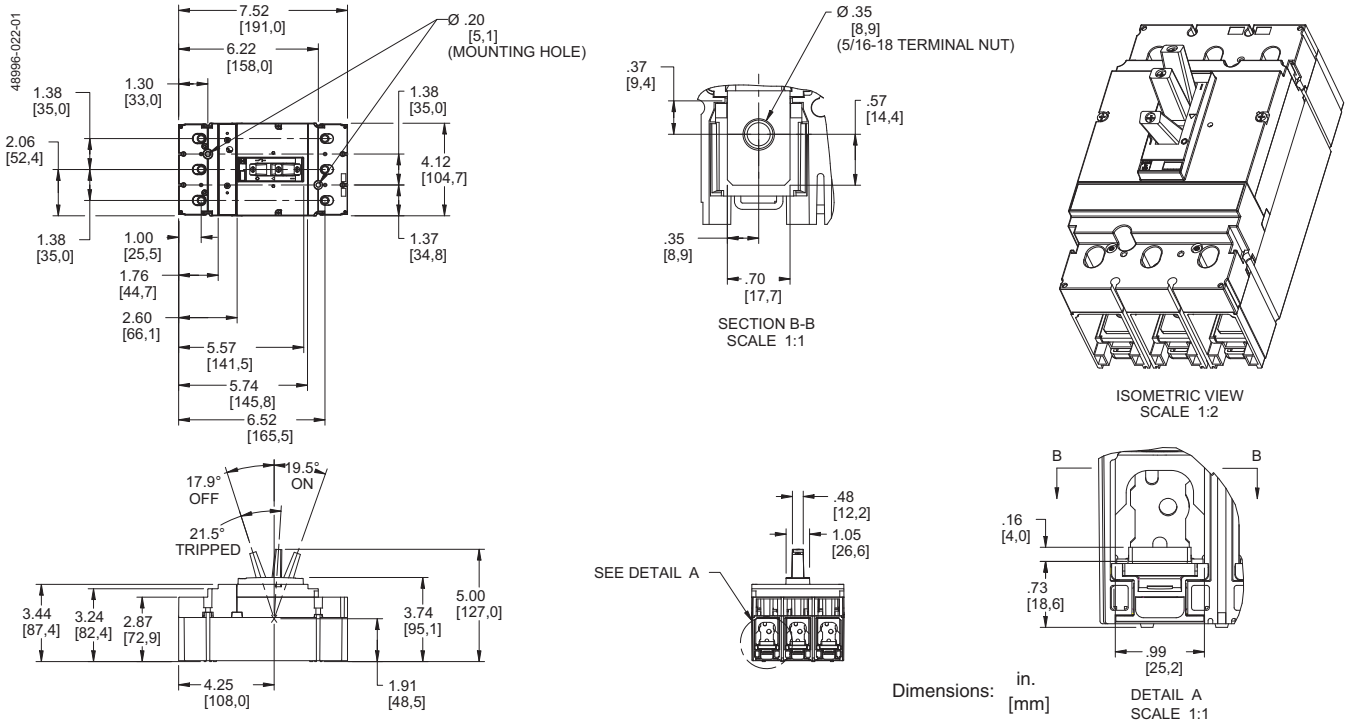
The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein.
This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications.
It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof.
Neither Schneider Electric Industries SAS nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein.

Main Breaker (250A)

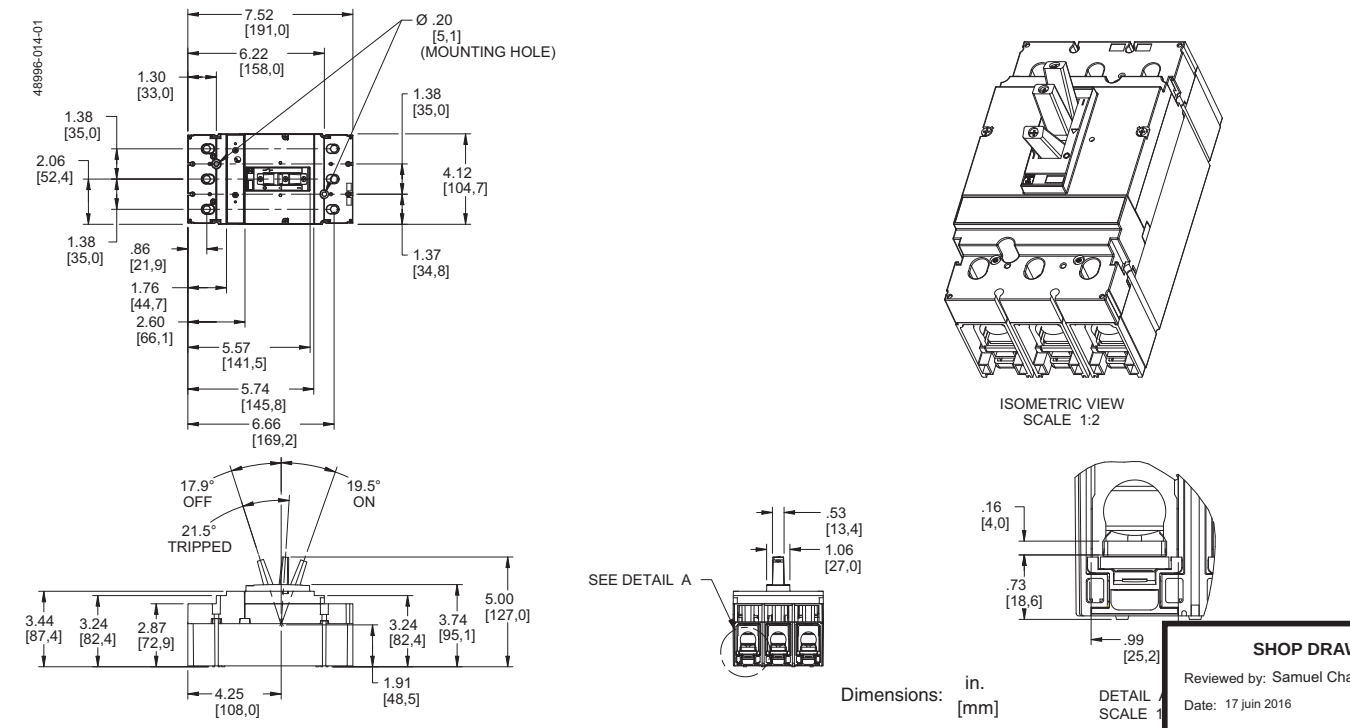
Powerpact® H- and J-frame Circuit Breakers
Section 5—Dimensions

J-frame Dimensional Drawings*

150–250 A Bus Bar J-frame 3-Pole



150–250 A Lug-Lug J-frame 3-Pole



* 2-dimensional (2D) drawings & 3-dimensional (3D) models are available online in multiple file formats.

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
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SIFEC NORTH INC.

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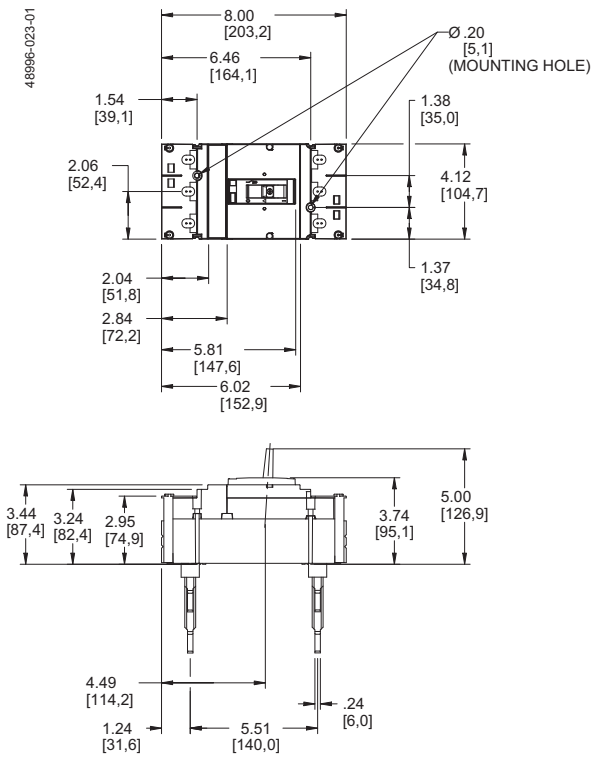
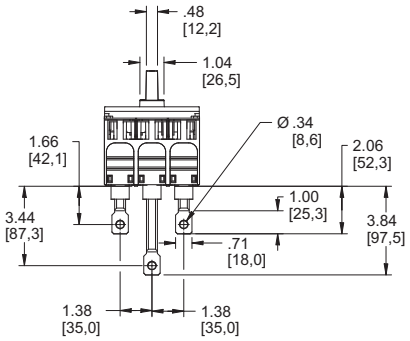
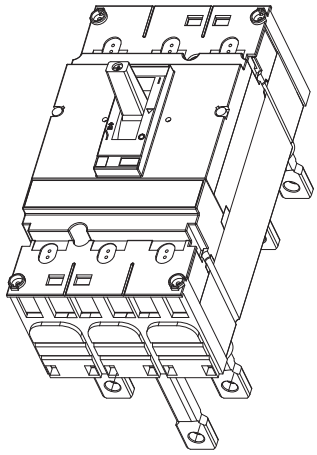
150–250 A Rear Connected J-frame 3-Pole



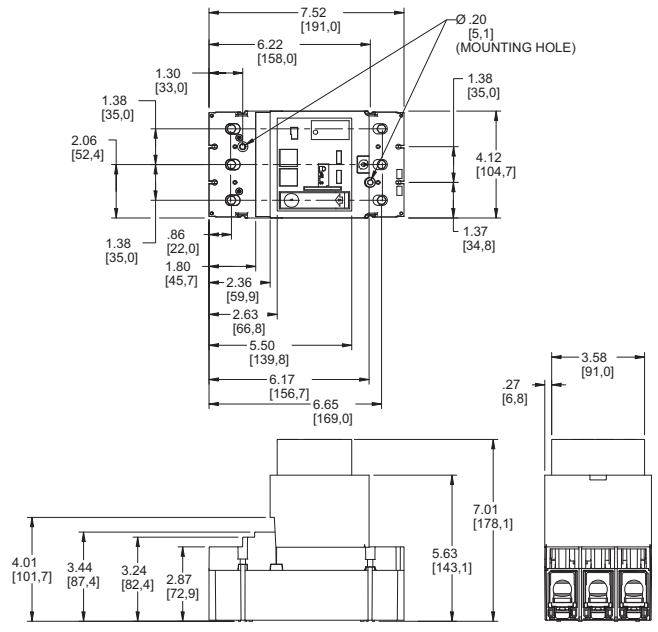




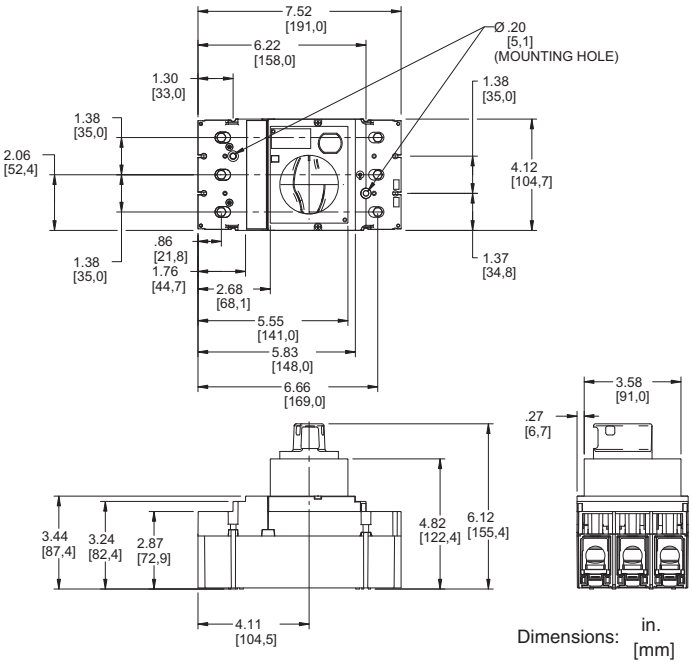
ISOMETRIC VIEW
SCALE 1:2

Dimensions: in. [mm]

J-frame Motor Operator Detail



J-frame Rotary Handle Detail



Dimensions: in. [mm]

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Main Breaker enclosure (250A)

Enclosures for PowerPact® H- and J-Frame Circuit Breakers

J250AWK

J250R

Versatile solutions for multiple applications

The new Square D® enclosures for PowerPact H- and J-Frame circuit breakers offer enhanced flexibility for 15 A to 250 A applications where a branch circuit disconnect with circuit protection is required. They are suitable for use as service entrance equipment and feature a neutral capacity up to 200%.

Customer Values

- **Versatility** – Provides a full line of enclosures for application of PowerPact H- and J-Frame 15 A to 250 A circuit breakers:
  - Type 1 catalog number J250S (surface mount) and J250F (flush mount)
    – IP30 rated per IEC60529
  - Type 3R catalog number J250R (outdoor)
    – IP43 rated per IEC60529
  - Type 3, 3R, 4, 4X, 5, 12 catalog number J250DS (type 304 stainless steel, corrosion resistant, watertight)
    – IP64 rated per IEC60529
  - Type 3R, 5, 12 catalog number J250AWK (dust tight)
    – IP64 rated per IEC60529

- **Flexibility** – Designed to work with all PowerPact H- and J-Frame circuit breaker internal mounted accessories and lug options

- **Accessibility** – Features quick release cover that latches on DS (type 4X) and AWK (type 12) enclosures

- **Performance** –
  - AIC Ratings up to 125 KA @ 240 V, 65 KA @ 480 V and 25 KA @ 600 V
  - Universal North American application - cULus listed

Benefits of PowerPact Circuit Breakers

- Uniform interruption ratings (D, G, J, L) simplify selection and application of ratings
- New and improved ratings available; L interruption level for 125 KA at 240 V
- Complete 600 V Delta ratings: makes them suitable for any market in North America
- Improved series ratings in enclosures

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

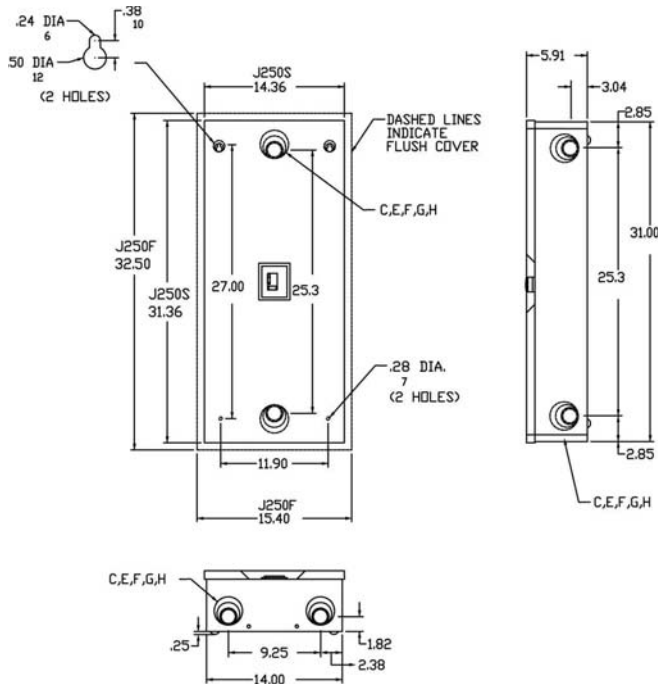
a brand of Schneider Electric

SQUARE D

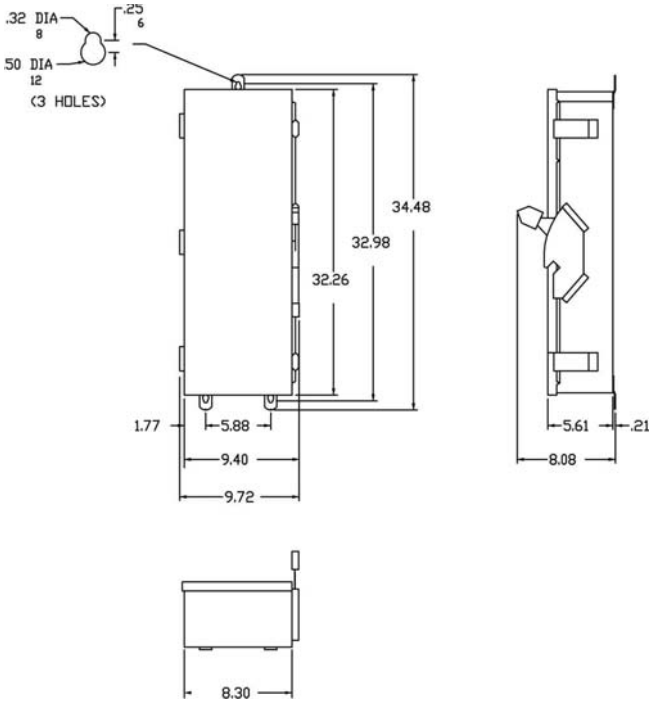
Main Breaker enclosure (250A)

Cross Reference

NEW! H and J type					Existing KA type				
Catalog #	**Series**	**H**	**W**	**D**	**Catalog #**	**Series**	**H**	**W**	**D**
J250F	A01	31.36"	14.36"	6"	KA225F	E2	29.88"	13.75"	5.38"
J250S	A01	32.40"	15.40"	6"	KA225S	E2	28.38"	12.50"	6.13"
J250R	A01	31.05"	14.47"	6.28"	KA225RB	E2	28.50"	12.38"	5.38"
J250DS	A01	32.26"	9.72"	5.61"	KA225DS	E2	25.25"	9.50"	5.38"
J250AWK	A01	32.26"	9.72"	5.61"	KA225AWK	E2	25.25"	9.50"	5.38"



J250S/F



J250AWK/DS

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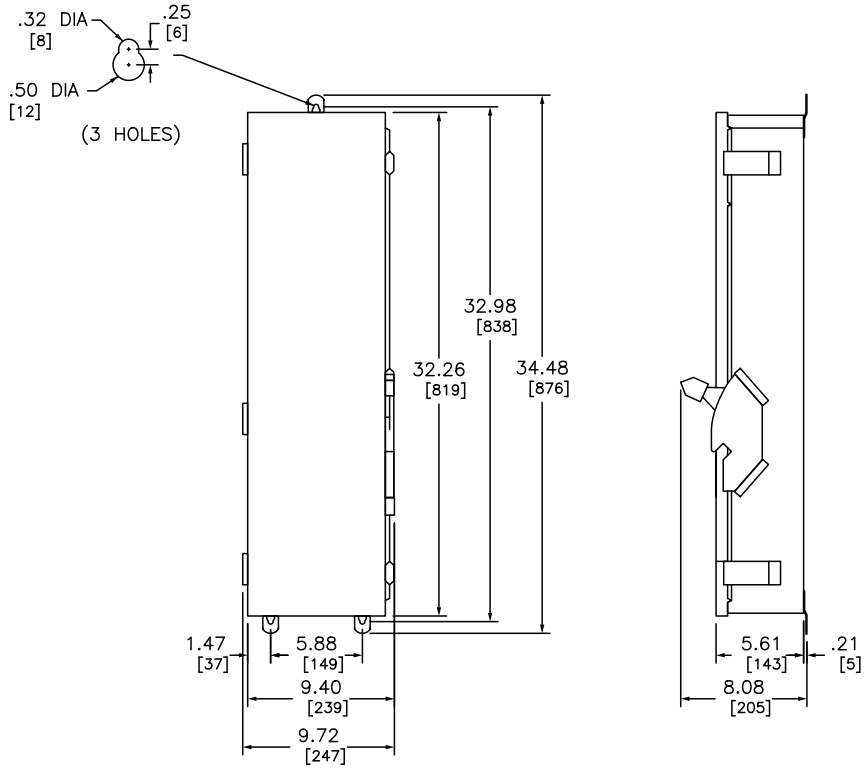
Schneider Electric North American Operating Division

1415 S. Rosele Road
Palatine, IL 60067
Tel: 847-397-2600
Fax: 847-925-7500

Order Number 4100HO0503

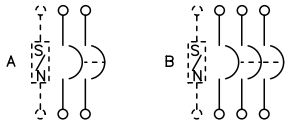
Main Breaker Enclosure



J250AWK
NEMA/EEMAC TYPE 12/3R

J250DS
NEMA/EEMAC TYPE 3,3R,4,4X,5 OR 12

WIRING DIAGRAM



CIRCUIT BREAKER TERMINAL LUG DATA

CIRCUIT BREAKER CATALOG NO. PREFIX	AMPERE RATING	CONDUCTORS PER PHASE	WIRE SIZE (AWG/KCMIL) MAX	WIRE SIZE (AWG/KCMIL) MIN	TYPE
HD, HG HJ, HL	15–150	1	#3/0	#14	AL/CU
JD, JG JJ, JL	150–250	1	#4/0	#1/0	AL/CU

FIELD INSTALLABLE SOLID NEUTRAL ASSEMBLIES AND GROUND KIT

CATALOG NUMBER	MAXIMUM AMPERE RATING	NUMBER OF TERMINALS	CONDUCTORS PER TERMINAL	WIRE SIZE (AWG/KCMIL) MAX	WIRE SIZE (AWG/KCMIL) MIN	TYPE
SN100FA	100A	2	1	#1/0	#14	AL
				#1/0	#12	AL
SN400LA	250A	2	1 OR 2	#600 #250	#1 #1	AL OR CU AL OR CU
		2	1	#300	#4	AL OR CU
PK0GTJ250	250A	2	1	#300	#6	AL OR CU

DUAL DIMENSIONS: INCHES MILLIMETERS

FIELD INSTALLABLE CIRCUIT BREAKER DATA

CIRCUIT BREAKER CATALOG NO PREFIX	WIRING DIA	AMPERE RATING	UL LISTED INTERRUPTING RATING RMS SYMMETRICAL AMPERES AC VOLTAGE 240	480Y/277	480	600Y/347	600	DC VOLTAGE 125	250	500	FEDERAL SPECS W-C-375B/GEN
HD	A,B	15–150	25K	18K	18K	14K	14K	20K	20K	–	
JD	A,B	150–250	25K	18K	18K	14K	14K	20K	20K	–	
HG	A,B	15–150	65K	35K	35K	18K	18K	20K	20K	–	
JG	A,B	150–250	65K	35K	35K	18K	18K	20K	20K	–	
HJ	A,B	15–150	100K	65K	65K	25K	25K	20K	20K	–	
JJ	A,B	150–250	100K	65K	65K	25K	25K	20K	20K	–	
HL	A,B	15–150	125K	65K	65K	25K	25K	20K	20K	–	
JL	A,B	150–250	125K	65K	65K	25K	25K	20K	20K	–	

NOTES:
FINISH – NEMA/EEMAC TYPE 12/3R, GRAY BAKED ENAMEL ELECTRODEPOSITED OVER CLEANED PHOSPHATIZED STEEL. NEMA/EEMAC TYPE 3,3R,4,4X,5 OR 12 – TYPE 304 STAINLESS STEEL.
UL LISTED – FILE E–136861 CSA CERTIFIED – FILE #LL89067.
CE MARKED
SUITABLE FOR USE AS SERVICE EQUIPMENT WHEN NEUTRAL ASSEMBLY IS INSTALLED.
NEUTRAL – INSULATED GROUNDABLE.

CIRCUIT BREAKER ENCLOSURES
15–250 AMPERE
ENCLOSURE – NEMA/EEMAC TYPE 12/3R INDUSTRIAL
NEMA/EEMAC TYPE 3,3R,4,4X,5 OR 12 STAINLESS STEEL

SQUARE D
Schneider Electric

DWG# NO. 3363

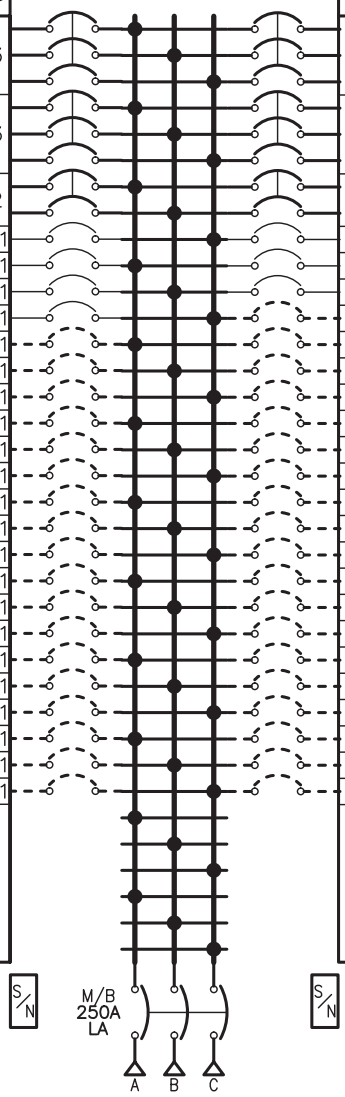
JULY 2008

Shop Drawings
Contractor Approval
Approved by: S.B.S., G. F.
Date: Mar 03, 2015
SIFEC NORTH INC

Panel P-1

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--
–	----	--	--/--/--	–	----	--	--/--/--

CKT NO	ACCESSORIES	TYPE	RATING AMP/P	RATING AMP/P	TYPE	ACCESSORIES	CKT NO
1		QOB	100/3	100/3	QOB		2
3							4
5							6
7		QOB	100/3	60/3	QOB		8
9							10
11							12
13		QOB	30/2	30/2	QOB		14
15							16
17		QOB	15/1	15/1	QOB		18
19		QOB	15/1	15/1	QOB		20
21		QOB	15/1	15/1	QOB		22
23		QOB	15/1	15/1	QOB	PREPARED SPACE	24
25	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	26
27	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	28
29	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	30
31	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	32
33	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	34
35	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	36
37	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	38
39	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	40
41	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	42
43	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	44
45	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	46
47	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	48
49	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	50
51	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	52
53	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	54
55	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	56
57	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	58
59	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	60
61							62
63							64
65							66
67							68
69							70
71	BLANK					BLANK	72



SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

PHYSICAL DATA

ENCLOSURE Type 3R/4/4X/5/12 StainlessStl
FRONT CAT#: Trim w/Box
BOX CAT#: MH744WPSSULNF
DIMENSIONS:
74''H x 20''W x 6.5''D
WIRE BENDING SPACE:
TOP – 12.25
BOTTOM – 15.43
SIDE – 5.9
PBA: 711SS
BUSSING: Copper
Silver/Tin Plated
OPTIONAL FEATURES:
ALUMINUM SOLID NEUTRAL
ALUMINUM GROUND BAR

ELECTRICAL DATA

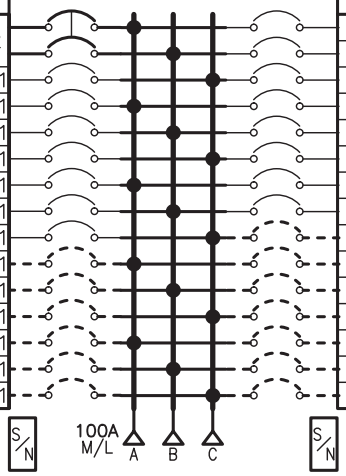
SYSTEM: 208Y/120V 3Ph 4W 60Hz
System Ampacity: 250A
10kA SYMS. SCCR
MAIN: MAIN BREAKER LA 250A
Bottom FEED
42kA AIR
INCOMING CONDUCTORS(S) PER NEC
Wire Bending Space:
#1 – 600,(2)#1 – 250 kcml
BRANCH MOUNTING TYPE: BOLT–ON
----------BRANCH SUMMATION----------
3 – 100A/3P QOB
7 – 15A/1P QOB
1 – 60A/3P QOB
2 – 30A/2P QOB
37 – 15A/1P–PS QOB

JOB NAME:	SPE–WATER SUPPLY SYSTEM	EQUIPMENT DESIGNATION:	P1
JOB LOCATION:	MIRABEL QC	EQUIPMENT TYPE:	NQ (Circuit Breaker Type) PANEL 1 OF 1
DRAWN BY:	(Q2C)	DRAWING TYPE:	ONE LINE DIAGRAM
ENGR:			
DATE:	June 14 2016		
DRAWING STATUS:	QUOTE	DWG# 038436634–01	PG 1 OF 1 REV –

Panel P-2

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--
–	----	--	--/--/--	–	----	--	--/--/--

CKT NO	ACCESSORIES	TYPE	RATING AMP/P
1		QOB	30/2
3			
5		QOB	15/1
7		QOB	15/1
9		QOB	15/1
11		QOB	15/1
13		QOB	15/1
15		QOB	15/1
17		QOB	15/1
19	PREPARED SPACE	QOB	15/1
21	PREPARED SPACE	QOB	15/1
23	PREPARED SPACE	QOB	15/1
25	PREPARED SPACE	QOB	15/1
27	PREPARED SPACE	QOB	15/1
29	PREPARED SPACE	QOB	15/1



RATING AMP/P	TYPE	ACCESSORIES	CKT NO
25/1	QOB		2
20/1	QOB		4
15/1	QOB		6
15/1	QOB		8
15/1	QOB		10
15/1	QOB		12
15/1	QOB		14
15/1	QOB		16
15/1	QOB	PREPARED SPACE	18
15/1	QOB	PREPARED SPACE	20
15/1	QOB	PREPARED SPACE	22
15/1	QOB	PREPARED SPACE	24
15/1	QOB	PREPARED SPACE	26
15/1	QOB	PREPARED SPACE	28
15/1	QOB	PREPARED SPACE	30

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed [X]

Reviewed as noted [ ]

Resubmit [ ]

Out for approval

SIFEC NORTH INC.

PHYSICAL DATA

ENCLOSURE Type 3R/4/4X/5/12 StainlessStl
FRONT CAT#: Trim w/Box
BOX CAT#: MH32WPSSULNF
DIMENSIONS:
32''H x 20''W x 6.5''D
WIRE BENDING SPACE:
TOP – 3.25
BOTTOM – 9.6
SIDE – 6.13
PBA: 711SS

BUSSING: Copper
Silver/Tin Plated

OPTIONAL FEATURES:
ALUMINUM SOLID NEUTRAL
ALUMINUM GROUND BAR

ELECTRICAL DATA

SYSTEM: 208Y/120V 3Ph 4W 60Hz
System Ampacity: 100A
10kA SYMS. SCCR

MAIN: MAIN LUGS : 100A
Bottom FEED
INCOMING CONDUCTORS(S) PER NEC
Wire Bending Space:
#6 – 2/0 AWG

BRANCH MOUNTING TYPE: BOLT-ON

----------BRANCH SUMMATION----------

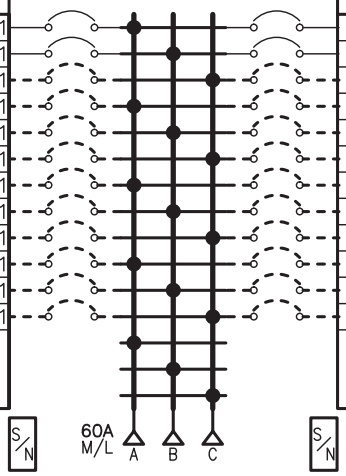
1 – 30A/2P QOB
13 – 15A/1P-PS QOB
1 – 20A/1P QOB
13 – 15A/1P QOB
1 – 25A/1P QOB

JOB NAME:	SPE-WATER SUPPLY SYSTEM	EQUIPMENT DESIGNATION:	P2
JOB LOCATION:	MIRABEL QC	EQUIPMENT TYPE:	NQ (Circuit Breaker Type) PANEL 1 OF 1
DRAWN BY:	(Q2C)	DRAWING TYPE:	ONE LINE DIAGRAM
ENGR:			
DATE:	June 14 2016		
DRAWING STATUS:	QUOTE	DWG# 038436634-01	PG 1 OF 1 REV –

Panel PA-1

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--
–	----	--	--/--/--	–	----	--	--/--/--

CKT NO	ACCESSORIES	TYPE	RATING AMP/P	RATING AMP/P	TYPE	ACCESSORIES	CKT NO
1		QOB	15/1	15/1	QOB		2
3		QOB	15/1	15/1	QOB		4
5	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	6
7	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	8
9	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	10
11	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	12
13	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	14
15	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	16
17	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	18
19	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	20
21	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	22
23	PREPARED SPACE	QOB	15/1	15/1	QOB	PREPARED SPACE	24
25							26
27							28
29	BLANK					BLANK	30



PHYSICAL DATA

ENCLOSURE Type 3R/4/4X/5/12 StainlessStl
FRONT CAT#: Trim w/Box
BOX CAT#: MH32WPSSULNF
DIMENSIONS:
32''H x 20''W x 6.5''D
WIRE BENDING SPACE:
TOP – 3.25
BOTTOM – 9.6
SIDE – 6.13
PBA: 711SS
BUSSING: Copper
Silver/Tin Plated
OPTIONAL FEATURES:
ALUMINUM SOLID NEUTRAL
ALUMINUM GROUND BAR

ELECTRICAL DATA

SYSTEM: 208Y/120V 3Ph 4W 60Hz
System Ampacity: 60A
10kA SYMS. SCCR
MAIN: MAIN LUGS : 60A
Bottom FEED
INCOMING CONDUCTORS(S) PER NEC
Wire Bending Space:
#6 – 2/0 AWG
BRANCH MOUNTING TYPE: BOLT–ON
----------BRANCH SUMMATION----------
4 – 15A/1P QOB
20 – 15A/1P–PS QOB

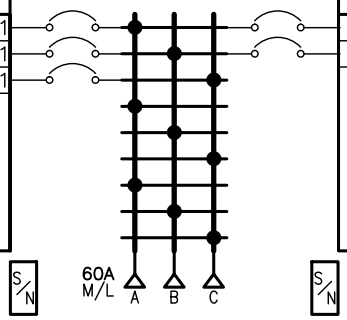
SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

JOB NAME:	SPE–WATER SUPPLY SYSTEM	EQUIPMENT DESIGNATION:	PA–1
JOB LOCATION:	MIRABEL QC	EQUIPMENT TYPE:	NQ (Circuit Breaker Type) PANEL 1 OF 1
DRAWN BY:	(Q2C)	DRAWING TYPE:	ONE LINE DIAGRAM
ENGR:			
DATE:	June 14 2016		
DRAWING STATUS:	QUOTE	DWG# 038436634–01	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	–	----	--/--/--
–	----	--	--/--/--	–	----	--/--/--

Genset Load Centre Panel -- In Generator Room

CKT NO	ACCESSORIES	TYPE	RATING AMP/P
1		QOB	20/1
3		QOB	15/1
5		QOB	15/1
7			
9			
11			
13			
15			
17	BLANK		



RATING AMP/P	TYPE	ACCESSORIES	CKT NO
20/1	QOB		2
15/1	QOB		4
			6
			8
			10
			12
			14
			16
		BLANK	18

PHYSICAL DATA

ENCLOSURE Type 3R/5/12
FRONT CAT#: Trim w/Box
BOX CAT#: MH26WP
DIMENSIONS:
26''H x 20''W x 6.5''D
WIRE BENDING SPACE:
TOP – 3.25
BOTTOM – 9.6
SIDE – 6.13
PBA: 711
BUSSING: Copper
Silver/Tin Plated
OPTIONAL FEATURES:
ALUMINUM SOLID NEUTRAL
ALUMINUM GROUND BAR

ELECTRICAL DATA

SYSTEM: 208Y/120V 3Ph 4W 60Hz
System Ampacity: 60A
10kA SYMS. SCCR
MAIN: MAIN LUGS : 60A
Bottom FEED
INCOMING CONDUCTORS(S) PER NEC
Wire Bending Space:
#6 – 2/0 AWG
BRANCH MOUNTING TYPE: BOLT-ON
----------BRANCH SUMMATION----------
2 – 20A/1P QOB 3 – 15A/1P QOB

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: N.K.
Date: July 11, 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016

Reviewed X
Reviewed as noted
Resubmit

Out for approval

SIFEC NORTH INC.

JOB NAME:	SPER-GENSET LOAD CENTRE	EQUIPMENT DESIGNATION:	
JOB LOCATION:	LACHUTE QC	EQUIPMENT TYPE:	NQ (Circuit Breaker Type) PANEL 1 OF 1
DRAWN BY:	(Q2C)	DRAWING TYPE:	ONE LINE DIAGRAM
ENGR:			
DATE:	July 07 2016		
DRAWING STATUS:	QUOTE	DWG# 038534250-01	PG 1 OF 1 REV –

Low level float switch for DWT
High level float switch for WWT

Flygt ENM-10 liquid level regulators

TRIED-AND-TRUE SIMPLICITY

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

FLYGT
a xylem brand

Low level float switch for DWT
High level float switch for WWT

So simple, yet so reliable

Proper level regulation is critical for operational reliability. Lack of proper regulation can cause improper operation, pump damage or, in the worst case, overflow that results in environmental and economic consequences. With over a decade of experience and countless satisfied users, the natural choice for level regulation is the Flygt ENM-10.

Simple, reliable and effective

The Flygt ENM-10 level regulators are the ideal choice for most level control applications, such as wastewater pumping stations and ground water or drainage pumping. When the liquid level reaches the regulator, the bulb tilts, activating the internal microswitch, which starts or stops a pump or triggers an alarm device.

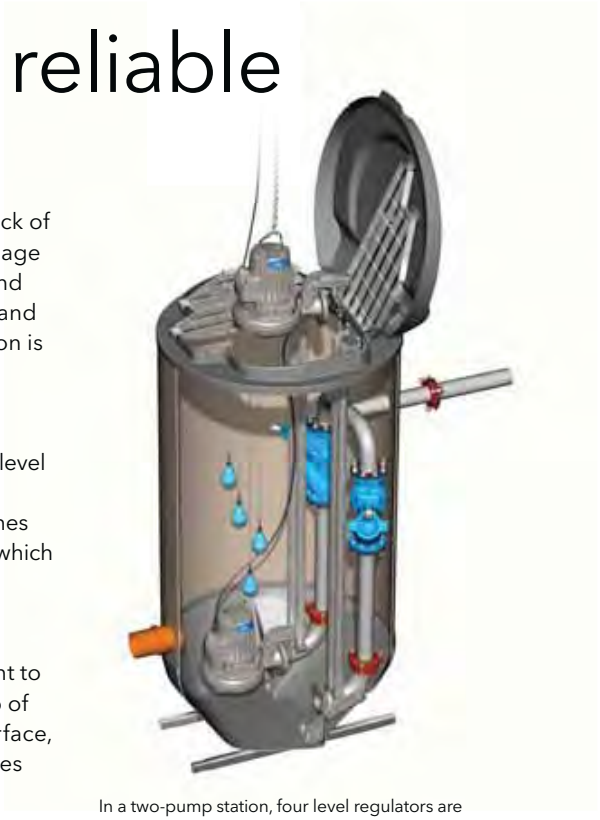
Practically maintenance free

The outer casing of Flygt ENM-10 level regulators are resistant to most aggressive liquids. The cable material prevents buildup of deposits and other impurities. Rather than floating on the surface, ENM-10 hangs immersed in the liquid. This prevents the cables from tangling when several regulators are used.

Xylem testing indicates Flygt ENM-10 level regulators last several times longer than most standard level regulators. This ensures reliable operation and a low degree of maintenance, thereby keeping service costs down to a minimum over the life cycle.

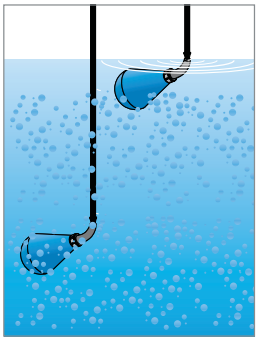
Environmentally friendly

The Flygt ENM-10 level regulator contains no harmful or toxic materials such as lead or mercury and does not require the use of any adhesives. All plastic components are welded and screwed together.

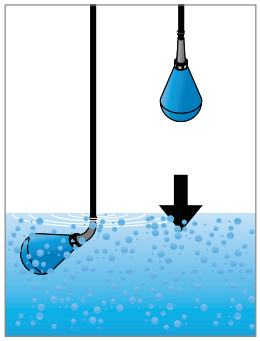


In a two-pump station, four level regulators are generally used. One is positioned at the stop level, one at each pump's start level, and the fourth regulator is used to trigger a high level alarm.

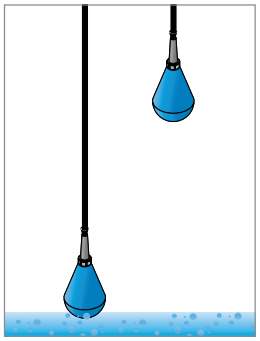
Operating principle



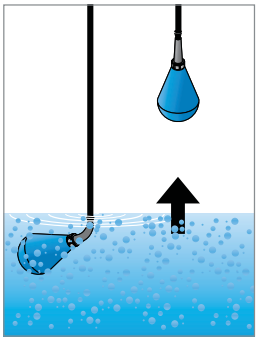
1. Media to be pumped reaches the pre-set level and tilts the upper regulator, which signals the start of the pumping process.



2. The pumping process drains the media.



3. The pumping process stops when the lower regulator returns to the vertical position and signals a stop.



4. The media level begins to rise, starting the process again.

Low level float switch for DWT
High level float switch for WWT

With a variety of installations in mind
The Flygt liquid level regulator comes in two main versions, standard and Ex-approved. Depending upon the media and type of installation, the Flygt ENM-10 is available for a broad range of liquid densities and with many cable lengths from which to choose.

Features

Standard

Ex

Watertight cable
Encases and protects power supply to the microswitch.

Operational mechanism
Initiates pump start and pump stop through the microswitch when the Flygt ENM-10 tilts or resumes its original position. Delivers reliable performance under all operating conditions including the slow movements often found in stormwater or rainwater installations.

Bending relief (protective sleeve)
Enables watertight, oil-resistant cable entry.

Microswitch
Provides proven quality, performance and reliability for all operating conditions, including switching low currents.

Accessories

Flygt ENM-10 cable holder
Dedicated accessory that reduces the cable wear. Sold separately or as package with the Flygt ENM-10.

Flygt Ex safety barrier
This two-channel safety barrier protects against overvoltage for liquid level regulators. Required when Flygt ENM-10s are to be used in Ex-installations.

Technical data

	Standard version	Ex-approved version
Cable lengths	6, 13, 20, 30 or 50 m* (20, 42, 65,100 or 167 ft.)	6, 13, or 20 m (20, 42 or 65 ft.)
Liquid density	Between 0.95 and 1.10 g/cm³*	Between 0.95 and 1.10 g/cm³
Materials	Body: Polypropylene Bending relief: EPDM rubber Cable: Special compound PVC & NBR/PVC	Body: Conductive polypropylene/carbon black Bending relief: NBR/PVC rubber Cable: NBR/PVC
Liquid temperature	Min. 0°C (32°F) Max. 60°C (140°F)	Min. 0°C (32°F) Max. 60°C (140°F)
Ingress protection	IP 68	IP 68
Electrical range (microswitch)	Interrupting capacity: AC: 250 V/10 A resistive load AC: 250 V/3 A inductive load at cosϕ = 0.5 DC: 24 V/ 10mA min., 6 A max. Note that local regulations may limit the voltage.	Interrupting capacity: AC: 250 V/10 A resistive load AC: 250 V/3 A inductive load at cosϕ = 0.5 DC: 24 V/ 10mA min., 6 A max. Note that local regulations may limit the voltage.
Approvals	CE, CSA, SEMKO, NEMKO, DEMKO	CE, SEMKO, NEMKO, DEMKO, ATEX/IECEX

*Other cable lengths and liquid densities available upon request.
The Flygt ENM-10 is a part of the Level Sensor product range from Xylem, covering most level measuring needs.

Low level float switch for DWT
High level float switch for WWT

Xylem [ˈzīləm]

1) The tissue in plants that brings water upward from the roots
2) A leading global water technology company

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com

xylem
Let's Solve Water

1319 . Flygt ENM 10 . 1 . Master . 1 . 20120103

Chapter 29 SUBMERSIBLE PUMP STARTER (VFD)

MANUFACTURER/DISTRIBUTOR:

CDE
298, Rue De Martigny Ouest
Saint-Jérôme (Québec)
J7Y 4C9
Phone.: (450) 438-1263
Fax: (450) 438-3728
Courriel : cde@cde.qc.ca

29.1 **ABB VFD DRIVE**

ABB low voltage drives
ACS550, 0.75 - 550 Hp
Technical Catalog

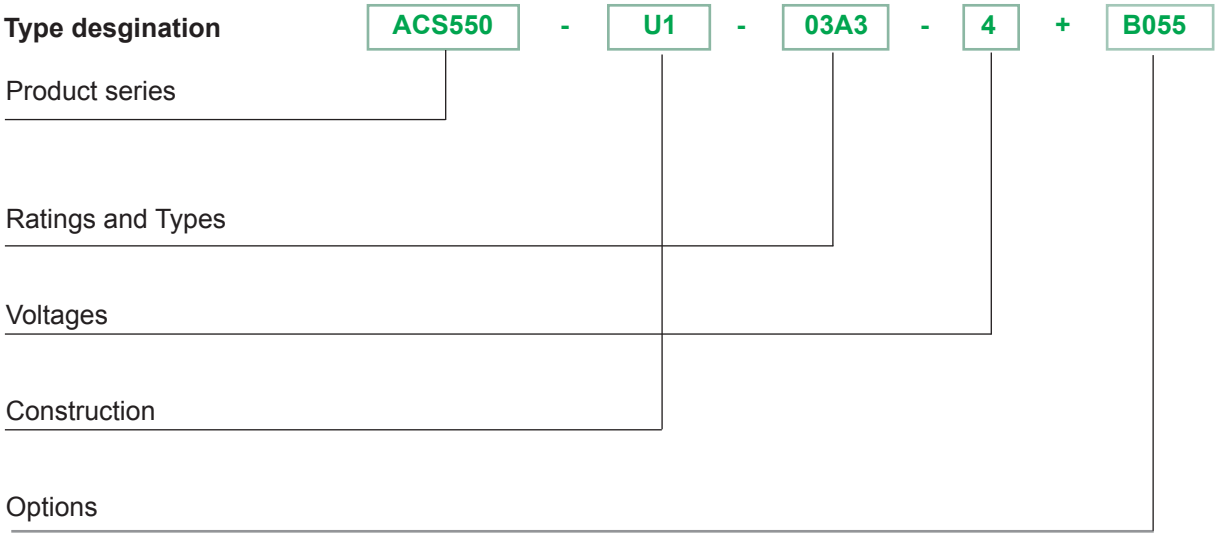
Power and productivity
for a better world™

Selecting and ordering your drive

Type designation is a unique reference number that clearly identifies the drive by construction, power and voltage rating and selected options. Using the type designation you can specify your drives from the wide range of options available. Options are added to the type designation using the corresponding “plus” (+) code.

Build up your own ordering code using the type designation key below or contact your local ABB drives sales office and let them know what you want. Use page 3 as a reference section for more information.

ACS550-U1-088A-2



ACS550
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Introduction to ACS550

ACS550	-	U1	-	03A3	-	4	+	B055

What is the ACS550 Customer Value?

- Reduced commissioning and installation costs
  - Many assistants including Start-up, Drive Optimizer, Real-time Clock, Diagnostics, Maintenance, Serial and PID.
  - Two soft-keys that change according to the operator panel state
  - Field upgradeable firmware
  - Easy connection of cables
  - New conduit box is suitable for US and Europe
  - Built-in brake chopper (10Hp, 230V / 15Hp, 480V and 600 V)
  - Optional plug-in fieldbus modules
  - Reduced size and weight with Patented Swinging Choke (R1-R6) - equivalent to a 5% Line Impedance
  - 3% Impedance AC Line Reactor (R8)
  - Removable operator panel
  - Only Class T fuses required for high speed short circuit protection
  - NEMA 12 enclosure does not require derating
  - Smaller physical size of internal option slots
  - FlashDrop programming (unpowered drive)

- Reduced energy costs without power factor penalties and correction capacitors
  - Patented swinging choke provides substantially reduced harmonics, more inductance to the correct load and higher power factor
  - Up to 25% less THD v. traditional DC choke
  - Daily timer controls for time-of-day backoff e.g. start/stop process changes

- Reduced Drive-Motor system failures and costs
  - Preventative “Maintenance Assistant” annunciation feature schedules Drive-Motor system maintenance

The ABB ACS550 AC drive combines a sophisticated microprocessor with an advanced IGBT power switching technology to deliver V/Hz, Closed Loop Flux Vector and Sensorless Vector control of AC motors. Its intuitive control panel offers numerous benefits making it the most user-friendly panel in the drives industry. The extensive library of pre-programmed application macros maximizes convenience and minimizes start-up time. This drive can handle the most demanding industrial applications in an efficient, dependable and economic manner.

Where can it be used?

The ABB ACS550 standard drive can be used in a wide range of industries. Typical applications include pump, fan and constant torque use, such as conveyors. The ABB ACS550 standard drive is ideal for those situations where there is a need for simplicity to install, commission and use and where customizing or special product engineering is not required.

ABB ACS550 standard drive promises

- Quick delivery
- Easy installation
- Trouble-free start-up
- Intuitive operation

Highlights:

- Advanced control panel permitting intuitive operation
- Patented swinging choke for superior harmonic reduction (R1-R6) and AC line reactor (R8)
- Sensorless vector control
- Integral EMC filter as standard
- Built-in Modbus RTU and numerous internally mountable fieldbus adapters
- FlashDrop
- Coated boards for harsh environments
- UL, cUL, C-Tick and Gost-R approved
- Built-in brake chopper (10Hp, 230V / 15Hp, 480V and 600 V)
- Many assistants including Start-up, Drive Optimizer, Real-time Clock, Diagnostics, Maintenance, Serial and PID
- Seismic Certification to ICC AC-156 Criteria

Main features

Feature	Note	Benefit
Advanced Control Panel	Two soft-keys change according to the state of the panel Built-in "Help" button Real-time clock, allows timed tracing of faults and setting of parameters at various times of day Changed parameter menu	Easy commissioning Fast set-up Easier configuration Rapid fault diagnostics Quick access to recent parameter changes
Brake Chopper	Built-in up to 15 Hp (480 and 600V) and up to 10 Hp (240V)	Reduced installation cost
Chokes	5% equivalent impedance swinging choke-matches the right inductance to the right load, suppressing and reducing harmonics (R1-R6), 3% impedance AC line reactor (R8)	Reduces Total Harmonic Distortion (THD) emissions up to 25%
Connectivity	Simple to install: Easy connection of cables Easy connection of external fieldbus systems through multiple I/Os and plug-in options	Reduced installation time Secure cable connections
Assistants (v3.11a+)	Diagnostic assistant activated when fault occurs Maintenance assistant monitors running hours or motor rotation Start-up assistant guides user through all essential settings without going to parameter list and offers option for parameter backup automatically PID Controller assistant guides user set-up without going to parameter list Real-time clock assistant helps user adjust time and date functions Serial communications assistant provides a convenient way to set-up fieldbus connections Drive optimizer permits user to choose drive set-up for low noise, drive & motor efficiency or motor control accuracy	Quick fault diagnostics Takes care of drive preventative maintenance Easy set-up of parameters Simplifies closed loop process control adjustment Allows quick adjustment of time and date Provides easy set-up of fieldbus connectivity Quickly tailors drive to application
Built-in EMC	Built-in category C2 (1st environment) filter	No need for external filtering
Sensorless vector control	Improve motor control performance	Enables wider range of applications
Switching frequency control	Permits the highest possible switching frequency based on operating and ambient conditions	Considerable motor noise reduction and improved efficiency
Flashdrop	Faster and easier drive set-up and programming	New fast, safe and trouble free method to download parameters available without powering the drive - patented
Coated boards	Longer lifetime in hostile environments. Reduced servicing requirements	Protections against moisture and hostile particles as standard
Flange Mounting Kits	Allows mounting the drive with the heatsink external to a 3rd party enclosure - frame size R1-R6.	Reduces heat and enclosure size

Ratings, Types and Voltages

Type code

This is the unique reference number that clearly indentifies the drive by mounting configuration, power rating and voltage. Once you have selected the type code, the frame size can be used to determine the drives dimensions, shown on the next page.

Voltages

The ACS550 is available in three voltage ranges:
2 = 208 - 240V
4 = 380 - 480V
6 = 500 - 600V

Notes

1. I_{2N}: continuous base current with 110% overload for 1 minute / 10 minutes.
2. I_{2hd}: continuous base current with 150% overload for 1 minute / 10 minutes.
3. 180% I_{hd} continuous base current available for 2 seconds / 1 minute.
4. The rated current of the ACS550 must be greater than or equal to the rated motor current to achieve the rated motor power given in the table.
5. All -U1 models come with a conduit box and advanced control panel as standard.
6. Horsepower is based on NEMA motor ratings for most 4-pole motors (1800 rpm). Check motor nameplate current for compatibility.
7. All 230V product can be operated on 230V single-phase power, using a de-rate of the output current of 50%.
8. All -U2 models come standard with US conduit openings, top entry / top exit, common mode filter for drives larger than 200 HP, fused disconnect and extended enclosure with advanced control panel.

Type Code UL Type 1 NEMA 1 (5,8)	Nominal Ratings				Frame Size
	Normal Duty (CT) (110% I_{2N})		Heavy Duty (CT) (150% I_{2hd})		
	I_{2N} A (1,7)	P_N HP (4,6)	I_{2hd} A (2,3,7)	P_{hd} HP (4,6)	
ACS550-U1-04A6-2	4.6	1.0	3.5	0.75	R1
ACS550-U1-06A6-2	6.6	1.5	4.6	1.0	R1
ACS550-U1-07A5-2	7.5	2.0	6.6	1.5	R1
ACS550-U1-012A-2	11.8	3.0	7.5	2	R1
ACS550-U1-017A-2	16.7	5.0	11.8	3	R1
ACS550-U1-024A-2	24.2	7.5	16.7	5	R2
ACS550-U1-031A-2	30.8	10	24.2	7.5	R2
ACS550-U1-046A-2	46.2	15	30.8	10	R3
ACS550-U1-059A-2	59.4	20	46.2	15	R3
ACS550-U1-075A-2	74.8	25	59.4	20	R4
ACS550-U1-088A-2	88	30	74.8	25	R4
ACS550-U1-114A-2	114	40	88	30	R4
ACS550-U1-143A-2	143	50	114	40	R6
ACS550-U1-178A-2	178	60	150	50	R6
ACS550-U1-221A-2	221	75	178	60	R6
ACS550-U1-248A-2	248	100	192	75	R6
ACS550-U1-03A3-4	3.3	1.5	2.4	1	R1
ACS550-U1-04A1-4	4.1	2	3.3	1.5	R1
ACS550-U1-06A9-4	6.9	3	5.4	2	R1
ACS550-U1-08A8-4	8.8	5	6.9	3	R1
ACS550-U1-012A-4	11.9	7.5	8.8	5	R1
ACS550-U1-015A-4	15.4	10	11.9	7.5	R2
ACS550-U1-023A-4	23	15	15.4	10	R2
ACS550-U1-031A-4	31	20	23	15	R3
ACS550-U1-038A-4	38	25	31	20	R3
ACS550-U1-045A-4	44	30	38	25	R3
ACS550-U1-059A-4	59	40	44	30	R4
ACS550-U1-072A-4	72	50	59	40	R4
ACS550-U1-078A-4	77	60	65	50	R4
ACS550-U1-097A-4	96	75	77	60	R4
ACS550-U1-125A-4	124	100	96	75	R5
ACS550-U1-157A-4	157	125	124	100	R6
ACS550-U1-180A-4	180	150	156	125	R6
ACS550-U1-246A-4	245	200	192	150	R6
ACS550-U2-316A-4	316	250	240	200	R8
ACS550-U2-368A-4	368	300	302	250	R8
ACS550-U2-414A-4	414	350	368	300	R8
ACS550-U2-486A-4	486	400	414	350	R8
ACS550-U2-526A-4	526	450	477	400	R8
ACS550-U2-602A-4	602	500	515	450	R8
ACS550-U2-645A-4	645	550	590	500	R8
ACS550-U1-02A7-6	2.7	2	2.4	1.5	R2
ACS550-U1-03A9-6	3.9	3	2.7	2.0	R2
ACS550-U1-06A1-6	6.1	5	3.9	3.0	R2
ACS550-U1-09A0-6	9	7.5	6.1	5.0	R2
ACS550-U1-011A-6	11	10	9	7.5	R2
ACS550-U1-017A-6	17	15	11	10	R2
ACS550-U1-022A-6	22	20	17	15	R3
ACS550-U1-027A-6	27	25	22	20	R3
ACS550-U1-032A-6	32	30	27	25	R4
ACS550-U1-041A-6	41	40	32	30	R4
ACS550-U1-052A-6	52	50	41	40	R4
ACS550-U1-062A-6	62	60	52	50	R4
ACS550-U1-077A-6	77	75	62	60	R6
ACS550-U1-099A-6	99	100	77	75	R6
ACS550-U1-125A-6	125	125	99	100	R6
ACS550-U1-144A-6	144	150	125	125	R6

Construction

"U1" within the type code indicates the drive mounting configuration. U1 models are wall-mounted, while "U2" models are free-standing with an extended enclosure and fused disconnect. Choose the correct one for your needs from the table below:

U1

- Wall mounted, frame size R1-R6
- 0.75 - 200 HP
- UL Type 1 (IP21) NEMA 1 or UL Type 12 (IP54) NEMA 12
- Built-in EMC filter
- Standard software
- Built-in Modbus RTU interface
- Cable connection box
- Brake chopper in frame sizes R1-R2
- Advanced control panel
- Swinging choke (Frames R1-R6)

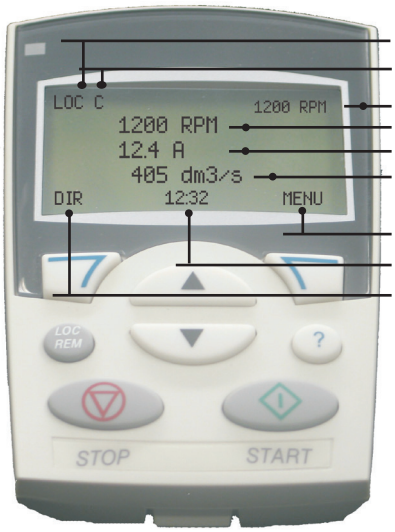
U2

- Free standing, frame size R8
- 250 - 550Hp
- UL Type 1 (IP21) NEMA 1
- Standard software
- Built-in Modbus RTU interface
- Free-standing with extended enclosure and fused disconnect
- Advanced control panel
- AC Reactor (Frame R8)

Advanced Control Panel

For easy drive programming, a detachable, multilingual alphanumeric advanced control panel is delivered as standard. The control panel has various assistants and built-in help functions to guide the user. It includes a real time clock, which can be used during fault logging and in controlling the drive, such as start/stop and maintenance reminders. The control panel can be used for copying parameters for back up or for downloading to another drive. A large graphical display and soft keys make it extremely easy to navigate.

Name	Function
Start	Initiates operation of drive
Stop	Ceases operation of drive
Up	Changes parameters and their value/ increases reference
Down	Changes parameters and their value/ decreases reference
Loc/Rem	Changes drive state from local control to remote control (I/O or other external source)
HELP	Built-in "Help" button
Soft key 1	Function changes according to state of panel
Soft key 2	Function changes according to state of panel



Local/Remote indication
Motor rotation indicator
Speed reference
Actual value 1, Actual motor speed (selectable)
Actual value 2, Output current (selectable)
Actual value 3, Process value (selectable)
Soft key 2 function
Real time clock
Soft key 1 function

Options
Control Interfaces

How to select options

The options shown below are available for use with the ACS550. Each item has a 4-digit option code, which is shown in the table below. This code is added to the end of the type code above using a '+'. Ordering options using the plus option code provides a factory installed option, while using the field kit code provides a field installable kit (-KIT).

Available options

Plus Option Code	Description	Field Kit Code
Protection class		
+B055	UL Type 12 (IP54) NEMA 12	
Slot 1 Options		
+L511	Relay Output Extension	OREL-01-KIT
+L502	Pulse Encoder Interface	OTAC-01-KIT
Slot 2 Options		
+L512	115/230V Digital Input Interface	OHDI-01-KIT
+K451	DeviceNet	RDNA-01-KIT
+K454	Profibus-DP	RPBA-01-KIT
+K462	ControlNet	RCNA-01-KIT
+K466	EtherNet/IP and Modbus/TCP	RETA-01-KIT
+K457	CANopen	RCAN-01-KIT
+K467	PROFINET and Modbus/TCP	RETA-02-KIT

NOTE:
- Only one option can be installed in each option slot.
- Embedded Modbus RTU

Panel Mounting Kit (OPMP-01)

The panel mounting kit, OPMP-01, enables mounting of control panels on cabinet doors. This kit includes a 10 ft (3 m) extension cable, a gasket, mounting screws and a mounting template.

ACS-CP-EXT: permits permanent mounting of panel to external surface of NEMA 1 or NEMA 12 enclosures.

ACS-CP-EXT-IP66: permits permanent mounting of panel to external surface of NEMA 4X enclosures.

DriveWindow Light 2 (3AFE64532871)

DriveWindow Light 2 is a PC software used for rapid commissioning, operating and programming of drives. It has features for programming, monitoring, troubleshooting and maintenance.

It is also a set-up and control tool which is Win98, WinNT, Win2000 and WinXP compatible.

DriveWindow Light 2 operates both off- and on-line. No additional PC hardware is required. It uses the PC's RS-232 port. It is also compatible with drive types ACS350, ACS800, DCS400 and DCS800.

DriveWindow Light 2 features:

- Graphical start-up wizards
- Off- and on-line viewing and changing of drive parameters
- Backup and restore parameters. In a fault situation, the parameters can be reloaded resulting in time savings
- Graphical monitoring of actual signal values
- I/O mapping table
- Control of the drive

DrivePM

DrivePM (Parameter Manager) is a software tool designed to create, edit and copy parameter sets included with a FlashDrop. For each parameter, and parameter group, the user can change the default or hide the parameter or entire group. FlashDrop does not require the drive to have power applied. FlashDrop is also compatible with the ACS150 and ACS350.

FlashDrop MFDT-01

FlashDrop is a powerful palm-sized tool for fast and easy parameter selecting and setting. This tool can be used to download parameters to a drive in less than three seconds. Using this tool, it is possible to hide selected parameters to protect the machine. Only parameters needed in the application are shown. FlashDrop does not require the drive to be powered. The MFDT-01 includes Drive PM (Drive Parameter Manager) software tool to create, edit and copy parameter sets.

FlashDrop
(MFDT-01)

Options
Plug-in Options

Relay Output Extension Module (+L511)

This plug-in option offers three additional relay outputs. They can be used to actuate motor starters for pumps using a lead-lag alternation scheme with the built-in Pump-Fan Macro. All relays can be programmed to on/off by using the advanced control panel's clock. Alternatively, fieldbus adapters can be used to control any external components in the system.

Pulse Encoder Interface (+L502)

The Pulse Encoder Interface module offers a differential or single ended interface for a digital pulse encoder connection. The module is capable of operating from either a 15 or 24 VDC signal with a maximum frequency of 200kHz.

115/230V Digital Input Interface (+L512)

The 115/230V Digital Input Interface module offers six (6) 115V or three (3) 230V rated relays mounted on a common board used to drive DI1 through DI6 of the ACS550. The 115/230V must be provided by the user. The module cannot be used in conjunction with any fieldbus module as it occupies the same option slot.

Plug-in Fieldbus Modules

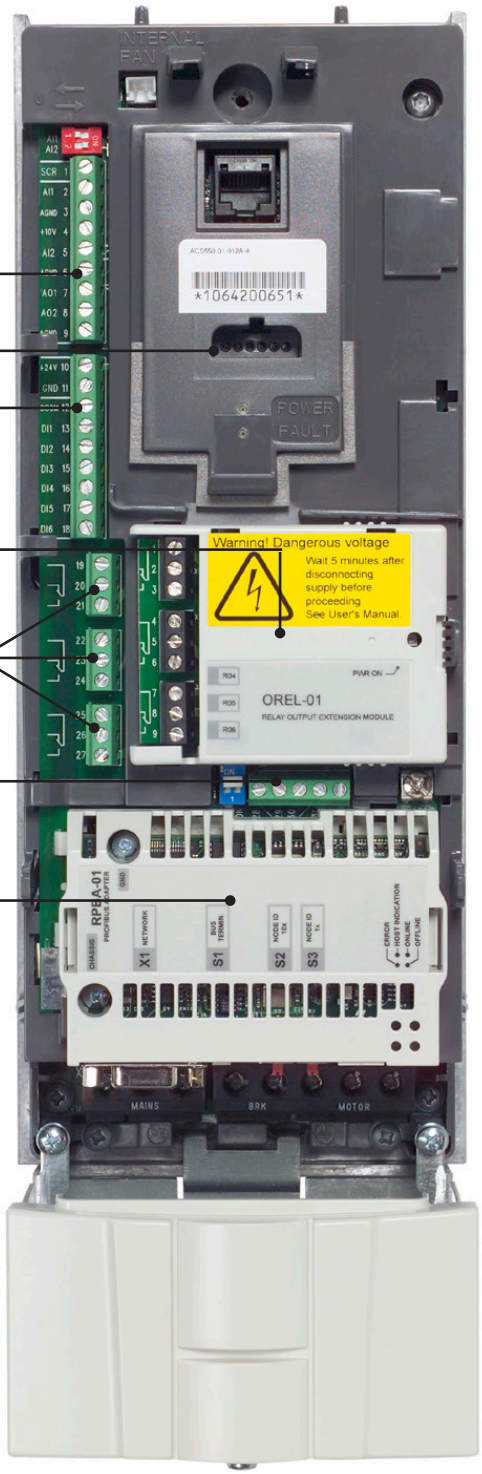
The plug-in fieldbus options bring connectivity to major automation systems. A single twisted pair avoids large amounts of conventional cabling, thereby reducing cost and increasing system reliability.

The ACS550 supports the following fieldbus options:

- CANopen
- ControlNet™
- DeviceNet™
- Embedded Modbus® RTU
- EtherNet/IP™ Modbus/TCP®
- Profibus-DP®
- PROFINET IO®

NOTE:

- Only one option can be installed in each option slot.



Options
External Options

Brake Units and Choppers
Frame sizes R1 to R2 are delivered with integrated brake choppers as standard. Other units can use an external brake chopper and resistor. For more information, please refer to the ABB Low Voltage Drives PowerOhm Resistors Price List. (LVD-PNPL02U-EN).

Flange Mounting Kits
Flange Mounting Kits for the ACS550 drives allow mounting of the drive with the heatsink external to a 3rd party enclosure. Use of the flange kit requires removal of the drive cover, reducing protection to IP00. The flange kit can be used with 3rd party UL Type 1 & 12 (NEMA 1 & 12) enclosures. R5 and R6 kits provide NEMA 1 protection only.

Flange Mounting Kits

Frame Size	Field Kit Code
R1	FMK-A-R1
R2	FMK-A-R2
R3	FMK-A-R3
R4	FMK-A-R4
R5	AC8-FLNGMT-R5
R6	AC8-FLNGMT-R6

Technical Data
Cooling

Cooling Air Flow 208 - 240V Units

Type Code	Frame Size	W	BTU/Hr	m^3/h	ft^3/min
-04A6-2	R1	55	189	44	26
-06A6-2	R1	73	249	44	26
-07A5-2	R1	81	276	44	26
-012A-2	R1	118	404	44	26
-017A-2	R1	161	551	44	26
-024A-2	R2	227	776	88	52
-031A-2	R2	285	973	88	52
-046A-2	R3	420	1434	134	79
-059A-2	R3	536	1829	134	79
-075A-2	R4	671	2290	280	165
-088A-2	R4	786	2685	280	165
-114A-2	R4	1014	3463	280	165
-143A-2	R6	1268	4331	405	238
-178A-2	R6	1575	5379	405	238
-221A-2	R6	1952	6666	405	238
-248A-2	R6	2189	7474	405	238

Cooling Air Flow 500 - 600V Units

Type Code	Frame Size	W	BTU/Hr	m^3/h	ft^3/min
-02A7-6	R2	46	157	88	52
-03A9-6	R2	68	232	88	52
-06A1-6	R2	124	423	88	52
-09A0-6	R2	170	581	88	52
-011A-6	R2	232	792	88	52
-017A-6	R2	337	1150	88	52
-022A-6	R3	457	1560	134	79
-027A-6	R3	562	1918	134	79
-032A-6	R4	667	2276	280	165
-041A-6	R4	907	3096	280	165
-052A-6	R4	1120	3820	280	165
-062A-6	R4	1295	4420	280	165
-077A-6	R6	1504	5136	405	238
-099A-6	R6	1821	6219	405	238
-125A-6	R6	2442	8339	405	238
-144A-6	R6	2813	9607	405	238

Cooling Air Flow 380 - 480V Units

Type Code	Frame Size	W	BTU/Hr	m^3/h	ft^3/min
-03A3-4	R1	40	137	44	26
-04A1-4	R1	52	178	44	26
-06A9-4	R1	97	331	44	26
-08A8-4	R1	127	434	44	26
-012A-4	R1	172	587	44	26
-015A-4	R2	232	792	88	52
-023A-4	R2	337	1151	88	52
-031A-4	R3	457	1561	134	79
-038A-4	R3	562	1919	134	79
-045A-4	R3	667	2278	134	79
-059A-4	R4	907	3098	280	165
-072A-4	R4	1120	3825	280	165
-078A-4	R4	1300	4300	280	165
-097A-4	R4	1440	4918	280	165
-125A-4	R5	1940	6625	350	205
-157A-4	R6	2310	7889	405	238
-180A-4	R6	2810	9897	405	238
-246A-4	R6	3850	13148	540	318
-316A-4	R8	4550	15539	1220	718
-368A-4	R8	6850	23394	1220	718
-414A-4	R8	7400	25000	1220	718
-486A-4	R8	7850	26809	1220	718
-526A-4	R8	7600	25955	1220	718
-602A-4	R8	8100	27663	1220	718
-645A-4	R8	9100	31078	1220	718

ACS550 are configured with cooling air fans. The cooling air must be free from corrosive materials with a maximum ambient temperature of 40oC (50oC with derating).

Free space requirements

Enclosure Type	Space above mm / in	Space below mm / in	Space on left and right mm / in
U1 - Wall Mount	200 / 7.9	200 / 7.9	0
U2 - Floor Mount	200 / 7.9	0	0

Technical Data
Fuse connections

Standard fuses can be used with ABB standard drives. For fuse connections see table below.

Recommended input protection fuses

Type Code	Frame Size	Input Current A	Mains Fuses	
			IEC269 gG (A)	UL Class T (A)
-04A6-2	R1	4.6	10	10
-06A6-2	R1	6.6	10	10
-07A5-2	R1	7.5	10	10
-012A-2	R1	11.8	16	15
-017A-2	R1	16.7	25	25
-024A-2	R2	24.2	25	30
-031A-2	R2	30.8	40	40
-046A-2	R3	46.2	63	60
-059A-2	R3	59.4	63	80
-075A-2	R4	74.8	80	100
-088A-2	R4	88.0	100	110
-114A-2	R4	114.0	125	150
-143A-2	R6	143.0	200	200
-178A-2	R6	178.0	250	250
-221A-2	R6	221.0	315	300
-248A-2	R6	248.0	315	350
-03A3-4	R1	3.3	10	10
-04A1-4	R1	4.1	10	10
-06A9-4	R1	6.9	10	10
-08A8-4	R1	8.8	10	15
-012A-4	R1	11.9	16	15
-015A-4	R2	15.4	16	20
-023A-4	R2	23.0	25	30
-031A-4	R3	31.0	35	40
-038A-4	R3	38.0	50	50
-045A-4	R3	44.0	50	60
-059A-4	R4	59.0	63	80
-072A-4	R4	72.0	80	90
-078A-4	R4	77.0	80	100
-097A-4	R4	96.0	125	125
-125A-4	R5	124.0	160	175
-157A-4	R6	157.0	200	200
-180A-4	R6	180.0	250	250
-246A-4	R6	245.0	250	250
-316A-4	R8	316.0	400	400
-368A-4	R8	368.0	400	400
-414A-4	R8	414.0	500	500
-486A-4	R8	486.0	500	500
-526A-4	R8	526.0	630	630
-602A-4	R8	602.0	630	630
-645A-4	R8	645.0	800	800
-02A7-6	R2	2.7	10	10
-03A9-6	R2	3.9	10	10
-06A1-6	R2	6.1	10	10
-09A0-6	R2	9.0	16	15
-011A-6	R2	11.0	16	15
-017A-6	R2	17.0	25	25
-022A-6	R3	22.0	25	25
-027A-6	R3	27.0	35	40
-032A-6	R4	32.0	35	40
-041A-6	R4	41.0	50	50
-052A-6	R4	52.0	60	60
-062A-6	R4	62.0	80	80
-077A-6	R6	77.0	80	100
-099A-6	R6	99.0	125	150
-125A-6	R6	125.0	160	175
-144A-6	R6	144.0	200	200

Technical Specification

Input power connection	
Voltage and power range	3-phase, 208 to 240 V, +10/-15%, 0.75 - 100Hp 3-phase, 380 to 480 V, +10/-15%, 1 - 550Hp 3-phase, 500 to 600V, +10/-15%, 1.5 - 150Hp
Frequency	48 to 63 Hz
Power factor	0.98

Motor connection	
Voltage	3-phase, from 0 to U_{SUPPLY}
Frequency	0 to 500 Hz
Continuous loading capability (constant torque at a max ambient temperature of 40°c)	Rated output current I_{2N}
Overload capacity (at a max. ambient temperature of 40°c)	At normal use 1.1 x I_{2N} for 1 minute every 10 minutes At heavy-duty use 1.5 x I_{2hd} for 1 minute every 10 minutes Always 1.8 x I_{2hd} for 2 seconds every 60 seconds
Switching frequency	
Standard	Default 4 kHz
Selectable	0.75 - 150Hp - 1 kHz, 4 kHz, 8 kHz, 12 kHz up to 550Hp - 1 kHz, 4 kHz
Acceleration time	0.1 to 1800 s
Deceleration time	0.1 to 1800 s

Environmental limits	
Ambient temperature	-15 to 40°C (5 to 104°F) 40 to 50°C (104 to 122°F) No frost allowed f_{switch} 4 kHz, P_N and I_2 derated to 90%
Altitude Output current	Rated current available at 0 to 1000 m (3300 ft) reduced by 1% per 100 m over 1000 m (3300 ft) to 2000 m (6600 ft)
Relative humidity	lower than 95% (without condensation)
Protection class	UL Type 1 or 12 (NEMA 1 or NEMA 12)
Enclosure color	NCS 1502-Y, RAL 9002, PMS 420 C
Contamination levels	IEC 721-3-3 No conductive dust allowed
Transportation	Class 1C2 (chemical gases), Class 1S2 (solid particles)
Storage	Class 2C2 (chemical gases), Class 2S2 (solid particles)
Operation	Class 3C2 (chemical gases), Class 3S2 (solid particles)

Motor Control	
Speed Control **Open Loop** **Closed Loop** **Open Loop** **Closed Loop**	 20% of motor nominal slip 0.1% of motor nominal speed < 1% s with 100% torque step 0.5% s with 100% torque step
Motor Control **Open Loop** **Closed Loop** **Open Loop** **Closed Loop**	 <10ms with nominal torque <10ms with nominal torque ±5% with nominal torque ±2% with nominal torque

Programmable control connections	
Two analog inputs	
Voltage signal	0 (2) to 10 V, R_{in} > 312 kΩ single-ended
Current signal	0 (4) to 20 mA, R_{in} = 100 Ω single-ended
Potentiometer reference value	10 V ±2% max. 10 mA, R < 10 kΩ
Maximum delay	12...32 ms
Resolution	0.1%
Accuracy	±1%
Two analog outputs	0 (4) to 20 mA, load < 500 Ω
Accuracy	±3%
Auxiliary voltage	24 V DC ±10%, max. 250 mA
Six digital inputs	12 V... 24 V DC with internal or external supply, PNP and NPN
Input impedance	2.4 kΩ
Maximum delay	5 ms ± 1ms
Three relay outputs	
Maximum switching voltage	250 V AC/30 V DC
Maximum switching current	6 A/30 V DC; 1500 V A/230 V AC
Maximum continuous current	2 A rms
Serial communication	
RS 485	Built-in Modbus RTU protocol

Product compliance

240V products: UL, cUL, CSA, CE, C-TICK, and GOST-R approvals
480V products: UL, cUL, CSA, CE, C-TICK, and GOST-R approvals
600V products: UL, cUL, CSA, C-TICK, and GOST-R approvals

Low Voltage Directive 73/23/EEC with supplements
Machinery Directive 98/37/EC
EMC Directive 89/336/EEC with supplements
Quality assurance system ISO 9001 and Environmental system ISO 14001
Seismic Certification to ICC AC-156

EMC according to EN61800-3

1st environment restricted distribution for frame sizes R3, R4 with 75 m motor cables and for frame sizes R1, R2, R5, R6 with 100 m motor cables.

2nd environment unrestricted distribution for frame sizes R1 - R4 with 300 m cable and for frame sizes R5 - R8 with 100 m motor cables as standard.

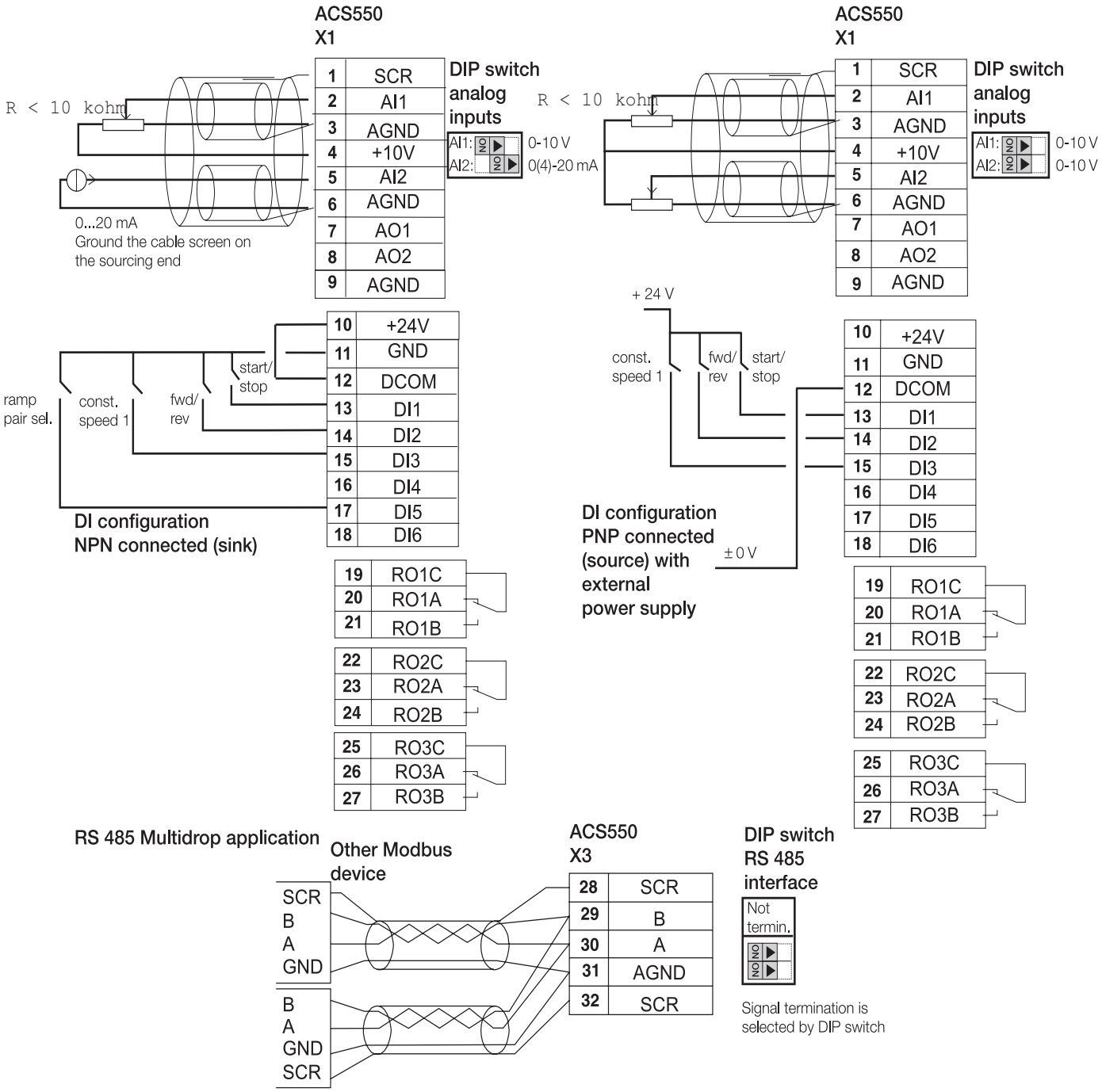
These cable lengths are for EMC purposes only. For long motor cable lengths, external EMC filters are available on request.

EMC standards in general

EN 61800-3/A11 (2000), product standard	EN 61800-3 (2004), product standard	EN 55011, product family standard for industrial, scientific and medical (ISM) equipment
1st Environment, unrestricted distribution	Category C1	Group 1 Class B
1st Environment, restricted distribution	Category C2	Group 1 Class A
2nd Environment, unrestricted distribution	Category C3	Group 2 Class A
2nd Environment, restricted distribution	Category C4	Not Applicable

Control Connections

These connections are shown as examples only. Please refer to the ACS550 User's Manual (3AUA0000001609) for more detailed information.



Fieldbus Control
Gateway to your process

ABB AC drives have the connectivity to major automation systems. This is achieved with a dedicated gateway concept between the fieldbus systems and ABB drives.

The fieldbus gateway is a snap-on module that can be easily mounted inside the drive. As a result of the wide range of fieldbus gateways, your choice for an automation system becomes independent of your decision to use first-class ABB AC drives.

Manufacturing Flexibility

Drive control
The drive Control Word (16 bit) provides a wide variety of functions from Start, Stop and Reset to Ramp Generator control. Typical setpoint values like Speed, Torque and Position can be transmitted to the drive with 15 bit accuracy.

Drive monitoring
A set of drive parameters and/or actual signals, like torque, speed, position, current etc., can be selected for cyclic data transfer providing fast data for operators and the manufacturing process.

Drive diagnostics
Accurate and reliable diagnostic information can be obtained via the drive Alarm, Limit and Fault Words reducing the down time of the drive and therefore, also the down time of the manufacturing process.

Drive parameter handling
Total integration of the drives in the production process is achieved by single parameter read/write up to complete parameter set-up or download.

Easy to expand
Serial communication simplifies the latest trend of modular machine design enabling expansion of the installation at a later stage with low effort.

Reduced Installation and Engineering Effort

Cabling
Substituting the large amount of conventional Drive Control cabling with a single twisted pair reduces costs and increases system reliability.

Design
The use of Fieldbus Control reduces engineering time at installation due to the modular structure of the hardware and software.

Commissioning and assembly
The modular machine configuration allows pre-commissioning of single machine sections and provides easy and fast assembly of the complete installation.

Currently Available Gateways

- CANopen
- ControlNet™
- DeviceNet™
- Embedded Modbus® RTU
- Modbus/TCP®
- EtherNet/IP™
- Profibus-DP®
- PROFINET IO®

ABB ACS550 Packaged Drives

ACS550 Packaged Drive

ACS550-PC and PD packaged drives combine ACS550 AC drives with the disconnect arrangement of your choice in one coordinated, easy to install package. Packages are available with an input disconnect switch and fast acting, current limiting fuses (ACS550-PD) or an input circuit breaker (ACS550-PC). Units with a circuit breaker disconnect at and above ratings of 30 HP at 208/240V and 75 HP at 480 & 600V are also equipped with fast acting, drive input fuses to limit damage to the drive and provide for the possibility of drive repair in the unlikely event that a short circuit or ground fault should develop within the input power structure of the drive.

Disconnects are externally operable and interlocked with the enclosure door. The cover mounted disconnect operating handle may be padlocked in the off position with up to three padlocks. The multilingual, alphanumeric drive control panel is provided on the cover of NEMA 1 and NEMA 12 enclosed devices, and on the drive within NEMA 3R enclosed units.

Vertical Wall Mount Enclosures

NEMA 1 and NEMA 12 enclosed ACS550-PC and PD Drives with Disconnect through 25 HP at 208/240V and 60 HP at 480 and 600V are provided in vertical wall mount enclosures. This unique construction provides a minimum footprint advantageous for use in overcrowded electrical rooms or mezzanines, or for direct mounting on machines or columns. Input and output conduit entry is at the bottom of the enclosure.

Oversized Wall Mounting Enclosures

For NEMA 1 and NEMA 12 enclosed ACS550-PC and PD Drives with Disconnect from 30 to 100 HP at 208/240V, 75 to 200 HP at 480 & 600V, wall mounting enclosures are sized to accommodate the field addition of components that users frequently desire to include at these higher horsepower ratings. A removable conduit plate is provided at the top of the enclosure.

Free Standing Packages

From 250 HP to 550 HP at 480V, ACS550-PC enclosures will accommodate the field installation of additional components. Where additional enclosure panel space is required, an auxiliary enclosure section is available. A molded case circuit breaker provides the disconnect means function while fast acting, current limiting drive input fuses provide short circuit protection. A removable conduit mounting plate is provided at the top of the enclosure.

NEMA 3R Enclosures

For outdoor applications, the ACS550 Drive with Disconnect is available in NEMA 3R enclosures up to 100 HP at 208/240V and 200 HP at 480 & 600V. Construction is sheet steel with a tough powder coat paint finish for corrosion resistance. A 100 watt, thermostatically controlled space heater and thermostatic control of the force ventilated cooling system are provided as standard.

ABB ACS550 Packaged Drives

ACS550 Packaged Drive with Bypass

ACS550 Packaged Drive with Bypass
The ACS550-CC is a complete Drive with Bypass Package that includes an ACS550 Adjustable Frequency Drive, a bypass function that allows the motor to be run at full voltage in the event the drive is shut down for service, a main disconnect means and branch circuit short circuit and ground fault protection. Complete, pre-engineered packages reduce time, effort and the cost of installing the popular drive bypass option.

The bypass function is configured entirely of standard industrial control components. It includes two electrically interlocked contactors, a motor overload relay, a control power transformer with primary and secondary fusing, and a cover mounted DRIVE-OFF-BYPASS selector switch.

Bypass is accomplished by means of the two contactors. One is the bypass contactor used to connect the motor directly to the power line. The other is the output contactor that disconnects the motor from the drive output when operating in the bypass mode. This prevents the "back feeding" that would occur if line voltage were applied to the drive output terminals. The drive output contactor and the bypass contactor are electrically interlocked to prevent simultaneous operation.

Externally Operated Devices
ACS550 Drive with Bypass Packages include an input circuit breaker with a door mounted external operating handle that is interlocked with the enclosure door and lockable in the OFF position with up to three padlocks. The multilingual, alphanumeric drive control panel is mounted on the door of the enclosure. An optional drive service switch (+F267) isolates the drive from the power source for service and provides superior functionality to a three-contactor arrangement.

Drive Input Fuses Standard
Fast acting, current limiting drive input fuses are provided as standard to limit damage and allow for possible drive repair if a short circuit or ground fault should develop in the drive input bridge. This is particularly pertinent for drives at the higher ratings where it is generally more economical to repair rather than replace the drive. The drive fuses are also intended to provide for immediate operation of the bypass function after such a fault.

Enclosure Options
Drive with Bypass Packages are available in NEMA 1 and NEMA 12 enclosures through 100 HP at 208/240V, 400 HP at 480V and 150 HP at 600V. For outdoor applications, NEMA 3R enclosed packages are available through 100 HP at 208/240V and 200 HP at 480 & 600V. NEMA 3R enclosures are sheet steel construction with a tough powder coat paint finish for corrosion resistance and include a 100 watt, thermostatically controlled space heater and thermostatic control of the force ventilated cooling system as standard.

NEMA 1 Wall Mount

NEMA 1 Floor Mount

NEMA 3R Floor Mount

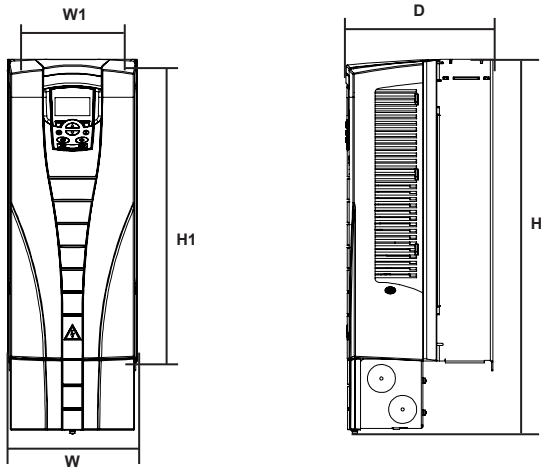
Ratings, Types and Voltages

System Voltage	Base Drive Type Code	Frame Size	Nominal Ratings				Base Drive NEMA 1 Dim Ref UX1	Base Drive NEMA 12 Dim Ref UX12	Bypass NEMA 1 Dim Ref CX1	Bypass NEMA 12 Dim Ref CX12	Bypass NEMA 3R Dim Ref CX3R	Input Discon-nect NEMA 1 Dim Ref PX1	Input Discon-nect NEMA 12 Dim Ref PX12	Input Discon-nect NEMA 3R Dim Ref PX3R
			Normal Duty		Heavy Duty									
			I_{2N} A	P_N HP	I_{2hd} A	P_{hd} HP								
208/240 V	ACS550-XX-04A6-2	R1	4.6	1	3.5	0.75	1	1	1	1	1	1	1	1
	ACS550-XX-06A6-2	R1	6.6	1.5	4.6	1	1	1	1	1	1	1	1	1
	ACS550-XX-07A5-2	R1	7.5	2	6.6	1.5	1	1	1	1	1	1	1	1
	ACS550-XX-012A-4	R1	11.8	3	7.5	2	1	1	1	1	1	1	1	1
	ACS550-XX-017A-2	R1	16.7	5	11.8	3	1	1	1	1	1	1	1	1
	ACS550-XX-024A-2	R2	24.2	7.5	16.7	5	2	2	3	3	2	2	2	2
	ACS550-XX-031A-2	R2	30.8	10	24.2	7.5	2	2	3	3	2	2	2	3
	ACS550-XX-046A-2	R3	46.2	15	30.8	10	3	3	4	5	3	3	3	3
	ACS550-XX-059A-2	R3	59.4	20	46.2	15	3	3	4	5	3	3	3	3
	ACS550-XX-075A-2	R4	74.8	25	59.4	20	4	4	6	6	4	4	4	4
	ACS550-XX-088A-2	R4	88	30	74.8	25	4	4	9	7	5	5	5	5
	ACS550-XX-114A-2	R4	114	40	88	30	4	4	9	7	5	5	5	5
	ACS550-XX-143A-2	R6	143	50	114	40	6	6	10	10	7	6	6	6
	ACS550-XX-178A-2	R6	178	60	150	50	6	6	10	10	7	6	6	6
	ACS550-XX-221A-2	R6	221	75	178	60	6	6	11	10	8	6	6	6
	ACS550-XX-248A-2	R6	248	100	192	75	6	6	11	10	8	6	6	6
480V	ACS550-XX-03A3-4	R1	3.3	1.5	2.4	1	1	1	1	1	1	1	1	1
	ACS550-XX-04A1-4	R1	4.1	2	3.3	1.5	1	1	1	1	1	1	1	1
	ACS550-XX-06A9-4	R1	6.9	3	5.4	2	1	1	1	1	1	1	1	1
	ACS550-XX-08A8-4	R1	8.8	5	6.9	3	1	1	1	1	1	1	1	1
	ACS550-XX-012A-4	R1	11.9	7.5	8.8	5	1	1	1	1	1	1	1	1
	ACS550-XX-015A-4	R2	15.4	10	11.9	7.5	2	2	2	2	2	2	2	2
	ACS550-XX-023A-4	R2	23	15	15.4	10	2	2	2	2	2	2	2	2
	ACS550-XX-031A-4	R3	31	20	23	15	3	3	4	4	3	3	3	3
	ACS550-XX-038A-4	R3	38	25	31	20	3	3	4	4	3	3	3	3
	ACS550-XX-045A-4	R3	44	30	38	25	3	3	4	5	3	3	3	3
	ACS550-XX-059A-4	R4	59	40	44	30	4	4	5	6	4	4	4	4
	ACS550-XX-072A-4	R4	72	50	59	40	4	4	5	6	4	4	4	4
	ACS550-XX-078A-4	R4	77	60	65	50	4	4	5	6	4	4	4	4
	ACS550-XX-097A-4	R4	96	75	77	60	4	4	6	7	5	5	5	5
	ACS550-XX-125A-4	R5	124	100	96	75	5	5	7	8	6	5	5	6
	ACS550-XX-157A-4	R6	157	125	124	100	6	6	10	9	7	6	6	6
	ACS550-XX-180A-4	R6	180	150	156	125	6	6	10	9	7	6	6	6
	ACS550-XX-246A-4	R6	245	200	192	150	6	6	11	10	8	6	6	6
	ACS550-XX-316A-4	R8	316	250	240	200	8		12	11		8	8	
	ACS550-XX-368A-4	R8	368	300	302	250	8		13	12		8	8	
	ACS550-XX-414A-4	R8	414	350	368	300	8		13	12		8	8	
	ACS550-XX-486A-4	R8	486	400	414	350	8		13	12		8	8	
	ACS550-XX-526A-4	R8	526	450	477	400	8						8	
	ACS550-XX-602A-4	R8	602	500	515	450	8						8	
	ACS550-XX-645A-4	R8	645	550	590	500	8						8	
600V	ACS550-XX-02A7-6	R2	2.7	2	2.4	1.5	2	2	2	2	2	2	2	2
	ACS550-XX-03A9-6	R2	3.9	3	2.7	2	2	2	2	2	2	2	2	2
	ACS550-XX-06A1-6	R2	6.1	5	3.9	3	2	2	2	2	2	2	2	2
	ACS550-XX-09A0-6	R2	9	7.5	6.1	5	2	2	2	2	2	2	2	2
	ACS550-XX-011A-6	R2	11	10	9	7.5	2	2	2	2	2	2	2	2
	ACS550-XX-017A-6	R2	17	15	11	10	2	2	2	2	2	2	2	2
	ACS550-XX-022A-6	R3	22	20	17	15	3	3	4	4	3	3	3	3
	ACS550-XX-027A-6	R3	27	25	22	20	3	3	4	4	3	3	3	3
	ACS550-XX-032A-6	R4	32	30	27	25	4	4	5	6	4	4	4	4
	ACS550-XX-041A-6	R4	41	40	32	30	4	4	5	6	4	4	4	4
	ACS550-XX-052A-6	R4	52	50	41	40	4	4	5	6	4	4	4	4
	ACS550-XX-062A-6	R4	62	60	52	50	4	4	5	6	4	4	4	4
	ACS550-XX-077A-6	R6	77	75	62	60	6	6	8	9	6	6	6	6
	ACS550-XX-099A-6	R6	99	100	77	75	6	6	8	9	6	6	6	6
	ACS550-XX-125A-6	R6	125	125	99	100	6	6	10	9	6	6	6	6
	ACS550-XX-144A-6	R6	144	150	125	125	6	6	10	9	6	6	6	6

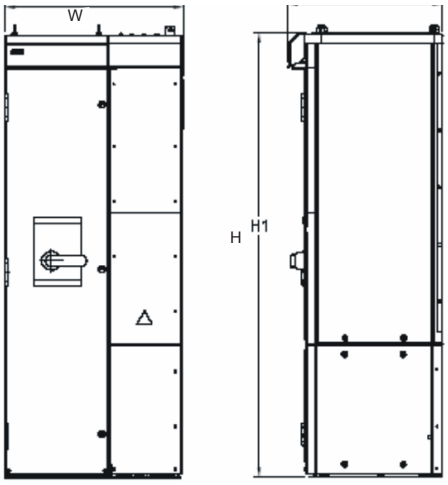
Notes:
xx = contruction designations:
U1 = Base Drive - Wall mount
U2 = Base Drive - Floor mount
PD = Packaged Drive with Switch and Fuse
PC = Packaged Drive with Circuit Breaker
CC = Packaged Drive with Bypass

Dimensions

ACS550-UX, NEMA 1/UL Type 1



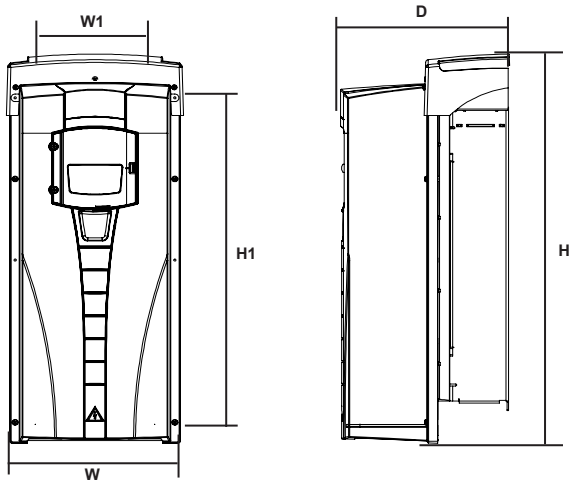
Wall Mount (UX1-1 - UX1-6)



Floor Mount (UX1-7 - UX1-8)

Dim	Frame	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
		H1	W1	Mounting Hardware	H	W	D	Weight	
UX1-1	R1	12.5	3.9	#10	14.5	4.9	8.3	14.3	3AUA0000001559 - sheet 1
UX1-2	R2	16.4	3.9	#10	18.5	4.9	8.7	19.5	3AUA0000001560 - sheet 1
UX1-3	R3	18.6	6.3	#10	23	8	9.1	35	3AUA0000001571 - sheet 1
UX1-4	R4	22.8	6.3	#10	27.1	8	10.3	53	3AUA0000001572 - sheet 1
UX1-5	R5	23.2	9.4	0.25	29	10.5	11.3	75	3AUA0000004629 - sheet 1
UX1-6	R6	26.6	10.4	0.25	35	11.9	15.8	152	3AUA0000004633 - sheet 1
UX1-7	R7	Free Standing		NA	59.2	24	19.5	430	Consult Factory
UX1-8	R8	Free Standing		NA	83.9	31.5	23	827	Consult Factory

ACS550-UX, NEMA 12/UL Type 12

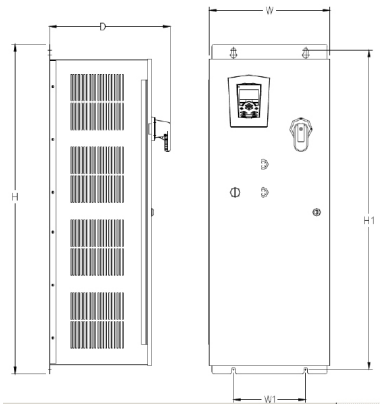


Wall Mount (UX12-1 - UX12-6)

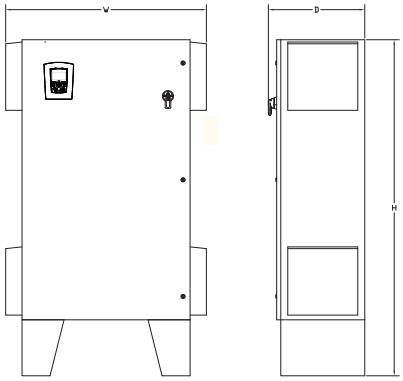
Dim	Frame	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
		H1	W1	Mounting Hardware	H	W	D	Weight	
UX12-1	R1	12.5	3.9	#10	18.1	8.4	9.2	17.6	3AUA0000004031 - sheet 1
UX12-2	R2	16.4	3.9	#10	22.1	8.4	9.6	24.3	3AUA0000004032 - sheet 1
UX12-3	R3	18.6	6.3	#10	24.8	10.1	10	37.5	3AUA0000004029 - sheet 1
UX12-4	R4	22.8	6.3	#10	29.9	10.1	11.2	57.3	3AUA0000004043 - sheet 1
UX12-5	R5	23.2	9.4	0.25	30.5	14.5	12.2	92.6	3AUA0000004634 - sheet 1
UX12-6	R6	26.6	10.4	0.25	36.4	16.1	16.7	190	3AUA0000004635 - sheet 1

Dimensions

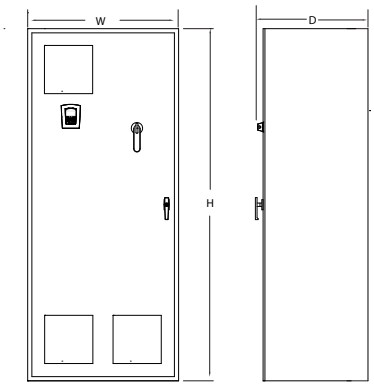
ACS550-Cx NEMA 1 / UL Type 1



Wall Mount (CX1-1 - CX1-8)



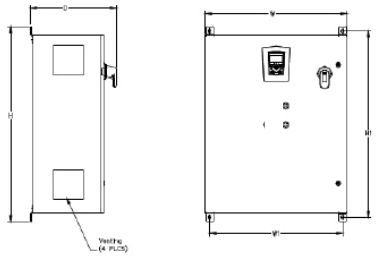
Wall Mount (CX1-9 - CX1-11)



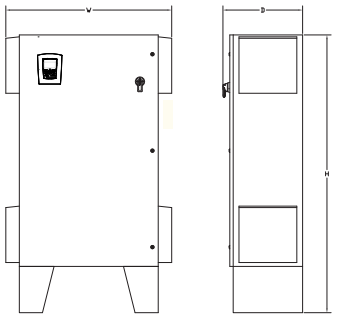
Floor Mount (CX1-12 - CX1-13)

Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
CX1-1	36.2	8.2	0.375	37.3	13.7	13.7	77	3AUA0000012797 - sheet 4
CX1-2	36.2	8.2	0.375	37.3	13.7	13.7	82	3AUA0000012797 - sheet 4
CX1-3	53.2	10	0.375	54.3	16.3	14.6	108	3AUA0000012798 - sheet 4
CX1-4	53.2	10	0.375	54.3	16.3	14.6	134	3AUA0000012798 - sheet 4
CX1-5	53.2	10	0.375	54.3	16.3	14.6	168	3AUA0000012798 - sheet 4
CX1-6	61.7	13	0.375	62.8	19.3	19.2	198	3AUA0000012799 - sheet 4
CX1-7	61.7	13	0.375	62.8	19.3	19.2	262	3AUA0000012799 - sheet 4
CX1-8	61.7	13	0.375	62.8	19.3	19.2	340	3AUA0000012799 - sheet 4
CX1-9	Free Standing		Ø0.56	74.1	35	20.7	278	3AUA0000012800 - sheet 4
CX1-10	Free Standing		Ø0.56	74.1	35	20.7	419	3AUA0000012800 - sheet 4
CX1-11	Free Standing		Ø0.56	72	36	23	545	3AUA0000024944 - sheet 4
CX1-12	Free Standing		N/A	84	36	33.4	1276	3AUA0000013236 - sheet 4
CX1-13	Free Standing		N/A	84	60	33.4	1459	3AUA0000013223 - sheet 4

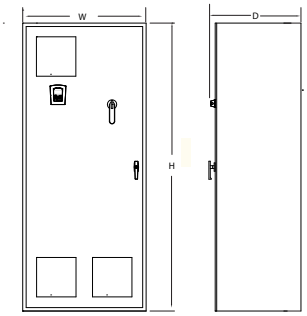
ACS550-Cx NEMA 12 / UL Type 12



Wall Mount (CX1-1 - CX1-9)



Wall Mount (CX1-10)

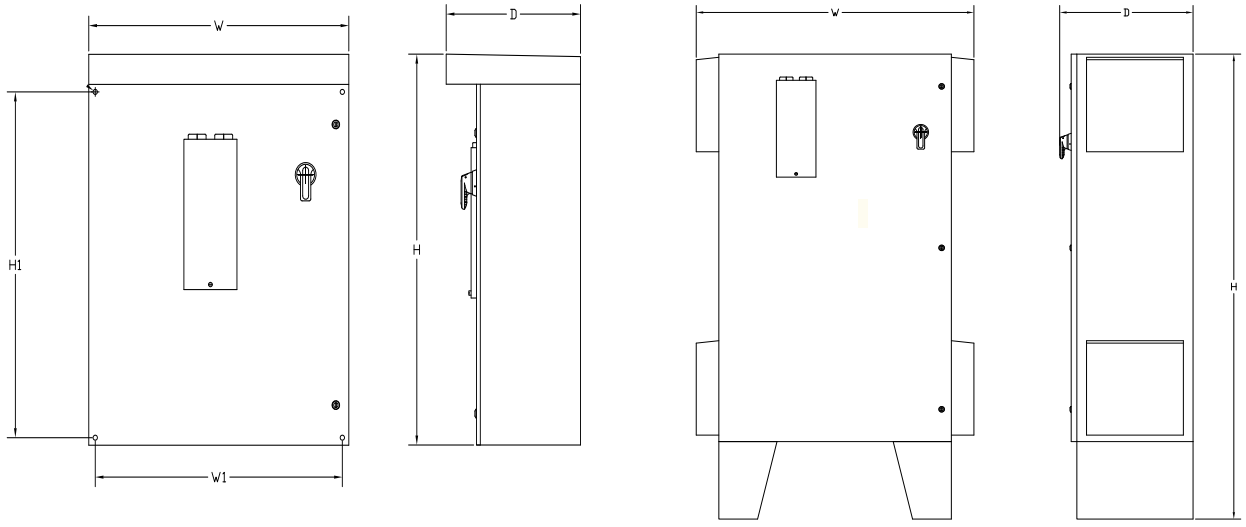


Floor Mount (CX1-11 - CX1-13)

Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
CX12-1	25.5	16.5	0.375	27	18	14.5	79	3AUA0000012801 - sheet 4
CX12-2	25.5	16.5	0.375	27	18	14.5	84	3AUA0000012801 - sheet 4
CX12-3	31.5	22.5	0.375	33	24	14.5	112	3AUA0000012802 - sheet 4
CX12-4	31.5	22.5	0.375	33	24	14.5	141	3AUA0000012802 - sheet 4
CX12-5	37.5	28.5	0.375	39	30	14.5	172	3AUA0000012803 - sheet 4
CX12-6	37.5	28.5	0.375	39	30	14.5	205	3AUA0000012803 - sheet 4
CX12-7	49.5	34.5	0.375	51.4	36	22.5	260	3AUA0000012804 - sheet 4
CX12-8	49.5	34.5	0.375	51.4	36	22.5	324	3AUA0000012804 - sheet 4
CX12-9	49.5	34.5	0.375	51.4	36	22.5	401	3AUA0000012804 - sheet 4
CX12-10	Free Standing		Ø0.56	72	36	23	545	3AUA0000012805 - sheet 4
CX12-11	Free Standing		N/A	84	36	33.4	1276	3AUA0000013237 - sheet 4
CX12-12	Free Standing		N/A	84	60	33.4	1459	3AUA0000013224 - sheet 4

Dimensions

ACS550-Cx UL Type 3R / NEMA 3R

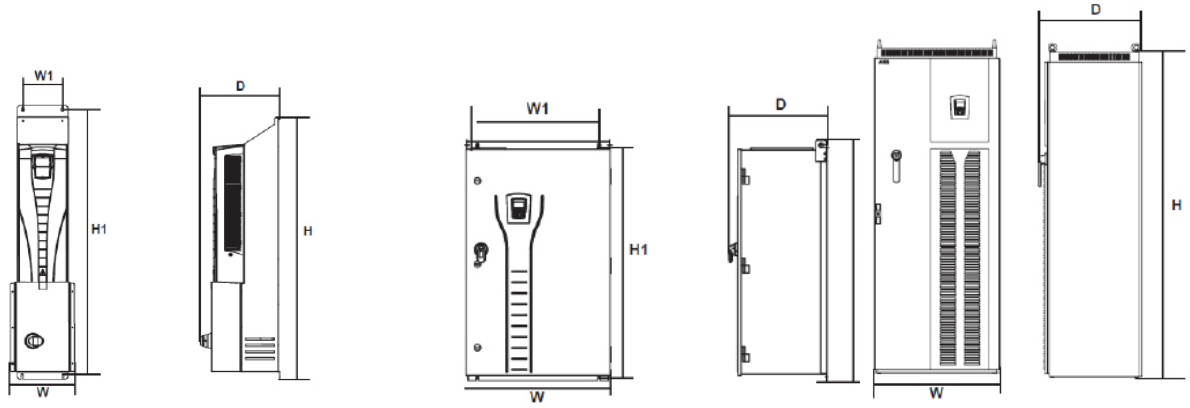


Wall Mount (CX3R-1-7)

Floor Mount (CX3R-8)

Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
CX3R-1	22.5	16.5	0.375	27	18	13.5	82	3AUA0000060121 - sheet 4
CX3R-2	22.5	16.5	0.375	27	18	13.5	88	3AUA0000060121 - sheet 4
CX3R-3	28.5	22.5	0.375	33	24	13.5	145	3AUA0000060122 - sheet 4
CX3R-4	34.5	28.5	0.375	39	30	15.5	213	3AUA0000060123 - sheet 4
CX3R-5	46.5	34.5	0.375	51	36	21.5	268	3AUA0000060124 - sheet 4
CX3R-6	46.5	34.5	0.375	51	36	21.5	332	3AUA0000060124 - sheet 4
CX3R-7	46.5	34.5	0.375	51	36	21.5	409	3AUA0000060124 - sheet 4
CX3R-8	Free Standing		0.375	72	43	20.7	554	3AUA0000060125 - sheet 4

ACS550-Px UL Type 1 / NEMA 1



Wall Mount (PX1-1 - PX1-4)

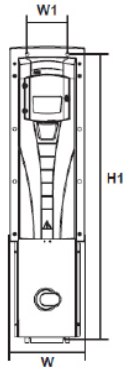
Wall Mount (PX1-5 - PX1-6)

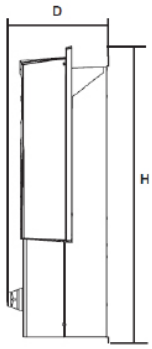
Floor Mount (PX1-8)

Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
PX1-1	28	3.9	0.25	28.7	7.8	11.2	33	3AUA0000008216 - sheet 1
PX1-2	32	3.9	0.25	32.6	7.8	11.6	42	3AUA0000008218 - sheet 1
PX1-3	38.7	6.3	0.25	39.9	10.2	11.9	75	3AUA0000008220 - sheet 1
PX1-4	44	6.3	0.25	45.2	10.2	13.1	95	3AUA0000008221 - sheet 1
PX1-5	46.3	23.6	0.375	47.7	28.1	19	267	3AUA0000021148 - sheet 1
PX1-6	46.3	23.6	0.375	47.7	28.1	19	359	3AUA0000021148 - sheet 1
PX1-8	Free Standing		Ø0.63	83.7	31.7	25.9	794	3AUA0000021152 - sheet 1

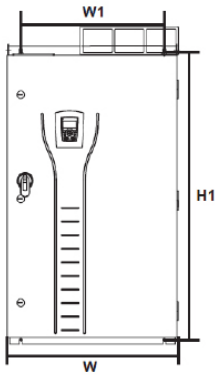
Dimensions

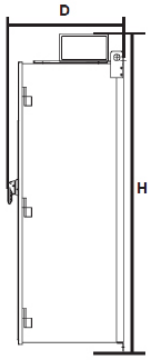
ACS550-Px UL Type 12 / NEMA 12



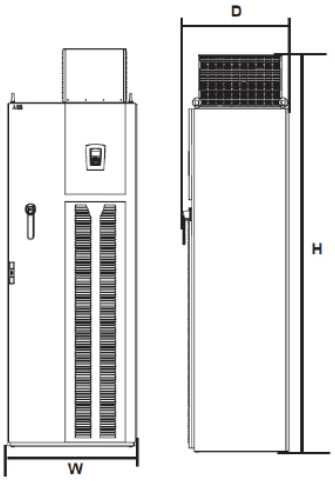


Wall Mount (PX12-1 - PX12-4)





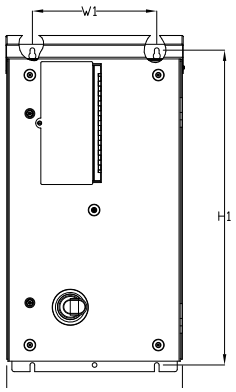
Wall Mount (PX12-5 - PX12-6)

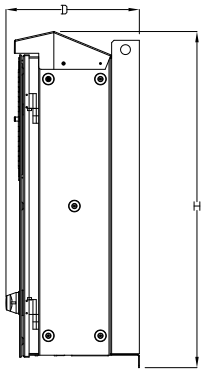


Floor Mount (PX12-8)

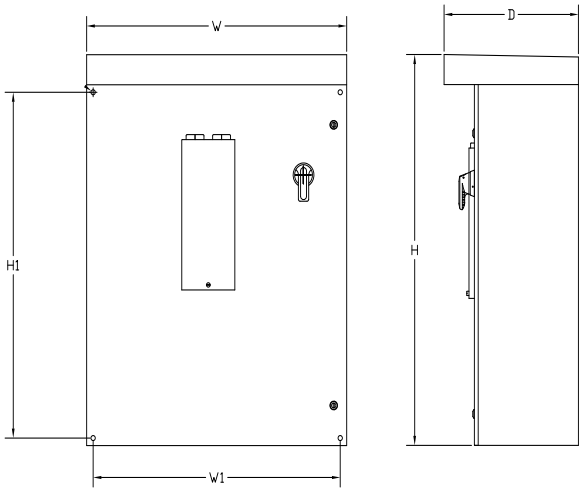
Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
PX12-1	28	3.9	0.25	29.3	8.7	11.2	37	3AUA0000008216 - sheet 2
PX12-2	32	3.9	0.25	33.2	8.7	11.6	46	3AUA0000008218 - sheet 2
PX12-3	38.7	6.3	0.25	40.6	10.5	11.9	79	3AUA0000008220 - sheet 2
PX12-4	44	6.3	0.25	45.8	10.5	13.1	99	3AUA0000008221 - sheet 2
PX12-5	46.3	23.6	0.375	54.3	28.1	19	267	3AUA0000021149 - sheet 1
PX12-6	46.3	23.6	0.375	54.3	28.1	19	359	3AUA0000021149 - sheet 1
PX12-8	Free Standing		Ø0.63	93.6	31.7	25.9	838	3AUA0000021153 - sheet 1

ACS550-Px UL Type 3R / NEMA 3R





Wall Mount (PX3R-1 - PX3R-4)



Wall Mount (PX3R-5 - PX3R-6)

Dim	Mounting Dimensions			Shipping Dimensions				Dimension Drawing
	H1	W1	Mounting Hardware	H	W	D	Weight	
PX3R-1	31.9	12.6	0.375	34	17.8	13.5	128	3AUA0000016377 - sheet 1
PX3R-2	31.9	12.6	0.375	34	17.8	13.5	134	3AUA0000016377 - sheet 1
PX3R-3	36.1	15.7	0.375	38.1	20.9	15.3	176	3AUA0000016380 - sheet 1
PX3R-4	36.1	15.7	0.375	38.1	20.9	15.3	194	3AUA0000016380 - sheet 1
PX3R-5	34.5	28.5	0.375	39	30	15.5	203	3AUA0000060123 - sheet 2
PX3R-6	46.5	34.5	0.375	51	36	21.5	203	3AUA0000060124 - sheet 2

Secure uptime throughout the drive life cycle

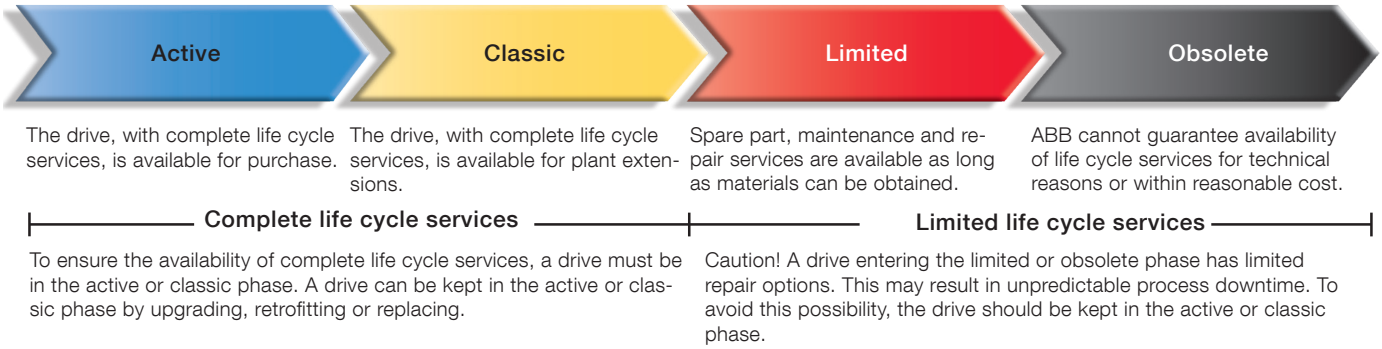
ABB follows a four-phase model for managing the life cycles of its drives. The life cycle phases are active, classic, limited and obsolete. Within each phase, every drive series has a defined set of services.
Examples of individual services are drive selection and dimensioning, installation and commissioning, preventive and corrective maintenance, remote monitoring and intelligent diagnostics, technical support, upgrade and retrofit, replacement and recycling plus training and learning.
In the active phase the drive is in serial production. The drive, with complete life cycle services, is available for purchase.
In the classic phase, the serial production of the drive has ended. The drive, with complete life cycle services, is available for plant extensions.
In the limited phase, the drive is no longer available. The life cycle services are limited. Spare parts as well as maintenance and repair services are available as long as materials can be obtained.
In the obsolete phase, the drive is not available. ABB cannot guarantee availability of services for technical reasons or within reasonable cost.

To ensure the availability of complete life cycle services, ABB recommends that a drive is kept in the active or classic phase by upgrading, retrofitting or replacing.
In the classic phase ABB carries out an annual review for each drive life cycle plan. Should any changes to the availability or duration of the services be necessary, ABB gives a life cycle announcement indicating eventual change of life cycle phase and/or any change in the duration of services.
In the limited phase, ABB issues a life cycle phase change announcement, half a year prior to shifting the product into the obsolete phase.

Maximizing return on investment

The four-phase life cycle management model provides customers with a transparent method for managing their investment in drives. In each phase, customers clearly see what life cycle services are available, and more importantly, what services are not available. Decisions on upgrading, retrofitting or replacing drives can be made with confidence.

ABB drive life cycle management model



Contact us

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Website www.abb.com/drives

ACS550-PHTC01U-EN REVJ Effective 09/18/2014

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Power and productivity
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ACS550

User's Manual
ACS550-01 Drives (0.75...160 kW)
ACS550-U1 Drives (1...200 hp)

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List of related manuals

GENERAL MANUALS

ACS550-01/U1 User's Manual (0.75…160 kW) / (1…200 hp)
3AFE64804588 (*3AUA0000001418*) (English)

Flange Mounting Instructions

Kit, IP21 / UL type 1	Frame size	Code (English)
FMK-A-R1	R1	*100000982*
FMK-A-R2	R2	*100000984*
FMK-A-R3	R3	*100000986*
FMK-A-R4	R4	*100000988*
AC8-FLNGMT-R5 [1]	R5	ACS800-PNTG01U-EN
AC8-FLNGMT-R6 [1]	R6	

1. Not available for ACS550-01 series

Kit, IP54 / UL type 12	Frame size	Code (English)
FMK-B-R1	R1	*100000990*
FMK-B-R2	R2	*100000992*
FMK-B-R3	R3	*100000994*
FMK-B-R4	R4	*100000996*

OPTION MANUALS

(delivered with optional equipment)

MFDT-01 FlashDrop User's Manual
3AFE68591074 (English)

OHDI-01 115/230 V Digital Input Module User's Manual
3AUA0000003101 (English)

OREL-01 Relay Output Extension Module User's Manual
3AUA0000001935 (English)

OTAC-01 User's Manual Pulse Encoder Interface Module User's Manual
3AUA0000001938 (English)

RCAN-01 CANopen Adapter User's Manual
3AFE64504231 (English)

RCNA-01 ControlNet Adapter User's Manual
3AFE64506005 (English)

RDNA-01 DeviceNet Adapter User's Manual
3AFE64504223 (English)

RECA-01 EtherCAT Adapter Module User's Manual
3AUA0000043520 (English)

REPL-01 Ethernet POWERLINK Adapter Module User's Manual
3AUA0000052289 (English)

REPL-02 Ethernet POWERLINK Adapter Module User's Manual
3AUA0000090411 (English)

RETA-01 Ethernet Adapter Module User's Manual
3AFE64539736 (English)

RETA-02 Ethernet Adapter Module User's Manual
3AFE68895383 (English)

RPBA-01 PROFIBUS DP Adapter User's Manual
3AFE64504215 (English)

SREA-01 Ethernet Adapter User's Manual
3AUA0000042896 (English)

Typical contents

- Safety
- Installation
- Programming/Start-up
- Diagnostics
- Technical data

MAINTENANCE MANUALS

Guide for Capacitor Reforming in ACS50, ACS55, ACS150, ACS310, ACS350, ACS355, ACS550, ACH550 and R1-R4 OINT-/SINT-boards
3AFE68735190 (English)

ACS550-01 manuals

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ACS550-01/U1 Drives
0.75…160 kW
1…200 hp

User's Manual

3AFE64804588 (3AUA0000001418) Rev H
EN
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Safety instructions

Use of warnings and notes

There are two types of safety instructions throughout this manual:

- Notes draw attention to a particular condition or fact, or give information on a subject.
- Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment. They also tell you how to avoid the danger. The warning symbols are used as follows:

Electricity warning warns of hazards from electricity which can cause physical injury and/or damage to the equipment.

General warning warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment.

General safety

WARNING! Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- Use safety shoes to avoid foot injury.
- Handle the drive carefully.
- Beware of hot surfaces. Some parts, such as heatsinks, remain hot for a while after disconnection of the electrical supply. See chapter *Technical data* on page *277*.
- Keep the drive in its package or protect it otherwise from dust and burr from drilling and grinding until you install it. Protect also the installed drive against dust and burr. Electrically conductive debris inside the drive can cause damage or malfunction.

Electrical safety

WARNING! The ACS550 adjustable speed AC drive should ONLY be installed by a qualified electrician.

WARNING! Even when the motor is stopped, dangerous voltage is present at the power circuit terminals U1, V1, W1 and U2, V2, W2 and, depending on the frame size, UDC+ and UDC-, or BRK+ and BRK-.

WARNING! Dangerous voltage is present when input power is connected. After disconnecting the supply, wait at least 5 minutes (to let the intermediate circuit capacitors discharge) before removing the cover.

WARNING! Even when power is switched off from the input terminals of the ACS550, there may be dangerous voltage (from external sources) on the terminals of the relay outputs RO1...RO3.

WARNING! When the control terminals of two or more drives are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the drives or an external supply.

WARNING! If you install the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), disconnect the internal EMC filter, otherwise the system will be connected to ground potential through the EMC filter capacitors. This can cause danger or damage the drive.

If you install the drive on a corner-grounded TN system, disconnect the internal EMC filter, otherwise the system will be connected to ground potential through the EMC filter capacitors. This will damage the drive.

Note: Disconnecting the internal EMC filter increases the conducted emission and reduces the drive EMC compatibility considerably.

See section *Disconnecting the internal EMC filter* on page *27*. Also see sections *IT systems* on page *286* and *Corner-grounded TN systems* on page *285*.

WARNING! Do not attempt to install or remove EM1, EM3, F1 or F2 screws while power is applied to the drive's input terminals.

Maintenance

WARNING! The ACS550-01/U1 is not field repairable. Never attempt to repair a malfunctioning drive; contact your local ABB representative for replacement.

Control of the drive and motor

WARNING! Do not control the motor with the disconnecting device (disconnecting means); instead, use the control panel start and stop keys and , or commands via the I/O board of the drive. The maximum allowed number of charging cycles of the DC capacitors (i.e. power-ups by applying power) is five in ten minutes.

WARNING! The ACS550 will start up automatically after an input voltage interruption if the external run command is on.

Note: For more technical information, contact your local ABB representative.

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Contents of this manual

Compatibility

This manual covers ACS550-01/U1 drives. The manual is compatible with the ACS550-01/U1 drive firmware version 3.14e or later. See parameter 3301 FIRMWARE on page *155*.

Intended use

The ACS550-01/U1 is a general purpose drive. The macros should only be applied to the applications defined in the respective section.

Intended audience

This manual is intended for personnel who install, commission, operate and service the drive. Read the manual before working on the drive. The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

Installation

Study these installation instructions carefully before proceeding. **Failure to observe the warnings and instructions may cause a malfunction or personal hazard.**

WARNING! Before you begin read chapter *Safety instructions* on page *5*.

Note: The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

Installation flow chart

The installation of the ACS550 adjustable speed AC drive follows the outline below. The steps must be carried out in the order shown. At the right of each step are references to the detailed information needed for the correct installation of the drive.

Task	See
PREPARE for installation	*Preparing for installation* on page *16*
↓	
PREPARE the mounting location	*Prepare the mounting location* on page *20*
↓	
REMOVE the front cover	*Remove the front cover* on page *21*
↓	
MOUNT the drive	*Mount the drive* on page *22*
↓	
INSTALL wiring	*Wiring overview* on page *23* and *Check the insulation of the assembly* on page *30*
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↓	
REINSTALL the cover	*Reinstall the cover* on page *36*
↓	
START-UP	*How to start up the drive* on page *37*

Preparing for installation

Lifting the drive

Lift the drive only by the metal chassis.

IP2040

Unpacking the drive

1. Unpack the drive.
2. Check for any damage and notify the shipper immediately if damaged components are found.
3. Check the contents against the order and the shipping label to verify that all parts have been received.

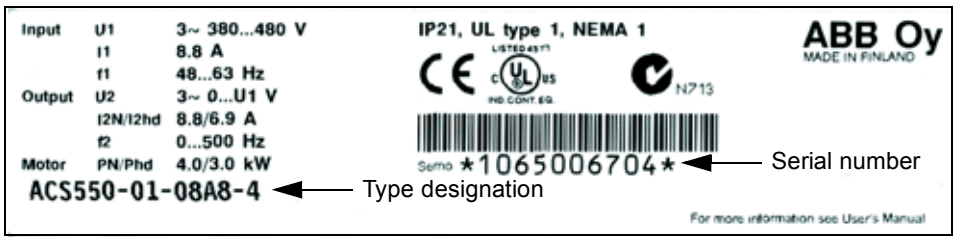
Drive identification

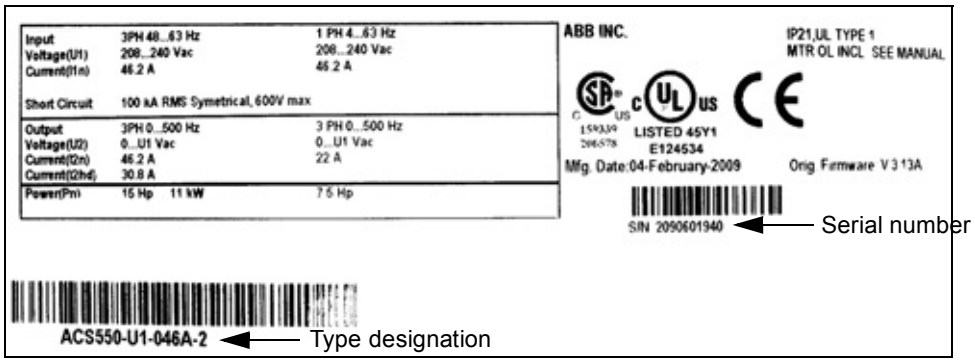
Drive labels

To determine the type of drive you are installing, refer to either:

- serial number label attached on upper part of the choke plate between the mounting holes, or

- type designation label attached on the heat sink – on the right side of the drive cover. Two examples of the type designation label are given below.





The labels contain information on the *Type designation* (page *17*), *Ratings and frame size* (page *17*), *Serial number* (page *17*), degree of protection (see also *Degrees of protection* on page *306*) and valid markings (see also *Markings* on page *309*).

Type designation

Use the following chart to interpret the type designation found on both the type designation and the serial number label.

ACS550-01-08A8-4+J404+…

AC, Standard Drive – 550 product series

Construction (region specific)
01 = Setup and parts specific to IEC installation and compliance
U1 = Setup and parts specific to US installation and NEMA compliance

Output current rating
e.g. 08A8 = 8.8 A, see section *Ratings* on page *277* for details

Voltage rating
2 = 208…240 V AC
4 = 380…480 V AC
6 = 500…600 V AC

Options
Examples of options:

B055	=	IP54 / UL type 12 (no specification = IP21 / UL type 1). UL type 12 is not available for type ACS550-01-290A-4.
0J400	=	No control panel
J404	=	ACS-CP-C Basic Control Panel
L511	=	OREL-01 Relay output extension
K451	=	RDNA-01 DeviceNet
K454	=	RPBA-01 PROFIBUS DP

Ratings and frame size

The chart in section *Ratings* on page *277* lists technical specifications and identifies the drive's frame size – significant, since some instructions in this document vary, depending on the drive's frame size. To read the ratings table, you need the "Output current rating" entry from the type designation. Also, when using the ratings table, note that the table is broken into sections based on the drive's "Voltage rating".

Serial number

The format of the drive serial number shown on the labels is described below.

Serial number is of format CYYWWXXXXX, where

C:	Country of manufacture
YY:	Year of manufacture
WW:	Week of manufacture; 01, 02, 03, … for week 1, week 2, week 3, …
XXXXX:	Integer starting every week from 00001.

Motor compatibility

The motor, drive and supply power must be compatible:

Motor specification	Verify	Reference
Motor type	3-phase induction motor	–
Nominal current	Motor value is within this range: 0.2…2.0 · I_{2hd} (I_{2hd} = drive heavy duty current)	• Type designation label on drive, entry for Output I_{2hd}, or • Type designation on drive and rating table in chapter *Technical data* on page *277*.
Nominal frequency	10…500 Hz	–
Voltage range	Motor is compatible with the ACS550 voltage range.	208…240 V (for ACS550-X1-XXXX-2) or 380…480 V (for ACS550-X1-XXXX-4) or 500…600 V (for ACS550-U1-XXXX-6)
Insulation	500…600 V drives: Either the motor complies with NEMA MG1 Part 31, or a du/dt filter is used between the motor and drive.	For ACS550-U1-XXXX-6

Tools required

To install the ACS550 you need the following:

- screwdrivers (as appropriate for the mounting hardware used)
- wire stripper
- tape measure
- drill
- for installations involving ACS550-U1, frame sizes R5 or R6 and IP54 / UL type 12 enclosures: punch for creating conduit mounting holes
- for installations involving ACS550-U1, frame size R6: appropriate crimping tool for power cable lugs. See section *Power terminal considerations – R6 frame size* on page *287*.
- mounting hardware: screws or nuts and bolts, four each. The type of hardware depends on the mounting surface and the frame size. For the dimensions and weights of the frames, see *Dimensions and weights* on page *303*.

Frame size	Mounting hardware	
R1…R4	M5	#10
R5	M6	1/4 in
R6	M8	5/16 in

Suitable environment and enclosure

Confirm that the site meets the environmental requirements. To prevent damage prior to installation, store and transport the drive according to the environmental requirements specified for storage and transportation. See section *Ambient conditions* on page *307*.

Confirm that the enclosure is appropriate, based on the site contamination level:

- IP21 / UL type 1 enclosure: The site must be free of airborne dust, corrosive gases or liquids, and conductive contaminants such as dripping water, condensation, carbon dust and metallic particles.
- IP54 / UL type 12 enclosure: This enclosure provides protection from airborne dust and light sprays or splashing water from all directions.
- If, for some reason, an IP21 drive needs to be installed without the conduit box or cover, or an IP54 drive without the conduit plate or hood, see the note in chapter *Technical data*, page *310*.

Suitable mounting location

Confirm that the mounting location meets the following constraints:

- The drive must be mounted vertically on a smooth, solid surface, and in a suitable environment as defined above. For horizontal installation, contact your local ABB representative for more information.
- The minimum space requirements for the drive are the outside dimensions (see section *Outside dimensions* on page *304*), plus air flow space around the drive (see section *Losses, cooling data and noise* on page *301*).
- The distance between the motor and the drive is limited by the maximum motor cable length. See section *Motor connection specifications* on page *289*.
- The mounting site must support the drive's modest weight. See section *Weight* on page *306*.

Installing the drive

WARNING! Before installing the ACS550, ensure the input power supply to the drive is off.

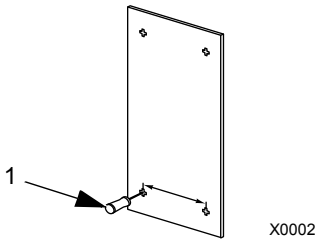
For flange mounting (mounting the drive in a cooling air duct), see the appropriate *Flange Mounting Instructions*:

Frame size	IP21 / UL type 1		IP54 / UL type 12	
	Kit	Code (English)	Kit	Code (English)
R1	FMK-A-R1	100000982	FMK-B-R1	100000990
R2	FMK-A-R2	100000984	FMK-B-R2	100000992
R3	FMK-A-R3	100000986	FMK-B-R3	100000994
R4	FMK-A-R4	100000988	FMK-B-R4	100000996
R5	AC8-FLNGMT-R5 [1]	ACS800-PNTG01U-EN	-	-
R6	AC8-FLNGMT-R6 [1]		-	-

1. Not available in ACS550-01 series.

Prepare the mounting location

The ACS550 should only be mounted where all of the requirements defined in section *Preparing for installation* on page *16* are met.



1. Mark the position of the mounting holes with the help of the mounting template provided with the drive.
2. Drill the holes.

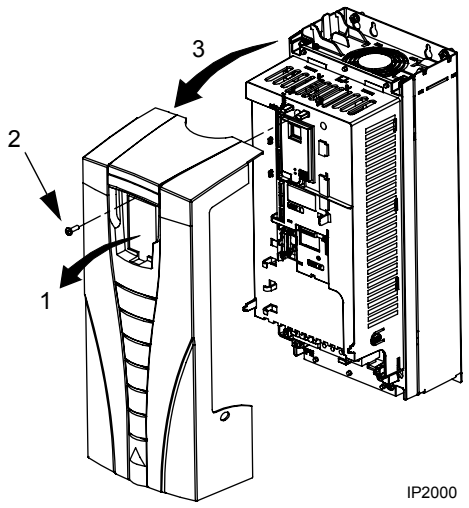
Note: Frame sizes R3 and R4 have four holes along the top. Use only two. If possible, use the two outside holes (to allow room to remove the fan for maintenance).

Note: ACS400 drives can be replaced using the original mounting holes. For R1 and R2 frame sizes, the mounting holes are identical. For R3 and R4 frame sizes, the inside mounting holes on the top of ACS550 drives match ACS400 mounts.

Remove the front cover

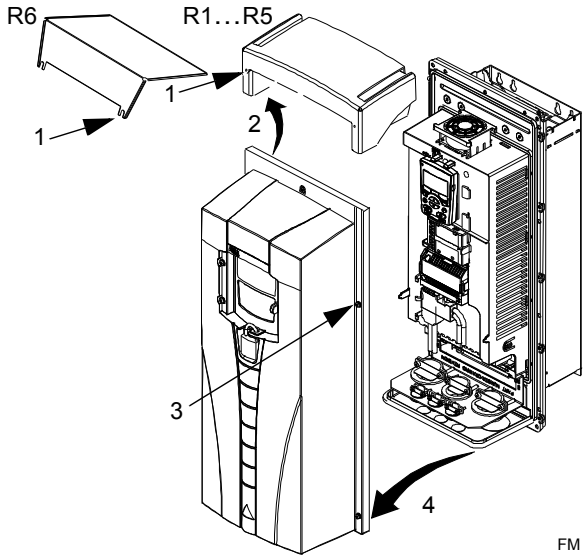
IP21 / UL type 1

1. Remove the control panel, if attached.
2. Loosen the captive screw at the top.
3. Pull near the top to remove the cover.



IP54 / UL type 12

1. If hood is present: Remove screws (2) holding hood in place.
2. If hood is present: Slide hood up and off of the cover.
3. Loosen the captive screws around the edge of the cover.
4. Remove the cover.



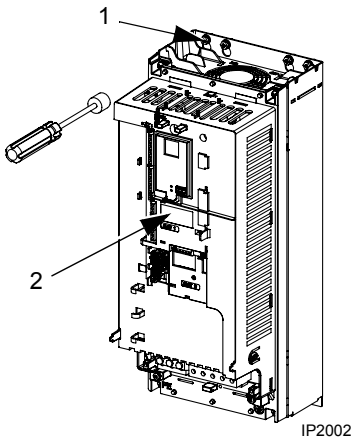
Mount the drive

IP21 / UL type 1

1. Position the ACS550 onto the mounting screws or bolts and securely tighten in all four corners.

   Note: Lift the ACS550 by its metal chassis (frame size R6 by the lifting holes on both sides at the top).

2. Non-English speaking locations: Add a warning sticker in the appropriate language over the existing warning on the top of the module.



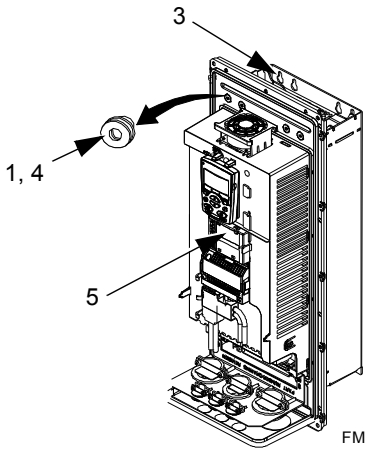
IP54 / UL type 12

For the IP54 / UL type 12 enclosures, rubber plugs are required in the holes provided for access to the drive mounting slots.

1. As required for access, remove the rubber plugs. Push plugs out from the back of the drive.
2. R5 & R6: Align the sheet metal hood (not shown) in front of the drive's top mounting holes. (Attach as part of next step.)
3. Position the ACS550 onto the mounting screws or bolts and securely tighten in all four corners.

   Note: Lift the ACS550 by its metal chassis (frame size R6 by the lifting holes on both sides at the top).

4. Reinstall the rubber plugs.
5. Non-English speaking locations: Add a warning sticker in the appropriate language over the existing warning on the top of the module.



Wiring overview

Conduit/Gland kit

Wiring drives with the IP21 / UL type 1 enclosure requires a conduit/gland kit with the following items:

- conduit/gland box
- five (5) cable clamps (ACS550-01 only)
- screws
- cover.

The kit is included with IP21 / UL type 1 enclosures.

Wiring requirements

WARNING! Ensure the motor is compatible for use with the ACS550. The drive must be installed by a competent person in accordance with the considerations defined in section *Preparing for installation* on page *16*. If in doubt, contact your local ABB representative.

As you install the wiring, observe the following:

- There are four sets of wiring instructions – one set for each combination of drive enclosure type (IP21 / UL type and IP54 / UL type 12) and wiring type (conduit or cable). Be sure to select the appropriate procedure.
- Determine electro-magnetic compliance (EMC) requirements per local codes. See section *Motor cable requirements for CE & C-Tick compliance* on page *293*. In general:
  - Follow local codes for cable size.
  - Keep these four classes of wiring separated: input power wiring, motor wiring, control/communications wiring and braking unit wiring.
- When installing input power and motor wiring, refer to the following, as appropriate:

Terminal	Description	Specifications and notes
U1, V1, W1[1]	3-phase power supply input	*Input power connections* on page *281*
PE	Protective Ground	*Ground connections* on page *285*
U2, V2, W2	Power output to motor	*Motor connections* on page *289*

[1] The ACS550 -x1-xxxx-2 (208…240 V series) can be used with a single phase supply, if output current is derated by 50%. For single phase supply voltage, connect power at U1 and W1.

- To locate input power and motor connection terminals, see section *Power connection diagrams* on page *25*. For specifications on power terminals, see section *Drive's power connection terminals* on page *286*.
- For corner-grounded TN systems, see section *Corner-grounded TN systems* on page *285*.
- For IT systems, see section *IT systems* on page *286*.

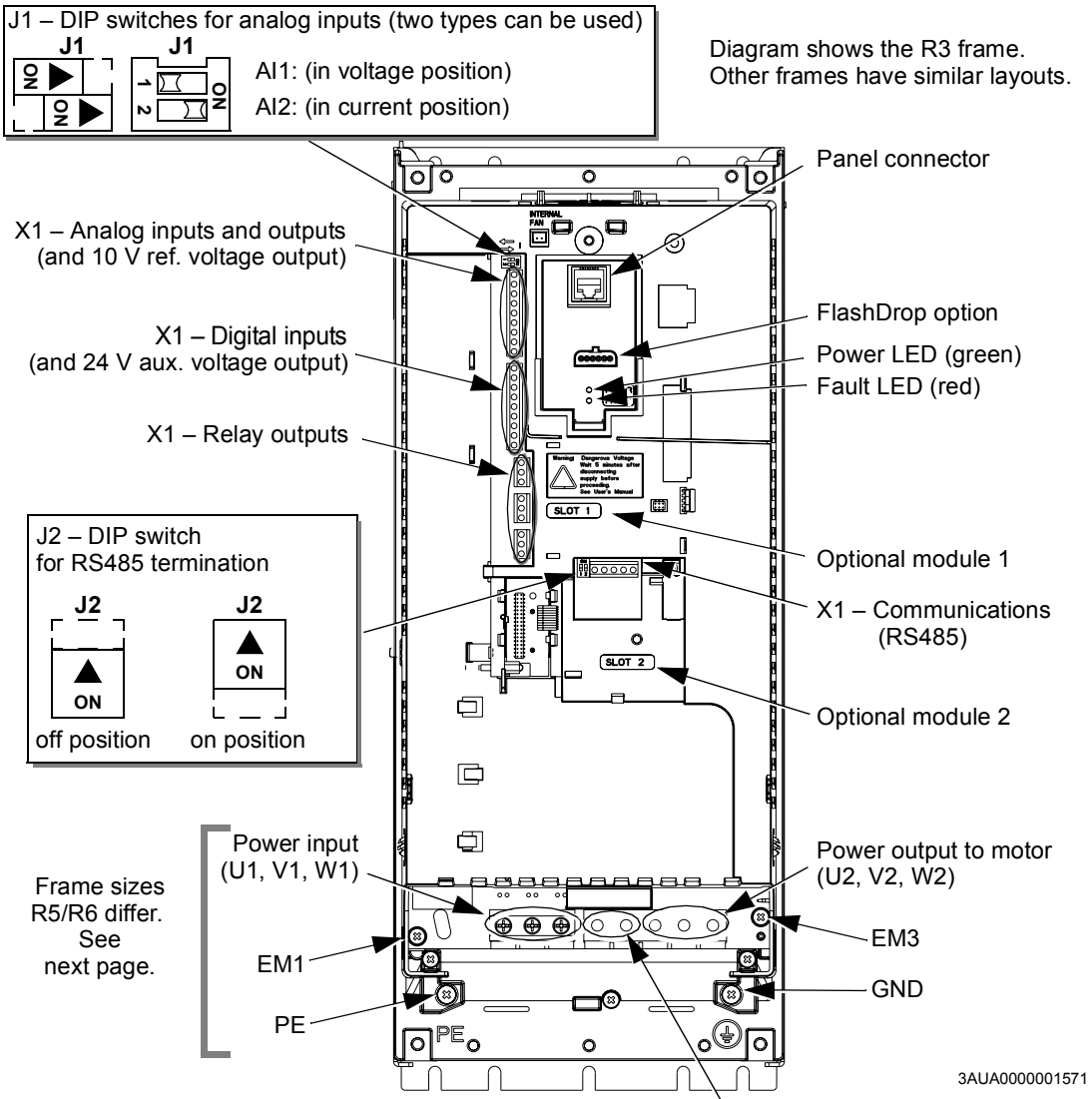
- For frame size R6, see section *Power terminal considerations – R6 frame size* on page *287* to install the appropriate cable lugs.
- For drives using braking (optional), refer to the following, as appropriate:

Frame size	Terminal	Description	Braking accessory
R1, R2	BRK+, BRK-	Braking resistor	Braking resistor. See section *Brake components* on page *295*.
R3, R4, R5, R6	UDC+, UDC-	DC bus	Contact your ABB representative to order either: • braking unit or • chopper and resistor

- When installing control wiring, refer to the following chapters or sections, as appropriate:
  - *Control terminals table* on page *28*
  - *Control connections* on page *299*
  - *Application macros* on page *77*
  - *Complete parameter descriptions* on page *106*
  - *Embedded fieldbus* on page *203*
  - *Fieldbus adapter* on page *237*.

Power connection diagrams

The following diagram shows the terminal layout for frame size R3, which, in general, applies to frame sizes R1...R6, except for the R5/R6 power and ground terminals.

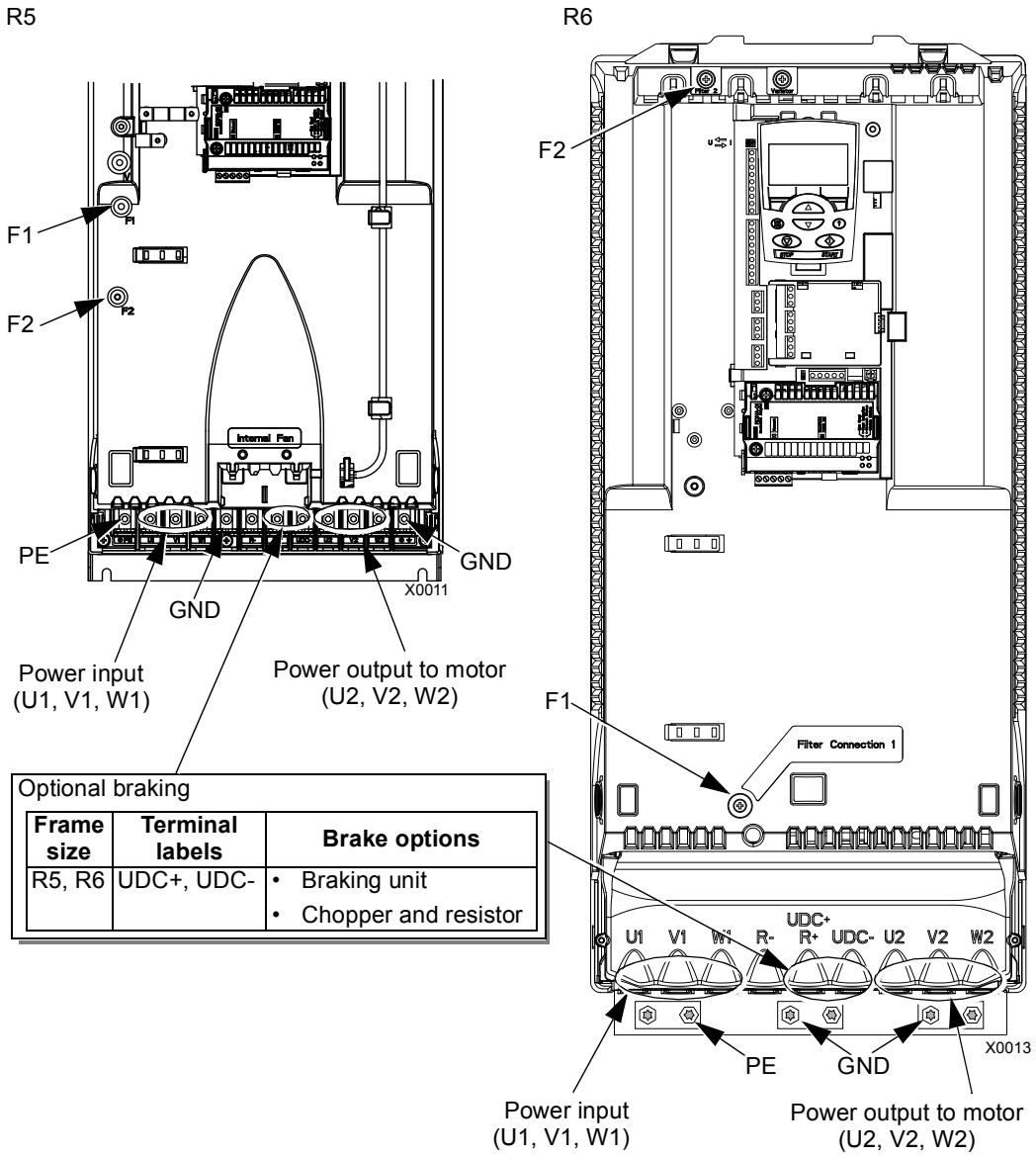


Optional braking

Frame size	Terminal labels	Brake options
R1, R2	BRK+, BRK-	Brake resistor
R3, R4	UDC+, UDC-	• Braking unit • Chopper and resistor

WARNING! To avoid danger, or damage to the drive, on IT systems and corner-grounded TN systems, see section *Disconnecting the internal EMC filter* on page 27.

The following diagram shows the power and ground terminal layout for frame sizes R5 and R6end



Frame size	Terminal labels	Brake options
R5, R6	UDC+, UDC-	• Braking unit • Chopper and resistor

WARNING! To avoid danger, or damage to the drive, on IT systems and corner-grounded TN systems, see section *Disconnecting the internal EMC filter* on page *27*.

Disconnecting the internal EMC filter

On certain types of systems, you must disconnect the internal EMC filter, otherwise the system will be connected to ground potential through the EMC filter capacitors, which might cause danger, or damage the drive.

Note: Disconnecting the internal EMC filter increases the conducted emission and reduces the drive EMC compatibility considerably.

The following table shows the installation rules for the EMC filter screws in order to connect or disconnect the filter, depending on the system type and the frame size. For more information on the different system types, see *IT systems* on page *286* and *Corner-grounded TN systems* on page *285*.

The locations of screws EM1 and EM3 are shown in the diagram on page *25*. The locations of screws F1 and F2 are shown in the diagram on page *26*.

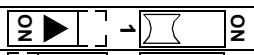
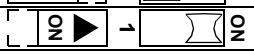
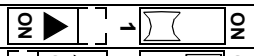
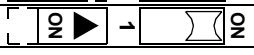
Frame sizes	Screw	Symmetrically grounded TN systems (TN-S systems)	Corner-grounded TN systems	IT systems (ungrounded or high-resistance-grounded [> 30 ohm])
R1…R3	EM1	x	x	•
	EM3[1]	x	•	•
R4	EM1	x	x	–
	EM3[1]	x	–	–
R5…R6	F1	x	x	–
	F2	x	x	–

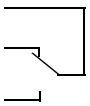
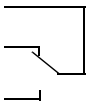
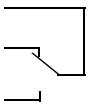
x = Install the screw. (EMC filter will be connected.)
• = Replace the screw with the provided polyamide screw. (EMC filter will be disconnected.)
– = Remove the screw. (EMC filter will be disconnected.)

[1] ACS550-U1 drives are shipped with screw EM3 already removed.

Control terminals table

The following provides information for connecting control wiring at X1 on the drive.

	X1		Hardware description
Analog I/O	1	SCR	Terminal for signal cable shield (screen). (Connected internally to chassis ground.)
	2	AI1	Analog input channel 1, programmable. Default[2] = frequency reference. Resolution 0.1%, accuracy ±1%.
			Two different DIP switch types can be used.
			J1: AI1 OFF: 0…10 V (R_i = 312 kohm) 
			J1: AI1 ON: 0…20 mA (R_i = 100 ohm) 
	3	AGND	Analog input circuit common (connected internally to chassis gnd. through 1 Mohm).
	4	+10 V	Potentiometer reference source: 10 V ±2%, max. 10 mA (1 kohm $\leq R \leq$ 10 kohm).
	5	AI2	Analog input channel 2, programmable. Default[2] = not used. Resolution 0.1%, accuracy ±1%.
			Two different DIP switch types can be used.
			J1: AI2 OFF: 0…10 V (R_i = 312 kohm) 
			J1: AI2 ON: 0…20 mA (R_i = 100 ohm) 
	6	AGND	Analog input circuit common (connected internally to chassis gnd. through 1 Mohm).
	7	AO1	Analog output, programmable. Default[2] = frequency. 0…20 mA (load < 500 ohm). Accuracy ±3%.
	8	AO2	Analog output, programmable. Default[2] = current. 0…20 mA (load < 500 ohm). Accuracy ±3%.
	9	AGND	Analog output circuit common (connected internally to chassis gnd. through 1 Mohm).
Digital inputs[1]	10	+24V	Auxiliary voltage output 24 V DC / 250 mA (reference to GND), short circuit protected.
	11	GND	Auxiliary voltage output common (connected internally as floating).
	12	DCOM	Digital input common. To activate a digital input, there must be $\geq +10$ V (or $\leq$ -10 V) between that input and DCOM. The 24 V may be provided by the ACS550 (X1-10) or by an external 12…24 V source of either polarity.
	13	DI1	Digital input 1, programmable. Default[2] = start/stop.
	14	DI2	Digital input 2, programmable. Default[2] = fwd/rev.
	15	DI3	Digital input 3, programmable. Default[2] = constant speed sel (code).
	16	DI4	Digital input 4, programmable. Default[2] = constant speed sel (code).
	17	DI5	Digital input 5, programmable. Default[2] = ramp pair selection (code).
	18	DI6	Digital input 6, programmable. Default[2] = not used.

	X1			Hardware description
Relay outputs	19	RO1C		Relay output 1, programmable. Default[2] = Ready Maximum: 250 V AC / 30 V DC, 2 A Minimum: 500 mW (12 V, 10 mA)
	20	RO1A		
	21	RO1B		
	22	RO2C		Relay output 2, programmable. Default[2] = Running Maximum: 250 V AC / 30 V DC, 2 A Minimum: 500 mW (12 V, 10 mA)
	23	RO2A		
	24	RO2B		
	25	RO3C		Relay output 3, programmable. Default[2] = Fault (-1) Maximum: 250 V AC / 30 V DC, 2 A Minimum: 500 mW (12 V, 10 mA)
	26	RO3A		
	27	RO3B		

[1] Digital input impedance 1.5 kohm. Maximum voltage for digital inputs is 30 V.

[2] Default values depend on the macro used. Values specified are for the default macro. See chapter *Application macros* on page *77*.

Note: Terminals 3, 6 and 9 are at the same potential.

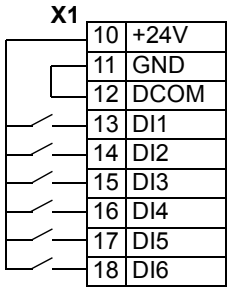
Note: For safety reasons the fault relay signals a "fault" when the ACS550 is powered down.

WARNING! All ELV (Extra Low Voltage) circuits connected to the drive must be used within a zone of equipotential bonding, i.e. within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by a proper factory grounding.

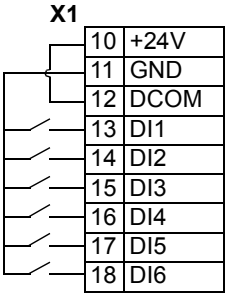
The terminals on the control board as well as on the optional modules attachable to the board fulfil the Protective Extra Low Voltage (PELV) requirements stated in EN 50178, provided that the external circuits connected to the terminals also fulfil the requirements and the installation site is below 2000 m (6562 ft).

You can wire the digital input terminals in either a PNP or NPN configuration.

PNP connection (source)



NPN connection (sink)



Check the insulation of the assembly

Drive

Do not make any voltage tolerance or insulation resistance tests on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

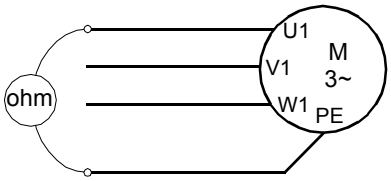
Supply cable

Check the insulation of the supply (input) cable according to local regulations before connecting to the drive.

Motor and motor cable

Check the insulation of the motor and motor cable as follows:

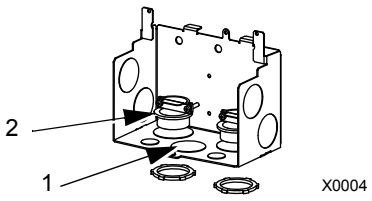
1. Check that the motor cable is connected to the motor, and disconnected from the drive output terminals U2, V2 and W2.
2. Measure the insulation resistance between phase conductors and between each phase conductor and the Protective Earth conductor using a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions. **Note:** Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



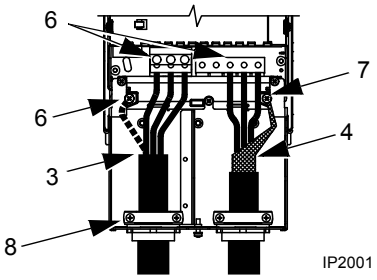
Install the wiring

*Wiring **IP21** / UL type 1 enclosure with **cables***

1. Open the appropriate knockouts in the conduit/gland box. (See section *Conduit/Gland kit* on page *23*.)
2. Install the cable clamps for the power/motor cables.



3. On the input power cable, strip the sheathing back far enough to route individual wires.
4. On the motor cable, strip the sheathing back far enough to expose the copper wire shield so that the shield can be twisted into a bundle (pig-tail). Keep the bundle not longer than five times its width to minimize noise radiation.
   360° grounding under the clamp is recommended for the motor cable to minimize noise radiation. In this case, remove the sheathing at the cable clamp.
5. Route both cables through the clamps.
6. Strip and connect the power/motor wires and the power ground wire to the drive terminals. See the table on the right for tightening torques.

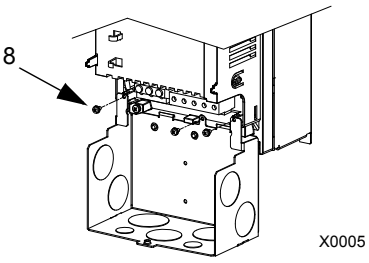


IP2001

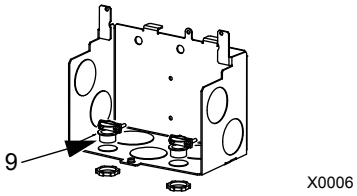
Frame size	Tightening torque	
	N·m	lb·ft
R1, R2	1.4	1
R3	2.5	1.8
R4	5.6; PE: 2	4; PE 1.5
R5	15	11
R6	40; PE: 8	30; PE: 6

Note: For R6 frame size, refer to section *Power terminal considerations – R6 frame size* on page *287*.

7. Connect the bundle (pig-tail) created from the motor cable shield to the GND terminal.
8. Install conduit/gland box and tighten the cable clamps.
9. Install the cable clamp(s) for the control cable(s). (Power/motor cables and clamps not shown in the figure.)

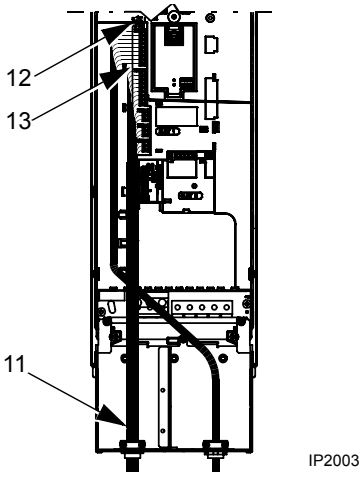


X0005



X0006

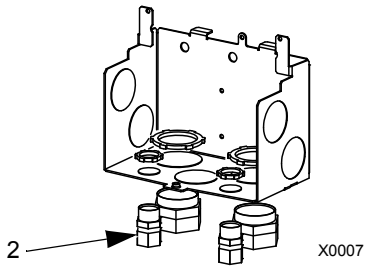
10. Strip control cable sheathing and twist the copper shield into a bundle (pig-tail).
11. Route control cable(s) through clamp(s) and tighten clamp(s).
12. Connect the ground shield bundle (pig-tail) for digital and analog I/O cables at X1-1. (Ground only at the drive end.)
13. Strip and connect the individual control wires to the drive terminals. See section *Control terminals table* on page *28*. Use a tightening torque of 0.4 N·m (0.3 lb·ft).
14. Install the conduit/gland box cover (1 screw).



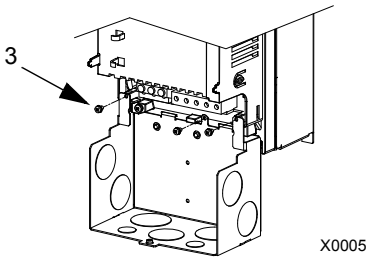
IP2003

*Wiring **IP21** / UL type 1 enclosure with **conduit***

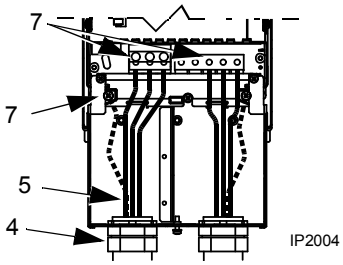
1. Open the appropriate knockouts in the conduit/gland box. (See section *Conduit/Gland kit* on page *23*.)
2. Install thin-wall conduit clamps (not supplied).



3. Install conduit/gland box.
4. Connect conduit runs to box.



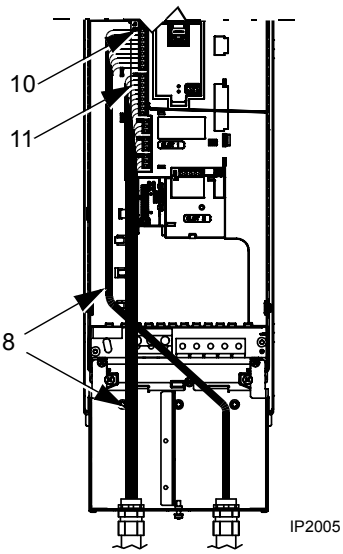
5. Route input power and motor wiring through conduits (must be separate conduit runs).
6. Strip wires.
7. Connect power, motor and ground wires to the drive terminals. See the table on the right for tightening torques.



Note: For R6 frame size, refer to section *Power terminal considerations – R6 frame size* on page *287*.

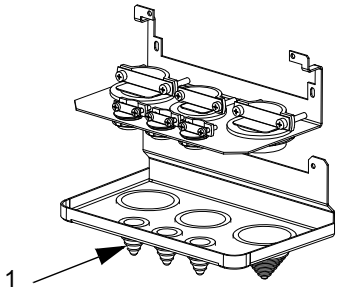
Frame size	Tightening torque	
	N·m	lb·ft
R1, R2	1.4	1
R3	2.5	1.8
R4	5.6; PE: 2	4; PE 1.5
R5	15	11
R6	40; PE: 8	30; PE: 6

8. Route the control cable through the conduit (must be separate from input power and motor conduit runs).
9. Strip the control cable sheathing and twist the copper shield into a bundle (pig-tail).
10. Connect the ground shield bundle (pig-tail) for digital and analog I/O cables at X1-1. (Ground only at the drive end.)
11. Strip and connect the individual control wires to the drive terminals. See section *Control terminals table* on page *28*. Use a tightening torque of 0.4 N·m (0.3 lb·ft).
12. Install the conduit/gland box cover (1 screw).

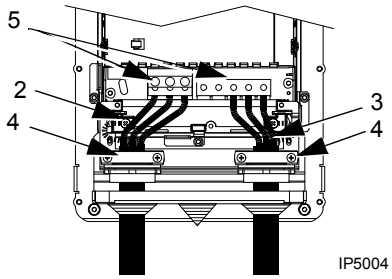


*Wiring **IP54** / UL type 12 enclosure with **cables***

1. Cut the cable seals as needed for the power, motor and control cables. The cable seals are cone-shaped, rubber seals on the bottom of the drive. The conical part of the seals must face downwards when the seals are inserted in the lead-through plate holes.



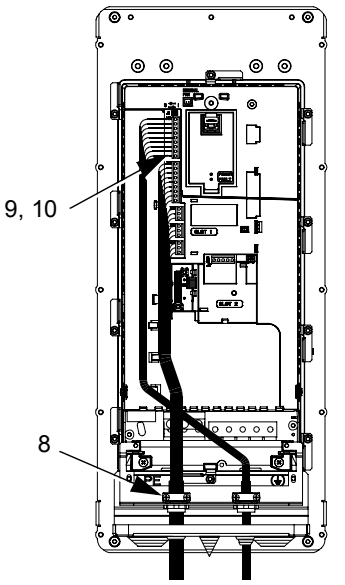
2. On the input power cable, strip the sheathing back far enough to route individual wires.
3. On the motor cable, strip the sheathing back far enough to expose the copper wire shield so that the shield can be twisted into a bundle (pig-tail). Keep the bundle not longer than five times its width to minimize noise radiation.
   360° grounding under the clamp is recommended for the motor cable to minimize noise radiation. In this case, remove the sheathing at the cable clamp.
4. Route both cables through the clamps and tighten the clamps.
5. Strip and connect the power/motor wires and the power ground wire to the drive terminals. See the table on the right for tightening torques.



Frame size	Tightening torque	
	N·m	lb·ft
R1, R2	1.4	1
R3	2.5	1.8
R4	5.6; PE: 2	4; PE 1.5
R5	15	11
R6	40; PE: 8	30; PE: 6

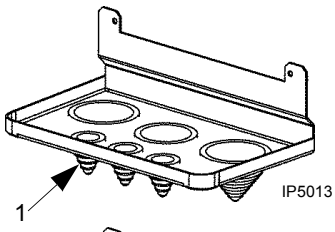
Note: For R6 frame size, refer to section *Power terminal considerations – R6 frame size* on page *287*.

6. Connect the bundle (pig-tail) created from the motor cable shield to the GND terminal.
7. Strip control cable sheathing and twist the copper shield into a bundle (pig-tail).
8. Route control cable(s) through clamp(s) and tighten clamp(s).
9. Connect the ground shield bundle (pig-tail) for digital and analog I/O cables at X1-1. (Ground only at the drive end.)
10. Strip and connect the individual control wires to the drive terminals. See section *Control terminals table* on page *28*. Use a tightening torque of 0.4 N·m (0.3 lb·ft).

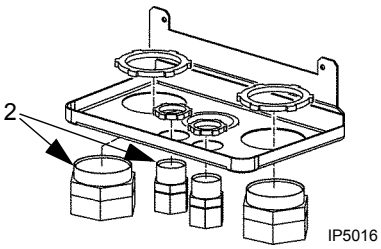


*Wiring **IP54** / UL type 12 enclosure with **conduit***

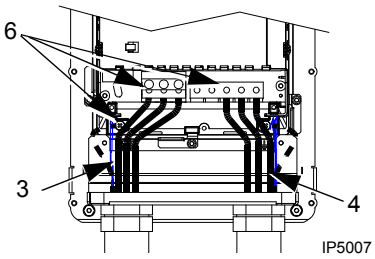
1. Remove and discard the cable seals where conduit will be installed. (The cable seals are cone-shaped, rubber seals on the bottom of the drive.)



2. For each conduit run, install water tight conduit connectors (not supplied).



3. Route the power wiring through the conduit.
4. Route the motor wiring through the conduit.
5. Strip the wires.
6. Connect the power, motor and ground wires to the drive terminals. See the table on the right for tightening torques.



Note: For R6 frame size, refer to section *Power terminal considerations – R6 frame size* on page *287*.

Frame size	Tightening torque	
	N·m	**lb·ft**
R1, R2	1.4	1
R3	2.5	1.8
R4	5.6; PE: 2	4; PE 1.5
R5	15	11
R6	40; PE: 8	30; PE: 6

7. Route the control cable through the conduit.
8. Strip the control cable sheathing and twist the copper shield into a bundle (pig-tail).
9. Connect the ground shield bundle (pig-tail) for digital and analog I/O cables at X1-1. (Ground only at the drive end.)
10. Strip and connect the individual control wires to the drive terminals. See section *Control terminals table* on page *28*. Use a tightening torque of 0.4 N·m (0.3 lb·ft).

Check installation

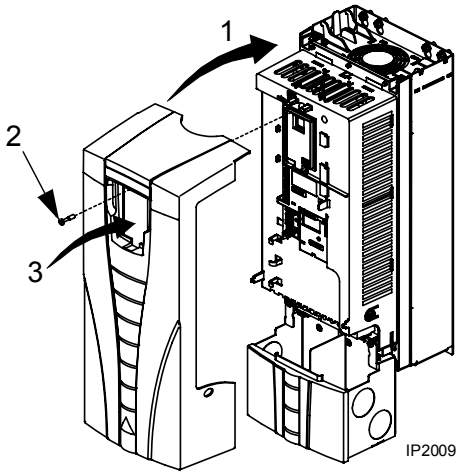
Before applying power, perform the following checks.

✓	Check
	Installation environment conforms to the drive's specifications for ambient conditions.
	The drive is mounted securely.
	Space around the drive meets the drive's specifications for cooling.
	The motor and driven equipment are ready for start.
	For IT systems and corner-grounded TN systems: The internal EMC filter is disconnected (see section *Disconnecting the internal EMC filter* on page 27).
	The drive is properly grounded.
	The input power (mains) voltage matches the drive nominal input voltage.
	The input power (mains) connections at U1, V1 and W1 are connected and tightened as specified.
	The input power (mains) fuses are installed.
	The motor connections at U2, V2 and W2 are connected and tightened as specified.
	The motor cable is routed away from other cables.
	NO power factor compensation capacitors are in the motor cable.
	The control connections are connected and tightened as specified.
	NO tools or foreign objects (such as drill shavings) are inside the drive.
	NO alternate power source for the motor (such as a bypass connection) is connected – no voltage is applied to the output of the drive.

Reinstall the cover

IP21 / UL type 1

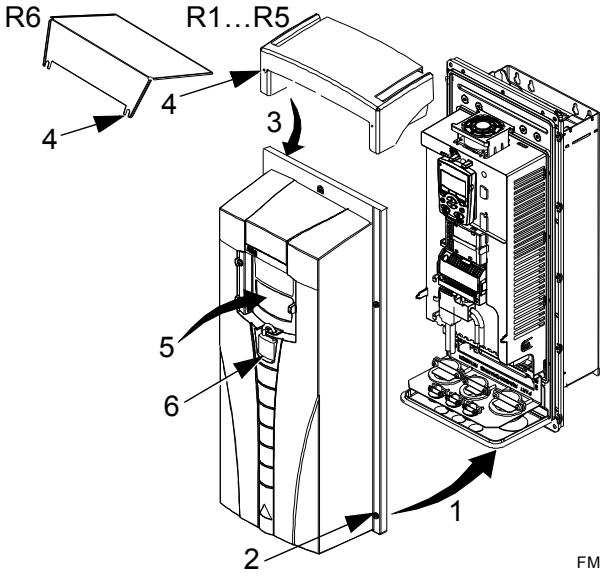
1. Align the cover and slide it on.
2. Tighten the captive screw.
3. Reinstall the control panel.
4. Continue with start-up. See chapter *Start-up, control with I/O and ID Run* on page *37*.



IP54 / UL type 12

1. Align the cover and slide it on.
2. Tighten the captive screws around the edge of the cover.
3. Slide the hood down over the top of the cover. (Only needed for UL type 12 installations.)
4. Install the two screws that attach the hood. (Only needed for UL type 12 installations.)
5. Install the control panel.

Note: The control panel window must be closed to comply with IP54 / UL type 12.



6. Optional: Add a lock (not supplied) to secure the control panel window.
7. Continue with start-up. See chapter *Start-up, control with I/O and ID Run* on page *37*.

Start-up, control with I/O and ID Run

The chapter instructs how to:

- perform the start-up
- start, stop, change the direction of rotation and adjust the speed of the motor through the I/O interface
- perform an Identification Run for the drive.

Using the control panel to do these tasks is explained briefly in this chapter. For details on how to use the control panel, refer to chapter *Control panels* starting on page *47*.

How to start up the drive

How you start up the drive depends on the control panel you have.

- **If you have an Assistant Control Panel**, you can either run the Start-up Assistant (see section *How to perform the guided start-up* on page *42*) or perform a limited start-up (see section *How to perform the limited start-up* on page *37*).

  The Start-up Assistant, which is included in the Assistant Control Panel only, guides you through all essential settings to be done. In the limited start-up, the drive gives no guidance; you go through the very basic settings by following the instructions given in the manual.

- **If you have a Basic Control Panel**, follow the instructions given in section *How to perform the limited start-up* on page *37*.

How to perform the limited start-up

For the limited start-up, you can use the Basic Control Panel or the Assistant Control Panel. The instructions below are valid for both control panels, but the displays shown are the Basic Control Panel displays, unless the instruction applies to the Assistant Control Panel only.

Before you start, ensure that you have the motor nameplate data on hand.

SAFETY

The start-up may only be carried out by a qualified electrician.

The safety instructions given in chapter *Safety instructions* must be followed during the start-up procedure.

The drive will start up automatically at power up, if the external run command is on.

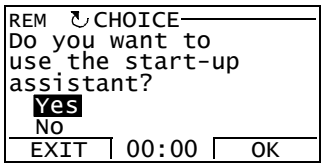
☐ Check the installation. See the checklist in chapter *Installation*, page *35*.

☐ Check that the starting of the motor does not cause any danger.
De-couple the driven machine if:
- there is a risk of damage in case of incorrect direction of rotation, or
- an ID Run needs to be performed during the drive start-up. ID Run is essential only in applications that require the ultimate in motor control accuracy.

POWER-UP

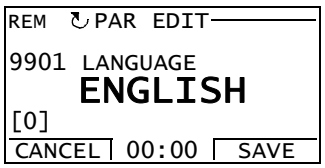
☐ Apply input power.
The Basic Control Panel powers up into the Output mode.

The Assistant Control Panel asks if you want to run the Start-up Assistant. If you press EXIT, the Start-up Assistant is not run, and you can continue with manual start-up in a similar manner as described below for the Basic Control Panel.



MANUAL ENTRY OF START-UP DATA (*Group 99: START-UP DATA*)

☐ If you have an Assistant Control Panel, select the language (the Basic Control Panel does not support languages). See parameter *9901* for the values of the available language alternatives. You find parameter descriptions in section *Complete parameter descriptions* starting on page *106*.

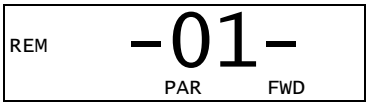


The general parameter setting procedure is described below for the Basic Control Panel. You find more detailed instructions for the Basic Control Panel on page *73*. Instructions for the Assistant Control Panel are on page *55*.

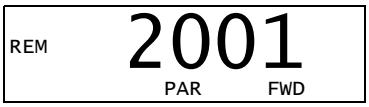
The general parameter setting procedure:

1. To go to the Main menu, press if the bottom line shows OUTPUT; otherwise press repeatedly until you see MENU at the bottom.

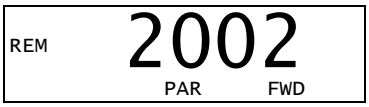
2. Press keys / until you see "PAr" and press .



3. Find the appropriate parameter group with keys / and press .



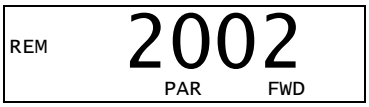
4. Find the appropriate parameter in the group with keys /.



5. Press and hold for about two seconds until the parameter value is shown with SET under the value.

6. Change the value with keys /. The value changes faster while you keep the key pressed down.

7. Save the parameter value by pressing .



☐ Select the application macro (parameter *9902*). The general parameter setting procedure is given above.

The default value 1 (ABB STANDARD) is suitable in most cases.

REM 9902 PAR FWD

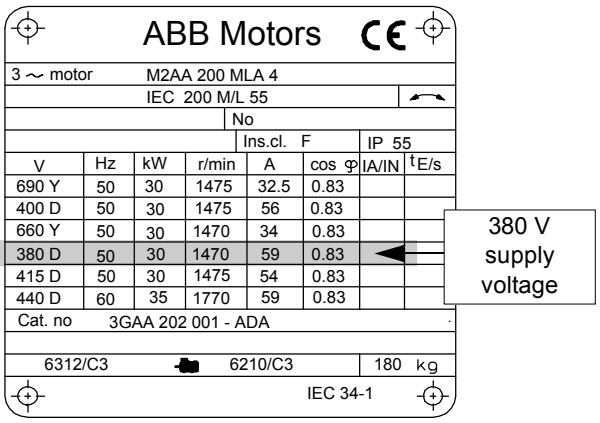
☐ Select the motor control mode (parameter *9904*).

1 (VECTOR:SPEED) is suitable in most cases. 2 (VECTOR:TORQ) is suitable for torque control applications. 3 (SCALAR:FREQ) is recommended

- for multimotor drives when the number of the motors connected to the drive is variable
- when the nominal current of the motor is less than 20% of the nominal current of the drive
- when the drive is used for test purposes with no motor connected.

REM 9904 PAR FWD

☐ Enter the motor data from the motor nameplate:



Note: Set the motor data to exactly the same value as on the motor nameplate. For example, if the motor nominal speed is 1470 rpm on the nameplate, setting the value of parameter *9908* MOTOR NOM SPEED to 1500 rpm results in the wrong operation of the drive.

- motor nominal voltage (parameter *9905*)

REM 9905 PAR FWD

- motor nominal current (parameter *9906*)

  Allowed range: 0.2…2.0 · I_{2hd} A

REM 9906 PAR FWD

- motor nominal frequency (parameter *9907*)

REM 9907 PAR FWD

- motor nominal speed (parameter *9908*)

REM 9908 PAR FWD

- motor nominal power (parameter *9909*)

REM 9909 PAR FWD

☐ Select the motor identification method (parameter *9910*).

The default value 0 (OFF/IDMAGN) using the identification magnetization is suitable for most applications. It is applied in this basic start-up procedure. Note however that this requires that:

- parameter *9904* is set to 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ), or
- parameter *9904* is set to 3 (SCALAR:FREQ) and parameter *2101* is set to 3 (SCALAR FLYST) or 5 (FLY + BOOST).

If your selection is 0 (OFF/IDMAGN), move to the next step.

Value 1 (ON), which performs a separate ID Run, should be selected if:

- vector control mode is used [parameter *9904* = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ)], and/or
- the operation point is near zero speed, and/or
- operation at torque range above the motor nominal torque over a wide speed range and without any measured speed feedback is required.

If you decide to do the ID Run [value 1 (ON)], continue by following the separate instructions given on page *45* in section *How to perform the ID Run* and then return to step *DIRECTION OF THE MOTOR ROTATION* on page *40*.

IDENTIFICATION MAGNETIZATION WITH ID RUN SELECTION 0 (OFF/IDMAGN)

☐ As stated above, the identification magnetization is performed only if:

- parameter *9904* is set to 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ), or
- parameter *9904* is set to 3 (SCALAR:FREQ) and parameter *2101* is set to 3 (SCALAR FLYST) or 5 (FLY + BOOST).

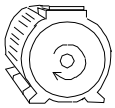
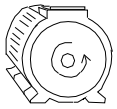
Press key LOC/REM to switch to local control (LOC shown on the left).

Press ◇ to start the drive. The motor model is now calculated by magnetizing the motor for 10 to 15 s at zero speed (motor not rotating).

DIRECTION OF THE MOTOR ROTATION

☐ Check the direction of the motor rotation.

- If the drive is in remote control (REM shown on the left), switch to local control by pressing LOC/REM.
- To go to the Main menu, press ⌐ if the bottom line shows OUTPUT; otherwise press ⌐ repeatedly until you see MENU at the bottom.
- Press keys ▲/▼ until you see "rEF" and press ⌐.
- Increase the frequency reference from zero to a small value with key ▲.
- Press ◇ to start the motor.
- Check that the actual direction of the motor is the same as indicated on the display (FWD means forward and REV reverse).
- Press ▽ to stop the motor.

	To change the direction of the motor rotation: • Disconnect input power from the drive, and wait 5 minutes for the intermediate circuit capacitors to discharge. Measure the voltage between each input terminal (U1, V1 and W1) and earth with a multimeter to ensure that the drive is discharged. • Exchange the position of two motor cable phase conductors at the drive output terminals or at the motor connection box. • Verify your work by applying input power and repeating the check as described above.	 forward direction  reverse direction
	SPEED LIMITS AND ACCELERATION/DECELERATION TIMES	
☐	Set the minimum speed (parameter *2001*).	LOC 2001 PAR FWD
☐	Set the maximum speed (parameter *2002*).	LOC 2002 PAR FWD
☐	Set the acceleration time 1 (parameter *2202*). **Note:** Check also acceleration time 2 (parameter *2205*) if two acceleration times will be used in the application.	LOC 2202 PAR FWD
☐	Set the deceleration time 1 (parameter *2203*). **Note:** Set also deceleration time 2 (parameter *2206*) if two deceleration times will be used in the application.	LOC 2203 PAR FWD
	SAVING A USER PARAMETER SET AND FINAL CHECK	
☐	The start-up is now completed. However, it might be useful at this stage to set the parameters required by your application and save the settings as a user parameter set as instructed in section *User parameter sets* on page *88*.	LOC 9902 PAR FWD
☐	Check that the drive state is OK. Basic Control Panel: Check that there are no faults or alarms shown on the display. If you want to check the LEDs on the front of the drive, switch first to remote control (otherwise a fault is generated) before removing the panel and verifying that the red LED is not lit and the green LED is lit but not blinking. Assistant Control Panel: Check that there are no faults or alarms shown on the display and that the panel LED is green and does not blink.	
	The drive is now ready for use.	

How to perform the guided start-up

To be able to perform the guided start-up, you need the Assistant Control Panel.

Before you start, ensure that you have the motor nameplate data on hand.

SAFETY

The start-up may only be carried out by a qualified electrician.

The safety instructions given in chapter *Safety instructions* must be followed during the start-up procedure.

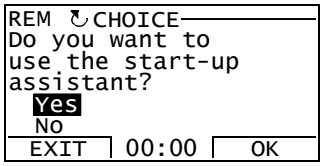
The drive will start up automatically at power up, if the external run command is on.

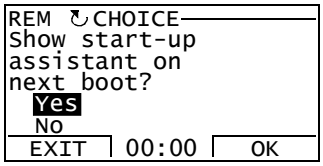
☐ Check the installation. See the checklist in chapter *Installation*, page *35*.

☐ Check that the starting of the motor does not cause any danger.
De-couple the driven machine if:
- there is a risk of damage in case of incorrect direction of rotation, or
- an ID Run needs to be performed during the drive start-up. ID Run is essential only in applications that require the ultimate in motor control accuracy.

POWER-UP

☐ Apply input power. The control panel first asks if you want to use the Start-up Assistant.
- Press OK (when Yes is highlighted) to run the Start-up Assistant.
- Press EXIT if you do not want to run the Start-up Assistant.
- Press key ▼ to highlight No and then press OK if you want to make the panel ask (or not ask) the question about running the Start-up Assistant again the next time you switch on the power to the drive.



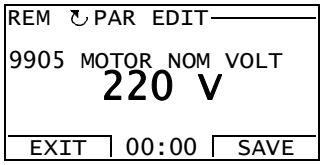


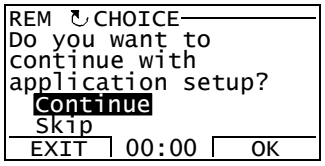
SELECTING THE LANGUAGE

☐ If you decided to run the Start-up Assistant, the display then asks you to select the language. Scroll to the desired language with keys ▲/▼ and press SAVE to accept.
If you press EXIT, the Start-up Assistant is stopped.

STARTING THE GUIDED SET-UP

☐ The Start-up Assistant now guides you through the set-up tasks, starting with the motor set-up. Set the motor data to exactly the same value as on the motor nameplate.
Scroll to the desired parameter value with keys ▲/▼ and press SAVE to accept and continue with the Start-up Assistant.
Note: At any time, if you press EXIT, the Start-up Assistant is stopped and the display goes to the Output mode.



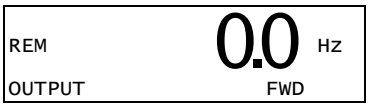
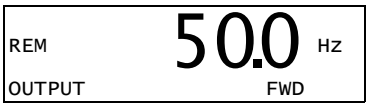
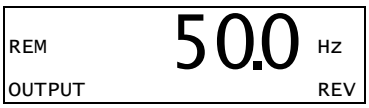
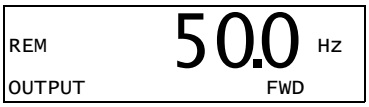
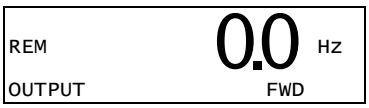
☐	After completing a set-up task, the Start-up Assistant suggests the next one. • Press OK (when Continue is highlighted) to continue with the suggested task. • Press key ▼ to highlight Skip and then press OK to move to the following task without doing the suggested task. • Press EXIT to stop the Start-up Assistant.	
SAVING A USER PARAMETER SET AND FINAL CHECK		
☐	The start-up is now completed. However, it might be useful at this stage to set the parameters required by your application and save the settings as a user parameter set as instructed in section *User parameter sets* on page *88*.	
☐	After the whole set-up is completed, check there are no faults or alarms shown on the display and the panel LED is green and does not blink.	
The drive is now ready for use.		

How to control the drive through the I/O interface

The table below instructs how to operate the drive through the digital and analog inputs when:

- the motor start-up is performed, and
- the default (standard) parameter settings are valid.

Displays of the Basic Control Panel are shown as an example.

PRELIMINARY SETTINGS	
If you need to change the direction of rotation, check that parameter *1003* is set to 3 (REQUEST).	
Ensure that the control connections are wired according to the connection diagram given for the ABB Standard macro.	See section *ABB Standard macro* on page *78*.
Ensure that the drive is in remote control. Press key LOC REM to switch between remote and local control.	In remote control, the panel display shows text REM.
STARTING AND CONTROLLING THE SPEED OF THE MOTOR	
Start by switching digital input DI1 on. Assistant Control Panel: The arrow starts rotating. It is dotted until the setpoint is reached. Basic Control Panel: Text FWD starts flashing fast and stops after the setpoint is reached	
Regulate the drive output frequency (motor speed) by adjusting the voltage of analog input AI1.	
CHANGING THE DIRECTION OF ROTATION OF THE MOTOR	
Reverse direction: Switch digital input DI2 on.	
Forward direction: Switch digital input DI2 off.	
STOPPING THE MOTOR	
Switch digital input DI1 off. The motor stops. Assistant Control Panel: The arrow stops rotating. Basic Control Panel: Text FWD starts flashing slowly.	

How to perform the ID Run

The drive estimates motor characteristics automatically using identification magnetization when the drive is started for the first time and after any motor parameter (*Group 99: START-UP DATA*) is changed. This is valid when parameter *9910* ID RUN has value 0 (OFF/IDMAGN), and

- parameter *9904* = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ), or
- parameter *9904* = 3 (SCALAR:FREQ) and parameter *2101* = 3 (SCALAR FLYST) or 5 (FLY + BOOST).

In most applications there is no need to perform a separate ID Run [*9910* ID RUN = 1 (ON)]. The ID Run should be selected if:

- vector control mode is used [parameter *9904* = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ)], and/or
- the operation point is near zero speed, and/or
- operation at torque range above the motor nominal torque over a wide speed range and without any measured speed feedback is required.

Note: If motor parameters (*Group 99: START-UP DATA*) are changed after the ID Run, it must be repeated.

ID Run procedure

The general parameter setting procedure is not repeated here. For Assistant Control Panel see page *55* and for Basic Control Panel page *73* in chapter *Control panels*.

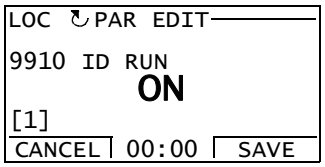
PRE-CHECK

WARNING! The motor will run at up to approximately 50…80% of the nominal speed during the ID Run. The motor will rotate in the forward direction. **Ensure that it is safe to run the motor before performing the ID Run!**

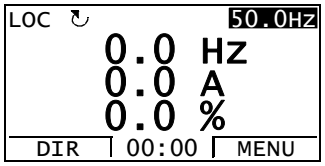
- ☐ De-couple the motor from the driven equipment.
- ☐ Check that the values of the motor data parameters *9905*…*9909* are equivalent to those on the motor nameplate, as shown in the steps on page *39*.
- ☐ If parameter values (*Group 01: OPERATING DATA* to *Group 98: OPTIONS*) are changed before the ID Run, check that the new settings meet the following conditions:
  - ☐ *2001* MINIMUM SPEED $\leq$ 0 rpm
  - ☐ *2002* MAXIMUM SPEED > 80% of the motor rated speed
  - ☐ *2003* MAXIMUM CURRENT $\geq I_{2hd}$
  - ☐ *2017* MAX TORQUE 1 > 50% or *2018* MAX TORQUE 2 > 50%, depending on which limit is in use according to parameter *2014* MAX TORQUE SEL.
- ☐ Check that the Run Enable signal is on (parameter *1601*).
- ☐ Ensure that the panel is in local control (LOC shown on the left / at the top). Press key LOC REM to switch between local and remote control.

ID RUN WITH THE ASSISTANT CONTROL PANEL

☐ Change parameter *9910* ID RUN to 1 (ON). Save the new setting by pressing SAVE.

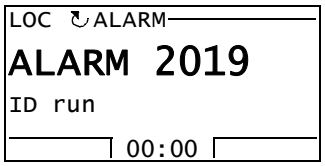


☐ If you want to monitor actual values during the ID Run, go to the Output mode by pressing EXIT repeatedly until you get there.



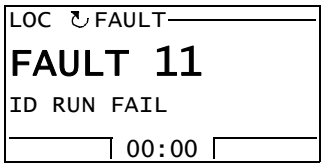
☐ Press ◇ to start the ID Run. The panel keeps switching between the display that was shown when you started the ID Run and the alarm display presented on the right.

In general, it is recommended not to press any control panel keys during the ID Run. However, you can stop the ID Run at any time by pressing ▽.



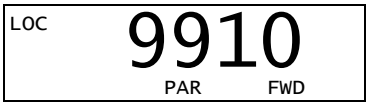
After the ID Run is completed, the alarm display is not shown any more.

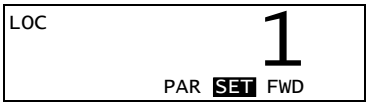
If the ID Run fails, the fault display presented on the right is shown.



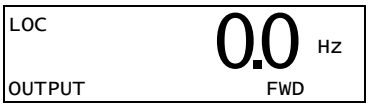
ID RUN WITH THE BASIC CONTROL PANEL

☐ Change parameter *9910* ID RUN to 1 (ON). Save the new setting by pressing ▽.



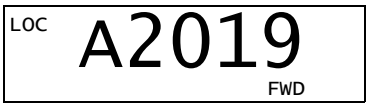


☐ If you want to monitor actual values during the ID Run, go to the Output mode by pressing ▽ repeatedly until you get there.



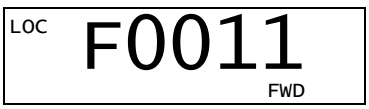
☐ Press ◇ to start the ID Run. The panel keeps switching between the display that was shown when you started the ID Run and the alarm display presented on the right.

In general, it is recommended not to press any control panel keys during the ID Run. However, you can stop the ID Run at any time by pressing ▽.



After the ID Run is completed, the alarm display is not shown any more.

If the ID Run fails, the fault display presented on the right is shown.



Control panels

About control panels

Use a control panel to control the drive, read status data and adjust parameters. The drive works with either of two different control panel types:

- Basic Control Panel – This panel (described in section *Basic Control Panel* on page *68*) provides basic tools for manual entry of parameter values.
- Assistant Control Panel – This panel (described below) includes pre-programmed assistants to automate the most common parameter setups. The panel provides language support. It is available with different language sets.

Compatibility

The manual is compatible with the following panel versions:

- Basic Control Panel: ACS-CP-C Rev. M or later
- Assistant Control Panel (Area 1): ACS-CP-A Rev. F or later
  (new panel series manufactured since 2007 with serial number XYYWWRXXXX, where year YY = 07 or greater and revision R = F, G, E, …)
- Assistant Control Panel (Asia): ACS-CP-D Rev. Q or later

See page *51* for how to find out the version of your Assistant Control Panel. See parameter *9901* LANGUAGE to see the languages supported by the different Assistant Control Panels.

Assistant Control Panel

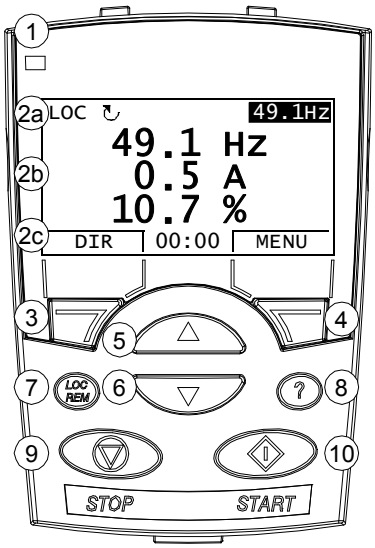
Features

The Assistant Control Panel features:

- alphanumeric control panel with an LCD display
- language selection for the display
- Start-up Assistant to ease drive commissioning
- copy function – parameters can be copied to the control panel memory for later transfer to other drives or for backup of a particular system.
- context sensitive help
- real time clock.

Overview

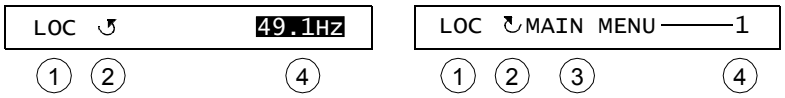
The following table summarizes the key functions and displays on the Assistant Control Panel.



No.	Use
1	Status LED – Green for normal operation. If LED is flashing, or red, see section *Diagnostic displays* on page *259*.
2	LCD display – Divided into three main areas: a. Status line – variable, depending on the mode of operation, see section *Status line* on page *49*. b. Center – variable; in general, shows signal and parameter values, menus or lists. Shows also faults and alarms. c. Bottom line – shows current functions of the two soft keys and, if enabled, the clock display.
3	Soft key 1 – Function depends on the context. The text in the lower left corner of the LCD display indicates the function.
4	Soft key 2 – Function depends on the context. The text in the lower right corner of the LCD display indicates the function.
5	Up – • Scrolls up through a menu or list displayed in the center of the LCD display. • Increments a value if a parameter is selected. • Increments the reference value if the upper right corner is highlighted. Holding the key down changes the value faster.
6	Down – • Scrolls down through a menu or list displayed in the center of the LCD display. • Decrements a value if a parameter is selected. • Decrements the reference value if the upper right corner is highlighted. Holding the key down changes the value faster.
7	LOC/REM – Changes between local and remote control of the drive.
8	Help – Displays context sensitive information when the key is pressed. The information displayed describes the item currently highlighted in the center of the display.
9	STOP – Stops the drive in local control.
10	START – Starts the drive in local control.

Status line

The top line of the LCD display shows the basic status information of the drive.



No.	Field	Alternatives	Significance
1	Control location	LOC	Drive control is local, that is, from the control panel.
		REM	Drive control is remote, such as the drive I/O or fieldbus.
2	State	↻	Forward shaft direction
		↺	Reverse shaft direction
		Rotating arrow	Drive is running at setpoint.
		Dotted rotating arrow	Drive is running but not at setpoint.
		Stationary arrow	Drive is stopped.
		Dotted stationary arrow	Start command is present, but the motor is not running, e.g. because start enable is missing.
3	Panel operation mode		• Name of the current mode • Name of the list or menu shown • Name of the operation state, e.g. PAR EDIT.
4	Reference value or number of the selected item		• Reference value in the Output mode • Number of the highlighted item, e.g mode, parameter group or fault.

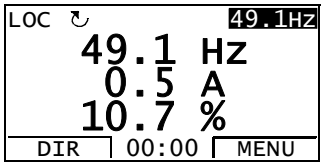
Operation

You operate the control panel with menus and keys. The keys include two context-sensitive soft keys, whose current function is indicated by the text shown in the display above each key.

You select an option, e.g. operation mode or parameter, by scrolling the ▲ and ▼ arrow keys until the option is highlighted (in reverse video) and then pressing the relevant soft key. With the right soft key you usually enter a mode, accept an option or save the changes. The left soft key is used to cancel the made changes and return to the previous operation level.

The Assistant Control Panel has nine panel modes: Output, Parameters, Assistants, Changed Parameters, Fault Logger, Time and Date, Parameter Backup, I/O Settings and Fault. The operation in the first eight modes is described in this chapter. When a fault or alarm occurs, the panel goes automatically to the Fault mode showing the fault or alarm. You can reset it in the Output or Fault mode (see chapter *Diagnostics*).

Initially, the panel is in the Output mode, where you can start, stop, change the direction, switch between local and remote control, modify the reference value and monitor up to three actual values. To do other tasks, go first to the Main menu and select the appropriate mode on the menu. The status line (see section *Status line* on page *49*) shows the name of the current menu, mode, item or state.



How to do common tasks

The table below lists common tasks, the mode in which you can perform them and the page number where the steps to do the task are described in detail.

Task	Mode	Page
How to get help	Any	*51*
How to find out the panel version	At power up	*51*
How to adjust the display contrast	Output	*54*
How to switch between local and remote control	Any	*52*
How to start and stop the drive	Any	*52*
How to change the direction of the motor rotation	Output	*53*
How to set the speed, frequency or torque reference	Output	*54*
How to change the value of a parameter	Parameters	*55*
How to select the monitored signals	Parameters	*56*
How to do guided tasks (specification of related parameter sets) with assistants	Assistants	*57*
How to view and edit changed parameters	Changed Parameters	*60*
How to view faults	Fault Logger	*61*
How to reset faults and alarms	Output, Fault	*265*
How to show/hide the clock, change date and time formats, set the clock and enable/disable automatic clock transitions according to the daylight saving changes	Time and Date	*62*
How to copy parameters from the drive to the control panel	Parameter Backup	*65*
How to restore parameters from the control panel to the drive	Parameter Backup	*65*
How to view backup information	Parameter Backup	*66*
How to edit and change parameter settings related to I/O terminals	I/O Settings	*67*

How to get help

Step	Action	Display
1.	Press (?) to read the context-sensitive help text for the item that is highlighted. If help text exists for the item, it is shown on the display.	LOC ↻PAR GROUPS——10 01 OPERATING DATA 03 FB ACTUAL SIGNALS 04 FAULT HISTORY 10 START/STOP/DIR 11 REFERENCE SELECT EXIT | 00:00 | SEL LOC ↻HELP This group defines external sources (EXT1 and EXT2) for commands that enable start, stop and EXIT | 00:00 |
2.	If the whole text is not visible, scroll the lines with keys ▲ and ▼.	LOC ↻HELP external sources (EXT1 and EXT2) for commands that enable start, stop and direction changes. EXIT | 00:00 |
3.	After reading the text, return to the previous display by pressing EXIT.	LOC ↻PAR GROUPS——10 01 OPERATING DATA 03 FB ACTUAL SIGNALS 04 FAULT HISTORY 10 START/STOP/DIR 11 REFERENCE SELECT EXIT | 00:00 | SEL

How to find out the panel version

Step	Action	Display
1.	If the power is switched on, switch it off.	
2.	Keep key (?) pressed down while you switch on the power and read the information. The display shows the following panel information: Panel FW: panel firmware version ROM CRC: panel ROM check sum Flash Rev: flash content version Flash content comment. When you release the (?) key, the panel goes to the Output mode.	PANEL VERSION INFO Panel FW: x.xx ROM CRC: xxxxxxxxxx Flash Rev: x.xx xxxxxxxxxxxxxxxxxxxx

How to start, stop and switch between local and remote control

You can start, stop and switch between local and remote control in any mode. To be able to start or stop the drive, the drive must be in local control.

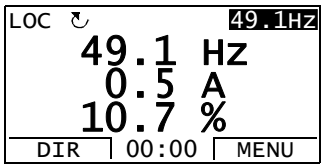
Step	Action	Display
1.	• To switch between remote control (REM shown on the status line) and local control (LOC shown on the status line), press (LOC REM). **Note:** Switching to local control can be disabled with parameter *1606* LOCAL LOCK. The very first time the drive is powered up, it is in remote control (REM) and controlled through the drive I/O terminals. To switch to local control (LOC) and control the drive using the control panel, press (LOC REM). The result depends on how long you press the key: • If you release the key immediately (the display flashes "Switching to the local control mode"), the drive stops. Set the local control reference as instructed on page *54*. • If you press the key for about two seconds, the drive continues as before. The drive copies the current remote values for the run/stop status and the reference, and uses them as the initial local control settings. • To stop the drive in local control, press (STOP). • To start the drive in local control, press (START).	LOC ↻ MESSAGE Switching to the local control mode. 00:00 The arrow (↻ or ↺) on the status line stops rotating. The arrow (↻ or ↺) on the status line starts rotating. It is dotted until the drive reaches the setpoint.

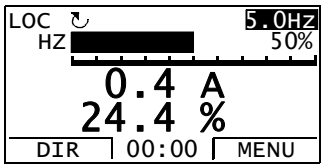
Output mode

In the Output mode, you can:

- monitor actual values of up to three signals in *Group 01: OPERATING DATA*
- change the direction of the motor rotation
- set the speed, frequency or torque reference
- adjust the display contrast
- start, stop, change the direction and switch between local and remote control.

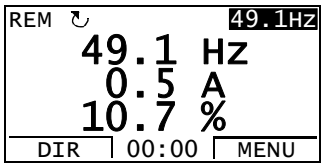
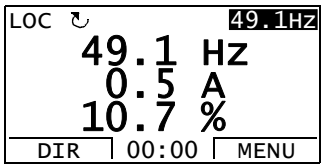
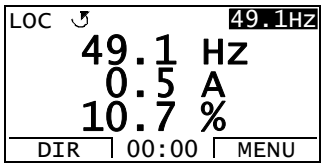
You get to the Output mode by pressing EXIT repeatedly.



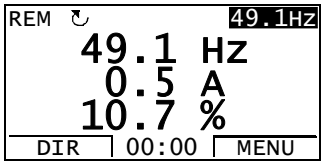
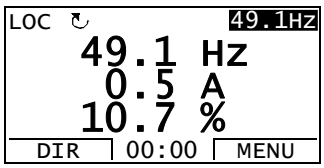
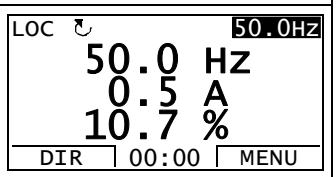


The top right corner of the display shows the reference value. The center can be configured to show up to three signal values or bar graphs. If just one or two signals are selected for display, the number and name of each displayed signal are shown in addition to the value or bar graph. See page *56* for instructions on selecting and modifying the monitored signals.

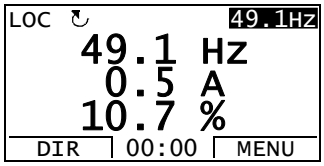
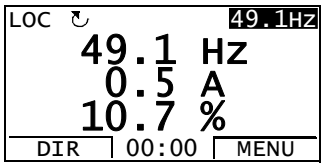
How to change the direction of the motor rotation

Step	Action	Display
1.	If you are not in the Output mode, press EXIT repeatedly until you get there.	
2.	If the drive is in remote control (REM shown on the status line), switch to local control by pressing LOC/REM. The display briefly shows a message about changing the mode and then returns to the Output mode.	
3.	To change the direction from forward (↻ shown on the status line) to reverse (↺ shown on the status line), or vice versa, press DIR. **Note**: Parameter *1003* DIRECTION must be set to 3 (REQUEST).	

How to set the speed, frequency or torque reference

Step	Action	Display
1.	If you are not in the Output mode, press EXIT repeatedly until you get there.	
2.	If the drive is in remote control (REM shown on the status line), switch to local control by pressing LOC/REM. The display briefly shows a message about changing the mode and then returns to the Output mode. **Note**: With *Group 11: REFERENCE SELECT*, you can allow the reference modification in remote control.	
3.	• To increase the highlighted reference value shown in the top right corner of the display, press ▲. The value changes immediately. It is stored in the drive permanent memory and restored automatically after power switch-off. • To decrease the value, press ▼.	

How to adjust the display contrast

Step	Action	Display
1.	If you are not in the Output mode, press EXIT repeatedly until you get there.	
2.	• To increase the contrast, press keys MENU and ▲ simultaneously. • To decrease the contrast, press keys MENU and ▼ simultaneously.	

Parameters mode

In the Parameters mode, you can:

- view and change parameter values
- start, stop, change the direction and switch between local and remote control.

How to select a parameter and change its value

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	LOC ↻MAIN MENU———1 **PARAMETERS** ASSISTANTS CHANGED PAR EXIT | 00:00 | ENTER
2.	Go to the Parameters mode by selecting PARAMETERS on the menu with keys ▲ and ▼, and pressing ENTER.	LOC ↻PAR GROUPS——01 **01 OPERATING DATA** 03 FB ACTUAL SIGNALS 04 FAULT HISTORY 10 START/STOP/DIR 11 REFERENCE SELECT EXIT | 00:00 | SEL
3.	Select the appropriate parameter group with keys ▲ and ▼. Press SEL.	LOC ↻PAR GROUPS——99 **99 START-UP DATA** 01 OPERATING DATA 03 FB ACTUAL SIGNALS 04 FAULT HISTORY 10 START/STOP/DIR EXIT | 00:00 | SEL LOC ↻PARAMETERS——— **9901 LANGUAGE** **ENGLISH** 9902 APPLIC MACRO 9904 MOTOR CTRL MODE 9905 MOTOR NOM VOLT EXIT | 00:00 | EDIT
4.	Select the appropriate parameter with keys ▲ and ▼. The current value of the parameter is shown below the selected parameter. Press EDIT.	LOC ↻PARAMETERS——— 9901 LANGUAGE **9902 APPLIC MACRO** **ABB STANDARD** 9904 MOTOR CTRL MODE 9905 MOTOR NOM VOLT EXIT | 00:00 | EDIT LOC ↻PAR EDIT——— 9902 APPLIC MACRO **ABB STANDARD** [1] CANCEL | 00:00 | SAVE
5.	Specify a new value for the parameter with keys ▲ and ▼. Pressing the key once increments or decrements the value. Holding the key down changes the value faster. Pressing the keys simultaneously replaces the displayed value with the default value.	LOC ↻PAR EDIT——— 9902 APPLIC MACRO **3-WIRE** [2] CANCEL | 00:00 | SAVE
6.	• To save the new value, press SAVE. • To cancel the new value and keep the original, press CANCEL.	LOC ↻PARAMETERS——— 9901 LANGUAGE **9902 APPLIC MACRO** **3-WIRE** 9904 MOTOR CTRL MODE 9905 MOTOR NOM VOLT EXIT | 00:00 | EDIT

How to select the monitored signals

Step	Action	Display
1.	You can select which signals are monitored in the Output mode and how they are displayed with *Group 34: PANEL DISPLAY* parameters. See page *55* for detailed instructions on changing parameter values. By default, the display shows three signals. The particular default signals depend on the value of parameter *9902* APPLIC MACRO: For macros whose default value of parameter *9904* MOTOR CTRL MODE is 1 (VECTOR:SPEED), the default for signal 1 is *0102* SPEED, otherwise *0103* OUTPUT FREQ. The defaults for signals 2 and 3 are always *0104* CURRENT and *0105* TORQUE, respectively. To change the default signals, select up to three signals from *Group 01: OPERATING DATA* to be shown. Signal 1: Change the value of parameter *3401* SIGNAL1 PARAM to the index of the signal parameter in *Group 01: OPERATING DATA* (= number of the parameter without the leading zero), e.g. 105 means parameter *0105* TORQUE. Value 100 means that no signal is displayed. Repeat for signals 2 (*3408* SIGNAL2 PARAM) and 3 (*3415* SIGNAL3 PARAM).	LOC ↻ PAR EDIT 3401 SIGNAL1 PARAM OUTPUT FREQ [103] CANCEL 00:00 SAVE LOC ↻ PAR EDIT 3408 SIGNAL2 PARAM CURRENT [104] CANCEL 00:00 SAVE LOC ↻ PAR EDIT 3415 SIGNAL3 PARAM TORQUE [105] CANCEL 00:00 SAVE
2.	Select how you want the signals to be displayed: as a decimal number or a bar graph. For decimal numbers, you can specify the decimal point location, or use the decimal point location and unit of the source signal [setting (9 (DIRECT)]. For details, see parameter *3404*. Signal 1: parameter *3404* OUTPUT1 DSP FORM Signal 2: parameter *3411* OUTPUT2 DSP FORM Signal 3: parameter *3418* OUTPUT3 DSP FORM.	LOC ↻ PAR EDIT 3404 OUTPUT1 DSP FORM DIRECT [9] CANCEL 00:00 SAVE
3.	Select the units to be displayed for the signals. This has no effect if parameter *3404*/*3411*/*3418* is set to 9 (DIRECT). For details, see parameter *3405*. Signal 1: parameter *3405* OUTPUT1 UNIT Signal 2: parameter *3412* OUTPUT2 UNIT Signal 3: parameter *3419* OUTPUT3 UNIT.	LOC ↻ PAR EDIT 3405 OUTPUT1 UNIT Hz [3] CANCEL 00:00 SAVE
4.	Select the scalings for the signals by specifying the minimum and maximum display values. This has no effect if parameter *3404*/*3411*/*3418* is set to 9 (DIRECT). For details, see parameters *3406* and *3407*. Signal 1: parameters *3406* OUTPUT1 MIN and *3407* OUTPUT1 MAX Signal 2: parameters *3413* OUTPUT2 MIN and *3414* OUTPUT2 MAX Signal 3: parameters *3420* OUTPUT3 MIN and *3421* OUTPUT3 MAX.	LOC ↻ PAR EDIT 3406 OUTPUT1 MIN 0.0 Hz CANCEL 00:00 SAVE LOC ↻ PAR EDIT 3407 OUTPUT1 MAX 500.0 Hz CANCEL 00:00 SAVE

Assistants mode

When the drive is first powered up, the Start-up Assistant guides you through the setup of the basic parameters. The Start-up Assistant is divided into assistants, each of which guides you through the task of specifying a related parameter set, for example Motor Set-up or PID Control. You can activate the assistants one after the other as the Start-up Assistant suggests, or independently. The tasks of the assistants are listed in the table on page *58*.

In the Assistants mode, you can:

- use assistants to guide you through the specification of a set of basic parameters
- start, stop, change the direction and switch between local and remote control.

How to use an assistant

The table below shows the basic operation sequence which leads you through assistants. The Motor Set-up Assistant is used as an example.

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	LOC ↻MAIN MENU 1 PARAMETERS ASSISTANTS CHANGED PAR EXIT | 00:00 | ENTER
2.	Go to the Assistants mode by selecting ASSISTANTS on the menu with keys ▲ and ▼, and pressing ENTER.	LOC ↻ASSISTANTS 1 Start-up assistant Motor Set-up Application Speed control EXT1 Speed control EXT2 EXIT | 00:00 | SEL
3.	Select the assistant with keys ▲ and ▼, and press SEL. If you select any other assistant than the Start-up Assistant, it guides you through the task of specification of its parameter set as shown in steps *4.* and *5.* below. After that you can select another assistant on the Assistants menu or exit the Assistants mode. The Motor Set-up Assistant is used here as an example. If you select the Start-up Assistant, it activates the first assistant, which guides you through the task of specification of its parameter set as shown in steps *4.* and *5.* below. The Start-up Assistant then asks if you want to continue with the next assistant or skip it – select the appropriate answer with keys ▲ and ▼, and press SEL. If you choose to skip, the Start-up Assistant asks the same question about the next assistant, and so on.	LOC ↻PAR EDIT 9905 MOTOR NOM VOLT 220 V EXIT | 00:00 | SAVE LOC ↻CHOICE Do you want to continue with application setup? Continue Skip EXIT | 00:00 | OK
4.	• To specify a new value, press keys ▲ and ▼. • To ask for information on the requested parameter, press key ?. Scroll the help text with keys ▲ and ▼. Close the help by pressing EXIT.	LOC ↻PAR EDIT 9905 MOTOR NOM VOLT 240 V EXIT | 00:00 | SAVE LOC ↻HELP Set as given on the motor nameplate. Voltage value must correspond to motor D/Y connection. EXIT | 00:00 |

Step	Action	Display
5.	• To accept the new value and continue to the setting of the next parameter, press SAVE. • To stop the assistant, press EXIT.	LOC ↻ PAR EDIT 9906 MOTOR NOM CURR 1.2 A EXIT 00:00 SAVE

The table below lists the tasks of the assistants and the relevant drive parameters. Depending on the selection made in the Application task (parameter *9902* APPLIC MACRO), the Start-up Assistant decides, which consequent tasks it suggests.

Name	Description	Set parameters
Language select	Selecting the language	*9901*
Motor set-up	Setting the motor data Performing the motor identification. (If the speed limits are not in the allowed range: Setting the limits.)	*9904*…*9909* *9910*
Application	Selecting the application macro	*9902*, parameters associated to the macro
Option modules	Activating the option modules	*Group 35: MOTOR TEMP MEAS* *Group 52: PANEL COMM* *9802*
Speed control EXT1	Selecting the source for the speed reference (If AI1 is used: Setting analog input AI1 limits, scale, inversion) Setting the reference limits Setting the speed (frequency) limits Setting the acceleration and deceleration times	*1103* (*1301*…*1303*, *3001*) *1104*, *1105* *2001*, *2002*, (*2007*, *2008*) *2202*, *2203*
Speed control EXT2	Selecting the source for the speed reference (If AI1 is used: Setting analog input AI1 limits, scale, inversion) Setting the reference limits	*1106* (*1301*…*1303*, *3001*) *1107*, *1108*
Torque control	Selecting the source for the torque reference (If AI1 is used: Setting analog input AI1 limits, scale, inversion) Setting the reference limits Setting the torque ramp up and ramp down times	*1106* (*1301*…*1303*, *3001*) *1107*, *1108* *2401*, *2402*
PID control	Selecting the source for the process reference (If AI1 is used: Setting analog input AI1 limits, scale, inversion) Setting the reference limits Setting the speed (reference) limits Setting the source and limits for the process actual value	*1106* (*1301*…*1303*, *3001*) *1107*, *1108* *2001*, *2002*, (*2007*, *2008*) *4016*, *4018*, *4019*
Start/Stop control	Selecting the source for start and stop signals of the two external control locations, EXT1 and EXT2 Selecting between EXT1 and EXT2 Defining the direction control Defining the start and stop modes Selecting the use of Run Enable signal	*1001*, *1002* *1102* *1003* *2101*…*2103* *1601*
Timed functions	Setting the timed functions Selecting the timed start/stop control for external control locations EXT1 and EXT2 Selecting timed EXT1/EXT2 control Activation of timed constant speed 1	*Group 36: TIMED FUNCTIONS* *1001*, *1002* *1102* *1201*

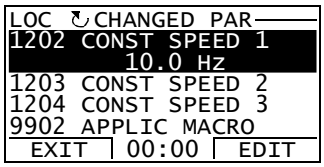
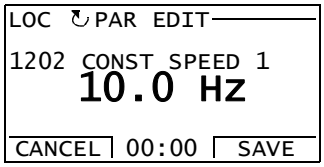
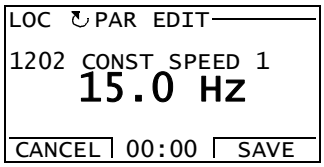
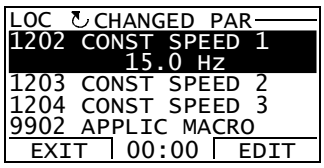
Name	Description	Set parameters
	Selecting timed function status indicated through relay output RO	*1401*
	Selecting timed PID1 parameter set 1/2 control	*4027*
Protections	Setting the current and torque limits	*2003*, *2017*
Output signals	Selecting the signals indicated through relay output RO	*Group 14: RELAY OUTPUTS*
	Selecting the signals indicated through analog output AO	*Group 15: ANALOG OUTPUTS*
	Setting the minimum, maximum, scaling and inversion	

Changed Parameters mode

In the Changed Parameters mode, you can:

- view a list of all parameters that have been changed from the macro default values
- change these parameters
- start, stop, change the direction and switch between local and remote control.

How to view and edit changed parameters

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	
2.	Go to the Changed Parameters mode by selecting CHANGED PAR on the menu with keys ▲ and ▼, and pressing ENTER.	
3.	Select the changed parameter on the list with keys ▲ and ▼. The value of the selected parameter is shown below it. Press EDIT to modify the value.	
4.	Specify a new value for the parameter with keys ▲ and ▼. Pressing the key once increments or decrements the value. Holding the key down changes the value faster. Pressing the keys simultaneously replaces the displayed value with the default value.	
5.	• To accept the new value, press SAVE. If the new value is the default value, the parameter is removed from the list of changed parameters. • To cancel the new value and keep the original, press CANCEL.	

Fault Logger mode

In the Fault Logger mode, you can:

- view the drive fault history of maximum ten faults (after a power off, only the three latest faults are kept in the memory)
- see the details of the three latest faults (after a power off, the details of only the most recent fault is kept in the memory)
- read the help text for the fault
- start, stop, change the direction and switch between local and remote control.

How to view faults

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	LOC ↻MAIN MENU 1 PARAMETERS ASSISTANTS CHANGED PAR EXIT 00:00 ENTER
2.	Go to the Fault Logger mode by selecting FAULT LOGGER on the menu with keys ▲ and ▼, and pressing ENTER. The display shows the fault log starting with the latest fault. The number on the row is the fault code according to which the causes and corrective actions are listed in chapter *Diagnostics*.	LOC ↻FAULT LOGGER 10: PANEL LOSS 19.03.05 13:04:57 6: DC UNDERVOLT 6: AI1 LOSS EXIT 00:00 DETAIL
3.	To see the details of a fault, select it with keys ▲ and ▼, and press DETAIL.	LOC ↻PANEL LOSS FAULT 10 FAULT TIME 1 13:04:57 FAULT TIME 2 EXIT 00:00 DIAG
4.	To show the help text, press DIAG. Scroll the help text with keys ▲ and ▼. After reading the help, press OK to return to the previous display.	LOC ↻DIAGNOSTICS Check: Comm lines and connections, parameter 3002, parameters in groups 10 and 11. EXIT 00:00 OK

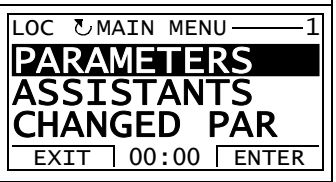
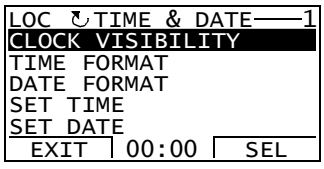
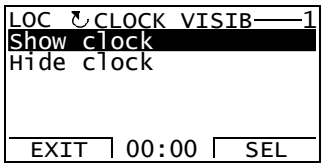
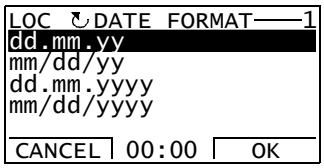
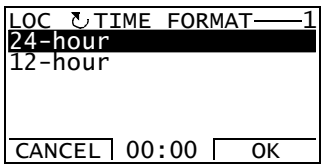
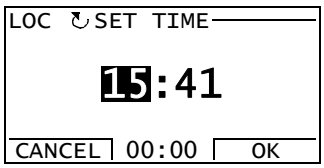
Time and Date mode

In the Time and Date mode, you can:

- show or hide the clock
- change date and time display formats
- set the date and time
- enable or disable automatic clock transitions according to the daylight saving changes
- start, stop, change the direction and switch between local and remote control.

The Assistant Control Panel contains a battery to ensure the function of the clock when the panel is not powered by the drive.

How to show or hide the clock, change display formats, set the date and time and enable or disable clock transitions due to daylight saving changes

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	
2.	Go to the Time and Date mode by selecting TIME & DATE on the menu with keys ▲ and ▼, and pressing ENTER.	
3.	• To show (hide) the clock, select CLOCK VISIBLILITY on the menu, press SEL, select Show clock (Hide clock) and press SEL, or, if you want to return to the previous display without making changes, press EXIT.	
	• To specify the date format, select DATE FORMAT on the menu, press SEL and select a suitable format. Press OK to save or CANCEL to cancel your changes.	
	• To specify the time format, select TIME FORMAT on the menu, press SEL and select a suitable format. Press OK to save or CANCEL to cancel your changes.	
	• To set the time, select SET TIME on the menu and press SEL. Specify the hours with keys ▲ and ▼, and press OK.Then specify the minutes. Press OK to save or CANCEL to cancel your changes.	

Step	Action	Display
	• To set the date, select SET DATE on the menu and press SEL. Specify the first part of the date (day or month depending on the selected date format) with keys ▲ and ▼, and press OK. Repeat for the second part. After specifying the year, press OK. To cancel your changes, press CANCEL. • To enable or disable the automatic clock transitions according to the daylight saving changes, select DAYLIGHT SAVING on the menu and press SEL. Pressing ? opens the help that shows the beginning and end dates of the period during which daylight saving time is used in each country or area whose daylight saving changes you can select to be followed. • To disable automatic clock transitions according to the daylight saving changes, select Off and press SEL. • To enable automatic clock transitions, select the country or area whose daylight saving changes are followed and press SEL. • To return to the previous display without making changes, press EXIT.	LOC ↻SET DATE 19.03.05 CANCEL | 00:00 | OK LOC DAYLIGHT SAV—1 Off EU US Australia1:NSW,Vict.. Australia2:Tasmania.. EXIT | 00:00 | SEL LOC HELP EU: On: Mar last Sunday Off: Oct last Sunday US: EXIT | 00:00 |

Parameter Backup mode

The Parameter Backup mode is used to export parameters from one drive to another or to make a backup of the drive parameters. Uploading to the panel stores all drive parameters, including up to two user sets, to the Assistant Control Panel. The full set, partial parameter set (application) and user sets can then be downloaded from the control panel to another drive or the same drive. Uploading and downloading can be performed in local control.

The control panel memory is non-volatile and does not depend on the panel battery.

In the Parameter Backup mode, you can:

- copy all parameters from the drive to the control panel (UPLOAD TO PANEL). This includes all defined user sets of parameters and internal (not adjustable by the user) parameters such as those created by the ID Run.
- view the information about the backup stored to the control panel with UPLOAD TO PANEL (BACKUP INFO). This includes e.g. the type and rating of the drive where the backup was made. It is useful to check this information when you are going to copy the parameters to another drive with DOWNLOAD FULL SET to ensure that the drives match.
- restore the full parameter set from the control panel to the drive (DOWNLOAD FULL SET). This writes all parameters, including the internal non-user-adjustable motor parameters, to the drive. It does not include the user sets of parameters.

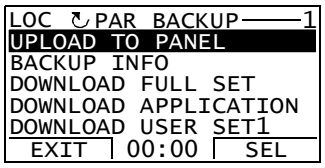
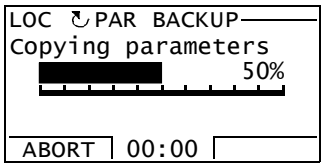
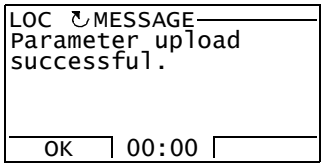
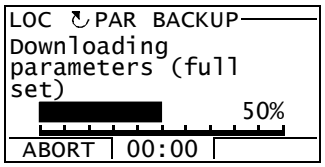
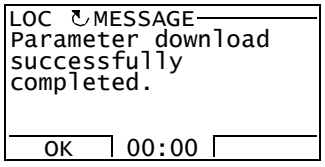
  Note: Only use this function to restore a drive from a backup or to transfer parameters to systems that are identical to the original system.
- copy a partial parameter set (part of the full set) from the control panel to a drive (DOWNLOAD APPLICATION). The partial set does not include user sets, internal motor parameters, parameters *9905*…*9909*, *1605*, *1607*, *5201*, nor any *Group 51: EXT COMM MODULE* and *Group 53: EFB PROTOCOL* parameters.

  The source and target drives and their motor sizes do not need to be the same.
- copy USER S1 parameters from the control panel to the drive (DOWNLOAD USER SET1). A user set includes *Group 99: START-UP DATA* parameters and the internal motor parameters.

  The function is only shown on the menu when User Set 1 has been first saved using parameter *9902* APPLIC MACRO (see section *User parameter sets* on page *88*) and then uploaded to the control panel with UPLOAD TO PANEL.
- copy USER S2 parameters from the control panel to the drive (DOWNLOAD USER SET2). As DOWNLOAD USER SET1 above.
- start, stop, change the direction and switch between local and remote control.

How to upload and download parameters

For the upload and download functions available, see above. Note that the drive has to be in local control for uploading and downloading.

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu. – If REM is shown on the status line, press LOC/REM to switch to local control.	
2.	Go to the Par Backup mode by selecting PAR BACKUP on the menu with keys ▲ and ▼, and pressing ENTER.	
3.	• To copy all parameters (including user sets and internal parameters) from the drive to the control panel, select UPLOAD TO PANEL on the Par Backup menu with keys ▲ and ▼, and press SEL. During the transfer, the display shows the transfer status as a percentage of completion. Press ABORT if you want to stop the operation. After the upload is completed, the display shows a message about the completion. Press OK to return to the Par Backup menu. • To perform downloads, select the appropriate operation (here DOWNLOAD FULL SET is used as an example) on the Par Backup menu with keys ▲ and ▼, and press SEL. The display shows the transfer status as a percentage of completion. Press ABORT if you want stop the operation. After the download is completed, the display shows a message about the completion. Press OK to return to the Par Backup menu.	   

How to view information about the backup

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	LOC ↻MAIN MENU 1 PARAMETERS ASSISTANTS CHANGED PAR EXIT | 00:00 | ENTER
2.	Go to the Par Backup mode by selecting PAR BACKUP on the menu with keys ▲ and ▼, and pressing ENTER.	LOC ↻PAR BACKUP 1 UPLOAD TO PANEL BACKUP INFO DOWNLOAD FULL SET DOWNLOAD APPLICATION DOWNLOAD USER SET1 EXIT | 00:00 | SEL
3.	Select BACKUP INFO on the Par Backup menu with keys ▲ and ▼, and press SEL. The display shows the following information about the drive where the backup was made: DRIVE TYPE: type of the drive DRIVE RATING: rating of the drive in format XXXYZ, where XXX: nominal current rating. If present, an "A" indicates a decimal point, e.g. 4A6 means 4.6 A. Y: 2 = 200 V 4 = 400 V 6 = 600 V Z: i = European loading package n = US loading package FIRMWARE: firmware version of the drive. You can scroll the information with keys ▲ and ▼.	LOC ↻BACKUP INFO DRIVE TYPE ACS550 3304 DRIVE RATING 4A62i 3301 FIRMWARE EXIT | 00:00 | LOC ↻BACKUP INFO ACS550 3304 DRIVE RATING 4A62i 3301 FIRMWARE 300F hex EXIT | 00:00 |
4.	Press EXIT to return to the Par Backup menu.	LOC ↻PAR BACKUP 1 UPLOAD TO PANEL BACKUP INFO DOWNLOAD FULL SET DOWNLOAD APPLICATION DOWNLOAD USER SET1 EXIT | 00:00 | SEL

I/O Settings mode

In the I/O Settings mode, you can:

- check the parameter settings related to any I/O terminal
- edit the parameter setting. For example, if "1103: REF1" is listed under Ain1 (Analog input 1), that is, parameter *1103* REF1 SELECT has value AI1, you can change its value to e.g. AI2. You cannot, however, set the value of parameter *1106* REF2 SELECT to AI1.
- start, stop, change the direction and switch between local and remote control.

How to edit and change parameter settings related to I/O terminals

Step	Action	Display
1.	Go to the Main menu by pressing MENU if you are in the Output mode, otherwise by pressing EXIT repeatedly until you get to the Main menu.	LOC ↻MAIN MENU 1 PARAMETERS ASSISTANTS CHANGED PAR EXIT 00:00 ENTER
2.	Go the I/O Settings mode by selecting I/O SETTINGS on the menu with keys ▲ and ▼, and pressing ENTER.	LOC ↻I/O SETTINGS 1 DIGITAL INPUTS (DI) ANALOG INPUTS (AI) RELAY OUTPUTS (ROUT) ANALOG OUTPUTS (AOUT) PANEL EXIT 00:00 SEL
3.	Select the I/O group, e.g. DIGITAL INPUTS, with keys ▲ and ▼, and press SEL. After a brief pause, the display shows the current settings for the selection.	LOC ↻I/O SETTINGS –DI1– 1001:START/STOP (E1) –DI2– –DI3– EXIT 00:00
4.	Select the setting (line with a parameter number) with keys ▲ and ▼, and press EDIT.	LOC ↻PAR EDIT 1001 EXT1 COMMANDS DI1 [1] CANCEL 00:00 SAVE
5.	Specify a new value for the setting with keys ▲ and ▼. Pressing the key once increments or decrements the value. Holding the key down changes the value faster. Pressing the keys simultaneously replaces the displayed value with the default value.	LOC ↻PAR EDIT 1001 EXT1 COMMANDS DI1,2 [2] CANCEL 00:00 SAVE
6.	• To save the new value, press SAVE. • To cancel the new value and keep the original, press CANCEL.	LOC ↻I/O SETTINGS –DI1– 1001:START/STOP (E1) –DI2– 1001:DIR (E1) –DI3– EXIT 00:00

Basic Control Panel

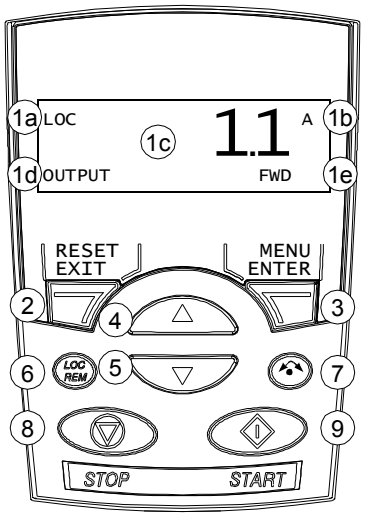
Features

The Basic Control Panel features:

- numeric control panel with an LCD display
- copy function – parameters can be copied to the control panel memory for later transfer to other drives or for backup of a particular system.

Overview

The following table summarizes the key functions and displays on the Basic Control Panel.



No.	Use
1	LCD display – Divided into five areas: a. Upper left – Control location: LOC: drive control is local, that is, from the control panel REM: drive control is remote, such as the drive I/O or fieldbus. b. Upper right – Unit of the displayed value. c. Center – Variable; in general, shows parameter and signal values, menus or lists. Shows also fault and alarm codes. d. Lower left and center – Panel operation state: OUTPUT: Output mode PAR: Parameter mode MENU: Main menu FAULT: Fault mode. e. Lower right – Indicators: FWD (forward) / REV (reverse): direction of the motor rotation Flashing slowly: stopped Flashing rapidly: running, not at setpoint Steady: running, at setpoint SET: Displayed value can be modified (in the Parameter and Reference modes).
2	RESET/EXIT – Exits to the next higher menu level without saving changed values. Resets faults in the Output and Fault modes.
3	MENU/ENTER – Enters deeper into menu level. In the Parameter mode, saves the displayed value as the new setting.
4	Up – • Scrolls up through a menu or list. • Increases a value if a parameter is selected. • Increases the reference value in the Reference mode. Holding the key down changes the value faster.
5	Down – • Scrolls down through a menu or list. • Decreases a value if a parameter is selected. • Decreases the reference value in the Reference mode. Holding the key down changes the value faster.
6	LOC/REM – Changes between local and remote control of the drive.
7	DIR – Changes the direction of the motor rotation.
8	STOP – Stops the drive in local control.
9	START – Starts the drive in local control.

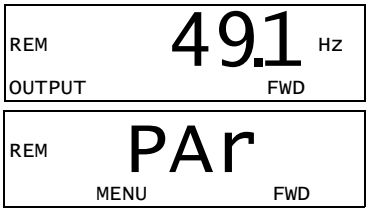
Operation

You operate the control panel with menus and keys. You select an option, e.g. operation mode or parameter, by scrolling the ▲ and ▼ arrow keys until the option is visible in the display and then pressing the ↵ key.

With the ↵ key, you return to the previous operation level without saving the made changes.

The Basic Control Panel has five panel modes: Output, Reference, Parameter, Copy and Fault. The operation in the first four modes is described in this chapter. When a fault or alarm occurs, the panel goes automatically to the Fault mode showing the fault or alarm code. You can reset the fault or alarm in the Output or Fault mode (see chapter *Diagnostics*).

After the power is switched on, the panel is in the Output mode, where you can start, stop, change the direction, switch between local and remote control and monitor up to three actual values (one at a time). To do other tasks, go first to the Main menu and select the appropriate mode.



How to do common tasks

The table below lists common tasks, the mode in which you can perform them and the page number where the steps to do the task are described in detail.

Task	Mode	Page
How to switch between local and remote control	Any	*70*
How to start and stop the drive	Any	*70*
How to change the direction of the motor rotation	Any	*70*
How to browse the monitored signals	Output	*71*
How to set the speed, frequency or torque reference	Reference	*72*
How to change the value of a parameter	Parameter	*73*
How to select the monitored signals	Parameter	*74*
How to reset faults and alarms	Output, Fault	*265*
How to copy parameters from the drive to the control panel	Copy	*76*
How to restore parameters from the control panel to the drive	Copy	*76*

How to start, stop and switch between local and remote control

You can start, stop and switch between local and remote control in any mode. To be able to start or stop the drive, the drive must be in local control.

Step	Action	Display
1.	• To switch between remote control (REM shown on the left) and local control (LOC shown on the left), press (LOC REM). **Note:** Switching to local control can be disabled with parameter *1606* LOCAL LOCK. After pressing the key, the display briefly shows message "LoC" or "rE", as appropriate, before returning to the previous display. The very first time the drive is powered up, it is in remote control (REM) and controlled through the drive I/O terminals. To switch to local control (LOC) and control the drive using the control panel, press (LOC REM). The result depends on how long you press the key: • If you release the key immediately (the display flashes "LoC"), the drive stops. Set the local control reference as instructed on page *72*. • If you press the key for about two seconds (release when the display changes from "LoC" to "LoC r"), the drive continues as before. The drive copies the current remote values for the run/stop status and the reference, and uses them as the initial local control settings. • To stop the drive in local control, press (STOP). • To start the drive in local control, press (START).	LOC 49.1 Hz OUTPUT FWD LOC LoC FWD Text FWD or REV on the bottom line starts flashing slowly. Text FWD or REV on the bottom line starts flashing rapidly. It stops flashing when the drive reaches the setpoint.

How to change the direction of the motor rotation

You can change the direction of the motor rotation in any mode.

Step	Action	Display
1.	If the drive is in remote control (REM shown on the left), switch to local control by pressing (LOC REM). The display briefly shows message "LoC" before returning to the previous display.	LOC 49.1 Hz OUTPUT FWD
2.	To change the direction from forward (FWD shown at the bottom) to reverse (REV shown at the bottom), or vice versa, press (DIR). **Note**: Parameter *1003* DIRECTION must be set to 3 (REQUEST).	LOC 49.1 Hz OUTPUT REV

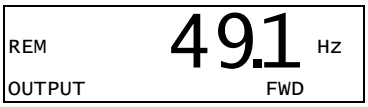
Output mode

In the Output mode, you can:

- monitor actual values of up to three *Group 01: OPERATING DATA* signals, one signal at a time
- start, stop, change the direction and switch between local and remote control.

You get to the Output mode by pressing ☰ until the display shows text OUTPUT at the bottom.

The display shows the value of one *Group 01: OPERATING DATA* signal. The unit is shown on the right. Page *74* tells how to select up to three signals to be monitored in the Output mode. The table below shows how to view them one at a time.



How to browse the monitored signals

Step	Action	Display
1.	If more than one signals have been selected to be monitored (see page *74*), you can browse them in the Output mode. To browse the signals forward, press key ▲ repeatedly. To browse them backward, press key ▼ repeatedly.	REM 49.1 Hz OUTPUT FWD REM 0.5 A OUTPUT FWD REM 10.7 % OUTPUT FWD

Reference mode

In the Reference mode, you can:

- set the speed, frequency or torque reference
- start, stop, change the direction and switch between local and remote control.

How to set the speed, frequency or torque reference

Step	Action	Display
1.	Go to the Main menu by pressing if you are in the Output mode, otherwise by pressing repeatedly until you see MENU at the bottom.	REM PAr MENU FWD
2.	If the drive is in remote control (REM shown on the left), switch to local control by pressing LOC/REM. The display briefly shows "LoC" before switching to local control. **Note**: With *Group 11: REFERENCE SELECT*, you can allow the reference modification in remote control (REM).	LOC PAr MENU FWD
3.	If the panel is not in the Reference mode ("rEF" not visible), press key ▲ or ▼ until you see "rEF" and then press . Now the display shows the current reference value with SET under the value.	LOC rEF MENU FWD LOC 49.1 Hz SET FWD
4.	• To increase the reference value, press ▲. • To decrease the reference value, press ▼. The value changes immediately when you press the key. It is stored in the drive permanent memory and restored automatically after power switch-off.	LOC 50.0 Hz SET FWD

Parameter mode

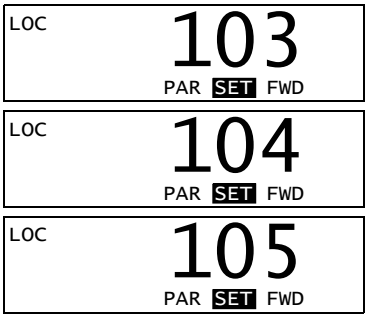
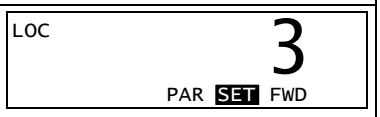
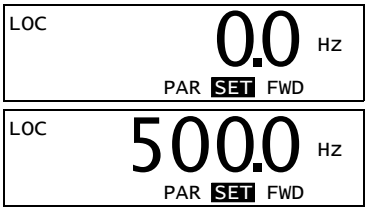
In the Parameter mode, you can:

- view and change parameter values
- select and modify the signals shown in the Output mode
- start, stop, change the direction and switch between local and remote control.

How to select a parameter and change its value

Step	Action	Display
1.	Go to the Main menu by pressing if you are in the Output mode, otherwise by pressing repeatedly until you see MENU at the bottom.	LOC rEF MENU FWD
2.	If the panel is not in the Parameter mode ("PAr" not visible), press key or until you see "PAr" and then press . The display shows the number of one of the parameter groups.	LOC PAr MENU FWD LOC -01- PAR FWD
3.	Use keys and to find the desired parameter group.	LOC -11- PAR FWD
4.	Press . The display shows one of the parameters in the selected group.	LOC 1101 PAR FWD
5.	Use keys and to find the desired parameter.	LOC 1103 PAR FWD
6.	Press and hold for about two seconds until the display shows the value of the parameter with SET underneath indicating that changing of the value is now possible. **Note:** When SET is visible, pressing keys and simultaneously changes the displayed value to the default value of the parameter.	LOC 1 PAR SET FWD
7.	Use keys and to select the parameter value. When you have changed the parameter value, SET starts flashing. • To save the displayed parameter value, press . • To cancel the new value and keep the original, press .	LOC 2 PAR SET FWD LOC 1103 PAR FWD

How to select the monitored signals

Step	Action	Display
1.	You can select which signals are monitored in the Output mode and how they are displayed with *Group 34: PANEL DISPLAY* parameters. See page *55* for detailed instructions on changing parameter values. By default, you can monitor three signals by browsing (see page *71*). The particular default signals depend on the value of parameter *9902* APPLIC MACRO: For macros whose default value of parameter *9904* MOTOR CTRL MODE is 1 (VECTOR:SPEED), the default for signal 1 is *0102* SPEED, otherwise *0103* OUTPUT FREQ. The defaults for signals 2 and 3 are always *0104* CURRENT and *0105* TORQUE, respectively. To change the default signals, select from *Group 01: OPERATING DATA* up to three signals to be browsed. Signal 1: Change the value of parameter *3401* SIGNAL1 PARAM to the index of the signal parameter in *Group 01: OPERATING DATA* (= number of the parameter without the leading zero), e.g. 105 means parameter *0105* TORQUE. Value 100 means that no signal is displayed. Repeat for signals 2 (*3408* SIGNAL2 PARAM) and 3 (*3415* SIGNAL3 PARAM). For example, if *3401* = 0 and *3415* = 0, browsing is disabled and only the signal specified by *3408* appears in the display. If all three parameters are set to 0, i.e. no signals are selected for monitoring, the panel displays text "n.A".	
2.	Specify the decimal point location, or use the decimal point location and unit of the source signal [setting (9 (DIRECT)]. Bar graphs are not available for Basic Operation Panel. For details, see parameter *3404*. Signal 1: parameter *3404* OUTPUT1 DSP FORM Signal 2: parameter *3411* OUTPUT2 DSP FORM Signal 3: parameter *3418* OUTPUT3 DSP FORM.	
3.	Select the units to be displayed for the signals. This has no effect if parameter *3404*/*3411*/*3418* is set to 9 (DIRECT). For details, see parameter *3405*. Signal 1: parameter *3405* OUTPUT1 UNIT Signal 2: parameter *3412* OUTPUT2 UNIT Signal 3: parameter *3419* OUTPUT3 UNIT.	
4.	Select the scalings for the signals by specifying the minimum and maximum display values. This has no effect if parameter *3404*/*3411*/*3418* is set to 9 (DIRECT). For details, see parameters *3406* and *3407*. Signal 1: parameters *3406* OUTPUT1 MIN and *3407* OUTPUT1 MAX Signal 2: parameters *3413* OUTPUT2 MIN and *3414* OUTPUT2 MAX Signal 3: parameters *3420* OUTPUT3 MIN and *3421* OUTPUT3 MAX.	

Copy mode

The Basic Control Panel can store a full set of drive parameters and up to two user sets of drive parameters to the control panel. The control panel memory is non-volatile.

In the Copy mode, you can:

- copy all parameters from the drive to the control panel (uL – Upload). This includes all defined user sets of parameters and internal (not adjustable by the user) parameters such as those created by the ID Run.
- restore the full parameter set from the control panel to the drive (dL A – Download All). This writes all parameters, including the internal non-user-adjustable motor parameters, to the drive. It does not include the user sets of parameters.

  Note: Only use this function to restore a drive, or to transfer parameters to systems that are identical to the original system.
- copy a partial parameter set from the control panel to a drive (dL P – Download Partial). The partial set does not include user sets, internal motor parameters, parameters *9905*…*9909*, *1605*, *1607*, *5201*, nor any *Group 51: EXT COMM MODULE* and *Group 53: EFB PROTOCOL* parameters.

  The source and target drives and their motor sizes do not need to be the same.
- copy USER S1 parameters from the control panel to the drive (dL u1 – Download User Set 1). A user set includes *Group 99: START-UP DATA* parameters and the internal motor parameters.

  The function is only shown on the menu when User Set 1 has been first saved using parameter *9902* APPLIC MACRO (see section *User parameter sets* on page *88*) and then uploaded to panel.
- copy USER S2 parameters from the control panel to the drive (dL u2 – Download User Set 2). As dL u1 – Download User Set 1 above.
- start, stop, change the direction and switch between local and remote control.

How to upload and download parameters

For the upload and download functions available, see above.

Step	Action	Display
1.	Go to the Main menu by pressing if you are in the Output mode, otherwise by pressing repeatedly until you see MENU at the bottom.	LOC PAr MENU FWD
2.	If the panel is not in the Copy mode ("CoPY" not visible), press key or until you see "CoPY". Press .	LOC CoPY MENU FWD LOC dL u1 MENU FWD
3.	• To upload all parameters (including user sets) from the drive to the control panel, step to "uL" with keys and . Press . During the transfer, the display shows the transfer status as a percentage of completion. • To perform downloads, step to the appropriate operation (here "dL A", Download All, is used as an example) with keys and . Press . During the transfer, the display shows the transfer status as a percentage of completion.	LOC uL MENU FWD LOC uL 50 % FWD LOC dL A MENU FWD LOC dL 50 % FWD

Basic Control Panel alarm codes

In addition to the faults and alarms generated by the drive (see chapter *Diagnostics*), the Basic Control Panel indicates control panel alarms with a code of form A5xxx. See section *Alarm codes (Basic Control Panel)* on page *269* for a list of the alarm codes and descriptions.

Application macros

Macros change a group of parameters to new, predefined values. Use macros to minimize the need for manual editing of parameters. Selecting a macro sets all other parameters to their default values, except:

- *Group 99: START-UP DATA* parameters (except parameter *9904*)
- *1602* PARAMETER LOCK
- *1607* PARAM SAVE
- *3018* COMM FAULT FUNC and *3019* COMM FAULT TIME
- *9802* COMM PROT SEL
- *Group 50: ENCODER* … *Group 53: EFB PROTOCOL* parameters
- *Group 29: MAINTENANCE TRIG* parameters.

After selecting a macro, you can make additional parameter changes manually with the control panel.

You enable application macros by setting the value for parameter *9902* APPLIC MACRO. By default, 1, ABB STANDARD, is the enabled macro.

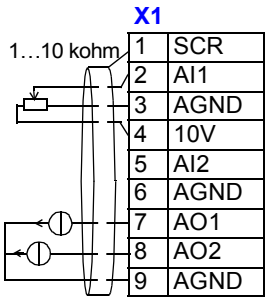
The following sections describe each of the application macros and provide a connection example for each macro.

The last section in this chapter, *Macro default values for parameters*, lists the parameters that the macros change and the default values established by each macro.

ABB Standard macro

This is the default macro. It provides a general purpose, 2-wire I/O configuration, with three (3) constant speeds. Parameter values are the default values defined in section *Complete parameter list* on page *91*.

Connection example:



Signal cable shield (screen)
External frequency reference 1: 0…10 V[1]
Analog input circuit common
Reference voltage 10 V DC
Not used
Analog input circuit common
Output frequency: 0…20 mA
Output current: 0…20 mA
Analog output circuit common

Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start/Stop: Activate to start
Fwd/Rev: Activate to reverse rotation direction
Constant speed selection[2]
Constant speed selection[2]
Ramp pair selection: Activate to select 2nd acc/dec ramp pair
Not used

Relay output 1, programmable
Default operation:
Ready =>19 connected to 21

Relay output 2, programmable
Default operation:
Running =>22 connected to 24

Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

Note 1. The external reference is used as a speed reference if a vector mode is selected.

Note 2. Code:
0 = open, 1 = connected

DI3	DI4	Output
0	0	Reference through AI1
1	0	CONST SPEED 1 (1202)
0	1	CONST SPEED 2 (1203)
1	1	CONST SPEED 3 (1204)

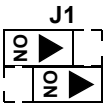
Input signals

- Analog reference (AI1)
- Start, stop and direction (DI1,2)
- Constant speed selection (DI3,4)
- Ramp pair (1 of 2) selection (DI5)

Output signals

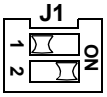
- Analog output AO1: Frequency
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



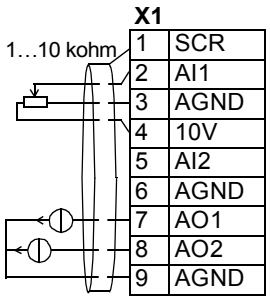
AI1: 0…10 V
AI2: 0(4)…20 mA

3-wire macro

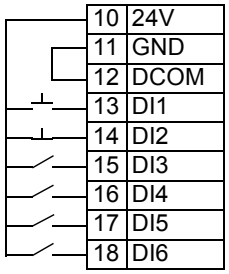
This macro is used when the drive is controlled using momentary push-buttons. It provides three (3) constant speeds. To enable, set the value of parameter 9902 to 2 (3-WIRE).

Note: When the stop input (DI2) is deactivated (no input), the control panel start/stop buttons are disabled.

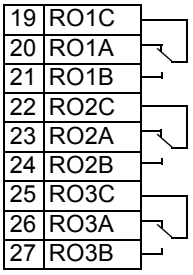
Connection example:



Signal cable shield (screen)
External speed reference 1: 0…10 V
Analog input circuit common
Reference voltage 10 V DC
Not used
Analog input circuit common
Motor output speed: 0…20 mA
Output current: 0…20 mA
Analog output circuit common



Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start: Momentary activation with DI2 activated starts the drive
Stop: Momentary deactivation stops the drive
Fwd/Rev: Activation reverses rotation direction
Constant speed selection[1]
Constant speed selection[1]
Not used



Relay output 1, programmable
Default operation:
Ready =>19 connected to 21
Relay output 2, programmable
Default operation:
Running =>22 connected to 24
Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

Note 1. Code:
0 = open, 1 = connected

DI4	DI5	Output
0	0	Reference through AI1
1	0	CONST SPEED 1 (1202)
0	1	CONST SPEED 2 (1203)
1	1	CONST SPEED 3 (1204)

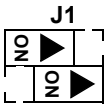
Input signals

- Analog reference (AI1)
- Start, stop and direction (DI1,2,3)
- Constant speed selection (DI4,5)

Output signals

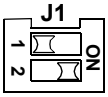
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or

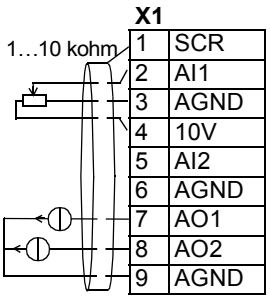


AI1: 0…10 V
AI2: 0(4)…20 mA

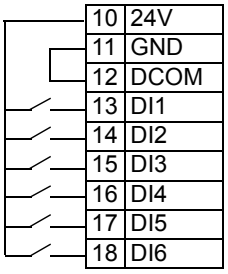
Alternate macro

This macro provides an I/O configuration adopted to a sequence of DI control signals used when alternating the rotation direction of the motor. To enable, set the value of parameter 9902 to 3 (ALTERNATE).

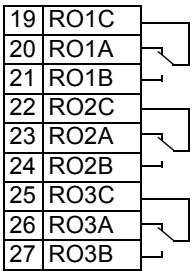
Connection example:



Signal cable shield (screen)
External speed reference 1: 0…10 V
Analog input circuit common
Reference voltage 10 V DC
Not used
Analog input circuit common
Motor output speed: 0…20 mA
Output current: 0…20 mA
Analog output circuit common



Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start fwd: If DI1 state is the same as DI2, the drive **stops**
Start reverse
Constant speed selection[1]
Constant speed selection[1]
Ramp pair selection: Activation selects 2nd acc/dec ramp pair
Run enable: Deactivation always stops the drive



Relay output 1, programmable
Default operation:
Ready =>19 connected to 21
Relay output 2, programmable
Default operation:
Running =>22 connected to 24
Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

Note 1. Code:
0 = open, 1 = connected

DI3	DI4	Output
0	0	Reference through AI1
1	0	CONST SPEED 1 (1202)
0	1	CONST SPEED 2 (1203)
1	1	CONST SPEED 3 (1204)

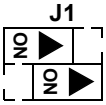
Input signals

- Analog reference (AI1)
- Start, stop and direction (DI1,2)
- Constant speed selection (DI3,4)
- Ramp pair 1/2 selection (DI5)
- Run enable (DI6)

Output signals

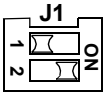
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or

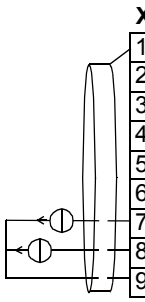


AI1: 0…10 V
AI2: 0(4)…20 mA

Motor Potentiometer macro

This macro provides a cost-effective interface for PLCs that vary the speed of the motor using only digital signals. To enable, set the value of parameter 9902 to 4 (MOTOR POT).

Connection example:



X1

1	SCR	Signal cable shield (screen)
2	AI1	Not used
3	AGND	Analog input circuit common
4	10V	Reference voltage 10 V DC
5	AI2	Not used
6	AGND	Analog input circuit common
7	AO1	**Motor output speed:** 0…20 mA
8	AO2	**Output current:** 0…20 mA
9	AGND	Analog output circuit common
10	24V	Auxiliary voltage output +24 V DC
11	GND	Auxiliary voltage output common
12	DCOM	Digital input common for all
13	DI1	**Start/stop:** Activation starts the drive.
14	DI2	**Forward/reverse:** Activation reverses rotation direction.
15	DI3	**Reference up:** Activation increases the reference[1]
16	DI4	**Reference down:** Activation decreases the reference[1]
17	DI5	**Constant speed 1:** 1202
18	DI6	**Run enable:** Deactivation always stops the drive.
19	RO1C	Relay output 1, programmable Default operation: **Ready** =>19 connected to 21
20	RO1A	
21	RO1B	
22	RO2C	Relay output 2, programmable Default operation: **Running** =>22 connected to 24
23	RO2A	
24	RO2B	
25	RO3C	Relay output 3, programmable Default operation: **Fault (-1)** =>25 connected to 27 (Fault => 25 connected to 26)
26	RO3A	
27	RO3B	

Note 1. For DI3 and DI4:

- If both are active or inactive the speed reference is unchanged.
- The existing speed reference is stored during stop or power down.

Note 2.

- Settings of the ramp times with acceleration and deceleration time 2 (parameters 2205 and 2206).

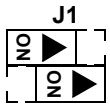
Input signals

- Start, stop and direction (DI1,2)
- Reference up/down (DI3,4)
- Constant speed selection (DI5)
- Run enable (DI6)

Output signals

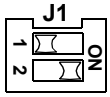
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



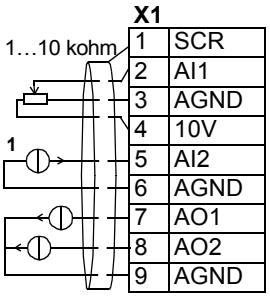
AI1: 0…10 V
AI2: 0(4)…20 mA

Hand-Auto macro

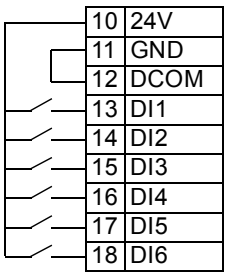
This macro provides an I/O configuration that is typically used in HVAC applications. To enable, set the value of parameter 9902 to 5 (HAND/AUTO).

Note: Parameter 2108 START INHIBIT must remain in the default setting, 0 (OFF).

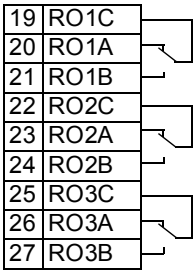
Connection example:



Signal cable shield (screen)
External reference 1: 0…10 V **(Hand Control)**
Analog input circuit common
Reference voltage 10 V DC
External reference 2: 0…20 mA **(Auto Control)**
Analog input circuit common
Motor output speed: 0…20 mA
Output current: 0…20 mA
Analog output circuit common



Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start/Stop (Hand): Activation starts the drive
Forward/Reverse (Hand): Activation reverses rotation direction
EXT1/EXT2 Selection: Activation selects auto control
Run enable: Deactivation always stops the drive
Forward/Reverse (Auto): Activation reverses rotation direction
Start/Stop (Auto): Activation starts the drive



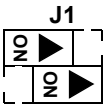
Relay output 1, programmable
Default operation:
Ready =>19 connected to 21
Relay output 2, programmable
Default operation:
Running =>22 connected to 24
Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

Note 1.
The sensor for AI2 is powered externally. See the manufacturer's instructions. To use sensors supplied by the drive aux. voltage output, see page *86*.

Input signals
- Two analog references (AI1, 2)
- Start/stop – hand/auto (DI1, 6)
- Direction – hand/auto (DI2, 5)
- Control location selection (DI3)
- Run enable (DI4)

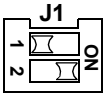
Output signals
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



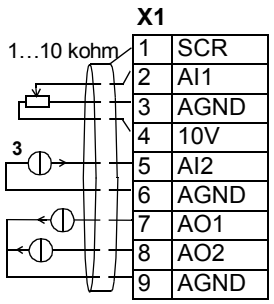
AI1: 0…10 V
AI2: 0(4)…20 mA

PID Control macro

This macro provides parameter settings for closed-loop control systems such as pressure control, flow control, etc. To enable, set the value of parameter 9902 to 6 (PID CONTROL).

Note: Parameter 2108 START INHIBIT must remain in the default setting, 0 (OFF).

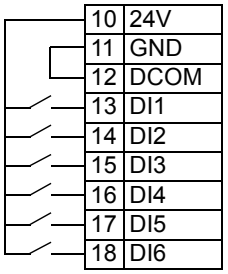
Connection example:



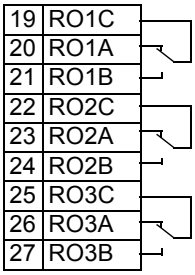
Signal cable shield (screen)
External ref. 1 (Manual) or Ext ref. 2 (PID): 0…10 V[1]
Analog input circuit common
Reference voltage 10 V DC
Actual signal (PID): 4…20 mA
Analog input circuit common
Motor output speed: 0…20 mA
Output current: 0…20 mA
Analog output circuit common

Note 1.
Manual: 0…10V => speed reference
PID: 0…10V => 0…100% PID setpoint

Note 3.
The sensor for AI2 is powered externally. See the manufacturer's instructions. To use sensors supplied by the drive aux. voltage output, see page *86*.



Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start/Stop (Hand): Activation starts the drive
EXT1/EXT2 selection: Activation selects PID control
Constant speed selection 1: (Not used in PID control)[2]
Constant speed selection 2: (Not used in PID control)[2]
Run enable: Deactivation always stops the drive
Start/Stop (PID): Activation starts the drive



Relay output 1, programmable
Default operation:
Ready =>19 connected to 21
Relay output 2, programmable
Default operation:
Running =>22 connected to 24
Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

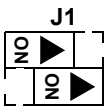
Note 2. Code:
0 = open, 1 = connected

DI3	DI4	Output
0	0	Reference through AI1
1	0	CONST SPEED 1 (1202)
0	1	CONST SPEED 2 (1203)
1	1	CONST SPEED 3 (1204)

Input signals
- Analog reference (AI1)
- Actual value (AI2)
- Start/stop – hand/PID (DI1, 6)
- EXT1/EXT2 selection (DI2)
- Constant speed selection (DI3, 4)
- Run enable (DI5)

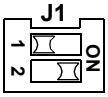
Output signals
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



AI1: 0…10 V
AI2: 0(4)…20 mA

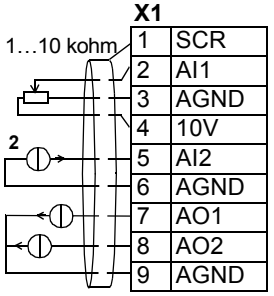
Note: Use the following switch-on order:
1. EXT1/EXT2
2. Run Enable
3. Start.

PFC macro

This macro provides parameter settings for pump and fan control (PFC) applications. To enable, set the value of parameter 9902 to 7 (PFC CONTROL).

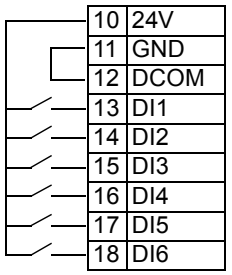
Note: Parameter 2108 START INHIBIT must remain in the default setting, 0 (OFF).

Connection example:

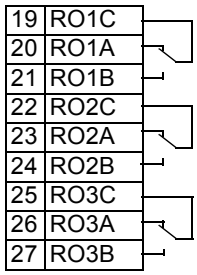


Signal cable shield (screen)
External ref. 1 (Manual) or Ext ref. 2 (PID/PFC): 0…10 V[1]
Analog input circuit common
Reference voltage 10 V DC
Actual signal (PID): 4…20 mA
Analog input circuit common
Output frequency: 0…20 mA
Actual 1 (PI controller actual value): 0(4)…20 mA
Analog output circuit common

Note 1.
Manual: 0…10V => 0…50 Hz
PID/PFC: 0…10V => 0…100% PID setpoint



Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start/Stop (Manual): Activation starts the drive
Run enable: Deactivation always stops the drive
EXT1/EXT2 selection: Activation selects PFC control
Interlock: Deactivation always stops the drive
Interlock: Deactivation stops constant speed motor
Start/Stop (PFC): Activation starts the drive



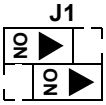
Relay output 1, programmable
Default operation:
Running =>19 connected to 21
Relay output 2, programmable
Default operation:
Fault (-1) =>22 connected to 24 (Fault => 22 connected to 23)
Relay output 3, programmable
Default operation:
Auxiliary motor switched on=>25 connected to 27

Note 2.
The sensor for AI2 is powered externally. See the manufacturer's instructions. To use sensors supplied by the drive aux. voltage output, see page *86*.

Input signals
- Analog ref. and actual (AI1, 2)
- Start/stop – manual/PFC (DI1, 6)
- Run enable (DI2)
- EXT1/EXT2 selection (DI3)
- Interlock (DI4, 5)

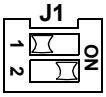
Output signals
- Analog output AO1: Frequency
- Analog output AO2: Actual 1
- Relay output 1: Running
- Relay output 2: Fault (-1)
- Relay output 3: Aux. motor ON

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



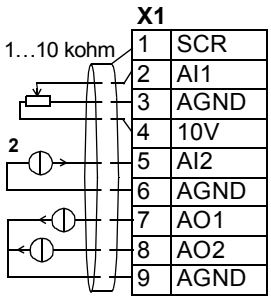
AI1: 0…10 V
AI2: 0(4)…20 mA

Note: Use the following switch-on order:
1. EXT1/EXT2
2. Run Enable
3. Start.

Torque Control macro

This macro provides parameter settings for applications that require torque control of the motor. Control can also be switched to speed control. To enable, set the value of parameter 9902 to 8 (TORQUE CTRL).

Connection example:



Signal cable shield (screen)
External speed reference 1: 0…10 V
Analog input circuit common
Reference voltage 10 V DC
External torque reference: 4…20 mA
Analog input circuit common
Motor output speed: 0…20 mA
Output current: 0…20 mA
Analog output circuit common

Auxiliary voltage output +24 V DC
Auxiliary voltage output common
Digital input common for all
Start/stop: Activation starts the drive.
Forward/reverse: Activation reverses direction[1]
Speed/torque control: Activation selects torque control
Constant speed 1: 1202
Ramp pair selection: Activate to select 2nd acc/dec ramp pair
Run enable: Deactivation always stops the drive

Relay output 1, programmable
Default operation:
Ready =>19 connected to 21

Relay output 2, programmable
Default operation:
Running =>22 connected to 24

Relay output 3, programmable
Default operation:
Fault (-1) =>25 connected to 27
(Fault => 25 connected to 26)

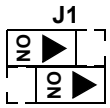
Note 1.
- Reverses rotation direction in speed control.
- Reverses torque direction in torque control.

Note 2.
The sensor for AI2 is powered externally. See the manufacturer's instructions. To use sensors supplied by the drive aux. voltage output, see page *86*.

Input signals
- Two analog references (AI1, 2)
- Start/stop and direction (DI1, 2)
- Speed/torque control (DI3)
- Constant speed selection (DI4)
- Ramp pair 1/2 selection (DI5)
- Run enable (DI6)

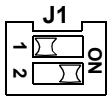
Output signals
- Analog output AO1: Speed
- Analog output AO2: Current
- Relay output 1: Ready
- Relay output 2: Running
- Relay output 3: Fault (-1)

Jumper setting



AI1: 0…10 V
AI2: 0(4)…20 mA

or



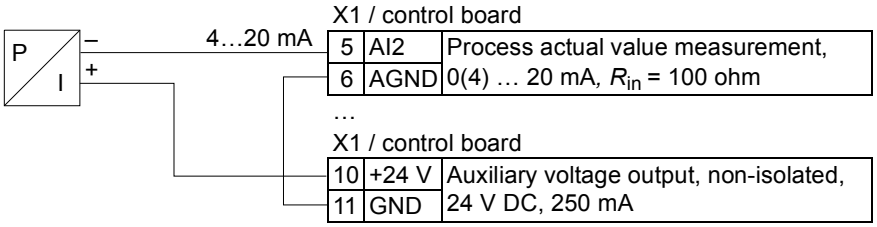
AI1: 0…10 V
AI2: 0(4)…20 mA

Connection examples of two-wire and three-wire sensors

Many applications use process PI(D) and need a feedback signal from the process. The feedback signal is typically connected to analog input 2 (AI2).

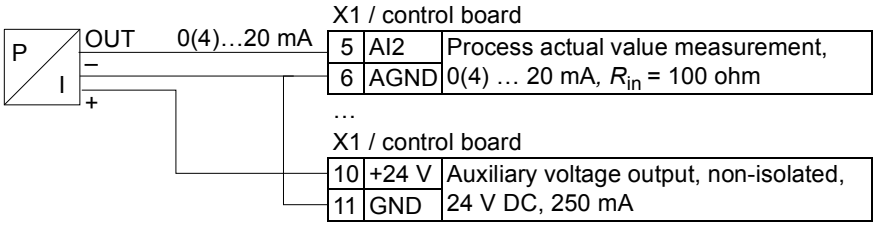
The macro wiring diagrams for each macro earlier in this chapter use an externally powered sensor (connections not shown). The figures below give examples of connections using a two-wire or three-wire sensor/transmitter supplied by the drive auxiliary voltage output.

Two-wire sensor/transmitter



Note: The sensor is supplied through its current output and the drive feeds the supply voltage (+24 V). Thus the output signal must be 4…20 mA, not 0…20 mA

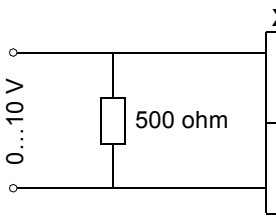
Three-wire sensor/transmitter



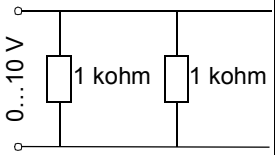
Connection for obtaining 0…10 V from analog outputs

To obtain 0…10 V from analog outputs, connect a 500 ohm resistor (or two 1 kohm resistors in parallel) between the analog output and analog output circuit common AGND.

Examples for analog output 2 AO2 are shown in the figure below.



X1		
8	AO2	Analog output 2. Default output 0…20 mA.
9	AGND	Analog input circuit common. Internally connected to chassis through a 1 Mohm resistor.



X1		
8	AO2	Analog output 2. Default output 0…20 mA.
9	AGND	Analog input circuit common. Internally connected to chassis through a 1 Mohm resistor.

User parameter sets

In addition to the standard application macros, it is possible to save two user parameter sets into the permanent memory and load them at a later time. A user parameter set consists of the user parameter settings, including *Group 99: START-UP DATA*, and the results of the motor identification. The panel reference is also saved if the user parameter set is saved and loaded in local control. The remote control setting is saved into the user parameter set, but the local control setting is not.

The steps below show how to save and load User Parameter Set 1. The procedure for User Parameter Set 2 is identical, only the parameter *9902* values are different.

To save User Parameter Set 1:

- Adjust the parameters. Perform the motor identification if it is needed in the application but it is not done yet.
- Save the parameter settings and the results of the motor identification to the permanent memory by changing parameter *9902* to -1 (USER S1 SAVE).
- Press SAVE (Assistant Control Panel) or MENU ENTER (Basic Control Panel).

To load User Parameter Set 1:

- Change parameter *9902* to 0 (USER S1 LOAD).
- Press SAVE (Assistant Control Panel) or MENU ENTER (Basic Control Panel) to load.

The user parameter set can also be switched through digital inputs (see parameter *1605*).

Note: Loading the user parameter set restores the parameter settings including *Group 99: START-UP DATA* and the results of the motor identification. Check that the settings correspond to the motor used.

Hint: The user can for example switch the drive between two motors without having to adjust the motor parameters and to repeat the motor identification every time the motor is changed. The user needs only to adjust the settings and perform the motor identification once for each motor and then to save the data as two user parameter sets. When the motor is changed, only the corresponding user parameter set needs to be loaded, and the drive is ready to operate.

Macro default values for parameters

Parameter default values are listed in section *Complete parameter list* on page *91*. Changing from the default macro (ABB Standard), that is, editing the value of parameter 9902, changes the parameter default values as defined in the following tables.

Note: There are two sets of values because the defaults are configured for 50 Hz/ IEC compliance (ACS550-01) and 60 Hz/NEMA compliance (ACS550-U1).

ACS550-01

Parameter		ABB Standard	3-wire	Alternate	Motor Potenti-ometer	Hand-auto	PID Control	PFC Control	Torque Control
9902	APPLIC MACRO	1 = ABB STANDARD	2 = 3-WIRE	3 = ALTERNATE	4 = MOTOR POT	5 = HAND/AUTO	6 = PID CONTROL	7 = PFC CONTROL	8 = TORQUE CTRL
9904	MOTOR CTRL MODE	3 = SCALAR: FREQ	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	3 = SCALAR: FREQ	2 = VECTOR: TORQUE
1001	EXT1 COMMANDS	2 = DI1,2	4 = DI1P,2P,3	9 = DI1F,2R	2 = DI1,2	2 = DI1,2	1 = DI1	1 = DI1	2 = DI1,2
1002	EXT2 COMMANDS	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	7 = DI6,5	6 = DI6	6 = DI6	2 = DI1,2
1003	DIRECTION	3 = REQUEST	3 = REQUEST	3 = REQUEST	3 = REQUEST	3 = REQUEST	1 = FORWARD	1 = FORWARD	3 = REQUEST
1102	EXT1/EXT2 SEL	0 = EXT1	0 = EXT1	0 = EXT1	0 = EXT1	3 = DI3	2 = DI2	3 = DI3	3 = DI3
1103	REF1 SELECT	1 = AI1	1 = AI1	1 = AI1	12 = DI3U,4D(NC)	1 = AI1	1 = AI1	1 = AI1	1 = AI1
1106	REF2 SELECT	2 = AI2	2 = AI2	2 = AI2	2 = AI2	2 = AI2	19 = PID1OUT	19 = PID1OUT	2 = AI2
1201	CONST SPEED SEL	9 = DI3,4	10 = DI4,5	9 = DI3,4	5 = DI5	0 = NOT SEL	9 = DI3,4	0 = NOT SEL	4 = DI4
1304	MINIMUM AI2	0.0%	0.0%	0.0%	0.0%	20.0%	20.0%	20.0%	20.0%
1401	RELAY OUTPUT 1	1 = READY	1 = READY	1 = READY	1 = READY	1 = READY	1 = READY	2 = RUN	1 = READY
1402	RELAY OUTPUT 2	2 = RUN	2 = RUN	2 = RUN	2 = RUN	2 = RUN	2 = RUN	3 = FAULT(-1)	2 = RUN
1403	RELAY OUTPUT 3	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	31 = PFC	3 = FAULT(-1)
1501	AO1 CONTENT SEL	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
1507	AO2 CONTENT SEL	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	130 = PID 1 FBK	104 = CURRENT
1510	MINIMUM AO2	0.0 mA	0.0 mA	0.0 mA	0.0 mA	0.0 mA	0.0 mA	4.0 mA	0.0 mA
1601	RUN ENABLE	0 = NOT SEL	0 = NOT SEL	6 = DI6	6 = DI6	4 = DI4	5 = DI5	2 = DI2	6 = DI6
2201	ACC/DEC 1/2 SEL	5 = DI5	0 = NOT SEL	5 = DI5	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	5 = DI5
3201	SUPERV 1 PARAM	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
3401	SIGNAL1 PARAM	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
4001	GAIN	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
4002	INTEGRATION TIME	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	3.0 s	60.0 s
4101	GAIN	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
4102	INTEGRATION TIME	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	3.0 s	60.0 s
8123	PFC ENABLE	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	1 = ACTIVE	0 = NOT SEL

ACS550-U1

Parameter		ABB Standard	3-wire	Alternate	Motor Potenti-ometer	Hand-auto	PID Control	PFC Control	Torque Control
9902	APPLIC MACRO	1 = ABB STANDARD	2 = 3-WIRE	3 = ALTERNATE	4 = MOTOR POT	5 = HAND/AUTO	6 = PID CONTROL	7 = PFC CONTROL	8 = TORQUE CTRL
9904	MOTOR CTRL MODE	3 = SCALAR: FREQ	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	1 = VECTOR: SPEED	3 = SCALAR: FREQ	2 = VECTOR: TORQUE
1001	EXT1 COMMANDS	2 = DI1,2	4 = DI1P,2P,3	9 = DI1F,2R	2 = DI1,2	2 = DI1,2	1 = DI1	1 = DI1	2 = DI1,2
1002	EXT2 COMMANDS	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	7 = DI6,5	6 = DI6	6 = DI6	2 = DI1,2
1003	DIRECTION	3 = REQUEST	3 = REQUEST	3 = REQUEST	3 = REQUEST	3 = REQUEST	1 = FORWARD	1 = FORWARD	3 = REQUEST
1102	EXT1/EXT2 SEL	0 = EXT1	0 = EXT1	0 = EXT1	0 = EXT1	3 = DI3	2 = DI2	3 = DI3	3 = DI3
1103	REF1 SELECT	1 = AI1	1 = AI1	1 = AI1	12 = DI3U,4D(NC)	1 = AI1	1 = AI1	1 = AI1	1 = AI1
1106	REF2 SELECT	2 = AI2	2 = AI2	2 = AI2	2 = AI2	2 = AI2	19 = PID1OUT	19 = PID1OUT	2 = AI2
1201	CONST SPEED SEL	9 = DI3,4	10 = DI4,5	9 = DI3,4	5 = DI5	0 = NOT SEL	9 = DI3,4	0 = NOT SEL	4 = DI4
1304	MINIMUM AI2	0.0%	0.0%	0.0%	0.0%	20.0%	20.0%	20.0%	20.0%
1401	RELAY OUTPUT 1	1 = READY	1 = READY	1 = READY	1 = READY	1 = READY	1 = READY	2 = RUN	1 = READY
1402	RELAY OUTPUT 2	2 = RUN	2 = RUN	2 = RUN	2 = RUN	2 = RUN	2 = RUN	3 = FAULT(-1)	2 = RUN
1403	RELAY OUTPUT 3	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	3 = FAULT(-1)	31 = PFC	3 = FAULT(-1)
1501	AO1 CONTENT SEL	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
1507	AO2 CONTENT SEL	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	104 = CURRENT	130 = PID 1 FBK	104 = CURRENT
1510	MINIMUM AO2	0.0 mA	0.0 mA	0.0 mA	0.0 mA	0.0 mA	0.0 mA	4.0 mA	0.0 mA
1601	RUN ENABLE	0 = NOT SEL	0 = NOT SEL	6 = DI6	6 = DI6	4 = DI4	5 = DI5	2 = DI2	6 = DI6
2201	ACC/DEC 1/2 SEL	5 = DI5	0 = NOT SEL	5 = DI5	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	5 = DI5
3201	SUPERV 1 PARAM	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
3401	SIGNAL1 PARAM	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	102 = 0102 SPEED	103 = 0103 OUTPUT FREQ	102 = 0102 SPEED
4001	GAIN	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
4002	INTEGRATION TIME	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	3.0 s	60.0 s
4101	GAIN	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
4102	INTEGRATION TIME	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	60.0 s	3.0 s	60.0 s
8123	PFC ENABLE	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	0 = NOT SEL	1 = ACTIVE	0 = NOT SEL

Parameters

Complete parameter list

The following table lists all parameters. Table header abbreviations are:

- S = Parameters can be modified only when the drive is stopped.
- User = Space to enter desired parameter values.

Some values depend on the "construction" as indicated in the table by "-01:" = Setup and parts specific to IEC installation and compliance or "-U1:" = Setup and parts specific to US installation and NEMA compliance. Refer to the type designation on the drive, for example ACS550-**01**-08A8-4.

Code	Name	Range	Resolution	Default	User	S
Group 99: START-UP DATA						
9901	LANGUAGE	0…16 / 0…3	1	0 (ENGLISH)		
9902	APPLIC MACRO	-3…8, 31	1	1 (ABB STANDARD)		✓
9904	MOTOR CTRL MODE	1 = VECTOR:SPEED, 2 = VECTOR:TORQUE, 3 = SCALAR:FREQ	1	3 (SCALAR:FREQ)		✓
9905	MOTOR NOM VOLT	-01-yyyy-2: 115…345 V / -U1-yyyy-2: 115…345 V -01-yyyy-4: 200…600 V / -U1-yyyy-4: 230…690 V -U1-yyyy-6: 288…862 V	1 V	-01-yyyy-2: 230 V / -U1-yyyy-2: 230 V -01:-yyyy-4 400 V / -U1-yyyy-4: 460 V -U1-yyyy-6: 575 V		✓
9906	MOTOR NOM CURR	0.2 · I_{2hd} … 2.0 · I_{2hd}	0.1 A	1.0 · I_{2hd}		✓
9907	MOTOR NOM FREQ	10.0…500.0 Hz	0.1 Hz	-01: 50.0 Hz / -U1: 60.0 Hz		✓
9908	MOTOR NOM SPEED	50…30000 rpm	1 rpm	Size dependent		✓
9909	MOTOR NOM POWER	0.2…3.0 · P_{hd}	-01: 0.1 kW / -U1: 0.1 hp	1.0 · P_{hd}		✓
9910	ID RUN	0 = OFF/IDMAGN, 1 = ON	1	0 (OFF/IDMAGN)		✓
9915	MOTOR COSPHI	0 = IDENTIFIED, 0.01…0.97	0.01	0 (IDENTIFIED)		✓
Group 01: OPERATING DATA						
0101	SPEED & DIR	-30000…30000 rpm	1 rpm	-		
0102	SPEED	0…30000 rpm	1 rpm	-		
0103	OUTPUT FREQ	0.0…500.0 Hz	0.1 Hz	-		
0104	CURRENT	0.0…2.0 · I_{2hd}	0.1 A	-		
0105	TORQUE	-200.0…200.0%	0.1%	-		
0106	POWER	-2.0…2.0 · P_{hd}	0.1 kW	-		
0107	DC BUS VOLTAGE	0…2.5 · V_{dN}	1 V	-		
0109	OUTPUT VOLTAGE	0…2.0 · V_{dN}	1 V	-		
0110	DRIVE TEMP	0.0…150.0 °C	0.1 °C	-		
0111	EXTERNAL REF 1	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-		
0112	EXTERNAL REF 2	0.0…100.0% (0.0…600.0% for torque)	0.1%	-		
0113	CTRL LOCATION	0 = LOCAL, 1 = EXT1, 2 = EXT2	1	-		

Code	Name	Range	Resolution	Default	User	S
0114	RUN TIME (R)	0…9999 h	1 h	-		
0115	KWH COUNTER (R)	0…65535 kWh	1 kWh	-		
0116	APPL BLK OUTPUT	0.0…100.0% (0.0…600.0% for torque)	0.1%	-		
0118	DI 1-3 STATUS	000…111 (0…7 decimal)	1	-		
0119	DI 4-6 STATUS	000…111 (0…7 decimal)	1	-		
0120	AI 1	0.0…100.0%	0.1%	-		
0121	AI 2	0.0…100.0%	0.1%	-		
0122	RO 1-3 STATUS	000…111 (0…7 decimal)	1	-		
0123	RO 4-6 STATUS	000…111 (0…7 decimal)	1	-		
0124	AO 1	0.0…20.0 mA	0.1 mA	-		
0125	AO 2	0.0…20.0 mA	0.1 mA	-		
0126	PID 1 OUTPUT	-1000.0…1000.0%	0.1%	-		
0127	PID 2 OUTPUT	-100.0…100.0%	0.1%	-		
0128	PID 1 SETPNT	Unit and scale defined by par. 4006/ 4106 and 4007/4107	-	-		
0129	PID 2 SETPNT	Unit and scale defined by par. 4206 and 4207		-		
0130	PID 1 FBK	Unit and scale defined by par. 4006/ 4106 and 4007/4107	-	-		
0131	PID 2 FBK	Unit and scale defined by par. 4206 and 4207	-	-		
0132	PID 1 DEVIATION	Unit and scale defined by par. 4006/ 4106 and 4007/4107	-	-		
0133	PID 2 DEVIATION	Unit and scale defined by par. 4206 and 4207	-	-		
0134	COMM RO WORD	0…65535	1	-		
0135	COMM VALUE 1	-32768…+32767	1	-		
0136	COMM VALUE 2	-32768…+32767	1	-		
0137	PROCESS VAR 1	-	1			
0138	PROCESS VAR 2	-	1			
0139	PROCESS VAR 3	-	1			
0140	RUN TIME	0.00…499.99 kh	0.01 kh	-		
0141	MWH COUNTER	0…65535 MWh	1 MWh	-		
0142	REVOLUTION CNTR	0…65535 Mrev	1 Mrev	-		
0143	DRIVE ON TIME HI	0…65535 days	1 day	-		
0144	DRIVE ON TIME LO	00:00:00…23:59:58	1 = 2 s	-		
0145	MOTOR TEMP	Par. 3501 = 1…3: -10…200 °C Par. 3501 = 4: 0…5000 ohm Par. 3501 = 5…6: 0…1	1	-		
0146	MECH ANGLE	0…32768	1	-		
0147	MECH REVS	-32768 …+32767	1	-		
0148	Z PLS DETECTED	0 = NOT DETECTED, 1 = DETECTED	1	-		
0150	CB TEMP	-20.0…150.0 °C	1.0 °C	-		
0153	MOT THERM STRESS	0.0…100.0%	0.1%	-		
0158	PID COMM VALUE 1	-32768 …+32767	1	-		
0159	PID COMM VALUE 2	-32768 …+32767	1	-		
0174	SAVED KWH	0.0…999.9 kWh	0.1 kWh	-		

Code	Name	Range	Resolution	Default	User	S
0175	SAVED MWH	0…65535 MWh	1 MWh	-		
0176	SAVED AMOUNT 1	0.0…999.9	0.1	-		
0177	SAVED AMOUNT 2	0…65535	1	-		
0178	SAVED CO2	0.0…6553.5 tn	0.1 tn	-		
Group 03: FB ACTUAL SIGNALS						
0301	FB CMD WORD 1	-	-	-		
0302	FB CMD WORD 2	-	-	-		
0303	FB STS WORD 1	-	-	-		
0304	FB STS WORD 2	-	1	-		
0305	FAULT WORD 1	-	1	-		
0306	FAULT WORD 2	-	1	-		
0307	FAULT WORD 3	-	1	-		
0308	ALARM WORD 1	-	1	-		
0309	ALARM WORD 2	-	1	-		
Group 04: FAULT HISTORY						
0401	LAST FAULT	Fault codes (panel displays as text)	1	0		
0402	FAULT TIME 1	Date dd.mm.yy / power-on time in days	1 day	0		
0403	FAULT TIME 2	Time hh.mm.ss	2 s	0		
0404	SPEED AT FLT	-32768…+32767	1 rpm	0		
0405	FREQ AT FLT	-3276.8…+3276.7	0.1 Hz	0		
0406	VOLTAGE AT FLT	0.0…6553.5	0.1 V	0		
0407	CURRENT AT FLT	0.0…6553.5	0.1 A	0		
0408	TORQUE AT FLT	-3276.8…+3276.7	0.1%	0		
0409	STATUS AT FLT	0000…FFFF hex	1	0		
0410	DI 1-3 AT FLT	000…111 (0…7 decimal)	1	0		
0411	DI 4-6 AT FLT	000…111 (0…7 decimal)	1	0		
0412	PREVIOUS FAULT 1	As par. 0401	1	0		
0413	PREVIOUS FAULT 2	As par. 0401	1	0		
Group 10: START/STOP/DIR						
1001	EXT1 COMMANDS	0…14	1	2 (DI1,2)		✓
1002	EXT2 COMMANDS	0…14	1	0 (NOT SEL)		✓
1003	DIRECTION	1 = FORWARD, 2 = REVERSE, 3 = REQUEST	1	3 (REQUEST)		✓
1004	JOGGING SEL	-6…6	1	0 (NOT SEL)		✓
Group 11: REFERENCE SELECT						
1101	KEYPAD REF SEL	1 = REF1(Hz/rpm), 2 = REF2(%)	1	1 [REF1(Hz/rpm)]		
1102	EXT1/EXT2 SEL	-6…12	1	0 (EXT1)		✓
1103	REF1 SELECT	0…17, 20…21	1	1 (AI1)		✓
1104	REF1 MIN	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
1105	REF1 MAX	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 50.0 (52.0) Hz / 1500 rpm -U1: 60.0 (62.0) Hz / 1800 rpm		
1106	REF2 SELECT	0…17, 19…21	1	2 (AI2)		✓
1107	REF2 MIN	0.0…100.0% (0.0…600.0% for torque)	0.1%	0.0%		
1108	REF2 MAX	0.0…100.0% (0.0…600.0% for torque)	0.1%	100.0%		

Code	Name	Range	Resolution	Default	User	S
Group 12: CONSTANT SPEEDS						
1201	CONST SPEED SEL	-14 …19	1	9 (DI3,4)		✓
1202	CONST SPEED 1	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 5.0 Hz / 300 rpm -U1: 6.0 Hz / 360 rpm		
1203	CONST SPEED 2	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 10.0 Hz / 600 rpm -U1: 12.0 Hz / 720 rpm		
1204	CONST SPEED 3	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 15.0 Hz / 900 rpm -U1: 18.0 Hz / 1080 rpm		
1205	CONST SPEED 4	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 20.0 Hz / 1200 rpm -U1: 24.0 Hz / 1440 rpm		
1206	CONST SPEED 5	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 25.0 Hz / 1500 rpm -U1: 30.0 Hz / 1800 rpm		
1207	CONST SPEED 6	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 40.0 Hz / 2400 rpm -U1: 48.0 Hz / 2880 rpm		
1208	CONST SPEED 7	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-01: 50.0 Hz / 3000 rpm -U1: 60.0 Hz / 3600 rpm		
1209	TIMED MODE SEL	1 = EXT/CS1/2/3, 2 = CS1/2/3/4	1	2 (CS1/2/3/4)		✓
Group 13: ANALOG INPUTS						
1301	MINIMUM AI1	0.0…100.0%	0.1%	0.0%		
1302	MAXIMUM AI1	0.0…100.0%	0.1%	100.0%		
1303	FILTER AI1	0.0…10.0 s	0.1 s	0.1 s		
1304	MINIMUM AI2	0.0…100.0%	0.1%	0.0%		
1305	MAXIMUM AI2	0.0…100.0%	0.1%	100.0%		
1306	FILTER AI2	0.0…10.0 s	0.1 s	0.1 s		
Group 14: RELAY OUTPUTS						
1401	RELAY OUTPUT 1	0…44, 46, 47, 52	1	1 (READY)		
1402	RELAY OUTPUT 2	0…44, 46, 47, 52	1	2 (RUN)		
1403	RELAY OUTPUT 3	0…44, 46, 47, 52	1	3 [FAULT(-1)]		
1404	RO 1 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1405	RO 1 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1406	RO 2 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1407	RO 2 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1408	RO 3 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1409	RO 3 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1410	RELAY OUTPUT 4	0…44, 46, 47, 52	1	0 (NOT SEL)		
1411	RELAY OUTPUT 5	0…44, 46, 47, 52	1	0 (NOT SEL)		
1412	RELAY OUTPUT 6	0…44, 46, 47, 52	1	0 (NOT SEL)		
1413	RO 4 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1414	RO 4 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1415	RO 5 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1416	RO 5 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1417	RO 6 ON DELAY	0.0…3600.0 s	0.1 s	0.0 s		
1418	RO 6 OFF DELAY	0.0…3600.0 s	0.1 s	0.0 s		
Group 15: ANALOG OUTPUTS						
1501	AO1 CONTENT SEL	99…178	1	103 (parameter 0103 OUTPUT FREQ)		

Code	Name	Range	Resolution	Default	User	S
1502	AO1 CONTENT MIN	-	-	Depends on the signal selected with par. 1501		
1503	AO1 CONTENT MAX	-	-	Depends on the signal selected with par. 1501		
1504	MINIMUM AO1	0.0…20.0 mA	0.1 mA	0.0 mA		
1505	MAXIMUM AO1	0.0…20.0 mA	0.1 mA	20.0 mA		
1506	FILTER AO1	0.0…10.0 s	0.1 s	0.1 s		
1507	AO2 CONTENT SEL	99…178	1	104 (parameter 0104 CURRENT)		
1508	AO2 CONTENT MIN	-	-	Depends on the signal selected with par. 1507		
1509	AO2 CONTENT MAX	-	-	Depends on the signal selected with par. 1507		
1510	MINIMUM AO2	0.0…20.0 mA	0.1 mA	0.0 mA		
1511	MAXIMUM AO2	0.0…20.0 mA	0.1 mA	20.0 mA		
1512	FILTER AO2	0.0…10.0 s	0.1 s	0.1 s		
Group 16: SYSTEM CONTROLS						
1601	RUN ENABLE	-6…7	1	0 (NOT SEL)		✓
1602	PARAMETER LOCK	0 = LOCKED, 1 = OPEN, 2 = NOT SAVED	1	1 (OPEN)		
1603	PASS CODE	0…65535	1	0		
1604	FAULT RESET SEL	-6…8	1	0 (KEYPAD)		
1605	USER PAR SET CHG	-6…6	1	0 (NOT SEL)		
1606	LOCAL LOCK	-6…8	1	0 (NOT SEL)		
1607	PARAM SAVE	0 = DONE, 1 = SAVE…	1	0 (DONE)		
1608	START ENABLE 1	-6…7	1	0 (NOT SEL)		✓
1609	START ENABLE 2	-6…7	1	0 (NOT SEL)		✓
1610	DISPLAY ALARMS	0 = NO, 1 = YES	1	0 (NO)		
1611	PARAMETER VIEW	0 = DEFAULT, 1 = FLASHDROP	1	0 (DEFAULT)		
1612	FAN CONTROL	0 = AUTO,1 = ON	1	0 (AUTO)		
1613	FAULT RESET	0 = DEFAULT, 1 = RESET NOW	1	0 (DEFAULT)		
Group 20: LIMITS						
2001	MINIMUM SPEED	-30000…30000 rpm	1 rpm	0 rpm		✓
2002	MAXIMUM SPEED	0…30000 rpm	1 rpm	-01: 1500 rpm / -U1: 1800 rpm		✓
2003	MAX CURRENT	0… 1.8 · I_{2hd}	0.1 A	1.8 · I_{2hd}		✓
2005	OVERVOLT CTRL	0 = DISABLE, 1 = ENABLE	1	1 (ENABLE)		
2006	UNDERVOLT CTRL	0 = DISABLE, 1 = ENABLE(TIME), 2 = ENABLE	1	1 [ENABLE(TIME)]		
2007	MINIMUM FREQ	-500.0…500.0 Hz	0.1 Hz	0.0 Hz		✓
2008	MAXIMUM FREQ	0.0…500.0 Hz	0.1 Hz	-01: 50.0 (52.0) Hz / -U1: 60.0 (62.0) Hz		✓
2013	MIN TORQUE SEL	-6…7	1	0 (MIN TORQUE 1)		
2014	MAX TORQUE SEL	-6…7	1	0 (MAX TORQUE 1)		
2015	MIN TORQUE 1	-600.0…0.0%	0.1%	-300.0%		
2016	MIN TORQUE 2	-600.0…0.0%	0.1%	-300.0%		
2017	MAX TORQUE 1	0.0…600.0%	0.1%	300.0%		
2018	MAX TORQUE 2	0.0…600.0%	0.1%	300.0%		

Code	Name	Range	Resolution	Default	User	S
Group 21: START/STOP						
2101	START FUNCTION	Vector control modes: 1, 2, 8 Scalar control mode: 1…5, 8	1	8 (RAMP)		✓
2102	STOP FUNCTION	1 = COAST, 2 = RAMP	1	1 (COAST)		
2103	DC MAGN TIME	0.00…10.00 s	0.01 s	0.30 s		
2104	DC HOLD CTL	0 = NOT SEL, 1 = DC HOLD, 2 = DC BRAKING	1	0 (NOT SEL)		✓
2105	DC HOLD SPEED	0…360 rpm	1 rpm	5 rpm		
2106	DC CURR REF	0…100%	1%	30%		
2107	DC BRAKE TIME	0.0…250.0 s	0.1 s	0.0 s		
2108	START INHIBIT	0 = OFF, 1 = ON	1	0 (OFF)		
2109	EMERG STOP SEL	-6…6	1	0 (NOT SEL)		
2110	TORQ BOOST CURR	15…300%	1%	100%		
2112	ZERO SPEED DELAY	0.0 = NOT SEL, 0.1…60.0 s	0.1 s	0.0 s (NOT SEL)		
2113	START DELAY	0.00…60.00 s	0.01 s	0.00 s		
Group 22: ACCEL/DECEL						
2201	ACC/DEC 1/2 SEL	-6…7	1	5 (DI5)		
2202	ACCELER TIME 1	0.0…1800.0 s	0.1 s	5.0 s		
2203	DECELER TIME 1	0.0…1800.0 s	0.1 s	5.0 s		
2204	RAMP SHAPE 1	0.0 = LINEAR, 0.1…1000.0 s	0.1 s	0.0 s		
2205	ACCELER TIME 2	0.0…1800.0 s	0.1 s	60.0 s		
2206	DECELER TIME 2	0.0…1800.0 s	0.1 s	60.0 s		
2207	RAMP SHAPE 2	0.0 = LINEAR, 0.1…1000.0 s	0.1 s	0.0 s		
2208	EMERG DEC TIME	0.0…1800.0 s	0.1 s	1.0 s		
2209	RAMP INPUT 0	-6…7	1	0 (NOT SEL)		
Group 23: SPEED CONTROL						
2301	PROP GAIN	0.00…200.00	0.01	5.00		
2302	INTEGRATION TIME	0.00…600.00 s	0.01 s	0.50 s		
2303	DERIVATION TIME	0…10000 ms	1 ms	0 ms		
2304	ACC COMPENSATION	0.00…600.00 s	0.01 s	0.00 s		
2305	AUTOTUNE RUN	0 = OFF, 1 = ON	1	0 (OFF)		
Group 24: TORQUE CONTROL						
2401	TORQ RAMP UP	0.00…120.00 s	0.01 s	0.00 s		
2402	TORQ RAMP DOWN	0.00…120.00 s	0.01 s	0.00 s		
Group 25: CRITICAL SPEEDS						
2501	CRIT SPEED SEL	0 = OFF, 1 = ON	1	0 (OFF)		
2502	CRIT SPEED 1 LO	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
2503	CRIT SPEED 1 HI	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
2504	CRIT SPEED 2 LO	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
2505	CRIT SPEED 2 HI	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
2506	CRIT SPEED 3 LO	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
2507	CRIT SPEED 3 HI	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
Group 26: MOTOR CONTROL						
2601	FLUX OPT ENABLE	0 = OFF, 1 = ON	1	0 (OFF)		
2602	FLUX BRAKING	0 = OFF, 1 = ON	1	0 (OFF)		

Code	Name	Range	Resolution	Default	User	S
2603	IR COMP VOLT	0.0…100.0 V	0.1 V	Size dependent		
2604	IR COMP FREQ	0…100%	1%	80%		
2605	U/F RATIO	1 = LINEAR, 2 = SQUARED	1	1 (LINEAR)		
2606	SWITCHING FREQ	1, 2, 4, 8, 12 kHz	-	4 kHz		
2607	SWITCH FREQ CTRL	0 = OFF, 1 = ON	1	1 (ON)		
2608	SLIP COMP RATIO	0…200%	1%	0%		
2609	NOISE SMOOTHING	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
2619	DC STABILIZER	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
2625	OVERMODULATION	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
Group 29: MAINTENANCE TRIG						
2901	COOLING FAN TRIG	0.0…6553.5 kh, 0.0 disables	0.1 kh	0.0 kh		
2902	COOLING FAN ACT	0.0…6553.5 kh	0.1 kh	0.0 kh		
2903	REVOLUTION TRIG	0…65535 Mrev, 0 disables	1 Mrev	0 Mrev		
2904	REVOLUTION ACT	0…65535 Mrev	1 Mrev	0 Mrev		
2905	RUN TIME TRIG	0.0…6553.5 kh, 0.0 disables	0.1 kh	0.0 kh		
2906	RUN TIME ACT	0.0…6553.5 kh	0.1 kh	0.0 kh		
2907	USER MWh TRIG	0.0…6553.5 MWh, 0.0 disables	0.1 MWh	0.0 MWh		
2908	USER MWh ACT	0.0…6553.5 MWh	0.1 MWh	0.0 MWh		
Group 30: FAULT FUNCTIONS						
3001	AI<MIN FUNCTION	0…3	1	0 (NOT SEL)		
3002	PANEL COMM ERR	1…3	1	1 (FAULT)		
3003	EXTERNAL FAULT 1	-6…6	1	0 (NOT SEL)		
3004	EXTERNAL FAULT 2	-6…6	1	0 (NOT SEL)		
3005	MOT THERM PROT	0 = NOT SEL, 1 = FAULT, 2 = ALARM	1	1 (FAULT)		
3006	MOT THERM TIME	256…9999 s	1 s	500 s		
3007	MOT LOAD CURVE	50…150%	1%	100%		
3008	ZERO SPEED LOAD	25…150%	1%	70%		
3009	BREAK POINT FREQ	1…250 Hz	1 Hz	35 Hz		
3010	STALL FUNCTION	0 = NOT SEL, 1 = FAULT, 2 = ALARM	1	0 (NOT SEL)		
3011	STALL FREQUENCY	0.5…50.0 Hz	0.1 Hz	20.0 Hz		
3012	STALL TIME	10…400 s	1 s	20 s		
3017	EARTH FAULT	0 = DISABLE, 1 = ENABLE	1	1 (ENABLE)		✓
3018	COMM FAULT FUNC	0 = NOT SEL, 1 = FAULT, 2 = CONST SP 7, 3 = LAST SPEED	1	0 (NOT SEL)		
3019	COMM FAULT TIME	0.0…600.0 s	0.1 s	3.0 s		
3021	AI1 FAULT LIMIT	0.0…100.0%	0.1%	0.0%		
3022	AI2 FAULT LIMIT	0.0…100.0%	0.1%	0.0%		
3023	WIRING FAULT	0 = DISABLE, 1 = ENABLE	1	1 (ENABLE)		✓
3024	CB TEMP FAULT	0 = DISABLE, 1 = ENABLE	1	1 (ENABLE)		
3028	EARTH FAULT LVL	1…3	1	-01: 2 (MEDIUM) -U1: 1 (LOW)		
Group 31: AUTOMATIC RESET						
3101	NUMBER OF TRIALS	0…5	1	0		
3102	TRIAL TIME	1.0…600.0 s	0.1 s	30.0 s		
3103	DELAY TIME	0.0…120.0 s	0.1 s	0.0 s		

Code	Name	Range	Resolution	Default	User	S
3104	AR OVERCURRENT	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
3105	AR OVERVOLTAGE	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
3106	AR UNDERVOLTAGE	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
3107	AR AI<MIN	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
3108	AR EXTERNAL FLT	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
Group 32: SUPERVISION						
3201	SUPERV 1 PARAM	100 = NOT SELECTED, 101…178	1	103 (parameter 0103 OUTPUT FREQ)		
3202	SUPERV 1 LIM LO	-	-	Depends on the signal selected with par. 3201		
3203	SUPERV 1 LIM HI	-	-	Depends on the signal selected with par. 3201		
3204	SUPERV 2 PARAM	100 = NOT SELECTED, 101…178	1	104 (parameter 0104 CURRENT)		
3205	SUPERV 2 LIM LO	-	-	Depends on the signal selected with par. 3204		
3206	SUPERV 2 LIM HI	-	-	Depends on the signal selected with par. 3204		
3207	SUPERV 3 PARAM	100 = NOT SELECTED, 101…178	1	105 (parameter 0105 TORQUE)		
3208	SUPERV 3 LIM LO	-	-	Depends on the signal selected with par. 3207		
3209	SUPERV 3 LIM HI	-	-	Depends on the signal selected with par. 3207		
Group 33: INFORMATION						
3301	FIRMWARE	0000…FFFF hex	1	Firmware version		
3302	LOADING PACKAGE	0000…FFFF hex	1	Type dependent		
3303	TEST DATE	yy.ww	0.01	-		
3304	DRIVE RATING	-	-	Type dependent		
3305	PARAMETER TABLE	0000…FFFF hex	1	Type dependent		
Group 34: PANEL DISPLAY						
3401	SIGNAL1 PARAM	100 = NOT SELECTED, 101…178	1	103 (parameter 0103 OUTPUT FREQ)		
3402	SIGNAL1 MIN	-	-	Depends on the signal selected with par. 3401		
3403	SIGNAL1 MAX	-	-	Depends on the signal selected with par. 3401		
3404	OUTPUT1 DSP FORM	0…9	1	9 (DIRECT)		
3405	OUTPUT1 UNIT	0…127	1	Depends on the signal selected with par. 3401		
3406	OUTPUT1 MIN	-	-	Depends on the signal selected with par. 3401		
3407	OUTPUT1 MAX	-	-	Depends on the signal selected with par. 3401		
3408	SIGNAL2 PARAM	100 = NOT SELECTED, 101…178	1	104 (parameter 0104 CURRENT)		
3409	SIGNAL2 MIN	-	-	Depends on the signal selected with par. 3408		
3410	SIGNAL2 MAX	-	-	Depends on the signal selected with par. 3408		

Code	Name	Range	Resolution	Default	User	S
3411	OUTPUT2 DSP FORM	0…9	1	9 (DIRECT)		
3412	OUTPUT2 UNIT	0…127	1	Depends on the signal selected with par. 3408		
3413	OUTPUT2 MIN	-	-	Depends on the signal selected with par. 3408		
3414	OUTPUT2 MAX	-	-	Depends on the signal selected with par. 3408		
3415	SIGNAL3 PARAM	100 = NOT SELECTED, 101…178	1	105 (parameter 0105 TORQUE)		
3416	SIGNAL3 MIN	-	-	Depends on the signal selected with par. 3415		
3417	SIGNAL3 MAX	-	-	Depends on the signal selected with par. 3415		
3418	OUTPUT3 DSP FORM	0…9	1	9 (DIRECT)		
3419	OUTPUT3 UNIT	0…127	1	Depends on the signal selected with par. 3415		
3420	OUTPUT3 MIN	-	-	Depends on the signal selected with par. 3415		
3421	OUTPUT3 MAX	-	-	Depends on the signal selected with par. 3415		
Group 35: MOTOR TEMP MEAS						
3501	SENSOR TYPE	0…6	1	0 (NONE)		
3502	INPUT SELECTION	1…8	1	1 (AI1)		
3503	ALARM LIMIT	Par. 3501 = 1…3: -10…200 °C Par. 3501 = 4: 0…5000 ohm Par. 3501 = 5…6: 0…1	1	110 °C / 1500 ohm / 0		
3504	FAULT LIMIT	Par. 3501 = 1…3: -10…200 °C Par. 3501 = 4: 0…5000 ohm Par. 3501 = 5…6: 0…1	1	130 °C / 4000 ohm / 0		
Group 36: TIMED FUNCTIONS						
3601	TIMERS ENABLE	-6…7	1	0 (NOT SEL)		
3602	START TIME 1	00:00:00…23:59:58	2 s	00:00:00		
3603	STOP TIME 1	00:00:00…23:59:58	2 s	00:00:00		
3604	START DAY 1	1…7	1	1 (MONDAY)		
3605	STOP DAY 1	1…7	1	1 (MONDAY)		
3606	START TIME 2	00:00:00…23:59:58	2 s	00:00:00		
3607	STOP TIME 2	00:00:00…23:59:58	2 s	00:00:00		
3608	START DAY 2	1…7	1	1 (MONDAY)		
3609	STOP DAY 2	1…7	1	1 (MONDAY)		
3610	START TIME 3	00:00:00…23:59:58	2 s	00:00:00		
3611	STOP TIME 3	00:00:00…23:59:58	2 s	00:00:00		
3612	START DAY 3	1…7	1	1 (MONDAY)		
3613	STOP DAY 3	1…7	1	1 (MONDAY)		
3614	START TIME 4	00:00:00…23:59:58	2 s	00:00:00		
3615	STOP TIME 4	00:00:00…23:59:58	2 s	00:00:00		
3616	START DAY 4	1…7	1	1 (MONDAY)		
3617	STOP DAY 4	1…7	1	1 (MONDAY)		
3622	BOOSTER SEL	-6…6	1	0 (NOT SEL)		
3623	BOOSTER TIME	00:00:00…23:59:58	2 s	00:00:00		

Code	Name	Range	Resolution	Default	User	S
3626 … 3629	TIMED FUNC 1…4 SRC	0…31	1	0 (NOT SEL)		
Group 37: USER LOAD CURVE						
3701	USER LOAD C MODE	0…3	1	0 (NOT SEL)		
3702	USER LOAD C FUNC	1 = FAULT, 2 = ALARM	1	1 (FAULT)		
3703	USER LOAD C TIME	10…400 s	1 s	20 s		
3704	LOAD FREQ 1	0…500 Hz	1 Hz	5 Hz		
3705	LOAD TORQ LOW 1	0…600%	1%	10%		
3706	LOAD TORQ HIGH 1	0…600%	1%	300%		
3707	LOAD FREQ 2	0…500 Hz	1 Hz	25 Hz		
3708	LOAD TORQ LOW 2	0…600%	1%	15%		
3709	LOAD TORQ HIGH 2	0…600%	1%	300%		
3710	LOAD FREQ 3	0…500 Hz	1 Hz	43 Hz		
3711	LOAD TORQ LOW 3	0…600%	1%	25%		
3712	LOAD TORQ HIGH 3	0…600%	1%	300%		
3713	LOAD FREQ 4	0…500 Hz	1 Hz	50 Hz		
3714	LOAD TORQ LOW 4	0…600%	1%	30%		
3715	LOAD TORQ HIGH 4	0…600%	1%	300%		
3716	LOAD FREQ 5	0…500 Hz	1 Hz	500 Hz		
3717	LOAD TORQ LOW 5	0…600%	1%	30%		
3718	LOAD TORQ HIGH 5	0…600%	1%	300%		
Group 40: PROCESS PID SET 1						
4001	GAIN	0.1…100.0	0.1	1.0		
4002	INTEGRATION TIME	0.0 = NOT SEL, 0.1…3600.0 s	0.1 s	60.0 s		
4003	DERIVATION TIME	0.0…10.0 s	0.1 s	0.0 s		
4004	PID DERIV FILTER	0.0…10.0 s	0.1 s	1.0 s		
4005	ERROR VALUE INV	0 = NO, 1 = YES	1	0 (NO)		
4006	UNITS	0…127	1	4 (%)		
4007	UNIT SCALE	0…4	1	1		
4008	0% VALUE	Unit and scale defined by par. 4006 and 4007	-	0.0		
4009	100% VALUE	Unit and scale defined by par. 4006 and 4007	-	100.0		
4010	SET POINT SEL	0…2, 8…17, 19…20	1	1 (AI1)		✓
4011	INTERNAL SETPNT	Unit and scale defined by par. 4006 and 4007	-	40.0		
4012	SETPOINT MIN	-500.0…500.0%	0.1%	0.0%		
4013	SETPOINT MAX	-500.0…500.0%	0.1%	100.0%		
4014	FBK SEL	1…13	1	1 (ACT1)		
4015	FBK MULTIPLIER	0.000 = NOT SEL, -32.768…32.767	0.001	0.000 (NOT SEL)		
4016	ACT1 INPUT	1…7	1	2 (AI2)		✓
4017	ACT2 INPUT	1…7	1	2 (AI2)		✓
4018	ACT1 MINIMUM	-1000…1000%	1%	0%		
4019	ACT1 MAXIMUM	-1000…1000%	1%	100%		
4020	ACT2 MINIMUM	-1000…1000%	1%	0%		

Code	Name	Range	Resolution	Default	User	S
4021	ACT2 MAXIMUM	-1000…1000%	1%	100%		
4022	SLEEP SELECTION	-6…7	1	0 (NOT SEL)		
4023	PID SLEEP LEVEL	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
4024	PID SLEEP DELAY	0.0…3600.0 s	0.1 s	60.0 s		
4025	WAKE-UP DEV	Unit and scale defined by par. 4006 and 4007	-	0.0		
4026	WAKE-UP DELAY	0.00…60.00 s	0.01 s	0.50 s		
4027	PID 1 PARAM SET	-6…14	1	0 (SET 1)		
Group 41: PROCESS PID SET 2						
4101	GAIN	0.1…100.0	0.1	1.0		
4102	INTEGRATION TIME	0.0 = NOT SEL, 0.1…3600.0 s	0.1 s	60.0 s		
4103	DERIVATION TIME	0.0…10.0 s	0.1 s	0.0 s		
4104	PID DERIV FILTER	0.0…10.0 s	0.1 s	1.0 s		
4105	ERROR VALUE INV	0 = NO, 1 = YES	1	0 (NO)		
4106	UNITS	0…127	1	4 (%)		
4107	UNIT SCALE	0…4	1	1		
4108	0% VALUE	Unit and scale defined by par. 4106 and 4107	-	0.0		
4109	100% VALUE	Unit and scale defined by par. 4106 and 4107	-	100.0		
4110	SET POINT SEL	0…2, 8…17, 19…20	1	1 (AI1)		✓
4111	INTERNAL SETPNT	Unit and scale defined by par. 4106 and 4107	-	40.0		
4112	SETPOINT MIN	-500.0…500.0%	0.1%	0.0%		
4113	SETPOINT MAX	-500.0…500.0%	0.1%	100.0%		
4114	FBK SEL	1…13	1	1 (ACT1)		
4115	FBK MULTIPLIER	0.000 = NOT SEL, -32.768…32.767	0.001	0.000 (NOT SEL)		
4116	ACT1 INPUT	1…7	1	2 (AI2)		✓
4117	ACT2 INPUT	1…7	1	2 (AI2)		✓
4118	ACT1 MINIMUM	-1000…1000%	1%	0%		
4119	ACT1 MAXIMUM	-1000…1000%	1%	100%		
4120	ACT2 MINIMUM	-1000…1000%	1%	0%		
4121	ACT2 MAXIMUM	-1000…1000%	1%	100%		
4122	SLEEP SELECTION	-6…7	1	0 (NOT SEL)		
4123	PID SLEEP LEVEL	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	0.0 Hz / 0 rpm		
4124	PID SLEEP DELAY	0.0…3600.0 s	0.1 s	60.0 s		
4125	WAKE-UP DEV	Unit and scale defined by par. 4106 and 4107	-	0.0		
4126	WAKE-UP DELAY	0.00…60.00 s	0.01 s	0.50 s		
Group 42: EXT / TRIM PID						
4201	GAIN	0.1…100.0	0.1	1.0		
4202	INTEGRATION TIME	0.0 = NOT SEL, 0.1…3600.0 s	0.1 s	60.0 s		
4203	DERIVATION TIME	0.0…10.0 s	0.1 s	0.0 s		
4204	PID DERIV FILTER	0.0…10.0 s	0.1 s	1.0 s		
4205	ERROR VALUE INV	0 = NO, 1 = YES	1	0 (NO)		
4206	UNITS	0…127	1	4 (%)		

Code	Name	Range	Resolution	Default	User	S
4207	UNIT SCALE	0…4	1	1		
4208	0% VALUE	Unit and scale defined by par. 4206 and 4207	-	0.0		
4209	100% VALUE	Unit and scale defined by par. 4206 and 4207	-	100.0		
4210	SET POINT SEL	0…2, 8…17, 19…20	1	1 (AI1)		✓
4211	INTERNAL SETPNT	Unit and scale defined by par. 4206 and 4207	-	40.0		
4212	SETPOINT MIN	-500.0…500.0%	0.1%	0.0%		
4213	SETPOINT MAX	-500.0…500.0%	0.1%	100.0%		
4214	FBK SEL	1…13	1	1 (ACT1)		
4215	FBK MULTIPLIER	0.000 = NOT SEL, -32.768…32.767	0.001	0.000 (NOT SEL)		
4216	ACT1 INPUT	1…7	1	2 (AI2)		✓
4217	ACT2 INPUT	1…7	1	2 (AI2)		✓
4218	ACT1 MINIMUM	-1000…1000%	1%	0%		
4219	ACT1 MAXIMUM	-1000…1000%	1%	100%		
4220	ACT2 MINIMUM	-1000…1000%	1%	0%		
4221	ACT2 MAXIMUM	-1000…1000%	1%	100%		
4228	ACTIVATE	-6…12	1	0 (NOT SEL)		
4229	OFFSET	0.0…100.0%	0.1%	0.0%		
4230	TRIM MODE	0 = NOT SEL, 1 = PROPORTIONAL, 3 = DIRECT	1	0 (NOT SEL)		
4231	TRIM SCALE	-100.0…100.0%	0.1%	0.0%		
4232	CORRECTION SRC	1 = PID2REF, 2 = PID2OUTPUT	1	1 (PID2REF)		
Group 45: ENERGY SAVING						
4502	ENERGY PRICE	0.00…655.35	0.01	0.00		
4507	CO2 CONV FACTOR	0.0…10.0 tn/MWh	0.1 tn/MWh	0.5 tn/MWh		
4508	PUMP POWER	0.0…1000.0%	0.1%	100.0%		
4509	ENERGY RESET	0 = DONE, 1 = RESET	1	0 (DONE)		
Group 50: ENCODER						
5001	PULSE NR	50…16384	1	1024		✓
5002	ENCODER ENABLE	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		✓
5003	ENCODER FAULT	1 = FAULT, 2 = ALARM	1	1 (FAULT)		✓
5010	Z PLS ENABLE	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		✓
5011	POSITION RESET	0 = DISABLE, 1 = ENABLE	1	0 (DISABLE)		
Group 51: EXT COMM MODULE						
5101	FBA TYPE	-	-	0 (NOT DEFINED)		
5102… 5126	FB PAR 2…26	0…65535	1	0		
5127	FBA PAR REFRESH	0 = DONE, 1 = REFRESH	1	0 (DONE)		✓
5128	FILE CPI FW REV	0000…FFFF hex	1	0		
5129	FILE CONFIG ID	0000…FFFF hex	1	0		
5130	FILE CONFIG REV	0000…FFFF hex	1	0		
5131	FBA STATUS	0…6	1	0 (IDLE)		
5132	FBA CPI FW REV	0000…FFFF hex	1	0		
5133	FBA APPL FW REV	0000…FFFF hex	1	0		

Code	Name	Range	Resolution	Default	User	S
Group 52: PANEL COMM						
5201	STATION ID	1…247	1	1		
5202	BAUD RATE	9.6, 19.2, 38.4, 57.6, 115.2 kbits/s	-	9.6 kbits/s		
5203	PARITY	0 = 8 NONE 1, 1 = 8 NONE 2, 2 = 8 EVEN 1, 3 = 8 ODD 1	1	0 (8 NONE 1)		
5204	OK MESSAGES	0…65535	1	-		
5205	PARITY ERRORS	0…65535	1	-		
5206	FRAME ERRORS	0…65535	1	-		
5207	BUFFER OVERRUNS	0…65535	1	-		
5208	CRC ERRORS	0…65535	1	-		
Group 53: EFB PROTOCOL						
5301	EFB PROTOCOL ID	0…0xFFFF	1	0		
5302	EFB STATION ID	0…65535	1	1		✓
5303	EFB BAUD RATE	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 76.8 kbits/s	-	9.6 kbits/s		
5304	EFB PARITY	0 = 8 NONE 1, 1 = 8 NONE 2, 2 = 8 EVEN 1, 3 = 8 ODD 1		0 (8 NONE 1)		
5305	EFB CTRL PROFILE	0 = ABB DRV LIM, 1 = DCU PROFILE, 2 = ABB DRV FULL	1	0 (ABB DRV LIM)		
5306	EFB OK MESSAGES	0…65535	1	0		
5307	EFB CRC ERRORS	0…65535	1	0		
5308	EFB UART ERRORS	0…65535	1	0		
5309	EFB STATUS	0…7	1	0 (IDLE)		
5310	EFB PAR 10	0…65535	1	0		
5311	EFB PAR 11	0…65535	1	0		
5312	EFB PAR 12	0…65535	1	0		
5313	EFB PAR 13	0…65535	1	0		
5314	EFB PAR 14	0…65535	1	0		
5315	EFB PAR 15	0…65535	1	0		
5316	EFB PAR 16	0…65535	1	0		
5317	EFB PAR 17	0…65535	1	0		
5318	EFB PAR 18	0…65535	1	0		
5319	EFB PAR 19	0000…FFFF hex	1	0		
5320	EFB PAR 20	0000…FFFF hex	1	0		
Group 64: LOAD ANALYZER						
6401	PVL SIGNAL	100…178	1	103 (parameter 0103 OUTPUT FREQ)		
6402	PVL FILTER TIME	0.0…120.0 s	0.1 s	0.1 s		
6403	LOGGERS RESET	-6…7	1	0 (NOT SEL)		
6404	AL2 SIGNAL	101…178	1	103 (parameter 0103 OUTPUT FREQ)		
6405	AL2 SIGNAL BASE	-	-	Depends on the signal selected with par. 6404.		
6406	PEAK VALUE	-	-	-		
6407	PEAK TIME 1	Date dd.mm.yy / power-on time in days	1 d	-		
6408	PEAK TIME 2	Time hh.mm.ss	2 s	-		
6409	CURRENT AT PEAK	0.0…6553.5 A	0.1 A	-		

Code	Name	Range	Resolution	Default	User	S
6410	UDC AT PEAK	0…65535 V	1 V	-		
6411	FREQ AT PEAK	0.0…6553.5 Hz	0.1 Hz	-		
6412	TIME OF RESET 1	Date dd.mm.yy / power-on time in days	1 d	-		
6413	TIME OF RESET 2	Time hh.mm.ss	2 s	-		
6414	AL1RANGE0TO10	0.0…100.0%	0.1%	-		
6415	AL1RANGE10TO20	0.0…100.0%	0.1%	-		
6416	AL1RANGE20TO30	0.0…100.0%	0.1%	-		
6417	AL1RANGE30TO40	0.0…100.0%	0.1%	-		
6418	AL1RANGE40TO50	0.0…100.0%	0.1%	-		
6419	AL1RANGE50TO60	0.0…100.0%	0.1%	-		
6420	AL1RANGE60TO70	0.0…100.0%	0.1%	-		
6421	AL1RANGE70TO80	0.0…100.0%	0.1%	-		
6422	AL1RANGE80TO90	0.0…100.0%	0.1%	-		
6423	AL1RANGE90TO	0.0…100.0%	0.1%	-		
6424	AL2RANGE0TO10	0.0…100.0%	0.1%	-		
6425	AL2RANGE10TO20	0.0…100.0%	0.1%	-		
6426	AL2RANGE20TO30	0.0…100.0%	0.1%	-		
6427	AL2RANGE30TO40	0.0…100.0%	0.1%	-		
6428	AL2RANGE40TO50	0.0…100.0%	0.1%	-		
6429	AL2RANGE50TO60	0.0…100.0%	0.1%	-		
6430	AL2RANGE60TO70	0.0…100.0%	0.1%	-		
6431	AL2RANGE70TO80	0.0…100.0%	0.1%	-		
6432	AL2RANGE80TO90	0.0…100.0%	0.1%	-		
6433	AL2RANGE90TO	0.0…100.0%	0.1%	-		
Group 81: PFC CONTROL						
8103	REFERENCE STEP 1	0.0…100.0%	0.1%	0.0%		
8104	REFERENCE STEP 2	0.0…100.0%	0.1%	0.0%		
8105	REFERENCE STEP 3	0.0…100.0%	0.1%	0.0%		
8109	START FREQ 1	0.0…500.0 Hz	0.1 Hz	-01: 50.0 Hz / -U1: 60.0 Hz		
8110	START FREQ 2	0.0…500.0 Hz	0.1 Hz	-01: 50.0 Hz / -U1: 60.0 Hz		
8111	START FREQ 3	0.0…500.0 Hz	0.1 Hz	-01: 50.0 Hz / -U1: 60.0 Hz		
8112	LOW FREQ 1	0.0…500.0 Hz	0.1 Hz	-01: 25.0 Hz / -U1: 30.0 Hz		
8113	LOW FREQ 2	0.0…500.0 Hz	0.1 Hz	-01: 25.0 Hz / -U1: 30.0 Hz		
8114	LOW FREQ 3	0.0…500.0 Hz	0.1 Hz	-01: 25.0 Hz / -U1: 30.0 Hz		
8115	AUX MOT START D	0.0…3600.0 s	0.1 s	5.0 s		
8116	AUX MOT STOP D	0.0…3600.0 s	0.1 s	3.0 s		
8117	NR OF AUX MOT	0…4	1	1		✓
8118	AUTOCHNG INTERV	-0.1 = TEST MODE, 0.0 = NOT SEL, 0.1…336.0 h	0.1 h	0.0 h (NOT SEL)		✓
8119	AUTOCHNG LEVEL	0.0…100.0%	0.1%	50.0%		
8120	INTERLOCKS	0…6	1	4 (DI4)		✓

Code	Name	Range	Resolution	Default	User	S
8121	REG BYPASS CTRL	0 = NO, 1 = YES	1	0 (NO)		
8122	PFC START DELAY	0.00…10.00 s	0.01 s	0.50 s		
8123	PFC ENABLE	0 = NOT SEL, 1 = ACTIVE	1	0 (NOT SEL)		✓
8124	ACC IN AUX STOP	0.0 = NOT SEL, 0.1…1800.0 s	0.1 s	0.0 s (NOT SEL)		
8125	DEC IN AUX START	0.0 = NOT SEL, 0.1…1800.0 s	0.1 s	0.0 s (NOT SEL)		
8126	TMED AUTOCHNG	0…4	1	0 (NOT SEL)		
8127	MOTORS	1…7	1	2		✓
8128	AUX START ORDER	1 = EVEN RUNTIME, 2 = RELAY ORDER	1	1 (EVEN RUNTIME)		✓
Group 98: OPTIONS						
9802	COMM PROT SEL	0 = NOT SEL, 1 = STD MODBUS, 4 = EXT FBA	1	0 (NOT SEL)		✓

Complete parameter descriptions

This section describes the actual signals and parameters for ACS550.

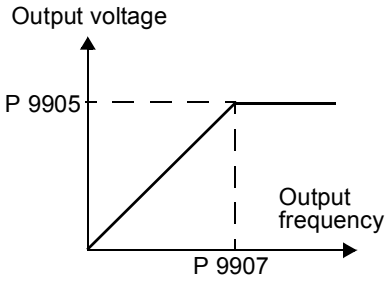
Group 99: START-UP DATA

This group defines special start-up data required to:

- set up the drive
- enter motor information.

Code	Description
9901	**LANGUAGE** Selects the display language. There are two different Assistant Control Panels, each supporting a different language set. (Panel ACS-CP-L supporting languages 0, 2, 11…15 has been integrated into ACS-CP-A.) Assistant Control Panel ACS-CP-A: 0 = ENGLISH 1 = ENGLISH (AM) 2 = DEUTSCH 3 = ITALIANO 4 = ESPAÑOL 5 = PORTUGUES 6 = NEDERLANDS 7 = FRANÇAIS 8 = DANSK 9 = SUOMI 10 = SVENSKA 11 = RUSSKI 12 = POLSKI 13 = TÜRKÇE 14 = CZECH 15 = MAGYAR 16 = ELLINIKA Assistant Control Panel ACS-CP-D (Asia): 0 = ENGLISH 1 = CHINESE 2 = KOREAN 3 = JAPANESE
9902	**APPLIC MACRO** Selects an application macro. Application macros automatically edit parameters to configure the ACS550 for a particular application. 1 = ABB STANDARD 2 = 3-WIRE 3 = ALTERNATE 4 = MOTOR POT 5 = HAND/AUTO 6 = PID CONTROL 7 = PFC CONTROL 8 = TORQUE CTRL 31 = LOAD FD SET 0 = USER S1 LOAD -1 = USER S1 SAVE -2 = USER S2 LOAD -3 = USER S2 SAVE 31 = LOAD FD SET – FlashDrop parameter values as defined by the FlashDrop file. Parameter view is selected by parameter 1611 PARAMETER VIEW. • FlashDrop is an optional device for fast copying of parameters to unpowered drives. FlashDrop allows easy customization of the parameter list, e.g. selected parameters can be hidden. For more information, see *MFDT-01 FlashDrop User's Manual* (3AFE68591074 [English]). -1 = USER S1 SAVE, -3 = USER S2 SAVE – With these it is possible to save two different user parameter sets into the drive permanent memory for later use. Each set contains parameter settings, including *Group 99: START-UP DATA*, and the results of the motor identification run. 0 = USER S1 LOAD, -2 = USER S2 LOAD – With these the user parameter sets can be taken back in use.
9904	**MOTOR CTRL MODE** Selects the motor control mode. 1 = VECTOR:SPEED – sensorless vector control mode. • Reference 1 is speed reference in rpm. • Reference 2 is speed reference in % (100% is absolute maximum speed, equal to the value of parameter 2002 MAXIMUM SPEED, or 2001 MINIMUM SPEED if the absolute value of the minimum speed is greater than the maximum speed). 2 = VECTOR:TORQ. • Reference 1 is speed reference in rpm. • Reference 2 is torque reference in % (100% is nominal torque.) 3 = SCALAR:FREQ – scalar control mode. • Reference 1 is frequency reference in Hz. • Reference 2 is frequency reference in % (100% is absolute maximum frequency, equal to the value of parameter 2008 MAXIMUM FREQ, or 2007 MINIMUM FREQ if the absolute value of the minimum speed is greater than the maximum speed).

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>9905</td><td>MOTOR NOM VOLT
Defines the nominal motor voltage.
• Must equal the value on the motor rating plate.
• The ACS550 cannot supply the motor with a voltage greater than the input power (mains) voltage.</td></tr>
<tr><td>9906</td><td>MOTOR NOM CURR
Defines the nominal motor current.
• Must equal the value on the motor rating plate.
• Range allowed: 0.2…2.0 · I_{2hd} (where I_{2hd} is drive current).</td></tr>
<tr><td>9907</td><td>MOTOR NOM FREQ
Defines the nominal motor frequency.
• Range: 10…500 Hz (typically 50 or 60 Hz)
• Sets the frequency at which output voltage equals the MOTOR NOM VOLT.
• Field weakening point = Nom Freq · Supply Volt / Mot Nom Volt</td></tr>
<tr><td>9908</td><td>MOTOR NOM SPEED
Defines the nominal motor speed.
• Must equal the value on the motor rating plate.</td></tr>
<tr><td>9909</td><td>MOTOR NOM POWER
Defines the nominal motor power.
• Must equal the value on the motor rating plate.</td></tr>
<tr><td>9910</td><td>ID RUN
This parameter controls a self-calibration process called the Motor ID Run. During this process, the drive operates the motor (motor rotating) and makes measurements in order to identify motor characteristics and create a model used for internal calculations. An ID Run is especially effective when:
• vector control mode is used [parameter 9904 = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ)], and/or
• operation point is near zero speed, and/or
• operation requires a torque range above the motor nominal torque, over a wide speed range, and without any measured speed feedback (i.e. without a pulse encoder).
0 = OFF/IDMAGN – The Motor ID Run process is not run. Identification magnetization is performed, depending on parameter 9904 and 2101 settings. In identification magnetization, the motor model is calculated at first start by magnetizing the motor for 10 to 15 s at zero speed (motor not rotating). The model is recalculated always at start after motor parameter changes.
• Parameter 9904 = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ): Identification magnetization is performed.
• Parameter 9904 = 3 (SCALAR:FREQ) and parameter 2101 = 3 (SCALAR FLYST) or 5 (FLY + BOOST): Identification magnetization is performed.
• Parameter 9904 = 3 (SCALAR:FREQ) and parameter 2101 has other value than 3 (SCALAR FLYST) or 5 (FLY + BOOST): Identification magnetization is not performed.
1 = ON – Enables the Motor ID Run, during which the motor is rotating, at the next start command. After run completion, this value automatically changes to 0.
Note: The motor must be de-coupled from the driven equipment.
Note: If motor parameters are changed after ID Run, repeat the ID Run.
WARNING! The motor will run at up to approximately 50…80% of the nominal speed during the ID Run. The motor will rotate in the forward direction.
Ensure that it is safe to run the motor before performing the ID Run!
See also section How to perform the ID Run on page 45.</td></tr>
<tr><td>9915</td><td>MOTOR COSPHI
Defines the nominal motor cos phi (power factor). The parameter improves performance especially with high efficiency motors.
0 = IDENTIFIED – Drive identifies the cos phi automatically by estimation.
0.01…0.97 – Value entered used as the cos phi.</td></tr>
</table>

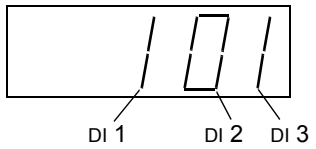


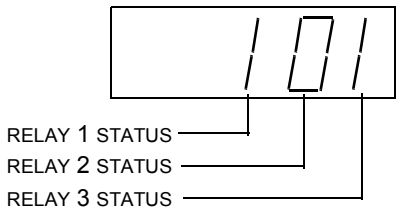
Group 01: OPERATING DATA

This group contains drive operating data, including actual signals. The drive sets the values for actual signals, based on measurements or calculations. You cannot set these values.

Code	Description
0101	**SPEED & DIR** The calculated signed speed of the motor (rpm). The absolute value of 0101 SPEED & DIR is the same as the value of 0102 SPEED. • The value of 0101 SPEED & DIR is positive if the motor runs in the forward direction. • The value of 0101 SPEED & DIR is negative if the motor runs in the reverse direction.
0102	**SPEED** The calculated speed of the motor (rpm). (Parameter 0102 or 0103 is shown by default in the control panel Output mode.)
0103	**OUTPUT FREQ** The frequency (Hz) applied to the motor. (Parameter 0102 or 0103 is shown by default in the control panel Output mode.)
0104	**CURRENT** The motor current, as measured by the ACS550. (Shown by default in the control panel Output mode.)
0105	**TORQUE** Output torque. Calculated value of torque on motor shaft in % of motor nominal torque. (Shown by default in the control panel Output mode.)
0106	**POWER** The measured motor power in kW.
0107	**DC BUS VOLTAGE** The DC bus voltage in V DC, as measured by the ACS550.
0109	**OUTPUT VOLTAGE** The voltage applied to the motor.
0110	**DRIVE TEMP** The temperature of the drive power transistors in degrees Celsius.
0111	**EXTERNAL REF 1** External reference, REF1, in rpm or Hz – units determined by parameter 9904.
0112	**EXTERNAL REF 2** External reference, REF2, in %.
0113	**CTRL LOCATION** Active control location. Alternatives are: 0 = LOCAL 1 = EXT1 2 = EXT2
0114	**RUN TIME (R)** The drive's accumulated running time in hours (h). • Can be **reset** by pressing UP and DOWN keys simultaneously when the control panel is in the Parameters mode.
0115	**KWH COUNTER (R)** The drive's accumulated power consumption in kilowatt hours. • The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0. • Can be **reset** by pressing UP and DOWN keys simultaneously when the control panel is in the Parameters mode.
0116	**APPL BLK OUTPUT** Application block output signal. Value is from either: • PFC control, if PFC Control is active, or • Parameter 0112 EXTERNAL REF 2.

Code	Description
0118	**DI 1-3 STATUS** Status of the three digital inputs. • Status is displayed as a binary number. • 1 indicates that the input is activated. • 0 indicates that the input is deactivated.
0119	**DI 4-6 STATUS** Status of the three digital inputs. • See parameter 0118 DI 1-3 STATUS.
0120	**AI 1** The relative value of analog input 1 in %.
0121	**AI 2** The relative value of analog input 2 in %.
0122	**RO 1-3 STATUS** Status of the three relay outputs. • 1 indicates that the relay is energized. • 0 indicates that the relay is de-energized.
0123	**RO 4-6 STATUS** Status of the three relay outputs. Available if OREL-01 Relay Output Extension Module is installed. • See parameter 0122.
0124	**AO 1** The analog output 1 value in milliamperes.
0125	**AO 2** The analog output 2 value in milliamperes.
0126	**PID 1 OUTPUT** The PID controller 1 output value in %.
0127	**PID 2 OUTPUT** The PID controller 2 output value in %.
0128	**PID 1 SETPNT** The PID 1 controller setpoint signal. • Units and scale defined by PID parameters.
0129	**PID 2 SETPNT** The PID 2 controller setpoint signal. • Units and scale defined by PID parameters.
0130	**PID 1 FBK** The PID 1 controller feedback signal. • Units and scale defined by PID parameters.
0131	**PID 2 FBK** The PID 2 controller feedback signal. • Units and scale defined by PID parameters.
0132	**PID 1 DEVIATION** The difference between the PID 1 controller reference value and actual value. • Units and scale defined by PID parameters.
0133	**PID 2 DEVIATION** The difference between the PID 2 controller reference value and actual value. • Units and scale defined by PID parameters.
0134	**COMM RO WORD** Free data location that can be written from serial link. • Used for relay output control. • See parameter 1401.
0135	**COMM VALUE 1** Free data location that can be written from serial link.





Code	Description
0136	**COMM VALUE 2** Free data location that can be written from serial link.
0137	**PROCESS VAR 1** Process variable 1 • Defined by parameters in *Group 34: PANEL DISPLAY*.
0138	**PROCESS VAR 2** Process variable 2 • Defined by parameters in *Group 34: PANEL DISPLAY*.
0139	**PROCESS VAR 3** Process variable 3 • Defined by parameters in *Group 34: PANEL DISPLAY*.
0140	**RUN TIME** The drive's accumulated running time in thousands of hours (kh). • Cannot be reset.
0141	**MWH COUNTER** The drive's accumulated power consumption in megawatt hours. • The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0. • Cannot be reset.
0142	**REVOLUTION CNTR** The motor's accumulated revolutions in millions of revolutions. • Can be reset by pressing UP and DOWN keys simultaneously when the control panel is in the Parameters mode.
0143	**DRIVE ON TIME HI** The drive's accumulated power-on time in days. • Cannot be reset.
0144	**DRIVE ON TIME LO** The drive's accumulated power-on time in 2 second ticks (30 ticks = 60 seconds). • Shown in format hh.mm.ss. • Cannot be reset.
0145	**MOTOR TEMP** Motor temperature in degrees Celsius / PTC resistance in ohms. • Applies only if motor temperature sensor is set up. • See parameter 3501.
0146	**MECH ANGLE** Defines the motor shaft's angular position to about 0.01° (32,768 divisions for 360°). The position is defined as 0 at power up. During operation the zero position can be set by: • a Z-pulse input, if parameter 5010 Z PLS ENABLE = 1 (ENABLE) • parameter 5011 POSITION RESET, if parameter 5010 Z PLS ENABLE = 2 (DISABLE) • any status change of parameter 5002 ENCODER ENABLE.
0147	**MECH REVS** A signed integer that counts full revolutions of the motor shaft. The value: • increments when parameter 0146 MECH ANGLE changes from 32767 to 0 • decrements when parameter 0146 MECH ANGLE changes from 0 to 32767.
0148	**Z PLS DETECTED** Encoder zero pulse detector. When a Z-pulse defines the zero position, the shaft must pass through the zero position to trigger a Z-pulse. Until then, the shaft position is unknown (the drive uses the shaft position at power up as zero). This parameter signals when parameter 0146 MECH ANGLE is valid. The parameter starts at 0 = NOT DETECTED on power-up and changes to 1 = DETECTED only if: • parameter 5010 Z PLS ENABLE = 1 (ENABLE) and • an encoder Z-pulse has been detected.
0150	**CB TEMP** Temperature of the drive control board in degrees Celsius. **Note:** Some drives have a control board (OMIO) that does not support this feature. These drives always show the constant value of 25.0 °C.

Code	Description
0153	**MOT THERM STRESS** Estimated rise of the motor temperature. Value equals to the estimated motor thermal stress as a percentage of the motor temperature trip level.
0158	**PID COMM VALUE 1** Data received from fieldbus for PID control (PID1 and PID2).
0159	**PID COMM VALUE 2** Data received from fieldbus for PID control (PID1 and PID2).
0174	**SAVED KWH** Energy saved in kWh compared to the energy used when the pump is connected directly to the supply. See the note on page *180*. • The counter value is accumulated till it reaches 999.9 after which the counter rolls over and starts again from 0.0 and the counter value of signal 0175 is incremented by one. Can be reset with parameter 4509 ENERGY RESET (resets all energy calculators at the same time). • See *Group 45: ENERGY SAVING*.
0175	**SAVED MWH** Energy saved in MWh compared to the energy used when the pump is connected directly to the supply. See the note on page *180*. • The counter value is accumulated till it reaches 65535 after which the counter rolls over and starts again from 0. • Can be reset with parameter 4509 ENERGY RESET (resets all energy calculators at the same time). • See *Group 45: ENERGY SAVING*.
0176	**SAVED AMOUNT 1** Energy saved in local currency (remainder when the total saved energy is divided by 1000). See the note on page *180*. • To find out the total saved energy in currency units, add the value of parameter 0177 multiplied by 1000 to the value of parameter 0176. **Example:** 0176 SAVED AMOUNT 1 = 123.4 0177 SAVED AMOUNT 2 = 5 Total saved energy = 5 · 1000 + 123.4 = 5123.4 currency units. • The counter value is accumulated till it reaches 999.9 after which the counter rolls over and starts again from 0.0 and the counter value of signal 0177 is incremented by one. • Can be reset with parameter 4509 ENERGY RESET (resets all energy calculators at the same time). • Local energy price is set with parameter 4502 ENERGY PRICE. • See *Group 45: ENERGY SAVING*.
0177	**SAVED AMOUNT 2** Energy saved in local currency in thousand currency units. Eg value 5 means 5000 currency units. See the note on page *180*. • The counter value is accumulated till it reaches 65535 (the counter does not roll over). • See parameter 0176 SAVED AMOUNT 1.
0178	**SAVED CO2** Reduction on carbon dioxide emissions in tn. See the note on page *180*. • The counter value is accumulated till it reaches 6553.5 (the counter does not roll over). • Can be reset with parameter 4509 ENERGY RESET (resets all energy calculators at the same time). • CO2 conversion factor is set with parameter 4507 CO2 CONV FACTOR. • See *Group 45: ENERGY SAVING*.

Group 03: FB ACTUAL SIGNALS

This group monitors fieldbus communications.

Code	Description
0301	**FB CMD WORD 1** Read-only copy of the Fieldbus Command Word 1. • The fieldbus command is the principal means for controlling the drive from a fieldbus controller. The command consists of two Command Words. Bit-coded instructions in the Command Words switch the drive between states. • To control the drive, using the Command Words, an external location (EXT1 or EXT2) must be active and set to COMM. (See parameters 1001 and 1002.) • The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays as 0001. All zeros and a 1 in Bit 15 displays as 8000.
0302	**FB CMD WORD 2** Read-only copy of the Fieldbus Command Word 2. • See parameter 0301.

Bit #	0301, FB CMD WORD 1	0302, FB CMD WORD 2
0	STOP	FBLOCAL_CTL
1	START	FBLOCAL_REF
2	REVERSE	START_DISABLE1
3	LOCAL	START_DISABLE2
4	RESET	Reserved
5	EXT2	Reserved
6	RUN_DISABLE	Reserved
7	STPMODE_R	Reserved
8	STPMODE_EM	Reserved
9	STPMODE_C	Reserved
10	RAMP_2	Reserved
11	RAMP_OUT_0	REF_CONST
12	RAMP_HOLD	REF_AVE
13	RAMP_IN_0	LINK_ON
14	RREQ_LOCALLOC	REQ_STARTINH
15	TORQLIM2	OFF_INTERLOCK

Code	Description
0303	**FB STS WORD 1** Read-only copy of the Status Word 1. • The drive sends status information to the fieldbus controller. The status consists of two Status Words. • The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays as 0001. All zeros and a 1 in Bit 15 displays as 8000.
0304	**FB STS WORD 2** Read-only copy of the Status Word 2. • See parameter 0303.

Bit #	0303, FB STS WORD 1	0304, FB STS WORD 2
0	READY	ALARM
1	ENABLED	NOTICE
2	STARTED	DIRLOCK
3	RUNNING	LOCALLOCK
4	ZERO_SPEED	CTL_MODE
5	ACCELERATE	Reserved
6	DECELERATE	Reserved
7	AT_SETPOINT	CPY_CTL
8	LIMIT	CPY_REF1
9	SUPERVISION	CPY_REF2
10	REV_REF	REQ_CTL
11	REV_ACT	REQ_REF1
12	PANEL_LOCAL	REQ_REF2
13	FIELDBUS_LOCAL	REQ_REF2EXT
14	EXT2_ACT	ACK_STARTINH
15	FAULT	ACK_OFF_ILCK

Code	Description
0305	**FAULT WORD 1** Read-only copy of the Fault Word 1. • When a fault is active, the corresponding bit for the active fault is set in the Fault Words. • Each fault has a dedicated bit allocated within Fault Words. • See section *Fault listing* on page *260* for a description of the faults. • The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays as 0001. All zeros and a 1 in Bit 15 displays as 8000.
0306	**FAULT WORD 2** Read-only copy of the Fault Word 2. • See parameter 0305.
0307	**FAULT WORD 3** Read-only copy of the Fault Word 3. • See parameter 0305.

Bit #	0305, FAULT WORD 1	0306, FAULT WORD 2	0307, FAULT WORD 3
0	OVERCURRENT	Obsolete	EFB 1
1	DC OVERVOLT	THERM FAIL	EFB 2
2	DEV OVERTEMP	OPEX LINK	EFB 3
3	SHORT CIRC	OPEX PWR	INCOMPATIBLE SW
4	Reserved	CURR MEAS	USER LOAD CURVE
5	DC UNDERVOLT	SUPPLY PHASE	Reserved
6	AI1 LOSS	ENCODER ERR	Reserved
7	AI2 LOSS	OVERSPEED	Reserved
8	MOT OVERTEMP	Reserved	Reserved
9	PANEL LOSS	DRIVE ID	Reserved
10	ID RUN FAIL	CONFIG FILE	System error
11	MOTOR STALL	SERIAL 1 ERR	System error
12	CB OVERTEMP	EFB CON FILE	System error
13	EXT FAULT 1	FORCE TRIP	System error
14	EXT FAULT 2	MOTOR PHASE	System error
15	EARTH FAULT	OUTP WIRING	Param. setting fault

Code	Description
0308	**ALARM WORD 1** • When an alarm is active, the corresponding bit for the active alarm is set in the Alarm Words. • Each alarm has a dedicated bit allocated within Alarm Words. • Bits remain set until the whole alarm word is reset. (Reset by writing zero to the word.) • The control panel displays the word in hex. For example, all zeros and a 1 in Bit 0 displays as 0001. All zeros and a 1 in Bit 15 displays as 8000.
0309	**ALARM WORD 2** See parameter 0308.

Bit #	0308, ALARM WORD 1	0309, ALARM WORD 2
0	OVERCURRENT	Reserved
1	OVERVOLTAGE	PID SLEEP
2	UNDERVOLTAGE	ID RUN
3	DIR LOCK	Reserved
4	IO COMM	START ENABLE 1 MISSING
5	AI1 LOSS	START ENABLE 2 MISSING
6	AI2 LOSS	EMERGENCY STOP
7	PANEL LOSS	ENCODER ERROR
8	DEVICE OVERTEMP	FIRST START
9	MOTOR TEMP	Reserved
10	Reserved	USER LOAD CURVE
11	MOTOR STALL	START DELAY
12	AUTORESET	Reserved
13	AUTOCHANGE	Reserved
14	PFC I LOCK	Reserved
15	Reserved	Reserved

Group 04: FAULT HISTORY

This group stores a recent history of the faults reported by the drive.

Code	Description
0401	**LAST FAULT** 0 – Clear the fault history (on panel = NO RECORD). n – Fault code of the last recorded fault. The fault code is displayed as a name. See section *Fault listing* on page *260* for the fault codes and names. The fault name shown for this parameter may be shorter than the corresponding name in the fault listing, which shows the names as they are shown in the fault display.
0402	**FAULT TIME 1** The day on which the last fault occurred. Either as: • A date – if real time clock is operating. • The number of days after power on – if real time clock is not used, or was not set.
0403	**FAULT TIME 2** The time at which the last fault occurred. Either as: • Real time, in format hh:mm:ss – if real time clock is operating. • The time since power on (minus the whole days reported in 0402), in format hh:mm:ss – if real time clock is not used, or was not set. • Format on the Basic Control Panel: The time since power on in 2-second ticks (minus the whole days reported in 0402). 30 ticks = 60 seconds. E.g. Value 514 equals 17 minutes and 8 seconds (= 514/30).
0404	**SPEED AT FLT** The motor speed (rpm) at the time the last fault occurred.
0405	**FREQ AT FLT** The frequency (Hz) at the time the last fault occurred.
0406	**VOLTAGE AT FLT** The DC bus voltage (V) at the time the last fault occurred.
0407	**CURRENT AT FLT** The motor current (A) at the time the last fault occurred.
0408	**TORQUE AT FLT** The motor torque (%) at the time the last fault occurred.
0409	**STATUS AT FLT** The drive status (hex code word) at the time the last fault occurred.
0410	**DI 1-3 AT FLT** The status of digital inputs 1…3 at the time the last fault occurred.
0411	**DI 4-6 AT FLT** The status of digital inputs 4…6 at the time the last fault occurred.
0412	**PREVIOUS FAULT 1** Fault code of the second last fault. Read-only.
0413	**PREVIOUS FAULT 2** Fault code of the third last fault. Read-only.

Group 10: START/STOP/DIR

This group:

- defines external sources (EXT1 and EXT2) for commands that enable start, stop and direction changes
- locks direction or enables direction control.

To select between the two external locations use the next group (parameter 1102).

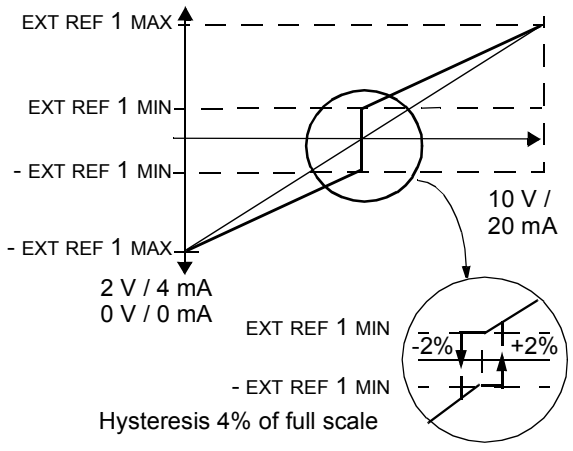
Code	Description
1001	**EXT1 COMMANDS** Defines external control location 1 (EXT1) – the configuration of start, stop and direction commands. 0 = NOT SEL – No external start, stop and direction command source. 1 = DI1 – Two-wire Start/Stop. • Start/Stop is through digital input DI1 (DI1 activated = Start; DI1 de-activated = Stop). • Parameter 1003 defines the direction. Selecting 1003 = 3 (REQUEST) is the same as 1003 = 1 (FORWARD). 2 = DI1,2 – Two-wire Start/Stop, Direction. • Start/Stop is through digital input DI1 (DI1 activated = Start; DI1 de-activated = Stop). • Direction control [requires parameter 1003 = 3 (REQUEST)] is through digital input DI2 (DI2 activated = Reverse; de-activated = Forward). 3 = DI1P,2P – Three-wire Start/Stop. • Start/Stop commands are through momentary push-buttons (the P stands for "pulse"). • Start is through a normally open push-button connected to digital input DI1. In order to start the drive, the digital input DI2 must be activated prior to the pulse in DI1. • Connect multiple Start push-buttons in parallel. • Stop is through a normally closed push-button connected to digital input DI2. • Connect multiple Stop push-buttons in series. • Parameter 1003 defines the direction. Selecting 1003 = 3 (REQUEST) is the same as 1003 = 1 (FORWARD). 4 = DI1P,2P,3 – Three-wire Start/Stop, Direction. • Start/Stop commands are through momentary push-buttons, as described for DI1P,2P. • Direction control [requires parameter 1003 = 3 (REQUEST)] is through digital input DI3 (DI3 activated = Reverse; de-activated = Forward). 5 = DI1P,2P,3P – Start Forward, Start Reverse and Stop. • Start and Direction commands are given simultaneously with two separate momentary push-buttons (the P stands for "pulse"). • Start Forward command is through a normally open push-button connected to digital input DI1. In order to start the drive, the digital input DI3 must be activated prior to the pulse in DI1. • Start Reverse command is through a normally open push-button connected to digital input DI2. In order to start the drive, the digital input DI3 must be activated during the pulse in DI2. • Connect multiple Start push-buttons in parallel. • Stop is through a normally closed push-button connected to digital input DI3. • Connect multiple Stop push-buttons in series. • Requires parameter 1003 = 3 (REQUEST). 6 = DI6 – Two-wire Start/Stop. • Start/Stop is through digital input DI6 (DI6 activated = Start; DI6 de-activated = Stop). • Parameter 1003 defines the direction. Selecting 1003 = 3 (REQUEST) is the same as 1003 = 1 (FORWARD). 7 = DI6,5 – Two-wire Start/Stop/Direction. • Start/Stop is through digital input DI6 (DI6 activated = Start; DI6 de-activated = Stop). • Direction control [requires parameter 1003 = 3 (REQUEST)] is through digital input DI5. (DI5 activated = Reverse; de-activated = Forward). 8 = KEYPAD – Control Panel. • Start/Stop and Direction commands are through the control panel when EXT1 is active. • Direction control requires parameter 1003 = 3 (REQUEST). 9 = DI1F,2R – Start/Stop/Direction commands through DI1 and DI2 combinations. • Start forward = DI1 activated and DI2 de-activated. • Start reverse = DI1 de-activated and DI2 activated. • Stop = both DI1 and DI2 activated, or both de-activated. • Requires parameter 1003 = 3 (REQUEST). 10 = COMM – Assigns the fieldbus Command Word as the source for the start/stop and direction commands. • Bits 0,1, 2 of Command Word 1 (parameter 0301) activates the start/stop and direction commands. • See Fieldbus user's manual for detailed instructions.

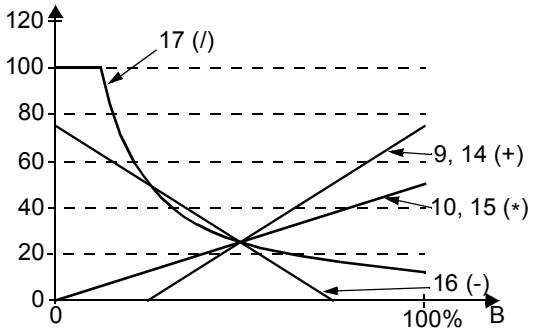
Code	Description
	11 = TIMED FUNC 1. – Assigns Start/Stop control to Timed Function 1 (Timed Function activated = START; Timed Function de-activated = STOP). See *Group 36: TIMED FUNCTIONS*. 12…14 = TIMED FUNC 2…4 – Assigns Start/Stop control to Timed Function 2…4. See TIMED FUNC 1 above.
1002	**EXT2 COMMANDS** Defines external control location 2 (EXT2) – the configuration of start, stop and direction commands. • See parameter 1001 EXT1 COMMANDS above.
1003	**DIRECTION** Defines the control of motor rotation direction. 1 = FORWARD – Rotation is fixed in the forward direction. 2 = REVERSE – Rotation is fixed in the reverse direction. 3 = REQUEST – Rotation direction can be changed on command.
1004	**JOGGING SEL** Defines the signal that activates the jogging function. Jogging uses Constant Speed 7 (parameter 1208) for speed reference and ramp pair 2 (parameters 2205 and 2206) for accelerating and decelerating. When the jogging activation signal is lost, the drive uses ramp stop to decelerate to zero speed, even if coast stop is used in normal operation (parameter 2102). The jogging status can be parameterized to relay outputs (parameter 1401). The jogging status is also seen in DCU Profile status bit 21. 0 = NOT SEL – Disables the jogging function. 1 = DI1 – Activates/de-activates jogging based on the state of DI1 (DI1 activated = jogging active; DI1 de-activated = jogging inactive). 2…6 = DI2…DI6 – Activates jogging based on the state of the selected digital input. See DI1 above. -1 = DI1(INV) – Activates jogging based on the state of DI1 (DI1 activated = jogging inactive; DI1 de-activated = jogging active). -2…-6 = DI2(INV)…DI6(INV) – Activates jogging based on the state of the selected digital input. See DI1(INV) above.

Group 11: REFERENCE SELECT

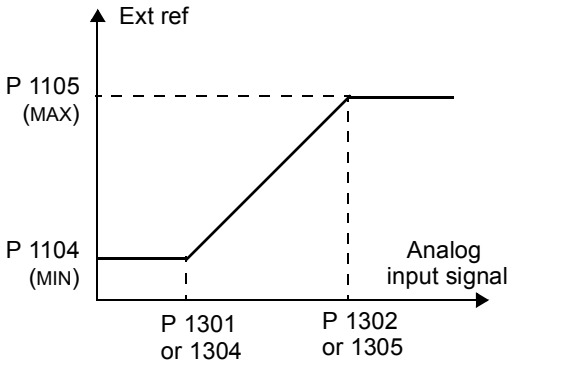
This group defines:

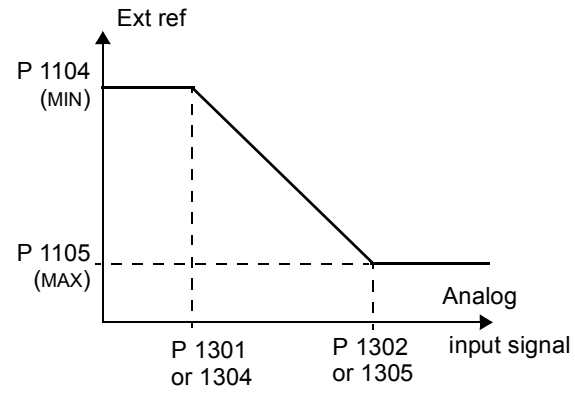
- how the drive selects between command sources
- characteristics and sources for REF1 and REF2.

Code	Description
1101	**KEYPAD REF SEL** Selects the reference controlled in local control mode. 1 = REF1(Hz/rpm) – Reference type depends on parameter 9904 MOTOR CTRL MODE. • Speed reference (rpm) if 9904 = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ). • Frequency reference (Hz) if 9904 = 3 (SCALAR:FREQ). 2 = REF2(%)
1102	**EXT1/EXT2 SEL** Defines the source for selecting between the two external control locations EXT1 or EXT2. Thus, defines the source for Start/Stop/Direction commands and reference signals. 0 = EXT1 – Selects external control location 1 (EXT1). • See parameter 1001 EXT1 COMMANDS for EXT1's Start/Stop/Dir definitions. • See parameter 1103 REF1 SELECT for EXT1's reference definitions. 1 = DI1 – Assigns control to EXT1 or EXT2 based on the state of DI1 (DI1 activated = EXT2; DI1 de-activated = EXT1). 2…6 = DI2…DI6 – Assigns control to EXT1 or EXT2 based on the state of the selected digital input. See DI1 above. 7 = EXT2 – Selects external control location 2 (EXT2). • See parameter 1002 EXT2 COMMANDS for EXT2's Start/Stop/Dir definitions. • See parameter 1106 REF2 SELECT for EXT2's reference definitions. 8 = COMM – Assigns control of the drive via external control location EXT1 or EXT2 based on the fieldbus control word. • Bit 5 of the Command Word 1 (parameter 0301) defines the active external control location (EXT1 or EXT2). • See Fieldbus user's manual for detailed instructions. 9 = TIMED FUNC 1 – Assigns control to EXT1 or EXT2 based on the state of the Timed Function (Timed Function activated = EXT2; Timed Function de-activated = EXT1). See *Group 36: TIMED FUNCTIONS*. 10…12 = TIMED FUNC 2…4 – Assigns control to EXT1 or EXT2 based on the state of the Timed Function. See TIMED FUNC 1 above. -1 = DI1(INV) – Assigns control to EXT1 or EXT2 based on the state of DI1 (DI1 activated = EXT1; DI1 de-activated = EXT2). -2…-6 = DI2(INV)…DI6(INV) – Assigns control to EXT1 or EXT2 based on the state of the selected digital input. See DI1(INV) above.
1103	**REF1 SELECT** Selects the signal source for external reference REF1. 0 = KEYPAD – Defines the control panel as the reference source. 1 = AI1 – Defines analog input 1 (AI1) as the reference source. 2 = AI2 – Defines analog input 2 (AI2) as the reference source. 3 = AI1/JOYST – Defines analog input 1 (AI1), configured for joystick operation, as the reference source. • The minimum input signal runs the drive at the maximum reference in the reverse direction. Define the minimum using parameter 1104. • The maximum input signal runs the drive at maximum reference in the forward direction. Define the maximum using parameter 1105. • Requires parameter 1003 = 3 (REQUEST). **WARNING!** Because the low end of the reference range commands full reverse operation, do not use 0 V as the lower end of the reference range. Doing so means that if the control signal is lost (which is a 0 V input) the result is full reverse operation. Instead, use the following set-up so that loss of the analog input triggers a fault, stopping the drive: • Set parameter 1301 MINIMUM AI1 (1304 MINIMUM AI2) at 20% (2 V or 4 mA). • Set parameter 3021 AI1 FAULT LIMIT to a value 5% or higher. • Set parameter 3001 AI<MIN FUNCTION to 1 (FAULT). 4 = AI2/JOYST – Defines analog input 2 (AI2), configured for joystick operation, as the reference source. • See above (AI1/JOYST) description. 

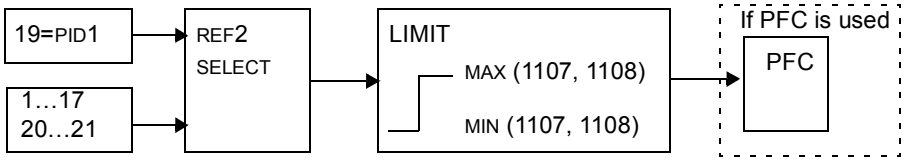
Code	Description
	5 = DI3U,4D(R) – Defines digital inputs as the speed reference source (motor potentiometer control). • Digital input DI3 increases the speed (the U stands for "up"). • Digital input DI4 decreases the speed (the D stands for "down"). • A Stop command resets the reference to zero (the R stands for "reset"). • Parameter 2205 ACCELER TIME 2 controls the reference signal's rate of change. 6 = DI3U,4D – Same as above (DI3U,4D(R)), except: • A Stop command does not reset the reference to zero. The reference is stored. • When the drive restarts, the motor ramps up (at the selected acceleration rate) to the stored reference. 7 = DI5U,6D – Same as above (DI3U,4D), except that DI5 and DI6 are the digital inputs used. 8 = COMM – Defines the fieldbus as the reference source. 9 = COMM+AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog input reference correction below. 10 = COMM*AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog input reference correction below. 11 = DI3U,4D(RNC) – Same as DI3U,4D(R) above, except that: • Changing the control source (EXT1 to EXT2, EXT2 to EXT1, LOC to REM) does not copy the reference. 12 = DI3U,4D(NC) – Same as DI3U,4D above, except that: • Changing the control source (EXT1 to EXT2, EXT2 to EXT1, LOC to REM) does not copy the reference. • Stop command resets reference to zero. 13 = DI5U,6D(NC) – Same as DI5U,6D above, except that: • Changing the control source (EXT1 to EXT2, EXT2 to EXT1, LOC to REM) does not copy the reference. 14 = AI1+AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 15 = AI1*AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 16 = AI1-AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 17 = AI1/AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 20 = KEYPAD(RNC) – Defines the control panel as the reference source. • A Stop command resets the reference to zero (the R stands for reset.). • Changing the control source (EXT1 to EXT2, EXT2 to EXT1) does not copy the reference. 21 = KEYPAD(NC) – Defines the control panel as the reference source. • A Stop command does not reset the reference to zero. The reference is stored. • Changing the control source (EXT1 to EXT2, EXT2 to EXT1) does not copy the reference.
	Analog input reference correction Parameter values 9, 10 and 14…17 use the formula in the following table. **Value setting** / **Calculation of the AI reference** C + B: C value + (B value - 50% of reference value) C * B: C value · (B value / 50% of reference value) C - B: (C value + 50% of reference value) - B value C / B: (C value · 50% of reference value) / B value Where: • C = Main reference value (= COMM for values 9, 10 and = AI1 for values 14…17). • B = Correcting reference (= AI1 for values 9, 10 and = AI2 for values 14…17). **Example:** The figure shows the reference source curves for value settings 9, 10 and 14…17, where: • C = 25%. • P 4012 SETPOINT MIN = 0. • P 4013 SETPOINT MAX = 0. • B varies along the horizontal axis. 

Code	Description
1104	**REF1 MIN** Sets the minimum for external reference 1. • The minimum analog input signal (as a percent of the full signal in volts or amperes) corresponds to REF1 MIN in Hz/rpm. • Parameter 1301 MINIMUM AI1 or 1304 MINIMUM AI2 sets the minimum analog input signal. • These parameters (reference and analog min. and max. settings) provide scale and offset adjustment for the reference.
1105	**REF1 MAX** Sets the maximum for external reference 1. • The maximum analog input signal (as a percent of full the signal in volts or amperes) corresponds to REF1 MAX in Hz/rpm. • Parameter 1302 MAXIMUM AI1 or 1305 MAXIMUM AI2 sets the maximum analog input signal.





1106	**REF2 SELECT** Selects the signal source for external reference REF2. 0…17 – Same as for parameter 1103 REF1 SELECT. 19 = PID1OUT – The reference is taken from the PID1 output. See *Group 40: PROCESS PID SET 1* and *Group 41: PROCESS PID SET 2*. 20…21 – Same as for parameter 1103 REF1 SELECT.



1107	**REF2 MIN** Sets the minimum for external reference 2. • The minimum analog input signal (in volts or amperes) corresponds to REF2 MIN in %. • Parameter 1301 MINIMUM AI1 or 1304 MINIMUM AI2 sets the minimum analog input signal. • This parameter sets the minimum frequency reference. • The value is a percentage of the: – maximum frequency or speed – maximum process reference – nominal torque.
1108	**REF2 MAX** Sets the maximum for external reference 2. • The maximum analog input signal (in volts or amperes) corresponds to REF2 MAX in %. • Parameter 1302 MAXIMUM AI1 or 1305 MAXIMUM AI2 sets the maximum analog input signal. • This parameter sets the maximum frequency reference. • The value is a percentage of the: – maximum frequency or speed – maximum process reference – nominal torque.

Group 12: CONSTANT SPEEDS

This group defines a set of constant speeds. In general:

- You can program up to 7 constant speeds, ranging from 0...500 Hz or 0...30000 rpm.
- Values must be positive (No negative speed values for constant speeds).
- Constant speed selections are ignored if:
  - the torque control is active, or
  - the process PID reference is followed, or
  - the drive is in local control mode, or
  - PFC (Pump-Fan Control) is active.

Note: Parameter 1208 CONST SPEED 7 acts also as a so-called fault speed which may be activated if the control signal is lost. For example, see parameters 3001 AI<MIN FUNCTION, 3002 PANEL COMM ERR and 3018 COMM FAULT FUNC.

Code	Description
1201	**CONST SPEED SEL** Defines the digital inputs used to select Constant Speeds. See general comments in introduction. 0 = NOT SEL – Disables the constant speed function. 1 = DI1 – Selects Constant Speed 1 with digital input DI1. • Digital input activated = Constant Speed 1 activated. 2…6 = DI2…DI6 – Selects Constant Speed 1 with digital input DI2…DI6. See above. 7 = DI1,2 – Selects one of three Constant Speeds (1…3) using DI1 and DI2. • Uses two digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):

DI1	DI2	Function
0	0	No constant speed
1	0	Constant speed 1 (1202)
0	1	Constant speed 2 (1203)
1	1	Constant speed 3 (1204)

• Can be set up as a so-called fault speed, which is activated if the control signal is lost. Refer to parameter 3001 AI<MIN function and parameter 3002 PANEL COMM ERR.

8 = DI2,3 – Selects one of three Constant Speeds (1…3) using DI2 and DI3.
• See above (DI1,2) for code.
9 = DI3,4 – Selects one of three Constant Speeds (1…3) using DI3 and DI4.
• See above (DI1,2) for code.
10 = DI4,5 – Selects one of three Constant Speeds (1…3) using DI4 and DI5.
• See above (DI1,2) for code.
11 = DI5,6 – Selects one of three Constant Speeds (1…3) using DI5 and DI6.
• See above (DI1,2) for code.
12 = DI1,2,3 – Selects one of seven Constant Speeds (1…7) using DI1, DI2 and DI3.
• Uses three digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):

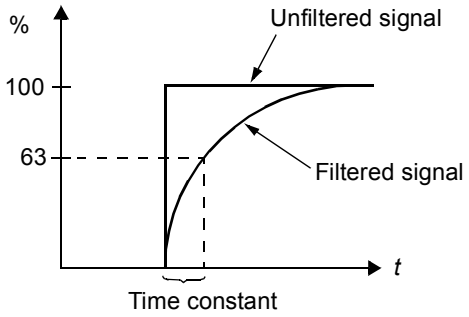
DI1	DI2	DI3	Function
0	0	0	No constant speed
1	0	0	Constant speed 1 (1202)
0	1	0	Constant speed 2 (1203)
1	1	0	Constant speed 3 (1204)
0	0	1	Constant speed 4 (1205)
1	0	1	Constant speed 5 (1206)
0	1	1	Constant speed 6 (1207)
1	1	1	Constant speed 7 (1208)

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>13 = DI3,4,5 – Selects one of seven Constant Speeds (1…7) using DI3, DI4 and DI5.
• See above (DI1,2,3) for code.
14 = DI4,5,6 – Selects one of seven Constant Speeds (1…7) using DI4, DI5 and DI6.
• See above (DI1,2,3) for code.
15…18 = TIMED FUNC 1…4 – Selects Constant Speed 1, Constant Speed 2 or the external reference, depending on the state of the Timed Function (1…4) and constant speed mode. See parameter 1209 TIMED MODE SEL and Group 36: TIMED FUNCTIONS.
19 = TIMED FUN1&2 – Selects a constant speed or the external reference, depending on the state of Timed Functions 1 & 2 and constant speed mode. See parameter 1209 TIMED MODE SEL and Group 36: TIMED FUNCTIONS.
-1 = DI1(INV) – Selects Constant Speed 1 with digital input DI1.
• Inverse operation: Digital input de-activated = Constant Speed 1 activated.
-2…- 6 = DI2(INV)…DI6(INV) – Selects Constant Speed 1 with digital input. See above.
-7 = DI1,2(INV) – Selects one of three Constant Speeds (1…3) using DI1 and DI2.
• Inverse operation uses two digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):
<table>
<tr><th>DI1</th><th>DI2</th><th>Function</th></tr>
<tr><td>1</td><td>1</td><td>No constant speed</td></tr>
<tr><td>0</td><td>1</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>1</td><td>0</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>0</td><td>0</td><td>Constant speed 3 (1204)</td></tr>
</table>
-8 = DI2,3(INV) – Selects one of three Constant Speeds (1…3) using DI2 and DI3.
• See above (DI1,2(INV)) for code.
-9 = DI3,4(INV) – Selects one of three Constant Speeds (1…3) using DI3 and DI4.
• See above (DI1,2(INV)) for code.
-10 = DI4,5(INV) – Selects one of three Constant Speeds (1…3) using DI4 and DI5.
• See above (DI1,2(INV)) for code.
-11 = DI5,6(INV) – Selects one of three Constant Speeds (1…3) using DI5 and DI6.
• See above (DI1,2(INV)) for code.
-12 = DI1,2,3(INV) – Selects one of seven Constant Speeds (1…7) using DI1, DI2 and DI3.
• Inverse operation uses three digital inputs, as defined below (0 = DI de-activated, 1 = DI activated):
<table>
<tr><th>DI1</th><th>DI2</th><th>DI3</th><th>Function</th></tr>
<tr><td>1</td><td>1</td><td>1</td><td>No constant speed</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Constant speed 3 (1204)</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>Constant speed 4 (1205)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>Constant speed 5 (1206)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>Constant speed 6 (1207)</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>Constant speed 7 (1208)</td></tr>
</table>
-13 = DI3,4,5(INV) – Selects one of seven Constant Speeds (1…7) using DI3, DI4 and DI5.
• See above (DI1,2,3(INV)) for code.
-14 = DI4,5,6(INV) – Selects one of seven Constant Speeds (1…7) using DI4, DI5 and DI6.
• See above (DI1,2,3(INV)) for code.</td></tr>
<tr><td>1202</td><td>CONST SPEED 1
Sets value for Constant Speed 1.
• The range and units depend on parameter 9904 MOTOR CTRL MODE.
• Range: 0…30000 rpm when 9904 = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ).
• Range: 0…500 Hz when 9904 = 3 (SCALAR:FREQ).</td></tr>
<tr><td>1203
…
1208</td><td>CONST SPEED 2…CONST SPEED 7
Each sets a value for a Constant Speed. See CONST SPEED 1 above.
Constant Speed 7 is used also as jogging speed. See parameter 1004 JOGGING SEL.</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>1209</td><td>
TIMED MODE SEL
Defines timed function activated constant speed mode. Timed function can be used to change between the external reference and constant speeds when parameter 1201 CONST SPEED SEL = 15…18 (TIMED FUNC 1…4) or 19 (TIMED FUN1&2).
1 = EXT/CS1/2/3
• If parameter 1201 = 15…18 (TIMED FUNC 1…4), selects an external speed when this timed function (1…4) is not active and selects Constant speed 1 when it is active.
<table>
<tr><th>TIMED FUNCTION 1…4</th><th>Function</th></tr>
<tr><td>0</td><td>External reference</td></tr>
<tr><td>1</td><td>Constant speed 1 (1202)</td></tr>
</table>
• If parameter 1201 = 19 (TIMED FUN1&2), selects an external speed when neither timed function is active, selects Constant speed 1 when only Timed function 1 is active, selects Constant speed 2 when only Timed function 2 is active and selects Constant speed 3 when both Timed functions 1 and 2 are active.
<table>
<tr><th>TIMED FUNCTION 1</th><th>TIMED FUNCTION 2</th><th>Function</th></tr>
<tr><td>0</td><td>0</td><td>External reference</td></tr>
<tr><td>1</td><td>0</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>0</td><td>1</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>1</td><td>1</td><td>Constant speed 3 (1204)</td></tr>
</table>
2 = CS1/2/3/4
• If parameter 1201 = 15…18 (TIMED FUNC 1…4), selects Constant speed 1 when this timed function (1…4) is not active and selects Constant speed 2 when it is active.
<table>
<tr><th>TIMED FUNCTION 1…4</th><th>Function</th></tr>
<tr><td>0</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>1</td><td>Constant speed 2 (1203)</td></tr>
</table>
• If parameter 1201 = 19 (TIMED FUN1&2), selects Constant speed 1 when neither timed function is active, selects Constant speed 2 when only Timed function 1 is active, selects Constant speed 3 when only Timed function 2 is active and selects Constant speed 4 when both Timed functions 1 and 2 are active.
<table>
<tr><th>TIMED FUNCTION 1</th><th>TIMED FUNCTION 2</th><th>Function</th></tr>
<tr><td>0</td><td>0</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>1</td><td>0</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>0</td><td>1</td><td>Constant speed 3 (1204)</td></tr>
<tr><td>1</td><td>1</td><td>Constant speed 4 (1205)</td></tr>
</table>
</td></tr>
</table>

Group 13: ANALOG INPUTS

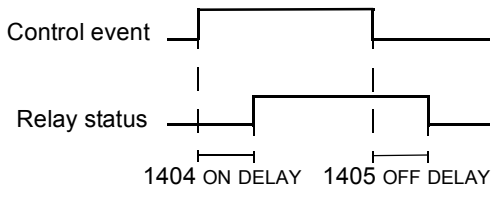
This group defines the limits and the filtering for analog inputs.

Code	Description
1301	**MINIMUM AI1** Defines the minimum value of the analog input. • Define value as a percent of the full analog signal range. See example below. • The minimum analog input signal corresponds to 1104 REF1 MIN or 1107 REF2 MIN. • MINIMUM AI cannot be greater than MAXIMUM AI. • These parameters (reference and analog min. and max. settings) provide scale and offset adjustment for the reference. • See the figure at parameter 1104. **Example:** To set the minimum analog input value to 4 mA: • Configure the analog input for 0…20 mA current signal. • Calculate the minimum (4 mA) as a percent of full range (20 mA) = 4 mA / 20 mA · 100% = 20%
1302	**MAXIMUM AI1** Defines the maximum value of the analog input. • Define value as a percent of the full analog signal range. • The maximum analog input signal corresponds to 1105 REF1 MAX or 1108 REF2 MAX. • See the figure at parameter 1104.
1303	**FILTER AI1** Defines the filter time constant for analog input 1 (AI1). • The filtered signal reaches 63% of a step change within the time specified. 
1304	**MINIMUM AI2** Defines the minimum value of the analog input. • See MINIMUM AI1 above.
1305	**MAXIMUM AI2** Defines the maximum value of the analog input. • See MAXIMUM AI1 above.
1306	**FILTER AI2** Defines the filter time constant for analog input 2 (AI2). • See FILTER AI1 above.

Group 14: RELAY OUTPUTS

This group defines the condition that activates each of the relay outputs. Relay outputs 4…6 are only available if OREL-01 Relay Output Extension Module is installed.

Code	Description
1401	**RELAY OUTPUT 1** Defines the event or condition that activates relay 1 – what relay output 1 means. 0 = NOT SEL – Relay is not used and is de-energized. 1 = READY – Energize relay when drive is ready to function. Requires: • Run enable signal present. • No faults exist. • Supply voltage is within range. • Emergency Stop command is not on. 2 = RUN – Energize relay when the drive is running. 3 = FAULT(-1) – Energize relay when power is applied. De-energizes when a fault occurs. 4 = FAULT – Energize relay when a fault is active. 5 = ALARM – Energize relay when an alarm is active. 6 = REVERSED – Energize relay when motor rotates in reverse direction. 7 = STARTED – Energize relay when drive receives a start command (even if Run Enable signal is not present). De-energized relay when drive receives a stop command or a fault occurs. 8= SUPRV1 OVER – Energize relay when first supervised parameter (3201) exceeds the limit (3203). • See *Group 32: SUPERVISION* starting on page *153*. 9 = SUPRV1 UNDER – Energize relay when first supervised parameter (3201) drops below the limit (3202). • See *Group 32: SUPERVISION* starting on page *153*. 10 = SUPRV2 OVER – Energize relay when second supervised parameter (3204) exceeds the limit (3206). • See *Group 32: SUPERVISION* starting on page *153*. 11 = SUPRV2 UNDER – Energize relay when second supervised parameter (3204) drops below the limit (3205). • See *Group 32: SUPERVISION* starting on page *153*. 12 = SUPRV3 OVER – Energize relay when third supervised parameter (3207) exceeds the limit (3209). • See *Group 32: SUPERVISION* starting on page *153*. 13 = SUPRV3 UNDER – Energize relay when third supervised parameter (3207) drops below the limit (3208). • See *Group 32: SUPERVISION* starting on page *153*. 14 = AT SET POINT – Energize relay when the output frequency is equal to the reference frequency. 15 = FAULT(RST) – Energize relay when the drive is in a fault condition and will reset after the programmed auto-reset delay. • See parameter 3103 DELAY TIME. 16 = FLT/ALARM – Energize relay when fault or alarm occurs. 17 = EXT CTRL – Energize relay when external control is selected. 18 = REF 2 SEL – Energize relay when EXT2 is selected. 19 = CONST FREQ – Energize relay when a constant speed is selected. 20 = REF LOSS – Energize relay when reference or active control place is lost. 21 = OVERCURRENT – Energize relay when an overcurrent alarm or fault occurs. 22 = OVERVOLTAGE – Energize relay when an overvoltage alarm or fault occurs. 23 = DRIVE TEMP – Energize relay when a drive or control board overtemperature alarm or fault occurs. 24 = UNDERVOLTAGE – Energize relay when an undervoltage alarm or fault occurs. 25 = AI1 LOSS – Energize relay when AI1 signal is lost. 26 = AI2 LOSS – Energize relay when AI2 signal is lost. 27 = MOTOR TEMP – Energize relay when a motor overtemperature alarm or fault occurs. 28 = STALL – Energize relay when a stall alarm or fault exists. 30 = PID SLEEP – Energize relay when the PID sleep function is active. 31 = PFC – Use relay to start/stop motor in PFC control (See *Group 81: PFC CONTROL*). • Use this option only when PFC control is used. • Selection activated / deactivated when drive is not running. 32 = AUTOCHANGE – Energize relay when PFC autochange operation is performed. • Use this option only when PFC control is used. 33 = FLUX READY – Energize relay when the motor is magnetized and able to supply nominal torque (motor has reached nominal magnetizing). 34 = USER MACRO 2 – Energize relay when User Parameter Set 2 is active.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>35 = COMM – Energize relay based on input from fieldbus communication.
• Fieldbus writes binary code in parameter 0134 that can energize relay 1…relay 6 according to the following:
<table>
<tr><th>Par. 0134</th><th>Binary</th><th>RO6</th><th>RO5</th><th>RO4</th><th>RO3</th><th>RO2</th><th>RO1</th></tr>
<tr><td>0</td><td>000000</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>000001</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>2</td><td>000010</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>3</td><td>000011</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>4</td><td>000100</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>5…62</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>63</td><td>111111</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>
• 0 = De-energize relay, 1 = Energize relay.
36 = COMM(-1) – Energize relay based on input from fieldbus communication.
• Fieldbus writes binary code in parameter 0134 that can energize relay 1…relay 6 according to the following:
<table>
<tr><th>Par. 0134</th><th>Binary</th><th>RO6</th><th>RO5</th><th>RO4</th><th>RO3</th><th>RO2</th><th>RO1</th></tr>
<tr><td>0</td><td>000000</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>000001</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>2</td><td>000010</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>3</td><td>000011</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>4</td><td>000100</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>5…62</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>63</td><td>111111</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
• 0 = De-energize relay, 1 = Energize relay.
37 = TIMED FUNC 1 – Energize relay when Timed Function 1 is active. See Group 36: TIMED FUNCTIONS.
38…40 = TIMED FUNC 2…4 – Energize relay when Timed Function 2…4 is active. See TIMED FUNC 1 above.
41 = MNT TRIG FAN – Energize relay when cooling fan counter is triggered. See Group 29: MAINTENANCE TRIG.
42 = MNT TRIG REV – Energize relay when revolutions counter is triggered. See Group 29: MAINTENANCE TRIG.
43 = MNT TRIG RUN – Energize relay when run time counter is triggered. See Group 29: MAINTENANCE TRIG.
44 = MNT TRIG MWH – Energize relay when MWh counter is triggered. See Group 29: MAINTENANCE TRIG.
46 = START DELAY – Energize relay when a start delay is active.
47 = USER LOAD C – Energize relay when a user load curve fault or alarm occurs.
52 = JOG ACTIVE – Energize relay when the jogging function is active.</td></tr>
<tr><td>1402</td><td>RELAY OUTPUT 2
Defines the event or condition that activates relay 2 – what relay output 2 means.
• See 1401 RELAY OUTPUT 1.</td></tr>
<tr><td>1403</td><td>RELAY OUTPUT 3
Defines the event or condition that activates relay 3 – what relay output 3 means.
• See 1401 RELAY OUTPUT 1.</td></tr>
<tr><td>1404</td><td>RO 1 ON DELAY
Defines the switch-on delay for relay 1.
• On / off delays are ignored when relay output 1401 is set to PFC.</td><td rowspan="2"> 
</td></tr>
<tr><td>1405</td><td>RO 1 OFF DELAY
Defines the switch-off delay for relay 1.
• On / off delays are ignored when relay output 1401 is set to PFC.</td></tr>
<tr><td>1406</td><td>RO 2 ON DELAY
Defines the switch-on delay for relay 2.
• See RO 1 ON DELAY.</td></tr>
<tr><td>1407</td><td>RO 2 OFF DELAY
Defines the switch-off delay for relay 2.
• See RO 1 OFF DELAY.</td></tr>
<tr><td>1408</td><td>RO 3 ON DELAY
Defines the switch-on delay for relay 3.
• See RO 1 ON DELAY.</td></tr>
</table>

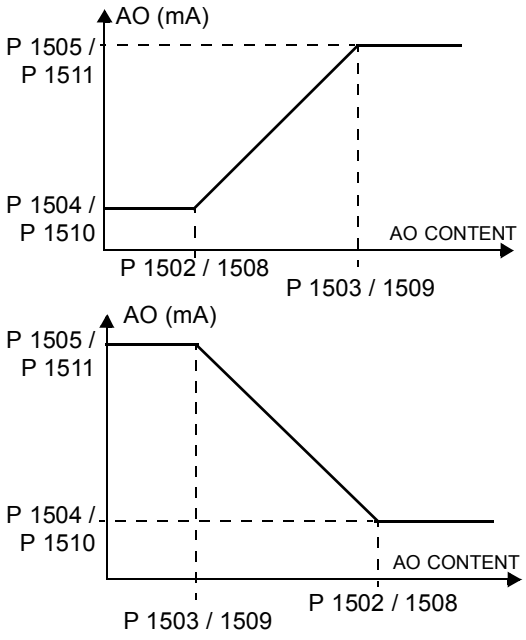
Code	Description
1409	**RO 3 OFF DELAY** Switch-off delay for relay 3. • See RO 1 OFF DELAY.
1410 … 1412	**RELAY OUTPUT 4…6** Defines the event or condition that activates relay 4…6 – what relay output 4…6 means. Available if OREL-01 Relay Output Extension Module is installed. • See 1401 RELAY OUTPUT 1.
1413	**RO 4 ON DELAY** Defines the switch-on delay for relay 4. • See RO 1 ON DELAY.
1414	**RO 4 OFF DELAY** Defines the switch-off delay for relay 4. • See RO 1 OFF DELAY.
1415	**RO 5 ON DELAY** Defines the switch-on delay for relay 5. • See RO 1 ON DELAY.
1416	**RO 5 OFF DELAY** Defines the switch-off delay for relay 5. • See RO 1 OFF DELAY.
1417	**RO 6 ON DELAY** Defines the switch-on delay for relay 6. • See RO 1 ON DELAY.
1418	**RO 6 OFF DELAY** Defines the switch-off delay for relay 6. • See RO 1 OFF DELAY.

Group 15: ANALOG OUTPUTS

This group defines the drive's analog (current signal) outputs. The drive's analog outputs can be:

- any parameter in *Group 01: OPERATING DATA*
- limited to programmable minimum and maximum values of output current
- scaled (and/or inverted) by defining the minimum and maximum values of the source parameter (or content). Defining an maximum value (parameter 1503 or 1509) that is less than the content minimum value (parameter 1502 or 1508) results in an inverted output.
- filtered.

Code	Description
1501	**AO1 CONTENT SEL** Defines the content for analog output AO1. 99 = EXCITE PTC – Provides a current source for sensor type PTC. Output = 1.6 mA. See *Group 35: MOTOR TEMP MEAS*. 100 = EXCITE PT100 – Provides a current source for sensor type PT100. Output = 9.1 mA. See *Group 35: MOTOR TEMP MEAS*. 101…178 – Output corresponds to a parameter in *Group 01: OPERATING DATA*. • Parameter defined by value (value 102 = parameter 0102)
1502	**AO1 CONTENT MIN** Sets the minimum content value. • Content is the parameter selected by parameter 1501. • Minimum value refers to the minimum content value that will be converted to an analog output. • These parameters (content and current min. and max. settings) provide scale and offset adjustment for the output. See the figure.
1503	**AO1 CONTENT MAX** Sets the maximum content value • Content is the parameter selected by parameter 1501. • Maximum value refers to the maximum content value that will be converted to an analog output.
1504	**MINIMUM AO1** Sets the minimum output current.
1505	**MAXIMUM AO1** Sets the maximum output current.
1506	**FILTER AO1** Defines the filter time constant for AO1. • The filtered signal reaches 63% of a step change within the time specified. • See the figure in parameter 1303.
1507	**AO2 CONTENT SEL** Defines the content for analog output AO2. See AO1 CONTENT SEL above.
1508	**AO2 CONTENT MIN** Sets the minimum content value. See AO1 CONTENT MIN above.
1509	**AO2 CONTENT MAX** Sets the maximum content value. See AO1 CONTENT MAX above.
1510	**MINIMUM AO2** Sets the minimum output current. See MINIMUM AO1 above.



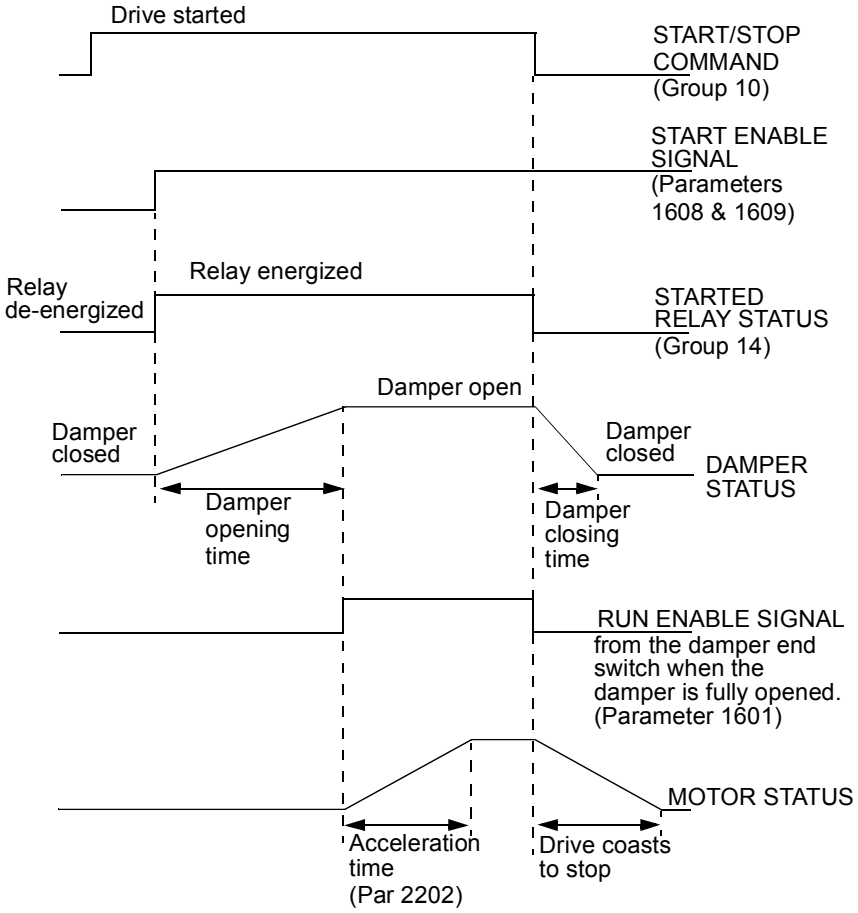
Code	Description
1511	**MAXIMUM AO2** Sets the maximum output current. See MAXIMUM AO1 above.
1512	**FILTER AO2** Defines the filter time constant for AO2. See FILTER AO1 above.

Group 16: SYSTEM CONTROLS

This group defines a variety of system level locks, resets and enables.

Code	Description
1601	**RUN ENABLE** Selects the source of the run enable signal. 0 = NOT SEL – Allows the drive to start without an external run enable signal. 1 = DI1 – Defines digital input DI1 as the run enable signal. • This digital input must be activated for run enable. • If the voltage drops and de-activates this digital input, the drive will coast to stop and not start until the run enable signal resumes. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the run enable signal. • See DI1 above. 7 = COMM – Assigns the fieldbus Command Word as the source for the run enable signal. • Bit 6 of the Command Word 1 (parameter 0301) activates the run disable signal. • See fieldbus user's manual for detailed instructions. -1 = DI1(INV) – Defines an inverted digital input DI1 as the run enable signal. • This digital input must be de-activated for run enable. • If this digital input activates, the drive will coast to stop and not start until the run enable signal resumes. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the run enable signal. • See DI1(INV) above.
1602	**PARAMETER LOCK** Determines if the control panel can change parameter values. • This lock does not limit parameter changes made by macros. • This lock does not limit parameter changes written by fieldbus inputs. • This parameter value can be changed only if the correct pass code is entered. See parameter 1603 PASS CODE. 0 = LOCKED – You cannot use the control panel to change parameter values. • The lock can be opened by entering the valid pass code to parameter 1603. 1 = OPEN – You can use the control panel to change parameter values. 2 = NOT SAVED – You can use the control panel to change parameter values, but they are not stored in permanent memory. • Set parameter 1607 PARAM SAVE to 1 (SAVE) to store changed parameter values to memory.
1603	**PASS CODE** Entering the correct pass code allows you to change the parameter lock. • See parameter 1602 above. • The code 358 allows you to change the value of the parameter 1602 once. • This entry reverts back to 0 automatically.
1604	**FAULT RESET SEL** Selects the source for the fault reset signal. The signal resets the drive after a fault trip if the cause of the fault no longer exists. 0 = KEYPAD – Defines the control panel as the only fault reset source. • Fault reset is always possible with control panel. 1 = DI1 – Defines digital input DI1 as a fault reset source. • Activating the digital input resets the drive. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as a fault reset source. • See DI1 above. 7 = START/STOP – Defines the Stop command as a fault reset source. • Do not use this option when fieldbus communication provides the start, stop and direction commands. 8 = COMM – Defines the fieldbus as a fault reset source. • The Command Word is supplied through fieldbus communication. • The bit 4 of the Command Word 1 (parameter 0301) resets the drive. -1 = DI1(INV) – Defines an inverted digital input DI1 as a fault reset source. • De-activating the digital input resets the drive. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as a fault reset source. • See DI1(INV) above.

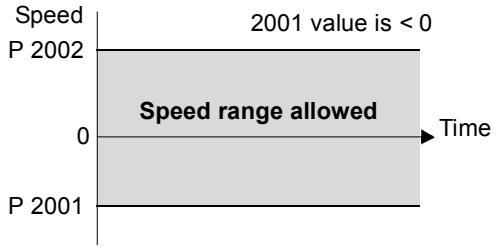
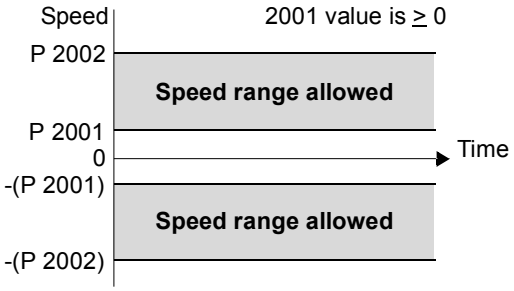
Code	Description
1605	**USER PAR SET CHG** Defines control for changing the user parameter set. • See parameter 9902 APPLIC MACRO. • The drive must be stopped to change User Parameter Sets. • During a change, the drive will not start. **Note:** Always save the User Parameter Set after changing any parameter settings, or performing a motor identification. • Whenever the power is cycled, or parameter 9902 APPLIC MACRO is changed, the drive loads the last settings saved. Any unsaved changes to a user parameter set are lost. **Note:** The value of this parameter (1605) is not included in the User Parameter Sets, and it does not change if User Parameter Sets change. **Note:** You can use a relay output to supervise the selection of User Parameter Set 2. • See parameter 1401. 0 = NOT SEL – Defines the control panel (using parameter 9902) as the only control for changing User Parameter Sets. 1 = DI1 – Defines digital input DI1 as a control for changing User Parameter Sets. • The drive loads User Parameter Set 1 on the falling edge of the digital input. • The drive loads User Parameter Set 2 on the rising edge of the digital input. • The User Parameter Set changes only when the drive is stopped. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as a control for changing User Parameter Sets. • See DI1 above. -1 = DI1(INV) – Defines an inverted digital input DI1 as a control for changing User Parameter Sets. • The drive loads User Parameter Set 1 on the rising edge of the digital input. • The drive loads User Parameter Set 2 on the falling edge of the digital input. • The User Parameter Set changes only when the drive is stopped. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as a control for changing User Parameter Sets. • See DI1(INV) above.
1606	**LOCAL LOCK** Defines control for the use of the LOC mode. The LOC mode allows drive control from the control panel. • When LOCAL LOCK is active, the control panel cannot change to LOC mode. 0 = NOT SEL – Disables the lock. The control panel can select LOC and control the drive. 1 = DI1 – Defines digital input DI1 as the control for setting the local lock. • Activating the digital input locks out local control. • De-activating the digital input enable the LOC selection. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for setting the local lock. • See DI1 above. 7 = ON – Sets the lock. The control panel cannot select LOC and cannot control the drive. 8 = COMM – Defines bit 14 of the Command Word 1 as the control for setting the local lock. • The Command Word is supplied through fieldbus communication. • The Command Word is 0301. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for setting the local lock. • De-activating the digital input locks out local control. • Activating the digital input enable the LOC selection. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for setting the local lock. • See DI1(INV) above.
1607	**PARAM SAVE** Saves all altered parameters to permanent memory. • Parameters altered through a fieldbus are not automatically saved to permanent memory. To save, you must use this parameter. • If 1602 PARAMETER LOCK = 2 (NOT SAVED), parameters altered from the control panel are not saved. To save, you must use this parameter. • If 1602 PARAMETER LOCK = 1 (OPEN), parameters altered from the control panel are stored immediately to permanent memory. 0 = DONE – Value changes automatically when all parameters are saved. 1 = SAVE… – Saves altered parameters to permanent memory.

Code	Description
1608	**START ENABLE 1** Selects the source of the start enable 1 signal. **Note:** Start enable functionality differs from the run enable functionality. 0 = NOT SEL – Allows the drive to start without an external start enable signal. 1 = DI1 – Defines digital input DI1 as the start enable 1 signal. • This digital input must be activated for start enable 1 signal. • If the voltage drops and de-activates this digital input, the drive will coast to stop and show alarm 2021 on the panel display. The drive will not start until start enable 1 signal resumes. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the start enable 1 signal. • See DI1 above. 7 = COMM – Assigns the fieldbus Command Word as the source for the start enable 1 signal. • Bit 2 of the Command word 2 (parameter 0302) activates the start disable 1 signal. • See fieldbus user's manual for detailed instructions. -1 = DI1(INV) – Defines an inverted digital input DI1 as the start enable 1 signal. -2…-6 = DI2 (INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the start enable 1 signal. • See DI1 (INV) above. 

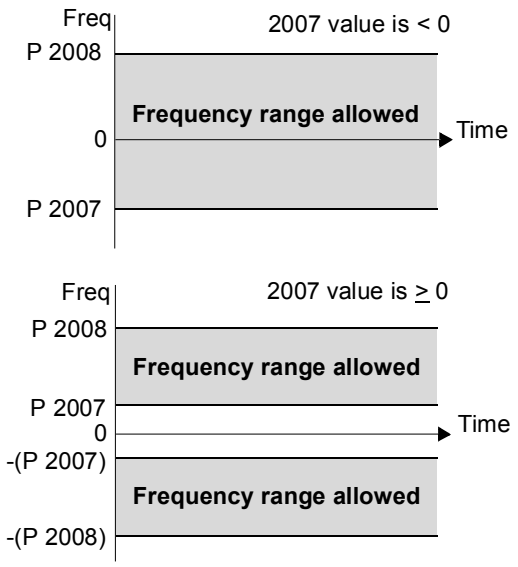
Code	Description
1609	**START ENABLE 2** Selects the source of the start enable 2 signal. **Note:** Start enable functionality differs from the run enable functionality. 0 = NOT SEL – Allows the drive to start without an external start enable signal. 1 = DI1 – Defines digital input DI1 as the start enable 2 signal. • This digital input must be activated for start enable 2 signal. • If the voltage drops and de-activates this digital input, the drive will coast to stop and show alarm 2022 on the panel display. The drive will not start until start enable 2 signal resumes. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the start enable 2 signal. • See DI1 above. 7 = COMM – Assigns the fieldbus Command Word as the source for the start enable 2 signal. Bit 3 of the Command word 2 (parameter 0302) activates the start disable 2 signal. • See fieldbus user's manual for detailed instructions. -1 = DI1(INV) – Defines an inverted digital input DI1 as the start enable 2 signal. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the start enable 2 signal. • See DI1 (INV) above.
1610	**DISPLAY ALARMS** Controls the visibility of the following alarms: • 2001, Overcurrent alarm • 2002, Overvoltage alarm • 2003, Undervoltage alarm • 2009, Device overtemperature alarm. For more information, see section *Alarm listing* on page *267*. 0 = NO – The above alarms are suppressed. 1 = YES – All of the above alarms are enabled.
1611	**PARAMETER VIEW** Selects the parameter view, i.e. which parameters are shown. **Note:** This parameter is visible only when it is activated by the optional FlashDrop device. FlashDrop is designed for fast copying of parameters to unpowered drives. It allows easy customization of the parameter list, e.g. selected parameters can be hidden. For more information, see *MFDT-01 FlashDrop User's Manual* (3AFE68591074 [English]). FlashDrop parameter values are activated by setting parameter 9902 to 31 (LOAD FD SET). 0 = DEFAULT – Complete long and short parameter lists are shown. 1 = FLASHDROP – FlashDrop parameter list is shown. Does not include short parameter list. Parameters that are hidden by the FlashDrop device are not visible.
1612	**FAN CONTROL** Selects drive cooling fan control. Can be used to mitigate DC voltage fluctuations. 0 = AUTO – Fan is controlled automatically (default). 1 = ON – Fan is always forced on.
1613	**FAULT RESET** Allows to reset faults with a parameter. Can be used to reset faults from remote monitoring systems that have access to drive parameters. 0 = DEFAULT – Fault is not reset (default) 1 = RESET NOW – Resets fault.

Group 20: LIMITS

This group defines minimum and maximum limits to follow in driving the motor – speed, frequency, current, torque, etc.

Code	Description
2001	**MINIMUM SPEED** Defines the minimum speed (rpm) allowed. • A positive (or zero) minimum speed value defines two ranges, one positive and one negative. • A negative minimum speed value defines one speed range. • See the figure. 
2002	**MAXIMUM SPEED** Defines the maximum speed (rpm) allowed. 
2003	**MAX CURRENT** Defines the maximum output current (A) supplied by the drive to the motor.
2005	**OVERVOLT CTRL** Sets the DC overvoltage controller on or off. • Fast braking of a high inertia load causes the DC bus voltage to rise to the overvoltage control limit. To prevent the DC voltage from exceeding the trip limit, the overvoltage controller automatically decreases the braking torque by increasing output frequency. 0 = DISABLE – Disables controller. 1 = ENABLE – Enables controller **Note:** If a braking chopper or a braking resistor is connected to the drive, this parameter value must be set to 0 (DISABLE) to ensure proper operation of the chopper.
2006	**UNDERVOLT CTRL** Sets the DC undervoltage controller on or off. When on: • If the DC bus voltage drops due to loss of input power, the undervoltage controller decreases the motor speed in order to keep the DC bus voltage above the lower limit. • When the motor speed decreases, the inertia of the load causes regeneration back into the drive, keeping the DC bus charged and preventing an undervoltage trip. • The DC undervoltage controller increases power loss ride-through on systems with a high inertia, such as a centrifuge or a fan. 0 = DISABLE – Disables controller. 1 = ENABLE(TIME) – Enables controller with 500 ms time limit for operation. 2 = ENABLE – Enables controller without maximum time limit for operation.

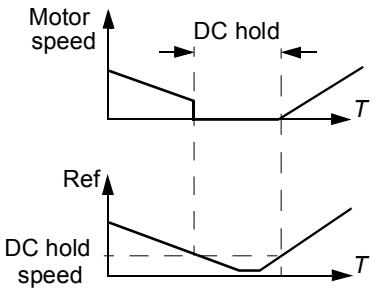
Code	Description
2007	**MINIMUM FREQ** Defines the minimum limit for the drive output frequency. • A positive or zero minimum frequency value defines two ranges, one positive and one negative. • A negative minimum frequency value defines one speed range. See the figure. **Note:** Keep MINIMUM FREQ ≤ MAXIMUM FREQ.
2008	**MAXIMUM FREQ** Defines the maximum limit for the drive output frequency.
2013	**MIN TORQUE SEL** Defines control of the selection between two minimum torque limits (2015 MIN TORQUE 1 and 2016 MIN TORQUE 2). 0 = MIN TORQUE 1 – Selects 2015 MIN TORQUE 1 as the minimum limit used. 1 = DI1 – Defines digital input DI1 as the control for selecting the minimum limit used. • Activating the digital input selects MIN TORQUE 2 value. • De-activating the digital input selects MIN TORQUE 1 value. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for selecting the minimum limit used. • See DI1 above. 7 = COMM – Defines bit 15 of the Command Word 1 as the control for selecting the minimum limit used. • The Command Word is supplied through fieldbus communication. • The Command Word is parameter 0301. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for selecting the minimum limit used. • Activating the digital input selects MIN TORQUE 1 value. • De-activating the digital input selects MIN TORQUE 2 value. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for selecting the minimum limit used. • See DI1(INV) above.
2014	**MAX TORQUE SEL** Defines control of the selection between two maximum torque limits (2017 MAX TORQUE 1 and 2018 MAX TORQUE 2). 0 = MAX TORQUE 1 – Selects 2017 MAX TORQUE 1 as the maximum limit used. 1 = DI1 – Defines digital input DI1 as the control for selecting the maximum limit used. • Activating the digital input selects MAX TORQUE 2 value. • De-activating the digital input selects MAX TORQUE 1 value. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for selecting the maximum limit used. • See DI1 above. 7 = COMM – Defines bit 15 of the Command Word 1 as the control for selecting the maximum limit used. • The Command Word is supplied through fieldbus communication. • The Command Word is parameter 0301. -1 = DI1(INV) – Defines an inverted digital input di1 as the control for selecting the maximum limit used. • Activating the digital input selects MAX TORQUE 1 value. • De-activating the digital input selects MAX TORQUE 2 value. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for selecting the maximum limit used. • See DI1(INV) above.
2015	**MIN TORQUE 1** Sets the first minimum limit for torque (%). Value is a percent of the motor nominal torque.
2016	**MIN TORQUE 2** Sets the second minimum limit for torque (%). Value is a percent of the motor nominal torque.



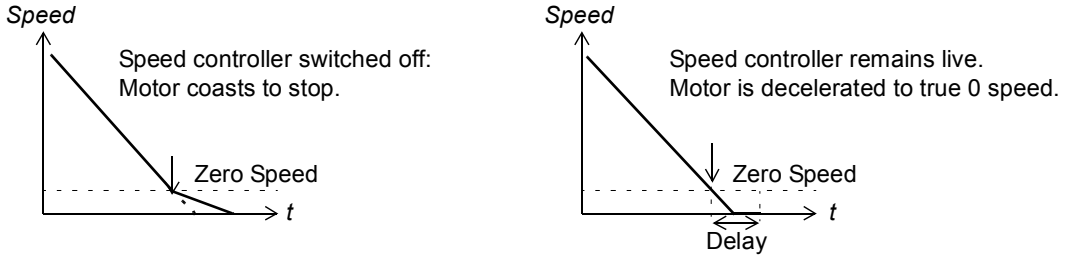
Code	Description
2017	**MAX TORQUE 1** Sets the first maximum limit for torque (%). Value is a percent of the motor nominal torque.
2018	**MAX TORQUE 2** Sets the second maximum limit for torque (%). Value is a percent of the motor nominal torque.

Group 21: START/STOP

This group defines how the motor starts and stops. The ACS550 supports several start and stop modes.

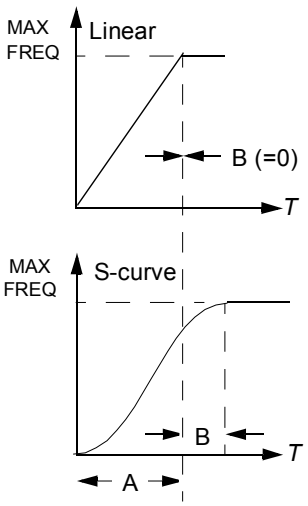
Code	Description
2101	**START FUNCTION** Selects the motor start method. The valid options depend on the value of parameter 9904 MOTOR CTRL MODE. 1 = AUTO – Selects the automatic start mode. • Vector control modes: Optimal start in most cases. The drive automatically selects the correct output frequency to start a rotating motor. • SCALAR:FREQ mode: Immediate start from zero frequency. Identical to selection 8 = RAMP. 2 = DC MAGN – Selects the DC Magnetizing start mode. **Note:** The DC Magnetizing start mode cannot start a rotating motor. **Note:** The drive starts when the set pre-magnetizing time (parameter 2103 DC MAGN TIME) has passed, even if motor magnetization is not complete. • Vector control modes: Magnetizes the motor within the time determined by the parameter 2103 DC MAGN TIME using DC current. The normal control is released exactly after the magnetizing time. This selection guarantees the highest possible break-away torque. • SCALAR:FREQ mode: Magnetizes the motor within the time determined by the parameter 2103 DC MAGN TIME using DC current. The normal control is released exactly after the magnetizing time. 3 = SCALAR FLYST – Selects the flying start mode. • Vector control modes: Not applicable. • SCALAR:FREQ mode: The drive automatically selects the correct output frequency to start a rotating motor – useful if the motor is already rotating and if the drive will start smoothly at the current frequency. • Cannot be used in multimotor systems. 4 = TORQ BOOST – Selects the automatic torque boost mode (SCALAR:FREQ mode only). • May be necessary in drives with high starting torque. • Torque boost is only applied at start, ending when output frequency exceeds 20 Hz or when output frequency is equal to reference. • In the beginning the motor magnetizes within the time determined by the parameter 2103 DC MAGN TIME using DC current. • See parameter 2110 TORQ BOOST CURR. 5 = FLY + BOOST – Selects both the flying start and the torque boost mode (SCALAR:FREQ mode only). • Flying start routine is performed first and the motor is magnetized. If the speed is found to be zero, the torque boost is done. 8 = RAMP – Immediate start from zero frequency.
2102	**STOP FUNCTION** Selects the motor stop method. 1 = COAST – Selects cutting off the motor power as the stop method. The motor coasts to stop. 2 = RAMP – Selects using a deceleration ramp. • Deceleration ramp is defined by 2203 DECELER TIME 1 or 2206 DECELER TIME 2 (whichever is active).
2103	**DC MAGN TIME** Defines the pre-magnetizing time for the DC Magnetizing start mode. • Use parameter 2101 to select the start mode. • After the start command, the drive pre-magnetizes the motor for the time defined here and then starts the motor. • Set the pre-magnetizing time just long enough to allow full motor magnetization. Too long a time heats the motor excessively.
2104	**DC HOLD CTL** Selects whether DC current is used for braking or DC Hold. 0 = NOT SEL – Disables the DC current operation. 1 = DC HOLD – Enables the DC Hold function. See the diagram. • Requires parameter 9904 MOTOR CTRL MODE = 1 (VECTOR:SPEED) • Stops generating sinusoidal current and injects DC into the motor when both the reference and the motor speed drop below the value of parameter 2105. • When the reference rises above the level of parameter 2105 the drive resumes normal operation. 2 = DC BRAKING – Enables the DC Injection Braking after modulation has stopped. • If parameter 2102 STOP FUNCTION is 1 (COAST), braking is applied after start is removed. • If parameter 2102 STOP FUNCTION is 2 (RAMP), braking is applied after ramp. 

Code	Description
2105	**DC HOLD SPEED** Sets the speed for DC Hold. Requires that parameter 2104 DC HOLD CTL = 1 (DC HOLD).
2106	**DC CURR REF** Defines the DC current control reference as a percentage of parameter 9906 MOTOR NOM CURR.
2107	**DC BRAKE TIME** Defines the DC brake time after modulation has stopped, if parameter 2104 is 2 (DC BRAKING).
2108	**START INHIBIT** Sets the Start inhibit function on or off. If the drive is not actively started and running, the Start inhibit function ignores a pending start command in any of the following situations and a new start command is required: • A fault is reset. • Run Enable (parameter 1601) activates while start command is active. • Mode changes from local to remote. • Control switches from EXT1 to EXT2. • Control switches from EXT2 to EXT1. 0 = OFF – Disables the Start inhibit function. 1 = ON – Enables the Start inhibit function.
2109	**EMERG STOP SEL** Defines control of the Emergency stop command. When activated: • Emergency stop decelerates the motor using the emergency stop ramp (parameter 2208 EMERG DEC TIME). • Requires an external stop command and removal of the emergency stop command before drive can restart. 0 = NOT SEL – Disables the Emergency stop function through digital inputs. 1 = DI1 – Defines digital input DI1 as the control for Emergency stop command. • Activating the digital input issues an Emergency stop command. • De-activating the digital input removes the Emergency stop command. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for Emergency stop command. • See DI1 above. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for Emergency stop command. • De-activating the digital input issues an Emergency stop command. • Activating the digital input removes the Emergency stop command. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for Emergency stop command. • See DI1(INV) above.
2110	**TORQ BOOST CURR** Sets the maximum supplied current during torque boost. • See parameter 2101 START FUNCTION.

Code	Description
2112	**ZERO SPEED DELAY** Defines the delay for the Zero Speed Delay function. If parameter value is set to zero, the Zero Speed Delay function is disabled. The function is useful in applications where a smooth and quick restarting is essential. During the delay the drive knows accurately the rotor position. **No Zero Speed Delay** **With Zero Speed Delay**  Zero speed delay can be used e.g. with jogging function or mechanical brake. **No Zero Speed Delay** The drive receives a stop command and decelerates along a ramp. When the motor actual speed falls below an internal limit (called Zero Speed), the speed controller is switched off. The drive modulation is stopped and the motor coasts to standstill. **With Zero Speed Delay** The drive receives a stop command and decelerates along a ramp. When the motor actual speed falls below an internal limit (called Zero Speed), the zero speed delay function activates. During the delay the functions keeps the speed controller live: The drive modulates, motor is magnetized and drive is ready for a quick restart. **Note:** Parameter 2102 STOP FUNCTION must be 2 = RAMP for zero speed delay to operate. 0.0 = NOT SEL – Disables the Zero Speed Delay function.
2113	**START DELAY** Defines the Start delay. After the conditions for start have been fulfilled, the drive waits until the delay has elapsed and then starts the motor. Start delay can be used with all start modes. • If START DELAY = zero, the delay is disabled. • During the Start delay, alarm 2028 START DELAY is shown.

Group 22: ACCEL/DECEL

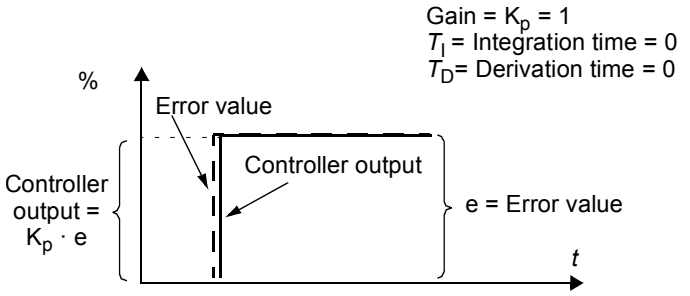
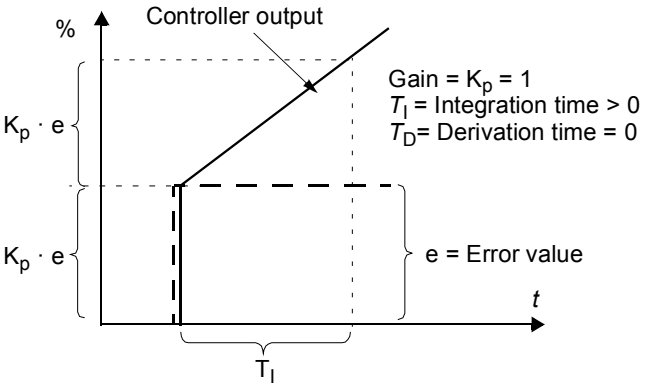
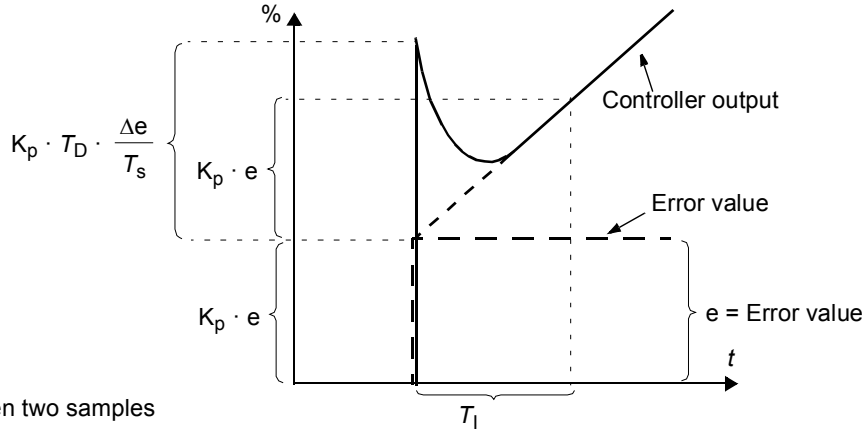
This group defines ramps that control the rate of acceleration and deceleration. You define these ramps as a pair, one for acceleration and one for deceleration. You can define two pairs of ramps and use a digital input to select one or the other pair.

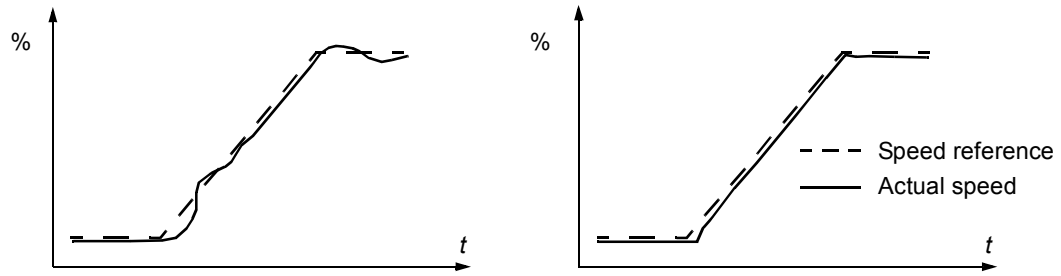
Code	Description
2201	**ACC/DEC 1/2 SEL** Defines control for selection of acceleration/deceleration ramps. • Ramps are defined in pairs, one each for acceleration and deceleration. • See below for the ramp definition parameters. 0 = NOT SEL – Disables selection, the first ramp pair is used. 1 = DI1 – Defines digital input DI1 as the control for ramp pair selection. • Activating the digital input selects ramp pair 2. • De-activating the digital input selects ramp pair 1. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for ramp pair selection. • See DI1 above. 7 = COMM – Defines bit 10 of the Command Word 1 as the control for ramp pair selection. • The Command Word is supplied through fieldbus communication. • The Command Word is parameter 0301. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for ramp pair selection. • De-activating the digital input selects ramp pair 2 • Activating the digital input selects ramp pair 1. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for ramp pair selection. • See DI1(INV) above.
2202	**ACCELER TIME 1** Sets the acceleration time for zero to maximum frequency for ramp pair 1. See A in the figure. • Actual acceleration time also depends on 2204 RAMP SHAPE 1. • See 2008 MAXIMUM FREQ.
2203	**DECELER TIME 1** Sets the deceleration time for maximum frequency to zero for ramp pair 1. • Actual deceleration time also depends on 2204 RAMP SHAPE 1. • See 2008 MAXIMUM FREQ.
2204	**RAMP SHAPE 1** Selects the shape of the acceleration/deceleration ramp for ramp pair 1. See B in the figure. • Shape is defined as a ramp, unless additional time is specified here to reach the maximum frequency. A longer time provides a softer transition at each end of the slope. The shape becomes an s-curve. • Rule of thumb: 1/5 is a suitable relation between the ramp shape time and the acceleration ramp time. 0.0 = LINEAR – Specifies linear acceleration/deceleration ramps for ramp pair 1. 0.1…1000.0 = S-CURVE – Specifies s-curve acceleration/deceleration ramps for ramp pair 1.
	 A = 2202 ACCELER TIME 1 B = 2204 RAMP SHAPE 1
2205	**ACCELER TIME 2** Sets the acceleration time for zero to maximum frequency for ramp pair 2. • See 2202 ACCELER TIME 1. • Used also as jogging acceleration time. See 1004 JOGGING SEL.
2206	**DECELER TIME 2** Sets the deceleration time for maximum frequency to zero for ramp pair 2. • See 2203 DECELER TIME 1. • Used also as jogging deceleration time. See 1004 JOGGING SEL.
2207	**RAMP SHAPE 2** Selects the shape of the acceleration/deceleration ramp for ramp pair 2. • See 2204 RAMP SHAPE 1.

Code	Description
2208	**EMERG DEC TIME** Sets the deceleration time for maximum frequency to zero for an emergency. • See parameter 2109 EMERG STOP SEL. • Ramp is linear.
2209	**RAMP INPUT 0** Defines control for forcing the speed to 0 with the currently used deceleration ramp (see parameters 2203 DECELER TIME 1 and 2206 DECELER TIME 2). 0 = NOT SEL – Not selected. 1 = DI1 – Defines digital input DI1 as the control for forcing the speed to 0. • Activating the digital input forces the speed to zero, after which the speed will stay at 0. • De-activating the digital input: speed control resumes normal operation. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for forcing the speed to 0. • See DI1 above. 7 = COMM – Defines bit 13 of the Command Word 1 as the control for forcing the speed to 0. • The Command Word is supplied through fieldbus communication. • The Command Word is parameter 0301. -1 = DI1(INV) – Defines inverted digital input DI1 as the control for forcing the speed to 0. • De-activating the digital input forces the speed to 0. • Activating the digital input: speed control resumes normal operation. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for forcing the speed to 0. • See DI1(INV) above.

Group 23: SPEED CONTROL

This group defines variables used for speed control operation.

Code	Description
2301	**PROP GAIN** Sets the relative gain for the speed controller. • Larger values may cause speed oscillation. • The figure shows the speed controller output after an error step (error remains constant). **Note:** You can use parameter 2305 AUTOTUNE RUN to automatically set the proportional gain. 
2302	**INTEGRATION TIME** Sets the integration time for the speed controller. • The integration time defines the rate at which the controller output changes for a constant error value. • Shorter integration times correct continuous errors faster. • Control becomes unstable if the integration time is too short. • The figure shows the speed controller output after an error step (error remains constant). **Note:** You can use parameter 2305 AUTOTUNE RUN to automatically set the integration time. 
2303	**DERIVATION TIME** Sets the derivation time for the speed controller. • Derivative action makes the control more responsive to error value changes. • The longer the derivation time, the more the speed controller output is boosted during the change. • If the derivation time is set to zero, the controller works as a PI controller, otherwise as a PID controller. The figure below shows the speed controller output after an error step when the error remains constant.  Gain = K_p = 1 T_I = Integration time > 0 T_D= Derivation time > 0 T_s= Sample time period = 2 ms Δe = Error value change between two samples

Code	Description
2304	**ACC COMPENSATION** Sets the derivation time for acceleration compensation. • Adding a derivative of the reference to the output of the speed controller compensates for inertia during acceleration. • 2303 DERIVATION TIME describes the principle of derivative action. • Rule of thumb: Set this parameter between 50 and 100% of the sum of the mechanical time constants for the motor and the driven machine. • The figure shows the speed responses when a high inertia load is accelerated along a ramp. * **No acceleration compensation** **Acceleration compensation**  ***Note:** You can use parameter 2305 AUTOTUNE RUN to automatically set acceleration compensation.
2305	**AUTOTUNE RUN** Starts automatic tuning of the speed controller. 0 = OFF – Disables the Autotune creation process. (Does not disable the operation of Autotune settings.) 1 = ON – Activates speed controller autotuning. Automatically reverts to OFF. Procedure: **Note:** The motor load must be connected. • Run the motor at a constant speed of 20 to 40% of the rated speed. • Change the autotuning parameter 2305 to ON. The drive: • Accelerates the motor. • Calculates values for proportional gain, integration time and acceleration compensation. • Changes parameters 2301, 2302 and 2304 to these values. • Resets 2305 to OFF.

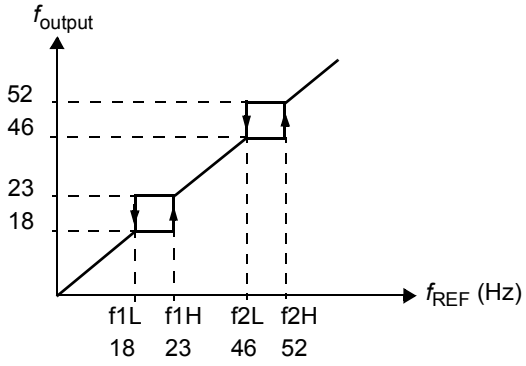
Group 24: TORQUE CONTROL

This group defines variables used for torque control operation.

Code	Description
2401	**TORQ RAMP UP** Defines the torque reference ramp up time – The minimum time for the reference to increase from zero to the nominal motor torque.
2402	**TORQ RAMP DOWN** Defines the torque reference ramp down time – The minimum time for the reference to decrease from the nominal motor torque to zero.

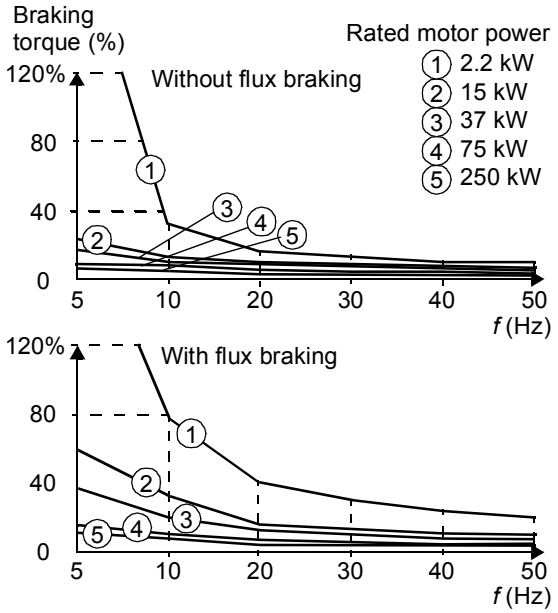
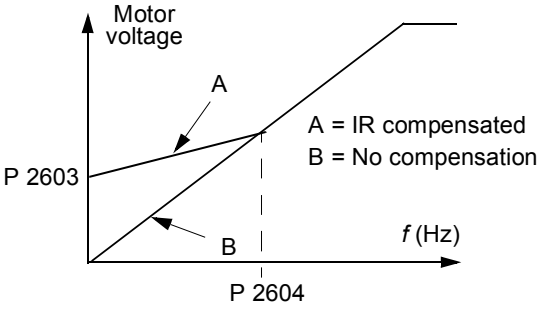
Group 25: CRITICAL SPEEDS

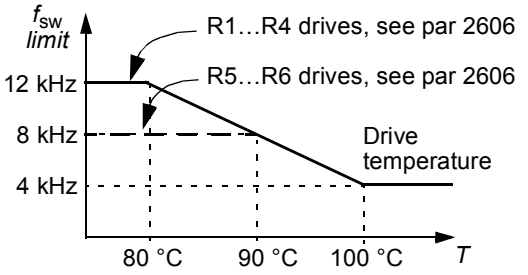
This group defines up to three critical speeds or ranges of speeds that are to be avoided due, for example, to mechanical resonance problems at certain speeds.

Code	Description
2501	**CRIT SPEED SEL** Sets the critical speeds function on or off. The critical speed function avoids specific speed ranges. 0 = OFF – Disables the critical speeds function. 1 = ON – Enables the critical speeds function. **Example:** To avoid speeds at which a fan system vibrates badly: • Determine problem speed ranges. Assume they are found to be: 18…23 Hz and 46…52 Hz. • Set 2501 CRIT SPEED SEL = 1. • Set 2502 CRIT SPEED 1 LO = 18 Hz. • Set 2503 CRIT SPEED 1 HI = 23 Hz. • Set 2504 CRIT SPEED 2 LO = 46 Hz. • Set 2505 CRIT SPEED 2 HI = 52 Hz. 
2502	**CRIT SPEED 1 LO** Sets the minimum limit for critical speed range 1. • The value must be less than or equal to 2503 CRIT SPEED 1 HI. • Units are rpm, unless 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ), then units are Hz.
2503	**CRIT SPEED 1 HI** Sets the maximum limit for critical speed range 1. • The value must be greater than or equal to 2502 CRIT SPEED 1 LO. • Units are rpm, unless 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ), then units are Hz.
2504	**CRIT SPEED 2 LO** Sets the minimum limit for critical speed range 2. • See parameter 2502.
2505	**CRIT SPEED 2 HI** Sets the maximum limit for critical speed range 2. • See parameter 2503.
2506	**CRIT SPEED 3 LO** Sets the minimum limit for critical speed range 3. • See parameter 2502.
2507	**CRIT SPEED 3 HI** Sets the maximum limit for critical speed range 3. • See parameter 2503.

Group 26: MOTOR CONTROL

This group defines variables used for motor control.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>2601</td><td colspan="2">FLUX OPT ENABLE
Changes the magnitude of the flux depending on the actual load. Flux Optimization can reduce the total energy consumption and noise, and it should be enabled for drives that usually operate below nominal load.
0 = OFF – Disables the feature.
1 = ON – Enables the feature.</td></tr>
<tr><td>2602</td><td>FLUX BRAKING
Provides faster deceleration by raising the level of magnetization in the motor when needed, instead of limiting the deceleration ramp. By increasing the flux in the motor, the energy of the mechanical system is changed to thermal energy in the motor.
• Requires parameter 9904 MOTOR CTRL MODE = 1 (VECTOR:SPEED) OR 2 (VECTOR:TORQ).
0 = OFF – Disables the feature.
1 = ON – Enables the feature.</td><td> 
</td></tr>
<tr><td>2603</td><td>IR COMP VOLT
Sets the IR compensation voltage used for 0 Hz.
• Requires parameter 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ).
• Keep IR compensation as low as possible to prevent overheating.
• Typical IR compensation values are:
<table><tr><th colspan="6">380…480 V drives</th></tr><tr><td>P_N (kW)</td><td>3</td><td>7.5</td><td>15</td><td>37</td><td>132</td></tr><tr><td>IR comp (V)</td><td>18</td><td>15</td><td>12</td><td>8</td><td>3</td></tr></table></td><td rowspan="2">IR compensation
• When enabled, IR compensation provides an extra voltage boost to the motor at low speeds. Use IR compensation, for example, in applications that require a high breakaway torque.
 
</td></tr>
<tr><td>2604</td><td>IR COMP FREQ
Sets the frequency at which IR compensation is 0 V (in % of motor frequency).</td></tr>
<tr><td>2605</td><td colspan="2">U/F RATIO
Selects the form for the U/f (voltage to frequency) ratio below field weakening point.
1 = LINEAR – Preferred for constant torque applications.
2 = SQUARED – Preferred for centrifugal pump and fan applications. (SQUARED is more silent for most operating frequencies.)</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>2606</td><td>SWITCHING FREQ
Sets the switching frequency for the drive. Also see parameter 2607 SWITCH FREQ CTRL and section Switching frequency derating on page 280.
• Higher switching frequencies mean less noise.
• In multimotor systems, do not change the switching frequency from the default value.
• 12 kHz switching frequency is available in scalar control mode, that is when parameter 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ).
• See the availability of switching frequencies for different drive types in the table below.
<table>
<tr><th></th><th>1, 2, 4 and 8 kHz</th><th>12 kHz</th></tr>
<tr><td>208…240 V</td><td>All types</td><td>Frame sizes R1…R4 in scalar control mode</td></tr>
<tr><td>380…480 V</td><td>All types</td><td>Frame sizes R1…R4 (except ACS550-01-097A-4) in scalar control mode</td></tr>
<tr><td>500…600 V</td><td>All types</td><td>Frame sizes R2…R4 in scalar control mode</td></tr>
</table>
</td></tr>
<tr><td>2607</td><td>SWITCH FREQ CTRL
The switching frequency may be reduced if the ACS550 internal temperature rises above a limit. See the figure. This function allows the highest possible switching frequency to be used based on operating conditions. Higher switching frequency results in lower acoustic noise.
• In multimotor systems, do no disable (set OFF) the function.
0 = OFF – The function is disabled.
1 = ON – The switching frequency is limited according to the figure.
 
</td></tr>
<tr><td>2608</td><td>SLIP COMP RATIO
Sets gain for slip compensation (in %).
• A squirrel-cage motor slips under load. Increasing the frequency as the motor torque increases compensates for the slip.
• Requires parameter 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ).
0 – No slip compensation.
1…200 – Increasing slip compensation. 100% means full slip compensation.</td></tr>
<tr><td>2609</td><td>NOISE SMOOTHING
This parameter introduces a random component to the switching frequency. Noise smoothing distributes the acoustic motor noise over a range of frequencies instead of a single tonal frequency resulting in lower peak noise intensity. The random component has an average of 0 Hz. It is added to the switching frequency set by parameter 2606 SWITCHING FREQ. This parameter has no effect if parameter 2606 = 12 kHz.
0 = DISABLE
1 = ENABLE.</td></tr>
<tr><td>2619</td><td>DC STABILIZER
Enables or disables the DC voltage stabilizer. The DC stabilizer is used in scalar control mode to prevent possible voltage oscillations in the drive DC bus caused by motor load or weak supply network. In case of voltage variation the drive tunes the frequency reference to stabilize the DC bus voltage and therefore the load torque oscillation.
0 = DISABLE – Disables DC stabilizer.
1 = ENABLE – Enables DC stabilizer.</td></tr>
<tr><td>2625</td><td>OVERMODULATION
Enables or disables overmodulation. Disabling overmodulation can help in some applications in field weakening area.
0 = DISABLE – Disables overmodulation.
1 = ENABLE – Enables overmodulation.</td></tr>
</table>

Group 29: MAINTENANCE TRIG

This group contains usage levels and trigger points. When usage reaches the set trigger point, a notice displayed on the control panel signals that maintenance is due.

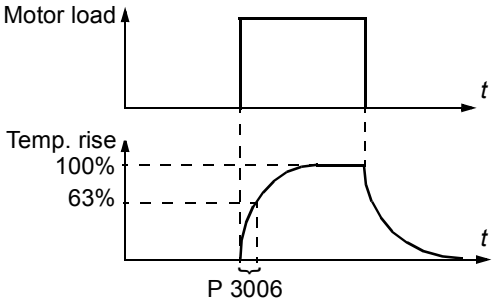
Code	Description
2901	**COOLING FAN TRIG** Sets the trigger point for the drive's cooling fan counter. • Value is compared to parameter 2902 value. 0.0 – Disables the trigger.
2902	**COOLING FAN ACT** Defines the actual value of the drive's cooling fan counter. • When parameter 2901 has been set to a non-zero value, the counter starts. • When the actual value of the counter exceeds the value defined by parameter 2901, a maintenance notice is displayed on the panel. 0.0 – Resets the parameter.
2903	**REVOLUTION TRIG** Sets the trigger point for the motor's accumulated revolutions counter. • Value is compared to parameter 2904 value. 0 – Disables the trigger.
2904	**REVOLUTION ACT** Defines the actual value of the motor's accumulated revolutions counter. • When parameter 2903 has been set to a non-zero value, the counter starts. • When the actual value of the counter exceeds the value defined by parameter 2903, a maintenance notice is displayed on the panel. 0 – Resets the parameter.
2905	**RUN TIME TRIG** Sets the trigger point for the drive's run time counter. • Value is compared to parameter 2906 value. 0.0 – Disables the trigger.
2906	**RUN TIME ACT** Defines the actual value of the drive's run time counter. • When parameter 2905 has been set to a non-zero value, the counter starts. • When the actual value of the counter exceeds the value defined by parameter 2905, a maintenance notice is displayed on the panel. 0.0 – Resets the parameter.
2907	**USER MWh TRIG** Sets the trigger point for the drive's accumulated power consumption (in megawatt hours) counter. • Value is compared to parameter 2908 value. 0.0 – Disables the trigger.
2908	**USER MWh ACT** Defines the actual value of the drive's accumulated power consumption (in megawatt hours) counter. • When parameter 2907 has been set to a non-zero value, the counter starts. • When the actual value of the counter exceeds the value defined by parameter 2907, a maintenance notice is displayed on the panel. 0.0 – Resets the parameter.

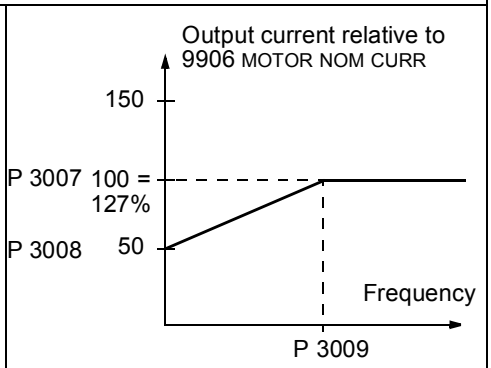
Group 30: FAULT FUNCTIONS

This group defines situations that the drive should recognize as potential faults and defines how the drive should respond if the fault is detected.

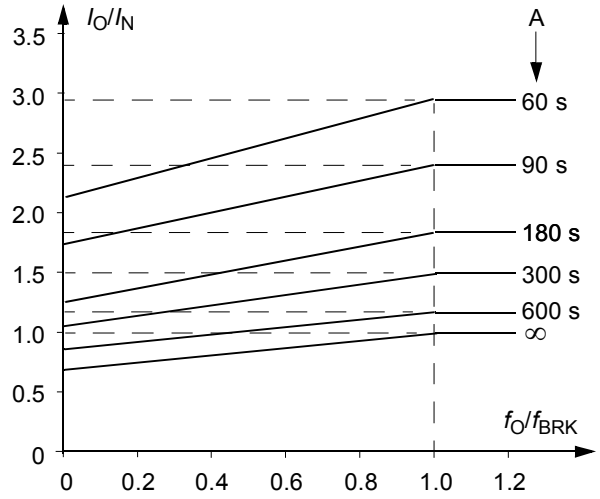
Code	Description
3001	**AI<MIN FUNCTION** Defines the drive response if the analog input (AI) signal drops below the fault limits and AI is used • as the active reference source (*Group 11: REFERENCE SELECT*) • as the Process or External PID controllers' feedback or setpoint source (*Group 40: PROCESS PID SET 1*, *Group 41: PROCESS PID SET 2* or *Group 42: EXT / TRIM PID*) and the corresponding PID controller is active. 3021 AI1 FAULT LIMIT and 3022 AI2 FAULT LIMIT set the fault limits. 0 = NOT SEL – No response. 1 = FAULT – Displays a fault (7, AI1 LOSS or 8, AI2 LOSS) and the drive coasts to stop. 2 = CONST SP 7 – Displays an alarm (2006, AI1 LOSS or 2007, AI2 LOSS) and sets speed using 1208 CONST SPEED 7. 3 = LAST SPEED – Displays an alarm (2006, AI1 LOSS or 2007, AI2 LOSS) and sets speed using the last operating level. This value is the average speed over the last 10 seconds. **WARNING!** If you select CONST SP 7 or LAST SPEED, make sure that continued operation is safe when the analog input signal is lost.
3002	**PANEL COMM ERR** Defines the drive response to a control panel communication error. 1 = FAULT – Displays a fault (10, PANEL LOSS) and the drive coasts to stop. 2 = CONST SP 7 – Displays an alarm (2008, PANEL LOSS) and sets speed using 1208 CONST SPEED 7. 3 = LAST SPEED – Displays an alarm (2008, PANEL LOSS) and sets speed using the last operating level. This value is the average speed over the last 10 seconds. **Note:** When either of the two external control locations are active, and start, stop and/or direction are through the control panel – 1001 EXT1 COMMANDS / 1002 EXT2 COMMANDS = 8 (KEYPAD) – the drive follows speed/frequency reference according to the configuration of the external control locations, instead of the value of the last speed or parameter 1208 CONST SPEED 7. **WARNING!** If you select CONST SP 7 or LAST SPEED, make sure that continued operation is safe when the control panel communication is lost.
3003	**EXTERNAL FAULT 1** Defines the External Fault 1 signal input and the drive response to an external fault. 0 = NOT SEL – External fault signal is not used. 1 = DI1 – Defines digital input DI1 as the external fault input. • Activating the digital input indicates a fault. The drive displays a fault (14, EXT FAULT 1) and the drive coasts to stop. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the external fault input. • See DI1 above. -1 = DI1(INV) – Defines an inverted digital input DI1 as the external fault input. • De-activating the digital input indicates a fault. The drive displays a fault (14, EXT FAULT 1) and the drive coasts to stop. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the external fault input. • See DI1(INV) above.
3004	**EXTERNAL FAULT 2** Defines the External Fault 2 signal input and the drive response to an external fault. • See parameter 3003 above.
3005	**MOT THERM PROT** Defines the drive response to motor overheating. 0 = NOT SEL – No response and/or motor thermal protection not set up. 1 = FAULT – When the calculated motor temperature exceeds 90 °C, displays an alarm (2010, MOTOR TEMP). When the calculated motor temperature exceeds 110 °C, displays a fault (9, MOT OVERTEMP) and the drive coasts to stop. 2 = ALARM – When the calculated motor temperature exceeds 90 °C, displays an alarm (2010, MOTOR TEMP).

Code	Description
3006	**MOT THERM TIME** Sets the motor thermal time constant for the motor temperature model. • This is the time required for the motor to reach 63% of the final temperature with steady load. • For thermal protection according to UL requirements for NEMA class motors, use the rule of thumb: MOTOR THERM TIME equals 35 times t6, where t6 (in seconds) is specified by the motor manufacturer as the time that the motor can safely operate at six times its rated current. • The thermal time for a Class 10 trip curve is 350 s, for a Class 20 trip curve 700 s, and for a Class 30 trip curve 1050 s.
3007	**MOT LOAD CURVE** Sets the maximum allowable operating load of the motor. • With the default value 100%, motor overload protection is functioning when the constant current exceeds 127% of the parameter 9906 MOTOR NOM CURR value. • The default overloadability is at the same level as what motor manufacturers typically allow below 30 °C (86 °F) ambient temperature and below 1000 m (3300 ft) altitude. When the ambient temperature exceeds 30 °C (86 °F) or the installation altitude is over 1000 m (3300 ft), decrease the parameter 3007 value according to the motor manufacturer's recommendation. **Example:** If the constant protection level needs to be 115% of the motor nominal current, set parameter 3007 value to 91% (= 115/127·100%).
3008	**ZERO SPEED LOAD** Sets the maximum allowable current at zero speed. • Value is relative to 9906 MOTOR NOM CURR.
3009	**BREAK POINT FREQ** Sets the break point frequency for the motor load curve.



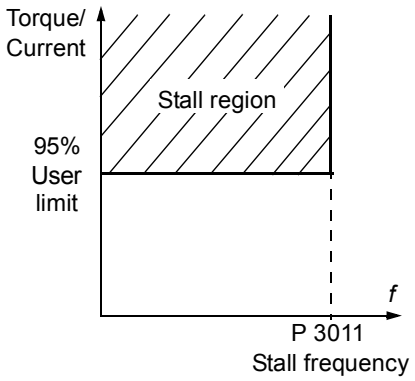


Example: Thermal protection trip times when parameters 3006 MOT THERM TIME, 3007 MOT LOAD CURVE and 3008 ZERO SPEED LOAD have default values.



I_O = Output current
I_N = Nominal motor current
f_O = Output frequency
f_{BRK} = Break point frequency
A = Trip time

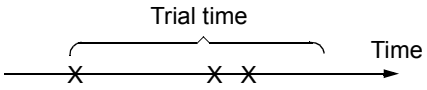
Code	Description
3010	**STALL FUNCTION** This parameter defines the operation of the Stall function. This protection is active if the drive operates in the stall region (see the figure) for the time defined by 3012 STALL TIME. The "User Limit" is defined in *Group 20: LIMITS* by 2017 MAX TORQUE 1, 2018 MAX TORQUE 2, or the limit on the COMM input. 0 = NOT SEL – Stall protection is not used. 1 = FAULT – When the drive operates in the stall region for the time set by 3012 STALL TIME: • The drive coasts to stop. • A fault indication is displayed. 2 = ALARM – When the drive operates in the stall region for the time set by 3012 STALL TIME: • An alarm indication is displayed. • The alarm disappears when the drive is out of the stall region for half the time set by parameter 3012 STALL TIME.
3011	**STALL FREQUENCY** This parameter sets the frequency value for the Stall function. Refer to the figure.
3012	**STALL TIME** This parameter sets the time value for the Stall function.
3017	**EARTH FAULT** Defines the drive response if the drive detects a ground fault in the motor or motor cables. The drive monitors for ground faults while the drive is running, and while the drive is not running. See also parameter 3023 WIRING FAULT and 3028 EARTH FAULT LVL. **Note:** Disabling earth fault (ground fault) may void the warranty. 0 = DISABLE – No drive response to ground faults. 1 = ENABLE – Ground faults display fault 16 (EARTH FAULT), and (if running) the drive coasts to stop.
3018	**COMM FAULT FUNC** Defines the drive response if the fieldbus communication is lost. 0 = NOT SEL – No response. 1 = FAULT – Displays a fault (28, SERIAL 1 ERR) and the drive coasts to stop. 2 = CONST SP 7 – Displays an alarm (2005, I/O COMM) and sets speed using 1208 CONST SPEED 7. This "alarm speed" remains active until the fieldbus writes a new reference value. 3 = LAST SPEED – Displays an alarm (2005, I/O COMM) and sets speed using the last operating level. This value is the average speed over the last 10 seconds. This "alarm speed" remains active until the fieldbus writes a new reference value. ⚠ **WARNING!** If you select CONST SP 7, or LAST SPEED, make sure that continued operation is safe when fieldbus communication is lost.
3019	**COMM FAULT TIME** Sets the communication fault time used with 3018 COMM FAULT FUNC. • Brief interruptions in the fieldbus communication are not treated as faults if they are less than the COMM FAULT TIME value.
3021	**AI1 FAULT LIMIT** Sets a fault level for analog input 1. • See 3001 AI<MIN FUNCTION.
3022	**AI2 FAULT LIMIT** Sets a fault level for analog input 2. • See 3001 AI<MIN FUNCTION.



Code	Description
3023	**WIRING FAULT** Defines the drive response to cross wiring faults and to ground faults detected when the drive is NOT running. When the drive is not running it monitors for: • Improper connections of input power to the drive output (the drive can display fault 35, OUTPUT WIRING if improper connections are detected). • Ground faults (the drive can display fault 16, EARTH FAULT if a ground fault is detected). Also, see parameter 3017 EARTH FAULT. **Note:** Disabling wiring fault (ground fault) may void the warranty. 0 = DISABLE – No drive response to either of the above monitoring results. 1 = ENABLE – The drive displays faults when this monitoring detects problems.
3024	**CB TEMP FAULT** Defines the drive response to control board overheating. Not for drives with an OMIO control board. 0 = DISABLE – No response. 1 = ENABLE – Displays fault 37 (CB OVERTEMP) and the drive coasts to stop.
3028	**EARTH FAULT LVL** Defines detection level for earth fault. See *Correcting faults*, fault 16, EARTH FAULT. **Note:** Parameter 3017 EARTH FAULT has to be enabled. 1 = LOW – Low level leakage current, high sensitivity. The drive trips to low ground (earth) leakage current (default in the USA software version). 2 = MEDIUM – Medium sensitivity to ground (earth) fault current (default in the European software version). 3 = HIGH – High level leakage current, low sensitivity. The drive trips to higher ground (earth) leakage current.

Group 31: AUTOMATIC RESET

This group defines conditions for automatic resets. An automatic reset occurs after a particular fault is detected. The drive holds for a set delay time, then automatically restarts. You can limit the number of resets in a specified time period and set up automatic resets for a variety of faults.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>3101</td><td>NUMBER OF TRIALS
Sets the number of allowed automatic resets within a trial period defined by 3102 TRIAL TIME.
• If the number of automatic resets exceeds this limit (within the trial time), the drive prevents additional automatic resets and remains stopped.
• Starting then requires a successful reset performed from the control panel or from a source selected by 1604 FAULT RESET SEL.</td><td rowspan="2">Example: Three faults have occurred in the trial time. The last is reset only if the value for 3101 NUMBER OF TRIALS is 3 or more.
 

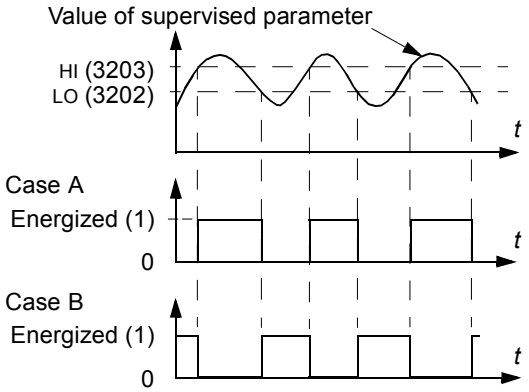
x = Automatic reset</td></tr>
<tr><td>3102</td><td>TRIAL TIME
Sets the time period used for counting and limiting the number of resets.
• See 3101 NUMBER OF TRIALS.</td></tr>
<tr><td>3103</td><td colspan="2">DELAY TIME
Sets the delay time between a fault detection and attempted drive restart.
• If DELAY TIME = zero, the drive resets immediately.</td></tr>
<tr><td>3104</td><td colspan="2">AR OVERCURRENT
Sets the automatic reset for the overcurrent function on or off.
0 = DISABLE – Disables automatic reset.
1 = ENABLE – Enables automatic reset.
• Automatically resets the fault (OVERCURRENT) after the delay set by 3103 DELAY TIME, and the drive resumes normal operation.</td></tr>
<tr><td>3105</td><td colspan="2">AR OVERVOLTAGE
Sets the automatic reset for the overvoltage function on or off.
0 = DISABLE – Disables automatic reset.
1 = ENABLE – Enables automatic reset.
• Automatically resets the fault (DC OVERVOLT) after the delay set by 3103 DELAY TIME, and the drive resumes normal operation.</td></tr>
<tr><td>3106</td><td colspan="2">AR UNDERVOLTAGE
Sets the automatic reset for the undervoltage function on or off.
0 = DISABLE – Disables automatic reset.
1 = ENABLE – Enables automatic reset.
• Automatically resets the fault (DC UNDERVOLT) after the delay set by 3103 DELAY TIME, and the drive resumes normal operation.</td></tr>
<tr><td>3107</td><td colspan="2">AR AI<MIN
Sets the automatic reset for the analog input less than minimum value function on or off.
0 = DISABLE – Disables automatic reset.
1 = ENABLE – Enables automatic reset.
• Automatically resets the fault (AI<MIN) after the delay set by 3103 DELAY TIME, and the drive resumes normal operation.
WARNING! When the analog input signal is restored, the drive may restart, even after a long stop. Make sure that automatic, long delayed starts will not cause physical injury and/or damage equipment.</td></tr>
<tr><td>3108</td><td colspan="2">AR EXTERNAL FLT
Sets the automatic reset for external faults function on or off.
0 = DISABLE – Disables automatic reset.
1 = ENABLE – Enables automatic reset.
• Automatically resets the fault (EXT FAULT 1 or EXT FAULT 2) after the delay set by 3103 DELAY TIME, and the drive resumes normal operation.</td></tr>
</table>

Group 32: SUPERVISION

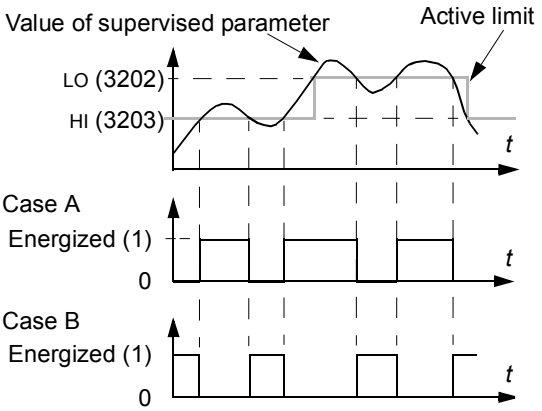
This group defines supervision for up to three signals from *Group 01: OPERATING DATA*. Supervision monitors a specified parameter and energizes a relay output if the parameter passes a defined limit. Use *Group 14: RELAY OUTPUTS* to define the relay and whether the relay activates when the signal is too low or too high.

Code	Description
3201	**SUPERV 1 PARAM** Selects the first supervised parameter. • Must be a parameter number from *Group 01: OPERATING DATA*. • 100 = NOT SELECTED – No parameter selected. • 101…178 – Selects parameter 0101…0178. • If the supervised parameter passes a limit, a relay output is energized. • The supervision limits are defined in this group. • The relay outputs are defined in *Group 14: RELAY OUTPUTS* (definition also specifies which supervision limit is monitored). **LO ≤ HI** Operating data supervision using relay outputs, when LO≤HI. • Case A = Parameter 1401 RELAY OUTPUT 1 (or 1402 RELAY OUTPUT 2, etc.) value is SUPRV1 OVER or SUPRV2 OVER. Use for monitoring when/if the supervised signal exceeds a given limit. The relay remains active until the supervised value drops below the low limit. • Case B = Parameter 1401 RELAY OUTPUT 1 (or 1402 RELAY OUTPUT 2, etc.) value is SUPRV1 UNDER or SUPRV2 UNDER. Use for monitoring when/if the supervised signal falls below a given limit. The relay remains active until the supervised value rises above the high limit. **LO > HI** Operating data supervision using relay outputs, when LO>HI. The lowest limit (HI 3203) is active initially and remains active until the supervised parameter goes above the highest limit (LO 3202), making that limit the active limit. That limit remains active until the supervised parameter goes below the lowest limit (HI 3203), making that limit active. • Case A = Parameter 1401 RELAY OUTPUT 1 (or 1402 RELAY OUTPUT 2, etc.) value is SUPRV1 OVER or SUPRV2 OVER. Initially the relay is de-energized. It is energized whenever the supervised parameter goes above the active limit. • Case B = Parameter 1401 RELAY OUTPUT 1 (or 1402 RELAY OUTPUT 2, etc.) value is SUPRV1 UNDER or SUPRV2 UNDER. Initially the relay is energized. It is de-energized whenever the supervised parameter goes below the active limit.
3202	**SUPERV 1 LIM LO** Sets the low limit for the first supervised parameter. See 3201 SUPERV 1 PARAM above.
3203	**SUPERV 1 LIM HI** Sets the high limit for the first supervised parameter. See 3201 SUPERV 1 PARAM above.
3204	**SUPERV 2 PARAM** Selects the second supervised parameter. See 3201 SUPERV 1 PARAM above.
3205	**SUPERV 2 LIM LO** Sets the low limit for the second supervised parameter. See 3204 SUPERV 2 PARAM above.
3206	**SUPERV 2 LIM HI** Sets the high limit for the second supervised parameter. See 3204 SUPERV 2 PARAM above.

LO ≤ HI
Note: Case LO ≤ HI represents a normal hysteresis.



LO > HI
Note: Case LO>HI represents a special hysteresis with two separate supervision limits.



Code	Description
3207	**SUPERV 3 PARAM** Selects the third supervised parameter. See 3201 SUPERV 1 PARAM above.
3208	**SUPERV 3 LIM LO** Sets the low limit for the third supervised parameter. See 3207 SUPERV 3 PARAM above.
3209	**SUPERV 3 LIM HI** Sets the high limit for the third supervised parameter. See 3207 SUPERV 3 PARAM above.

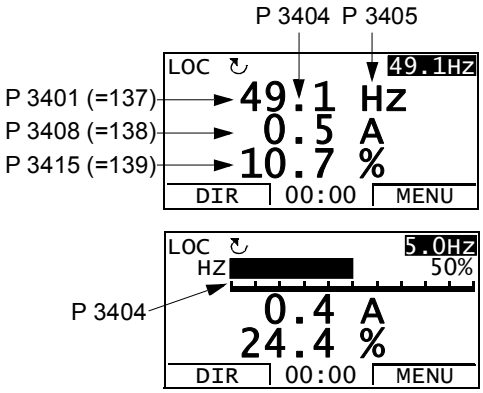
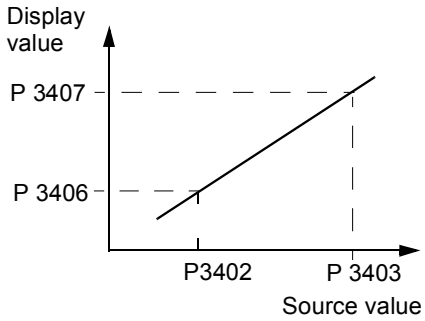
Group 33: INFORMATION

This group provides access to information about the drive's current programs: versions and test date.

Code	Description
3301	**FIRMWARE** Contains the version of the drive's firmware.
3302	**LOADING PACKAGE** Contains the version of the loading package.
3303	**TEST DATE** Contains the test date (yy.ww).
3304	**DRIVE RATING** Indicates the drive's current and voltage rating. The format is XXXY, where: • XXX = The nominal current rating of the drive in amperes. If present, an "A" indicates a decimal point in the rating for the current. For example XXX = 8A8 indicates a nominal current rating of 8.8 A. • Y = The voltage rating of the drive, where Y = : • 2 indicates a 208…240 V rating. • 4 indicates a 380…480 V rating. • 6 indicates a 500…600 V rating.
3305	**PARAMETER TABLE** Contains the version of the parameter table used in the drive.

Group 34: PANEL DISPLAY

This group defines the content for control panel display (middle area), when the control panel is in the Output mode.

Code	Description	
3401	**SIGNAL1 PARAM** Selects the first parameter (by number) displayed on the control panel. • Definitions in this group define display content when the control panel is in the control mode. • Any parameter number in *Group 01: OPERATING DATA* can be selected. • Using the following parameters, the display value can be scaled, converted to convenient units and/or displayed as a bar graph. • The figure identifies selections made by parameters in this group. • If just one or two parameters are selected for display, that is just one or two of the values of parameters 3401 SIGNAL1 PARAM, 3408 SIGNAL2 PARAM and 3415 SIGNAL3 PARAM are other than 100 (NOT SELECTED), the number and name of each displayed parameter are shown in addition to the value. 100 = NOT SELECTED – First parameter not displayed. 101…178 – Displays parameter 0101…0178. If parameter does not exist, the display shows "n.a.".	
3402	**SIGNAL1 MIN** Defines the minimum expected value for the first display parameter. Use parameters 3402, 3403, 3406 and 3407, for example to convert a *Group 01: OPERATING DATA* parameter, such as 0102 SPEED (in rpm) to the speed of a conveyor driven by the motor (in ft/min). For such a conversion, the source values in the figure are the min. and max. motor speed, and the display values are the corresponding min. and max. conveyor speed. Use parameter 3405 to select the proper units for the display. **Note:** Selecting units does not convert values. Parameter is not effective if parameter 3404 OUTPUT1 DSP FORM = 9 (DIRECT).	
3403	**SIGNAL1 MAX** Defines the maximum expected value for the first display parameter. **Note:** Parameter is not effective if parameter 3404 OUTPUT1 DSP FORM = 9 (DIRECT).	
3404	**OUTPUT1 DSP FORM** Defines the decimal point location for the first display parameter. 0…7 – Defines the decimal point location. • Enter the number of digits desired to the right of the decimal point. • See the table for an example using pi (3.14159). 8 = BAR METER – Specifies a bar meter display. 9 = DIRECT – Decimal point location and units of measure are identical to the source signal. See *Group 01: OPERATING DATA* parameter listing in section *Complete parameter list* on page *91* for resolution (which indicates the decimal point location) and the units of measure.	

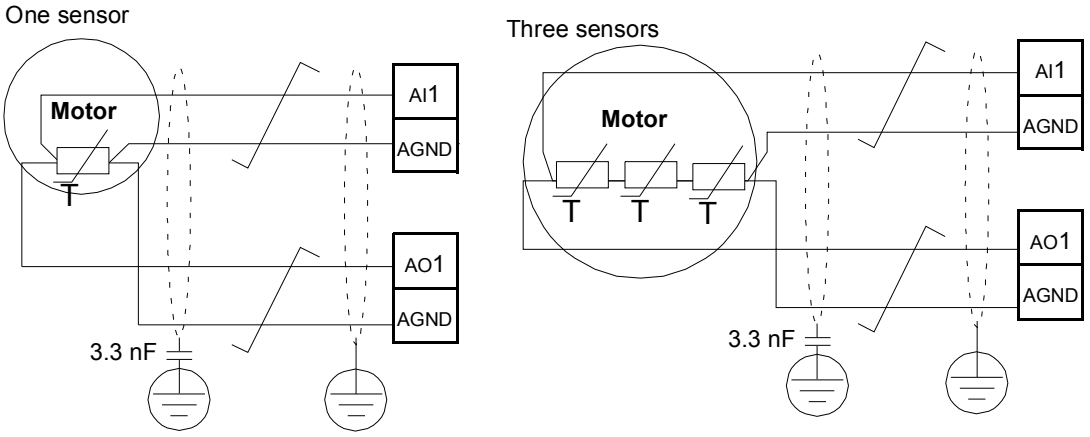
3404 value	Display	Range
0	± 3	-32768…+32767 (Signed)
1	± 3.1	
2	± 3.14	
3	± 3.142	
4	3	0…65535 (Unsigned)
5	3.1	
6	3.14	
7	3.142	
8	Bar meter displayed.	
9	Decimal point location and units as for the source signal.	

Code	Description
3405	**OUTPUT1 UNIT** Selects the units used with the first display parameter. **Note:** Parameter is not effective if parameter 3404 OUTPUT1 DSP FORM = 9 (DIRECT). 0 = NO UNIT, 9 = °C, 18 = MWh, 27 = ft, 36 = l/s, 45 = Pa, 54 = lb/m, 63 = Mrev 1 = A, 10 = lb ft, 19 = m/s, 28 = MGD, 37 = l/min, 46 = GPS, 55 = lb/h, 64 = d 2 = V, 11 = mA, 20 = m^3/h, 29 = inHg, 38 = l/h, 47 = gal/s, 56 = FPS, 65 = inWC 3 = Hz, 12 = mV, 21 = dm^3/s, 30 = FPM, 39 = m^3/s, 48 = gal/m, 57 = ft/s, 66 = m/min 4 = %, 13 = kW, 22 = bar, 31 = kb/s, 40 = m^3/m, 49 = gal/h, 58 = inH_2O, 67 = Nm 5 = s, 14 = W, 23 = kPa, 32 = kHz, 41 = kg/s, 50 = ft^3/s, 59 = in wg, 68 = Km^3/h 6 = h, 15 = kWh, 24 = GPM, 33 = ohm, 42 = kg/m, 51 = ft^3/m, 60 = ft wg 7 = rpm, 16 = °F, 25 = PSI, 34 = ppm, 43 = kg/h, 52 = ft^3/h, 61 = lbsi 8 = kh, 17 = hp, 26 = CFM, 35 = pps, 44 = mbar, 53 = lb/s, 62 = ms The following units are useful for the bar display. 117 = %ref, 119 = %dev, 121 = % SP, 123 = Iout, 125 = Fout, 127 = Vdc 118 = %act, 120 = % LD, 122 = %FBK, 124 = Vout, 126 = Tout
3406	**OUTPUT1 MIN** Sets the minimum value displayed for the first display parameter. **Note:** Parameter is not effective if parameter 3404 OUTPUT1 DSP FORM = 9 (DIRECT).
3407	**OUTPUT1 MAX** Sets the maximum value displayed for the first display parameter. **Note:** Parameter is not effective if parameter 3404 OUTPUT1 DSP FORM = 9 (DIRECT).
3408	**SIGNAL2 PARAM** Selects the second parameter (by number) displayed on the control panel. See parameter 3401.
3409	**SIGNAL2 MIN** Defines the minimum expected value for the second display parameter. See parameter 3402.
3410	**SIGNAL2 MAX** Defines the maximum expected value for the second display parameter. See parameter 3403.
3411	**OUTPUT2 DSP FORM** Defines the decimal point location for the second display parameter. See parameter 3404.
3412	**OUTPUT2 UNIT** Selects the units used with the second display parameter. See parameter 3405.
3413	**OUTPUT2 MIN** Sets the minimum value displayed for the second display parameter. See parameter 3406.
3414	**OUTPUT2 MAX** Sets the maximum value displayed for the second display parameter. See parameter 3407.
3415	**SIGNAL3 PARAM** Selects the third parameter (by number) displayed on the control panel. See parameter 3401.
3416	**SIGNAL3 MIN** Defines the minimum expected value for the third display parameter. See parameter 3402.
3417	**SIGNAL3 MAX** Defines the maximum expected value for the third display parameter. See parameter 3403.
3418	**OUTPUT3 DSP FORM** Defines the decimal point location for the third display parameter. See parameter 3404.
3419	**OUTPUT3 UNIT** Selects the units used with the third display parameter. See parameter 3405.
3420	**OUTPUT3 MIN** Sets the minimum value displayed for the third display parameter. See parameter 3406.

Code	Description
3421	**OUTPUT3 MAX** Sets the maximum value displayed for the third display parameter. See parameter 3407.

Group 35: MOTOR TEMP MEAS

This group defines the detection and reporting for a particular potential fault – motor overheating, as detected by a temperature sensor. Typical connections are shown below.

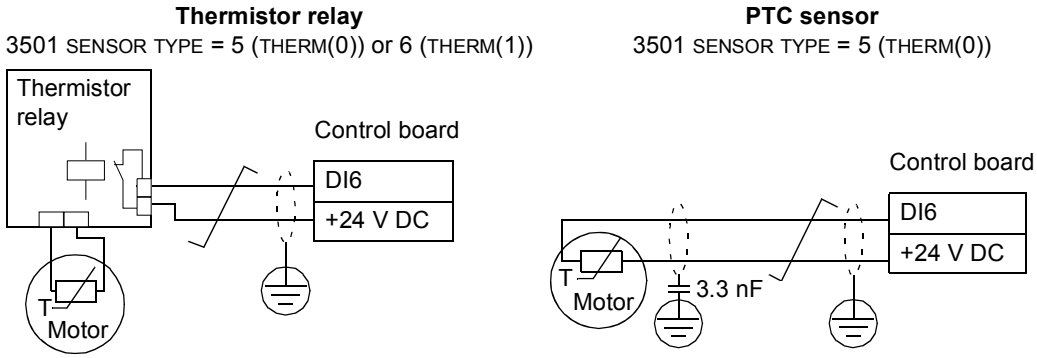


WARNING! IEC 60664 requires double or reinforced insulation between live parts and the surface of accessible parts of electrical equipment which are either non-conductive or conductive but not connected to the protective earth.

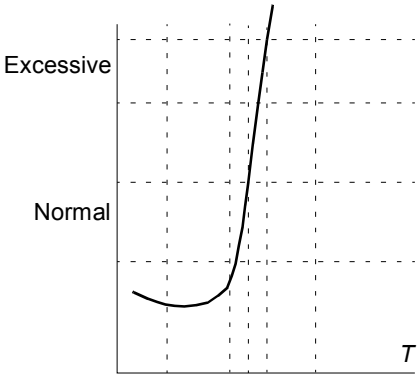
To fulfil this requirement, connect a thermistor (and other similar components) to the drive's control terminals using any of these alternatives:

- Separate the thermistor from live parts of the motor with double reinforced insulation.
- Protect all circuits connected to the drive's digital and analog inputs. Protect against contact, and insulate from other low voltage circuits with basic insulation (rated for the same voltage level as the drive's main circuit).
- Use an external thermistor relay. The relay insulation must be rated for the same voltage level as the drive's main circuit.

The figure below shows thermistor relay and PTC sensor connections using a digital input. At the motor end, the cable shield should be earthed through, eg a 3.3 nF capacitor. If this is not possible, leave the shield unconnected.



For other faults, or for anticipating motor overheating using a model, see *Group 30: FAULT FUNCTIONS*.

Code	Description
3501	**SENSOR TYPE** Identifies the type of the motor temperature sensor used, PT100 (°C), PTC (ohm) or thermistor. See parameters 1501 AO1 CONTENT SEL and 1507 AO2 CONTENT SEL. 0 = NONE 1 = 1 x PT100 – Sensor configuration uses one PT100 sensor. • Analog output AO1 or AO2 feeds constant current through the sensor. • The sensor resistance increases as the motor temperature rises, as does the voltage over the sensor. • The temperature measurement function reads the voltage through analog input AI1 or AI2 and converts it to degrees Celsius. 2 = 2 x PT100 – Sensor configuration uses two PT100 sensors. • Operation is the same as for above 1 x PT100. 3 = 3 x PT100 – Sensor configuration uses three PT100 sensors. • Operation is the same as for above 1 x PT100. 4 = PTC – Sensor configuration uses one PTC. • The analog output feeds a constant current through the sensor. • The resistance of the sensor increases sharply as the motor temperature rises over the PTC reference temperature (T_{ref}), as does the voltage over the resistor. The temperature measurement function reads the voltage through analog input AI1 and converts it into ohms. • The table below and the graph show typical PTC sensor resistance as a function of the motor operating temperature.  Temperature / Resistance: Normal < 1.5 kohm; Excessive > 4 kohm 5 = THERM(0) – Sensor configuration uses a thermistor. • Motor thermal protection is activated through a digital input. Connect either a PTC sensor or a normally closed thermistor relay to a digital input. • When the digital input is '0', the motor is overheated. • See the connection figure on page *159*. • The table below and the graph show the resistance requirements for a PTC sensor connected between 24 V and a digital input as a function of the motor operating temperature. Temperature / Resistance: Normal < 3 kohm; Excessive > 28 kohm 6 = THERM(1) – Sensor configuration uses a thermistor. • Motor thermal protection is activated through a digital input. Connect a normally open thermistor relay to a digital input. • When the digital input is '1', the motor is overheated. • See the connection figure on page *159*.
3502	**INPUT SELECTION** Defines the input used for the temperature sensor. 1 = AI1 – PT100 and PTC. 2 = AI2 – PT100 and PTC. 3…8 = DI1…DI6 – Thermistor and PTC
3503	**ALARM LIMIT** Defines the alarm limit for motor temperature measurement. • At motor temperatures above this limit, the drive displays an alarm (2010, MOTOR TEMP) For thermistors or PTC connected to a digital input: 0 – de-activated 1 – activated

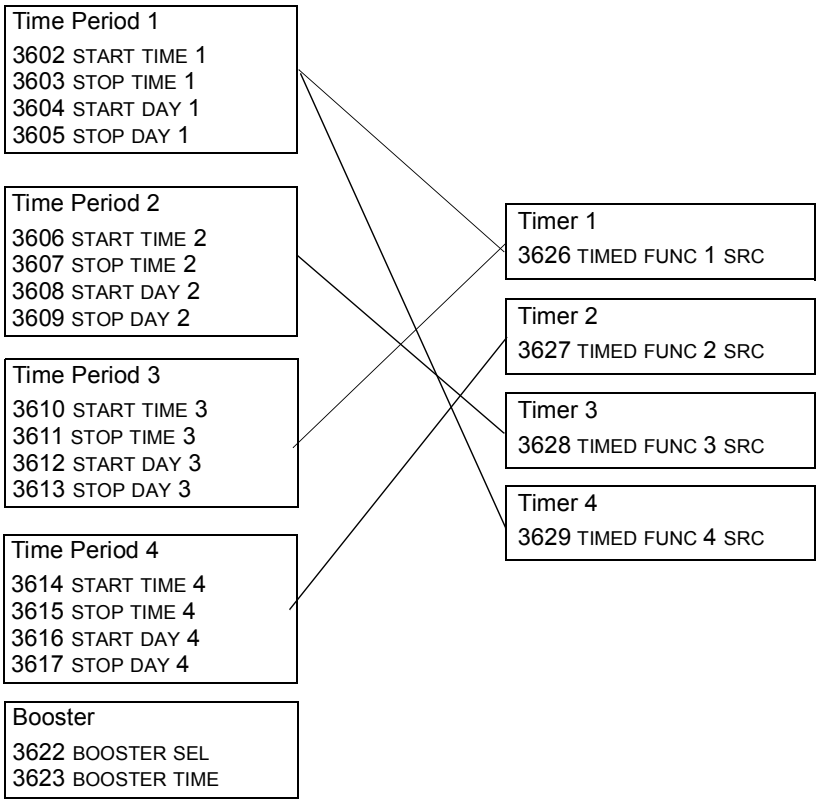
Code	Description
3504	**FAULT LIMIT** Defines the fault limit for motor temperature measurement. • At motor temperatures above this limit, the drive displays a fault (9, MOT OVERTEMP) and stops the drive. For thermistors or PTC connected to a digital input: 0 – de-activated 1 – activated

Group 36: TIMED FUNCTIONS

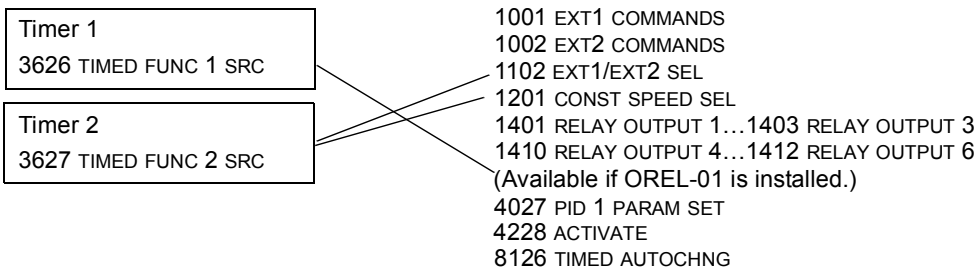
This group defines the timed functions. The timed functions include:

- four daily start and stop times
- four weekly start, stop and boost times
- four timers for collecting selected periods together.

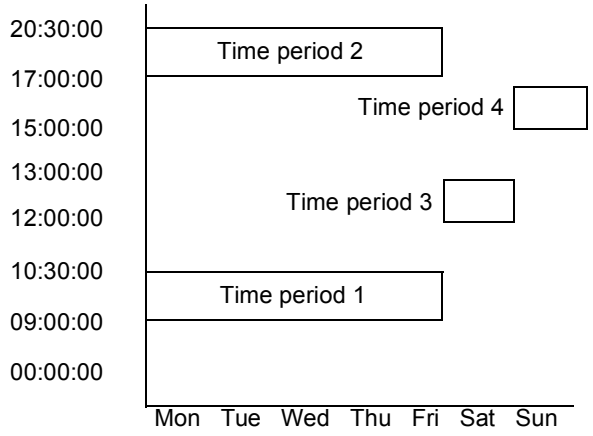
A timer can be connected to multiple time periods and a time period can be in multiple timers.

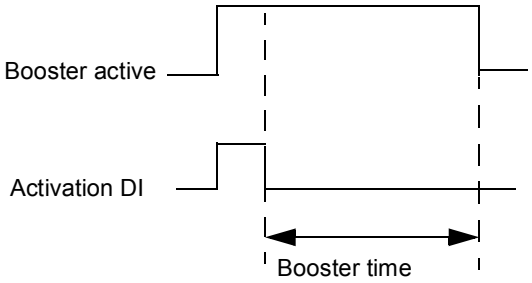


A parameter can be connected to only one timer.



You can use the Timed functions assistant for easy configuring. For more information on the assistants, see section *Assistants mode* on page *57*.

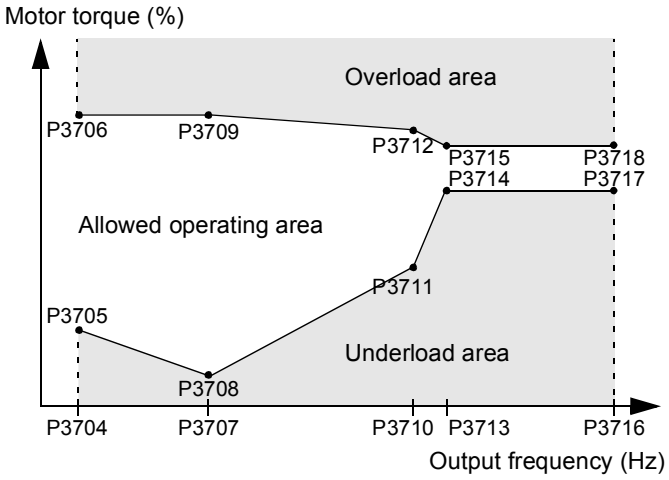
Code	Description
3601	**TIMERS ENABLE** Selects the source for the timer enable signal. 0 = NOT SEL – Timed functions are disabled. 1 = DI1 – Defines digital input DI1 as the timed function enable signal. • The digital input must be activated to enable the timed function. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the timed function enable signal. 7 = ACTIVE – Timed functions are enabled. -1 = DI1(INV) – Defines an inverted digital input DI1 as the timed function enable signal. • This digital input must be de-activated to enable the timed function. • -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the timed function enable signal.
3602	**START TIME 1** Defines the daily start time. • The time can be changed in steps of 2 seconds. • If parameter value is 07:00:00, the timer is activated at 7 a.m. • The figure shows multiple timers on different weekdays. 
3603	**STOP TIME 1** Defines the daily stop time. • The time can be changed in steps of 2 seconds. • If the parameter value is 09:00:00, the timer is deactivated at 9 a.m.
3604	**START DAY 1** Defines the weekly start day. 1 = MONDAY…7 = SUNDAY • If parameter value is 1, timer 1 weekly is active from Monday midnight (00:00:00).
3605	**STOP DAY 1** Defines weekly stop day. 1 = MONDAY…7 = SUNDAY • If parameter value is 5, timer 1 weekly is deactivated on Friday midnight (23:59:58).
3606	**START TIME 2** Defines timer2 daily start time. • See parameter 3602.
3607	**STOP TIME 2** Defines timer 2 daily stop time. • See parameter 3603.
3608	**START DAY 2** Defines timer 2 weekly start day. • See parameter 3604.
3609	**STOP DAY 2** Defines timer 2 weekly stop day. • See parameter 3605.
3610	**START TIME 3** Defines timer 3 daily start time. • See parameter 3602.
3611	**STOP TIME 3** Defines timer 3 daily stop time. • See parameter 3603.

Code	Description
3612	**START DAY 3** Defines timer 3 weekly start day. • See parameter 3604.
3613	**STOP DAY 3** Defines timer 3 weekly stop day. • See parameter 3605.
3614	**START TIME 4** Defines timer 4 daily start time. • See parameter 3602.
3615	**STOP TIME 4** Defines timer 4 daily stop time. • See parameter 3603.
3616	**START DAY 4** Defines timer 4 weekly start day. • See parameter 3604.
3617	**STOP DAY 4** Defines timer 4 weekly stop day. • See parameter 3605.
3622	**BOOSTER SEL** Selects the source for the booster signal. 0 = NOT SEL – Booster signal is disabled. 1 = DI1 – Defines DI1 as the booster signal. 2…6 = DI2…DI6 – Defines DI2…DI6 as the booster signal. -1 = DI1(INV) – Defines an inverted digital input DI1 as the booster signal. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the booster signal.
3623	**BOOSTER TIME** Defines the booster ON time. Time is started when booster sel signal is released. If parameter value is 01:30:00, booster is active for 1 hour and 30 minutes after activation DI is released. 
3626	**TIMED FUNC 1 SRC** Defines the time periods used by the timer. 0 = NOT SEL – No time periods have been selected. 1 = T1 – Time Period 1 selected in the timer. 2 = T2 – Time Period 2 selected in the timer. 3 = T1+T2 – Time Periods 1 and 2 selected in the timer. 4 = T3 – Time Period 3 selected in the timer. 5 = T1+T3 – Time Periods 1 and 3 selected in the timer. 6 = T2+T3 – Time Periods 2 and 3 selected in the timer. 7 = T1+T2+T3 – Time Periods 1, 2 and 3 selected in the timer. 8 = T4 – Time Period 4 selected in the timer. 9 = T1+T4 – Time Periods 1 and 4 selected in the timer. 10 = T2+T4 – Time Periods 2 and 4 selected in the timer. 11 = T1+T2+T4 – Time Periods 1, 2 and 4 selected in the timer. 12 = T3+T4 – Time Periods 3 and 4 selected in the timer. 13 = T1+T3+T4 – Time Periods 1, 3 and 4 selected in the timer. 14 = T2+T3+T4 – Time Periods 2, 3 and 4 selected in the timer. 15 = T1+T2+T3+T4 – Time Periods 1, 2, 3 and 4 selected in the timer. 16 = BOOSTER – Booster selected in the timer. 17 = T1+B – Booster and Time Period 1 selected in the timer. 18 = T2+B – Booster and Time Period 2 selected in the timer. 19 = T1+T2+B – Booster and Time Periods 1 and 2 selected in the timer. 20 = T3+B – Booster and Time Period 3 selected in the timer.

Code	Description
	21 = T1+T3+B – Booster and Time Periods 1 and 3 selected in the timer. 22 = T2+T3+B – Booster and Time Periods 2 and 3 selected in the timer. 23 = T1+T2+T3+B – Booster and Time Periods 1, 2 and 3 selected in the timer. 24 = T4+B – Booster and Time Period 4 selected in the timer. 25 = T1+T4+B – Booster and Time Periods 1 and 4 selected in the timer. 26 = T2+T4+B – Booster and Time Periods 2 and 4 selected in the timer. 27 = T1+T2+T4+B – Booster and Time Periods 1, 2 and 4 selected in the timer. 28 = T3+T4+B – Booster and Time Periods 3 and 4 selected in the timer. 29 = T1+T3+T4+B – Booster and Time Periods 1, 3 and 4 selected in the timer. 30 = T2+T3+T4+B – Booster and Time Periods 2, 3 and 4 selected in the timer. 31 = T1+2+3+4+B – Booster and Time Periods 1, 2, 3 and 4 selected in the timer.
3627	**TIMED FUNC 2 SRC** • See parameter 3626.
3628	**TIMED FUNC 3 SRC** • See parameter 3626.
3629	**TIMED FUNC 4 SRC** • See parameter 3626.

Group 37: USER LOAD CURVE

This group defines supervision of user adjustable load curves (motor torque as a function of frequency). The curve is defined by five points.

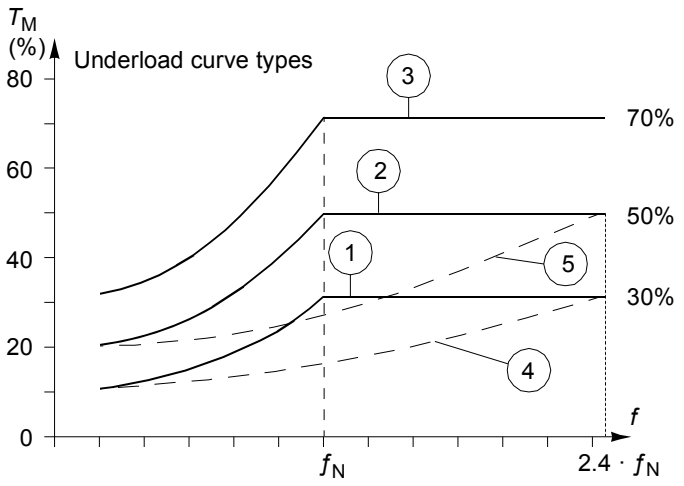
Code	Description
3701	**USER LOAD C MODE** Supervision mode for the user adjustable load curves. This functionality replaces the former underload supervision in *Group 30: FAULT FUNCTIONS*. To emulate it, see section *Correspondence with the obsolete underload supervision* on page *167*. 0 = NOT SEL – Supervision is not active. 1 = UNDERLOAD – Supervision for the torque dropping below the underload curve. 2 = OVERLOAD – Supervision for the torque exceeding the overload curve. 3 = BOTH – Supervision for the torque dropping below the underload curve or exceeding the overload curve. 
3702	**USER LOAD C FUNC** Action wanted during load supervision. 1 = FAULT – A fault is generated when the condition defined by 3701 USER LOAD C MODE has been valid longer than the time set by 3703 USER LOAD C TIME. 2 = ALARM – An alarm is generated when the condition defined by 3701 USER LOAD C MODE has been valid longer than half of the time defined by 3703 USER LOAD C TIME.
3703	**USER LOAD C TIME** Defines the time limit for generating a fault. • Half of this time is used as the limit for generating an alarm.
3704	**LOAD FREQ 1** Defines the frequency value of the first load curve definition point. • Must be smaller than 3707 LOAD FREQ 2.
3705	**LOAD TORQ LOW 1** Defines the torque value of the first underload curve definition point. • Must be smaller than 3706 LOAD TORQ HIGH 1.
3706	**LOAD TORQ HIGH 1** Defines the torque value of the first overload curve definition point.
3707	**LOAD FREQ 2** Defines the frequency value of the second load curve definition point. • Must be smaller than 3710 LOAD FREQ 3.
3708	**LOAD TORQ LOW 2** Defines the torque value of the second underload curve definition point. • Must be smaller than 3709 LOAD TORQ HIGH 2.
3709	**LOAD TORQ HIGH 2** Defines the torque value of the second overload curve definition point.
3710	**LOAD FREQ 3** Defines the frequency value of the third load curve definition point. • Must be smaller than 3713 LOAD FREQ 4.
3711	**LOAD TORQ LOW 3** Defines the torque value of the third underload curve definition point. • Must be smaller than 3712 LOAD TORQ HIGH 3.
3712	**LOAD TORQ HIGH 3** Defines the torque value of the third overload curve definition point.

Code	Description
3713	**LOAD FREQ 4** Defines the frequency value of the fourth load curve definition point. • Must be smaller than 3716 LOAD FREQ 5
3714	**LOAD TORQ LOW 4** Defines the torque value of the fourth underload curve definition point. • Must be smaller than 3715 LOAD TORQ HIGH 4.
3715	**LOAD TORQ HIGH 4** Defines the torque value of the fourth overload curve definition point.
3716	**LOAD FREQ 5** Defines the frequency value of fifth load curve definition point.
3717	**LOAD TORQ LOW 5** Defines the torque value of the fifth underload curve definition point. • Must be smaller than 3718 LOAD TORQ HIGH 5.
3718	**LOAD TORQ HIGH 5** Defines the torque value of the fifth overload curve definition point.

Correspondence with the obsolete underload supervision

The now obsolete parameter 3015 UNDERLOAD CURVE provided five selectable curves shown in the figure. The parameter characteristics were as described below.

- If the load drops below the set curve for longer than the time set by parameter 3014 UNDERLOAD TIME (obsolete), the underload protection is activated.
- Curves 1…3 reach maximum at the motor rated frequency set by parameter 9907 MOTOR NOM FREQ.
- T_M = nominal torque of the motor.
- f_N = nominal frequency of the motor.



If you want to emulate the behavior of an old underload curve with parameters as in the shaded columns, set the new parameters as in the white columns in the two tables below:

Underload supervision with parameters 3013…3015 (obsolete)	Obsolete parameters		New parameters		
	3013 UNDERLOAD FUNCTION	3014 UNDERLOAD TIME	3701 USER LOAD C MODE	3702 USER LOAD C FUNC	3703 USER LOAD C TIME
No underload functionality	0	-	0	-	-
Underload curve, fault generated	1	t	1	1	t
Underload curve, alarm generated	2	t	1	2	2 · t

Obs. par.	New parameters														
3015 UNDER LOAD CURVE	3704 LOAD FREQ 1 (Hz)		3705 LOAD TORQ LOW 1 (%)	3707 LOAD FREQ 2 (Hz)		3708 LOAD TORQ LOW 2 (%)	3710 LOAD FREQ 3 (Hz)		3711 LOAD TORQ LOW 3 (%)	3713 LOAD FREQ 4 (Hz)		3714 LOAD TORQ LOW 4 (%)	3716 LOAD FREQ 5 (Hz)		3717 LOAD TORQ LOW 5 (%)
	EU	US		EU	US		EU	US		EU	US		EU	US	
1	5	6	10	32	38	17	41	50	23	50	60	30	500	500	30
2	5	6	20	31	37	30	42	50	40	50	60	50	500	500	50
3	5	6	30	31	37	43	42	50	57	50	60	70	500	500	70
4	5	6	10	73	88	17	98	117	23	120	144	30	500	500	30
5	5	6	20	71	86	30	99	119	40	120	144	50	500	500	50

Group 40: PROCESS PID SET 1

This group defines a set of parameters used with the Process PID (PID1) controller.

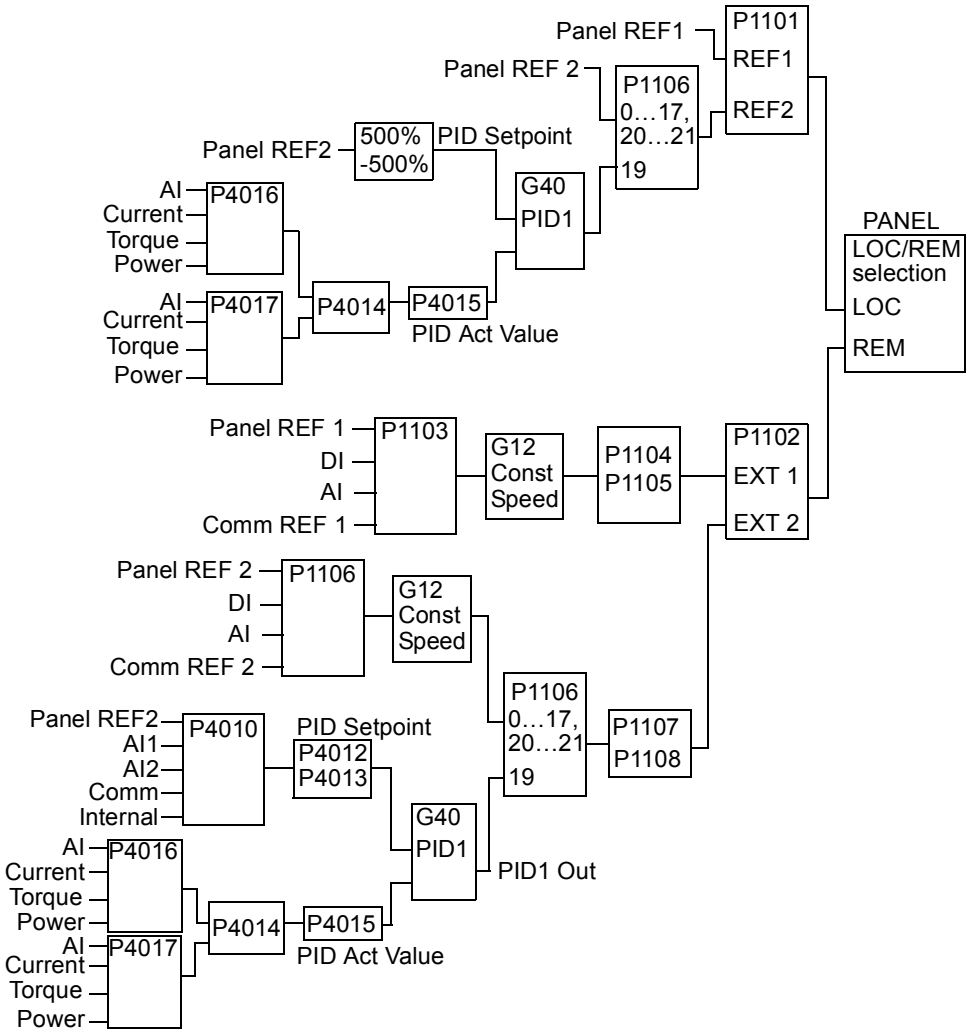
Typically only parameters in this group are needed.

PID controller – Basic set-up

In PID control mode, the drive compares a reference signal (setpoint) to an actual signal (feedback) and automatically adjusts the speed of the drive to match the two signals. The difference between the two signals is the error value.

Typically PID control mode is used, when the speed of a motor needs to be controlled based on pressure, flow or temperature. In most cases – when there is only 1 transducer signal wired to the ACS550 – only parameter group 40 is needed.

The following is a schematic of setpoint/feedback signal flow using parameter group 40.



Note: In order to activate and use the PID controller, parameter 1106 must be set to value 19.

PID controller – Advanced

The ACS550 has two separate PID controllers:

- Process PID (PID1) and
- External PID (PID2)

Process PID (PID1) has 2 separate sets of parameters:

- Process PID (PID1) SET1, defined in *Group 40: PROCESS PID SET 1* and
- Process PID (PID1) SET2, defined in *Group 41: PROCESS PID SET 2*

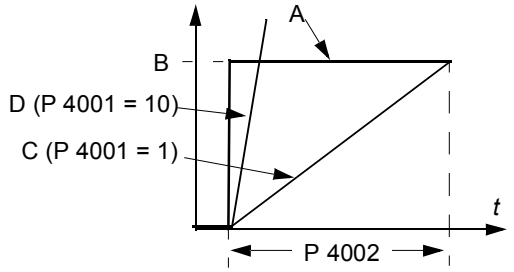
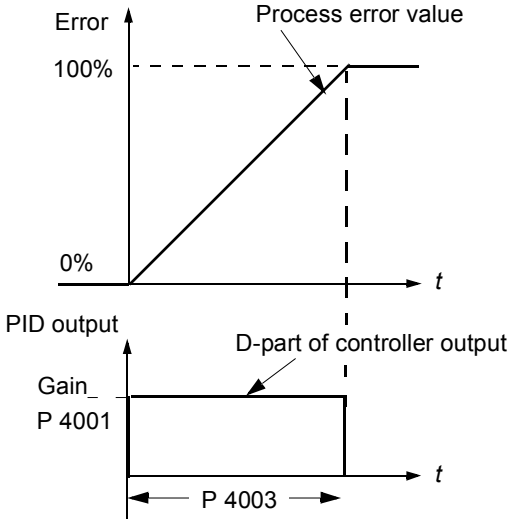
You can select between the two different sets by using parameter 4027.

Typically two different PID controller sets are used when the load of the motor changes considerably from one situation to another.

You can use External PID (PID2), defined in *Group 42: EXT / TRIM PID*, in two different ways:

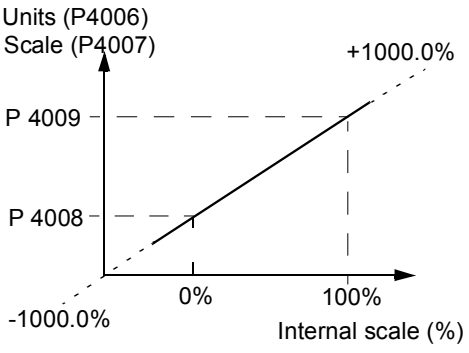
- Instead of using additional PID controller hardware, you can set outputs of the ACS550 to control a field instrument like a damper or a valve. In this case, set parameter 4230 to value 0. (0 is the default value.)
- You can use External PID (PID2) to trim or fine-tune the speed of the ACS550.

Code	Description
4001	**GAIN** Defines the PID controller's gain. • The setting range is 0.1… 100. • At 0.1, the PID controller output changes one-tenth as much as the error value. • At 100, the PID controller output changes one hundred times as much as the error value. Use the proportional gain and integration time values to adjust the responsiveness of the system. • A low value for proportional gain and a high value for integral time ensures stable operation, but provides sluggish response. If the proportional gain value is too large or the integral time too short, the system can become unstable. Procedure: • Initially, set: • 4001 GAIN = 0.1. • 4002 INTEGRATION TIME = 20 seconds. • Start the system and see if it reaches the setpoint quickly while maintaining stable operation. If not, increase GAIN (4001) until the actual signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation. • Reduce GAIN (4001) until the oscillation stops. • Set GAIN (4001) to 0.4 to 0.6 times the above value. • Decrease the INTEGRATION TIME (4002) until the feedback signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation. • Increase INTEGRATION TIME (4002) until the oscillation stops. • Set INTEGRATION TIME (4002) to 1.15 to 1.5 times the above value. • If the feedback signal contains high frequency noise, increase the value of parameter 1303 FILTER AI1 or 1306 FILTER AI2 until the noise is filtered from the signal.

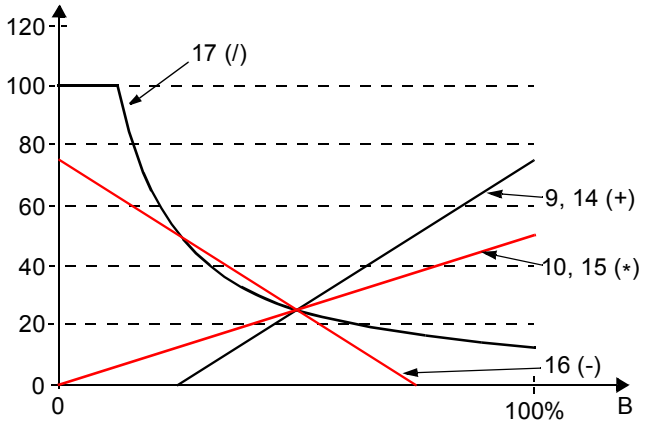
Code	Description
4002	**INTEGRATION TIME** Defines the PID controller's integration time. Integration time is, by definition, the time required to increase the output by the error value: • Error value is constant and 100%. • Gain = 1. • Integration time of 1 second denotes that a 100% change is achieved in 1 second. 0.0 = NOT SEL – Disables integration (I-part of controller). 0.1…3600.0 – Integration time (seconds). • See 4001 for adjustment procedure.  A = Error B = Error value step C = Controller output with Gain = 1 D = Controller output with Gain = 10
4003	**DERIVATION TIME** Defines the PID controller's derivation time. • You can add the derivative of the error to the PID controller output. The derivative is the error value's rate of change. For example, if the process error value changes linearly, the derivative is a constant added to the PID controller output. • The error-derivative is filtered with a 1-pole filter. The time constant of the filter is defined by parameter 4004 PID DERIV FILTER. 0.0…10.0 – Derivation time (seconds). 
4004	**PID DERIV FILTER** Defines the filter time constant for the error-derivative part of the PID controller output. • Before being added to the PID controller output, the error-derivative is filtered with a 1-pole filter. • Increasing the filter time smooths the error-derivative, reducing noise. 0.0…10.0 – Filter time constant (seconds).
4005	**ERROR VALUE INV** Selects either a normal or inverted relationship between the feedback signal and the drive speed. 0 = NO – Normal, a decrease in feedback signal increases drive speed. Error = Ref - Fbk 1 = YES – Inverted, a decrease in feedback signal decreases drive speed. Error = Fbk - Ref
4006	**UNITS** Selects the unit for the PID controller actual values. (PID1 parameters 0128, 0130 and 0132). • See parameter 3405 for list of available units.
4007	**UNIT SCALE** Defines the decimal point location in PID controller actual values. • Enter the decimal point location counting in from the right end of the entry. • See the table for an example using pi (3.14159).

4007 value	Entry	Display
0	00003	3
1	00031	3.1
2	00314	3.14
3	03142	3.142
4	31416	3.1416

Code	Description
4008	**0% VALUE** Defines (together with the next parameter) the scaling applied to the PID controller's actual values (PID1 parameters 0128, 0130 and 0132). • Units and scale are defined by parameters 4006 and 4007.
4009	**100% VALUE** Defines (together with the previous parameter) the scaling applied to the PID controller's actual values. • Units and scale are defined by parameters 4006 and 4007.



Code	Description
4010	**SET POINT SEL** Defines the reference signal source for the PID controller. • Parameter has no significance when the PID regulator is by-passed (see 8121 REG BYPASS CTRL). 0 = KEYPAD – Control panel provides reference. 1 = AI1 – Analog input 1 provides reference. 2 = AI2 – Analog input 2 provides reference. 8 = COMM – Fieldbus provides reference. 9 = COMM+AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog input reference correction below. 10 = COMM*AI1 – Defines a fieldbus and analog input 1 (AI1) combination as the reference source. See Analog input reference correction below. 11 = DI3U,4D(RNC) – Digital inputs, acting as a motor potentiometer control, provide reference. • DI3 increases the speed (the U stands for "up") • DI4 decreases the reference (the D stands for "down"). • Parameter 2205 ACCELER TIME 2 controls the reference signal's rate of change. • R = Stop command resets the reference to zero. • NC = Reference value is not copied. 12 = DI3U,4D(NC) – Same as DI3U,4D(RNC) above, except: • Stop command does not reset reference to zero. At restart the motor ramps up, at the selected acceleration rate, to the stored reference. 13 = DI5U,6D(NC) – Same as DI3U,4D(NC) above, except: • Uses digital inputs DI5 and DI6. 14 = AI1+AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 15 = AI1*AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 16 = AI1-AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 17 = AI1/AI2 – Defines an analog input 1 (AI1) and analog input 2 (AI2) combination as the reference source. See Analog input reference correction below. 19 = INTERNAL – A constant value set using parameter 4011 provides reference. 20 = PID2OUT – Defines PID controller 2 output (parameter 0127 PID 2 OUTPUT) as the reference source.

Code	Description
	Analog input reference correction Parameter values 9, 10 and 14…17 use the formula in the following table. **Value setting** / **Calculation of the AI reference** C + B: C value + (B value - 50% of reference value) C * B: C value · (B value / 50% of reference value) C - B: (C value + 50% of reference value) - B value C / B: (C value · 50% of reference value) / B value Where: • C = Main reference value (= COMM for values 9, 10 and = AI1 for values 14…17) • B = Correcting reference (= AI1 for values 9, 10 and = AI2 for values 14…17). **Example:** The figure shows the reference source curves for value settings 9, 10 and 14…17, where: • C = 25%. • P 4012 SETPOINT MIN = 0. • P 4013 SETPOINT MAX = 0. • B varies along the horizontal axis. 
4011	**INTERNAL SETPNT** Sets a constant value used for the process reference. • Units and scale are defined by parameters 4006 and 4007.
4012	**SETPOINT MIN** Sets the minimum value for the reference signal source. • See parameter 4010.
4013	**SETPOINT MAX** Sets the maximum value for the reference signal source. • See parameter 4010.
4014	**FBK SEL** Defines the PID controller feedback (actual signal). • You can define a combination of two actual values (ACT1 and ACT2) as the feedback signal. • Use parameter 4016 to define the source for actual value 1 (ACT1). • Use parameter 4017 to define the source for actual value 2 (ACT2). 1 = ACT1 – Actual value 1 (ACT1) provides the feedback signal. 2 = ACT1-ACT2 – ACT1 minus ACT2 provides the feedback signal. 3 = ACT1+ACT2 – ACT1 plus ACT2 provides the feedback signal. 4 = ACT1*ACT2 – ACT1 times ACT2 provides the feedback signal. 5 = ACT1/ACT2 – ACT1 divided by ACT2 provides the feedback signal. 6 = MIN(ACT1,2) – The smaller of ACT1 or ACT2 provides the feedback signal. 7 = MAX(ACT1,2) – The greater of ACT1 or ACT2 provides the feedback signal. 8 = sqrt(ACT1-2) – Square root of the value for ACT1 minus ACT2 provides the feedback signal. 9 = sqA1+sqA2 – Square root of ACT1 plus the square root of ACT2 provides the feedback signal. 10 = sqrt(ACT1) – Square root of ACT1 provides the feedback signal. 11 = COMM FBK 1 – Signal 0158 PID COMM VALUE 1 provides the feedback signal. 12 = COMM FBK 2 – Signal 0159 PID COMM VALUE 2 provides the feedback signal. 13 = AVE(ACT1,2) – The average of ACT1 and ACT2 provides the feedback signal.
4015	**FBK MULTIPLIER** Defines an extra multiplier for the PID feedback value FBK defined by parameter 4014. • Used mainly in applications where the flow is calculated from the pressure difference. 0.000 = NOT SEL – The parameter has no effect (1.000 used as the multiplier). -32.768…32.767 – Multiplier applied to the signal defined by parameter 4014 FBK SEL. **Example:** $FBK = Multiplier \times \sqrt{A1 - A2}$

4016 ACT1 INPUT

Defines the source for actual value 1 (ACT1). See also parameter 4018 ACT1 MINIMUM.
1 = AI1 – Uses analog input 1 for ACT1.
2 = AI2 – Uses analog input 2 for ACT1.
3 = CURRENT – Uses current for ACT1.
4 = TORQUE – Uses torque for ACT1.
5 = POWER – Uses power for ACT1.
6 = COMM ACT 1 – Uses value of signal 0158 PID COMM VALUE 1 for ACT1.
7 = COMM ACT 2 – Uses value of signal 0159 PID COMM VALUE 2 for ACT1.

4017 ACT2 INPUT

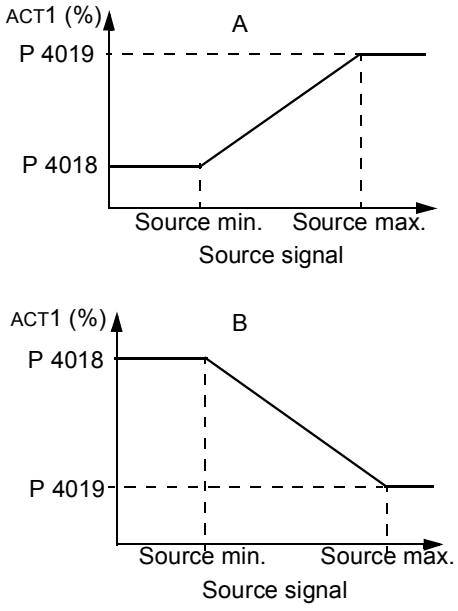
Defines the source for actual value 2 (ACT2). See also parameter 4020 ACT2 MINIMUM.
1 = AI1 – Uses analog input 1 for ACT2.
2 = AI2 – Uses analog input 2 for ACT2.
3 = CURRENT – Uses current for ACT2.
4 = TORQUE – Uses torque for ACT2.
5 = POWER – Uses power for ACT2.
6 = COMM ACT 1 – Uses value of signal 0158 PID COMM VALUE 1 for ACT2.
7 = COMM ACT 2 – Uses value of signal 0159 PID COMM VALUE 2 for ACT2.

4018 ACT1 MINIMUM

Sets the minimum value for ACT1.
- Scales the source signal used as the actual value ACT1 (defined by parameter 4016 ACT1 INPUT). For parameter 4016 values 6 (COMM ACT 1) and 7 (COMM ACT 2) scaling is not done.

Par 4016	Source	Source min.	Source max.
1	Analog input 1	1301 MINIMUM AI1	1302 MAXIMUM AI1
2	Analog input 2	1304 MINIMUM AI2	1305 MAXIMUM AI2
3	Current	0	2 · nominal current
4	Torque	-2 · nominal torque	2 · nominal torque
5	Power	-2 · nominal power	2 · nominal power

- See the figure: A= Normal; B = Inversion (ACT1 MINIMUM > ACT1 MAXIMUM)



4019 ACT1 MAXIMUM

Sets the maximum value for ACT1.
- See 4018 ACT1 MINIMUM.

4020 ACT2 MINIMUM

Sets the minimum value for ACT2.
- See 4018 ACT1 MINIMUM.

4021 ACT2 MAXIMUM

Sets the maximum value for ACT2.
- See 4018 ACT1 MINIMUM.

4022 SLEEP SELECTION

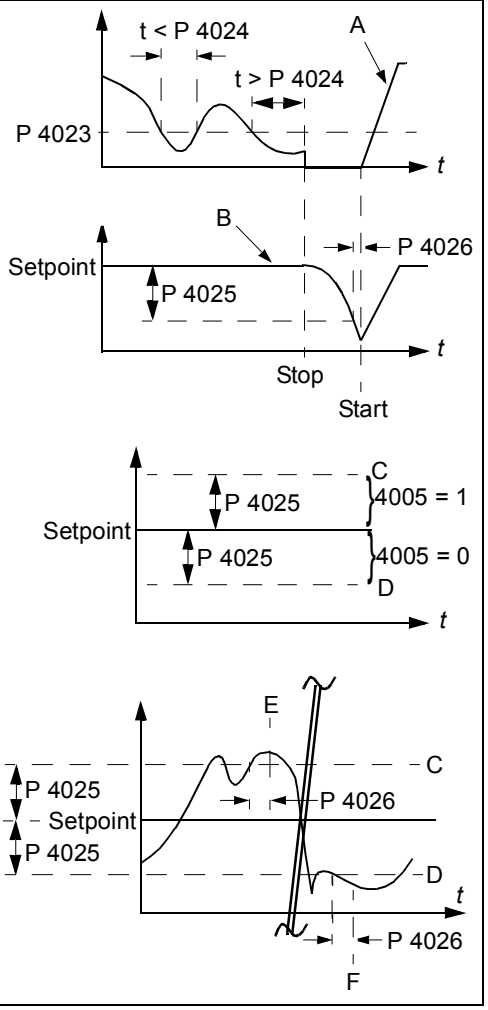
Defines the control for the PID sleep function.
0 = NOT SEL– Disables the PID sleep control function.
1 = DI1 – Defines digital input DI1 as the control for the PID sleep function.
- Activating the digital input activates the sleep function.
- De-activating the digital input restores PID control.

2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for the PID sleep function.
- See DI1 above.

7 = INTERNAL – Defines the output rpm/frequency, process reference and process actual value as the control for the PID sleep function. Refer to parameters 4025 WAKE-UP DEV and 4023 PID SLEEP LEVEL.
-1 = DI1(INV) – Defines an inverted digital input DI1 as the control for the PID sleep function.
- De-activating the digital input activates the sleep function.
- Activating the digital input restores PID control.

-2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for the PID sleep function.
- See DI1(INV) above.

Code	Description
4023	**PID SLEEP LEVEL** Sets the motor speed / frequency that enables the PID sleep function – a motor speed / frequency below this level, for at least the time period 4024 PID SLEEP DELAY enables the PID sleep function (stopping the drive). • Requires 4022 = 7 (INTERNAL). • See the figure: A = PID output level; B = PID process feedback.
4024	**PID SLEEP DELAY** Sets the time delay for the PID sleep function – a motor speed / frequency below 4023 PID SLEEP LEVEL for at least this time period enables the PID sleep function (stopping the drive). • See 4023 PID SLEEP LEVEL above.
4025	**WAKE-UP DEV** Defines the wake-up deviation – a deviation from the setpoint greater than this value, for at least the time period 4026 WAKE-UP DELAY, re-starts the PID controller. • Parameters 4006 and 4007 define the units and scale. • Parameter 4005 = 0, Wake-up level = Setpoint - Wake-up deviation. • Parameter 4005 = 1, Wake-up level = Setpoint + Wake-up deviation. • Wake-up level can be above or below setpoint. See the figures: • C = Wake-up level when parameter 4005 = 1 • D = Wake-up level when parameter 4005 = 0 • E = Feedback is above wake-up level and lasts longer than 4026 WAKE-UP DELAY – PID function wakes up. • F = Feedback is below wake-up level and lasts longer than 4026 WAKE-UP DELAY – PID function wakes up.
4026	**WAKE-UP DELAY** Defines the wake-up delay – a deviation from the setpoint greater than 4025 WAKE-UP DEV, for at least this time period, re-starts the PID controller.



Code	Description
4027	**PID 1 PARAM SET** Process PID (PID1) has two separate sets of parameters, PID set 1 and PID set 2. • PID set 1 uses parameters 4001…4026. • PID set 2 uses parameters 4101…4126. PID 1 PARAM SET defines which set is selected. 0 = SET 1 – PID Set 1 (parameters 4001…4026) is active. 1 = DI1 – Defines digital input DI1 as the control for PID Set selection. • Activating the digital input selects PID Set 2. • De-activating the digital input selects PID Set 1. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for PID Set selection. • See DI1 above. 7 = SET 2 – PID Set 2 (parameters 4101…4126) is active. 8…11 = TIMED FUNC 1…4 – Defines the Timed function as the control for the PID Set selection (Timed function de-activated = PID Set 1; Timed function activated = PID Set 2) • See *Group 36: TIMED FUNCTIONS*. 12 = 2-ZONE MIN – The drive calculates the difference between setpoint 1 and feedback 1 as well as setpoint 2 and feedback 2. The drive will control the zone (and select the set) that has a larger difference. • A positive difference (a setpoint higher than the feedback) is always larger than a negative difference. This keeps feedback values at or above the setpoint. • Controller does not react to the situation of feedback above setpoint if another zone's feedback is closer to its setpoint. 13 = 2-ZONE MAX – The drive calculates the difference between setpoint 1 and feedback 1 as well as setpoint 2 and feedback 2. The drive will control the zone (and select the set) that has a smaller difference. • A negative difference (a setpoint lower than the feedback) is always smaller than a positive difference. This keeps feedback values at or below the setpoint. • Controller does not react to the situation of feedback below setpoint if another zone's feedback is closer to its setpoint. 14 = 2-ZONE AVE – The drive calculates the difference between setpoint 1 and feedback 1 as well as setpoint 2 and feedback 2. In addition, it calculates the average of the deviations and uses it to control zone 1. Therefore one feedback is kept above its setpoint and another is kept as much below its setpoint. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for PID Set selection. • Activating the digital input selects PID Set 1. • De-activating the digital input selects PID Set 2. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for PID Set selection. • See DI1(INV) above.

Group 41: PROCESS PID SET 2

Parameters of this group belong to PID parameter set 2. The operation of parameters 4101…4126 is analogous with set 1 parameters 4001…4026.

PID parameter set 2 can be selected by parameter 4027 PID 1 PARAM SET.

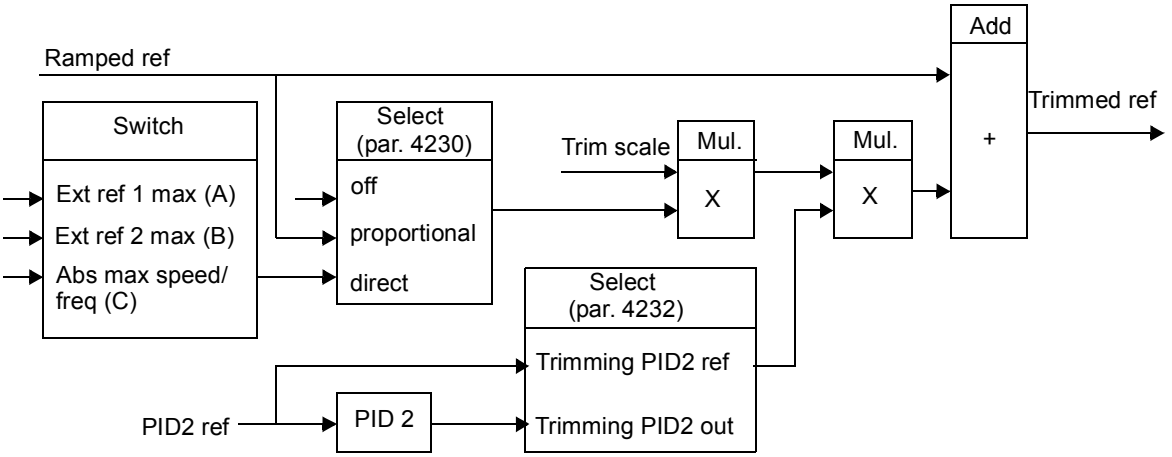
Code	Description
4101 … 4126	See 4001 …4026

Group 42: EXT / TRIM PID

This group defines the parameters used for the second PID controller (PID2), which is used for the External / Trimming PID.

The operation of parameters 4201...4221 is analogous with Process PID set 1 (PID1) parameters 4001…4021.

Code	Description
4201 … 4221	See 4001 …4021
4228	**ACTIVATE** Defines the source for enabling the external PID function. • Requires 4230 TRIM MODE = 0 (NOT SEL). 0 = NOT SEL – Disables external PID control. 1 = DI1 – Defines digital input DI1 as the control for enabling external PID control. • Activating the digital input enables external PID control. • De-activating the digital input disables external PID control. 2…6 = DI2…DI6 – Defines digital input DI2…DI6 as the control for enabling external PID control. • See DI1 above. 7 = DRIVE RUN – Defines the start command as the control for enabling external PID control. • Activating the start command (drive is running) enables external PID control. 8 = ON – Defines the power-on as the control for enabling external PID control. • Activating power to the drive enables external PID control. 9…12 = TIMED FUNC 1…4 – Defines the Timed function as the control for enabling external PID control (Timed function active enables external PID control). • See *Group 36: TIMED FUNCTIONS*. -1 = DI1(INV) – Defines an inverted digital input DI1 as the control for enabling external PID control. • Activating the digital input disables external PID control. • De-activating the digital input enables external PID control. -2…-6 = DI2(INV)…DI6(INV) – Defines an inverted digital input DI2…DI6 as the control for enabling external PID control. • See DI1(INV) above.
4229	**OFFSET** Defines the offset for the PID output. • When PID is activated, output starts from this value. • When PID is deactivated, output resets to this value. • Parameter is active when 4230 TRIM MODE = 0 (trim mode is not active).
4230	**TRIM MODE** Selects the type of trim, if any. Using the trim it is possible to combine a corrective factor to the drive reference. 0 = NOT SEL – Disables the trim function. 1 = PROPORTIONAL – Adds a trim factor that is proportional to the rpm/Hz reference. 2 = DIRECT – Adds a trim factor based on the control loop's maximum limit.
4231	**TRIM SCALE** Defines the multiplier (as a percent, plus or minus) used in the trim mode.

Code	Description
4232	**CORRECTION SRC** Defines the trimming reference for the correction source. 1 = PID2REF – Uses appropriate REF MAX (SWITCH A OR B): • 1105 REF1 MAX when REF1 is active (A). • 1108 REF2 MAX when REF2 is active (B). 2 = PID2OUTPUT – Uses the absolute maximum speed or frequency (Switch C): • 2002 MAXIMUM SPEED if 9904 MOTOR CTRL MODE = 1 (VECTOR:SPEED) or 2 (VECTOR:TORQ). • 2008 MAXIMUM FREQ if 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ). 

Group 45: ENERGY SAVING

This group defines the setup of calculation and optimization of energy savings.

Note: The values of saved energy parameters 0174 SAVED KWH, 0175 SAVED MWH, 0176 SAVED AMOUNT 1, 0177 SAVED AMOUNT 2 and 0178 SAVED CO2 are derived from subtracting the drive's energy consumed from the direct-on-line (DOL) consumption calculated on the basis of parameter 4508 PUMP POWER. As such, the accuracy of the values is dependent on the accuracy of the power estimate entered in that parameter.

Code	Description
4502	**ENERGY PRICE** Price of energy per kWh. • Used for reference when energy savings are calculated. • See parameters 0174 SAVED KWH, 0175 SAVED MWH, 0176 SAVED AMOUNT 1, 0177 SAVED AMOUNT 2 and 0178 SAVED CO2 (reduction on carbon dioxide emissions in tn).
4507	**CO2 CONV FACTOR** Conversion factor for converting energy into CO2 emissions (kg/kWh or tn/MWh). Used for multiplying the saved energy in MWh to calculate the value of parameter 0178 SAVED CO2 (reduction on carbon dioxide emissions in tn).
4508	**PUMP POWER** Pump power (as a percentage of the nominal motor power) when connected directly to supply (DOL). • Used for reference when energy savings are calculated. • See parameters 0174 SAVED KWH, 0175 SAVED MWH, 0176 SAVED AMOUNT 1, 0177 SAVED AMOUNT 2 and 0178 SAVED CO2. • It is possible to use this parameter as the reference power also for other applications than pumps. The reference power can also be some other constant power than a motor connected directly online.
4509	**ENERGY RESET** Resets energy calculators 0174 SAVED KWH, 0175 SAVED MWH, 0176 SAVED AMOUNT 1, 0177 SAVED AMOUNT 2 and 0178 SAVED CO2.

Group 50: ENCODER

This group defines the setup for encoder use:

- Sets the number of encoder pulses per shaft revolution.
- Enables the encoder operation.
- Defines how mechanical angle and revolution data is reset.

See also *User's Manual for Pulse Encoder Interface Module OTAC-01* (3AUA0000001938 [English]).

Code	Description
5001	**PULSE NR** Sets the number of pulses provided by an optional encoder for each full motor shaft revolution (ppr).
5002	**ENCODER ENABLE** Enables/disables an optional encoder. 0 = DISABLE – Drive uses speed feedback derived from the internal motor model (applies for any setting of parameter 9904 MOTOR CTRL MODE). 1 = ENABLE – Drive uses feedback from an optional encoder. This function requires the Pulse Encoder Interface Module (OTAC-01) and an encoder. Operation depends on the setting of parameter 9904 MOTOR CTRL MODE: • 9904 = 1 (VECTOR:SPEED): The encoder provides improved speed feedback and improved low speed torque accuracy. • 9904 = 2 (VECTOR:TORQ): The encoder provides improved speed feedback and improved low speed torque accuracy. • 9904 = 3 (SCALAR:SPEED): The encoder provides speed feedback. (This is not closed loop speed regulation. However, using parameter 2608 SLIP COMP RATIO and an encoder improves steady state speed accuracy.)
5003	**ENCODER FAULT** Defines the drive operation if a failure is detected in communication between the encoder and the encoder interface module, or between the module and the drive. 1 = FAULT – The drive generates fault ENCODER ERR, and the motor coasts to a stop. 2 = ALARM – The drive generates alarm ENCODER ERR and operates as if parameter 5002 ENCODER ENABLE = 0 (DISABLE), that is, speed feedback is derived from the internal motor model.
5010	**Z PLS ENABLE** Enables/disables the use of an encoder's Z-pulse to define the motor shaft's zero position. When enabled, a Z-pulse input resets parameter 0146 MECH ANGLE to zero to define the shaft's zero position. This function requires an encoder that provides Z-pulse signals. 0 = DISABLE – Z-pulse input is not present or ignored if present. 1 = ENABLE – A Z-pulse input resets parameter 0146 MECH ANGLE to zero.
5011	**POSITION RESET** Resets the encoder's position feedback. This parameter is self-clearing. 0 = DISABLE – Inactive. 1 = ENABLE – Resets the encoder position feedback. Parameters reset depends on the state of parameter 5010 Z PLS ENABLE: • 5010 = 0 (DISABLE) – Reset applies to parameters 0147 MECH REVS and 0146 MECH ANGLE. • 5010 = 1 (ENABLE) – Reset applies only to parameter 0147 MECH REVS.

Group 51: EXT COMM MODULE

This group defines set-up variables for a fieldbus adapter (FBA) communication module. For more information on these parameters, refer to the user's manual supplied with the FBA module.

Code	Description
5101	**FBA TYPE** Displays the type of the connected fieldbus adapter module. 0 = NOT DEFINED – Module not found, or not properly connected, or parameter 9802 is not set to 4 (EXT FBA). 1 = PROFIBUS-DP 21 = LONWORKS 32 = CANopen 37 = DEVICENET 101 = CONTROLNET 128 = ETHERNET 132 = PROFINET 135 = EtherCAT 136 = EPL – Ethernet POWERLINK
5102 … 5126	**FB PAR 2…FB PAR 26** Refer to communication module documentation for more information on these parameters.
5127	**FBA PAR REFRESH** Validates any changed fieldbus parameter settings. 0 = DONE – Refreshing done. 1 = REFRESH – Refreshing. • After refreshing, the value reverts automatically to DONE.
5128	**FILE CPI FW REV** Displays the CPI firmware revision of the drive's fieldbus adapter configuration file. Format is xyz where: • x = major revision number • y = minor revision number • z = correction number **Example:** 107 = revision 1.07
5129	**FILE CONFIG ID** Displays the revision of the drive's fieldbus adapter module's configuration file identification. • File configuration information is drive application program-dependent.
5130	**FILE CONFIG REV** Contains the revision of the drive's fieldbus adapter module configuration file. **Example:** 1 = revision 1
5131	**FBA STATUS** Contains the status of the adapter module. 0 = IDLE – Adapter not configured. 1 = EXECUT INIT – Adapter is initializing. 2 = TIME OUT – A timeout has occurred in the communication between the adapter and the drive. 3 = CONFIG ERROR – Adapter configuration error. • The revision code of the adapter's CPI firmware revision is older than required CPI firmware version defined in the drive's configuration file (parameter 5132 < 5128). 4 = OFF-LINE – Adapter is off-line. 5 = ON-LINE – Adapter is on-line. 6 = RESET – Adapter is performing a hardware reset.
5132	**FBA CPI FW REV** Contains the revision of the module's CPI program. Format is xyz where: • x = major revision number • y = minor revision number • z = correction number **Example:** 107 = revision 1.07
5133	**FBA APPL FW REV** Contains the revision of the module's application program. Format is xyz (see parameter 5132).

Group 52: PANEL COMM

This group defines the communication settings for the control panel port on the drive. Normally, when using the supplied control panel, there is no need to change settings in this group.

In this group, parameter modifications take effect on the next power-up.

Code	Description
5201	**STATION ID** Defines the address of the drive. • Two units with the same address are not allowed on-line. • Range: 1…247
5202	**BAUD RATE** Defines the communication speed of the drive in kbits per second (kb/s). 9.6 kb/s 19.2 kb/s 38.4 kb/s 57.6 kb/s 115.2 kb/s
5203	**PARITY** Sets the character format to be used with the panel communication. 0 = 8 NONE 1 – 8 data bits, no parity, one stop bit. 1 = 8 NONE 2 – 8 data bits, no parity, two stop bits. 2 = 8 EVEN 1 – 8 data bits, even parity, one stop bit. 3 = 8 ODD 1 – 8 data bits, odd parity, one stop bit.
5204	**OK MESSAGES** Contains a count of valid Modbus messages received by the drive. • During normal operation, this counter is increasing constantly.
5205	**PARITY ERRORS** Contains a count of the characters with a parity error that is received from the bus. For high counts, check: • Parity settings of devices connected on the bus – they must not differ. • Ambient electro-magnetic noise levels – high noise levels generate errors.
5206	**FRAME ERRORS** Contains a count of the characters with a framing error that the bus receives. For high counts, check: • Communication speed settings of devices connected on the bus – they must not differ. • Ambient electro-magnetic noise levels – high noise levels generate errors.
5207	**BUFFER OVERRUNS** Contains a count of the characters received that cannot be placed in the buffer. • Longest possible message length for the drive is 128 bytes. • Received messages exceeding 128 bytes overflow the buffer. The excess characters are counted.
5208	**CRC ERRORS** Contains a count of the messages with a CRC error that the drive receives. For high counts, check: • Ambient electro-magnetic noise levels – high noise levels generate errors. • CRC calculations for possible errors.

Group 53: EFB PROTOCOL

This group defines set-up variables used for an embedded fieldbus (EFB) communication protocol. The standard EFB protocol in the ACS550 is Modbus. See chapter *Embedded fieldbus* page *203*.

Code	Description
5301	**EFB PROTOCOL ID** Contains the identification and program revision of the protocol. • Format: XXYY, where xx = protocol ID, and YY = program revision.
5302	**EFB STATION ID** Defines the node address of the RS485 link. • The node address on each unit must be unique.
5303	**EFB BAUD RATE** Defines the communication speed of the RS485 link in kbits per second (kb/s). 1.2 kb/s 2.4 kb/s 4.8 kb/s 9.6 kb/s 19.2 kb/s 38.4 kb/s 57.6 kb/s 76.8 kb/s
5304	**EFB PARITY** Defines the data length, parity and stop bits to be used with the RS485 link communication. • The same settings must be used in all on-line stations. 0 = 8 NONE 1 – 8 data bits, no parity, one stop bit. 1 = 8 NONE 2 – 8 data bits, no parity, two stop bits. 2 = 8 EVEN 1 – 8 data bits, even parity, one stop bit. 3 = 8 ODD 1 – 8 data bits, odd parity, one stop bit.
5305	**EFB CTRL PROFILE** Selects the communication profile used by the EFB protocol. 0 = ABB DRV LIM – Operation of Control/Status Words conforms to ABB Drives Profile, as used in ACS400. 1 = DCU PROFILE – Operation of Control/Status Words conforms to 32-bit DCU Profile. 2 = ABB DRV FULL – Operation of Control/Status Words conforms to ABB Drives Profile, as used in ACS600/800.
5306	**EFB OK MESSAGES** Contains a count of valid messages received by the drive. • During normal operation, this counter is increasing constantly.
5307	**EFB CRC ERRORS** Contains a count of the messages with a CRC error received by the drive. For high counts, check: • Ambient electro-magnetic noise levels – high noise levels generate errors. • CRC calculations for possible errors.
5308	**EFB UART ERRORS** Contains a count of the messages with a character error received by the drive.
5309	**EFB STATUS** Contains the status of the EFB protocol. 0 = IDLE – EFB protocol is configured, but not receiving any messages. 1 = EXECUT INIT – EFB protocol is initializing. 2 = TIME OUT – A timeout has occurred in the communication between the network master and the EFB protocol. 3 = CONFIG ERROR – EFB protocol has a configuration error. 4 = OFF-LINE – EFB protocol is receiving messages that are NOT addressed to this drive. 5 = ON-LINE – EFB protocol is receiving messages that are addressed to this drive. 6 = RESET – EFB protocol is performing a hardware reset. 7 = LISTEN ONLY – EFB protocol is in listen-only mode.
5310	**EFB PAR 10** Specifies the parameter mapped to Modbus Register 40005.

Code	Description
5311	**EFB PAR 11** Specifies the parameter mapped to Modbus Register 40006.
5312	**EFB PAR 12** Specifies the parameter mapped to Modbus Register 40007.
5313	**EFB PAR 13** Specifies the parameter mapped to Modbus Register 40008.
5314	**EFB PAR 14** Specifies the parameter mapped to Modbus Register 40009.
5315	**EFB PAR 15** Specifies the parameter mapped to Modbus Register 40010.
5316	**EFB PAR 16** Specifies the parameter mapped to Modbus Register 40011.
5317	**EFB PAR 17** Specifies the parameter mapped to Modbus Register 40012.
5318	**EFB PAR 18** For Modbus: Sets additional delay in milliseconds before the ACS550 begins transmitting response to the master request.
5319	**EFB PAR 19** ABB Drives profile (ABB DRV LIM or ABB DRV FULL) Control Word. Read only copy of the Fieldbus Control Word.
5320	**EFB PAR 20** ABB Drives profile (ABB DRV LIM or ABB DRV FULL) Status Word. Read only copy of the Fieldbus Status Word.

Group 64: LOAD ANALYZER

This group defines the load analyzer, which can be used for analyzing the customer's process and sizing the drive and the motor.

The peak value is logged at 2 ms level, and the distribution loggers are updated on 0.2 s (200 ms) time level. Three different values can be logged.

1. Amplitude logger 1: The measured current is logged continuously. The distribution as a percentage of the nominal current I_{2N} is shown in ten classes.
2. Peak value logger: One signal in group 1 can be logged for the peak (maximum) value. The peak value of the signal, peak time (time when the peak value was detected) as well the frequency, current and DC voltage at the peak time are shown.
3. Amplitude logger 2: One signal in group 1 can be logged for amplitude distribution. The base value (100% value) can be set by the user.

The first logger cannot be reset. The other two loggers can be reset by a user-defined method. They are also reset if either of the signals or the peak value filter time is changed.

Code	Description
6401	**PVL SIGNAL** Defines (by number) the signal logged for the peak value. • Any parameter number in *Group 01: OPERATING DATA* can be selected. Eg 102 = parameter 0102 SPEED. 100 = NOT SELECTED – No signal (parameter) logged for the peak value. 101…178 – Logs parameter 0101…0178.
6402	**PVL FILTER TIME** Defines the filter time for peak value logging. • 0.0…120.0 – Filter time (seconds).
6403	**LOGGERS RESET** Defines the source for the reset of peak value logger and amplitude logger 2. 0 = NOT SEL – No reset selected. 1 = DI1 – Reset loggers on the rising edge of digital input DI1. 2…6 = DI2…DI6 – Reset loggers on the rising edge of digital input DI2…DI6. 7 = RESET – Reset loggers. Parameter is set to NOT SEL. -1 = DI1(INV) – Reset loggers on the falling edge of digital input DI1. -2…-6 = DI2(INV) …DI6(INV) – Reset loggers on the falling edge of digital input DI2…DI6.
6404	**AL2 SIGNAL** Defines the signal logged for amplitude logger 2. • Any parameter number in *Group 01: OPERATING DATA* can be selected. Eg 102 = parameter 0102 SPEED. 100 = NOT SELECTED – No signal (parameter) logged for amplitude distribution (amplitude logger 2). 101…178 – Logs parameter 0101…0178.
6405	**AL2 SIGNAL BASE** Defines the base value from which the percentage distribution is calculated. • Representation and default value depends on the signal selected with parameter 6404 AL2 SIGNAL.
6406	**PEAK VALUE** Detected peak value of the signal selected with parameter 6401 PVL SIGNAL.
6407	**PEAK TIME 1** Date of the peak value detection. • Format: Date if the real time clock is operating (dd.mm.yy). / The number of days elapsed after the power-on if the real time clock is not used, or was not set (xx d).
6408	**PEAK TIME 2** Time of the peak value detection. • Format: hours:minutes:seconds.

Code	Description
6409	**CURRENT AT PEAK** Current at the moment of the peak value (amperes).
6410	**UDC AT PEAK** DC voltage at the moment of the peak value (volts).
6411	**FREQ AT PEAK** Output frequency at the moment of the peak value (herzes).
6412	**TIME OF RESET 1** Last reset date of the peak logger and amplitude logger 2. • Format: Date if the real time clock is operating (dd.mm.yy). / The number of days elapsed after the power-on if the real time clock is not used, or was not set (xx d).
6413	**TIME OF RESET 2** Last reset time of the peak logger and amplitude logger 2. • Format: hours:minutes:seconds.
6414	**AL1RANGE0TO10** Amplitude logger 1 (current in percent of nominal current I_{2N}) 0…10% distribution.
6415	**AL1RANGE10TO20** Amplitude logger 1 (current in percent of nominal current I_{2N}) 10…20% distribution.
6416	**AL1RANGE20TO30** Amplitude logger 1 (current in percent of nominal current I_{2N}) 20…30% distribution.
6417	**AL1RANGE30TO40** Amplitude logger 1 (current in percent of nominal current I_{2N}) 30…40% distribution.
6418	**AL1RANGE40TO50** Amplitude logger 1 (current in percent of nominal current I_{2N}) 40…50% distribution.
6419	**AL1RANGE50TO60** Amplitude logger 1 (current in percent of nominal current I_{2N}) 50…60% distribution.
6420	**AL1RANGE60TO70** Amplitude logger 1 (current in percent of nominal current I_{2N}) 60…70% distribution.
6421	**AL1RANGE70TO80** Amplitude logger 1 (current in percent of nominal current I_{2N}) 70…80% distribution.
6422	**AL1RANGE80TO90** Amplitude logger 1 (current in percent of nominal current I_{2N}) 80…90% distribution.
6423	**AL1RANGE90TO** Amplitude logger 1 (current in percent of nominal current I_{2N}) over 90% distribution.
6424	**AL2RANGE0TO10** Amplitude logger 2 (signal selection with parameter 6404) 0…10% distribution.
6425	**AL2RANGE10TO20** Amplitude logger 2 (signal selection with parameter 6404) 10…20% distribution.
6426	**AL2RANGE20TO30** Amplitude logger 2 (signal selection with parameter 6404) 20…30% distribution.
6427	**AL2RANGE30TO40** Amplitude logger 2 (signal selection with parameter 6404) 30…40% distribution.
6428	**AL2RANGE40TO50** Amplitude logger 2 (signal selection with parameter 6404) 40…50% distribution.
6429	**AL2RANGE50TO60** Amplitude logger 2 (signal selection with parameter 6404) 50…60% distribution.
6430	**AL2RANGE60TO70** Amplitude logger 2 (signal selection with parameter 6404) 60…70% distribution.
6431	**AL2RANGE70TO80** Amplitude logger 2 (signal selection with parameter 6404) 70…80% distribution.

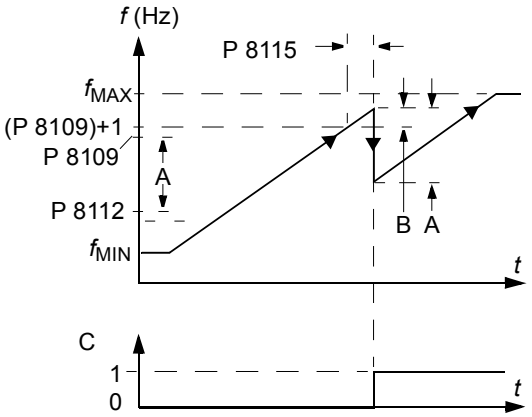
Code	Description
6432	**AL2RANGE80TO90** Amplitude logger 2 (signal selection with parameter 6404) 80…90% distribution.
6433	**AL2RANGE90TO** Amplitude logger 2 (signal selection with parameter 6404) over 90% distribution.

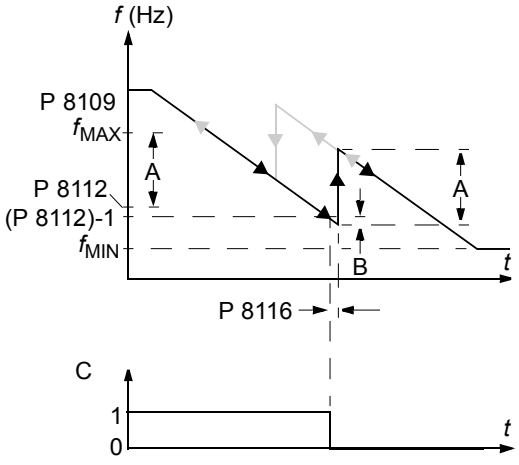
Group 81: PFC CONTROL

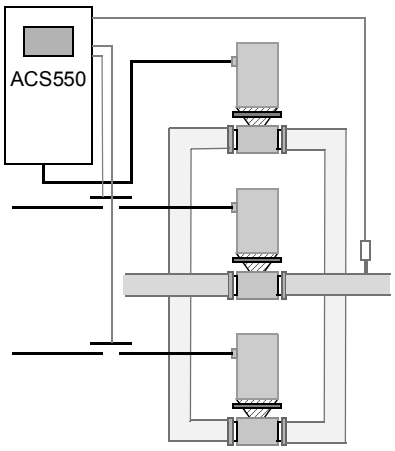
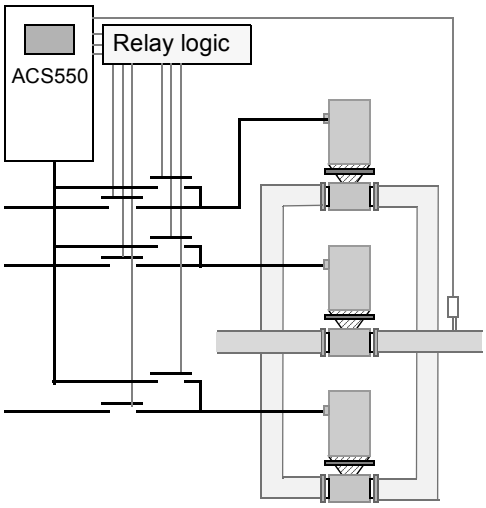
This group defines a Pump-Fan Control (PFC) mode of operation. The major features of PFC control are:

- The ACS550 controls the motor of pump no. 1, varying the motor speed to control the pump capacity. This motor is the speed regulated motor.
- Direct line connections power the motor of pump no. 2 and pump no.3, etc. The ACS550 switches pump no. 2 (and then pump no. 3, etc.) on and off as needed. These motors are auxiliary motors.
- The ACS550 PID control uses two signals: a process reference and an actual value feedback. The PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference.
- When demand (defined by the process reference) exceeds the first motor's capacity (user defined as a frequency limit), the PFC control automatically starts an auxiliary pump. The PFC also reduces the speed of the first pump to account for the auxiliary pump's addition to total output. Then, as before, the PID controller adjusts the speed (frequency) of the first pump such that the actual value follows the process reference. If demand continues to increase, PFC adds additional auxiliary pumps, using the same process.
- When demand drops, such that the first pump speed falls below a minimum limit (user defined by a frequency limit), the PFC control automatically stops an auxiliary pump. The PFC also increases the speed of the first pump to account for the auxiliary pump's missing output.
- An Interlock function (when enabled) identifies off-line (out of service) motors, and the PFC control skips to the next available motor in the sequence.
- An Autochange function (when enabled and with the appropriate switchgear) equalizes duty time between the pump motors. Autochange periodically increments the position of each motor in the rotation – the speed regulated motor becomes the last auxiliary motor, the first auxiliary motor becomes the speed regulated motor, etc.

Code	Description
8103	**REFERENCE STEP 1** Sets a percentage value that is added to the process reference. • Applies only when at least one auxiliary (constant speed) motor is running. • Default value is 0%. **Example:** An ACS550 operates three parallel pumps that maintain water pressure in a pipe. • 4011 INTERNAL SETPNT sets a constant pressure reference that controls the pressure in the pipe. • The speed regulated pump operates alone at low water consumption levels. • As water consumption increases, first one constant speed pump operates, then, the second. • As flow increases, the pressure at the output end of the pipe drops relative to the pressure measured at the input end. As auxiliary motors step in to increase the flow, the adjustments below correct the reference to more closely match the output pressure. • When the first auxiliary pump operates, increase the reference with parameter 8103 REFERENCE STEP 1. • When two auxiliary pumps operate, increase the reference with parameter 8103 REFERENCE STEP 1 + parameter 8104 REFERENCE STEP 2. • When three auxiliary pumps operate, increase the reference with parameter 8103 REFERENCE STEP 1 + parameter 8104 REFERENCE STEP 2 + parameter 8105 REFERENCE STEP 3.

Code	Description
8104	**REFERENCE STEP 2** Sets a percentage value that is added to the process reference. • Applies only when at least two auxiliary (constant speed) motors are running. • See parameter 8103 REFERENCE STEP 1.
8105	**REFERENCE STEP 3** Sets a percentage value that is added to the process reference. • Applies only when at least three auxiliary (constant speed) motors are running. • See parameter 8103 REFERENCE STEP 1.
8109	**START FREQ 1** Sets the frequency limit used to start the first auxiliary motor. The first auxiliary motor starts if: • No auxiliary motors are running. • ACS550 output frequency exceeds the limit: 8109 + 1 Hz. • Output frequency stays above a relaxed limit (8109 - 1 Hz) for at least the time: 8115 AUX MOT START D. After the first auxiliary motor starts: • Output frequency decreases by the value = (8109 START FREQ 1) - (8112 LOW FREQ 1). • In effect, the output of the speed regulated motor drops to compensate for the input from the auxiliary motor. See the figure, where: • A = (8109 START FREQ 1) - (8112 LOW FREQ 1) • B = Output frequency increase during the start delay. • C = Diagram showing auxiliary motor's run status as frequency increases (1 = On). **Note:** 8109 START FREQ 1 value must be between: • 8112 LOW FREQ 1 • (2008 MAXIMUM FREQ) -1. 
8110	**START FREQ 2** Sets the frequency limit used to start the second auxiliary motor. • See 8109 START FREQ 1 for a complete description of the operation. The second auxiliary motor starts if: • One auxiliary motor is running. • ACS550 output frequency exceeds the limit: 8110 + 1. • Output frequency stays above the relaxed limit (8110 - 1 Hz) for at least the time: 8115 AUX MOT START D.
8111	**START FREQ 3** Sets the frequency limit used to start the third auxiliary motor. • See 8109 START FREQ 1 for a complete description of the operation. The third auxiliary motor starts if: • Two auxiliary motors are running. • ACS550 output frequency exceeds the limit: 8111 + 1 Hz. • Output frequency stays above the relaxed limit (8111 - 1 Hz) for at least the time: 8115 AUX MOT START D.

Code	Description
8112	**LOW FREQ 1** Sets the frequency limit used to stop the first auxiliary motor. The first auxiliary motor stops if: • Only one (the first) auxiliary motor is running. • ACS550 output frequency drops below the limit: 8112 - 1. • Output frequency stays below the relaxed limit (8112 + 1 Hz) for at least the time: 8116 AUX MOT STOP D. After the first auxiliary motor stops: • Output frequency increases by the value = (8109 START FREQ 1) - (8112 LOW FREQ 1). • In effect, the output of the speed regulated motor increases to compensate for the loss of the auxiliary motor. See the figure, where: • A = (8109 START FREQ 1) - (8112 LOW FREQ 1) • B = Output frequency decrease during the stop delay. • C = Diagram showing auxiliary motor's run status as frequency decreases (1 = On). • Grey path = Shows hysteresis – if time is reversed, the path backwards is not the same. For details on the path for starting, see the diagram at 8109 START FREQ 1. **Note:** 8112 LOW FREQ 1 value must be between: • (2007 MINIMUM FREQ) +1. • 8109 START FREQ 1 
8113	**LOW FREQ 2** Sets the frequency limit used to stop the second auxiliary motor. • See 8112 LOW FREQ 1 for a complete description of the operation. The second auxiliary motor stops if: • Two auxiliary motors are running. • ACS550 output frequency drops below the limit: 8113 - 1. • Output frequency stays below the relaxed limit (8113 + 1 Hz) for at least the time: 8116 AUX MOT STOP D.
8114	**LOW FREQ 3** Sets the frequency limit used to stop the third auxiliary motor. • See 8112 LOW FREQ 1 for a complete description of the operation. The third auxiliary motor stops if: • Three auxiliary motors are running. • ACS550 output frequency drops below the limit: 8114 - 1. • Output frequency stays below the relaxed limit (8114 + 1 Hz) for at least the time: 8116 AUX MOT STOP D.
8115	**AUX MOT START D** Sets the Start Delay for the auxiliary motors. • The output frequency must remain above the start frequency limit (parameter 8109, 8110, or 8111) for this time period before the auxiliary motor starts. • See 8109 START FREQ 1 for a complete description of the operation.
8116	**AUX MOT STOP D** Sets the Stop Delay for the auxiliary motors. • The output frequency must remain below the low frequency limit (parameter 8112, 8113, or 8114) for this time period before the auxiliary motor stops. • See 8112 LOW FREQ 1 for a complete description of the operation.

Code	Description
8117	**NR OF AUX MOT** Sets the number of auxiliary motors. • Each auxiliary motor requires a relay output, which the drive uses to send start/stop signals. • The Autochange function, if used, requires an additional relay output for the speed regulated motor. • The following describes the set-up of the required relay outputs. **Relay outputs** As noted above, each auxiliary motor requires a relay output, which the drive uses to send start/stop signals. The following describes how the drive keeps track of motors and relays. • The ACS550 provides relay outputs RO1…RO3. • An external digital output module (OREL-01) can be added to provide relay outputs RO4…RO6. • Parameters 1401…1403 and 1410…1412 define, respectively, how relays RO1…RO6 are used – the parameter value 31 PFC defines the relay as used for PFC. • The ACS550 assigns auxiliary motors to relays in ascending order. If the Autochange function is disabled, the first auxiliary motor is the one connected to the first relay with a parameter setting = 31 PFC, and so on. If the Autochange function is used, the assignments rotate. Initially, the speed regulated motor is the one connected to the first relay with a parameter setting = 31 PFC, the first auxiliary motor is the one connected to the second relay with a parameter setting = 31 PFC, and so on.  Standard PFC mode  PFC with Autochange mode • The fourth auxiliary motor uses the same reference step, low frequency and start frequency values as the third auxiliary motor.

Code **Description**

- The table below shows the ACS550 PFC motor assignments for some typical settings in the Relay Output parameters (1401…1403 and 1410…1412), where the settings are either =31 (PFC), or =X (anything but 31), and where the Autochange function is disabled (8118 AUTOCHNG INTERV = 0.0).

Parameter setting							ACS550 Relay assignment					
							Autochange disabled					
1401	1402	1403	1410	1411	1412	8117	RO1	RO2	RO3	RO4	RO5	RO6
31	X	X	X	X	X	1	Aux.	X	X	X	X	X
31	31	X	X	X	X	2	Aux.	Aux.	X	X	X	X
31	31	31	X	X	X	3	Aux.	Aux.	Aux.	X	X	X
X	31	31	X	X	X	2	X	Aux.	Aux.	X	X	X
X	X	X	31	X	31	2	X	X	X	Aux.	X	Aux.
31	31	X	X	X	X	1*	Aux.	Aux.	X	X	X	X

* = One additional relay output for the PFC that is in use. One motor is in "sleep" when the other is rotating.

- The table below shows the ACS550 PFC motor assignments for some typical settings in the Relay Output parameters (1401…1403 and 1410…1412), where the settings are either =31 (PFC), or =X (anything but 31), and where the Autochange function is enabled (8118 AUTOCHNG INTERV = value > 0.0).

Parameter setting							ACS550 Relay assignment					
							Autochange enabled					
1401	1402	1403	1410	1411	1412	8117	RO1	RO2	RO3	RO4	RO5	RO6
31	31	X	X	X	X	1	PFC	PFC	X	X	X	X
31	31	31	X	X	X	2	PFC	PFC	PFC	X	X	X
X	31	31	X	X	X	1	X	PFC	PFC	X	X	X
X	X	X	31	X	31	1	X	X	X	PFC	X	PFC
31	31	X	X	X	X	0**	PFC	PFC	X	X	X	X

** = No auxiliary motors, but the autochange function is in use. Working as a standard PID-control.

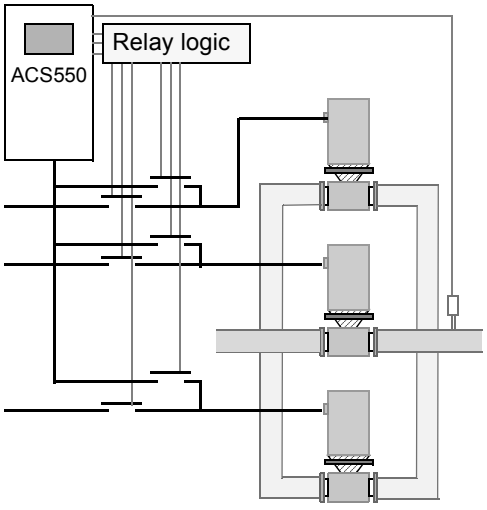
8118 **AUTOCHNG INTERV**

Controls operation of the Autochange function and sets the interval between changes.

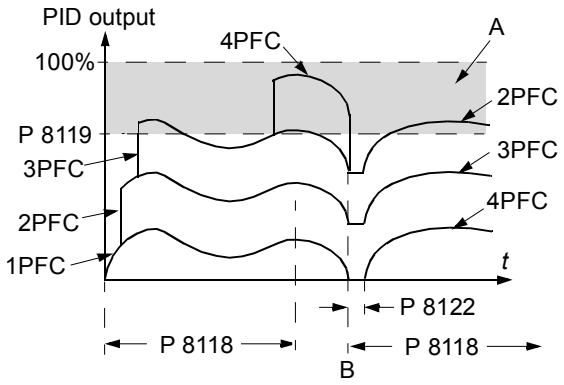
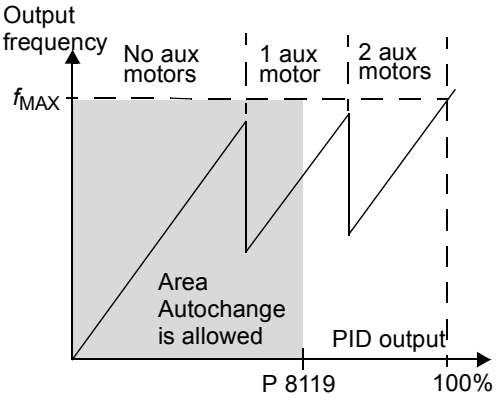
- The Autochange time interval only applies to the time when the speed regulated motor is running.
- See parameter 8119 AUTOCHNG LEVEL for an overview of the Autochange function.
- The drive always coasts to stop when autochange is performed.
- Autochange enabled requires parameter 8120 INTERLOCKS = value > 0.

-0.1 = TEST MODE – Forces the interval to value 36…48 s.
0.0 = NOT SEL – Disables the Autochange function.
0.1…336 – The operating time interval (the time when the start signal is on) between automatic motor changes.

WARNING! When enabled, the Autochange function requires the interlocks (8120 INTERLOCKS = value > 0) enabled. During autochange the power output is interrupted and the drive coasts to stop, preventing damage to the contacts.



PFC with Autochange mode

Code	Description
8119	**AUTOCHNG LEVEL** Sets an upper limit, as a percent of output capacity, for the autochange logic. When the output from the PID/PFC control block exceeds this limit, autochange is prevented. For example, use this parameter to deny autochange when the Pump-Fan system is operating near maximum capacity. **Autochange overview** The purpose of the autochange operation is to equalize duty time between multiple motors used in a system. At each autochange operation: • A different motor takes a turn connected to the ACS550 output – the speed regulated motor. • The starting order of the other motors rotates. The Autochange function requires: • External switchgear for changing the drive's output power connections. • Parameter 8120 INTERLOCKS = value > 0. Autochange is performed when: • The running time since the previous autochange reaches the time set by 8118 AUTOCHNG INTERV. • The PFC input is below the level set by this parameter, 8119 AUTOCHNG LEVEL. **Note:** The ACS550 always coasts to stop when autochange is performed. In an autochange, the Autochange function does all of the following (see the figure): • Initiates a change when the running time, since the last autochange, reaches 8118 AUTOCHNG INTERV, and PFC input is below limit 8119 AUTOCHNG LEVEL. • Stops the speed regulated motor. • Switches off the contactor of the speed regulated motor. • Increments the starting order counter, to change the starting order for the motors. • Identifies the next motor in line to be the speed regulated motor. • Switches off the above motor's contactor, if the motor was running. Any other running motors are not interrupted. • Switches on the contactor of the new speed regulated motor. The autochange switchgear connects this motor to the ACS550 power output. • Delays motor start for the time 8122 PFC START DELAY. • Starts the speed regulated motor. • Identifies the next constant speed motor in the rotation. • Switches the above motor on, but only if the new speed regulated motor had been running (as a constant speed motor) – This step keeps an equal number of motors running before and after autochange. • Continues with normal PFC operation.  A = Area above 8119 AUTOCHNG LEVEL – autochange not allowed. B = Autochange occurs. 1PFC, etc. = PID output associated with each motor. **Starting order counter** The operation of the starting-order counter: • The relay output parameter definitions (1401…1403 and 1410…1412) establish the initial motor sequence. (The lowest parameter number with a value 31 (PFC) identifies the relay connected to 1PFC, the first motor, and so on.) • Initially, 1PFC = speed regulated motor, 2PFC = 1st auxiliary motor, etc. • The first autochange shifts the sequence to: 2PFC = speed regulated motor, 3PFC = 1st auxiliary motor, …, 1PFC = last auxiliary motor. • The next autochange shifts the sequence again, and so on. • If the autochange cannot start a needed motor because all inactive motors are interlocked, the drive displays an alarm (2015, PFC I LOCK).  • When ACS550 power supply is switched off, the counter preserves the current Autochange rotation positions in permanent memory. When power is restored, the Autochange rotation starts at the position stored in memory. • If the PFC relay configuration is changed (or if the PFC enable value is changed), the rotation is reset. (See the first bullet above.)

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>8120</td><td>
INTERLOCKS
Defines operation of the Interlock function. When the Interlock function is enabled:
• An interlock is active when its command signal is absent.
• An interlock is inactive when its command signal is present.
• The ACS550 will not start if a start command occurs when the speed regulated motor's interlock is active – the control panel displays an alarm (2015, PFC I LOCK).
Wire each Interlock circuit as follows:
• Wire a contact of the motor's On/Off switch to the Interlock circuit – the drive's PFC logic can then recognize that the motor is switched off and start the next available motor.
• Wire a contact of the motor thermal relay (or other protective device in the motor circuit) to the Interlock input – the drive's PFC logic can then recognize that a motor fault is activated and stop the motor.
0 = NOT SEL – Disables the Interlock function. All digital inputs are available for other purposes.
• Requires 8118 AUTOCHNG INTERV = 0.0 (The Autochange function must be disabled if Interlock function is disabled.)
1 = DI1 – Enables the Interlock function and assigns a digital input (starting with DI1) to the interlock signal for each PFC relay. These assignments are defined in the following table and depend on:
• the number of PFC relays [number of parameters 1401…1403 and 1410…1412 with value = 31 (PFC)]
• the Autochange function status (disabled if 8118 AUTOCHNG INTERV = 0.0, and otherwise enabled).
<table>
<tr><th>No. PFC relays</th><th>Autochange disabled (P 8118)</th><th>Autochange enabled (P 8118)</th></tr>
<tr><td>0</td><td>DI1: Speed Reg Motor
DI2…DI6: Free</td><td>Not allowed</td></tr>
<tr><td>1</td><td>DI1: Speed Reg Motor
DI2: First PFC Relay
DI3…DI6: Free</td><td>DI1: First PFC Relay
DI2…DI6: Free</td></tr>
<tr><td>2</td><td>DI1: Speed Reg Motor
DI2: First PFC Relay
DI3: Second PFC Relay
DI4…DI6: Free</td><td>DI1: First PFC Relay
DI2: Second PFC Relay
DI3…DI6: Free</td></tr>
<tr><td>3</td><td>DI1: Speed Reg Motor
DI2: First PFC Relay
DI3: Second PFC Relay
DI4: Third PFC Relay
DI5…DI6: Free</td><td>DI1: First PFC Relay
DI2: Second PFC Relay
DI3: Third PFC Relay
DI4…DI6: Free</td></tr>
<tr><td>4</td><td>DI1: Speed Reg Motor
DI2: First PFC Relay
DI3: Second PFC Relay
DI4: Third PFC Relay
DI5: Fourth PFC Relay
DI6: Free</td><td>DI1: First PFC Relay
DI2: Second PFC Relay
DI3: Third PFC Relay
DI4: Fourth PFC Relay
DI5…DI6: Free</td></tr>
<tr><td>5</td><td>DI1: Speed Reg Motor
DI2: First PFC Relay
DI3: Second PFC Relay
DI4: Third PFC Relay
DI5: Fourth PFC Relay
DI6: Fifth PFC Relay</td><td>DI1: First PFC Relay
DI2: Second PFC Relay
DI3: Third PFC Relay
DI4: Fourth PFC Relay
DI5: Fifth PFC Relay
DI6: Free</td></tr>
<tr><td>6</td><td>Not allowed</td><td>DI1: First PFC Relay
DI2: Second PFC Relay
DI3: Third PFC Relay
DI4: Fourth PFC Relay
DI5: Fifth PFC Relay
DI6: Sixth PFC Relay</td></tr>
</table>
</td></tr>
</table>

Code	Description
	2 = DI2 – Enables the Interlock function and assigns a digital input (starting with DI2) to the interlock signal for each PFC relay. These assignments are defined in the following table and depend on: • the number of PFC relays [number of parameters 1401…1403 and 1410…1412 with value = 31 (PFC)] • the Autochange function status (disabled if 8118 AUTOCHNG INTERV = 0.0, and otherwise enabled).

No. PFC relays	Autochange disabled (P 8118)	Autochange enabled (P 8118)
0	DI1: Free DI2: Speed Reg Motor DI3…DI6: Free	Not allowed
1	DI1: Free DI2: Speed Reg Motor DI3: First PFC Relay DI4…DI6: Free	DI1: Free DI2: First PFC Relay DI3…DI6: Free
2	DI1: Free DI2: Speed Reg Motor DI3: First PFC Relay DI4: Second PFC Relay DI5…DI6: Free	DI1: Free DI2: First PFC Relay DI3: Second PFC Relay DI4…DI6: Free
3	DI1: Free DI2: Speed Reg Motor DI3: First PFC Relay DI4: Second PFC Relay DI5: Third PFC Relay DI6: Free	DI1: Free DI2: First PFC Relay DI3: Second PFC Relay DI4: Third PFC Relay DI5…DI6: Free
4	DI1: Free DI2: Speed Reg Motor DI3: First PFC Relay DI4: Second PFC Relay DI5: Third PFC Relay DI6: Fourth PFC Relay	DI1: Free DI2: First PFC Relay DI3: Second PFC Relay DI4: Third PFC Relay DI5: Fourth PFC Relay DI6: Free
5	Not allowed	DI1: Free DI2: First PFC Relay DI3: Second PFC Relay DI4: Third PFC Relay DI5: Fourth PFC Relay DI6: Fifth PFC Relay
6	Not allowed	Not allowed

Code | **Description**

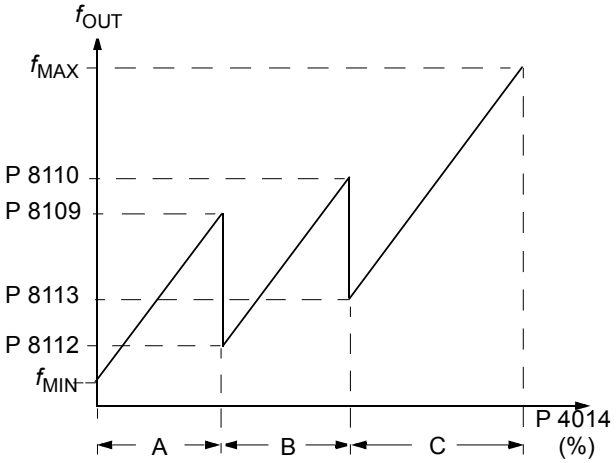
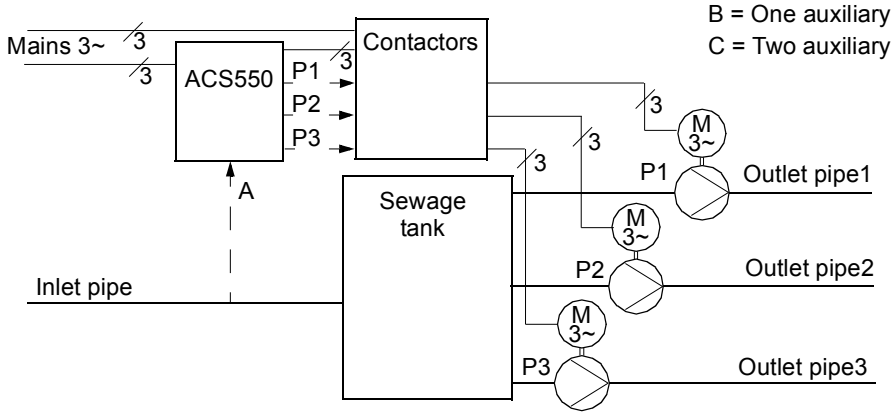
3 = DI3 – Enables the Interlocks function and assigns a digital input (starting with DI3) to the interlock signal for each PFC relay. These assignments are defined in the following table and depend on:
• the number of PFC relays [number of parameters 1401…1403 and 1410…1412 with value = 31 (PFC)]
• the Autochange function status (disabled if 8118 AUTOCHNG INTERV = 0.0, and otherwise enabled).

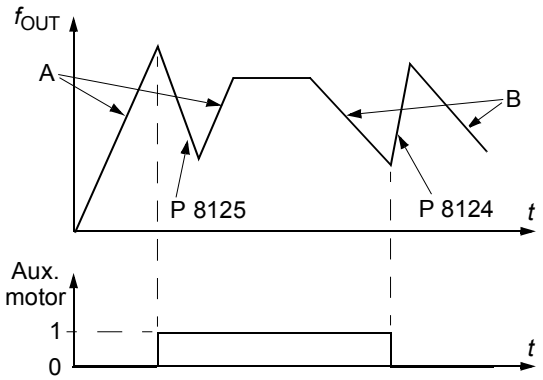
No. PFC relays	Autochange disabled (P 8118)	Autochange enabled (P 8118)
0	DI1…DI2: Free DI3: Speed Reg Motor DI4…DI6: Free	Not allowed
1	DI1…DI2: Free DI3: Speed Reg Motor DI4: First PFC Relay DI5…DI6: Free	DI1…DI2: Free DI3: First PFC Relay DI4…DI6: Free
2	DI1…DI2: Free DI3: Speed Reg Motor DI4: First PFC Relay DI5: Second PFC Relay DI6: Free	DI1…DI2: Free DI3: First PFC Relay DI4: Second PFC Relay DI5…DI6: Free
3	DI1…DI2: Free DI3: Speed Reg Motor DI4: First PFC Relay DI5: Second PFC Relay DI6: Third PFC Relay	DI1…DI2: Free DI3: First PFC Relay DI4: Second PFC Relay DI5: Third PFC Relay DI6: Free
4	Not allowed	DI1…DI2: Free DI3: First PFC Relay DI4: Second PFC Relay DI5: Third PFC Relay DI6: Fourth PFC Relay
5…6	Not allowed	Not allowed

4 = DI4 – Enables the Interlock function and assigns a digital input (starting with DI4) to the interlock signal for each PFC relay. These assignments are defined in the following table and depend on:
• the number of PFC relays [number of parameters 1401…1403 and 1410…1412 with value = 31 (PFC)]
• the Autochange function status (disabled if 8118 AUTOCHNG INTERV = 0.0, and otherwise enabled).

No. PFC relays	Autochange disabled (P 8118)	Autochange enabled (P 8118)
0	DI1…DI3: Free DI4: Speed Reg Motor DI5…DI6: Free	Not allowed
1	DI1…DI3: Free DI4: Speed Reg Motor DI5: First PFC Relay DI6: Free	DI1…DI3: Free DI4: First PFC Relay DI5…DI6: Free
2	DI1…DI3: Free DI4: Speed Reg Motor DI5: First PFC Relay DI6: Second PFC Relay	DI1…DI3: Free DI4: First PFC Relay DI5: Second PFC Relay DI6: Free
3	Not allowed	DI1…DI3: Free DI4: First PFC Relay DI5: Second PFC Relay DI6: Third PFC Relay
4…6	Not allowed	Not allowed

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
5 = DI5 – Enables the Interlock function and assigns a digital input (starting with DI5) to the interlock signal for each PFC relay. These assignments are defined in the following table and depend on:
• the number of PFC relays [number of parameters 1401…1403 and 1410…1412 with value = 31 (PFC)]
• the Autochange function status (disabled if 8118 AUTOCHNG INTERV = 0.0, and otherwise enabled).
<table>
<tr><th>No. PFC relays</th><th>Autochange disabled (P 8118)</th><th>Autochange enabled (P 8118)</th></tr>
<tr><td>0</td><td>DI1…DI4: Free
DI5: Speed Reg Motor
DI6: Free</td><td>Not allowed</td></tr>
<tr><td>1</td><td>DI1…DI4: Free
DI5: Speed Reg Motor
DI6: First PFC Relay</td><td>DI1…DI4: Free
DI5: First PFC Relay
DI6: Free</td></tr>
<tr><td>2</td><td>Not allowed</td><td>DI1…DI4: Free
DI5: First PFC Relay
DI6: Second PFC Relay</td></tr>
<tr><td>3…6</td><td>Not allowed</td><td>Not allowed</td></tr>
</table>
6 = DI6 – Enables the Interlock function and assigns digital input DI6 to the interlock signal for the speed regulated motor.
• Requires 8118 AUTOCHNG INTERV = 0.0.
<table>
<tr><th>No. PFC relays</th><th>Autochange disabled</th><th>Autochange enabled</th></tr>
<tr><td>0</td><td>DI1…DI5: Free
DI6: Speed Reg Motor</td><td>Not allowed</td></tr>
<tr><td>1</td><td>Not allowed</td><td>DI1…DI5: Free
DI6: First PFC Relay</td></tr>
<tr><td>2…6</td><td>Not allowed</td><td>Not allowed</td></tr>
</table>
</td></tr>
</table>

Code	Description
8121	**REG BYPASS CTRL** Selects Regulator by-pass control. When enabled, Regulator by-pass control provides a simple control mechanism without a PID regulator. • Use Regulator by-pass control only in special applications. 0 = NO – Disables Regulator by-pass control. The drive uses the normal PFC reference: 1106 REF2 SELECT. 1 = YES – Enables Regulator by-pass control. • The process PID regulator is bypassed. Actual value of PID is used as the PFC reference (input). Normally EXT REF2 is used as the PFC reference. • The drive uses the feedback signal defined by 4014 FBK SEL (or 4114) for the PFC frequency reference. • The figure shows the relation between the control signal 4014 FBK SEL (OR 4114) and the speed regulated motor's frequency in a three-motor system. **Example:** In the diagram below, the pumping station's outlet flow is controlled by the measured inlet flow (A).  A = No auxiliary motors running B = One auxiliary motor running C = Two auxiliary motors running 
8122	**PFC START DELAY** Sets the start delay for speed regulated motors in the system. Using the delay, the drive works as follows: • Switches on the contactor of the speed regulated motor – connecting the motor to the ACS550 power output. • Delays motor start for the time 8122 PFC START DELAY. • Starts the speed regulated motor. • Starts auxiliary motors. See parameter 8115 for delay. **WARNING!** Motors equipped with star-delta starters require a PFC Start Delay. • After the ACS550 relay output switches a motor on, the star-delta starter must switch to the star-connection and then back to the delta-connection before the drive applies power. • So, the PFC Start Delay must be longer than the time setting of the star-delta starter.
8123	**PFC ENABLE** Selects PFC control. When enabled, PFC control: • Switches in, or out, auxiliary constant speed motors as output demand increases or decreases. Parameters 8109 START FREQ 1 to 8114 LOW FREQ 3 define the switch points in terms of the drive output frequency. • Adjusts the speed regulated motor output down, as auxiliary motors are added, and adjusts the speed regulated motor output up, as auxiliary motors are taken off line. • Provides Interlock functions, if enabled. • Requires 9904 MOTOR CTRL MODE = 3 (SCALAR:FREQ). 0 = NOT SEL – Disables PFC control. 1 = ACTIVE – Enables PFC control.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>8124</td><td>ACC IN AUX STOP
Sets the PFC acceleration time for a zero-to-maximum frequency ramp. This PFC acceleration ramp:
• Applies to the speed regulated motor, when an auxiliary motor is switched off.
• Replaces the acceleration ramp defined in Group 22: ACCEL/DECEL.
• Applies only until the output of the regulated motor increases by an amount equal to the output of the switched off auxiliary motor. Then the acceleration ramp defined in Group 22: ACCEL/DECEL applies.
0 = NOT SEL.
0.1…1800 – Activates this function using the value entered as the acceleration time.</td></tr>
<tr><td>8125</td><td>DEC IN AUX START
Sets the PFC deceleration time for a maximum-to-zero frequency ramp. This PFC deceleration ramp:
• Applies to the speed regulated motor, when an auxiliary motor is switched on.
• Replaces the deceleration ramp defined in Group 22: ACCEL/DECEL.
• Applies only until the output of the regulated motor decreases by an amount equal to the output of the auxiliary motor. Then the deceleration ramp defined in Group 22: ACCEL/DECEL applies.
0 = NOT SEL.
0.1…1800 – Activates this function using the value entered as the deceleration time.</td></tr>
<tr><td colspan="2"> 

• A = speed regulated motor accelerating using Group 22: ACCEL/DECEL parameters (2202 or 2205).
• B = speed regulated motor decelerating using Group 22: ACCEL/DECEL parameters (2203 or 2206).
• At aux. motor start, speed regulated motor decelerates using 8125 DEC IN AUX START.
• At aux. motor stop, speed regulated motor accelerates using 8124 ACC IN AUX STOP.</td></tr>
<tr><td>8126</td><td colspan="2">TIMED AUTOCHNG
Sets the autochange using a Timed function. See parameter 8119 AUTOCHNG LEVEL.
0 = NOT SEL.
1 = TIMED FUNC 1 – Enables autochange when Timed function 1 is active.
2…4 = TIMED FUNC 2…4 – Enables autochange when Timed function 2…4 is active.</td></tr>
<tr><td>8127</td><td colspan="2">MOTORS
Sets the actual number of PFC controlled motors (maximum 7 motors, 1 speed regulated, 3 connected direct-on-line and 3 spare motors).
• This value includes also the speed regulated motor.
• This value must be compatible with the number of relays allocated to PFC if the Autochange function is used.
• If Autochange function is not used, the speed regulated motor does not need to have a relay output allocated to PFC but it needs to be included in this value.</td></tr>
<tr><td>8128</td><td colspan="2">AUX START ORDER
Sets the start order of the auxiliary motors.
1 = EVEN RUNTIME – Time sharing is active. Evens out the cumulative run time of the auxiliary motors. The start order depends on the run time: The auxiliary motor whose cumulative run time is shortest is started first, then the motor whose cumulative run time is the second shortest etc. When the demand drops, the first motor to be stopped is the one whose cumulative run time is longest.
2 = RELAY ORDER – The start order is fixed to be the order of the relays.</td></tr>
</table>

Group 98: OPTIONS

This group configures for options, in particular, enabling serial communication with the drive.

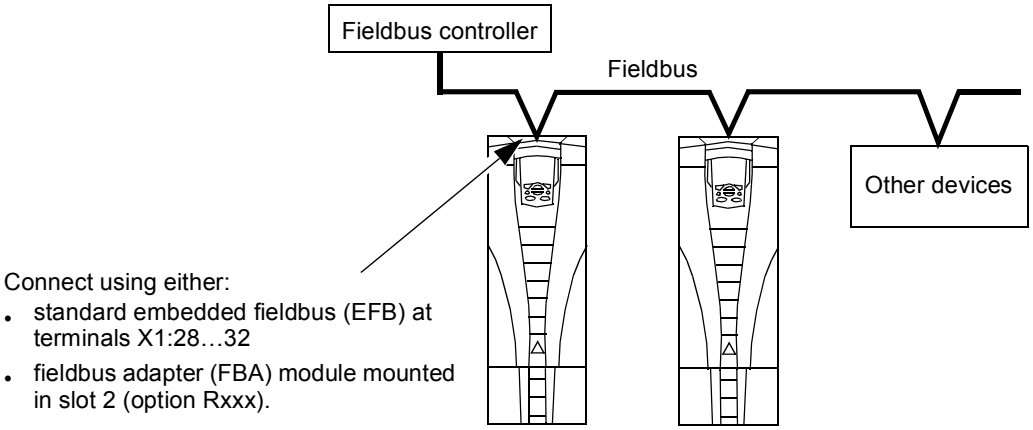
Code	Description
9802	**COMM PROT SEL** Selects the communication protocol. 0 = NOT SEL – No communication protocol selected. 1 = STD MODBUS – The drive communicates with Modbus via the RS485 channel (X1-communications, terminal). • See also *Group 53: EFB PROTOCOL*. 4 = EXT FBA – The drive communicates via a fieldbus adapter module in option slot 2 of the drive. • See also *Group 51: EXT COMM MODULE*.

Embedded fieldbus

Overview

The ACS550 can be set up to accept control from an external system using standard serial communication protocols. When using serial communication, the ACS550 can either:

- receive all of its control information from the fieldbus, or
- be controlled from some combination of fieldbus control and other available control locations, such as digital or analog inputs and the control panel.



Two basic serial communications configurations are available:

- embedded fieldbus (EFB) – Using the RS485 interface at terminals X1:28…32 on the control board, a control system can communicate with the drive using the Modbus® protocol. (For protocol and profile descriptions, see sections *Modbus protocol technical data* and *ABB control profiles technical data* later in this chapter.)
- fieldbus adapter (FBA) – See chapter *Fieldbus adapter* on page *237*.

Control interface

In general, the basic control interface between Modbus and the drive consists of:

- Output words
  - Control Word
  - Reference1
  - Reference2
- Input words
  - Status Word
  - Actual value 1
  - Actual value 2

– Actual value 3
– Actual value 4
– Actual value 5
– Actual value 6
– Actual value 7
– Actual value 8

The content of these words is defined by profiles. For details on the profiles used, sees section *ABB control profiles technical data* on page *224*.

Note: The words "output" and "input" are used as seen from the fieldbus controller point of view. For example an output describes data flow from the fieldbus controller to the drive and appears as an input from the drive point of view.

Planning

Network planning should address the following questions:

- What types and quantities of devices must be connected to the network?
- What control information must be sent down to the drives?
- What feedback information must be sent from the drives to the controlling system?

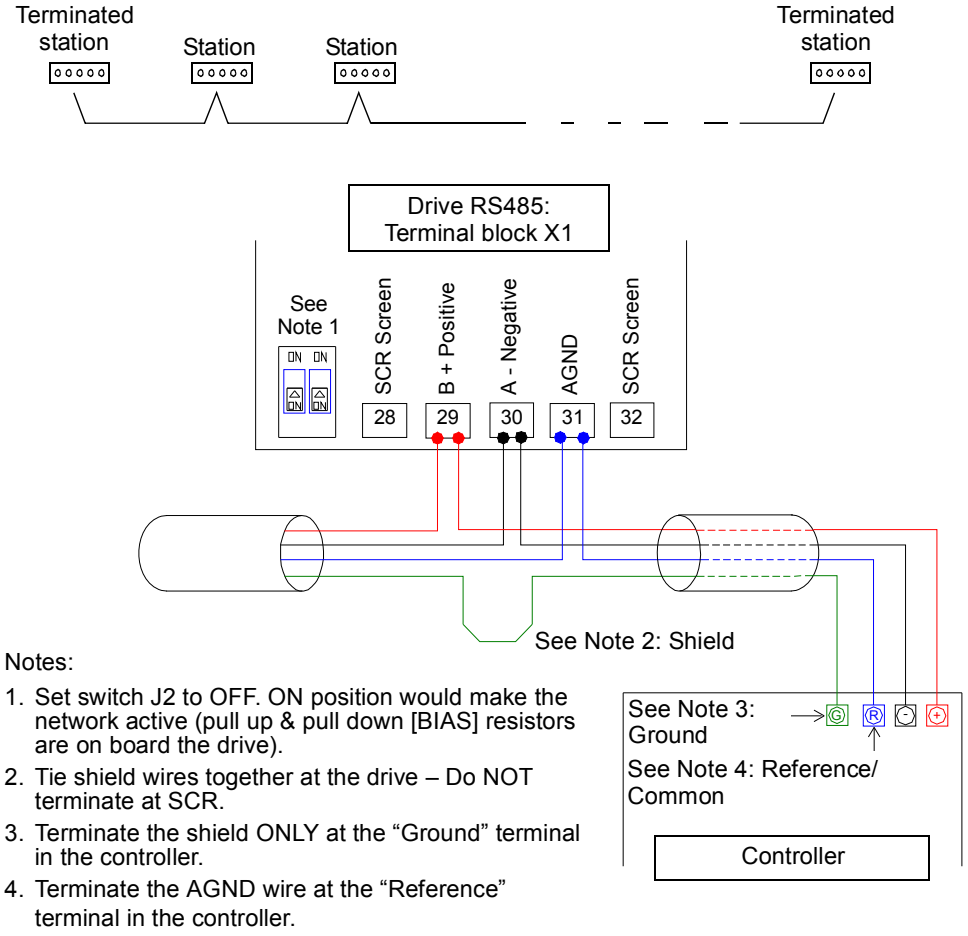
Mechanical and electrical installation – EFB

WARNING! Connections should be made only while the drive is disconnected from the power source.

Drive terminals 28...32 are for RS485 communications.

- Use Belden 9842 or equivalent. Belden 9842 is a dual twisted, shielded pair cable with a wave impedance of 120 ohm.
- Use one of these twisted shielded pairs for the RS485 link. Use this pair to connect all A (-) terminals together and all B (+) terminals together.
- Use one of the wires in the other pair for the logical ground (terminal 31), leaving one wire unused.
- Do not directly ground the RS485 network at any point. Ground all devices on the network using their corresponding earthing terminals.
- As always, the grounding wires should not form any closed loops, and all the devices should be earthed to a common ground.
- Connect the RS485 link in a daisy-chained bus, without dropout lines.

- To reduce noise on the network, terminate the RS485 network using 120 Ω resistors at both ends of the network. Use the DIP switch to connect or disconnect the termination resistors. See the following diagram.



Notes:

1. Set switch J2 to OFF. ON position would make the network active (pull up & pull down [BIAS] resistors are on board the drive).
2. Tie shield wires together at the drive – Do NOT terminate at SCR.
3. Terminate the shield ONLY at the "Ground" terminal in the controller.
4. Terminate the AGND wire at the "Reference" terminal in the controller.

- For configuration information see the following sections:
  - *Communication set-up – EFB* on page *205*
  - *Activate drive control functions – EFB* on page *207*
  - The appropriate EFB protocol specific technical data. For example, *Modbus protocol technical data* on page *215*.

Communication set-up – EFB

Serial communication selection

To activate the serial communication, set parameter 9802 COMM PROT SEL = 1 (STD MODBUS).

Note: If you cannot see the desired selection on the panel, your drive does not have that protocol software in the application memory.

Serial communication configuration

Setting 9802 automatically sets the appropriate default values in parameters that define the communication process. These parameters and descriptions are defined below. In particular, note that the station Id may require adjustment.

Code	Description	Protocol reference
		Modbus
5301	EFB PROTOCOL ID Contains the identification and program revision of the protocol.	Do not edit. Any non-zero value entered for parameter 9802 COMM PROT SEL, sets this parameter automatically. The format is: XXYY, where XX = protocol ID, and YY = program revision.
5302	EFB STATION ID Defines the node address of the RS485 link. **Note:** For a new address to take affect, the drive power must be cycled **or** 5302 must first be set to 0 before selecting a new address. Leaving 5302 = 0 places the RS485 channel in reset, disabling communication.	Set each drive on the network with a unique value for this parameter. When this protocol is selected, the default value for this parameter is: 1
5303	EFB BAUD RATE Defines the communication speed of the RS485 link in kbits per second (kbits/s). 1.2 kb/s 19.2 kb/s 2.4 kb/s 38.4 kb/s 4.8 kb/s 57.6 kb/s 9.6 kb/s 76.8 kb/s	When this protocol is selected, the default value for this parameter is: 9.6
5304	EFB PARITY Defines the data length, parity and stop bits to be used with the RS485 communication. • The same settings must be used in all on-line stations. 0 = 8 NONE 1 – 8 data bits, no parity, one stop bit. 1 = 8 NONE 2 – 8 data bits, no parity, two stop bits. 2 = 8 EVEN 1 – 8 data bits, even parity, one stop bit. 3 = 8 ODD 1 – 8 data bits, odd parity, one stop bit.	When this protocol is selected, the default value for this parameter is: 1
5305	EFB CTRL PROFILE Selects the communication profile used by the EFB protocol. 0 = ABB DRV LIM – Operation of Control/Status Words conforms to ABB Drives Profile, as used in ACS400. 1 = DCU PROFILE – Operation of Control/Status Words conforms to 32-bit DCU Profile. 2 = ABB DRV FULL – Operation of Control/Status Words conforms to ABB Drives Profile, as used in ACS600/800.	When this protocol is selected, the default value for this parameter is: 0

Note: After any changes to the communication settings, the protocol must be reactivated by either cycling the drive power, or by clearing and then restoring the station Id (5302).

Activate drive control functions – EFB

Controlling the drive

Fieldbus control of various drive functions requires configuration to:

- tell the drive to accept fieldbus control of the function
- define as a fieldbus input, any drive data required for control
- define as a fieldbus output, any control data required by the drive.

The following sections describe, at a general level, the configuration required for each control function. For the protocol-specific details, see the document supplied with the FBA module.

Start/Stop Direction control

Using the fieldbus for start/stop/direction control of the drive requires:

- drive parameter values set as defined below
- fieldbus controller supplied command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Modbus[1] protocol reference	
				ABB DRV	DCU PROFILE
1001	EXT1 COMMANDS	10 (COMM)	Start/Stop by fieldbus with Ext1 selected.	40001 bits 0…3	40031 bits 0, 1
1002	EXT2 COMMANDS	10 (COMM)	Start/Stop by fieldbus with Ext2 selected.	40001 bits 0…3	40031 bits 0, 1
1003	DIRECTION	3 (REQUEST)	Direction by fieldbus.	4002/4003[2]	40031 bit 3

[1] For Modbus, the protocol reference can depend on the profile used, hence two columns in these tables. One column refers to the ABB Drives profile, selected when parameter 5305 = 0 (ABB DRV LIM) or 5305 = 2 (ABB DRV FULL). The other column refers to the DCU profile selected when parameter 5305 = 1 (DCU PROFILE). See section *ABB control profiles technical data* on page *224*.

[2] The reference provides direction control – a negative reference provides reverse rotation.

Input reference select

Using the fieldbus to provide input references to the drive requires:

- drive parameter values set as defined below
- fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Modbus protocol reference	
				ABB DRV	DCU PROFILE
1102	EXT1/EXT2 SEL	8 (COMM)	Reference set selection by fieldbus.	40001 bit 11	40031 bit 5
1103	REF1 SELECT	8 (COMM)	Input reference 1 by fieldbus.	40002	
1106	REF2 SELECT	8 (COMM)	Input reference 2 by fieldbus.	40003	

Reference Scaling

Where required, REFERENCES can be scaled. See the following, as appropriate:

- Modbus Register *40002* in section *Modbus protocol technical data* on page *215*
- *Reference scaling* in section *ABB control profiles technical data* on page *224*.

Miscellaneous drive control

Using the fieldbus for miscellaneous drive control requires:

- drive parameter values set as defined below
- fieldbus controller supplied command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Modbus protocol reference	
				ABB DRV	DCU PROFILE
1601	RUN ENABLE	7 (COMM)	Run enable by fieldbus.	40001 bit 3	40031 bit 6 (inverted)
1604	FAULT RESET SEL	8 (COMM)	Fault reset by fieldbus.	40001 bit 7	40031 bit 4
1606	LOCAL LOCK	8 (COMM)	Source for local lock selection is the fieldbus.	Does not apply	40031 bit 14
1607	PARAM SAVE	1 (SAVE)	Saves altered parameters to memory (then value returns to 0).	41607	
1608	START ENABLE 1	7 (COMM)	Source for start enable 1 is the fieldbus Command word.	Does not apply.	40032 bit 2
1609	START ENABLE 2	7 (COMM)	Source for start enable 2 is the fieldbus Command word.		40032 bit 3
2013	MIN TORQUE SEL	7 (COMM)	Source for minimum torque selection is the fieldbus.		40031 bit 15
2014	MAX TORQUE SEL	7 (COMM)	Source for maximum torque selection is the fieldbus.		
2201	ACC/DEC 1/2 SEL	7 (COMM)	Source for ramp pair selection is the fieldbus.		40031 bit 10

Relay output control

Using the fieldbus for relay output control requires:

- drive parameter values set as defined below
- fieldbus controller supplied, binary coded, relay command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Modbus protocol reference	
				ABB DRV	DCU PROFILE
1401	RELAY OUTPUT 1	35 (COMM)	Relay Output 1 controlled by fieldbus.	40134 bit 0 or 00033	
1402	RELAY OUTPUT 2	35 (COMM)	Relay Output 2 controlled by fieldbus.	40134 bit 1 or 00034	
1403	RELAY OUTPUT 3	35 (COMM)	Relay Output 3 controlled by fieldbus.	40134 bit 2 or 00035	
1410[1]	RELAY OUTPUT 4	35 (COMM)	Relay Output 4 controlled by fieldbus.	40134 bit 3 or 00036	
1411[1]	RELAY OUTPUT 5	35 (COMM)	Relay Output 5 controlled by fieldbus.	40134 bit 4 or 00037	
1412[1]	RELAY OUTPUT 6	35 (COMM)	Relay Output 6 controlled by fieldbus.	40134 bit 5 or 00038	

[1] More than 3 relays requires the addition of a relay extension module.

Note: Relay status feedback occurs without configuration as defined below.

Drive parameter		Description	Modbus protocol reference	
			ABB DRV	DCU PROFILE
0122	RO 1-3 STATUS	Relay 1…3 status.	40122	
0123	RO 4-6 STATUS	Relay 4…6 status.	40123	

Analog output control

Using the fieldbus for analog output control (e.g. PID setpoint) requires:

- drive parameter values set as defined below
- fieldbus controller supplied analog value(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Modbus protocol reference	
				ABB DRV	DCU PROFILE
1501	AO1 CONTENT SEL	135 (COMM VALUE 1)	Analog Output 1 controlled by writing to parameter 0135.	–	
0135	COMM VALUE 1	–		40135	
1507	AO2 CONTENT SEL	136 (COMM VALUE 2)	Analog Output 2 controlled by writing to parameter 0136.	–	
0136	COMM VALUE 2	–		40136	

PID control setpoint source

Using the following settings to select the fieldbus as the setpoint source for PID loops:

Drive parameter		Value	Description	Modbus protocol reference	
				ABB DRV	DCU PROFILE
4010	SET POINT SEL (Set 1)	8 (COMM VALUE 1) 9 (COMM+AI1) 10 (COMM*AI1)	Setpoint is input reference 2 (+/-/* AI1)	40003	
4110	SET POINT SEL (Set 2)				
4210	SET POINT SEL (Ext/Trim)				

Communication fault

When using fieldbus control, specify the drive's action if serial communication is lost.

Drive parameter		Value	Description
3018	COMM FAULT FUNC	0 (NOT SEL) 1 (FAULT) 2 (CONST SP7) 3 (LAST SPEED)	Set for appropriate drive response.
3019	COMM FAULT TIME	Set time delay before acting on a communication loss.	

Feedback from the drive – EFB

Pre-defined feedback

Inputs to the controller (drive outputs) have pre-defined meanings established by the protocol. This feedback does not require drive configuration. The following table lists a sample of feedback data. For a complete listing, see input word/point/object listings in the technical data for the appropriate protocol starting on page *215*.

Drive parameter		Modbus protocol reference	
		ABB DRV	DCU PROFILE
0102	SPEED	40102	
0103	OUTPUT FREQ	40103	
0104	CURRENT	40104	
0105	TORQUE	40105	
0106	POWER	40106	
0107	DC BUS VOLTAGE	40107	
0109	OUTPUT VOLTAGE	40109	
0301	FB CMD WORD1 – bit 0 (STOP)	40301 bit 0	
0301	FB CMD WORD1 1 – bit 2 (REV)	40301 bit 2	
0118	DI 1-3 STATUS – bit 0 (DI3)	40118	

Note: With Modbus, any parameter can be accessed using the format: "4" followed by the parameter number.

Actual value scaling

The scaling of actual values can be protocol dependent. In general, for Actual Values, scale the feedback integer using the parameter's resolution. (See section *Complete parameter list* on page *91* for parameter resolutions.) For example:

Feedback integer	Parameter resolution	(Feedback integer) · (Parameter resolution) = Scaled value
1	0.1 mA	1 · 0.1 mA = 0.1 mA
10	0.1%	10 · 0.1% = 1%

Where parameters are in percent, the *Complete parameter descriptions* section specifies what parameter corresponds to 100%. In such cases, to convert from percent to engineering units, multiply by the value of the parameter that defines 100% and divide by 100%.

For example:

Feedback integer	Parameter resolution	Value of the parameter that defines 100%	(Feedback integer) · (Parameter resolution) · (Value of 100% ref.) / 100% = Scaled value
10	0.1%	1500 rpm[1]	10 · 0.1% · 1500 RPM / 100% = 15 rpm
100	0.1%	500 Hz[2]	100 · 0.1% · 500 Hz / 100% = 50 Hz

[1] Assuming, for the sake of this example, that the Actual Value uses parameter 9908 MOT NOM SPEED as the 100% reference and that 9908 = 1500 rpm.

[2] Assuming, for the sake of this example, that the Actual Value uses parameter 9907 MOT NOM FREQ as the 100% reference and that 9907 = 500 Hz.

Diagnostics – EFB

Fault queue for drive diagnostics

For general ACS550 diagnostics information, see chapter *Diagnostics* on page *259*. The three most recent ACS550 faults are reported to the fieldbus as defined below.

Drive parameter		Modbus protocol reference	
		ABB DRV	DCU PROFILE
0401	LAST FAULT	40401	
0412	PREVIOUS FAULT 1	40412	
0413	PREVIOUS FAULT 2	40413	

Serial communication diagnostics

Network problems can be caused by multiple sources. Some of these sources are:

- loose connections
- incorrect wiring (including swapped wires)
- bad grounding
- duplicate station numbers
- incorrect setup of drives or other devices on the network.

The major diagnostic features for fault tracing on an EFB network include *Group 53: EFB PROTOCOL* parameters 5306…5309. Section *Complete parameter descriptions* on page *106* describes these parameters in detail.

Diagnostic situations

The sub-sections below describe various diagnostic situations – the problem symptoms and corrective actions.

Normal operation

During normal network operation, 5306…5309 parameter values act as follows at each drive:

- 5306 EFB OK MESSAGES advances (advances for each message properly received and addressed to this drive).
- 5307 EFB CRC ERRORS does not advance at all (advances when an invalid message CRC is received).
- 5308 EFB UART ERRORS does not advance at all (advances when character format errors are detected, such as parity or framing errors).
- 5309 EFB STATUS value varies depending on network traffic.

Loss of communication

The ACS550 behavior, if communication is lost, was configured earlier in section *Communication fault* on page *210*. The parameters are 3018 COMM FAULT FUNC and 3019 COMM FAULT TIME. Section *Complete parameter descriptions* on page *106* describes these parameters in detail.

No master station on line

If no master station is on line: Neither the EFB OK MESSAGES nor the errors (5307 EFB CRC ERRORS and 5308 EFB UART ERRORS) increase on any of the stations.

To correct:

- Check that a network master is connected and properly programmed on the network.
- Verify that the cable is connected and that it is not cut or short circuited.

Duplicate stations

If two or more stations have duplicate numbers:

- Two or more drives cannot be addressed.
- Every time there is a read or write to one particular station, the value for 5307 EFB CRC ERRORS or 5308 EFB UART ERRORS advances.

To correct: Verify the station numbers of all stations. Change conflicting station numbers.

Swapped wires

If the communication wires are swapped (terminal A on one drive is connected to terminal B on another):

- The value of 5306 EFB OK MESSAGES does not advance.
- The values of 5307 EFB CRC ERRORS and 5308 EFB UART ERRORS are advancing.

To correct: Check that the RS-485 lines are not swapped.

Fault 28 – Serial 1 Err

If the drive's control panel shows fault code 28, SERIAL 1 ERR, check for either of the following:

- The master system is down. To correct, resolve problem with master system.
- The communication connection is bad. To correct, check communication connection at the drive.
- The time-out selection for the drive is too short for the given installation. The master is not polling the drive within the specified time-out delay. To correct, increase the time set by parameter 3019 COMM FAULT TIME.

Faults 31…33 – EFB1…EFB3

The three EFB fault codes listed for the drive in chapter *Diagnostics* on page *259* (fault codes 31…33) are not used.

Intermittent off-line occurrences

The problems described above are the most common problems encountered with ACS550 serial communication. Intermittent problems might also be caused by:

- marginally loose connections
- wear on wires caused by equipment vibrations
- insufficient grounding and shielding on both the devices and on the communication cables.

Modbus protocol technical data

Overview

The Modbus® protocol was introduced by Modicon, Inc. for use in control environments featuring Modicon programmable controllers. Due to its ease of use and implementation, this common PLC language was quickly adopted as a de-facto standard for integration of a wide variety of master controllers and slave devices.

Modbus is a serial, asynchronous protocol. Transactions are half-duplex, featuring a single Master controlling one or more Slaves. While RS232 can be used for point-to-point communication between a single Master and a single Slave, a more common implementation features a multi-drop RS485 network with a single Master controlling multiple Slaves. The ACS550 features RS485 for its Modbus physical interface.

RTU

The Modbus specification defines two distinct transmission modes: ASCII and RTU. The ACS550 supports RTU only.

Feature summary

The following Modbus function codes are supported by the ACS550.

Function	Code (Hex)	Description
Read Coil Status	0x01	Read discrete output status. For the ACS550, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (e.g. RO1=Coil 33).
Read Discrete Input Status	0x02	Read discrete inputs status. For the ACS550, the individual bits of the status word are mapped to Inputs 1…16 or 1…32, depending on the active profile. Terminal inputs are mapped sequentially beginning with Input 33 (e.g. DI1=Input 33).
Read Multiple Holding Registers	0x03	Read multiple holding registers. For the ACS550, the entire parameter set is mapped as holding registers, as well as command, status and reference values.
Read Multiple Input Registers	0x04	Read multiple input registers. For the ACS550, the 2 analog input channels are mapped as input registers 1 & 2.
Force Single Coil	0x05	Write a single discrete output. For the ACS550, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (e.g. RO1=Coil 33).
Write Single Holding Register	0x06	Write single holding register. For the ACS550, the entire parameter set is mapped as holding registers, as well as command, status and reference values.
Diagnostics	0x08	Perform Modbus diagnostics. Subcodes for Query (0x00), Restart (0x01) & Listen Only (0x04) are supported.
Force Multiple Coils	0x0F	Write multiple discrete outputs. For the ACS550, the individual bits of the control word are mapped to Coils 1…16. Relay outputs are mapped sequentially beginning with Coil 33 (e.g. RO1=Coil 33).
Write Multiple Holding Registers	0x10	Write multiple holding registers. For the ACS550, the entire parameter set is mapped as holding registers, as well as command, status and reference values.
Read/Write Multiple Holding Registers	0x17	This function combines functions 0x03 and 0x10 into a single command.

Mapping summary

The following table summarizes the mapping between the ACS550 (parameters and I/0) and Modbus reference space. For details, see *Modbus addressing* below.

ACS550	Modbus reference	Supported function codes
• Control Bits • Relay Outputs	Coils(0xxxx)	• 01 – Read Coil Status • 05 – Force Single Coil • 15 – Force Multiple Coils
• Status Bits • Discrete Inputs	Discrete Inputs(1xxxx)	• 02 – Read Input Status
• Analog Inputs	Input Registers(3xxxxx)	• 04 – Read Input Registers
• Parameters • Control/Status Words • References	Holding Registers(4xxxx)	• 03 – Read 4X Registers • 06 – Preset Single 4X Register • 16 – Preset Multiple 4X Registers • 23 – Read/Write 4X Registers

Communication profiles

When communicating by Modbus, the ACS550 supports multiple profiles for control and status information. Parameter 5305 EFB CTRL PROFILE selects the profile used.

- ABB DRV LIM – The primary (and default) profile is the ABB DRV LIM profile. This implementation of the ABB Drives profile standardizes the control interface with ACS400 drives. The ABB Drives profile is based on the PROFIBUS interface. It is discussed in detail in the following sections.
- DCU PROFILE – The DCU PROFILE profile extends the control and status interface to 32 bits. It is the internal interface between the main drive application and the embedded fieldbus environment.
- ABB DRV FULL – ABB DRV FULL is the implementation of the ABB Drives profile that standardizes the control interface with ACS600 and ACS800 drives. This implementation supports two control word bits not supported by the ABB DRV LIM implementation.

Modbus addressing

With Modbus, each function code implies access to a specific Modbus reference set. Thus, the leading digit is not included in the address field of a Modbus message.

Note: The ACS550 supports the zero-based addressing of the Modbus specification. Holding register 40002 is addressed as 0001 in a Modbus message. Similarly, coil 33 is addressed as 0032 in a Modbus message.

Refer again to the *Mapping summary* above. The following sections describe, in detail, the mapping to each Modbus reference set.

0xxxx Mapping – Modbus coils. The drive maps the following information to the 0xxxx Modbus set called Modbus Coils:

- bit-wise map of the CONTROL WORD (selected using parameter 5305 EFB CTRL PROFILE). The first 32 coils are reserved for this purpose.

- relay output states, numbered sequentially beginning with coil 00033.

The following table summarizes the 0xxxx reference set:

Modbus ref.	**Internal location (all profiles)**	ABB DRV LIM **(5305 = 0)**	DCU PROFILE **(5305 = 1)**	ABB DRV FULL **(5305 = 2)**
00001	CONTROL WORD – Bit 0	OFF1[1]	STOP	OFF1[1]
00002	CONTROL WORD – Bit 1	OFF2[1]	START	OFF2[1]
00003	CONTROL WORD – Bit 2	OFF3[1]	REVERSE	OFF3[1]
00004	CONTROL WORD – Bit 3	START	LOCAL	START
00005	CONTROL WORD – Bit 4	N/A	RESET	RAMP_OUT_ZERO[1]
00006	CONTROL WORD – Bit 5	RAMP_HOLD[1]	EXT2	RAMP_HOLD[1]
00007	CONTROL WORD – Bit 6	RAMP_IN_ZERO[1]	RUN_DISABLE	RAMP_IN_ZERO[1]
00008	CONTROL WORD – Bit 7	RESET	STPMODE_R	RESET
00009	CONTROL WORD – Bit 8	N/A	STPMODE_EM	N/A
00010	CONTROL WORD – Bit 9	N/A	STPMODE_C	N/A
00011	CONTROL WORD – Bit 10	N/A	RAMP_2	REMOTE_CMD[1]
00012	CONTROL WORD – Bit 11	EXT2	RAMP_OUT_0	EXT2
00013	CONTROL WORD – Bit 12	N/A	RAMP_HOLD	N/A
00014	CONTROL WORD – Bit 13	N/A	RAMP_IN_0	N/A
00015	CONTROL WORD – Bit 14	N/A	REQ_LOCALLOCK	N/A
00016	CONTROL WORD – Bit 15	N/A	TORQLIM2	N/A
00017	CONTROL WORD – Bit 16	Does not apply	FBLOCAL_CTL	Does not apply
00018	CONTROL WORD – Bit 17		FBLOCAL_REF	
00019	CONTROL WORD – Bit 18		START_DISABLE1	
00020	CONTROL WORD – Bit 19		START_DISABLE2	
00021… **0**0032	Reserved	Reserved	Reserved	Reserved
00033	RELAY OUTPUT 1	Relay Output 1	Relay Output 1	Relay Output 1
00034	RELAY OUTPUT 2	Relay Output 2	Relay Output 2	Relay Output 2
00035	RELAY OUTPUT 3	Relay Output 3	Relay Output 3	Relay Output 3
00036	RELAY OUTPUT 4	Relay Output 4	Relay Output 4	Relay Output 4
00037	RELAY OUTPUT 5	Relay Output 5	Relay Output 5	Relay Output 5
00038	RELAY OUTPUT 6	Relay Output 6	Relay Output 6	Relay Output 6

[1] = Active low

For the 0xxxx registers:

- Status is always readable.
- Forcing is allowed by user configuration of the drive for fieldbus control.
- Additional relay outputs are added sequentially.

The ACS550 supports the following Modbus function codes for coils:

Function code	Description
01	Read coil status
05	Force single coil
15 (0x0F Hex)	Force multiple coils

1xxxx Mapping – Modbus discrete inputs. The drive maps the following information to the 1xxxx Modbus set called Modbus Discrete Inputs:

- bit-wise map of the STATUS WORD (selected using parameter 5305 EFB CTRL PROFILE). The first 32 inputs are reserved for this purpose.
- discrete hardware inputs, numbered sequentially beginning with input 33.

The following table summarizes the 1xxxx reference set:

Modbus ref.	Internal location (all profiles)	ABB DRV (5305 = 0 OR 2)	DCU PROFILE (5305 = 1)
10001	STATUS WORD – Bit 0	RDY_ON	READY
10002	STATUS WORD – Bit 1	RDY_RUN	ENABLED
10003	STATUS WORD – Bit 2	RDY_REF	STARTED
10004	STATUS WORD – Bit 3	TRIPPED	RUNNING
10005	STATUS WORD – Bit 4	OFF_2_STA[1]	ZERO_SPEED
10006	STATUS WORD – Bit 5	OFF_3_STA[1]	ACCELERATE
10007	STATUS WORD – Bit 6	SWC_ON_INHIB	DECELERATE
10008	STATUS WORD – Bit 7	ALARM	AT_SETPOINT
10009	STATUS WORD – Bit 8	AT_SETPOINT	LIMIT
10010	STATUS WORD – Bit 9	REMOTE	SUPERVISION
10011	STATUS WORD – Bit 10	ABOVE_LIMIT	REV_REF
10012	STATUS WORD – Bit 11	EXT2	REV_ACT
10013	STATUS WORD – Bit 12	RUN_ENABLE	PANEL_LOCAL
10014	STATUS WORD – Bit 13	N/A	FIELDBUS_LOCAL
10015	STATUS WORD – Bit 14	N/A	EXT2_ACT
10016	STATUS WORD – Bit 15	N/A	FAULT
10017	STATUS WORD – Bit 16	Reserved	ALARM
10018	STATUS WORD – Bit 17	Reserved	REQ_MAINT
10019	STATUS WORD – Bit 18	Reserved	DIRLOCK
10020	STATUS WORD – Bit 19	Reserved	LOCALLOCK
10021	STATUS WORD – Bit 20	Reserved	CTL_MODE
10022	STATUS WORD – Bit 21	Reserved	Reserved
10023	STATUS WORD – Bit 22	Reserved	Reserved
10024	STATUS WORD – Bit 23	Reserved	Reserved
10025	STATUS WORD – Bit 24	Reserved	Reserved
10026	STATUS WORD – Bit 25	Reserved	Reserved
10027	STATUS WORD – Bit 26	Reserved	REQ_CTL

Modbus ref.	Internal location (all profiles)	ABB DRV (5305 = 0 OR 2)	DCU PROFILE (5305 = 1)
10028	STATUS WORD – Bit 27	Reserved	REQ_REF1
10029	STATUS WORD – Bit 28	Reserved	REQ_REF2
10030	STATUS WORD – Bit 29	Reserved	REQ_REF2EXT
10031	STATUS WORD – Bit 30	Reserved	ACK_STARTINH
10032	STATUS WORD – Bit 31	Reserved	ACK_OFF_ILCK
10033	DI1	DI1	DI1
10034	DI2	DI2	DI2
10035	DI3	DI3	DI3
10036	DI4	DI4	DI4
10037	DI5	DI5	DI5
10038	DI6	DI6	DI6

[1] = Active low

For the 1xxxx registers:

- Additional discrete inputs are added sequentially.

The ACS550 supports the following Modbus function codes for discrete inputs:

Function code	Description
02	Read input status

3xxxx Mapping – Modbus inputs. The drive maps the following information to the 3xxxx Modbus addresses called Modbus input registers:

- any user defined analog inputs.

The following table summarizes the input registers:

Modbus reference	ACS550 all profiles	Remarks
30001	AI1	This register shall report the level of Analog Input 1 (0…100%).
30002	AI2	This register shall report the level of Analog Input 2 (0…100%).

The ACS550 supports the following Modbus function codes for 3xxxx registers:

Function code	Description
04	Read 3xxxx input status

4xxxx Register mapping. The drive maps its parameters and other data to the 4xxxx holding registers as follows:

- 40001…40099 map to drive control and actual values. These registers are described in the table below.
- 40101…49999 map to drive parameters 0101…9999. Register addresses that do not correspond to drive parameters are invalid. If there is an attempt to read or write outside the parameter addresses, the Modbus interface returns an exception code to the controller.

The following table summarizes the 4xxxx drive control registers 40001…40099 (for 4xxxx registers above 40099, see the drive parameter list, e.g. 40102 is parameter 0102):

Modbus register		Access	Remarks
40001	CONTROL WORD	R/W	Maps directly to the profile'S CONTROL WORD. Supported only if 5305 = 0 or 2 (ABB Drives profile). Parameter 5319 holds a copy in hex format. If 5305 = 1 (DCU profile selected), the register remains empty.
40002	Reference 1	R/W	Range = 0…+20000 (scaled to 0…1105 REF1 MAX), or -20000…0 (scaled to 1105 REF1 MAX…0).
40003	Reference 2	R/W	Range = 0…+10000 (scaled to 0…1108 REF2 MAX), or -10000…0 (scaled to 1108 REF2 MAX…0).
40004	STATUS WORD	R	Maps directly to the profile'S STATUS WORD. Supported only if 5305 = 0 or 2 (ABB Drives profile). Parameter 5320 holds a copy in hex format. If 5305 = 1 (DCU profile selected), the register remains empty.
40005	Actual 1 (select using 5310)	R	By default, stores a copy of 0103 OUTPUT FREQ. Use parameter 5310 to select a different actual value for this register.
40006	Actual 2 (select using 5311)	R	By default, stores a copy of 0104 CURRENT. Use parameter 5311 to select a different actual value for this register.
40007	Actual 3 (select using 5312)	R	By default, stores nothing. Use parameter 5312 to select an actual value for this register.
40008	Actual 4 (select using 5313)	R	By default, stores nothing. Use parameter 5313 to select an actual value for this register.
40009	Actual 5 (select using 5314)	R	By default, stores nothing. Use parameter 5314 to select an actual value for this register.
40010	Actual 6 (select using 5315)	R	By default, stores nothing. Use parameter 5315 to select an actual value for this register.
40011	Actual 7 (select using 5316)	R	By default, stores nothing. Use parameter 5316 to select an actual value for this register.
40012	Actual 8 (select using 5317)	R	By default, stores nothing. Use parameter 5317 to select an actual value for this register.
40031	ACS550 CONTROL WORD LSW	R/W	Maps directly to the Least Significant Word of the DCU profile's CONTROL WORD. Supported only if 5305 = 1. See parameter 0301.
40032	ACS550 CONTROL WORD MSW	R	Maps directly to the Most Significant Word of the DCU profile's CONTROL WORD. Supported only if 5305 = 1. See parameter 0302.
40033	ACS550 STATUS WORD LSW	R	Maps directly to the Least Significant Word of the DCU profile's STATUS WORD. Supported only if 5305 = 1. See parameter 0303.
40034	ACS550 STATUS WORD MSW	R	Maps directly to the Most Significant Word of the DCU profile's STATUS WORD. Supported only if 5305 = 1. See parameter 0304.
40045	REFERENCE 1 LSW	R/W	The least significant word of reference 1. Supported only by the DCU profile i.e. when 5305 ECB CTRL PROFILE setting is DCU profile.

Modbus register		Access	Remarks
40046	REFERENCE 1 MSW	R/W	The most significant word of reference 1. Supported only by the DCU profile i.e. when 5305 ECB CTRL PROFILE setting is DCU profile.
40047	REFERENCE 2 LSW	R/W	The least significant word of reference 2. Supported only by the DCU profile i.e. when 5305 ECB CTRL PROFILE setting is DCU profile.
40048	REFERENCE 2 MSW	R/W	The most significant word of reference 2. Supported only by DCU profile i.e. when 5305 ECB CTRL PROFILE setting is DCU profile.

For the Modbus protocol, drive parameters in *Group 53: EFB PROTOCOL* report the parameter mapping to 4xxxx Registers.

Code	Description
5310	EFB PAR 10 Specifies the parameter mapped to Modbus register 40005.
5311	EFB PAR 11 Specifies the parameter mapped to Modbus register 40006.
5312	EFB PAR 12 Specifies the parameter mapped to Modbus register 40007.
5313	EFB PAR 13 Specifies the parameter mapped to Modbus register 40008.
5314	EFB PAR 14 Specifies the parameter mapped to Modbus register 40009.
5315	EFB PAR 15 Specifies the parameter mapped to Modbus register 40010.
5316	EFB PAR 16 Specifies the parameter mapped to Modbus register 40011.
5317	EFB PAR 17 Specifies the parameter mapped to Modbus register 40012.
5318	EFB PAR 18 Sets additional delay in milliseconds before the ACS550 begins transmitting response to the master request.
5319	EFB PAR 19 Holds a copy (in hex) of the CONTROL WORD, Modbus register 40001.
5320	EFB PAR 20 Holds a copy (in hex) of the STATUS WORD, Modbus register 40004.

Except where restricted by the drive, all parameters are available for both reading and writing. The parameter writes are verified for the correct value and for a valid register addresses.

Note: Parameter writes through standard Modbus are always volatile i.e. modified values are not automatically stored to permanent memory. Use parameter 1607 PARAM SAVE to save all altered values.

The ACS550 supports the following Modbus function codes for 4xxxx registers:

Function code	Description
03	Read holding 4xxxx registers
06	Preset single 4xxxx register
16 (0x10 Hex)	Preset multiple 4xxxx registers
23 (0x17 Hex)	Read/write 4xxxx registers

Actual values

The contents of the register addresses 40005…40012 are ACTUAL VALUES and are:

- specified using parameters 5310…5317
- Read-only values containing information on the operation of the drive
- 16-bit words containing a sign bit and a 15-bit integer
- when negative values, written as the two's complement of the corresponding positive value
- scaled as described earlier in section *Actual value scaling* on page *211*.

Exception codes

Exception codes are serial communication responses from the drive. The ACS550 supports the standard Modbus exception codes defined below.

Exception code	Name	Meaning
01	ILLEGAL FUNCTION	Unsupported Command
02	ILLEGAL DATA ADDRESS	The data address received in the query is not allowable. It is not a defined parameter/group.
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for the ACS550, because it is one of the following: • Outside min. or max. limits. • Parameter is read-only. • Message is too long. • Parameter write not allowed when start is active. • Parameter write not allowed when factory macro is selected.

ABB control profiles technical data

Overview

ABB Drives profile

The ABB Drives profile provides a standard profile that can be used on multiple protocols, including Modbus and the protocols available on the FBA module. Two implementations of the ABB Drives profile are available:

- ABB DRV FULL – This implementation standardizes the control interface with ACS600 and ACS800 drives.
- ABB DRV LIM – This implementation standardizes the control interface with ACS400 drives. This implementation does not support two control word bits supported by ABB DRV FULL.

Except as noted, the following "ABB Drives Profile" descriptions apply to both implementations.

DCU profile

The DCU profile extends the control and status interface to 32 bits. It is the internal interface between the main drive application and the embedded fieldbus environment.

Control Word

The CONTROL WORD is the principal means for controlling the drive from a fieldbus system. The fieldbus master station sends the CONTROL WORD to the drive. The drive switches between states according to the bit-coded instructions in the CONTROL WORD. Using the CONTROL WORD requires that:

- The drive is in remote (REM) control.
- The serial communication channel is defined as the source for controlling commands (set using parameters such as 1001 EXT1 COMMANDS, 1002 EXT2 COMMANDS and 1102 EXT1/EXT2 SEL).
- The serial communication channel used is configured to use an ABB control profile. For example, to use the control profile ABB DRV FULL requires both parameter 9802 COMM PROT SEL = 1 (STD MODBUS) and parameter 5305 EFB CTRL PROFILE = 2 (ABB DRV FULL).

ABB Drives profile

The following table and the state diagram later in this sub-section describe the CONTROL WORD content for the ABB Drives profile.

ABB Drives profile CONTROL WORD (See parameter 5319)				
Bit	**Name**	**Value**	**Commanded state**	**Comments**
0	OFF1 CONTROL	1	READY TO OPERATE	Enter READY TO OPERATE
		0	EMERGENCY OFF	Drive ramps to stop according to currently active deceleration ramp (2203 or 2205) Normal command sequence: • Enter OFF1 ACTIVE • Proceed to READY TO SWITCH ON, unless other interlocks (OFF2, OFF3) are active.
1	OFF2 CONTROL	1	OPERATING	Continue operation (OFF2 inactive)
		0	EMERGENCY OFF	Drive coasts to stop. Normal command sequence: • Enter OFF2 ACTIVE • Proceed to SWITCHON INHIBITED
2	OFF3 CONTROL	1	OPERATING	Continue operation (OFF3 inactive)
		0	EMERGENCY STOP	Drive stops within time specified by parameter 2208. Normal command sequence: • Enter OFF3 ACTIVE • Proceed to SWITCH ON INHIBITED ⚠ **WARNING!** Be sure motor and driven equipment can be stopped using this mode.
3	INHIBIT OPERATION	1	OPERATION ENABLED	Enter OPERATION ENABLED (Note the Run enable signal must be active. See 1601. If 1601 is set to COMM, this bit also actives the Run Enable signal.)
		0	OPERATION INHIBITED	Inhibit operation. Enter OPERATION INHIBITED
4	Unused (**ABB DRV LIM**)			
	RAMP_OUT_ ZERO (**ABB DRV FULL**)	1	NORMAL OPERATION	Enter RAMP FUNCTION GENERATOR: ACCELERATION ENABLED
		0	RFG OUT ZERO	Force ramp function generator output to Zero. Drive ramps to stop (current and DC voltage limits in force).
5	RAMP_HOLD	1	RFG OUT ENABLED	Enable ramp function. Enter RAMP FUNCTION GENERATOR: ACCELERATOR ENABLED
		0	RFG OUT HOLD	Halt ramping (Ramp Function Generator output held)
6	RAMP_IN_ ZERO	1	RFG INPUT ENABLED	Normal operation. Enter OPERATING
		0	RFG INPUT ZERO	Force Ramp Function Generator input to zero.

ABB Drives profile CONTROL WORD (See parameter 5319)				
Bit	**Name**	**Value**	**Commanded state**	**Comments**
7	RESET	0=>1	RESET	Fault reset if an active fault exists (Enter SWITCH-ON INHIBITED). Effective if 1604 = COMM.
		0	OPERATING	Continue normal operation
8…9	Unused			
10	Unused (**ABB DRV LIM**)			
	REMOTE_CMD (**ABB DRV FULL**)	1		Fieldbus control enabled.
		0		• CW ≠ 0 or Ref ≠ 0: Retain last CW and Ref. • CW = 0 and Ref = 0: Fieldbus control enabled. • Ref and deceleration/acceleration ramp are locked.
11	EXT CTRL LOC	1	EXT2 SELECT	Select external control location 2 (EXT2). Effective if 1102 = COMM.
		0	EXT1 SELECT	Select external control location 1 (EXT1). Effective if 1102 = COMM.
12…15	Unused			

DCU Profile

The following tables describe the CONTROL WORD content for the DCU profile.

DCU profile CONTROL WORD (See parameter 0301)				
Bit	**Name**	**Value**	**Command/Req.**	**Comments**
0	STOP	1	Stop	Stops according to either the stop mode parameter or the stop mode requests (bits 7 and 8). Simultaneous STOP and START commands result in a stop command.
		0	(no op)	
1	START	1	Start	
		0	(no op)	
2	REVERSE	1	Reverse direction	This bit XOR'd with the sign of the reference defines direction.
		0	Forward direction	
3	LOCAL	1	Local mode	When the fieldbus sets this bit, it steals control and the drive moves to fieldbus local control mode.
		0	External mode	
4	RESET	-> 1	Reset	Edge sensitive.
		other	(no op)	
5	EXT2	1	Switch to EXT2	
		0	Switch to EXT1	
6	RUN_DISABLE	1	Run disable	Inverted run enable.
		0	Run enable on	
7	STPMODE_R	1	Normal ramp stop mode	
		0	(no op)	

DCU profile CONTROL WORD (See parameter 0301)				
Bit	**Name**	**Value**	**Command/Req.**	**Comments**
8	STPMODE_EM	1	Emergency ramp stop mode	
		0	(no op)	
9	STPMODE_C	1	Coast stop mode	
		0	(no op)	
10	RAMP_2	1	Ramp pair 2	
		0	Ramp pair 1	
11	RAMP_OUT_0	1	Ramp output to 0	
		0	(no op)	
12	RAMP_HOLD	1	Ramp freeze	
		0	(no op)	
13	RAMP_IN_0	1	Ramp input to 0	
		0	(no op)	
14	RREQ_LOCALLOC	1	Local mode lock	In lock, drive will not switch to local mode.
		0	(no op)	
15	TORQLIM2	1	Torque limit pair 2	
		0	Torque limit pair 1	

DCU profile CONTROL WORD (See parameter 0302)				
Bit	**Name**	**Value**	**Function**	**Comments**
16…26	Reserved			
27	REF_CONST	1	Constant speed ref.	These bits are only for supervision purposes.
		0	(no op)	
28	REF_AVE	1	Average speed ref.	
		0	(no op)	
29	LINK_ON	1	Master is detected in link	
		0	Link is down	
30	REQ_STARTINH	1	Start inhibit request is pending	
		0	Start inhibit request is OFF	
31	OFF_INTERLOCK	1	Panel OFF button pressed	For the control panel (or PC tool) this is the OFF button interlock.
		0	(no op)	

Status Word

The contents of the STATUS WORD is status information, sent by the drive to the master station.

ABB Drives profile

The following table and the state diagram later in this sub-section describe the STATUS WORD content for the ABB Drives profile.

ABB Drives profile (EFB) STATUS WORD (See parameter 5320)			
Bit	**Name**	**Value**	**Description (Correspond to states/boxes in the state diagram)**
0	RDY_ON	1	READY TO SWITCH ON
		0	NOT READY TO SWITCH ON
1	RDY_RUN	1	READY TO OPERATE
		0	OFF1 ACTIVE
2	RDY_REF	1	OPERATION ENABLED
		0	OPERATION INHIBITED
3	TRIPPED	0…1	FAULT
		0	No fault
4	OFF_2_STA	1	OFF2 INACTIVE
		0	**OFF2 ACTIVE**
5	OFF_3_STA	1	OFF3 INACTIVE
		0	**OFF3 ACTIVE**
6	SWC_ON_INHIB	1	SWITCH-ON INHIBIT ACTIVE
		0	SWITCH-ON INHIBIT NOT ACTIVE
7	ALARM	1	Alarm (See section *Alarm listing* on page *267* for details on alarms.)
		0	No alarm
8	AT_SETPOINT	1	OPERATING. Actual value equals (within tolerance limits) the reference value.
		0	Actual value is outside tolerance limits (not equal to reference value).
9	REMOTE	1	Drive control location: REMOTE (EXT1 or EXT2)
		0	Drive control location: LOCAL
10	ABOVE_LIMIT	1	Supervised parameter's value ≥ supervision high limit. Bit remains "1" until supervised parameter's value < supervision low limit. See *Group 32: SUPERVISION*.
		0	Supervised parameter's value < supervision low limit. Bit remains "0" until supervised parameter's value > supervision high limit. See *Group 32: SUPERVISION*.
11	EXT CTRL LOC	1	External control location 2 (EXT2) selected
		0	External control location 1 (EXT1) selected
12	EXT RUN ENABLE	1	External Run Enable signal received
		0	No External Run Enable signal received
13… 15	Unused		

DCU profile

The following tables describe the STATUS WORD content for the DCU profile.

DCU profile STATUS WORD (See parameter 0303)			
Bit	**Name**	**Value**	**Status**
0	READY	1	Drive is ready to receive start command.
		0	Drive is not ready.
1	ENABLED	1	External run enable signal received.
		0	No external run enable signal received.
2	STARTED	1	Drive has received start command.
		0	Drive has not received start command.
3	RUNNING	1	Drive is modulating.
		0	Drive is not modulating.
4	ZERO_SPEED	1	Drive is at zero speed.
		0	Drive has not reached zero speed.
5	ACCELERATE	1	Drive is accelerating.
		0	Drive is not accelerating.
6	DECELERATE	1	Drive is decelerating.
		0	Drive is not decelerating.
7	AT_SETPOINT	1	Drive is at setpoint.
		0	Drive has not reached setpoint.
8	LIMIT	1	Operation is limited by *Group 20: LIMITS* settings.
		0	Operation is within *Group 20: LIMITS* settings.
9	SUPERVISION	1	A supervised parameter (*Group 32: SUPERVISION*) is outside its limits.
		0	All supervised parameters are within limits.
10	REV_REF	1	Drive reference is in reverse direction.
		0	Drive reference is in forward direction.
11	REV_ACT	1	Drive is running in reverse direction.
		0	Drive is running in forward direction.
12	PANEL_LOCAL	1	Control is in control panel (or PC tool) local mode.
		0	Control is not in control panel local mode.
13	FIELDBUS_LOCAL	1	Control is in fieldbus local mode (steals control panel local).
		0	Control is not in fieldbus local mode.
14	EXT2_ACT	1	Control is in EXT2 mode.
		0	Control is in EXT1 mode.
15	FAULT	1	Drive is in a fault state.
		0	Drive is not in a fault state.

DCU profile STATUS WORD (See parameter 0304)			
Bit	**Name**	**Value**	**Status**
16	ALARM	1	An alarm is on.
		0	No alarms are on.
17	REQ_MAINT	1	A maintenance request is pending.
		0	No maintenance request is pending.
18	DIRLOCK	1	Direction lock is ON. (Direction change is locked out.)
		0	Direction lock is OFF.
19	LOCALLOCK	1	Local mode lock is ON. (Local mode is locked out.)
		0	Local mode lock is OFF.
20	CTL_MODE	1	Drive is in vector control mode.
		0	Drive is in scalar control mode.
21…25	Reserved		
26	REQ_CTL	1	Copy the control word
		0	(no op)
27	REQ_REF1	1	Reference 1 requested in this channel.
		0	Reference 1 is not requested in this channel.
28	REQ_REF2	1	Reference 2 requested in this channel.
		0	Reference 2 is not requested in this channel.
29	REQ_REF2EXT	1	External PID reference 2 requested in this channel.
		0	External PID reference 2 is not requested in this channel.
30	ACK_STARTINH	1	A start inhibit from this channel is granted.
		0	A start inhibit from this channel is not granted.
31	ACK_OFF_ILCK	1	Start inhibit due to OFF button
		0	Normal operation

State diagram

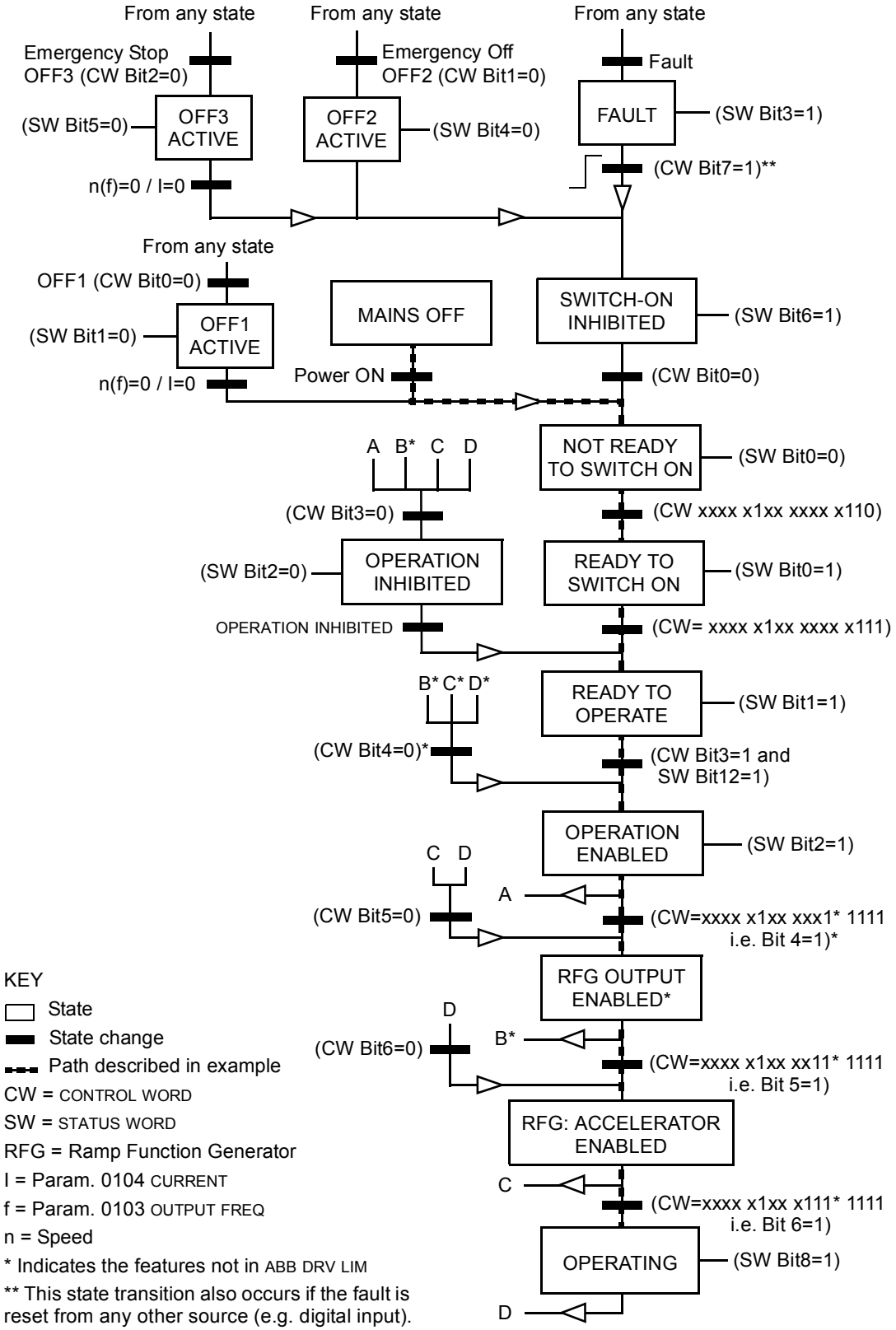
ABB Drives profile

To illustrate the operation of the state diagram, the following example (ABB DRV LIM implementation of the ABB Drives profile) uses the control word to start the drive:

- First, the requirements for using the CONTROL WORD must be met. See above.
- When the power is first connected, the state of the drive is not ready to switch on. See dotted lined path (▪▪▪) in the state diagram below.
- Use the CONTROL WORD to step through the state machine states until the OPERATING state is reached, meaning that the drive is running and follows the given reference. See the table below.

Step	CONTROL WORD **Value**	**Description**
1	CW = 0000 0000 0000 0110 bit 15 bit 0	This CW value changes the drive state to READY TO SWITCH ON.
2		Wait at least 100 ms before proceeding.
3	CW = 0000 0000 0000 0111	This CW value changes the drive state to READY TO OPERATE.
4	CW = 0000 0000 0000 1111	This CW value changes the drive state to OPERATION ENABLED. The drive starts, but will not accelerate.
5	CW = 0000 0000 0010 1111	This CW value releases the ramp function generator (RFG) output and changes the drive state to RFG: ACCELERATOR ENABLED.
6	CW = 0000 0000 0110 1111	This CW value releases the ramp function generator (RFG) output and changes the drive state to OPERATING. The drive accelerates to the given reference and follows the reference.

The state diagram below describes the start-stop function of CONTROL WORD (CW) and STATUS WORD (SW) bits for the ABB Drives profile.



Reference scaling

Fieldbus references REF1 and REF2 are scaled as shown in the following tables.

Fieldbus scaling for ABB Drives profile

Reference	Range	Reference type	Scaling	Remarks
REF1	-32767 … +32767	Speed or frequency	-20000 = -**(par. 1105)** 0 = 0 +20000 = **(par. 1105)** (20000 corresponds to 100%)	Final reference limited by 1104/1105. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
REF2	-32767 … +32767	Speed or frequency	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 1107/1108. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
		Torque	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 2015/2017 (torque1) or 2016/2018 (torque2).
		PID Reference	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 4012/4013 (PID set1) or 4112/4113 (PID set2).

Note: The setting of parameter 1104 REF1 MIN and 1107 REF2 MIN has no effect on the scaling of references.

Fieldbus scaling for DCU profile

Reference	Range	Reference type	Scaling	Remarks
REF1	-214783648 … +214783647	Speed or frequency	1000 = 1 rpm / 1 Hz	Final reference limited by 1104/1105. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
REF2	-214783648 … +214783647	Speed or frequency	1000 = 1%	Final reference limited by 1107/1108. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
		Torque	1000 = 1%	Final reference limited by 2015/2017 (torque1) or 2016/2018 (torque2).
		PID Reference	1000 = 1%	Final reference limited by 4012/4013 (PID set1) or 4112/4113 (PID set2).

Note: The setting of parameter 1104 REF1 MIN and 1107 REF2 MIN has no effect on the scaling of references.

Scaling examples

When parameter 1103 REF1 SELECT or 1106 REF2 SELECT is set to COMM+AI1 or COMM*AI1, the reference is scaled as follows:

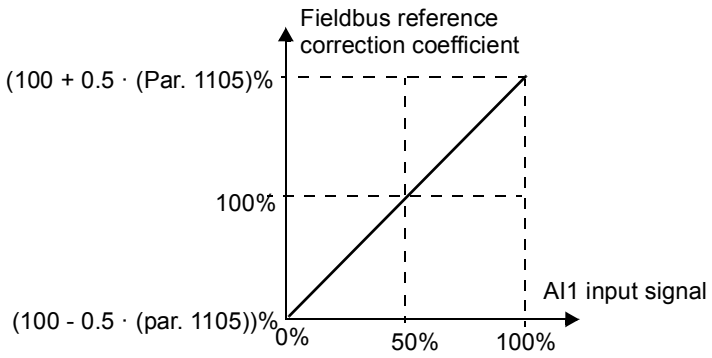
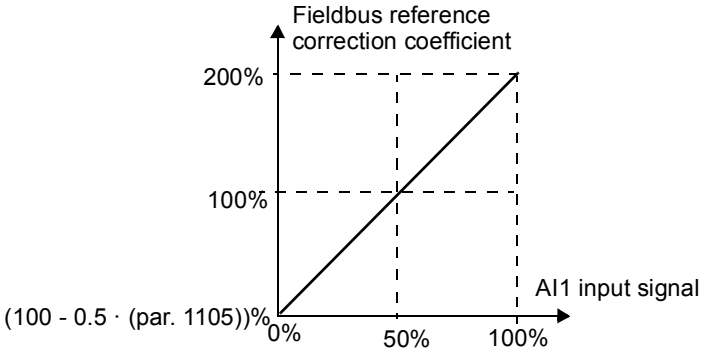
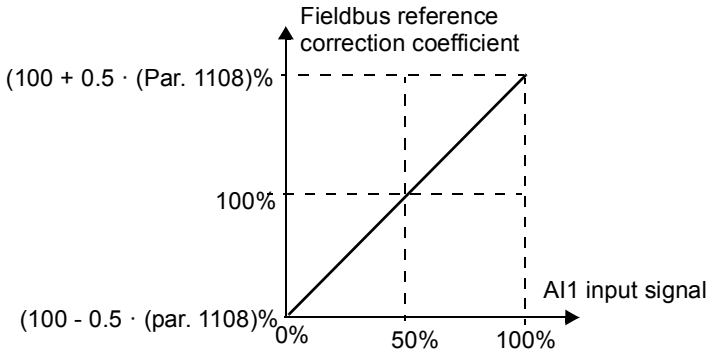
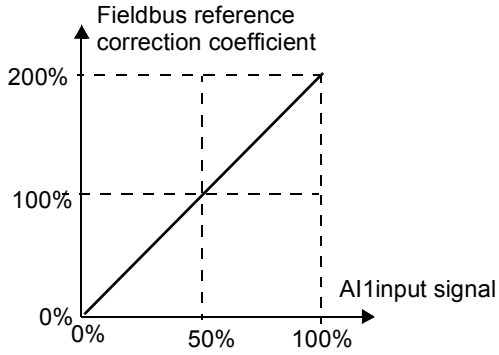
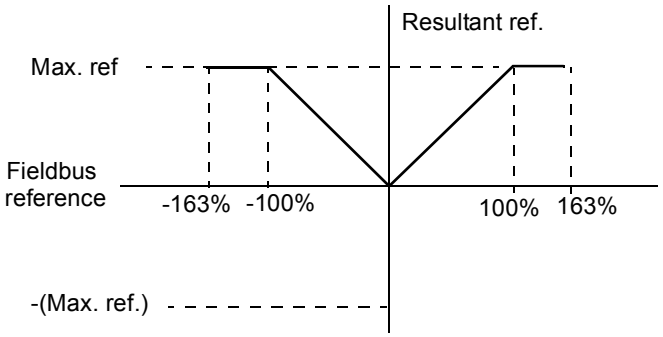
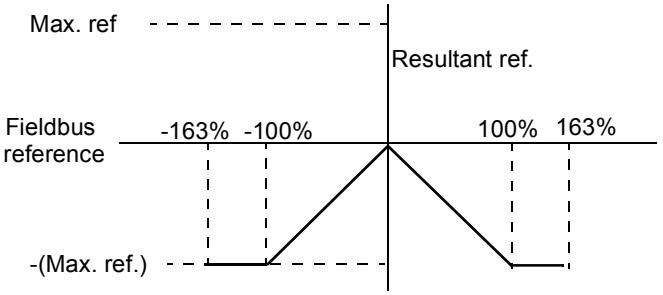
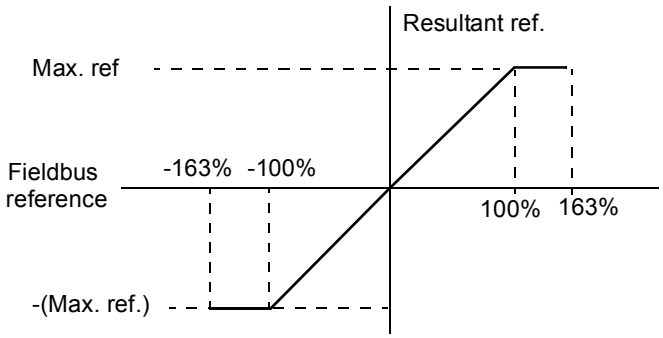
ABB Drives and DCU profiles		
Reference	**Value setting**	**AI reference scaling**
REF1	COMM+AI1	COMM (%) +(AI (%) - 0.5 · REF1 MAX (%)) 
REF1	COMM*AI1	COMM (%) · (AI (%) / 0.5 · REF1 MAX (%)) 
REF2	COMM+AI1	COMM (%) + (AI (%) - 0.5 · REF2 MAX (%)) 

ABB Drives and DCU profiles		
Reference	**Value setting**	**AI reference scaling**
REF2	COMM*AI1	COMM (%) · (AI (%) / 0.5 · REF2 MAX (%)) 

Reference handling

Use *Group 10: START/STOP/DIR* parameters to configure for control of rotation direction for each control location (EXT1 and EXT2). The following diagrams illustrate how group 10 parameters and the sign of the fieldbus reference interact to produce REFERENCE values (REF1 and REF2). Note, fieldbus references are bipolar, that is they can be positive or negative.

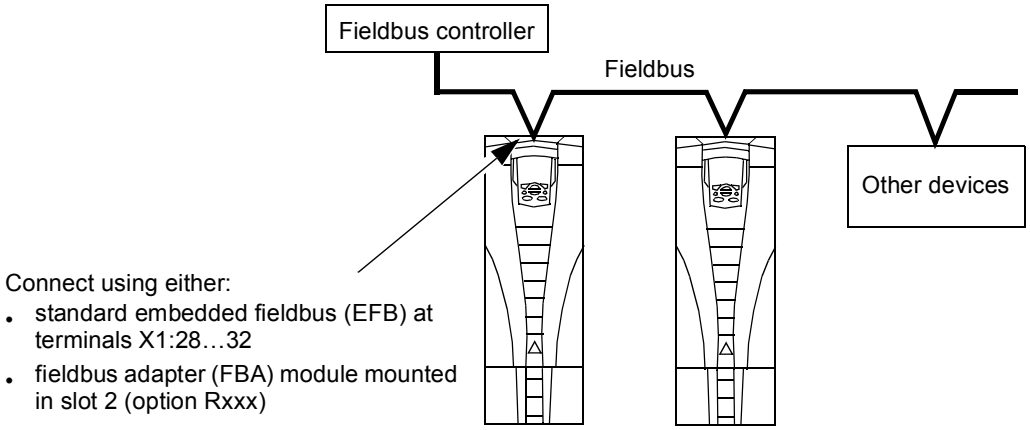
ABB Drives profile		
Parameter	**Value setting**	**AI reference scaling**
1003 DIRECTION	1 (FORWARD)	
1003 DIRECTION	2 (REVERSE)	
1003 DIRECTION	3 (REQUEST)	

Fieldbus adapter

Overview

The ACS550 can be set up to accept control from an external system using standard serial communication protocols. When using serial communication, the ACS550 can either:

- receive all of its control information from the fieldbus, or
- be controlled from some combination of fieldbus control and other available control locations, such as digital or analog inputs and the control panel.



Two basic serial communications configurations are available:

- embedded fieldbus (EFB) – See chapter *Embedded fieldbus* on page *203*.
- fieldbus adapter (FBA) – With one of the optional FBA modules in the drive's expansion slot 2, the drive can communicate to a control system using one of the following protocols:
  - PROFIBUS DP
  - Ethernet (Modbus/TCP, EtherNet/IP, EtherCAT, PROFINET IO, POWERLINK)
  - CANopen
  - DeviceNet
  - ControlNet.

The ACS550 detects automatically which communication protocol is used by the plug-in fieldbus adapter. The default settings for each protocol assume that the profile used is the protocol's industry-standard drive profile (e.g. PROFIdrive for PROFIBUS, AC/DC Drive for DeviceNet). All of the FBA protocols can also be configured for the ABB Drives profile.

Configuration details depend on the protocol and profile used.These details are provided in a user's manual supplied with the FBA module.

Details for the ABB Drives profile (which apply for all protocols) are provided in section *ABB Drives profile technical data* on page *248*.

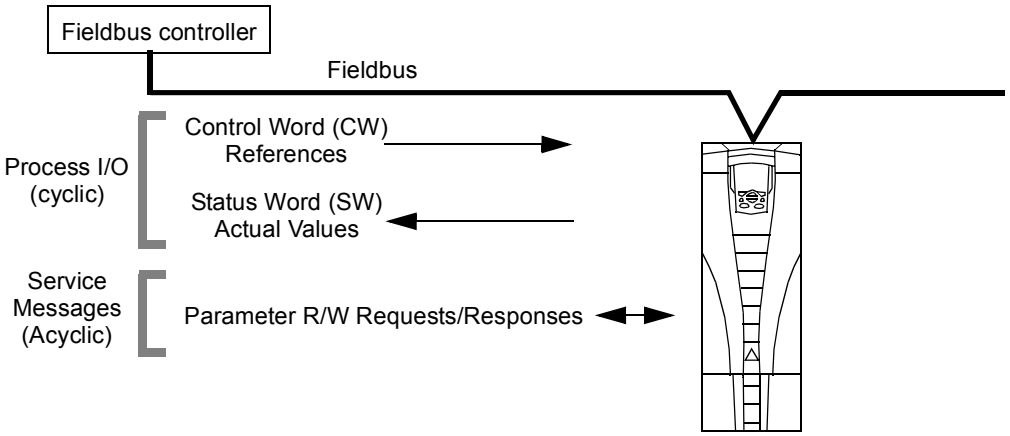
Control interface

In general, the basic control interface between the fieldbus system and the drive consists of:

- Output Words:
  - CONTROL WORD
  - REFERENCE (speed or frequency)
  - Others: The drive supports a maximum of 15 output words. Protocols limits may further restrict the total.
- Input Words:
  - STATUS WORD
  - Actual Value (speed or frequency)
  - Others: The drive supports a maximum of 15 input words. Protocols limits may further restrict the total.

Note: The words "output" and "input" are used as seen from the fieldbus controller point of view. For example an output describes data flow from the fieldbus controller to the drive and appears as an input from the drive point of view.

The meanings of the controller interface words are not restricted by the ACS550. However, the profile used may set particular meanings.



Control Word

The CONTROL WORD is the principal means for controlling the drive from a fieldbus system. The fieldbus controller sends the CONTROL WORD to the drive. The drive switches between states according to the bit-coded instructions in the CONTROL WORD. Using the CONTROL WORD requires that:

- The drive is in remote (REM) control.
- The serial communication channel is defined as the source for controlling commands from EXT1 (set using parameters 1001 EXT1 COMMANDS and 1102 EXT1/EXT2 SEL).
- The external plug-in fieldbus adapter is activated:

– Parameter 9802 COMM PROT SEL = 4 (EXT FBA).
– The external plug-in fieldbus adapter is configured to use the drive profile mode or drive profile objects.

The content of the CONTROL WORD depends on the protocol/profile used. See the user's manual provided with the FBA module and/or section *ABB Drives profile technical data* on page *248*.

Status Word

The STATUS WORD is a 16-bit word containing status information, sent by the drive to the fieldbus controller. The content of the STATUS WORD depends on the protocol/profile used. See the user's manual provided with the FBA module and/or section *ABB Drives profile technical data* on page *248*.

Reference

The contents of each REFERENCE word:

- can be used, as speed or frequency reference
- is a 16-bit word comprised of a sign bit and a 15-bit integer
- Negative references (indicating reversed rotation direction) are indicated by the two's complement of the corresponding positive reference value.

The use of a second reference (REF2) is supported only when a protocol is configured for the ABB Drives profile.

Reference scaling is fieldbus type specific. See the user's manual provided with the FBA module and/or the following sections as appropriate:

- *Reference scaling* on page *252* (*ABB Drives profile technical data*)
- *Reference scaling* on page *256* (*Generic profile technical data*).

Actual Values

Actual Values are 16-bit words containing information on selected operations of the drive. Drive Actual Values (for example, *Group 10: START/STOP/DIR* parameters) can be mapped to Input Words using *Group 51: EXT COMM MODULE* parameters (protocol-dependent, but typically parameters 5104…5126).

Planning

Network planning should address the following questions:

- What types and quantities of devices must be connected to the network?
- What control information must be sent down to the drives?
- What feedback information must be sent from the drives to the controlling system?

Mechanical and electrical installation – FBA

WARNING! Connections should be made only while the drive is disconnected from the power source.

Overview

The FBA (fieldbus adapter) is a plug-in module that fits in the drive's expansion slot 2. The module is held in place with plastic retaining clips and two screws. The screws also ground the shield for the module cable and connect the module GND signals to the drive control board.

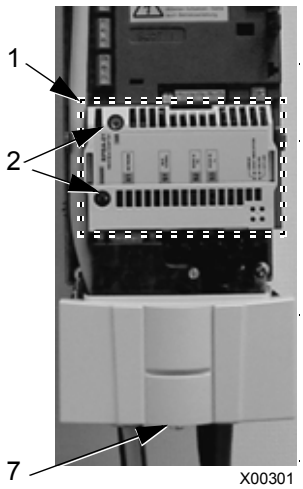
On installation of the module, electrical connection to the drive is automatically established through the 34-pin connector.

Mounting procedure

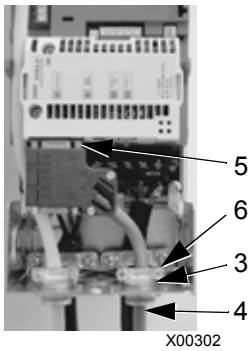
Note: Install the input power and motor cables first.

1. Insert the module carefully into the drive expansion slot 2 until the retaining clips lock the module into position.
2. Fasten the two screws (included) to the stand-offs.

Note: Correct installation of the screws is essential for fulfilling the EMC requirements and for proper operation of the module.



3. Open the appropriate knockout in the conduit box and install the cable clamp for the network cable.
4. Route the network cable through the cable clamp.
5. Connect the network cable to the module's network connector.
6. Tighten the cable clamp.
7. Install the conduit box cover (1 screw).
8. For configuration information see the following:
   - section *Communication set-up – FBA* on page *241*
   - section *Activate drive control functions – FBA* on page *241*
   - The protocol specific documentation provided with the module.



Communication set-up – FBA

Serial communication selection

To activate the serial communication, use parameter 9802 COMM PROT SEL. Set 9802 = 4 (EXT FBA).

Serial communication configuration

Setting 9802, together with mounting a particular FBA module, automatically sets the appropriate default values in parameters that define the communication process. These parameters and descriptions are defined in the user's manual supplied with the FBA module.

- Parameter 5101 is automatically configured.
- Parameters 5102…5126 are protocol-dependent and define, for example, the profile used and additional I/O words. These parameters are referred to as the fieldbus configuration parameters. See the user's manual provided with the FBA module for details on the fieldbus configuration parameters.
- Parameter 5127 forces the validation of changes to parameters 5102…5126. If parameter 5127 is not used, changes to parameters 5102…5126 take affect only after the drive power is cycled.
- Parameters 5128…5133 provide data about the FBA module currently installed (e.g. component versions and status).

See *Group 51: EXT COMM MODULE* for parameter descriptions.

Activate drive control functions – FBA

Fieldbus control of various drive functions requires configuration to:

- tell the drive to accept fieldbus control of the function
- define as a fieldbus input, any drive data required for control
- define as a fieldbus output, any control data required by the drive.

The following sections describe, at a general level, the configuration required for each control function. The last column in each table below is deliberately blank. See the user's manual supplied with the FBA module for the appropriate entry.

Start/Stop Direction control

Using the fieldbus for start/stop/direction control of the drive requires:

- drive parameter values set as defined below
- fieldbus controller supplied command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Protocol reference
1001	EXT1 COMMANDS	10 (COMM)	Start/Stop controlled by fieldbus with Ext1 selected.	

Drive parameter		Value	Description	Protocol reference
1002	EXT2 COMMANDS	10 (COMM)	Start/Stop by controlled fieldbus with Ext2 selected.	
1003	DIRECTION	3 (REQUEST)	Direction controlled by fieldbus.	

Input reference select

Using the fieldbus to provide input reference to the drive requires:

- drive parameter value set as defined below
- fieldbus controller supplied reference word(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Protocol reference
1102	EXT1/EXT2 SEL	8 (COMM)	Ref. selected by fieldbus. (Required only if 2 references used.)	
1103	REF1 SELECT	8 (COMM) 9 (COMM+AI1) 10 (COMM*AI1)	Input reference 1supplied by fieldbus.	
1106	REF2 SELECT	8 (COMM) 9 (COMM+AI) 10 (COMM*AI)	Input reference 2 supplied by fieldbus. (Required only if 2 references used.)	

Note: Multiple references are supported only when using the ABB Drives profile.

Scaling

Where required, REFERENCES can be scaled. See the following sections, as appropriate:

- *Reference scaling* on page *252* (*ABB Drives profile technical data*)
- *Reference scaling* on page *256* (*Generic profile technical data*).

System control

Using the fieldbus for miscellaneous drive control requires:

- drive parameter values set as defined below
- fieldbus controller command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Protocol reference
1601	RUN ENABLE	7 (COMM)	Run enable by fieldbus.	
1604	FAULT RESET SEL	8 (COMM)	Fault reset by fieldbus.	
1607	PARAM SAVE	1 (SAVE)	Saves altered parameters to memory (then value returns to 0).	

Relay output control

Using the fieldbus for relay output control requires:

- drive parameter values set as defined below
- fieldbus controller supplied, binary coded, relay command(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Protocol reference
1401	RELAY OUTPUT 1	35 (COMM) 36 (COMM(-1))	Relay Output 1 controlled by fieldbus.	
1402	RELAY OUTPUT 2		Relay Output 2 controlled by fieldbus.	
1403	RELAY OUTPUT 3		Relay Output 3 controlled by fieldbus.	
1410[1]	RELAY OUTPUT 4		Relay Output 4 controlled by fieldbus.	
1411[1]	RELAY OUTPUT 5		Relay Output 5 controlled by fieldbus.	
1412[1]	RELAY OUTPUT 6		Relay Output 6 controlled by fieldbus.	

[1] More than 3 relays requires the addition of a relay extension module.

Note: Relay status feedback occurs without configuration as defined below.

Drive parameter		Value	Protocol reference
0122	RO 1-3 STATUS	Relay 1…3 status.	
0123	RO 4-6 STATUS	Relay 4…6 status.	

Analog output control

Using the fieldbus for analog output control (e.g. PID setpoint) requires:

- drive parameter values set as defined below
- fieldbus controller supplied analog value(s) in the appropriate location. (The location is defined by the Protocol Reference, which is protocol dependent.)

Drive parameter		Value	Description	Protocol reference
1501	AO1 CONTENT SEL	135 (COMM VALUE 1)	Analog Output 1 controlled by writing to parameter 0135.	–
0135	COMM VALUE 1	–		
1502 … 1505	AO1 CONTENT MIN … MAXIMUM AO1	Set appropriate values.	Used for scaling	–
1506	FILTER AO1		Filter time constant for AO1.	–
1507	AO2 CONTENT SEL	136 (COMM VALUE 2)	Analog Output 2 controlled by writing to parameter 0136.	–
0136	COMM VALUE 2	–		
1508 … 1511	AO2 CONTENT MIN … MAXIMUM AO2	Set appropriate values.	Used for scaling	–
1512	FILTER AO2		Filter time constant for AO2.	–

PID Control setpoint source

Using the following settings to select the fieldbus as the setpoint source for PID loops:

Drive parameter		Value	Setting	Protocol reference
4010	SET POINT SEL (Set 1)	8 (COMM VALUE 1) 9 (COMM+AI1) 10 (COMM*AI1)	Setpoint is input reference 2 (+/-/* AI1)	
4110	SET POINT SEL (Set 2)			
4210	SET POINT SEL (Ext/Trim)			

Communication fault

When using fieldbus control, specify the drive's action if serial communication is lost.

Drive parameter		Value	Description
3018	COMM FAULT FUNC	0 (NOT SEL) 1 (FAULT) 2 (CONST SP7) 3 (LAST SPEED)	Set for appropriate drive response.
3019	COMM FAULT TIME	Set time delay before acting on a communication loss.	

Feedback from the drive – FBA

Inputs to the controller (drive outputs) have pre-defined meanings established by the protocol. This feedback does not require drive configuration. The following table lists a sample of feedback data. For a complete listing, see all parameters listed in section *Complete parameter descriptions* on page *106*.

Drive parameter		Protocol reference
0102	SPEED	
0103	OUTPUT FREQ	
0104	CURRENT	
0105	TORQUE	
0106	POWER	
0107	DC BUS VOLTAGE	
0109	OUTPUT VOLTAGE	
0301	FB CMD WORD 1 – bit 0 (STOP)	
0301	FB CMD WORD 1 – bit 2 (REV)	
0118	DI 1-3 STATUS – bit 0 (DI3)	

Scaling

To scale the drive parameter values see the following sections, as appropriate:

- *Actual Value scaling* on page *255* (*ABB Drives profile technical data*)
- *Actual Value scaling* on page *257* (*Generic profile technical data*).

Diagnostics – FBA

Fault handling

The ACS550 provides fault information as follows:

- The control panel display shows a fault code and text. See chapter *Diagnostics* on page *259* for a complete description.
- Parameters 0401 LAST FAULT, 0412 PREVIOUS FAULT1 and 0413 PREVIOUS FAULT2 store the most recent faults.
- For fieldbus access, the drive reports faults as a hexadecimal value, assigned and coded according to the DRIVECOM specification. See the table below. Not all profiles support requesting fault codes using this specification. For profiles that support this specification, the profile documentation defines the proper fault request process.

Drive fault code		Fieldbus fault code (DRIVECOM specification)
1	OVERCURRENT	2310h
2	DC OVERVOLT	3210h
3	DEV OVERTEMP	4210h
4	SHORT CIRC	2340h
5	Reserved	FF6Bh
6	DC UNDERVOLT	3220h
7	AI1 LOSS	8110h
8	AI2 LOSS	8110h
9	MOT OVERTEMP	4310h
10	PANEL LOSS	5300h
11	ID RUN FAIL	FF84h
12	MOTOR STALL	7121h
14	EXT FAULT 1	9000h
15	EXT FAULT 2	9001h
16	EARTH FAULT	2330h
17	Obsolete	FF6Ah
18	THERM FAIL	5210h
19	OPEX LINK	7500h
20	OPEX PWR	5414h
21	CURR MEAS	2211h
22	SUPPLY PHASE	3130h
23	ENCODER ERR	7301h
24	OVERSPEED	7310h
25	Reserved	FF80h
26	DRIVE ID	5400h

Drive fault code		Fieldbus fault code (DRIVECOM specification)
27	CONFIG FILE	630Fh
28	SERIAL 1 ERR	7510h
29	EFB CON FILE	6306h
30	FORCE TRIP	FF90h
31	EFB 1	FF92h
32	EFB 2	FF93h
33	EFB 3	FF94h
34	MOTOR PHASE	FF56h
35	OUTP WIRING	FF95h
36	INCOMPATIBLE SW	630Fh
37	CB OVERTEMP	4110h
38	USER LOAD CURVE	FF6Bh
101	SERF CORRUPT	FF55h
102	Reserved	FF55h
103	SERF MACRO	FF55h
104	Reserved	FF55h
105	Reserved	FF55h
201	DSP T1 OVERLOAD	6100h
202	DSP T2 OVERLOAD	6100h
203	DSP T3 OVERLOAD	6100h
204	DSP STACK ERROR	6100h
205	Reserved (obsolete)	5000h
206	CB ID ERROR	5000h
207	EFB LOAD ERROR	6100h
1000	PAR HZRPM	6320h
1001	PAR PFC REF NEG	6320h
1002	Reserved (obsolete)	6320h
1003	PAR AI SCALE	6320h
1004	PAR AO SCALE	6320h
1005	PAR PCU 2	6320h
1006	PAR EXT RO	6320h
1007	PAR FIELDBUS MISSING	6320h
1008	PAR PFC MODE	6320h
1009	PAR PCU 1	6320h
1012	PAR PFC IO 1	6320h
1013	PAR PFC IO 2	6320h
1014	PAR PFC IO 3	6320h
1016	PAR USER LOAD C	6320h

Serial communication diagnostics

Besides the drive fault codes, the FBA module has diagnostic tools. Refer to the user's manual supplied with the FBA module.

ABB Drives profile technical data

Overview

The ABB Drives profile provides a standard profile that can be used on multiple protocols, including protocols available on the FBA module. This section describes the ABB Drives profile implemented for FBA modules.

Control Word

As described earlier in section *Control interface* on page *238*, the CONTROL WORD is the principal means for controlling the drive from a fieldbus system.

The following table and the state diagram later in this sub-section describe the CONTROL WORD content for the ABB Drives profile.

ABB Drives profile (FBA) CONTROL WORD				
Bit	**Name**	**Value**	**Commanded state**	**Comments**
0	OFF1 CONTROL	1	READY TO OPERATE	Enter READY TO OPERATE
		0	EMERGENCY OFF	Drive ramps to stop according to currently active deceleration ramp (2203 or 2205) Normal command sequence: • Enter OFF1 ACTIVE • Proceed to READY TO SWITCH ON, unless other interlocks (OFF2, OFF3) are active.
1	OFF2 CONTROL	1	OPERATING	Continue operation (OFF2 inactive)
		0	EMERGENCY OFF	Drive coasts to stop. Normal command sequence: • Enter OFF2 ACTIVE • Proceed to SWITCHON INHIBITED
2	OFF3 CONTROL	1	OPERATING	Continue operation (OFF3 inactive)
		0	EMERGENCY STOP	Drive stops within in time specified by parameter 2208. Normal command sequence: • Enter OFF3 ACTIVE • Proceed to SWITCH ON INHIBITED ⚠ **WARNING!** Be sure motor and driven equipment can be stopped using this mode.
3	INHIBIT OPERATION	1	OPERATION ENABLED	Enter OPERATION ENABLED (Note the Run enable signal must be active. See 1601. If 1601 is set to COMM, this bit also actives the Run Enable signal.)
		0	OPERATION INHIBITED	Inhibit operation. Enter OPERATION INHIBITED
4	RAMP_OUT_ ZERO	1	NORMAL OPERATION	Enter RAMP FUNCTION GENERATOR: ACCELERATION ENABLED
		0	RFG OUT ZERO	Force ramp function generator output to Zero. Drive ramps to stop (current and DC voltage limits in force).

ABB Drives profile (FBA) CONTROL WORD				
Bit	**Name**	**Value**	**Commanded state**	**Comments**
5	RAMP_HOLD	1	RFG OUT ENABLED	Enable ramp function. Enter RAMP FUNCTION GENERATOR: ACCELERATOR ENABLED
		0	RFG OUT HOLD	Halt ramping (Ramp Function Generator output held)
6	RAMP_IN_ ZERO	1	RFG INPUT ENABLED	Normal operation. Enter OPERATING
		0	RFG INPUT ZERO	Force Ramp Function Generator input to zero.
7	RESET	0=>1	RESET	Fault reset if an active fault exists (Enter SWITCH-ON INHIBITED). Effective if 1604 = COMM.
		0	OPERATING	Continue normal operation
8…9	Unused			
10	REMOTE_CMD	1		Fieldbus control enabled
		0		• CW ≠ 0 or Ref ≠ 0: Retain last CW and Ref. • CW = 0 and Ref = 0: Fieldbus control enabled. • Ref and deceleration/acceleration ramp are locked.
11	EXT CTRL LOC	1	EXT2 SELECT	Select external control location 2 (EXT2). Effective if 1102 = COMM.
		0	EXT1 SELECT	Select external control location 1 (EXT1). Effective if 1102 = COMM.
12…15	Unused			

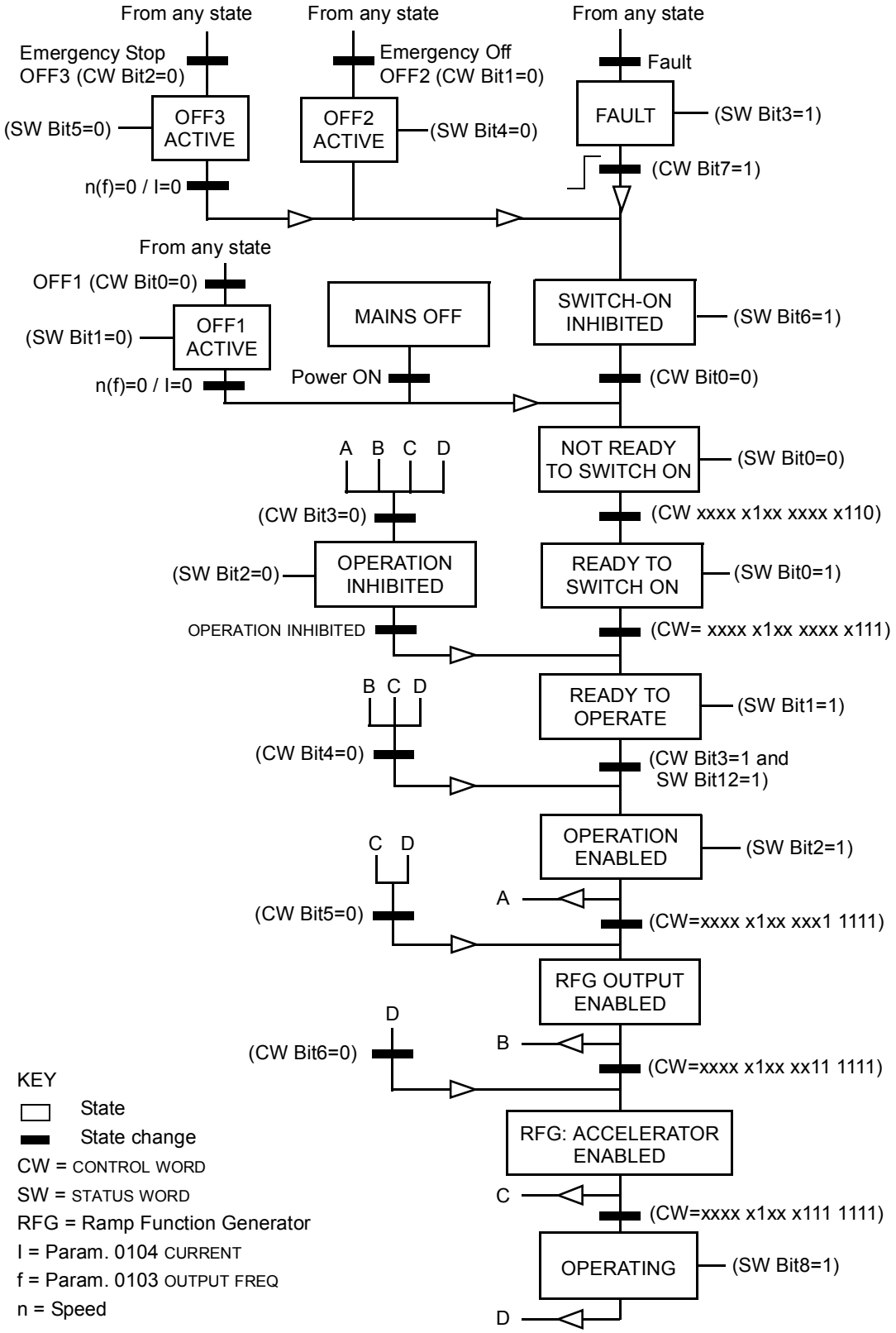
Status Word

As described earlier in section *Control interface* on page *238*, the contents of the STATUS WORD is status information, sent by the drive to the master station. The following table and the state diagram later in this sub-section describe the status word content.

ABB Drives profile (FBA) STATUS WORD			
Bit	**Name**	**Value**	**Description (Correspond to states/boxes in the state diagram)**
0	RDY_ON	1	READY TO SWITCH ON
		0	NOT READY TO SWITCH ON
1	RDY_RUN	1	READY TO OPERATE
		0	OFF1 ACTIVE
2	RDY_REF	1	OPERATION ENABLED
		0	OPERATION INHIBITED
3	TRIPPED	0…1	FAULT
		0	No fault

ABB Drives profile (FBA) STATUS WORD			
Bit	**Name**	**Value**	**Description (Correspond to states/boxes in the state diagram)**
4	OFF_2_STA	1	OFF2 inactive
		0	**OFF2 ACTIVE**
5	OFF_3_STA	1	OFF3 inactive
		0	**OFF3 ACTIVE**
6	SWC_ON_INHIB	1	SWITCH-ON INHIBIT ACTIVE
		0	SWITCH-ON INHIBIT NOT ACTIVE
7	ALARM	1	Alarm (See section *Alarm listing* on page *267* for details on alarms.)
		0	No alarm
8	AT_SETPOINT	1	OPERATING. Actual value equals (within tolerance limits) the reference value.
		0	Actual value is outside tolerance limits (not equal to reference value).
9	REMOTE	1	Drive control location: REMOTE (EXT1 or EXT2)
		0	Drive control location: LOCAL
10	ABOVE_LIMIT	1	Supervised parameter's value ≥ supervision high limit. Bit remains "1" until supervised parameter's value < supervision low limit. See *Group 32: SUPERVISION*.
		0	Supervised parameter's value < supervision low limit. Bit remains "0" until supervised parameter's value > supervision high limit. See *Group 32: SUPERVISION*.
11	EXT CTRL LOC	1	External control location 2 (EXT2) selected
		0	External control location 1 (EXT1) selected
12	EXT RUN ENABLE	1	External Run Enable signal received
		0	No External Run Enable signal received
13… 15	Unused		

The state diagram below describes the start-stop function of CONTROL WORD (CW) and STATUS WORD (SW) bits.



Reference

As described earlier in section *Control interface* on page *238*, the REFERENCE word is a speed or frequency reference.

Reference scaling

The following table describes REFERENCE scaling for the ABB Drives profile.

ABB Drives Profile (FBA)				
Reference	**Range**	**Reference type**	**Scaling**	**Remarks**
REF1	-32767… +32767	Speed or frequency	-20000 = -**(par. 1105)** 0 = 0 +20000 = **(par. 1105)** (20000 corresponds to 100%)	Final reference limited by 1104/1105. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
REF2	-32767… +32767	Speed or frequency	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 1107/1108. Actual motor speed limited by 2001/2002 (speed) or 2007/2008 (frequency).
		Torque	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 2015/2017 (torque1) or 2016/2018 (torque2).
		PID Reference	-10000 = -**(par. 1108)** 0 = 0 +10000 = **(par. 1108)** (10000 corresponds to 100%)	Final reference limited by 4012/4013 (PID set1) or 4112/4113 (PID set2).

Note: The setting of parameter 1104 REF1 MIN and 1107 REF2 MIN has no effect on the scaling of references.

When parameter 1103 REF1 SELECT or 1106 REF2 SELECT is set to COMM+AI1 or COMM*AI1, the reference is scaled as follows:

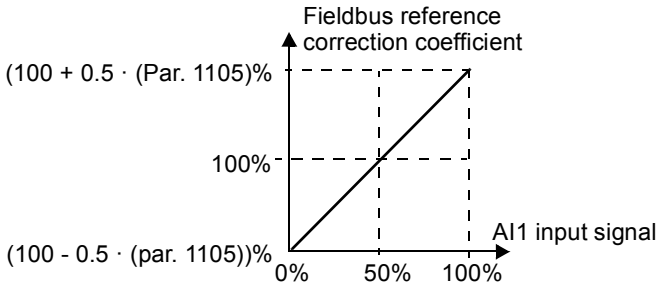
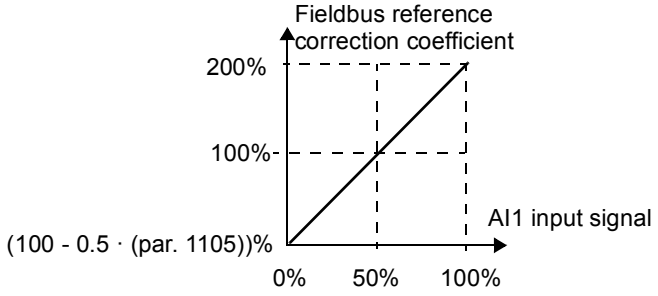
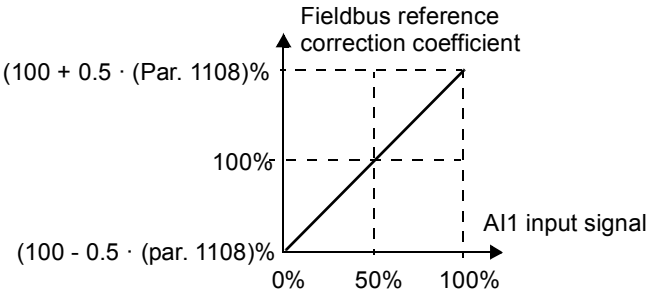
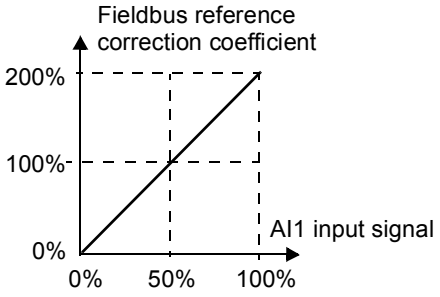
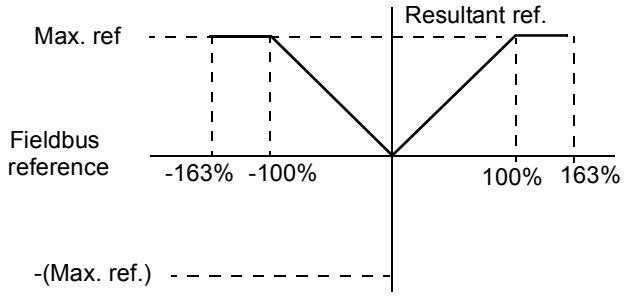
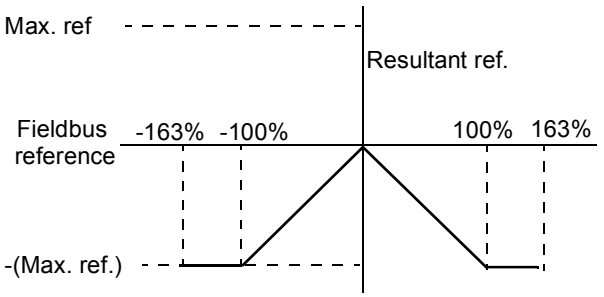
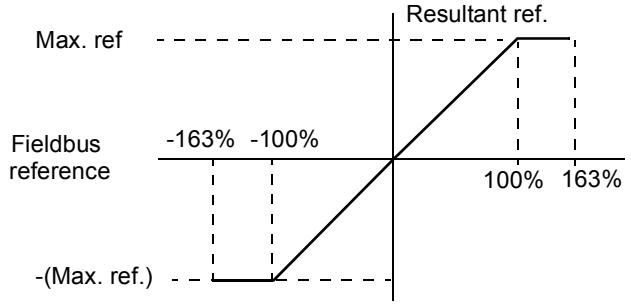
ABB Drives profile (FBA)		
Reference	**Value setting**	**AI reference scaling**
REF1	COMM+AI1	COMM (%) + (AI (%) - 0.5 · REF1 MAX (%)) 

ABB Drives profile (FBA)		
Reference	**Value setting**	**AI reference scaling**
REF1	COMM*AI1	COMM (%) · (AI (%) / 0.5 · REF1 MAX (%)) 
REF2	COMM+AI1	COMM (%) + (AI (%) - 0.5 · REF2 MAX (%)) 
REF2	COMM*AI1	COMM (%) · (AI (%) / 0.5 · REF2 MAX (%)) 

Reference handling

Use *Group 10: START/STOP/DIR* parameters to configure for control of rotation direction for each control location (EXT1 and EXT2). The following diagrams illustrate how group 10 parameters and the sign of the fieldbus reference interact to produce REFERENCE values (REF1 and REF2). Note, fieldbus references are bipolar, that is they can be positive or negative.

ABB Drives profile		
Parameter	**Value setting**	**AI reference scaling**
1003 DIRECTION	1 (FORWARD)	
1003 DIRECTION	2 (REVERSE)	
1003 DIRECTION	3 (REQUEST)	

Actual Value

As described earlier in section *Control interface* on page *238*, Actual Values are words containing drive values.

Actual Value scaling

The scaling of the integers sent to the fieldbus as Actual Values depends on the resolution of the selected drive parameter. Except as noted for ACT1 and ACT2 below, scale the feedback integer using the resolution listed for the parameter in section *Complete parameter list* on page *91*. For example:

Feedback integer	Parameter resolution	Scaled Value
1	0.1 mA	1 · 0.1 mA = 0.1 mA
10	0.1%	10 · 0.1% = 1%

Data words 5 and 6 are scaled as follows:

ABB Drives profile		
	Contents	**Scaling**
ACT1	ACTUAL SPEED	-20000 … +20000 = -(par. 1105) … +(par. 1105)
ACT2	TORQUE	-10000 … +10000 = -100% … +100%

Virtual addresses of the drive control

The virtual address area of the drive control is allocated as follows:

1	Control Word
2	Reference 1 (REF1)
3	Reference 2 (REF2)
4	Status Word
5	Actual Value 1 (ACT1)
6	Actual Value 2 (ACT2)

Generic profile technical data

Overview

The generic profile aims to fulfill the industry-standard drive profile for each protocol (e.g. PROFIdrive for PROFIBUS, AC/DC Drive for DeviceNet).

Control Word

As described earlier in section *Control interface* on page *238*, the CONTROL WORD is the principal means for controlling the drive from a fieldbus system. For specific CONTROL WORD content, see the user's manual provided with the FBA module.

Status Word

As described earlier in section *Control interface* on page *238*, the contents of the STATUS WORD is status information, sent by the drive to the master station. For specific STATUS WORD content, see the user's manual provided with the FBA module.

Reference

As described earlier in section *Control interface* on page *238*, the REFERENCE word is a speed or frequency reference.

Note: REF2 is not supported by the Generic Drive profiles.

Reference scaling

REFERENCE scaling is fieldbus type specific. However, at the drive, the meaning of a 100% REFERENCE value is fixed as described in the table below. For a detailed description on the range and scaling of the REFERENCE, see the user's manual supplied with the FBA module.

Generic profile				
Reference	**Range**	**Reference type**	**Scaling**	**Remarks**
REF	Fieldbus specific	Speed	-100% = -**(par. 9908)** 0 = 0 +100 = **(par. 9908)**	Final reference limited by 1104/1105. Actual motor speed limited by 2001/ 2002 (speed).
		Frequency	-100% = -**(par. 9907)** 0 = 0 +100 = **(par. 9907)**	Final reference limited by 1104/1105. Actual motor speed limited by 2007/ 2008 (frequency).

Actual Values

As described earlier in section *Control interface* on page *238*, Actual Values are words containing drive values.

Actual Value scaling

For Actual Values, scale the feedback integer using the parameter's resolution. (See section *Complete parameter list* on page *91* for parameter resolutions.) For example:

Feedback integer	Parameter resolution	(Feedback integer) · (Parameter resolution) = Scaled Value
1	0.1 mA	1 · 0.1 mA = 0.1 mA
10	0.1%	10 · 0.1% = 1%

Where parameters are in percent, the *Complete parameter list* section specifies what parameter corresponds to 100%. In such cases, to convert from percent to engineering units, multiply by the value of the parameter that defines 100% and divide by 100%. For example:

Feedback integer	Parameter resolution	Value of the parameter that defines 100%	(Feedback integer) · (Parameter resolution) · (Value of 100% ref.) / 100% = Scaled Value
10	0.1%	1500 rpm[1]	10 · 0.1% · 1500 RPM / 100% = 15 rpm
100	0.1%	500 Hz[2]	100 · 0.1% · 500 Hz / 100% = 50 Hz

[1] Assuming, for the sake of this example, that the Actual Value uses parameter 9908 MOT NOM SPEED as the 100% reference and that 9908 = 1500 rpm.

[2] Assuming, for the sake of this example, that the Actual Value uses parameter 9907 MOT NOM FREQ as the 100% reference and that 9907 = 500 Hz.

Actual Value mapping

See the user's manual supplied with the FBA module.

Diagnostics

WARNING! Do not attempt any measurement, parts replacement or other service procedure not described in this manual. Such action will void the warranty, may endanger correct operation and increase downtime and expense.

WARNING! All electrical installation and maintenance work described in this chapter should only be undertaken by qualified service personnel. The safety instructions in chapter *Safety instructions* on page *5* must be followed.

Diagnostic displays

The drive detects error situations and reports them using:

- the green and red LED on the body of the drive
- the status LED on the control panel (if an Assistant Control Panel is attached to the drive)
- the control panel display (if a control panel is attached to the drive)
- the Fault Word and Alarm Word parameter bits (parameters 0305 to 0309). See *Group 03: FB ACTUAL SIGNALS* on page *112* for the bit definitions.

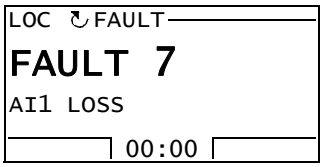
The form of the display depends on the severity of the error. You can specify the severity for many errors by directing the drive to:

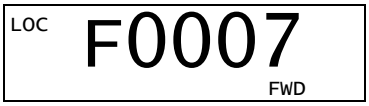
- ignore the error situation
- report the situation as an alarm
- report the situation as a fault.

Red – Faults

The drive signals that it has detected a severe error, or fault, by:

- enabling the red LED on the drive (LED is either steady on or blinking)
- showing the steady red status LED on the control panel (if attached to the drive)
- setting an appropriate bit in a Fault Word parameter (0305 to 0307)
- overriding the control panel display with the display of a fault code in the Fault mode (figures on the right)
- stopping the motor (if it was on).





The fault code on the control panel display is temporary. Pressing any of the following keys removes the fault message: MENU, ENTER, UP, or DOWN key.

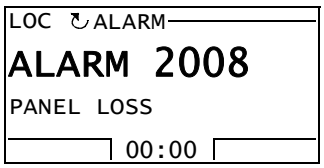
The message reappears after a few seconds if the control panel is not touched and the fault is still active.

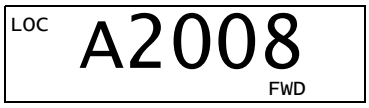
Flashing green – Alarms

For less severe errors, called alarms, the diagnostic display is advisory. For these situations, the drive is simply reporting that it had detected something "unusual." In these situations, the drive:

- flashes the green LED on the drive (does not apply to alarms that arise from control panel operation errors)
- flashes the green LED on the control panel (if attached to the drive)
- sets an appropriate bit in an Alarm Word parameter (0308 or 0309). See *Group 03: FB ACTUAL SIGNALS* on page *112* for the bit definitions
- overrides the control panel display with the display of an alarm code and/or name in the Fault mode (figures on the right).

Alarm messages disappear from the control panel display after a few seconds. The message returns periodically as long as the alarm condition exists.





Correcting faults

The recommended corrective action for faults is:

- Use the table in section *Fault listing* below to find and address the root cause of the problem.
- Reset the drive. See section *Fault resetting* on page *265*.

Fault listing

The following table lists the faults by code number and describes each. The fault name is the long form shown in the Fault mode of the Assistant Control Panel when the fault occurs. The fault names shown (for Assistant Control Panel only) in the Fault Logger mode (see page *61*) and the fault names for parameter 0401 LAST FAULT may be shorter.

Fault code	Fault name in panel	Description and recommended corrective action
1	OVERCURRENT	Output current is excessive. Check for and correct: • Excessive motor load. • Insufficient acceleration time (parameters 2202 ACCELER TIME 1 and 2205 ACCELER TIME 2). • Faulty motor, motor cables or connections.

Fault code	Fault name in panel	Description and recommended corrective action
2	DC OVERVOLT	Intermediate circuit DC voltage is excessive. Check for and correct: • Static or transient overvoltages in the input power supply. • Insufficient deceleration time (parameters 2203 DECELER TIME 1 and 2206 DECELER TIME 2). • Undersized brake chopper (if present). • Verify that overvoltage controller is ON (using parameter 2005).
3	DEV OVERTEMP	Drive heatsink is overheated. Temperature is at or above limit. R1…R4: 115 °C (239 °F) R5, R6: 125 °C (257 °F) Check for and correct: • Fan failure. • Obstructions in the air flow. • Dirt or dust coating on the heat sink. • Excessive ambient temperature. • Excessive motor load.
4	SHORT CIRC	Fault current. Check for and correct: • A short-circuit in the motor cable(s) or motor. • Supply disturbances.
5	RESERVED	Not used.
6	DC UNDERVOLT	Intermediate circuit DC voltage is not sufficient. Check for and correct: • Missing phase in the input power supply. • Blown fuse. • Undervoltage on mains.
7	AI1 LOSS	Analog input 1 loss. Analog input value is less than AI1 FAULT LIMIT (3021). Check for and correct: • Source and connection for analog input. • Parameter settings for AI1 FAULT LIMIT (3021) and 3001 AI<MIN FUNCTION.
8	AI2 LOSS	Analog input 2 loss. Analog input value is less than AI2 FAULT LIMIT (3022). Check for and correct: • Source and connection for analog input. • Parameter settings for AI2 FAULT LIMIT (3022) and 3001 AI<MIN FUNCTION.
9	MOT OVERTEMP	Motor is too hot, based on either the drive's estimate or on temperature feedback. • Check for overloaded motor. • Adjust the parameters used for the estimate (3005…3009). • Check the temperature sensors and *Group 35: MOTOR TEMP MEAS* parameters.
10	PANEL LOSS	Panel communication is lost and either: • Drive is in local control mode (the control panel displays LOC), or • Drive is in remote control mode (REM) and is parameterized to accept start/stop, direction or reference from the control panel. To correct check: • Communication lines and connections. • Parameter 3002 PANEL COMM ERR. • Parameters in *Group 10: START/STOP/DIR* and *Group 11: REFERENCE SELECT* (if drive operation is REM).

Fault code	Fault name in panel	Description and recommended corrective action
11	ID RUN FAIL	The Motor ID Run was not completed successfully. Check for and correct: • Motor connections. • Motor parameters 9905…9909.
12	MOTOR STALL	Motor or process stall. Motor is operating in the stall region. Check for and correct: • Excessive load. • Insufficient motor power. • Parameters 3010…3012.
13	RESERVED	Not used.
14	EXT FAULT 1	Digital input defined to report first external fault is active. See parameter 3003 EXTERNAL FAULT 1.
15	EXT FAULT 2	Digital input defined to report second external fault is active. See parameter 3004 EXTERNAL FAULT 2.
16	EARTH FAULT	Possible ground fault detected in the motor or motor cables. The drive monitors for ground faults while the drive is running and while the drive is not running. Detection is more sensitive when the drive is not running and can produce false positives. Possible corrections: • Check for/correct faults in the input wiring. • Verify that motor cable does not exceed maximum specified length. • Decrease the detection level for earth fault with parameter 3028 EARTH FAULT LVL. • A delta grounded input power supply and motor cables with high capacitance may result in erroneous error reports during non-running tests. To disable response to fault monitoring when the drive is not running, use parameter 3023 WIRING FAULT. To disable response to all ground fault monitoring, use parameter 3017 EARTH FAULT. **Note:** Disabling earth fault (ground fault) may void the warranty.
17	OBSOLETE	Not used.
18	THERM FAIL	Internal fault. The thermistor measuring the internal temperature of the drive is open or shorted. Contact your local ABB representative.
19	OPEX LINK	Internal fault. A communication-related problem has been detected on the fiber optic link between the control and OINT boards. Contact your local ABB representative.
20	OPEX PWR	Internal fault. Exceptionally low voltage detected on the OINT power supply. Contact your local ABB representative.
21	CURR MEAS	Internal fault. Current measurement is out of range. Contact your local ABB representative.
22	SUPPLY PHASE	Ripple voltage in the DC link is too high. Check for and correct: • Missing mains phase. • Blown fuse.

Fault code	Fault name in panel	Description and recommended corrective action
23	ENCODER ERR	The drive is not detecting a valid encoder signal. Check for and correct: • Encoder presence and proper connection (reverse wired = channel A connected to terminal of channel B or vice versa, loose connection or short circuit). • Voltage logic levels are outside of the specified range. • A working and properly connected Pulse Encoder Interface Module, OTAC-01. • Wrong value entered in parameter 5001 PULSE NR. A wrong value will only be detected if the error is such that the calculated slip is greater than 4 times the rated slip of the motor. • Encoder is not being used, but parameter 5002 ENCODER ENABLE = 1 (ENABLE).
24	OVERSPEED	Motor speed is greater than 120% of the larger (in magnitude) of 2001 MINIMUM SPEED or 2002 MAXIMUM SPEED. Check for and correct: • Parameter settings for 2001 and 2002. • Adequacy of motor braking torque. • Applicability of torque control. • Brake chopper and resistor.
25	RESERVED	Not used.
26	DRIVE ID	Internal fault. Configuration Block Drive ID is not valid. Contact your local ABB representative.
27	CONFIG FILE	Internal configuration file has an error. Contact your local ABB representative.
28	SERIAL 1 ERR	Fieldbus communication has timed out. Check for and correct: • Fault setup (3018 COMM FAULT FUNC and 3019 COMM FAULT TIME). • Communication settings (*Group 51: EXT COMM MODULE* or *Group 53: EFB PROTOCOL* as appropriate). • Poor connections and/or noise on line.
29	EFB CON FILE	Error in reading the configuration file for the embedded fieldbus.
30	FORCE TRIP	Fault trip forced by the fieldbus. See the fieldbus User's Manual.
31	EFB 1	Fault code reserved for the embedded fieldbus (EFB) protocol application. The meaning is protocol dependent.
32	EFB 2	
33	EFB 3	
34	MOTOR PHASE	Fault in the motor circuit. One of the motor phases is lost. Check for and correct: • Motor fault. • Motor cable fault. • Thermal relay fault (if used). • Internal fault.
35	OUTP WIRING	Incorrect input power and motor cable connection (i.e., input power cable is connected to drive motor connection). The fault can be erroneously declared if the drive is faulty or the input power is a delta grounded system and the motor cable capacitance is large. This fault can be disabled by using parameter 3023 WIRING FAULT. • Check input power connections. Check grounding.

Fault code	Fault name in panel	Description and recommended corrective action
36	INCOMPATIBLE SW	The drive cannot use the software. • Internal fault. • The loaded software is not compatible with the drive. • Call support representative.
37	CB OVERTEMP	Drive control board is overheated. The fault trip limit is 88 °C. Check for and correct: • Excessive ambient temperature. • Fan failure. • Obstructions in the air flow. Not for drives with an OMIO control board.
38	USER LOAD CURVE	Condition defined by parameter 3701 USER LOAD C MODE has been valid longer than the time defined by 3703 USER LOAD C TIME.
101… 199	SYSTEM ERROR	Error internal to the drive. Contact your local ABB representative and report the error number.
201… 299	SYSTEM ERROR	Error in the system. Contact your local ABB representative and report the error number.
-	UNKNOWN DRIVE TYPE: ACS550 SUPPORTED DRIVES: X	Wrong type of panel, i.e. panel that supports drive X but not the ACS550, has been connected to the ACS550.

Faults that indicate conflicts in the parameter settings are listed below.

Fault code	Fault name in panel	Description and recommended corrective action
1000	PAR HZRPM	Parameter values are inconsistent. Check for any of the following: • 2001 MINIMUM SPEED > 2002 MAXIMUM SPEED. • 2007 MINIMUM FREQ > 2008 MAXIMUM FREQ. • 2001 MINIMUM SPEED / 9908 MOTOR NOM SPEED is outside proper range (> 50). • 2002 MAXIMUM SPEED / 9908 MOTOR NOM SPEED is outside proper range (> 50). • 2007 MINIMUM FREQ / 9907 MOTOR NOM FREQ is outside proper range (> 50). • 2008 MAXIMUM FREQ / 9907 MOTOR NOM FREQ is outside proper range (> 50).
1001	PAR PFC REF NEG	Parameter values are inconsistent. Check for the following: • 2007 MINIMUM FREQ is negative, when 8123 PFC ENABLE is active.
1002	RESERVED	Not used.
1003	PAR AI SCALE	Parameter values are inconsistent. Check for any of the following: • 1301 MINIMUM AI1 > 1302 MAXIMUM AI1. • 1304 MINIMUM AI2 > 1305 MAXIMUM AI2.
1004	PAR AO SCALE	Parameter values are inconsistent. Check for any of the following: • 1504 MINIMUM AO1 > 1505 MAXIMUM AO1. • 1510 MINIMUM AO2 > 1511 MAXIMUM AO2.

Fault code	Fault name in panel	Description and recommended corrective action
1005	PAR PCU 2	Parameter values for power control are inconsistent: Improper motor nominal kVA or motor nominal power. Check for the following: • 1.1 ≤ (9906 MOTOR NOM CURR · 9905 MOTOR NOM VOLT · 1.73 / P_N) ≤ 3.0 where: P_N = 1000 · 9909 MOTOR NOM POWER (if units are kW) or P_N = 746 · 9909 MOTOR NOM POWER (if units are hp, e.g. in US)
1006	PAR EXT RO	Parameter values are inconsistent. Check for the following: • Extension relay module not connected and • 1410…1412 RELAY OUTPUTS 4…6 have non-zero values.
1007	PAR FIELDBUS MISSING	Parameter values are inconsistent. Check for and correct: • A parameter is set for fieldbus control (e.g. 1001 EXT1 COMMANDS = 10 (COMM)), but 9802 COMM PROT SEL = 0.
1008	PAR PFC MODE	Parameter values are inconsistent – 9904 MOTOR CTRL MODE must be = 3 (SCALAR:FREQ), when 8123 PFC ENABLE is activated.
1009	PAR PCU 1	Parameter values for power control are inconsistent: Improper motor nominal frequency or speed. Check for both of the following: • 1 ≤ (60 · 9907 MOTOR NOM FREQ / 9908 MOTOR NOM SPEED ≤ 16 • 0.8 ≤ 9908 MOTOR NOM SPEED / (120 · 9907 MOTOR NOM FREQ / Motor Poles) ≤ 0.992
1010/ 1011	RESERVED	Not used.
1012	PAR PFC IO 1	IO configuration is not complete – not enough relays are parameterized to PFC. Or, a conflict exists between *Group 14: RELAY OUTPUTS*, parameter 8117 NR OF AUX MOT and parameter 8118 AUTOCHNG INTERV.
1013	PAR PFC IO 2	IO configuration is not complete – the actual number of PFC motors (parameter 8127, MOTORS) does not match the PFC motors in *Group 14: RELAY OUTPUTS* and parameter 8118 AUTOCHNG INTERV.
1014	PAR PFC IO 3	IO configuration is not complete – the drive is unable to allocate a digital input (interlock) for each PFC motor (parameters 8120 INTERLOCKS and 8127 MOTORS).
1015	RESERVED	Not used.
1016	PAR USER LOAD C	Parameter values for the user load curve are inconsistent. Check that the following conditions are met: • 3704 LOAD FREQ 1 ≤ 3707 LOAD FREQ 2 ≤ 3710 LOAD FREQ 3 ≤ 3713 LOAD FREQ 4 ≤ 3716 LOAD FREQ 5. • 3705 LOAD TORQ LOW 1 ≤ 3706 LOAD TORQ HIGH 1. • 3708 LOAD TORQ LOW 2 ≤ 3709 LOAD TORQ HIGH 2. • 3711 LOAD TORQ LOW 3 ≤ 3712 LOAD TORQ HIGH 3. • 3714 LOAD TORQ LOW 4 ≤ 3715 LOAD TORQ HIGH 4. • 3717 LOAD TORQ LOW 5 ≤ 3718 LOAD TORQ HIGH 5.

Fault resetting

The ACS550 can be configured to automatically reset certain faults. Refer to parameter *Group 31: AUTOMATIC RESET*.

WARNING! If an external source for start command is selected and it is active, the ACS550 may start immediately after fault reset.

Flashing red LED

To reset the drive for faults indicated by a flashing red LED:

- Turn the power off for 5 minutes.

Red LED

To reset the drive for faults indicated by a red LED (on, not flashing), correct the problem and do one of the following:

- Press RESET from the control panel.
- Turn the power off for 5 minutes.

Depending on the value of 1604 FAULT RESET SEL, the following could also be used to reset the drive:

- digital input
- serial communication.

When the fault has been corrected, the motor can be started.

History

For reference, the last three fault codes are stored into parameters 0401, 0412, 0413. For the most recent fault (identified by parameter 0401), the drive stores additional data (in parameters 0402…0411) to aid in troubleshooting a problem. For example, parameter 0404 stores the motor speed at the time of the fault.

The Assistant Control Panel provides additional information about the fault history. See section *Fault Logger mode* on page *61* for more information.

To clear the fault history (all of the *Group 04: FAULT HISTORY* parameters):

1. Using the control panel in the Parameters mode, select parameter 0401.
2. Press EDIT (or ENTER on the Basic Control Panel).
3. Press UP and DOWN at the same time.
4. Press SAVE.

Correcting alarms

The recommended corrective action for alarms is:

- Determine if the alarm requires any corrective action (action is not always required).
- Use the table in section *Alarm listing* below to find and address the root cause of the problem.

Alarm listing

The following table lists the alarms by code number and describes each.

Alarm code	Display	Description
2001	OVERCURRENT	Current limiting controller is active. Check for and correct: • Excessive motor load. • Insufficient acceleration time (parameters 2202 ACCELER TIME 1 and 2205 ACCELER TIME 2). • Faulty motor, motor cables or connections.
2002	OVERVOLTAGE	Overvoltage controller is active. Check for and correct: • Static or transient overvoltages in the input power supply. • Insufficient deceleration time (parameters 2203 DECELER TIME 1 and 2206 DECELER TIME 2).
2003	UNDERVOLTAGE	Undervoltage controller is active. Check for and correct: • Undervoltage on mains.
2004	DIR LOCK	The change in direction being attempted is not allowed. Either: • Do not attempt to change the direction of motor rotation, or • Change parameter 1003 DIRECTION to allow direction change (if reverse operation is safe).
2005	IO COMM	Fieldbus communication has timed out. Check for and correct: • Fault setup (3018 COMM FAULT FUNC and 3019 COMM FAULT TIME). • Communication settings (*Group 51: EXT COMM MODULE* or *Group 53: EFB PROTOCOL* as appropriate). • Poor connections and/or noise on line.
2006	AI1 LOSS	Analog input 1 is lost, or value is less than the minimum setting. Check: • Input source and connections. • Parameter that sets the minimum (3021). • Parameter that sets the alarm/fault operation (3001),
2007	AI2 LOSS	Analog input 2 is lost, or value is less than the minimum setting. Check: • Input source and connections. • Parameter that sets the minimum (3022). • Parameter that sets the alarm/fault operation (3001).
2008	PANEL LOSS	Panel communication is lost and either: • Drive is in local control mode (the control panel displays LOC), or • Drive is in remote control mode (REM) and is parameterized to accept start/stop, direction or reference from the control panel. To correct check: • Communication lines and connections. • Parameter 3002 PANEL COMM ERR. • Parameters in *Group 10: START/STOP/DIR* and *Group 11: REFERENCE SELECT* (if drive operation is REM).

Alarm code	Display	Description
2009	DEVICE OVERTEMP	Drive heatsink is hot. This alarm warns that a DEVICE OVERTEMP fault may be near. R1…R4: 100 °C (212 °F) R5, R6: 110 °C (230 °F) Check for and correct: • Fan failure. • Obstructions in the air flow. • Dirt or dust coating on the heat sink. • Excessive ambient temperature. • Excessive motor load.
2010	MOTOR TEMP	Motor is hot, based on either the drive's estimate or on temperature feedback. This alarm warns that a MOT OVERTEMP fault trip may be near. Check: • Check for overloaded motor. • Adjust the parameters used for the estimate (3005…3009). • Check the temperature sensors and *Group 35: MOTOR TEMP MEAS*.
2011	RESERVED	Not used.
2012	MOTOR STALL	Motor is operating in the stall region. This alarm warns that a MOTOR STALL fault trip may be near.
2013 (Note 1)	AUTORESET	This alarm warns that the drive is about to perform an automatic fault reset, which may start the motor. • To control automatic reset, use *Group 31: AUTOMATIC RESET*.
2014 (Note 1)	AUTOCHANGE	This alarm warns that the PFC autochange function is active. • To control PFC, use *Group 81: PFC CONTROL* and the *PFC macro* on page *84*.
2015	PFC I LOCK	This alarm warns that the PFC interlocks are active, which means that the drive cannot start the following: • Any motor (when Autochange is used). • The speed regulated motor (when Autochange is not used).
2016/ 2017	RESERVED	Not used.
2018 (Note 1)	PID SLEEP	This alarm warns that the PID sleep function is active, which means that the motor could accelerate when the PID sleep function ends. • To control PID sleep, use parameters 4022…4026 or 4122…4126.
2019	ID RUN	Performing ID Run.
2020	RESERVED	Not used.
2021	START ENABLE 1 MISSING	This alarm warns that the Start Enable 1 signal is missing. • To control Start Enable 1 function, use parameter 1608. To correct, check: • Digital input configuration. • Communication settings.
2022	START ENABLE 2 MISSING	This alarm warns that the Start Enable 2 signal is missing. • To control Start Enable 2 function, use parameter 1609. To correct, check: • Digital input configuration. • Communication settings.

Alarm code	Display	Description
2023	EMERGENCY STOP	Emergency stop activated.
2024	ENCODER ERROR	The drive is not detecting a valid encoder signal. Check for and correct: • Encoder presence and proper connection (reverse wired, loose connection or short circuit). • Voltage logic levels are outside of the specified range. • A working and properly connected Pulse Encoder Interface Module, OTAC-01. • Wrong value entered in parameter 5001 PULSE NR. A wrong value will only be detected if the error is such that the calculated slip is greater than 4 times the rated slip of the motor. • Encoder is not being used, but parameter 5002 ENCODER ENABLE = 1 (ENABLE).
2025	FIRST START	Signals that a the drive is performing a First Start evaluation of motor characteristics. This is normal the first time the motor is run after motor parameters are entered or changed. See parameter 9910 ID RUN for a description of motor models.
2026	RESERVED	Not used.
2027	USER LOAD CURVE	This alarm warns that the condition defined by parameter 3701 USER LOAD C MODE has been valid longer than half of the time defined by 3703 USER LOAD C TIME.
2028	START DELAY	Shown during the Start delay. See parameter 2113 START DELAY.

Note 1. Even when the relay output is configured to indicate alarm conditions (e.g. parameter 1401 RELAY OUTPUT 1 = 5 (ALARM) or 16 (FLT/ALARM)), this alarm is not indicated by a relay output.

Alarm codes (Basic Control Panel)

The Basic Control Panel indicates control panel alarms with a code, A5xxx. The following table lists the alarm codes and descriptions.

Code	Description
5001	Drive is not responding.
5002	The communication profile is incompatible with the drive.
5010	The panel's parameter backup file is corrupted.
5011	Drive is controlled from another source.
5012	Rotation direction is locked.
5013	Button is disabled, because start is inhibited.
5014	Button is disabled, because drive is faulted.
5015	Button is disabled, because local mode lock is on.
5018	Parameter default value can't be found.
5019	Writing a non-zero value is prohibited (can only write a zero value).
5020	Group or parameter does not exist or parameter value is inconsistent.
5021	Group or parameter is hidden.
5022	Group or parameter is write protected.
5023	Modification is not allowed while the drive is running.

Code	Description
5024	Drive is busy, try again.
5025	Write is not allowed while upload or download is in progress.
5026	Value is at or below low limit.
5027	Value is at or above high limit.
5028	Value is invalid – doesn't match any values in the discrete values list.
5029	Memory is not ready, try again.
5030	Request is invalid.
5031	Drive is not ready, e.g due to low DC voltage.
5032	Parameter error was detected.
5040	Selected parameter set can't be found in the current parameter backup.
5041	Parameter backup doesn't fit into memory.
5042	Selected parameter set can't be found in the current parameter backup.
5043	No start inhibit was granted.
5044	Parameter backup versions do not match.
5050	Parameter upload was aborted.
5051	File error was detected.
5052	Parameter upload attempt has failed.
5060	Parameter download was aborted.
5062	Parameter download attempt has failed.
5070	Panel backup memory write error was detected.
5071	Panel backup memory read error was detected.
5080	Operation is not allowed, because the drive is not in local mode.
5081	Operation is not allowed, because a fault is active.
5083	Operation is not allowed, because parameter lock is not open.
5084	Operation is not allowed, because drive is busy, try again.
5085	Download is not allowed, because drive types are incompatible.
5086	Download is not allowed, because drive models are incompatible.
5087	Download is not allowed, because parameter sets do not match.
5088	Operation failed, because a drive memory error was detected.
5089	Download failed, because a CRC error was detected.
5090	Download failed, because a data processing error was detected.
5091	Operation failed, because a parameter error was detected.
5092	Download failed, because parameter sets do not match.

Maintenance

WARNING! Read chapter *Safety instructions* on page *5* before performing any maintenance on the equipment. Ignoring the safety instructions can cause injury or death.

Maintenance intervals

If installed in an appropriate environment, the drive requires very little maintenance. This table lists the routine maintenance intervals recommended by ABB.

Maintenance	Interval	Instruction
Heatsink temperature check and cleaning	Depends on the dustiness of the environment (every 6…12 months)	See *Heatsink* on page *271*.
Main cooling fan replacement	Every six years	See *Main fan replacement* on page *272*.
Internal enclosure cooling fan replacement (IP54 / UL type 12 drives)	Every three years.	See *Internal enclosure fan replacement* on *274*.
Capacitor reforming	Every year when stored	See *Reforming* on page *275*.
Capacitor replacement (frame sizes R5 and R6)	Every nine years	See *Replacement* on page *275*.
Replace battery in the Assistant Control Panel	Every ten years	See *Battery* on page *275*.

Consult your local ABB representative for more details on the maintenance. On the Internet, go to www.abb.com/drives and select *Service – Maintenance*.

Heatsink

The heatsink fins accumulate dust from the cooling air. Since a dusty heatsink is less efficient at cooling the drive, overtemperature faults become more likely. In a "normal" environment (not dusty, not clean) check the heatsink annually, in a dusty environment check more often.

Clean the heatsink as follows (when necessary):

1. Remove power from the drive.
2. Remove the cooling fan (see section *Main fan replacement* on page *272*).
3. Blow clean compressed air (not humid) from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust.

Note: If there is a risk of the dust entering adjoining equipment, perform the cleaning in another room.

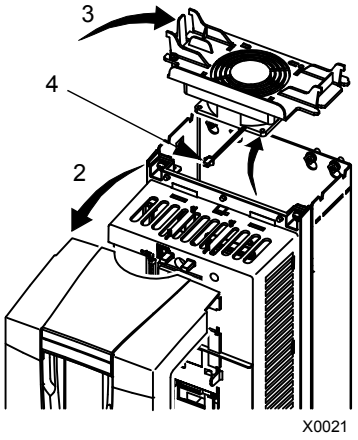
4. Reinstall the cooling fan.
5. Restore power.

Main fan replacement

Fan failure can be predicted by the increasing noise from fan bearings and the gradual rise in the heatsink temperature in spite of heatsink cleaning. If the drive is operated in a critical part of a process, fan replacement is recommended once these symptoms start appearing. Replacement fans are available from ABB. Do not use other than ABB specified spare parts.

Frame sizes R1...R4

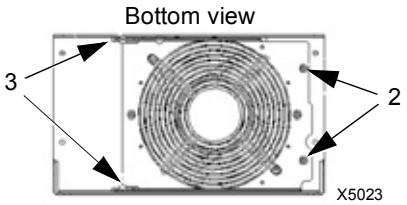
To replace the fan:



1. Remove power from the drive.
2. Remove drive cover.
3. For frame size:
   - R1, R2: Press together the retaining clips on the fan cover sides, and lift.
   - R3, R4: Press in on the lever located on the left side of the fan mount, and rotate the fan up and out.
4. Disconnect the fan cable.
5. Reinstall the fan in reverse order.
6. Restore power.

Frame size R5

To replace the fan:



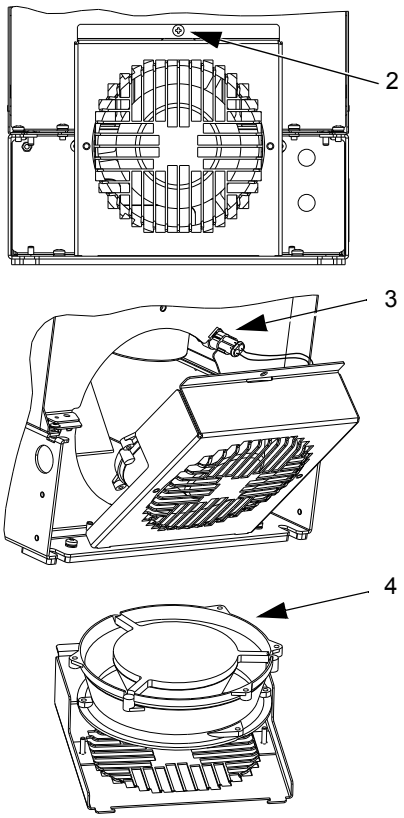
1. Remove power from drive.
2. Remove the screws attaching the fan.
3. Remove the fan: Swing the fan out on its hinges.
4. Disconnect the fan cable.
5. Reinstall the fan in reverse order.
6. Restore power.

Arrows in the fan show the directions of the rotation and air flow.

Frame size R6

To replace the fan:

1. Remove power from the drive.
2. Remove the screw attaching the fan casing and let the casing lean down against the limiters.
3. Slide out the cable connector and disconnect it.
4. Take off the casing and replace the fan onto the casing's pins.
5. Reinstall the casing in reverse order.
6. Restore power.



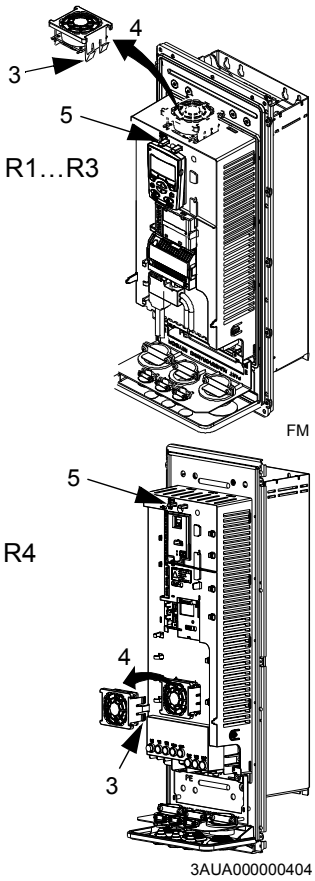
Internal enclosure fan replacement

IP54 / UL type 12 enclosures have an additional internal fan to circulate air inside the enclosure.

Frame sizes R1…R4

To replace the internal enclosure fan in frame sizes R1 to R3 (located at the top of the drive) and R4 (located in front of the drive):

1. Remove power from the drive.
2. Remove the front cover.
3. The housing that holds the fan in place has barbed retaining clips at each corner. Press all four clips toward the center to release the barbs.
4. When the clips/barbs are free, pull the housing up to remove from the drive.
5. Disconnect the fan cable.
6. Install the fan in reverse order, noting that:
   - The fan air flow is up (refer to the arrow on fan).
   - The fan wire harness is toward the front.
   - The notched housing barb is located in the right-rear corner.
   - The fan cable connects just forward of the fan at the top of the drive.



Frame sizes R5 and R6

To replace the internal enclosure fan in frame sizes R5 or R6:

1. Remove power from the drive.
2. Remove the front cover.
3. Lift the fan out and disconnect the cable.
4. Install the fan in reverse order.
5. Restore power.

Capacitors

Reforming

The drive DC link capacitors need to be reformed (re-aged) if the drive has been non-operational for more than one year. Without reforming, capacitors may be damaged when the drive starts to operate. It is therefore recommended to reform the capacitors once a year. See section *Serial number* on page *17* for how to check the date of manufacture from the serial number shown on the drive labels.

For information on reforming the capacitors, refer to *Guide for Capacitor Reforming in ACS50, ACS55, ACS150, ACS310, ACS350, ACS355, ACS550, ACH550 and R1-R4 OINT-/SINTboards* (3AFE68735190 [English]), available on the Internet (go to www.abb.com and enter the code in the Search field).

Replacement

The drive intermediate circuit employs several electrolytic capacitors. Capacitor life can be prolonged by lowering the ambient temperature.

It is not possible to predict a capacitor failure. Capacitor failure is usually followed by a input power fuse failure or a fault trip. Contact ABB if capacitor failure is suspected. Replacements for frame size R5 and R6 are available from ABB. Do not use other than ABB specified spare parts.

Control panel

Cleaning

Use a soft damp cloth to clean the control panel. Avoid harsh cleaners which could scratch the display window.

Battery

A battery is only used in Assistant Control Panels that have the clock function available and enabled. The battery keeps the clock operating in memory during power interruptions.

To remove the battery, use a coin to rotate the battery holder on the back of the control panel. Replace the battery with type CR2032.

Note: The battery is NOT required for any control panel or drive function, except the clock.

Technical data

Ratings

By type designation, the table below provides ratings for the ACS550 adjustable speed AC drive, including:

- IEC ratings
- NEMA ratings (shaded columns)
- frame size.

Ratings, 208…240 V drives

Abbreviated column headers are described in section *Symbols* on page *279*.

Type	Normal use			Heavy-duty use			Frame size
ACS550-x1- see below	I_{2N} A	P_N kW	P_N hp	I_{2hd} A	P_{hd} kW	P_{hd} hp	
Three-phase supply voltage, 208…240 V							
-04A6-2	4.6	0.75	1	3.5	0.55	0.75	R1
-06A6-2	6.6	1.1	1.5	4.6	0.75	1	R1
-07A5-2	7.5	1.5	2	6.6	1.1	1.5	R1
-012A-2	11.8	2.2	3	7.5	1.5	2	R1
-017A-2	16.7	4	5	11.8	2.2	3	R1
-024A-2	24.2	5.5	7.5	16.7	4	5	R2
-031A-2	30.8	7.5	10	24.2	5.5	7.5	R2
-046A-2	46.2	11	15	30.8	7.5	10	R3
-059A-2	59.4	15	20	46.2	11	15	R3
-075A-2	74.8	18.5	25	59.4	15	20	R4
-088A-2	88.0	22	30	74.8	18.5	25	R4
-114A-2	114	30	40	88.0	22	30	R4
-143A-2	143	37	50	114	30	40	R6
-178A-2	178	45	60	150	37	50	R6
-221A-2	221	55	75	178	45	60	R6
-248A-2	248	75	100	192	55	75	R6

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Ratings, 380…480 V drives

Abbreviated column headers are described in section *Symbols* on page *279*.

Type	Normal use			Heavy-duty use			Frame size
ACS550-x1- see below	I_{2N} **A**	P_N **kW**	P_N **hp**	I_{2hd} **A**	P_{hd} **kW**	P_{hd} **hp**	
Three-phase supply voltage, **380**…**480 V**							
-03A3-4	3.3	1.1	1.5	2.4	0.75	1	R1
-04A1-4	4.1	1.5	2	3.3	1.1	1.5	R1
-05A4-4	5.4	2.2	Note 1	4.1	1.5	Note 1	R1
-06A9-4	6.9	3	3	5.4	2.2	3	R1
-08A8-4	8.8	4	5	6.9	3	3	R1
-012A-4	11.9	5.5	7.5	8.8	4	5	R1
-015A-4	15.4	7.5	10	11.9	5.5	7.5	R2
-023A-4	23	11	15	15.4	7.5	10	R2
-031A-4	31	15	20	23	11	15	R3
-038A-4	38	18.5	25	31	15	20	R3
-045A-4	45	22	30	38	18.5	25	R3
-059A-4	59	30	40	44	22	30	R4
-072A-4	72	37	50	59	30	40	R4
-078A-4	77	Note 2	60	72	Note 2	50	R4
-087A-4	87	45	Note 1	72	37	Note 1	R4
-097A-4	97	Note 2	75	77	Note 2	60	R4
-125A-4	125	55	Note 1	87	45	Note 1	R5
-125A-4	125	Note 2	100	96	Note 2	75	R5
-157A-4	157	75	125	124	55	100	R6
-180A-4	180	90	150	156	75	125	R6
-195A-4	205	110	Note 1	162	90	Note 1	R6
-246A-4	246	132	200	192	110	150	R6
-290A-4	290	160	Note 1	246	132	200	R6

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1. Not available in ACS550-U1 series.
2. Not available in ACS550-01 series.

Ratings, 500…600 V drives

Abbreviated column headers are described in section *Symbols* on page *279*.

Type	Normal use			Heavy-duty use			Frame size
ACS550-U1- see below	I_{2N} A	P_N kW	P_N hp	I_{2hd} A	P_{hd} kW	P_{hd} hp	
Three-phase supply voltage, **500**…**600 V** (Note 1)							
-02A7-6	2.7	1.5	2	2.4	1.1	1.5	R2
-03A9-6	3.9	2.2	3	2.7	1.5	2	R2
-06A1-6	6.1	4	5	3.9	2.2	3	R2
-09A0-6	9.0	5.5	7.5	6.1	4	5	R2
-011A-6	11	7.5	10	9.0	5.5	7.5	R2
-017A-6	17	11	15	11	7.5	10	R2
-022A-6	22	15	20	17	11	15	R3
-027A-6	27	18.5	25	22	15	20	R3
-032A-6	32	22	30	27	18.5	25	R4
-041A-6	41	30	40	32	22	30	R4
-052A-6	52	37	50	41	30	40	R4
-062A-6	62	45	60	52	37	50	R4
-077A-6	77	55	75	62	45	60	R6
-099A-6	99	75	100	77	55	75	R6
-125A-6	125	90	125	99	75	100	R6
-144A-6	144	110	150	125	90	125	R6

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1. Not available in ACS550-01 series.

Symbols

Typical ratings:

Normal use (10% overload capability)

I_{2N} continuous rms current. 10% overload is allowed for one minute in ten minutes.

P_N typical motor power in normal use. The kilowatt power ratings apply to most IEC, 4-pole motors. The horsepower ratings apply to most 4-pole NEMA motors.

Heavy-duty use (50% overload capability)

I_{2hd} continuous rms current. 50% overload is allowed for one minute in ten minutes.

P_{hd} typical motor power in heavy duty use. The kilowatt power ratings apply to most IEC, 4-pole motors. The horsepower ratings apply to most 4-pole NEMA motors.

Sizing

The current ratings are the same regardless of the supply voltage within one voltage range. To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. Also note that:

- the ratings apply for ambient temperature of 40 °C (104 °F)
- the maximum allowed motor shaft power is limited to $1.5 \cdot P_{hd}$. If the limit is exceeded, motor torque and current are automatically restricted. The function protects the input bridge of the drive against overload.

In multimotor systems, the output current of the drive must be equal to or greater than the calculated sum of the input currents of all motors.

Derating

The load capacity (current and power) decreases for certain situations, as defined below. In such situations, where full motor power is required, oversize the drive so that the derated value provides sufficient capacity.

For example, if your application requires 15.4 A of motor current and a 8 kHz switching frequency, calculate the appropriate drive size requirement as follows:

The minimum size required = 15.4 A / 0.80 = 19.25 A

Where: 0.80 is the derating for 8 kHz switching frequency (see section *Switching frequency derating* on page *280*).

Referring to I_{2N} in the ratings tables (starting from page *277*), the following drives exceed the I_{2N} requirement of 19.25 A: ACS550-x1-023A-4, or ACS550-x1-024A-2.

Temperature derating

In the temperature range +40 °C...50 °C (+104 °F...122 °F), the rated output current is decreased 1% for every 1 °C (1.8 °F) above +40 °C (+104 °F). Calculate the output current by multiplying the current given in the rating table by the derating factor.

Example If the ambient temperature is 50 °C (+122 °F), the derating factor is 100% - 1%/°C · 10 °C = 90% or 0.90.
The output current is then 0.90 · I_{2N} or 0.90 · I_{2hd}.

Altitude derating

In altitudes 1000...4000 m (3300...13,200 ft) above sea level, the derating is 1% for every 100 m (330 ft). If the installation site is higher than 2000 m (6600 ft) above sea level, contact your local ABB representative for further information.

Single phase supply derating

For 208…240 V series drives, a single phase supply can be used. In that case, the derating is 50%.

Switching frequency derating

When using the 8 kHz switching frequency (parameter 2606),

- derate all rated currents and powers (including drive's overload currents) to 80%.

When using the 12 kHz switching frequency (parameter 2606),

- derate all rated currents and powers (including drive's overload currents) to 65% (to 50% for 600 V, R4 frame sizes, that is for ACS550-U1-032A-6 … ACS550-U1-062A-6),
- derate ambient temperature maximum to 30 °C (86 °F).
- Note: The continuous maximum current is limited to I_{2hd}.

Note: Setting parameter 2607 SWITCH FREQ CTRL = 1 (ON) allows the drive to reduce the switching frequency if/when the drive's internal temperature exceeds 80 °C (with 12 kHz switching frequency) or 90 °C (with 8 kHz switching frequency). See the parameter description for 2607 for details.

Input power connections

WARNING! Do not operate the drive outside the nominal input line voltage range. Overvoltage can result in permanent damage to the drive.

Input power specifications

Input power (mains) connection specifications	
Voltage (U_1)	208/220/230/240 V AC 3-phase (or 1-phase) -15%…+10% for ACS550-x1-xxxx-2. 380/400/415/440/460/480 V AC 3-phase -15%…+10% for ACS550-x1-xxxx-4. 500/525/575/600 V AC 3-phase -15%…+10% for ACS550-U1-xxxx-6.
Prospective short-circuit current (IEC 629)	Maximum allowed prospective short-circuit current in the supply is 100 kA providing that the input power cable of the drive is protected with appropriate fuses. US: 100 000 AIC.
Frequency	48…63 Hz
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)
Cable temperature rating	90 °C (194 °F) rating minimum

Disconnecting device for isolation

Install a hand-operated input disconnecting device (disconnecting means) between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work.

- **Europe**: To meet the European Union Directives, according to standard EN 60204-1, Safety of Machinery, the disconnecting device must be one of the following types:
  - a switch-disconnector of utilization category AC-23B (EN 60947-3)
  - a disconnector having an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
  - a circuit breaker suitable for isolation in accordance with EN 60947-2.
- **Other regions**: The disconnecting device must conform to the applicable safety regulations.

Fuses

Branch circuit protection must be provided by the end user and sized per national and local electric codes. The following tables provide fuse recommendations for short circuit protection on the drive's input power.

The rated fuse currents given in the tables are the maximums for the mentioned fuse types. If smaller fuse ratings are used, check that the fuse rms current rating is larger than the input current.

Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the fuse type, the supply network impedance as well as the cross-sectional area, material and length of the supply cable. In case the 0.5 seconds operating time is exceeded with the gG or T fuses, ultra rapid (aR) fuses will in most cases reduce the operating time to an acceptable level.

Fuses, 208…240 V drives

ACS550-x1- see below	Input current A	Input power (mains) fuses		
		IEC 60269 gG (A)	UL Class T (A)	Bussmann type
-04A6-2	4.6	10	10	JJS-10
-06A6-2	6.6			
-07A5-2	7.5			
-012A-2	11.8	16	15	JJS-15
-017A-2	16.7	25	25	JJS-25
-024A-2	24.2		30	JJS-30
-031A-2	30.8	40	40	JJS-40
-046A-2	46.2	63	60	JJS-60
-059A-2	59.4		80	JJS-80
-075A-2	74.8	80	100	JJS-100
-088A-2	88.0	100	110	JJS-110
-114A-2	114	125	150	JJS-150
-143A-2	143	200	200	JJS-200
-178A-2	178	250	250	JJS-250
-221A-2	221	315	300	JJS-300
-248A-2	248		350	JJS-350

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Fuses, 380…480 V drives

ACS550-x1- see below	Input current A	Input power (mains) fuses		
		IEC 60269 gG (A)	UL Class T (A)	Bussmann type
-03A3-4	3.3	10	10	JJS-10
-04A1-4	4.1			
-05A4-4	5.4			
-06A9-4	6.9			
-08A8-4	8.8		15	JJS-15
-012A-4	11.9	16		
-015A-4	15.4		20	JJS-20
-023A-4	23	25	30	JJS-30
-031A-4	31	35	40	JJS-40
-038A-4	38	50	50	JJS-50
-045A-4	45		60	JJS-60
-059A-4	59	63	80	JJS-80
-072A-4	72	80	90	JJS-90
-078A-4	77		100	JJS-100

ACS550-x1- see below	Input current A	Input power (mains) fuses		
		IEC 60269 gG (A)	UL Class T (A)	Bussmann type
-087A-4	87	125	125	JJS-125
-097A-4	97			
-125A-4	125	160	175	JJS-175
-157A-4	157	200	200	JJS-200
-180A-4	180	250	250	JJS-250
-195A-4	205			
-246A-4	246	315	350	JJS-350
-290A-4	290			

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Fuses, 500…600 V drives

ACS550-U1- see below	Input current A	Input power (mains) fuses		
		IEC 60269 gG (A)	UL Class T (A)	Bussmann type
-02A7-6	2.7	10	10	JJS-10
-03A9-6	3.9			
-06A1-6	6.1			
-09A0-6	9.0	16	15	JJS-15
-011A-6	11			
-017A-6	17	25	25	JJS-25
-022A-6	22			
-027A-6	27	35	40	JJS-40
-032A-6	32			
-041A-6	41	50	50	JJS-50
-052A-6	52	60	60	JJS-60
-062A-6	62	80	80	JJS-80
-077A-6	77		100	JJS-100
-099A-6	99	125	150	JJS-150
-125A-6	125	160	175	JJS-175
-144A-6	144	200	200	JJS-200

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Emergency stop devices

The overall design of the installation must include emergency stop devices and any other safety equipment that may be needed. Pressing STOP on the drive's control panel does NOT:

- generate an emergency stop of the motor
- separate the drive from dangerous potential.

Input power cables/wiring

Input wiring can be any of:

- a four conductor cable (three phases and ground/protective earth). Shielding is not required.
- four insulated conductors routed through conduit.

Size wiring according to local safety regulations, appropriate input voltage and the drive's load current.

Note: The conductor must be less than the maximum limit defined by the terminal size. Check the maximum wire size according to the table in section *Drive's power connection terminals* on page *286*.

The table below lists copper and aluminium cable types for different load currents. These recommendations apply only for the conditions listed at the top of the table.

IEC					NEC	
Based on: • EN 60204-1 and IEC 60364-5-2 • PVC insulation • 30 °C (86 °F) ambient temperature • 70 °C (158 °F) surface temperature • cables with concentric copper shield • not more than nine cables laid on cable ladder side by side.					Based on: • NEC Table 310-16 for copper wires • 90 °C (194 °F) wire insulation • 40 °C (104 °F) ambient temperature • not more than three current-carrying conductors in raceway or cable, or earth (directly buried) • copper cables with concentric copper shield.	
Max. load current A	**Cu cable mm²**		**Max. load current A**	**Al cable mm²**	**Max. load current A**	**Cu wire size AWG/kcmil**
14	3×1.5				22.8	14
20	3×2.5				27.3	12
27	3×4				36.4	10
34	3×6				50.1	8
47	3×10				68.3	6
62	3×16		61	3x25	86.5	4
79	3×25		75	3x35	100	3
98	3×35		91	3×50	118	2
119	3×50		117	3×70	137	1
153	3×70		143	3×95	155	1/0
186	3×95		165	3×120	178	2/0
215	3×120		191	3×150	205	3/0
249	3×150		218	3×185	237	4/0
284	3×185		257	3×240	264	250 MCM or 2 × 1
330	3×240		274	3× (3×50)	291	300 MCM or 2 × 1/0
			285	2× (3×95)	319	350 MCM or 2 × 2/0

Ground connections

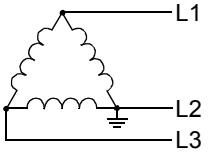
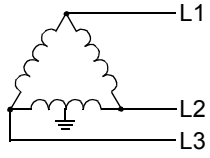
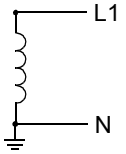
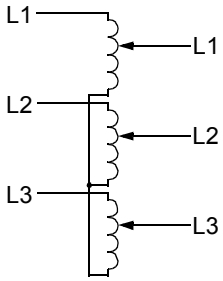
For personnel safety, proper operation and reduction of electromagnetic emission/ pick-up, the drive and the motor must be grounded at the installation site.

- Conductors must be adequately sized as required by safety regulations.
- Power cable shields must be connected to the drive PE terminal in order to meet safety regulations.
- Power cable shields are suitable for use as equipment grounding conductors only when the shield conductors are adequately sized as required by safety regulations.
- In multiple drive installations, do not connect drive terminals in series.

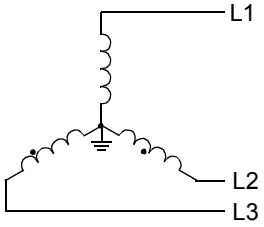
Corner-grounded TN systems

WARNING! Do not attempt to install or remove the EMC filter screws EM1, EM3, F1 or F2 while power is applied to the drive's input terminals.

Corner-grounded TN systems are defined in the following table. In such systems, disconnect the internal ground connection through the EMC filter capacitors (do this also if the grounding configuration of the system is unknown), see section *Disconnecting the internal EMC filter* on page *27*.

Corner-grounded TN systems – EMC filter must be disconnected			
Grounded at the corner of the delta		Grounded at the mid point of a delta leg	
Single phase, grounded at an end point		Three phase "Variac" without solidly grounded neutral	

The EMC filter capacitors make an internal ground connection that reduces electro-magnetic emission. Where EMC (electro-magnetic compatibility) is a concern, and the system is symmetrically grounded, the EMC filter may be connected. For reference, the diagram on the right illustrates a symmetrically grounded TN system (TN-S system).



IT systems

WARNING! Do not attempt to install or remove the EMC filter screws EM1, EM3, F1 or F2 while power is applied to the drive's input terminals.

For IT systems (an ungrounded power system or a high-resistance-grounded [over 30 ohm] power system):

- Disconnect the ground connection to the internal EMC filter, see section *Disconnecting the internal EMC filter* on page *27*.
- Where EMC requirements exist, check for excessive emission propagated to neighboring low voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, use a supply transformer with static screening between the primary and secondary windings.
- Do NOT install an external RFI/EMC filter. Using an EMC filter grounds the input power through the filter capacitors, which could be dangerous and could damage the drive.

Drive's power connection terminals

The following table provides specifications for the drive's power connection terminals.

Note: See the recommended cable sizes for different load currents in section *Input power cables/wiring* on page *284*.

Frame size	U1, V1, W1 U2, V2, W2 BRK+, UDC+ terminals						Earthing PE terminal			
	Minimum wire size		Maximum wire size		Tightening torque		Maximum wire size		Tightening torque	
	mm^2	AWG	mm^2	AWG	N·m	lb·ft	mm^2	AWG	N·m	lb·ft
R1	0.75	18	10	8	1.4	1	10	8	1.4	1
R2	0.75	18	10	8	1.4	1	10	8	1.4	1
R3	2.5	14	25	3	2.5	1.8	16	6	1.8	1.3
R4	6	10	50	1/0	5.6	4	25	3	2	1.5
R5	6	10	70	2/0	15	11	70	2/0	15	11
R6	95[1]	3/0[1]	240	350 MCM	40	30	95	3/0	8	6

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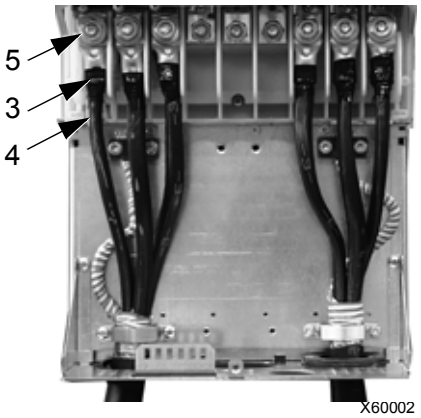
[1] See section *Power terminal considerations – R6 frame size* on page *287*.

Power terminal considerations – R6 frame size

WARNING! For R6 power terminals, if screw-on terminal lugs are supplied, they can only be used for wire sizes that are 95 mm^2 (3/0 AWG) or larger. Smaller wires will loosen and may damage the drive. They require crimp-on ring lugs as described below.

Crimp-on ring lugs

On the R6 frame size, if screw-on terminal lugs are supplied but the cable size used is less than 95 mm^2 (3/0 AWG), or if no screw-on terminal lugs are supplied at all, use crimp-on ring lugs according to the following procedure.



1. Select appropriate ring lugs from the following table.
2. Remove the screw-on terminal lugs, if supplied.
3. Attach the ring lugs to the drive end of the cables.
4. Isolate the ends of the ring lugs with insulating tape or shrink tubing.
5. Attach the ring lugs to the drive.

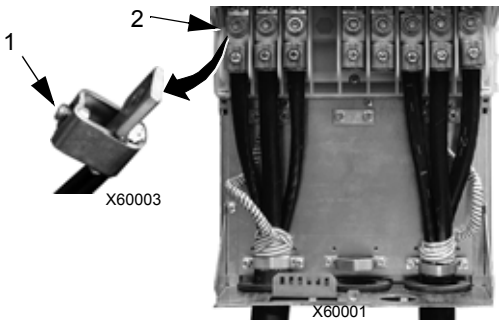
Wire size		Manufacturer	Ring lug	Crimping tool	No. of crimps
mm^2	kcmil/ AWG				
16	6	Burndy	YAV6C-L2	MY29-3	1
		Ilsco	CCL-6-38	ILC-10	2
25	4	Burndy	YA4C-L4BOX	MY29-3	1
		Ilsco	CCL-4-38	MT-25	1
35	2	Burndy	YA2C-L4BOX	MY29-3	2
		Ilsco	CRC-2	IDT-12	1
		Ilsco	CCL-2-38	MT-25	1
50	1	Burndy	YA1C-L4BOX	MY29-3	2
		Ilsco	CRA-1-38	IDT-12	1
		Ilsco	CCL-1-38	MT-25	1
		Thomas & Betts	54148	TBM-8	3
55	1/0	Burndy	YA25-L4BOX	MY29-3	2
		Ilsco	CRB-0	IDT-12	1
		Ilsco	CCL-1/0-38	MT-25	1
		Thomas & Betts	54109	TBM-8	3

Wire size		Manufacturer	Ring lug	Crimping tool	No. of crimps
mm^2	kcmil/ AWG				
70	2/0	Burndy	YAL26T38	MY29-3	2
		Ilsco	CRA-2/0	IDT-12	1
		Ilsco	CCL-2/0-38	MT-25	1
		Thomas & Betts	54110	TBM-8	3
95	3/0	Burndy	YAL27T38	MY29-3	2
		Ilsco	CRA-3/0	IDT-12	1
		Ilsco	CCL-3/0-38	MT-25	1
		Thomas & Betts	54111	TBM-8	3
95	3/0	Burndy	YA28R4	MY29-3	2
		Ilsco	CRA-4/0	IDT-12	1
		Ilsco	CCL-4/0-38	MT-25	2
		Thomas & Betts	54112	TBM-8	4

Screw-on terminal lugs

Use the following procedure to attach cables if screw-on terminal lugs are supplied and the cable size is 95 mm^2 (3/0 AWG) or larger.

1. Attach the supplied screw-on lugs to the drive end of the cables.
2. Attach screw-on lugs to the drive.



Motor connections

WARNING! Never connect line power to the drive output terminals: U2, V2 or W2. Line voltage applied to the output can result in permanent damage to the drive. If frequent bypassing is required, use mechanically interlocked switches or contactors.

WARNING! Do not connect any motor with a nominal voltage less than one half of the drive's nominal input voltage.

WARNING! Disconnect the drive before conducting any voltage tolerance (Hi-Pot) test or insulation resistance (Megger) test on the motor or motor cables. Do not conduct these tests on the drive.

Motor connection specifications

<table>
<tr><th colspan="2">Motor connection specifications</th></tr>
<tr><td>Voltage (U_2)</td><td>0…U_1, 3-phase symmetrical, U_{max} at the field weakening point</td></tr>
<tr><td>Frequency</td><td>0…500 Hz</td></tr>
<tr><td>Frequency resolution</td><td>0.01 Hz</td></tr>
<tr><td>Current</td><td>See section Ratings on page 277.</td></tr>
<tr><td>Field weakening point</td><td>10…500 Hz</td></tr>
<tr><td>Switching frequency</td><td>Selectable. See the availability in the table below.
<table>
<tr><th></th><th>1, 2, 4 and 8 kHz</th><th>12 kHz</th></tr>
<tr><td>208…240 V</td><td>All types</td><td>Frame sizes R1…R4 in scalar control mode</td></tr>
<tr><td>380…480 V</td><td>All types</td><td>Frame sizes R1…R4 (except ACS550-01-097A-4) in scalar control mode</td></tr>
<tr><td>500…600 V</td><td>All types</td><td>Frame sizes R2…R4 in scalar control mode</td></tr>
</table></td></tr>
<tr><td>Cable temperature rating</td><td>90 °C (194 °F) rating minimum.</td></tr>
<tr><td>Maximum motor cable length</td><td>See section Motor cable lengths on page 289.</td></tr>
</table>

Motor cable lengths

Maximum motor cable lengths for 400 V and 600 V drives are given in the sections below.

In multimotor systems, the calculated sum of all motor cable lengths must not exceed the maximum motor cable length given in the appropriate table below.

Motor cable length for 400 V drives

The table below shows the maximum motor cable lengths for 400 V drives with different switching frequencies. Examples for using the table are also given.

Maximum cable length for 400 V drives																		
Frame size	EMC limits												Operational limits					
	Second environment (category C3[1])						First environment (category C2[1])						Basic unit				With du/dt filters	
	1 kHz		4 kHz		8 kHz		1 kHz		4 kHz		8 kHz		1/4 kHz		8/12 kHz			
	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
R1	300	980	300	980	300	980	300	980	300	980	300	980	100	330	100	330	150	490
R2	300	980	300	980	300	980	300	980	100	330	30	98	200	660	100	330	250	820
R3	300	980	300	980	300	980	300	980	75	245	75	245	200	660	100	330	250	820
R4	300	980	300	980	300	980	300	980	75	245	75	245	200	660	100	330	300	980
R5	100	330	100	330	100	330	100	330	100	330	100	330	300	980	150[2]	490[2]	300	980
R6	100	330	100	330	[3]	[3]	100	330	100	330	[3]	[3]	300	980	150[2]	490[2]	300	980

[1] See the new terms in section *IEC/EN 61800-3:2004 Definitions* on page *311*.

[2] 12 kHz switching frequency is not available.

[3] Not tested.

Sine filters further extend the cable lengths.

Under heading "Operational limits", the "Basic unit" columns define the cable lengths with which the basic drive unit works without problems within the drive specification, without installing any further options. Column "With du/dt filters" defines the cable lengths when an external du/dt filter is used.

The columns under heading "EMC limits" show the maximum cable lengths with which the units have been tested for EMC emissions. The factory guarantees that these cable lengths meet the EMC standard requirements.

If external sine filters are installed, longer cable lengths can be used. With sine filters the limiting factors are the voltage drop of the cable, which has to be taken into account in engineering, as well as the EMC limits (where applicable).

The default switching frequency is 4 kHz.

WARNING! Using a motor cable longer than specified in the table above may cause permanent damage to the drive.

Examples for using the table:

Requirements	Checking and conclusions
R1 frame size, 8 kHz fsw, Category C2, 150 m (490 ft) cable	Check operational limits for R1 and 8 kHz -> for a 150 m (490 ft) cable a du/dt filter is needed. Check EMC limits -> EMC requirements for Category C2 are met with a 150 m (490 ft) cable.

Requirements	Checking and conclusions
R3 frame size, 4 kHz fsw, Category C3, 300 m (980 ft) cable	Check operational limits for R3 and 4 kHz -> a 300 m (980 ft) cable cannot be used even with a du/dt filter. A sine filter must be used and the voltage drop of the cable must be taken into account in the installation. Check EMC limits -> EMC requirements for Category C3 are met with a 300 m (980 ft) cable.
R5 frame size, 8 kHz fsw, Category C3, 150 m (490 ft) cable	Check operational limits for R5 and 8 kHz -> for a 150 m (490 ft) cable the basic unit is sufficient. Check EMC limits -> EMC requirements for Category C3 cannot be met with a 300 m (980 ft) cable. The installation configuration is not possible. An EMC plan is recommended to overcome the situation.
R6 frame size, 4 kHz fsw, EMC limits not applicable, 150 m (490 ft) cable	Check operational limits for R6 and 4 kHz -> for a 150 m (490 ft) cable the basic unit is sufficient. EMC limits do not need to be checked as there are no EMC requirements.

Motor cable length for 600 V drives

The table below shows the maximum motor cable lengths for 600 V drives with different switching frequencies. As the 600 V drives are not CE approved, cable lengths for EMC limits are not given.

Maximum cable length for 600 V drives				
Frame size	Operational limits			
	1/4 kHz		8/12 kHz	
	m	ft	m	ft
R2	100	330	100	330
R3…R4	200	660	100	330
R6	300	980	150[2]	490[2]

[2] 12 kHz switching frequency is not available.

WARNING! Using a motor cable longer than specified in the table above may cause permanent damage to the drive.

Motor thermal protection

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value (see parameter 3501 SENSOR TYPE), the function either monitors a calculated temperature value (based on a motor thermal model, see parameters 3005 MOT THERM PROT … 3009 BREAK POINT FREQ) or an actual temperature indication given by motor temperature sensors (see *Group 35: MOTOR TEMP MEAS*). The user can tune the thermal model further by feeding in additional motor and load data.

The most common temperature sensors are:

- motor sizes IEC180…225: thermal switch (e.g. Klixon)
- motor sizes IEC200…250 and larger: PTC or PT100.

Ground fault protection

ACS550 internal fault logic detects ground faults in the drive, motor, or motor cable. This fault logic:

- is NOT a personal safety or fire protection feature
- can be disabled using parameter 3017 EARTH FAULT

  Note: Disabling earth fault (ground fault) may void the warranty.
- could be tripped by leakage currents (input power to ground) associated with long high capacitance motor cables.

Grounding and routing

Motor cable shielding

Motor cables require shielding using conduit, armored cable or shielded cable.

- Conduit – When using conduit:
  - Bridge joints with a ground conductor bonded to the conduit on each side of the joint.
  - Bond conduit run to the drive enclosure.
  - Use a separate conduit run for motor cables (also separate input power and control cables).
  - Use a separate conduit run for each drive.
- Armored cable – When using armored cable:
  - Use six-conductor (3 phases and 3 grounds), type MC continuous corrugated aluminium armor cable with symmetrical grounds.
  - Armored motor cable can share a cable tray with input power cables, but not with control cables.
- Shielded cable – For shielded cable details, see section *Motor cable requirements for CE & C-Tick compliance* on page *293*.

Grounding

See section *Ground connections* on page *285*.

For CE compliant installations and installations where EMC emissions must be minimized, see section *Effective motor cable shields* on page *294*.

Drive's motor connection terminals

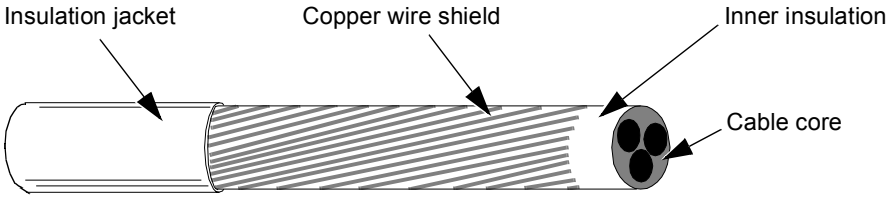
The drive's motor and input power terminals have the same specifications. See section *Drive's power connection terminals* on page *286*.

Motor cable requirements for CE & C-Tick compliance

The requirements in this section apply for CE or C-Tick compliance.

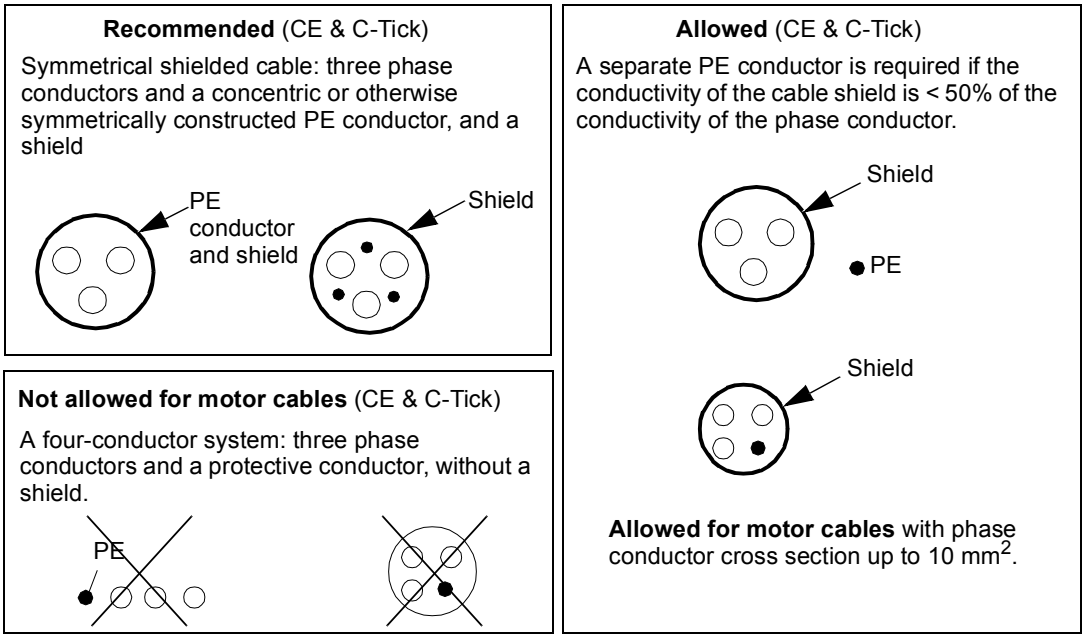
Minimum requirement (CE & C-Tick)

The motor cable must be a symmetrical three conductor cable with a concentric PE conductor or a four conductor cable with a concentric shield, however, a symmetrical constructed PE conductor is always recommended. The following figure shows the minimum requirement for the motor cable shield (for example, MCMK, Draka NK Cables).



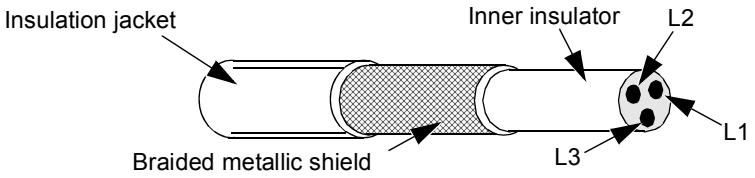
Recommendation for conductor layout

The following figure compares conductor layout features in motor cables.



Effective motor cable shields

The general rule for cable shield effectiveness is: the better and tighter the cable's shield, the lower the radiated emission level. The following figure shows an example of an effective construction (for example Ölflex-Servo-FD 780 CP, Lappkabel or MCCMK, NK Cables).



EN 61800-3 compliant motor cables

The most efficient EMC filtering can be achieved by following these rules:

- Motor cables must have an effective shield as described in section *Effective motor cable shields* on page *294*.
- Motor cable shield wires must be twisted together into a bundle (pig-tail) – the bundle length must be less than five times its width – and connected to the terminal marked ⏚ (at the bottom right-hand corner of the drive).
- At the motor end, the motor cable shield must be earthed 360 degrees with an EMC cable gland, or the shield wires must be twisted together into a bundle (pig-tail) not longer than five times its width and connected to the PE terminal of the motor.
- See section *Motor cable length for 400 V drives*, columns "*EMC limits*" on page *290* to check the maximum motor cable lengths and the need for filters for 400 V drives for IEC/EN 61800-3 compliance.

WARNING! Do not use RFI/EMC filters on IT systems.

Brake components

Availability

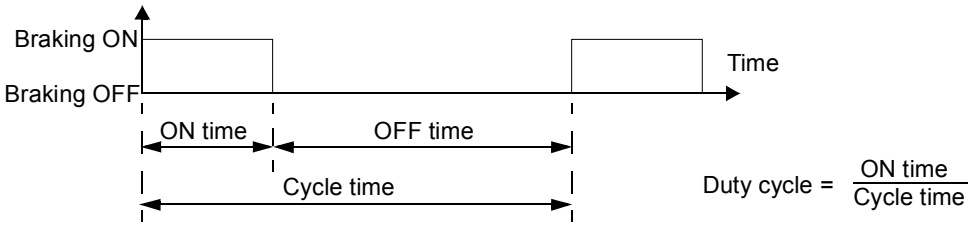
Braking availability for ACS550 drives, by frame size is:

- R1 and R2 – a built-in brake chopper is standard equipment. Add appropriate resistor, as determined using the following section. Resistors are available from ABB.
- R3…R6 – does not include an internal brake chopper. Connect a chopper and a resistor, or a brake unit to the DC link terminals on the drive. Contact your ABB representative for appropriate parts.

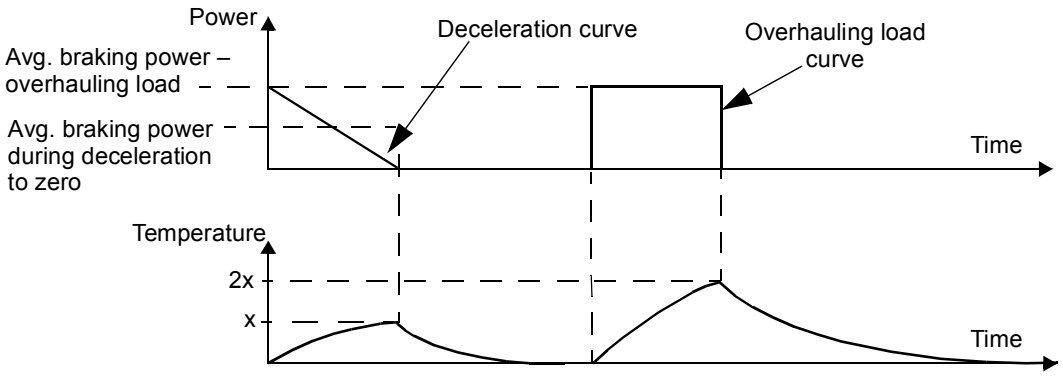
Selecting the braking resistors (frame sizes R1 and R2)

Braking resistor must meet three requirements:

- Resistance must be always higher than the minimum value R_{MIN} defined for the drive type in the following tables. Never use resistance below this value.
- Resistance must be low enough to be able to produce the desired braking torque. To achieve the maximum braking torque (the larger of 150% of heavy duty or 110% of nominal duty), the resistance must not exceed R_{MAX}. If maximum braking torque is not necessary, resistor values can exceed R_{MAX}.
- The resistor power rating must be high enough to dissipate the braking power. This requirement involves many factors:
  - the maximum continuous power rating for the resistor(s)
  - the rate at which the resistor changes temperature (resistor thermal time constant)
  - maximum braking time ON – If the regeneration (braking) power is larger than the resistor rated power, there is a limit to the ON time, or the resistor overheats before the OFF period begins.
  - minimum braking time OFF – If the regeneration (braking) power is larger than the resistor rated power, the OFF time must be large enough for the resistor to cool between ON periods.



  - the peak braking power requirement
  - type of braking (deceleration to zero vs. overhauling load) – During deceleration to zero, the generated power steadily decreases, averaging half of the peak power. For an overhauling load, the braking is countering an external force (gravity for example) and the braking power is constant. The total heat generated from an overhauling load is double the heat generated from deceleration to zero speed (for the same peak torque and ON time).



The many variables in the last requirement above are most easily dealt with using the following tables.

- First, determine your maximum braking time ON (ON_{MAX}), minimum braking time OFF (OFF_{MIN}) and load type (deceleration or overhauling load).
- Calculate duty cycle:

$$\text{Duty cycle} = \frac{ON_{MAX}}{(ON_{MAX} + OFF_{MIN})} \cdot 100\%$$

- In the appropriate table, find the column that best matches your data:
  - $ON_{MAX} \leq$ column specification and
  - Duty cycle $\leq$ column specification
- Find the row that matches your drive.
- The minimum power rating for deceleration to zero is the value in the selected row/column.
- For overhauling loads, double the rating in the selected row/column, or use the "Continuous ON" column.

208…240 V drives

Type ACS550-01/U1- see below	Resistance		Resistor[1] minimum continuous power rating				
			Deceleration-to-zero rating				P_{rcont} Continuous ON > 60 s ON > 25% Duty
	R_{MAX}	R_{MIN}	P_{r3} ≤ 3 s ON ≥ 27 s OFF ≤ 10% Duty	P_{r10} ≤ 10 s ON ≥ 50 s OFF ≤ 17% Duty	P_{r30} ≤ 30 s ON ≥ 180 s OFF ≤ 14% Duty	P_{r60} ≤ 60 s ON ≥ 180 s OFF ≤ 25% Duty	
	ohm	ohm	W	W	W	W	W
Three-phase supply voltage, **208…240 V**							
-04A6-2	234	80	45	80	120	200	1100
-06A6-2	160	80	65	120	175	280	1500
-07A5-2	117	44	85	160	235	390	2200
-012A-2	80	44	125	235	345	570	3000
-017A-2	48	44	210	390	575	950	4000
-024A-2	32	30	315	590	860	1425	5500
-031A-2	23	22	430	800	1175	1940	7500

[1] Resistor time constant specification must be ≥ 85 seconds.

380…480 V drives

Type ACS550-01/U1- see below	Resistance		Resistor[1] minimum continuous power rating				
			Deceleration-to-zero rating				P_{rcont} Continuous ON > 60 s ON > 25% Duty
	R_{MAX}	R_{MIN}	P_{r3} ≤ 3 s ON ≥ 27 s OFF ≤ 10% Duty	P_{r10} ≤ 10 s ON ≥ 50 s OFF ≤ 17% Duty	P_{r30} ≤ 30 s ON ≥ 180 s OFF ≤ 14% Duty	P_{r60} ≤ 60 s ON ≥ 180 s OFF ≤ 25% Duty	
	ohm	ohm	W	W	W	W	W
Three-phase supply voltage, **380**…**480 V**							
-03A3-4	641	120	65	120	175	285	1100
-04A1-4	470	120	90	160	235	390	1500
-05A4-4	320	120	125	235	345	570	2200
-06A9-4	235	80	170	320	470	775	3000
-08A8-4	192	80	210	400	575	950	4000
-012A-4	128	80	315	590	860	1425	5500
-015A-4	94	63	425	800	1175	1950	7500
-023A-4	64	63	625	1175	1725	2850	11000

[1] Resistor time constant specification must be ≥ 85 seconds.

500…600 V drives

Type ACS550-U1- see below	Resistance		Resistor[1] minimum continuous power rating				
			Deceleration-to-zero rating				P_{rcont} Continuous ON > 60 s ON > 25% Duty
	R_{MAX}	R_{MIN}	P_{r3} ≤ 3 s ON ≥ 27 s OFF ≤ 10% Duty	P_{r10} ≤ 10 s ON ≥ 50 s OFF ≤ 17% Duty	P_{r30} ≤ 30 s ON ≥ 180 s OFF ≤ 14% Duty	P_{r60} ≤ 60 s ON ≥ 180 s OFF ≤ 25% Duty	
	ohm	ohm	W	W	W	W	W
Three-phase supply voltage, **500…600 V**							
-02A7-6	548	80	93	175	257	425	1462
-03A9-6	373	80	137	257	377	624	2144
-06A1-6	224	80	228	429	629	1040	3573
-09A0-6	149	80	342	643	943	1560	5359
-011A-6	110	60	467	877	1286	2127	7308
-017A-6	75	60	685	1286	1886	3119	10718

[1] Resistor time constant specification must be ≥ 85 seconds.

WARNING! Never use a brake resistor with a resistance below the minimum value specified for the particular drive. The drive and the internal chopper are not able to handle the overcurrent caused by the low resistance.

Symbols

R_{MIN} – Minimum allowed resistance of the braking resistor.

R_{MAX} – Maximum resistance allowed if maximum braking torque is necessary.

P_{rx} – Duty-cycle based resistor power rating in deceleration braking, where "x" is ON_{MAX} time.

Installing and wiring resistors

All resistors must be installed outside the drive module in a place where they can dissipate heat.

WARNING! The surface temperature of the resistor is very high, and air flowing from the resistor is very hot. Materials near the brake resistor must be non-flammable. Provide protection from accidental contact with the resistor.

To ensure that the input fuses protect the resistor cable, use resistor cables with the same rating as used for the power input to the drive.

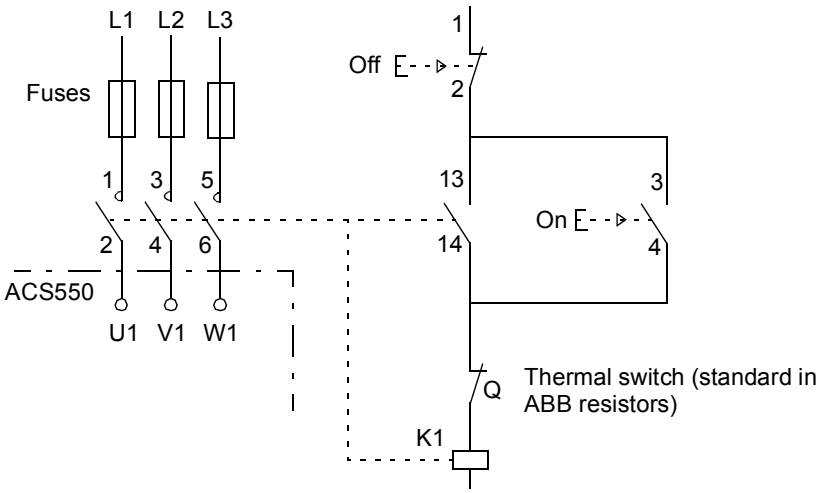
The maximum length of the resistor cable(s) is 10 m (33 ft). See section *Power connection diagrams* on page *25* for the resistor cable connection points.

Mandatory circuit protection

The following setup is essential for safety – it interrupts the main supply in fault situations involving chopper shorts:

- Equip the drive with a main contactor.
- Wire the contactor so that it opens if the resistor thermal switch opens (an overheated resistor opens the contactor).

Below is a simple wiring diagram example.



Parameter set-up

To enable dynamic braking, switch off the drive's overvoltage control [Set parameter 2005 = 0 (DISABLE)].

Control connections

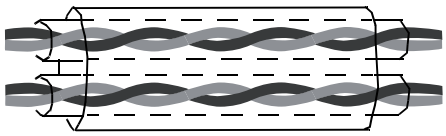
Control connection specifications

Control connection specifications	
Analog inputs and outputs	See section *Control terminals table* on page *28*.
Digital inputs	Digital input impedance 1.5 kohm. Maximum voltage for digital inputs is 30 V.
Relays (digital outputs)	• Max. contact voltage: 30 V DC, 250 V AC • Max. contact current / power: 6 A, 30 V DC; 1500 VA, 250 V AC • Max. continuous current: 2 A rms (cos φ = 1), 1 A rms (cos φ = 0.4) • Minimum load: 500 mW (12 V, 10 mA) • Contact material: Silver-nickel (AgN) • Isolation between relay digital outputs, test voltage: 2.5 kV rms, 1 minute
Cable specifications	See section *Control terminals table* on page *28*.

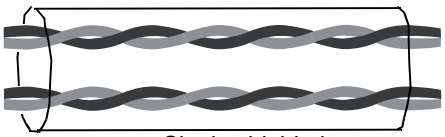
Control cables

General recommendations

Use multi-core cables with a braided copper wire shield, temperature rated at 60 °C (140 °F) or above:



Double shielded
Example: JAMAK by Draka NK Cables



Single shielded
Example: NOMAK by Draka NK Cables

For digital and analog I/O cables, twist the shield together into a bundle (pig-tail) not longer than five times its width and connect it to terminal X1-1 at the drive end. Leave the other end of the cable shield unconnected.

For connecting the shield wires of the RS485 cable, see the instructions (and notes) in section *Mechanical and electrical installation – EFB* on page *204*.

Route control cables to minimize radiation to the cable:

- Route as far away as possible from the input power and motor cables (at least 20 cm [8 in]).
- Where control cables must cross power cables, make sure they are at an angle as near 90° as possible.
- Stay at least 20 cm (8 in) from the sides of the drive.

Use care in mixing signal types on the same cable:

- Do not mix relay-controlled signals using more than 30 V and other control signals in the same cable.
- Run relay-controlled signals as twisted pairs (especially if voltage > 48 V). Relay-controlled signals using less than 48 V can be run in the same cables as digital input signals.

Note: Never mix 24 V DC and 115/230 V AC signals in the same cable.

Analog cables

Recommendations for analog signal runs:

- Use double shielded, twisted pair cable.
- Use one individually shielded pair for each signal.
- Do not use a common return for different analog signals.

Digital cables

Recommendation for digital signal runs: A double shielded cable is the best alternative, but single-shielded, twisted, multi-pair cable is also usable.

Control panel cable

If the control panel is connected to the drive with a cable, use only Category 5 Patch ethernet cable. The maximum length that is tested to meet EMC specifications is 3 m (9.8 ft). Longer cables are susceptible to electromagnetic noise and must be user-tested to verify that EMC requirements are met. Where long runs are required (especially for runs longer than about 12 m [40 ft]), use a RS232/RS485 converter at each end and run RS485 cable.

Drive's control connection terminals

The following table provides specifications for the drive's control terminals

Frame size	Control			
	Maximum wire size [1]		Tightening torque	
	mm^2	AWG	N·m	lb·ft
All	1.5	16	0.4	0.3

[1] Values given for solid wires.
For stranded wires, the maximum size is 1 mm^2.

Efficiency

Approximately 98% at nominal power level.

Losses, cooling data and noise

Cooling specifications	
Method	Internal fan, flow direction from bottom to top.
Requirement	Free space above and below the ACS550 drive: 200 mm (8 in). Free space is not required on the drive's sides – ACS550 drives can be mounted side-by-side.

Air flow, 208…240 V drives

The following table lists the requirements for the cooling air flow data for 208…240 V drives at full load in all ambient conditions listed in *Ambient conditions* on page *307*.

Drive		Heat dissipation		Air flow		Noise
ACS550-x1-	**Frame size**	**W**	**BTU/hr**	**m^3/h**	**ft^3/min**	**dB**
-04A6-2	R1	55	189	44	26	52
-06A6-2	R1	73	249	44	26	52
-07A5-2	R1	81	276	44	26	52
-012A-2	R1	118	404	44	26	52
-017A-2	R1	161	551	44	26	52
-024A-2	R2	227	776	88	52	66
-031A-2	R2	285	973	88	52	66
-046A-2	R3	420	1434	134	79	67
-059A-2	R3	536	1829	134	79	67
-075A-2	R4	671	2290	280	165	75
-088A-2	R4	786	2685	280	165	75
-114A-2	R4	1014	3463	280	165	75
-143A-2	R6	1268	4431	405	238	77
-178A-2	R6	1575	5379	405	238	77
-221A-2	R6	1952	6666	405	238	77
-248A-2	R6	2189	7474	405	238	77

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Air flow, 380…480 V drives

The following table lists the requirements for the cooling air flow data for 380…480 V drives at full load in all ambient conditions listed in *Ambient conditions* on page *307*.

Drive		Heat dissipation		Air flow		Noise
ACS550-x1-	**Frame size**	**W**	**BTU/hr**	**m^3/h**	**ft^3/min**	**dB**
-03A3-4	R1	40	137	44	26	52
-04A1-4	R1	52	178	44	26	52
-05A4-4	R1	73	249	44	26	52
-06A9-4	R1	97	331	44	26	52
-08A8-4	R1	127	434	44	26	52
-012A-4	R1	172	587	44	26	52

Drive		Heat dissipation		Air flow		Noise
ACS550-x1-	Frame size	W	BTU/hr	m^3/h	ft^3/min	dB
-015A-4	R2	232	792	88	52	66
-023A-4	R2	337	1151	88	52	66
-031A-4	R3	457	1561	134	79	67
-038A-4	R3	562	1919	134	79	67
-045A-4	R3	667	2278	134	79	67
-059A-4	R4	907	3098	280	165	75
-072A-4	R4	1120	3825	280	165	75
-078A-4	R4	1295	4423	250	147	75
-087A-4	R4	1440	4918	280	165	75
-097A-4	R4	1440	4918	280	165	75
-125A-4	R5	1940	6625	350	205	75
-157A-4	R6	2310	7889	405	238	77
-180A-4	R6	2810	9597	405	238	77
-195A-4	R6	3050	10416	405	238	77
-246A-4	R6	3260	11134	405	238	77
-290A-4	R6	3850	13125	405	238	77

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Air flow, 500…600 V drives

The following table lists the requirements for the cooling air flow data for 500…600 V drives at full load in all ambient conditions listed in *Ambient conditions* on page *307*.

Drive		Heat dissipation		Air flow		Noise
ACS550-U1-	Frame size	W	BTU/hr	m^3/h	ft^3/min	dB
-02A7-6	R2	52	178	88	52	66
-03A9-6	R2	73	249	88	52	66
-06A1-6	R2	127	434	88	52	66
-09A0-6	R2	172	587	88	52	66
-011A-6	R2	232	792	88	52	66
-017A-6	R2	337	1151	88	52	66
-022A-6	R3	457	1561	134	79	67
-027A-6	R3	562	1919	134	79	67
-032A-6	R4	667	2278	280	165	75
-041A-6	R4	907	3098	280	165	75
-052A-6	R4	1117	3815	280	165	75
-062A-6	R4	1357	4634	280	165	75
-077A-6	R6	2310	7889	405	238	77
-099A-6	R6	2310	7889	405	238	77
-125A-6	R6	2310	7889	405	238	77

Drive		Heat dissipation		Air flow		Noise
ACS550-U1-	Frame size	W	BTU/hr	m^3/h	ft^3/min	dB
-144A-6	R6	2310	7889	405	238	77

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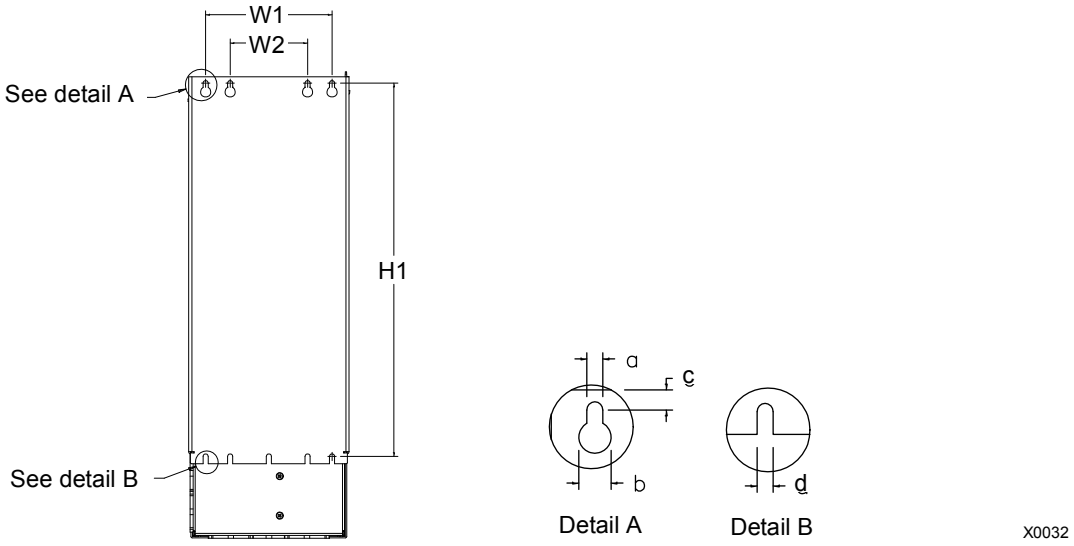
Dimensions and weights

The dimensions and mass for the ACS550 depend on the frame size and enclosure type. If unsure of the frame size, first, find the "Type" designation on the drive labels (see sections *The labels contain information on the Type designation (page 17), Ratings and frame size (page 17), Serial number (page 17), degree of protection (see also Degrees of protection on page 306) and valid markings (see also Markings on page 309).* on page *17* and *Drive labels* on page *16*). Then look up that type designation in the rating tables (see chapter *Technical data*, page *277*), to determine the frame size.

Mounting dimensions



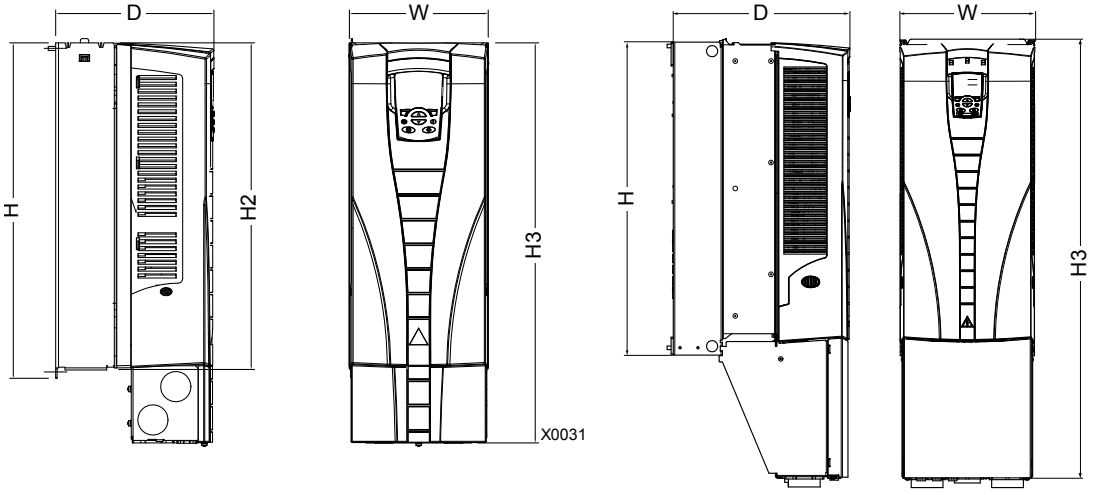
IP21 / UL type 1 and IP54 / UL type 12 – Dimensions for each frame size												
Ref.	R1		R2		R3		R4		R5		R6	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
W1[1]	98.0	3.9	98.0	3.9	160	6.3	160	6.3	238	9.4	263	10.4
W2[1]	--	--	--	--	98.0	3.9	98.0	3.9	--	--	--	--
H1[1]	318	12.5	418	16.4	473	18.6	578	22.8	588	23.2	675	26.6
a	5.5	0.2	5.5	0.2	6.5	0.25	6.5	0.25	6.5	0.25	9.0	0.35
b	10.0	0.4	10.0	0.4	13.0	0.5	13.0	0.5	14.0	0.55	18.0	0.71
c	5.5	0.2	5.5	0.2	8.0	0.3	8.0	0.3	8.5	0.3	8.5	0.3
d	5.5	0.2	5.5	0.2	6.5	0.25	6.5	0.25	6.5	0.25	9.0	0.35

[1] Center to center dimension.

Outside dimensions

Drives with IP21 / UL type 1 enclosures

Types ACS550-x1-221A-2, ACS550-x1-246A-4, ACS550-x1-248A-2, and ACS550-01-290A-4, frame size R6



IP21 / UL type 1 – dimensions for each frame size												
Ref.	**R1**		**R2**		**R3**		**R4**		**R5**		**R6**	
	mm	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
W	125	4.9	125	4.9	203	8.0	203	8.0	265	10.4	302	11.9
H	330	13.0	430	16.9	490	19.3	596	23.5	602	23.7	700	27.6
H2	315	12.4	415	16.3	478	18.8	583	23.0	578	22.8	698	27.5
H3	369	14.5	469	18.5	583	23.0	689	27.1	736	29.0	888[1]	35.0[1]
D	212	8.3	222	8.7	231	9.1	262	10.3	286	11.3	400	15.8

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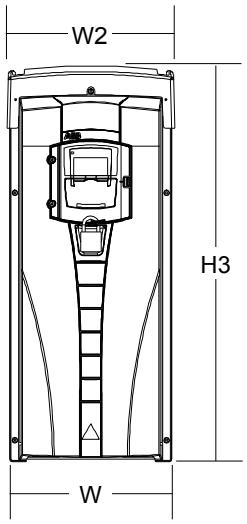
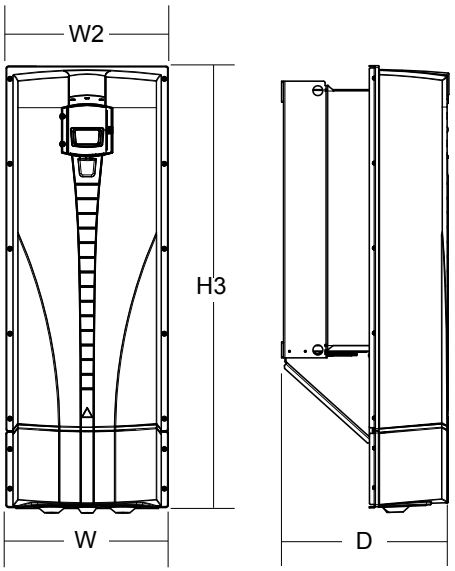
1. ACS550-x1-221A-2, ACS550-x1-246A-4, ACS550-x1-248A-2 and ACS550-x1-290A-4: 981 mm / 38.6 in.

Drives with IP54 / UL type 12 enclosures



Type ACS550-01-290A-4, IP54
(UL type 12 not available), frame size R6



IP54 / UL type 12 – Dimensions for each frame size												
Ref.	**R1**		**R2**		**R3**		**R4**		**R5**		**R6**[2]	
	mm	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**
W	213	8.4	213	8.4	257	10.1	257	10.1	369	14.5	410	16.1
W2	222	8.8	222	8.8	267	10.5	267	10.5	369	14.5	410	16.1
H3	461	18.2	561	22.1	629	24.8	760	29.9	775	30.5	924[1]	36.4[1]
D	234	9.2	245	9.7	254	10.0	284	11.2	309	12.2	423	16.7

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1. ACS550-01-290A-4: 1119 mm / 44.1 in.
2. UL type 12 not available for ACS550-01-290A-4.

Weight

The following table lists typical maximum weights for each frame size. Variations within each frame size (due to components associated with voltage/current ratings and options) are minor.

Enclosure	Weight											
	R1		R2		R3		R4		R5		R6	
	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
IP21 / UL type 1	6.5	14.3	9.0	19.8	16	35	24	53	34	75	69[1]	152[1]
IP54 / UL type 12	8.0	17.6	11.0	24.3	17.0	37.5	26.0	57.3	42.0	93.0	86.0[2]	190[2]

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1. ACS550-x1-221A-2, IP21 / UL type 1:70 kg / 154 lb
   ACS550-x1-246A-4, IP21 / UL type 1: 70 kg / 154 lb,
   ACS550-x1-248A-2, IP21 / UL type 1,80 kg / 176 lb.
   ACS550-01-290A-4, IP21 / UL type 1: 80 kg / 176 lb.
2. ACS550-x1-246A-4, IP54 / UL type 12: 80 kg / 176 lb
   ACS550-01-290A-4, IP54: 90 kg / 198 lb (UL type 12 not available).

Degrees of protection

Available enclosures:

- IP21 / UL type 1 enclosure. The site must be free of airborne dust, corrosive gases or liquids, and conductive contaminants such as condensation, carbon dust and metallic particles.
- IP54 / UL type 12 enclosure. This enclosure provides protection from airborne dust and light sprays or splashing water from all directions.

  Note: UL type 12 enclosure is not available for type ACS550-01-290A-4.

Compared to the IP21 / UL type 1 enclosure, the IP54 / UL type 12 enclosure has:

- the same internal plastic shell as the IP21 enclosure
- a different outer plastic cover
- an additional internal fan to improve cooling
- larger dimensions
- the same rating (does not require a derating).

Ambient conditions

The following table lists the ACS550 environmental requirements.

Ambient environment requirements		
	Installation site	**Storage and transportation in the protective package**
Altitude	• 0…1000 m (0…3 300 ft) • 1000…2000 m (3 300…6 600 ft) if P_N and I_{2N} derated 1% every 100 m above 1000 m (300 ft above 3 300 ft)	
Ambient temperature	• Min. -15 °C (5 °F) – no frost allowed • Max. (fsw = 1 or 4) 40 °C (104 °F); 50 °C (122 °F) if P_N and I_{2N} derated to 90% • Max. (fsw = 8) 40 °C (104 °F) if P_N and I_{2N} derated to 80% • Max. (fsw = 12) 30 °C (86 °F) if P_N and I_{2N} derated to 65% (to 50% for 600 V, R4 frame sizes, that is for ACS550-U1-032A-6 … ACS550-U1-062A-6)	-40…70 °C (-40…158 °F)
Relative humidity	5…95%, no condensation allowed	
Contamination levels (IEC 60721-3-3)	• No conductive dust allowed. • The ACS550 should be installed in clean air according to enclosure classification. • Cooling air must be clean, free from corrosive materials and free from electrically conductive dust. • Chemical gases: Class 3C2 • Solid particles: Class 3S2	Storage • No conductive dust allowed. • Chemical gases: Class 1C2 • Solid particles: Class 1S2 Transportation • No conductive dust allowed. • Chemical gases: Class 2C2 • Solid particles: Class 2S2

The following table lists the standard stress testing that the ACS550 passes.

Stress tests		
	Without shipping package	**Inside shipping package**
Sinusoidal vibration	Mechanical conditions: In accordance with IEC 60721-3-3, Class 3M4 • 2…9 Hz 3.0 mm (0.12 in) • 9…200 Hz 10 m/s^2 (33 ft/s^2)	In accordance with ISTA 1A and 1B specifications.
Shock	Not allowed	In accordance with IEC 68-2-29: max. 100 m/s^2 (330 ft/s^2), 11ms
Free fall	Not allowed	• 76 cm (30 in), frame size R1 • 61cm (24 in), frame size R2 • 46 cm (18 in), frame size R3 • 31 cm (12 in), frame size R4 • 25 cm (10 in), frame size R5 • 15 cm (6 in), frame size R6

Materials

Material specifications	
Drive enclosure	• PC/ABS 2.5 mm, color NCS 1502-Y or NCS 7000-N • Hot-dip zinc coated steel sheet 1.5…2 mm, thickness of coating 20 micrometers. If the surface is painted, the total thickness of the coating (zinc and paint) is 80…100 micrometers. • Cast aluminium AlSi • Extruded aluminium AlSi
Package	Corrugated board, expanded polystyrene, plywood, raw wood (heat dried). Package wrap consists of one or more of the following: PE-LD plastic wrap, PP or steel bands.
Disposal	The drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks. If recycling is not feasible, all parts excluding electrolytic capacitors and printed circuit boards can be landfilled. The DC capacitors contain electrolyte and, if the drive is not provided with the RoHS marking, the printed circuit boards contain lead, both of which are classified as hazardous waste within the EU. They must be removed and handled according to local regulations. For further information on environmental aspects and more detailed recycling instructions, contact your local ABB representative.

Applicable standards

Drive compliance with the following standards is identified by the standard "marks" on the type designation label. The following standards are applicable to the drive:

Mark	Applicable standards	
CE	EN 50178:1997	Electronic equipment for use in power installations
	IEC/EN 60204-1:2005	Safety of machinery. Electrical equipment of machines. Part 1: General requirements. *Provisions for compliance:* The final assembler of the machine is responsible for installing: • an emergency-stop device • a supply disconnecting device.
	IEC/EN 60529:1989 + A1:1999 + A2:2013	Degrees of protection provided by enclosures (IP code)
	IEC 60664-1:2002	Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests
	IEC/EN 61800-5-1:2007	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements. Electrical, thermal and energy
	IEC/EN 61800-3:2004 +A1:2012	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
	IEC/EN 61000-3-12:2011	Electromagnetic compatibility (EMC). Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and = 75 A per phase
	IEC/EN 61800-3:2004 +A1:2012	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
c UL us LISTED	UL 508C	UL Standard for Safety, Power Conversion Equipment, third edition
	C22.2 No. 14	CSA Standard for Industrial Control Equipment (for ACS550-U1 drives only)

Markings

CE marking

CE A CE mark is attached to the drive to verify that the drive follows the provisions of the European Low Voltage, EMC and RoHS Directives

Note: The 600 V ACS550-U1 drives are not CE approved.

Compliance with the European Low Voltage Directive

The compliance with the European Low Voltage Directive has been verified according to standards IEC/EN 60204-1:2005 and EN 50178:1997.

Compliance with the European EMC Directive

The Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard IEC/EN 61800-3:2004 +A1:2012 covers requirements stated for drives.

Compliance with IEC/EN 61800-3:2004 +A1:2012

See page 311.

C-Tick marking

The drive carries C-Tick marking.

C-Tick marking is required in Australia and New Zealand. A C-Tick mark is attached to the drive to verify compliance with the relevant standard (IEC 61800-3:2004) – Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods), mandated by the Trans-Tasman Electromagnetic Compatibility Scheme.

The Trans-Tasman Electromagnetic Compatibility Scheme (EMCS) was introduced by the Australian Communication Authority (ACA) and the Radio Spectrum Management Group (RSM) of the New Zealand Ministry of Economic Development (NZMED) in November 2001. The aim of the scheme is to protect the radio frequency spectrum by introducing technical limits for emission from electrical/ electronic products.

Compliance with IEC/EN 61800-3:004

See page 311.

UL/CSA markings

An UL mark is attached to ACS550 drives to verify that the drive follows the provisions of UL 508C.

A CSA mark is attached to ACS550-**U1** type drives to verify that the drive follows the provisions of C22.2 NO. 14.

The ACS550 is suitable for use in a circuit capable of delivering not more than 100 kA RMS symmetrical amperes, 600 V maximum. The ampere rating is based on tests done according to UL 508.

Branch circuit protection must be provided in accordance with local codes.

The ACS550 has an electronic motor protection feature that complies with the requirements of UL 508C and, for ACS550-U1, C22.2 No. 14. When this feature is selected and properly adjusted, additional overload protection is not required unless more than one motor is connected to the drive or unless additional protection is required by applicable safety regulations. See parameters 3005 (MOT THERM PROT) and 3006 (MOT THERM RATE).

The drives are to be used in a controlled environment. See section *Ambient conditions* on page 307 for specific limits.

Note: For open type enclosures, i.e. drives without the conduit box and/or cover for IP21 / UL type 1 drives, or without the conduit plate and/or hood for IP54 / UL type 12 drives, the drive must be mounted inside an enclosure in accordance with National Electric Code and local electrical codes.

Brake choppers, when applied with appropriately sized brake resistors, will allow the drive to dissipate regenerative energy (normally associated with quickly decelerating a motor). Frame sizes R1 and R2 have a built-in brake chopper as standard

equipment. For frame sizes R3…R6, contact your local ABB representative for appropriate parts. See section *Brake components* on page *295*.

EAC marking

The drive has EAC certification. EAC marking is required in Russia, Belarus and Kazakhstan.

IEC/EN 61800-3:2004 Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

First environment includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes establishments connected to a network not directly supplying domestic premises.

Drive of category C2: drive of rated voltage less than 1000 V and intended to be installed and commissioned only by a professional when used in the first environment.

Note: A professional is a person or organization having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

Category C2 has the same EMC emission limits as the earlier class first environment restricted distribution. EMC standard IEC/EN 61800-3 does not any more restrict the distribution of the drive, but the using, installation and commissioning are defined.

Drive of category C3: drive of rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.

Category C3 has the same EMC emission limits as the earlier class second environment unrestricted distribution.

Compliance with the IEC/EN 61800-3:2004 +A1:2012

The immunity performance of the drive complies with the demands of IEC/EN 61800-3, category C2 (see page *311* for IEC/EN 61800-3 definitions). The emission limits of IEC/EN 61800-3 comply with the provisions described below.

First environment (drives of category C2)

1. The internal EMC filter is connected.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. The motor cable length does not exceed the allowed maximum length specified in section *Motor cable length for 400 V drives* on page *290* for the frame size and switching frequency in use.

WARNING! In a domestic environment, this product may cause radio inference, in which case supplementary mitigation measures may be required.

Second environment (drives of category C3)

1. The internal EMC filter is connected.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. The motor cable length does not exceed the allowed maximum length specified in section *Motor cable length for 400 V drives* on page *290* for the frame size and switching frequency in use.

   WARNING! A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

Note: It is not allowed to install a drive with the internal EMC filter connected on IT (ungrounded) systems. The supply network becomes connected to ground potential through the EMC filter capacitors, which may cause danger or damage the drive.

Note: It is not allowed to install a drive with the internal EMC filter connected to a corner grounded TN system as this would damage the drive.

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Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

Product training

For information on ABB product training, navigate to www.abb.com/drives and select *Training courses*.

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EFFECTIVE: 2014-07-04
SUPERSEDES: 3AFE64804588 (3AUA0000001418) Rev G 2009-07-07

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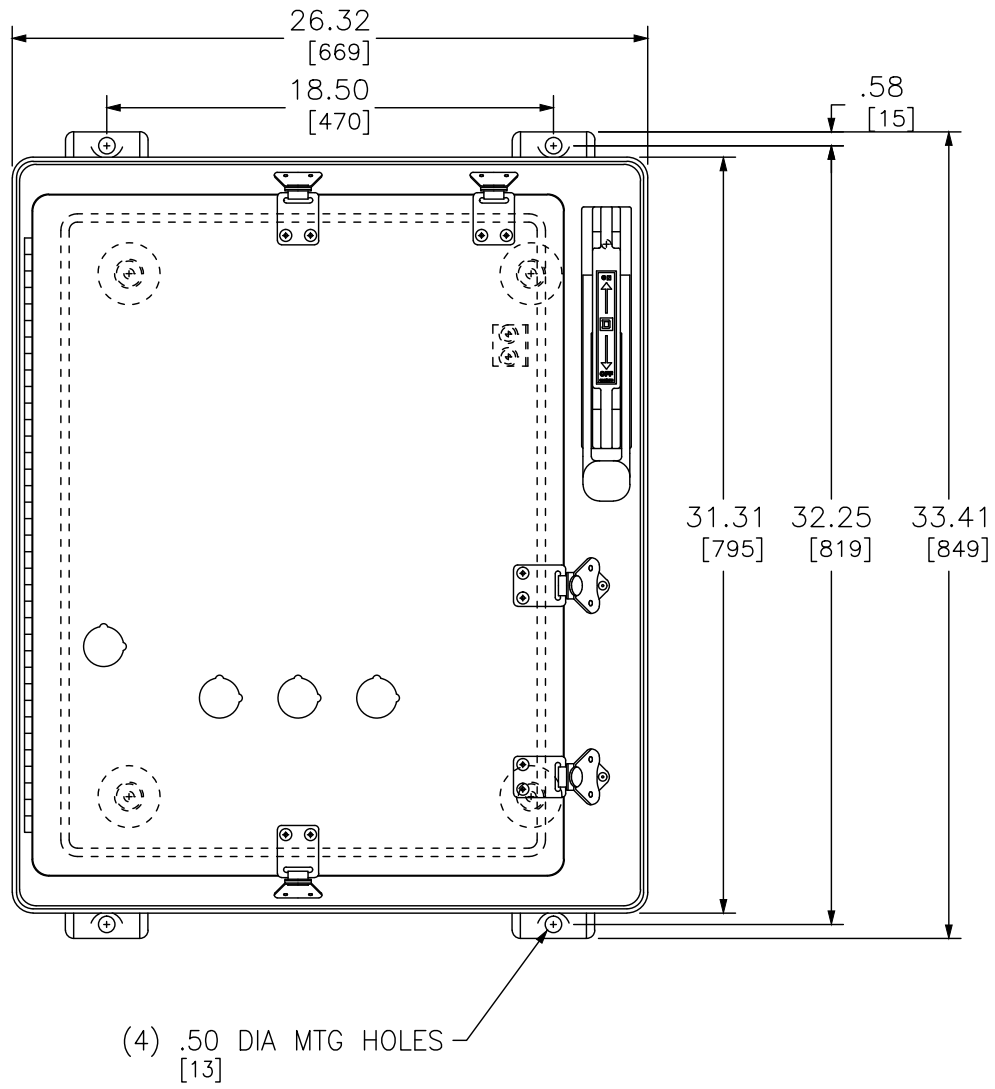
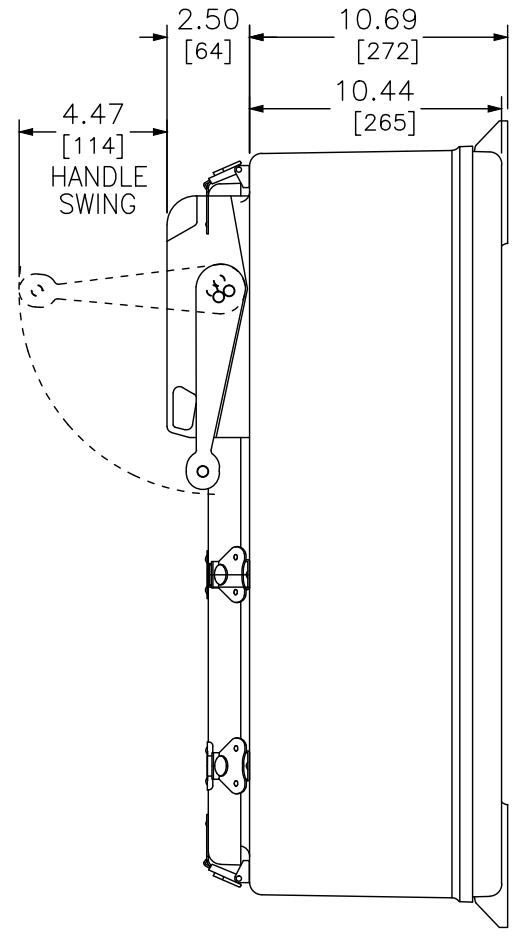
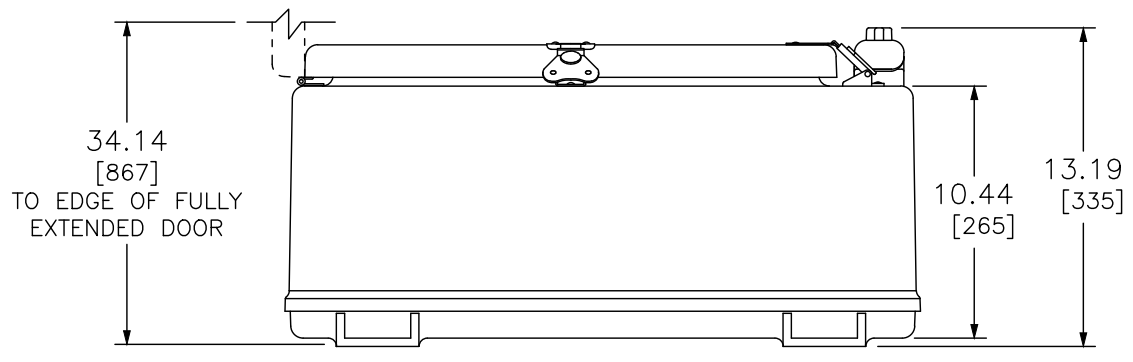
REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
–	----	--	--/--/--	–	----	--	--/--/--	–	----	--	--/--/--

CLASS 8538/8539 COMBINATION STARTERS
NEMA TYPE 4X CORROSION RESISTANT ENCLOSURE







DUAL DIMENSIONS: INCHES
MILLIMETERS

NEMA SIZE	CLASS	TYPE	HUB * SIZE	HUB * QUANTITY
3	8538 & 8539	SEW	.75	1
			2.50	2
4	8539	SFW	.75	1
			2.50	2

NOTE: THE DIMENSIONS INCLUDE SPACE FOR A CONTROL TRANSFORMER (FORM F4T).
* ENCLOSURES ARE NOT PREDRILLED FOR HUBS. HUBS ARE SUPPLIED WITH EACH NEMA 4X COMBINATION STARTER BUT NOT INSTALLED.

PROJ NO: 030-62105
REF NO: 030-62105D

JOB NAME:	SPE-WATER SUPPLY SYSTEM	EQUIPMENT DESIGNATION:	
JOB LOCATION:	807	EQUIPMENT TYPE:	
DRAWN BY:	(Q2C)	DRAWING TYPE:	
ENGR:		SQUARE D by Schneider Electric	
DATE:	November 15 2017		
DRAWING STATUS:	QUOTE	DWG# F38475114-01	PG 1 OF 1 REV –

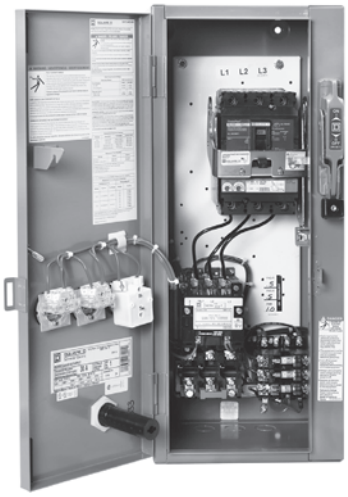
Combination Starters

NEMA Style

Catalog
8538CT9701R08/17

2017

Class 8538/8539, 8738/8739



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Schneider Electric™

Non-Reversing Combination Starters, NEMA Style

General Information

Class 8538 and 8539 Type S combination starters combine the requirements of motor overload and short-circuit protection into one package. These starters are manufactured in accordance with NEMA standards and are UL Listed (although some Form numbers may not be listed—contact your local Square D™ representative for information). Class 8538 and 8539 combination starters are designed to operate at 600 Vac maximum, 50 to 60 Hz—and come standard with melting alloy overload relays. Bimetallic and solid-state overload relays are available as options (see pages 45–46).

Type 2 Coordination

Square D brand is one of the leaders in North America and Europe in providing starters that are verified by UL to comply with IEC 947-4-1 and Type 2 coordination. This means that the controller components—the contactor, the overload relay, and the motor branch circuit protective device (fuses or circuit breaker)—will be suitable for further use following a short-circuit fault (even though contact welding is recognized but can be easily broken). This allows for replacement of components during normal scheduled maintenance.

Square D starters and specified fuses have been tested by UL and CSA (at 100,000 A fault current) for operation at 600 Vac. Class 8538 Type S combination starters, NEMA Size 0–5, with fusible disconnect switches have tested to Type 2 performance criteria.

Class 8538 Disconnect Switch Type

Class 8538 combination starters can be furnished with either a fusible or non-fusible disconnect switch. Class 8538 combination starters are available in NEMA Size 0–6.

The design of the fusible disconnect switch combination starter uses a flange-operated visible blade switch. Interchangeable fuse clips, straight-through wiring, space for a fused control transformer with additional capacity, and provisions for adding a disconnect switch electrical interlock are key features of the combination starters.

The fusible disconnect switch device can be furnished with Class R fuse clips, increasing the short-circuit rating to 100,000 A.

Size 0–2 non-fusible combination starters can be converted to a fusible type. See catalog 9999CT9701 for fuse block kits and fuse kits.

Class 8539 Electronic Motor Circuit Protector (MCP) or Thermal-Magnetic Circuit Breaker Type

Class 8539 combination starters can be furnished with either an electronic motor circuit protector (MCP) or a thermal-magnetic circuit breaker. Class 8539 combination starters are available in NEMA Size 0–7.

The circuit breakers in Class 8539 combination starters can be furnished with a factory installed auxiliary switch for remote indication of an open/tripped or closed circuit breaker. For one auxiliary switch, specify **Form Y74**. For two auxiliary switches, specify **Form Y75**. The switches are furnished with normally open and normally closed circuits with a common connection. Contacts must be used on the same polarity and are rated 15 A at 240 Vac.

An alarm switch can be factory installed only—specify **Form Y742.** The alarm switch is used to actuate bell alarms and warning lights. It operates only when the circuit breaker is tripped. The alarm switch consists of a normally open single-pole, single-throw switch. The contacts are rated 4 A at 240 Vac.

Circuit breaker combination starters have short-circuit interrupting ratings up to 100,000 A. See page 39 for details.

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Enclosures—Class 8538 and 8539 combination starters are available in the following enclosures:

- NEMA 1 General Purpose
- NEMA 4 & 4X Watertight and Dusttight Stainless Steel
- NEMA 4X Watertight, Dusttight, and Corrosion Resistant Glass-Polyester
- NEMA 12/3R Dusttight and Driptight for Industrial Use

These enclosures have three holes (30.5 mm) as standard for installation of Class 9001 Type K push buttons, pilot lights, and other cover-mounted control units.

The NEMA 4 & 4X stainless steel enclosures (Sizes 0–5) have a brushed finish. Sizes 6–7 are painted sheet-steel enclosures and are rated NEMA 4 only. Hubs come standard on NEMA 4X enclosures.

NEMA 12 enclosures can be field modified for outdoor applications. Specify **Form G26** for NEMA 3R (no additional charge). See page 19 for additional information.

Oversize Enclosures—Class 8538 disconnect switch type and Class 8539 electronic motor circuit protector (MCP), Sizes 0–2, are also available in NEMA 1, 4 & 4X, and 12/3R oversize enclosures. The oversize enclosures provide additional panel space for customer installation of control transformers, fuse blocks, terminal blocks, relays, and other auxiliary equipment.

Coil Voltages—AC coils are available for application at 50–60 Hz. The coils for NEMA Size 00–5 devices are designed to operate satisfactorily on line voltages of 85–110% of rated voltage. NEMA Size 6–7 contactors come with a DC coil operated by a solid-state rectifier circuit, which is powered by an AC source and designed to operate satisfactorily on line voltages of 90–110% of rated voltage.

> **NOTE:** A voltage code is required when ordering combination starters. Polyphase combination starters with 24 Vac or 120 Vac coil voltages come wired for **separate control**.

Auxiliary Contacts—Additional auxiliary contacts can be added to Type S starters. Refer to page 37 for the maximum number of auxiliary units and the Form designations for factory-installed auxiliary contacts. See catalog 9999CT9701 for auxiliary contact kits for field installation.

Type S Accessories—Additional accessories such as fuse blocks, fuse clip kits, disconnect switch and circuit breaker interlocks, and cover-mounted control units are available as field modifications. See catalog 9999CT9701. For factory modifications (Forms), see page 42.

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Overload Protection

Type S magnetic starters are used for full-voltage starting and stopping of AC squirrel cage motors. Motor overload protection for three-phase starter applications can be provided through one of four options, as follows:

Solid-State Overload Relay Protection (Motor Logic™ SSOLR)—These ambient insensitive overload relays are available on Sizes 00–6 and standard on Size 7. They provide phase loss and phase unbalance protection. To order, add Form **H30** (for selectable trip class 10 or 20 protection). For more information about Motor Logic SSOLRs, see page 45 and catalog 9065CT9701. (Product catalog number example: 8536SCO3V06**H30**)

Adapted Bimetallic Overload Relay (NEMA Sizes 00–1)—The adapted bimetallic motor starter consists of a specially designed adapter. It attaches with bus bars to the Type S NEMA contactor and holds the IEC-style bimetallic overload relay (type LRD or LR3D). This starter configuration can be ordered by adding Form **E** (adapter only) to the standard catalog number. The LRD or LR3D bimetallic overload relay must be purchased separately, based on the motor FLA, and installed in the field in order to operate the starter. For more information—including how to order the adapted bimetallic overload relay as a factory installed option—see page 45 and catalog 9065CT9701. (Product catalog number example: 8536SCO3V06**E**)

TeSys™ T Motor Management System (NEMA Sizes 1–6)—The flexible TeSys T system integrates seamlessly into your automation system through five major communication protocols. The TeSys T system can predict what will happen in the process, as it accurately monitors current, voltage, and power over a wide range. This option is available for control voltages of 24 Vac or 100–240 Vac. For additional information about the TeSys T Motor Management System, see page 46 and catalog 9065CT9701.

> **NOTE:** The full catalog number contains a four-character Form number (for example, 8536SCO3V06**H616**).

Melting Alloy Thermal Overload Relays—Melting alloy type thermal overload blocks are installed as part of the starter, and thermal elements must be selected and installed separately in order to operate the starter. For a three-phase motor, three thermal units must be ordered using the tables in catalog 9065CT9701. The catalog number includes no Form number (for example, 8536SCO3V06).

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Fusible, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

For Class J fuse clip, use Form **Y1072** (no additional charge).

Table 1: Class 8538 Fusible Full Voltage Type (Class H and K Fuse Clips), with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Poly-phase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0-5)[1]	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R Industrial Use Dusttight and Driptight[2]	
							With External Reset	Without External Reset
				Type[3]	Type[3]	Type[3]	Type[3]	Type[3]
200 (208)	3	0	30	SBG12●●●H30 [4]	SBW12●●●H30[4]	SBW22●●●H30[4]	SBA22●●●H30[4]	SBA12●●●H30[4]
	5	1	30	SCG12●●●H30 [4]	SCW12●●●H30[4]	SCW22●●●H30[4]	SCA22●●●H30[4]	SCA12●●●H30[4]
	7.5		60	SCG13●●●H30[4]	SCW13●●●H30[4]	SCW23●●●H30[4]	SCA23●●●H30[4]	SCA13●●●H30[4]
	10	2	60	SDG12●●●H30	SDW12●●●H30	SDW22●●●H30[4]	SDA22●●●H30	SDA12●●●H30
	20	3	100	SEG15●●●H30	SEW15●●●H30	SEW25●●●H30	SEA25●●●H30	SEA15●●●H30
	25		200	SEG12●●●H30	SEW12●●●H30	—	SEA22●●●H30	SEA12●●●H30
	40	4	200	SFG15●●●H30	SFW15●●●H30	—	SFA25●●●H30	SFA15●●●H30
	75	5	400	SGG15●●●H30	SGW15●●●H30	—	SGA25●●●H30	SGA15●●●H30
	150	6	600	SHG13●●●H30	SHW13●●●H30	—	SHA23●●●H30	SHA13●●●H30
230 (240)	3	0	30	SBG12●●●H30[4]	SBW12●●●H30[4]	SBW22●●●H30[4]	SBA22●●●H30[4]	SBA12●●●H30[4]
	5	1	30	SCG12●●●H30[4]	SCW12●●●H30[4]	SCW22●●●H30[4]	SCA22●●●H30[4]	SCA12●●●H30[4]
	7.5		60	SCG13●●●H30[4]	SCW13●●●H30[4]	SCW23●●●H30[4]	SCA23●●●H30[4]	SCA13●●●H30[4]
	10	2	60	SDG12●●●H30[4]	SDW12●●●H30	SDW22●●●H30[4]	SDA22●●●H30	SDA12●●●H30
	25	3	100	SEG15●●●H30	SEW15●●●H30	SEW25●●●H30	SEA25●●●H30	SEA15●●●H30
	30		200	SEG12●●●H30	SEW12●●●H30	—	SEA22●●●H30	SEA12●●●H30
	50	4	200	SFG15●●●H30	SFW15●●●H30	—	SFA25●●●H30	SFA15●●●H30
	100	5	400	SGG15●●●H30	SGW15●●●H30	—	SGA25●●●H30	SGA15●●●H30
	200	6	600	SHG13●●●H30	SHW13●●●H30	—	SHA23●●●H30	SHA13●●●H30
460 (480)	5	0	30	SBG13●●●H30[4]	SBW13●●●H30[4]	SBW23●●●H30[4]	SBA23●●●H30[4]	SBA13●●●H30[4]
	10	1	30	SCG14●●●H30[4]	SCW14●●●H30[4]	SCW24●●●H30[4]	SCA24●●●H30[4]	SCA14●●●H30[4]
	15	2	30	SDG16●●●H30[4]	SDW16●●●H30[4]	SDW26●●●H30[4]	SDA26●●●H30[4]	SDA16●●●H30[4]
	25		60	SDG14●●●H30	SDW14●●●H30	SDW24●●●H30	SDA24●●●H30	SDA14●●●H30
	50	3	100	SEG13●●●H30	SEW13●●●H30	SEW23●●●H30	SEA23●●●H30	SEA13●●●H30
	100	4	200	SFG13●●●H30	SFW13●●●H30	—	SFA23●●●H30	SFA13●●●H30
	200	5	400	SGG13●●●H30	SGW13●●●H30	—	SGA23●●●H30	SGA13●●●H30
	400	6	600	SHG12●●●H30	SHW12●●●H30	—	SHA22●●●H30	SHA12●●●H30
575 (600)	5	0	30	SBG13●●●H30[4]	SBW13●●●H30[4]	SBW23●●●H30[4]	SBA23●●●H30[4]	SBA13●●●H30[4]
	10	1	30	SCG14●●●H30[4]	SCW14●●●H30[4]	SCW24●●●H30[4]	SCA24●●●H30[4]	SCA14●●●H30[4]
	15	2	30	SDG16●●●H30[4]	SDW16●●●H30[4]	SDW26●●●H30[4]	SDA26●●●H30[4]	SDA16●●●H30[4]
	25		60	SDG14●●●H30	SDW14●●●H30	SDW24●●●H30	SDA24●●●H30	SDA14●●●H30
	50	3	100	SEG13●●●H30	SEW13●●●H30	SEW23●●●H30	SEA23●●●H30	SEA13●●●H30
	100	4	200	SFG13●●●H30	SFW13●●●H30	—	SFA23●●●H30	SFA13●●●H30
	200	5	400	SGG13●●●H30	SGW13●●●H30	—	SGA23●●●H30	SGA13●●●H30
	400	6	600	SHG12●●●H30	SHW12●●●H30	—	SHA22●●●H30	SHA12●●●H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 5 on page 8.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

File E152395
CCN NKJH7

File LR584
Class 3211 04

Note:
Some units are not CSA certified. Consult the factory.

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Table 2: Class 8538 Fusible Disconnect Switch Type (Class H Fuse Clips), Single Phase [1], with Melting Alloy Overload Relay (see Thermal Unit Selection)

Ratings						Enclosure				
Motor Voltage	Max. Hp	Coil Voltage	NEMA Size	Poles	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R [2] Industrial Use Dusttight and Driptight	
									With External Reset	Without External Reset
						Type	Type	Type	Type	Type
120	1	120	0	2	30	SBG62V02	SBW62V02	SBW65V02	SBA65V02	SBA62V02
	2		1		30	SCG62V02	SCW62V02	SCW65V02	SCA65V02	SCA62V02
	3		2		60	SDG62V02	SDW62V02	SDW65V02	SDA65V02	SDA62V02
240	2	240	0	2	30	SBG62V03	SBW62V03	SBW65V03	SBA65V03	SBA62V03
	3		1		30	SCG62V03	SCW62V03	SCW65V03	SCA65V03	SCA62V03
	7.5		2		60	SDG62V03	SDW62V03	SDW65V03	SDA65V03	SDA62V03

[1] Single-phase units require one thermal unit. They are not available with solid-state overload relays (Form H••). Not included in the Laser™ Delivery program.

[2] NEMA 12 enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

Non-Fusible, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 3: Class 8538 Non-Fusible Full Voltage Type, Non-Reversing, with Motor Logic SSOLR (replace ••• with the voltage code)

Ratings			Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5) [1]	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R [2] Industrial Use Dusttight and Driptight	
						With External Reset	Without External Reset
			Type [3]	Type [3]	Type [3]	Type [3]	Type [3]
200 (208)	3	0	SBG11•••H30[4]	SBW11•••H30[4]	SBW21•••H30[4]	SBA21•••H30[4]	SBA11•••H30[4]
	7.5	1	SCG11•••H30[4]	SCW11•••H30[4]	SCW21•••H30[4]	SCA21•••H30[4]	SCA11•••H30[4]
	10	2	SDG11•••H30	SDW11•••H30	SDW21•••H30	SDA21•••H30	SDA11•••H30
	25	3	SEG11•••H30	SEW11•••H30	SEW21•••H30	SEA21•••H30	SEA11•••H30
	40	4	SFG11•••H30	SFW11•••H30	—	SFA21•••H30	SFA11•••H30
	75	5	SGG11•••H30	SGW11•••H30	—	SGA21•••H30	SGA11•••H30
	150	6	SHG11•••H30	SHW11•••H30	—	SHA21•••H30	SHA11•••H30
230 (240)	3	0	SBG11•••H30[4]	SBW11•••H30[4]	SBW21•••H30[4]	SBA21•••H30[4]	SBA11•••H30[4]
	7.5	1	SCG11•••H30[4]	SCW11•••H30[4]	SCW21•••H30[4]	SCA21•••H30[4]	SCA11•••H30[4]
	15	2	SDG11•••H30	SDW11•••H30	SDW21•••H30	SDA21•••H30	SDA11•••H30
	30	3	SEG11•••H30	SEW11•••H30	SEW21•••H30	SEA21•••H30	SEA11•••H30
	50	4	SFG11•••H30	SFW11•••H30	—	SFA21•••H30	SFA11•••H30
	100	5	SGG11•••H30	SGW11•••H30	—	SGA21•••H30	SGA11•••H30
	200	6	SHG11•••H30	SHW11•••H30	—	SHA21•••H30	SHA11•••H30
460 (480)	5	0	SBG11•••H30[4]	SBW11•••H30[4]	SBW21•••H30[4]	SBA21•••H30[4]	SBA11•••H30[4]
	10	1	SCG11•••H30[4]	SCW11•••H30[4]	SCW21•••H30[4]	SCA21•••H30[4]	SCA11•••H30[4]
	25	2	SDG11•••H30	SDW11•••H30	SDW21•••H30	SDA21•••H30	SDA11•••H30
	50	3	SEG11•••H30	SEW11•••H30	SEW21•••H30	SEA21•••H30	SEA11•••H30
	100	4	SFG11•••H30	SFW11•••H30	—	SFA21•••H30	SFA11•••H30
	200	5	SGG11•••H30	SGW11•••H30	—	SGA21•••H30	SGA11•••H30
	400	6	SHG11•••H30	SHW11•••H30	—	SHA21•••H30	SHA11•••H30
575 (600)	5	0	SBG11•••H30[4]	SBW11•••H30[4]	SBW21•••H30[4]	SBA21•••H30[4]	SBA11•••H30[4]
	10	1	SCG11•••H30[4]	SCW11•••H30[4]	SCW21•••H30[4]	SCA21•••H30[4]	SCA11•••H30[4]
	25	2	SDG11•••H30	SDW11•••H30	SDW21•••H30	SDA21•••H30	SDA11•••H30
	50	3	SEG11•••H30	SEW11•••H30	SEW21•••H30	SEA21•••H30	SEA11•••H30
	100	4	SFG11•••H30	SFW11•••H30	—	SFA21•••H30	SFA11•••H30
	200	5	SGG11•••H30	SGW11•••H30	—	SGA21•••H30	SGA11•••H30
	400	6	SHG11•••H30	SHW11•••H30	—	SHA21•••H30	SHA11•••H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (•••) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 5 on page 8.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

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Table 4: Class 8538 Non-Fusible Disconnect Switch Type, Single Phase [1], with Melting Alloy Overload Relay (see Thermal Unit Selection)

Ratings					Enclosure				
Motor Voltage	Max. Hp	Coil Voltage	NEMA Size	Poles	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R [2] Industrial Use Dusttight and Driptight	
								With External Reset	Without External Reset
					Type	Type	Type	Type	Type
120	1 2 3	120	0 1 2	2	SBG61V02 SCG61V02 SDG61V02	SBW61V02 SCW61V02 SDW61V02	SBW64V02 SCW64V02 SDW64V02	SBA64V02 SCA64V02 SDA64V02	SBA61V02 SCA61V02 SDA61V02
240	2 3 7.5	240	0 1 2	2	SBG61V03 SCG61V03 SDG61V03	SBW61V03 SCW61V03 SDW61V03	SBW64V03 SCW64V03 SDW64V03	SBA64V03 SCA64V03 SDA64V03	SBA61V03 SCA61V03 SDA61V03

[1] Single-phase units require one thermal unit. They are not available with solid-state overload relays (Form H••).
Not included in the Laser™ Delivery program.

[2] NEMA 12 enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

Table 5: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
277 [1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8538SCG11V02H30**S**).
Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Class R Fuse Clips, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 6: Class 8538 Fusible (with Class R Fuse Clips) Full Voltage Type, Non-Reversing, with Motor Logic SSOLR (100,000 AIC Rated) (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5) [1]	NEMA 4 & 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R Industrial Use Dusttight and Driptight [2] With External Reset	NEMA 12/3R Industrial Use Dusttight and Driptight [2] Without External Reset
				Type [3]	Type [3]	Type [3]	Type [3]	Type [3]
200 (208)	3	0	30	SBG32●●●H30[4]	SBW32●●●H30[4]	SBW42●●●H30[4]	SBA42●●●H30[4]	SBA32●●●H30[4]
	5	1	30	SCG32●●●H30[4]	SCW32●●●H30[4]	SCW42●●●H30[4]	SCA42●●●H30[4]	SCA32●●●H30[4]
	7.5	1	60	SCG33●●●H30[4]	SCW33●●●H30[4]	SCW43●●●H30[4]	SCA43●●●H30[4]	SCA33●●●H30[4]
	10	2	60	SDG32●●●H30	SDW32●●●H30[4]	SDW42●●●H30[4]	SDA42●●●H30[4]	SDA32●●●H30[4]
	20	3	100	SEG35●●●H30	SEW35●●●H30	SEW45●●●H30	SEA45●●●H30	SEA35●●●H30
	25	3	200	SEG32●●●H30	SEW32●●●H30	—	SEA42●●●H30	SEA32●●●H30
	40	4	200	SFG35●●●H30	SFW35●●●H30	—	SFA45●●●H30	SFA35●●●H30
	75	5	400	SGG35●●●H30	SGW35●●●H30	—	SGA45●●●H30	SGA35●●●H30
	150	6	600	SHG33●●●H30	SHW33●●●H30	—	SHA43●●●H30	SHA33●●●H30
230 (240)	3	0	30	SBG32●●●H30[4]	SBW32●●●H30[4]	SBW42●●●H30[4]	SBA42●●●H30[4]	SBA32●●●H30[4]
	5	1	30	SCG32●●●H30[4]	SCW32●●●H30[4]	SCW42●●●H30[4]	SCA42●●●H30[4]	SCA32●●●H30[4]
	7.5	1	60	SCG33●●●H30[4]	SCW33●●●H30[4]	SCW43●●●H30[4]	SCA43●●●H30[4]	SCA33●●●H30[4]
	15	2	60	SDG32●●●H30	SDW32●●●H30	SDW42●●●H30	SDA42●●●H30	SDA32●●●H30
	25	3	100	SEG35●●●H30	SEW35●●●H30	SEW45●●●H30	SEA45●●●H30	SEA35●●●H30
	30	3	200	SEG32●●●H30	SEW32●●●H30	—	SEA42●●●H30	SEA32●●●H30
	50	4	200	SFG35●●●H30	SFW35●●●H30	—	SFA45●●●H30	SFA35●●●H30
	100	5	400	SGG35●●●H30	SGW35●●●H30	—	SGA45●●●H30	SGA35●●●H30
	200	6	600	SHG33●●●H30	SHW33●●●H30	—	SHA43●●●H30	SHA33●●●H30
460 (480)	5	0	30	SBG33●●●H30[4]	SBW33●●●H30[4]	SBW43●●●H30[4]	SBA43●●●H30[4]	SBA33●●●H30[4]
	10	1	30	SCG34●●●H30[4]	SCW34●●●H30[4]	SCW44●●●H30[4]	SCA44●●●H30[4]	SCA34●●●H30[4]
	15	2	30	SDG36●●●H30[4]	SDW36●●●H30[4]	SDW46●●●H30[4]	SDA46●●●H30[4]	SDA36●●●H30[4]
	25	2	60	SDG34●●●H30	SDW34●●●H30	SDW44●●●H30	SDA44●●●H30	SDA34●●●H30
	50	3	100	SEG33●●●H30	SEW33●●●H30	SEW43●●●H30	SEA43●●●H30	SEA33●●●H30
	100	4	200	SFG33●●●H30	SFW33●●●H30	—	SFA43●●●H30	SFA33●●●H30
	200	5	400	SGG33●●●H30	SGW33●●●H30	—	SGA43●●●H30	SGA33●●●H30
	400	6	600	SHG32●●●H30	SHW32●●●H30	—	SHA42●●●H30	SHA32●●●H30
575 (600)	5	0	30	SBG33●●●H30[4]	SBW33●●●H30[4]	SBW43●●●H30[4]	SBA43●●●H30[4]	SBA33●●●H30[4]
	10	1	30	SCG34●●●H30[4]	SCW34●●●H30[4]	SCW44●●●H30[4]	SCA44●●●H30[4]	SCA34●●●H30[4]
	15	2	30	SDG36●●●H30[4]	SDW36●●●H30[4]	SDW46●●●H30[4]	SDA46●●●H30[4]	SDA36●●●H30[4]
	25	2	60	SDG34●●●H30	SDW34●●●H30	SDW44●●●H30	SDA44●●●H30	SDA34●●●H30
	50	3	100	SEG33●●●H30	SEW33●●●H30	SEW43●●●H30	SEA43●●●H30	SEA33●●●H30
	100	4	200	SFG33●●●H30	SFW33●●●H30	—	SFA43●●●H30	SFA33●●●H30
	200	5	400	SGG33●●●H30	SGW33●●●H30	—	SGA43●●●H30	SGA33●●●H30
	400	6	600	SHG32●●●H30	SHW32●●●H30	—	SHA42●●●H30	SHA32●●●H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 8 on page 10.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

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Table 7: Class 8538 Fusible Disconnect Switch Type (Class R Fuses), Single Phase [1], with Melting Alloy Overload Relay

Ratings						Enclosure				
Motor Voltage	Max. Hp	Coil Voltage	NEMA Size	Poles	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R Industrial Dusttight and Driptight	
									With External Reset	Without External Reset
						Type	Type	Type	Type	Type
120	1	120	0	2	30	SBG63V02	SBW63V02	SBW66V02	SBA66V02	SBA63V02
	2		1		30	SCG63V02	SCW63V02	SCW66V02	SCA66V02	SCA63V02
	3		2		60	SDG63V02	SDW63V02	SDW66V02	SDA66V02	SDA63V02
240	2	240	0	2	30	SBG63V03	SBW63V03	SBW66V03	SBA66V03	SBA63V03
	3		1		30	SCG63V03	SCW63V03	SCW66V03	SCA66V03	SCA63V03
	7.5		2		60	SDG63V03	SDW63V03	SDW66V03	SDA66V03	SDA63V03

[1] Single-phase units require one thermal unit. They are not available with solid-state overload relays (Form H••). Not included in the Laser™ Delivery program.

NOTE: Some control transformers may require the use of oversize enclosures. See Table 71 on page 44 for control transformer selection.

Table 8: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24[1]	—	V01
120[1]	110	V02
208	—	V08
240	220	V03
277[1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8538SCG32V02H30**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Oversize Enclosures, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 9: Class 8538 with Oversize Enclosures (replace ●●● with the voltage code)

Ratings				Enclosure			
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dustight, Stainless Steel (304)	NEMA 12/3R[5], Industrial Use, Dusttight and Driptight With External Reset	NEMA 12/3R[5], Industrial Use, Dusttight and Driptight Without External Reset
				Type [3]	Type [3]	Type [3]	Type [3]
Class 8538 Non-Fusible Disconnect Switch Type—NEMA Size 0–2 [1], [2]							
200 (208)	3	0	N/A	SBG11S8●●●H30[4]	SBW11S8●●●H30[4]	SBA21S8●●●H30[4]	SBA11S8●●●H30[4]
	7.5	1	N/A	SCG11S8●●●H30[4]	SCW11S8●●●H30[4]	SCA21S8●●●H30[4]	SCA11S8●●●H30[4]
	10	2	N/A	SDG11S8●●●H30	SDW11S8●●●H30	SDA21S8●●●H30	SDA11S8●●●H30
230 (240)	3	0	N/A	SBG11S8●●●H30[4]	SBW11S8●●●H30[4]	SBA21S8●●●H30[4]	SBA11S8●●●H30[4]
	7.5	1	N/A	SCG11S8●●●H30[4]	SCW11S8●●●H30[4]	SCA21S8●●●H30[4]	SCA11S8●●●H30[4]
	15	2	N/A	SDG11S8●●●H30	SDW11S8●●●H30	SDA21S8●●●H30	SDA11S8●●●H30
460 (480)	5	0	N/A	SBG11S8●●●H30[4]	SBW11S8●●●H30[4]	SBA21S8●●●H30[4]	SBA11S8●●●H30[4]
	10	1	N/A	SCG11S8●●●H30[4]	SCW11S8●●●H30[4]	SCA21S8●●●H30[4]	SCA11S8●●●H30[4]
	25	2	N/A	SDG11S8●●●H30	SDW11S8●●●H30	SDA21S8●●●H30	SDA11S8●●●H30
575 (600)	5	0	N/A	SBG11S8●●●H30[4]	SBW11S8●●●H30[4]	SBA21S8●●●H30[4]	SBA11S8●●●H30[4]
	10	1	N/A	SCG11S8●●●H30[4]	SCW11S8●●●H30[4]	SCA21S8●●●H30[4]	SCA11S8●●●H30[4]
	25	2	N/A	SDG11S8●●●H30	SDW11S8●●●H30	SDA21S8●●●H30	SDA11S8●●●H30
Class 8538 Fusible Disconnect Switch Type—NEMA Size 0–2 [1], [2]							
200 (208)	3	0	30	SBG12S8●●●H30[4]	SBW12S8●●●H30[4]	SBA22S8●●●H30[4]	SBA12S8●●●H30[4]
	5	1	30	SCG12S8●●●H30[4]	SCW12S8●●●H30[4]	SCA22S8●●●H30[4]	SCA12S8●●●H30[4]
	7.5	1	60	SCG13S8●●●H30[4]	SCW13S8●●●H30[4]	SCA23S8●●●H30[4]	SCA13S8●●●H30[4]
	10	2	60	SDG12S8●●●H30	SDW12S8●●●H30	SDA22S8●●●H30	SDA12S8●●●H30
230 (240)	3	0	30	SBG12S8●●●H30[4]	SBW12S8●●●H30[4]	SBA22S8●●●H30[4]	SBA12S8●●●H30[4]
	5	1	30	SCG12S8●●●H30[4]	SCW12S8●●●H30[4]	SCA22S8●●●H30[4]	SCA12S8●●●H30[4]
	7.5	1	60	SCG13S8●●●H30[4]	SCW13S8●●●H30[4]	SCA23S8●●●H30[4]	SCA13S8●●●H30[4]
	15	2	60	SDG12S8●●●H30	SDW12S8●●●H30	SDA22S8●●●H30	SDA12S8●●●H30
460 (480)	5	0	30	SBG13S8●●●H30[4]	SBW13S8●●●H30[4]	SBA23S8●●●H30[4]	SBA13S8●●●H30[4]
	10	1	30	SCG14S8●●●H30[4]	SCW14S8●●●H30[4]	SCA24S8●●●H30[4]	SCA14S8●●●H30[4]
	15	2	30	SDG16S8●●●H30[4]	SDW16S8●●●H30[4]	SDA26S8●●●H30[4]	SDA16S8●●●H30[4]
	25	2	60	SDG14S8●●●H30	SDW14S8●●●H30	SDA24S8●●●H30	SDA14S8●●●H30
575 (600)	5	0	30	SBG13S8●●●H30[4]	SBW13S8●●●H30[4]	SBA23S8●●●H30[4]	SBA13S8●●●H30[4]
	10	1	30	SCG14S8●●●H30[4]	SCW14S8●●●H30[4]	SCA24S8●●●H30[4]	SCA14S8●●●H30[4]
	15	2	30	SDG16S8●●●H30[4]	SDW16S8●●●H30[4]	SDA26S8●●●H30[4]	SDA16S8●●●H30[4]
	25	2	60	SDG14S8●●●H30	SDW14S8●●●H30	SDA24S8●●●H30	SDA14S8●●●H30
Class 8538 Fusible Disconnect Switch Type with Class R Fuse Clips—NEMA Size 0–2 [1], [2]							
200 (208)	3	0	30	SBG32S8●●●H30[4]	SBW32S8●●●H30[4]	SBA42S8●●●H30[4]	SBA32S8●●●H30[4]
	5	1	30	SCG32S8●●●H30[4]	SCW32S8●●●H30[4]	SCA42S8●●●H30[4]	SCA32S8●●●H30[4]
	7.5	1	60	SCG33S8●●●H30[4]	SCW33S8●●●H30[4]	SCA43S8●●●H30[4]	SCA33S8●●●H30[4]
	10	2	60	SDG32S8●●●H30	SDW32S8●●●H30	SDA42S8●●●H30	SDA32S8●●●H30
230 (240)	3	0	30	SBG32S8●●●H30[4]	SBW32S8●●●H30[4]	SBA42S8●●●H30[4]	SBA32S8●●●H30[4]
	5	1	30	SCG32S8●●●H30[4]	SCW32S8●●●H30	SCA42S8●●●H30	SCA32S8●●●H30
	7.5	1	60	SCG33S8●●●H30	SCW33S8●●●H30[4]	SCA43S8●●●H30[4]	SCA33S8●●●H30[4]
	15	2	60	SDG32S8●●●H30	SDW32S8●●●H30	SDA42S8●●●H30	SDA32S8●●●H30
460 (480)	5	0	30	SBG33S8●●●H30[4]	SBW33S8●●●H30 [4]	SBA43S8●●●H30[4]	SBA33S8●●●H30[4]
	10	1	30	SCG34S8●●●H30[4]	SCW34S8●●●H30[4]	SCA44S8●●●H30[4]	SCA34S8●●●H30[4]
	15	2	30	SDG36S8●●●H30[4]	SDW36S8●●●H30[4]	SDA46S8●●●H30[4]	SDA36S8●●●H30[4]
	25	2	60	SDG34S8●●●H30	SDW34S8●●●H30	SDA44S8●●●H30	SDA34S8●●●H30
575 (600)	5	0	30	SBG33S8●●●H30[4]	SBW33S8●●●H30[4]	SBA43S8●●●H30[4]	SBA33S8●●●H30[4]
	10	1	30	SCG34S8●●●H30[4]	SCW34S8●●●H30[4]	SCA44S8●●●H30[4]	SCA34S8●●●H30[4]
	15	2	30	SDG36S8●●●H30[4]	SDW36S8●●●H30[4]	SDA46S8●●●H30[4]	SDA36S8●●●H30[4]
	25	2	60	SDG34S8●●●H30	SDW34S8●●●H30	SDA44S8●●●H30	SDA34S8●●●H30

[1] For Size 3–5 starters in oversize NEMA 1, 4, or 12 enclosures, contact the factory for pricing and TAG number.

[2] Not included in the Laser™ Delivery program.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 10 on page 12.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

[5] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

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Table 10: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24[1]	—	V01
120[1]	110	V02
208	—	V08
240	220	V03
277[1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8538SCG11S8V02H30**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Electronic MCP, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 11: Class 8539 Full Voltage Type, Non-Reversing, 200–240 V, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Hp Range Polyphase	NEMA Size	Circuit Breaker [1]	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5) [2]	NEMA 4 & 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R Industrial Use Dusttight and Driptight [3]	
							With External Reset	Without External Reset
				Type [4]	Type [4]	Type [4]	Type [4]	Type [4]
200 (208)	0.25–3	0	HLL36030M71	SBG43●●●H30 [5]	SBW43●●●H30 [5]	SBW53●●●H30 [5]	SBA53●●●H30 [5]	SBA43●●●H30 [5]
	0.25–5 7.5	1	HLL36030M71 HLL36050M72	SCG44●●●H30 [5] SCG45●●●H30 [5]	SCW44●●●H30 [5] SCW45●●●H30 [5]	SCW54●●●H30 [5] SCW55●●●H30 [5]	SCA54●●●H30 [5] SCA55●●●H30 [5]	SCA44●●●H30 [5] SCA45●●●H30 [5]
	1.5–5 7.5–10	2	HLL36030M71 HLL36050M72	SDG42●●●H30 [5] SDG43●●●H30	SDW42●●●H30 [5] SDW43●●●H30	SDW52●●●H30 [5] SDW53●●●H30	SDA52●●●H30 [5] SDA53●●●H30	SDA42●●●H30 [5] SDA43●●●H30
	15–25	3	HLL36100M73	SEG42●●●H30	SEW42●●●H30	SEW52●●●H30	SEA52●●●H30	SEA42●●●H30
	30–40	4	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	50–60 75	5	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG45●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	100 125–150	6	LJL36400M36 LJL36600M42	SHG43●●●H30 SHG45●●●H30	SHW43●●●H30 SHW45●●●H30	— —	SHA53●●●H30 SHA55●●●H30	SHA43●●●H30 SHA45●●●H30
230 (240)	0.25–3	0	HLL36030M71	SBG43●●●H30 [5]	SBW43●●●H30 [5]	SBW53●●●H30 [5]	SBA53●●●H30 [5]	SBA43●●●H30 [5]
	0.25–7.5	1	HLL36030M71	SCG44●●●H30 [5]	SCW44●●●H30 [5]	SCW54●●●H30 [5]	SCA54●●●H30 [5]	SCA44●●●H30 [5]
	1.5–7.5 10 15	2	HLL36030M71 HLL36050M72 HLL36100M73	SDG42●●●H30 [5] SDG43●●●H30 SDG44●●●H30	SDW42●●●H30 [5] SDW43●●●H30 SDW44●●●H30	SDW52●●●H30 [5] SDW53●●●H30 SDW54●●●H30	SDA52●●●H30 [5] SDA53●●●H30 SDA54●●●H30	SDA42●●●H30 [5] SDA43●●●H30 SDA44●●●H30
	15–30	3	HLL36100M73	SEG42●●●H30	SEW42●●●H30	SEW52●●●H30	SEA52●●●H30	SEA42●●●H30
	40–50	4	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	60 75–100	5	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG46●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	125–150 200	6	LJL36600M42 PLL34080M68	SHG45●●●H30 SHG46●●●H30	SHW45●●●H30 SHW46●●●H30	— —	SHA55●●●H30 SHA56●●●H30	SHA45●●●H30 SHA46●●●H30
	250–300	7	PLL36100M69	SJA43●●●H30	SJW43●●●H30	—	SJA53●●●H30	—

[1] See Digest Section 7 for the circuit breaker adjustment range.

[2] Size 6 and 7 enclosures are NEMA 4 sheet steel.

[3] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[4] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 12.

[5] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

Standard unit

File E152395
CCN NKJH, NKJH7

Table 12: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
277 [1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, 8539SCG41V02**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Electronic MCP, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 13: Class 8539 Full Voltage Type, Non-Reversing, 460–600 V, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Hp Range Polyphase	NEMA Size	Circuit Breaker [1]	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5)[2]	NEMA 4 & 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R[3] Industrial Use Dusttight and Driptight	
							With External Reset	Without External Reset
				Type[4]	Type[4]	Type[4]	Type [4]	Type[4]
460 (480)	0.25–5	0	HLL36030M71	SBG43●●●H30[5]	SBW43●●●H30[5]	SBW53●●●H30[5]	SBA53●●●H30[5]	SBA43●●●H30 [5]
	0.25–10	1	HLL36030M71	SCG44●●●H30[5]	SCW44●●●H30[5]	SCW54●●●H30[5]	SCA54●●●H30[5]	SCA44●●●H30[5]
	5–15 20–25	2	HLL36030M71 HLL36050M72	SDG42●●●H30[5] SDG43●●●H30	SDW42●●●H30[5] SDW43●●●H30	SDW52●●●H30[5] SDW53●●●H30	SDA52●●●H30[5] SDA53●●●H30	SDA42●●●H30[5] SDA43●●●H30
	20–25 30–50	3	HLL36050M72 HLL36100M73	SEG41●●●H30 SEG42●●●H30	SEW41●●●H30 SEW42●●●H30	SEW51●●●H30 SEW52●●●H30	SEA51●●●H30 SEA52●●●H30	SEA41●●●H30 SEA42●●●H30
	60–100	4	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	125 150–200	5	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG45●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	250–350 400	6	LJL36600M42 PLL34080M68	SHG45●●●H30 SHG46●●●H30	SHW45●●●H30 SHW46●●●H30	— —	SHA55●●●H30 SHA56●●●H30	SHA45●●●H30 SHA46●●●H30
	500 600	7	PLL36080M68 PLL36100M69	SJA42●●●H30 SJA43●●●H30	SJW42●●●H30 SJW43●●●H30	— —	SJA52●●●H30 SJA53●●●H30	— —
575 (600)	0.25–5	0	HLL36030M71	SBG43●●●H30[5]	SBW43●●●H30[5]	SBW53●●●H30[5]	SBA53●●●H30[5]	SBA43●●●H30[5]
	0.25–10	1	HLL36030M71	SCG44●●●H30[5]	SCW44●●●H30[5]	SCW54●●●H30[5]	SCA54●●●H30[5]	SCA44●●●H30[5]
	5–20 25	2	HLL36030M71 HLL36050M72	SDG42●●●H30[5] SDG43●●●H30	SDW42●●●H30[5] SDW43●●●H30	SDW52●●●H30[5] SDW53●●●H30	SDA52●●●H30[5] SDA53●●●H30	SDA42●●●H30[5] SDA43●●●H30
	25–30 40–50	3	HLL36050M72 HLL36100M73	SEG41●●●H30 SEG42●●●H30	SEW41●●●H30 SEW42●●●H30	SEW51●●●H30 SEW52●●●H30	SEA51●●●H30 SEA52●●●H30	SEA41●●●H30 SEA42●●●H30
	60–100	4	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	125–150 200	5	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG45●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	250 300–400	6	LJL36400M36 LJL36600M42	SHG43●●●H30 SHG45●●●H30	SHW43●●●H30 SHW45●●●H30	— —	SHA53●●●H30 SHA55●●●H30	SHA43●●●H30 SHA45●●●H30
	500–600	7	PLL34100M69	SJG41●●●H30	SJW41●●●H30	—	SJA51●●●H30	—

[1] See Digest Section 7 for the circuit breaker adjustment range.

[2] Size 6 and 7 enclosures are NEMA 4 only, painted sheet steel.

[3] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[4] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 14.

[5] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

Table 14: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24[1]	—	V01
120[1]	110	V02
208	—	V08
240	220	V03
277[1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8539SCG41V02**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Electronic MCP, Oversize, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

Table 15: Class 8539 Electronic Motor Circuit Protectors (MCP) in Oversize Enclosure, NEMA Size 0–2 [1]
Full Voltage Type, Non-Reversing with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure			
						NEMA 12/3R Industrial Use Dusttight and Driptight [3]	
Motor Voltage (Starter Voltage)	Hp Range Polyphase	NEMA Size	Circuit Breaker [2]	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	With External Reset	Without External Reset
				Type[4]	Type[4]	Type[4]	Type[4]
200 (208)	0.25–3	0	HLL36030M71	SBG43S8●●●H30[5]	SBW43S8●●●H30[5]	SBA53S8●●●H30[5]	SBA43S8●●●H30[5]
	0.25–5 7.5	1	HLL36030M71 HLL36050M72	SCG44S8●●●H30[5] SCG45S8●●●H30[5]	SCW44S8●●●H30[5] SCW45S8●●●H30[5]	SCA54S8●●●H30[5] SCA55S8●●●H30[5]	SCA44S8●●●H30[5] SCA45S8●●●H30[5]
	1.5–5 7.5–10	2	HLL36030M71 HLL36050M72	SDG42S8●●●H30[5] SDG43S8●●●H30	SDW42S8●●●H30[5] SDW43S8●●●H30	SDA52S8●●●H30[5] SDA53S8●●●H30	SDA42S8●●●H30[5] SDA43S8●●●H30
230 (240)	0.25–3	0	HLL36030M71	SBG43S8●●●H30[5]	SBW43S8●●●H30[5]	SBA53S8●●●H30[5]	SBA43S8●●●H30[5]
	0.25–7.5	1	HLL36030M71	SCG44S8●●●H30[5]	SCW44S8●●●H30[5]	SCA54S8●●●H30[5]	SCA44S8●●●H30[5]
	1.5–7.5 10 15	2	HLL36030M71 HLL36050M72 HLL36100M73	SDG42S8●●●H30[5] SDG43S8●●●H30 SDG44S8●●●H30	SDW42S8●●●H30[5] SDW43S8●●●H30 SDW44S8●●●H30	SDA52S8●●●H30[5] SDA53S8●●●H30 SDA54S8●●●H30	SDA42S8●●●H30[5] SDA43S8●●●H30 SDA44S8●●●H30
460 (480)	0.25–5	0	HLL36030M71	SBG43S8●●●H30[5]	SBW43S8●●●H30[5]	SBA53S8●●●H30[5]	SBA43S8●●●H30[5]
	0.25–10	1	HLL36030M71	SCG44S8●●●H30[5]	SCW44S8●●●H30[5]	SCA54S8●●●H30[5]	SCA44S8●●●H30[5]
	5–15 20–25	2	HLL36030M71 HLL36050M72	SDG42S8●●●H30[5] SDG43S8●●●H30	SDW42S8●●●H30[5] SDW43S8●●●H30	SDA52S8●●●H30[5] SDA53S8●●●H30	SDA42S8●●●H30[5] SDA43S8●●●H30
575 (600)	0.25–5	0	HLL36060M71	SBG43S8●●●H30[5]	SBW43S8●●●H30[5]	SBA53S8●●●H30[5]	SBA43S8●●●H30[5]
	0.25–10	1	HLL36030M71	SCG44S8●●●H30[5]	SCW44S8●●●H30[5]	SCA54S8●●●H30[5]	SCA44S8●●●H30[5]
	5–20 25	2	HLL36030M71 HLL36050M72	SDG42S8●●●H30[5] SDG43S8●●●H30	SDW42S8●●●H30[5] SDW43S8●●●H30	SDA52S8●●●H30[5] SDA53S8●●●H30	SDA42S8●●●H30[5] SDA43S8●●●H30

[1] Not included in the Laser™ Delivery program.

[2] See Digest Section 7 for the circuit breaker adjustment range.

[3] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[4] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 16.

[5] Form H30, with the possibility of a fourth character to select a lower FLA range (for example, H308). See page 45.

Table 16: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
277 [1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8539SCG41S8V02**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Thermal-Magnetic, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 17: Class 8539 Full Voltage, Thermal-Magnetic Circuit Breaker Type, Non-Reversing, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings					Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Poly-phase	NEMA Size	Circuit Breaker		NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5) [1]	NEMA 4 & 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R [2] Dusttight and Driptight Industrial Use	
								With External Reset	Without External Reset
			Type	Rating (A)	Type[3]	Type[3]	Type[3]	Type[3]	Type[3]
200 (208)	2 3	0	HLL36015 HLL36020	15 20	SBG1●●●H30[4] SBG3●●●H30[4]	SBW1●●●H30[4] SBW3●●●H30[4]	SBW11●●●H30[4] SBW13●●●H30[4]	SBA11●●●H30[4] SBA13●●●H30[4]	SBA1●●●H30[4] SBA3●●●H30[4]
	5 7.5	1	HLL36035 HLL36050	35 50	SCG5●●●H30[4] SCG2●●●H30[4]	SCW5●●●H30[4] SCW2●●●H30[4]	SCW15●●●H30[4] SCW12●●●H30[4]	SCA15●●●H30[4] SCA12●●●H30[4]	SCA5●●●H30[4] SCA2●●●H30[4]
	10	2	HLL36060	60	SDG1●●●H30	SDW1●●●H30	SDW11●●●H30	SDA11●●●H30	SDA1●●●H30
	15 20 25	3	HLL36100 HLL36125 HLL36150	100 125 150	SEG3●●●H30 SEG1●●●H30 SEG5●●●H30	SEW3●●●H30 SEW1●●●H30 SEW5●●●H30	SEW13●●●H30 SEW11●●●H30 SEW15●●●H30	SEA13●●●H30 SEA11●●●H30 SEA15●●●H30	SEA3●●●H30 SEA1●●●H30 SEA5●●●H30
	30 40	4	JLL36200 JLL36250	200 250	SFG3●●●H30 SFG4●●●H30	SFW3●●●H30 SFW4●●●H30	SFW13●●●H30 SFW14●●●H30	SFA13●●●H30 SFA14●●●H30	SFA3●●●H30 SFA4●●●H30
	50 60–75	5	JLL36250 LLL36400U33X	250 400	SGG6●●●H30 SGG4●●●H30	SGW6●●●H30 SGW4●●●H30	— —	SGA16●●●H30 SGA14●●●H30	SGA6●●●H30 SGA4●●●H30
	100–125 150	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
230 (240)	2 3	0	HLL36015 HLL36020	15 20	SBG1●●●H30[4] SBG3●●●H30[4]	SBW1●●●H30[4] SBW3●●●H30[4]	SBW11●●●H30[4] SBW13●●●H30[4]	SBA11●●●H30[4] SBA13●●●H30[4]	SBA1●●●H30[4] SBA3●●●H30[4]
	5 7.5	1	HLL36035 HLL36045	35 45	SCG5●●●H30[4] SCG6●●●H30[4]	SCW5●●●H30[4] SCW6●●●H30[4]	SCW15●●●H30[4] SCW16●●●H30[4]	SCA15●●●H30[4] SCA16●●●H30[4]	SCA1●●●H30[4] SCA6●●●H30[4]
	10 15	2	HLL36060 HLL36090	60 90	SDG1●●●H30 SDG7●●●H30	SDW1●●●H30 SDW7●●●H30	SDW11●●●H30 SDW17●●●H30	SDA11●●●H30 SDA17●●●H30	SDA1●●●H30 SDA7●●●H30
	20 25–30	3	HLL36100 HLL36150	100 150	SEG3●●●H30 SEG5●●●H30	SEW3●●●H30 SEW5●●●H30	SEW13●●●H30 SEW15●●●H30	SEA13●●●H30 SEA15●●●H30	SEA3●●●H30 SEA5●●●H30
	40 50	4	JLL36225 JLL36250	225 250	SFG1●●●H30 SFG4●●●H30	SFW1●●●H30 SFW4●●●H30	SFW11●●●H30 SFW14●●●H30	SFA11●●●H30 SFA14●●●H30	SFA1●●●H30 SFA4●●●H30
	60 75 100	5	JLL36250 LLL36400U33X LLL36600U33X	250 400 600	SGG6●●●H30 SGG4●●●H30 SGG2●●●H30	SGW6●●●H30 SGW4●●●H30 SGW2●●●H30	— — —	SGA16●●●H30 SGA14●●●H30 SGA12●●●H30	SGA6●●●H30 SGA4●●●H30 SGA2●●●H30
	125 150–200	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
	250–300	7	PKL36100	1200	SJG3●●●H30	SJW3●●●H30	—	SJA13●●●H30	—

[1] Size 6 and 7 enclosures are NEMA 4 only, painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes listed in Table 18.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

Table 18: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24[1]	—	V01
120[1]	110	V02
208	—	V08
240	220	V03
277[1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8539SCG5V02**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

Dimensions . . . . . Page 18
Factory Modifications (Forms) . . . . . Page 42
Type S Accessories (Class 9999) . . . . . Catalog 9999CT9701R10/07

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Thermal-Magnetic, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 19: Class 8539 Line Voltage, Thermal-Magnetic Circuit Breaker Type, Non-Reversing, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings					Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Poly-phase	NEMA Size	Circuit Breaker		NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5)[1]	NEMA 4 & 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R Industrial Use Dusttight and Driptight [2]	
								With External Reset	Without External Reset
			Type	Rating (A)	Type[3]	Type[3]	Type[3]	Type[3]	Type[3]
460 (480)	5	0	HLL36015	15	SBG1●●●H30[4]	SBW1●●●H30[4]	SBW11●●●H30[4]	SBA11●●●H30[4]	SBA1●●●H30[4]
	7.5 10	1	HLL36025 HLL36030	25 30	SCG3●●●H30[4] SCG7●●●H30[4]	SCW3●●●H30[4] SCW7●●●H30[4]	SCW13●●●H30[4] SCW17●●●H30[4]	SCA13●●●H30[4] SCA17●●●H30[4]	SCA3●●●H30[4] SCA7●●●H30[4]
	15 20 25	2	HLL36045 HLL36060 HLL36070	45 60 70	SDG3●●●H30 SDG1●●●H30 SDG5●●●H30	SDW3●●●H30 SDW1●●●H30 SDW5●●●H30	SDW13●●●H30 SDW11●●●H30 SDW15●●●H30	SDA13●●●H30 SDA11●●●H30 SDA15●●●H30	SDA3●●●H30 SDA1●●●H30 SDA5●●●H30
	30 40 50	3	HLL36080 HLL36100 HLL36150	80 100 150	SEG7●●●H30 SEG3●●●H30 SEG5●●●H30	SEW7●●●H30 SEW3●●●H30 SEW5●●●H30	SEW17●●●H30 SEW13●●●H30 SEW15●●●H30	SEA17●●●H30 SEA13●●●H30 SEA15●●●H30	SEA7●●●H30 SEA3●●●H30 SEA5●●●H30
	60 75 100	4	JLL36150 JLL36200 JLL36250	150 200 250	SFG5●●●H30 SFG3●●●H30 SFG4●●●H30	SFW5●●●H30 SFW3●●●H30 SFW4●●●H30	SFW15●●●H30 SFW13●●●H30 SFW14●●●H30	SFA15●●●H30 SFA13●●●H30 SFA14●●●H30	SFA5●●●H30 SFA3●●●H30 SFA4●●●H30
	125–150 200	5	LLL36400U33X LLL36600U33X	400 600	SGG4●●●H30 SGG2●●●H30	SGW4●●●H30 SGW2●●●H30	— —	SGA14●●●H30 SGA12●●●H30	SGA4●●●H30 SGA2●●●H30
	250 300–400	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
	500–600	7	PLL36120	1200	SJG3●●●H30	SJW3●●●H30	—	SJA13●●●H30	—
575 (600)	5	0	HLL36015	15	SBG1●●●H30[4]	SBW1●●●H30[4]	SBW11●●●H30[4]	SBA11●●●H30[4]	SBA1●●●H30[4]
	7.5 10	1	HLL36020 HLL36025	20 25	SCG8●●●H30[4] SCG3●●●H30[4]	SCW8●●●H30[4] SCW3●●●H30[4]	SCW18●●●H30[4] SCW13●●●H30[4]	SCA18●●●H30[4] SCA13●●●H30[4]	SCA8●●●H30[4] SCA3●●●H30[4]
	15 20 25	2	HLL36035 HLL36045 HLL36060	35 45 60	SDG8●●●H30 SDG3●●●H30 SDG1●●●H30	SDW8●●●H30 SDW3●●●H30 SDW1●●●H30	SDW18●●●H30 SDW13●●●H30 SDW11●●●H30	SDA18●●●H30 SDA13●●●H30 SDA11●●●H30	SDA8●●●H30 SDA3●●●H30 SDA1●●●H30
	30 40 50	3	HLL36070 HLL36090 HLL36100	70 90 100	SEG4●●●H30 SEG6●●●H30 SEG3●●●H30	SEW4●●●H30 SEW6●●●H30 SEW3●●●H30	SEW14●●●H30 SEW16●●●H30 SEW13●●●H30	SEA14●●●H30 SEA16●●●H30 SEA13●●●H30	SEA4●●●H30 SEA6●●●H30 SEA3●●●H30
	60–75 100	4	JLL36150 JLL36250	150 250	SFG5●●●H30 SFG4●●●H30	SFW5●●●H30 SFW4●●●H30	SFW15●●●H30 SFW14●●●H30	SFA15●●●H30 SFA14●●●H30	SFA5●●●H30 SFA4●●●H30
	125–150 200	5	JLL36250 LLL36400U33X	250 400	SGG6●●●H30 SGG4●●●H30	SGW6●●●H30 SGW4●●●H30	— —	SGA16●●●H30 SGA14●●●H30	SGA6●●●H30 SGA4●●●H30
	250–350 400	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
	500–600	7	PKL36100	1200	SJG2●●●H30	SJW2●●●H30	—	SJA12●●●H30	—

[1] Size 6 and 7 enclosures are NEMA 4 only, painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes listed in Table 18 on page 16.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

Table 20: Single-Phase[1] Thermal-Magnetic Circuit Breaker Type, Class 8539

Ratings							Enclosure				
Motor Voltage	Max. Hp	Coil Voltage	NEMA Size	Poles	Circuit Breaker		NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–2)	NEMA 4 & 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R[2] Dusttight and Driptight Industrial Use	
					Type	Rating (A)				With External Reset	Without External Reset
							Type	Type	Type	Type	Type
120	1 2 3	120	0 1 2	2	HLL26030 HLL26050 HLL26080	30 50 80	SBG72V02 SCG72V02 SDG71V02	SBW72V02 SCW72V02 SDW71V02	SBW75V02 SCW75V02 SDW74V02	SBA75V02 SCA75V02 SDA74V02	SBA72V02 SCA72V02 SDA71V02
240	2 3 7.5	240	0 1 2	2	HLL26025 HLL26035 HLL26080	25 35 80	SBG71V03 SCG71V03 SDG71V03	SBW71V03 SCW71V03 SDW71V03	SBW74V03 SCW74V03 SDW74V03	SBA74V03 SCA74V03 SDA74V03	SBA71V03 SCA71V03 SDA71V03

NOTE: Some control transformers may require the use of oversize enclosures. Refer to Table 71 on page 44 for control transformer selection.

[1] Single phase units require one thermal unit and are not available with solid-state overload relays (Form Hxx). Not included in the Laser™ Delivery program.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

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Dimensions for Non-Reversing Combination Starters

NEMA 1 Enclosures

NOTE: The dimensions in Tables 21 and 22 include space for Form **FF4T** (standard control transformer). An oversize enclosure may be required for Form **FF4T11** (100 VA additional capacity) and Form **FF4T12** (200 VA additional capacity). See Table 57 on page 38 for replacement transformer selection.

Table 21: Sizes 0–2, NEMA 1 Enclosure—See Figure 1

NEMA Size	Class	Type	Dimensions, in.																Top & Bottom		Sides	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	W	X	Y	
0–1	8538	SBG, SCG	9.5	22.5	8.34	6.38	20.5	14.66	1.81	1.69	3	2.31	1.06	3.25	2.19	1.25	0.88	—	0.5–0.75	0.5–0.75	0.5	38
	8539	SBG, SCG	9.5	22.5	9.84	6.38	20.5	14.66	1.81	1.69	3	2.31	1.06	3.25	2.19	1.25	0.88	—	0.5–0.75	0.5–0.75	0.5	38
2	8538, 8539	SDG	10.5	26	9.59	7.38	24	16.91	2.13	2	4	2.31	1.06	3.25	2.19	1.25	0.88	—	1–1.25	0.5–0.75	0.5	54

Table 22: Sizes 3–6, NEMA 1 Enclosure—See Figure 2

NEMA Size	Type	Class	Dimensions, in.																Top & Bottom		Sides	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	W	X	Y	
3[1]	8538, 8539	SEG	15.25	42	10.59	9.25	3	22.72	41	0.5	—	2.83	3.53	5	2.69	5.38	1.28	0.91	1–1.25 2–2.5	0.5–0.75	0.5	102
4	8538	SFG	16	52.5	10.53	10	3	23.66	51.5	0.5	—	2.83	3.53	5	2.69	5.38	1.28	0.91	2.5	0.5–0.75	0.5	163
	8539	SFG	16	52.5	10.53	10	3	23.66	51.5	0.5	—	2.83	3.53	5	2.69	5.38	1.28	0.91	2.5	0.5–0.75	0.5	163
5	8538	SGG	20	78	15.5	12	4	29.41	77	0.5	—	3.52	4.61	9.25	3.19	—	—	—	0.5–0.75[2]	3	—	450
	8539	SGG	20	66	13.72	12	4	29.41	65	0.5	—	3.52	4.61	5	3.19	—	—	—	0.5–0.75	3	—	420
6[3]	8538, 8539	SHG	36	90	21.03	—	—	41.38	—	—	—	—	—	5	—	—	—	—	—	—	—	—

[1] For Class 8538 Size 3 devices with 200 A fuse clips, use the dimensions for Class 8538 Size 4 devices.

[2] Left side only.

[3] Size 6 enclosures are floor mounting.

Figure 1: NEMA 1 Enclosure Sizes 0–2

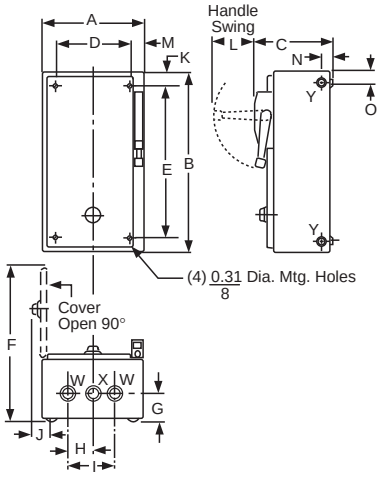
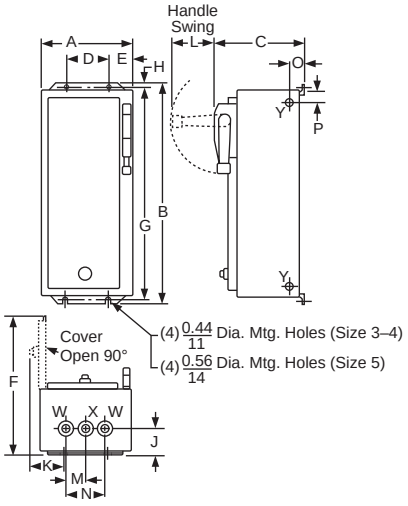


Figure 2: NEMA 1 Enclosure Sizes 3–6



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NEMA 12/3R Enclosures

Modifying NEMA 12 for Outdoor Applications (not for use in salt air or corrosive environments)

Field Modifications for NEMA 3 dusttight, raintight, and sleet resistant outdoor applications are as follows: Watertight conduit hubs or equivalent provision for watertight connection at the conduit entrance shall be used.

Field Modifications for NEMA 3R rainproof and sleet resistant outdoor applications are as follows:

1. Watertight conduit hubs or equivalent provision for watertight connection at the conduit entrance, when the conduit enters at a level higher than the lowest live part, shall be used.
2. Drain holes of 1/8 inch diameter shall be added to the bottom of the enclosure.

Table 23: NEMA 12/3R Enclosure (see Figure 3)
Dimensions include space for control circuit transformers.

NEMA Size	Class	Type	Dimensions, in.										Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	
0–1	8538	SBA SCA	9.5	8.34	24	3.25	2.5	4.5	23.5	0.59	4.44	14.31	40
	8539	SBA SCA	9.5	9.84	24	3.25	2.5	4.5	23.5	0.59	4.44	14.31	40
2	8538, 8539	SDA	10.5	9.59	27.75	3.25	2.5	5.5	27	0.38	4.13	16.56	55
3[1]	8538, 8539	SEA	15.25	10.59	42	5	3	9.25	41	0.5	5.06	22.31	111
4	8538	SFA	16	10.53	52.5	5	3	10	51.5	0.5	4.19	22.97	170
	8539	SFA	16	10.53	52.5	5	3	10	51.5	0.5	5.19	22.97	170
5	8538	SGA	20	13.72	78	9.25	4	12	77	0.5	7.78	29.41	—
	8539	SGA	20	13.72	66	5	4	12	65	0.5	7.78	27.41	440
6[2]	8538, 8539	SHA	36	17	90	5	—	—	—	—	—	47.38	—

[1] For Class 8538 Size 3 devices with 200 A fuse clips, use the dimensions for Class 8538 Size 4 devices.

[2] Size 6 enclosures are floor mounting.

Oversize Enclosures

Table 24: NEMA 1, 4, 4X Stainless, and 12 Oversize Enclosures—See Figure 4

NEMA Size	NEMA Enclosure	Dimensions, in.					
		Wide	High	Deep	Handle	Mounting	
		A	B	C	L	D	E
0–2	1	15	28.75	9.59	3.25	11.63	26.25
	4	15	30.03	9.59	3.25	10	29.75
	12	15	31	10.97	3.25	9	30.25

Figure 3: NEMA 12/3R Enclosure

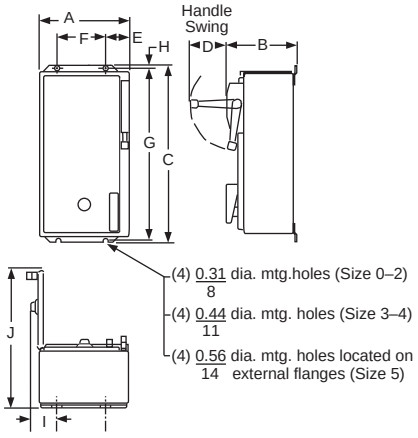
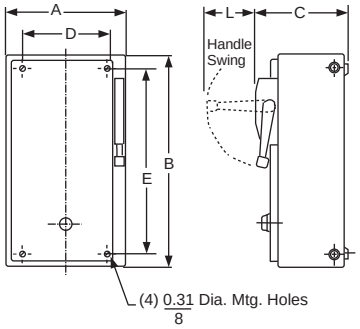


Figure 4: Class 8538 and 8539 In Oversize Enclosures—NEMA 1, 4 & 4X Stainless, 12/3R



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NEMA 4, 4X Enclosures (for oversize enclosures, see page 19)

Figure 5:
NEMA 4X Polyester Enclosure

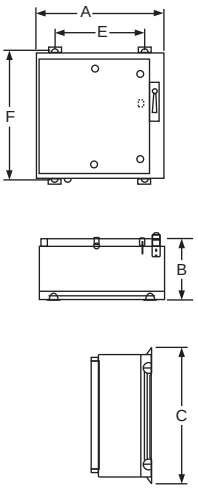


Table 25: NEMA 4X Polyester Enclosure (see Figure 5)

NEMA Size	Class	Dimensions, in. [1]					
		Type	A	B	C	E	F
0–1	8538	SBW SCW SDW	13.72	11.4	26.94	6.25	25.75
0–1	8539						
0–2	8738, 8739	SBW SCW SDW	25.25	11.4	27.00	17.88	25.75
2	8538, 8539						
3–4	8538, 8738 8539, 8739	SEW SFW [2]	26.31	11.4	33.50	18.50	32.25

[1] Dimensions include space for Form **FF4T** (standard control transformer) and Form **FF4T10** (50 VA additional capacity). An oversize enclosure may be required for other control transformers.

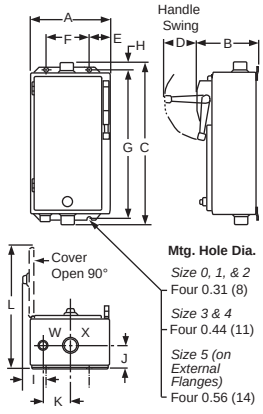
[2] 8539 Size 4 only.

Table 26: Information on Hubs

Hubs are furnished with each NEMA 4X combination starter as shown in this table. Note that hubs are only installed in stainless steel enclosures; they are not installed in polyester enclosures.

NEMA Size	Hub Size, Quantity = 1	Hub Size, Quantity = 2
0–1	0.75 in.	1.00 in.
2	0.75 in.	1.50 in.
3–4	0.75 in.	2.50 in.

Figure 6:
NEMA 4 & 4X Stainless Steel Enclosure



Dim: in. (mm)

Table 27: NEMA 4 and 4X Stainless Steel Enclosure (see Figure 6)

NEMA Size	Class	Type	Dimensions, in.[1]												Bottom	Top & Bottom	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	W (Hub)	X (Hub)	
0–1	8538	SBW SCW	9.5	8.34	24.06	3.25	2.5	4.5	23.5	0.59	3.03	1.31	2.31	14.28	0.75	1	40
	8539		9.5	9.84	24.06	3.25	2.5	4.5	23.5	0.59	3.03	1.31	2.31	14.28	0.75	1	40
2	8538, 8539	SDW	10.5	9.59	27.75	3.25	2.5	5.5	27	0.59	3	2	2.63	16.53	0.75	1.5	55
3[2]	8538, 8539	SEW	15.25	10.59	42	5	3.19	10.25	40.5	0.59	3	2.56	3.19	22.19	0.75	2.5	111
4	8538	SFW	16	10.53	52.5	5	3.56	11	51	0.59	3	2.56	3.19	22.47	0.75	2.5	158
	8539	SFW	16	10.53	52.5	3.25	2.5	11	51	0.59	3	2.56	3.19	22.47	0.75	2.5	120
5	8538	SGW	20	13.72	78	9.25	4	12	77	0.56	4.5	3	3.5	29.41	0.75	3.5	—
	8539	SGW	20	13.72	66	5	4	12	65	0.56	4.5	3	3.5	29.41	0.75	3.5	440
6[3]	8538, 8539	SHW	36	17	90	—	—	—	—	—	—	—	—	47.88	—	—	—

[1] Dimensions include space for Form **FF4T** (standard control transformer). An oversize enclosure may be required for Form **FF4T11** (100 VA additional capacity) and Form **FF4T12** (200 VA additional capacity).

[2] For Class 8538 Size 3 devices with 200 A fuse clips, use the dimensions for Class 8538 Size 4 devices.

[3] Size 6 enclosures are floor mounting.

Table 28: Conduit Sizes, Locations A, B, C, and D

NEMA Size	Standard
0–1	1.25
2	1.5
3–4	2.5
5	4

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Panel Layout Drawings

Table 29: Standard Enclosures—NEMA1, 4 & 4X Stainless, and 12/3R

This table identifies open panel space on standard NEMA 1, 4 & 4X stainless steel, and 12/3R combination starters. Space and mounting holes are provided in all combination starters for the field addition of a control transformer—see Table 71 on page 44 for control transformer selection.

Class	NEMA Size	Dimensions, in.								
		A	B	C	D	E	F	G	H	I
8538	0, 1	6.9	18.5	6.9	6.5	0	3.5	3.4	6.9	4.0
8539				6.5	7.9					—
8538	2	7.9	22.0	7.5	7.0	3.1	4.8	0	7.7	6.0
8539				6.5	8.4					—
8538	3	12.0	29.5	9.0	7.7	0	5.6	6.4	12.9	5.3
8539				6.5	8.5					—
8538	4	13.0	39.0	11.0	11.5	0	7.0	6.0	13.0	9.0
8539				6.8	12.5					—
8538	5[1]	17.3	59.0	13.5	25.0	0	10.8	6.5	20.5	—
8539				JLL: 6.8 LLL: 9.0	JLL: 23.0 LLL: 24.5					—
8538	6	32.0	82.0	32.0	40.0	0	13.0	19.0	35.0	—
8539				LLL: 9.0 MJL: 12.5	LLL: 25.5 MJL: 40.5					—

[1] Size 5 combination starter does not contain a full-size panel. No usable panel space is available.

Figure 7: Class 8538—Standard

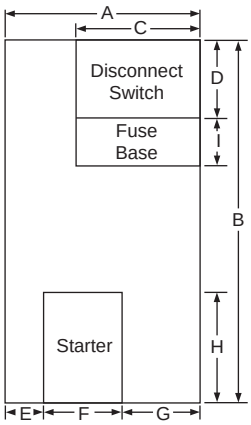
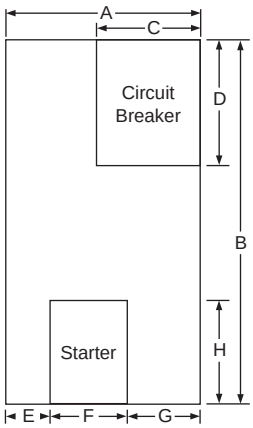


Figure 8: Class 8539—Standard



Oversize Enclosures—NEMA 1, 4 & 4X Stainless, and 12

Combination starters in oversize enclosures provide additional panel space for field addition of control relays, timing relays, terminal blocks, or other auxiliary equipment. Disconnect switch devices offer more than 130 in² of available panel space, and circuit breaker devices more than 180 in².

Figure 9: Class 8538—Oversize

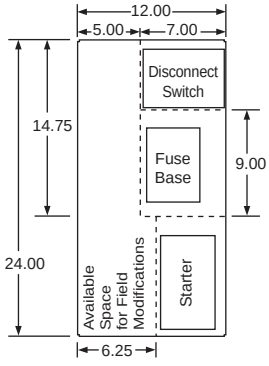
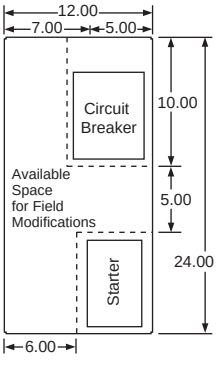


Figure 10: Class 8539—Oversize



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Reversing Combination Starters, NEMA Style

General Information—Reversing Combination Starters

Class 8738 and 8739 Type S reversing combination starters combine the requirements of motor overload and short-circuit protection into one convenient package. Type S reversing combination starters are manufactured in accordance with NEMA standards, are UL Listed, and are CSA certified. Class 8738 and 8739 reversing combination starters are designed to operate at 600 Vac, 50–60 Hz. Type S reversing combination starters come standard with melting alloy overload relays. Bimetallic and solid-state overload relays are available as options (see pages 45–46).

Enclosures—Class 8738 and 8739 reversing combination starters are available in the following enclosures:

- NEMA 1 General Purpose
- NEMA 4 & 4X Watertight and Dusttight
- NEMA 4X Watertight, Dusttight, and Corrosion Resistant Glass-Polyester
- NEMA 12/3R Dusttight and Driptight for Industrial Use

The NEMA 4 & 4X stainless steel enclosures (Sizes 0–5) have a brushed finish. Sizes 6–7 are sheet-steel enclosures and are rated NEMA 4 only.

The NEMA 4X glass-polyester enclosed devices are UL Listed. Hubs are furnished as standard on NEMA 4X enclosures.

NEMA 12/3R enclosures can be field modified for outdoor applications. Specify **Form G26** for NEMA 3R (no additional charge). See page 19 for details.

Coil Voltages—AC coils are available for application at 50/60 Hz. NEMA Sizes 00–5 are furnished with coils designed to operate satisfactorily on line voltages of 85–110% of rated voltage.
NEMA Size 6–7 contactors are furnished with a DC coil operated by a solid-state rectifier circuit, which is powered by an AC source.

> **NOTE:** A voltage code is required when ordering combination starters. Polyphase combination starters with 24 Vac or 120 Vac coil voltages come wired for **separate control**.

Auxiliary Contacts—Additional auxiliary contacts may be added to Type S starters. See page 37 for the maximum number of auxiliary units and the Form designations for factory installed auxiliary contacts. See catalog 9999CT9701 for auxiliary contact kits for field installation.

Type S Accessories—Additional accessories such as fuse blocks, fuse clip kits, disconnect switch and circuit breaker interlocks, and cover-mounted control units are available for field modifications. For factory modifications (Forms), see page 42. For field modification kits, see catalog 9999CT9701.

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Overload Protection

Type S magnetic starters are used for full-voltage starting and stopping of AC squirrel cage motors. Motor overload protection for three-phase starter applications can be provided through one of four options, as follows:

Solid-State Overload Relay Protection (Motor Logic™ SSOLR)—These ambient insensitive overload relays are available on Sizes 00–6 and standard on Size 7. They provide phase loss and phase unbalance protection. To order, add Form **H30** (for selectable trip class 10 or 20 protection). For more information about Motor Logic SSOLRs, see page 45 and catalog 9065CT9701. (Product catalog number example: 8536SCO3V06**H30**)

Adapted Bimetallic Overload Relay (NEMA Sizes 00–1)—The adapted bimetallic motor starter includes a specially designed adapter. It attaches with bus bars to the Type S NEMA contactor and holds the IEC-style bimetallic overload relay (type LRD or LR3D). This starter configuration can be ordered by adding Form **E** (adapter only) to the standard catalog number. The LRD or LR3D bimetallic overload relay must be purchased separately, based on the motor FLA, and installed in the field in order to operate the starter. For more information—including how to order the adapted bimetallic overload relay as a factory installed option—see page 45 and catalog 9065CT9701. (Product catalog number example: 8536SCO3V06**E**)

TeSys T Motor Management System (NEMA Sizes 1–6)—The flexible TeSys T system integrates seamlessly into your automation system through five major communication protocols. The TeSys T system can predict what will happen in the process, as it accurately monitors current, voltage, and power over a wide range. This option is available for control voltages of 24 Vac or 100–240 Vac. For additional information about the TeSys T Motor Management System, see page 46 and catalog 9065CT9701. NOTE: The full catalog number contains a four-character Form number (for example, 8536SCO3V06**H616**).

Melting Alloy Thermal Overload Relays—Melting alloy style thermal overload blocks are installed as part of the starter, and thermal elements must be selected and installed separately in order to operate the starter. For a three-phase motor, three thermal units must be ordered using the tables in catalog 9065CT9701. The catalog number includes no Form number (for example, 8536SCO3V06).

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Fusible, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 30: Class 8738 Reversing Full-Voltage Type, Fusible (with Class H and K Fuse Clips), with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R Industrial Use Dusttight and Driptight [1]	
							With External Reset	Without External Reset
				Type [2]	Type [2]	Type [2]	Type [2]	Type [2]
200 (208)	3	0	30	SBG12●●●H30 [3]	SBW12●●●H30[3]	SBW22●●●H30[3]	SBA22●●●H30[3]	SBA12●●●H30[3]
	5	1	30	SCG12●●●H30[3]	SCW12●●●H30[3]	SCW22●●●H30[3]	SCA22●●●H30[3]	SCA12●●●H30[3]
	7.5		60	SCG13●●●H30[3]	SCW13●●●H30[3]	SCW23●●●H30[3]	SCA23●●●H30[3]	SCA13●●●H30[3]
	10	2	60	SDG12●●●H30	SDW12●●●H30	SDW22●●●H30	SDA22●●●H30	SDA12●●●H30
	20	3	100	SEG15●●●H30	SEW15●●●H30	—	SEA25●●●H30	SEA15●●●H30
	40	4	200	SFG15●●●H30	SFW15●●●H30	—	SFA25●●●H30	SFA15●●●H30
	75	5	400	SGG15●●●H30	SGW15●●●H30	—	SGA25●●●H30	SGA15●●●H30
230 (240)	3	0	30	SBG12●●●H30[3]	SBW12●●●H30[3]	SBW22●●●H30[3]	SBA22●●●H30[3]	SBA12●●●H30[3]
	5	1	30	SCG12●●●H30[3]	SCW12●●●H30[3]	SCW22●●●H30[3]	SCA22●●●H30[3]	SCA12●●●H30[3]
	7.5		60	SCG13●●●H30[3]	SCW13●●●H30[3]	SCW23●●●H30[3]	SCA23●●●H30[3]	SCA13●●●H30[3]
	15	2	60	SDG12●●●H30	SDW12●●●H30	SDW22●●●H30	SDA22●●●H30	SDA12●●●H30
	25	3	100	SEG15●●●H30	SEW15●●●H30	—	SEA25●●●H30	SEA15●●●H30
	50	4	200	SFG15●●●H30	SFW15●●●H30	—	SFA25●●●H30	SFA15●●●H30
	100	5	400	SGG15●●●H30	SGW15●●●H30	—	SGA25●●●H30	SGA1●●●H30
460 (480)	5	0	30	SBG13●●●H30[3]	SBW13●●●H30[3]	SBW23●●●H30[3]	SBA23●●●H30[3]	SBA13●●●H30[3]
	10	1	30	SCG14●●●H30[3]	SCW14●●●H30[3]	SCW24●●●H30[3]	SCA24●●●H30[3]	SCA14●●●H30[3]
	15	2	30	SDG16●●●H30[3]	SDW16●●●H30[3]	SDW26●●●H30[3]	SDA26●●●H30[3]	SDA16●●●H30[3]
	25		60	SDG14●●●H30	SDW14●●●H30	SDW24●●●H30	SDA24●●●H30	SDA14●●●H30
	50	3	100	SEG13●●●H30	SEW13●●●H30	—	SEA23●●●H30	SEA13●●●H30
	100	4	200	SFG13●●●H30	SFW13●●●H30	—	SFA23●●●H30	SFA13●●●H30
	200	5	400	SGG13●●●H30	SGW13●●●H30	—	SGA23●●●H30	SGA13●●●H30
575 (600)	5	0	30	SBG13●●●H30[3]	SBW13●●●H30[3]	SBW23●●●H30[3]	SBA23●●●H30[3]	SBA13●●●H30[3]
	10	1	30	SCG14●●●H30[3]	SCW14●●●H30[3]	SCW24●●●H30[3]	SCA24●●●H30[3]	SCA14●●●H30[3]
	15	2	30	SDG16●●●H30[3]	SDW16●●●H30[3]	SDW26●●●H30[3]	SDA26●●●H30[3]	SDA16●●●H30[3]
	25		60	SDG14●●●H30	SDW14●●●H30	SDW24●●●H30	SDA24●●●H30	SDA14●●●H30
	50	3	100	SEG13●●●H30	SEW13●●●H30	—	SEA23●●●H30	SEA13●●●H30
	100	4	200	SFG13●●●H30	SFW13●●●H30	—	SFA23●●●H30	SFA13●●●H30
	200	5	400	SGG13●●●H30	SGW13●●●H30	—	SGA23●●●H30	SGA13●●●H30

[1] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[2] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 31.

[3] Form H30, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

Table 31: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
277 [1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

Standard unit

File E152395
CCN, NKJH, KNKJH7

File LR584
Class 3211 04

Note that some units are not CSA certified. Consult the factory.

[1] These voltage codes must include **Form S** (no charge) for separate control (for example, order as 8738SCG13V02**S**).
Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Non-Fusible, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 32: Class 8738 Non-Fusible Disconnect Switch Type—Full-Voltage, Reversing, with Motor Logic SSOLR

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	NEMA 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R [1] Industrial Use Dusttight and Driptight	
							With External Reset	Without External Reset
				Type [2]	Type [2]	Type [2]	Type [2]	Type [2]
200 (208)	3	0	None	SBG11●●●H30 [3]	SBW11●●●H30[3]	SBW21●●●H30[3]	SBA21●●●H30[3]	SBA11●●●H30[3]
	7.5	1	None	SCG11●●●H30[3]	SCW11●●●H30[3]	SCW21●●●H30[3]	SCA21●●●H30[3]	SCA11●●●H30[3]
	10	2	None	SDG11●●●H30	SDW11●●●H30	SDW21●●●H30	SDA21●●●H30	SDA11●●●H30
	25	3	None	SEG11●●●H30	SEW11●●●H30	—	SEA21●●●H30	SEA11●●●H30
	40	4	None	SFG11●●●H30	SFW11●●●H30	—	SFA21●●●H30	SFA11●●●H30
	75	5	None	SGG11●●●H30	SGW11●●●H30	—	SGA21●●●H30	SGA11●●●H30
230 (240)	3	0	None	SBG11●●●H30[3]	SBW11●●●H30[3]	SBW21●●●H30[3]	SBA21●●●H30[3]	SBA11●●●H30[3]
	7.5	1	None	SCG11●●●H30[3]	SCW11●●●H30[3]	SCW21●●●H30[3]	SCA21●●●H30[3]	SCA11●●●H30[3]
	15	2	None	SDG11●●●H30	SDW11●●●H30	SDW21●●●H30	SDA21●●●H30	SDA11●●●H30
	30	3	None	SEG11●●●H30	SEW11●●●H30	—	SEA21●●●H30	SEA11●●●H30
	50	4	None	SFG11●●●H30	SFW11●●●H30	—	SFA21●●●H30	SFA11●●●H30
	100	5	None	SGG11●●●H30	SGW11●●●H30	—	SGA21●●●H30	SGA11●●●H30
460 (480)	5	0	None	SBG11●●●H30[3]	SBW11●●●H30[3]	SBW21●●●H30[3]	SBA21●●●H30[3]	SBA11●●●H3 [3]
	10	1	None	SCG11●●●H30[3]	SCW11●●●H30[3]	SCW21●●●H30[3]	SCA21●●●H30[3]	SCA11●●●H30[3]
	25	2	None	SDG11●●●H30	SDW11●●●H30	SDW21●●●H30	SDA21●●●H30	SDA11●●●H30
	50	3	None	SEG11●●●H30	SEW11●●●H30	—	SEA21●●●H30	SEA11●●●H30
	100	4	None	SFG11●●●H30	SFW11●●●H30	—	SFA21●●●H30	SFA11●●●H30
	200	5	None	SGG11●●●H30	SGW11●●●H30	—	SGA21●●●H30	SGA11●●●H30
575 (600)	5	0	None	SBG11●●●H30[3]	SBW11●●●H30[3]	SBW21●●●H30[3]	SBA21●●●H30[3]	SBA11●●●H30[3]
	10	1	None	SCG11●●●H30[3]	SCW11●●●H30[3]	SCW21●●●H30[3]	SCA21●●●H30[3]	SCA11●●●H30[3]
	25	2	None	SDG11●●●H30	SDW11●●●H30	SDW21●●●H30	SDA21●●●H30	SDA11●●●H30
	50	3	None	SEG11●●●H30	SEW11●●●H30	—	SEA21●●●H30	SEA11●●●H30
	100	4	None	SFG11●●●H30	SFW11●●●H30	—	SFA21●●●H30	SFA11●●●H30
	200	5	None	SGG11●●●H30	SGW11●●●H30	—	SGA21●●●H30	SGA11●●●H30

[1] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[2] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 35 on page 28.

[3] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

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Class R Fuse Clips, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 33: Class 8738 Disconnect Switch Type, Fusible, with Class R Fuse Clips—100,000 AIC Rating (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Fuse Clip Size (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304)	NEMA 4X Watertight, Dusttight, and Corrosion Resistant Polyester	NEMA 12/3R [1] Industrial Use Dusttight and Driptight	
							With External Reset	Without External Reset
				Type [2]	Type [2]	Type [2]	Type [2]	Type [2]
200 (208)	3	0	30	SBG32●●●H30 [3]	SBW32●●●H30[3]	SBW42●●●H30[3]	SBA42●●●H30[3]	SBA32●●●H30[3]
	5	1	30	SCG32●●●H30[3]	SCW32●●●H30[3]	SCW42●●●H30[3]	SCA42●●●H30[3]	SCA32●●●H30[3]
	7.5		60	SCG33●●●H30[3]	SCW33●●●H30[3]	SCW43●●●H30[3]	SCA43●●●H30[3]	SCA33●●●H30[3]
	10	2	60	SDG32●●●H30	SDW32●●●H30	SDW42●●●H30	SDA42●●●H30	SDA32●●●H30
	20	3	100	SEG35●●●H30	SEW35●●●H30	—	SEA45●●●H30	SEA35●●●H30
	40	4	200	SFG35●●●H30	SFW35●●●H30	—	SFA45●●●H30	SFA35●●●H30
	75	5	400	SGG35●●●H30	SGW35●●●H30	—	SGA45●●●H30	SGA35●●●H30
230 (240)	3	0	30	SBG32●●●H30[3]	SBW32●●●H30[3]	SBW42●●●H30[3]	SBA42●●●H30[3]	SBA32●●●H30[3]
	5	1	30	SCG32●●●H30[3]	SCW32●●●H30[3]	SCW42●●●H30[3]	SCA42●●●H30[3]	SCA32●●●H30[3]
	7.5		60	SCG33●●●H30[3]	SCW33●●●H30[3]	SCW43●●●H30[3]	SCA43●●●H30[3]	SCA33●●●H30[3]
	15	2	60	SDG32●●●H30	SDW32●●●H30	SDW42●●●H30	SDA42●●●H30	SDA32●●●H30
	25	3	100	SEG35●●●H30	SEW35●●●H30	—	SEA45●●●H30	SEA3●●●H30
	50	4	200	SFG35●●●H30	SFW35●●●H30	—	SFA45●●●H30	SFA35●●●H30
	100	5	400	SGG35●●●H30	SGW35●●●H30	—	SGA45●●●H30	SGA35●●●H30
460 (480)	5	0	30	SBG33●●●H30[3]	SBW33●●●H30[3]	SBW43●●●H30[3]	SBA43●●●H30[3]	SBA33●●●H30[3]
	10	1	30	SCG34●●●H30[3]	SCW34●●●H30[3]	SCW44●●●H30[3]	SCA44●●●H30[3]	SCA34●●●H30[3]
	15	2	30	SDG36●●●H30[3]	SDW36●●●H30[3]	SDW46●●●H30[3]	SDA46●●●H30[3]	SDA36●●●H30[3]
	25		60	SDG34●●●H30	SDW34●●●H30	SDW44●●●H30	SDA44●●●H30	SDA34●●●H30
	50	3	100	SEG33●●●H30	SEW33●●●H30	—	SEA43●●●H30	SEA33●●●H30
	100	4	200	SFG33●●●H30	SFW33●●●H30	—	SFA43●●●H30	SFA33●●●H30
	200	5	400	SGG33●●●H30	SGW33●●●H30	—	SGA43●●●H30	SGA33●●●H30
575 (600)	5	0	30	SBG33●●●H30[3]	SBW33●●●H30[3]	SBW43●●●H30[3]	SBA43●●●H30[3]	SBA33●●●H30[3]
	10	1	30	SCG34●●●H30[3]	SCW34●●●H30[3]	SCW44●●●H30[3]	SCA44●●●H30[3]	SCA34●●●H30[3]
	15	2	30	SDG36●●●H30[3]	SDW36●●●H30[3]	SDW46●●●H30[3]	SDA46●●●H30[3]	SDA36●●●H30[3]
	25		60	SDG34●●●H30	SDW34●●●H30	SDW44●●●H30	SDA44●●●H30	SDA34●●●H30
	50	3	100	SEG33●●●H30	SEW33●●●H30	—	SEA43●●●H30	SEA33●●●H30
	100	4	200	SFG33●●●H30	SFW33●●●H30	—	SFA43●●●H30	SFA33●●●H30
	200	5	400	SGG33●●●H30	SGW33●●●H30	—	SGA43●●●H30	SGA33●●●H30

[1] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[2] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 35 on page 28.

[3] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

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Electronic MCP, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 34: Class 8739 Electronic MCP, Full-Voltage Type, Reversing with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings				Enclosure				
Motor Voltage (Starter Voltage)	NEMA Size	Hp Range Polyphase	Circuit Breaker (See Digest Section 7 for Adjustment Range)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0-5)[1]	NEMA 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R[2] Industrial Use Dusttight and Driptight	
							With External Reset	Without External Reset
				Type[3]	Type[3]	Type [3]	Type[3]	Type[3]
200 (208)	0	0.25–3	HLL36030M71	SBG43●●●H30 [4]	SBW43●●●H30 [4]	SBW53●●●H30 [4]	SBA53●●●H30 [4]	SBA43●●●H30 [4]
	1	0.25–5	HLL36030M71	SCG44●●●H30 [4]	SCW44●●●H30 [4]	SCW54●●●H30 [4]	SCA54●●●H30 [4]	SCA44●●●H30 [4]
		7.5	HLL36050M72	SCG45●●●H30 [4]	SCW45●●●H30 [4]	SCW55●●●H30 [4]	SCA55●●●H30 [4]	SCA45●●●H30 [4]
	2	1.5–5	HLL36030M71	SDG42●●●H30 [4]	SDW42●●●H30 [4]	SDW52●●●H30 [4]	SDA52●●●H30 [4]	SDA42●●●H30 [4]
		7.5–10	HLL36050M72	SDG43●●●H30	SDW43●●●H30	SDW53●●●H30	SDA53●●●H30	SDA43●●●H30
	3	15–25	HLL36100M73	SEG42●●●H30	SEW42●●●H30	SEW52●●●H30	SEA52●●●H30	SEA42●●●H30
	4	30–40	JJL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	5	50–60	JLL36250M75	SGG44●●●H30	SGW44●●●H30	—	SGA54●●●H30	SGA44●●●H30
		75	LJL36400M36	SGG45●●●H30	SGW45●●●H30	—	SGA55●●●H30	SGA45●●●H30
	6	100	LJL36400M36	SHG43●●●H30	SHW43●●●H30	—	SHA53●●●H30	SHA43●●●H30
		125–150	LJL36600M42	SHG45●●●H30	SHW45●●●H30	—	SHA55●●●H30	SHA45●●●H30
230 (240)	0	0.25–3	HLL36030M71	SBG43●●●H30 [4]	SBW43●●●H30 [4]	SBW53●●●H30 [4]	SBA53●●●H30 [4]	SBA43●●●H30 [4]
	1	0.25–7.5	HLL36030M71	SCG44●●●H30 [4]	SCW44●●●H30 [4]	SCW54●●●H30 [4]	SCA54●●●H30 [4]	SCA44●●●H30 [4]
	2	1.5–7.5	HLL36030M71	SDG42●●●H30 [4]	SDW42●●●H30 [4]	SDW52●●●H30 [4]	SDA52●●●H30 [4]	SDA42●●●H30 [4]
		10	HLL36050M72	SDG43●●●H30	SDW43●●●H30	SDW53●●●H30	SDA53●●●H30	SDA43●●●H30
		15	HLL36100M73	SDG44●●●H30	SDW44●●●H30	SDW54●●●H30	SDA54●●●H30	SDA44●●●H30
	3	15–30	HLL36100M73	SEG42●●●H30	SEW42●●●H30	SEW52●●●H30	SEA52●●●H30	SEA42●●●H30
	4	40–50	JJL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	5	60	JLL36250M75	SGG44●●●H30	SGW44●●●H30	—	SGA54●●●H30	SGA44●●●H30
		75–100	LJL36400M36	SGG45●●●H30	SGW45●●●H30	—	SGA55●●●H30	SGA45●●●H30
	6	125–150	LJL36600M42	SHG45●●●H30	SHW45●●●H30	—	SHA55●●●H30	SHA45●●●H30
		200	PLL34080M68	SHG46●●●H30	SHW46●●●H30	—	SHA56●●●H30	SHA46●●●H30
460 (480)	0	0.25–5	HLL36030M71	SBG43●●●H30 [4]	SBW43●●●H30 [4]	SBW53●●●H30 [4]	SBA53●●●H30 [4]	SBA43●●●H30 [4]
	1	0.25–10	HLL36030M71	SCG44●●●H30 [4]	SCW44●●●H30 [4]	SCW54●●●H30 [4]	SCA54●●●H30 [4]	SCA44●●●H30 [4]
	2	5–15	HLL36030M71	SDG42●●●H30 [4]	SDW42●●●H30 [4]	SDW52●●●H30 [4]	SDA52●●●H30 [4]	SDA42●●●H30 [4]
		20–25	HLL36050M72	SDG43●●●H30	SDW43●●●H30	SDW53●●●H30	SDA53●●●H30	SDA43●●●H30
	3	20–25 30–50	HLL36050M72 HLL36100M73	SEG41●●●H30 SEG42●●●H30	SEW41●●●H30 SEW42●●●H30	SEW51●●●H30 SEW52●●●H30	SEA51●●●H30 SEA52●●●H30	SEA41●●●H30 SEA42●●●H30
	4	60–100	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	5	125 150–200	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG45●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	6	250–350 400	LJL36600M42 PLL34080M68	SHG45●●●H30 SHG46●●●H30	SHW45●●●H30 SHW46●●●H30	— —	SHA55●●●H30 SHA56●●●H30	SHA45●●●H30 SHA46●●●H30
575 (600)	0	0.25–5	HLL36030M71	SBG43●●●H30 [4]	SBW43●●●H30 [4]	SBW53●●●H30 [4]	SBA53●●●H30 [4]	SBA43●●●H30 [4]
	1	0.25–10	HLL36030M71	SCG44●●●H30 [4]	SCW44●●●H30 [4]	SCW54●●●H30 [4]	SCA54●●●H30 [4]	SCA44●●●H30 [4]
	2	5–20 25	HLL36030M71 HLL36050M72	SDG42●●●H30 [4] SDG43●●●H30	SDW42●●●H30 [4] SDW43●●●H30	SDW52●●●H30 [4] SDW53●●●H30	SDA52●●●H30 [4] SDA53●●●H30	SDA42●●●H30 [4] SDA43●●●H30
	3	25–30 40–50	HLL36050M72 HLL36100M73	SEG41●●●H30 SEG42●●●H30	SEW41●●●H30 SEW42●●●H30	SEW51●●●H30 SEW52●●●H30	SEA51●●●H30 SEA52●●●H30	SEA41●●●H30 SEA42●●●H30
	4	60–100	JLL36250M75	SFG44●●●H30	SFW44●●●H30	SFW54●●●H30	SFA54●●●H30	SFA44●●●H30
	5	125–150 200	JLL36250M75 LJL36400M36	SGG44●●●H30 SGG45●●●H30	SGW44●●●H30 SGW45●●●H30	— —	SGA54●●●H30 SGA55●●●H30	SGA44●●●H30 SGA45●●●H30
	6	250 300–400	LJL36400M36 LJL36600M42	SHG43●●●H30 SHG45●●●H30	SHW43●●●H30 SHW45●●●H30	— —	SHA53●●●H30 SHA55●●●H30	SHA43●●●H30 SHA45●●●H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 35 on page 28.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

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Table 35: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24[1]	—	V01
120[1]	110	V02
208	—	V08
240	220	V03
277[1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8739SCG41V02**S**).
Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Thermal-Magnetic, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 36: Class 8739 Thermal-Magnetic, Full-Voltage Type, Reversing, 200–240 V, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings					Enclosure				
			Circuit Breaker		NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0-5)[1]	NEMA 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R[2] Industrial Use Dusttight and Driptight	
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Type	Rating (A)				With External Reset	Without External Reset
					Type[3]	Type[3]	Type[3]	Type[3]	Type[3]
200 (208)	2 3	0	HLL36015 HLL36020	15 20	SBG1●●●H30 [4] SBG3●●●H30 [4]	SBW1●●●H30 [4] SBW3●●●H30 [4]	SBW11●●●H30 [4] SBW13●●●H30 [4]	SBA11●●●H30 [4] SBA13●●●H30 [4]	SBA1●●●H30 [4] SBA3●●●H30 [4]
	5 7.5	1	HLL36035 HLL36050	35 50	SCG5●●●H30 [4] SCG2●●●H30 [4]	SCW5●●●H30 [4] SCW2●●●H30 [4]	SCW15●●●H30 [4] SCW12●●●H30 [4]	SCA15●●●H30 [4] SCA12●●●H30 [4]	SCA5●●●H30 [4] SCA2●●●H30 [4]
	10	2	HLL36060	60	SDG1●●●H30	SDW1●●●H30	SDW11●●●H30	SDA11●●●H30	SDA1●●●H30
	15 20 25	3	HLL36100 HLL36125 HLL36150	100 125 150	SEG3●●●H30 SEG1●●●H30 SEG5●●●H30	SEW3●●●H30 SEW1●●●H30 SEW5●●●H30	SEW13●●●H30 SEW11●●●H30 SEW15●●●H30	SEA13●●●H30 SEA11●●●H30 SEA15●●●H30	SEA3●●●H30 SEA1●●●H30 SEA5●●●H30
	30 40	4	JLL36200 JLL36250	200 250	SFG3●●●H30 SFG4●●●H30	SFW3●●●H30 SFW4●●●H30	SFW13●●●H30 SFW14●●●H30	SFA13●●●H30 SFA14●●●H30	SFA3●●●H30 SFA4●●●H30
	50 60–75	5	JLL36250 LLL36400U33X	250 400	SGG6●●●H30 SGG4●●●H30	SGW6●●●H30 SGW4●●●H30	— —	SGA16●●●H30 SGA14●●●H30	SGA6●●●H30 SGA4●●●H30
	100–125 150	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
230 (240)	2 3	0	HLL36015 HLL36020	15 20	SBG1●●●H30 [4] SBG3●●●H30 [4]	SBW1●●●H30 [4] SBW3●●●H30 [4]	SBW11●●●H30 [4] SBW13●●●H30 [4]	SBA11●●●H30 [4] SBA13●●●H30 [4]	SBA1●●●H30 [4] SBA3●●●H30 [4]
	5 7.5	1	HLL36035 HLL36045	35 45	SCG5●●●H30[4] SCG6●●●H30[4]	SCW5●●●H30[4] SCW6●●●H30[4]	SCW15●●●H30[4] SCW16●●●H30[4]	SCA15●●●H30[4] SCA16●●●H30[4]	SCA5●●●H30[4] SCA6●●●H30[4]
	10 15	2	HLL36060 HLL36090	60 90	SDG1●●●H30 SDG7●●●H30	SDW1●●●H30 SDW7●●●H30	SDW11●●●H30 SDW17●●●H30	SDA11●●●H30 SDA17●●●H30	SDA1●●●H30 SDA7●●●H30
	20 25–30	3	HLL36100 HLL36150	100 150	SEG3●●●H30 SEG5●●●H30	SEW3●●●H30 SEW5●●●H30	SEW13●●●H30 SEW15●●●H30	SEA13●●●H30 SEA15●●●H30	SEA3●●●H30 SEA5●●●H30
	40 50	4	JLL36225 JLL36250	225 250	SFG1●●●H30 SFG4●●●H30	SFW1●●●H30 SFW4●●●H30	SFW11●●●H30 SFW14●●●H30	SFA11●●●H30 SFA14●●●H30	SFA1●●●H30 SFA4●●●H30
	60 75 100	5	JLL36250 LLL36400U33X LLL36600U33X	250 400 600	SGG6●●●H30 SGG4●●●H30 SGG2●●●H30	SGW6●●●H30 SGW4●●●H30 SGW2●●●H30	— — —	SGA16●●●H30 SGA14●●●H30 SGA12●●●H30	SGA6●●●H30 SGA4●●●H30 SGA2●●●H30
	125 150–200	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 37.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

Table 37: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
277 [1]	—	V04
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8739SCG5V02**S**).
Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Thermal-Magnetic, 3-Pole Polyphase—600 Vac Maximum, 50–60 Hz

Table 38: Class 8739 Thermal-Magnetic, Full-Voltage Type, Reversing, 460–600 V, with Motor Logic SSOLR (replace ●●● with the voltage code)

Ratings					Enclosure				
Motor Voltage (Starter Voltage)	Max. Hp Polyphase	NEMA Size	Circuit Breaker Type	Circuit Breaker Rating (A)	NEMA 1 General Purpose	NEMA 4 & 4X Watertight and Dusttight Stainless Steel (304) (Sizes 0–5) [1]	NEMA 4X Watertight, Dusttight and Corrosion Resistant Polyester	NEMA 12/3R [2] Industrial Use Dusttight and Driptight With External Reset	NEMA 12/3R [2] Industrial Use Dusttight and Driptight Without External Reset
					Type [3]	Type [3]	Type [3]	Type [3]	Type [3]
460 (480)	5	0	HLL36015	15	SBG1●●●H30 [4]	SBW1●●●H30 [4]	SBW11●●●H30 [4]	SBA11●●●H30 [4]	SBA1●●●H30 [4]
	7.5 10	1	HLL36025 HLL36030	25 30	SCG3●●●H30 [4] SCG7●●●H30 [4]	SCW3●●●H30 [4] SCW7●●●H30 [4]	SCW13●●●H30 [4] SCW17●●●H30 [4]	SCA13●●●H30 [4] SCA17●●●H30 [4]	SCA3●●●H30 [4] SCA7●●●H30 [4]
	15 20 25	2	HLL36045 HLL36060 HLL36070	45 60 70	SDG3●●●H30 SDG1●●●H30 SDG5●●●H30	SDW3●●●H30 SDW1●●●H30 SDW5●●●H30	SDW13●●●H30 SDW11●●●H30 SDW15●●●H30	SDA13●●●H30 SDA11●●●H30 SDA15●●●H30	SDA3●●●H30 SDA1●●●H30 SDA5●●●H30
	30 40 50	3	HLL36080 HLL36100 HLL36150	80 100 150	SEG6●●●H30 SEG3●●●H30 SEG5●●●H30	SEW6●●●H30 SEW3●●●H30 SEW5●●●H30	SEW16●●●H30 SEW13●●●H30 SEW15●●●H30	SEA16●●●H30 SEA13●●●H30 SEA15●●●H30	SEA6●●●H30 SEA3●●●H30 SEA5●●●H30
	60 75 100	4	JJL36105 JJL36200 JJL36250	150 200 250	SFG5●●●H30 SFG3●●●H30 SFG4●●●H30	SFW5●●●H30 SFW3●●●H30 SFW4●●●H30	SFW15●●●H30 SFW13●●●H30 SFW14●●●H30	SFA15●●●H30 SFA13●●●H30 SFA14●●●H30	SFA5●●●H30 SFA3●●●H30 SFA4●●●H30
	125–150 200	5	LLL36400U33X LLL36600U33X	400 600	SGG4●●●H30 SGG2●●●H30	SGW4●●●H30 SGW2●●●H30	— —	SGA14●●●H30 SGA12●●●H30	SGA4●●●H30 SGA2●●●H30
	250 300–400	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30
575 (600)	5	0	HLL36015	15	SBG1●●●H30 [4]	SBW1●●●H30 [4]	SBW11●●●H30 [4]	SBA11●●●H30 [4]	SBA1●●●H30 [4]
	7.5 10	1	HLL36020 HLL36025	20 25	SCG8●●●H30 [4] SCG3●●●H30 [4]	SCW8●●●H30 [4] SCW3●●●H30 [4]	SCW18●●●H30 [4] SCW13●●●H30 [4]	SCA18●●●H30 [4] SCA13●●●H30 [4]	SCA8●●●H30 [4] SCA3●●●H30 [4]
	15 20 25	2	HLL36035 HLL36045 HLL36060	35 45 60	SDG8●●●H30 SDG3●●●H30 SDG1●●●H30	SDW8●●●H30 SDW3●●●H30 SDW1●●●H30	SDW18●●●H30 SDW13●●●H30 SDW11●●●H30	SDA18●●●H30 SDA13●●●H30 SDA12●●●H30	SDA8●●●H30 SDA3●●●H30 SDA1●●●H30
	30 40 50	3	HLL36070 HLL36090 HLL36100	70 90 100	SEG4●●●H30 SEG6●●●H30 SEG3●●●H30	SEW4●●●H30 SEW6●●●H30 SEW3●●●H30	SEW14●●●H30 SEW16●●●H30 SEW13●●●H30	SEA14●●●H30 SEA16●●●H30 SEA13●●●H30	SEA4●●●H30 SEA6●●●H30 SEA3●●●H30
	60–75 100	4	JLL36150 JLL36250	150 250	SFG5●●●H30 SFG4●●●H30	SFW5●●●H30 SFW4●●●H30	SFW15●●●H30 SFW14●●●H30	SFA15●●●H30 SFA14●●●H30	SFA5●●●H30 SFA4●●●H30
	125–150 200	5	JLL36250 LLL36400U33X	250 400	SGG6●●●H30 SGG4●●●H30	SGW6●●●H30 SGW4●●●H30	— —	SGA16●●●H30 SGA14●●●H30	SGA6●●●H30 SGA4●●●H30
	250–350 400	6	LLL36600U33X MJL36800	600 800	SHG4●●●H30 SHG5●●●H30	SHW4●●●H30 SHW5●●●H30	— —	SHA14●●●H30 SHA15●●●H30	SHA4●●●H30 SHA5●●●H30

[1] Size 6 starter enclosures are NEMA 4 painted sheet steel.

[2] NEMA 12/3R enclosures can be field modified for outdoor non-corrosive and non–service entrance rated applications. See page 19 for more information.

[3] Replace the three bullets (●●●) in the catalog number with the coil voltage code. Refer to the standard coil voltage codes shown in Table 39.

[4] **Form H30**, with the possibility of a fourth character to select a lower FLA range (for example, **H308**). See page 45.

Table 39: Coil Voltage Codes

Voltage		Code
60 Hz	50 Hz	
24 [1]	—	V01
120 [1]	110	V02
208	—	V08
240	220	V03
480	440	V06
600	550	V07
Specify	Specify	V99

[1] **Form S** (no charge) must be included with these voltage codes where a separate source of voltage is used for the control coil (for example, order as 8739SDG3V02**S**). Note that **24 V** coils are **not** available on Sizes 4–7.

NOTE: For voltage codes used with control transformers, see Table 71 on page 44.

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Dimensions for Reversing Combination Starters—NEMA 1, 12, and 3R

Table 40: NEMA 1 Enclosure, Sizes 0–2 (see Figure 11)

NEMA Size	Class	Type	Dimensions (in.) [1]																Top & Bottom		Sides	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	W	X	Y	
0–1	8738, 8739	SBG SCG	13.75	23	8.34	10.63	21	18.91	1.88	1.88	3.75	2.31	1.06	3.25	2.19	1.25	0.88	—	0.25 / 0.75 / 1	0.25 / 0.75 / 1	0.25	49
2	8738, 8739	SDG	15	28.75	9.59	11.63	26.25	21.47	2.19	2	4	2.56	1.25	3.25	2.19	1.25	0.91	—	1 / 1.25	1 / 1.25	0.25	80

[1] These dimensions are also for **Form FF4T** (standard control transformer), **Form FF4T11** (100 VA additional capacity), and **Form FF4T12** (200 VA additional capacity).

Table 41: NEMA 1 Enclosure, Sizes 3–6 (see Figure 12)

NEMA Size	Class	Type	Dimensions (in.) [1]																Top & Bottom		Sides	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	W	X	Y	
3	8738, 8739	SEG	18.5	44	10.59	12.5	3	25.97	43.5	0.25	—	2.81	3.5	5	2.69	5.38	1.22	0.91	1 / 1.25 2 / 2.25	0.25 / 0.75	0.25	245
4	8738	SFG	21	51.5	10.53	15	3	30.72	51	0.25	—	2.81	3.5	5	2.69	5.38	1.22	0.91	2.5	0.25 / 0.75	0.25	—
	8739	SFG	18.5	44	10.59	12.5	3	25.97	43.5	0.25	—	2.81	3.5	5	2.69	5.38	1.22	0.91	1 / 1.25 2 / 2.25	0.25 / 0.75	0.25	—
5	8738	SGG	30	77	15.5	22	4	39.41	76	0.25	—	3.5	6.28	9.25	3.19	—	—	—	0.25 / 0.75	3	—	—
	8739	SGG	30	65	13.72	22	4	39.41	64	0.25	—	3.5	6.28	5	3.19	—	—	—	0.25 / 0.75	3	—	—
6	8738, 8739	SHG	36	90	17.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[1] These dimensions are also for **Form FF4T** (standard control transformer), **Form FF4T11** (100 VA additional capacity), and **Form FF4T12** (200 VA additional capacity).

Table 42: NEMA 12/3R Enclosure (see Figure 13)

NEMA Size	Class	Type	Dimensions (in.) [1]										Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	
0–1	8738, 8739	SBA SCA	13.75	10.09	24.75	3.25	2.5	8.75	24	0.38	3.75	20.31	52
2	8738, 8739	SDA	15	10.97	31	3.25	3	9	30.25	0.38	3.75	23.44	95
3	8738, 8739	SEA	18.5	10.59	45	5	3	12.5	44	0.25	3.75	25.59	255
4	8738	SFA	21	10.59	52.5	5	3	15	51.5	0.25	3.75	30.34	—
	8739	SFA	18.5	10.59	45	3.25	3	12.5	44	0.25	3.75	25.59	—
5	8738	SGA	30	15.5	78	9.25	4	22	77	0.25	7.5	39.41	—
	8739	SGA	30	15.5	66	—	4	22	65	0.25	7.5	37.88	—
6 [2]	8739	SHA	36	17.03	90	—	—	—	—	—	—	—	—

[1] These dimensions are also for **Form FF4T** (standard control transformer), **Form FF4T11** (100 VA additional capacity), and **Form FF4T12** (200 VA additional capacity).

[2] Size 6 enclosures are floor mounting.

Figure 11: NEMA 1 Enclosure (Sizes 0–2)

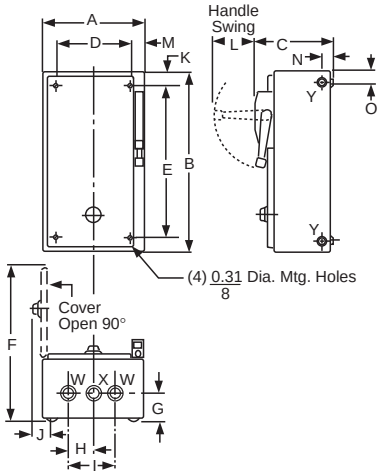


Figure 12: NEMA 1 Enclosure (Sizes 3–6)

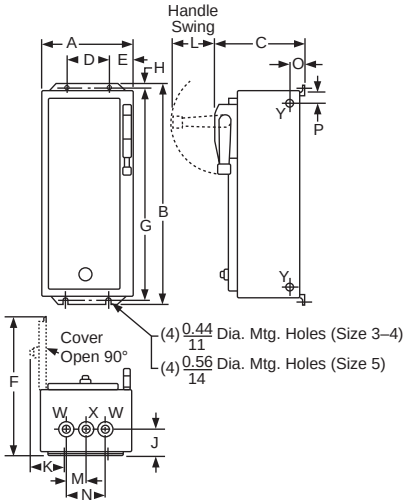
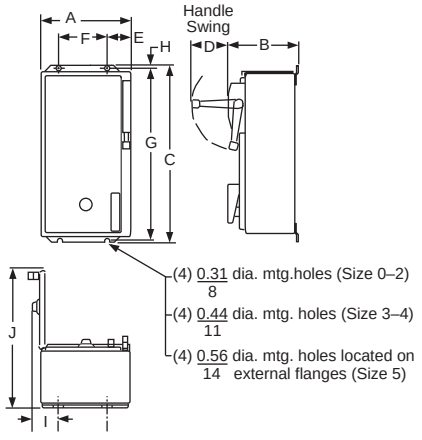


Figure 13: NEMA 12/3R Enclosure



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Dimensions for Reversing Combination Starters—NEMA 4 and 4X

Table 43: NEMA 4X Polyester Enclosure (see Figure 14)

NEMA Size	Class	Dimensions (in.) [1]					
		Type	A	B	C	E	F
0-2	8738 & 8739	SBW SCW SDW	25.25	11.4	27.00	17.88	25.75
3-4	8739	SEW SFW	26.31	11.4	33.50	18.50	32.25

[1] These dimensions are also for **Form FF4T** (standard control transformer), **Form FF4T11** (100 VA additional capacity), and **Form FF4T12** (200 VA additional capacity).

Table 44: Information on Hubs

Hubs are furnished with each NEMA 4X combination starter as shown in this table. Note that hubs are installed only in stainless steel enclosures; they are not installed in polyester enclosures.

NEMA Size	Hub Size, Quantity = 1	Hub Size, Quantity = 2
0 & 1	0.75 in.	1.00 in.
2	0.75 in.	1.50 in.
3 & 4	0.75 in.	2.50 in.

Table 45: NEMA 4 & 4X Stainless Steel Enclosure (see Figure 15)

NEMA Size	Class	Type	Dimensions (in.)												Bottom	Top & Bot.	Wt. (lb)
			A	B	C	D	E	F	G	H	I	J	K	L	W (Hub)	X (Hub)	
0–1	8738, 8739	SBW SCW	13.75	8.34	25.19	3.25	2.5	8.75	24	0.59	3	1.63	2.31	18.53	0.75	1	52
2	8738, 8739	SDW	15	9.59	30.03	3.25	2.5	10	29.75	0.63	3	2	2.63	21.03	0.75	1.5	95
3	8738, 8739	SEW	18.5	10.56	45.19	5	3	12.5	44	0.59	3.5	2.63	3.19	25.5	0.75	2.5	255
4	8738	SFW	21	10.53	52.69	5	3	15	51.5	0.59	3.5	2.63	3.19	30.25	0.75	2.5	—
	8739	SFW	18.5	10.56	45.19	5	3	12.5	44	0.59	3.5	2.63	3.19	25.5	0.75	2.5	—
5	8738	SGW	30	15.5	78.09	9.25	4	22	77	0.56	6.09	3	3.5	39.41	0.75	3.5	—
	8739	SGW	30	13.89	66.09	5	4	22	65	0.56	6.09	3	3.5	37.88	0.75	3.5	—
6	8739	SHW	36	17.03	98	—	—	—	—	—	—	—	—	—	—	—	—

Figure 14: NEMA 4X Polyester Enclosure

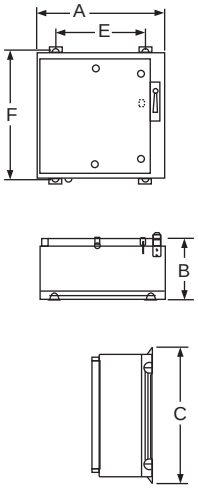
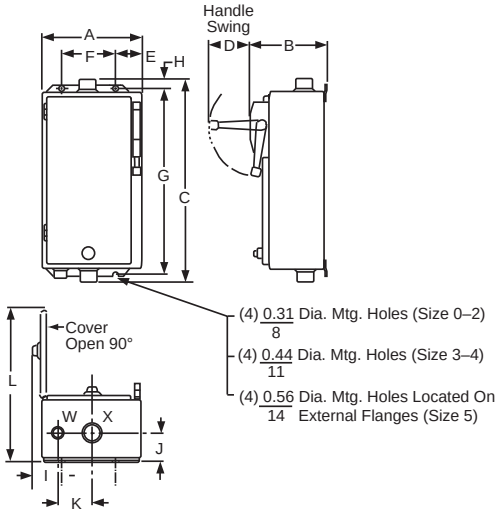


Figure 15: NEMA 4 & 4X Stainless Enclosure



NOTE: Illustrations are for dimensional information only, and may not represent the actual enclosure.

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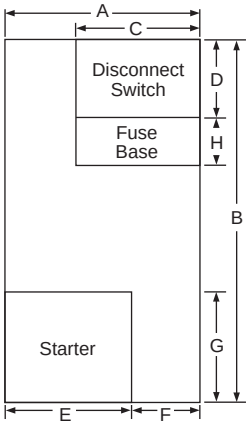
Panel Layout Drawings

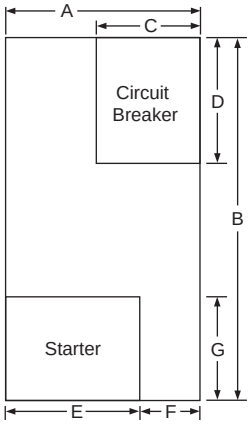
Table 46: Panel Layout Drawings—NEMA 1, 4 & 4X Stainless, 12/3R

Class	NEMA	Dimensions, in.							
		A	B	C	D	E	F	G	H
8738	0, 1	10.75	19	6.9	6.5	7.25	3.5	9	4
8739				6.5	7.9				–
8738	2	12	24	7.5	7.0	7.75	4.25	11	6
8739				7	8.8				–
8738	3	15.5	32.5	9	7.7	15.5	0	14	5
8739				8.25	8.5				–
8738	4	18	39	11.5	20.5	18	0	17	–
8739		15.5	32.5	9.25	10.5	15	0	15	
8738	5 [1]	27	59	26	25.0	21	6	21	–
8739		27	58	JLL: 6.8; LLL: 9	JLL: 23; LLL: 24.5	21	6	21	–
8739	6	32	82	LLL: 9; MJL: 12.5	LLL: 26; MJL: 27.5	22.5	9.5	36	–

[1] Size 5 combination starter does not contain a full-size panel. No usable panel space is available.



Class 8738



Class 8739

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Application Data

Table 47: Ratings and Application Data

NEMA Size	Load Voltage	Max. Hp Rating				Continuous Current Rating (A) 600 V Max.	Service-Limit Current Rating (A) [1]	Tungsten and Infrared Lamp Load (A), 250 V Max. [2]	Resistance Heating Loads (KW) other than Infrared Lamp Loads [3]		KVA Rating for Switching Transformer Primaries at 50 or 60 Cycles				3 Ø Rating for Switching Capacitors [4]
		Nonplugging and Nonjogging Duty		Plugging and Jogging Duty [5]							Inrush Currents (Worst Case Peak)				
											≤20 Times Peak of Continuous Current Rating		>20 to 40 Times Peak of Continuous Current Rating		
		Single Phase	Poly-phase	Single Phase	Poly-phase				Single Phase	Poly-phase	Single Phase	Poly-phase	Single Phase	Poly-phase	KVAR
00	115	0.5	—	—	—	9	11	5	—	—	—	—	—	—	—
	200	—	1.5	—	—	9	11	5	—	—	—	—	—	—	—
	230	1	1.5	—	—	9	11	5	—	—	—	—	—	—	—
	380	—	1.5	—	—	9	11	—	—	—	—	—	—	—	—
	460	—	2	—	—	9	11	—	—	—	—	—	—	—	—
	575	—	2	—	—	9	11	—	—	—	—	—	—	—	—
0	115	1	—	0.5	—	18	21	10	—	—	0.6	—	0.3	—	—
	200	—	3	—	1.5	18	21	10	—	—	—	1.8	—	0.9	—
	230	2	3	1	1.5	18	21	10	—	—	1.2	2.1	0.6	1.0	—
	380	—	5	—	1.5	18	21	—	—	—	—	—	—	—	—
	460	—	5	—	2	18	21	—	—	—	2.4	4.2	1.2	2.1	—
	575	—	5	—	2	18	21	—	—	—	3.0	5.2	1.5	2.6	—
1	115	2	—	1	—	27	32	15	3	5	1.2	—	0.6	—	—
	200	—	7.5	—	3	27	32	15	—	9.1	—	3.6	—	1.8	—
	230	3	7.5	2	3	27	32	15	6	10	2.4	4.3	1.2	2.1	—
	380	—	10	—	5	27	32	—	—	16.5	—	—	—	—	—
	460	—	10	—	5	27	32	—	12	20	4.9	8.5	2.5	4.3	—
	575	—	10	—	5	27	32	—	15	25	6.2	11.0	3.1	5.3	—
1P	115	3	—	1.5	—	36	42	24	—	—	—	—	—	—	—
	230	5	—	3	—	36	42	24	—	—	—	—	—	—	—
2	115	3	—	2	—	45	52	30	5	8.5	2.1	—	1.0	—	—
	200	—	10	—	7.5	45	52	30	—	15.4	—	6.3	—	3.1	—
	230	7.5	15	5	10	45	52	30	10	17	4.1	7.2	2.1	3.6	8
	380	—	25	—	15	45	52	—	—	28	—	—	—	—	—
	460	—	25	—	15	45	52	—	20	34	8.3	14	4.2	7.2	16
	575	—	25	—	15	45	52	—	25	43	10.0	18	5.2	8.9	20
3	115	—	—	—	—	90	104	60	10	17	4.1	—	2.0	—	—
	200	—	25	—	15	90	104	60	—	31	—	12	—	6.1	—
	230	—	30	—	20	90	104	60	20	34	8.1	14	4.1	7.0	27
	380	—	50	—	30	90	104	—	—	56	—	—	—	—	—
	460	—	50	—	30	90	104	—	40	68	16	28	8.1	14	53
	575	—	50	—	30	90	104	—	50	86	20	35	10	18	67
4	200	—	40	—	25	135	156	120	—	45	—	20	—	10	—
	230	—	50	—	30	135	156	120	30	52	14	23	6.8	12	40
	380	—	75	—	50	135	156	—	—	86.7	—	—	—	—	—
	460	—	100	—	60	135	156	—	60	105	27	47	14	23	80
	575	—	100	—	60	135	156	—	75	130	34	59	17	29	100
5 [6]	200	—	75	—	60	270	311	240	—	91	—	41	—	20	—
	230	—	100	—	75	270	311	240	60	105	27	47	14	24	80
	380	—	150	—	125	270	311	—	—	173	—	—	—	—	—
	460	—	200	—	150	270	311	—	120	210	54	94	27	47	160
	575	—	200	—	150	270	311	—	150	260	68	117	34	59	200
6 [6]	200	—	150	—	125	540	621	480	—	182	—	81	—	41	—
	230	—	200	—	150	540	621	480	120	210	54	94	27	47	160
	380	—	300	—	250	540	621	—	—	342	—	—	—	—	—
	460	—	400	—	300	540	621	—	240	415	108	188	54	94	320
	575	—	400	—	300	540	621	—	300	515	135	234	68	117	400
7 [6]	230	—	300	—	—	810	932	—	180	315	—	—	—	—	240
	460	—	600	—	—	810	932	—	360	625	—	—	—	—	480
	575	—	600	—	—	810	932	—	450	775	—	—	—	—	600

[1] Per NEMA Standards paragraph ICS 2-321.20, the service-limit current represents the maximum rms current, in Amperes, which the controller may be expected to carry for protracted periods in normal service. At service-limit current ratings, temperature rises may exceed those obtained by testing the controller at its continuous current rating. The ultimate trip current of over-current (overload) relays or other motor protective devices shall not exceed the service-limit current ratings of the controller.

[2] **Fluorescent Lamp Loads**—300 V and Less—The characteristics of fluorescent lamps are such that it is not necessary to derate Class 8502 contactors below their normal continuous current rating. Class 8903 contactors may also be used with fluorescent lamp loads. For controlling tungsten and infrared lamp loads, and resistance heating loads, Class 8903 AC lighting contactors are recommended. These contactors are specifically designed for such loads and are applied at their full rating as listed in the Class 8903 Lighting Contactors) section of the *Digest*.

[3] Ratings apply to contactors which are used to switch the load at the utilization voltage of the heat-producing element with a duty that requires continuous operation of not more than five openings per minute. Class 8903 Types L and S lighting contactors are rated for resistance heating loads.

[4] When discharged, a capacitor has essentially zero impedance. For repetitive switching by a contactor, sufficient impedance should be connected in series to limit inrush current to not more than 6 times the contactor's rated continuous current. In many installations, the impedance of the connecting conductors may be sufficient for this purpose. When switching to connect additional banks, the banks already on the line may be charged and can supply additional available short-circuit current which should be considered when selecting the impedance to limit the current.

[5] Ratings shown are for applications requiring repeated interruptions of stalled motor current or repeated closing of high transient currents encountered in rapid motor reversal, involving more than five openings or closings per minute and more than ten in a ten-minute period, such as plug-stop, plug-reverse or jogging duty. Ratings apply to single-speed and multi-speed controllers.

[6] For NEMA Size 6 and 7, the operation rate is as follows: Continuous operation, 3 operations/minute maximum; Jogging or Plugging Duty, 15 operations/minute—3 minutes maximum.

Table 48: Code Letter—Maximum Allowable Motor

Motor Hp Rating	Max. Allowable Motor Code Letter
1.5–2	L
3–5	K
7.5 and above	H

The motor ratings in Table 47 are NEMA standard ratings and apply only when the code letter of the motor is the same as or occurs earlier in the alphabet than what is shown in Table 48. Motors with code letters occurring later in the alphabet may require a larger controller. Consult the Customer Care Center at 1-888-778-2733.

NOTE: Tables and footnotes are taken from NEMA Standards.

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The ratings for capacitor switching in Table 47 on page 34 assume the following maximum available fault currents (rms symmetrical amperes):

- NEMA Size 00–3: 5,000 A
- NEMA Size 4–5: 10,000 A
- NEMA Size 6: 18,000 A
- NEMA Size 7: 30,000 A

If the available fault current is greater than these values, connect sufficient impedance in series.

Refer to the instruction material for the actual tested SCCR values.

Power Contact Ratings: All contactors and starters are rated in accordance with NEMA standards. The ratings shown in the selection tables are for normal service. For complete data on power contact ratings, refer to Table 47 on page 34.

Table 49: Short-Circuit Protection
According to the National Electrical Code, branch circuit overcurrent protection must be provided for each contactor or starter. For starters, refer to the instructions furnished with the thermal unit selection table. For contactors (Class 8502 or 8702), provide branch circuit overcurrent protection in accordance with the National Electrical Code, except do not exceed the maximum protective device ratings shown below.

NEMA Size	Maximum Voltage	Class K5, RK5 or RK1 Fuse (Amperes)	Class J or T Fuse (Amperes)	Inverse-Time Circuit Breaker (Amperes)
00	600	10	15	15
	250	12	15	15
0	600	20	30	20
	250	25	30	35
1	600	30	60	40
	250	40	60	60
2	600	60	100	80
	250	60	100	90
3	600	100	200	125
	250	125	200	150
4	600	200	400	225
5	600	400	600	400
6	600	600	1200[1]	800
7	600	600	1600[1]	1200

[1] Class L Fuse only.

Capacitor Switching: The kilovar ratings of enclosed, three-phase contactors used as switches for capacitor loads, when only one load appears on the secondary of a distribution system, are shown in Table 47 on page 34.

Table 50: Coil Burden (Mean Values)

NEMA Size	No. of Poles	Inrush VA		Sealed VA		Sealed W	
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
00	2–3	—	165	—	33	—	6
0–1	1–5	232	245	26	27	7.7	7.8
2	2–3	296	311	36	37	12	14
	4–5	429	438	37	38	12	14
3	2–3	676	700	47	46	15	14
	4–5	1260	1185	89	85	23.4	22
4	2–5						
5	2–3	2970	2970	250	212	42	39
6[1]	2–3	1495	1780	56	48	27	32
7[1]	2–3	—	1960	—	59	—	36

[1] Size 6 and 7 have a DC coil. The values shown are for the AC input to the DC power supply that provides power to the coil. Ambient temperature (operating temperature): 0 to 40 °C (32 to 104 °F).

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Table 51: Maintenance of Equipment

Class 9998 repair parts kits are available for all Class 8502 contactors and Class 8536 starters. Instruction bulletins with a complete list of replaceable parts are furnished with all enclosed devices. Bulletins are available online and are listed below along with the appropriate contact parts kit.

Device				Instruction Bulletin	Supercedes Service Bulletin	Replacement Contacts, Class 9998
NEMA Size	Type	Series	No. of Poles			Type
00	SA	A	2-3	—	362AS	SL2
		B	2-3	30072-013-08	556AS	SJ1
0	SB	A&B	1-3 4 5	30072-013-09	277AS 277AS & 250AS 277AS & 250AS	SL2 SL12 One SL12 & one SL22; or one SL2 & two SL22
1	SC	A&B	1-3 4 5	30072-013-10	278AS 278AS & 250AS 278AS & 250AS	SL3 SL13 One SL13 & one SL22; or one SL3 & two SL22
1P	SC	A	2	30072-013-10	278AS	SL3
2	SD	A	2-3 4 5	30072-013-11	279AS 279AS & 293AS 279AS & 293AS	SL4 SL14 One SL14 & one SL24; or one SL4 & two SL24
3	SE	A	2 3 4 5	30072-013-01 30072-013-01 30072-013-03 30072-013-03	305AS 305AS 326AS 326AS	SL6 SL7 Two SL6 One SL6 & one SL7
4	SF	A	2 3 4 5	30072-013-02 30072-013-02 30072-013-03 30072-013-03	306AS 306AS 326AS 326AS	SL8 SL9 Two SL8 One SL8 & one SL9
5	SG	A	2 3	30072-013-18 30072-013-18	328AS 328AS	SL10 SL11
	SGO	B	2 3	30072-013-103 30072-013-103	—	SL10 SL11
6	SH	A	2 3	—	342AS 342AS	SL25 SL26
		B	2 3	30072-013-12 30072-013-12	370AS 370AS	SL25 SL26
7	SJ	A (Class 8536)	2 3	—	397AS, 30072-013-13	SL30 SL31
		A (Class 8502) C (Class 8536)	2 3	30072-013-59 30072-013-59	—	SL30 SL31

Table 52: Terminals

NEMA Size	Type	Line Terminals on Disconnect Means *(the numbers in parentheses are quantities)*			Power Terminals on Magnetic Starter			Control Terminals on Magnetic Starter		
		Type of Lug	Wire Range, AWG		Type of Lug	Wire Range	Wires Per Terminal	Type of Lug	Wire Range	Wires Per Terminal
			Switch	Circuit Breaker						
0, 1	SB, SC	Box Lug	14–1/0 Cu/Al	(1) 14–3/0, Al or Cu	Pressure Wire	14–8 Cu	1 or 2	Pressure Wire	16–12 Cu	2
2	SD	Box Lug	14–1/0 Cu/Al	(1) 14–3/0, Al or Cu	Box Lug	14–4 Cu	1	Pressure Wire	16–12 Cu	2
3	SE	Box Lug	14–1/0 Cu/Al	(1) 14–3/0, Al or Cu	Box Lug	14–0 Cu	1	Pressure Wire	16–12 Cu	2
4	SF	Box Lug	6–300 MCM Cu/Al	**JLL Circuit Breaker, 150–175 A**: (1) 4–4/0, Al or Cu **JLL Circuit Breaker, 200–250 A**: (1) 3/0–350 MCM, Al or Cu	Box Lug	8–250 MCM Cu	1	Pressure Wire	16–12 Cu	2
5	SG	Box Lug	(1) 4–500 MCM Cu	**DJL36400 Circuit Breaker**: (1) 2–500 MCM Al; or (1) 2–350 MCM Cu **DLL36600 Circuit Breaker**: (2) 2/0–500 MCM Al; or (2) 2/0–350 MCM Cu **JLL36250 Circuit Breaker**: (1) 3/0–350 MCM Al; or (1) 3/0–350 MCM Cu	Box Lug	4–500 MCM Cu	1	Pressure Wire	16–12 Cu	2
6	SH	Box Lug	—	**DJL36600, DLL Circuit Breaker**: (2) 2/0–500 MCM Al; or (2) 2/0–350 MCM Cu **DJL36400 Circuit Breaker**: (1) 2–600 MCM Al; or (1) 2–350 MCM Cu **MJL36800 Circuit Breaker**: (3) 3/0–500 MCM Al; or (3) 3/0–350 MCM Cu **PLL34080M68 Circuit Breaker**: (3) 3/0–500 MCM Al; or (3) 3/0–350 MCM Cu	Parallel Groove	250–500 MCM Cu	1 or 2	Pressure Wire	16–12 Cu	2
7	SJ	Box Lug	—	**PJL, PKL, PLL Circuit Breaker**: (4) 3/0–300 MCM, Al or Cu	Parallel Groove	250–500 MCM Cu	1–4	Pressure Wire	16–12 Cu	2

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Table 53: Auxiliary Units

Auxiliary contacts, power poles, and timer attachments can be added by the factory or in the field on all Type S starters and contactors. This table shows the maximum number of auxiliary units *(in **addition** to the holding circuit contact)* that can be added to a given size starter or contactor. In addition, it is possible to add a second internal contact on NEMA Size 0–2 contactors and starters.

NEMA Size	Type	No. of Poles—Basic Contactor	Maximum Number of External Auxiliary Units (in addition to the holding circuit contact)
00	SA	2–3	4 single-circuit auxiliary contacts (N.O. or N.C.) if second internal auxiliary contact is not used.
0–2	SB–SD	1–3	4 single-circuit auxiliary contacts (N.O. or N.C.)[1]
			2 single-circuit auxiliary contacts (N.O. or N.C.) plus 1 power pole adder (1 or 2 poles, N.O. or N.C.)
		4–5	2 single-circuit auxiliary contacts (N.O. or N.C.)
3–4	SE–SF	2–5	3 single-circuit auxiliary contacts (N.O. or N.C.)
5	SG	2–3	2 single-circuit auxiliary contacts (N.O. or N.C.) plus 1 NEMA Size 0–1 or Size 2 power pole adder (1 or 2 poles, N.O. or N.C.)
6–7	SH–SJ	2–3	3 single-circuit auxiliary contacts (N.O. or N.C.)
			2 single-circuit auxiliary contacts (N.O. or N.C.) plus 1 NEMA Size 0–1 or Size 2 power pole adder (1 or 2 poles, N.O. or N.C.)

[1] When adding 4 external auxiliary contacts to one Size 0 or 1 contactor, remove one of the return springs.

Table 54: Factory Installed Additional Auxiliary Contacts—Form Numbers

This table lists the Form designations for use when ordering **factory-installed** electrical contacts. For field modification kits, see Class 9999 Accessories.

Number of N.O. Contacts	Number of N.C. Contacts	Form Number
0	1	X01
0	2	X02
0	3	X03
0	4	X04
1	0	X10
1	1	X11
1	2	X12
1	3	X13
2	0	X20
2	1	X21
2	2	X22
3	0	X30
3	1	X31
4	0	X40

Table 55: Disconnect Switch and Circuit Breaker Interlocks

Class	Type	Series	SPDT (Form Y74) Class 9999 Type	DPDT (Form Y75) Class 9999 Type
Disconnect Switch				
8538[1]	SB, SC, SD	Series B	R6	R7
8538	SBA, SCA, SBG, SCG	Series D & above	TC11	TC21
	SBAS8, SCAS8, SBGS8, SCGS8	Series D & above	TC10	TC20
	SDA, SDA[1], SDG, SDG[1]	Series D & above	TC10	TC20
8538, 8738	SD	Series C	R43	R44
	SB, SC	Series C	R45	R46
	SE, SF	Series A	R8	R9
	SE	Series B & C	R41	R42
	SEA, SEG	Series D & above	TC10	TC20
	SF	Series B & C	R39	R40
	SG	—	R35	R36
8738	SBA, SCA, SBG, SCG	Series E & above	TC11	TC21
	SBAS8, SCAS8, SBGS8, SCGS8	Series E & above	TC10	TC20
	SDA, SDG	Series E & above	TC10	TC20
Circuit Breaker				
8539, 8739	SB, SC, SD, SE, SF, SG	Series K	R26	R27

[1] Class 8538 type numbers ending in suffix **S8**.

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Table 56: Disconnect Switch and Circuit Breaker Interlock Electrical Ratings

Class 9999 Type R6, 8, 26, 35, 39, 41, 43, 45, TC10, & TC11				Class 9999 Type R7, 9, 27, 36, 40, 42, 44, 46 & TC 20, 21					
Vac 50 or 60 Hz	Maximum Current			Vac 50 or 60 Hz	Maximum Current				
	Make	Break	Continuous Carrying Current (A)		Make		Break		Continuous Carrying Current (A)
	(A)	(A)			(A)	VA	(A)	VA	
120	40	15	15	120	30	3450	3	345	10
240	20	10	15	240	15	3450	1.5	345	10
480	10	6	15	480	7.5	3450	0.75	345	10
600	8	5	15	600	6	3450	0.6	345	10

Control Circuit Transformers

Class 9070 Type TF control transformers are normally used in order to provide a lower voltage to the control circuit. (To order a factory-installed transformer with fused protection, specify Form FF4T). The addition of a transformer often requires the use of a larger enclosure (refer to the dimensions on page 19). Table 57 shows the transformer selection for the given sized starters and contactors, with or without auxiliary units.

Table 57: Control Transformer Selection

NEMA Size	Starter Type	Standard Capacity (Form FF4T)	Additional Capacity		
			50 VA (Form FF4T10)	100 VA (Form FF4T11)	200 VA (Form FF4T12)
		Class 9070, Type [1]			
0, 1	SB, SC	TF100	TF150	TF200	TF300
2	SD	TF100	TF150	TF200	TF300
3	SE	TF150	TF200	TF300	TF500
4	SF	TF300	TF300	TF500	T500
5	SG	TF100 and 8501XO20	TF100 and 8501XO20	TF150 and 8501XO20	TF300 and 8501XO20
6	SH	EO3S2 is standard	N/A	EO3FS2 and T100	EO3S2 and TF200
7	SJ	EO19S2 is standard	N/A	EO19S2 and TF100	EO3S2 and TF200

[1] Complete the control transformer Class and Type with the voltage code. See Table 71 on page 44.

NOTE: 9070TF transformers are now standard in Series K combination starters when factory installed.

File E78360
CCN NITW2

Transformers

File E61239
CCN XPTQ

File LR37055
Class 5411 06

Table 58: Electronic Motor Circuit Protector (MCP) Selection by Hp Ratings of Induction-type Squirrel-Cage Motors

This table indicates the MCP adjustable trip range that corresponds to the suffix of the circuit breaker catalog number. The MCP motor circuit protector should be adjusted to a level just above locked-rotor current of the motor. This setting provides optimum overcurrent protection for the motor. For more information on MCP instantaneous-trip circuit breakers, refer to the MCP circuit breaker section of this catalog.

3Ø, 60 Hz Voltages				Full-Load Amperes	Suffix
200 Vac	230 Vac	460 Vac	575 Vac		
0.5–5	0.5–7.5	0.75–15	1–20	1.5–25	M71
5–10	5–15	10–30	15–40	14–42	M72
10–25	15–30	25–60	30–75	30–80	M73
20–40	25–50	50–100	60–125	58–130	M74
40–60	50–75	100–150	125–200	114–217	M75

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Table 59: UL Listed Short-Circuit Ratings—Class 8539 Electronic MCP Style

Enclosure	NEMA Size	AIC at 480 Vac (RMS)	AIC at 600 Vac (RMS)
Standard (NEMA 1, 4 and 4X stainless, and 12/3R)	0, 1	100,000	35,000
	2–5	100,000	50,000
	6	65,000	18,000
	7	65,000	30,000

Table 60: UL Listed Short-Circuit Ratings—Class 8539 Thermal-Magnetic Circuit Breaker Style

Enclosure	NEMA Size	AIC at 480 Vac (RMS)	AIC at 600 Vac (RMS)
Standard (NEMA 1, 4 and 4X stainless, and 12/3R)	0, 1	100,000	35,000
	2—5	100,000	50,000
	6	65,000	18,000
	7	65,000	30,000

Table 61: UL Listed Short-Circuit Ratings—Class 8538 Disconnect Switch Style

Enclosure	NEMA Size	NEMA Fuse Class	Available Amperes, RMS Symmetrical
Oversize	0–2	Class H or K	5,000
Standard	0–2	Class R/J	100,000
Standard (non-oversize NEMA 1, 4 and 4X stainless, and 12)	0–3	Class H or K	5,000
	0–3	Class R/J	100,000
	4–5	Class H or K	10,000
	4–5	Class R/J	100,000
	6	Class H or K	18,000
	6	Class R/J	100,000

Table 62: Motor Code Letters

Horsepower	Motor Code Letters
0.5 or less	A-L
0.75–1.5	A-K
2–3	A-J
5–25	A-H
30–125	A-G
150 or more	A-F

NOTE: The combination starter selection tables on pages 15–14 are suitable for motors with locked-rotor current letters according to NEC Table 430-7(b) as listed in Table 62. For other motors, a special thermal-magnetic circuit breaker with adjustable magnetic trip settings for the specific motor is required. When ordering for these special applications, specify the motor horsepower, voltage, frequency, full-load current, and code letter (or locked rotor current) to help ensure proper protection.

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Control Circuit Transformers

Space and drilling are provided in all combination starters—in NEMA 1, 4 & 4X stainless, and 12/3R enclosures—for the field addition (or factory installation) of a Class 9070 transformer. For standard control transformer selection in reversing combination starters, see Table 63. For primary fusing of the control circuit, the Class 9999 Type SF4 fuseholder kit is suggested. This kit can be either panel mounted or side mounted on the Type S starter.

Table 63: Control Transformer Selection

NEMA Size	Starter Type	Standard Capacity (Form FF4T)	Additional Capacity		
			50 VA (Form FF4T10)	100 VA (Form FF4T11)	200 VA (Form FF4T12)
		Class 9070, Type [1]			
0 & 1	SB & SC	TF100	TF150	TF200	TF300
2	SD	TF100	TF150	TF200	TF300
3	SE	TF150	TF200	TF300	TF500
4	SF	TF300	TF300	TF500	T500
5	SG	TF100 and 8501XO20	TF100 and 8501XO20	TF150 and 8501XO20	TF300 and 8501XO20
6	SH	EO3S2 is standard	N/A	EO3FS2 and T100	EO3S2 and TF200
7	SJ	EO19S2 is standard	N/A	EO19S2 and TF100	EO3S2 and TF200

[1] Complete the contactor or starter Class and Type with the voltage code. See Table 71 on page 44.

NOTE: 9070TF transformers are now standard in Series K combination starters.

Table 64: Class 8738 UL Short-Circuit Ratings

NEMA Size	Fuse Clip Type	Enclosure [1]	Ampere Interrupting Capability Rating (AIC)
0–3	Standard	Standard	5,000
0–3	Class R	Standard	100,000
4–5	Standard	Standard	10,000
4–5	Class R	Standard	100,000

[1] Standard enclosures include NEMA 1, 4 & 4X stainless, and 12/3R.

Table 65: Class 8739—UL Listed Short-Circuit Ratings

	Motor Circuit Protector and Thermal-Magnetic Styles		
NEMA Size	Enclosure [1]	AIC at 480 Vac (RMS)	AIC at 600 Vac (RMS)
0, 1	Standard	100,000	35,000
2–5	Standard	100,000	50,000
6	Standard	65,000	18,000
7	Standard	65,000	30,000

[1] Standard enclosures include NEMA 1, 4 and 4X stainless, and 12/3R.

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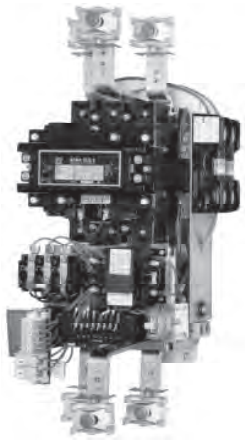
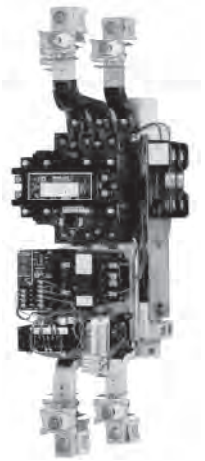


NEMA Size 6 Starter
8536 SH



NEMA Size 7 Starter
8536 SJ

NEMA Size 6 Type SH and NEMA Size 7 Type SJ contactors and starters have a DC coil operated by a solid-state rectifier circuit mounted on the device and powered from an AC source. The NEMA Size 6 and 7 devices come standard with a fused control-circuit transformer rated 240/480-120 V 60 Hz, 220/440-110 V 50 Hz. The purpose of this transformer is to provide an isolated supply, 120 V 60 Hz / 110 V 50 Hz, for the control circuit. NEMA Size 6 and 7 devices can be ordered for other system voltages by specifying the voltage and frequency desired.

Operation Rates—Continuous Operation: 3 operations/minute maximum. Jogging or Plugging Duty: 15 operations/minute—3 minutes maximum.

Field Conversion—Devices can be field converted to other system voltages by one of the following methods, ***not*** *by the usual practice of changing the coil*:

1. If the factory wiring is 480 V 60 Hz / 440 V 50 Hz, the device can be converted to 240 V 60 Hz / 220 V 50 Hz by reconnecting the control transformer as illustrated on the instruction sheet furnished with the controller. This is the same method that would be used on Class 9070 control circuit transformers.

   Conversion to any other voltage requires replacement of the control transformer. For other system voltages—for example, 208, 277, 380, 600 V—a new transformer with single-voltage primary must be selected from Table 66 or 67. Control transformer connections are illustrated on the instruction sheet furnished with the controller.
2. If the factory wiring is any voltage *other than* 480 V 60 Hz / 440 V 50 Hz, conversion to another voltage requires replacement of the control transformer. Refer to Table 66 or 67.
3. In Square D combination starters, the standard transformer provided can be used to power a maximum of five Class 9001 Type K illuminated operators powered with transformer-type light modules. When additional capacity to power control relays or other inductive loads is required, a second transformer must be added. Additional capacity can be purchased as Form FF4T with additions in 100 VA increments.
4. Standard controllers are wired for common control and are not convertible for operation of the control circuit from a separate source of supply voltage. Controllers designated Form S have special wiring designed for separate control. They are furnished with an isolating transformer, usually having a 120 V primary and 120 V secondary, which must not be bypassed. Form S controllers are not convertible for operation on common control.

Tables 66 and 67 list the replacement transformers for NEMA Size 6 and 7 Type S contactors and starters. To change voltages on these devices, coils are not changed—instead, transformers are changed to those with the desired voltage.

Table 66: NEMA Size 6 Replacement Control Transformers (150 VA) for Type S Devices

Voltage		Class 9070
60 Hz	50 Hz	Type
240/480–120	220/440–110	31104-512-50
208–120	—	31104-512-52
277–120	—	31104-512-53
—	380–110	31104-512-54
600–120	550–110	31104-512-51
120–120	110–110	31104-512-55
240–120	220–110	31104-512-56

Table 67: NEMA Size 7 Replacement Control Transformers (200 VA) for Type S Devices

Voltage		Class 9070
60 Hz	50 Hz	Type
240/480-120	220/440-110	31123-501-50
208-120	—	31123-501-52
277-120	—	31123-501-53
—	380-110	31123-501-54
600-120	550-110	31123-501-51
120-120	110-110	31123-501-55
240-120	220-110	31123-501-56

Auxiliary Contacts: An N.O. holding circuit contact and an N.C. auxiliary contact come standard. The holding circuit contact may or may not be required for either 3-wire or 2-wire control. NEMA Size 6 and 7 devices have an additional N.C. auxiliary contact wired in the coil control circuit. ***Do not*** *use this N.C. contact for any other purpose.*

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Factory Modifications (Forms)

Factory-installed modifications are available for the Classes of control equipment listed in the tables below. Kits are also available for many field modifications and normal parts replacement on most control items. Refer to Class 9998 and 9999 products in *Digest* Section 16 for complete listings.

Standard equipment dimensions and enclosure construction may not apply when certain special features are added. Such cases should be referred to the factory with complete description when accurate dimensions are required.

NOTE: If a UL label is required, consult the local Square D field office. Some Forms **are not** UL Listed.

Table 68: Full Voltage Starters—Cover-Mounted Control Units

Controller	Pilot Device	Factory Modifications	Enclosure Type	Form
Pilot Devices in the Cover Full Voltage Non-Reversing Controllers Only Classes 8538 8539	**Push Buttons [1]**	Start-Stop	1 [2], 3R, 4, 4X, 12/3R	A
		Start-Stop (maintained contact) [3], [4]	1 [2], 3R, 4, 4X, 12/3R	A16
		Start-Stop push button and Hand-Off-Auto selector switch [4]	1 [2], 3R, 4, 4X [5], 12/3R	AC
		On-Off [4]	1 [2], 3R, 4, 4X [5], 12/3R	A3
		Single oiltight push button (specify marking) [4]	1, 3R, 4, 4X [5], 12/3R	A11
	Selector Switches	Hand-Off-Auto	1 [2], 3R, 4, 4X, 12/3R	C
		On-Off [4]	1 [2], 3R, 4, 4X [5], 12/3R	C6
		Non-standard markings for pilot devices [4]	1, 3R, 4, 12/3R	G12 [6]
		Addition of a padlock attachment to Class 9001 operators [4]	1, 3R, 4, 12/3R	G122
	Pilot Lights (specify color and type) [7]	Without operating interlock	See Table 69 on page 43. [7]	
		With operating interlock (add price of each interlock per light)	1, 3R, 4, 4X [5], 12/3R	X
Pilot Devices in Cover Full Voltage Reversing and Multi-Speed Controllers Only Classes 8738 8739	**Push Buttons [1]**	Forward-Reverse-Stop [4]	1, 4, 4X [5], 12/3R	A1
		High-Low-Stop [4]	1, 4, 12/3R	A2
		Fast-Off-Slow [4]	1, 4, 12/3R	A9
		High-Low push button and Hand-Off-Auto selector [4]	1, 4, 12/3R	A10C
		Single oiltight push button (specify marking) [4]	1, 4, 4X [5], 12/3R	A11
	Selector Switches	Hand-Off-Auto	1, 4, 4X [5], 12/3R	C
		On-Off [4]	1, 4, 4X [5]	C6
		High-Off-Low	1, 4, 12/3R	C7
		Forward-Off-Reverse [4]	1, 4, 4X [5], 12/3R	C14
		High-Low and Hand-Off-Auto [4]	1, 4, 12/3R	CC17
		Slow-Fast [4]	1, 4, 4X [5], 12/3R	C19
		Forward-Reverse [4]	1, 4, 4X [5], 12/3R	C20
		High-Low-Off-Auto [4]	1, 4, 12/3R	C25
		Non-standard markings for pilot devices [4]	Any	G12 [6]
	Pilot Lights (specify color and type) [7]	Without operating interlock	See Table 69 on page 43. [7]	
		With operating interlock	1, 4, 4X [5], 12/3R	X [8]

[1] All push buttons are momentary contact unless specified otherwise.

[2] Selection of various Form combinations may force the use of a larger enclosure.

[3] Specify the appropriate Class 9001 Type K or SK operator.

[4] Not available for Size 00.

[5] This Form is available with a NEMA 4X enclosure only with Class 8538, 8539, 8738, and 8739 devices.

[6] Specify the marking and/or the required Class 9001 Type KN or SKN legend plate.

[7] Indicate the pilot light color as Form P1 (red), Form P2 (green), and so forth, as shown in Table 69 on page 43. Unless otherwise requested, standard practice is to wire a red pilot light to indicate that the device is energized. No additional auxiliary contact is required. Also, standard practice is to wire a green pilot light to indicate that the device is de-energized. An additional normally closed auxiliary contact is provided. A wiring diagram must be provided for other pilot light colors or arrangements.

[8] To determine the maximum number of auxiliary contacts that can be added to each Type S device, and for the appropriate X Form, refer to Table 53 on page 37.

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Table 69: Pilot Light Forms

Description	Form			
	Standard	Push-to-Test	LED	LED-Push-to-Test
Red On	P1	P21	P51	P42
Red Off	P71	P81	P91	P43
Red Unwired	P38	P28	P58	P44
Green On	P72	P82	P92	P45
Green Off	P2	P22	P52	P46
Green Unwired	P39	P29	P59	P47
Amber	P3	P23	P53	P63
Clear	P4	P24	P54	P64
Yellow	P35	P25	P55	P48
Blue	P36	P26	P56	P66
White	P37	P27	P57	P67
Red Low—Green Hi	P73	P83	P93	P77
Green Low—Red Hi	P74	P84	P94	P78
Red Off—Green Fwd/Rev	P75	P85	P95	P79
Green Off—Red Fwd/Rev	P76	P86	P96	P80

Table 70: Control Circuit, Full Voltage Controllers Only

Classes	Factory Modifications		Enclosure Type	Form	NEMA Size								
					00	0	1	2	3	4	5	6	7
	Separate control circuit—specify voltage and frequency		Any	S	X	X	X	X	X	X	X	X	X
	Fused control circuit (without control transformer)												
	One fuse [1]		1, 3R, 4, 4X, 12/3R	F	X	X	X	X	X	X	X	—	—
	Two fuses [1]		1, 3R, 4, 4X, 7, 9, 12/3R	F4	X	X	X	X	X	X	X	—	—
	Control Circuit Transformers [2]—Standard capacity (50 or 60 Hz) Note: All orders requesting Form FT will be supplied as Form FF4T.												
	FUSES												
8538	**Primary**	**Secondary**											
8539	2	1	1, 4, 4X, 12/3R	FF4T	X	X	X	X	X	X	X	X	X
8738	2	2	1, 4, 4X, 12/3R	F4F10T	X	X	X	X	X	X	X	—	—
8739	**Additional Capacity (50 or 60 Hz)**												
	Two fuses in primary and one fuse in secondary												
	100 VA additional capacity		1, 4, 4X, 12/3R	FF4T11	X	X	X	X	X	X	X	X	X
	200 VA additional capacity		1, 4, 4X, 12/3R	FF4T12	X	X	X	X	X	X	X	X	X
	300 VA additional capacity		1, 4, 4X, 12/3R	FF4T13	X	X	X	X	X	X	X	X	X
	400 VA additional capacity		1, 4, 4X, 12/3R	FF4T14	X	X	X	X	X	X	X	X	X
	500 VA additional capacity		1, 4, 4X, 12/3R	FF4T15	X	X	X	X	X	X	X	X	X

[1] Not available for Sizes 6 and 7.

[2] See Table 71 on page 44.

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Control Circuit Transformer Selection

The standard primary/secondary voltages for control circuit transformers are shown in Table 71.

Table 71: Selection of Control Circuit Transformers—AC-Operated Devices

Voltage, 60 Hz (Primary—Secondary)	Code
120—24 [1]	V89
208—120	V84
240—24 [1]	V82
240—120	V80
277—120	V85
480—24 [1]	V83
480—120	V81
480—240	V87
600—120	V86
Specify	V99

[1] **24 V** coils are **not** available on Sizes 4–7.

To order, select the desired device with the appropriate transformer Form designation. Then convert the previously selected voltage code (V●●) to reflect the desired primary/secondary voltage for the transformer. The secondary voltage should equal the previously selected coil voltage of the device.

Table 72: Example: Control Circuit Transformer Selection

You have selected 8538SDG16V02S. V02S indicates a coil voltage of 120-60/110-50 wired for separate control. You would like to add **Form FF4T**, with transformer voltages of 480 V primary, 120 V secondary, and solid-state overload relay protection with selectable Class 10/20 trip class (**Form H30**).

The new and complete Class, Type, voltage code, and Form number will be:

Class	Type	Voltage Code	Form *(list the Form numbers in alphabetical order)*
8538	SDG16	V81	FF4H30T

Table 73: Marine Control

Class	Enclosure Type	Description	Form
8538, 8539, 8738, 8739	12/3R or 4/4X (stainless steel only)	Factory modification of the standard device for use as marine control in accordance with UL508	M10

Table 74: Power Poles, Coil Transient Suppressors, and Terminal Blocks—Full Voltage Controllers Only Classes 8538, 8539, 8738, 8739

Factory Modifications				Enclosure Type	Class 9999, Type	Form	NEMA Size								
							00	0	1	2	3	4	5	6	7
Power Poles (addition of one) [1]	NEMA Size 1, 30 A	Single pole	N.O.	Any	SB6	Y428	—	X	X	X [2]	X	X	X	X	X
			N.C.	Any	SB7	Y429	—	X	X	X [1]	X	X	X	X	X
		Double pole	N.O./N.O.	Any	SB9	Y430	—	X	X	X [1]	X	X	X	X	X
			N.C./N.C.	Any	SB10	Y434	—	X	X	X [1]	X	X	X	X	X
			N.O./N.C.	Any	SB8	Y435	—	X	X	X [1]	X	X	X	X	X
	NEMA Size 2	Single pole	N.O.	Any	SB11	Y436	—	—	—	X [1]	X	X	X	X	X
			N.C.	Any	SB12	Y437	—	—	—	X [1]	X	X	X	X	X
		Double pole	N.O./N.O.	Any	SB14	Y438	—	—	—	X [1]	X	X	X	X	X
			N.C./N.C.	Any	SB15	Y439	—	—	—	X [1]	X	X	X	X	X
			N.O./N.C.	Any	SB13	Y440	—	—	—	X [1]	X	X	X	X	X
Miscellaneous	Coil transient suppressor (120 V only), per coil.			Any	Any	Y145	X	X	X	X	X	X	X	X	X
	Addition of terminal blocks (specify wired or unwired).														
	Wired, per terminal, each			1, 4, 12	Any	G56● [3]	—	X	X	X	X	X	X	X	X
	Unwired, per terminal, each			1, 4, 12		G50● [3]	—	X	X	X	X	X	X	X	X

[1] Single- or double-circuit power pole adders may be factory or field installed on 2- and 3-pole Type S contactors and starters. This table lists the Form designation for factory-installed power pole adders. Only one power pole adder can be installed per contactor. For field modification kits, see Class 9999 Accessories in the Digest.

[2] When adding a power pole to a Size 2 device, also specify Form **Y118** (stronger coil, Size 2 only).

[3] Addition of terminal block 9080CA or 9080GR6 only. Replace the bullet (●) in the Form number with the number of circuits (example: **G505** is a five-circuit, unwired terminal block). Available in groups of five only.

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Solid-State Overload Relay Factory Modifications (Forms)

The solid-state overload relay (SSOLR) is available on NEMA Size 00–7.
For Class 8538, 8539, 8738, and 8739 devices.

Form Description H # # #

Type S Starter with Motor Logic™ Solid-State Overload Relay (SSOLR)

3: Motor Logic SSOLR, Class 10/20 (Selectable)

0: No additional modifications
1: N.O. auxiliary contact (field convertible to N.C.)

Special SSOLR / Contactor Size Combinations (Base Unit and Feature Units):
(must be specified on Size 00 starter orders)
Blank: SSOLR matched to the starter size (for example, Size 1 contactor and 9-27 A SSOLR)
0: 6–18 A SSOLR on a starter size as indicated by the starter catalog number
1: 9–27 A SSOLR on a starter size as indicated by the starter catalog number
2: 15–45 A SSOLR on a starter size as indicated by the starter catalog number
3: 30–90 A SSOLR on a starter size as indicated by the starter catalog number
4: 45–135 A SSOLR on a starter size as indicated by the starter catalog number
8: 1.5–4.5 A SSOLR on a starter size as indicated by the starter catalog number (only on Feature Units)
9: 3–9 A SSOLR on a starter size as indicated by the starter catalog number

Special note for Class 8810 devices:

You **must** specify two separate Form numbers to get Motor Logic overload relays on two-speed starters.

The catalog number will be alphanumeric. Example:
- Open style, Size 4 two speed starter with Motor Logic SSOLRs
- Single winding, 460 V, constant or variable torque
- High speed FLA = 96 A
- Low speed FLA = 27 A (use Size 2 overload relay)

Catalog number to order: **8810SF01V02H30H302S**
Where:
- Form H30 is a Size 4 contactor with a 45–135 A Motor Logic SSOLR for high speed
- Form H302 is a 15–45 A Motor Logic SSOLR on the low speed contactor.

Table 75: Forms, Motor Logic SSOLR Classes 8536, 8538, 8539, 8736, 8738, 8739, 8810, and 8940

Factory Modification: Motor Logic SSOLR Class 10/20 (Selectable)	NEMA Size and Overload Current Range								
	00	0	1	2	3	4	5	6	7
	3–9 A	6–18 A	9–27 A	15–45 A	30–90 A	45–135 A	90–270 A	180–540 A	270–810 A
SSOLR—No Additional Modifications	H30	H30	H30	H30	H30	H30	H30	H30	Standard
SSOLR—With Auxiliary Contact	H31	H31	H31	H31	H31	H31	H31	H31	H31

Table 76: Special Starter Combinations with Motor Logic Overload Relay Protection

NEMA Contactor Size	SSOLR Size						
	00_B	00_C	0	1	2	3	4
00	[1]	Standard	—	—	—	—	—
0	[1]	[1]	Standard	—	—	—	—
1	[1]	[1]	[1]	Standard	—	—	—
2	[1]	[1]	[1]	[1]	Standard	—	—
3	—	—	—	—	—	Standard	—
4	—	—	—	—	—	—	Standard

[1] Available factory starter combination.

Adapted Bimetallic Overload Relay for Type S NEMA Starter (Forms)

This bimetallic overload relay is available on NEMA Sizes 00, 0, and 1 for Class 8538, 8539, 8738 and 8739 devices. To order a starter with the adapter only, add **Form E** to the catalog number (for example, 8536SBG2V02**E**S). When ordering with the adapter and the bimetallic overload relay installed, refer to Table 77 on page 46.

Form Description E # ## #

Bimetallic Overload Relay

Class
1: Class 10 Balanced Loads (with single phase sensitivity)
2: Class 20 Balanced Loads (with single phase sensitivity)
3: Class 10 Unbalanced Loads (without single phase sensitivity)
4: Class 20 Unbalanced Loads (without single phase sensitivity)

FLA: Suffix from the TeSys D Overload Relays table below (for example, for 4–6 FLA, use suffix **10**)

Terminals: **0** for screw terminal and **6** for ring tongue terminals

Sample catalog number: **8536SCO3V02E2160S**
NEMA Size 1 starter controlling a 7.5 hp motor (11 FLA)—Bimetallic overload relay is LRD16L (9–13 FLA)

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Table 77: TeSys D Overload Relays for Size 00–1 Type S Starters, Non-Reversing and Reversing, Classes 8538, 8539, 8736, 8738, and 8739

Current Setting Range, Amperes	Class 20 *with* Single-Phase Sensitivity		Class 20 *without* Single-Phase Sensitivity		Factory Installed— Catalog Number Suffix
	Screw Termination	Ring Tongue Connector	Screw Termination	Ring Tongue Connector	
0.40–0.63	LRD04L	LRD04L6	LR3D04L	LR3D04L6	04
0.63–1	LRD05L	LRD05L6	LR3D05L	LR3D05L6	05
1–1.6	LRD06L	LRD06L6	LR3D06L	LR3D06L6	06
1.6–2.5	LRD07L	LRD07L6	LR3D07L	LR3D07L6	07
2.5–4	LRD08L	LRD08L6	LR3D08L	LR3D08L6	08
4–6	LRD10L	LRD10L6	LR3D10L	LR3D10L6	10
5.5–8	LRD12L	LRD12L6	LR3D12L	LR3D12L6	12
7–10	LRD14L	LRD14L6	LR3D14L	LR3D14L6	14
9–13	LRD16L	LRD16L6	LR3D16L	LR3D16L6	16
12–18	LRD21L	LRD21L6	LR3D21L	LR3D21L6	21
17 to 24	LRD22L	LRD22L6	LR3D22L	LR3D22L6	22
23 to 32	LRD32L	LRD32L6	LR3D32L	LR3D32L6	32

TeSys T Factory Modifications (Forms)

Table 78: Communication Codes

Communication Network	Code
Modbus™	2
Profibus®	3
CANopen	4
DeviceNet®	5
Ethernet TCP/IP (communication protocols: Ethernet/IP and Modbus/TCP)	6

Table 79: TeSys T Motor Management System Modifications H6xx or H7xx for use with 8538, 8539, 8738 & 8739 (Enclosed Combination Starters)

Used on Size	Range	Form [1]	
		Control Voltage	
		100–240 Vac	24 Vdc
1	0.4–8 A	H61●	H71●
	1.35–27 A	H62●	H72●
2, 3	5.0–100 A	H63●	H73●
4	8–160 (CT 300:5, 3 turns)	H65●	H75●
5	24–480 A (CT 300:5, 1 turn)	H66●	H76●
6	48–960 A (CT 600:5, 1 turn)	H67●	H77●

[1] Replace the bullet (●) with the code for the the communication option according to Table 78 (for example, H612).

NOTES:

- To order TeSys T starters, use the product configurator.
- The auxiliary contact controlling the starter coil has a maximum rating of 240 Vac.

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Interlocks and Control Transformers

An electrical interlock can be factory installed in a combination starter, or installed in the field. For factory modification, specify **Form Y74** for single-pole, or **Form Y75** for double-pole interlocks. For field installation, see Table 80.

A one- or two-pole electrical interlock can be added to the disconnect switch or circuit breaker. In this way, if a separate control circuit is used, the magnetic starter can be de-energized when the disconnect means is switched to the Off position. See Table 80 for proper interlock selection. For electrical ratings of disconnect switch and circuit breaker interlocks, see Table 81.

Table 80: Electrical Interlocks for Disconnect Switches and Circuit Breakers—Field Installation

Class	Type	SPDT [1]	DPDT
		Class 9999 Type	Class 9999 Type
Disconnect Switch Interlocks			
8538 [2]	SB, SC, SD (Series B)	R6	R7
8538	SBA, SCA, SBG, SCG (Series D and above)	TC11	TC21
	SBAS8, SCAS8, SBGS8, SCGS8 (Series D and above)	TC10	TC20
	SDA, SDA [2] SDG, SDG [2] (Series D and above)	TC10	TC20
8538, 8738	SB, SC (Series C)	R45	R46
	SD (Series C)	R43	R44
	SE, SF (Series A)	R8	R9
	SE (Series B & C)	R41	R42
	SF (Series B & C)	R39	R40
	SG	R35	R36
	SEA, SEG (Series D and above)	TC10	TC20
8738	SBAS8, SCAS8, SBGS8, SCGS8 (Series E and above)	TC10	TC20
	SBA, SCA, SBG, SCG (Series E and above)	TC11	TC21
	SDA, SDG (Series E and above)	TC10	TC20
Circuit Breaker Interlocks			
8539, 8739	SB, SC, SD, SE, SF, SG (Series K)	R26	R27

[1] For factory modification, specify **Form Y74** for single-pole, or **Form Y75** for double-pole interlocks.

[2] Class 8538 type numbers ending in suffix **S8**.

Table 81: Electrical Ratings for Disconnect Switch and Circuit Breaker Interlocks

Class 9999 Type R6, 8, 26, 35, 39, 41, 43, 45, TC10, & TC11				Class 9999 Type R7, 9, 27, 36, 40, 42, 44, 46 & TC 20, 21					
Vac 50 or 60 Hz	Maximum Current			Vac 50 or 60 Hz	Maximum Current				
	Make	Break	Continuous Carrying Current (A)		Make		Break		Continuous Carrying Current (A)
	(A)	(A)			A	VA	A	VA	
120	40	15	15	120	30	3450	3	345	10
240	20	10	15	240	15	3450	1.5	345	10
480	10	6	15	480	7.5	3450	0.75	345	10
600	8	5	15	600	6	3450	0.6	345	10

Control Transformers

9070TF transformers are now standard in Series K combination starters when factory installed.

Table 82: Control Transformer Selection

NEMA Size	Starter Type	Standard Capacity	Additional Capacity		
			50 VA	100 VA	200 VA
		Form FF4T	Form FF4T10	Form FF4T11	Form FF4T12
		Class 9070 Type [1]			
0 & 1	SB & SC	TF100	TF150	TF200	TF300
2	SD	TF100	TF150	TF200	TF300
3	SE	TF150	TF200	TF300	TF500
4	SF	TF300	TF300	TF500	T500
5	SG	TF100 and 8501XO20	TF100 and 8501XO20	TF150 and 8501XO20	TF300 and 8501XO20
6	SH	EO3S2 is standard	N/A	EO3FS2 and T100	EO3S2 and TF200
7	SJ	EO19S2 is standard	N/A	EO19S2 and TF100	EO3S2 and TF200

[1] Complete the contactor or starter Class and Type with the voltage code. See Table 71 on page 44.

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Internal Auxiliary Switch—Circuit breakers can be furnished with a factory installed auxiliary switch for remote indication of an open/tripped or closed circuit breaker. One auxiliary switch (**Form Y741**) or two auxiliary switches (**Form Y751**) can be furnished. The switches come with normally open and normally closed circuits with a common connection. Contacts must be used on the same polarity and are rated 15 A at 240 Vac. The auxiliary switches are located internally and come with 19–20 in. leads.

Alarm Switch—The alarm switch is used to actuate bell alarms and warning lights. It operates only when the circuit breaker is tripped. The alarm switch is factory installed only (**Form Y742**) and consists of a single-pole, single-throw switch, which is normally open except when the circuit breaker is tripped. The contacts are rated 4 A at 240 Vac. This switch is located in the circuit breaker and comes with 19–20 in. leads.

Transformer Selection—In all disconnect switch and circuit breaker combination starters in enclosures (NEMA 1, 4 & 4X stainless and polyester, and 12/3R), space and drilling are available for the field addition or factory installation of a Class 9070 control circuit transformer and Class 9999 Type SFR4 fuse holder. This kit can be either panel mounted or side mounted on the Type S starter. For standard control transformer selection in combination starters, see Table 82 on page 47. For secondary fuse holder, order 9080PF1.

Fuse Block Mounting Brackets—The standard capacity transformer, Class 9070 Type TF100, for the Size 0 and 1 starters mounts to the right of the magnetic starter.

Codes and Standards—Most combination starters and Forms are UL Listed in file E152395, Category NKJH, and CSA approved in File CR 584.

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8538CT9701R08/17 Replaces 8538CT9701 01/1998

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Chapter 30 LIGHTING

MANUFACTURER/DISTRIBUTOR:

CDE
298, Rue De Martigny Ouest
Saint-Jérôme (Québec)
J7Y 4C9
Phone.: (450) 438-1263
Fax: (450) 438-3728
Courriel : cde@cde.qc.ca

30.1 **TYPE A LITHONIA VAP 12000LM PCL MD MVOLT GZ10 35K 80CRI CMB**

30.2 **TYPE B - Lithonia TWS LED 1 50K 120 PE**

30.3 **TYPE C - Lithonia TWP LED 20C 700 50K T3M 120 PE DDBXD**

30.4 **EXIT SIGN - AIMLITE CARPW0636 U M-2SM4LJ WHT/ATD**

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

ARCHWAY™ PASSAGE™

VAP LED

CEILING/
SUSPEND MOUNT

FEATURES & SPECIFICATIONS

INTENDED USE — Ideal for use in applications where smart, energy-efficient fixtures are desired. Typical applications include parking garages, canopies, transportation, schools, hospitals, cold storage and exterior retail environments where moisture or dust is a concern. Polycarbonate enclosure protects fixture while remaining easy to service and clean.

CONSTRUCTION — UV-stabilized, injection-molded, impact-resistant, frosted polycarbonate housing with continuous pouredin-place, closed-cell gasket. 20-gauge steel channel and channel cover. Aluminum sheet metal board plate for thermal conduction and support. Captive, tamper-resistant, polycarbonate latches standard (8 Torx T-20 tamper-resistant screws included). Stainless steel latches also available. Fixture design allows for approximately 4% up-light.

OPTICS — UV-stabilized, injection-molded, impact-resistant, clear transparent and frosted, polycarbonate lens with aesthetic rib detail (.080" thick). Miro 5 aluminum reflector used to achieve wide distribution.

ELECTRICAL — Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Electronic LED driver rated for 44 input watts and is standard 0-10V dimming. Integral 6kV/3kA surge protection, tested in accordance to IEEE/ANSI standards. L85 at 60,000 hours.

INSTALLATION — Stainless steel surface spring-mounting brackets standard (2 included) allows for ceiling or suspended mount. A variety of stainless steel mounting options also available: J-box mounting and mounting brackets for suspension with aircraft cable (cable not included). Optional stainless steel V-hooks available for chain hanging (chain not included). Surface conduit entry on each end and on top. For horizontal and vertical mounting on a wall, application must be under a covered ceiling and QMB option recommended. 1/2" - 3/4" KO. When wall mounted the product will be rated for damp location only.

LISTINGS — CSA Certified to UL and C-UL standards. For use in ambient temperatures ranging from -20°F (-29°C) to 104°F(40°C). VAP LED is wet location listed for covered ceiling applications. IP65 and IP66 rated. VAP LED is NSF Splash Zone rated when suspended or ceiling mounted. When wall mounted the product will be rated for damp location only. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

For installed Rough Service Product(s), Acuity warrants that, for the lifetime of the product(s), the polycarbonate lens and/or polycarbonate housing will withstand breakage resulting from occasional physical abuse and rough handling (the "Rough Service Warranty"), notwithstanding the vandalism exclusion set forth at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

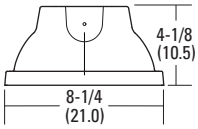
All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Specifications

Length: 54-3/4 (139.1)
Width: 8-1/4 (21.0)
Depth: 4-1/8 (10.5)
Weight: 13.5 lbs. (5.9 kg)

All dimensions are shown in inches (centimeters) unless otherwise noted.



ORDERING INFORMATION

Lead times will vary depending on options selected. Consult with your sales representative.

Example: VAP 4000LM FST MD MVOLT GZ10 40K 80CRI

VAP							
Series	**Nominal lumens**	**Diffuser**	**Distribution**	**Voltage**	**Driver**	**Color temperature**	**CRI**
VAP	4000LM 4,000 lumens	FST Frosted polycarbonate lens	MD Medium	MVOLT MVOLT	GZ10 0 - 10V dimming	30K 3000K	80CRI 80 CRI
	6000LM 6,000 lumens	PCL Clear polycarbonate lens	WD Wide	120 120V		35K 3500K	90CRI 90 CRI
	12000LM 12,000 lumens[1]			277 277V		40K 4000K	
				347 347V[2]		50K 5000K	
				480 480V[2]			

Options[3]

SF	Single fuse[4]	STSL	Stainless steel tamper resistant latches	MSI10XAWL10M DSCXAWL	Xpoint wireless integral motion sensor, On/Off operation for motion sensing, override Off due to daylight[4]
BSL722	Bodine® emergency LED battery pack for 0°C and up[4,5]	QMB	Quick-mount ceiling bracket	MSI10NWL	Low mount 360 integral motion sensor, wet location, On/Off operation[4]
BSL722C	Bodine® emergency LED battery pack for -20°C and up[4,5]	CMB	Chain-mount suspension bracket	MSI102L3VWL	Low mount 360 integral motion sensor, wet location, High/Low operation (bi-level)[4]
WLF	Wet location fitting (two outboard, top)[6]	JSB	Junction box snap-bracket	MSI10NWL DSCNWL	Low mount 360 integral motion sensor, wet location , On/Off operation for motion sensing, override Off due to daylight[4]
WLFIN	Wet location fitting (two inboard, top)[6]	LSC	Lens safety clip	XAD	XPoint™ wireless controller ,0-10V dimming[9]
WLFEND	Wet location fitting (one end)[6]	DL	Damp location[8]		
WLFEND2	Wet location fitting (both ends)[6,7]	L/SP	Less surge protection device		
CS89	6' white cord, 16/3, no plug, wet location				
CS88	6' Brad Harrison 16/3 cord and straight blade plug set[4]				
CS88L12	12' Brad Harrison 16/3 cord and straight blade plug set[4]				

Accessories: *Order as separate catalog number. (Ships separately)*

VAPSMB	Surface spring-mount bracket	RK1 T20BIT	Hex base driver bit, Torx T20. Tamper resistant screws with center reject pin
VAPQMB	Quick-mount ceiling bracket	RK1 T20DRV	Torx T20 screwdriver for use with tamper resistant screws with center reject pin
VAPCMB	Chain-mount bracket		
VAPJSB	Junction box snap bracket		
HC36	Wire hook and 36" chain set[10,11]		

Notes

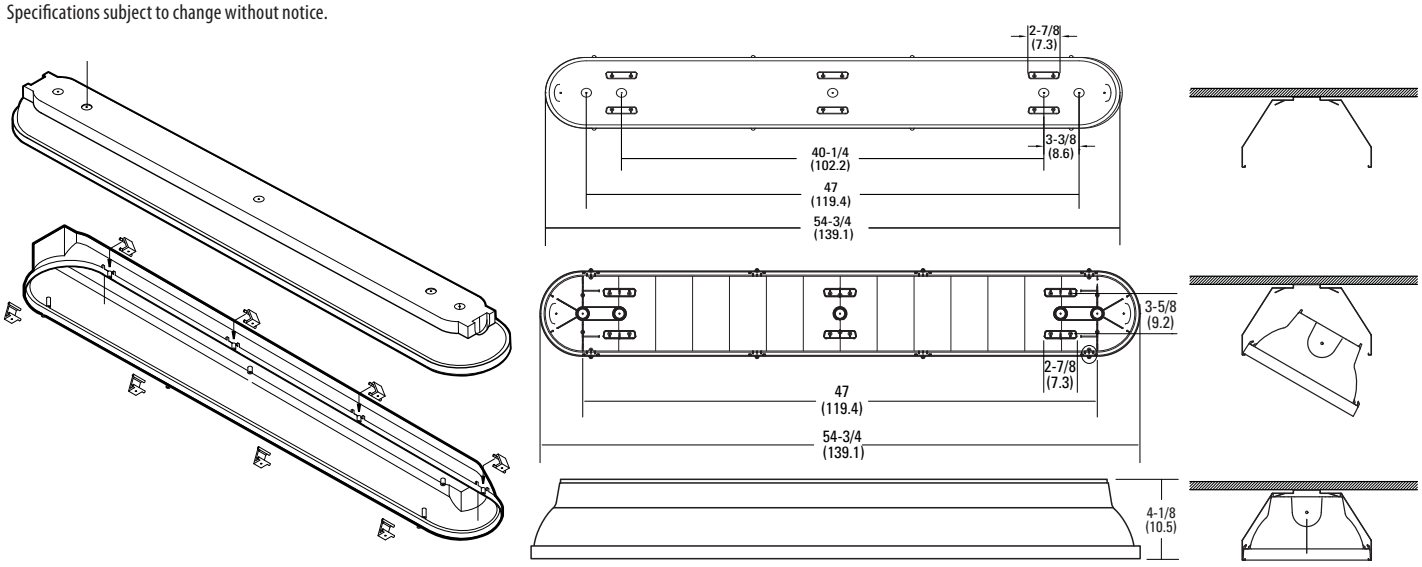
1. Not available with BSL722 or BSL722C options.
2. 347V and 480V utilize a step-down transformer. Available 60HZ only.
3. For additional options, consult factory.
4. Must specify voltage.
5. Not available with 12000LM lumen package. Maximum ambient temperature 30 C.
6. 5/8" long NPT threaded hub.
7. Not available with cord, sensor, or photocell options.
8. Required when using battery packs or cord sets that are not rated for wet locations.
9. Not available with BSL722 and BSL722C option.
10. Requires CMB (chain mount bracket) option.
11. For stainless steel, specify STS (example: HC36 STS).

VAP Linear Rough Service, LED

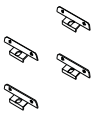
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

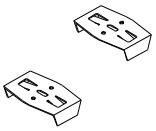


MOUNTING ACCESSORIES

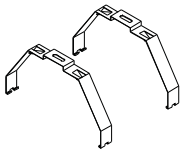


CMB - Ceiling Mounting Brackets

JSB - Junction Box Mounting Bracket



QMB - Quick-Mount Mounting Brackets



SMB - Surface Mounting Brackets (ship with fixture as standard)

ARCHWAY™ PASSAGE™ LED Specification Matrix								
Nominal lumens	Initial delivered lumens @ 80CRI with clear polycarbonate lens			Initial delivered lumens @80CRI with frosted polycarbonate lens			Wattage @120V	Comparable source
	3500K	4000K	5000K	3500K	4000K	5000K		
4000LM	5,200	5,208	5,672	4,420	4,428	4,822	42	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
6000LM	6,630	6,643	7,234	5,637	5,648	6,150	62	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
12000LM	11,034	11,056	12,040	9,380	9,400	10,236	107	4-lamp 32W T8, 2-lamp 54W T5HO, 150W HID

Operating hours	0	10,000	20,000	25,000	35,000	50,000	60,000	75,000	100,000
Lumen Maintenance Factor	1	.95	.92	.91	.89	.86	.84	.81	.77

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An AcuityBrands Company

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VAP Linear Rough Service, LED

SBOR - WET LOCATION Motion Sensor (see www.sensorswitch.com for additional information)

- 360° coverage
- On/Off dim
- Photocell optional
- IP66 rated
- Photocell and 0-10VDC dimming options.

Fixture sensor nomenclature	SBOR sensor nomenclature
For shortest lead times use one of the following SBOR confi gurations	
MSI10NWL	SBOR 10 OEX EB3 WH
MSI102L3VWL	SBOR 10 OEX D EB3 WH 3V
MSI10NWL DSCNWL	SBOR 10 OEX P EB3 WH

MOTION SENSOR

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example**: MSI6NWL

Series	Lens option	Dimming	Minimum dim level	Environmental factors
MSI Passive infrared occupancy sensor	6 High mount, 360° 10 Low mount, 360°	N On\off 2LXX Bi level range[1] CXX Continous dim range[1] XA Xpoint wireless signal to external system	0V Off 1V 1VDC 2V 2VDC 3V 3VDC 4V 4VDC 5V 5VDC	WL Wet location

PHOTOCELL (must be ordered with MSI motion sensor, see above fixture sensor nomenclature table)

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example**: DSCNWL

Series	Dimming	Environmental factors
DSC Passive infrared occupancy sensor with photocell	N On\off 2LXX Bi level range[1] CXX Continous dim range[1] XA Xpoint wireless signal to external system	WL Wet location

Notes

1 XX denotes dimming range.(Ex. 3V, 4V, etc.)

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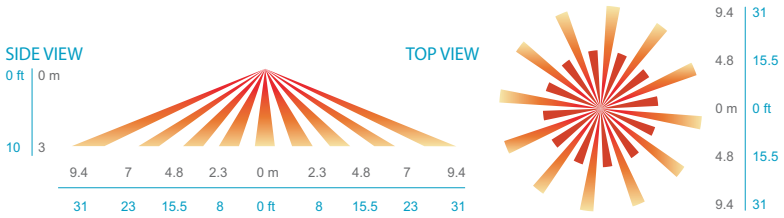
VAP Linear Rough Service, LED

COVERAGE PATTERNS

PARKING GARAGE / LOW MOUNT APPLICATIONS

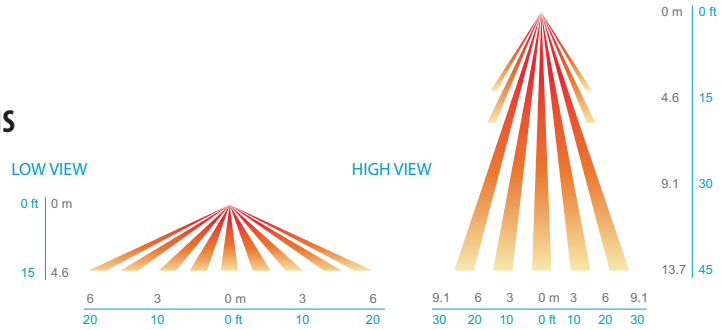
In general, the SBOR 10 is recommended for 8-15 ft (2.44-4.57 m) mounting and provides a coverage area radius for walking motion of greater than 2x the mounting height. The SBOR 10 ODP is ideal for parking garage and low pole mount applications. When mounted 10 ft high, for example, on a luminaire in a parking garage, the sensor's coverage for walking motion extends out 30 ft in a 360º pattern. This closely matches the lighting distribution of a typical parking garage luminaire. When mounted to a light pole, for example, in a parking lot or along a path, the sensor provides 270º of coverage (90º is blocked by the pole). Note, walking askew to sensor typically results in earlier detection than walking directly at sensor.



Coverage Pattern of Low Mount Lens Option (SBOR 10)

SITE & AREA LIGHTING / HIGH MOUNT APPLICATIONS

The SBOR 6 is intended for higher pole mount applications, between 15-30 ft (4.57-9.14 m), and provides a coverage area radius for walking motion of 15-20 ft (4.57-6.10 m). When mounted to a pole the sensor provides 270º of coverage (90º is blocked by the pole).



Coverage Pattern of High Mount Lens Option (SBOR 6)

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Type B Lights - Lithonia TWS LED 1 50K 120 PE

TWS LED
LED Wall Luminaire

Catalog Number

Notes

Type

Hit the Tab key or mouse over the page to see all interactive elements.

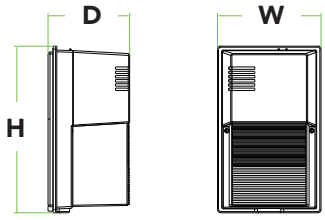
Specifications

Width: 6-3/4" *(17.2 cm)*

Height: 10-7/8" *(27.7 cm)*

Depth: 5-5/16" *(13.5 cm)*

Weight: 3.19 lbs *(1.45 kg)*



Introduction

The popular TWS luminaire is now available with long-lasting, energy-efficient LED technology. Featuring a classic dayform, the TWS LED offers a traditional appearance and is powered by advanced LEDs.

The TWS LED luminaire is powerful yet energy efficient, capable of replacing up to a 70W HPS wall pack while saving up to 78% in energy costs. With long-life LEDs, the TWS LED eliminates frequent lamp and ballast replacements associated with traditional technologies.

Ordering Information

EXAMPLE: TWS LED 1 50K 120 PE

TWS LED					
Series	**Performance Package**	**Color Temperature**	**Voltage**	**Control Options**	**Finish**
TWS LED	1 1017 lumens	50K 5000K [1]	120 120V [2]	PE Photoelectric cell, button type	(blank) Dark bronze

Accessories

Ordered and shipped separately.

TWSWG Wire Guard

NOTES

1. Corrected color temperature (CCT) shown is nominal per ANSI C78, 377-2008.
2. 120V driver operates on 120V.

FEATURES & SPECIFICATIONS

INTENDED USE
The TWS LED combines traditional wall pack design with high-output LEDs to provide an energy-efficient, low maintenance LED wall pack suitable for replacing up to 70W HPS fixtures. The traditional shape helps maintain building aesthetics when replacing only a portion of your building's wall packs. TWS LED is for outdoor applications such as personnel doors, loading areas, driveways and parking areas.

CONSTRUCTION
Back plate is die-cast aluminum. Front cover is impact-resistant polycarbonate which is fully gasketed. All electronics are protected in the upper housing. Housing is sealed against moisture and environmental contaminants.

FINISH
UV stabilized polycarbonate front cover has dark bronze color which provides superior resistance to corrosion and weathering and that can withstand extreme climate changes without cracking or peeling.

OPTICS
Protective polycarbonate lens covers the LEDs. Prismatic front cover and precision-molded reflector for superior uniformity and fixture spacing. Light engine is available in 5000K (69 min. CRI).

ELECTRICAL
Light engine consists of two high-powered, long-life, high-efficacy LEDs mounted on an internal aluminum heat sink to maximize heat dissipation and promote long life (L95/100,000 hours at 40°C). Driver and integral photocell operate at 120V and are fully enclosed in the upper housing. There are no user serviceable parts.

INSTALLATION
Back housing easily mounts to any recessed junction box. With all electronics in upper housing the open lower section makes wiring easy. Mount on any vertical surface. Not recommended in applications where a sprayed stream of water can come in direct contact with polycarbonate lens.

LISTINGS
UL Certified to US and Canadian safety standards for wet-location mounting higher than 4 feet off the ground.

Rated for -40°C to 40°C ambient temperature.

WARRANTY
Five-year limited warranty. Full warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Specifications are subject to change without notice. Actual performance may differ as a result of end-user environment and application

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
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Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Actual performance may differ as a result of end-user environment and application.

Performance Package	Drive Current (mA)	CCT	System Watts	50K (5000K, 67 CRI)				
				Lumens	B	U	G	LPW
1	900	5000K	19W	1,017	1	3	1	54

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.03
10°C	50°F	1.02
20°C	68°F	1.01
25°C	**77°F**	**1.00**
30°C	86°F	0.99
40°C	104°F	0.98

Electrical Load

LED Package	Drive Current (mA)	System Watts	Current (A)			
			120	208	240	277
1	1000	19W	0.20	0.12	0.10	0.09

Projected LED Lumen Maintenance

Data references the extrapolated performance projections in a **40°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	55,000	100,000
Lumen Maintenance Factor	1.0	0.98	0.97	0.97	0.95

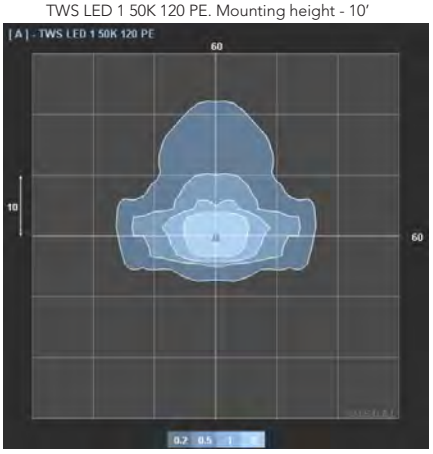
Photometric Diagrams

To see complete photometric reports or download .ies files for this product, visit the Lithonia Lighting TWS LED homepage. Tested in accordance with IESNA LM-79 and LM-80 standards

TWS LED 1 50K 120 PE. Mounting height - 10'

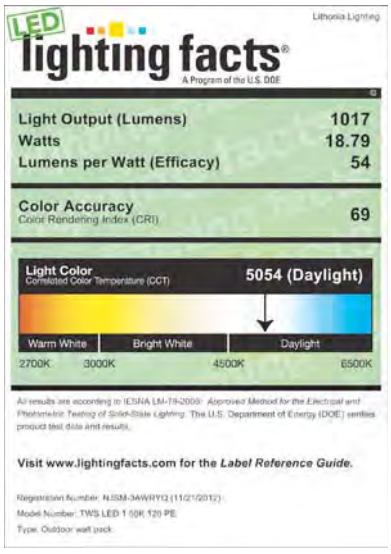
LEGEND

- 0.2 fc
- 0.5 fc
- 1.0 fc
- 2.0 fc



Test No. LTL226725 tested in accordance with IESNA LM-79-08.

Lighting Facts Labels



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Type C Lights Lithonia TWP LED 20C 700 50K T3M 120 PE DDXB

TWP LED
LED Wall Luminaire

Catalog Number

Notes

Type

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

Hit the Tab key or mouse over the page to see all interactive elements.

Introduction

The popular TWP luminaire is now available with LED technology. Cast in a traditional dayform, the TWP LED offers a classic appearance and is powered by advanced LEDs. A one-piece polycarbonate cover delivers enhanced durability and is vandal resistant, making the TWP LED ideal for lower mounting heights or high-traffic areas.

The new TWP LED luminaire is powerful yet energy efficient, capable of replacing up to a 250W metal halide luminaire while saving up to 77% in energy costs. Offering an expected service life of more than 20 years, the TWP LED eliminates frequent lamp and ballast replacements associated with traditional technologies.

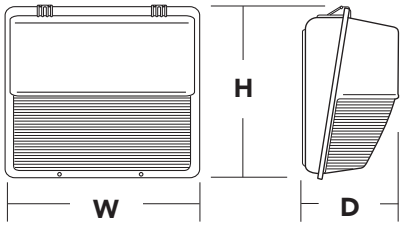
Specifications

Width: 16-1/8" *(41.0 cm)*

Height: 15-1/2" *(39.4 cm)*

Depth: 7-3/4" *(19.7 cm)*

Weight: 15 lbs *(6.8kg)*



Ordering Information

EXAMPLE: TWP LED 30C 700 50K T3M MVOLT DDBXD

TWP LED						
Series	**Performance Package**	**Distribution**	**Voltage**	**Control Options**	**Other Options**	**Finish** *(required)*
TWP LED	**LEDs** 10C 10 LEDs (one engine) 20C 20 LEDs (two engines) 30C 30 LEDs (one engine) **Drive current** 700 700 mA **Color temperature** 40K 4000 K 50K 5000 K	T3M Type III Medium	MVOLT [1] 120 [1] 208 [1] 240 [1] 277 [1] 347 [2] 480 [2]	**Shipped installed** PE Photoelectric cell, button type [3]	**Shipped installed** SF Single fuse (120, 277, 347V) [4] DF Double fuse (208, 240, 480V) [4] TP Tamper proof screws NOM NOM Certified SPD Separate surge protection [5] **Shipped separately** WG Wire guard [6]	DDBXD Dark bronze DBLXD Black DWHXD White DDBTXD Textured dark bronze DBLBXD Textured black DWHGXD Textured white

Stock configurations are offered for shorter lead times:

Standard Part Number	Stock Part Number
TWP LED 10C 700 40K T3M MVOLT DDBXD	TWP LED 10C 40K
TWP LED 20C 700 40K T3M MVOLT DDBXD	TWP LED 20C 40K
TWP LED 30C 700 40K T3M MVOLT DDBXD	TWP LED 30C 40K
TWP LED 10C 700 50K T3M MVOLT DDBXD	TWP LED 10C 50K
TWP LED 20C 700 50K T3M MVOLT DDBXD	TWP LED 20C 50K
TWP LED 30C 700 50K T3M MVOLT DDBXD	TWP LED 30C 50K

Accessories

Ordered and shipped separately.

TWPWG U Wire guard accessory [7]

NOTES
1. MVOLT driver operates on any line voltage from 120-277V (50/60 Hz). Specify 120, 208, 240 or 277 options only when ordering with fusing (SF, DF options) or photocontrol (PE).
2. Not available with 10C option.
3. Must specify voltage; not available with MVOLT or 480 voltage options.
4. Single fuse (SF) requires 120, 277 or 347 voltage option. Double fuse (DF) requires 208, 240 or 480 voltage option.
5. See the electrical section on page 2 for more details.
6. Also available as a separate accessory; see Accessories information at left.
7. Requires field modification (only when ordered as a separate accessory).

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Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts. Contact factory for performance data on any configurations not shown here.

LEDs	Drive Current (mA)	Performance Package	System Watts	Dist. Type	40K (4000 K, 70 CRI)					50K (5000 K, 70 CRI)				
					Lumens	B	U	G	LPW	Lumens	B	U	G	LPW
10C (10 LEDs)	700	10C 700 --K	26W	T3M	2,183	0	3	2	83	2197	0	3	2	84
20C (20 LEDs)	700	20C 700 --K	45W	T3M	4,207	0	3	3	93	4233	0	3	3	94
30C (30 LEDs)	700	30C 700 --K	67W	T3M	5,176	0	3	3	77	5208	0	3	3	77

Lumen Ambient Temperature (LAT) Multipliers

Use these factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F).

Ambient		Lumen Multiplier
0°C	32°F	1.02
10°C	50°F	1.01
20°C	68°F	1.00
25°C	**77°F**	**1.00**
30°C	86°F	1.00
40°C	104°F	0.98

Projected LED Lumen Maintenance

Data references the extrapolated performance projections for the **TWP LED 30C 700** platform in a **25°C ambient**, based on 10,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11).

To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Operating Hours	0	25,000	50,000	100,000
Lumen Maintenance Factor	1.0	0.99	0.99	0.98

Electrical Load

LEDs	Drive Current (mA)	System Watts	Current (A)					
			120V	208V	240V	277V	347V	480V
10C	700	26 W	0.24	0.14	0.12	0.10	-	-
20C	700	45 W	0.42	0.24	0.21	0.18	0.14	0.10
30C	700	67 W	0.62	0.36	0.31	0.27	0.21	0.16

FEATURES & SPECIFICATIONS

INTENDED USE
The energy savings, long life and easy-to-install design of the TWP LED make it the smart choice for building-mounted doorway and pathway illumination for nearly any facility.

CONSTRUCTION
Die-cast aluminum rear housing has an impact-resistant, UV-stabilized polycarbonate front housing and refractor that is fully gasketed. Modular design allows for ease of maintenance. The LED driver is mounted to the front casting to thermally isolate it from the light engine for low operating temperature and long life. Housing is completely sealed against moisture and environmental contaminants.

FINISH
Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 3 mils thickness for a finish that can withstand extreme climate changes without cracking or peeling. Available in textured and non-textured finishes.

OPTICS
Protective polycarbonate lens covers the light engine's precision-molded proprietary acrylic lenses. Light engines are available in 4000K and 5000K configurations.

ELECTRICAL
Light engine(s) consist of 10 or 30 high-efficacy LEDs mounted to a metal-core circuit board and integral aluminum heat sink to maximize heat dissipation and promote long life (L94/100,000 hrs at 25°C). The electronic driver has a power factor of >90%, THD <20%, and a minimum 2.5 KV surge rating. When ordering the SPD option, a separate surge protection device is installed within the luminaire which meets a minimum Category C low operation (per ANSI/IEEE C62.41.2).

INSTALLATION
Top 3/4" threaded wiring access. Back access through removable 3/4" knockout. Feed-thru wiring can be achieved by using a condulet tee. Mount on any flat, vertical surface.

LISTINGS
UL listed for wet locations. Rated for -40°C minimum ambient. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY
Five year limited warranty. Full warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx.

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C. Specifications subject to change without notice.

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Strobe - AST-2-90-130-AC-AM

AST - 2 PENDANT MOUNT STROBE WARNING LIGHT

APPLICATIONS:

- to visually indicate warnings or hazards in high noise level areas where audible signals may not be heard
- to indicate the starting and stopping of operations in a manufacturing environment
- to indicate faulty equipment

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

FEATURES:

- solid state power supply
- low power consumption (12 watts)
- intensity 2,000,000 candlepower (peak)
- Polycarbonate fresnel lens
- cast zinc alloy housing with a grey epoxy finish for superior corrosion resistance
- designed for intermittent visual signaling as well as longer duration signaling applications
- flash rate - 60 flashes/minute
- flash tube life - minimum 10 million flashes at 60 flashes/minute
- 3/4 conduit entry
- weatherproof

9001:2008 ISO Certified Made in Canada

Applied Strobe Technology Company Limited
INDUSTRIAL STROBE WARNING LIGHTS
8345 Stanley Avenue, Niagara Falls, Ontario, Canada L2E 6X8 905-374-3077, Fax 905-374-6114
U.S. Address: 2315 Whirlpool St., Suite #182, Niagara Falls, NY 14305
e-mail: sales@appliedstrobe.com www.appliedstrobe.com

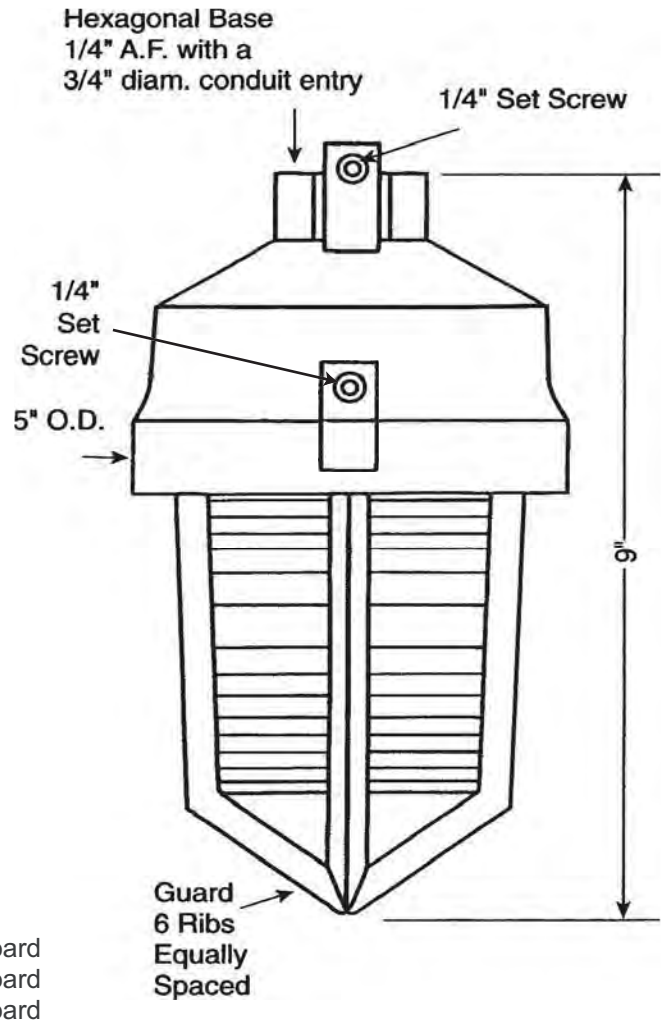
Temperature Range

-40 C to +85 C

Electrical Ratings

Supply Voltage Range	Frequency	Current Range (avg)	Inrush Current (max)
90 to 130 VAC	50/60Hz	.118 A to .090 A	.250 A
220 to 250 VAC	50/60Hz	.072 A to .055 A	.220 A
10 to 30 VDC	-	.8 A to .4 A	1.30 A
50 to 60 VDC	-	.360 A to .300 A	. 820 A
90 to 130VDC	-	.175A to .090 A	. 250 A
220 to 250VDC	-	.070A to .055 A	. 220 A
15 to 30 VDC	-	.8 A to .4 A	1.30 A

Net Weight: 4.5 lbs



Ordering Information

Model No	Input Voltage
AST-2-90-130-AC	90 - 130 VAC
AST-2-220-250-AC	220 - 250 VAC
AST-2-10-30-DC	10 - 30 VDC
AST-2-90-130-DC	90 - 130 VDC
AST-2-220-250-DC	220 - 250 VDC
AST-2-50-60-DC	50 - 60 VDC

Lens Colors

AM - Amber Lens
BL - Blue Lens
RE - Red Lens
GR - Green Lens
CL - Clear Lens

Ordering Example

AST-2-10-30-DC-RE

Replacement Parts

Circuit Board

AST-2 - 90-130-AC -Board	90 - 130	VAC	Circuit Board
AST-2-220-250-AC -Board	220 - 250	VAC	Circuit Board
AST-2 - 10 - 30-DC -Board	10 - 30	VDC	Circuit Board
AST-2 - 90-130-DC -Board	90 - 130	VDC	Circuit Board
AST-2-220-250-DC -Board	220 - 250	VDC	Circuit Board
AST-2 - 50 - 60-DC -Board	50 - 60	VDC	Circuit Board

Flash Tube

AST-FT 3050 Flash Tube

Lenses

AST-2-Lens-RE	Red Lens
AST-2-Lens-AM	Amber Lens
AST-2-Lens-BL	Blue Lens
AST-2-Lens-GR	Green Lens
AST-2-Lens-CL	Clear Lens

Fire Beacon Werma Signaltechnik 22410075

LED-Dauerleuchte

LED Perm. Beacon

22X #00 XX

(vorläufiges techn. Datenblatt)
(provisional technical data sheet)

WERMA Signaltechnik
GmbH + Co. KG
Dürbheimer Straße 15
78604 Rietheim-Weilheim
Phone +49(0)7424 9557-0
Fax +49(0)7424 9557-44
info@werma.com

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Elektrische Daten:
electrical specification

Einschaltstrom: *starting current*	max. 0,5A (24V)
Stromaufnahme: *current consumption*	Ieff ≤ siehe Liste *Ieff ≤ see list*
Tonart: *tone type*	Dauerton *continuous tone*
Einschaltdauer: *duty cycle*	100 % ED *100 %*
Lebensdauer: *life duration*	max. 100.000 h

Bestell-Nr.:
order no.:

221 #00 75	*24V*	*AC/DC*	*45 mA*	*BM*	*133g*
221 #00 67	*115V*	*AC*	*25 mA*	*BM*	*106g*
221 #00 68	*230V*	*AC*	*25 mA*	*BM*	*107g*
224 #00 75	*24V*	*AC/DC*	*45 mA*	*WM*	*144g*
224 #00 67	*115V*	*AC*	*25 mA*	*WM*	*142g*
224 #00 68	*230V*	*AC*	*25 mA*	*WM*	*142g*

\# 1 = rot 2 = grün 3 = gelb 4 = klar 5 = blau
\# *1 = red 2 = green 3 =yellow 4 = clear 5 = blue*

Mechanische Daten:
mechanical specification

Material Kalotte: *dome material*	PC
Material Adapte: *Adapter material*	PC/ABS-blend, schwarz *PC/ABS-blend, black*
Material Sockel: *material base*	PA GF, schwarz *PA GF, black*
Einbaulage: *installation position*	BM beliebig WM Kalotte nach oben *BM as required* *WM dome facing upwards*
Befestigung fixing	BM=Bodenmontage / WM=Winkelmontage *BM=Base mounting / WM=Bracket mounting*
Dichtung seal	BM vorhanden *BM existing*
Anschluss: *connection*	CAGE CLAMP Technik bis 2,5 mm² eindrähtig *CAGE CLAMP technology up to 2.5 mm² single wire*
Kabeleinführung: *cable entry*	BM: Durchgangsloch, Kabeldurchmesser max. 10mm WM: Kabelverschraubung M12x1,5; Kabeldurchmesser 3 - 6 mm *BM: Through-hole, cable diameter max. 10mm* *WM: cable gland M12x1,5; cable diameter 3 - 6 mm*
Zugentlastung: *stain relief*	Vorhanden bei WM *Existing at WM*
Gewicht ca.: *weight approx.*	Siehe Liste *See list*
Temperatur: *temperature*	-20° ... +50 °C
Schutzart: *protection rating*	IP65 in montiertem Zustand *IP65 when mounted*

Vorschriften: *regulations*
Die zutreffenden EG-Richtlinien werden erfüllt / UL-Listung vorhanden
conforms to current EU regulations / UL listed

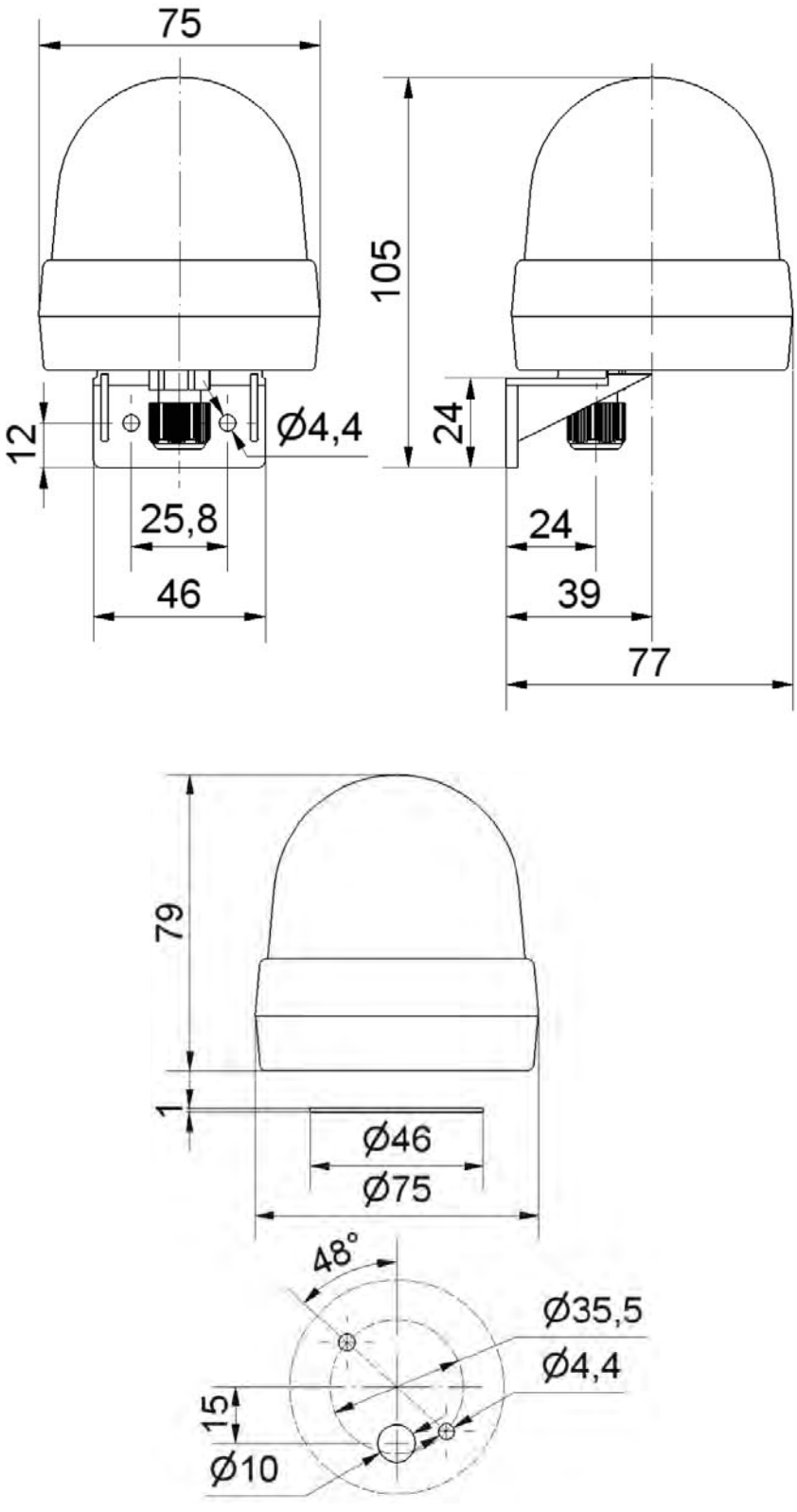
SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

Hinweis: Alle Angaben beziehen sich auf U_{nenn} und Raumtemperatur!
Note: All electrical and life duration specifications refer to U_{nenn} and room temperature!

	Angelegt *created*	**Bearbeitet** *edited*	**Geprüft** *checked*	**Freigegeben** *approved*	**Datenblatt-Nr.** *data sheet no.*
Name *name*	Matwe	JBE	TS	Hö	**312.221.001-01**
Datum *date*	11.09.02	26.03.13	28.03.13	28.03.13	**Seite 1 - 2** *page 1 - 2*

Fire Beacon Werma Signaltechnik 22410075

Ausdruck ist nur zur Information und wird bei Änderung nicht berücksichtigt. *This printed copy is for information only and is subject to alternation.*



CARPW

Project: | Contractor:

Exit Signs - Aimlight CARPW0636 1 M-2SM4LJ WHT/ATD

COMBO ALUMINUM

NBC2010 Compliant
LED 120/347VAC Input

Approvals:
CSA Certified to C22.2 #141 and C860

DESCRIPTION

The CARPW series of commercial combination extruded signs and battery units features a fully modern appearance. The extruded aluminum design provides for a rigid, durable and lightweight sign. Two PAR18 small style, front mounted heads are standard, PAR36 large style or MR16 type are optional. Available with either 6VDC or 12VDC.

CIRCUITRY

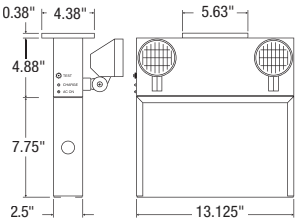
- LED ultra bright light source
- 120/347VAC Input, field selectable
- 1.9 Watt power consumption for LED exit portion of combination sign
- LED Emergency DC wattages as follows:
  6VDC = 0.9W **12VDC** = 0.9W
- Wattage capacities from 36 to 72 watts
- 30 minutes emergency power duration standard
- Momentary push button test switch
- Pilot LEDs for AC ON and CHARGE
- Fully automatic, constant voltage current limited charger
- Solid state design and construction with brownout and short circuit protection
- Temperature compensated
- Maintenance free, sealed lead acid battery

Comes standard with three pictogram legends for direction selection.

MECHANICAL

- Extruded aluminum construction
- Slide in/out captive faceplate(s) and backplate for rapid and simplified installation
- Universal spider knockout pattern stamped into backplate for junction box mounting
- Universal models include ceiling or end mount, field installable canopy kit c/w spider plate
- Multiple conduit entry knockouts
- White powder coat finish standard, other finishes and colors optional
- Front head mounted is standard, side mount is optional

DIMENSIONS



SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

ORDERING GUIDE

M — /

Series	Nbr of faces	Mounting	Head/Lamp		Color	Options†
CARPW0636 **CARPW0650** **CARPW1236** **CARPW1250** **CARPW1272** (See model ratings table below)	**U** - Universal faces **1** - Single face **2** - Double face	**M** - Universal	**0** - No heads **1SM** - One PAR18 **2SM** - Two PAR18 **1LG** - One PAR36 **2LG** - Two PAR36	**1MD** - One MR16 **2MD** - Two MR16 **1MB** - One MR16 **2MB** - Two MR16 (See lamp list below)	**WHT** - White (standard) **BLK** - Black **GRY** - Grey **CUS** - Custom color (specify)	**VDR, WRG*, LXG, SPW, BKO, BNO, ATD, LPD, BTD, TDL**** **0** - No indicators (double face only) D U UR DR DL UL **Note:** Indicators option available for single & double option only.

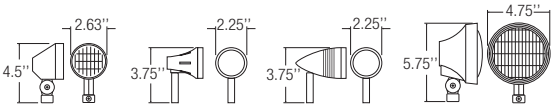
† For detailed options descriptions, please consult the options page. * Specify mounting. ** Specify AC voltage.

LAMP SELECTION

	6 Volts	12 Volts
PAR18 - Small head		
LED	3LJ, 4LJ	3LJ, 4LJ
Quartz halogen	08Q, 10Q, 12Q	08Q, 10Q, 12Q
Tungsten	09T	09T, 12T, 18T
MR16 - Small head c/w MR16 Lamp		
LED	4LR	4LR, 6LA, 7LA
Quartz halogen	08Q, 10Q, 12Q	08Q, 10Q, 12Q, 20Q
PAR36 - Large head		
Quartz halogen	08Q, 10Q, 12Q, 20Q	08Q, 10Q, 12Q, 20Q, 35Q
Tungsten	09T, 18T, 25T	09T, 18T, 25T
Quartz sealed beam	08SBQ, 10SBQ, 12SBQ, 20SBQ	08SBQ, 12SBQ, 20SBQ, 35SBQ, 55SBQ
Tungsten sealed beam	09SBT, 18SBT	N/A

MODEL RATINGS

		Wattage capacities			
Model	Voltage	30 min.	60 min.	90 min.	120 min.
CARPW0636	6V	36	18	12	9
CARPW0650	6V	50	25	16	12
CARPW1236	12V	36	18	12	9
CARPW1250	12V	50	25	16	12
CARPW1272	12V	72	36	24	18



Type SM - PAR18
Thermoplastic
18W max.

Type MD - MR16
Die cast
35W max.

Type MB - MR16
Die cast
35W max.

Type LG - PAR36
Thermoplastic
18W max.

Chapter 31 FIRE ALARM

MANUFACTURER/DISTRIBUTOR:

CDE
298, Rue De Martigny Ouest
Saint-Jérôme (Québec)
J7Y 4C9
Phone.: (450) 438-1263
Fax: (450) 438-3728
Courriel : cde@cde.qc.ca

31.1 **CHUBB EDWARDS 283B-PL**

31.2 **CHUBB EDWARDS 284B-PL**

Rate-of-rise/Fixed Temperature Heat Detectors

280B-PL Series

Overview

280B-PL Series heat detectors offer fixed temperature or combination rate-of-rise and fixed temperature detection.

RATE-OF-RISE: A temperature increase at the sensor of 15°F (9°C) or more per minute activates the rate-of-rise feature. This closes the contacts in the sensor to transmit the alarm condition to the fire alarm control panel. When the rate-of-rise element alone has been activated, the sensor is self-restoring.

FIXED TEMPERATURE: If the temperature of the center disk rises to the sensor's rated temperature, the fixed temperature element activates. This closes contacts in the sensor and transmits an alarm condition to the fire alarm control panel. The fixed temperature element is non-restorable and, when activated, the detector must be replaced. The need for replacement is indicated when the center disk has fallen free from the detector .

Standard Features

- UL listed for 50 ft. (15.2m) spacing
- Single pole — normally open contact
- Low profile with mounting plate
- Pure white finish
- Mounting flexibility with screw terminals
- Easy twist-on installation
- On-site testing of rate-of-rise feature
- Positive operating indication — for fixed temperature element

Application

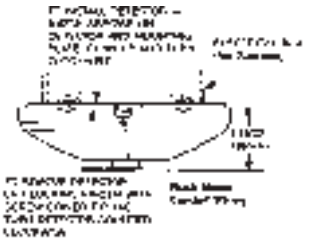
Heat detectors are most suitable for environments where rapid fire development can be expected. When selecting the location on the ceiling for the heat sensor, do not locate it in direct path of hot or cold air flow. Refer to the detector specifications for the recommended maximum spacing. Earlier detector response may be obtained by reducing the spacing between detectors.

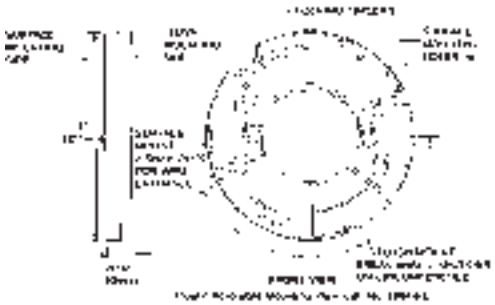
Installation

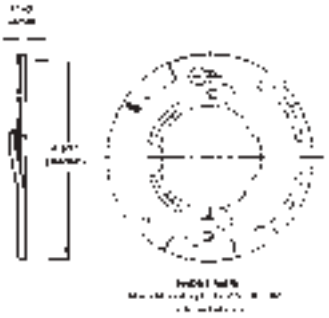
Edwards 280B series heat sensors come standard with a white plastic reversible mounting plate. The plate is designed for surface or flush mounting and installs directly to a standard North American 3½ or 4 inch octagon box. Once the mounting plate is fixed, a simple twist will lock the sensor in place. It can be removed using a screwdriver to release the tamper-resistant locking finger. This helps prevent unauthorized removal.

Mounting

The plastic mounting plate is molded to accommodate exposed wiring.







Specifications

Catalog Number	281B-PL	282B-PL	283B-PL	284B-PL
UL Temperature Rating	135°F (57°C)	194°F (90°C)	135°F (57°C)	194°F (90°C)
UL Max Ambient Temp. at Ceiling	100°F (38°C)	150°F (66°C)	100°F (38°C)	150°F (66°C)
Detector Type	Fixed Temperature and Rate-of-Rise Rate-of-rise: 15° F (9° C), self restoring		Fixed Temperature Only	
UL Recommended Coverage*	2,500 ft.² (232 m²)			
UL Recommended Spacing	50 ft. (15.2 m)			
FM Recommended Spacing	30 ft. (9.14 m)			
UL Maximum Distance from Wall	25 ft. (7.6m) from any wall or projection extending down from the ceiling more than 12 inches (305 mm)			
Contacts – Rating	Single Pole Normally Open 3.0 amps at 6 to 125 Vac; 1.0 amp at 6 to 24 Vdc; 0.3 amps at 125 Vdc; 0.1 amps at 250 Vdc			
Operating Environment	Indoor – Dry			
Agency Listings	UL, FM, CSFM			

* Maximum detector coverage has been determined by UL to provide detection time equal to sprinkler devices spaced at 10 ft (3.05m) intervals on a smooth ceiling 15 feet 9 inches (4.8m) high. Higher ceilings may adversely affect detection time. Earlier detection may be obtained by reducing the spacing between sensors. (See NFPA 72, Chapter 5)

Ordering Information

Cat. No.	Description	Ship Wt. lb (kg)
281B-PL	Heat Detector, 135°F (57°C), Rate-of-Rise and Fixed Temperature	1.0 (0.5)
282B-PL	Heat Detector, 194°F (90°C), Rate-of-Rise and Fixed Temperature	
283B-PL	Heat Detector, 135°F (57°C), Fixed Temperature	
284B-PL	Heat Detector, 194°F (90°C), Fixed Temperature	

Detector Accessories	
280A-PL	Plastic Mounting Plate – White, Reversible (included)

Contact us...

Phone: 1-800-336-4206
Web: *www.edwardssignaling.com*

Edwards Signaling is an **EDWARDS** brand.

3 Farm Glen Boulevard
Farmington, CT 06032

In Canada, contact Chubb Edwards...
Email: inquiries@chubbedwards.com
Web: *www.chubbedwards.com*

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WARNING – Use For Property Protection Only: Heat sensors do not protect life against fire and smoke. In most fires, hazardous levels of smoke, heat and toxic gases can build up before a heat detector would initiate an alarm. Independent studies indicate that heat detectors should only be used when property protection alone is involved. In cases where life safety is a factor, the use of smoke detectors is recommended.

Under no circumstances should heat detectors be relied upon as the sole measure to ensure fire safety. However, if they are spaced in accordance with the directions in the Specifications table, these sensors can contribute, within an overall fire safety program, to reducing the risk of avoidable property losses.

Chapter 32 THERMOSTAT

MANUFACTURER/DISTRIBUTOR:

S.C.I. Montréal Inc.
3311, boul. Industriel
Laval Qc H7L 4S3
T : 450-668-8866
T : 514-990-8866
1-800-667-8866
info@scimtl.ca

32.1 **HONEYWELL T775M2048 TEMPERATURE CONTROLER**

32.2 **HONEYWELL T631A1162 THERMOSTAT RED SQUARE**

32.3 **HONEYWELL T87K1015 THERMOSTAT ROUND**

Honeywell

T775A/B/M Series 2000 Electronic Stand-Alone Controllers

INSTALLATION INSTRUCTIONS

PRODUCT DESCRIPTION

The T775 electronic stand-alone controllers are the next generation of commercial and agricultural controls capable of remote sensing of temperature and providing switched and/or proportional outputs to various types of loads.

Five models have analog (modulating) outputs for actuator and motor control, and NEMA-4 weatherproof enclosures are available for wet environments.

IMPORTANT

Each T775A/B/M controller is an operating control, not a limit or safety control. If used in applications requiring safety or limit controls, a separate safety or limit control device is required.

Table 1. T775A/B/M Controller Configurations.

Controller Model[a]	Description	Replaces	SPDT Relay Outputs	Analog (Mod) Outputs[b]	Floating Outputs[c]	Sensor Inputs	Nbr of Sensors Included	Enclosure
T775A2009	Standard	T775A1001	1	None	None	1	1	NEMA 1
T775B2016	Standard	N/A	2	None	1	2	1	NEMA 4X
T775B2024	Standard	T775C1009 T775D1008	4	None	2	2	1	NEMA 4X
T775B2032	Standard	T775A1019 T775B1000	2	None	1	2	1	NEMA 1
T775B2040	Standard	T775A1027 T775A1035 T775B1018 T775B1026 T775B1042	4	None	2	2	1	NEMA 1
T775M2006	Modulating	N/A	None	2	N/A	2	1	NEMA 1
T775M2014	Modulating	T775G1005 T775G1013 T775G1021 T775G1039	4	2	N/A	2[d]	1	NEMA 4X
T775M2022	Modulating	N/A	2	2	N/A	2[d]	1	NEMA 4X
T775M2030	Modulating	T775E1114 T775F1022 T775F1055 T775F1089	4	2	N/A	2[d]	1	NEMA 1
T775M2048	Modulating	T775E1015 T775E1023 T775E1056 T775E1064 T775E1098	2	2	N/A	2[d]	1	NEMA 1

[a] All models include a digital input for use with the disable or setback option.

[b] The modulating (analog) outputs are 4-20 mA, 0-10 Vdc, 2-10 Vdc, or Series 90 selectable.

[c] Each floating output eliminates two SPDT relays.

[d] These models can support a high/low modulating limit at Sensor B for temperature control at Sensor A.

62-0254-13

Temperature Sensors[a]

The controller accepts 1,097 Ohms PTC at 77°F (25°C):

- 50021579-001 – Standard sensor (included with all models except NEMA 4X models)
- T775-SENS-STRAP– Strap on sensor with wiring box
- T775-SENS-WR – Water resistant with 5 foot leads (included with NEMA 4X models)
- T775-SENS-WT – Watertight with 6 foot lead
- T775-SENS-OAT – Outdoor air temperature sensor
- C7031B2005 – 6 inch duct mount with wiring box
- C7031D2003 – 5 inch immersion sensor with wiring box (use immersion well; P/N 50001774-001)
- C7031J2009 – 12 foot duct averaging sensor with wiring box
- C7046D1008 – 8 inch duct probe with mounting flange
- C7100D1001 – 12 inch fast response, duct averaging sensor with flange
- C7130B1009 – Room mount sensor

[a] See form 62-0265 - *Temperature Sensors for the T775 Series 2000 Stand-alone Controller*

Accessories

- 107324A – Bulb Holder, duct insertion
- 107408 – Heat Conductive Compound, 4 ounce
- 50001774-001 – Immersion Well, stainless steel 304, 1/2 in. threading.

Product Changes

Below are the changes to T775A/B/M models starting with Series 3 (March 2009). Series 3 can be identified by the sideways 3 after the part number on the device label.

1. Modulating high and low limit now both function in either the heat or the cool mode.
2. MIN ON added.
3. SYNC added.
4. Differential and throttling range increased to 300°F.
5. Setpoint and Enable options added to the DI options.
6. HIDE option added to MOD1 and MOD2 (to hide them on the home screen).

Controller Dimensions

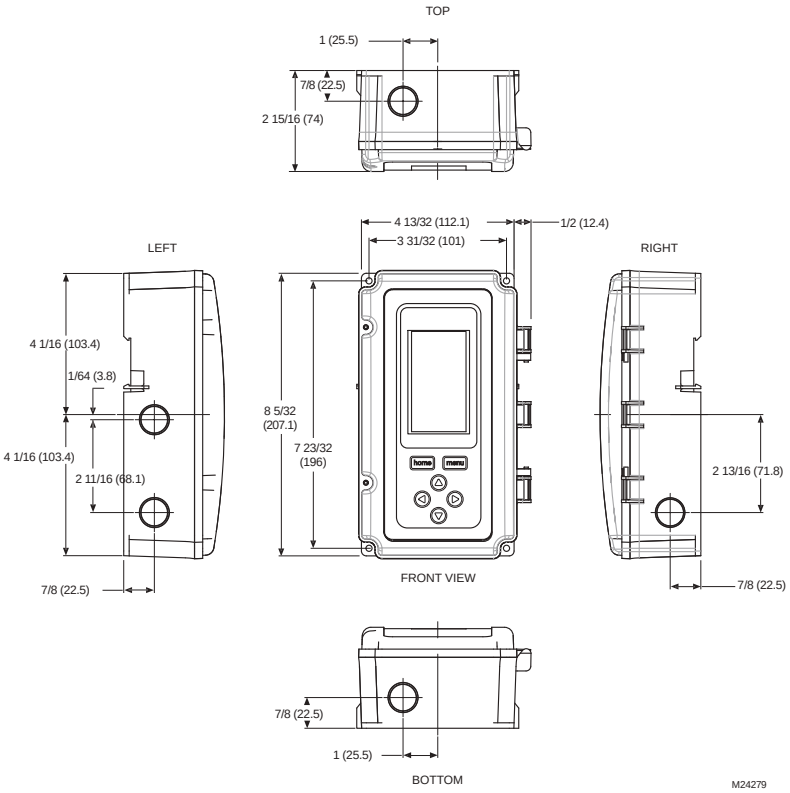

Fig. 1. T775A/B/M Dimensions in inches (mm).

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BEFORE INSTALLATION

Review the “SPECIFICATIONS” on page 35 before installing the controller.

When Installing This Product

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check ratings given in instructions and on the product to ensure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

INSTALLATION AND SETUP

The following installation procedures are typically performed in the order listed:

1. Mounting — See “MOUNTING” below.
2. Wiring — See “WIRING” on this page.
3. Checkout — See page 11.
4. Programming — See page 14.
5. Scheduling (optional) — See page 30.

Additional topics are:
- Temperature sensor calibration begins on page 11.
- Interface overview begins on page 12.
- Setup (for advanced options) begins on page 17.
- Summary menu begins on page 34.
- Troubleshooting begins on page 34.

MOUNTING

This section describes the mounting procedures for the controller and temperature sensor(s).

Controller Mounting

IMPORTANT

Avoid mounting in areas where acid fumes or other deteriorating vapors can attack the metal parts of the controller circuit board, or in areas where escaping gas or other explosive vapors are present.

IMPORTANT

The controller must be mounted in a position that allows clearance for wiring, servicing, and removal.

Use a screwdriver to pry out only the knockouts that you will use.

If mounting on DIN rail, be sure to remove the knockouts before mounting. See “Controller Wiring” on page 5 and Fig. 7 on page 6 for recommended knockout usage and locations. If you do not use an opened knockout be sure to cover it.

Mount the controller on any convenient interior location using the four mounting holes provided on the back of the enclosure using #6 or #8 screws (screws are not provided and must be obtained separately). Use controller dimensions in Fig. 1 on page 2 as a guide.

The controller may be mounted in any orientation. However, mounting in the orientation shown in Fig. 1 on page 2 permits proper viewing of the LCD display and use of the keypad.

NEMA 4 Enclosure Mounting

For models with NEMA 4 enclosures, ensure that waterproof wire/conduit fittings are used at the knockouts for all wiring attachments. Refer to Fig. 7 on page 6 for knockout locations.

IMPORTANT

For NEMA 4 enclosures, be sure to cover and seal all unused open knockouts.

Temperature Sensor(s) Mounting and Location

Temperature sensors may be located up to 1,000 feet (304 m) from the T775A/B/M controller. Refer to Table 3 on page 11 for calibration guidelines.

The sensors may be mounted on a wall or panel for sensing space temperature, strapped to a pipe or inserted in an immersion well (see Fig. 2) for hot or cold water sensing, or taped to a standard cap or bulb holder for duct air sensing. To prevent moisture or condensation entering the sensor through the lead wire holes, mount the sensor with the lead wires exiting the bottom of the sensor.

NOTES:
1. The included sensor is not designed for very wet applications. For immersion applications, an immersion well is used.
2. Heat conductive compound must be used in immersion wells.
3. Refer to the list of temperature sensors on page 2 for this type of installation

.

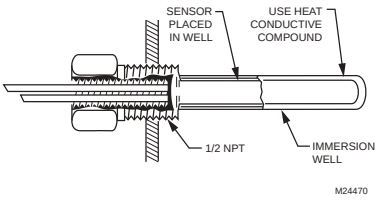

Fig. 2. Sensor Inserted in Immersion Well.

NOTE: Multiple sensors may be parallel-series wired to sense average temperatures in large spaces. Refer to Fig. 3 on page 4.

WIRING

All wiring must comply with applicable electrical codes and ordinances, or as specified on installation wiring diagrams. Controller wiring is terminated to the screw terminal blocks located inside the device.

The remainder of this section describes the temperature sensor wiring and the T775A/B/M controller wiring.

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Wiring Connections Access

To access the wiring connections, remove the two screws on the left side of the enclosure and gently swing open the top. Be careful to not stress the ribbon cables that connect the keypad and LCD display to the controller circuit board.

Temperature Sensor Wiring

CAUTION

Electrical Shock Hazard.
Can short equipment circuitry.
Make sure that metal tube of sensor does not short against T terminals in wall-mounted case.

IMPORTANT

Poor wiring practices can cause erratic readings from the sensor. Avoid the following to ensure proper operation:

- *Do not route the temperature sensor wiring with building power wiring.*
- *Do not locate the temperature sensor wiring next to control contactors.*
- *Do not locate the temperature sensor wiring near electrical motors.*
- *Do not locate the temperature sensor wiring near welding equipment.*
- *Make sure good mechanical connections are made to both the sensor and the controller.*
- *Do not mount the sensor with the lead wire end pointing up in an area where condensation can occur.*

If any of the above conditions cannot be avoided, use shielded cable.

NOTE: Each T775 controller must be wired to its own sensor(s). However, a benefit of the T775 controller's accuracy is that there is no more than a 2° F (-7° C) differential between any two T775 controllers.

Multiple Parallel Sensors

Multiple sensors can be parallel-series wired to sense average temperatures in large spaces. To maintain control accuracy, the number of sensors to be parallel-series wired must be of the n^2 power (for example, 4, 9, 16, etc.). Refer to Fig. 3

.

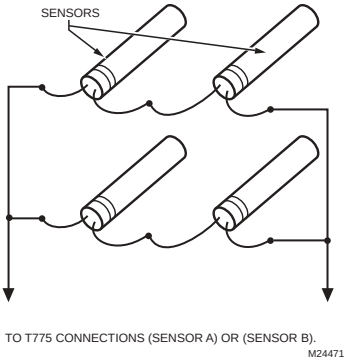

Fig. 3. Parallel-Series Wiring of Sensors.

Temperature Sensor Wire Type and Size

Temperature sensors use standard AWG 18/2 unshielded wire. For cable runs greater than 25 feet or where electrical interference may be a problem, shielded cable is recommended (See Fig. 4).

Refer to "Temperature Sensor Calibration" on page 11 for wire size selection where cable runs are longer than 25 feet.

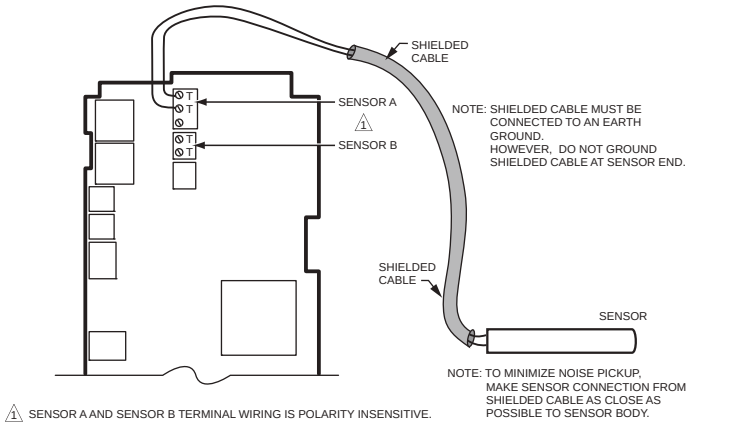

Fig. 4. Sensor Wiring — Showing Shielded Cable Connection to Sensor A.

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Controller Wiring

WARNING

Electrical Shock Hazard.
Can cause severe injury, death or property damage.
Disconnect power supply before beginning wiring, or making wiring connections, to prevent electrical shock or equipment damage.

CAUTION

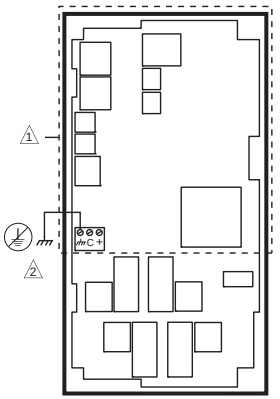
Do not use 24 Vac power to power any external loads if 120 Vac or 240 Vac is used to power the T775A/B/M controller.

CAUTION

A separate earth ground is required.
Equipment damage can result if the earth ground is not connected. See Fig. 5 and Table 2 on page 6.

CAUTION

Equipment Damage Hazard.
Electrostatic discharge can short equipment circuitry.
Ensure that you are properly grounded before handling the unit



1 NO HIGH VOLTAGE. CLASS 2 WIRING ONLY.

2 EARTH GROUND TERMINAL MUST BE CONNECTED TO CONDUIT CLAMP LOCALLY.

M24296

Fig. 5. Earth Ground.

IMPORTANT

Poor wiring practices can cause erratic readings from the sensor. To ensure proper operation, ensure that good mechanical connections are made to both the sensor and the controller.

IMPORTANT

When wiring the input power, only one source of power can be applied to the T775A/B/M controller (24 Vac or 120 Vac or 240 Vac).

See Fig. 7 on page 6 for locating the appropriate power input, remote sensors input, low voltage, contact closure, and load output terminals.

Access to the terminals can be gained through standard conduit knockouts (A through E in Fig. 7 on page 6) located around the perimeter of the enclosure:

- Knockouts A and B should be used only for sensor and low-voltage wiring.
- Knockouts C, D, and E can be used to gain access to the load relay output terminals and 120/240 Vac power wiring.

Controller Wiring Method

Wire the sensors and outputs, then wire the power connection.

Each terminal can accommodate the following gauges of wire:

- Single wire – from 14 AWG to 22 AWG solid or stranded
- Multiple wires – up to two 22 AWG stranded

For 24, 120, or 240 Vac power connections:

- Single wire – from 14 to 18 AWG solid or stranded

Prepare wiring for the terminal blocks, as follows:

1. Strip 1/2 in. (13 mm) insulation from the conductor.
2. Cut a single wire to 3/16 in. (5 mm). Insert the wire in the required terminal location and tighten the screw.
3. If two or more wires are being inserted into one terminal location, twist the wires together a minimum of three turns before inserting them to ensure proper electrical contact.
4. Cut the twisted end of the wires to 3/16 in. (5 mm) before inserting them into the terminal and tightening the screw.
5. Pull on each wire in all terminals to check for good mechanical connection

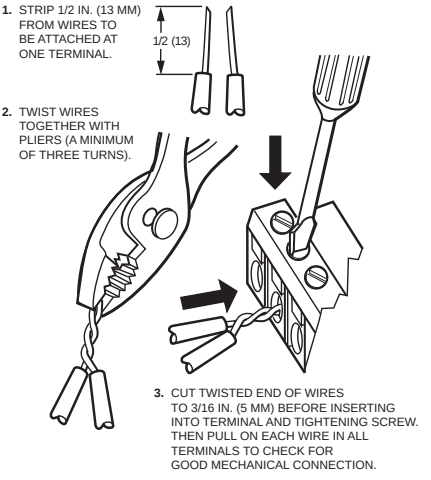


Fig. 6. Attaching Two or More Wires at Terminal Blocks.

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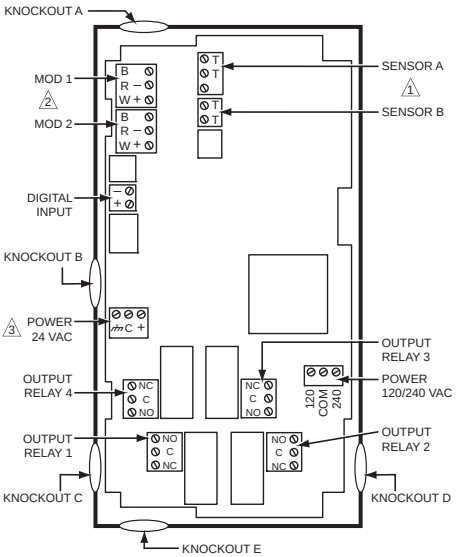
Controller Wiring Details

The wiring connection terminals are shown in Fig. 7 and are described in Table 2.

See Fig. 8 – 22 beginning on page 6 for typical T775A/B/M wiring applications.



1 SENSORS A AND B USE THE TWO TT CONNECTIONS AND ARE POLARITY INSENSITIVE.

2 FOR MOD 1 AND MOD 2 CURRENT (mA) OR VOLTAGE (VDC) OUTPUT, USE SIGNAL (+) & COMMON (-).
FOR MOD 1 AND MOD 2 SERIES 90 OUTPUT, USE W, R, & B.

3 A SEPARATE EARTH GROUND IS REQUIRED FOR ANY POWER SOURCE (24, 120, OR 240 VAC).

M24474

Fig. 7. T775A/B/M Terminal and Feature Locations.

NOTE: Refer to Table 1 on page 1 for the specific configuration of sensors and outputs supported by the model you are installing.

NOTE: For NEMA 4 enclosures, use waterproof fittings for wiring/conduit connections at knockouts.

Table 2. Description of Wiring Terminal Connections.

Connection	Terminal Label	Description
Sensors		
Sensor A	T T	Temperature Sensor; polarity insensitive
Sensor B		
Outputs		
Relay 1 Relay 2 Relay 3 Relay 4	NO COM NC	120-240 Vac Relay Output
Mod 1	+ - (Vdc or mA)	Modulating Output
Mod 2	W R B (Series 90)[a]	

Table 2. Description of Wiring Terminal Connections. (Continued)

Connection	Terminal Label	Description
Input		
DI	+ -	Digital Input (dry contact)
24 Vac Power		
24V +	+	24 Vac Hot
Common	C	24 Vac Common
Ground	⏚	Earth Ground[b]
120 or 240 Vac Power		
120 Vac	120	120 Vac Power
Common	COM	Common
240 Vac	240	240 Vac Power

[a] For Series 90 connections, you must insert a 340 Ohm resistor across terminals R and W. Refer to Fig. 19 on page 9. The resistor is included with the controller.

[b] A separate earth ground is required for all installations regardless of the power source (24, 120, or 240 Vac). Refer to Fig. 5 on page 5.

WIRING APPLICATIONS (EXAMPLES)

Fig. 8 – 22 illustrate typical controller wiring for various applications.

NOTE: The electronic Series 90 output provided with modulating T775 models can not drive electro-mechanical slidewire devices like older Series 3 modulating meters (prior to Series 6), V9055s, and S984s.

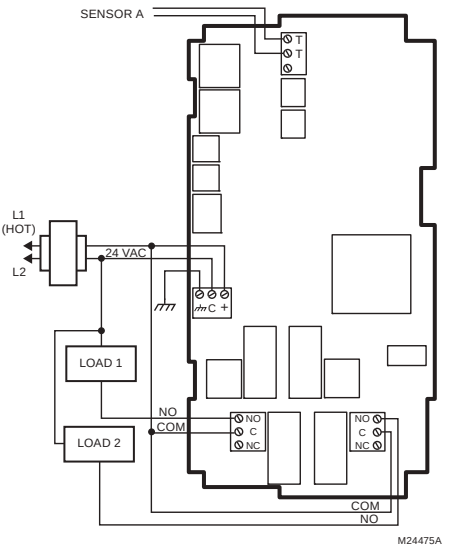


Fig. 8. Wiring for Two-Stage Control – 24 Vac Input and 24 Vac Load.

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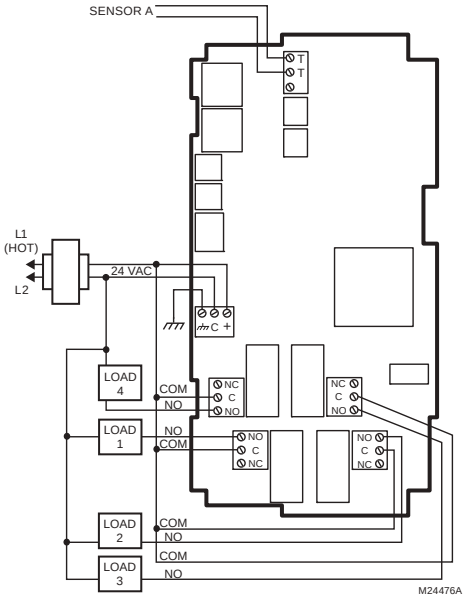

Fig. 9. Wiring for Four-Stage Control – 24 Vac Input and 24 Vac Load.

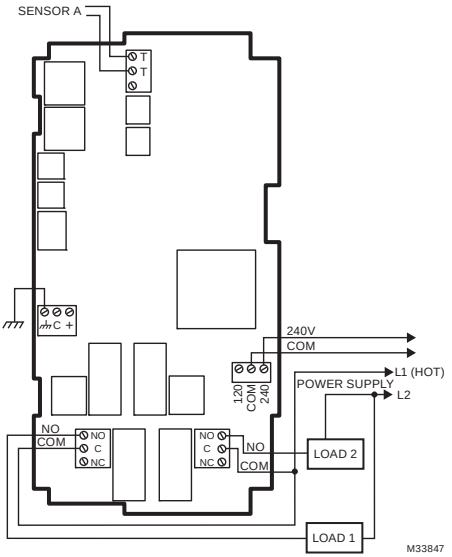

Fig. 11. Wiring for Two-Stage Control with 240 Vac.

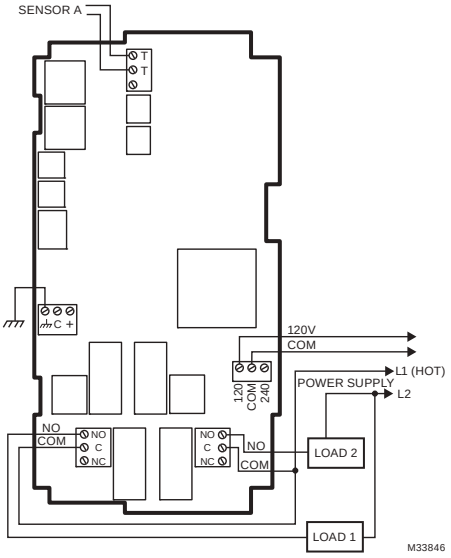

Fig. 10. Wiring for Two-Stage Control with 120 Vac (120 Vac Input and 120 Vac Load Shown).

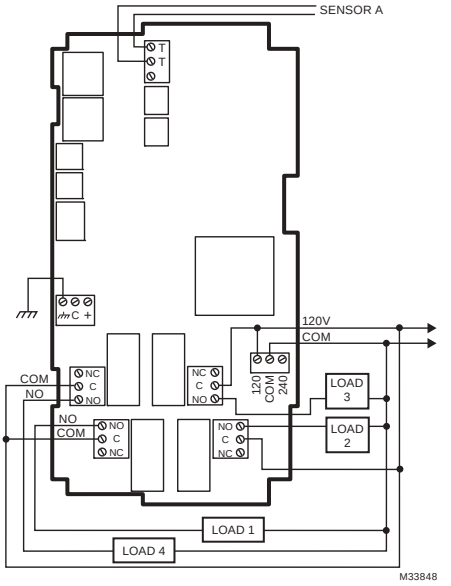

Fig. 12. Wiring for Four-Stage Control with 120 Vac (120 Vac Input and 120 Vac Load Shown).

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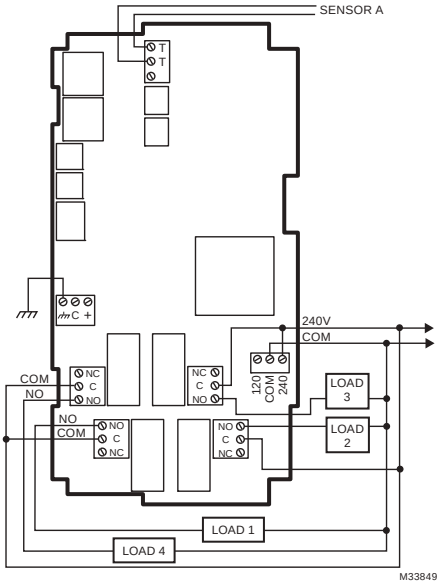

Fig. 13. Wiring for Four-Stage Control with 240 Vac.

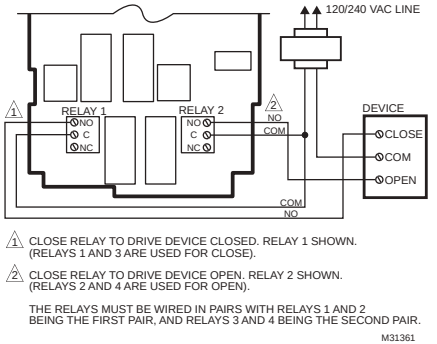

Fig. 14. Wiring for Floating Output (Relay 1 and Relay 2 Pair Shown)

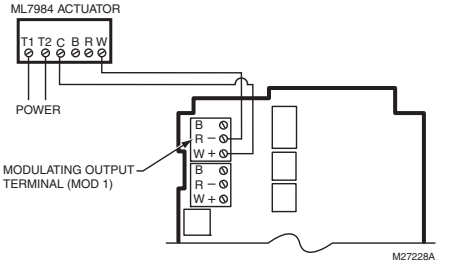

Fig. 15. Wiring for ML7984 Valve Actuator (Using 4 to 20 mA Signal)

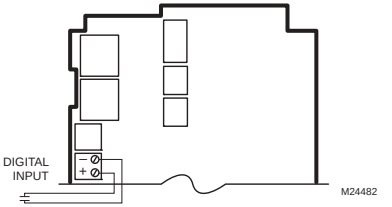

Fig. 16. Wiring for Digital Input (Dry Contact).

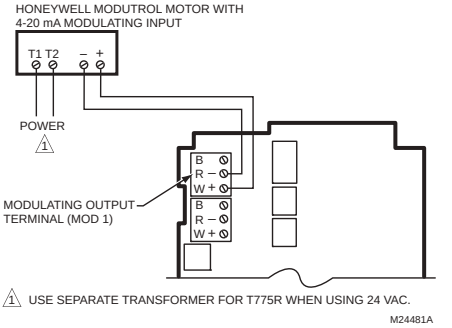

Fig. 17. Wiring for Mod Motor or Direct Coupled Actuator with 4 to 20 mA Control Input

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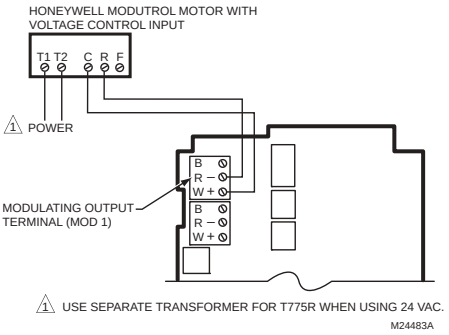

Fig. 18. Wiring for Mod Motor or Direct Coupled Actuator with 0 to 10 Vdc Control Input

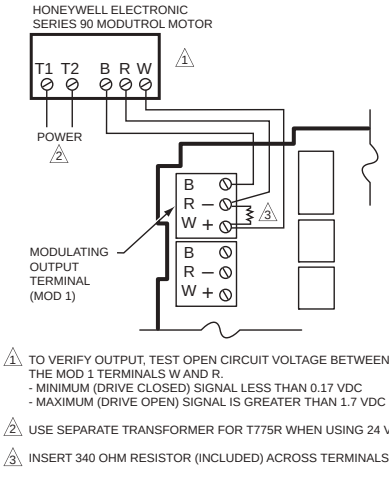

Fig. 19. Wiring for Series 90 Modutrol Motor Control

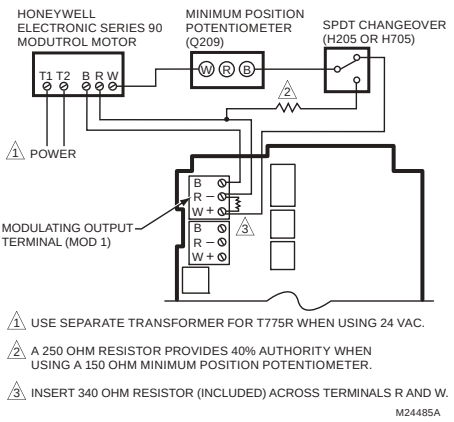

Fig. 20. Wiring for Changeover Relay and Minimum Position Potentiometer Used with Series 90 Modutrol Motors.

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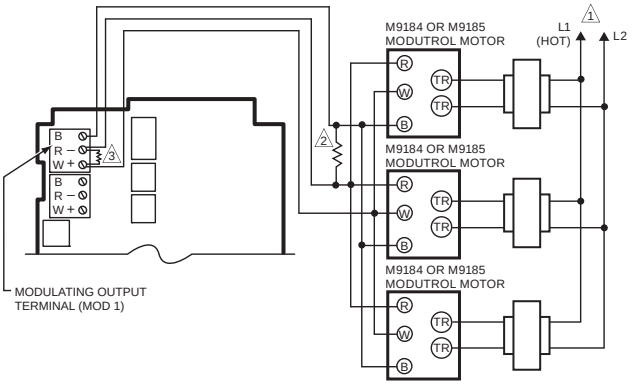
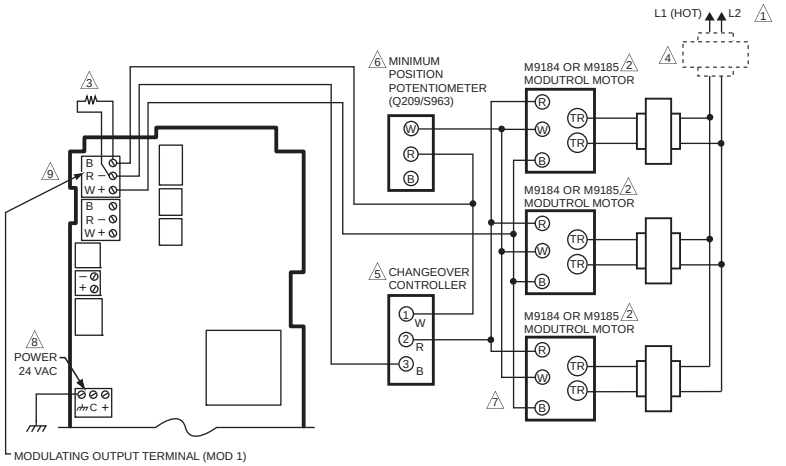


1. POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.
2. USE A 1300 OHM RESISTOR FOR TWO MOTORS, 910 OHM RESISTOR FOR THREE MOTORS. THE 407EAU RESISTOR KIT, WHICH IS SHIPPED WITH THE M9184 AND M9185 MOTORS, INCLUDES BOTH RESISTORS.
3. INSERT 340 OHM RESISTOR (INCLUDED) ACROSS TERMINALS R AND W.

M24486

Fig. 21. Wiring for Three Series 90 Modutrol Motors

.



1. POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.
2. UP TO SIX SIMILAR MOTORS CAN BE CONNECTED IN UNISON.
3. USE RESISTOR BETWEEN R AND B ON THE MOD 1 TERMINAL: 1300 OHMS FOR TWO MOTORS; 910 OHMS FOR THREE MOTORS (4074EAU KIT).
4. IF COMMON TRANSFORMER IS USED, ALL MOTORS MUST BE IN PHASE. CONNECT THE SAME TRANSFORMER LEAD TO T1 ON EACH MOTOR, CONNECT THE OTHER TRANSFORMER LEAD TO T2 ON EACH MOTOR.
5. USE TEMPERATURE CONTROLLER SUCH AS H205 OR H705, OR T675A FOR CHANGEOVER CONTROL.
6. AUTHORITY OF MINIMUM POSITION POTENTIOMETER, IF USED, INCREASES WITH THE NUMBER OF MOTORS IN PARALLEL. WITH ONE MOTOR, 50% STROKE; WITH TWO MOTORS, 100% STROKE; WITH THREE MOTORS, 100% STROKE WITH 1/3 OF FULL POTENTIOMETER ROTATION.
7. REVERSING THE B AND W TERMINALS ON ONE OR MORE MOTORS WILL NOT AFFECT CONTROL PERFORMANCE ON THE OTHER MOTORS. THE SYSTEM CAN BE CONFIGURED TO HAVE SOME MOTORS BE REVERSE ACTING AND OTHER MOTORS BE DIRECT ACTING.
8. USE SEPARATE TRANSFORMER FOR T775 WHEN POWERING FROM 24 VAC.
9. THE SYSTEM IS SHOWN CONNECTED FOR COOLING. FOR HEATING, REVERSE THE W AND B LEADS OF THE MODULATING OUTPUT ON THE T775 CONTROLLER.

M24487

Fig. 22. Wiring for Unison Control of M9184 or M9185 Modutrol IV Motor Using One Minimum Position Potentiometer for All Motors.

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CHECKOUT

Inspect all wiring connections at the controller terminals, and verify compliance with the installation wiring diagrams.

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury, death or property damage.
Disconnect power supply before beginning wiring or making wiring connections, to prevent electrical shock or equipment damage.

If any wiring changes are required, *first* be sure to remove power from the controller *before* starting work. Pay particular attention to verifying the power connection (24, 120, or 240 Vac).

After the controller is installed and wired, apply power.

Power Loss

The date and time settings are retained for 24 hours after a power outage. After a power loss of more than 24 hours, the date and time settings may need to be reentered. All other settings are stored permanently.

Temperature Sensor Calibration

As wire length increases, resistance increases and thus the temperature reading increases. If necessary, calibrate the sensor input by reducing the value by the amount shown in the Table 3. For example, a wire run with 18 gauge wire of 1,000 feet, requires a calibration offset of -6.0° F (-21° C).

IMPORTANT

If the calibration value in the table exceeds the controller's calibration limits of +/-10° F (+/-6° C), you must use a heavier gauge wire.

For example, with a wire run of 1,000 feet you must use 20 AWG wire or heavier in order to calibrate for wire loss within the limits of the controller.

See "2.2.2.2. CALIBRATE (the sensor)" on page 18 for the instructions to enter the calibration value.

Table 3. Temperature Sensor Calibration for Resistance Loss Due to Wire Length.

AWG Rating	mΩ/ft	Temperature Offset in °F (Foot)[a]		
		200 ft	500 ft	1,000 ft
14	2.5	0.46	1.14	2.28
16	4.0	0.72	1.82	3.64
18	6.4	1.16	2.90	5.82
20	10.2	1.86	4.64	9.28
22	16.1	2.92	7.32	14.64

AWG Rating	mΩ/m	Temperature Offset in °C (Meter)[a]		
		100 m	200 m	300 m
14	8.3	0.44	0.86	1.30
16	13.2	0.68	1.38	2.06
18	21.0	1.10	2.18	3.28
20	33.5	1.74	3.48	5.22
22	52.8	2.74	5.48	8.22

[a] This is the distance from the controller to the sensor (already accounts for round trip distance).

Fig. 23 shows how sensor resistance varies with temperature for a sensor having a positive temperature coefficient (PTC) of 2.1 Ohms per degree F (3.85 Ohms per degree C)

.

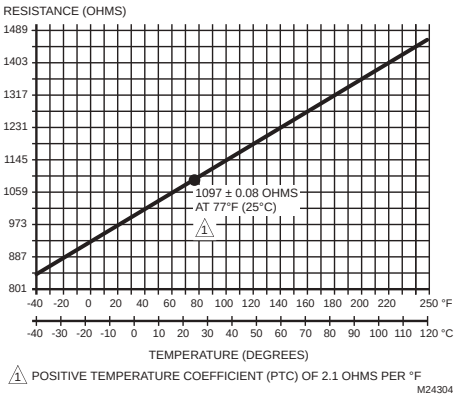

Fig. 23. Sensor Resistance vs. Temperature.

INTERFACE OVERVIEW

The T775A/B/M controllers use an LCD panel and 6-button keypad to provide status information and permit user input of the programming, setup, and scheduling parameters.

The following figure describes the display areas of the LCD and the keypad

.

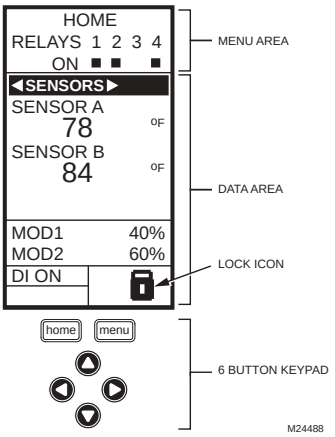

Fig. 24. LCD Display - Home Screen And Keypad.

Menu Area – On the home screen, the LCD displays the configured relays and whether they are active. In Program, Setup or Schedule mode, the LCD displays the current menu selection and its order within the menu hierarchy.

Data Area – On the home screen, the LCD displays the sensors and outputs status. In Setup or Program mode, the LCD displays menu choices, parameter selections, and data values.

Lock Icon – The icon indicates the **MENU** button is locked and prevents access to the Setup and Program menus.

NOTE: Pressing and holding the HOME and MENU buttons simultaneously for five seconds locks/unlocks the MENU button.

6-Button Keypad – The keypad is used to access the menus and enter values (See "Using the LCD Panel Interface").

Using the LCD Panel Interface

The 6-button keypad is used to move through the menus and enter or change parameter values.

Home Button

Pressing the **HOME** button at any time exits the current Programming or Setup display screen and returns to the home screen as shown in Fig. 24 and Fig. 25.

Menu Button

- Pressing the **MENU** button always displays the Program menu. If you are in Setup mode, you exit setup and return to the Program menu.
- **Pressing and holding the MENU button for five seconds leaves the current screen and displays the Setup menu.**

Left and Right Arrow Buttons (◀ and ▶)

Use these buttons to move backward (◀) and forward (▶) through the Program and Setup menus.

Up and Down Arrow Buttons (▲ and ▼)

Use these buttons to move your selection up and down through a menu or list.

- When the desired item is highlighted, you press the ▶ arrow button to display that item's content.
- When a value is displayed (e.g. 70° F), the up and down arrows increase and decrease the value.

NOTE: Once you select an item from a list or enter a value, pressing the ◀ or ▶ or HOME button accepts your selection or value and stores it in the controller's memory.

Home Screen

In the normal run state, the LCD home screen displays the current sensed temperatures, the modulating outputs status, the active status of the output relays, and error and status codes.

Active relays are indicated by the small black square (■) just below the relay number. Fig. 25 shows the home screen with relays 1, 2, and 4 energized.

Pressing the ◀ and ▶ buttons from the home screen cycles through each modulating output that is paired with the sensor it controls and the active output relays

.

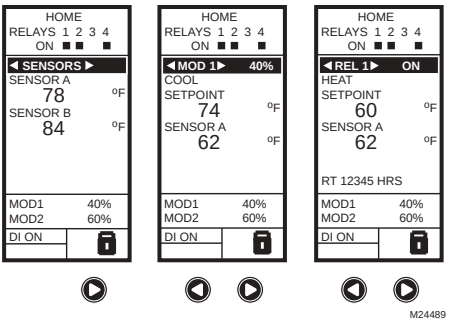

Fig. 25. LCD Display - Home Screen Displaying Sensors, Active Relays, and Mod Outputs.

NOTE: The modulating output home screen and the relay home screen do not dynamically update the active relay status, sensor values, and modulating output percentages. The information is a snapshot taken when you press the ◀ or ▶ button to display the screen.

IMPORTANT

After four minutes of inactivity (no buttons pressed), the LCD display reverts to the home screen display.

Accessing the Menus

Menus are used for programming, scheduling, viewing the summary settings, and setup of advanced options.

Programming, Scheduling, and Summary Menus

To access these menus from the home screen, press the **MENU** button (See Fig. 26)

.

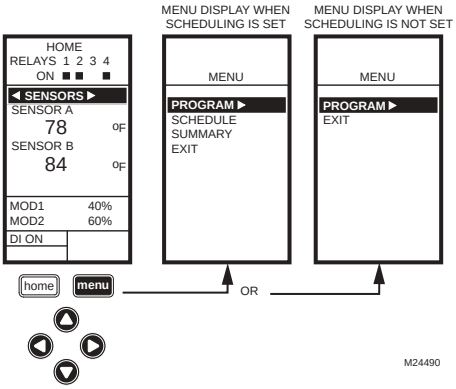

Fig. 26. Menus.

Depending on whether scheduling is enabled or not, the LCD displays one of two menus as shown in Fig. 26. Scheduling is enabled from the Setup menu's Output settings (See "2.3.3.1. USE SCHED" on page 25).

Setup Menu

To access the Setup menu, press and hold the **MENU** button for five seconds (Refer to Fig. 27).

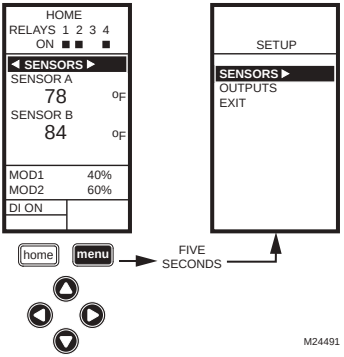

Fig. 27. Setup Menu.

Using the Menus

When you are working with the menus, use the:

- **Left arrow button (◀) to scroll backward through the menus •Right arrow button** (▶) to select the highlighted menu item and display its content
- **Up and Down arrow buttons** (▲ and ▼) to scroll up and down through a list of items or to increase or decrease the value of a displayed parameter

NOTE: If you press the HOME button or there is no keypad activity for four minutes, you exit Program mode and return to the home screen.

If you press the MENU button, you exit and return to the menu.

1. PROGRAMMING

The controller must be programmed before being placed into service.

IMPORTANT

During programming, the controller is live at all times. For example, the contacts may open and close when adjusting the setpoint.

The Programming process uses a hierarchical menu structure that is easy to use. You press the ◀ and ▶ arrow buttons to move forward and backward through the menus.

NOTES:

1. The controller interface is intuitive. You may find that you do not need the following procedure instructions to program the controller. You may want to use this procedure simply as a reference to locate the particular option or parameter of interest.
2. The menus can display only those relays that are defined in Setup (See "2.3.2. NBR OF RELAYS" on page 24). For example, if you configure only two relays, then only two relays display on the appropriate menus.
3. If you press the **HOME** button or there is no keypad activity for four minutes, you exit Program mode and return to the home screen.
4. If you press the **MENU** button, you exit Program mode and return to the menu.

Setpoint and Differential

The following describes the relationship between setpoint and differential for heating and cooling. These settings are programmed for each output relay.

Heating Mode Setpoint and Differential

In heating mode, the differential is below the setpoint. The relay de-energizes when the temperature rises to the setpoint. As the temperature drops to the setpoint minus the differential, the relay energizes.

Cooling Mode Setpoint and Differential

In cooling mode, the differential is above the setpoint. The relay de-energizes when the temperature falls to the setpoint. As the temperature rises to the setpoint plus the differential, the relay energizes.

Setpoint High Limit

You can set a single irreversible setpoint high limit maximum value, which is applied to all outputs.

Adjust the setpoint (at any output) to the desired maximum setpoint. Then, simultaneously press the **home,** ◀, and ▶ buttons and continue to press all three buttons for five seconds to set the setpoint high limit maximum to this value.

NOTE: You must press all three buttons at exactly the same time for this action to occur.

IMPORTANT

1. *This action sets the maximum setpoint value of **all** outputs to the setpoint high limit maximum.*
2. *Setting the high limit setpoint maximum is **irreversible**. If you perform the action inadvertently gently and this setpoint adversely affects the control of your system, you must replace the controller.*

Programming the T775A/B/M Controller

To program the controller, perform the following procedures in the order listed:

1. Enter Program mode — see "1.1. Entering Program Mode"
2. Program the Outputs — see "1.2. Program Menu for Outputs"

When programming is complete, you may continue with "3. SCHEDULING" on page 30 or, for advanced options, continue with "2. SETUP (ADVANCED OPTIONS)" on page 17.

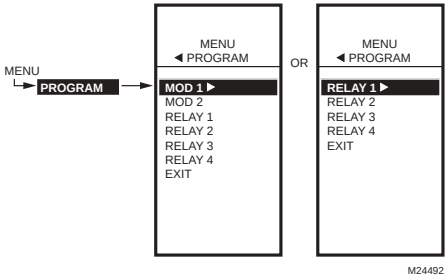

Fig. 28. Program Menu.

1.1. Entering Program Mode

Press the **MENU** button, then select PROGRAM and press the ▶ button to view the Program menu.

Fig. 28 shows the Program menus for controllers with and without Modulating Outputs.

NOTE: Modulating outputs are not available on the T775A and T775B controller models.

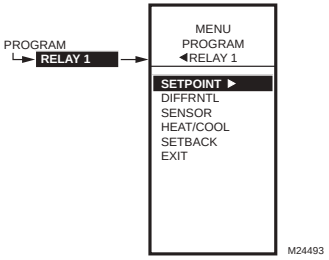

Fig. 29. Program Menu Outputs.

1.2. Program Menu for Outputs

Press the **MENU** button, select PROGRAM, then select RELAY 1 (or MOD 1) to view the parameters. Fig. 29 shows RELAY 1.

NOTE: For MOD 1 and 2, THROT RNG replaces DIFFRNTL.

NOTE: The Setback parameter displays only if scheduling is enabled (See Fig. 57 on page 24) or the DI Option is set to Setback. (See Fig. 60 on page 26).

Continue with "1.2.1. SETPOINT".

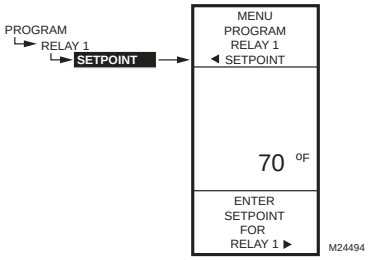

Fig. 30. Program - Setpoint.

1.2.1. SETPOINT

1. From the menu, use the ▲ and ▼ buttons to highlight SETPOINT.
2. Press the ► button to display the setpoint value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired setpoint temperature.
   Default: 70° F (21° C)
   Range: -40° to 248° F (-40° to 120° C)
4. Press the ► button to accept the setpoint temperature and display the next option.

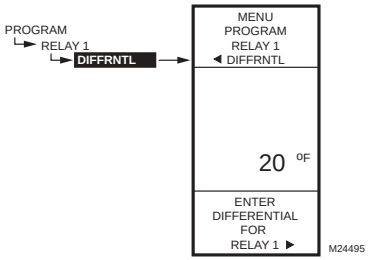

Fig. 31. Program - Differential or Throttling Range.

1.2.2. DIFFERENTIAL or THROTTLING RANGE

Differential is used for Relay outputs and Throttling Range is used for Modulating outputs.

1. From the menu, use the ▲ and ▼ buttons to highlight THROT RNG or DIFFERNTL.
2. Press the ► button to display the throttling range value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired value.
   Default: 20° F (-7° C)
   Range: 1° to 300° F (1° to 149° C).
4. Press the ► button to accept the value and display the next option.

In heating mode, the Differential is below the setpoint. The relay de-energizes when the temperature rises to the setpoint. As the temperature drops to the setpoint minus the Differential, the relay energizes.

In cooling mode, the Differential is above the setpoint. The relay de-energizes when the temperature falls to the setpoint. As the temperature rises to the setpoint plus the Differential, the relay energizes.

The Throttling Range brackets the setpoint setting, e.g., if the setpoint is 72°F (22° C) and the throttling range is 10° F (-12° C), then the effective throttling temperature range is 67° to 77° F (19° to 25° C). This applies to both modulating outputs and floating outputs.

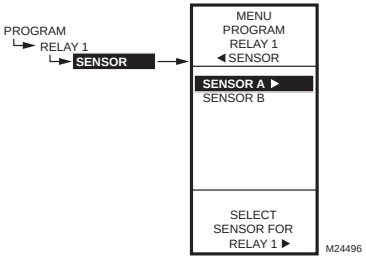

Fig. 32. Program - Sensor.

1.2.3. SENSOR

1. From the menu, use the ▲ and ▼ buttons to highlight SENSOR.
2. Press the ► button to display the sensor selections.
3. Use the ▲ and ▼ buttons to select Sensor A or B.
4. Press the ► button to accept the highlighted sensor and display the next option.

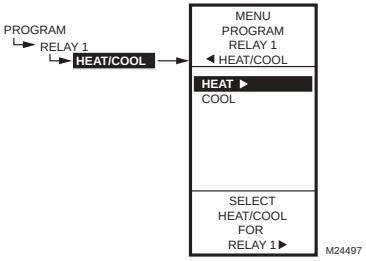

Fig. 33. Program - Heat/Cool.

1.2.4. HEAT/COOL

1. From the menu, use the ▲ and ▼ buttons to highlight HEAT/COOL.
   Default: HEAT
2. Press the ► button to display the heat and cool selections.
3. Use the ▲ and ▼ buttons to select Heat or Cool.
4. Press the ► button to accept the highlighted selection and display the next option.

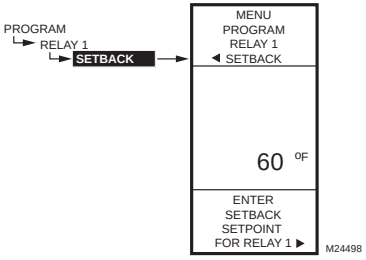

Fig. 34. Program - Setback.

1.2.5. SETBACK

The Setback temperature option displays if scheduling is enabled (See Fig. 57 on page 24) or the DI Option is set to Setback. (See Fig. 60 on page 26).

This is the desired setpoint temperature that you want to use during setback mode for this output. For example, if your setpoint is 70° F (21° C) and you want the temperature to drop 10° F during setback mode, enter 60° F (16° C) as the setpoint for this output.

1. From the menu, use the ▲ and ▼ buttons to highlight SETBACK.
2. Use the ▲ and ▼ buttons to increase/decrease the desired setpoint temperature.
   Default: 60° F (16° C)
   Range: -40° to 248° F (-40° to 120° C)
3. Press the ► button to accept the value and display the menu.

1.2.6. Program Next Output (Mod or Relay)

For the next output (Mod or Relay), select the desired output from the Program menu (Refer to Fig. 28 on page 14).

Go to “1.2.1. SETPOINT” on page 15 to program the next output.

When you finish programming the outputs, continue with “1.2.7. Exiting Program Mode” on page 17.

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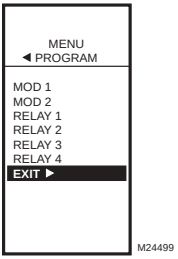

Fig. 35. Program - Exit.

1.2.7. Exiting Program Mode

Press the **HOME** button to leave programming mode and return to the home screen.

This completes the programming procedure.

2.SETUP (ADVANCED OPTIONS)

Setup provides the ability to change the factory default settings for the temperature sensors and outputs, to enable/disable reset control, and to enable/disable scheduling.

NOTE: The controller interface is intuitive. You may find that you do not need the following setup instructions for the sensors and outputs. You may want to use this procedure simply as a reference to locate the particular option or parameter of interest.

NOTES:

1. If you press the **HOME** button or there is no keypad activity for four minutes, you exit Setup mode and return to the home screen.
2. If you press the **MENU** button, you exit Setup mode and return to the menu.

Setup Procedure

The Setup process uses a hierarchical menu structure that is easy to use. You press the ◄ and ► arrow buttons to move forward and backward through the menus.

NOTE: The menus can display only those relays that are defined in Setup (see "2.3.2. NBR OF RELAYS" on page 24). For example, if you configure only two relays, then only two relays display on the appropriate menus.

Once in Setup mode, you use the —

- **Left arrow button (◄)** to scroll backward through the Setup menus
- **Right arrow button** (►) to select the highlighted menu item and display its content
- **Up and Down arrow buttons** (▲ and ▼) to scroll up and down through a list of items or to increase or decrease the value of a displayed setup parameter

To change the controller's sensors and output setup parameters, perform the following procedures in the order listed:

1. Enter Setup mode — see "2.1. Entering Setup Mode"
2. Setup Sensors — see "2.2. Setting up the Sensors"
3. Setup Outputs — see "2.3. Setting up the Outputs" on page 21
4. Exit Setup Mode — see "2.4. EXIT Setup Mode" on page 30

2.1. Entering Setup Mode

To enter Setup mode, press and hold the **MENU** button for five seconds to display the Setup menu. Refer to Fig. 27 on page 13.

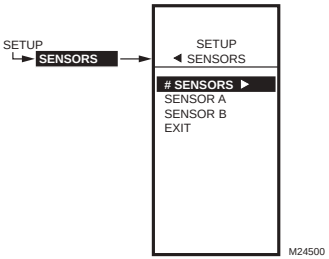

Fig. 36. Setup - Sensors Menu.

2.2. Setting up the Sensors

1. From the Setup menu, use the ▲ and ▼ buttons to highlight SENSORS.
2. Press the ► button to display the Sensors menu.

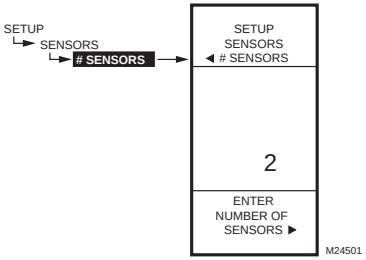

Fig. 37. Setup - Sensors - Number of Sensors.

2.2.1. Number of SENSORS

The value entered here determines the number of sensors displayed on the home screen.

1. From the Sensors menu, highlight # SENSORS then press the ► button to display the number of sensors.
2. Use the ▲ and ▼ buttons to enter the number of sensors (1 or 2).
   Default: 2
3. Press the ► button to accept the value and display the SENSOR A selection.

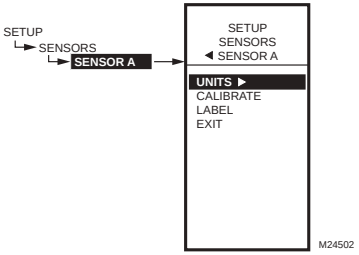

Fig. 38. Setup - Sensors - Sensor A Menu.

2.2.2. SENSOR A

1. From the Sensors menu, highlight SENSOR A.
2. Press the ► button to display the Sensor A selections.

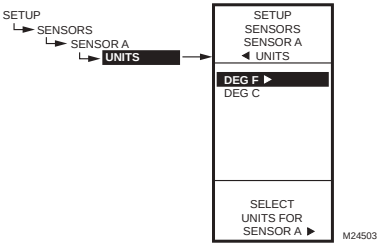

Fig. 39. Setup - Sensors - Sensor A - Units.

2.2.2.1. UNITS (° F or ° C)

IMPORTANT

This is a global change and affects the unit values for all temperature parameters on all displays.

The UNITS screen displays only for Sensor A.

1. From the Sensor A selections, use the ▲ and ▼ buttons to highlight UNITS.
2. Press the ► button to display the temperature units.
3. Use the ▲ and ▼ buttons to highlight F or C.
   Default: F (Fahrenheit)
4. Press the ► button to accept the units and return to the Sensor A selections.

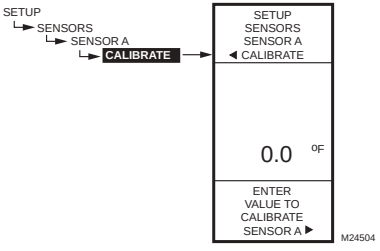

Fig. 40. Setup - Sensors - Sensor A - Calibrate.

2.2.2.2. CALIBRATE (the sensor)

Ensure that the wire size calibration value is within the limits. See “Temperature Sensor Calibration” on page 11.

1. From the Sensor A selections, use the ▲ and ▼ buttons to highlight CALIBRATE.
2. Press the ► button to display the calibration degree value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired calibration degrees.
   Default: 0.0
   Range: +/-10° F (+/-6° C)
4. Press the ► button to accept the value and return to the Sensor A selections.

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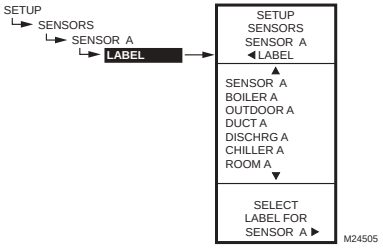

Fig. 41. Setup - Sensors - Sensor A - Label.

2.2.2.3. LABEL (the sensor input)

For a sensor already labeled, the display positions to and highlights that label.

1. From the Sensor A selections, use the ▲ and ▼ buttons to highlight LABEL.
2. Press the ► button to display the label list.
3. Use the ▲ and ▼ buttons to scroll through list and highlight the desired label.
   You may need to scroll up or down to view all possible labels.
4. Use the ► button to accept the highlighted label and exit the list.

NOTE: The label names in list order are: Sensor, Boiler, Outdoor, Duct, Dischrg, Chiller, Room, Supply, Return, and Animals.

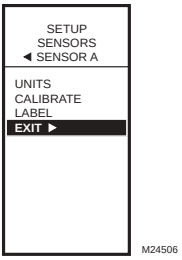

Fig. 42. Setup - Sensors - Sensor A - Exit.

2.2.2.4. Exit Sensor A Setup

Press the ◄ button to exit Sensor A selections and return to the Sensors menu.
or
Use the ▲ and ▼ buttons to highlight EXIT and press the ► button.

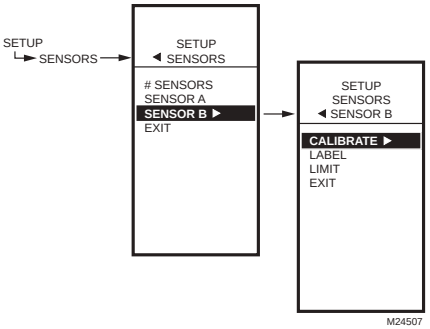

Fig. 43. Setup - Sensors - Sensor B Menu.

2.2.3. SENSOR B

For the T775M2030 and T775M2048 models only, which have a High/Low modulating temperature limit, the LIMIT item displays on the Sensor B menu.

1. From the Sensors menu, use the ▼ button to highlight SENSOR B.
2. Press the ► button to display the Sensor B menu.

2.2.3.1. CALIBRATE

Setting the calibration value is accomplished the same way as the Sensor A. See “2.2.2.2. CALIBRATE (the sensor)” on page 18.

2.2.3.2. LABEL

Setting the label is accomplished the same way as the Sensor A. See “2.2.2.3. LABEL (the sensor input)” on page 19.

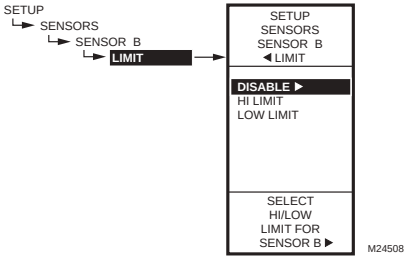

Fig. 44. Setup - Sensors - Sensor B - Limit.

2.2.4. LIMIT (Sensor B only)

For the T775M2030 and T775M2048 models only, the LIMIT item displays on the Sensor B menu.

NOTE: The LIMIT option acts *only* on Modulating Output 1.

1. From the Sensors menu, use the ▼ button to highlight SENSOR B.
2. Press the ► button to display the Sensor B menu.
3. Use the ▲ and ▼ buttons to select the LIMIT item.
4. Use the ► button to display the Limit selections.
5. Use the ▲ and ▼ buttons to select the desired limit, (Disable, Hi Limit, or Low Limit).
   Default: Disable
6. Press the ► button to accept the value and return to the Sensor B menu.

When you select Hi Limit or Low Limit, the Sensor B menu changes and adds the Hi/Low Limit and Throttling Range items.

If you are setting a Hi or Low Limit, continue with "2.2.4.1. HI LIMIT or LOW LIMIT (Sensor B only)".

If you selected Disable for the Limit value, continue with "2.3. Setting up the Outputs" on page 21.

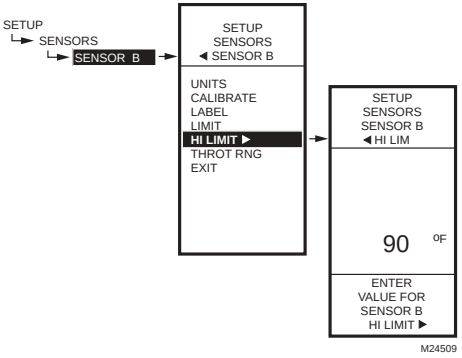

Fig. 45. Setup - Sensors - Sensor B - Hi/Low Limit (showing Hi Limit).

2.2.4.1. HI LIMIT or LOW LIMIT (Sensor B only)

Fig. 45 shows the High Limit, but the process is the same for setting the Low Limit.

Sensor B can be assigned a high/low limit, so that as you are controlling temperature at Sensor A, the control adjusts its modulating output to prevent exceeding the user-entered limit for Sensor B.

1. From the Sensor B menu, use the ▼ button to highlight HI LIMIT or LOW LIMIT.
2. Press the ► button display the LIMIT value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired Limit value.
4. Press the ► button to accept the value and return to the Limit menu.

The high and low limit action will work in either the heat or the cool mode as follows:

- When the low limit is used in the heat mode, the MOD1 output *increases* to prevent reaching the low limit at sensor B.
- When the high limit is used in the heat mode, the MOD1 output *decreases* to prevent reaching the hi limit at sensor B.
- When the low limit is used in the cool mode, the MOD1 output *decreases* to prevent reaching the low limit at sensor B.
- When the high limit is used in the cool mode, the MOD1 output *increases* to prevent reaching hi limit at sensor B.

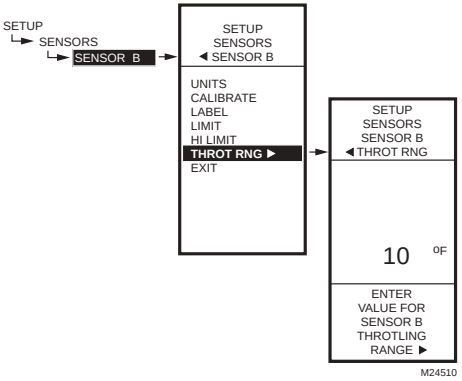

Fig. 46. Setup - Sensors - Sensor B - Throttling Range.

2.2.4.2. THROTTLING RANGE (Sensor B only)

The throttling range for the modulating high or low limit positions the setpoint at the end of the throttling range. For example, with a high limit at Sensor B of 200°F and a throttling range of 10°F, the modulating output controlling Sensor A begins to throttle back at 190°F (88°C), and fully closes at 200°F (93°C). Conversely, the throttling range for the low limit begins above the setpoint in the same manner.

1. From the Limit menu, use the ▼ button to highlight THROT RNG.
2. Use the ▲ and ▼ buttons to increase/decrease the desired value for the Throttling Range.
   Default = 0
3. Press the ► button to accept the value and return to the Limit menu.
4. Press the ◄ button to exit the Limit menu.
5. Press the ◄ button to exit the Sensors menu and return to the Setup menu.

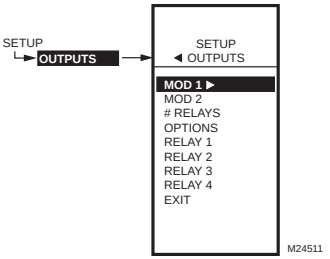

Fig. 47. Setup - Outputs Menu.

2.3. Setting up the Outputs

1. From the Setup menu, use the ▲ and ▼ buttons to highlight OUTPUTS.
2. Press the ► button to display the Outputs menu.

NOTE: The menus (e.g. the Outputs menu shown here) can display only those relays that are defined in Setup (see "2.3.2. NBR OF RELAYS" on page 24). For example, if you configure only two relays, then only two relays display on the appropriate menus.

The following procedures set up each modulating output and relay output.

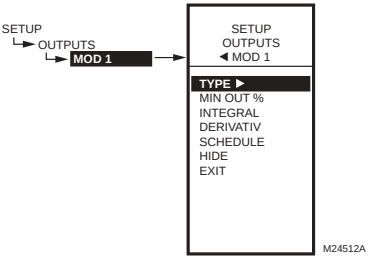

Fig. 48. Setup - Outputs - Modulating Output Menu.

2.3.1. Setting up the Modulating Outputs

1. From the Output menu, use the ▲ and ▼ buttons to highlight the desired modulating output (MOD 1 or MOD 2).
2. Press the ► button to display the selected MOD menu.

NOTE: Modulating outputs are not available on the T775A and T775B controller models. If you are setting up one of these controllers, skip to "2.3.2. NBR OF RELAYS" on page 24.

Use the remaining procedures, beginning with "2.3.1.1. TYPE (of output signal)" on page 22, to set up each modulating output. If you have two modulating outputs, repeat these procedures for each modulating output.

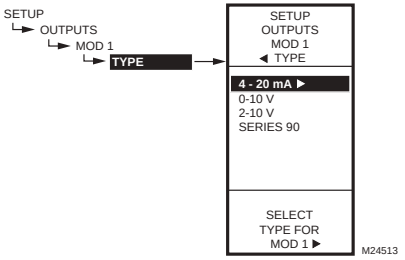

Fig. 49. Setup - Outputs - Mod Out - Type.

2.3.1.1. TYPE (of output signal)

1. From the Mod menu, use the ▲ and ▼ buttons to highlight TYPE.
2. Press the ► button to display the Type selections.
3. Use the ▲ and ▼ buttons to highlight the desired output type.
   Default: 4-20 mA
4. Press the ► button to accept the selected type and return to the Mod menu.

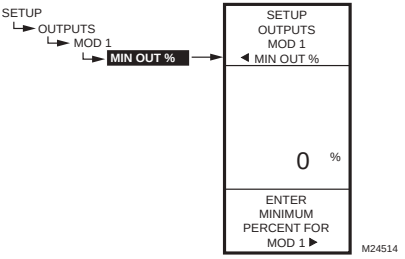

Fig. 50. Setup - Outputs - Mod Out - Minimum Output Percentage.

2.3.1.2. MIN OUT %

The minimum output % prevents the output from dropping below the value entered. This value can be useful to maintain minimum damper position.

Using the time clock or digital input to disable the output forces the output to 0%.

1. From the Mod menu, use the ▲ and ▼ buttons to highlight MIN OUT %.
2. Press the ► button to display the Min Out %.
3. Use the ▲ and ▼ buttons to increase/decrease the desired value from 0% to 100% in 1% increments.
   Default: 0%
   Range: 0 to 100%
4. Press the ► button to accept the percentage and return to the Mod menu.

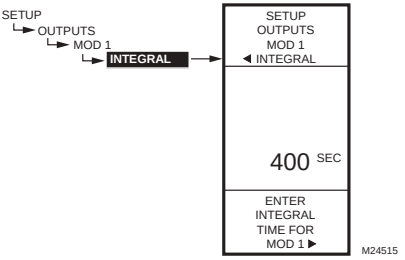

Fig. 51. Setup - Outputs - Mod Out - Integral.

2.3.1.3. INTEGRAL

1. From the Mod menu, use the ▲ and ▼ buttons to highlight INTEGRAL.
2. Press the ► button to display the Integral seconds.
3. Use the ▲ and ▼ buttons to increase/decrease the value from 0 to 3,600 in 10 second increments.
   Default: 400 seconds
   Range: 0 to 3,600 seconds
4. Press the ► button to accept the seconds and return to the Mod menu.

NOTES:

1. The Integral time is factory set for 400 seconds. This is a good middle range and should satisfy many applications. The integral time can be increased for applications where sensed response is slow, and can be decreased for applications where sensed response is fast (e.g. discharge air control).

2. As a starting point, an optimal integral time for discharge air typically ranges from 12 to 200 seconds. An optimal integral time for room control typically ranges from 60 to 2,500 seconds. The purpose of integral action is to reduce or eliminate the offset from setpoint during steady state control that is often seen in proportional only control.

3. Keep in mind that control is most sensitive to throttling range. Adjust the throttling range first before any adjustment to integral time. Adjust throttling range to be as wide as possible to start since this will provide the most stable control. Remember that the integral will eliminate the steady state error so you do not need to have a small throttling range to have accurate control. (Integral action allows for controlling to a setpoint even with a wide throttling range).

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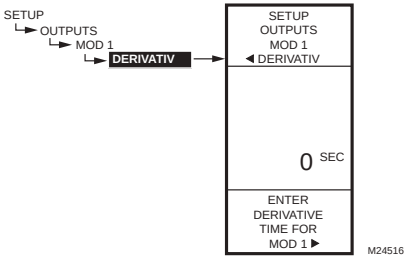

Fig. 52. Setup - Outputs - Mod Out - Derivative.

2.3.1.4. DERIVATIVE

The Derivative default value is factory set to zero (no derivative control). It is strongly recommended that the derivative remain at zero (0) unless you have a very good reason to adjust it. Derivative control is not needed in the vast majority of HVAC applications.

1. From the Mod menu, use the ▲ and ▼ buttons to highlight DERIVATIV.
2. Press the ► button to display the Derivative seconds.
3. Use the ▲ and ▼ buttons to increase/decrease the value.
   Default: 0 (zero)
   Range: 0 to 3,600 seconds
4. Press the ► button to accept the seconds and return to the Mod menu.

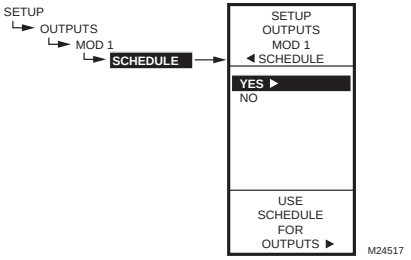

Fig. 53. Setup - Outputs - Mod Out - Schedule.

2.3.1.5. SCHEDULE

The Schedule option displays only if the USE SCHED parameter is set to Yes (See “2.3.3.1. USE SCHED” on page 25).

1. From the Mod menu, use the ▲ and ▼ buttons to highlight SCHEDULE.
2. Use the ▲ and ▼ buttons to highlight YES or NO.
   Default: YES
3. Press the ► button to accept the selection and return to the Mod menu.

Each output can be set up to follow or ignore the built in scheduler. To disable the scheduler for all outputs, see “2.3.3.1. USE SCHED” on page 25.

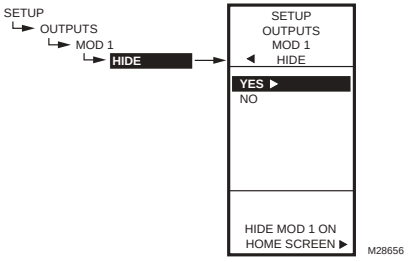

Fig. 54. Setup - Outputs - Mod 1/2 - Hide.

2.3.1.6. HIDE

The Hide option is used to prevent the MOD 1 and MOD 2 outputs from displaying on the Home screen.

1. From the Mod menu, use the ▲ and ▼ buttons to highlight HIDE.
2. Use the ▲ and ▼ buttons to highlight YES or NO.
   Default: YES
3. Press the ► button to accept the selection and return to the Mod menu.

NOTE: The MOD1 and MOD2 outputs are still active even when hidden from the Home screen.

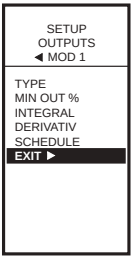

Fig. 55. Setup - Outputs - Mod Out - Exit.

2.3.1.7. EXIT

Press the ◄ button (or highlight EXIT and press the ► button) to exit the Mod menu and return to the Outputs menu.

If you have a second modulating output to configure, go to “2.3.1. Setting up the Modulating Outputs” on page 21.

If you are finished setting up the modulating outputs, continue with “2.3.2. NBR OF RELAYS”.

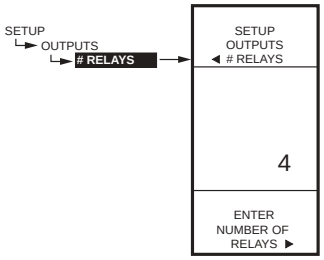

Fig. 56. Setup - Outputs - Number of Relays.

2.3.2. NBR OF RELAYS

1. From the Outputs menu, use the ▲ and ▼ buttons to highlight # RELAYS.
2. Press the ► button to display the number of relays.
3. Use the ▲ and ▼ buttons to display the number from 1 to 4 depending on the model. (See notes below.)
4. Press the ► button to accept the value and display the Outputs menu.

NOTES:

1. The T775A/B/M models have the following outputs available:
   T775A20191 relay output
   T775B2016up to 2 relay outputs
   T775B2024up to 4 relay outputs
   T775B2032up to 2 relay outputs
   T775B2040up to 4 relay outputs
   T775M2006no relay outputs
   T775M2014up to 4 relay outputs
2. The number of relay outputs entered here determines how many relays display on the home screen.

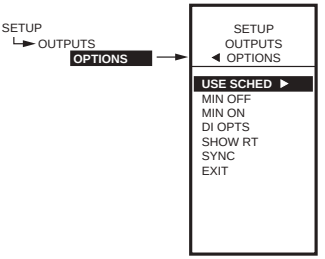

Fig. 57. Setup - Outputs - Options Menu.

2.3.3. OPTIONS

1. From the Outputs menu, use the ▲ and ▼ buttons to highlight OPTIONS.
2. Press the ► button to display the Options menu.

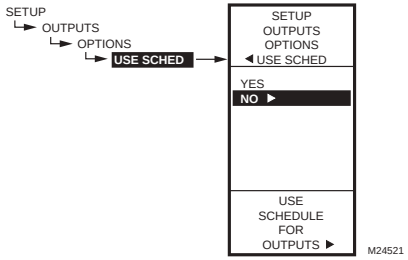

Fig. 58. Setup - Outputs - Options - Schedule.

2.3.3.1. USE SCHED

1. Press the ▶ button to display the schedule selections.
2. Use the ▲ and ▼ buttons to highlight YES or NO.
   Default: NO
3. Press the ▶ button to accept the value and display the MIN OFF option.

Selecting NO disables scheduling for **all** outputs.

Selecting YES enables scheduling for **all** outputs. When YES is selected, all individual outputs default to follow the schedule. However, each individual output can be removed from scheduling as desired.

With Scheduling enabled, when you return to Program mode, the new option for Scheduling displays. You can press the home key and then the menu key to view the Schedule options in the menu.

See “2.3.1.5. SCHEDULE” on page 23.

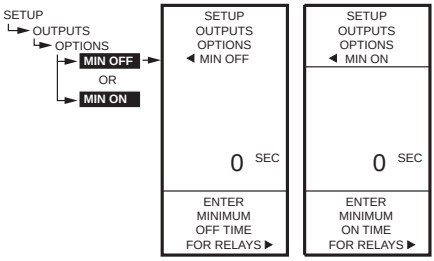

Fig. 59. Setup - Outputs - Options - Min Off/On Time.

2.3.3.2. MIN OFF or MIN ON

This is the minimum number of seconds of “off time” or “on time” for **all** relays.

1. Press the ▶ button to display the Min Off/On value.
2. Use the ▲ and ▼ buttons to increase/decrease the desired number of seconds from 0 to 990 seconds in 10 second increments.
   Default: 0 (zero)
   Range: 0 to 990 seconds
3. Press the ▶ button to accept the seconds and display the DI OPTIONS.

NOTES:

1. The minimum OFF or ON time applies to **all** relay outputs.
2. When minimum OFF or ON time is active, relays waiting to be energized display a flashing square underneath the relay number on the home screen.
3. If the minimum OFF time is not equal to zero (0), the minimum OFF time activates at power-up. To manually override, press the ◄ button at any time.

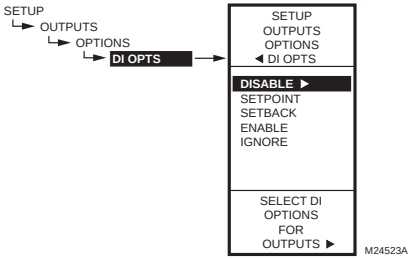

Fig. 60. Setup - Outputs - Options - DI Options.

2.3.3.3. DI OPTIONS (digital input options)

The DI Option you select applies to **all** outputs. This option overrides any Setpoint/Setback values entered in the Schedule.

1. Press the ► button to display the DI Option selections.
2. Use the ▲ and ▼ buttons to highlight DISABLE, SETBACK, or IGNORE.
   Default: DISABLE
3. Press the ► button to accept the value and display the SHOW RT option.

When the digital input (DI) closes, all outputs follow the DI option value (Disable, Setback, or Ignore):

- **DISABLE** disables the outputs; relays return to de-energized state and Mod outputs return to 0% output.
- **SETPOINT** forces the control to the setpoint temperature.
- **SETBACK** enables a setback temperature value to be programmed for each output and forces the control to the setback temperature.
  — To program the Setback temperature, see Fig. 34 on page 16.
- **ENABLE** energizes all relays and MOD outputs to 100%. Use this option carefully.
- **IGNORE** causes the digital input to have no effect on the Relay or Mod outputs.

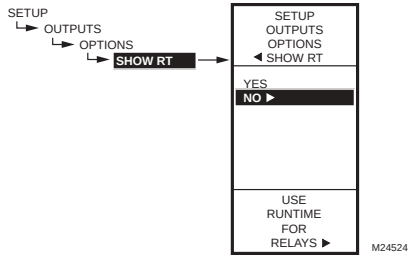

Fig. 61. Setup - Outputs - Options - Show Runtime.

2.3.3.4. SHOW RT (show run time hours)

1. Press the ► button to display the Show RT values.
2. Use the ▲ and ▼ buttons to select YES or NO.
   Default: YES
3. Press the ► button to accept the value and return to the Options menu.

Selecting YES shows the RT (run time) hours for **each** relay on the home screen displays.

NOTE: Run times can be reset to zero for each individual relay. You must do this for each relay that you want to reset to zero. See "2.3.4.3. RESET RT (run time hours)" on page 29.

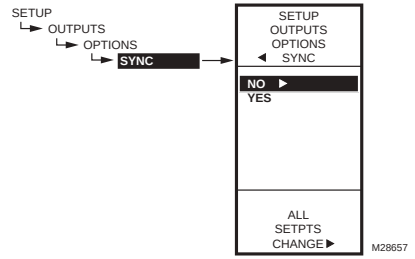

Fig. 62. Setup - Outputs - Options - Sync.

2.3.3.5. SYNC (synchronize setpoint changes)

1. Press the ► button to display the Sync values.
2. Use the ▲ and ▼ buttons to select YES or NO.
   Default: NO
3. Press the ► button to accept the value and return to the Options menu.

Depending on the model, selecting YES causes all setpoints for all relays and MODs to sync to any change to:

- Relay 1 for models without MOD outputs
- MOD1 for models with MOD outputs

For example, assume the MOD1 setpoint is 110°F, MOD2 is 115°F, and Relay 1 is 120°F. With SYNC=YES, when the MOD1 setpoint is adjusted to 112°F (increase 2°F), then MOD2 and all other relay setpoints increase by 2°F. Thus the MOD2 setpoint is now 117°F and the relay 1 setpoint is 122°F.

383/665

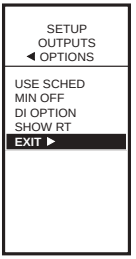

Fig. 63. Setup - Outputs - Options - Exit.

2.3.3.6. Exit Options Setup

Press the ◄ button (or highlight EXIT and press the ► button) to exit and return to the Outputs menu.

Continue with “2.3.4. Setting up the Relays”

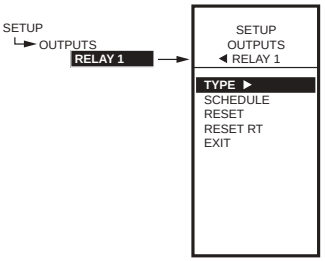

Fig. 64. Setup - Outputs - Relay Menu.

2.3.4. Setting up the Relays

1. From the Outputs menu, use the ▲ and ▼ buttons to highlight the desired relay (1-4 depending on model).
2. Press the ► button to display the selected relay menu.

The TYPE selection shown in Fig. 64 displays only for Relay 1 and Relay 3.

Continue with the remainder of section 3.4 to setup the relay outputs.

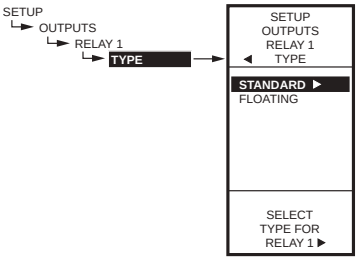

Fig. 65. Setup - Outputs - Relay - Type.

2.3.4.1. TYPE (standard or floating)

The Floating option is only available on the T775B2016, T775B2024, T775B2032, and T775B2040 models.

For these models, this selection displays only for Relay 1 and/or Relay 3.

1. Press the ► button to display the Type values.
2. Use the ▲ and ▼ buttons to select STANDARD OR FLOATING.
   Default: STANDARD (not floating)
3. Press the ► button to accept the value and return to the Relay menu.

If you select FLOATING, the relays are paired (1-2 or 3-4) and are setup together. Continue with “2.3.4.1.1. Floating Relay Menu”.

If you select STANDARD, go to “2.3.4.2. SCHEDULE” on page 29.

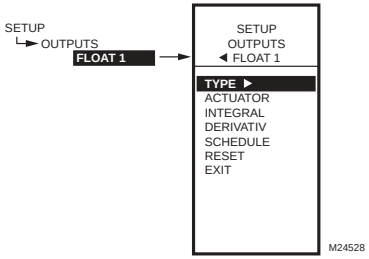

Fig. 66. Setup - Outputs - Floating Relay - Menu.

2.3.4.1.1. Floating Relay Menu

The Floating option is only available on the T775B2016, T775B2024, T775B2032, and T775B2040 models.

When Relay 1 or Relay 3 is setup as floating, relays are paired and the Float 1 or Float 2 menu displays with the selections shown in Fig. 66.

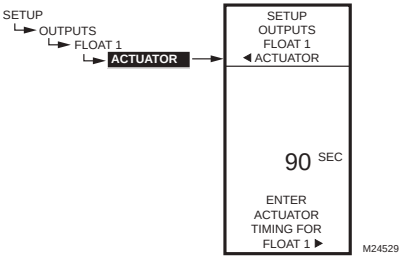

Fig. 67. Setup - Outputs - Floating Relay - Actuator.

2.3.4.1.1.1. ACTUATOR (floating relay only)

The Actuator option displays only on the T775B2016, T775B2024, T775B2032, and T775B2040 models when the Type option = Floating.

1. From the menu, use the ▲ and ▼ buttons to highlight ACTUATOR.
2. Press the ► button to display the actuator value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired number of seconds.
   Default: 90 seconds
   Range: 0 to 3,600 seconds)
4. Press the ► button to accept the value and display the INTEGRAL option.

The actuator run time is defined as the time needed to move the actuator from the fully closed to fully open position and visa versa.

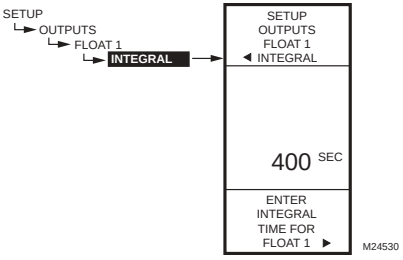

Fig. 68. Setup - Outputs - Floating Relay - Integral.

2.3.4.1.1.2. INTEGRAL (modulating/floating relay only)

The Actuator option displays only on the T775B2016, T775B2024, T775B2032, and T775B2040 models when the Type option = Floating.

1. From the menu, use the ▲ and ▼ buttons to highlight INTEGRAL.
2. Press the ► button to display the actuator value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired number of seconds.
   Default: 400 seconds
   Range: 0 to 3,600 seconds)
4. Press the ► button to accept the value and display the DERIVATIV option.

See Integral NOTES on page 22 for additional information about setting the Integral time.

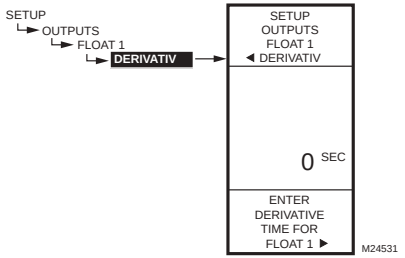

Fig. 69. Setup - Outputs - Floating Relay - Derivative.

2.3.4.1.1.3. DERIVATIVE (modulating/floating relay only)

The Derivative option displays only on the T775B2016, T775B2024, T775B2032, and T775B2040 models when the Type option = Floating.

1. From the menu, use the ▲ and ▼ buttons to highlight DERIVATIV.
2. Press the ► button to display the actuator value.
3. Use the ▲ and ▼ buttons to increase/decrease the desired number of seconds.
   Default: 0 seconds
   Range: 0 to 3,600 seconds)
4. Press the ► button to accept the value and display the SCHEDULE option.

Continue with "2.3.4.2. SCHEDULE" for the remaining relay selections.

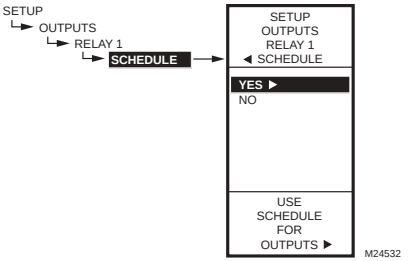

Fig. 70. Setup - Outputs - Relay - Schedule.

2.3.4.2. SCHEDULE

This selection displays only if "Use Sched = YES" is selected during the Output Options setup (see "2.3.3.1. USE SCHED" on page 25). When selected, individual outputs default to follow the schedule.

1. Press the ► button to display the Schedule values.
2. Use the ▲ and ▼ buttons to select YES or NO.
   Default: YES
3. Press the ► button to accept the value and return to the Relay menu.

An individual output can be selected to be controlled or not controlled by the schedule.

If NO is selected, the Setback selection does not appear in the Program menu for this output.

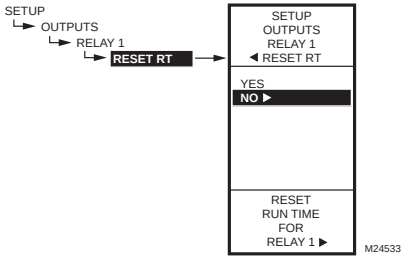

Fig. 71. Setup - Outputs - Relay - Reset Runtime.

2.3.4.3. RESET RT (run time hours)

This selection displays only if "Show RT = YES" is selected during Output Options setup (see "2.3.3.4. SHOW RT (show run time hours)" on page 26).

1. From the Relay menu, press the ► button to display the Reset RT values.
2. Use the ▲ and ▼ buttons to select YES or NO.
   Default: NO
3. Press the ► button to accept the value and return to the Relay menu.

Selecting YES immediately resets the output run time hours to zero for this output. When you subsequently return to this screen, the RESET RT defaults to NO.

NOTE: Run times can be reset to zero for each individual relay. You must do this for each relay that you want to reset to zero.

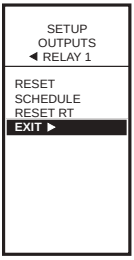

Fig. 72. Setup - Outputs - Relay - Exit.

2.4. EXIT Setup Mode

Press the ◄ button to exit the selected relay set up and return to the Outputs menu.

To setup the next relay output go to "2.3.4. Setting up the Relays" on page 27.

If you are finished setting up the relay outputs, press the **HOME** button to exit Setup mode and return to the home screen display.

This completes the Setup procedure.

3. SCHEDULING

Scheduling provides the ability to set daily temperature settings for up to two events per day. Typically, these are the daytime (setpoint) and the nighttime (setback) settings.

IMPORTANT

*To enable Scheduling, you must first enter Setup mode (press and hold the **MENU** button for 5 seconds), select OUTPUTS, select OPTIONS, select USE SCHED, and then select YES. (See "2.3.3.1. USE SCHED" on page 25).*

IMPORTANT

*To properly account for Daylight Saving time, be sure to set the Date **before** setting the Time. See "3.2.2. SET DATE" on page 31.*

NOTE: Each output is independently configurable to follow the schedule or not. For modulating outputs, See "2.3.1.5. SCHEDULE" on page 23. For relay outputs, see "2.3.4.2. SCHEDULE" on page 29.

NOTE: The controller interface is intuitive. You may find that you do not need the following scheduling instructions. You may want to use this procedure simply as a reference to locate the particular option or parameter of interest.

NOTES:

1. If you press the **HOME** button or there is no keypad activity for four minutes, you exit Scheduling mode and return to the home screen.
2. If you press the **MENU** button, you exit Scheduling mode and return to the menu.

To create or change a schedule, you use the —

- **Left arrow button** (◄) to scroll backward through the Schedule menus
- **Right arrow button** (►) to select the highlighted menu item and display its content
- **Up and Down arrow buttons** (▲ and ▼) to scroll up and down through a list of items or to increase or decrease the value of a displayed schedule parameter

Creating a Schedule

To create a schedule, perform the following in the order listed:

1. Enable Scheduling in Setup mode - See *"2.3.3.1. USE SCHED" on page 25*
2. Enter Schedule mode — See "3.1. Entering Schedule Mode"
3. Set the Schedule Options — See "3.2. OPTIONS"
4. Set Individual Schedules — begin with "3.3. Setting Individual Schedules" on page 32
5. Exit Schedule Mode — See "3.4. Exiting Scheduling Mode" on page 33

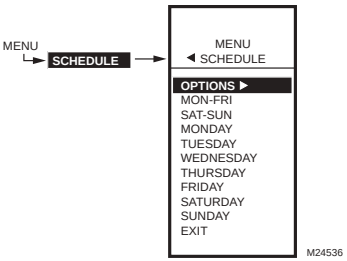

Fig. 73. Schedule - Menu.

3.1. Entering Schedule Mode

Press the **MENU** button, then select SCHEDULE and press the ► button to view the Schedule menu.

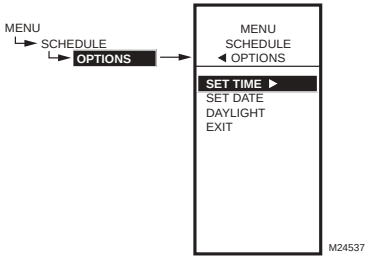

Fig. 74. Schedule - Options Menu.

3.2. OPTIONS

1. From the Schedule menu, use the ▲ and ▼ buttons to highlight OPTIONS.
2. Press the ► button to display the Options menu.

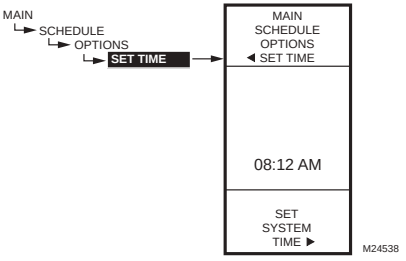

Fig. 75. Schedule - Options - System Time.

3.2.1. SET TIME

Setting the system time is required to enable the controller to follow daylight saving time.

IMPORTANT

*Set the Date **before** setting the Time. See "3.2.2. SET DATE".*

1. From the Options menu, use the ▲ and ▼ buttons to highlight SET TIME.
2. Press the ► button to display the current system time setting.
3. Use the ► button to cycle between the hour, minute, and AM/PM values.
4. Use the ▲ and ▼ buttons to increase/decrease the desired value for the hour, minute, and AM/PM.
5. Press the ◄ button to accept the Time and return to the Options menu.

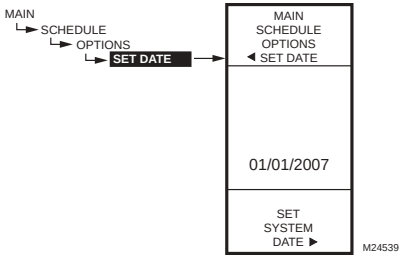

Fig. 76. Schedule - Options - System Date.

3.2.2. SET DATE

Setting the system date is required to enable the controller to follow daylight saving time.

IMPORTANT

*To properly account for Daylight Saving time, be sure to set the Date **before** setting the Time.*

1. From the Options menu, use the ▲ and ▼ buttons to highlight SET DATE.
2. Press the ► button to display the current system date setting.
3. Use the ► button to cycle between the month, day, and year values.
4. Use the ▲ and ▼ buttons to increase/decrease the desired value for the month, day, and year.
5. Press the ◄ button to accept the Date and return to the Options menu.

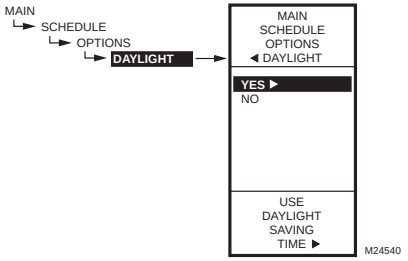

Fig. 77. Schedule - Options - Daylight Saving Time.

3.2.3. DAYLIGHT (daylight saving time)

1. From the Options menu, use the ▲ and ▼ buttons to highlight DAYLIGHT.
2. Press the ► button to display the current system setting for daylight saving time.
3. Use the ▲ and ▼ buttons to select YES or NO. Default: YES
4. Press the ► button to accept the value and return to the Options menu.
5. From the Options menu, use the Use the ▲ and ▼ buttons to highlight EXIT.
6. Press the ► button to return to the Schedule menu.

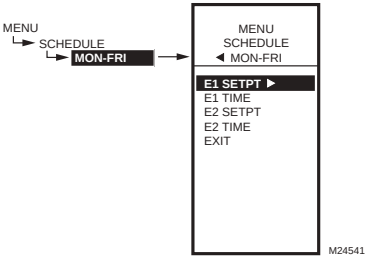

Fig. 78. Schedule Event Menu (Showing MON-FRI).

3.3. Setting Individual Schedules

As shown in the Schedule menu (Fig. 73 on page 30), schedules can be set for the following time periods:

- Monday through Friday
- Saturday and Sunday
- Individual days of the week

1. From the Schedule menu, use the ▲ and ▼ buttons to highlight the desired time period.
2. Press the ► button to display the Schedule menu for the selected time period.

For each selected time period, the schedule event (E1 and E2) parameters are exactly the same as shown in Fig. 78.

SCHEDULING EXAMPLE

Setting the schedule is independent of the temperature settings for the relay outputs. The following illustrates a weekly schedule for daytime (setpoint) and night time (setback) use and shows the factory default settings:

Table 4. Mon-Fri Schedule Defaults

DAY	EVENT	SETPT ACTION	TIME
Mon-Fri	Event 1 (E1)	Setpoint	6:00 AM [a]
Mon-Fri	Event 2 (E2)	Setback	6:00 PM [b]
Sat-Sun	Not used; remains in Setback from Mon-Fri E2 settings		

[a] Setpoint time span is 6:00 AM until 5:59 PM because setback starts at 6:00 PM.

[b] Setback time span is 6:00PM until 5:59 AM because setpoint starts at 6:00 AM.

To set a schedule, continue with “3.3.1. E1 SETPT (setpoint for event 1)”.

The following figures show the MON-FRI menu, but the menu selections are the same for any time period.

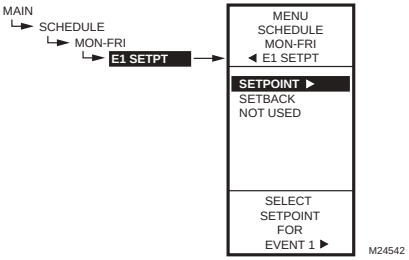

Fig. 79. Schedule - Event 1 Setpoint.

3.3.1. E1 SETPT (setpoint for event 1)

1. From the selected time period menu, use the ▲ and ▼ buttons to highlight E1 SETPT.
2. Press the ▶ button to display the setpoint options.
3. Use the ▲ and ▼ buttons to highlight the desired option.
4. Press the ▶ button to accept the value and return to the selected time period menu.

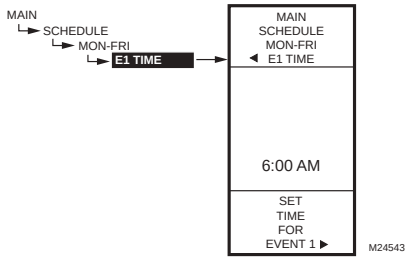

Fig. 80. Schedule - Event 1 Time.

3.3.2. E1 TIME (time for event 1)

1. From the selected time period menu, use the ▲ and ▼ buttons to highlight E1 TIME.
2. Press the ▶ button to display the current time setting for event 1.
3. Use the ▶ button to cycle between the hour, minute, and AM/PM values.
4. Use the ▲ and ▼ buttons to increase/decrease the desired value for the hour, minute, and AM/PM.
5. Press the ◀ button to accept the time and return to the selected time period menu.

3.3.3. E2 SETPOINT (setpoint for event 2)

Creating the setpoint for event 2 is accomplished the same way as the first event. See“3.3.1. E1 SETPT (setpoint for event 1)” on page 33.

3.3.4. E2 TIME (time for event 2)

Creating the time for event 2 is accomplished the same way as the first event. See “3.3.2. E1 TIME (time for event 1)” above.

3.3.5. EXIT (exit from selected time period settings)

After entering the time for event 2, use the ◀ button to exit the schedule time period and return to the Schedule menu (Fig. 73 on page 30) to select a different time period.

When you finish scheduling the time periods, continue with “3.4. Exiting Scheduling Mode”.

3.4. Exiting Scheduling Mode

Press the **HOME** button to exit the Schedule menu and return to the home screen display.

This completes the Scheduling procedure.

SUMMARY MENU

The Summary menu provides the ability to view the schedule (E1 and E2 times) for each relay for each day of the week.

NOTE: Scheduling must be enabled for the Summary menu to display. Enabling the schedule is determined in the Setup process for the Output Options (see "2.3.3.1. USE SCHED" on page 25).

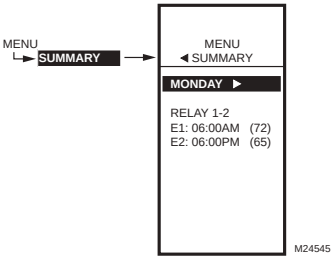

Fig. 81. Summary Example - Monday Settings.

For each relay, the Summary display indicates the time and temperature (in parenthesis) for each of the two scheduled events E1 and E2.

1. Press the **MENU** button to view the menu.
2. Use the ▲ and ▼ buttons to highlight SUMMARY.
3. Press the ► button to display the Summary settings.
4. Use the ► button to scroll forward through each day of the week (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday).
5. While viewing a specific day, use the ▲ and ▼ buttons to cycle through the individual relay schedules for that day.

When finished, press the home key to return to the home display screen.

TROUBLESHOOTING

Power Loss

The date and time settings are retained for 24 hours after a power outage. After a power loss of more than 24 hours, the date and time settings may need to be reentered. All other settings are stored permanently.

Errors and Diagnostics

The controller provides an error message and diagnostic status as described below.

Error Message

There is a two-character error code that displays in response to controller software problems:

EE

EEPROM Failure — The values read back from the EEPROM are not the same as written into the EEPROM. This error cannot be field repaired. Replace the device.

Diagnostic Messages

There are two diagnostic messages that can display in response to sensor problems. The diagnostic codes that can flash on the display are:

– –

Sensor Open or Shorted — Two dashes display when a sensor (typically temperature) is open or shorted. An open circuit is considered anything greater than 1570 ohms (greater than 300F), shorted anything less than 770 ohms (less than -73F). Whichever stages are operating with this sensor cease to control (meaning relays go to OFF and proportional outputs go to zero percent).

This message can also mean that the sensor is programmed, but not physically connected.

-60° or **270° F** (-51° or 132° C) Blinking

Temperature Out of Range — The temperature display blinks when the sensed temperature range is outside of the display range, below -60° F (-51° C) or above 270° F (132° C). The displayed value remains at that displayed limit and control continues. Controller continues to function unless an open or shorted state is detected.

Blinking relay status

Relay Minimum Off Time is Active — On the home screen, each relay's indicator (■) blinks while the relay's minimum off time is active.

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SPECIFICATIONS

Power: 24, 120, or 240 Vac; 50/60 Hz;
A separate earth ground is required for any power source.

Power Consumption:
- 8 VA maximum at 60 Hz
- 10 VA maximum at 50 Hz

Operating & Storage Temperature Ambient Rating:
- -40° to 125° F (-40° to 52° C) @ 50 Hz
- -40° to 140° F (-40° to 60° C) @ 60 Hz

Relative Humidity: 5% to 95% non-condensing

Relay Contact Output Ratings (N.O. and N.C.):
- 1/2 hp; 9.8 AFL, 58.8 ALR @ 120 Vac
- 1/2 hp; 4.9 AFL, 29.4 ALR @ 240 Vac
- 125 VA pilot duty @ 120/240 Vac
- 10A @ 24 Vac (resistive)

Modulating Outputs:
- 0-10 Vdc; drive a minimum of 2,000 Ohms
- 2-10 Vdc; drive a minimum of 2,000 Ohms
- 4-20 mA; drive a maximum of 600 Ohms
- Electronic Series 90
- Floating

DOC

Emissions Compliance

EN 55022: 2006
CISPR 22: 2006
VCCI V-3/2006.04
ICES-003, Issue 4: 2004
FCC PART 15 SUBPART B Class B Limit

Immunity Compliance

EN 61000-6-1: 2001 covering
EN 61000-4-2: 1995 + A1: 1998 + A2: 2001
EN 61000-4-3: 2002
EN 61000-4-4: 2004
EN 61000-4-5: 1995 + A1: 2001
EN 61000-4-6: 1996 + A1: 2001
EN 61000-4-8: 1993 + A1: 2001
EN 61000-4-11 2nd Ed.: 2004

Safety Compliance

UL 60730-1 for US and Canada

FCC Compliance Statement:

This equipment has been tested and found to comply with limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in residential installations. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television equipment reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
— Reorient or relocate the receiving antenna
— Move the equipment away from the receiver
— Plug the equipment into an outlet on a circuit different from that to which the receiver is connected
— Consult the dealer or an experienced radio/television technician for additional suggestions

You are cautioned that any change or modifications to the equipment not expressly approve by the party responsible for compliance could void Your authority to operate such equipment.

This device complies with Part 15 of the FCC Rules. Operation is subjected to the following two conditions 1) this device may not cause harmful interference and 2) this device must accept any interference received, including interference that may cause undesired operation.

By using this Honeywell literature, you agree that Honeywell will have no liability for any damages arising out of your use or modification to, the literature. You will defend and indemnify Honeywell, its affiliates and subsidiaries, from and against any liability, cost, or damages, including attorneys' fees, arising out of, or resulting from, any modification to the literature by you.

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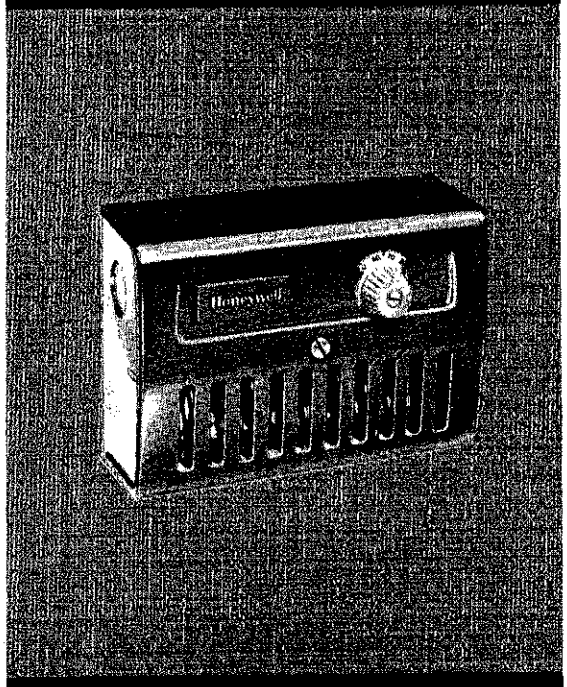
FARM-O-STAT AIRSWITCH CONTROLLERS



T631A-C

T631 CONTROLLERS PROVIDE LINE VOLTAGE CONTROL OF HEATING, COOLING, AND VENTILATION SYSTEMS IN FARM BUILDINGS OR STORAGE AREAS.

☐ Typical applications include barns, brooder houses, poultry houses, hog houses, pump houses, milk houses, and crop storage houses.

☐ Slots in front and bottom of case provide maximum air circulation over the coiled sensing element.

☐ Rugged steel case treated to resist corrosion.

☐ Dependable switching provided by spdt snap switch(es) permanently sealed against contamination.

☐ Temperature setting knob and scale on front of controller.

G.P.
Rev. 7-83•

Form Number 60-2214—6
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SPECIFICATIONS

TRADELINE MODELS

TRADELINE models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. TRADELINE model specifications are the same as those of standard models except as noted below.

TRADELINE MODEL AVAILABLE: T631C Airswitch Controller, with switch rated for 1 hp [0.7 kW].

TEMPERATURE SCALE RANGE: Minus 30 F to plus 100 F [minus 34 C to plus 38 C].

DIFFERENTIAL: 5 F [2.8 C].

ADDITIONAL FEATURES: TRADELINE pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODELS (also refer to Table 1):

T631A Farm-O-Stat Controller—for control of barn ventilation, red finish, spdt switching.

T631B Farm-O-Stat Controller—for control of barn ventilation, red finish, two spdt switches.

T631C Airswitch Controller—for temperature or ventilation control, gray finish, spdt switching.

For weatherproof Farm-O-Stat Controller in NEMA 4X enclosure, use T631F,G. See specification sheet, form 60-2509.

SENSING ELEMENT: Coiled copper tube.

MAXIMUM AMBIENT TEMPERATURES (tabulated by scale range):

TEMPERATURE SCALE RANGE	MAX. AMBIENT F	C
20 C to 60 C	150	66
35 F to 100 F	120	49
70 F to 140 F	150	66
0 F to 70 F	125	52
20 F to 90 F	125	52
-10 F to 60 F	125	52
-10 C to 30 C	125	52
-10 F to 100 F	125	52
-30 F to 100 F	125	52
70 F to 160 F	175	79
0 C to 40 C	120	49

MOUNTING MEANS: Screws through holes in back of case.

ADJUSTMENT: Knob on front of case.

UNDERWRITERS LABORATORIES INC. LISTED: File No. E4436, Vol. 1, dated 2-27-55; Guide No. XAPX.

CANADIAN STANDARDS ASSOCIATION COMPONENT LISTED: File No. LR1620, Guide No. 400-E-O.

REPLACEMENT PART:
103774 Spdt Switch.

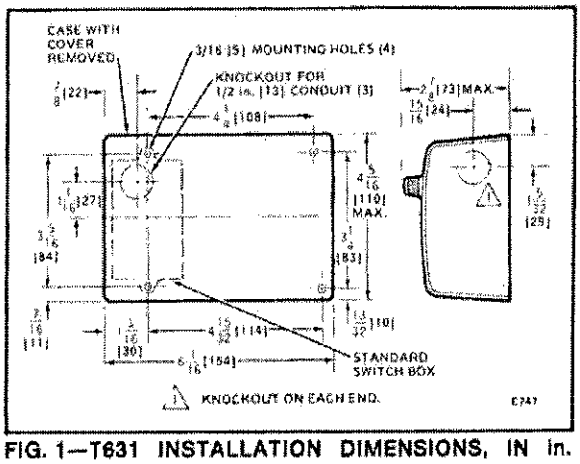

FIG. 1—T631 INSTALLATION DIMENSIONS, IN in. [mm SHOWN IN BRACKETS].

(continued on page 3)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. **Order number (specify T631C with ground screw, if desired).**
2. **Scale range.**
3. **Differential (including interstage differential for T631B).**
4. **One hp [0.7 kW] switch(es) if desired.**
5. **Accessory, if desired.**

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL SALES OFFICE (CHECK WHITE PAGES OF YOUR PHONE DIRECTORY).
2. HOME AND BUILDING CONTROL CUSTOMER RELATIONS
   HONEYWELL, INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422-4386

   (IN CANADA--HONEYWELL LIMITED/HONEYWELL LIMITEE, 35 DYNAMIC DRIVE, SCARBOROUGH, ONTARIO M1V 4Z9) INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

TABLE 1—MODEL NUMBERS

MODEL NUMBER	TEMPERATURE RANGE		DIFFERENTIAL SWITCH		ADDITIONAL FEATURES
	F	C	F	C	
T631A	35 to 100	2 to 38	2	1.1	—
	70 to 140	21 to 60	2	1.1	—
	0 to 70	-18 to 21	3	1.7	—
	-10 to 100	-23 to 38	3	1.7	—
	0 to 40	32 to 104	1.1	2	—
	70 to 140	21 to 60	8	4.4	—
	70 to 160	21 to 71	3	1.7	—
	35 to 100	2 to 38	3-1/2	1.9	with 1 hp [0.7 kW] rated switch
T631B	35 to 100	2 to 38	2	1.1	3-1/2 F [1.9 C] between switches
	35 to 100	2 to 38	2	1.1	9 F [5 C] between switches
	35 to 100	2 to 38	2	1.1	adjustable interstage differential[a]
	35 to 100	2 to 38	3-1/2	1.9	adjustable interstage differential[a]; with 1 hp [0.7 kW] rated switches
T631C	-10 to 60	-23 to 16	3	1.7	with 1 hp [0.7 kW] rated switch
	20 to 90	-7 to 32	3	1.7	with 1 hp [0.7 kW] rated switch
	70 to 140	21 to 60	2	1.1	—
	14 to 86	-10 to 30	3	1.7	—
	68 to 140	20 to 60	3	1.1	—
	35 to 100	2 to 38	2	1.1	—
	14 to 86	-10 to 30	3	1.7	with ground screw

[a]Interstage differential is adjustable from 0 F to 7 F [0 C to 4 C]. At 0 differential, both switches make at set point. With differential set above 0, speed change switch closes after fan switch, on temperature rise.

ELECTRICAL RATINGS (Amperes):

T631A,B

VOLTAGE (Vac)	24[a]	120	240	WITH 1 hp SWITCH	
				120	240
Full Load	2.0	7.4	3.7	16.0	8.0
Locked Rotor	—	44.4	22.2	96.0	48.0

[a]24 Vac rating for T631B.

T631C

VOLTAGE (Vac)	24	120	240	277	WITH 1 hp SWITCH			
					R-B		R-W	
					120	240	120	240
Full Load	2.0	7.4	3.7	3.0	8	5.1	16	8
Locked Rotor	—	44.4	22.2	18.0	48	30.6	80	40
Resistive Load	—	10.0	5.0	—	—	—	—	—

INSTALLATION

WHEN INSTALLING THIS PRODUCT. . .

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

CAUTION

Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.

LOCATION

Locate the T631 controller about 5 ft [1.5 m] above the floor in an area with good air circulation and average temperature. The controller mounts on any flat surface or on switch box with screws through back of case. Do not locate T631 on an outside wall, or where the controller will be affected by drafts or radiant heat from the sun.

MOUNTING ON FLAT SURFACE OR SWITCH BOX

1. Remove cover by unscrewing single screw in cover.
2. Remove appropriate knockout for wiring.
3. Attach controller to mounting surface or switch box.

NOTE: A wooden panel should be placed between the controller and the mounting surface if the surface is brick, metal, or concrete.

4. Run wires through the knockout and into the controller case.

WIRING

Disconnect power supply before making wiring connections to avoid possible electrical shock or equipment damage. All wiring must agree with local codes and ordinances.

Refer to the wiring diagrams (Figs. 2-8) and to installation information furnished with the system equipment when wiring the T631.

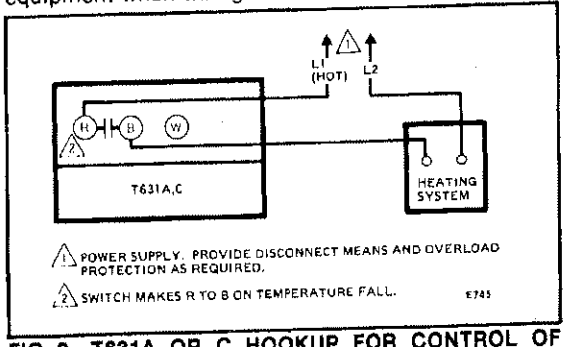

FIG. 2—T631A OR C HOOKUP FOR CONTROL OF HEATING SYSTEM.

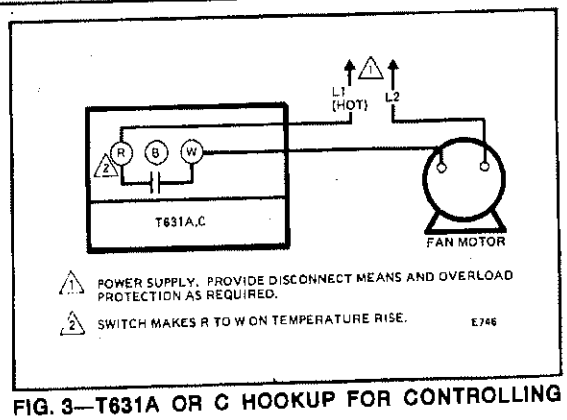

FIG. 3—T631A OR C HOOKUP FOR CONTROLLING FAN.

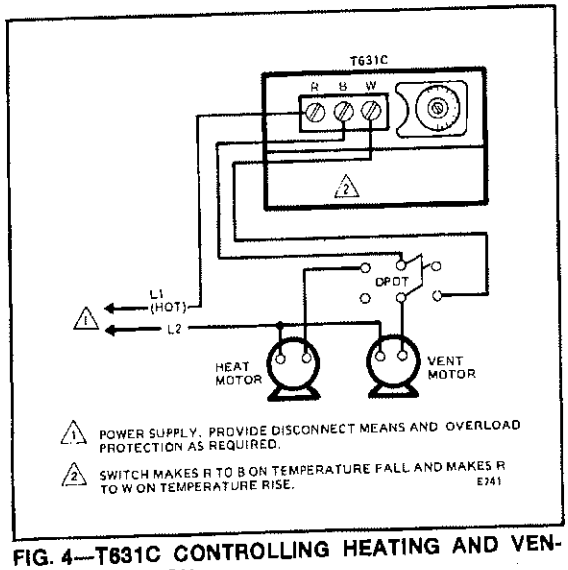

FIG. 4—T631C CONTROLLING HEATING AND VENTILATION.

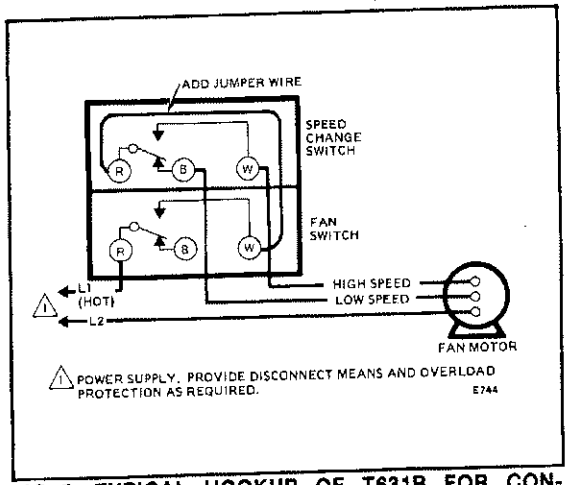

FIG. 5—TYPICAL HOOKUP OF T631B FOR CONTROLLING A 2-SPEED FAN.

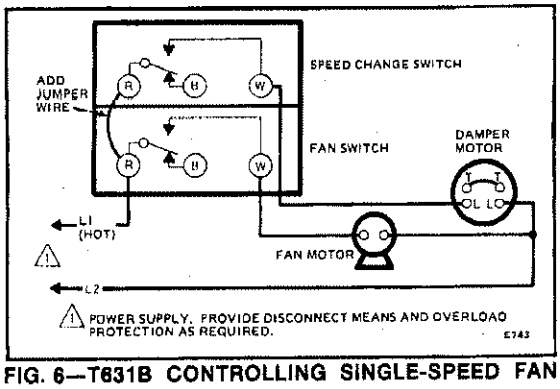

FIG. 6—T631B CONTROLLING SINGLE-SPEED FAN AND DAMPER MOTOR.

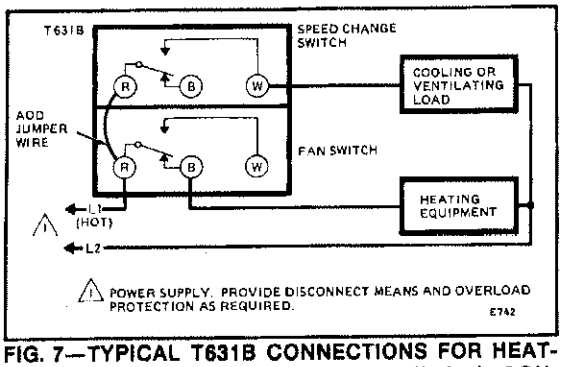

FIG. 7—TYPICAL T631B CONNECTIONS FOR HEATING AND COOLING (or ventilating) CONTROL.

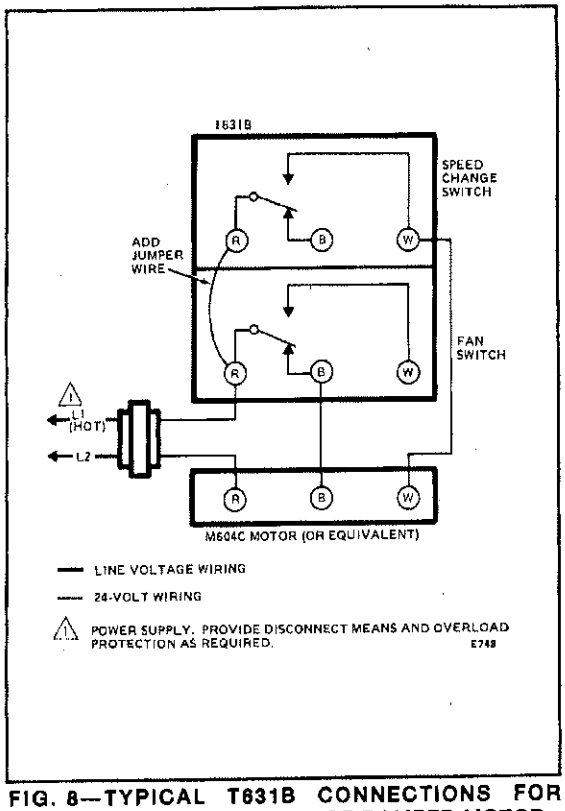

FIG. 8—TYPICAL T631B CONNECTIONS FOR FLOATING CONTROL OF DAMPER MOTOR.

CHECKOUT

1. Turn on the power.
2. Turn the temperature adjusting knob and scale across the indicator and back again. See Fig. 9. The controlled equipment should switch on and off.

When wired for heating (R to B), turning the dial counterclockwise ↶ to a higher setting simulates a space temperature drop and the heating equipment should come on. When the controller is wired for a cooling or ventilating application (R to W), turning the dial clockwise ↷ to a lower setting simulates a rise in temperature and the cooling or ventilating equipment should come on.

3. If the controlled equipment does not start and stop as indicated in step 2, disconnect the power supply and check the wiring and terminal connections.
4. If the controlled equipment operates opposite to the sequence desired, shut off the power and check for reversed leads on the switch.

IMPORTANT

If the T631 is mounted in an area where it is subjected to dust or other substances, clean periodically. Wipe the temperature sensing coil to maintain maximum air contact if the surrounding air contains oil or other adhesive substances.

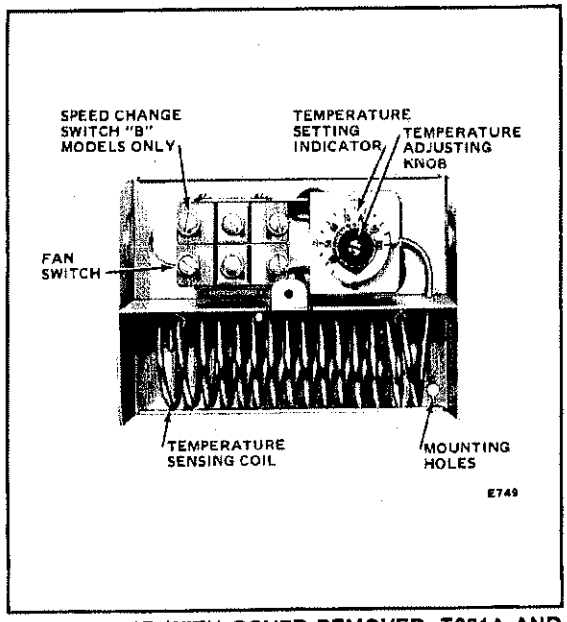

FIG. 9—T631B WITH COVER REMOVED. T631A AND C HAVE 3 WIRING TERMINALS ONLY.

If questions arise regarding this product, contact your distributor or local Honeywell representative.

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Mercury-Free Thermostat

Honeywell

The world's most popular thermostat has taken a turn for the future — with mercury-free models. Built on the proven performance and reliability of Honeywell tradition, The Round® Mercury-Free Thermostat features a precision electronic switch that completely eliminates the need for mercury. The display features an enlarged scale that makes it easier than ever to set the temperature exactly where you want it. And since The Round offers precise temperature accuracy, you'll know that what you set is what you'll get. From its classic design to its ease of use, The Round Mercury-Free Thermostat is a true source of comfort.

The Round® Mercury-Free Thermostat

IMPROVED DESIGN MAKES IT BETTER THAN EVER.

Electronic Switch —
Replaces mercury for environmentally friendly performance.

Proven Performance —
Accuracy and reliability has made Honeywell the number one thermostat choice of homeowners.

Classic Design —
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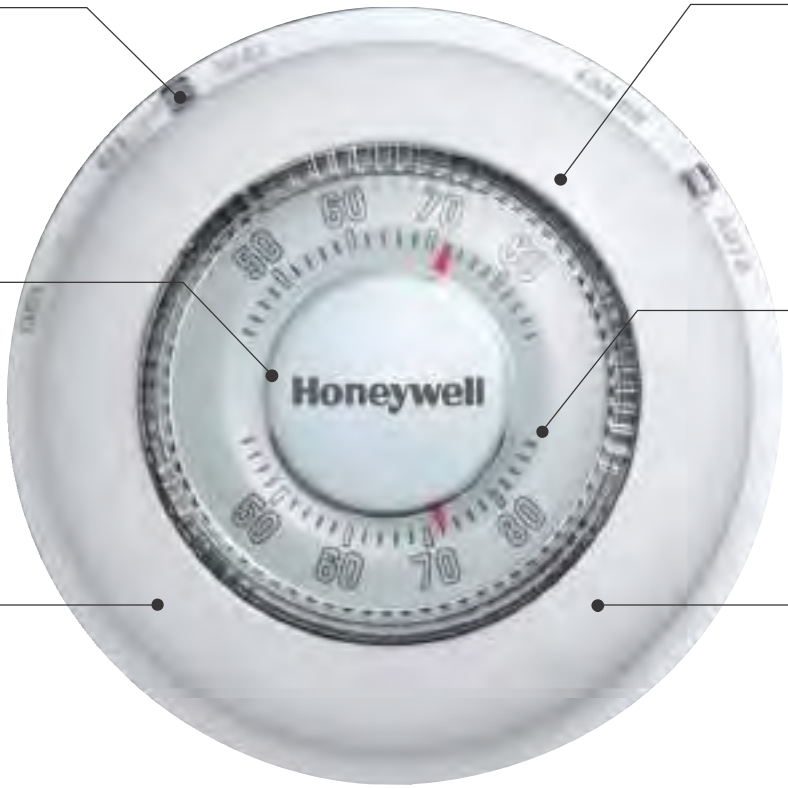

Easy-To-See™ Model —
The Easy-to-See model has an enlarged scale and raised designations that make seeing and setting the temperature easier than ever.

Precision Accuracy —
Reliable temperature control eliminates temperature swings.

5-Year Warranty

Part Numbers – U.S.	Part Numbers – Canada	Stages	Display Size
T87K1007	T87K1015	Heat Only	Standard
T87N1000	T87N1018	1 Heat/1 Cool	Standard
T87N1026		1 Heat/1 Cool	Large – Easy-to-see

Upgrade Options

Ask your heating and cooling professional about:

VisionPRO™ 8000 Touchscreen 7-Day Programmable Thermostat

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5-YEAR WARRANTY

50-9421
May 2006
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T87 Range Stops

INSTALLATION INSTRUCTIONS

APPLICATION

Use the 50010944-001 range stops with the T87K, N thermostats to limit the minimum and maximum temperature settings.

The 50010944-001 contains two range stop scales and two #2-28 x 3/8 phillips pan head screws.

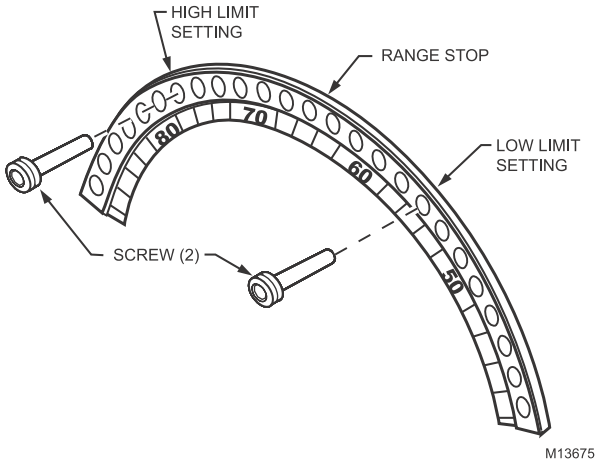

Fig. 1. Range stop and screws (Fahrenheit range).

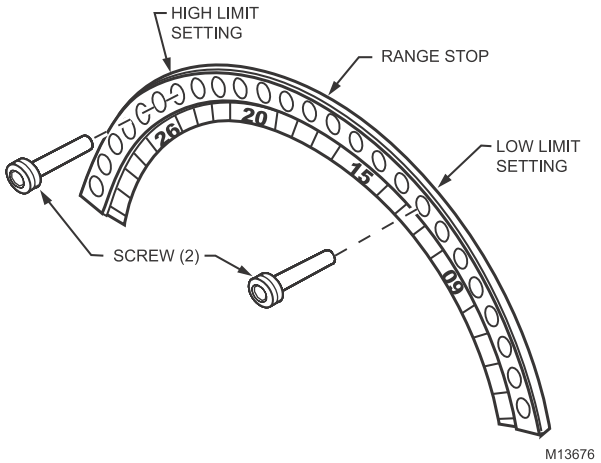

Fig. 2. Range stop and screws (Celsius range).

INSTALLATION

1. Set the thermostat to a temperature setting in the middle of the upper and lower range desired.
2. Remove the thermostat from its base (if already attached).
3. On the back of the thermostat, align the range stop with the holes on the back of the thermostat. See Fig. 3.

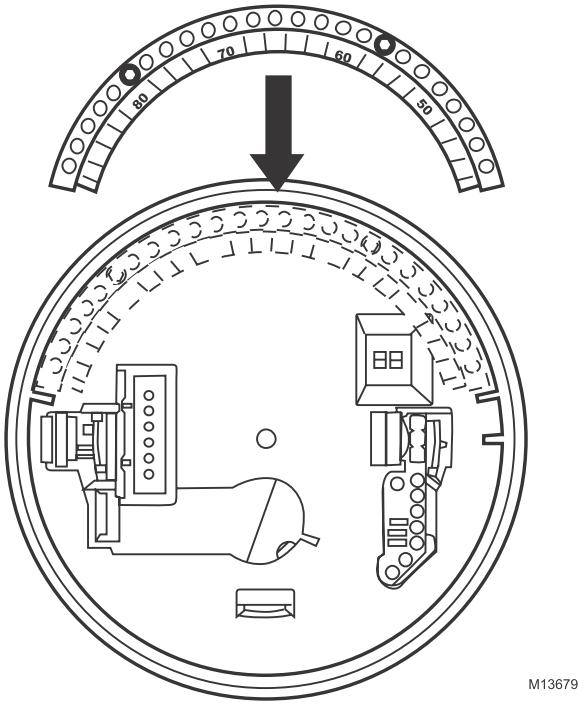

Fig. 3. Aligning range stop with thermostat.

4. Using the temperature markings on the range stop, insert supplied screws into the minimum and/or maximum range stop holes and tighten. Refer to Tables 1 and 2 for range stop temperatures. See Figs. 4 and 5.
5. Mount the thermostat onto its base and set desired temperature. See Fig. 5.

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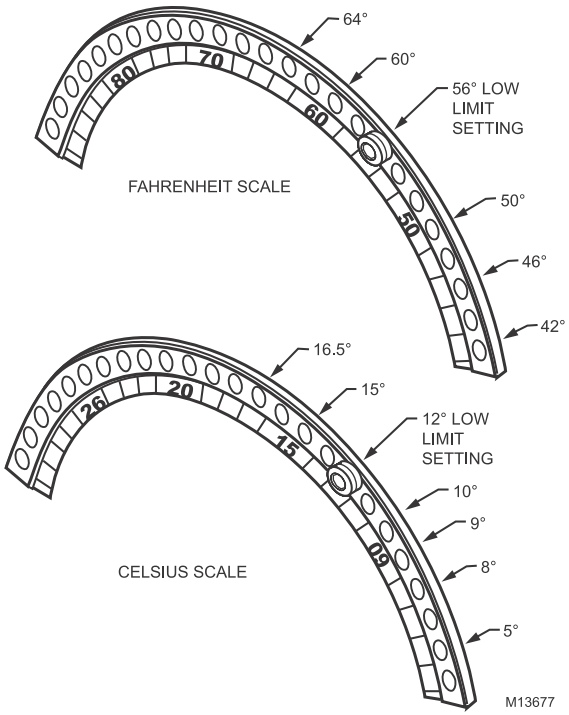

Fig. 4. Low range stop settings.

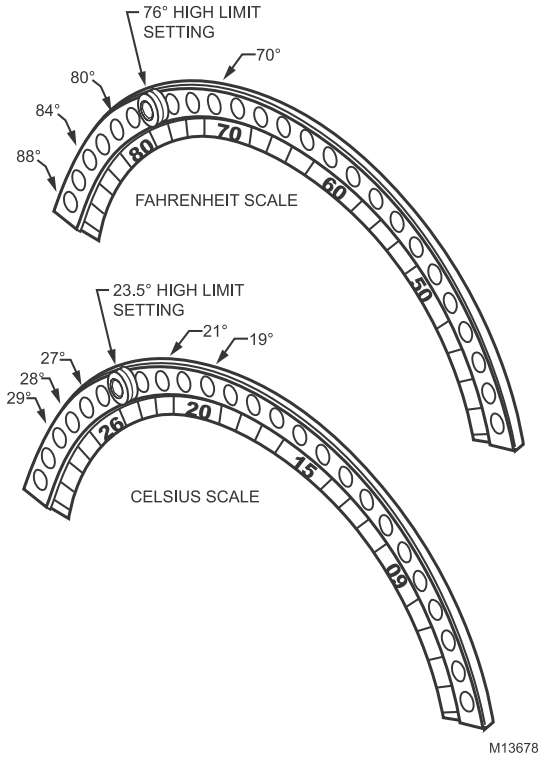

Fig. 5. High range stop settings.

Table 1. Low Limit Range Stop

°F	°C
42	4
44	5
46	6.5
48	8
50	9
52	10
54	11
56	12
58	13
60	14.5
62	15.5
64	16.5
66	17.5
68	19
70	20
72	21
74	22.5
76	23.5
78	24.5
80	26

Table 2. High Limit Range Stop

°F	°C
88	31
86	29.5
84	28
82	27.5
80	26
78	25
76	24
74	22.5
72	21.5
70	20
68	19
66	18
64	17
62	16
60	14.5

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Chapter 33 HEAT TRACE

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33.1 **HEAT TRACE CONTROLLER - Urecon UTC-2030-11**

33.2 **HEAT TRACE CABLE - Urecon Thermocable C13-240-COJ**

33.3 **TEMPERATURE SENSOR #1 - Urecon URTD-15-G**

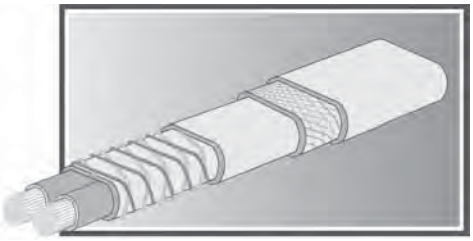
33.4 **TEMPERATURE SENSOR #2 - Urecon URTD-15-R**

33.5 **TEMPERATURE SENSOR #3 - Urecon URTD-30-G**

33.6 **POWER FEEDER KIT - Urecon PFK-4**

URECON
PRE-INSULATED PIPE

Heat trace controllers (HTC1,2), cables (HT1,2) and accessories



Submittal Data #147 E
Thermocable

Short Form Specifications

The electric heat tracing shall be constant watt parallel resistance THERMOCABLE® , supplied by Urecon.

Product Description

Urecon THERMOCABLE® is specifically designed for freeze protection of Urecon UIP® pre-insulated pipe. The THERMOCABLE® is a parallel resistance type heating strip which uses a thermally stable nichrome heating wire. The cable is has a series of heating zones which produce constant, predictable wattage per meter *(per ft)* output. Some of THERMOCABLE® features are:

- Smooth Teflon® overjacket permits easy conduit pulling
- Metallic ground braiding
- Can be cut to length in the field
- Moisture resistant
- Since Constant Watt cable does not have inrush current as with Self Limiting cables, smaller circuit breakers, wiring and fewer feed points are required resulting in reduced installation cost of the system.
- Cables are color coded for easy field identification. Helps eliminate the mistake of pulling in the wrong cable on projects where several cable types are being installed
- Over 20 years proven experience with millions of meters installed across North America
- All cable is CSA certified for wet locations

THERMOCABLE® can be used on any type of pipe, either metal or plastic. THERMOCABLE® is also available in several different watt densities and voltages as indicated on the Table 1.0.

Table 1.0 – THERMOCABLE® offered by Urecon

Part Number	Color	Watts		Volts	AWG	Maximum Circuit Length	
		per meter	*per foot*			meters	*feet*
C7-120-COJ	Blue	7	*2*	120	12	140	*450*
C8-120-COJ	Red	8	*2.4*	120	16	80	*275*
C13-120-COJ	Yellow	13	*4*	120	12	125	*400*
C10-240-COJ	Green	10	*3*	240	12	245	*800*
C13-240-COJ	Red	13	*4*	240	12	245	*800*
C20-240-COJ	Orange	20	*6*	240	12	200	*650*
C26-240-COJ	White	26	*8*	240	12	175	*570*
C13-575-COJ	Clear	13	*4*	575	12	425	*1400*
C20-575-COJ	Red	20	*6*	575	12	365	*1200*

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

Accessories

Urecon also provides electrical accessories for the THERMOCABLE® (power feed kit, splice kit, ect.) A complete listing of the electrical accessories can be found on table 1.1.

Table 1.1 – Accessories for THERMOCABLE®

A1333-12-COJ	Power and end termination kit for #12 AWG bus cable
A1333-12-COJ	Power and end termination kit for #16 AWG bus cable
E1336-COJ	Three pack end termination kits for #12 and #16 AWG bus cable
S1334-12-COJ	Splice Kit for #12 AWG bus cables
S1334-16-COJ	Splice Kit for #16 AWG bus cables
PFK 1	6m *(20ft)* power feed kit; contains all necessary material to connect two #12 AWG bus wire THERMOCABLE® on pre-insulated pipe to a Urecon Controller
PFK 4	3m *(10ft)* power feed kit; contains all necessary material to connect a 120 volts THERMOCABLE® on pre-insulated pipe to a Urecon Controller

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Local Representative

URECON
PRE-INSULATED PIPE

Submittal Data #151 E

Electronic Thermostat Model No. UTC-2030 program code # and Model No. UTC-2230 program code # (with circuit breaker)

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

This state-of-the-art electronic thermostat is designed to control one or more heating cables operating between 120 and 240 Vac having a total current draw that does not exceed 30A. It can be fitted with up to three temperature sensors as required by the application. Because separate temperature sensors are used, they may be installed on the pipe during the initial installation phase while the controller itself may be installed at a later date.

Features include:

- Universal power supply allowing operation at 120 to 240 Vac without wiring modifications (no neutral required).
- 2-pole, 30A, 240 Vac circuit breaker that allows operation from 120 to 240 Vac provides a local means of disconnect (on model 2230 only).
- Internal ground fault detection circuitry eliminating the need for an external ground fault device. “Alarm only” or “alarm and trip” is activated when ground fault condition is present.
- Three temperature sensor inputs: TS1 for pipe temperature control, TS2 (when enabled) for pipe temperature control at second location on the piping system and TS3 (when enabled) to serve as a high temperature limit for plastic piping protection. An alarm is activated when an enabled “open” or “shorted” sensor is detected.
- Low temperature alarm on both controlling sensors TS1 and TS2. Alarm level is factory set at dedicated level for each sensor. Feature is enabled at customer request.
- On-off control with a 1^0C *(1.8^0F)* temperature dead band for accurate control of piping systems. This close tolerance control can save thousands of kilowatt hours of power consumption and is ideal to control electric tracing systems in locations where power is costly.
- Override input (factory programmable): timed between 1-48 hours or non-timed. This feature forces the output “on” or “off” to suit the application.
- Auto-cycle function (when enabled) momentarily turns heating cable “on” at 24 hour interval to monitor ground fault condition of the load.
- One three-color LED indicator lamp mounted on the door of the controller operates as follows:
-
  - ❖ Green: When illuminated, the power supply to the controller is “on” and the pipe temperature at the sensor is above the set point. When extinguished, the power supply is “off”.
  - ❖ Amber: When illuminated, the temperature controller is calling for heat.
  - ❖ Red: When illuminated, this indicates that one of the alarms has been triggered. Controller is not calling for heat.
  - ❖ Amber and Red (alternating): This indicates that one of the alarms has been triggered. Controller is calling for heat.
- Non-volatile memory retains all programmed parameters in the event of a power outage.

Sensor type:
This temperature controller can be factory programmed to operate with one of two different types of temperature sensor. By default the controller is programmed for 100 ohms Platinum RTD sensor(s). It can also be programmed for 2252 ohms thermistor(s) on special request. The last two digits of the controller’s catalog number indicate the programming code. Control program codes from 01 to 49 are for use with RTDs and codes from 51 to 99 are for thermistors. Ensure that the proper type

of temperature sensor is used with the controller. Program codes are listed in tables 5 and 6.

URTD Temperature sensor:
100 ohms RTD temperature sensor for use with the UTC line of electronic thermostats. Available with 6 m *(20 ft),* 15 m *(50 ft)* or 30 m *(100 ft)* of grey or red PVC extension lead wire for ease of identification.

UTC-2030 specifications:

Alarm output:
1A max, 240 Vac max., 50/60 Hz, SPDT (form C) relay output configured for "fail safe" operation.

Approvals:
CSA "C" – "US" for ordinary locations.

Enclosure:
Nema 4, grey painted steel with ¼ turn latch.

Indicator light:
Nema 4 multi-function three color LED.

Input voltage range:
120-240 Vac, 50/60 Hz.

Monitoring and alarming:
The electronics monitor low temperature, ground fault current, open / shorted temperature sensor(s) and high cable temperature.

Operating ambient:
-40 to +40^{0}C (-40 to + 104^{0}F).

Power output:
2-pole relay output rated 30A - 240 Vac.

Terminal blocks:

Power terminals for #22 to #8 AWG		Spring loaded signal terminals for #28 to #12 AWG	
Power in	L1, N or L2	Sensors: TS1	#1 – 2 – 3 - 4
Heater out	H1, N or H2	TS2	#5 – 6 – 7 - 8
		TS3	#12 – 13 – 14 – 15
		Alarm relay	#9 – 10 – 11
		Alarm reset	#16 – 17
		Override input	#18 - 19

Factory programmable:
Note: You can use the default settings of the following features by selecting the appropriate program code.

Auto cycle:
When the temperature controller is energized, and then at 24 hours intervals, the controller performs an auto-cycle test by turning on the load to measure the ground fault leakage current. If the measured ground fault current is above the set level, the ground fault current alarm is activated. Can be disabled at the factory upon special request Ground fault detection

Factory adjustable to trip and alarm or alarm only. Setting @ 30 or 100 ma.

Remote override:
The user may force the unit on/off via a remote dry contact. Factory adjustable to operate in timed (1 – 48 hours) or continuous mode.

Temperature control: Three 3-wire 100 Ω @ 0^{0}C Platinum RTD.(alpha = 0,00385 Ω/Ω/^{0}C0, lead compensated to 20 Ω per lead.
or
three 2-wire 2 252 Ω @ 25 ^{0}C NTC Thermistor.

Dead band:
1 to 5 ^{0}C *(1.8 to 9 ^{0}F).*

Control temperature set point range:
-5 to 75 ^{0}C *(23 to 167 ^{0}F).*

Low temperature alarm:
Feature can be enabled to provide low temperature alarm on TS1 and TS2.

Low temperature set point range:
-10 to 75 ^{0}C *(14 to 167 ^{0}F).*

High cable temperature:
The third temperature sensor (referred to as TS3) is used as a high cable temperature limit for plastic piping system protection. When TS3 is enabled the high limit feature will override demand for heat and shut off the load when a high cable temperature condition is reached.

High temperature set point range:
25 to + 100 ^{0}C *(77 to +212 ^{0}F).*

UTC-2230 specifications:
Same as the UTC-2030 except for the following:
Circuit breaker: 2-pole, 30 A, 240 Vac, pre-wired to the temperature control board.

Terminal blocks:
Incoming power lugs at the circuit breaker for #14 to #4 AWG.

Enclosure:
Nema 4, grey painted steel with clips.

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Chapter 34 ALARM UNITS & CABLES

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34.1 **PROTALK PLUS ALARM UNIT B1290**

34.2 **EXPANDER UNIT FOR ALARM UNIT B1292**

34.3 **RW90 CABLES**

34.4 **RWU90 CABLES**

34.5 **TECK CABLES**

ProTalk® Plus Alarm Reporting Unit

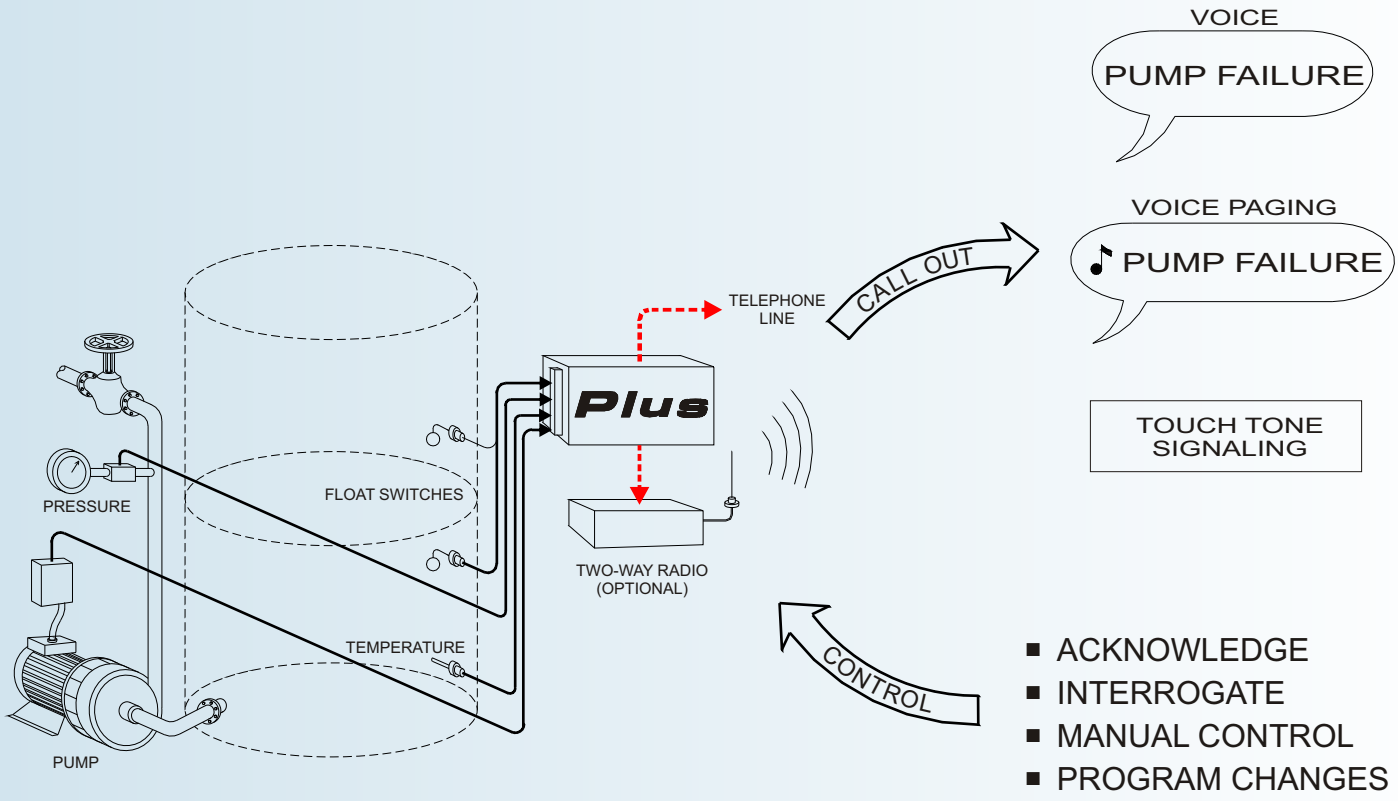
When you have access to a phone line or would like to make alarm announcements over a two way radio system the ProTalk Plus should be your first choice. With 8 Alarm inputs and 4 Relay control outputs, low temperature rating and rugged construction the Plus has been designed to ensure key personnel are informed whenever an alarm condition occurs.

Alarm messages are recorded in a toll quality voice and call out numbers can use any of the 4 directories. When an alarm occurs the Plus either key's up the radio or goes off hook and places a call to the first person in the list. When answered the Plus speaks its users recorded message and waits for an acknowledge code. If no acknowledge code is received the Plus goes to next phone number in the directory and continues till it receives an acknowledge code which stops the call out process. Additionally operators can call in to the Plus to interrogate its status, control any of the relay outputs or make programming changes.

Available accessories for the Plus include the Option 004 Battery Back-up Power Supply, Option 005 Telephone Line Transient Protector and the B1292 Expander, which provides an additional 8 alarm inputs and 4 relay outputs. Up to 7 B1292 Expanders can be used in one ProTalk Plus system.

BARNETT ENGINEERING LTD.
Telephone: (800) 268-2646 www.barnett-engg.com

ProTalk® *Plus* Alarm Reporting Unit



Key Features

- Reliable and flexible alarm monitoring
- Telephone line callout
- Two-way radio interface for alarm announcements on private radio systems (including paging) or PA systems
- 8 alarm inputs
- 4 control outputs
- Data logging of system events
- Field upgradable firmware
- CSA approved
- -40°C to +60°C temperature range

BARNETT ENGINEERING LTD.
Telephone: (800) 268-2646 www.barnett-engg.com

ProTalk® Plus Alarm Reporting Unit

Specifications

Physical	8.2” wide x 6.5” high x 2” deep Steel, powder coated matte black Mounting ears for panel installation
Environment	-40°C to + 60°C, 95% humidity, non-condensing
Connectors	Plug-in screw terminal block unless noted
Power	+10 to +30 VDC, negative ground, 50 mA standby, 150 mA maximum current, 10 mA per active relay A DC power source can be connected to the terminal block or a B1256 AC adapter can be connected the 2mm barrel jack
Alarm Inputs (8)	Optically isolated, 2 mA to operate, ground closure required
Relay Outputs (4)	Independant Form C outputs controlled by programmable codes or used as special function outputs. Rated: 1A at 30 Volts DC, 0.3A at 120 Volts AC
Radio Port	TX audio: 600 ohms, single ended, capacitor coupled – adjustable between 0 dBm and -20 dBm RX audio: 10K ohms, single ended, capacitor coupled – adjustable between 0 dBm and -20 dBm PTT output: Open collector, 25 VDC maximum, 150 mA maximum COS (channel busy) input: Ground closure, 1mA to operate
Telephone Port	RJ11 connector, tone or pulse dial
Program Ports	Telset: RJ11 connector, internal telset bias from the primary power supply - operates with standard touch-tone telephones USB: USB type B connector
Acknowledge Input	Ground closure, 1 mA to operate
Voice Quality	Digitized, toll quality, 64 kbps
Indicators	Alarms (8) - Red LED Outputs (4) - Red LED Status - Green LED Run Tone Voice Ring Hook PTT
Speaker	Internal, 100 mW, manual level adjust with externally accessible potentiometer
Expander Port	2.5mm jack for connection to B1292 expander modules - up to 7 expanders can be used

BARNETT ENGINEERING LTD.
Telephone: (800) 268-2646 www.barnett-engg.com

ProTalk® *Plus* Alarm Reporting Unit

Programmable Features

Voice Messages	Site Name, Alarm Names and Relay Names are user recorded, non-volatile. Can be recorded directly into the Plus unit or by using the PC Voice Editor.
Alarm Format	Selectable as Normally Open or Normally Closed. Can be either latching or momentary.
Alarm Format	Selects the delay time before a change at an input is recognized. Programmable from .1 to 19.9 in seconds or minutes.
Interval Timer	This 2 stage timer uses 'A' interval 'A' times before switching to the 'B' interval. The 'A' interval is adjustable between 1 and 249 minutes. The 'B' interval is adjustable between 0 and 249 minutes. (0 selects Auto Acknowledge)
Call Progress	When enabled, dial tone must be detected before dialing and voice activity before speaking.
Rings Before Answer	1 to 8 rings or never.
Access Code	Restricts remote access to only authorized users, 1 to 8 DTMF digits.
Acknowledge Code	Stops the alarm reporting cycle when received, 1 to 8 DTMF digits.
Interrogate Code	Forces annunciation of all active alarms, 1 to 8 DTMF digits.
Directory Control Code	Changes the directory that the alarms use for call out, 1 to 8 DTMF digits.
Alarm On/Off Codes	Sent when an alarm is active (on) or idle (off), separate on/off codes for each alarm.
Ack Voice Disable	Removes the request for an Ack code after alarm announcement. Useful for paging or PA systems.
Relay Format	Relays can be programmed as On/Off, Timed or Special Function Special functions are: new alarm, any alarm, acknowledge receipt or system error.
Relay Control Codes	When received, turns the relay On or Off, separate codes for each relay.
Relay On Time	Selects the On interval for a timed relay, programmable from 1 to 199 in seconds or minutes.
Relay Voices	Selects whether the state of enabled relays is spoken or not.
Alarm Reporting	Radio or telephone reporting is configurable to occur anywhere in the call out sequence.
Directory Format	4 selectable directories hold alarm reporting sequences. Inputs can be individually assigned to any directory.
Telephone Numbers	Up to 16 call out numbers in each of the 4 directories; each directory can hold 200 digits.
Radio Port	TX and RX level settings, PTT warmup interval, COS operation.
Radio Signaling	DTMF, 2 tone paging, five tone paging and single tones can be transmitted.
Remote Input Codes	When received, simulate an alarm activation, separate codes for each alarm; 1 to 8 DTMF digits.
Number of Expanders	Selects the number of attached B1292 expander modules, selectable from 0 to 7.
Event Logging	Alarm reporting events are automatically logged and can be retrieved by the PC application. A precision Real Time Clock is used to timestamp the events.
Voice Editor	This utility can be used to create and edit message files containing the user programmed phrases spoken by the unit. Phrases extracted from a message file or from a wave file can be used.
Update Firmware	Firmware upgrades and option activation can be done using this utility. Upgrade files are sent to the unit and the internal flash memory is updated. Options in the unit can be activated with the supplied option code.
Text Names	A text name can be assigned to the site, alarms and relays, up to 16 characters in length. These names are used for identification during event logging. The Voice Editor can import names from the program database.

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ProTalk® Plus

Installation & Operation Manual

December 2013
Rev. 2.03

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1. INTRODUCTION

This manual is for use with both Version 1 and Version 2 of the ProTalk Plus.

Additional features available on the version 2 model are:
- USB serial port – replaces the RS232 port
- Event Logging including a high stability real time clock
- Field reprogrammable firmware upgrades

Basic Operation

The ProTalk Plus model B1290 is a device used to monitor alarms at an unattended site. If an alarm occurs, such as building intrusion, power failure, high or low temperature or equipment failure, the B1290 automatically dials out on the telephone line. When the telephone is answered, the B1290 announces, in a clear voice, the name of the site and the alarm condition that has occurred. If there is no answer, the B1290 will continue to dial through a list of telephone numbers until it reaches someone and is able to report its alarm.

This manual describes the basic operation of the ProTalk Plus model B1290, and its most common applications. The B1290 can, however, be programmed to perform many more functions at the discretion of the user. It can announce alarms over radio, telephone, a public address system or any combination thereof. It can also be programmed to send coded tones along with the voice messages to activate such devices as radio pagers, relays or annunciator panels. It can be used as a master station to concentrate alarms from a number of remote sites. It can be commanded to perform remote control functions by receiving codes from a tone telephone. Expanders can be added to increase the capacity of the unit from the basic 8 alarm inputs and 4 relay outputs up to 64 alarm inputs and 32 relay outputs.

The B1290 can be completely customized for your application as all of the operating parameters are programmable by the user, including the voice messages. The B1290 can be programmed using a standard tone telephone. Stored voices in the B1290 prompt you step-by-step when you are entering new voice messages or codes, and speak back all the values that you have saved.

Using the PC software, it is also possible to program the B1290 from a computer. All of the information in the B1290 can be read, written and stored. This manual concentrates on handset programming; refer to the Help files in the PC programming application when using it to configure the B1290.

If event logging is used with the Version 2 model, the log reports can be read from the B1290 and saved to file.

The programming sections of this manual describe how the B1290 is configured with a phone set. Instructions for programming with the software application are found in the Help section of the program.

2. HOW TO USE THIS MANUAL

This manual is organized in such a way that, if you want the B1290 to function with its default settings as a simple telephone dialer, you only need to read the first two chapters of the manual covering the physical installation, basic programming and operation. If you wish to change some of the default settings or have the B1290 perform more advanced functions, continue on to the next chapter where the Program Codes are described in detail. Several step-by-step examples of programming the B1290 into different configurations are provided. The final chapter describes some of the problems most commonly experienced when the B1290 is first installed, and gives advice on troubleshooting.

3. GETTING STARTED

Description

The B1290 is housed in a metal case with plug-in terminal blocks and jacks for field wiring. Table 1 and Figure 1 show the connection points to the B1290. Figure 3 shows how wiring connections are made to the unit.

Table 1 ProTalk Wiring Connections

RADIO

1	Radio TX
2	Radio RX
3	PTT Output
4	COS Input
5	Ground
6	ACK Input
7	Ground
8	+11.5 to +28 power (Version 1) +10 to +30V power (Version 2)

RELAYS

1	Relay 1 NC
2	Relay 1 Common
3	Relay 1 NO
4	Relay 2 NC
5	Relay 2 Common
6	Relay 2 NO
7	Relay 3 NC
8	Relay 3 Common
9	Relay 3 NO
10	Relay 4 NC
11	Relay 4 Common
12	Relay 4 NO

SERIAL – RS232 (Ver.1)

2	RXD
3	TXD
4	DTR
5	GND
6	DSR

ALARMS

1	Alarm 1 Input
2	Alarm 2 Input
3	Alarm 3 Input
4	Alarm 4 Input
5	Alarm 5 Input
6	Alarm 6 Input
7	Alarm 7 Input
8	Alarm 8 Input
9	Ground
10	Ground

POWER

2.1mm power, centre ground

PHONE

RJ11 Line 1

PGM

RJ11 Line 1

EXP

2.1 mm mono, centre data

SERIAL – USB (Ver.2)

1	VBus
2	D1
3	D+
4	GND

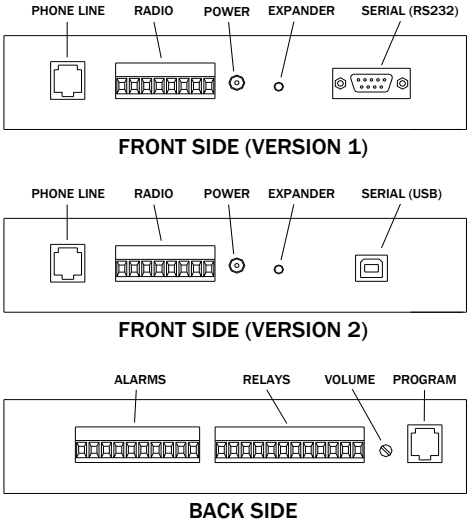


Figure 1 Connector Locations

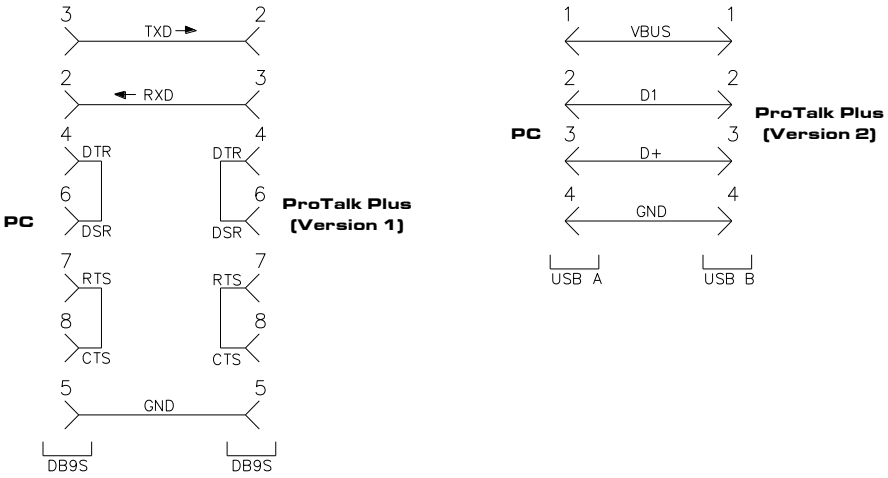


Figure 2 Programming Cable Wiring

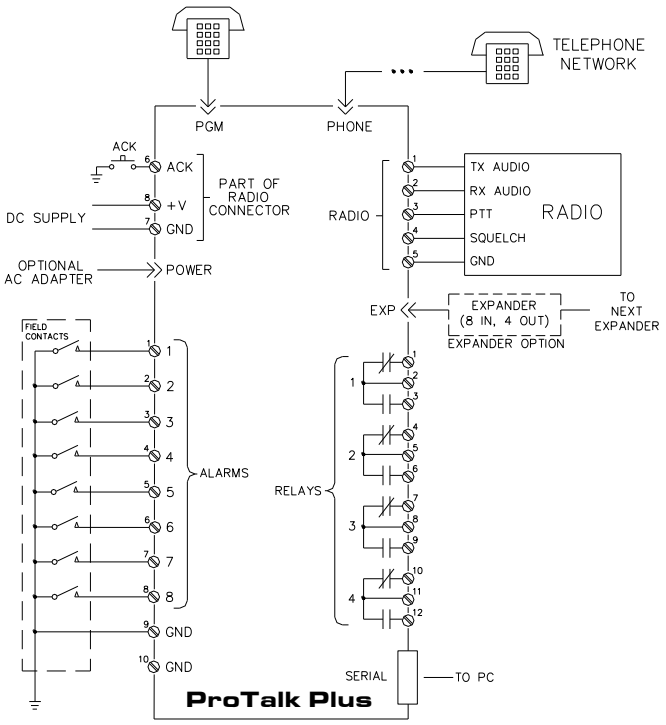


Figure 3 ProTalk Plus Wiring Diagram

Power Requirements

The B1290 will operate from a supply of +11.5 VDC to +28 VDC (Version 1) *or* +10 VDC to +30VDC (Version 2). The typical current requirement is 100 mA plus 10 mA per relay. Each expander uses an additional 60 mA plus 10 mA per active relay.

Connect power only to one of the two available inputs: the DC inputs on the Radio terminal block or the plug used with an AC adapter. The power supply used should be a safety approved Class 2 power supply source, current limited using a 2A in line slow blow fuse.

Installation

The B1290 should be installed in a clean, dry place suitable for electronic equipment. The unit will operate from -40ºC to +60ºC.

Caution: Power and the telephone line should not be connected until the rest of the installation is complete.

Use a flat blade screwdriver to make connections to the screw terminals on the sides of the enclosure.

Alarms

In its default condition, the B1290 looks for a normally open (NO) contact which closes to ground to indicate an alarm. The B1290 may also be programmed to accept inputs normally closed (NC) to ground which open on an alarm condition. To change this parameter, refer to the alarm format in I/O Configuration - Program Code 5. Ensure that all unused alarm points are either disabled or connected to ground when using NC contacts. Refer to Figure 4 for details on how to connect an alarm signal line.

All of the alarm inputs are optically isolated and are operated from the B1290's internal 12 volt supply.

Connect the alarm inputs to the positions labeled 1 through 8 on the ALARM terminal block.

Caution: DO NOT connect a voltage source to the alarm inputs.

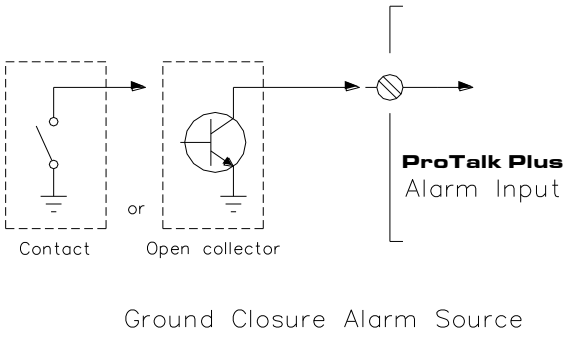


Figure 4 Alarm Input Connection

Relays

Four form C relay outputs are available, rated for 1.0 A at 30 VDC, or 0.3 A at 120 VAC. Connect external devices to the contacts on the RELAY connector. When connecting to larger loads, connect an interposing relay between the B1290 and the load.

Radio

If the alarms are to be announced over a radio, connect TX to the transmit audio of the radio, and RX to the receive audio. *RX should always be connected to squelched audio*. Independent transmit level adjustments are available for voice, DTMF and tone signals. Adjust the levels of the transmit audio signals using the programming phone or the software setup. For the receive level adjustment, set the programmed level to match the level of the incoming signal: for a -10 dBm received signal from the radio the programmed value would be -10 dBm. The range of adjustment for both receive and transmit signals is -20 dBm to 0 dBm.

The PTT output provides a ground closure through an open collector to signal the radio to transmit. Connect this point to the radio's push-to-talk circuit. The maximum rating is 150 mA, 25V.

The COS input is used to indicate to the B1290 whether the radio channel is busy. Connect this point to the output of the radio's carrier-operated switch or relay (COS or COR). In its default condition, the B1290 looks for a high signal to indicate the channel is clear and a low signal when the channel is busy. The B1290 may also be programmed to recognize the reverse polarity. To change this parameter, refer to the squelch polarity in System Settings - Program Code 6. This input is internally pulled up to work with open collector radio outputs. In its default program condition, the input is pulled high when clear and driven low when busy.

Local Acknowledge

This input is used to acknowledge an alarm locally at the B1290 without having to call in over the radio or telephone. Connect the ACK input to a normally open contact which will be grounded to acknowledge the alarm.

Telephone

The telephone line is connected to the RJ11 jack labeled PHONE on the side of the B1290. The line should be using the inner (red/green) pair. Audio levels to the telephone line are fixed internally in conformance with FCC regulations.

The telephone should always be the last item connected.

Caution: DO NOT plug the telephone line into the PGM jack, as damage could result to the B1290.

Expanders

Expanders are used to increase alarm and relay capacity of the B1290. They come in their own metal cases with all connectors clearly labeled. Expanders must be located in close proximity to the master B1290 unit for them to communicate properly. The new B1290 Version 2, when paired with the B1292 expander, can yield a maximum

distance of 100ft. All other combinations of past units (B1290 Version 1 and/or B1290E) are limited to a 14ft maximum distance. Shielded cables are provided to connect between the units and are cut to accommodate the maximum allowable distance of previous versions. Custom cables lengths are required for any other distances. Substituting cables is not recommended.

The alarm and relay connections on the expander are the same for the B1290 connections. Use the shielded cable provided to connect between the EXP connector on the B1290 and EXP on the expander. On subsequent expanders, use the cable supplied with the expander to connect between EXP on one expanders and EXP on the next.

Next set the rotary switch on the expander to configure its ID number. *(refer to the B1292 manual for more information)*

If the expander address is changed, the unit must have power removed and then reapplied in order for the master to recognize its new address. All the expander's programmed parameters, including the voice messages, are stored in the main ProTalk Plus and are downloaded on power-up.

The expander database will be automatically transferred from the ProTalk Plus if an expander address is changed or an expander is replaced.

The expander requires its own +12/+24 VDC and GND connections. Be sure that all units, master and expander(s), are always powered up and down together. Do not connect or disconnect expander cables when the system is powered up.

The PWR LED lights when the power is on. The expander also has an RX LED which lights when it is being polled by the master B1290, and a TX LED which indicates when it is responding.

Power-up Sequence

Once the installation is complete, DC power can be connected to the B1290. On start-up, the B1290 will go through a self-test sequence; ending with the firmware version being spoken over the speaker and the RUN LED staying on solid.

The telephone line may then be plugged in as the last connection. *Ensure that the telephone is connected into the PHONE port on the B1290.*

Start-up Programming – Version 1 Only*

**for Version 2 information, see tutorials on the programming disc included with this unit or visit our website at www.barnett-engg.com/support.*

Introduction

Now you are ready to begin programming. When the B1290 is initially powered up, it will prompt you to input three parameters which must be entered before it can operate — the voice messages, a list of telephone numbers and the Acknowledge Code. Once these values have been entered, with its default settings, the unit will function as a telephone dialer when an alarm is present. If you require the B1290 to perform more advanced functions, continue on to the chapter where the Program Codes are explained in detail.

Before you start programming, there are a few points with which you must be familiar. First, although it is possible to program the B1290 remotely by calling it up over the telephone line, it is assumed that when you initially install the unit you will be using a local programming phone. The B1290 must be programmed with a phone which sends DTMF tones (Touch Tone); it will not recognize the signals from a phone which sends dial pulses.

The B1290 is designed to be user friendly. When you listen in the earpiece of the programming phone, you will hear spoken messages. These are called voice "prompts", and they tell you what information the B1290 is expecting you to enter. Whenever you program a new value, the B1290 will immediately speak that parameter back to you, so you will know right away whether the code was entered correctly. You can change a parameter as many times as you like before going on to the next one. If you make a mistake, such as entering a value outside the range for that parameter, the B1290 will immediately let you know by announcing *Error*. And if you get confused, just hang up the phone and start again. The B1290 will start again at the beginning when you pick up the handset.

The other feature you need to know is how to enter data. If you were entering information from a keyboard or other terminal, you would use the "Enter" key or a "Carriage Return". A telephone does not have this key, so we substitute the code (*)(*) for "Enter". The two "stars" (asterisks) must be entered one after the other, with no more

than one second between the beginning of the first digit and the beginning of the second. This is a much longer time than most people think, and there is no need to rush when entering the code. If you enter the digits too fast, the telephone will only recognize one (*). You may get an *Error* message if this happens or else the B1290 will ignore the entry and wait for another (*)(*). The (*)(*) code is used throughout the programming sequence to enter information or proceed to the next step. With practice you will soon determine the correct speed.

Where the (#) digit is used in a DTMF code or a telephone number it must be entered as two # digits. For example, the DTMF code (#)(2)(#) would be entered as (#)(#)(2)(#)(#).

The B1290 will not work correctly until all three of the required parameters have been entered, so if you hang up in the middle of this procedure, the B1290 will take you back to the beginning of the sequence the next time you come off hook.

Throughout the programming sequence, the unit will speak stored parameters using a prompt, followed by the word "is", then the stored data. For example, to tell you the Acknowledge Code is set to 1234, the B1290 says *Acknowledge Code is 1234*. Input from the telephone's keypad is expected following this message. Whenever voice messages are required, the unit will beep twice, prompting the user to speak into the telephone handset.

Site ID and Voice Alarm Messages

Plug any standard tone telephone into the jack labeled "PGM".

Lift the handset to your ear. You will hear the B1290 speak the words *Program voice; site is* followed by silence since there is no voice message programmed.

B1290: "Program Voice"

B1290: "Site is…"

The B1290 is prompting you to enter the name of the site. The name you program will be announced at the start of every message along with the list of alarms. To record the voice message, enter the record code ((2)).

YOU: (2)(*)(*)

After you hit the second star, the B1290 will prompt you with a beep-beep tone.

B1290: "beep-beep"

As soon as you hear the tone, you can begin to record your message. The VOICE LED on the front panel will light while the B1290 is recording. Speak the name of the site, e.g. Ajax Compressor Station. The B1290 detects when you stop speaking and automatically plays back the message. The VOICE LED will light while it is playing back. *Do not hit any keys when you are finished recording your message; pauses between words may cause the recording to terminate.*

YOU: "Ajax Compressor Station"

B1290: "Site is Ajax Compressor Station"

Did the message played back sound acceptable? If you think it could be improved, enter the record code ((2)) followed by (*)(*) again and repeat the message as many times as you like. Once you are satisfied with the way the message sounds, hit the enter code ((*)(*)).

YOU: (*)(*) *Next*

The B1290 will prompt you for the next entry.

B1290: "Alarm One is... "

Repeat the above steps to record the alarm message, e.g. power failure.

YOU: (2)(*)(*)

B1290: "beep-beep"

YOU: "Power Failure"

B1290: "Alarm One is Power Failure."

Repeat the above steps until you are satisfied with the way the message sounds.

YOU: (*)(*) *Next*

B1290: "Alarm Two is... "

Enter the voice message associated with the second alarm point, e.g. intrusion alarm.

YOU: (2)(*)(*)

B1290: "beep-beep"

YOU: "Intrusion Alarm"

B1290: "Alarm Two is Intrusion Alarm"

YOU: (*)(*) *Next*

B1290: "Alarm Three is... "

Repeat the above steps until all the alarm points have been programmed. When you have entered all the voices, enter Quit ((#)(*)(*)) at the announcement of the next empty alarm. If you use all eight alarms, the B1290 will automatically advance after you enter the last voice message. The next step in the startup process is to program the telephone numbers.

YOU: (#)(*)(*) *Quit*

Telephone Numbers

B1290: "Program Directory"

B1290: "Directory A, Line One, is Radio Alert Voice" (*default*)

The B1290 has just spoken the actions that will occur from the commands on the first line in Directory A. The default radio announcement will now be replaced with a phone call-out command. Enter (2) to indicate you want to program the line with new commands.

YOU: (2)(*)(*) *Change line*

B1290: "beep"

Details on how directory commands are entered are shown in Program Code 2 Directories. The startup process described here provides only the basic auto-dialer configuration.

Enter the phone number using the pushbuttons on your telephone. The entry shown below will result in the B1290 dialing the selected number and then speaking the alarm messages. The (#)(0) at the beginning is the DIAL command, followed by a (#)(8) command for VOICE.

YOU: (#)(0) (4)(0)(3)(2)(5)(5)(9)(5)(4)(4) (#)(8) (*)(*)

B1290: "Directory A, Line One is DIAL 4032559544 VOICE."

If there is an error in the entry, hit the program code (2) followed by (*)(*) and try again. If the sequence is played back correctly, hit the enter code.

YOU: (*)(*) *Next*

B1290: "Directory A, Line Two is empty"

The B1290 is prompting you for the second directory line. The commands entered for line 2 are what will occur if there is no acknowledgement after the first line commands are completed during operation.

YOU: (2)(*)(*) *Change line*

B1290: "beep"

YOU: (#)(0) (4)(0)(3)(2)(5)(5)(2)(3)(4)(3) (#)(8) (*)(*)

B1290: "Directory A, Line Two is DIAL 4032552343 VOICE."

YOU: (*)(*) *Next*

B1290: "Directory A, Line Three is empty."

The B1290 is prompting you for a third telephone number to dial if it cannot get an acknowledgement from the first two. Continue entering telephone numbers up to a maximum of twenty. If you are not using twenty numbers, enter the Quit code (#) at the prompt. If you hit the Enter code (**) for an empty telephone number, the B1290 assumes that you have no more telephone numbers to enter and will jump to the next function.

YOU: ** *Next*

or

YOU: #** *Quit*

Acknowledge Code

B1290: "Program Acknowledge Code."

B1290: "Acknowledge Code is 1234."

The B1290 is prompting you to enter an acknowledge code. This is the code you send to the B1290 when it calls you to announce an alarm, to acknowledge that you have received the message, otherwise the unit will keep on dialing. 1234 is the default code. You may use this code or enter a different one from 1 to 8 digits in length. It should be something easy to remember.

YOU: 2468**

B1290: "Acknowledge Code is 2468."

YOU: ** *Next*

B1290: "Enter Program Code"

The B1290 is prompting you to enter a Program Code if you need to program more advanced functions into the unit. If you require them, proceed to the chapter where Program Codes are explained in detail. Otherwise, hang up the programming phone.

At this point the B1290 will function as an alarm reporting unit over the telephone, dialing through the numbers you have programmed into Directory A until it is answered, then announcing the voice messages you have recorded to report an alarm.

These parameters will be stored indefinitely and you will not be prompted to enter them again.

The next time you lift the programming phone off hook, the B1290 will announce its status and prompt you to *Enter Control Code*. DO NOT enter any codes from the telephone. WAIT five seconds; the B1290 will time out and automatically enter the programming mode. When you hear the prompt *Program Access; Enter Program Code*, you may begin programming.

Do not remove power from the B1290 while you are programming. Always put the telephone handset back on-hook before removing power.

4. FRONT PANEL

The front panel of the B1290 is shown in Figure 5. The description of the front panel indicators will assist you in verifying the correct operation of the unit.

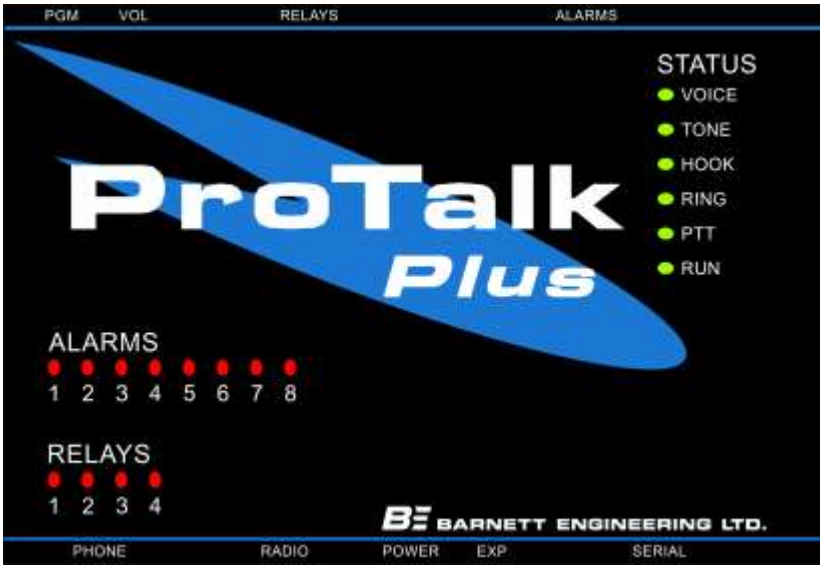


Figure 5 ProTalk Plus Front Panel

Alarm LEDs

The Alarm LEDs light when the associated alarm input is in the alarm state. Unacknowledged alarms will be flashing and any that have been acknowledged will be on solid.

Relay LEDs

The Relay LEDs light whenever the associated relay is on.

Voice

The Voice LED is on whenever the B1290 is recording or playing user messages. It flashes when vocabulary messages are being played or when there is an error in the user voices.

Tone

The Tone LED is on for the duration of a transmitted DTMF digit or other generated tone. It will also be on when call progress tones are detected on the phone line. It will flash once for each received or transmitted DTMF digit.

Hook

The Hook LED comes on whenever the B1290 goes off hook, to dial or answer the telephone. It will flash if a phone port error is detected (no dial tone or other expected call progress signal). The hook LED will also flash during pulse dialing.

Run

Version 1: The Run LED will be on steady when the B1290 is operating correctly; it will flash if an error condition is present.

Version 2: The Run LED will flash when the B1290 is operating correctly.

Ring

When ringing is detected on the telephone line, the Ring LED illuminates. Since answering the telephone is a low priority task to the B1290, it may ignore the ringing if it is processing other tasks (e.g. speaking on the radio).

PTT

The PTT LED will light when the B1290 generates a push-to-talk signal to the radio.

5. OPERATION

This chapter gives a detailed description of exactly how the B1290 will operate after the start-up programming has been completed. Parameters which may be altered are pointed out, with reference to the appropriate Program Code section.

Alarm Sequence

When the B1290 receives an alarm on one of its inputs, it goes off hook and listens for dial tone. If dial tone is not present, the B1290 will hang up and try again. After three unsuccessful attempts to detect dial tone, the B1290 will conclude there is a problem with the line and stop dialing. When this occurs the unit will report *Telephone Access Error* over the radio, set the error relay and flash the RUN and HOOK LEDs.

If dial tone is detected, the B1290 dials the first telephone number stored in Directory A using tone dialing. When the telephone line is answered, the B1290 will announce its Site ID, the list of any alarms present, and prompt the user to *Enter Acknowledge Code*. It will repeat this message a minimum of three times, pausing five seconds after each announcement to wait for an acknowledgment. When the Acknowledge Code is detected, the B1290 will announce *Alarms Acknowledged* and then prompt "Enter Control Code".

If the line is busy, if there is no answer, or if the B1290 does not receive the Acknowledge Code after announcing the alarm, it will hang up the telephone line, then go off hook again and dial the next number in the directory. If the B1290 dials all the way through the directory without being acknowledged, it will wait two minutes (Interval Timer A), then start dialing again from the top of the directory. After three tries (Times A) at two minute intervals, the B1290 will retry the list every ten minutes (Interval Timer B) thereafter, not stopping until it is acknowledged.

All of the timers and intervals mentioned above are adjustable. In addition, the B1290 may be programmed to announce the alarm a number of times over radio, or a public address system, as well as dialing on the telephone.

Acknowledging an Alarm

When the B1290 calls you on the telephone, it may take up to five seconds before it starts speaking. After it announces the alarms, it prompts you to *Enter Acknowledge Code.* You have five seconds to begin entering the digits.

If the B1290 has been programmed to operate its relays (Program Code 3, DTMF Codes), you may send a relay code over the telephone before acknowledging the alarms. The B1290 will actuate the relay, speak the associated voice message, and then prompt you again to *Enter Acknowledge Code.*

After the B1290 has detected the Acknowledge Code, it will speak the phrase *Alarms Acknowledged* and return to the "Enter Control Code" prompt. If no activity occurs for 5 seconds it will hang up.

Appending the # digit at the end of the Acknowledge code allows you to acknowledge the alarm for sixty minutes only. After one hour, the B1290 will check the alarm inputs again, and if the same alarm is still present, it will begin the reporting cycle just as if it was a new alarm.

Any series of digits entered immediately after the acknowledge code will be echoed back to the user. This feature is sometimes used in systems applications.

To acknowledge the B1290 locally, activate the local acknowledge switch connected to the unit (see the section on "Installation - Local Acknowledge"). The alarms may be acknowledged at any time. The *Alarms Acknowledged* announcement will occur whenever the B1290 is available to speak.

Telephoning the B1290

When you call the B1290 on the telephone, it will answer after four rings (Rings before Answer) and announce its site ID, any alarms which are present, and the status of any relays which have been assigned codes. After this announcement, the B1290 will prompt you to *Enter Control Code*. The B1290 then waits ten seconds for you to enter a code. This could be a code to operate one of the relays, an Acknowledge Code, an Interrogate Code, or an Access Code which would allow you to go into the programming mode. If an Access Code (password) has not been programmed, the B1290 will automatically go into the programming mode after five seconds, prompting you to

Enter Program Code. You may then program the B1290 from your telephone, the same as you would from a local programming phone.

The B1290 will hang up whenever it has waited for more than ten seconds without receiving a DTMF code.

Changing Telephone Directories

Telephone directories can be changed remotely without entering the programming mode. The directory can be changed by entering the Directory Control Code over the telephone system, local programming telephone, or two-way radio.

Refer to the Directory section, Program Code 2, for a description of the directory format and its uses.

This example uses the local programming phone to change the telephone format from DIRECTORY A to DIRECTORY B and then to DIRECTORY C. A typical installation may use a programming telephone mounted permanently at the site to make this procedure as simple as possible.

B1290:	"Enter Control Code"
YOU:	000
B1290:	"Telephone Format is Directory B"
YOU:	000
B1290:	"Telephone Format is Directory C"

It is also common to enter this code using a DTMF keypad over the radio system when the operators at the site change shift.

The B1290 will not allow an empty directory to be selected.

Error Messages

The B1290 will speak error messages when it is called on the phone line, interrogated over the radio port or when the local program phone is used.

Hardware Error

The B1290 speaks *Alert - Site Error* when either the user voices or the vocabulary memory space is corrupt.

Database Error

The B1290 speaks *Alert - Program Error* when either the configuration database is corrupt.

Phone Error

The B1290 speaks *Alert - Telephone Access Error* when there has been a call progress error, such as no dial tone, during a phone call.

Expander Error

The B1290 speaks *Alert - Expander Error* when a communication error is experienced with an expander.

6. PROGRAM SUMMARY

The codes used in the main programming menu are given as a summary below.

1 * * Voices (page 16)

2 * * Directories (page 17)

3 * * DTMF Codes (page 20)

4 * * Timer Configuration (page 21)

5 * * I/O Configuration (page 22)

6 * * System Settings (page 25)

7 * * Expanders (page 26)

8 * * Reset Database (page 27)

9 * * Audio Levels (page 27)

7. PROGRAM CODES

How to Enter the Programming Mode

To begin programming, you must hear the prompt *Enter Program Code* from the B1290. One way to get to this prompt was discussed in the chapter on **Getting Started**. After you have entered the initial voice messages, telephone numbers and an Acknowledge Code, the B1290 will prompt you to begin programming. A local programming phone may be used at any time to alter parameters. It is also possible to program the B1290 remotely by calling into it over the telephone line.

If you call a B1290 over the phone once it has been programmed, it will answer after four rings (default) and announce its site ID, any alarms present, the status of the relays (if they have been programmed) and any error status messages. Then it will prompt you to *Enter Control Code.* If the unit has been programmed to operate with a password, you must enter the Access Code at this time. The B1290 will reply with *Program Access* and prompt you to *Enter Program Code*. If an Access Code has not been programmed, the B1290 will time out after five seconds and automatically enter the programming mode. You will hear the prompt *Program Access; Enter Program Code*.

When you connect a local programming phone, the B1290 goes through a similar sequence. It will announce its site ID, any alarms present, the status of any programmed relays and any error status messages. Then it will prompt you to *Enter Control Code*. It is not necessary to know the Access Code to program from the local phone. Wait five seconds, and the B1290 will automatically prompt you with *Program Access; Enter Program Code*.

IMPORTANT: Remember that all programming codes must be followed by the "(*)(*)" code to enter them.

The following chapter, **Programming Reference**, divides the programming parameters into functional blocks. Refer to that chapter to determine the parameter changes required for a specific function.

Appendix C is a **Programming Tree** for the B1290. It gives an overview of the parameters which may be programmed and how they are organized. The Program Codes are explained in detail in the next section.

(1)(*)(*) Voices

When you enter Program Code 1, you will hear the following prompt:

B1290: "Enter Voice Code"

YOU: (1)(*)(*) *Record Site ID and alarm messages*

(2)(*)(*) *Record relay messages*

(3)(*)(*) *Erase all messages*

(*)(*) *Exit to Enter Program Code prompt*

Record Site ID and Alarm Messages

Record the voice messages associated with the unit (site ID) and each individual alarm point. These are the messages which will be announced over the radio or telephone whenever the alarm is present.

B1290: "Site is Ajax Compressor Station"

YOU: (2)(*)(*) *Record*

(#)(*)(*) *Quit*

(*)(*) *Enter/Next*

Default: empty

If the message is OK, continue by hitting Enter. If you would like to record a new message, enter (2)(*)(*) to record. As soon as you hit the second asterisk of the Enter code, the B1290 will beep, prompting you to record a voice message. When you stop speaking, the B1290 will detect your silence and immediately play back the message that you recorded. Pauses between words may cause the recording to terminate. Do NOT enter (*)(*) during the recording as the tones will disrupt normal callout operation. Repeat as many times as you need until the voice

message sounds acceptable. Then hit Enter (*)(*) to proceed, or (#)(*)(*) to return to the Enter Voice Code prompt. Entering Next advances to the alarm message section and the first alarm message will be spoken

B1290: "Alarm One is …"

YOU: (2)(*)(*) *Record*

(#)(*)(*) *Quit*

(*)(*) *Enter/Next*

If you enter messages for all eight alarms, the B1290 will automatically exit to the Enter Voice Code prompt.

Default: empty

Record Relay Messages

Record the voice messages associated with each relay. Note that the messages will only be announced if the relays have been programmed to operate from a string (see Program Code 3, Relay On/Off Codes). When a relay is operated, the B1290 will speak the voice message followed by the word "On" or "Off" to verify that the action was taken.

In some applications, it is not necessary to have voice confirmation when a relay is operated. To disable this feature, refer to Program Code 6 - Relay Voices.

The B1290 will always announce the condition of the relays when it is called up or interrogated for status.

B1290: "Relay One is ... "

YOU: (2)(*)(*) *Record*

YOU: (#)(*)(*) *Quit*

(*)(*) *Enter/Next*

Default: empty

Erase All Messages

B1290: "Enter Voice Empty Code"

YOU: (#)(3)(1)(*)(*) *Erase (exit with any other entry)*

B1290: "Voice is Empty"

YOU: (*)(*) *Enter/Next*

(2)(*)(*) Directories

There are four directories in the B1290. To allow different alarms to perform different actions when they are active, each alarm can be selected to use any one of the directories. Each directory defines a unique sequence of actions. There is also a Directory Control Code that modifies the directory selection that the alarms are programmed for. When this code is used there are restrictions placed on how the alarms are assigned to directories. There are three possible ways that the directories can be used.

1. If there is No Directory Control Code:

   Alarms can be assigned to any of the four directories and will always use the one that has been assigned.

2. If there is a Directory Control Code (method 1):

   Alarms can only be assigned to Directory A. When the Directory Control Code is received, the directory usage is modified such that the alarms now use the next directory with commands in it. If Directory B has commands, then it will be used. When the Directory Control Code is received again, directory usage advances to the next directory with commands in it.

   If all four directories have commands in them, then the Directory Control Code will simply advance to the next directory each time it is received. If the current setting is Directory D when the code is received, then it will return to Directory A.

If the next directory is unused, it will be skipped.

3. If there is a Directory Control Code (method 2):

If the alarms are assigned only to Directory A and Directory C, when the Directory Control Code is received, all of the alarms that are assigned to Directory A will switch to use Directory B and all of the Alarms assigned to Directory C will switch to use Directory D. When the Directory Control Code is received again, directories A and C will become the active directories.

Alarms cannot be assigned to Directory B or Directory D when this mode of operation is selected.

The directory structure is made up of a list of lines with each line containing a sequence of instructions. The B1290 performs the actions defined in each line then waits for a response. If the expected response is not received, the actions in the next line are carried out

Commands are placed into the directory line-by- line with a series of digits representing the required actions.

Commands that can be used in the directory and the digits used to select them are:

- #0 Dial + digits
- #1 Radio
- #2 Wait + 1-3 digits (seconds)
- #3 Alert
- #4 Two Tone Paging + (4 or 5 digits) + *+ (4 or 5 digits)
  (frequencies in .1 Hz. ie: 12345 would be 1234.5 Hz)
- #5 Five Tone Paging + 5 digits (5 digit cap code)
  or Five Tone Paging + 1digit + * + 5 digits (preamble+ cap code)
- #6 Single tone + (4 or 5 digits), frequency in .1 Hz. ie: 12345 would be 1234.5 Hz
- #7 DTMF + 1-16 digits
- #8 Voice
- #9 Answer

When Program Code 2 is selected, the B1290 responds with the prompt:

B1290: "Enter Directory"

YOU: 1** *Directory A*
2** *Directory B*
3** *Directory C*
4** *Directory D*
0** *Help (speaks a summary of commands)*
#** *Quit*

If one of the directories is selected, a typical response would be:

B1290: "Directory A, Line One is DIAL 4032559544 WAIT 3 SEC VOICE"

This is the command sequence in the first line of the directory and would result in the B1290 dialing the number 2559544, waiting for 3 seconds and then speaking the voice messages. At this time the following options are available:

- 2** *Change this line*
- 3** *Delete this line*
- 4** *Insert a new line before the current line*

#** *Quit*

** *Next*

Change This Line

To change the line, a complete sequence of commands and values must be entered. For example, if the setting was to be changed so that the wait time was 5 seconds instead of 3, the entry would be:

YOU: 2** *Change this line*

B1290: "beep"

YOU: #0 4032559544 #25 #8 **

B1290: "Directory A, Line One is DIAL 4032559544 WAIT 5 SEC VOICE"

This is the same command as [DIAL]4032559544 [WAIT]5 [VOICE] for this line in the PC programming software.

For an invalid entry, the B1290 will speak the word “Error” at the end.

Delete This Line

Deleting a line will automatically alter the line numbers of any subsequent commands. If there are no lines in use following the deletion, the B1290 will simply read empty. If there are commands in the lines following deletion, the numerical value of the subsequent lines will shift up in sequence: commands from line 3 will move to line 2 (line deleted), commands from line 4 will move to line 3,…

YOU: 3** *Delete this line*

B1290: "empty" *If the next line in the directory is empty*

or

B1290: "Directory A, Line One is DIAL 4032559544 DTMF 1234 VOICE" *Contents of the next line*

You can either accept this entry or edit the line.

Insert A New Line

Inserting a line will automatically alter the line numbers of any subsequent commands. If there are previously programmed commands in the subsequent lines to the line inserted, the numerical value of the lines will shift down in sequence: commands from line 2 (line inserted) will move to line 3, commands from line 3 will move to line 4,…

YOU: 4** *Insert a new line*

B1290: "beep"

YOU: #0 4032559544 #8 ** *(new entry)*

B1290: "Directory A, Line One is DIAL 4032559544 VOICE"

Next

The Next option allows you to advance to the next line in the directory

YOU: ** *Next*

Quit

The Quit option returns the B1290 to the Enter Directory Code prompt.

YOU: #** *Quit*

Limits: Each phone number may contain up to 39 digits.

Default: Directory A has the single command to turn on the radio and speak the voice messages; the other three

directories are empty.

If a pause is required when dialing, use the Wait command to insert a delay interval followed by a DTMF command with more digits. This feature is most often used when communicating with devices which require special signaling, such as paging terminals. The #, or pound digit, has no special meaning and is dialed as a pound.

When calling a paging terminal or someone who cannot acknowledge the call from their phone, it may be useful to wait before starting the next telephone call. This allows the called party to get to a phone and call the B1290 to acknowledge it before it calls out again. To do this, put a Wait command with the required delay on the next directory line and then a Dial command on the following line.

To send a group call with 2 Tone Paging, set tone A equal to tone B.

Do not use the Answer command immediately following a Dial command in the directories when Call Progress is enabled. This is the equivalent of two Answer commands and may result in unreliable operation.

3** DTMF Codes

The B1290 is capable of decoding, storing, and transmitting all DTMF codes, including codes received from a 4x4 keypad. Enter #** to clear a DTMF Code.

B1290: "Enter DTMF Code"

YOU: 1** *Acknowledge Code*

2** *Access Code*

3** *Relay On/Off Codes*

4** *Alarm On/Off Codes*

5** *Remote Alarm Input Codes*

6** *Interrogate Code*

7** *Directory Control Code*

** *Exit to Enter Program Code prompt*

Acknowledge Code

The Acknowledge Code is sent by the called party to indicate that the alarm message has been received. This stops the calling sequence of the B1290.

B1290: "Acknowledge Code is ... "

YOU: X** *(x = 1 to 8 DTMF digits)*

Default: 1234

Access Code

The Access Code is used as a password to prevent unauthorized callers from altering the programming of the B1290. If an Access Code has been programmed, it must be entered before a telephone caller will receive the *Enter Program Code* prompt. The Access Code is not required for local programming.

B1290: "Access Code is ... "

YOU: X** *(x = 1 to 8 DTMF digits, # = clear)*

Default: empty

Relay On/Off Input Codes

The relay codes allow users to perform remote control functions at the unattended site. Callers can operate relays on the B1290 by sending DTMF codes from their telephone or radio keypads. Each relay has one code to turn it on and a separate code to turn it off. When a relay is operated, the B1290 speaks a voice message associated with that relay

followed by the word “On” or “Off” (see Program Code 1 - Record Relay Voices).

B1290: "Relay One On Code is ... "

"Off Code is ... "

YOU: (X)(*)(*) *(x = 1 to 8 DTMF digits, # = clear)*

Default: empty

Alarm On/Off Output Codes

These codes are used to control DTMF-operated devices at the receiving end when an alarm is reported. A typical example would be sending a message to a pager with a digital display. The DTMF On string is sent during the alarm announcement, preceding the voice announcement for that alarm. The DTMF Off string is sent only over the radio port when the alarm returns to normal, and is not accompanied by a voice message. This feature might be used to turn the lamps of an annunciator panel on or off depending on the condition of the alarm. In simple system applications, the alarm On/Off codes of one B1290 might be programmed to be the same as the relay On/Off codes or remote alarm input codes of another B1290.

B1290: "Alarm One On code is ... "

"Off code is ... "

YOU: (X)(*)(*) *(x = 1 to 8 DTMF digits, # = clear)*

Default: empty

Remote Alarm Input Codes

If a remote alarm input code has been programmed, when it is received by the B1290 it will be interpreted exactly the same as an alarm on that input. The most common application is to obtain an alarm report from a remote site via radio. The Alarm LED will show the status for remote alarms.
Do not connect an alarm signal line to an input that has been programmed with a remote alarm input code.

B1290: "Alarm One Remote Alarm Code is ... "

YOU: (X)(*)(*) *(x = 1 to 8 DTMF digits, # = clear)*

Default: empty

Interrogate Code

The Interrogate Code is used to find the current status of the B1290. When it receives the code, the unit reports its site ID, any alarms which are present, the status of any relays which have been programmed to operate and any error status messages. Only the voice messages are repeated; no signaling is sent. As the B1290 always announces its status when it is telephoned, this code is used primarily for querying over radio.

B1290: "Interrogate Code is ... "

YOU: (X)(*)(*) *(x = 1 to 8 DTMF digits, # = clear)*

Default: 5678

Directory Control Code

The Directory Control Code is used to call up the B1290 and change the way that the alarms are using the directories. When it receives the code, the directory usage is modified. If the Directory Control Code is used there are restrictions on what directories are available - refer to Program Code 2 Directories for details.

B1290: "Directory Control Code is ... "

YOU: (X)(*)(*) *(x = 1 to 8 DTMF digits, # = clear)*

Default: 000

4 * * Timer Configuration

When you enter Program Code 4, the B1290 will automatically cycle through the following parameters. After the last one, "Times A", it will go back to the *Enter Program Code* prompt.

Rings Before Answering

When the B1290 is dialed, this parameter sets the number of times it will let the telephone ring before it answers.

B1290: "Answer rings is ... "

YOU: 0 * * *no answer*

X * * *number of rings (x = 1 to 8)*

* * *answer and automatically acknowledge after 8 rings*

Default: 4 (answer after 4 rings)

If the B1290 is on its own telephone line, it will normally be programmed to answer right away, after one or two rings. However, if the line is shared with other users, it should be programmed to answer after 6 to 8 rings, giving people lots of time to pick up the phone before the B1290 automatically answers.

The # is used when the called parties have dial pulse phones. They cannot acknowledge receipt of an alarm using a code. Instead the B1290 recognizes 8 rings on the telephone line as an Acknowledge Code. In the directory, a Wait command with the required delay, is placed on the line following the Dial command. This gives the called party

time to hang up the phone, call the B1290 back and let the phone ring 8 times to acknowledge receipt of the alarm (refer to Program Code 2 - Phone Directory).

Interval Timer A

If an alarm is not acknowledged after one pass through the directory, this timer determines how often the B1290 will repeat the reporting sequence.

B1290: "Timer A is 2 minutes"

YOU: X * * *minutes (x = 1 to 249)*

Default: 2 minutes

Interval Timer B

After the Timer A cycle has completed, this timer determines how often the B1290 goes through its alarm reporting sequence.

B1290: "Timer B is 10 minutes"

YOU: 0 * * *automatically acknowledge after Interval A*

X * * *minutes (x = 1 to 249)*

0 would be selected if the alarms were announced over a public address system, for example, where there is no way for the alarms to be acknowledged.

Default: 10 minutes

Cycles Through Timer A (Times A)

This number determines how many times the B1290 will cycle through its alarm reporting sequence at A intervals before switching to B intervals. With its default settings, the B1290 will try 3 times at 2 minute intervals, then switch to reporting at 10 minute intervals. The switch to the B interval is primarily to conserve air time on busy radio systems.

B1290: "Times A is …"

YOU: [X][*][*] *times (x = 0 to 8)*

Default: 3

[5][*][*] I/O Configuration

After you enter Program Code 5, the B1290 prompt for the Configuration Code. If you wish to go back to the *Enter Program Code* prompt without going through all of the codes, enter [*][*].

B1290: "Enter Configuration Code"

YOU: [1][*][*] *Alarm Input Setup*

[2][*][*] *Using Directory*

[3][*][*] *Relay Setup*

[*][*] *Exit to Enter Program Code prompt*

Alarm Input Setup

Alarm Format

This parameter changes the format of the B1290 alarm inputs to match the output of your monitoring devices in the field. Normally open inputs indicate an alarm when the input is grounded, and when the ground signal is removed, the alarm is interpreted as having cleared. Normally closed inputs are grounded in their normal state, and open when an alarm occurs. Latched inputs recognize a pulse as an alarm. After the pulse has disappeared, the input is deemed to be in the alarm condition until it is acknowledged.
Note: A latched alarm should provide a short, predictable pulse to the input of the ProTalk Plus; otherwise, it may have to be acknowledged twice. If the alarm is acknowledged while the input is active, the alarm will not be cleared and new alarms will not activate that input.

B1290: "Alarm Format is …"

YOU: [0][*][*] *Normally Open*

[1][*][*] *Normally Closed*

[2][*][*] *Normally Open, Latched*

[3][*][*] *Normally Closed, Latched*

[*][*] *Next*

Default: 0 (normally open)

Alarm Timer (Debounce) Timescale

The debounce timers on the alarm inputs can operate with a resolution of .1 seconds or .1 minutes. When the B1290 speaks ‘seconds’ for this value it is indicating that the timer is counting in .1 second steps and when it speaks ‘minutes’ it is counting in .1 minute steps.

B1290: "Alarm Timer is seconds"

YOU: [0][*][*] *Seconds*

[1][*][*] *Minutes*

[*][*] *Next*

Default: 0 (seconds)

Alarm Delay (Debounce)

This parameter controls the amount of time an alarm must be present before it actually registers as an alarm. This feature is often used to eliminate fleeting alarms, where the device in the field does not present a clean closure to indicate an alarm, but a series of bounces on the contacts. Another example might be to overcome momentary power fluctuations which cause false alarms to be reported. The debounce on each alarm may be individually set.

B1290: "Alarm One Delay is _ _ point _ seconds"

YOU: (X)(*)(*) *(x = 0.1 to 19.9)*

(#)(*)(*) *Exit*

(*)(*) *Next*

The value must be entered in tenths of a second, from 1 to 3 digits. The last digit entered is interpreted as the least significant, i.e. tenths of a second.

Default: 0.5 seconds

Using Directory

B1290: "Alarm One is Directory A"

YOU: (0)(*)(*) *Off*

(1)(*)(*) *Directory A*

(2)(*)(*) *Directory B*

(3)(*)(*) *Directory C*

(4)(*)(*) *Directory D*

(#)(*)(*) *Exit*

(*)(*) *Next*

Default: 1 (Directory A)
The selected directory will determine which sequences of actions are performed when this alarm is active. Each alarm can use any directory. If the Directory Control Code is used there are restrictions on what directories should be used - refer to Program Code 2 Directories for details.

Relay Setup

Relay Timer Timescale

The interval timers on the relay outputs can operate with a resolution of 1 second or 1 minute. When the B1290 speaks 'seconds' for this value it is indicating that the timer is counting in 1 second steps and when it speaks 'minutes' it is counting in 1 minute steps.

B1290: "Relay Timer is seconds"

YOU: (0)(*)(*) *Seconds*

(1)(*)(*) *Minutes*

(*)(*) *Next*

Default: 0 (seconds)

Relay On Time

The B1290 has four relays that are turned On with the relay On codes and turned Off with the relay Off codes. The relay timer may be used to turn On a relay for a specified duration and then turn it Off automatically. The timer controls the period of time the relay is On. The interval is programmable from 1 to 199 seconds or from 1 to 199 minutes depending on the setting of the relay timescale. The timers for each relay are programmed separately and operate independently.

Setting the time to zero will make the relay an On/Off type of relay. Setting the timer with the # digit makes the relay operate as a 'special function' output. This function is only available on the main ProTalk Plus unit and not on the expanders. The special functions are:

Relay 1	Unacknowledged Alarm Present
Relay 2	Any Alarm Present
Relay 3	Alarm Acknowledge Received - pulsed when the unit is acknowledged.
Relay 4	Error

B1290: "Relay One On Timer is _ _ seconds"

YOU: 0 * * *Not timed, uses the Relay Off Code*

X * * *(x = 1 to 199)*

* * *(Special function)*

Default: 0 (On until turned Off)

6 * * System Settings

When you enter Program Code 6, the B1290 will automatically cycle through the following parameters as you hit Enter (* *). When it has completed the whole list, it will return to the *Enter Program Code* prompt.

Dial Format

This parameter determines the method of dialing telephone. Tone format dials using DTMF tones (Touch-Tone). Pulse format dials using pulses as a rotary phone would. This parameter is only programmable in Version 1. The choice of format is only available in Version 1.

Version 1

B1290: "Dial Format is …"

YOU: 0 * * *Tone Dialing*

1 * * *Pulse Dialing*

* * *Exit*

* * *Next*

Version 2

B1290: "Dial Format is 0"

Default: 0 (tone dialing)

Squelch Polarity

This setting changes the polarity of the signal used to indicate a busy radio channel.

B1290: "Squelch is …"

YOU: 0 * * *Busy when the input is low*

1 * * *Busy when the input is high*

* * *Exit*

* * *Next*

Default: 0 (transmit on high)

Relay Voices

This setting enables or disables the B1290's spoken response to a relay operation. If the B1290 is used in a control situation where monitoring the relay operation is not required, the B1290 would be programmed with the relay voices muted. The B1290 relay voices should be enabled where verification of a relay operation is required.

B1290: "Relay Voice is ... "

YOU: 0 * * *Relay voices are not used*

1 * * *Relay voices are used*

	#**	*Exit*
	**	*Next*

Default: 1 (voices on)

Acknowledge Request

This setting enables or disables the B1290's voice prompt *Enter Acknowledge Code.* If the alarm announcement is over a public address system, for example, acknowledgment is not possible. The B1290 would be programmed for automatic acknowledge (see Interval Timer B, Program Code 4) and the request for an Acknowledge Code would be disabled.

The B1290 will continue transmitting its alarms until it receives some form of acknowledgment, automatic or otherwise, even if it does not request one.

B1290: "Acknowledge Voice is …"

YOU:	0**	*Acknowledge request is not used*
	1**	*Acknowledge request is used*
	#**	*Exit*
	**	*Next*

Default: 1 (enabled)

Call Progress (Dial Tone Enable)

This setting enables or disables the feature where the B1290 monitors the audio activity on the phone line when it places a call. If enabled, Call Progress will cause the B1290 to look for dial tone before dialing, watch for a busy signal on the called line and then wait until the called party speaks before the alarm announcement begins. Without Call Progress enabled, the B1290 will perform the dial-out operation and speak regardless of the signals encountered on the phone line.
Do not use the Answer command immediately following a Dial command in the directories when Call Progress is enabled. This is the equivalent of two Answer commands and may result in unreliable operation.

B1290: "Dial Tone is …"

YOU:	0**	*Call Progress is not used*
	1**	*Call Progress is used*
	#**	*Exit*
	**	*Next*

Default: 1 (enabled)

7** Expanders

When Program Code 7 is entered, the B1290 gives you the following parameters.

Number of Expanders

Increase the capacity of a basic B1290 by adding up to 7 expanders, each with an additional 8 alarm inputs and 4 relay outputs.

B1290: "Expander Number is . . . "

YOU:	X**	*Expanders (x = 0 to 7)*
	#**	*Exit*
	**	*Next*

Default: 0

Site Voice Enable

This setting enables or disables the announcement of a site ID from the expander unit. If the expander is being used to increase the number of alarms to be reported from a single site, you probably don't need to announce the site ID again. However, the site ID might be useful to differentiate between alarms from different areas or pieces of equipment.

B1290: "Expander Site Voice is . . . "

YOU: [0][*][*] Site voice is not used

[1][*][*] Site voice is used

[*][*] Next

Default: 0 (expander site ID disabled)

To program the parameters within the expander, the PGM port on the B1290 is used. Programming is done exactly as though the main unit itself was being programmed, except that the expander number precedes the program code. Refer to Example 10 - Adding an Expander for a specific description of this procedure.

[8][*][*] Reset Database

This code is used to reset all of the programmed parameters (excluding voices) to their default values.

B1290: "Enter Empty Code"

YOU: [#][3][1][*][*] *Clear Database*

[*][*] *Next*

Any other entry will leave the database unchanged.

[9][*][*] Audio Levels

This code is used to adjust audio levels for specific signals. For receive levels the setting should correspond to the level of the signal that is coming from the attached equipment. Receive levels can be in the range between -20 dBm and 0 dBm. For transmit levels, the setting determines the amplitude of the signal that will be produced at the output of the B1290. Transmit levels can be set in the range between -20 dBm and 0 dBm. Only even numbers are valid. If an odd number is entered, it will be rounded down. The negative sign is automatically applied to any non-zero value.

The settings for the audio levels are presented in the following order for modification

B1290: "Radio Code One is . . . " (Radio Transmit Tone Level)

YOU: [X][X][*][*] *Level setting (x = 20 to 0)*

[#][*][*] *Exit*

[*][*] *Next*

Default: 0

B1290: "Radio Code Two is . . . " (Radio Transmit DTMF Level)

YOU: [X][X][*][*] *Level setting (x = 20 to 0)*

[#][*][*] *Exit*

[*][*] *Next*

Default: 0

B1290: "Radio Code Three is . . . " (Radio Transmit Voice Level)

YOU: [X][X][*][*] *Level setting (x = 20 to 0)*

[#][*][*] *Exit*

[*][*] *Next*

Default: 0

B1290: "Radio Code Four is . . . " (Radio Receive Level)

YOU: [X][X][*][*] *Level setting (x = 20 to 0)*

[#][*][*] *Exit*

[*][*] *Next*

Default: 0

B1290: "Telephone Code Five is . . . " (Telephone Receive Level)

YOU: [X][X][*][*] *Level setting (x = 20 to 0)*

[#][*][*] *Exit*

[*][*] *Next*

Default: 0

8. PROGRAMMING REFERENCE

The ProTalk Plus is capable of performing many functions other than those set by its default values. If you require these extended capabilities, they are accessed through the program codes. If the default operation of the unit as described in the **Getting Started** chapter of this manual is sufficient, then you may ignore this section.

This chapter organizes the programming parameters by their functions. See the chapter on **Program Codes** for more detail on the use and meaning of the referenced parameters.

1. Alarm Announcement

This section identifies all of the parameters that determine WHAT is sent when an alarm occurs. By programming these parameters, you may send voice, signaling, and paging tones.

Directory Used (Program Code 5.2)

Directories (Program Code 2)

Record Alarm Voices (Program Code 1.1)

Alarm On/Off Output Codes (Program Code 3.4)

Acknowledge Request (Program Code 6)

Speak Messages (Program Code 2)

2. Alarm Operation

This section identifies all of the parameters that determine WHEN an alarm will be announced. By programming these parameters, you control when an alarm is recognized and announced by the ProTalk Plus.

Alarm Format (Program Code 5.1)

Alarm Delay Timebase (Program Code 5.1)

Alarm Debounce (Program Code 5.1)

Interval Timer A (Program Code 4)

Interval Timer B (Program Code 4)

Cycles Through Timer A (Program Code 4)

3. Operation Codes

These parameters control how the unit operates. When one of these codes is received, the B1290 performs the required function.

Acknowledge Code (Program Code 3.1)

Access Code (Program Code 3.2)

Interrogate Code (Program Code 3.6)

Remote Alarm Input Code (Program Code 3.5)

Directory Control Code (Program Code 3.7)

Access Code (Program Code 3.2)

4. Relay Control

The parameters required to control a relay are listed here. You may use any number of relays, but the ON/OFF input codes, voice message and relay ON time must be programmed for each relay used. The relay voice code enables or disables the voice confirmation for all relays.

Relay ON/OFF Control Codes (Program Code 3.3)

Record Relay Voices (Program Code 1.2)

Relay Timer Timebase (Program Code 5.3)

Relay On Time (Program Code 5.3)

Relay Voice (Program Code 6)

Relay Special Functions (Program Code 5.3)

5. Telephone Specific Parameters

This section describes the parameters used when the unit is required to transmit alarms or signaling over the telephone system.

Using Directory (Program Code 5.2)

Directory Telephone Numbers (Program Code 2)

Rings Before Answering (Program Code 4)

Dial Format (Program Code 6)

6. Radio Specific Parameters

These parameters control the operation of the unit when it is connected to a two-way radio. Refer to the installation section in Getting Started for the required connections to the radio.

Directory Radio Command (Program Code 2)

Squelch Polarity (Program Code 6)

Radio Warmup (Program Code 2)

7. Expander Attachment

When an expander is added to the system, these parameters must be set. They configure the main B1290 unit to accept the expander. The parameters within the expander must also be programmed. Refer to the Advanced Programming Examples for an example of how this is done.

Number of Expanders (Program Code 7)

Site Voice Enable (Program Code 7)

8. Audio Levels

Audio Levels (Program Code 9)

9. PROGRAMMING EXAMPLES

Example 1: Reporting Alarms over Radio and Telephone

In this example, assume that your company has a mobile radio system which is monitored by field personnel. Radio operators have DTMF pads on their mics so they can acknowledge an alarm from the B1290. They would like to have the alarm reported over the radio system three times with a 2 minute interval between transmissions, then dialed out over the telephone if it is not acknowledged. If the alarm is not acknowledged, the B1290 should try again in ten minutes. After six tries at ten minute intervals, the B1290 should switch to trying once an hour. The COS on the radio used with the B1290 gives a high signal when the channel is busy.

B1290:	Enter Program Code
YOU:	2 * * *Directory Code*
B1290:	Enter Directory
YOU:	1 * * *Directory A*
B1290:	Directory A, Line One is...
YOU:	2 * * *Change*
B1290:	'beep'
YOU:	# 1 # 8 * * *[RADIO] [VOICE]*
B1290:	Directory A, Line One is RADIO VOICE
YOU:	* * *Next*
B1290:	Directory A, Line Two is...
YOU:	2 * * *Change*
B1290:	'beep'
YOU:	# 2 1 2 0 * * *[WAIT]120 (seconds)*
B1290:	Directory A, Line Two is WAIT 120
YOU:	* * *Next*
B1290:	Directory A, Line Three is...
YOU:	2 * * *Change*
B1290:	'beep'
YOU:	# 1 # 8 * * *[RADIO] [VOICE]*
B1290:	Directory A, Line Three is RADIO VOICE
YOU:	* * *Next*
B1290:	Directory A, Line Four is...
YOU:	2 * * *Change*
B1290:	'beep'
YOU:	# 2 1 2 0 * * *[WAIT]120 (seconds)*
B1290:	Directory A, Line Four is WAIT 120
YOU:	* * *Next*
B1290:	Directory A, Line Five is...
YOU:	2 * * *Change*
B1290:	'beep'

YOU: #1 #8 ** *[RADIO] [VOICE]*

B1290: Directory A, Line Five is RADIO VOICE

YOU: ** *Next*

B1290: Directory A, Line Six is...

YOU: 2** *Change*

B1290: 'beep'

YOU: #2120 ** *[WAIT]120 (seconds)*

B1290: Directory A, Line Six is WAIT 120

YOU: ** *Next*

B1290: Directory A, Line Seven is...

YOU: 2** *Change*

B1290: 'beep'

YOU: #0 4032559544 #8 ** *[DIAL]4032559544 [VOICE]*

B1290: Directory A, Line Seven is DIAL 4032559544 VOICE

YOU: ** *Next*

B1290: Directory A, Line Eight is...

YOU: #** *Quit*

B1290: Enter Directory

YOU: #** *Quit*

B1290: Enter Program Code

YOU: 4** *Configuration*

B1290: Answer Rings is 4

YOU: ** *Next*

B1290: Timer A is 2 minutes

YOU: 10** *Enter 10 minutes*

B1290: Timer A is 10 minutes

YOU: ** *Next*

B1290: Timer B is 10 minutes

YOU: 60** *Enter 60 minutes*

B1290: Timer B is 60 minutes

YOU: ** *Next*

B1290: Times A is 3

YOU: 6** *Enter 6 times*

B1290: Times A is 6

YOU: ** *Next*

B1290: Enter Program Code

YOU: 6** *Select System Settings*

B1290: Dial Format is 0

YOU: (*)(*) *Next*

B1290: Squelch is 0

YOU: (1)(*)(*) *Enter busy when high*

B1290: Squelch is 1

YOU: (*)(*) *Next*

B1290: Relay Voice is On

At this point you are finished programming and may hang up the telephone. The directory is programmed with the voice message repeated three times on the radio and then once on the phone line. Another method of programming the radio announcement would be to have an alert tone followed by the message repeated twice. In this case the entry for each of the radio related commands would be:

B1290: Directory A, Line One is...

YOU: (#)(1) (#)(3) (#)(8) (#)(8) (*)(*) *[RADIO][ALERT] [VOICE][VOICE]*

B1290: Directory A, Line One is RADIO ALERT VOICE VOICE

Over the telephone, the message will be repeated only once.

If this programming is used, when the B1290 registers an alarm, the reporting cycle will be as follows:

Over radio: Alert tone
Ajax Compressor Station; Power Failure
Ajax Compressor Station; Power Failure
Enter Acknowledge Code
pause for 2 minutes

Alert tone
Ajax Compressor Station; Power Failure
Ajax Compressor Station; Power Failure
Enter Acknowledge Code
pause for 2 minutes

Alert tone
Ajax Compressor Station; Power Failure
Ajax Compressor Station; Power Failure
Enter Acknowledge Code
pause for 2 minutes

Over telephone: Dial 4032559544
Ajax Compressor Station; Power Failure
Enter Acknowledge Code
pause for 5 seconds -waiting for acknowledge code
Ajax Compressor Station; Power Failure
Enter Acknowledge Code
pause for 5 seconds -waiting for acknowledge code

This sequence repeats for 60 seconds.

If the Acknowledge Code is not received over the telephone, the B1290 will wait ten minutes and try the complete sequence again, starting with the radio cycle. If no Acknowledge Code is received after six tries at ten minute intervals, the B1290 will switch to reporting every hour until the alarm is acknowledged.

Example 2: Dialing from Two Different Telephone Directories

In this example, the B1290 is programmed to telephone whoever is on call if there is an alarm. The company has two groups of employees who take turns being on call. Instead of reprogramming the B1290 directory every week,

two directories are programmed. When the Directory Control Code is received, the B1290 is directed to dial from the other directory. The directory may be switched with the Directory Control Code over the telephone, local programming phone, or two-way radio. There are specific rules governing how the alarms can be assigned to directories if the Directory Change Code is used. Refer to Program Code 2 Directories for more information concerning these rules. This example starts by setting the telephone numbers in the two directories.

B1290: Enter Program Code

YOU: [2][*][*] *Directory Code*

B1290: Enter Directory

YOU: [1][*][*] *Directory A*

B1290: Directory A, Line One is...

YOU: [2][*][*] *Change*

B1290: 'beep'

YOU: [#][0] [4][0][3][2][5][5][9][5][4][4] [#][8] [*][*]
[DIAL]4032559544 [VOICE]

B1290: Directory A, Line One is DIAL 4032559544 VOICE

YOU: [*][*] *Next*

B1290: Directory A, Line Two is...

YOU: [2][*][*] *Change*

B1290: 'beep'

YOU: [#][0] [4][0][3][2][5][5][9][5][9][8] [#][8] [*][*]
[DIAL]4032559598 [VOICE]

B1290: Directory A, Line Two is DIAL 4032559598 VOICE

YOU: [*][*] *Next*

B1290: Directory A, Line Three is...

YOU: [#][*][*] *Quit*

B1290: Enter Directory

YOU: [2][*][*] *Select Directory B*

B1290: Directory B, Line One is...

YOU: [2][*][*] *Change*

B1290: 'beep'

YOU: [#][0] [4][0][3][7][6][6][4][4][2][2] [#][8] [*][*]
[DIAL]4032554437 [VOICE]

B1290: Directory B, Line One is DIAL 4032554437 VOICE

YOU: [*][*] *Next*

B1290: Directory B, Line Two is...

YOU: [2][*][*] *Change*

B1290: 'beep'

YOU: [#][0] [4][0][3][2][5][5][9][5][4][5] [#][8] [*][*]
[DIAL]4032559545 [VOICE]

B1290: Directory B, Line Two is DIAL 4032559545 VOICE

YOU: (*)(*) *Next*

B1290: Directory B, Line Three is...

YOU: (#)(*)(*) *Quit*

B1290: Enter Directory

YOU: (#)(*)(*) *Quit*

The telephone numbers have now been programmed. Now enter the Directory Control Code

B1290: Enter Program Code

YOU: (3)(*)(*) *DTMF Codes*

B1290: Enter DTMF Code

YOU: (7)(*)(*) *Directory Control Code*

B1290: Directory Control Code is...

YOU: (7)(8)(*)(*) *Enter Control Code*

B1290: Directory Control Code is 78

YOU: (*)(*) *Next*

B1290: Enter Program Code

Right now the B1290 is programmed with dialing commands in Directory A and Directory B. Any alarms that are to be switched between these two directories should be programmed to use Directory A or the control code will have no effect. Each alarm has its own setting for the directory it is using. Make sure that the alarms you want to have changed are set properly.

YOU: (5)(*)(*) *Select Configuration*

B1290: Enter Configuration Code

YOU: (2)(*)(*) *Select Using Directory*

B1290: Alarm One is Directory is...

YOU: (1)(*)(*) *Select Directory A*

B1290: Alarm One is Directory is A

YOU: (*)(*) *Next*

Repeat this for all of the alarms

When you wish to dial from the B directory, call up the B1290 and follow these steps:

B1290: Enter Control Code

YOU: (7)(8) *Directory Control Code*

B1290: Telephone Format is Directory B

And to change it back:

B1290: Enter Control Code

YOU: (7)(8) *Directory Control Code*

B1290: Telephone Format is Directory A

Example 3: Different Alarms Dialing Different Telephone Numbers

A B1290 is used in an application where there are two different types of related alarms. Some are building alarms, such as intrusion alarms, building temperature, power failure, etc. Others are alarms relating to specific equipment failures, such as compressor failure, high tank level or sump overflow. It is desirable to have the maintenance

personnel alerted if there is a building alarm, but if there is a problem with the equipment, it would be preferable to alert the operations technicians.

In this example, alarms 1 and 2 are connected to intrusion alarm and building high temperature respectively. These are building alarms, and are to dial the building maintenance people at 403-255-9544 and then 403-255-9598. Compressor failure and high tank level are fed to alarms 3 and 4. Since these are equipment problems, operations technicians at 403-255-4437 and then 403-255-9545 are to be alerted. Follow the previous example to enter the telephone numbers in Directory A and Directory B then set the alarms to use these two directories.

B1290: Enter Program Code

YOU: 5 * * *Select I/O Configuration*

B1290: Enter Configuration Code

YOU: 2 * * *Select Using Directory*

B1290: Alarm One is Directory...

YOU: 1 * * *Select Directory A*

B1290: Alarm One is Directory A

YOU: * * *Next*

B1290: Alarm Two is Directory...

YOU: 1 * * *Select Directory A*

B1290: Alarm Two is Directory A

YOU: * * *Next*

B1290: Alarm Three is Directory A

YOU: 2 * * *Select Directory B*

B1290: Alarm Three is Directory B

B1290: Alarm Four is Directory A

YOU: 2 * * *Select Directory B*

B1290: Alarm Four is Directory B

YOU: # * * *Quit*

The B1290 is now programmed to dial Directory A when alarms 1 or 2 occur, and Directory B when alarms 3 or 4 occur.

Example 4: Actuating Relays

In this example, when you receive the alarm "High Pressure" from the B1290, you would like to be able to operate a bypass valve for up to ten minutes. The valve can be controlled by one of the relays on the B1290 using Relay On and Relay Off codes.

B1290: Enter Program Code

YOU: 1 * * *Select Voices*

B1290: Enter Voice Code

YOU: 2 * * *Select Relay Voices*

B1290: Relay One is...

YOU: 2 * * *Change*

B1290: beep-beep

YOU: *Bypass Valve*

B1290: Relay One is Bypass Valve

YOU: (*)(*) *Next*

B1290: Relay Two is...

YOU: (#)(*)(*) *Quit*

B1290: Enter Voice Code

YOU: (#)(*)(*) *Quit*

B1290: Enter Program Code

YOU: (3)(*)(*) *Select DTMF Codes*

B1290: Enter DTMF Code

YOU: (3)(*)(*) *Select Relay On and Off Codes*

B1290: Relay One On Code is empty

YOU: (5)(5)(5)(*) *(pause)* (*)(*) *Enter On code*

B1290: Relay One On Code is 555✱

YOU: (*)(*) *Next*

B1290: Relay One Off Code is empty

YOU: (5)(5)(5)(#) (*)(*) *Enter Off code*

B1290: Relay One Off code is 555#

YOU: (*)(*) *Next*

B1290: Relay Two On Code is empty

YOU: (*)(*) *Next*

B1290: Relay Two Off Code is empty

And so on until all of the Relay Codes are done...

B1290: Enter DTMF Code

YOU: (*)(*) *Next*

B1290: Enter Program Code

YOU: (5)(*)(*) *I/O Configuration*

B1290: Enter Configuration Code

YOU: (3)(*)(*) *Next*

B1290: Relay Timer is seconds

YOU: (1)(*)(*) *Select minutes for the timebase*

B1290: Relay Timer is minutes

YOU: (*)(*) *Next*

B1290: Relay One On Timer is 00 minutes

YOU: (1)(0)(*)(*) *Select 10 minutes for the time*

B1290: Relay One On is 10 minutes

YOU: (*)(*) *Next*

B1290: Relay Two On timer is 00 minutes

At this time you are finished programming and can hang up the phone. When the B1290 calls you with an alarm, the sequence will be as follows:

B1290: Ajax Compressor Station; High Pressure.
Enter Acknowledge Code

YOU: 5 5 5 * *Send the Relay On Code*
Ajax Compressor Station;
Bypass Valve On (and Alarm - Enter Acknowledge Code).

YOU: 1 2 3 4 *Send the Acknowledge Code*

B1290: Ajax Compressor Station;
Alarms Acknowledged

Example 5: Operating a Radio Pager

In this example, when an alarm is received you want to contact the person on call, who is carrying a two-tone radio pager which operates on the company's private radio system. If the person does not call back to acknowledge the alarm, you want the B1290 to start dialing telephone numbers.

B1290: Enter Program Code

YOU: 2 * * *Directory Code*

B1290: Enter Directory

YOU: 1 * * *Directory A*

B1290: Directory A, Line One is...

YOU: 2 * * *Change*

B1290: 'beep'

YOU: # 1 # 4 0 8 5 5 5 * 1 4 3 3 4 # 8 * *
[RADIO][2TONE]855.5/1433.4 [VOICE]

B1290: Directory A, Line One is RADIO 2 TONE 855.5 Hz 1433.4 Hz VOICE

YOU: * * *Next*

B1290: Directory A, Line Two is...

YOU: 2 * * *Change*

B1290: 'beep'

YOU: # 0 4 0 3 2 5 5 9 5 4 4 # 8 * *

B1290: Directory A, Line Two is DIAL 4032559544 VOICE

YOU: * * *Next*

B1290: Directory A, Line Three...

You are finished programming and may hang up the phone.

Example 6: Dialing a Paging Terminal

In this example, rather than using a private radio system, the company's employees utilize a city-wide paging service. Normally when you dial the paging terminal, you are prompted to enter your own telephone number. Your number is then displayed on the digital read-out of the pager, so the paged party knows what number to call back. We are going to program the B1290 to call this paging terminal when it reports an alarm.

B1290: Enter Program Code

YOU: 2 * * *Directories*

B1290: Enter Directory

YOU: 1 * * *Directory A*

B1290: Directory A, Line One is...

YOU: 2 * * *Change*

B1290: 'beep'

YOU: # 0 4 0 3 2 5 5 9 5 4 4 # 2 4 # 7 7 3 4 * *
[DIAL]4032559544 [WAIT]4 [DTMF]734

B1290: Directory A Line One is DIAL 4032559544 WAIT 4 seconds DTMF 734

YOU: * * *Next*

You are finished programming and may hang up the phone.

When an alarm occurs, the B1290 will dial the number of the paging terminal, 255-9544; wait for the terminal to answer, wait 4 seconds while the terminal is prompting, then send the DTMF string 734 which represents the calling site. Any alarm will result in the paging message 734.

If you want to distinguish between one alarm and another, use the Alarm On Codes that can be assigned to each input.

B1290: Enter Program Code

YOU: 3 * * *DTMF Codes*

B1290: Enter DTMF Code

YOU: 4 * * *Select Alarm On/Off Codes*

B1290: Alarm One On Code is...

YOU: * 1 * *(pause)* * * *Code for alarm 1*

B1290: Alarm One On Code is ✱1✱

YOU: * * *Next*

B1290: Alarm One Off Code is...

YOU: * * *Next*

B1290: Alarm Two On Code is...

YOU: * 2 * *(pause)* * * *Code for alarm 2*

B1290: Alarm Two On Code is ✱2✱

YOU: * * *Next*

With this Alarm ON code programmed, the DTMF string *734* will be sent immediately preceding the alarm one message when alarm one is active. The message displayed on the pager will be: 734*1*

The string *2* will be sent with alarm two.

In this example, the same result could have been achieved by sending 734 as part of the alarm ON DTMF code. The 734 is included as part of the telephone number and is sent with every alarm. It appears much like a site identifier.

This example also assumes that the pager could be dialed directly. Sometimes a separate number for the pager must be dialed after the number for the paging terminal. In that case, you might need to insert another delay, and there might not be room to include the site identifier as part of the telephone number.

Another way the B1290 could be programmed to dial a paging terminal would be to make the alarm On DTMF code the same as the telephone number of the B1290. The telephone number would then be displayed on the pager, and the called party would receive the alarm message when he called the B1290 back. The B1290 would have to be programmed to wait some time for an acknowledgment before it continued dialing.

Example 7: Announcing Alarms over a Public Address System

In this example, the B1290 is used to announce alarms from an unattended location over a building's public address system. You want the alarms to be announced twice, repeated again one minute later then repeated for the last time one minute after this. To make the process stop after the third repetition, program Timer B to zero. A zero value in Timer B means that the alarm is automatically acknowledged after A Times.

Connect the radio port, TX Audio and PTT, from the B1290 to the PA inputs.

Starting with the timer setup:

B1290: Enter Program Code

YOU: 4 * *

B1290: Answer Rings is 4 (No effect on operation)

YOU: * * *Next*

B1290: Timer A is 2 minutes

YOU: 1 * * *Change the timer to 1 minute*

B1290: Timer A is 1 minutes

YOU: * * *Next*

B1290: Timer B is 10 minutes

YOU: 0 * * *Change the timer to zero*

B1290: Timer B is 0 minutes

YOU: * * *Next*

B1290: Times A is 3

YOU: 2 * * *Change the times A to 2*

B1290: Times A is 2

YOU: * * *Next*

The timers are now set, now put the commands into the directory.

B1290: Enter Program Code

YOU: 2 * * *Directory Code*

B1290: Enter Directory

YOU: 1 * * *Directory A*

B1290: Directory A, Line One is...

YOU: 2 * * *Change*

B1290: 'beep'

YOU: # 1 # 3 # 8 # 8

[RADIO][ALERT][VOICE][VOICE]

B1290: Directory A, Line One is RADIO ALERT VOICE VOICE

YOU: * * *Next*

B1290: Directory A, Line Two is..

YOU: # * * *Quit*

B1290: Enter Directory

YOU: # * * *Quit*

Now remove the acknowledge request prompt.

B1290: Enter Program Code

YOU: (6)(*)(*)

B1290: Dial Format is Zero

YOU: (*)(*) *Next*

B1290: Squelch is 0

YOU: (*)(*) *Next*

B1290: Relay voice is On

YOU: (*)(*) *Next*

B1290: Acknowledge Voice is On

YOU: (0)(*)(*)

B1290: Acknowledge Voice is Off

YOU: (*)(*) *Next*

B1290: Dial Tone is on

At this point you are finished programming and may hang up.

YOU: (*)(*) *Next*

Example 8: Activating an Annunciator Panel

In this system application, a B1290 is used to report alarms from a number of remote locations by turning the lamps of an annunciator panel on and off.

Figure 6 shows a system where two remote sites are transmitting DTMF codes to a central site. The Alarm On code associated with the remote alarms is the same as the Relay On code at the central site. Similarly, the Alarm Off codes at the remote locations are the same as the Relay Off codes at the central site.

When a remote alarm occurs, the DTMF code for that alarm is transmitted to the central site. On receiving this code, the central site activates the relay associated with that alarm. When the alarm clears, the Off code is transmitted from the remote, and the central site's associated relay is released.

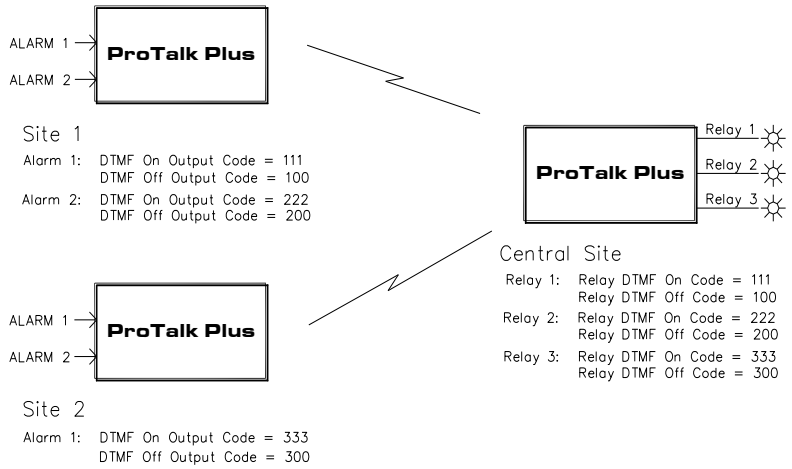


Figure 6 Activating an Annunciator Panel

Example 9: Concentrating Alarms from Remote Sites

In the following example, a number of remote sites report their alarms over radio to a B1290, which concentrates the alarms and reports them over the telephone.

Figure 7 is an example of two remote sites communicating with a central site to have their alarms announced over the telephone. At the remote sites, the B1290s are programmed to operate over radio. They are programmed with an alarm On output code and an Acknowledge Code. At the central site, the B1290 is programmed to accept remote alarm inputs on alarms 1, 2, and 3, and is connected to a telephone.

When one of the remote units is alarmed, it will send its alarm ON output code over the radio. This code will be interpreted as a remote alarm input code at the central unit. This will initiate the B1290 to send its alarm report over radio and telephone. As part of its alarm sequence over radio, the B1290 will send its alarm On output code. This code will be interpreted as an acknowledgment by the remote, and it will stop sending the alarm. The central unit will continue to report over radio and telephone until it is acknowledged.

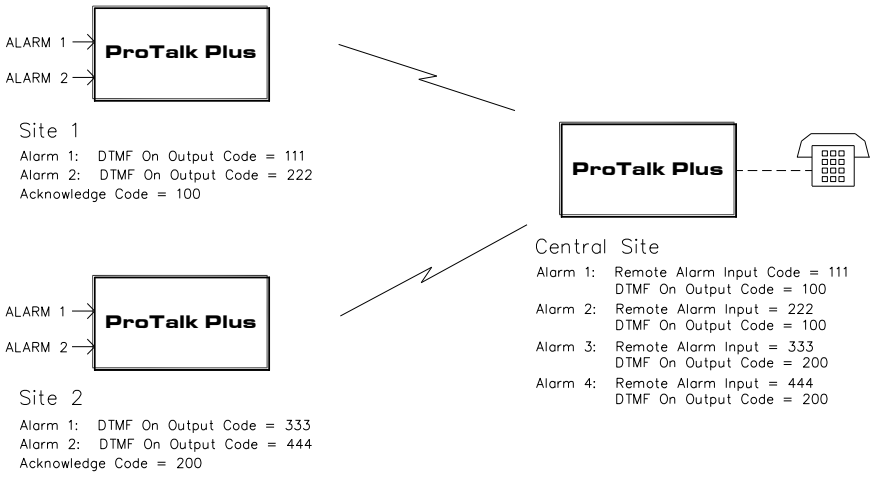


Figure 7 Concentrating Remote Alarms

Example 10: Adding an Expander (B1292)

In this example, you are adding an expander to a B1290 to increase the number of alarm inputs and relay outputs.

Install and program the main B1290 unit as per the instructions in this manual. Install the expander within 100' of the B1290. Complete the wiring to all the alarms and relays. Connect the cable supplied with the expander from the auxiliary connector on the B1290 to the EXP connector on the expander. Apply power to the installation

The expander is programmed from the B1290. Note that when the Program Code is entered, it is preceded by the number of the expander.

B1290:	Enter Program Code
YOU:	(7)(*)(*) *Expanders*
B1290:	Expander Number is 0
YOU:	(1)(*)(*) *Enter 1 for the number of expanders*
B1290:	Expander Number is One
YOU:	(*)(*) *Next*
B1290:	Expander Site Voice is 0 (default is not to announce the expander ID)
YOU:	(*)(*) *Next*
B1290:	Enter Program Code

YOU: 1 1 * * *Expander 1, Voices*

B1290: Enter Voice Code

YOU: 1 * * *Record Alarm Voices*

B1290: Expander One Site is...

YOU: * * *Next (Site ID is disabled - don't need a voice message)*

B1290: Expander One, Alarm One is...

YOU: 2 * * *Change this voice*

B1290: beep-beep

YOU: *Intrusion*

B1290: Expander One, Alarm One is Intrusion

YOU: * * *Next*

B1290: Expander One Alarm Two is...

YOU: 2 * * *Change this voice*

B1290: beep-beep

YOU: *High Temperature*

B1290: Expander One, Alarm Two is High Temperature

YOU: * * *Next*

B1290: Expander One, Alarm Three is...

Continue programming in the normal fashion, remembering to enter the number of the expander before the Program Code. Only the voices MUST be programmed; the other parameters have their standard defaults. Not all parameters are accessible in the expander. The following is a list of those which may be programmed:

- Voices
- Relay On/Off codes
- Alarm On/Off codes
- Remote alarm input codes
- Alarm format
- Relay On time
- Alarm delay (debounce)
- Expander Site ID enable

If you try to change the parameters in other expanders, the B1290 will announce *Error*. To solve this problem, define all of the expanders in the system in the B1290 using program code 7 (number of expanders).

To change the Alarm On code for the first alarm on the second expander, you would program the following (the example assumes that the number of expanders has already been set to 2 as shown above):

B1290: Enter Program Code

YOU: 2 3 * * *Expander 2, DTMF Codes*

B1290: Enter DTMF Code

YOU: 4 * * *Alarm On/Off Output codes*

B1290: Expander Two Alarm One On Code is Empty

YOU: 9 6 7 8 * * Enter code 9678

B1290: Expander Two Alarm One On Code is 9678

YOU: (*)(*) *Next*

etc.

10. TROUBLESHOOTING

Problem: I've hooked up the B1290 as per the installation instructions but nothing happens.

- Use a voltmeter to check that the power supply is properly connected. If an AC adapter is being used, it should have an output of at least 12 volts DC with a center-negative power connector. If the DC power source is connected to the RADIO terminal block, it should have the positive lead connected to terminal 8 and the negative lead to terminal 7.

- Do not attach power to both inputs at the same time.

Problem: The B1290 will not program from a local programming phone.

- If you do not hear the voice prompt to begin programming, check that the programming phone is plugged into the PGM jack and not the PHONE jack.

- If you hear the voice prompt to begin programming, but the B1290 does not register your entries, check that you are using a tone phone. Sometimes a pushbutton phone actually sends dial pulses rather than DTMF. You can tell the difference by listening in the earpiece; pulse dialing sounds like clicking, DTMF like tones.

- Check for the TONE LED on the front panel when a digit is being received. Some phones send short bursts of tone rather than continuous tone while the key is depressed. If the B1290 is not detecting DTMF, try another phone.

- Check the setting of the receive level for the phone port. Since it is not possible to do this using the programming phone, it will have to done with the programming software.

- Disconnect the RX input from the radio. Audio received from this input is summed with the audio from the programming phone. If noise is being received, it will affect the decoding of tones and the programming of the voices. The RX input should always be connected to squelched audio.

Problem: The B1290 does not dial out over the telephone line when an alarm occurs.

- Check that the phone line is plugged into the correct jack. The jack labeled PGM is for a local programming phone; the telephone line should be plugged into the PHONE jack.

- Check that the telephone is dialing from the correct directory (Program Code 2). The B1290 has four separate directories: A, B, C and D. Check that the telephone numbers are entered correctly in the selected directory, and that the directory is not empty.

- Check that an alarm is actually present, as indicated by the LEDs on the front panel. In its default condition, the B1290 expects to see a closure to ground at the alarm input. If your alarm inputs are normally closed contacts which open on an alarm condition, this parameter may be adjusted using Program Code 5. The debounce can also be set in this section. This parameter may be set to delay reporting an alarm until it has been present for a certain number of seconds, in which case it will not recognize a momentary closure.

- Check the program cable. The B1290 (Version 1) will remain in program mode if the DB9 cable is still connected to the unit. The alarm and RUN LEDs will flash when in this state.

Problem: The B1290 waits a long time before announcing the alarm over the radio.

- The B1290 will wait for one minute when the COS input is busy and then transmit anyway. This is done to ensure that an open squelch on the radio does not disable the reporting operation. Check the Squelch Polarity setting to make sure that it matches the operation of the radio's COS output. If the COS input to the B1290 is left open the Squelch Polarity should be set to 0 using Program Code 6.

- Check the alarm delay (debounce) parameter using Program Code 5. If a delay has been programmed, the B1290 will wait until the alarm has been present for that interval before reporting it.

- Check the directory programming to make sure that there is not an unwanted Wait command present.

Problem: The B1290 continues dialing even after the alarms have been acknowledged.

- The most common cause of this problem is fleeting alarms. They occur when the device reporting an alarm to the B1290 gives a series of pulses on the contacts instead of a clean closure. If the problem cannot be corrected in the

field wiring, one option is to “debounce” the alarms using the B1290 alarm delay parameter using Program Code 5. When this value is set, contacts must be closed for a specific period of time before they are recognized as alarms.

- Check if any new alarms are announced when the B1290 continues to dial after it has been acknowledged. Sometimes alarms at a remote site are related, occurring in a chain reaction from a single cause. The B1290 will start dialing when it receives the first alarm, but if another alarm occurs in the meantime, it will keep dialing until all the alarms are acknowledged.

Problem: The B1290 won’t answer the phone.

- Check that the phone line is plugged into the PHONE jack and not the PGM jack.

- Check that the phone line is using the inner red/green pair, and not the outer black/yellow pair (normally reserved for line 2).

- Check that the B1290 is configured to answer the phone, using Program Code 4. If the number of rings before answering is set to 0, the B1290 will never answer the phone.

- Answering the telephone will not occur if the B1290 is engaged in any of these activities: speaking on the radio, in local programming mode and when it is using the phone line to call out. Counting of rings only begins once the unit is in its idle state.

- Check that the ringing voltage on the telephone line exceeds 40 VAC at 20 Hz. The RING LED located on the front panel will indicate if proper ringing voltage is being received.

- Check that the telephone line has a standard ringing cadence of two seconds on, four seconds off. If the ringing cadence is greatly different, it may not be detected.

Problem: The B1290 will not acknowledge.

- Check that you are sending the correct digits. The acknowledge code can be changed using Program Code 3.

- If the B1290 is not acknowledging over radio, it may be necessary to adjust the receive level setting for the radio port.

- If the B1290 is not acknowledging over the telephone line, it may be necessary to adjust the receive level setting for the phone port.

- Check that the TONE LED on the front panel of the B1290 lights when a DTMF digit is received.

Problem: The B1290 does not activate its relay when I send the DTMF On code.

- Check that you are sending the right digits. The relay On/Off codes can be changed by using Program Code 3.

- Check the relay On time using Program Code 5. If the setting is 0, the relay will stay On until it is commanded Off. For any other setting, the relay will only operate for the programmed number of seconds.

- If the relays do not operate from codes sent over the radio, it may be necessary to adjust the receive level setting for the radio port.

- If the relays do not operate from codes sent over the telephone, it may be necessary to adjust the receive level setting for the phone port.

- Check that the TONE LED on the front panel of the B1290 lights when a digit is received.

Problem: Our operators live in an area which has a dial pulse exchange. How can they acknowledge the B1290 when it calls?

- Even though the operators have rotary phones, they can still send tone codes if they have a DTMF pad, purchased separately, which sits by the phone.

- The B1290 may be programmed to automatically acknowledge after eight rings. Thus if the B1290 calls an operator with a dial pulse phone, the operator can hang up after he hears the message, call the B1290 right back, let the phone ring eight times, and the B1290 will recognize that as an acknowledgment. Set the number of rings before answering to # in the Configuration section (Program Code 4), and put a Wait command in the next directory line to

allow time for them to call the B1290 back.

Problem: How can I prevent unauthorized personnel from calling up the B1290 and altering its programming?

- In its default condition, the B1290 does not require any type of password. If you wish to enter one, refer to the Access Code in the DTMF Codes section (Program Code 3). If an Access Code is programmed, anyone calling the B1290 will receive a report of its status, but it will prompt the caller to enter the Access Code before allowing them into the programming mode.

Problem: Can I use the (*) character as part of my DTMF strings? Won't this be confused with the "Enter" code?

- The (#) and (*) characters may be used as a part of any programmable DTMF string. The only time you must be careful is when entering an asterisk ((*)) as the last digit in a string. Be sure to wait more than one second after entering the last digit before hitting Enter ((*)(*)); otherwise the last (*) will be interpreted as part of the Enter code.

Problem: The B1290 has lost its programming.

- As it runs, the B1290 is constantly performing internal self-checks, and on rare occasions it may find that a memory location has been corrupted. If that happens, the B1290 resets all programmed parameters (except the voice messages) to the default values. At the same time, it will announce *Program Code Error* over the radio. As the telephone directories have been lost, the B1290 cannot dial out to report the failure over the phone. The only way you will be able to tell that something has gone wrong is by phoning the B1290; it will announce a *Program Code Error* as soon as it answers the phone. In order to have some local indication that an error has occurred, hook a local speaker into the radio connections.

The most common causes of a memory loss are power spikes which enter the board through the power, ground, telephone line, or radio connections.

Problem: I tried to change the telephone numbers and now the B1290 will not dial out at all.

- Check the programming for Directory A to be sure that the correct command sequence is entered. If a Directory Control Code is being used, make sure that the B1290 has not been changed to a directory that disables the alarm reporting. This would be the case where a directory contains the single Wait command or possibly commands for only the radio port.

11. SPECIFICATIONS

Alarm Inputs	8, optically isolated, 2mA to operate, ground closure required.
Control Outputs	4 independent form C outputs controlled by programmable codes or used as special function outputs. Rated: 1 Amp at 30 Volts DC, 0.3A at 120V AC
Telephone Connection	RJ11; tone or pulse line.
Programming Connection	RJ11; accepts a standard telephone.
Receive Audio	-20 dBm to 0 dBm, 10 k ohm impedance; unbalanced, AC coupled.
Transmit Audio	-20 dBm to 0 dBm, 600 ohm impedance, unbalanced, AC coupled.
Channel Busy (COS)	Ground closure.
PTT	Open collector, 25 V max, 150 mA max.
Acknowledge Input	Ground closure.
Voice Quality	Digitized, toll quality, 32 kbps.
Power	Version 1: +11.5 VDC to +28 VDC, 100 mA standby current, 10 mA per active relay. Version 2: +10V DC to +30V DC, 50 mA standby current, 150 mA maximum current, 10mA per active relay
Environment	-40ºC to + 60ºC, 95% relative humidity, non-condensing.
Physical	6.5” x 8.5” x 2” Plug-in terminals

12. APPENDIX A – PROGRAMMABLE FEATURES

Alarm Messages	Unique Site ID plus individual messages for each input. Message length is variable
Alarm Polarity	Selects NO or NC input format
Alarm Latch	Latches fleeting alarm inputs
Alarm Debounce	Selects the delay time before a change of state on the input is valid. Range is 0.1 to 19.9 in either seconds or minutes
Alarm Directory	Selects one of four directories that contain command actions to be taken when the alarm is active.
Interval Timer	Two stage timer that uses 'A' interval 'A' times before switching to 'B' interval. Both 'A' and 'B' interval are adjustable up to 249 minutes.
Acknowledge Code	Stops the reporting sequence: 1 to 8 digits
Interrogate Code	Speaks alarms and relay state: 1 to 8 digits
Alarm On/Off Output Codes	Sent when an alarm becomes active (on) or when it returns to normal (off). Different codes for each alarm. 1 to 8 digits
Remote Alarm Input	Simulate an alarm condition when received. Different codes for each alarm. 1 to 8 digits
Directory Control Code	Changes the alarms to use different directories; also referred to as shift change. Two modes are available: one where all alarms are assigned to Directory A and can be controlled to alternately use the other three directories and another where Directory A alternates with Directory B and Directory C alternates with Directory D.
Directory Commands	Each directory can have up to 20 lines of command sequences. The commands are executed when an alarm using the directory is active. The commands are: ▸ Dial - phone the programmed number. ▸ Voice - Speak the alarm messages ▸ Radio - turn on the radio transmitter ▸ Wait - Insert a pause: 1 to 249 seconds. ▸ 2 Tone - send a two tone page ▸ 5 Tone - send a five tone page ▸ 1 Tone - send a single tone ▸ Alert - send a beeping tone ▸ DTMF - send a string of digits ▸ Answer - monitor the call progress signals and wait for the called party to speak before announcing the alarm message.
Access Code	Password for dial-up access to programming:1 to 8 digits
Acknowledge Request	The acknowledge request at the end of the alarm annunciation can be disabled for use with public address systems.
Number of Rings	Sets the number of rings before the B1290 will answer the line: 1 to 8 rings or never.
Squelch Polarity	Sets the radio busy monitor to either high or low when busy.
Relay Voices	Voice messages that are returned when a relay is operated.
Disable Relay Voices	Relay voices are not spoken.
Relay On/Off Codes	DTMF codes that turn the relay on and off. Independent for each relay: 1 to 8 digits
Relay Timer	Makes the relay a timed type where it will remain on for the specified time after the On code is received. Range is 1 to 199 in either seconds or minutes
Relay Special Function	These automatic functions can be assigned to the relays: ▸ Relay 1: New (unacked) alarm on ▸ Relay 2: Any alarm on ▸ Relay 3: Alarm acknowledged (timed) ▸ Relay 4: Error

Pulse Dial	Forces dialing to be pulse instead of tone.
Number of Expanders	Sets the number of connected expanders.
Disable Expander ID	Stops the site ID in the expander from being spoken.
Audio Levels	Sets the gain for audio signals in the B1290

13. APPENDIX B – OPTIONS

B1256	AC Adapter
B1292	Expander module. Adds 8 inputs and 4 relays. Maximum of 7 expanders
Option 004	External power pack with 120 VAC power supply, sealed battery and charger, 12 hour capacity in standby. Connection of the Option 004 power supply is shown in Figure 8.

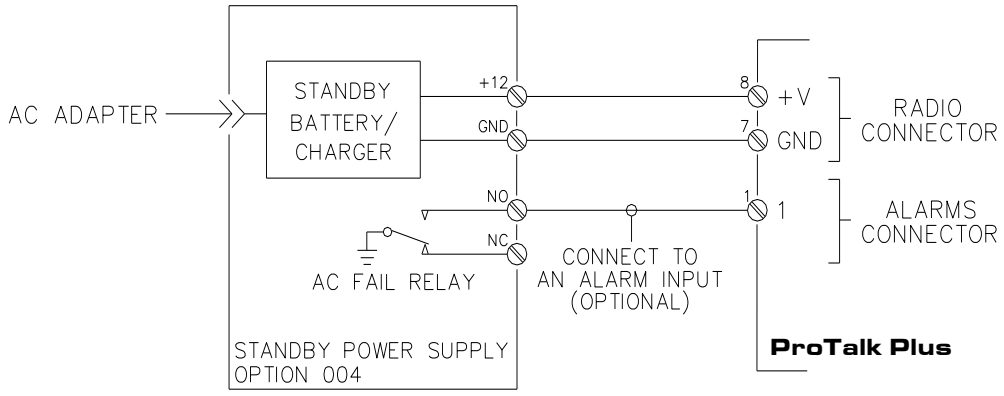
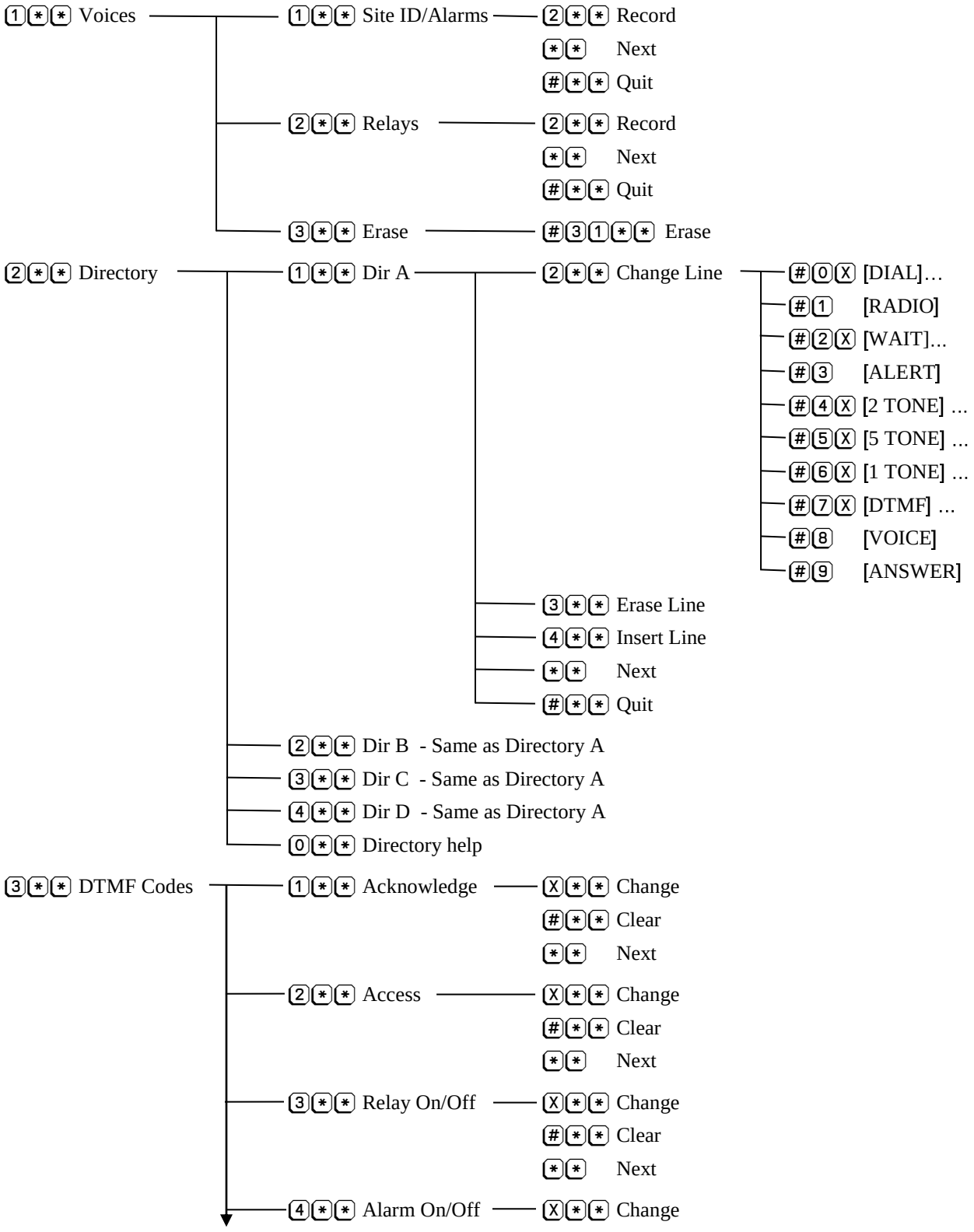
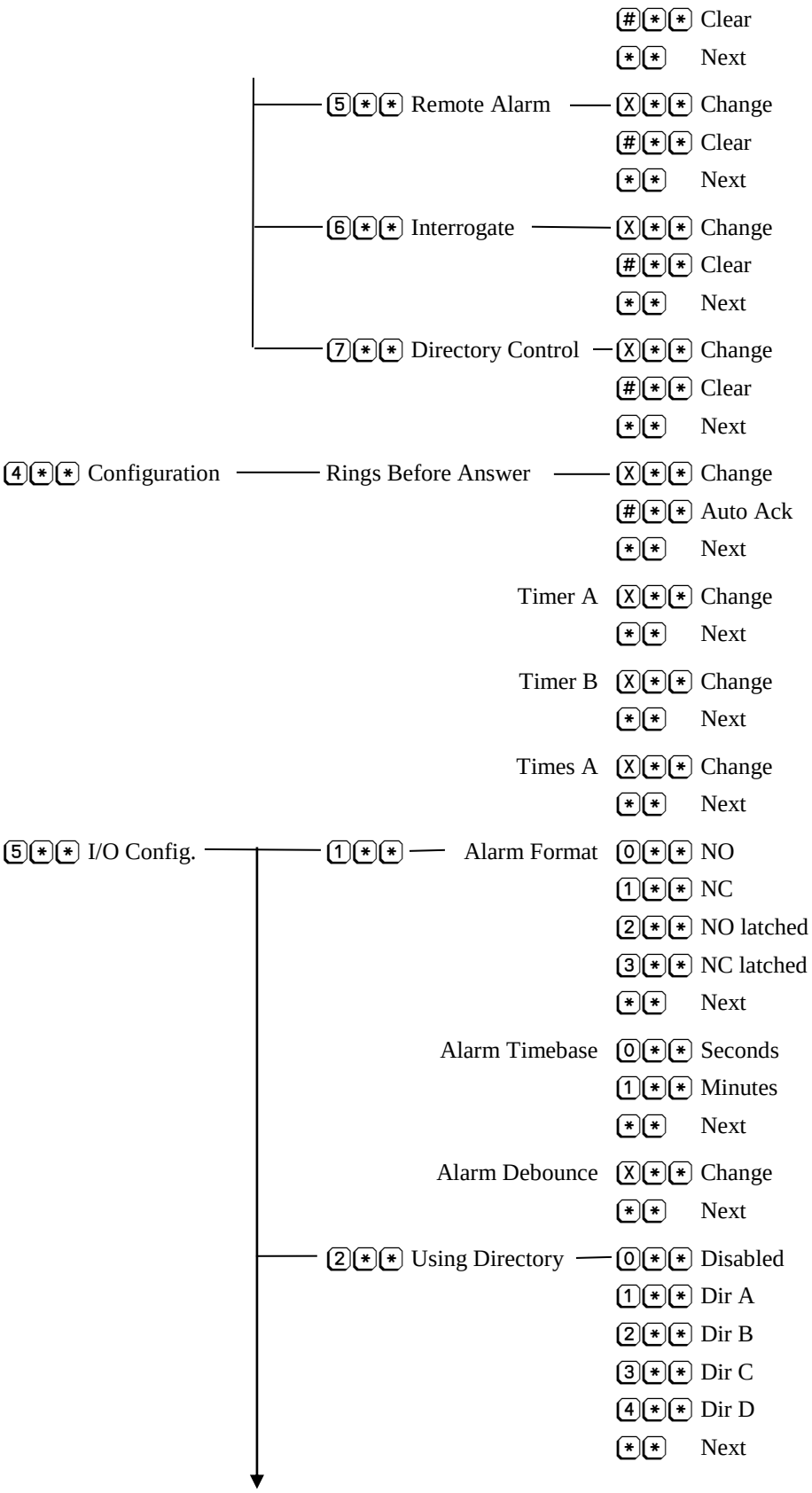


Figure 8 Option 004 Connections

14. APPENDIX C – PROGRAMMING TREE

The parameters used to program the ProTalk Plus are given as a summary below. Where X appears, user data is entered




#** Clear
** Next
5** Remote Alarm
X** Change
#** Clear
** Next
6** Interrogate
X** Change
#** Clear
** Next
7** Directory Control
X** Change
#** Clear
** Next
4** Configuration
Rings Before Answer
X** Change
#** Auto Ack
** Next
Timer A
X** Change
** Next
Timer B
X** Change
** Next
Times A
X** Change
** Next
5** I/O Config.
1** Alarm Format
0** NO
1** NC
2** NO latched
3** NC latched
** Next
Alarm Timebase
0** Seconds
1** Minutes
** Next
Alarm Debounce
X** Change
** Next
2** Using Directory
0** Disabled
1** Dir A
2** Dir B
3** Dir C
4** Dir D
** Next

- 3*** Relay Timebase
  - 0*** Seconds
  - 1*** Minutes
  - *** Next
- Relay Timer
  - 0*** Not timed
  - 1*** Special
  - X*** Change
  - *** Next

- 6*** System
  - Dial Format
    - 0*** Tone
    - 1*** Pulse
    - *** Next
  - Squelch Polarity
    - 0*** Busy low
    - 1*** Busy high
    - *** Next
  - Relay Voices
    - 0*** Off
    - 1*** On
    - *** Next
  - Ack Request
    - 0*** Off
    - 1*** On
    - *** Next
  - Dial Tone (Call Progress)
    - 0*** Off
    - 1*** On
    - *** Next

- 7*** Expanders
  - Number of Expanders
    - X*** Change
    - *** Next
  - Site Voice Enable
    - 0*** Off
    - 1*** On
    - *** Next

- 8*** Reset Database
  - #3 1*** Reset
  - *** Next

- 9*** Audio Levels
  - Radio TX Tone
    - X*** Change
    - *** Next
  - Radio TX DTMF
    - X*** Change
    - *** Next
  - Radio TX Voice
    - X*** Change
    - *** Next
  - Radio RX
    - X*** Change
    - *** Next

Phone RX [X][*][*] Change
[*][*] Next

15. APPENDIX D – MOUNTING

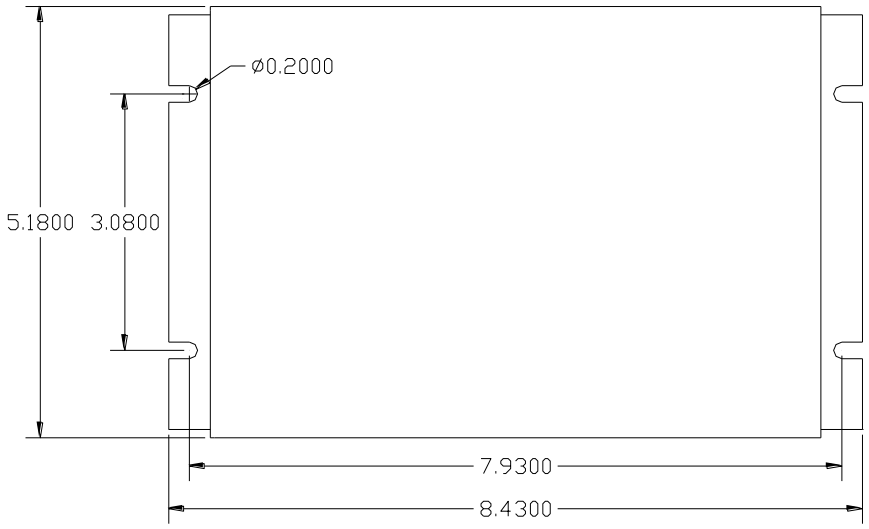


Figure 9 Mounting Detail

16. NOTICES

CSA Certification

The B1290 product has 60950-1 safety certification for Canada and USA.

Compliance

This Class A digital apparatus complies with Canadian ICES-003. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference and,

(2) this device must accept any interference received, including interference that may cause undesired operation.

Warning

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions manual, may cause interference to radio communications.

Operation of this equipment in a residential is likely to cause interference. Should this occur, the user (at his own expense) will be required to apply whatever measures necessary to correct the interference.

17. WARRANTY STATEMENT

Barnett Engineering Ltd. warrants that all equipment supplied shall be free from defects in material or workmanship at the time of delivery. Such warranty shall extend from the time of delivery for a period of 2 years. Buyer must provide written notice to Barnett Engineering Ltd. within this prescribed warranty period of any defect. If the defect is not the result of improper usage, service, maintenance, or installation and equipment has not been otherwise damaged or modified after delivery, Barnett Engineering Ltd. shall either replace or repair the defective part or parts of equipment or replace the equipment or refund the purchase price at Barnett Engineering Ltd.'s option after return of such equipment by buyer to Barnett Engineering Ltd. Shipment to Barnett Engineering Ltd.'s facility shall be borne on account of buyer.

(1)Consequential Damages: Barnett Engineering Ltd. shall not be liable for any incidental or consequential damages incurred as a result of any defect in any equipment sold hereunder and Barnett Engineering Ltd.'s liability is specifically limited to its obligation described herein to repair or replace a defective part or parts covered by this warranty.

(2)Exclusive Warranty: The warranty set forth herein is the only warranty, oral or written, made by Barnett Engineering Ltd. and is in lieu of and replaces all other warranties, expressed or implied, including the warranty of merchantability and the warranty of fitness for particular purpose.

ProTalk® B1292 Expander Unit

Expander

Expander

Expander

Expander

Expander

Expander

Key Features

- Expands ProTalk Plus input and output capabilities
- Each expander has 8 alarm inputs and 4 relay outputs
- Up to 7 expanders can be used
- 64 alarm inputs and 32 relay outputs maximum
- Fully compatible with previous expanders
- -40°C to +60°C temperature range

Expander

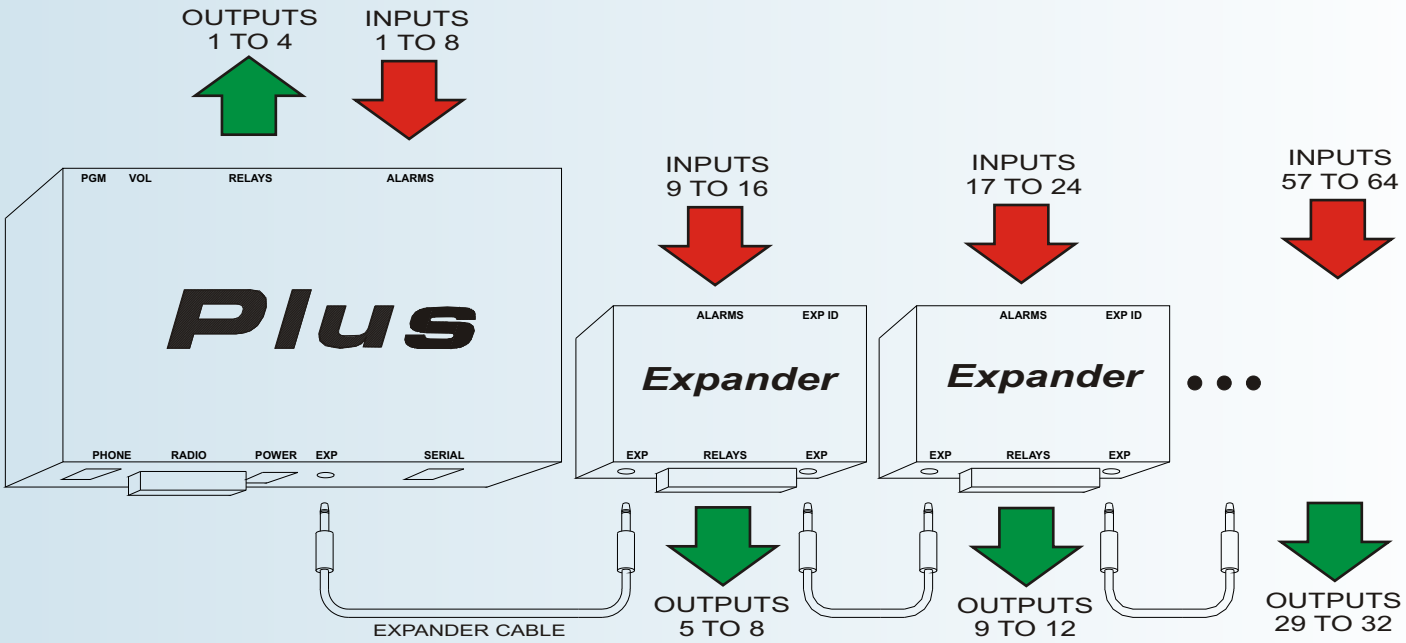
Expander

Expander

Expander

BARNETT ENGINEERING LTD.
Telephone: (800) 268-2646 www.barnett-engg.com

ProTalk® B1292 Expander Unit



Specifications

Physical	5.5” wide x 4.5” high x 2” deep Steel, powder coated matte black Mounting ears for panel installation
Environment	-40°C to + 60°C, 95% humidity, non-condensing
Connectors	Plug-in screw terminal block unless noted
Power	+11.5 to +28 VDC, negative ground, 50 mA standby, 150 mA maximum current, 10 mA per active relay
Alarm Inputs (8)	Optically isolated, 2 mA to operate, ground closure required
Relay Outputs (4)	Independent Form C outputs controlled by programmable codes or used as special function outputs. Rated: 1A at 30 Volts DC, 0.3A at 120 Volts AC
Expander Number	Rotary switch selects the expander number, externally accessible
Indicators	Alarms (8) - Red LED Outputs (4) - Red LED Status - Green LED Run TX (Data activity on the expander cable) RX (Data activity on the expander cable)
Expander Ports (2)	2.5mm jack for connection to the alarm reporting unit and other expander modules
Expander Cable	Coaxial cable with 2.5mm plugs, 24” standard length, longer lengths available Total combined length of all expander cables in a system is 75’

BARNETT ENGINEERING LTD.
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ProTalk®
Expander

Operating Manual
Model B1292

July 28, 2009
Rev. 1.01

Barnett Engineering Ltd.
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1. INTRODUCTION

The B1292 ProTalk Expander unit provides an additional 8 digital inputs and 4 relay outputs to either the B1225 or B1290 Alarm Reporting Units. Up to 7 expanders can be connected to the master unit for a total of 64 inputs and 32 outputs.

The B1292 is fully compatible with previous expanders and can be intermixed with older units on existing systems. It is housed in a compact 3.5’ x 5.5’ metal case and features LED indicators to display alarm and relay status information.

A coaxial communications cable connects the master unit to the first expander and each additional expander in a daisy-chain manner. The master unit controls communications on the cable.

2. INSTALLATION

The B1292 features plug-in terminal blocks for all alarm and relay connections.

A coax cable (supplied) connected to the EXP connector is used to establish serial communications with the master unit. Additional expanders are connected in a daisy chain configuration. Expanders must be powered up before or at the same time as the main ProTalk ARU.

Alarm Connector	
1	Alarm 1
2	Alarm 2
3	Alarm 3
4	Alarm 4
5	Alarm 5
6	Alarm 6
7	Alarm 7
8	Alarm 8
9	Ground
10	Ground
11	Ground
12	Power +11.5 to +28 VDC

Relay Connector	
1	Relay 1 NC
2	Relay 1 Common
3	Relay 1 NO
4	Relay 2 NC
5	Relay 2 Common
6	Relay 2 NO
7	Relay 3 NC
8	Relay 3 Common
9	Relay 3 NO
10	Relay 4 NC
11	Relay 4 Common
12	Relay 4 NO

Expander Communications (2)	
Inner	Signal
Outer	Ground

There are two connectors for expander communications (EXP); both connectors operate in the same way. It does not matter which connector is used for attaching the previous or next device in the system.

Do not apply power to the EXP connector.

3.1 WIRING DIAGRAM

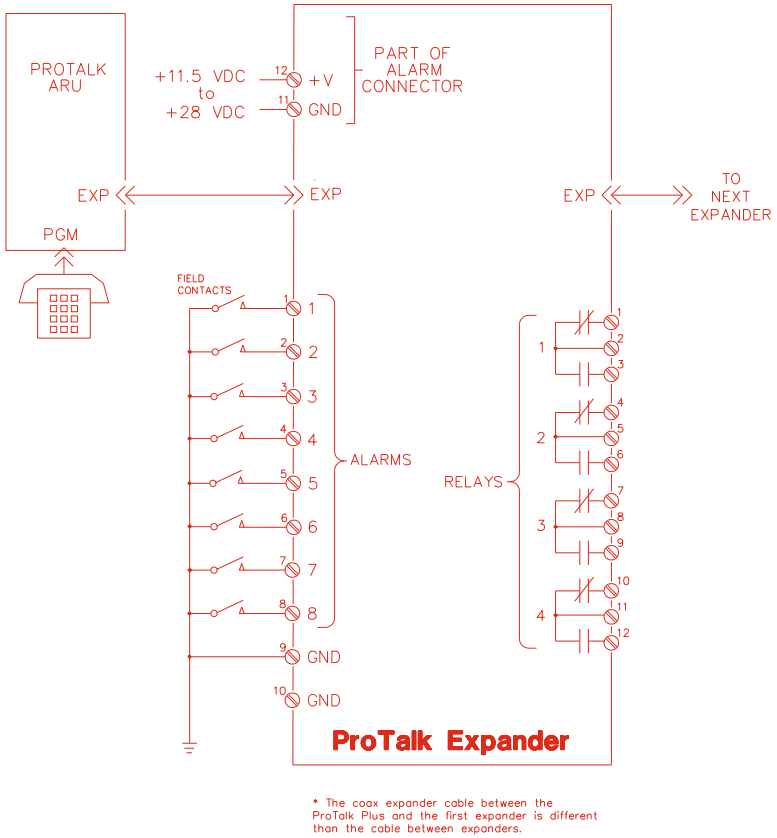


Figure 1 ProTalk Expander Wiring Connections

3. OPERATIONS

The front panel of the B1292 is shown in Figure 2. The front panel indicators assist in verifying the correct operation of the unit. Detailed information on the overall operation of the alarm system that the expander is being used with is contained in the manual for the main reporting unit.

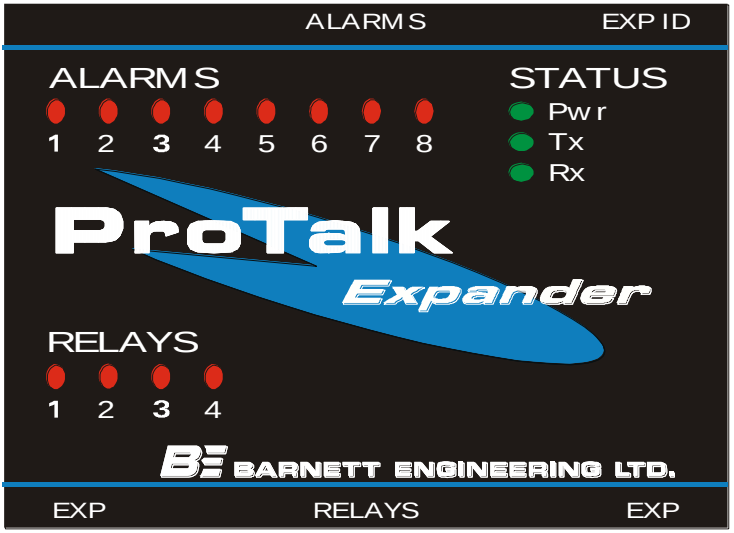


Figure 2 ProTalk Expander Front Panel

Alarm LEDs The Alarm LED is on when the associated input is in the alarm state. When connected to a B1290, unacknowledged alarms will be flashing and any that have been acknowledged will be on solid.

Relay LEDs The Relay LEDs light whenever the associated relay is on.

PWR LED The PWR LED indicates that power has been applied to the unit as well as the operational mode that it is configured for. Solid indicates that the unit is in B1225 mode, flashing indicates B1290 mode.

Tx LED The Tx LED lights when the B1292 is sending to the main unit.

Rx LED The Rx LED lights when a message are present on the serial bus.

4. PROGRAMMING (B1225 MODE)

4.1 OVERVIEW

Each expander has a unique ID number (1-7) set on the rotary switch. This ID number is used during programming to select the desired unit. If the expander ID is changed, the system must have power removed and then reapplied before the new address is recognized.

The operational mode of the B1292 will automatically be set when the unit is programmed. A solid PWR LED indicates B1225 mode.

Before programming the expander the "Number of Expanders" and "Expander Site Voice" must be set on the B1225. The expander is programmed through the B1225 with the handset.

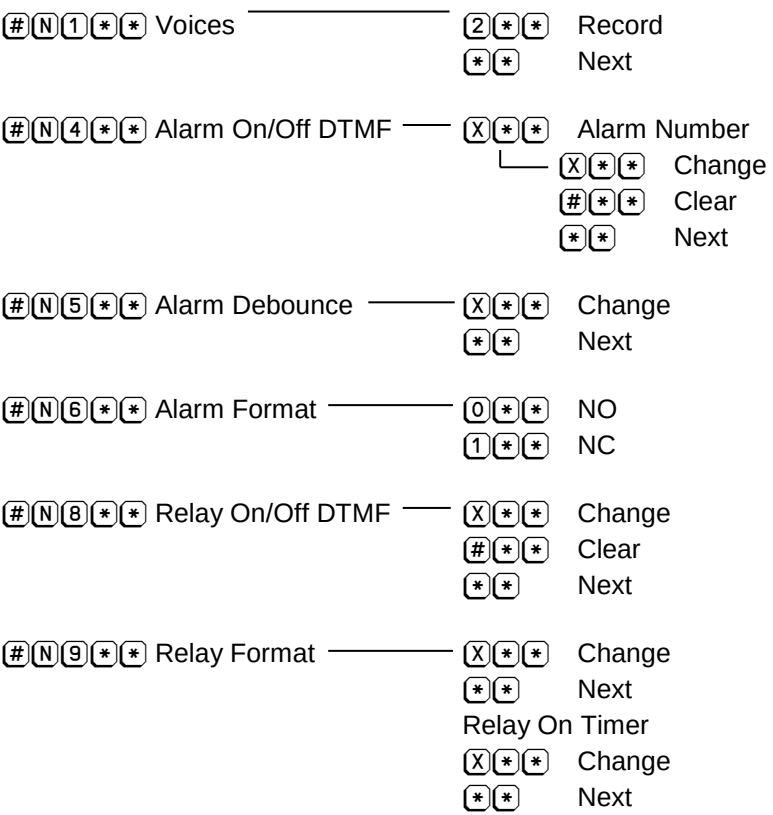
At the "Enter Program Code" prompt, the different functions of the expander can be selected by entering their program code. When an individual expander is accessed, its configuration is read into the B1225 over the expander serial connection. At this point, if necessary, the operational mode of the expander is automatically set B1225 mode. When the program phone is hung up the new configuration is written back to the expander and stored in non-volatile FLASH memory.

Although expanders are shipped with a "default" configuration, the Alarm Voices must be programmed.

A description of the programming procedure for a B1225 expander is given below. Use these codes in conjunction with the programming manual for the B1225. N is the expander ID number of the unit being programmed.

4.2 PROGRAMMING FLOWCHART (B1225 MODE)

(N) = expander ID number; where (X) appears, user data is entered.



4.3 PROGRAMMING EXAMPLES

(#)(N)(1)(*)(*) VOICES

The site identifier and each of the 8 alarm inputs are programmed for the expander in this section. The alarm messages are identified as N.1 to N.8 instead of 1 to 8 in the master B1225.

Example: You want to program the site identifier in the first expander to say "Delta Compressor"

ARU: ENTER PROGRAM CODE
YOU: #11✱✱ (selecting voice message)
ARU: EXPANDER1 SITE IS …
YOU: 2✱✱ (selecting change)
ARU: BEEP - (record light comes on)
YOU: (speaking) DELTA COMPRESSOR

ARU: EXPANDER 1 SITE IS DELTA COMPRESSOR
YOU: ✱✱
ARU: ALARM NUMBER 1 point 1 IS … (on to the alarm messages)

#N4✱✱ ALARM ON/OFF DTMF

The DTMF on and off strings will be programmed for the expander specified. As in the voice message programming section, the expander and alarms will be announced as N point 1 to N point 8

Example: You want to program the second input in expander 1 to have a DTMF ON code of 123 and an off code of 456.

ARU: ENTER PROGRAM CODE
YOU: #14✱✱
ARU: ENTER ALARM NUMBER
YOU: 2✱✱
ARU: ALARM NUMBER 1 point 2 DTMF ON CODE IS …
YOU: 123✱✱
ARU: ALARM NUMBER 1 point 2 DTMF ON CODE IS 123
YOU: ✱✱
ARU: DTMF OFF CODE IS …
YOU: 456✱✱
ARU: DTMF OFF CODE IS 456
YOU: ✱✱
ARU: ENTER ALARM NUMBER

#N5✱✱ ALARM DEBOUNCE

Alarm delay time (debounce time) can be set for each expander and must be between 0.1 and 19.9 seconds. One debounce time is used for all of the inputs on a particular expander. Each expander may have a different time. The input must remain active for this period of time in order for it to be considered a change of state.

Example: The debounce time for expander 2 is to be set at 3 seconds.

ARU: ENTER PROGRAM CODE
YOU: #25✱✱
ARU: EXPANDER 2 ALARM DELAY IS 0.5 SECONDS
YOU: 30✱✱
ARU: EXPANDER 2 ALARM DELAY IS 3.0 SECONDS
YOU: ✱✱

#N6✱✱ ALARM FORMAT

Each alarm input on an expander can be programmed to be Normally Open (N.O. – requiring a ground closure to become active) or Normally Closed (N.C. - requiring a release from ground to become active). The ALARM FORMAT must be a 0 for N.O. contacts or a 1 for N.C. contacts.

Example: The inputs for expander two are to be set for normally closed inputs.

ARU: ENTER PROGRAM CODE
YOU: #26✱✱

ARU: EXPANDER 2 ALARM FORMAT IS 0
YOU: 1✶✶
ARU: EXPANDER 2 ALARM FORMAT IS 1
YOU: ✶✶

(#)(N)(8)(*)(*) RELAY ON/OFF DTMF

The four relays on each expander can have DTMF on and off codes programmed for remote control. They will be announced as relay numbers X.1 to X.4 . The master will interpret DTMF strings from the radio system as ON or OFF controls for the relays. Each string may be up to 8 characters.

Example: The control codes for the output relays in expander one are to be programmed. The first relay will have an ON code of 789 and an OFF code of 321

ARU: ENTER PROGRAM CODE
YOU: #18✶✶
ARU: RELAY NUMBER 1 point 1 DTMF ON CODE IS EMPTY
YOU: 789✶✶
ARU: RELAY NUMBER 1 point 1 DTMF ON CODE IS 789
YOU: ✶✶
ARU: RELAY NUMBER 1 point 1 DTMF OFF CODE IS EMPTY
YOU: 321✶✶
ARU: RELAY NUMBER 1 point 1 DTMF OFF CODE IS 321
YOU: ✶✶

(#)(N)(9)(*)(*) RELAY FORMAT

This will specify the type of relays being used for each expander. The relays will be announced as N.1 to N.4. Each relay may be of a different format. (0=standard, 1=latched, 2=timed).

: Note: Relay Format 1 (Latched) is not supported in the B1292 and will default to "standard" if selected.

Example: Relay one in expander one is to be set as a timed relay.

ARU: ENTER PROGRAM CODE
YOU: #19✶✶
ARU: RELAY NUMBER 1 point 1 FORMAT IS ZERO
YOU: 2✶✶
ARU: RELAY NUMBER 1 point 1 FORMAT IS TWO
YOU: ✶✶

After relay 4 format is completed, if any formats are set to 2 (timed) the B1225 will prompt for "Expander N relay on timer is X seconds. The range of the timer is 1 to 199. This applies to all relays that were set for timed.

5. PROGRAMMING (B1290 MODE)

5.1 OVERVIEW

Each expander is assigned a unique ID number (1-7) using a rotary switch. This ID number is used during programming to select the desired unit.

If the expander ID is changed, the system must have power removed and then reapplied before the new address is recognized.

The operational mode of the B1292 will automatically be set when the unit is programmed. A flashing PWR LED indicates B1290 mode.

Before programming the expander the "Number of Expanders" and "Site Voice Enable" must be set on the B1290.

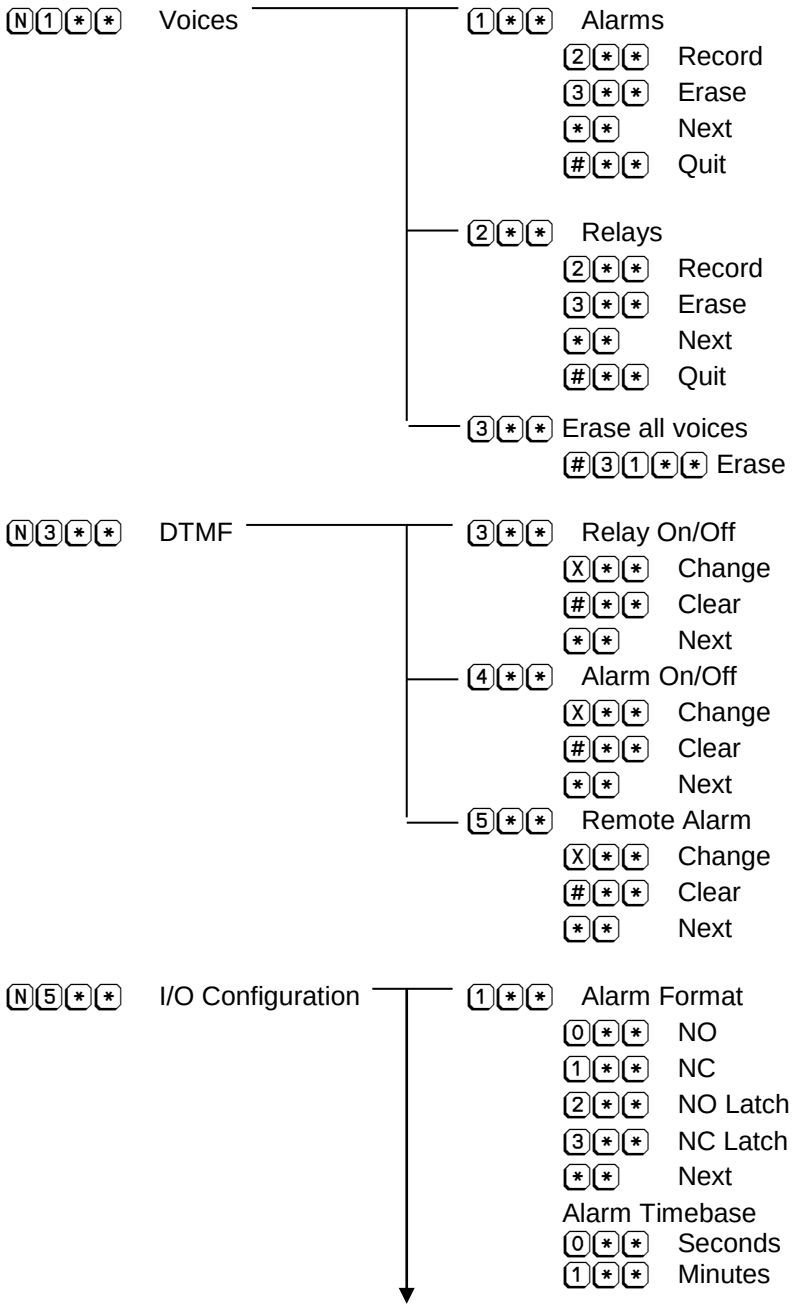
Expanders connected to a B1290 may be programmed through the B1290 handset, remotely or using PC Configuration Software.

All the expander's programmed parameters are stored in the main ProTalk Plus and are downloaded on power-up. The B1292 will switch to B1290 Mode when this download is complete.

The following program codes are valid for the B1292 expander when in B1290 mode. Use these codes in conjunction with the programming manual for the B1290. N is the expander ID number of the unit being programmed.

5.2 PROGRAMMING FLOWCHART (B1290 MODE)

[N] = expander ID number, where [X] appears, user data is entered.



- (*)(*) Next

Alarm Debounce

- (X)(*)(*) Change
- (*)(*) Next
- (#)(*)(*) Quit

- (2)(*)(*) Using Directory
  - (0)(*)(*) Off
  - (1)(*)(*) Dir A
  - (2)(*)(*) Dir B
  - (3)(*)(*) Dir C
  - (4)(*)(*) Dir D
  - (*)(*) Next
  - (#)(*)(*) Quit
- (3)(*)(*) Relay Timebase
  - (0)(*)(*) Seconds
  - (1)(*)(*) Minutes
  - (*)(*) Next

Relay Timer

- (0)(*)(*) Not Timed
- (X)(*)(*) Timed
- (*)(*) Next

5.3 PROGRAMMING EXAMPLES

(N)(1)(*)(*) VOICES

The site identifier and each of the 8 alarm and 4 relay voices are programmed for the expander in this section. Voice messages are of variable length and are terminated when the B1290 detects a period of silence.

Example: You want to program the site identifier in the first expander to say "Delta Compressor"

ARU: ENTER PROGRAM CODE
YOU: 11✱✱ (selecting voice message)
ARU: ENTER VOICE CODE
YOU: 1✱✱
ARU: EXPANDER 1 SITE IS …
YOU: 2✱✱ (selecting change)
ARU: BEEP
YOU: (speaking) DELTA COMPRESSOR
ARU: EXPANDER 1 SITE IS DELTA COMPRESSOR
YOU: ✱✱
ARU: EXPANDER 1 ALARM 1 IS …(on to the alarm messages)

N3** DTMF

The Relay On/Off, Alarm On/Off and Remote Alarm Codes are programmed in this section.

Example: You want to program the first Relay in expander 1 to have a DTMF ON code of 321 and an off code of 765.

ARU: ENTER PROGRAM CODE
YOU: 13✱✱
ARU: ENTER DTMF CODE
YOU: 3✱✱
ARU: EXPANDER 1 RELAY 1 ON CODE IS …
YOU: 321✱✱
ARU: EXPANDER 1 RELAY 1 ON CODE IS 321
YOU: ✱✱
ARU: OFF CODE IS …
YOU: 765✱✱
ARU: OFF CODE IS 765
YOU: ✱✱
ARU: EXPANDER 1 RELAY 2 ON CODE IS …

N5** I/O CONFIGURATION

This section allows configuration of the expander alarm format, timebases and directory usage. Refer to the B1290 manual for detailed programming instructions.

Example: You want to program Normally Closed Alarm inputs on expander 2 with the first alarm pointing to directory D.

ARU: ENTER PROGRAM CODE
YOU: 25✱✱
ARU: ENTER CONFIGURATION CODE
YOU: 1✱✱
ARU: EXPANDER 2 ALARM FORMAT IS 0
YOU: 1✱✱
ARU: EXPANDER 2 ALARM FORMAT IS 1
YOU: #✱✱
ARU: ENTER CONFIGURATION CODE
YOU: 2✱✱
ARU: EXPANDER 2 ALARM 1 IS DIRECTORY A
YOU: 4✱✱
ARU: EXPANDER 2 ALARM 1 IS DIRECTORY D
YOU: ✱✱
ARU: EXPANDER 2 ALARM 2 IS DIRECTORY A

6. SPECIFICATIONS

Alarm Inputs	8, optically isolated, 2mA to operate, ground closure required
Control Outputs	4 independent form C outputs controlled by programmable codes, On/Off or timed modes Rated: 1 Amp at 30 Volts
Adjustments	Rotary DIPswitch for setting the expander ID number
Power	+11.5 VDC to +28 VDC 50 mA standby, 200mA max at 12V
Environment	-40°C to + 60°C, 95% relative humidity, non-condensing
Physical	4.5” x 5.5” x 2” Plug-in terminals

7. WARRANTY STATEMENT

Barnett Engineering Ltd. warrants that all equipment supplied shall be free from defects in material or workmanship at the time of delivery. Such warranty shall extend from the time of delivery for a period of one year. Buyer must provide written notice to Barnett Engineering Ltd. within this prescribed warranty period of any defect. If the defect is not the result of improper usage, service, maintenance, or installation and equipment has not been otherwise damaged or modified after delivery, Barnett Engineering Ltd. shall either replace or repair the defective part or parts of equipment or replace the equipment or refund the purchase price at Barnett Engineering Ltd.'s option after return of such equipment by buyer to Barnett Engineering Ltd.

Shipment to Barnett Engineering Ltd.'s facility shall be borne on account of buyer.

(1) Consequential Damages: Barnett Engineering Ltd. shall not be liable for any incidental or consequential damages incurred as a result of any defect in any equipment sold hereunder and Barnett Engineering Ltd.'s liability is specifically limited to its obligation described herein to repair or replace a defective part or parts covered by this warranty.

(2) Exclusive Warranty: The warranty set forth herein is the only warranty, oral or written, made by Barnett Engineering Ltd. and is in lieu of and replaces all other warranties, expressed or implied, including the warranty of merchantability and the warranty of fitness for particular purpose.

WARNING: This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications.

Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

8. Appendix A - Mounting

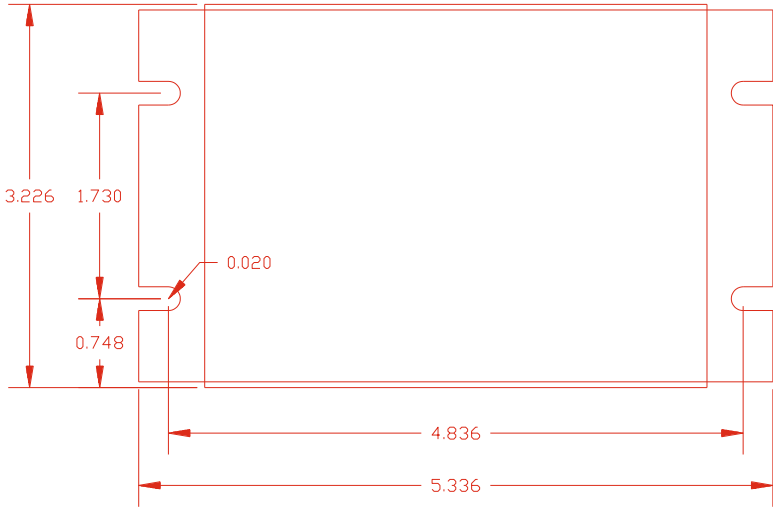
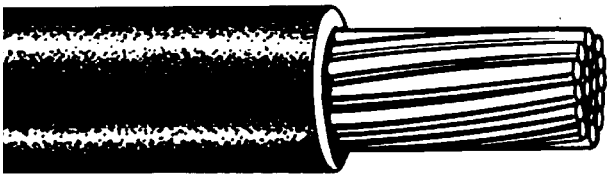


Figure 3 Mounting Detail

Type RW 90 Copper Conductor

XLPE Insulation,
90°C Wet or Dry, 600 Volt.



APPLICATIONS:

CSA listed for use at 90°C conductor temperature in dry or wet locations. May be installed in conduit and other recognized raceways. General purpose wiring for control, lighting and power circuits in residential and commercial buildings and industrial plants and for utility sub-stations, meters and generating plants. Suitable for installation at temperature down to -40°C.

SPECIFICATIONS:

1. In accordance with CSA C22.2 No 38.
2. The conductor is copper. Sizes 14 AWG (2.08 mm^2) through 8 AWG (8.37 mm^2) are solid or concentric strand. Sizes 6 AWG (13.3 mm^2) through 1000MCM (506.8 mm^2) are stranded.
3. Allowable ampacities per Table 2 of Canadian Electrical Code for not more than 3 copper conductors in a raceway or cable, 30°C ambient temperature. 5
5. No flame rating.
6. For stranding type of different sizes call local Anixter.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: N.K.
Date: July 11, 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 07 juillet 2016

Reviewed X
Reviewed as noted
Resubmit

Out for approval

SIFEC NORTH INC.

ANIXTER CATALOG NUMBER	SIZE		NO OF STRANDS	INSULATION THICKNESS		NOMINAL O.D.		NOMINAL WEIGHT		AMPS PER COND.	CONDUIT SIZE	
	AWG/MCM	MM²		IN	MM	IN	MM	LBS/M FT	KG/KM		IN	MM
SINGLE SOLID CONDUCTOR												
6CL-1401	14	2.08	Sol.	.030	.76	.13	3.30	17	25	15	1/2	13
6CL-1201	12	3.31	Sol.	.030	.76	.14	3.56	26	38	20	1/2	13
6CL-1001	10	5.26	Sol.	.030	.76	.16	4.06	38	56	30	1/2	13
SINGLE STRANDED CONDUCTOR												
6CL-1407	14	2.08	7	.030	.76	.13	3.30	18	26	15	1/2	13
6CL-1207	12	3.31	7	.030	.76	.15	3.81	27	40	20	1/2	13
6CL-1007	10	5.26	7	.030	.76	.18	4.57	41	61	30	1/2	13
6CL-0807	8	8.38	7	.045	1.14	.24	6.10	67	99	45	3/4	19
6CL-0607	6	13.3	7	.060	1.52	.30	7.62	100	148	65	1	25
6CL-0407	4	21	7	.060	1.52	.34	8.64	153	227	85	1	25
6CL-0307	3	27	7	.060	1.52	.37	9.40	192	285	105	1 1/4	32
6CL-0207	2	34	7	.060	1.52	.40	10.16	236	351	120	1 1/4	32
6CL-0119	1	42	19	.080	2.03	.47	11.94	299	444	140	1 1/4	32
6CL-10119	1/0	54	19	.080	2.03	.51	12.95	382	568	155	1 1/2	38
6CL-20219	2/0	67	19	.080	2.03	.55	13.97	470	699	185	1 1/2	38
6CL-30319	3/0	85	19	.080	2.03	.59	14.99	584	868	210	2	51
6CL-40419	4/0	107	19	.080	2.03	.65	16.51	727	1081	235	2	51
6CL-25037	250MCM	127	37	.090	2.29	.73	18.54	863	1284	265	2 1/2	64
6CL-30037	300MCM	152	37	.090	2.29	.78	19.81	1024	1523	295	2 1/2	64
6CL-35037	350MCM	178	37	.090	2.29	.82	20.83	1187	1766	325	2 1/2	64
6CL-40037	400MCM	203	37	.090	2.29	.87	22.10	1349	2007	345	3	76
6CL-50037	500MCM	254	37	.090	2.29	.95	24.13	1668	2481	395	3	76
6CL-75061	750MCM	381	61	.090	2.29	1.14	28.96	2488	3702	500	3 1/2	89
6CL-100061	1000MCM	508	61	.090	2.29	1.29	32.77	3293	4899	585	4	102

** 1000V material available*

Note:
600 MCM size is available OD = 1.07 in = 27.17 mm

Power Cables

APPROVED MANUFACTURERS | 4/0-1C 19 STR ALUM RWU90 XLPE INS -40 TO 90C 1KV BLK CSA C22.2 NO.38

Anixter # 6CO-40419-02

Qty: Meter

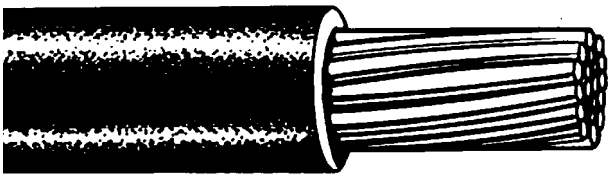
Request Quote ?

SPECIFICATION

Armor:	NO
Composite:	NO
Conductor Count:	1 CONDUCTOR
Conductor Material:	ALUMINUM
Conductor Size:	4/0 AWG
Conductor Type:	STRANDED
Earth/Ground Wires:	NO
Insulation Material:	XLP-CROSS LINKED POLYETHYLENE
Insulation Thickness:	95 MILS (.095")
Jacket Color:	BLACK
Jacket Material:	PVC-POLYVINYL CHLORIDE
Product Type:	RWU90
Screen/Shield:	UNSHIELDED
Temperature Rating:	90 DEGREES CENTIGRADE
Voltage Range:	1KV

Type RWU 90 Copper Conductor

XLP Insulation,
90°C Wet or Dry, 1000 Volt.



APPLICATIONS:

CSA listed for use at 90°C conductor temperature in dry or wet locations. May be installed in conduit and other recognized raceways. General purpose wiring for control, lighting and power circuits in residential and commercial buildings and industrial plants and for utility sub-stations, meters and generating plants. Suitable for direct burial installation. Minimum installation temperature -40°C.

SPECIFICATIONS:

1. In accordance with CSA C22.2 No 38.
2. The conductor is copper. Sizes 14 AWG (2.08 mm^2) to 10 AWG (5.26 mm^2) are concentric strand. Sizes 6 AWG (13.3 mm^2) through 1000MCM (508 mm^2) are compressed or compact stranding.
3. Allowable ampacities per Table 2 of Canadian Electrical Code for not more than 3 copper conductors in a raceway or cable, 30°C ambient temperature.

5. No flame rating.
6. For stranding type of different sizes call local Anixter.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: N.K.

Date: July 11, 2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

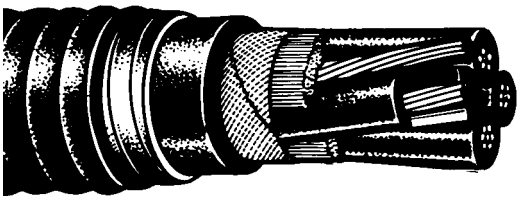
CHIARELLI ENGINEERING LTD.

ANIXTER CATALOG NUMBER	SIZE		NO OF STRANDS	INSULATION THICKNESS		NOMINAL O.D.		NOMINAL WEIGHT		AMPS PER COND.	CONDUIT SIZE	
	AWG/MCM	MM²		IN	MM	IN	MM	LBS/M FT	KG/KM		IN	MM
SINGLE STRANDED CONDUCTOR												
6CN-1407	14	2.08	7	.060	1.52	.20	5.0	23	34	15	1/2	13
6CN-1207	12	3.31	7	.060	1.52	.21	5.3	32	47	20	1/2	13
6CN-1007	10	5.26	7	.060	1.52	.24	6.0	46	68	30	1/2	13
6CN-0807	8	8.38	7	.080	2.03	.31	7.8	73	108	40	1	25
6CN-0607	6	13.3	7	.080	2.03	.33	8.3	111	165	65	1	25
6CN-0407	4	21	7	.080	2.03	.38	9.6	163	242	85	1 1/4	32
6CN-0307	3	27	7	.080	2.03	.41	10.4	230	342	105	1 1/4	32
6CN-0207	2	34	7	.080	2.03	.44	11.1	245	364	120	1 1/4	32
6CN-0119	1	42	19	.095	2.41	.51	12.9	314	467	140	1 1/2	38
6CN-10119	1/0	54	19	.095	2.41	.54	13.7	387	575	155	1 1/2	38
6CN-20219	2/0	67	19	.095	2.41	.58	14.7	476	708	185	2	51
6CN-30319	3/0	85	19	.095	2.41	.63	16.0	590	877	210	2	51
6CN-40419	4/0	107	19	.095	2.41	.68	17.2	723	1075	235	2	51
6CN-25037	250MCM	127	37	.110	2.79	.75	19.0	870	1294	265	2 1/2	64
6CN-30037	300MCM	152	37	.110	2.79	.81	20.5	1031	1534	295	2 1/2	64
6CN-35037	350MCM	178	37	.110	2.79	.85	21.5	1193	1775	335	2 1/2	64
6CN-40037	400MCM	203	37	.110	2.79	.90	22.8	1353	2013	345	3	76
6CN-50037	500MCM	254	37	.110	2.79	.98	24.8	1674	2490	395	3	76
6CN-75061	750MCM	381	61	.125	3.17	1.17	29.7	2489	3703	500	3 1/2	89
6CN-100061	1000MCM	508	61	.125	3.17	1.32	33.5	3290	4895	5855	4	102

Power Cables for the Old Truck fill station
from P-1 to PA-1

Teck 90 1 Kv Four Conductors

Aluminum Armor or Galv. Steel, 90°C, 1000 Volt,
XLPE Insulation, Inner PVC Jacket,
Interlock Armor, Outer PVC Jacket.



APPLICATIONS:

For exposed or concealed wiring in wet or dry locations. For use in ventilated, non-ventilated and ladder type cable troughs and ventilated flexible cableway in wet or dry locations. For direct earth burial. Approved for use in Class 1, Division 1, hazardous locations. Typical applications are for power, lighting and control circuits in:

Pulp and Paper Mills
Refineries
Steel Mills
Commercial Centers
Mines
Generating Stations
Industrial Plants
Chemical Plants
Food Processing Plants

SPECIFICATIONS:

1. Conductor: Class B stranded soft copper size #14 AWG-1000MCM.
2. Insulation: Cross-linked polyethylene (XLPE), type RW-90 per CSA Standard C22.2 No 131.
3. Identification: Surface color coding is standard for sizes up to and including No 2 AWG. For larger than No.2 AWG number coding is standard.
4. Grounding Conductor: In multiple conductor cables the uninsulated Class B stranded grounding conductor is included in the cable assembly.
5. Multiple conductor cables are assembled with suitable fillers and binder tape.
6 Inner Jacket: Polyvinyl Chloride (PVC).
7. Armor: Aluminum or galvanized steel interlocking armor.
8. Outer Jacket: Polyvinyl Chloride (PVC) heat, flame and moisture resistant jacket, suitable for installation in temperatures down to minus 40°C. The standard color is black but colored jackets are available.
9. The Cable is Certified to CSA C22.2 No.131 and No.174 for use in Class 1, Division 1, hazardous locations, (HL Rated), and is flame test rated FT-4.
10. Ampacities (Amps Per Cond.) are based on a 30°C ambient temperature according to the Canadian Electrical Code (Part 1).

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: N.K.
Date: July 11,2016

Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

Power Cables for the Old Truck fill station from P-1 to PA-1

ANIXTER CATALOG NUMBER	SIZE AWG/MCM	GROUND COND. SIZE AWG	AMPACITY IN 30°C AMBIENT AIR *	APPROXIMATE DIAMETERS						NOMINAL WEIGHT			
				INNER JACKET		ARMOR		OUTER JACKET		ALUMINUM ARMOR		STEEL ARMOR	
				IN	MM	IN	MM	IN	MM	LBS/M FT	KG/KM	LBS/M FT	KG/KM
7TL-1404	14	14	15	0.505	12.83	0.705	17.91	.810	20.57	280	431	435	657
7TL-1204	12	14	20	0.580	14.73	0.780	19.81	.885	22.48	360	416	530	788
7TL-1004	10	12	30	0.640	16.26	0.840	21.34	.945	24.00	445	662	630	937
7TL-0804	8	10	45	0.710	18.03	0.910	23.11	1.02	25.91	560	833	750	1116
7TL-0604	6	8	65	0.880	22.35	1.08	27.43	1.19	30.23	840	1250	1160	1726
7TL-0404	4	8	85	1.01	25.65	1.21	30.73	1.32	33.53	1140	1696	1500	2232
7TL-0304	3	6	105	1.10	37.94	1.30	33.02	1.41	35.81	1360	2008	1740	2589
7TL-0204	2	6	120	1.16	29.46	1.36	34.54	1.47	37.34	1560	2321	1860	2916
7TL-0104	1	6	140	1.32	33.53	1.52	38.61	1.65	41.91	1940	2886	2400	3571
7TL-1014	1/0	6	155	1.41	35.81	1.61	40.89	1.74	44.20	2300	3422	2750	4092
7TL-2024	2/0	6	185	1.51	38.35	1.76	44.70	1.89	48.01	2750	4092	3350	4984
7TL-3034	3/0	4	210	1.63	41.40	1.88	47.75	2.02	51.31	3350	4984	4000	5952
7TL-4044	4/0	4	235	1.81	45.97	2.06	52.32	2.20	55.85	4150	6175	4950	7365
7TL-2504	250	4	265	1.98	50.29	2.24	56.90	2.38	60.45	4800	7142	5700	8481
7TL-3004	300	4	295	2.12	53.85	2.36	59.94	2.52	64.01	5600	8332	6500	9672
7TL-3504	350	3	325	2.22	56.39	2.48	62.99	2.64	67.06	6400	9523	7300	10862
7TL-4004	400	3	345	2.32	58.93	2.58	65.53	2.74	69.60	7100	10564	8100	12052
7TL-5004	500	3	395	2.52	64.01	2.78	70.10	2.92	74.17	8500	12648	9600	14284
7TL-6004	600	2	455	2.72	69.09	2.96	75.18	3.12	79.25	9900	14731	11200	16665
7TL-7504	750	2	500	3.00	76.20	3.26	82.80	3.44	87.38	12400	18451	13600	20236
7TL-10004	1000	1	585	3.28	63.31	3.62	91.95	3.80	96.52	15800	23510	17200	25593
7TL-12504	1250	1/0	645	3.92	99.57	4.8	106.17	4.36	10.74	19600	29164	31500	31992

**Where fourth conductor is the neutral of a three-phase, four wire system, otherwise 80% of these values - CSA C22.1 Rule 4-004(3).*

NOTE: After Anixter number use "SJ" for steel, "AJ" for aluminum.

Chapter 35 CHLORINATION INJECTION SYSTEM

MANUFACTURER/DISTRIBUTOR:

Metcon Sales & Engineering
A/S Julia Alstanei
15 Connie Crescent, Unit 3
Concord, ON, L4K 1L3
Email: juliaa@metconeng.com
Tel: 905-738-2355 ext.302
Fax: 905-738-5520

35.1 **METCON DUPLEX PUMP PANEL SYSTEM**

35.2 **SEVERN TRENT SERVICES MICROCHEM2 ANALYZER CONTROLLER**

35.3 **NANODAC RECORDER**

35.4 **BADGER MAGNETIC FLOWMETER M-2000**

SHOP DRAWING FOR APPROVAL

Date : 14/06/2016

To:
Arktis Solutions
Chiarelli Engineering Management Ltd.
M.M. Mallet
P.O. Box 242
Gjoa Haven, NU, K0B 1J0
T: 867-446-0036
F: 866-475-1147

From :
Kudlik Construction Ltd.
C/O Jean-Sébastien Demers ing.
P.O. 727, 1519 Federal Road
Iqaluit, X0A 0H0
Tel.: 867-979-1166
F: 867-979-1169

SIFEC NORTH inc.
Electro Mechanical Contractor
P.O. Box 556
Rankin Inlet, NU, X0C 0G0
T: 866-437-4001
F: 206-338-2249

Project : 2016-061 **Igloolik Truck Fill - YGT12**
Process

	Owner Tag Number	Section	DESCRIPTION	Model	Status	Initial Date of submital
1	CMS-1 / 2 & CDP-1 / 2	22 42 01	Chlorination system	Mecton Engineering	Initial	14/06/2016

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed By: M.M.
Date: 15 June 2016

Reviewed pages 1 to 69
Reviewed ☒
Reviewed as noted ☐
Resubmit ☐

CHIARELLI ENGINEERING LTD.

SHOP DRAWING

Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

metcon
SALES & ENGINEERING LTD.

Job Name:	**Igloolik**
Job Number:	**15-S010793**
Date:	**June 14, 2015**

SHOP DRAWINGS

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 14 Juin, 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Gen Tanasie, P. Eng
Sr. Project Manager

Phone: 905-738-2355 x 236
E-mail:
genovevt@metconeng.com

metcon
SALES & ENGINEERING LTD.

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2. Shop Drawings	**08**
3. Equipment spec sheets:	**10**
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– Pump Panel Accessories	**18**
- Magnetic Flow Meter	**40**
- Hypochlorite Feeding System	**43**
- Chlorine Controller	**49**
- Chlorine Probe	**59**
- pH Probe	**61**
- Recorder / Controller	**63**

2.6 Chlorination System

System Description

Two identical dual pump, redundant piping, Viton elastomers for components, control box for power and signal with 3-way selector switch for duty selection. Each system is pre-mounted, pre-piped, pre-wired and pressure tested on HDPE board, as supplied by Metcon Sales & Engineering Ltd.
Both Chemical systems are built for max. 10 bar (145 psi).

Bill of Materials

4 PROMINENT Gamma/ X Chemical Pump

(Tag #: CP1, CP2, CP3 & CP4)

- Model: GMXa 1009BPB9U00UD1130BEN
- Max Capacity: 2.1 gph (8.0 l/hr) = 50.4 gpd (192 l/d)
- Max. Back Pressure: 145 psi (10 bar)
- Max stroking rate: 200 SPM and 100% stroke length
- Liquid End: Auto-degassing liquid end
- Operational status displayed via three LED lights indicating normal, low flow warning or lack of chemical/operational error
- Direct calibration function and built-in warning indicator
- Feed rate display: LPH or US gal/hour
- Pump Control: Manual + External + Analog Ctrl.
- Relay Contact: 2 A @ 250 Vac
- Power requirements: 0.7 A 115 / 1 / 60
- Suc./disch. connectors: 1/2" x 3/8"
- Control cable (2m): 1001300

Material of Construction
Liquid end type – Acrylic
Suction/Discharge Connectors – PVC
Seals – Viton
Valve Balls - Ceramic
Diaphragm – PTFE

Pumps Panel Accessories:

4 PROMINENT Flow Monitors Type II

- Model: 1009338
- Type: New Style
- Material: PVDF
- Seals: Viton B

8 CHEMLINE Back Pressure / Pressure Relief Valves

- Model: SB11A005VU
- Material: PVC
- Seals: Viton
- Size: ½” (12 mm)
- Ends: Union

28 CHEMLINE Ball Valves

- Model: 21A005VS
- Material: PVC
- Seals: Viton
- Size: ½” (12 mm)
- Ends: Socket

4 CHEMLINE Pressure Gauge and Isolator

- Model: SGA005-002PG
- Material: PVC
- Seals: Teflon
- Size: ½” (12 mm) - ¼” (6 mm)
- Pressure Range: 0-200 psi
- Filled: Glycerin

4 BLACOH Pulsation Dampener

- Model: RC-10PVC-E50
- Capacity: 10 cu.in (0.16 L)
- Body Material: PVC
- Ends: ½” FNPT
- Max. Pressure: 150 psi

4 PRIMARY FLUID Calibration Column

- Model: PV#2 – 500
- Capacity: 500 mL
- Body Material: Clear PVC
- Ends: Threaded

4 CHEMLINE Y Strainer

- Model: YSA005VS
- Size: ½" (12 mm)
- Material: PVC/Viton
- Screen Mesh: 24 (standard)

Note: Please advise if mesh 35 or 55 is required.

4 CHEMLINE Check Valves

- Model: BTA005VS
- Size: ½" x 3/8"
- Material: PP/Viton

2 PROMINENT Injection Valve

- Model: N/A (comes with pump)
- Size: ½" x 3/8"
- Material: PP/Viton

2 CHEMLINE Corp Stop, Chemlance Series (ship loose)

- Model: CL-005-VF
- Material: PVC
- Valve Material: Brasss
- Size: ½" (12 mm)
- Seals: Viton
- Ends: Threaded

2 Metcon Control Panel

- Model: 121006
- Size: 12"H x 10"W x 6"D
- Protection Rating: NEMA-4X
- Power Requirements: 3A @ 115 / 1 / 60
- Approvals: CSA
- Panel Components: As per drawing # 2

2.6.10.1 Electromagnetic Flow Meter

2 BADGER Electromagnetic Flow Meter

(Tag #: FM-1 & FM-2)

- Model: M2000 / 6"/ HR / GR / Intergral
- Element Size: 6" (150 mm)
- Flow Range: 30-11890 L/min (7.85-3141 gpm)
- Connections: 150# Flanged
- Amplifier: Mounted on meter
- Electrodes: Alloy-C
- Liner: Hard Rubber
- Body Material: Carbon Steel
- Power Requirements: 20 W @ 85….265 Vac
- Enclosure: NEMA-4X (IP66)
- Comes with: 316SS Grounding Rings

2.6.10.4 Hypochlorite Feeding System

2 ARCH CHEMICAL Calcium Hypo Feeding System

(Tag #: MC 4-50-#1 & MC 4-50-#2)

- Model: MC 4-50
- Dry Chemical Capacity: 62 lbs (28 kg)
- Nominal Operating Conc.: 1.7% AvCL
- Chlorine Delivery Rate: 1-50 lbs AvCI/Day @ 70°F
- Water Requirements: 1.0 gpm @ 50-150 psi
- Power Requirements: 15 A @ 120 Vac
- Comes with: 2 Pails (100 lbs) of Chlor Plus Dry Chlorinator Briquettes per Feeder

2.6.10.5 STS Chlorine Controller

2 STS Chlorine Controller, MicroChem2

- Model: T17M D 4 3 D 1 3 4 D E XX
- Input Channels: 3 (free chlorine, pH & temperature)
- Flow Cell: Panel Mount with pressure regulator
- Power Requirements: 120 Vac
- Installation: Wall Mounted
- Communication: RS-232
- Approval: CE / CSA

2.6.10.6 STS Chlorine Probe

2 STS Chlorine Controller, MicroChem2

- Model: 23184
- Measuring Range: 0-5 ppm
- Tolerable: 4 – 9.5 pH
- Comes with: 12 ft of cable

2.6.10.7 STS pH Probe

2 STS Chlorine Controller, MicroChem2

- Model: 01-4068
- Temperature Sensor: Built-In
- Probe Diameter: 12 mm (1/2 “)
- Comes with: 10 ft of cable

2.6.11 NANODAC Recorder / Controller

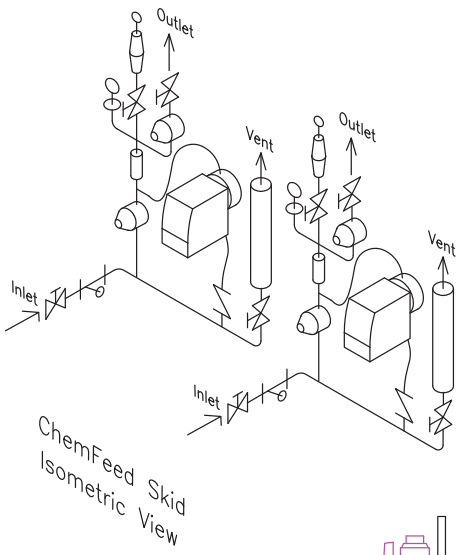
1 NANODAC Recorder / Controller

- Model: VH C P LRR XX TS SV XXXX ENG
- Power Requirements: 2 A @ 120 Vac
- Input Ports: 4
- Virtual Inputs 30
- Flash Memory: 50 Mb
- Communication Port: USB
- Communications: Modbus TCP/IP slave
- Screen: ¼ VGA color
- Keyboard with: 4 keys

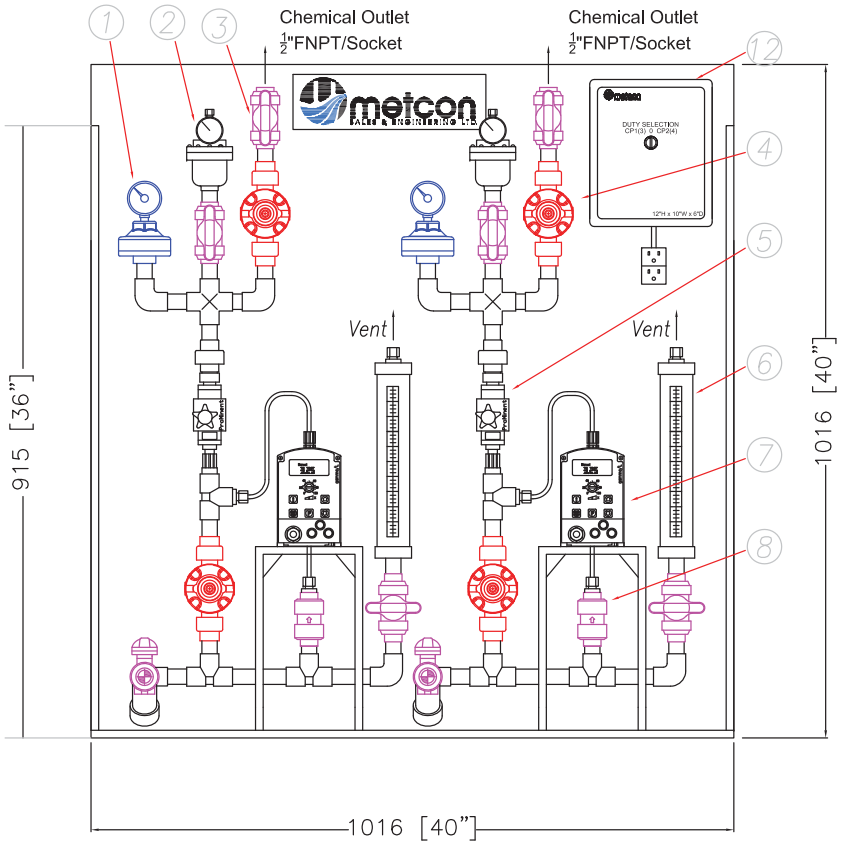
Note: Images are for illustration purposes only and may not reflect the actual product described.

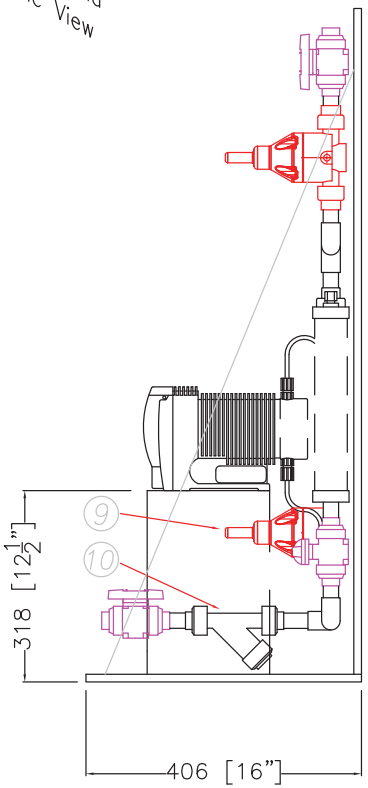
NOTES:

1. Two identical dual pump syetems.
2. Control panel for power signals and automating switchover, if required.
3. Selector switch for selection of duty pump.



ChemFeed Skid
Isometric View





REVISIONS:

No	Date	By	Description
1.			
2.			

BILL OF MATERIALS

#	Part #	Make	Description	Pcs
1.	SGA005002PG	Chemline	Pressure Gauge	4
2.	RC-10PVC-E50	Blacoh	Pulsation Dampener	4
3.	21A005VS	Chemline	Ball Valve	28
4.	SB11A005VU	Chemline	Back Pressure Valve	4
5.	1009338	Prominent	Flow Monitor	4
6.	PV#2 - 500	Primary Fluid	Calibration Column	4
7.	GMXa1009NPB 9U00UD1130B	Prominent	Chemical Feeding Pump	4
8.	BTA005VS	Chemline	Foot Valve	4
9.	SB11A005VU	Chemline	Pressure Relief Valve	4
10	YSA005VS	Chemline	Strainer	4
11	CL-005-VF	Chemline	Corp Stop (shipped loose)	2
12	121006	Metcon	Control Panel	2

- ☐ PROPOSAL ONLY
- ☒ FOR APPROVAL
- ☐ FOR CONSTRUCTION
- ☐ AS BUILT

metcon SALES & ENGINEERING LTD.

Dual Pump System

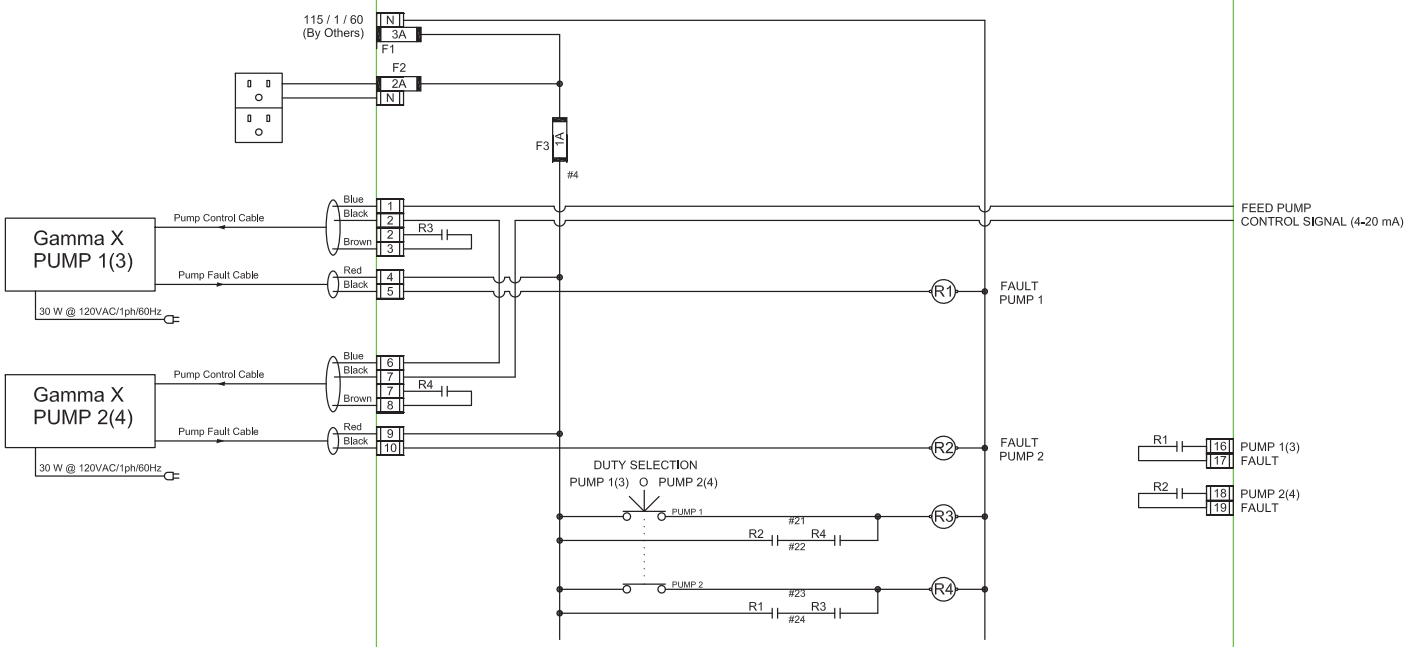
Layout & Dimensions

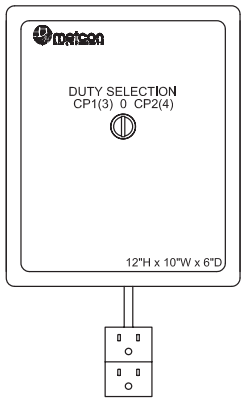
Date:	June 13, 2016
Job Number:	16-S010793
Job Name:	Igloolik
Dwg. #:	M-1
Approved by:	GM
Drawn by:	GT

Notes:

1. [ ] Indicates supplied by others.
2. Unit: Inches (mm). Do not scale this drawing. All dimmensions, sizing, orientation of piping, wiring and equipment, are estimations and approximations and are not to be used in other related design.
3. The information contained on this drawing is of confidential nature and shall not be used or reproduced without written consent from Metcon Sales and Engineering Limited.

CHEMICAL PUMPS CONTRL PANEL





NOTES:

1. Two identical control panels, one for each chemical system
2. Selected duty pump will automatically start after selection from selector switch. Second pump will be the stand-by one.
3. If selected duty pump fails, the stand-by pump will automatically start. Please advise if this feature is not required.
4. If manual control is required, disconnect control cable from pump. On manual control, start/stop and speed adjustment from pump key pad.
5. Control panels will have CSA approval (general inspection).

REVISIONS:

No	Date	By	Description
1.			
2.			

BILL OF MATERIALS

#	Part #	Make	Description	Pcs
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

☐ PROPOSAL ONLY
☒ FOR APPROVAL
☐ FOR CONSTRUCTION
☐ AS BUILT

metcon SALES & ENGINEERING LTD.

Control Panel

Wiring and Layout

Date:	June 13, 2016
Job Number:	16-S010793
Job Name:	Igloolik
Dwg. #:	E-1
Approved by:	GM
Drawn by:	GT

Notes:
1. [ ] Indicates supplied by others.
2. Units: Inches (mm). Do not scale this drawing. All dimmensions, sizing, orientation of piping, wiring and equipment, are estimations and approximations and are not to be used in other related design.
3. The information contained on this drawing is of confidential nature and shall not be used or reproduced without written consent from Metcon Sales and Engineering Limited.

the proven best-selling technology expanded
gamma/ X

Capacity range 1 ml/h - 45 l/h, 363 psi - 29 psi

Take a moment to discover a metering pump that sets new standards in terms of productivity, reliability and economy!

The new solenoid-driven diaphragm metering pump gamma/ X is user-friendly and has an extremely long service life, just like its predecessor. An innovative solenoid control measures the back pressure and protects the system from overload.

This technology makes a pressure sensor superfluous, meaning that operating safety can be significantly increased: no additional parts come into contact with the chemical, there are no additional sealing surfaces and no electronic components in contact with the chemical.

Whether the metering volume fluctuates or hydraulic failures affect the metering process – the gamma/ X keeps everything at your fingertips.

Bluetooth™

Your Benefits

- Virtually wear-free solenoid drive, overload proof and economical
- Suitable for continuous micro-metering from 1 ml/h thanks to the innovative solenoid control
- Simple adjustment of the capacity directly in l/h
- Direct input of the desired final concentration for volume-proportional metering tasks
- Trouble-free processes by the detection of hydraulic malfunctions or blocked discharge lines
- Integrated pressure measurement and display for greater safety during commissioning and operation
- External control via potential-free contacts with pulse multiplier and divider capability
- External control via 4-20 mA analog signal and scale adjustment of mA signal
- 4-20 mA output scalable to pump dosage
- Integrated timer for timed metering tasks
- Guaranteed metering by means of automatic bleeding
- Connection to process control systems via bus interfaces, such as Profinet, CAN bus, more features are in development.

ProMinent®

1-888-709-9933
www.prominent.ca

gamma/ X 09/15/CA
Printed in Canada

Experts in Chemical Feed and Water Treatment

X-tremely clever!
gamma/ X

ProMinent®

Technical Data

Field of application

- Can be integrated into automated processes and used in all industries
- The pump can work as an independent control unit with the process timer, for example in cooling tower water treatment

Type	Maximum			Connection size	Suction lift
gamma/ X	psi	l/h	ml/stroke	oØ x iØ inch	mWc
GMXa 1602	232	2.3	0.19	1/4 x 3/16	6.0**
GMXa 1604	232	3.6	0.30	1/4 x 3/16	6.0**
GMXa 0708	101	7.6	0.63	1/2 x 3/8	6.0**
GMXa 0414	58	14.0	1.17	1/2 x 3/8	3.0**
GMXa 0220	29	19.7	1.64	1/2 x 3/8	2.0**
GMXa 2504	363	3.8	0.32	*	6.0**
GMXa 1009	145	9.0	0.75	1/2 x 3/8	6.0**
GMXa 0715	101	14.5	1.21	1/2 x 3/8	4.0**
GMXa 0424	58	24.0	2.00	1/2 x 3/8	3.0**
GMXa 0245	29	45.0	3.70	1/2 x 3/8	2.0**

* NP version supplied with high pressure rated 8 x 4 PTFE discharge tubing.
** Suction lift with suction line and dosing head filled, (auto degassing liquid end with air in the suction line).

	Pump head	Suction/discharge valve	Ball seat	Valve Balls
NPE	Clear acrylic	PVC	EPDM	Ceramic
NPB	Clear acrylic	PVC	VITON	Ceramic
PVT	PVDF	PVDF	PVDF	Ceramic
SST	Stainless steel	Stainless steel	Ceramic	Ceramic

3 Valve auto-degassing version only in material NP with Hastelloy C spring and PVDF insert.
2 Valve auto-degassing version (PVT7) with PVDF and PTFE wetted parts. Diaphragm with a PTFE coating.
VITON registered trademark of DuPont Performance Elastomers L.L.C.
Permissible ambient temperature: -10 °C to +45 °C
Average power consumption: 24/30 W
Degree of protection: IP 65 / NEMA 4X, insulation class F

Bluetooth™ download the FREE app:
www.prominent.com/gammaX

Technical changes reserved.

ProMinent®
Experts in Chemical Feed and Water Treatment

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www.prominent.us

ProMinent® gamma/ X
Solenoid Diaphragm Metering Pumps

Overview: gamma/ X

The solenoid diaphragm metering pump gamma/ X incorporates a wealth of eXcellent ingenuity! With integrated pressure measurement, it ensures the smooth running of your metering process. The gamma/ X is ideal for all chemical metering applications.

(see page 102 for spare parts and page 123 for control cables)

- Capacity range from 1 ml / hr to 45 l/ hr, maximum discharge pressure up to 363 psi
- Simple adjustment of the capacity directly in l/hr
- Configurable discharge stroke, continuous or pulsed dosing
- Configurable suction stroke duration
- Stroke rate adjustable from 1 – 12,000 strokes per hour
- Electronic stroke length adjustment, continuous from 0 - 100% (recommended range 30 - 100%)
- Suitable for continuous micro-metering from 1 ml/hr thanks to the innovative solenoid control
- Integrated pressure measurement allows for detection of blocked discharge line, broken discharge lines and air or gas bubbles trapped in the dosing head
- Acrylic/PVC, PVT (PVDF) and Stainless Steel liquid end material versions
- Auto degassing liquid ends in Acrylic/ PVC and PVT
- High viscosity liquid ends (PVT4) for viscosities of up to 3000 cP
- Large backlit graphic display and status LED's with 360° visibility
- External control via voltage-free contacts with pulse multiplier/divider function
- External control via standard 4-20 mA signal, and scalable adjustment of mA signal to stroke rate
- Standard internal programmable timer for real-time dependent dosing routines i.e biocides, cooling towers etc.
- Standard pump capable of accepting 2 stage tank level sensor input, flow monitor input, diaphragm rupture sensor input and control cable input.
- NSF/ANSI 61 Approved Liquid ends
- Bluetooth interface as a standard feature

ProMinent® gamma/ X
Solenoid Diaphragm Metering Pumps

Specifications

Maximum stroke length:	For 70mm solenoid approx. 1.3 mm For 85mm solenoid approx. 1.5 mm
Materials of construction	
Housing:	Fibreglass reinforced PPE (Polyphenylene Ether)
Diaphragm:	PTFE faced EPDM with plastic core
Liquid end options:	Acrylic/PVC, PVDF, Stainless Steel
Enclosure rating:	IP 65 / NEMA 4X
Power supply:	100 – 230 VAC 1 Phase 50 / 60 Hz ± 10%
Power consumption:	1602 / 1604 / 0708 / 0414 / 0220 25 W 2504 / 1009 / 0715 / 0424 / 0245 30 W
Internal Fuse:	CSA approved 2.5 AT, 5mm x 20 mm Part # 732413
Check valves:	Double ball suction / discharge (PVT4 with spring loaded single ball)
Power cord:	6ft (2m) CSA Approved
Relay cable (optional):	6ft (2m) standard length
Relay Options	
Identcode Option 1:	Relay contact rated 230 VAC 2 A Max
Identcode Option 4:	Both relay contacts rated 24 V, 100 mA Max
Identcode Option C:	Isolated 4 – 20 mA output can drive up to 300 Ω maximum impedance Relay contact rated 24 V 100 mA
Ambient temperature range	
In operation:	-10°C to 45°C
Storage & Transport:	-20°C to 60°C

Max. fluid operating temperatures:

Material	Constant	Short Term*
Acrylic/PVC	45°C	60°C
PVDF	45°C	120°C
SS	45°C	120°C

*15 minutes at 29 psi maximum

Climate:	95% Relative humidity – non-condensing
Sound pressure level:	LpA < 70 dB according to EN ISO 20361
Warranty:	2 years on pump drive, 1 year on liquid end
Valve threads:	NP / PVT M20 x 1.5 (provided with adapters for tubing)
Standard production test:	All pumps are tested for capacity at maximum pressure prior to shipment
Max solids size in fluid:	Versions 1602 / 1604 / 2504 = 15µ Versions 0708 / 0414 / 0220 / 1009 / 0715 / 0424 / 0245 = 50 µ
Contact input	
Minimum pulse duration:	20 ms
Maxiumum pulse input:	25 pulses / second
Analog Input Impedance:	120 Ohms
Recommended Viscocity:	Max. 200 cPs for standard liquid end Max. 500 cPs for valve with springs Max. 50 cPs for auto-degassing liquid ends Max. 3000 cPs for high-viscosity liquid ends (higher possible)

ProMinent® gamma/ X
Solenoid Diaphragm Metering Pumps

Capacity Data

Pump Version (GMXa)	Capacity at Maximum Backpressure				Pre-Primed Suction Lift		Max. Stroking Rate	Tubing Connections O.D. X I.D.	SS Liquid end connections FNPT	Shipping Weight	
	psig	bar	L/h*	ml/stroke	ft**	m**	spm	inches	inches	NP/PV kg	SS kg
gamma/ X											
1602	232	16	2.30	0.19	19.6	6	200	1/4 x 3/16	1/4	3.6	4.1
1604	232	16	3.60	0.30	19.6	6	200	1/4 x 3/16	1/4	3.6	4.1
0708	101	7	7.60	0.63	19.6	6	200	1/2 x 3/8	1/4	3.7	5.0
0414	58	4	13.5	1.13	9.8	3	200	1/2 x 3/8	1/4	3.7	5.0
0220	29	2	19.70	1.64	6.5	2	200	1/2 x 3/8	3/8	3.7	5.0
2504	363	25	3.80	0.32	19.6	6	200	8 x 4***	1/4	4.9	5.5
1009	145	10	9.00	0.75	19.6	6	200	1/2 x 3/8	1/4	5.1	6.5
0715	101	7	14.50	1.21	13.1	4	200	1/2 x 3/8	1/4	5.1	6.5
0424	58	4	24.00	2.00	9.8	3	200	1/2 x 3/8	3/8	5.1	6.5
0245	29	2	45.00	3.70	6.5	2	200	1/2 x 3/8	3/8	5.2	7.0
gamma/ X metering pumps with auto degassing liquid ends NPB9 / NPE9											
1602	232	16	1.30	0.11	6.9	2.1	200	1/4 x 3/16	-	3.6	-
1604	232	16	2.40	0.21	8.8	2.7	200	1/4 x 3/16	-	3.6	
0708	101	7	6.80	0.57	6.5	2	200	1/2 x 3/8	-	3.7	-
0414	58	4	12.00	1.00	6.5	2	200	1/2 x 3/8	-	3.7	
0220	29	2	18.00	1.50	6.5	2	200	1/2 x 3/8	-	3.7	-
1009	145	10	8.00	0.67	9.8	3	200	1/2 x 3/8	-	5.1	
0715	101	7	12.00	1.00	8.2	2.5	200	1/2 x 3/8	-	5.1	-
0424	58	4	20.00	1.67	8.2	2.5	200	1/2 x 3/8	-	5.1	-

	Max Pressure psi	Capacity at Max Pressure	ml/stroke	1/2 Max Pressure psi	Capacity at 1/2 Max Pressure	ml/ stroke	Pre-Primed Suction Lift	Max. Stroking Rate	Tubing Connections O.D. X I.D.	Shipping Weight
	Data at Max Pressure			Data at 1/2 Max Pressure			m**	spm	inches	kg
gamma/ X metering pumps with auto degassing liquid ends PVT7										
1602	232	0.9	0.075	116	1.5	6	1.8	200	1/4 x 3/16	3.6
1604	232	1.55	0.13	116	2.7	6	1.8	200	1/4 x 3/16	3.6
0708	101	5.7	0.48	50	6.6	6	1.8	200	½ x 3/8	3.7
0414	58	12	1	29	13.8	6	1.8	200	½ x 3/8	3.7
0220	29	17.4	1.45	14.5	18.9	6	1.8	200	½ x 3/8	3.7
1009	145	6.0	0.5	73	7.8	6	1.8	200	½ x 3/8	5.1
0715	101	12.9	1.08	50	14.1	6	1.8	200	½ x 3/8	5.1
0424	58	19.2	1.6	29	21.6	6	1.8	200	½ x 3/8	5.1

gamma/X metering pumps with high viscosity liquid ends (PVT 4) have a 10 – 20 % lower capacity rating and are not self priming. Positive suction is recommended and pumps supplied with ½" MNPT connections.

* The given performance data represents guaranteed minimum values, tested using water as the medium at room temperature.

** Suction lift with suction line and dosing head filled, for auto degassing liquid ends with air in the suction line

*** NP version supplied with high pressure rated 8 x 4 PTFE discharge tubing

All data refers to water at 20 °C.

Materials in contact with the chemical					
	Dosing head	Suction/discharge valves	Ball seat	Seals	Balls
NPE	Clear acrylic	PVC	EPDM	EPDM	Ceramic
NPB	Clear acrylic	PVC	FKM	FKM	Ceramic
PVT	PVDF	PVDF	PVDF	PTFE	Ceramic
SST	Stainless steel material no. 1.4404	Stainless steel material no. 1.4404	Ceramic	PTFE	Ceramic

Auto degassing liquid ends in NP with a valve spring of Hastelloy C and PVDF valve insert. PVT7 versions with PVDF / PTFE wetted parts. Diaphragm with PTFE face.

FKM = fluorine rubber

Permissible ambient temperature: -10 °C to +45 °C

Average power consumption: 25 / 30 W

Degree of protection: IP 65, NEMA 4X

Scope of supply

Metering pump with power cable, connection set for tubing, connection as per table.

ProMinent® gamma/ X
Solenoid Diaphragm Metering Pumps

Identcode Ordering System: Gamma/X (GMXa)

GMXa

Capacity

Version	psi	l/h	Version	psi	l/h
1602	232	2.3	2504	363	3.8
1604	232	3.6	1009	145	9.0
0708	101	7.6	0715	101	14.5
0414	58	13.5	0424	58	24.0
0220	29	19.7	0245	29	45.0

Liquid end/valve material

- NP — Acrylic glass / PVC
- PV — PVDF/PVDF
- SS — Stainless steel 1.4404/1.4404

Seal/diaphragm material

- E — EPDM o-rings for NP Liquid end, PTFE faced diaphragm
- B — Viton o-rings for NP liquid end, PTFE faced diaphragm
- T — PTFE seals for PV and SS liquid ends, PTFE faced diaphragm
- S — Diaphragm with Viton coating for silicate applications, Viton o-rings with NP, PTFE seals with PV and SS

Liquid end version

- 0 — Non-bleed version, no valve springs, only for PV and SS version 0245
- 1 — Non-bleed version, with valve springs, only for PV and SS version 0245
- 2 — Bleed function, with bleed valve, no valve springs, only for NP and PV, not for version 0245 PV and all SS versions
- 3 — Bleed function, valve and valve springs, only for NP and PV, not for version 0245 PV and all SS versions
- 4 — Version for viscous media, only with PV versions 1604, 0708, 0414,1009, 0715, 0424
- 7 — Auto degassing without bypass, only with PV, not for versions 2504 and 0245
- 9 — Auto degassing with bypass, only with NP, not for versions 2504 and 0245

Hydraulic connections

- U — As per technical data

Diaphragm rupture indicator

- 0 — Without diaphragm rupture indicator
- 1 — With diaphragm rupture indicator, optical sensor

Version

- 0 — Standard

Logo

- 0 — Standard with ProMinent® logo

Power supply

- U — 100-230 V, ±10 %, 50/60 Hz

Cable and plug

- D — Canada / USA 115 V power cord 2m (6ft)

Relay

- 0 — Without relay
- 1 — Fault relay with C, NO, NC contacts rated 230 V 2A
- 4 — 2 x contacts, rated 24 V, 100 mA, fault and pacing configurable
- C — 1 contact rated 24V, 100 mA configurable and 4 – 20 mA ouput
- F — Auto degassing module (not available for version 2504)
- G — Auto degassing module + fault relay (not available for version 2504), comes with panel

Accessories

- 0 — Not included, with PVT4 or SS version pumps
- 1 — With Footvalve, Injection valve, 5ft suction tubing and 10 ft discharge tubing for NP and PV (not PVT4) as per technical data

Control version

- 3 — Manual + external with pulse control + analog 4 – 20 mA
- C* — Option 3 + CANopen interface
- R* — Option 3 + PROFIBUS DP interface

Flow monitor

- 0 — Input for flow monitor / DFMa signal

Bluetooth Connection

- B — Standard feature with pump

Language

- EN — English
- FR — French

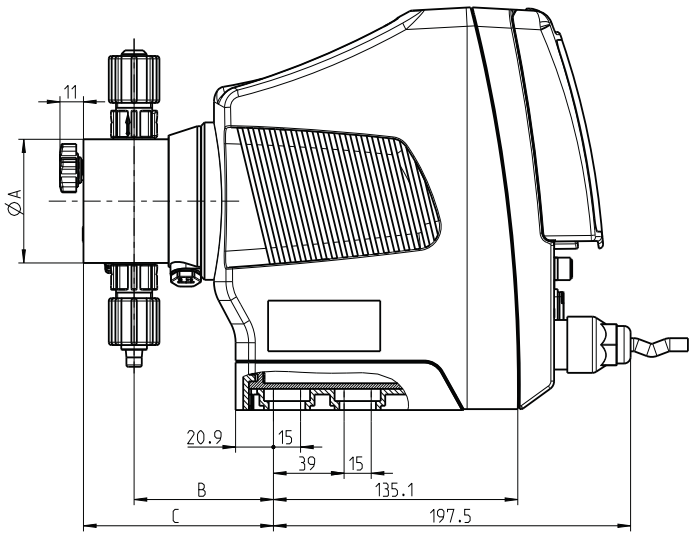
* Available 2016

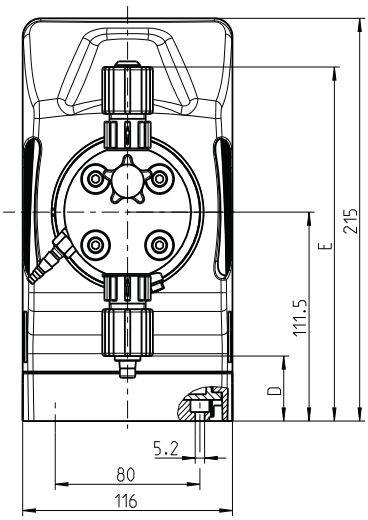
ProMinent® gamma/ X
Solenoid Diaphragm Metering Pumps

Dimensional Drawings

Material design NPB / NPE.

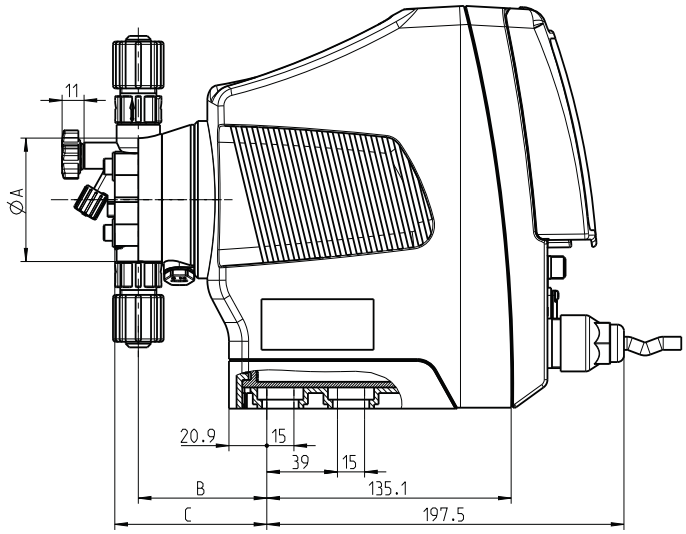
Type	ØA	B	C (m.E.)	C (o.E.)	D	E
0245	110	76	105	91	14	210
0424; 0220	90	76	104	91	23	200
0715; 0414	90	76	104	91	23	200
1009; 0708	90	74	102	91	23	200
1604	70	77	105	92	33	191
1602	70	77	105	92	33	191

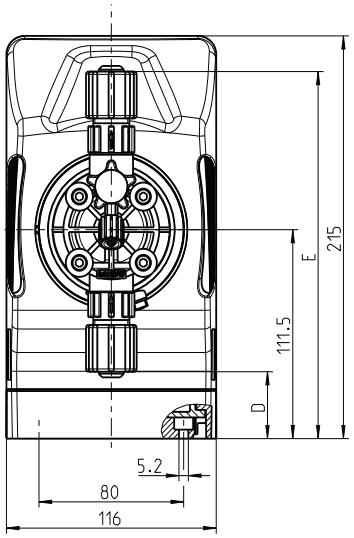




Material design PVT.

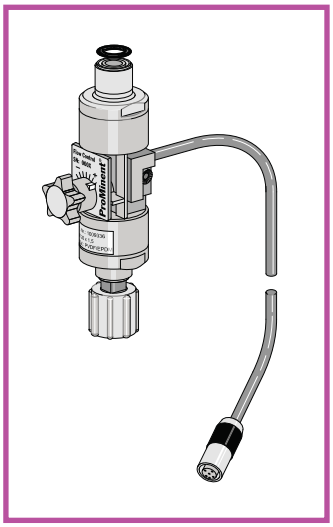
Type	ØA	B	C (m.E.)	C (o.E.)	D	E
0245	110	76	-	93	14	209
0424; 0220	90	79	90	-	25	203
0715; 0414	90	73	90	-	25	203
1009; 0708	90	75	92	-	25	203
1604	70	71	84	-	36	196
1602	70	71	84	-	36	196

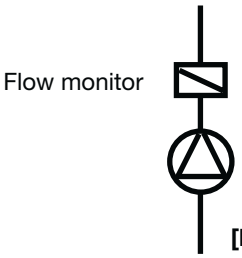




Adjustable metering monitor “Flow Control”

Supplied with connection cable for assembly directly to liquid end. Monitors individual strokes according to the float and orifice principle. The partial quantity of chemical flowing past the float is adjusted from the total stroke volume via the adjusting screw so that an alarm relay is actuated if the flow falls 20%. The user can select the number of incomplete strokes permitted (between 1 and 125) in accordance with the actual process requirements.





[For use with low-viscosity (water-like) fluids only].

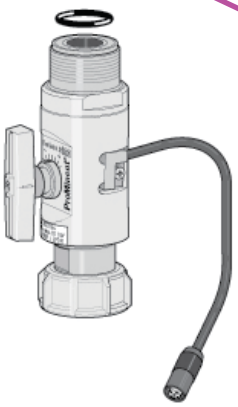
Materials:

Flow meter:	PVDF
Float:	PTFE-coated
O-rings:	Viton® B/EPDM

For gamma/L series in material versions PP, PVDF, NP and TT.

Flow Control	Material	Pump type	Part No.
Flow Control type I	PVDF, EPDM	1000, 1601, 1602	1009229
Flow Control type II	PVDF, EPDM	1005, 1605, 0708, 1008, 0413 0713, 0220, 0420, 0232	1009336
Flow Control type I	PVDF, Viton® B	1000, 1601, 1602	1009335
Flow Control type II	PVDF, Viton® B	1005, 1605, 0708, 1009, 0413 0713, 0220, 0420, 0232	1009338

For Sigma HM with connection cable for assembly to liquid end.



Flow Control	Material	Pump type	Part No.
Flow Control type III (Sigma/ 1)	PVDF, EPDM	12017, 10022, 12035, 10044 10050, 07065	1021168
	PVDF, Viton® B	12017, 10022, 12035, 10044 10050, 07065	1021169
Flow Control type III (Sigma/ 1 & 2)	PVDF, EPDM	07042, 04084, 04120, 12050 12090, 12130	1021170
	PVDF, Viton® B	07042, 04084, 04120, 12050 12090, 12130	1021171
Flow Control type IV (Sigma/ 2 & 3)	PVDF, EPDM	07120, 04350, 120145, 120190 120270	1021164
	PVDF, Viton® B	07120, 04350, 120145, 120190 120270	1021165
Flow Control type V (Sigma/ 3)	PVDF, EPDM	07410,07580, 04830	1021166
	PVDF, Viton® B	07410,07580, 04830	1021167

PDF Published A Pump System accessories (valves, pressure gauges, pulsation dampeners ...)

SB10/11 Series Back Pressure/Relief Valves

CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

PVC PP PVDF

CRN Registered as Category C Fittings Consult Chemline

SERIES: SB10 & SB11

SIZES: 3/8" – 2"

ENDS: True Union Socket, Threaded or ChemFlare™[1] Spigot[2] Bodies with Plain, Socket, Threaded or Flanged ends

DIAPHRAGM: PTFE Bonded EPDM

SEALS: EPDM, FKM (Viton®)

The Chemline SB Series Back Pressure/ Relief Valve has two functions. As a ***back pressure valve***, installed in-line downstream of a pump, the back pressure below the metering pump is maintained. When installed in the branch of a tee it is a ***pressure relief valve***. The valve stays closed until inlet pressure reaches the set pressure which is adjusted by turning the spring tensioning bolt. Inlet pressure acts on the PTFE control diaphragm opening the valve, allowing excess pressure to flow downwards through the orifice.

The SB10/11 Series is very sensitive to pressure changes and requires low overpressure to fully open. It is designed for ***clean fluids only***.

features

True Union Ends

- Easy installation and maintenance
- Eliminate chemical leakage problems common with old fashioned threaded connections

Long Cycling Life

- Dynamic seal is PTFE bonded EPDM for high chemical resistance
- This moulded diaphragm is designed for superior sealing and flex life

Designed for Superior Performance

- Valves are hydraulically designed for low hysteresis ("backlash") and to eliminate chatter
- Low overpressure to fully open
- Sensitive to pressure changes

technical

Set Pressure Ranges

- SB10 – 3 to 60 psi
- SB11 – 7 to 150 psi

– The only difference between SB10 and SB11 is the strength of spring

Maximum Viscosity

- 120cP is maximum recommended service viscosity

[1] For ChemFlare™ end connectors, consult Chemline.
[2] PP and PVDF spigot ends have DIN dimensions and will butt fuse directly to Chemline PP and PVDF piping systems.

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Chemline is a registered trade mark of Chemline Plastics Limited

SB10/11 Series Back Pressure/Relief Valves

working pressures vs. flow rate

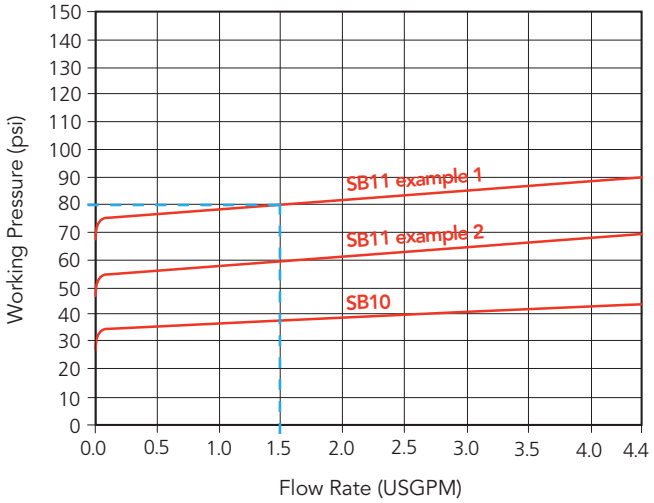
The curves show the relationship between the working pressure and the approximate flow rate through the valve for water at 20°C (68°F). These values vary depending on:

- the configuration of the piping and the pressure losses associated with it
- the fluid if not water at 20°C (68°F)
- whether the pressure is rising or falling. Hysteresis is approximately 4 psi.
- the profile of the flow curves will be the same for any set pressure

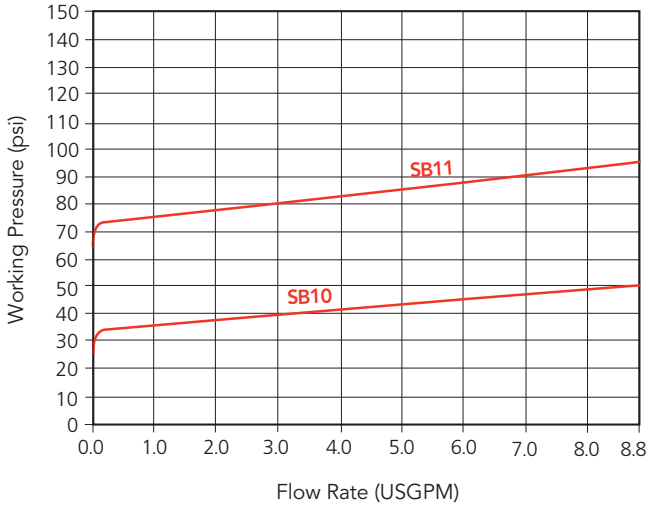
operation examples

1. The SB11 valve is set closed at 70 psi. At a pressure increase of 10 psi, a flow of approximately 1.5 USGPM will be reached.
   - set pressure = 70 psi
   - working pressure = 80 psi
   - opening pressure = approximately 74 psi
2. The SB11 valve is set closed at 50 psi. At a pressure increase of 10 psi, a flow of approximately 1.5 USGPM will be reached.
   - set pressure = 50 psi
   - working pressure = 60 psi
   - opening pressure = approximately 54 psi

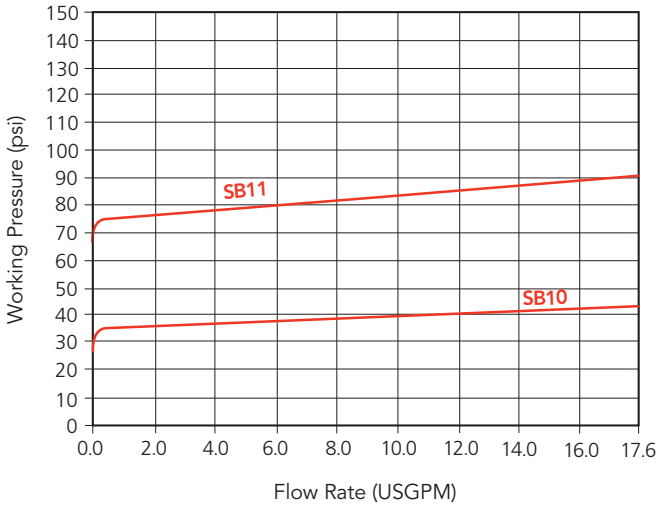
3/8" Valves



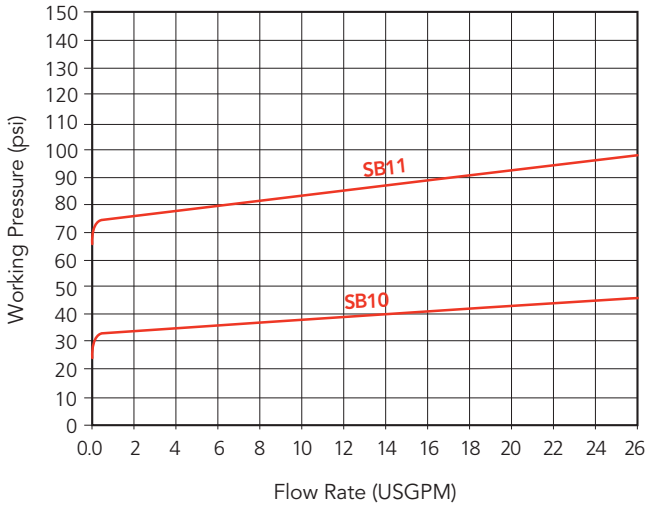
1/2" Valves



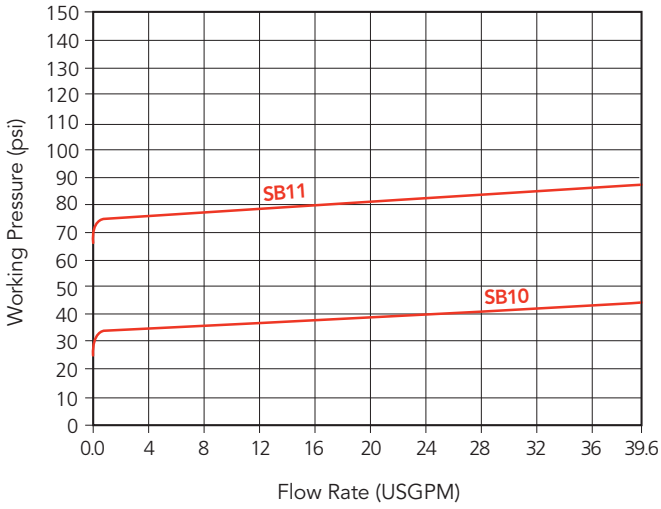
3/4" Valves



1" Valves

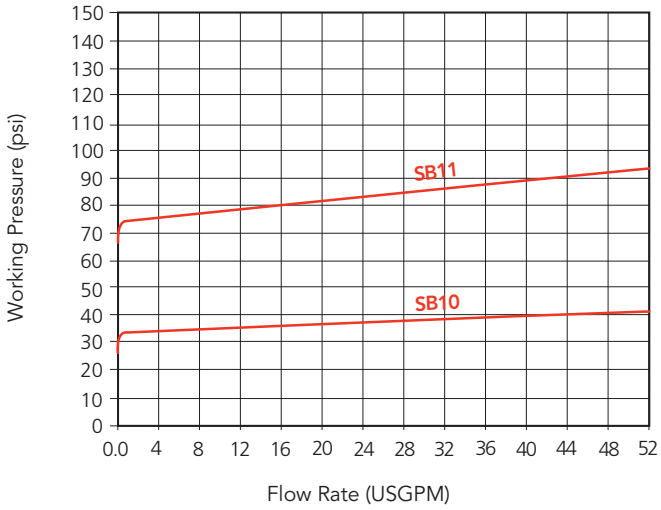


1-1/4" Valves

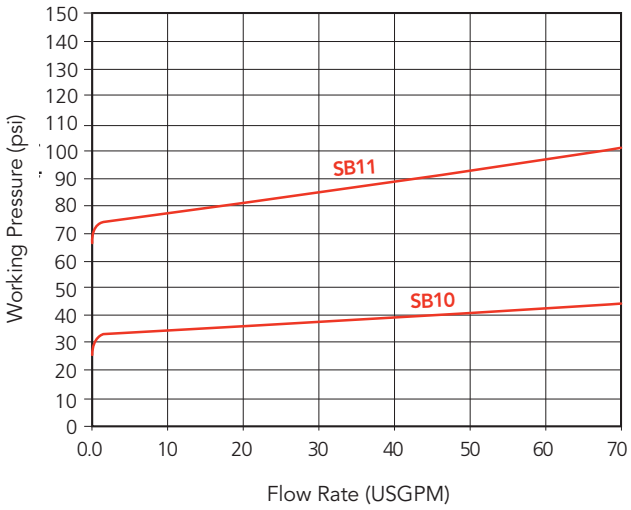


SB10/11 Series Back Pressure/Relief Valves

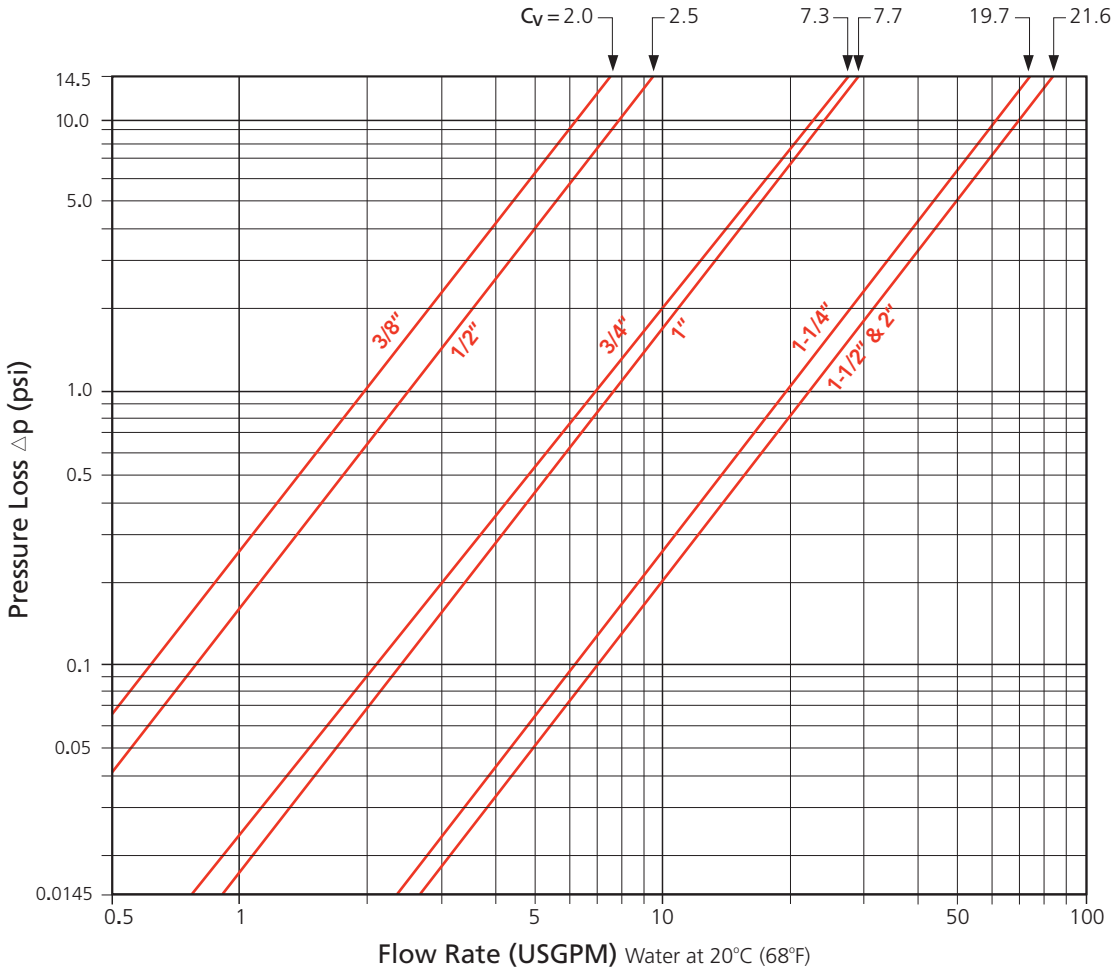
1-1/2" Valves



2" Valves

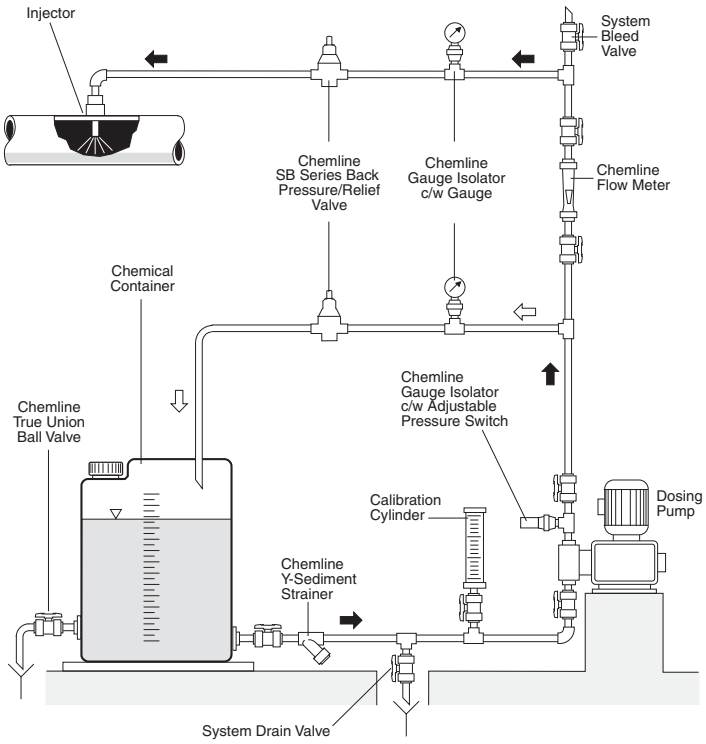


pressure loss nomogram for SB10 & SB11 valves



SB10/11 Series Back Pressure/Relief Valves

typical dosing system schematic



ChemFlare™ Ends

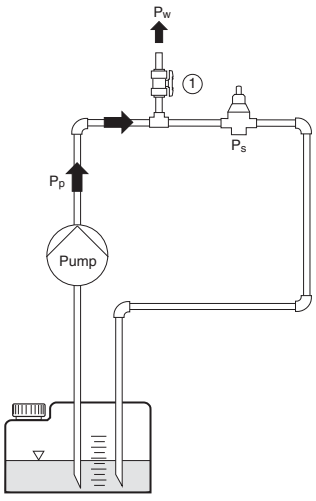
- For connection to PFA tube. Leak-free connections for difficult services such as sodium hypochlorite

Optional Pressure Gauge

- For inlet and/or outlet

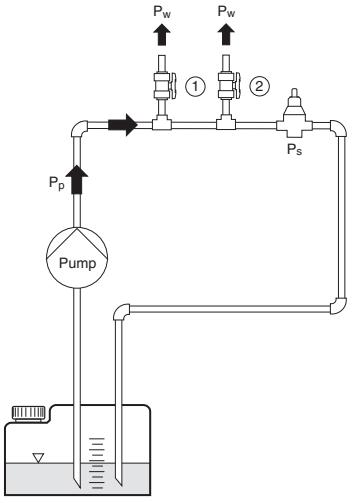
application of pressure relief valves

Constant System Pressure



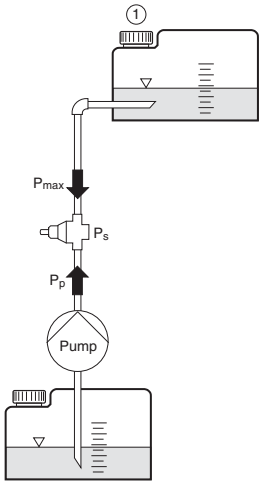
$P_p \geq P_w$
$P_p \geq P_s$ → valve opens
$P_p \leq P_s$ → valve closed

Consumer 1 and/or 2 Open, Valve Closes



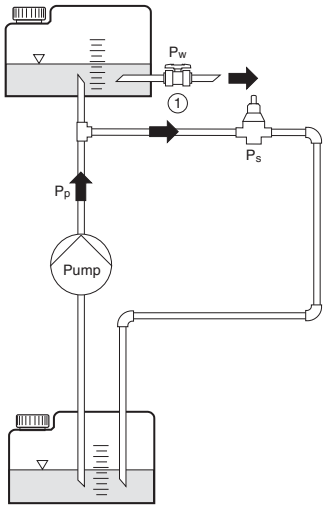
$P_p \geq P_s$ → valve opens
$P_p \leq P_s$ → valve closed

Non-Return Valve
Container 1 is located above the pump



$P_s \geq P_{max}$
$P_p \geq P_s$ → valve opens
$P_p \leq P_s$ → valve closed

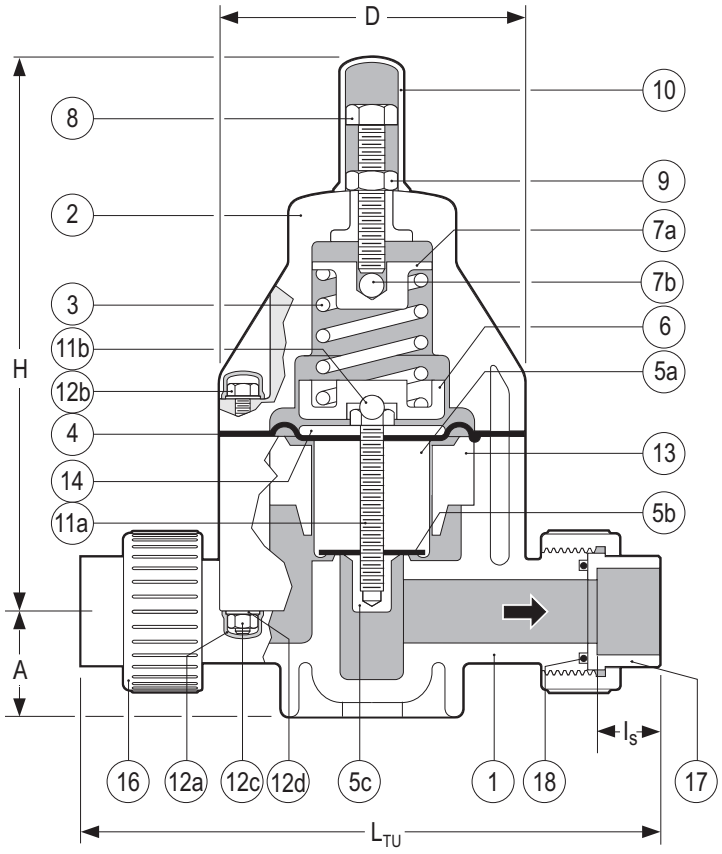
Overflow Valve
Pressure of container or application system should not exceed the maximum pressure value



$P_s \leq P_w$
$P_p \geq P_s$ → valve opens
$P_p \leq P_s$ → valve closed

P_w = Working Pressure
P_p = Pump Pressure
P_s = Set Pressure

SB10/11 Series Back Pressure/Relief Valves



True Union Body

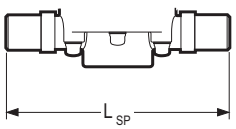
PARTS

▲ Recommended Spare Parts

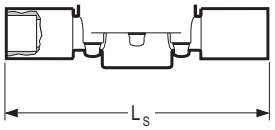
No.	Part	Pcs.	Materials
1	Body	1	PVC, PP, PVDF
2	Bonnet	1	PPG
3	Spring	1	Galvanized Steel
4▲	Control Diaphragm	1	PTFE bonded EPDM
5a▲	Piston	1	PVC, PP, PVDF
5b▲	Seat	1	EPDM, FPM(Viton®)
5c▲	Seat Retainer	1	PVC, PP, PVDF
6	Lower Spring Retainer	1	Cad. Plated Steel
7a	Upper Spring Retainer	1	Cad. Plated Steel
7b	Ball	1	304 SS
8	Spring Tensioning Bolt	1	304 SS
9	Lock Nut	1	304 SS
10	Spring Bolt Cap	1	PE
11a▲	Piston Bolt	1	304 SS
11b	Ball	1	304 SS
12a	Bolt/Nut Cap	8/12[1]	PE
12b	Hex Bolt	4/6[1]	304 SS
12c	Hex Nut	4/6[1]	304 SS
12d	Washer	8/12[1]	304 SS
13	Spacer Disc	1	PVC, PP, PVDF
14	Pressure Plate	1	Cad. Plated Steel
16	Union Nut	2	PVC, PP, PVDF
17	End Connector	2	PVC, PP, PVDF
18▲	Face O-Ring	2	EPDM, FPM(Viton®)

[1] 1/2" size / 3/4" to 2" sizes

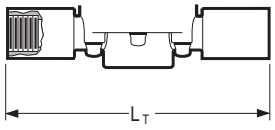
OTHER ENDS



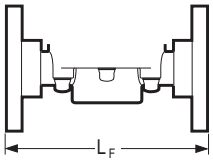
Spigot Body



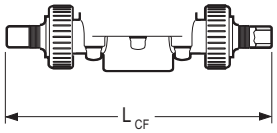
Socket



Threaded



Flanged



ChemFlare™

DIMENSIONS INCHES

WEIGHTS LB.

Cv VALUES

Size	D	H	PVC A	PVC I_S	PVC L_{TU}[2]	PVC L_{SP}	PVC L_S	PVC L_T	PVC L_F	PVC L_{CF}	PP and PVDF A	PP and PVDF L_{SP}[3]	PP and PVDF L_{TU}[2]	Weights PVC	Weights PP	Weights PVDF	USGPM Flow at 1 psi △P
3/8"	3.2	6.9	1.0	0.6	6.5	5.7	7.4	7.2	4.5	8.2	0.9	5.7	**	1.8	1.5	2.2	2.0
1/2"	3.2	6.9	1.0	0.6	6.8	5.7	8.0	7.8	6.3	8.3[4]	0.9	5.7	7.1	1.9	1.6	2.4	2.5
3/4"	4.2	8.0	1.5	0.7	8.3	6.9	9.3	8.9	7.4	9.7	1.4	6.9	8.4	4.1	3.5	4.6	7.3
1"	4.2	8.0	1.5	0.9	8.5	6.9	9.6	9.3	7.4	10.2	1.4	6.9	8.7	4.2	3.5	4.7	7.7
1-1/4"	5.8	10.3	2.2	1.0	10.9	8.8	11.6	11.2	9.2	13.5	2.1	8.8	10.9	11.0	9.0	12.0	19.7
1-1/2"	5.8	10.3	2.2	1.2	11.1	8.8	12.2	11.5	9.5	–	2.1	8.8	11.2	11.2	9.2	12.2	21.6
2"	5.8	10.3	2.2	1.5	11.3	9.6	12.9	12.0	10.0	–	2.1	9.6	13.2	11.4	9.4	12.4	21.6

[2] True Union Bodies come standard with socket ends. Threaded union ends are available. ** Consult Chemline.

[3] Spigot bodies are used for non union socket, threaded or flanged ends. All spigot ends have metric dimensions and the PP and PVDF spigots butt fuse directly to Chemline PP and PVDF piping. [4] Tube size can be reduced to 1/4" tube, LCF = 7.74" for 1/4", 8.26" for 3/8".

SB10/11 Series Back Pressure/Relief Valves

MAXIMUM PRESSURES PSI

	PVC				PP					PVDF					
Size	20°C 68°F	30°C 86°F	40°C 104°F	50°C 122°F	30°C 86°F	40°C 104°F	50°C 122°F	60°C 140°F	70°C 158°F	30°C 86°F	50°C 122°F	70°C 158°F	80°C 176°F	90°C 194°F	100°C 212°F
3/8"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
1/2"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
3/4"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
1"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
1-1/4"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
1-1/2"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15
2"	150	105	60	15	150	90	60	37	15	150	100	60	45	30	15

Temperature Ranges: PVC 0 to 50°C (32 to 122°F), **PP** 10 to 70°C (50 to 158°F), **PVDF** –30 to 100°C (–22 to 212°F).

SAMPLE SPECIFICATION

1. All Back Pressure/Relief Valves in PVC, PP or PVDF shall be Chemline SB10 or SB11 Series or equal in sizes 1/2" to 2". SB10 shall have inlet set pressure range of 3 to 60 psi and SB11 shall have an inlet set pressure range of 7 to 150 psi. All valves shall have a maximum inlet pressure rating of 150 psi. Valves shall be suitable for aggressive clean non scaling chemicals.
2. All exposed external metal parts including spring tensioning bolt and body bolts shall be 304 stainless steel covered with polyethylene caps.
3. All valves shall have a large PTFE coated control diaphragm to fully open at no more than 10-15% over pressure.
4. Static seals shall be EPDM or FPM (Viton®).
5. Socket ends 1/2" to 2" shall be Schedule 80 and conform to ASTM D-2467.
6. Threaded ends 1/2" to 2" shall conform to ASTM D-2464.
7. Butt fusion ends in PP and PVDF shall be compatible with Chemline metric polypropylene and PVDF piping systems.
8. Flanged ends shall be ANSI Class 150.
9. PVC compound shall have an ASTM cell classification 11564 as per ASTM D-1784 and a chemical resistance of 1 as per ASTM D-5260.
10. All polypropylene material shall conform to ASTM D-4101 PP 0211B67272 material requirements.
11. All PVDF material shall be unpigmented conforming to ASTM D-3222 Type 2 suspension resin material requirements and also with USDA Title 21, Chapter I, Part 177.2510 requirements for contact with food.
12. All valves shall have chemical resistant labels permanently marked with manufacturing number to provide production level traceability.

ORDERING EXAMPLE

Chemline Back Pressure/ Relief Valves	**SB11**	**A**	**005**	**V**	**U**
Pressure Range	**SB10** – 3 to 60 psi **SB11** – 7 to 150 psi				
Body Material	**A** – PVC **B** – PP **K** – PVDF				
Size	**003** – 3/8" **005** – 1/2" **007** – 3/4" **010** – 1" **012** – 1-1/4" **015** – 1-1/2" **020** – 2"				
Elastomers	**E** – EPDM **V** – FPM (Viton®)				
Ends	**S** – Socket **T** – Threaded **F** – Flanged **U** – Union Socket **CFx** – ChemFlare™ **Blank** – Spigot (Butt)				

Example: Chemline SB 11 Series, PVC, 1/2" diameter, FPM (Viton®) seals, Union socket ends.
x = 4 for 1/4", **6** for 3/8", **8** for 1/2", **12** for 1" ID tube connections.

OPTION

- **Integral Pressure Gauge** – for inlet and/or outlet

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PDF Published October 16, 2013

Type 21 Ball Valves

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The Chemline Type 21 True Union Ball valve incorporates state of the art features for long term performance. This is a full port, full blocking True Union valve pressure rated at 16 bar (230 psi)[4]. Double stem o-rings and Safety Shear stem design provide for a high degree of safety on hazardous fluid applications. All sizes have an ISO standard actuator mounting platform integral to the valve body. This provides for sturdy and secure mounting of pneumatic or electric actuators.

PVC CPVC PP PVDF

CRN Registered Consult Chemline

NSF[5] Certified to NSF/ANSI 61

SERIES: Type 21

SIZES: 3/8" – 4"

ENDS: Socket, Threaded, Flanged, Butt[1] or ChemFlare™

SEATS: PTFE

SEALS[2]: EPDM, FKM (Viton®), CPE[3]

features

Pressure rated to 230 psi[4]
- Provides a high factor of safety

Integral Actuator Mounting Platform
- Actuation is easy. Electric or pneumatic actuators may be mounted in the field.

Full Port
- High capacity and low pressure drops

Fully Blocking
- Downstream union nut may be safely disassembled for piping maintenance while valve is closed off under full system pressure

Built-In Spanner Wrench
- Top of the handle is designed to be used as a tool for accessing internal parts

Safety Shear Stem Design
- Stem has double o-rings
- Designed to hold full pressure even if stem breaks due to excessive torque

High Chemical Resistant Material
- PVC and CPVC compounds have an "A" chemical resistance rating as per ASTM D-1784. They have outperformed other PVC and CPVC compounds on aggressive chemicals.

[1] Butt ends for fusion to Chemline metric PP, PVDF or ECTFE (Halar®) piping.
[2] Other materials are available.
[3] CPE=Chlorinated Polyethylene.
[4] PVC, CPVC and PVDF 1/2" to 2" are rated at 230 psi; 2-1/2" to 4" and all size PP valves are rated at 150 psi at 20°C.
[5] PVC valves with EPDM or FKM (Viton®) seals are certified under NSF/ANSI Standard 61 for contact with drinking water.

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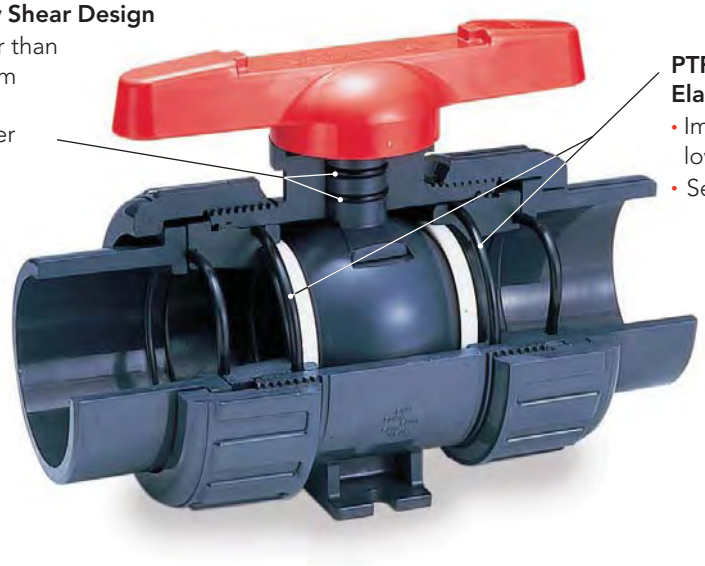
Type 21 Ball Valves

features

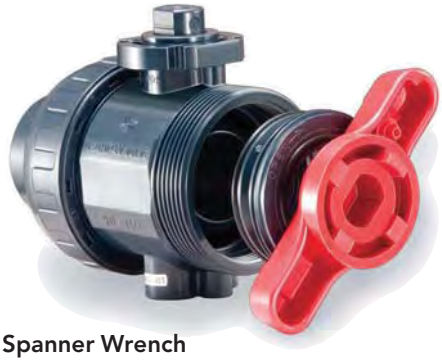
Double Stem O-Rings – Safety Shear Design

- Upper o-ring groove is deeper than lower. In case of excessive stem torque, stem will shear at the upper groove, leaving the inner o-ring intact to seal against full line pressure.



PTFE Seats have Elastomer Cushions

- Improved sealing while lowering stem torques
- Self adjusts for seat wear



Built in Spanner Wrench

- For removing or tightening the seat carrier
- All parts are replaceable

Integral Actuator Mounting Platform

- Actuation is easy. Electric or pneumatic actuators may be mounted in the field. Simply pull off the handle to reveal a standard ISO 5211 mounting platform which accepts bolt-on hardware.

Fully Blocking

- Downstream pipe may be removed while upstream side is still pressurized. This may be done with valve installed in either direction.

Base Mounting Pad

- Optional threaded inserts allow valves to be securely anchored
- Supplied standard with actuated valves

Type 21 Ball Valves

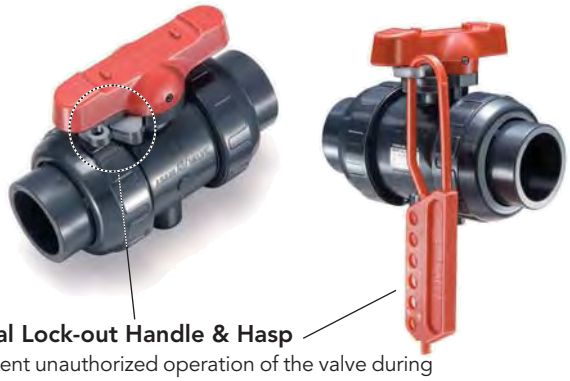
options + accessories

ChemFlare™ Ends

- For connection to PFA tube. Leak-free connections for difficult services such as sodium hypochlorite

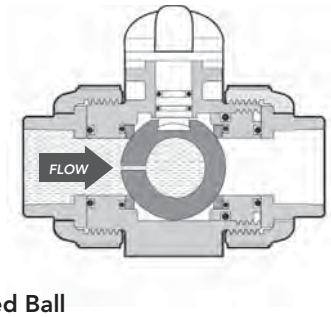
One-piece moulded PVC and CPVC 6" socket ends

- Allows installation of 4" valve in 6" line
- Factory moulded, not fabricated with couplings and reducers cemented together
- Fixed to valve mechanically just like the one-piece moulded factory flanges



Optional Lock-out Handle & Hasp

- To prevent unauthorized operation of the valve during maintenance shut-downs
- Padlocks go through holes in hasp



Vented Ball

- Recommended for all sodium hypochlorite services
- Valve shown in closed position

Different Colour Handles

- Choose a handle colour other than standard red for colour coding different services

Municipal Operating Nut

- 2" square nut for operating valves below grade using a standard municipal "key"
- Stainless Steel for corrosion resistance

Manual Limit Switch

- Electrical feedback of manual valve position
- NEMA 4X enclosure, position indicator beacon, 2x SPDT switches, stainless steel hardware

Shaft Extensions

- Different materials and lengths are available
- Several designs:
  - with no housing for indoors
  - with waterproofed PVC housing for indoors or outdoors
  - with stainless steel housing for buried or actuated services

Type 21 Ball Valves

electric + pneumatic actuation

Pneumatic and Electric Actuators

- A complete range of actuators and control accessories are available, mounted to valves using PPG plastic brackets and stainless steel couplings. Refer to separate data sheets.
- All actuators are CSA approved, have NEMA 4S enclosures, stainless steel hardware and permanently lubricated gear train

Electromni® Electric

- Type 21 ball valves up to 2"
- 120 in-lbs torque
- On-Off (3 wire), optional On-Off (2 wire)
- optional integrated lights, 1 feedback switch (120/240), 2 feedback switches (12/24)

Q Series Electric

- Type 21 ball valves up to 3"
- 300 in-lbs torque
- On-Off (3 wire) adjustable travel, optional On-Off (2 wire), failsafe 3-position, modulating
- Visual feedback, optional 2 feedback switches, feedback potentiometer and feedback transmitter

A Series Electric

- Type 21 ball valves up to 6"
- up to 2,000 in-lbs torque
- On-Off (3 wire) adjustable travel, optional On-Off (2 wire), failsafe multi-turn, 3 position modulating, BUS
- Visual feedback, optional 2 feedback switches, feedback potentiometer and feedback transmitter

V Series Electric

with Local Control Station

- Type 21 ball valves up to 6"
- up to 8,850 in-lbs torque
- On-Off (2/3 wire) adjustable travel, optional failsafe, modulating, BUS
- Visual feedback, 2 feedback switches, optional 2 extra feedback switches, feedback potentiometer and feedback transmitter

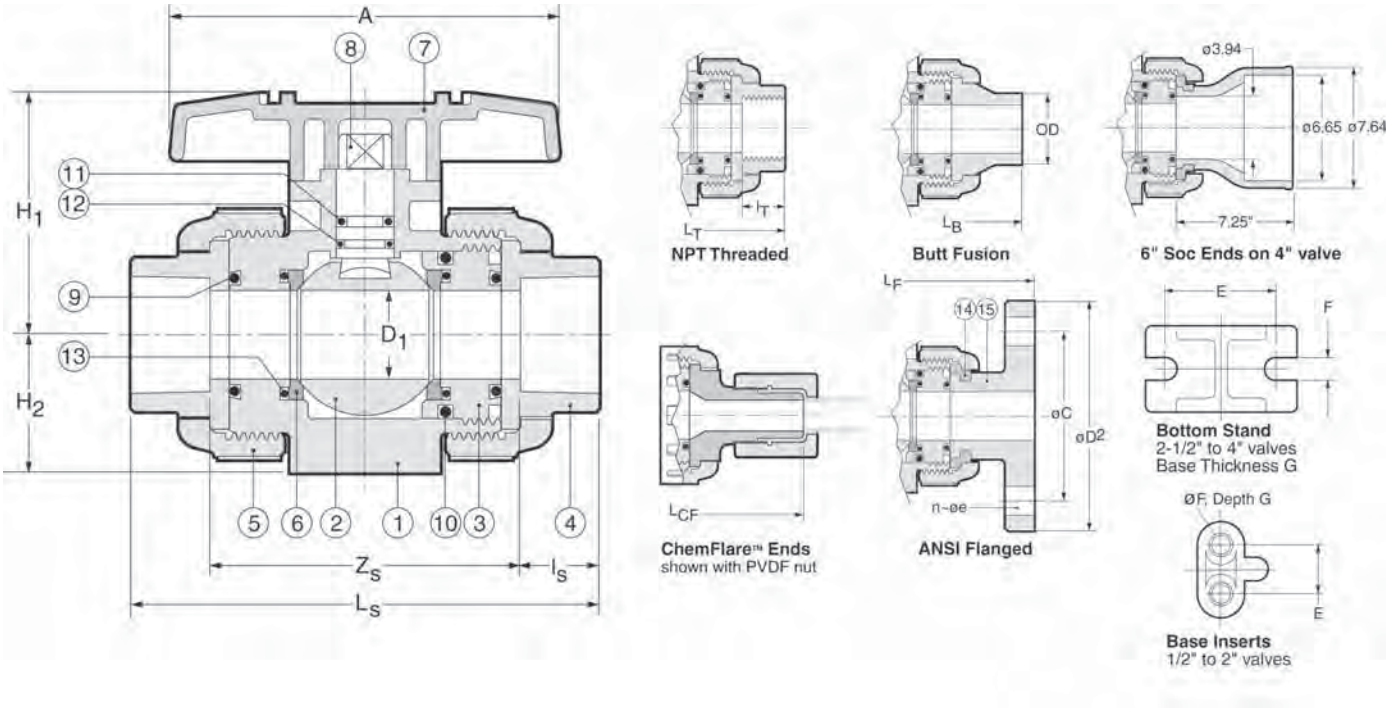
PA Series Pneumatic

- Type 21 ball valves up to 6"
- up to 10,660 in-lbs torque
- industrial process submerged
- bleach/water washdown
- Rilsan-coated aluminum

PP Series Pneumatic

- Type 21 ball valves up to 6"
- up to 1,335 in-lbs torque
- industrial process with minimal use of metal
- Glass-filled Polyamide

Type 21 Ball Valves



PARTS

▲ Recommended Spare Parts

No.	Part	Pcs.	Materials
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	Carrier[1]	1/2	PVC, CPVC, PP, PVDF
4	End Connector	2	PVC, CPVC, PP, PVDF
5	Union Nut	2	PVC, CPVC, PP, PVDF
6▲	Ball Seat	2	PTFE
7	Handle	1	ABS

[1] 1 carrier for sizes 1/2" to 2", 2 carriers for sizes 2-1/2" to 4"
[2] EPDM seals standard with PVC, CPVC, PP; FKM (Viton®) with PVDF valves
[3] 2 pcs 1/2" to 2", 6 pcs 2-1/2" to 4"

PARTS

▲ Recommended Spare Parts

No.	Part	Pcs.	Materials
8	Stem	1	PVC, CPVC, PP, PVDF
9▲	Face O-Ring[2]	2	EPDM, FKM (Viton®)
10▲	Carrier O-Ring[2]	2	EPDM, FKM (Viton®)
11▲	Upper Thicker Stem O-Ring[2]	1	EPDM, FKM (Viton®)
12▲	Lower Thinner Stem O-Ring[2]	1	EPDM, FKM (Viton®)
13	Seat Cushion[2]	2	EPDM, FKM (Viton®)
14	Flange Retainer[3]	2/6	PVDF
15	Flange	2	PVC, CPVC, PP, PVDF

DIMENSIONS INCHES

					End Connections																
					Socket			Threaded		Factory Flanged					Butt		ChemFlare™		Valve Base		
Size	D Bore	A	H_1	H_2	L_S	Z_S	l_S	l_T	L_T	L_F	D_2	C	n	e	L_B	OD	L_{CF}	Tube[4]	E	F[5]	G
1/2"	.59	3.6	2.03	1.14	4.45	2.70	.875	.64	4.02	5.63	3.50	2.38	4	.62	4.88	.79	6.12	1/2"	.75	.29	.43
3/4"	.79	3.9	2.34	1.38	5.08	3.08	1.00	.65	4.72	6.77	3.88	2.75	4	.62	5.67	.98	6.52	3/4"	.75	.29	.43
1"	.98	4.3	2.68	1.54	5.75	3.50	1.13	.81	5.16	7.36	4.25	3.12	4	.62	6.06	1.26	7.26	1"	.75	.29	.43
1-1/4"	1.22	4.8	3.17	1.85	6.46	5.21	1.25	.85	5.91	7.48	4.62	3.50	4	.62	6.85	1.57	9.58	1-1/4"	1.18	.35	.59
1-1/2"	1.57	5.2	3.50	2.17	7.24	4.49	1.38	.85	6.42	8.35	5.00	3.88	4	.62	7.64	1.97	–	–	1.18	.35	.59
2"	2.01	6.3	4.02	2.60	8.23	5.23	1.50	1.90	7.76	9.21	6.00	4.75	4	.75	8.82	2.48	–	–	1.18	.35	.59
2-1/2"	2.28	7.87	4.96	2.83	9.45	5.95	1.75	1.21	8.46	10.20	7.00	5.49	4	.75	9.72	2.95	–	–	1.89	.35	.23
3"	2.70	9.45	5.51	3.35	11.10	7.35	1.88	1.30	10.39	11.97	7.50	6.00	4	.75	11.61	3.54	–	–	2.17	.43	.28
4"	3.54	11.81	7.01	4.33	13.88	9.87	2.00	1.38	14.17	14.65	9.00	7.50	8	.75	14.76	4.33	–	–	2.56	.43	.32

[4] ChemFlare™ ends are available for reduced tube sizes down to 1/4".
[5] Optional threaded inserts: 1/2" to 1" valves – UNC 1/4"-20; 1-1/4" to 2" valves – UNC 5/16"-18. 'Recoil' brand inserts require drilling before insertion.

Type 21 Ball Valves

WORKING PRESSURES PSI, Water, Non-Shock

VACUUM RATING • 29.9 inches mercury

Size	PVC			CPVC						PP			PVDF				
	20°C 68°F	40°C 104°F	50°C 122°F	20°C 68°F	40°C 104°F	50°C 122°F	60°C 140°F	80°C 176°F	90°C 194°F	20°C 68°F	60°C 140°F	80°C 176°F	20°C 68°F	40°C 104°F	60°C 140°F	80°C 176°F	100°C 212°F
1/2"– 2"	230	165	150	230	165	150	120	75	55	150	85	55	230	185	150	110	85
2-1/2"– 4"	150	150	150	150	150	150	120	75	55	150	70	40	150	150	150	110	85

Temperature Ranges: PVC 0 to 60°C (32 to 140°F), **CPVC** 0 to 95°C (32 to 203°F), **PP** –20 to 80°C (–4 to 176°F), **PVDF** –40 to 100°C (–40 to 212°F)

WEIGHTS LB. THREADED or SOCKET

WEIGHTS LB. FLANGED

Size	PVC	CPVC	PP	PVDF	PVC	CPVC	PP	PVDF
1/2"	0.4	0.4	0.4	0.4	0.9	0.9	0.7	1.1
3/4"	0.7	0.7	0.7	0.9	1.3	1.5	1.1	1.5
1"	0.9	1.1	0.9	1.1	1.8	2.0	1.5	2.2
1-1/4"	1.5	1.5	1.3	1.8	2.6	2.9	2.0	3.3
1-1/2"	2.4	2.6	1.5	2.9	3.7	4.0	2.6	4.4
2"	4.0	4.4	2.6	4.9	5.5	6.0	4.0	8.2
2-1/2"	5.1	5.5	3.7	6.2	7.3	7.7	5.3	8.8
3"	8.2	8.8	5.5	9.9	10.1	11.0	7.5	12.6
4"	19.4	21.8	13.2	24.9	21.6	23.4	15.4	26.7

Cv VALUES VS. BALL ANGLE

Size	0%	25%	50%	75%	100%
1/2"	0	0.35	1.3	5.5	14.
3/4"	0	0.73	2.8	11.5	29.
1"	0	1.2	4.5	18.6	47.
1-1/4"	0	1.8	6.8	28.4	72.
1-1/2"	0	3.9	14.7	61.2	155.
2"	0	4.8	18.0	75.0	190.
2-1/2"	0	9.1	34.7	144.0	365.
3"	0	10.2	39.0	162.0	410.
4"	0	17.0	64.6	269.0	680.

SAMPLE SPECIFICATION

1. All True Union Ball Valves in PVC, CPVC, PP or PVDF shall be Chemline Type 21 or equal sizes 1/2" to 2" in PVC, CPVC, and PVDF rated at 230 psi and in PP 150 psi maximum working pressure. Sizes 2-1/2", 3" and 4" rated at 150 psi maximum working pressure with EPDM, FKM (Viton®) or CPE seals. Ball seats shall be PTFE with elastomer cushions for closure with minimum stem torques.
2. All valves will have Safety Shear stem design, blowout-proof with double o-rings for safety. The top o-ring groove shall be deeper so that if the stem breaks off under excessive torque the lower o-ring will remain intact and the valve will hold pressure.
3. All valves shall be full port and two-way blocking design.
4. All valves will be CRN (Canadian Registration Number) registered with TSSA.
5. PVC valves with EPDM or FKM (Viton®) seals shall be certified under NSF/ANSI Standard 61 for contact with drinking water.
6. All valves shall have chemical resistant labels permanently marked with manufacturing number to provide production level traceability.
7. PVC compound shall have an ASTM cell classification 12454-A with a minimum suffix "A" designation for chemical resistance as per ASTM D-1784 (CSA report LO 4000-172).
8. CPVC compound shall have an ASTM cell classification 23567-A with a minimum suffix "A" designation for chemical resistance as per ASTM D-1784.
9. PP material will conform to ASTM D-4101 PP 021 B 67272 material requirements.
10. PVDF material shall be unpigmented conforming to ASTM D-3222 material requirements and to be USDA Title 21 Chapter 1 Part 177. 2510 requirements for contact with food.
11. Socket ends in PVC and CPVC shall be Schedule 80 and conform to ASTM D-2467.
12. Threaded ends shall be Schedule 80 and conform to ASTM D-2464.
13. Butt fusion ends in PP or PVDF will be compatible with Chemline PP or PVDF metric piping systems.
14. Flanged ends shall be ANSI Class 150 one-piece factory moulded (not fabricated) to ensure maximum strength and close tolerance end to end dimensions.

ORDERING EXAMPLE

Chemline True Union Ball Valves	21	A	020	E	S
Body Material	**A** – PVC **B** – PP **C** – CPVC **K** – PVDF				
Size[1]	**002** – 1/4" **003** – 3/8" **005** – 1/2" **007** – 3/4" **010** – 1" **012** – 1-1/4" **015** – 1-1/2" **020** – 2" **025** – 2-1/2" **030** – 3" **040** – 4" **060** – 6"				
Seals	**E** – EPDM **V** – FKM (Viton®) **C** – CPE **B** – Nitrile **A** – Aflas®				
Ends	**S** – Socket **T** – Threaded **F** – Flanged **B** – Butt[2] **CF** – ChemFlare™				

Example: Chemline Type 21 True Union Ball Valve, PVC, 2", with EPDM seals, socket ends.

[1] 1/4" is normally the 3/8" valve reduced. 6" is 4" valve with 6" end connections.

[2] PP, PVDF and ECTFE (Halar®) metric butt fusion ends (1/2" to 4") connect to Chemline PP, PVDF and ECTFE (Halar®) piping systems.

OTHER OPTIONS & ACCESSORIES

- **Alternate O-Ring Seals**
- **Stem Extensions** made to any length
- **Limit Switches** – For open and/or closed position indication
- **Municipal Operating Nut**
- **Lubrication-free Valves** – Factory clean room assembled
- **Vented Ball** – For sodium hypochlorite applications

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PDF Published July 23, 2013

Gauge Isolators

CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

PVC PP PVDF

CRN Registered Consult Chemline

SERIES: SG

INLET CONNECTION: 1/4" or 1/2" Threaded[1]

INSTRUMENT CONNECTION: 1/4" or 1/2" Threaded

DIAPHRAGM: PTFE

Optional Gauge Isolators are available alone or with gauge mounted and prefilled with glycol[2]

Chemline SG Series Gauge Isolators allow inexpensive pressure gauges, or any other pressure instrument to be used in corrosive services. The upper chamber (gauge side) is filled with a stable fluid such as glycol or glycerine[2]. A diaphragm separates it from the lower chamber which receives the media under pressure.

The 1/2" gauge connection allows use of the popular 4" and 4-1/2" diameter gauges. Pressure switches or transmitters may also be installed. Customers can easily fill isolators and install their own gauges.

features

Easy to Mount Gauges

- It is easy to fill an isolator and field mount a gauge. No special equipment is required.
- Will accept popular 4" and 4-1/2" diameter gauges

Provision for Fill Port

- Housing may be drilled and tapped by Chemline or customer for a threaded fill port. This is used for filling isolator using a vacuum filling station

High Chemical Resistance

- Choice of body materials for a wide range of applications
- PTFE bonded EPDM dished diaphragm for high chemical resistance and sensitivity

Heavy Duty Design for Safety

- PPG[3] top chamber
- Heavy wall connection ports

A With 2" gauge
B With 4-1/2" gauge
C With 2" back mount gauge
D With pressure transmitter

[1] Other available inlet connections are 1/2" socket or 1/2" to 1" flanged.
[2] Other fluids are available for special applications such as chlorine service.
[3] Glass reinforced polypropylene.

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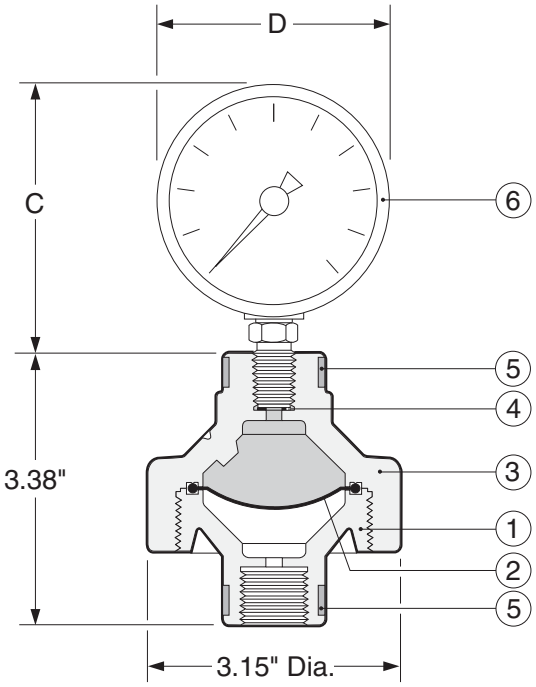
Gauge Isolators



PARTS

▲ Recommended Spare Parts

No.	Part	Pcs.	Materials
1	Body	1	PVC, PP, PVDF
2▲	Diaphragm	1	PTFE
3	Bonnet	1	PPG[1]
4	Gasket	1	EPDM
5	Stainless Steel Bands	2	304 SS
6	Optional Gauge	1	See below

[1]PPG = Glass reinforced polypropylene

OPTIONAL GAUGES

- Chemline offers the gauges listed below mounted to isolator and prefilled with glycol, glycerine or special fluid for chlorine applications. These gauges have dials and cases filled with either glycol (standard), glycerine or silicon for corrosion resistance and dampening.
- Chemline SG gauge isolators are not recommended for vacuum applications. They will not affect the gauge accuracy as low as 3" water pressure or 0.1 psi.

OTHER OPTIONS

- **Flanged** inlet connections
- **Threaded Fill Port** – drilled, tapped and plugged
- Chemline will mount any pressure instrument supplied free issue by customer

DIMENSIONS INCHES

Gauge Diameter	Item No.	Gauge Connection	Housing	Bourdon Tube	Window	Accuracy	Dimensions C	Dimensions D(max.)
2-1/2"	P025-xx	1/4"	316 SS	Brass	Polycarbonate	±1.5% of span	3.1	2.5
2-1/2"	P025-xx-SS	1/4"	316 SS	316 SS	Polycarbonate	±1.5% of span	3.1	2.5
2-1/2" Back Mount	P025-xx-SS/BM	1/4"	316 SS	316 SS	Polycarbonate	±1.5% of span	1.6	2.5
2-1/2" Back Mount	P025-xx-BM	1/4"	316 SS	Brass	Polycarbonate	±1.5% of span	1.6	2.5
4"	P040-xx-SS	1/2"	316 SS	316 SS	Safety Glass	±1% of span	4.5	4.0
4-1/2"	P045-xx-SS	1/2"	PBTP Plastic[2]	316 SS	Acrylic	±0.5% of span	6.3	5.8

xx denotes the maximum gauge pressure i.e., 30, 60, 100, 160 or 200 psi. See data page for recommended working pressures.
[2] PBTP = glass filled polyester.

WORKING PRESSURES PSI

WEIGHTS

Material	10 – 20°C 50 – 68°F	30°C 86°F	40°C 104°F	50°C 122°F	60°C 140°F	70°C 158°F	80°C 176°F	90°C 194°F	100°C 212°F	120°C 248°F	Net Weights Pounds[3]
PVC	150	100	80	45	15	–	–	–	–	–	1.0
PP	150	125	100	80	65	45	–	–	–	–	0.7
PVDF	150	150	150	125	105	85	70	60	45	30	1.3

Temperature Ranges: PVC 0 to 60°C (32 to 140°F), **PP** 10 to 80°C (50 to 176°F), **PVDF** –30 to 120°C (–22 to 248°F).
NR = Not Recommended. [3] Weights are for unfilled 1/2" x 1/2" isolators without gauges. 1/2" x 1/4" isolators are 20% lighter.

ORDERING EXAMPLE

Chemline Gauge Isolators	SG	A	005-	002	P	G
Body Material	**A** – PVC	**B** – PP	**K** – PVDF			
Inlet Size	**002** – 1/4"	**005** – 1/2"(Standard)				
Instrument Connection	**002** – 1/4"	**005** – 1/2"				
Diaphragm	**P** – PTFE bonded EPDM					
Filling & Mounting	**G** – Add only if isolator is supplied filled with glycol and gauge or pressure instrument is mounted by Chemline. Separate gauge item numbers are listed above.					

Example: Chemline SG Series Gauge Isolator, PVC, 1/2" x 1/4" FNPT inlet x instrument connections, PTFE diaphragm.

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DIMENSIONAL DRAWING
RC-10PVC-E50

MODEL #:	RC-10PVC-E50
AIR CONTROL:	CHARGE
BLADDER:	EPDM
CAPACITY:	10 CUBIC INCHES/0.16 LITERS
INLET:	0.5" FNPT
MAXIMUM PRESSURE:	150 PSI/10.3 BARS
NONWETTED HOUSING:	PVC
WETTED HOUSING:	PVC

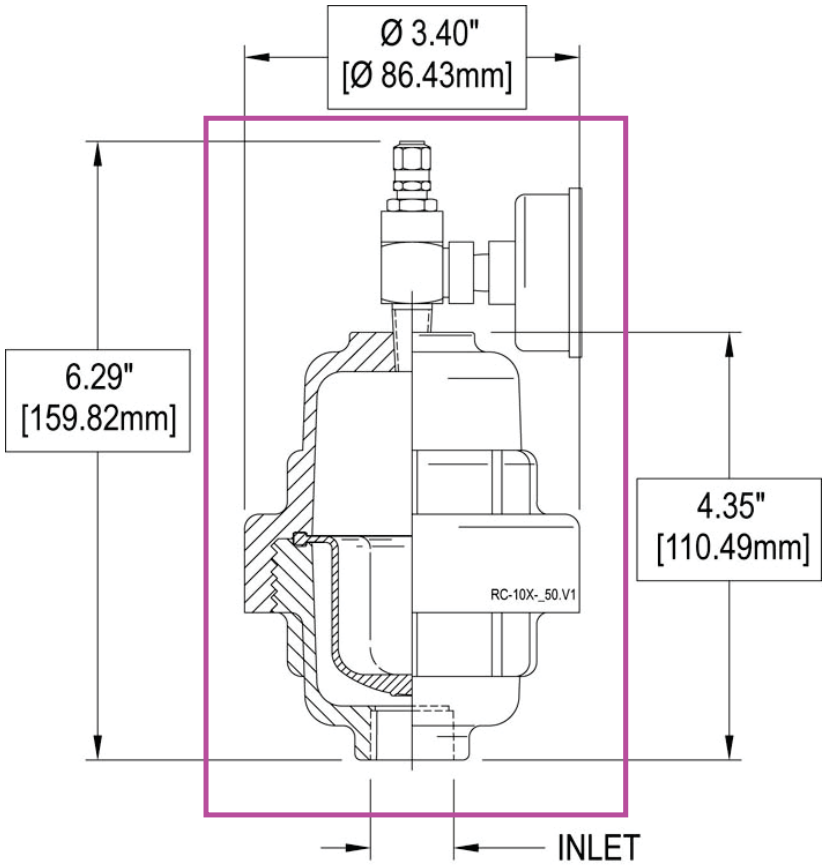
DISCLAIMER

ALTHOUGH THE INFORMATION ON THIS SHEET IS BELIEVED TO HAVE BEEN ACCURATE WHEN THE SHEET WAS FIRST PREPARED, SOME INFORMATION ON THIS SHEET MAY NOT BE ENTIRELY ACCURATE NOW. PLEASE VERIFY MATERIAL COMPONENTS, DIMENSIONS, AND PRESSURE RATING ON THE CURRENT BROCHURE FOR THIS PRODUCT BY BLACOH FLUID CONTROL, INC. (“BLACOH”) OR, IF NECESSARY, CONTACT BLACOH DIRECTLY. PRESSURE TOLERANCES, INCLUDING BUT NOT LIMITED TO, ON MODELS MADE OF PLASTIC, MAY BE REDUCED BY TEMPERATURE VARIATION AND BY THE COMPOSITION OF THE SUBSTANCE BEING PUMPED.

USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER ON A PUMP MAY BE DANGEROUS TO PERSONS AND PROPERTY. BY WAY OF EXAMPLE BUT NOT LIMITATION, USE OF AN INCOMPATIBLE OR UNSUITABLE DAMPENER MAY RESULT IN EXPLOSIONS, LEAKAGE OF LIQUIDS OR GASES (WHICH MAY BE HAZARDOUS), OR MALFUNCTIONING EQUIPMENT.

THE USER IS SOLELY RESPONSIBLE FOR (AND BLACOH IS NOT RESPONSIBLE FOR) VERIFYING THE COMPATIBILITY AND SUITABILITY OF A PARTICULAR DAMPENER FOR A PARTICULAR PUMP AND APPLICATION. AS WELL AS DETERMINING WHETHER TESTING OF A DAMPENER IS ADVISABLE PRIOR TO USE IN A PARTICULAR APPLICATION.

DIMENSIONAL DRAWING
(TOLERANCE ± .25")



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ACCUDRAW® Calibration Cylinders

Polypropylene

PVC

Glass

- PVC with removable "O" ring sealed top for easy cleaning

- yellow polypropylene level indicator float for high visibility

ACCUDRAW® ***has been developed for the accurate calibration of metering pumps. Standard features include:***

- translucent
- chemical resistant
- break resistant
- threaded, socket or flanged
- colored graduations and lettering
- PVC has dual scale USGPH & ml
- PVC sizes 100 - 20000 ml
- POLY sizes 100 - 4000 ml
- POLY meets ISO standards
- Glass sizes 100 - 20000 ml
- custom designs available

For detailed product information visit our website: primaryfluid.com

PRIMARY FLUID SYSTEMS INC.
Call Toll Free 1-800-776-6580
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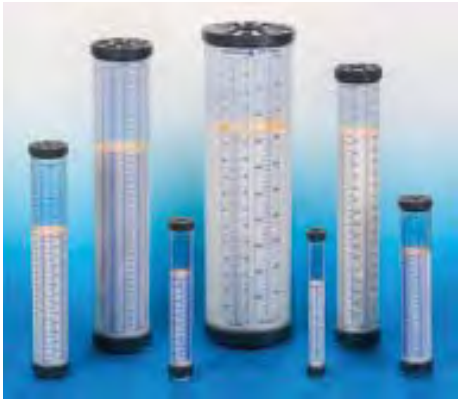
ACCUDRAW® Calibration Cylinders

"For Accuracy That Counts"

For complete product information visit our website: primaryfluid.com

Flanged: Glass, PVC

Flanged: PVC



PV#4

Sizing and Ordering Information:

ACCUDRAW Standard Materials of Construction

AC = All polypropylene construction (see below for options)
PV = All polyvinylchloride construction (see below for options)
ACS = Glass*

Note: Cylinders are NOT pressure vessels

Example: AC#1-1000B
AC = PP (polypropylene)
#1 = Bottom threaded connection only
1000 = 1000 ml
B = BSP Thread

e.g. Part # AC #1 - 1000 B

Type:
AC = Polypropylene
PV = PVC
ACS = Glass

Style:
1 = Bottom threaded conn. only
2 = Top and Bottom threaded conn.
3 = Bottom threaded conn. c/w removable vented dust cap
4 = Top/Bottom threaded conn. c/w removable "O" ring sealed top and float ring level indicator
**** Glass calibration cylinders available in Style 2 only***

Graduation Scale:
PP - ml only
PVC - ml and GPH
Glass - ml only

Std. connection is NPT thread
Optional: add suffix as follows
S = Socket weld connection (PVC only)
GTV = Glass/TFE construction
GKV = Glass/PVDF construction
GCV = Glass/CPVC construction
GSV = Glass/SS construction
B = BSP Thread
F = Flanged

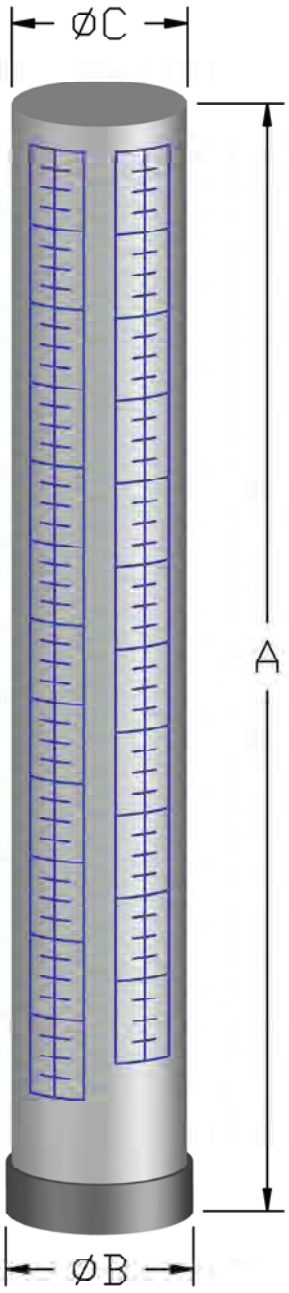
Substitute **E** for **V** for **EPDM** wetted "O" ring seal

Sizes:		**Material**
100 =	100 ml (1.6 GPH)	PP, PVC, Glass
250 =	250 ml (4 GPH)	PP, PVC, Glass
500 =	500 ml (8 GPH)	PP, PVC, Glass
1000 =	1000 ml (16 GPH)	PP, PVC, Glass
2000 =	2000 ml (32 GPH)	PP, PVC, Glass
4000 =	4000 ml (64 GPH)	PP, PVC, Glass
6000 =	6000 ml	Glass only
8000 =	8000 ml	Glass only
10000 =	10000 ml (160 GPH)	PVC, Glass
20000 =	20000 ml (320 GPH)	PVC, Glass

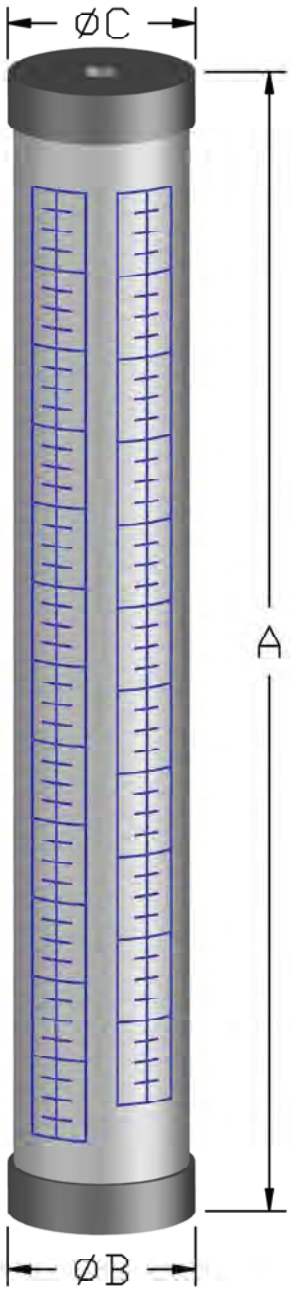
Custom sizes and materials available.

ACCUDRAW®

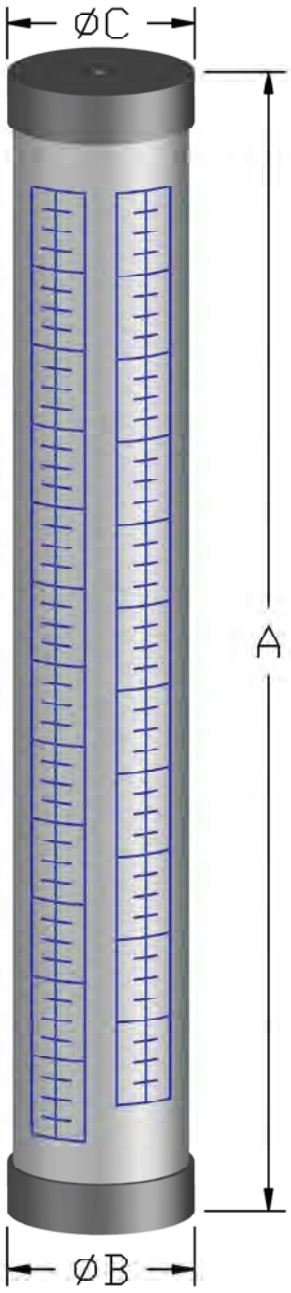
PV#1



PV#2
PV#4



PV#3



MODEL	SIZE ml(GPH)	DIV ml(GPH)	A (In.)	ØB (In.)	ØC (In.)	Connection	Top Conn.
PV#1	100 (1.60)	1.0 (0.02)	10.24	1.39	1.13	1/2" (DN 15)	OPEN
	250 (4.00)	2.0 (0.05)	11.04	1.89	1.63		
	500 (8.00)	5.0 (0.05)	12.25	2.39	2.13		
	1000 (16.0)	10.0 (0.125)	16.24	2.77	2.50		
	2000 (32.0)	20.0 (0.25)	20.16	3.52	3.13	1" (DN 25)	
	4000 (64.0)	25.0 (0.25)	22.16	4.52	4.13		
	10000 (160)	200.0 (2.00)	22.64	6.91	6.50	2" (DN 50)	
	20000 (320)	200.0 (2.00)	42.19	6.91	6.50		
PV#2 & PV#4	100 (1.60)	1.0 (0.02)	10.75	1.39	1.39	1/2" (DN 15)	1/2" (DN 15)
	250 (4.00)	2.0 (0.05)	11.51	1.89	1.89		
	500 (8.00)	5.0 (0.05)	12.75	2.39	2.39		
	1000 (16.0)	10.0 (0.125)	16.76	2.77	2.77		
	2000 (32.0)	20.0 (0.25)	20.67	3.52	3.52	1" (DN 25)	1" (DN 25)
	4000 (64.0)	25.0 (0.25)	22.66	4.52	4.52		
	10000 (160)	200.0 (2.00)	23.16	6.91	6.91	2" (DN 50)	2" (DN 50)
	20000 (320)	200.0 (2.00)	42.69	6.91	6.91		
PV#3	100 (1.60)	1.0 (0.02)	10.75	1.39	1.39	1/2" (DN 15)	DUST CAP
	250 (4.00)	2.0 (0.05)	11.51	1.89	1.89		
	500 (8.00)	5.0 (0.05)	12.75	2.39	2.39		
	1000 (16.0)	10.0 (0.125)	16.76	2.77	2.77		
	2000 (32.0)	20.0 (0.25)	20.67	3.52	3.52	1" (DN 25)	
	4000 (64.0)	25.0 (0.25)	22.66	4.52	4.52		
	10000 (160)	200.0 (2.00)	23.16	6.91	6.91	2" (DN 50)	
	20000 (320)	200.0 (2.00)	42.69	6.91	6.91		

NOTE:
PV#4 CALIBRATION CYLINDERS HAVE REMOVABLE TOP CAPS.

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PRIMARY FLUID SYSTEMS INC.
1050 Cooke Blvd, Burlington, Ontario L7T 4A8

ACCUDRAW PV-SERIES
CALIBRATION CYLINDERS (PVC)

DATE ISSUED: 23-JUN-09	SCALE: NTS	SHEET: 1 OF 1
PROJECT: ACCUDRAW PV-SERIES	DRAWN BY: VW	
APPROVED BY:	DWG NO: ADV_PV_CALCYL1	REV.#: 1

PDF Published March 1, 2013

Y Sediment Strainers

CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

The Chemline YSA Series Y Sediment Strainer is a safety filtration device designed to entrap occasional solid impurities in the line. This is to protect equipment with small orifices such as solenoid valves, and prevent damage to pumps or control valves, etc. The easily replaceable filter screen comes in a choice of meshes. The new YSA Series True Union models have greatly increased filtration areas. Pressure drops are lower and less frequent cleaning is required.

PVC [1]

CRN Registered Consult Chemline

NSF [4] Certified to NSF/ANSI 61

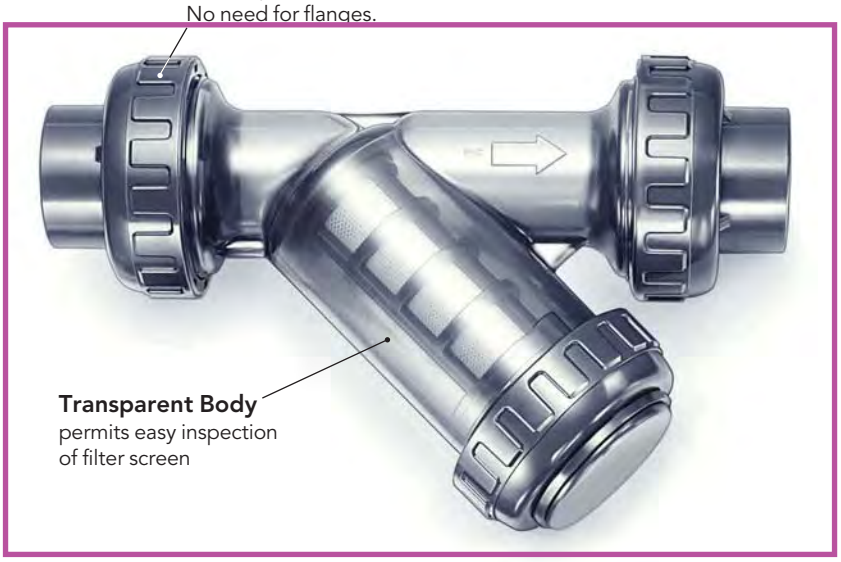
SERIES: YSA

SIZES: 1/2" – 4"

ENDS: True Union, Threaded, Socket, Flanged or ChemFlare™ [2]

SEALS: EPDM, FKM (Viton®) [3]

True Union Design
Body slips out of line.
No need for flanges.



Transparent Body
permits easy inspection
of filter screen

- **Easily Maintained**
  All parts are easily replaceable including the body

features

- **High Capacity**
- **Transparent Body**
- **Large Filtration Capacity Low Pressure Drops**
  – Diameter of screens are full pipe bore. The effective filtering area is in some sizes twice the filtering area of other makes. This results in larger filtration capacities and lower pressure drops.
- **Replaceable Filter Screens**
  – Available with choice of PVC 24, 35 or 55 mesh filter screens
  – 316 SS screens are also available
- **Dual Socket and Threaded Ends**
  – Sizes 1/2" to 2" in PVC are supplied with socket ends plus two free threaded ends in each box

- **Optional Flush Valve**

[1] Polypropylene and PVDF Strainers are available special order.
[2] For ChemFlare™ end connectors, consult Chemline.
[3] Other seal materials are available special order.
[4] PVC valves with EPDM or FKM (Viton®) seals are certified under NSF/ANSI Standard 61 for contact with drinking water.

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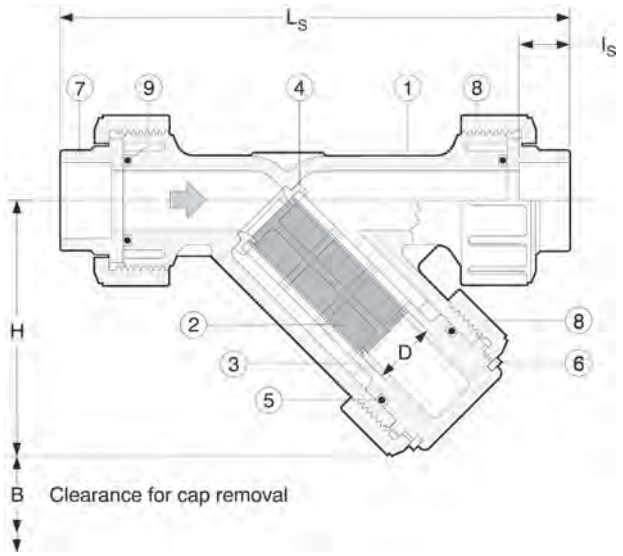
Y Sediment Strainers



PARTS

▲ Recommended Spare Parts

No.	Part	Pcs.	Materials
1	Body	1	PVC
2▲	Filter Screen	1	PVC, 316SS
3	Cap/Filter Cage	1	PVC
4▲	Screen Retainer	1	PVC
5▲	Cap O-Ring	1	EPDM, FKM (Viton®)
6	Split Ring	1	PVC
7	End Connector	2	PVC
8	Union Nut	3	PVC
9▲	Face O-Ring	2	EPDM, FKM (Viton®)

DIMENSIONS INCHES

Size	B	D	H (Closed)	L_T Threaded	L_S Socket	L_F Flanged	l_S Socket	Exposed Screen Area (in^2)
1/2″	3.	0.63	2.8	6.50	6.93	8.1	0.87	2.71
3/4″	4.	0.83	3.7	7.95	8.30	10.0	1.00	4.57
1″	5.	1.1	4.0	8.82	9.37	11.1	1.12	5.98
1-1/2″	6.	1.6	5.7	11.30	12.13	13.2	1.38	13.8
2″	7.	2.0	6.6	12.76	13.31	14.2	1.50	20.0
3″	8.	3.1	7.5	17.2	17.80	18.8	1.87	34.0
4″	11.	3.9	10.1	23.5	23.54	23.9	2.25	54.7

NET WEIGHTS LB.

Size	Threaded Socket	Flanged
1/2″	0.5	1.0
3/4″	1.0	1.6
1″	1.5	2.4
1-1/2″	3.4	4.6
2″	4.3	6.0
3″	12.7	14.7
4″	30.8	35.1

WORKING PRESSURES PSI

0-50°C 32-122°F
150
150
150
150
150
85
85

Temperature Range
0 to 60°C (32 to 140°F)

Cv VALUES

USGPM Flow at 1 PSI Pressure Drop
5.2
7.5
14.
34.
50.
110.
165.

With clean 24 mesh screen

FILTER SCREEN DATA

Equiv. Mesh	Micron Filtration	Hole Area (in^2)	Holes per in^2	% Open Area
24	690	.00114	135	15.4
35	490	.00053	258	13.7
55	250	.00011	774	8.5

24 mesh is supplied as standard, 35 or 55 mesh supplied on request.

Micron filtration is the smallest diameter of a sphere which will be retained by the mesh.

ORDERING EXAMPLE

Chemline PVC Y Strainers	YSA	020	E	S
Size	**005** – 1/2″ **007** – 3/4″ **010** – 1″ **012** – 1-1/4″ **015** – 1-1/2″ **020** – 2″ **030** – 3″ **040** – 4″ **060** – 6″[1]			
Seals	**E** – EPDM **V** – FKM (Viton®) **C** – CPE[2] **B** – Nitrile[3] **A** – Aflas®			
Ends	**S** – Socket **T** – Threaded **F** – Flanged **CF** – ChemFlare™			

Example: Chemline PVC Y Strainer, 2″, EPDM o-rings, socket ends.

[1] 6″ is 4″ strainer with 6″ end connections
[2] CPE=Chlorinated Polyethylene
[3] Nitrile is also called "Buna-N"

OPTIONS

- **Alternate O-Ring materials**
- **Flush out valve installed in cap**
- **316 Stainless Steel Screens** if greater open area is required
- **Polypropylene or PVDF Construction**
  – Design is different from YSA Series. Consult Chemline.

CHEMLINE PLASTICS
SUPERIOR FLOW SOLUTIONS

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PDF Published November 10, 2010

ChemLance

CHEMLINE Plastics Limited

Your Pipeline To Quality

PVC

SERIES: ChemLance

CONNECTIONS:
1/2" FNPT to Injection Valve,
1/2" MNPT to Water Main Pipe

SEALS: FKM (Viton®)

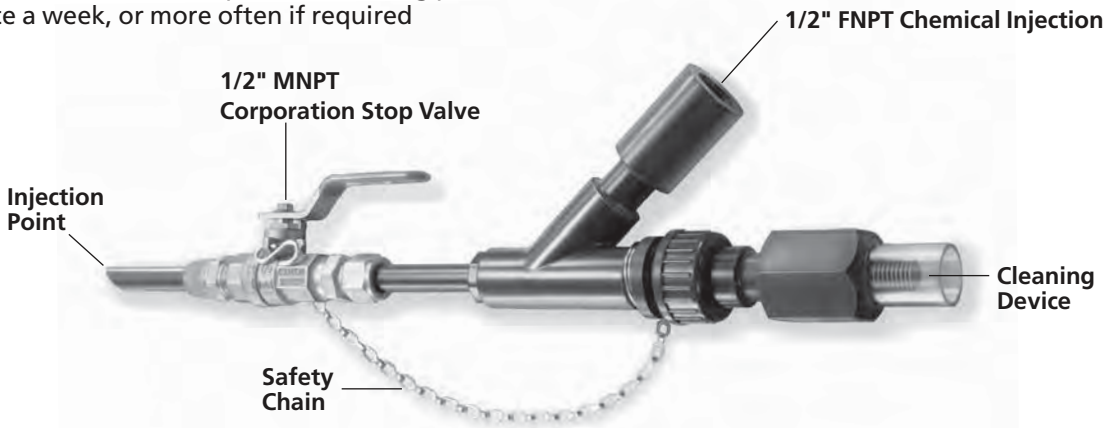
The ChemLance corporation stop with breakthrough cleaning technology is an effective solution to combat against clogs caused by precipitate build-up in chemical injection.

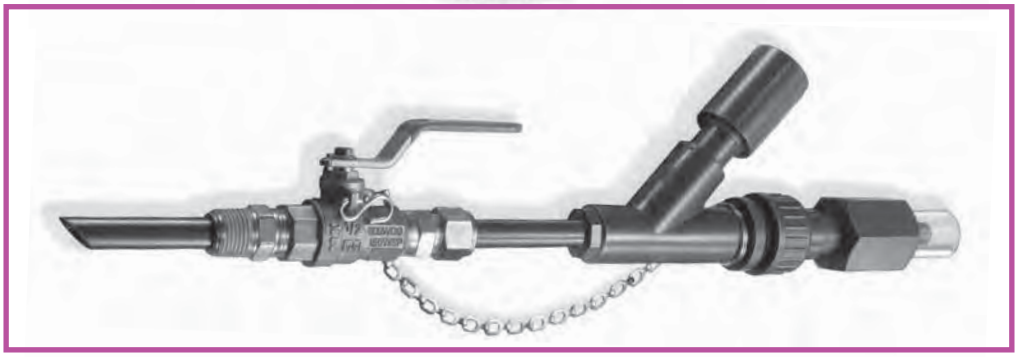
Precipitate build-up at the injection point is one of the most common problems facing chemical injection systems. This build-up obstructs the injection process, requiring the pumps to work harder, leading to excess pressure increase and eventual failure of the injection system. Clogging results in having to shut the system down to clean the injection point which is time consuming and hazardous.

The ChemLance uses a specialized cleaning system that is specificalally designed to breakthrough and clean away precipitate build-up without any interruption to the system. Simply turn the cleaning device and the build-up is eliminated in seconds.

Features

- Allows precipitate build-up to be cleaned away without any interruption to the system
- Hot-Tap – May be removed and reinstalled while the pipe is under pressure
- Eliminates downtime requirements associated with standard corporation stops
- Allows for injection in the centre of the main pipe (up to 12" diametre) for increased chemical dispersion
- Constructed with PVC material and Viton® gasket seals for superiour chemical resistance
- For proper maintenance, repeat the cleaning procedure at least once a week, or more often if required





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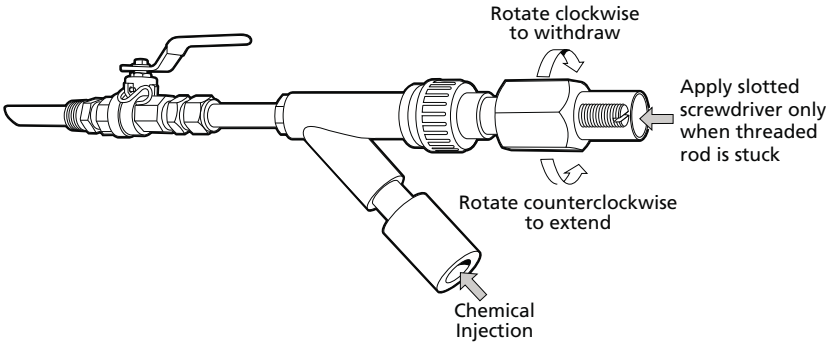
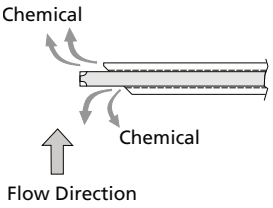
ChemLance

Operation



Top View

Cleaning Rod in Extended Position

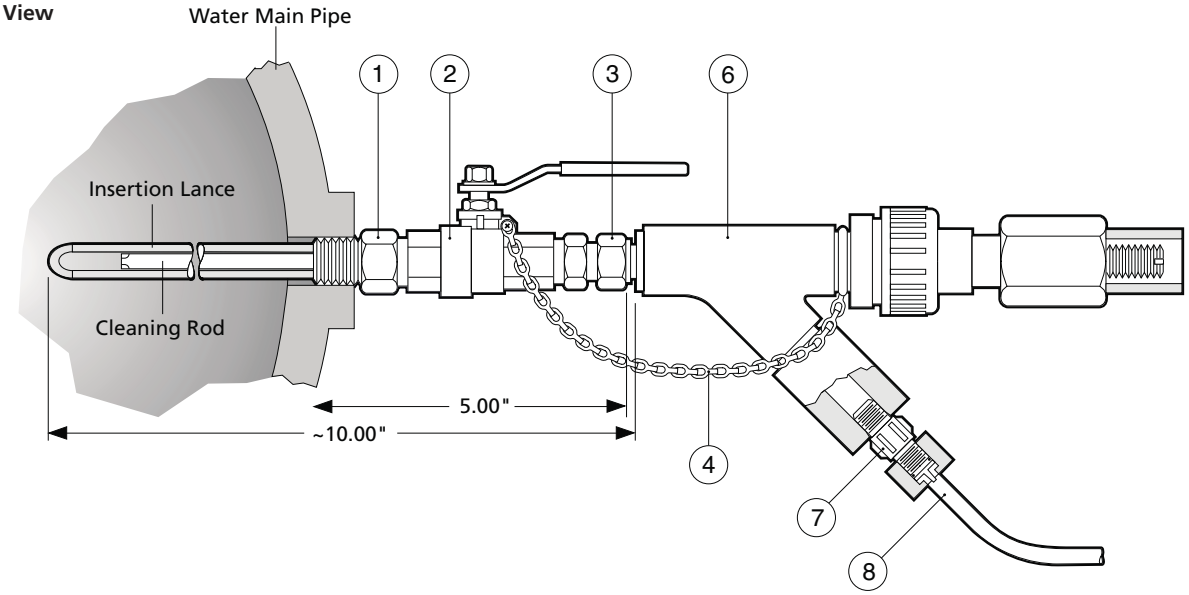


PARTS ▲Recommended Spare Parts

No.	Part	Pcs.	Materials
1	Water Main Pipe[1]	1	PVC, Metal
2	Hex Pipe Adaptor	1	1/2" Brass
3	Corporation Stop Valve	1	1/2" Brass
4	Safety Chain and Collar	1	Brass
5	Lock Nut	1	Brass
6	Lance Assembly	1	1/4"–1/2" PVC
7	PFC Injection Valve[2]	2	1/2" PVC
8▲	Flexible Tubing[2]	2	1/4"–1/2" PE

[1]Supplied by others.
[2]Ordered separately.

Side View



ORDERING EXAMPLE

Chemline Chemlance Corporation Stop (CL)	**A**	**005**	**V**	**T**
Body Material (**A**) – PVC				
Size (**005**) – 1/2" **007** – 3/4"				
Seals (**V**) – FPM (Viton®)				
Ends (**F**) – Threaded				

Example: Chemline Chemlance, PVC, 1/2" with FKM (Viton®) seals, threaded.

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Your Pipeline To Quality Valves, Piping, Flow Meters and Controls

Item 2.6.10.1 - BADGER Magnetic Flowmeter
Tag # FM-1 & FM-2

ModMAG®
M-Series® | B-MAG Electromagnetic Flow Meters

M-Series® M2000

Electromagnetic Flow Meter

DESCRIPTION

The Badger Meter M-Series® M2000 is the result of years of research and field use of electromagnetic flow meter technology. Based on Faraday's law of induction, these meters can measure almost any liquid, slurry or paste that has minimum electrical conductivity.

Designed, developed and manufactured under strict quality standards, the M-Series meter features sophisticated, processor-based signal conversion with accuracies of ±0.25 percent. The wide selection of liner and electrode materials helps ensure maximum compatibility and minimum maintenance over a long operating period.

OPERATION

The flow meter is a stainless steel tube lined with a non-conductive material. Outside the tube, two DC powered electromagnetic coils are positioned opposing each other. Perpendicular to these coils, two electrodes are inserted into the flow tube. Energized coils create a magnetic field across the whole diameter of the pipe.

As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. The M2000 amplifier receives the detector's analog signal, amplifies that signal and converts it into digital information. At the processor level, the signal is analyzed through a series of sophisticated software algorithms. After separating the signal from electrical noise, it is converted into both analog and digital signals that are used to display rate of flow and totalization.

With no moving parts in the flow stream, there is no pressure lost. Also, accuracy is not affected by temperature, pressure, viscosity or density and there is practically no maintenance required.

ELECTRODES

When looking from the end of the meter into the inside bore, the two measuring electrodes are positioned at three o'clock and nine o'clock. M2000 mag meters have an "empty pipe detection" feature. This is accomplished with a third electrode positioned in the meter between twelve o'clock and one o'clock.

If this electrode is not covered by fluid for a minimum five-second duration, the meter will display an "empty pipe detection" condition, send out an error message, if desired, and stop measuring to maintain accuracy. When the electrode again becomes covered with fluid, the error message will disappear and the meter will continue measuring.

As an option to using grounding rings, a grounding electrode (fourth electrode) can be built into the meter during manufacturing to assure proper grounding. The position of this electrode is at five o'clock.

APPLICATION

The M2000 amplifier can be integrally mounted to the detector or can be remote-mounted, if necessary and has many advantages over other conventional technologies. The meter targets a variety of applications and is well suited for the diverse water and wastewater treatment industry. The M2000 meter can accurately measure fluid flow—whether the fluid is water or a highly corrosive liquid, very viscous, contains a moderate amount of solids, or requires special handling. Today, magnetic meters are successfully used in industries including food and beverage, pharmaceutical, water and wastewater, and chemical

FEATURES

- Available in sizes 0.25…54" (6…1350 mm)
- Pulsed DC magnetic field for zero point stability
- Integral and remote signal converter availability
- Corrosion resistant liners for long life
- Measurement largely independent of flow profile
- User friendly programming procedure
- Empty pipe detection
- Power loss totalization
- Digital signal processor (32-bit)
- Non-volatile programming memory
- Rotating cover
- Calibrated in state-of-the-art facilities
- NSF listed
- CSA certified

Badger Meter

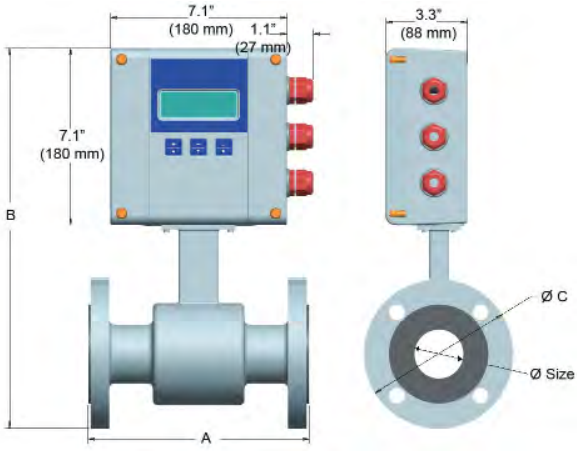
MAG-DS-01047-EN-06 (January 2015)

Product Data Sheet

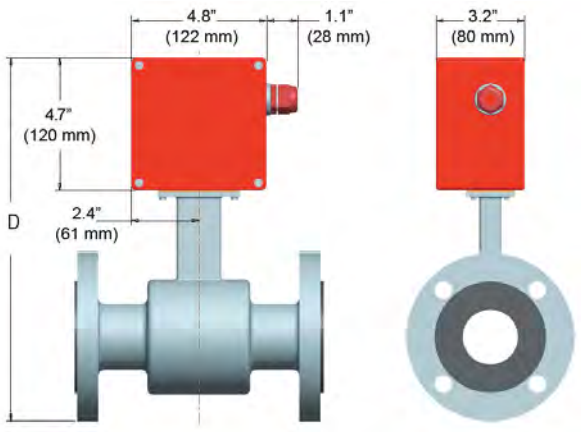
SPECIFICATIONS

Flow Range	0.10…39.4 ft/s (0.03…12 m/s)
Accuracy	± 0.25 percent of rate for velocities greater than 1.64 ft/s (0.50 m/s) ± 0.004 ft/s (± 1 mm/s) for velocities less than 1.64 ft/s (0.50 m/s)
Repeatability	± 0.1%
Power Supply	**AC Power Supply:** 85…265V AC; Typical Power: 20V A or 15W; Maximum Power: 26V A or 20W **Optional DC Power Supply:** 10…36V DC; Typical Power: 10W; Maximum Power: 14W
Analog Output	4…20 mA, 0…20 mA, 0…10 mA, 2…10 mA (programmable and scalable) Voltage sourced 24V DC isolated. Maximum loop resistance < 800 ohms.
Digital Output	Four total, configurable 24V DC sourcing active output (up to 2),100 mA total, 50 mA each; sinking open collector output (up to four), 30V DC max, 100 mA each; AC solid-state relay (up to 2), 48V AC, 500 mA max
Digital Input	Max 30V DC (programmable – positive zero return, external totalizer reset or preset batch start)
Frequency Output	Scalable up to 10 kHz, open collector up to 1 kHz, solid-state relay
Misc Output	High/low flow alarm (0…100% of flow), error alarm, empty pipe alarm, flow direction, preset batch alarm, 24V DC supply, ADE
Communication	RS232 Modbus RTU; RS485 Modbus RTU, HART, Profibus DP require separate daughterboards
Pulse Width	Scalable up to 10 kHz, passive open collector up to 10 kHz, active switched 24V DC. Up to two outputs (forward and reverse). Pulse width programmable from 1…1000 ms or 50% duty cycle.
Processing	32-bit DSP
Empty Pipe Detection	Field tunable for optimum performance based on specific application
Excitation Frequency	1 Hz, 3.75 Hz, 7.5 Hz or 15 Hz (factory optimized to pipe diameter)
Noise Dampening	Programmable 0…30 seconds
Low Flow Cut-Off	Programmable 0…10% of maximum flow
Galvanic Separation	250V
Fluid Conductivity	Minimum 5.0 micromhos/cm
Fluid Temperature	**With Remote Amplifier:** PFA, PTFE & Halar 302° F (150° C) **With Meter-Mounted Amplifier:** Rubber 178° F, (80° C), PFA, PTFE & Halar 212° F (100° C)
Ambient Temperature	– 4…140° F (–20…60° C)
Relative Humidity	Up to 90 percent non-condensing
Flow Direction	Unidirectional or bidirectional two separate totalizers (programmable)
Totalization	Programmable/resettable
Units of Measure	Ounce, pound, liter, US gallon, imperial gallon, barrel, hectoliter, mega gallon, cubic meter, cubic feet, acre feet
Display	4 x 20 character display with backlight
Programming	Three-button, external manual or remote
Amplifier Housing	Cast aluminum, powder-coated paint
Detector Housing	Carbon steel welded
Pipe Spool Material	316 stainless steel
Flanges	**Standard**: ANSI B16.5 Class 150 RF cast steel; **Optional:** 300 lb cast steel, 316 stainless steel
Liner Material	PFA up to 3/8", PTFE 1/2…24", soft and hard rubber from 1…54", Halar® from 14…40"
Electrode Materials	**Standard:** Alloy C; **Optional:** 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium
Mounting	Meter mount or remote wall mount (bracket supplied)
Locations	Indoor and outdoor
Meter Enclosure Classification	NEMA 4X (IP66); **Optional:** Submersible NEMA 6P (IP67), remote amplifier required
Junction Box Enclosure Protection	For remote amplifier option: powder-coated die-cast aluminum, NEMA 4 (IP66)
Cable Entries	1/2" NPT cord grip (3)
Optional Stainless Steel Grounding Rings	**Meter Size** — **Thickness (of one ring)** Up through 10" — 0.135" 12…54" — 0.187"
NSF Listed	Models with hard rubber liner, 4"size and up; PTFE liner, all sizes
Token Features	Data Logging (Blue token); Store/Restore (Red token); Firmware Upgrade (Black token)

DIMENSIONS IN INCHES (MILLIMETERS)



Meter with M2000 Amplifier



Meter with Junction Box for Remote M2000 Amplifier

Size		A		B		C		D		Est. Weight with M2000		Flow Range			
												LPM		GPM	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	lb	kg	min	max	min	max
1/4	6	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.05	20	0.01	5
5/16	8	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.09	36	0.02	10
3/8	10	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.14	57	0.04	15
1/2	15	6.7	170	14.0	356	3.5	89	11.4	288	10	4.5	0.32	127	0.08	34
3/4	20	6.7	170	14.2	361	3.9	99	11.5	293	13	5.5	0.46	183	0.12	48
1	25	8.9	225	14.4	366	4.3	108	11.7	298	18	8.0	0.79	318	0.21	84
1-1/4	32	8.9	225	15.2	386	4.6	117	12.5	318	20	9.0	1.5	594	0.39	157
1-1/2	40	8.9	225	15.4	390	5.0	127	12.7	322	21	9.5	2.1	834	0.55	220
2	50	8.9	225	15.9	403	6.0	152	13.2	335	26	11.5	3.6	1431	0.94	378
2-1/2	65	11.0	280	17.1	434	7.0	178	14.4	366	52	23.5	6.2	2471	1.63	653
3	80	11.0	280	17.3	440	7.5	191	14.7	372	54	24.5	8.4	3344	2.21	883
4	100	11.0	280	18.4	466	9.0	229	15.7	398	56	25.5	12	4997	3.30	1320
5	125	15.8	400	19.6	498	10.0	254	16.9	430	58	26.0	20	8008	5.29	2115
6	150	15.8	400	20.6	524	11.0	279	17.9	456	60	27.0	30	11890	7.85	3141
8	200	15.8	400	22.5	572	13.5	343	20.4	518	86	39.0	59	23765	15.69	6278
10	250	19.7	500	26.8	681	16.0	406	24.1	613	178	81.0	95	37934	25.05	10021
12	300	19.7	500	28.9	734	19.0	483	26.2	666	207	94.0	127	50894	33.61	13445
14	350	19.7	500	30.8	782	21.0	533	28.2	716	258	117	173	69272	45.75	18300
16	400	23.6	590	33.7	856	23.5	597	31.0	788	306	139	226	90477	59.75	23902
18	450	23.6	590	35.0	890	25.0	635	32.4	822	400	181	286	114511	75.63	30250
20	500	23.6	590	38.2	969	27.5	699	35.5	901	493	224	353	141371	93.37	37346
22	550	23.6	590	39.6	1005	29.5	749	36.9	937	523	237	428	171059	112.97	45189
24	600	23.6	590	42.2	1071	32.0	813	39.5	1003	552	251	509	203574	134.45	53779
28	700	23.6	590	46.2	1173	36.5	927	44.0	1118	648	294	693	277089	183.00	73199
30	750	31.5	800	48.3	1228	39.0	984	45.7	1161	702	319	795	318087	210.07	84030
32	800	31.5	800	52.2	1325	41.4	1015	49.5	1257	768	349	905	361912	239.02	95607
36	900	31.5	800	55.3	1405	46.0	1168	54.1	1374	848	385	1145	458045	302.51	121003
40	1000	31.5	800	60.0	1525	50.2	1230	57.4	1457	922	419	1414	565487	373.46	149386
42	1050	36.0	914	66.0	1675	53.0	1346	63.4	1610	1198	499	1559	623449	411.74	164698
48	1200	39.4	1000	69.9	1775	59.4	1455	67.2	1707	1208	549	2036	814301	537.79	215116
54	1350	39.4	1000	75.4	1915	66.2	1681	73.0	1927	1854	619	2576	1030599	680.64	272255

Item 2.6.10.4 - Hypochlorite Feed System - two units)

MC4-50 Feeding System

Dry Calcium Hypochlorite For Municipal Applications

The smarter way to water quality

PATENTED SPRAY TECHNOLOGY

DELIVERS UNPARALLELED CONSISTENT RESULTS

Constant Chlor plus

The Constant Chlor® Plus MC4-50 Dry Calcium Hypochlorite Feeding System

Designed via feedback from actual field users, **The Constant Chlor® Plus MC4-50 dry calcium hypochlorite feeding system** prepares and automatically delivers a consistently accurate dose of liquid available chlorine for disinfection applications. This feeding system can supply up to 50 pounds of AvCL/day on a sustained basis without the storage and handling issues associated with liquid bleach or chlorine gas.

With the ability to stand alone or be integrated with other process and control equipment, this highly customizable feeder uses NSF Standard 60 listed **Constant Chlor® Plus dry calcium hypochlorite briquettes** and patented spray technology to produce fresh liquid chlorine solution as needed. The reservoir is filled and volume maintained via an electronically controlled spray manifold where it is continually circulated to maintain unparalleled solution consistency.

FEATURES

- Unit constructed of high impact HDPE; all wetted areas, internal fittings and level controls constructed of suitable plastics or other non-metallic material
- Utilizes patented spray technology
- Patent-pending mixing mechanism within solution reservoir
- SCADA compatible
- Automatic solution tank refill
- Mechanical overflow-prevention valve
- Large 62 lb. capacity briquette hopper
- Delivers up to 50 lbs. AvCL per day
- Skid mounted with secondary containment
- Area for pump mount

BENEFITS

- Compatible with all types of pumps including positive displacement pumps
- Customizable, convenient and easy to use
- Effective, safer, easier & less expensive alternative to gas and liquid bleach
- Reduced regulatory compliance required including eligibility for Material of Trade (MOT) exceptions for transport
- Efficiencies in bulk storage and man hours
- Consistent and reliable chlorine solutions
- Operates at normal atmospheric pressure and is readily serviceable for refilling and cleaning while in operation
- Eliminates metering pump air locks due to off-gassing
- Eliminates transfer spills
- Minimizes man hours for maintenance and shut downs
- Pre-plumbed and skid mounted for ease of installation
- Internal mixing mechanism enables sustainable homogeneous solution and prevents solids build-up
- Option for pre-treatment

Specifications

Chlorine Delivery Rate*	1.0 - 50.0 lb. AvCl/day with 70° F inlet water temp.	Dry Chemical Capacity	62 lbs.
		Site Requirements:	
Discharge Pressure Range	50 - 150 psig	Inlet Water	1.0 gpm @ 50 - 150 psi (227 L/hr)
Water Inlet Size	1/2 Inch, FNPT	Electrical	20 amp @ 120V/1ph/60Hz
Solution Outlet (Injector) Size	1/2 Inch, MNPT	Operating Temperature	40° - 105° F

Delivery rate is dependant on the dosing pump size

Municipal Applications

Arch Chemicals, Inc. provides municipalities across the country with products that meet the toughest regulations and standards including NSF/ANSI 61 for our feeding equipment and NSF 60 for **Constant Chlor® Plus Briquettes**, allowing the public to rest easy about the quality of their water supply.

- Remote Well Sites
- Booster Stations
- Waste Water
- Reclaimed Water
- Surface Water Treatment Plants
- Ground Water Treatment Plants

Potable Water

- Provides hypochlorination to disinfect water supplies in smaller communities
- Requires low initial investment
- Maintains economical operating costs

Private Water Supplies

- Sanitizes wells, natural springs, cisterns and storage tanks by destroying microbes
- Purifies by destroying harmful organic matter

Other Water Treatments

- Controls slime and maximizes cooling efficiency in cooling towers, ponds and reservoirs of power plants
- Controls growth of slime in commercial air conditioning systems, improving cooling efficiency and eliminating unpleasant odors
- Destroys disease-producing organisms in raw or treated sewage
- Keeps decomposing septic sewage odors and masonry disintegration in check by "up sewer hypochlorination"

Patented Spray Technology

Patented Spray Technology + Constant Chlor® Plus Briquettes = Consistently Accurate Hypochlorite Solution

How it Works

Markedly different from erosion feeders currently on the market, the Constant Chlor® Plus MC4-50 feed system injects supply water into the unit by spraying upward into a bed of briquettes; this short intermittent spray cycle contacts the entire bottom of the bed evenly, not just the material resting on the grid.

Specifically designed for use in the Constant Chlor® Plus Spray Technology feed systems, the briquettes are relatively small, smooth and " pillow shaped" , for maintaining optimum packing in the spray bed.

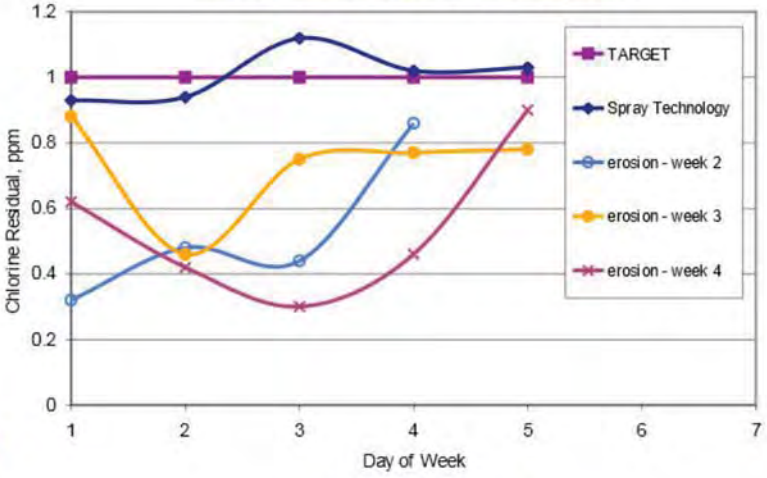
Maintaining a well-packed bed of briquettes significantly reduces the potential for large voids in the spray surface that can result in inconsistent residual concentration in the final solution.

The hypochlorite solution produced by the unit's spray cycle is collected in a 13-gallon solution tank, where the total volume is slowly and continuously mixed, further enhancing concentration consistency.

Unlike an erosion feeder, the Constant Chlor® Plus MC4-50 feeder sprays upward to a well packed bed of briquettes, contacting the entire bottom of the bed evenly. The chlorinated solution flows to the lower reservoir where it is continuously mixed. The accuracy and consistency of the resulting solution concentration far exceeds that achieved by an erosion feeder. Consequently, operator dosage adjustment is minimal.

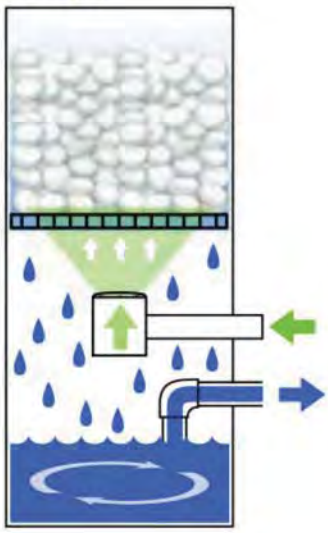
EROSION

ACCURACY AND CONSISTENCY OF SPRAY TECHNOLOGY VS EROSION



Data source: Arizona test facility

SPRAY

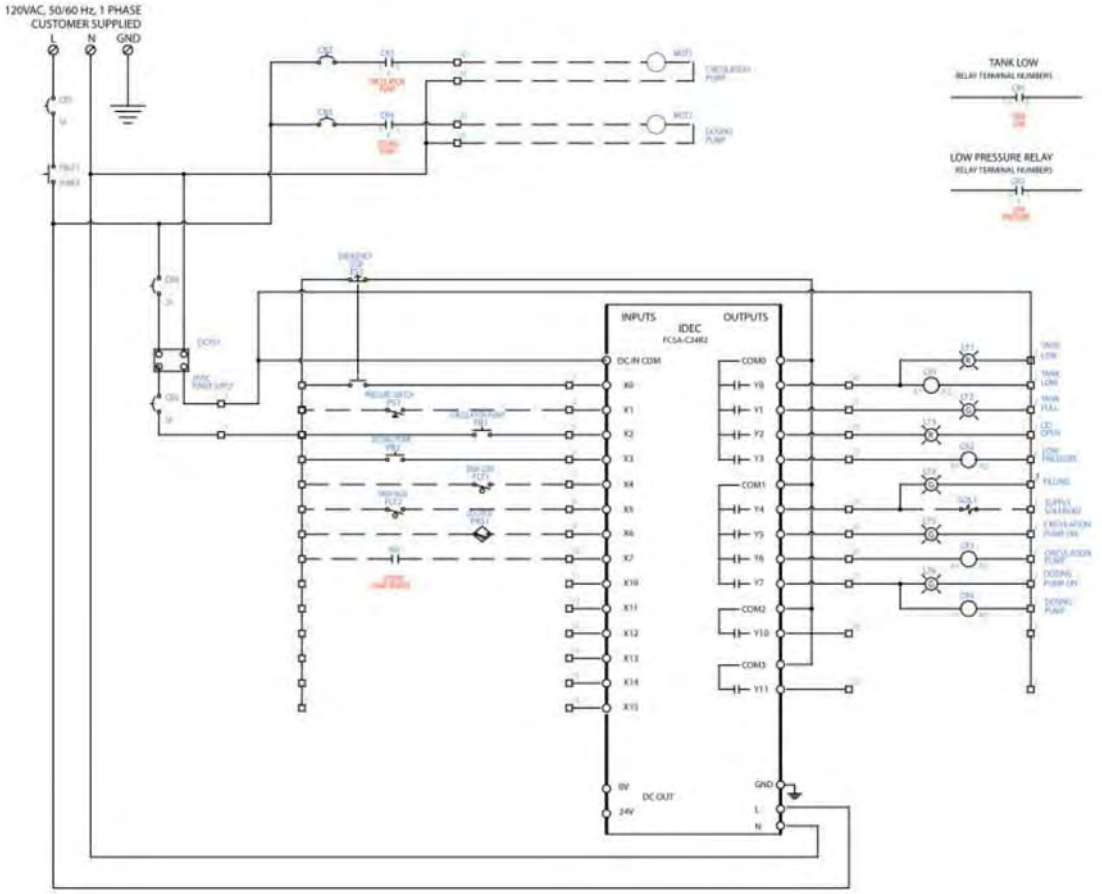


Product Stewardship

Protecting Health, Safety, and Environment
Product Stewardship

Arch is committed to maintaining and improving our leadership in Product Stewardship – from manufacture, marketing, distribution, use, recycling and disposal. Successful implementation includes educating all involved of their responsibilities to address society's interest in a healthy environment and in products that can be used safely. We are each responsible for providing a safe workplace, and all who use and handle products must follow safe and environmentally sound practices.

Electronics Panel and PLC Information



120/240VAC, 50/60Hz, 15/10A, 1Phase

4 Normally Open Contacts for Remote Interface. 1 Dry Contact for Remote Start of Dosing Pump

24VDC Control Power

PLC with 14 input/10 outputs

6 Inputs and 2 Outputs Available for Systems Integration

8 BUTTONS / INDICATORS

- E-STOP: Push-Button emergency stop for the unit. Turns OFF every function.
- OFF/ON Indicator: Push-Button to turn the unit ON or OFF.
- CIRCULATION PUMP: Circulation pump is interlocked with TANK LOW and will not operate if TANK LOW alarm is activated. Lamp flashes is circulation pump pressure drops below 5 psi. Push-Button to turn ON or OFF.
- DOSING PUMP: Chemical dosing pump is interlocked to the system. Will not pump if LOW CHLORINE SOLUTION alarm is activated. Remote or manual start capability. Push-Button to turn ON or OFF.
- LID OPEN: Prevents the unit from operating if lid is opened.
- FILLING: Indicates that the solenoid is energized and unit is making solution.
- TANK FULL: The high float is engaged and tank is full of chlorinated solution.
- TANK LOW: Solution inside tank is low, alarm condition.

Constant Chlor® Plus Briquettes

Constant Chlor® Plus Briquettes are designed for use in the Constant Chlor® Plus MC4-50 feeding system. The briquettes provide chlorine solution for use in many applications including treatment of surface and groundwater for municipal drinking water use, industrial process water as well as pre- and post-harvest food safety.

These patented, pillow-shaped briquettes contain a scale inhibitor designed to reduce maintenance and improve reliability of the feeder system.

FEATURES

- Dry Solid Product
  - Longer shelf life than liquid bleach
  - Occupies much less space than liquid bleach
  - Less hazardous than liquid bleach or gas chlorine
  - Easier to handle than liquid bleach or gas chlorine

SCALE INHIBITED

- Patented formulation
- Reduces maintenance of equipment

REGULATORY

- EPA No. 1258-1179
- NSF Standard 60, Drinking Water Additives
- Meets AWWA Standard B300

PROPERTIES

• Available Chlorine (wt%)	65% minimum
• Scale Inhibitor (wt%)	0.5%
• Weight	0.25 oz. (7 grams)
• Dimensions	1-1/4 in. X 3/4 in. X 1/2 in.
• Appearance	Pillow Shaped Briquettes

PACKAGING

Constant Chlor® Plus Dry Chlorinator Briquettes are available in 50 lb. plastic pails

Arch also produces Dry Tec® FG Briquettes (Food Grade) for use with the Constant Chlor® Plus MC4-50 feeder. Dry Tec® FG contains an anti scale formulation for food industry applications.

CALL 1-800-478-5727
to find out more about
CONSTANT CHLOR® PLUS
or visit our website at
www.archwaterworks.com/municipal

Constant Chlor plus
Automatic. Accurate. Consistent.

ARCH
Arch Chemicals, Inc.
5660 New Northside Dr NW, Suite 1100
Atlanta, GA 30328
1-800-478-5727

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Item 2.6.10.5 - Chlorine Controller (two units)

Series 4000 MicroChem2
Panel Mounted
Analyzer/Transmitter & Controller

Panel Mounted MicroChem2 systems include:
- Choice of Microchem configured as a multi channel transmitter or controller.
- Flow Cell Panels are capable of holding two probes. (1) CL2 and (1) 12mm Ph/ORP probe.
- 15' Sample Line
- 10' Drain Tube
- (1) 1/4" NPT X 1/4" OD Tube Fitting
- 4' Chlorine Probe cable assembly

- 115 Vac option provides a 6' power cord installed. 230 Vac equipment is supplied without a power cord.
- Panel mounted assemblies do not include Probe(s), which must be ordered seperately for field installation.

Pick your options and add prices.

T17M ___ 4 ___ D ___ ___ ___ ___ ___ Feature

A B C D E F G H I Position TYPE: U32

Position	Feature	Description	
A Electronics	B	Transmitter , MC2 (Note 1 & 2)	
	D	Controller, MC2 (Note 3) / Average Controller (Note 4)	
	E	Swimming pool controller, MC2 (Note 5)	
B Production Series	4		
C Channels	1	1 channel	
	2	2 channel	
	3	3 channel	
D Design Level	D		
E Voltage	1	110V	
	2	220V	
F Mounting	2	Panel mounted flow cell (Note 12, 13)	
	3	Panel mounted flow cell w/ Pressure Regulator (Note 12, 13, 15)	
G Expanded function board (Note 10)	2	RS485 (Note 8)	
	4	RS232 (default when not specified)	
H Approval	D	Standard	
	E	CE (Supplied with RS485)	
I Documentation	XX	Standard Documentation	
	01	Certification Documentation	

Note:

1. Available with 1, 2 or 3 channels.
2. When cleaning sequence is enabled, alarm transmission is limited to channel 1 and channel 2 only. Relays are not available for alarm transmission for channel 3.
3. Available with 2 or 3 channels. Set 4-20 mA (flow) on channel 2, the controlled sensor on channel 1, and optional 3rd measured sensor on channel 3.
4. Available with 2 or 3 channels. All measurements must be identical and can be any water constituent the instrument is capable of measuring i.e. Chlorine on Channels 1 and 2 (and 3 if selected).
5. Available with 2 or 3 channels. Available measurements include: pH and ORP, pH and Chlorine or pH ORP and Chlorine.
6. Voltage required is 115 or 230 V +/- 10% 50/60 Hz. Voltage is jumper selectable for 115 or 230 volts. Standard units are shipped with the jumper in the 230 volt position, without power cord. 115 volt includes a 6 foot cord. Panel assemblies are fully assembled and shipped with the voltage jumper is set per customer order.
7. Panel assemblies include a polyethylene back panel, (20"(508mm)H X 24"(610mm)W), with tubing, tubing connectors, dual flow cell housing, 4 ft CL4000 probe cable, and analyzer fully assembled. Probes are ordered separately, see 210.8320.
8. RS232 is standard. RS485 is available and requires an additional 2 week lead time.
9. Tubing connectors are used for connection of various flow regulation components.
10. Fitting gets inserted into part# 26098 to create a 90° tubing adaptor.
11. PH Probe w/3 foot cable is recommended for use with panel mounted flow cells. PH measurement requires its own channel card installed in the MicroChem2 for proper operation.
12. For applications with dual sample stream chlorine measurement, a 2 channel MicroChem2 should be ordered and an additional remote mounted flow cell should be ordered. See price page 210.8321.
13. Chlorine and Conductivity may not be measured into the same flow cell.
14. Carbon dechlorination filter (P/N 26903) is temporarily installed to provide a chlorine free sample for calibration. Includes (2) P/N 26098 tube fittings.
15. Pressure Regulator is used when sample pressure is unknown or above 15 PSI.

WE UNDERSTAND WATER TREATMENT

Series 4000 Transmitter/Controller

Specifically designed for drinking and water treatment plants and swimming pool applications, the MicroChem®2 is able to measure up to three of the following parameters: pH, ORP, Dissolved Oxygen, Chlorine, Chlorine Dioxide, Conductivity, 4-20 mA, and Temperature (PT100).

The MicroChem2 can be ordered in the following configurations:

ANALYZER/TRANSMITTER - The MicroChem2 is capable of accepting signal(s) from up to three sensors representing a wide variety of measurements.

CONTROLLER - The MicroChem2 can provide control of the measured parameter using a standard PID algorithm in conjunction with the sensor input signal, or as a PID Compound Loop controller utilizing the signal from the sensor and an optional 4-20 mA flow signal. Control output is available both as a 4-20 mA control signal and as a time proportional contact output. PID control is available if the 4-20 mA output signal is used. Gain and cycle time are used if the instrument is configured to control using relay contacts. If so, 4-20 mA retransmission signal is available on each configured channel. Optionally, an additional 4-20 mA output is available to retransmit the measured value if a 4-20 mA output signal is used for control.

SWIMMING POOL CONTROLLER - The MicroChem2 receives signals from pH, ORP and/or chlorine sensors and displays the measured values. It performs specific PID algorithms on pH and chlorine or ORP. The control is performed via a 4-20 mA output signal or with relay contacts. PID control is available if the 4-20 mA output signal is used. Gain and cycle time are used if the instrument is configured to control using relay contacts. If so, 4-20 mA retransmission signal is available on each configured channel. The MicroChem2 is also able to display and retransmit the sample temperature.

Design Features

- Capable of receiving inputs from up to three (3) sensors and/or 4-20 mA signals.
- Retransmits up to three (3) 4-20 mA signals.
- Measures, indicates and retransmit the sample temperature value.
- Galvanic isolation between inputs and outputs.
- Two (2) digital inputs (contacts).
- Up to seven (7) relay outputs, Contact outputs can be individually set as NO or NC via software.
- Modularity & flexibility: Additional channels are easily added and field sensors can be changed to achieve new measurements.
- Simplicity of use is also assured by message driven menus displayed in one of the following software selectable languages: English, French, German, Spanish and Italian.
- Alarms and deadband can be freely changed via software.
- Automatic temperature compensation.
- Password protected menus.
- Alarm and warning messages.
- Output freezing capability.
- Ability to drive a cleaning sequence for the sensor via dedicated software and relay contact outputs.
- Single point calibration procedure available for pH.
- The MicroChem2 Controller is capable of accepting a 4-20mA input signal as a Feed Forward parameter in the PID algorithm.
- Housing suitable for outdoor installations (NEMA 4, IP65 protection)
- Configuration and calibration are performed without opening the instrument cover via a membrane keypad and display.
- The MicroChem2 Swimming Pool Controller utilizes specific PID algorithms for pH and Chlorine/ORP.
- Self diagnostics
- Sensor sensitivity check during calibration procedure.
- Variety of Measurements; Chlorine (Free & Total), pH, ORP, Dissolved Oxygen, Chlorine Dioxide, Conductivity, 4-20 mAdc signal and Temperature.

Technical Data - Series 4000 Transmitter/Controller

Instrument Specifications:

Display: 2 Line x 16 LCD display with back light

Power supply: 115/230 Vac (~), ±10%, 50/60 Hz

Housing construction material: Goodlac V0 532 ULSD F17 self extinguishing tested according UL 94 and classified V0 (material ABS plus 17% fiberglass)

Enclosure classification: NEMA 4, IP65 suitable for outdoor mounting

Mounting: Hardware is supplied for wall mounting

Analog outputs: one for each installed channel; separately selectable for each channel, as 4-20 mA. Outputs are galvanically isolated from inputs. Load 0-1000 ohms, protected against short circuits.

Relay outputs: 24 V … (Vdc), 115/230 V~ (Vac), 3A max. Contact output status can be selected as NO or NC separately for each contact.

Serial communication interconnection: RS485 or RS232 serial port.

Storage temperature limits:
-40°F to 150°F (-40°C to 65°C)

Operating temperature limits:
15°F to 122°F (-10°C to 50°C)

Thermal drift: within 0.2% of full scale for a 50°F (10°C) temperature change.

Maximum relative humidity: 80% with temperature up to 31°C (88°F), with linear decrease down to 50% with temperature 40°C (104°F)

Accuracy: Depends upon wet end

Transmitter response time: 100 ms

Housing Dimensions: 8.6” x 10” x 4.8”
(220mm x 250mm x 120mm)

Weight: 6.6 lbs (3 kg)

Calibration procedures: for each channel and for each type of measurement a dual point calibration procedure is required. For pH a single point fast calibration procedure is also available. During dual point calibration procedure a sensor sensitivity check is performed.

WE UNDERSTAND WATER TREATMENT

Measuring range: freely selectable for each channel, within the limits indicated for each parameter:

Parameter	Span Range
KC4000	
pH	0.00 - 14.00
Oxidation Reduction Potential (mV)	-1500 / +1500 mV
Chlorine, Free or Total	0 - 10 ppm
Chlorine Dioxide	0 - 10 ppm
Temperature	0 - 100 °C
Conductivity	10 - 10,000 µS
DO4000	0 - 20 ppm
CL4000	
Free	0 - 2 ppm
Free	0 - 5 ppm
Free	0 - 10 ppm
RX4000	
Oxidation Reduction Potential	-1500 -/+ 1500 mg
pH4000	0 - 14 ppm

Panel Mounted MicroChem®2 & Chlorine Probe Flow Cell (Recommended use with CL4000 probes)

The Panel mounted MicroChem2® & chlorine flow cell is fully assembled with all flow control components; and the instrument is set to the proper voltage, with a power cord (120V only) mounted on a polypropylene back board that is 20" (508mm) H x 24" (610mm) W. It provides a neat aesthetically pleasing way to install the MicroChem2 transmitter and CL4000 bufferless chlorine probe measuring system. Each panel has a built in sample point for calibration verification and comes complete with chlorine probe cable, sample and drain tubing. The flow cell will accept one 25mm chlorine probe and one 12 mm pH or ORP probe to allow for dual measurements in a single sample stream. When ordered with the optional pressure reducing valve the panel can accept water sample pressures up to 150 psig.

Installation is straight forward. Simply insert the CL4000 probe and/or 12mm probe into the flow cell, connect the probe(s) to the MicroChem, plug in the power cord, connect the sample and drain lines and the instrument is ready to go.

Series CL4000 Chlorine Probes used with MicroChem®2

The CL4000 chlorine probes, in conjunction with the microprocessor based MicroChem®2 transmitter/ controller, form a simple and reliable system for measuring free residual chlorine WITHOUT the addition of reagent.

The system is primarily used for measuring chlorine in clean water, such as in drinking water treatment plants and cooling systems.

The chlorine probes are 3-electrode amperometric cells covered with a permeable membrane. The 3-electrode design eliminates the need for repeated zero adjustment typical of some analyzers.

The probe exterior is manufactured from durable PVC and stainless steel and has a diameter of 25mm (1 inch). The probes are engineered to fit in a specially designed flow cell.

The 3-electrode probes have significantly lower pH dependence and can be used without the need for pH compensation.

All the CL4000 probes are designed to run bufferless.

The probes have no moving parts and are designed to require minimal maintenance. Typically the membranes are replaced annually.

Technical Data - Series CL4000

Probe Types and Ranges
Free CL_2 (3 electrode), ranges available 0-2, 0-5 and 0-10 ppm

Measurement Method: Amperometric
The amperometric method is EPA approved for on-line chlorine residual monitoring in drinking water.

Temperature Compensation: internal

Accuracy: ±5% of range

Applications: Drinking/clean water There should be no surfactants in the sample.

Sample Inlet Pressure: 2 to 15 psig, sufficient to produce 0.5 L/min

Sample temperature: 41° to 104°F (5° to 40°C)

Material of Construction

Working and Counter Electrodes: gold and stainless steel
Reference Electrodes: silver/silver chloride

Probe outer: PVC, stainless steel

pH: 4 to 9.0 signal change is less than 5% per step change

Sample Flow: 30 liters per hour (8 GPH)

Sample inlet:
1/4 OD tube

Sample Drain: 3/4" tube
Outline and mounting dimensions:
Flow through cell:
14.6" (h) x 2" (l) x 2.4" (d) (370mm x 50mm x 60mm)
Probe:
1"(d) x 9"(l) (25mm x 230mm)

WE UNDERSTAND WATER TREATMENT

Series KC4000 Measuring Cell

The MicroChem®2 measuring cell Series KC4000, in conjunction with the microprocessor based MicroChem®2 transmitter/controller, forms a simple and reliable system for measuring residual chlorine (free and total) chlorine dioxide and temperature. Optional pH and ORP measurements are also available.

The system is primarily used for measuring chlorine or chlorine dioxide in clean water, such as in swimming pools, drinking water treatment plants and cooling systems, but can be also used in wastewater treatment plant applications when provided with the suitable filters (y strainer).

An amperometric cell composed of two concentric electrodes performs the analysis. The sensitivity of the cell is kept constant through the gritting action of a measured amount of Corundum sand placed in the electrode chamber at start up. The amperometric cell is furnished in a plexiglass body internally shaped as a reverse cone.

The cell body, with the exception of the KC4200, can be mounted with the following options:
- ORP electrode
- pH electrode
- Conductivity electrode
- Combination of any two

The flow regulator to which the KC cell is mounted maintains a constant flow at the inlet without any valves for samples with pressure varying inside the limits 7.5 to 60 PSI.

PVC flow regulator housing is suitable to fit a pH, conductivity and ORP electrode (optional) and a temperature sensor (included) of standard dimensions. This system is specially designed for multiple simultaneous measurements such as swimming pool applications. Under normal circumstances when measuring chlorine, sample pH correction is not usually required. The correction is only needed when measuring chlorine in a sample with a pH higher than 7.5 or highly variable.

Measuring cells can be supplied in different versions:
- standard (Model T17KC4100) for low sample pressure, with-out DP regulator, 0.1 to 0.5 bar (1.4 to 7 psig)
- standard (Model T17KC4200) includes: IP66 case, cell, electronics, cable, and PT thermistor. (IP66 case only available with 4200). (12mm probes not available for 4200). For indoor/outdoor installation. Provides protection against dust & water.
- standard (Model T17KC4400)
- standard (Model T17KC4500) with pH electrode
- standard (Model T17KC4600) with pH and ORP electrode
- standard (Model T17KC4700) for hot water 35.6°F to 149°F (2°C to 65°C)

Reagent Feed Options:

- Peristaltic Pump
- 120/240 Volts specified at time of order
- 19-liter reagent bottle(s)
  - one bottle shipped for free chlorine applications
  - two bottles shipped for total chlorine applications
- Reagent consumption - 10 liters/month
- Dimensions (reagent panel) 13.28” x 12.00” (337mm x 305mm)

Technical Data - Series KC4000

- Residual chlorine (free & total), chlorine dioxide and temperature
- Self cleaning electrodes
- Temperature compensation
- Swimming pools
- Wastewater treatment applications
- Potable water

Electrodes: gold measuring electrode, copper counter electrode

Type of measurements: free chlorine, total chlorine (with sample conditioning system), chlorine dioxide, ozone, pH and ORP, temperature, and conductivity

Chlorine Measurement Method: Amperometric

The amperometric method is EPA approved for on-line chlorine residual monitoring in drinking water.

Temperature compensation: standard, Pt 100 temperature element

Accuracy: chlorine/chlorine dioxide ± 5% of f.s.

pH: Accuracy is ± 0.2 pH units. When pH is higher than 12 the accuracy decreases.

Sample inlet pressure: 7.5 - 60 PSI (0.2 - 4 bar).

Sample temperature: temperature compensation from 36°F to 122°F (2°C to 50°C)

Limit of Detection: 10 ppb

Material of construction:
Electrodes: copper and gold
Cell: plexiglass
Pressure regulator: PVC

pH: no pH correction needed when measuring free chlorine if the pH is inside the limits of 4-7.5 and steady. The higher the pH the smaller the fluctuations allowed. The cell can be supplied with an optional reagent addition system.

Sample flow: 16 GPH (60 l/h)

Outline and mounting dimensions:
12.6" (h) x 7.9" (l) x 5.9" (d)
(320mm x 200mm x 150mm)

Weight: 6.6 lbs (3 Kg)

Measuring Ranges	
Chlorine	0 - 10 ppm
Chlorine Dioxide	0 - 10 ppm
pH	0 - 14
ORP (mV)	-1500/+1500
Temperature	0 - +100°C
Conductivity	0 - 99,999 µS

WE UNDERSTAND WATER TREATMENT

Series pH4000 pH and RX4000 ORP Probes

pH4000 Electrode: pH electrodes are 12mm in diameter, not temperature compensated and are designed for use with the KC4000 cell (PT100 temperature sensor is provided with the KC4000 housing). They are also used in the pH4000 Immersion probes.

Pipe Insertion Electrode with Built-in Temperature Compensation: A flat surface probe used in conjunction with a saddle tap, 1" insertion assembly and a ball valve is also available. The probe self cleans using the sample-flow.

pH4000 Electrode with Built-in Temperature Compensation: Electrodes feature a built-in PT100 within the 12mm epoxy body for temperature compensation. The primary use for these electrodes are to run along side the Cl4000 chlorine electrode and have been designed to be used in the acrylic flow through cell.

pH4000 and RX4000 Immersion Probes: The pH4000 Immersion Probes are available with gel electrolyte for general applications. They are supplied in a durable PVC immersion housing with a built-in PT100. They can be inserted directly into tanks, channels, or the specially designed flow cell (P/N 1T811B012U03, UK P/N 01-4041) which is piped in-line. Optionally the probes can be provided with nozzle devices for water or chemical jet cleaning

For applications that may contain fouling or fat/grease substances an optional cleaning nozzle accessory is available for automatic cleaning.

Technical Data - Series 4000 pH Probes and ORP Probes

- Temperature compensated measurement
- Simple to install and requires infrequent maintenance
- Optional cleaning nozzle for automatic cleaning
- Gel filled probes for typical drinking water and waste water applications

Measuring Range: 0-14 pH units (0-12 pH w/o Na+ error), -1500 to 1500mV (ORP)

Reference Gel Electrode: Ag/AgCl, KCl gel

Accuracy: ± 0.2 pH units; accuracy decreases above 12 pH (sodium ion error occurs)

Temperature Compensation: PT100 via probe (KC) or built in sensor

Sample Temperature[1]: 32° to 212°F (0 to 100°C)

Sample Conductivity (pH): greater than 100 micro siemens for standard probes

Pressure: 0 to 2 bar (0 to 30 psi)

Wetted parts: glass, epoxy, Pellon (nylon mat)

Dimensions: 4.5" (115mm) L x 0.5" (12mm Ø)

Flow-through Cells for Immersion (Probe) Housing

Application: non-pressurized sampling lines

Hydraulic connections: 1/2 suitable for ½"NPT
Optional self cleaning available

Feeding line: PVC hose, 5M

Nozzle consumption: with 28psi water pressure, 250L/hr.

Temperature measurement: built-in PT100 sensor

Ambient temperature: 0-50°C

Wetted parts: PVC, hard rubber

Mounting Bracket, Immersion Probe: PVC

Length, Immersion Probe Housing: 15.75" (400mm)

Flow-through acrylic cell for pH4000 (with built-in PT100 sensor) or RX4000 ORP Probe

Ambient temperature: 0-50°C

Wetted parts: Acrylic

Sample inlet and outlet connections: 5/16" (8 mm) x ¼" (6mm) tubing

Hydraulic Connections: ¼" NPT

Dimensions: 13.75" x 3.125" x 3.375"D
(350 mm x 80 mm x 86 mm)

Insertion Assembly

Application: pH measurement within a pipe

Hydraulic Connections: 1 inch male NPT

Pressure: 0-6.9 bar (0-100 psi)

Temperature measurement: PT100 sensor built into the insertion assembly

Ambient temperature: 0-80°C

Wetted parts: CPVC, HDPE, and Viton® o-rings

Mounting: requires tapped pipe to which the insertion assembly is mounted

Probe Dimensions: 3 inches L x 0.9 inch dia.

Insertion Depth: 12 inches

Length, assembly: 18 inches

Cable length: must be specified at time of order

SEVERN
TRENT
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210.0100.27 AUG/12

Item 2.6.10.6 - Chlorine Probe

CL4000 Chlorine Probes
Series 4000
MicroChem2

Chlorine Probes include:
- Electrolyte Solution, 100 ml bottle
- Membrane cap
- Abrasive paper
- Instruction Manual

Flow Through Cells include:
- Panel Mounted Flow Cells and Sample Control System. Flow Cell will accommodate (1) CL2 Probe & (1) 12mm Ph or ORP Probe.
- 15' 1/4" Sample tube
- 10' 3/4" Drain Tube
- (1) 1/4" NPT x 1/4" OD Tube Fitting

For a complete system choose the following:
- Chlorine Probe
- Cable
- Flow Cell Panel
- MicroChem2 Analyzer/Transmitter

- Must be used with the MicroChem2 - priced separately. See price page 210.8305
- See Analyzer price page 210.8310 for fully assembled panels.
- For Handheld Colorimeter - See price page 299.8300
- See Ph Probe price page if adding Ph measurement to flow cell.

Description / Range	Suggested Items	Item Number		
Chlorine Probe, pH tolerable 4.0 - 9.5 / 0-2 ppm (Note 1, 2)	X	23183		
Chlorine Probe, pH tolerable 4.0 - 9.5 / 0-5 ppm (Note 1, 2)	or	23184		
Chlorine Probe, pH tolerable 4.0 - 9.5 / 0-10 ppm (Note 1, 2)	or	23185		

Flow Cell Panel

Description	Suggested Items	Item Number		
Flow Cell Panel with PRV (Note 3, 13)	x	26881		
Flow Cell Panel (Note 12, 13)	or	26738		

Parts

Description	Suggested Items	Item Number		
4 Foot Cable (Note 2)	X	78-4001		
12 Foot Cable (Note 2)	or	78-4002		
40 Foot Cable (Note 2)	or	78-4003		

Accessories

Description	Suggested Items	Item Number		
Y Strainer 80 mesh, Max Inlet 75 PSIG		22901		
Flow Switch (Note 4)		22896		
Pressure Regulator Kit (Note 3, 11)		26735		

Note:
1. 3-electrode probes will measure Free Chlorine and are temperature compensated (0-40°C)/ pH tolerable in the range of 4-9.5. It is recommended that probes are operated at concentrations that are between 20 and 80% of range.
2. Cables must be used for the probes to function properly.
3. Optional PRV used when sample inlet pressure is unknown or greater then 15 PSI.
4. Flow Switch 22896 provides alarm when flow is not present.
5. Tubing Connectors are used for connection of tubing for various flow regulation components.
6. Carbon Dechlorinating Filter 26903 is temporarily installed to provide a chlorine free sample stream for calibration. Includes (2) P/N 26098 tubing fittings.
7. Annual maintenance kits include a Membrane Cap, PVC band, G-Holder, blue abrasive paper and 94-2136 electrolyte.
8. 100 ml of electrolyte will provide enough for 15 electrolyte refillings.
9. Shelf life of electrolyte is 2 years.
10. Fitting gets inserted into P/N 26098 to create a 90° tubing adapter.
11. Pressure Regulator Kit is included with Flow Cell Panel P/N 26881.
12. For use when sample input pressure is constant and between 2 - 15 PSI.
13. Chlorine and Conductivity may not be measured in the same Flow Cell.

Description	Suggested Items	Item Number		
Sample Fitting, Tubing, 1/4 NPT X 1/4 OD,Straight (Note 5)		26098		
Fitting, 90° Elbow, 1/4 Tube X 1/4 Stem (Note 5, 10)		26197		
Carbon Dechlorinating Filter with (2) 1/4" Tube Fittings (Note 6)	X	26903		
Sample Tubing, 1/4 OD X .170 ID PE, 25 FT Coil		17594		

Description	Suggested Items	Item Number		
Annual Maintenance Kit for: (Note 7, 8, 9)				
23183, 23184, 23185, 01-4032 and 01-4033 Probes Includes: PN 77-4004 and PN 94-2136	x	10-4002		
01-4034 and 01-4035 Probes Includes: PN 77-4004 and PN 94-2137		10-4003		
M48 Membrane Cap to fit 23183, 23184, 23185, 01-4032, 01-4033, 01-4034 and 01-4035 Probes		77-4004		
G-Holder for 23183, 23184, 23185, 01-4032 and 01-4033 Probes		77-4017		
Electrolyte Solution (100ml) for 01-4030 and 01-4031 Probes (Note 8, 9)		94-2135		
Electrolyte Solution (100ml) for 23183, 23184, 23185, 01-4032 and 01-4033 Probes (Note 8, 9)		94-2136	Recommended for purchase	
Electrolyte Solution (100ml) for 01-4034 and 01-4035 Probes (Note 8, 9)		94-2137		

Item 2.6.10.7 - pH Probe

Series PH4000
pH Sensor
Used with MicroChem2

Includes:
- Cable Length (3 or 10 meter)
- Electrode Handling Tool

Must be used with MicroChem2. Priced separately - See price page 210.8300

Immersion Probes

pH Immersion Probes

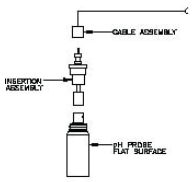
Description	Item Number	*
400 mm, Gel filled immersion probe, with 3 meter cable	T17PH411111	
400 mm, Gel filled immersion probe, with 10 meter cable	T17PH411121	

Replacement Electrodes, Parts and Accessories for Immersion Probes

Description	Item Number	*
Replacement immersion probe pH electrode, 12 mm, gel filled (3-meter cable) (Note 1)	1T614S029U01	
Replacement immersion probe pH electrode, 12 mm, gel filled (10-meter cable) (Note 1)	1T614S029U02	
Replacement electrode wrench, Series 4000	1T124F001U01	
Flow through cell assembly for immersion probes without cleaning option (Note 2)	1T811B012U02	
Flow through cell assembly for immersion probes with cleaning option (Note 2)	1T811B012U03	
Jet cleaning assembly for immersion probes (Note 3)	1T614B019U01	
Mounting bracket for immersion probes installed w/o flow through cell assembly (2 required)	1T624B038U01	

12 MM Probe

Description	Item Number	*
pH Probe, 12 mm, built in PT100 sensor, with 10 ft cable (Note 4, 12)	01-4068	
pH Probe, 12 mm, built in PT100 sensor, with 3 ft cable (Note 4, 12)	26189	
pH Probe, 12 mm, low conductivity w/temp comp, 3 ft cable (Note 13)	27063	
pH Probe, 12 mm, low conductivity w/temp comp, 10 ft cable (Note 13)	27064	
PH Probe, 12mm W/O Temp Comp, 30 inch cable (Note 7)	24752	
Acrylic Flow cell for use with above 12mm probe 01-4068 (Note 5)	23432	
Sample/Drain Tubing, 3/16" ID X 5/16" OD (per ft.) (Note 6)	R-376	



Flat Surface Probe

Description	Item Number	*
Insertion Assembly	24561	
pH electrode, flat surface probe(Note 8)	24562	
Ball Valve, 1 inch, CPVC for use with 24561	24564	

pH Buffers

Description	Item Number	
Cable, extension, per meter (Note 9)	1T677B134U01MT	
Junction Box (Note 9)	1T324C030U01	
Impedance adapter (Note 10)	1T324C010U01	

Accessories:

Description	Item Number	
Capsules, pH Standards, 4, 7 and 10 (Note 11)	1T141B008U02	Recommended for purchase
pH 4 Buffer, Box of 25 single use packets	R-6662	
pH 7 Buffer, Box of 25 single use packets	R-6663	
pH 10 Buffer, Box of 25 single use packets	R-6664	

Note:

1. Replacement electrodes can also be used with the KC4000.
   They can not be used with the acrylic flow cell: doing so will result in a RT fault.
2. Use with 400 mm imersion probes.
3. Includes 5-meter PVC tubing, clamp and "J" pipe and nozzle.
4. Provides temperature readout on display. Not for use with immersion probes or KC4000.
5. Supplied with sample valve. Has 2X compression fitting for flexible tubing.
6. Sample tubing is for sample inlet and outlet of Acrylic Flow Cell.
7. For use with KC4000 only. Temperature compensation is provided via PT100 probe supplied with KC4000.
8. Used in conjunction with saddle tap, 1" Insertion Assembly (P/N 24561) (complete with cable, 1" threaded NPT with built-in temperature element and BNC connector), and Ball Valve (P/N 24564) for attachment to saddle tap. May also be used at the bottom of a tank in conjunction with a female threaded, 1" full port ball valve to isolate the components from the pressurized system.
9. Cable is sold per meter. Cable extends distance of the pH probe from the analyzer. Cable is 7 wire - 3 for RTD, 2 for measurment and 2 are not used with current analyzer. Junction box is required for use with extension cables. Junction box dimensions: 100mm x 100mm, 6 pin board.
10. Impedance adapter is required if probe is 50 or more meters from instrument. Dimensions 50mm x 50mm.
11. Consists of 5 vials with 10 capsules each of 4, 7 and 10 = 150 capsules. Each capsule makes 100 mL of buffer.
12 For use in samples with conductivity greater than 100 micro siemens.
13. For use in low conductivity samples in the range of 50 - 100 micro siemens.

Item 2.6.11 NANODAC Recorder / Controller (one unit)

nanodac

Recorder/Controller

The ultimate in graphical recording combined with PID control and setpoint programs

The nanodac™ recorder/controller offers the ultimate in graphical recording combined with PID control for a box of its size. The compact ¼ DIN panel mount unit offers four high accuracy universal inputs for data recording and PID control. This secure data recording device with accurate control is enhanced by a full colour, ¼ VGA display to bring a crystal clear operator interface to even the smallest of machines.

Crystal clear, colour display

The 3.5" TFT display offers incredibly clear visualisation of process parameters with a wide selection of configurable views to best suit the application. Views include: Horizontal and vertical trends, Horizontal and vertical bar graphs, Numeric, Alarm panel, Alarm status, and control loops. The unit also provides user wiring from the front of the product for detailed configuration without the need to connect to a PC.

Data Acquisition and Recording

The nanodac recording functionality utilises the secure strategies and UHH format developed by Eurotherm through years of recording expertise. As well as multiple real-time views and historical review on the product, multiple data archiving strategies are provided utilising the 50MB onboard Flash memory, removable USB and data transfer via FTP to a specified server. The four universal input channels provide high accuracy (suitable for use in Nadcap applications) and 125ms parallel sampling. An additional 30 virtual channels can be utilised to provide maths, counter, slave communications and totaliser functionality within the instrument.

- Secure data recording
- 2 PID control loops
- Dual programmer
- High accuracy universal inputs
- USB removable data storage facility
- Compact design
- 50MB flash memory
- Ethernet communications
- ¼ VGA crystal clear display
- 30 virtual channels
- Steriliser Application Block
- Relative Humidity Application Block
- Multiple I/O options
- Cascade with auto-tune
- Multi-language support (French, German, Italian and Spanish)
- Webserver

Eurotherm®

PID Control Loops

The nanodac instrument can also provide up to three independent control loops (optional). This control functionality utilises the advanced Eurotherm PID algorithm providing high performance and reliability to your process. Functionality includes one of the best autotune facilities available along with overshoot inhibition (cutbacks); compensation for power fluctuations using power feedforward; linear, fan, oil and water cooling.

Heat Treatment is one of the many processes that often need to vary the setpoint of the control process over a set period of time; this is achieved by using a set-point program. The nanodac offers an optional Dual Programmer supporting up to 100 programs locally, each program supporting 25 segments. The nanodac also provides remote access to a further 100 programs that can be easily retrieved via FTP or USB memory stick.

Specification

General

General

I/O types Analogue i/p:	Four/eight
Digital i/p:	Two
Digital (logic) o/p:	Two max (see order code)
Relay o/p:	Four max (see order code)
DC output:	Three max (see order code)
Features:	Modbus TCP master/slave (optional) USB configuration save/restore Programmer (optional) Two control loops (optional) Zirconia probe support (optional) 30 Virtual channels (each configurable as counter, maths, totaliser or comms input) Steriliser (optional) Relative humidity (optional) Customised start up screen EtherNet/IP*

Environmental performance

Ambient temperature range:		
	Operating:	0 to 55°C
	Storage:	–20 to +70°C
Humidity range	Operating:	5% to 85% RH non condensing
	Storage:	5% to 85% RH non condensing
Protection:	Front panel:	IP65
Front panel washdown:		IP66, NEMA 12 (International)
Behind panel:		IP10 (International)
Shock/Vibration: T		o BS EN61131-2 (5 to 150 Hz. at 1g; 1 octave per min.)
Altitude:		<2000 metres
Atmosphere:		Not suitable for use in explosive or corrosive atmospheres
Electrical safety:		BS EN61010-1 (Installation category II; Pollution degree 2)
Electromagnetic compatibility		
Emissions	(Standard units):	BS EN61326 Class B – Light industrial
	(Low voltage option):	BS EN61326 Class A – Heavy industrial
Immunity:		BS EN61326 Industrial

Other approvals and compliance details

General:	CE and cUL, EN61010
PV input:	AMS2750D compliant
RoHS EU;	China
Packaging:	BS61131-2 section 2.1.3.3.

Physical

Panel mounting:	1/4 DIN
Weight: Instrument only:	0.44kg (15.52ozs)
Panel cutout dimension:	92 mm x 92 mm (both -0.0 +0.8) or 3.62 in x 3.62 in (both -0.00 +0.03 in)
Depth behind panel:	90 mm (3.54 in) excluding wiring

Operator interface

Display:	3.5" TFT colour display (320 pixels wide x 240 pixels high)
Controls:	Four navigation pushbuttons below the display screen (Page, Scroll, Lower and Raise)

Power requirements

Supply voltage:	Standard:	100 to 230V ac ±15% at 48 to 62Hz
	Low voltage:	24V ac (+10% –15%) at 48 to 62Hz, or 24V dc (+20% –15%)
Power dissipation:		9W (max.)
Fuse type:		No internal fuse fitted
Interrupt protection:	Standard:	Holdup >10ms at 85V RMS supply voltage
	Low voltage:	Holdup >10ms at 20.4V RMS supply voltage

Battery backup

Stored data:	Time, date
Replacement period:	Three years typical
Clock (real-time clock) data:	
Support time:	Minimum of 1 year with unit unpowered
Temperature stability:	0 to 55°C ≤±3.5ppm
RTC Aging:	First year to 10 year <± 5ppm
Type:	Poly-carbonmonofluoride/lithium (BR2330) (PA260195)

Replace battery with Panasonic BR2330/BE only. Use of another battery may present a risk of fire or explosion. See owners manual for safety instructions.

Caution Battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

Ethernet communications

Type:	10/100baseT Ethernet (IEEE802.3)
Protocols:	Modbus TCP/IP master/slave, EtherNet/IP client/server
Cable type:	Category 5
Maximum length:	100metres (110 yards)
Termination:	RJ45. Green LED illuminated = link connected; Amber LED flashing shows link activity

USB port

Number of ports:	One at rear of instrument
Standard:	USB1.1
Transmission speeds:	1.5MBit/sec (low speed device)
Maximum current:	<100mA
Peripherals supported:	Memory stick (8GB max), Bar code reader, QWERTY keyboard

Update/Archive rates

Sample rate (input/output):	8Hz
Trend update:	8Hz max.
Archive sample value:	Latest value at archive time
Display value:	Latest value at display update time

Analogue Input

General

Number of Inputs:	Four/eight
Input types:	dc Volts, dc mV, dc mA, dual mA (external shunt required), dual mV, dual TC†, Thermocouple, RTD (2-wire and 3-wire), Digital (Contact closure)
Input type mix:	Freely configurable Sample rate: 8Hz (125ms) 4Hz (250ms) if dual input enabled
Conversion method:	16 bit delta sigma
Input ranges:	See Table 1 and Table 2
Mains rejection (48 to 62Hz)	
Series mode:	> 95dB
Common mode:	>179dB
Common mode voltage:	250V ac max.
Series mode voltage:	280mV at lowest range; 5V peak to peak at highest range
Input Impedance:	40mV, 80mV, 2V ranges > 100MΩ; 62.5kΩ for input voltages > 5.6V 667kΩ for input ranges < 5.6V
Overvoltage protection	
Continuous:	±30V RMS
Transient (<1ms):	±200V pk-pk between terminals
Sensor break detection Type:	ac sensor break on each input giving quick response with no associated dc errors
Recognition time:	<3 seconds
Minimum break resistance:	40mV, 80mV ranges: 5kΩ; other ranges: 12.5kΩ
Shunt (mA inputs only):	1Ω to 1KΩ mounted externally
additional error due to shunt:	0.1% of Input

Isolation:

Channel to Channel:	300V RMS or dc (Double insulation) **Note:** If Dual Channel mode enabled primary and secondary inputs are not electrically isolated from each other.
Channel to common electronics:	300V RMS or dc (Double insulation)
Channel to ground:	300V RMS or dc (Double insulation)
Dielectric strength Test:	BS EN61010, 1 minute type test
Channel to Channel:	2500V ac
Channel to Ground:	1500V ac

Low Range	High Range	Resolution	Maximum error (Instrument at 25°C)	Temperature Performance
–40mV	40mV	1.9µV	4.6µV + 0.053% of reading	13ppm of input per °C
–80mV	80mV	3.2µV	7.5µV + 0.052% of reading	13ppm of input per °C
–2V	2V	82µV	420µV + 0.044% of reading	13ppm of input per °C
–3V	10V	500µV	1.5mV + 0.063% of reading	45ppm of input per °C

Table 1 Voltage input ranges

Note: Restricted to 2000mV if dual input mode enabled

Resistance input ranges

Temperature scale:	ITS90
Types, ranges and accuracies:	See Table 3
Maximum source current:	200µA
Pt100 figures Range:	0 to 400Ω (–200 to +850°C)
Resolution:	0.05°C
Calibration error:	±0.31°C ±0.023% of measurement in °C at 25°C ambient
Temperaure coefficent:	±0.01°C/°C ±25ppm/°C measurement in °C from 25°C ambient
Measurement noise:	0.05°C peak-peak with 1.6s input filter
Linearity error:	0.0033% (best fit straight line)
Lead resistance:	0 to 22Ω matched lead resistances
Bulb current:	200µA nominal

Low Range	High Range	Resolution	Maximum error (Instrument at 25°C)	Temperature Performance
0Ω	400Ω	20mΩ	120mΩ + 0.023% of reading	25ppm of input per °C

Table 2 Ohms (RTD) input ranges

RTD Type	Overall range (°C)	Standard	Max. linearisation error
Cu10	–20 to +400	General Electric Co.	0.02°C
Cu53	–70 to +200	RC21-4-1966	0.01°C
JPT100	–220 to +630	JIS C1604:1989	0.01°C
Ni100	–60 to + 250	DIN43760:1987	0.01°C
Ni120	–50 to +170	DIN43760:1987	0.01°C
Pt100	–200 to + 850	IEC751	0.01°C
Pt100A	–200 to + 600	Eurotherm Recorders SA	0.09°C

Table 3 RTD type details

Thermocouple data

Temperature scale:	ITS90
CJC Types:	Off, internal, external, remote.
Remote CJC source:	Any input channel
Internal CJC error:	<1°C max., with instrument at 25 °C
Internal CJC rejection ratio:	40:1 from 25°C
Upscale/downscale drive:	High, low or none independently configurable for each channel's sensor break detection
Types, ranges and accuracies:	See Table 4

T/C Type	Overall range (°C)	Standard	Max. linearisation error
B	0 to +1820	IEC584.1	0 to 400°C = 1.7°C 400 to 1820°C = 0.03°C
C	0 to +2300	Hoskins	0.12°C
D	0 to +2495	Hoskins	0.08°C
E	–270 to +1000	IEC584.1	0.03°C
G2	0 to +2315	Hoskins	0.07°C
J	–210 to +1200	IEC584.1	0.02°C
K	–270 to +1372	IEC584.1	0.04°C
L	–200 to +900	DIN43710:1985 (to IPTS68)	0.02°C
N	–270 to +1300	IEC584.1	0.04°C
R	–50 to +1768	IEC584.1	0.04°C
S	–50 to +1768	IEC584.1	0.04°C
T	–270 to +400	IEC584.1	0.02°C
U	–200 to +600	DIN43710:1985	0.08°C
NiMo/NiCo	–50 to +1410	ASTM E1751-95	0.06°C
Platinel	0 to +1370	Engelhard	0.02°C
Mi/NiMo	0 to +1406	Ipsen	0.14°C
Pt20%Rh/Pt40%/Rh	0 to +1888	ASTM E1751-95	0.07°C

Table 4 Thermocouple types, ranges and accuracies

Relay and Logic I/O

O/P1, O/P2 and O/P3 logic I/O and relay specification

Active (current on) current sourcing logic output

(O/P1 or O/P2 only)

Voltage o/p across terminals:	+11V min.; +13V max.
Short circuit output current:	6mA min. (steady state); 44mA max. (switch current)

Inactive (current off) current sourcing logic output

(O/P1 or O/P2 only)

Voltage output across terminals:	0V (min.); 300mV (max.)
Output source leakage current into short circuit:	0µA (min.); 100µA (max.)

Active (current on) contact closure sourcing logic input

(O/P1 only)

Input current Input at 12V:	0mA (min.); 44mA (max.)
Input at 0V:	6mA min. (steady state); 44mA max. (switch current)
Open circuit input voltage:	11V (min.); 13V (max.)
Open circuit (inactive) resistance:	500Ω (min.); ∞ (max.)
Closed circuit (active) resistance:	0Ω(min.); 150Ω (max.)

Relay contacts

Contact switching power (resistive):	Max. 2A at 230V RMS ±15% Min. 100mA at 12V
Current through terminals:	2A

Digital Inputs

Dig InA and Dig InB contact closure logic input

Contact closure

Short circuit sensing current (source):	5.5mA (min.); 6.5mA (max.)
Open circuit (inactive) resistance:	600Ω (min.); ∞ (max.)
Closed circuit (active) resistance:	0Ω (min.); 300Ω (max.)

DC Output (option)

O/P1, O/P2, O/P3 DC analogue outputs

Current outputs

(O/P1, O/P2 and O/P3)

Output ranges:	Configurable within 0 to 20mA
Load resistance:	500Ωmax.
Calibration accuracy:	<±100µA ±1% of reading

Voltage outputs

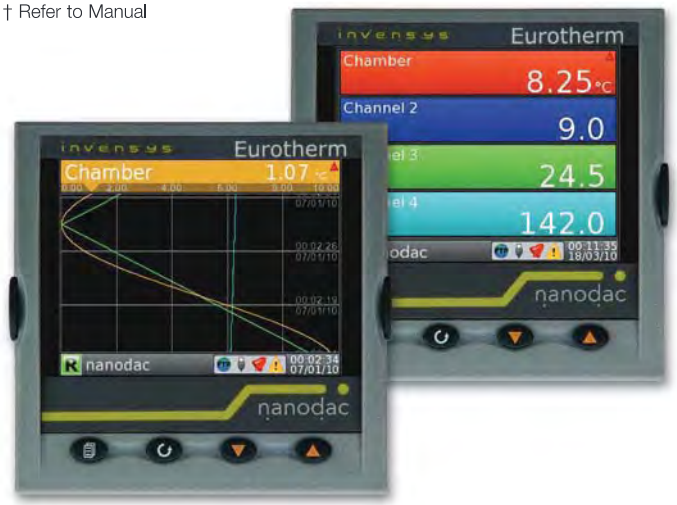
O/P3 only)

Voltage output across terminals:	0V (min.); 300mV (max.)
Output source leakage current into short circuit:	0µA (min.); 100µA (max.)

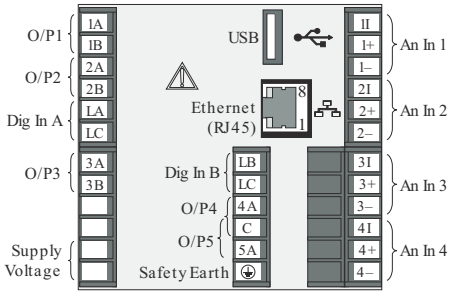
General

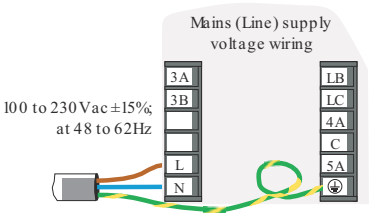
Isolation:	300V ac double insulated from instrument and other I/O
Resolution:	>11 bits
Thermal drift:	<100ppm/°C

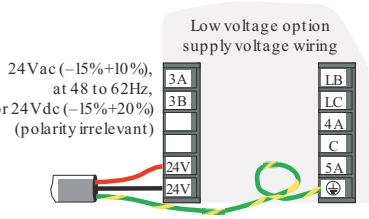
* Consult Factory
† Refer to Manual



Rear Terminals

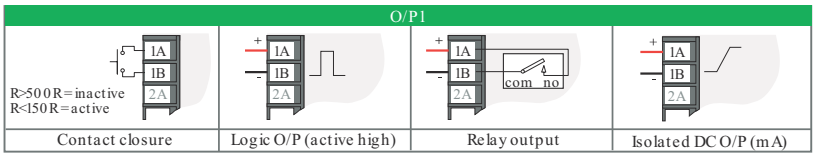


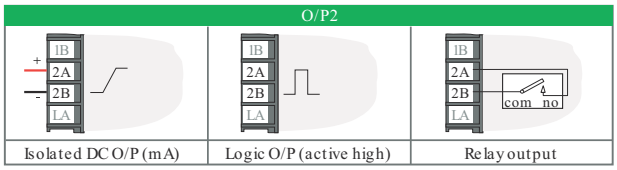




Termination details
The screw terminals accept wire sizes in the range:
Single wire 0.205 to 2.08 mm² (14 to 24 AWG) 2 wires 0.205 to 1.31 mm² (16 to 24 AWG) inclusive.

Screw terminals should be tightened to a torque not exceeding 0.4 Nm (3.54 lb in).

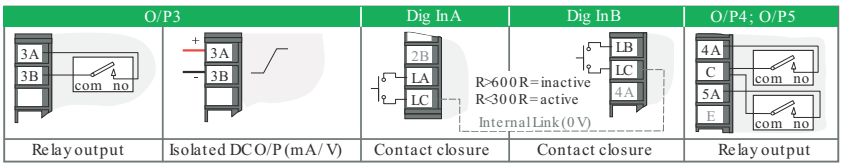


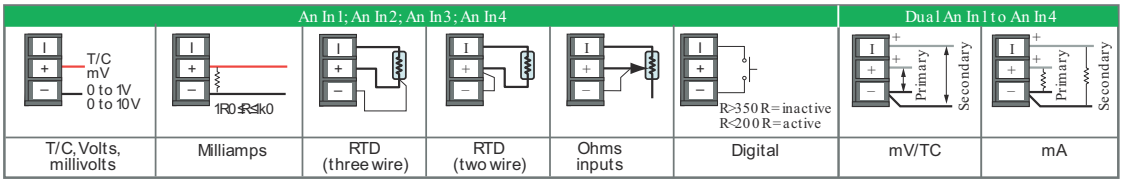


Use copper conductors only.

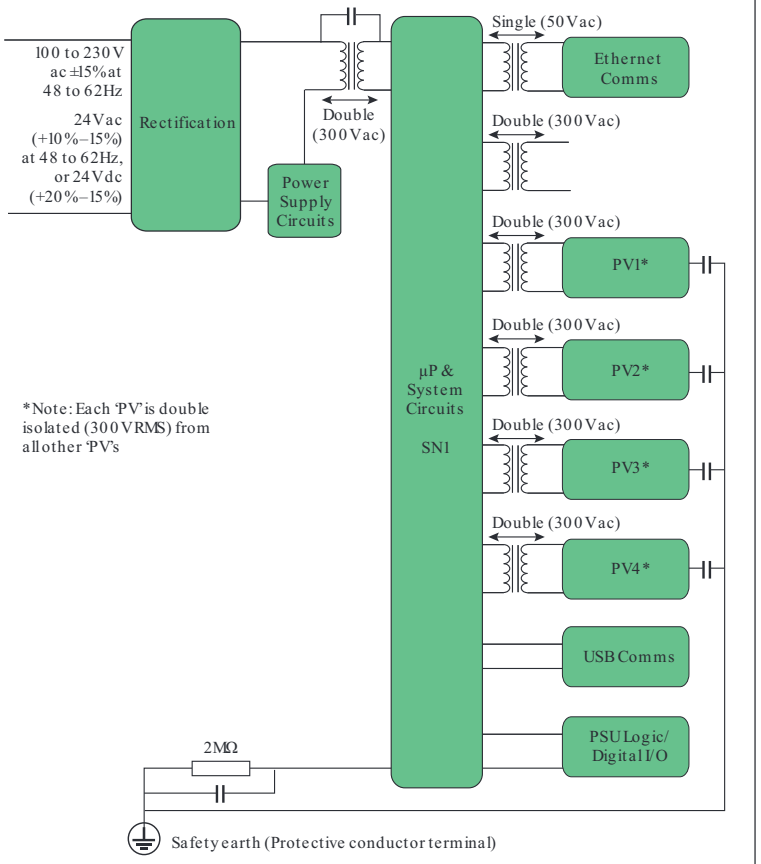
The power supply input is not fuse protected. This should be provided externally.

Each wire connected to LA, LB and LC must be less than 30 metres in length.

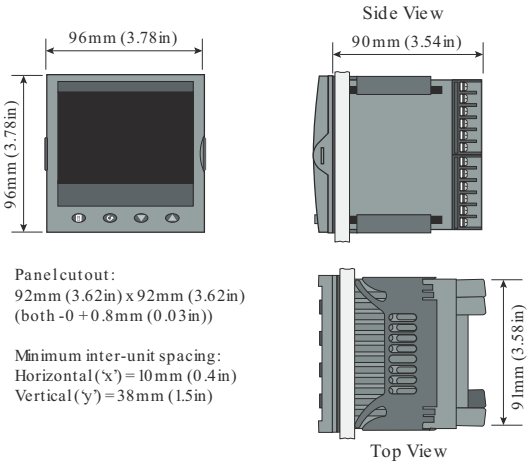




Isolation



Installation



Order Code

NANODAC	1	2	3	4	5	6	7

8	9	10	11	12	13	14

Basic Product

NANODAC	Graphical Recorder/ Controller

1 Supply Voltage

VH	100-230V ac ±15% at 48-62Hz
VL	24V ac (+10% –15%) at 48-62Hz, or 24V dc (+20% –15%)

2 Controller

X	None (default)
C	2 Control loops
A	Advanced control loop (includes 2 control loops)

3 Programmer

X	None (default)
P	Dual programmer

4 Output Options 1-2-3

LRR	Logic/Relay/Relay (default)
LRD	Logic/Relay/Iso DC output
LLR	Logic/Logic/Relay
RDD	Relay/Iso DC/Iso DC
DDD	Iso DC/Iso DC/Iso DC
LDD	Logic/Iso DC/Iso DC

5 Application Blocks

XX	None
ZC	Zirconia
RH	Humidity
ST	Steriliser

6 Communications Protocol

TS	Modbus TCP/IP slave (default)
TM	Modbus TCP/IP master
ES	EtherNet/IP* client/server
TE	Modbus TCP Master and EtherNet/IP*

7 Bezel

SV	Silver (standard)
WD	Wash down front*

* Consult Factory

8 Toolkit Blocks

XXXXX	None
BASIC	Basic toolkit blocks

9 Operating Language

ENG	English (default)
FRA	French
GER	German
ITA	Italian
SPA	Spanish

10 OEM Security

XXX	None
OEM	OEM Security enabled

11 Labels

XXXXX	No custom labels

12 Special

XXXXX	Default

13 Dual Input Channels

XX	None
05	5 inputs enabled
06	6 inputs enabled
07	7 inputs enabled
08	8 inputs enabled

14 Dual Thermocouple Support

XXX	None
TC	Dual T/C support enabled

ProMinent®

Operating Instructions Manual

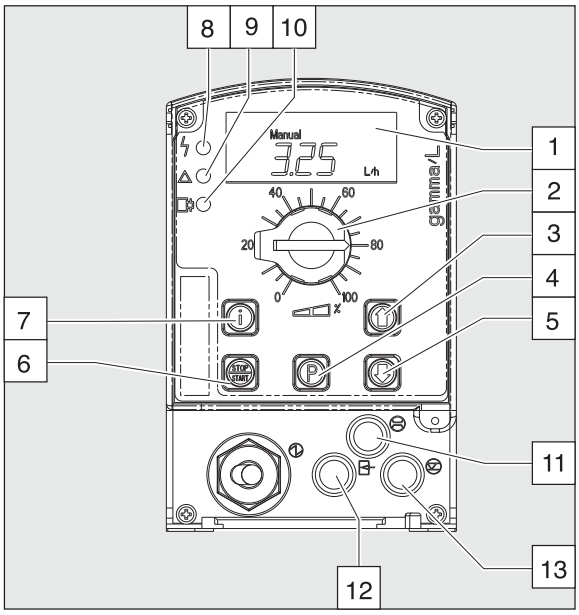
ProMinent® gamma/ L
Solenoid Metering Pump

GALA ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Please enter ident code of the device here

Please read the operating instructions through completely before commissioning this equipment! Do not discard!
Any part which has been subject to misuse is excluded from the warranty!

Control elements: overview



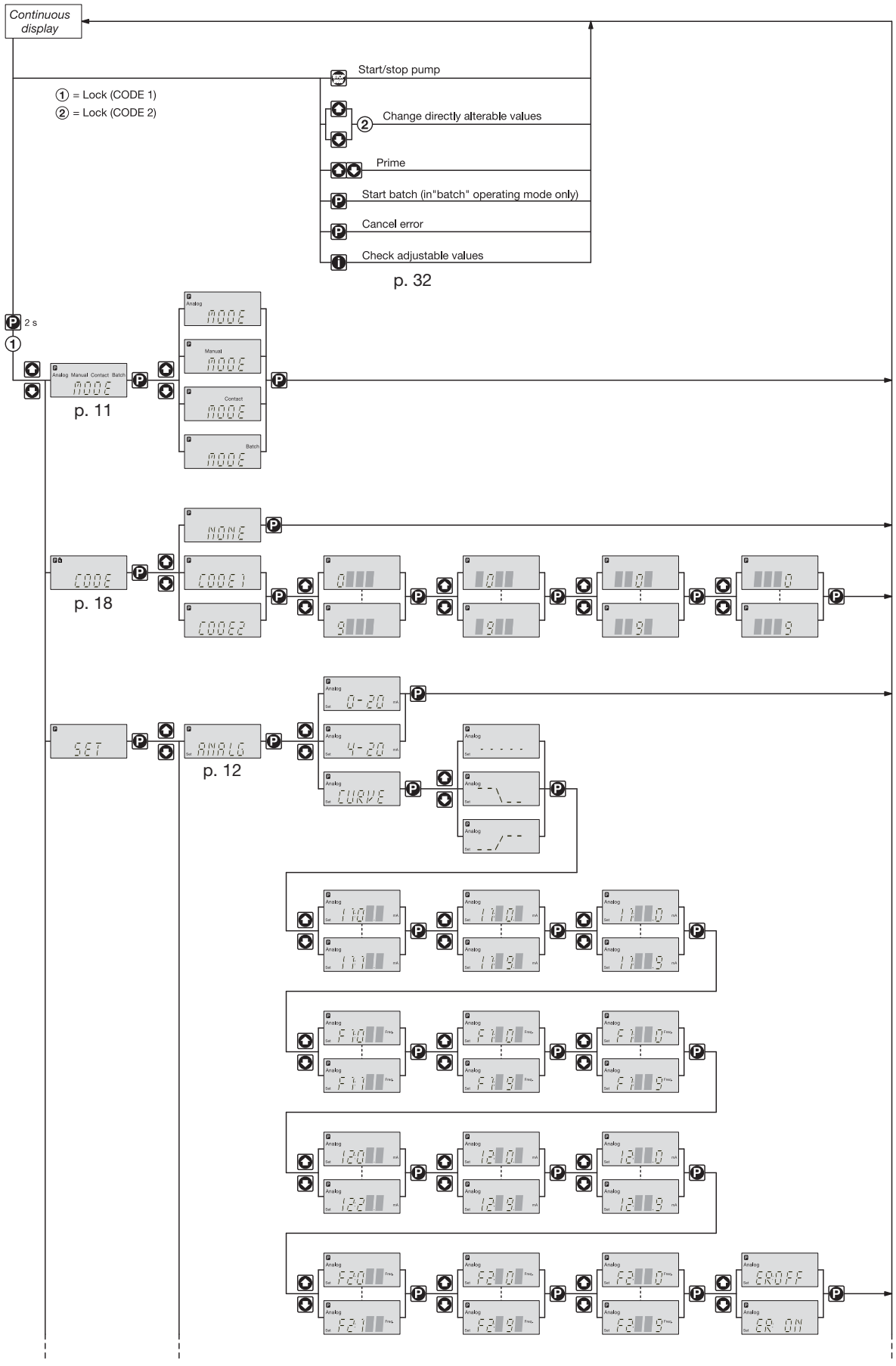
1 LCD display
2 Stroke length adjusting knob
3 UP key
4 P key
5 DOWN key
6 STOP/START key
7 i key
8 Fault indicator (red)
9 Warning indicator (yellow)
10 Operating indicator (green)

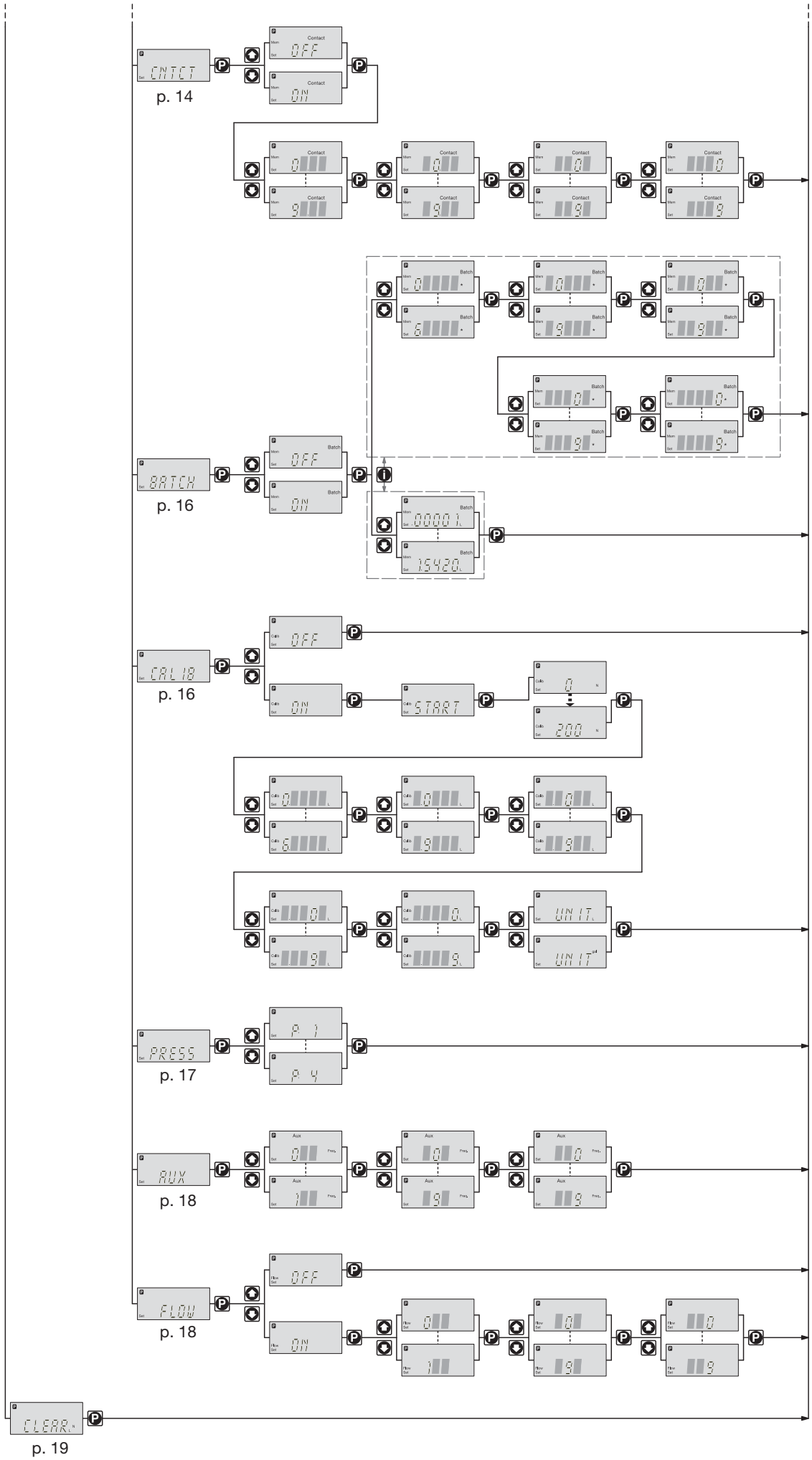
11 “Dosing monitor” terminal
12 “External control” terminal
13 “Float switch” terminal

Key functions

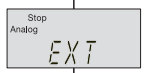
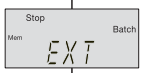
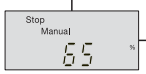
	In continuous display mode (operating)	In settings mode (settings)
STOP/START key		
Press briefly	Stop pump, start pump	Stop pump, start pump
P key		
Press briefly	Start batch (in “batch” operating mode only), Cancel error	Confirm entry- jump to next menu option or continuous display
Press for 2 s	Change to settings mode	---
Press for 3 s	---	Jump to continuous display
Press for 10 s	Display software version	---
Press for 15 s	Load factory settings (calibration)	---
Touche i		
Press x1	Toggle between continuous displays	Toggle between “change individual digits” and change a figure”
Press x2	---	For “change individual digits”: jumps to first digit
Arrow keys UP and DOWN		
Press x1 (until “Set” appears)	Change directly alterable values	Select other settings, change individual digit or figure
Press simultaneously	Prime	---

Operating-/Settings Diagram




CNTCT
Contact
OFF
ON
p. 14
BATCH
Batch
OFF
ON
p. 16
CALIB
Calib
OFF
ON
START
p. 16
PRESS
P. 1
P. 4
p. 17
AUX
Aux
p. 18
FLOW
Flow
OFF
ON
p. 18
CLEAR
p. 19

Continuous display

Continuous display	Operating mode "**Analog**" 0-20 mA	Operating mode "**Manual**"	Operating mode "**Contact**" with memory and tansfer factor 5	Operating mode "**Batch**" with memory and tansfer factor 5
Stroke rate				
Feed rate				
Total stroke number				
Total litres (feed quantity)				
"External" display				
Signal current				
Strokes remaining				
Batch size/ Litres remaining				
Factor				
Stroke length				

⏣⏣ = UP and/or DOWN arrow keys, directly alterable values

"Mem" appears only when "memory" function activated

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Identcode

Please enter the identity code on the device label into the grey box below

GALA — **GALA Series gamma/ L, version a**

Type	Capacity bar	Capacity l/h	
1000	10	0.74	Solenoid Ø 70/M70
1601	16	1,1	
1602	16	2.1	
1005	10	4.4	
0708	7	7.1	
0413	4	12.3	
0220	2	19.0	
1605	16	4.1	Solenoid Ø 85/M85
1008	10	6.8	
0713	7	11.0	
0420	4	17.1	
0232	2	32.0	

Material version:

PPE	Polypropylene/EPDM
PPB	Polypropylene/FPM
NPE	Acrylic glass/EPDM
NPB	Acrylic glass/FPM
PVT	PVDF/PTFE
TTT	PTFE/PTFE
SST	Stainless steel 1.4571/PTFE

Liquid end version:

0	Non-bleed, no valve spring, for NP, TT and SS only
1	Non-bleed, with valve spring, for NP, TT and SS only
2	Bleed function, no valve spring for PP, NP, PV, not type 0232
3	Bleed function, no valve spring for PP, NP, PV, not type 0232
4	No-vent with valve springs for highly viscous media
9	Self bleed function, for PP, NP, not for type 1000 and 0232

Hydraulic connection:

0	Standard connector as indicated in technical data
5	12/6 hose connector, pressure side only
9	10/4 hose connector, pressure side only

Version:

0	With ProMinent® logo

Power supply:

U	100 - 230 V, ±10 %, 50/60 Hz
M	12...24 V DC (only M 70)
N	24 V DC (only M 85)
P	24 V AC

Cable and plug:

A	2 m Euro
B	2 m Swiss
C	2 m Australian
D	2 m USA
1	2 m open end

Relay:

0	No relay
1	Fault indicating relay, (N/C) changeover relay
3	Fault indicating relay, (N/O) changeover relay
4	As 1 + pacing relay, (1 input each)
5	As 3 + pacing relay, (1 input each)

Accessories:

0	No accessories
1	Foot and dosing valve,, 2 m PVC suction tube, 5 m PE discharge tubing, PP, PC, and NP only
2	As 0 + calibrating cylinder
3	As 1 + calibrating cylinder

Control variants:

0	Manual + external 1:1
1	Manual + external with pulse control
2	Manual + external 1:1 with analogue current
3	Manual + external with pulse control + analogue current
4	as 0 + timer
5	as 3 + timer
P	as 3 + Profibus®

Access code:

0	No access code
1	Access code

Dosing monitoring:

0	Pulse input
1	Input for continuous contact

Pause/level:

0	Pause N/C level N/C

FPM = Fluorkautschuk

GALA ____ _ _ _ _ _ _ _ _ _ _ _ _ _

General User Guidelines

Please read through the following user Guidelines. Familiarity with these points ensures optimum use of the operating instructions.

On the fold-out page after the title page you will find the overviews “control elements and key functions” and “operating/settings diagrams”.
You will find it useful to open out the “control elements and key functions” overview as you read this instruction manual.

Key points in the text are indicated as follows:

- Enumerated points

▶ Hints

Working Guidelines:

NOTE

Guidelines are intended to make your work easier.

Safety Guidelines:

WARNING

Describes a potentially dangerous situation.
Could result in loss of life or serious injury if preventative measures are not taken.

CAUTION

Describes a potentially dangerous situation.
Could result in lesser injuries or damage to property if preventative measures are not taken.

IMPORTANT

Describes a potentially threatening situation.
Could result in damage to property if preventative measures are not taken.

The name plate affixed to the title page is identical to that on the gamma/ L pump supplied. This facilitates matching the correct operating instructions manual to the correct pump.

Please quote the identity code and the serial number, which you will find on the name plate, in any subsequent correspondence or when ordering spare parts. This will ensure accurate identification of the pump type and material version.

1 About This Pump

The pumps in the ProMinent® gamma/ L pump series are microprocessor controlled solenoid dosing pumps with the following special features:

- The feed rate can be displayed in l/h and/or gal/h (calibrated), or in strokes/min.
- The stroke rate is continuously adjustable and is displayed in the LCD display.
- Stroke rate adjustment is digitally accurate and is displayed in the LCD display.
- The rated pressure of the gamma/ L can be adapted to individual systems.
- Two pumps can be controlled in different ways via the same standard signal.
- Large, illuminated LCD display

The hydraulic parts of the gamma/ L are identical to those of the Beta®.

2 Safety

Correct use

The gamma/ L must be used for liquids only!
The gamma/ L may be used only in compliance with the technical data and specifications given in the operating instructions!
It is forbidden to use the gamma/ L for any other purpose, or to modify it in any way!
The gamma/ L is not suitable for dosing gases or solids!
The gamma/ L must be used by trained and authorised personnel only!
You must take notice of the information in the operating instructions concerning the various stages in the lifecycle of the device.

Safety Guidelines

WARNING

- **As soon as the gamma/ L is connected to the electricity supply it may commence pumping!**
  Avoid leakage of hazardous chemicals in this case!
  If this should occur, then press the STOP/START key or disconnect the gamma/ L from the power supply immediately!
- **The gamma/ L cannot be switched to a current-free status! In the event of an electrical accident, disconnect cable from the mains power supply!**
- **Disconnect cable from the mains power supply before commencing work on the gamma/ L!**
- **Always depressurise liquid end before commencing work on the gamma/ L!**
- **Empty and rinse out the liquid end before commencing work on the gamma/ L after use with hazardous or unknown chemicals!**
- **Pumps for radioactive materials may not be returned to ProMinent after use!**

CAUTION

- **It is not permitted to assemble and install ProMinent® dosing pumps with non-original parts unless these have been checked and recommended by ProMinent. It can result in harm to persons and property for which no liability will be accepted!**
- **When dosing aggressive materials, check the resistance of the pump materials (see ProMinent® resistance list in the product catalogue!)**
- **If another liquid end size is installed the pump must be reprogrammed on factory premises!**
- **Observe applicable national directives during installation!**

Sound intensity level

The sound intensity level is < 70 dB (A) at maximum stroke, maximum stroke rate, maximum back pressure (water) in accordance with:
DIN EN 12639 (Metering Pump Noise Measurement)

3 Storage, Transport and Unpacking

Transport and store the gamma/ L in the original packaging!

Protect the packed gamma/ L from moisture and the effects of chemicals!
Environmental conditions for storage and transport:
Storage and transport temperature: -10 bis +50 °C
Humidity: < 92 % relative humidity

Check that the delivery is complete:

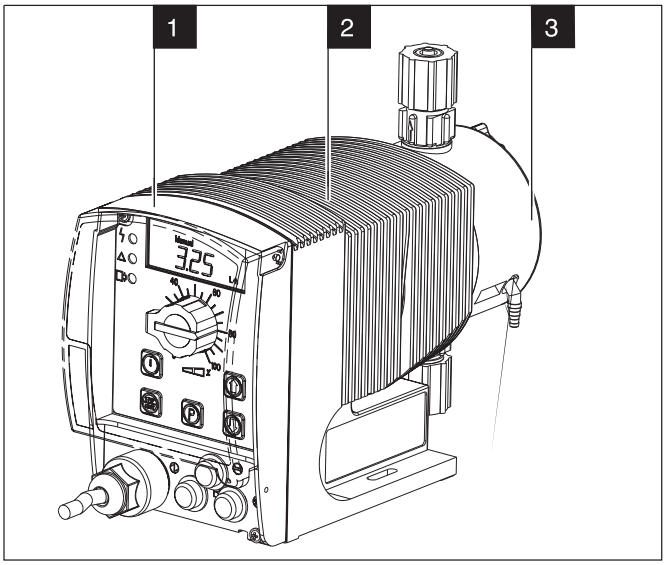
Delivery range

- Dosing pump with mains lead
- Operating instructions manual with EU conformity declaration
- Accessories if applicablesecteur

4 Device Overview and Control elements

When reading this section it is helpful to fold out the overview “Control elements and key functions”!

4.1 Device overview



1 Control unit
2 Power end
3 Liquid end

Fig. 01

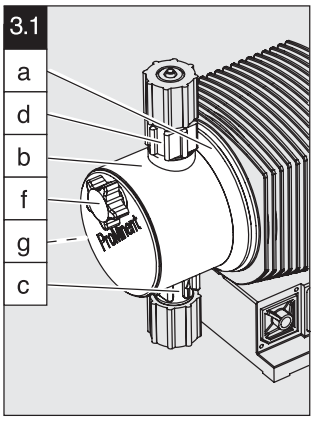


Fig. 02

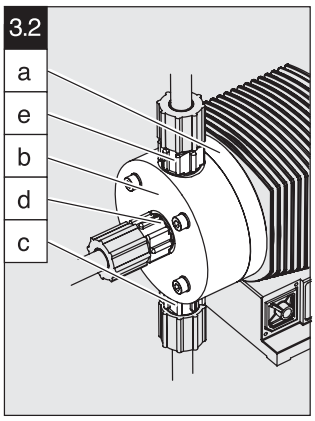


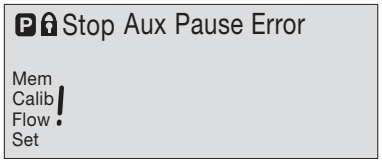
Fig. 03

a Backplate
b Liquid end
c Suction valve
d Discharge valve
e Bleed valve
f Coarse/fine bleed valve
g Bypass hose nozzle

4.2 Control elements

Please acquaint yourself with the gamma/ L control elements with the help of the “control elements and key functions” overview!

Indicators The LCD display supports the operation and setting of the gamma/ L with a range of indicators:



The indicators are interpreted as follows:

Symbol for P key:	The gamma/ L is in settings mode.
Close symbol:	In a continuous display: lock (if code has been set). In settings mode: indicates access to code menu.
Stop:	The gamma/ L has been stopped using the STOP/START key.
Aux:	The gamma/ L is pumping at the auxiliary frequency. In AUX menu: the gamma/ L is in the AUX menu.
Pause:	The gamma/ L has been stopped using the “pause” function (external).
Error:	A fault has occurred and the pump has been stopped.
Auto:	The gamma/ L is in “Auto” operating mode. Depending on the Identcode this means that the gamma/ L can be controlled using PROFIBUS® or the timer (as a comparison see the relevant supplementary instructions).
Mem:	An additional “memory” function has been set in the “contact” and “batch” operating modes. In CNTCT or BATCH menus (“mem” flashes): the memory function can be set
Calib:	The gamma/ L is in the CALIB menu. In a continuous display (“calib” flashes”): Deviation in stroke length of more than 10 degrees (e.g. a stroke length of 40 % when set at less than 30 % or greater than 50 %) from the value at the time of calibration.
Flow:	The gamma/ L is in the FLOW menu.
Set:	The gamma/ L is in the SET menu.
Command symbol:	The number of strokes reached is above the maximum value (99999) that can be shown in the LCD display

NOTE

The pump gamma/ L only displays the metering output in l or l/h or in gal or gal/h when calibrated.

5 Function Description

Function principle Dosing takes place as follows: the dosing diaphragm is forced into the liquid end; the pressure in the liquid end causes the suction valve to close and the chemical flows out of the liquid end through the discharge valve. The dosing diaphragm is then forced back out of the liquid end. The vacuum in the liquid end causes the discharge valve to close and fresh chemical flows into the suction valve in the liquid end. This concludes one operating cycle.

The dosing diaphragm is driven by an electronically controlled electrical solenoid.

Feed rate The feed rate is determined by the stroke length and the stroke rate.
The stroke length is set between 0 - 100 % using the stroke length adjusting knob.
Optimum dosing reproducibility is achieved by setting the stroke length to between 30 - 100 % (SEK type: 50 - 100 %)!
The stroke rate is set using the arrow keys (not in “analogue” operating mode) to between 0 - 180 strokes/min.

Self-bleed function Pumps with self-bleed function (= SEK types) can operate a prime action even when the discharge tubing is closed, discharging existing air through a bypass valve. These pumps can release gas even during operation, irrespective of the actual operating pressure.
An in-built pressure maintenance valve allows accurate dosing even in depressurised states.

Operating modes Operating modes are selected using the MODE menu (depending upon identity code, some operating modes may be absent).

“Analog” operating mode: (Identity code, control variant: analogue current)

The stroke rate is controlled via an analogue electrical signal via the “external control” terminal. Signal processing is pre-selected at the controller.

“Manual” operating mode: (Identity code, control variant: manual, standard function)

The stroke rate is controlled manually via the controller.

“Contact” operating mode:
(Identity code, control variant: external 1:1 / external with pulse control)

This operating mode offers the opportunity to make fine adjustments with small increase/ decrease factors. Dosing can be activated by a pulse via the “external control” terminal or by a semiconductor element. With the “pulse control” option it is possible to pre-set a feed quantity (batch) or number of strokes (factor 0.01 to 99.99) via the control unit.

“Batch” operating function:
(Identity code, control variant, external 1:1 / external with pulse control)

This operating mode offers the option of working with larger transfer factors (up to 65535). Metering can be triggered by pressing the P key or a pulse from the “external control” terminal via a contact or semiconductor element.
A batching quantity or number of strokes can be pre-selected via the control unit.

Operating mode “PROFIBUS®”: (Identcode, control variant: profibus®)

This operating mode offers the possibility to control the pump via PROFIBUS® (see “supplemental instructions for ProMinent gamma/ L and ProMinent Sigma versions with “PROFIBUS®”).

Functions The following functions can be selected using the SET menu:

“Calibrate” function:
The gamma/ L can be operated in all operating modes including in calibrating mode.
The corresponding continuous displays can show the actual feed quantity or the feed rate.
Calibration is maintained within the stroke frequency range 0 - 180 strokes/min.
Calibration is also maintained when a stroke frequency is altered up to ±10 %.

“Pressure level” function:
It is possible to set different pressure levels.

“Auxiliary frequency” function:
It is possible to set a stroke rate in the SET menu, which may be activated via the “external control” terminal. This auxiliary frequency overrides all other pre-set stroke rate frequencies.

“Flow” function:
Stops the gamma/ L when the flow is insufficient.
In the SET menu, the number of failed strokes is entered after which the pump will be turned off.

The following functions are available as standard:

“Float switch” function:
Information on the liquid level in the feed chemical container is transmitted to the gamma/ L. This option requires the installation of a 2-stage float switch. This is connected to the “float switch” terminal.

“Pause” function:
The gamma/ L can be stopped by remote control via the “external control” terminal.
The “pause” function operates only via the “external control” terminal.

The following functions are activated by keystrokes:

“Stop” function:
The gamma/ L can be stopped by pressing the STOP/START key without disconnecting from the mains power supply.

“Prime” function:
Priming (short term feed at maximum frequency) is activated by pressing both arrow keys at the same time (in “Stroke rate” permanent display).

Optional relay

The gamma/ L has two connection options.de deux options :

“Fault indicating relay” option:
In the event of fault signals, warning signals or float switch activation signals, connects an electrical circuit to trigger alarm sirens etc. The relay is retrofitted via an aperture in the power end.

“Fault indicating and pacing relay” option:
Along with the fault indicating relay, the pacing relay produces a contact for every stroke.
The relay is retrofitted via an aperture in the power end.

Function and error indicators

The operating and error status is shown via the three LEDs and the “error” indicator on the LCD (see also section 11):

LCD indicator

If a fault occurs “error” will appear along with an additional fault warning.

LED indicator

Operating indicator (green)
This indicator is lit as long as the gamma/ L is operating correctly.
It stops briefly with each stroke.

Warning indicator (yellow)
This warning light appears if the gamma/ L electronics detect a situation that could lead to a fault, e.g. “liquid levels low 1st stage”.

Warning indicator (red)
This warning light appears if a fault occurs, e.g. “liquid levels low 2nd stage”.

Hierarchy of operating modes, functions and fault statuses

The different operating modes, functions and fault statuses each have a differing effect on whether and how the gamma/ L functions. These effects are given below:

1. **Prime**
2. **Fault, stop, pause**
3. **Auxiliary frequency**
4. **Manual, analogue, contact, batch**

to:

1. “Prime” can take place in the permanent “Stoke rate” display in any pump mode (as long as it is operational).
2. “Fault”, “stop” and “pause” stop all system parts up to “prime”.
3. The stroke frequency of the “auxiliary frequency” always has precedence over the stroke frequency, which is set by an operating mode listed under 4.

6 Assembly and Installation

WARNING

- **Installation must be carried out by a trained engineer!**
- **Disconnect gamma/ L from mains power supply during installation!**
- **Risk of electric shock – This pump is supplied with a grounding conductor and grounding-type attachment plug. To reduce the risk of electric shock, be certain that it is connected only to a properly grounding-type receptacle.**
- **Observe applicable national directives when installing the dosing pumps!**
- **When connecting with parallel inductive power consumers a switch contact must be fitted, e.g. relay or contactor!**

IMPORTANT

The universal signal cable, the external/connecting cable and the liquid level monitoring cable should never be shortened to less than 1.20 m, otherwise the cable identification system will fail.

Connection to mains power supply

Connect the gamma/ L to the mains power supply using the mains lead

Parallel connection to inductive power consumers

If the gamma/ L is connected to the mains in parallel with inductive power consumers (e.g. solenoid valve, motor) they must be electrically isolated. This will avoid damage caused by induction and voltage surges when switching off.

▶ Fit individual contacts for the gamma/ L and supply power via auxiliary contactor or relay.

If this is not possible, then:

▶ Connect a varistor in parallel (order number 710912) or an RC circuit, 0.22 µF/220 Ω (order number 710802).

Power element (in base of pump)

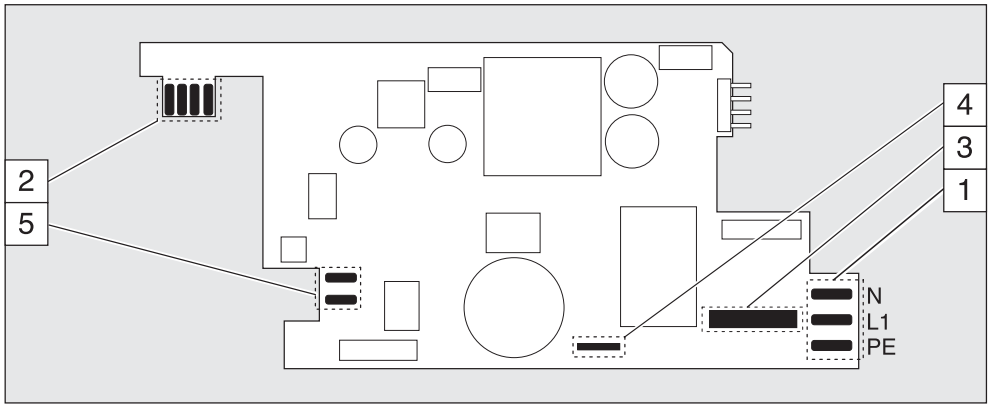


Fig. 04

1 Mains terminal
2 Relay circuit terminal
3 Fuse
4 Solenoid earth lead terminal
5 Solenoid terminal

"External control" terminal

The "external control" terminal is a five pin in-built terminal. It is compatible with the two and four core cables used previously.
The "auxiliary frequency" function is only available with a five core cable.

gamma/ L configuration

Electrical interface for “external contact” - “pause” - “auxiliary frequency”:

- tension contacts ouverts : env. 5 V
- Voltage when contacts open: approx. 5 V
- Input resistance: 10 kΩ
- Control: voltage free contact (load: 0.5 mA at 5 V),
  or: Semiconductor switch (residual voltage < 0.7 V)
- Maximum pulse frequency: 25 pulses/s
- Required pulse duration: ≥ 20 ms

Electrical interface for “external analogue”:

- Input load resistance: approx. 120 Ω
- Maximum current at input: 50 mA

gamma/ L configuration

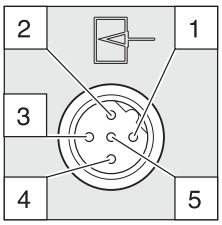


Fig. 05

Pin	Function	2 core cable	4 core cable	5 core cable
Pin 1	Pause	Jumped at pin 4	Brown	Brown
Pin 2	External contact	Brown	White	White
Pin 3	External analogue	–	Blue	Blue
Pin 4	Earth	White	Black	Black
Pin 5	Auxiliary frequency	–	–	Grey

Plug configuration

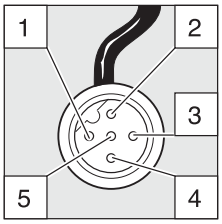


Fig. 06

“Pause” function

The gamma/ L is not operating when
- The cable is connected and pins 1 and 4 are free.

The gamma/ L is operating when
- The cable is connected and pins 1 and 4 are connected.
- There is no cable connected (pin 1 is free).

“Contact” and “Batch” operating modes

One or more discharge strokes are triggered when pin 2 and pin 4 are connected to one another for at least 20 ms.
Otherwise, pin 1 and pin 4 must be connected.

“Analogue” operating mode

The stroke frequency of the gamma/ L is controlled via an electrical signal. The electrical signal is applied between pins 3 and 4.
Otherwise, pin 1 and pin 4 must be connected.

“Auxiliary frequency” function

The gamma/ L runs at a pre-set stroke rate when pin 5 and pin 4 are connected to one another.
Otherwise, pin 1 and pin 4 must be connected.

The factory setting for this function is 180 strokes.

NOTE

For function and operating mode hierarchy, see section 5!

Connecting two gamma/ L pumps in series

Connect two gamma/ L pumps in series as follows if you wish to control both via **one** electrical signal in the “analog” operating mode (see section 7.4.2):

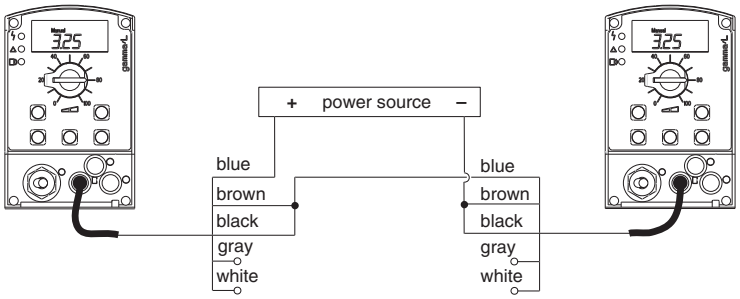


Fig. 07

“Float switch” terminal gamma/ L configuration

Optional fitting of a 2-stage float switch with prior warning and limit switch capacity.

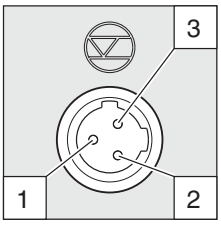


Fig. 08

Electrical interface:

- Voltage when contacts open: approx. +5 V
- Input resistance: 10 kΩ
- Controller: voltage free contact (load: 0.5 mA at + 5V),
  or: semiconductor switch (residual voltage < 0.7 V)

Plug configuration

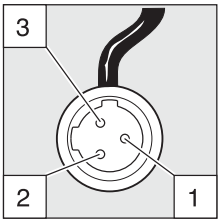


Fig. 09

Function		**3 core cable**
Pin 1	Earth	black
Pin 2	Minimum prior warning	blue
Pin 3	Minimum limit switch	brown

“Dosing monitor” terminal gamma/ L configuration

Optional connection of dosing monitor.

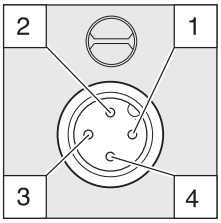


Fig. 10

Electrical interface:

- Voltage when contacts open: approx. +5 V
- Input resistance: 10 kΩ
- Controller: voltage free contact (load: 0.5 mA at +5 V)

Plug configuration

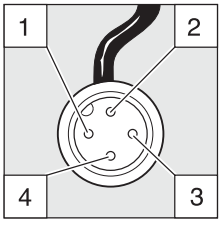


Fig. 11

Function		**4 core cable**
Pin 1	Power supply (5V)	brown
Pin 2	Encoding	white
Pin 3	Response	blue
Pin 4	Earth	black

Relay

"Fault indicating relay" output

A fault indicating relay may be ordered optionally. It is used as the signal output when a pump fault has been detected and to indicate the prior warning signal "liquid level low, stage 1" and the fault signal "liquid level low, stage 2".
Allocation of signal types to "N/O" and "N/C" relay states is selected on the basis of the identity code descriptors.
The relay can be retrofitted and is ready to operate after inserting the relay component (see section 6.2).

The gamma/ L is delivered ex works with default settings for a N/C relay. If an alternative switch function is required the gamma/ L can be reprogrammed at ProMinent.

Electrical interface

- Contact load: 250 V/2 A 50/60 Hz
- Operating life: > 200.000 switch cycles

"Fault indicating relay and pacing relay" output

A fault indicating relay and pacing relay output may be ordered optionally. The pacing relay output is electrically isolated via an optical coupler with a semiconductor switch. The second switch is a relay as for the "fault indicating relay" variant.
The fault indicating / pacing relay can be retrofitted (see section 6.2).

The gamma/ L is delivered ex works with default settings for a N/C fault indicating relay and a N/O pacing relay. If an alternative switch function is required the gamma/ L can be reprogrammed at ProMinent.

Electrical interface

For semiconductor switch

- Residual voltage: < 0,4 Volt at I_C = 1 mA
- Maximum voltage: < 100 mA
- Maximum current: 24 V/DC
- Pacing relay pulse duration: approx. 100 ms

For relay output

- Contact load: 24 V/100 mA 50/60 Hz
- Operating life: > 200.000 switch cycles

Relay cable contact configuration

"Fault indicating relay" option

VDE cable	CSA cable	Contact
white	white	NO (normally open)
green	red	NC (normally closed)
brown	black	C (common)

"Fault indicating relay and pacing relay" option

VDE cable		Contact	Relay
yellow	NO (normally open)	Fault indicating relay	
green	C (common)	Fault indicating relay	
white	NO (normally open)	Pacing relay	
brown	C (common)	Pacing relay	

6.1 Retrofitting relays

Delivery range:

1 relay circuit set with 2 screw fasteners
1 relay cable set with socket
1 seal

Press-out relay opening

WARNING

Disconnect gamma/ L from the mains power supply and rinse liquid end before commencing work (see section 12)!

IMPORTANT

When preparing the opening, ensure that the punch is not forced through the entire pump base!
Pump circuits may become damaged.

- ▶ Place the gamma/ L on a firm surface with the relay opening press-out section at the top (see fig. 12:a)
- ▶ Place a punch (dia. 8-15 mm) in the centre of the relay opening press-out section, and strike briefly and sharply with a hammer (approx. 250 g)
- ▶ If necessary clean up the edges of the opening
- ▶ Remove the pressed out section from the gamma/ L

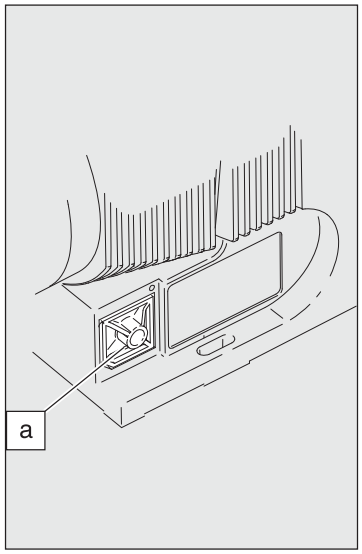


Fig. 12

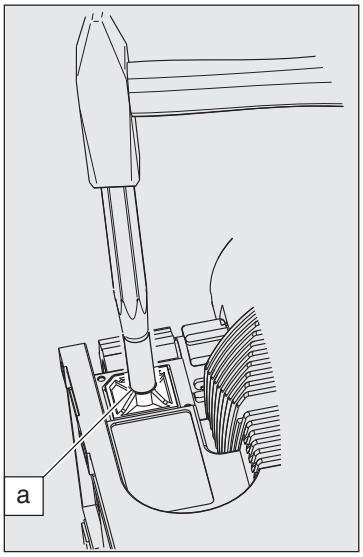


Fig. 13

Inserting the relay component

- ▶ Hold the relay component with your right hand gripping the left and right hand edges of the relay cover, and tilt the front end slightly to the left (see fig. 14)
- ▶ Push the relay component through the relay opening, holding the upper corner of the lower edge against the guide rail on the pump base, until the contact of the relay component has reached the controller contact. (See fig. 15: test: can you still move the end of the circuit back and forth?)
- ▶ Gently push the relay component right into the opening.
- ▶ Screw the relay cover firmly onto the housing using the screws provided.
- ▶ Insert the relay cable plug seal into the relay cover and screw on the plug (see fig. 16)

The gamma/ L is delivered ex works with default settings for a N/C fault indicating relay and a N/O pacing relay. If an alternative switch function is required the gamma/ L can be reprogrammed at ProMinent.

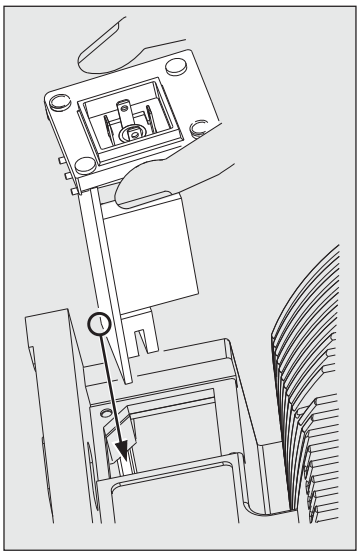


Fig. 14

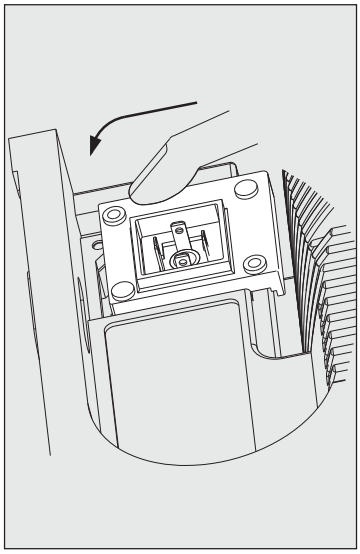


Fig. 15

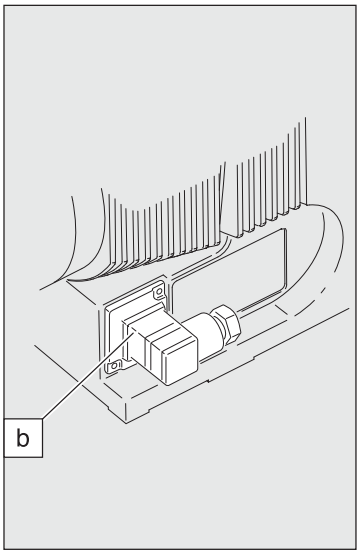


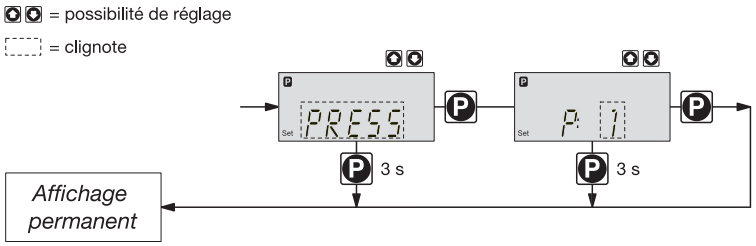
Fig. 16

7 Settings

NOTE

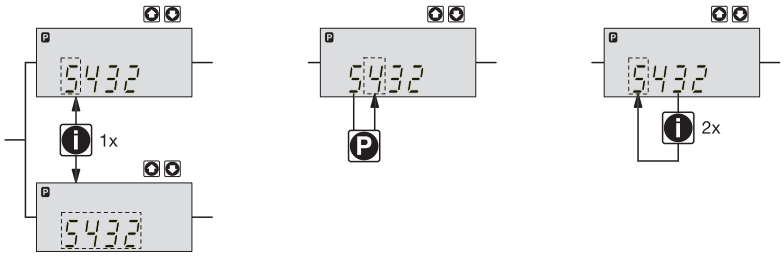
- **Open out the fold-out page following the title page fully! There you will find the overviews “control elements and key functions” and “operating/settings diagram”.**
- **If no keys are pressed within a period of 1 minute, the gamma/ L will return to a continuous display.**

Basic information for setting up the gamma/ L



Confirm entries Press the P key briefly;
you will automatically move to the next menu option or to a continuous display.

Exit menu option without confirming Press the P key for 3 s:
The entry is cancelled and you will return to a continuous display.



Incremental change lof a value Press the i key 1x;
you can toggle between altering the digits of a value (“change individual digits” = standard) or incremental alteration of a value (“change a figure”).

Change adjustable values Press UP or DOWN arrow key;
The flashing digit or figure will start to increase or decrease incrementally.

Confirm adjustable values For “change individual digits”: confirm each digit using the P key. When the last digit has been confirmed you will automatically move to the next menu option or to a continuous display.

For “change a figure”; press the P key 1x; you will simultaneously move to the next menu option or to a continuous display.

Correct wrongly set digits Press the i key 2x;
you will go back to the first digit.

7.1 Check adjustable values

Before setting up the gamma/ L you can check the current settings of adjustable values.

Press the i key (“i” as in “info”) when the gamma/ L is in continuous display mode (There is no P key symbol in the LCD display):

Each time you press the i key you will see a different continuous display. The number of continuous displays depends upon the identcode, the selected operating mode and the connected accessories (see overview “continuous displays”).

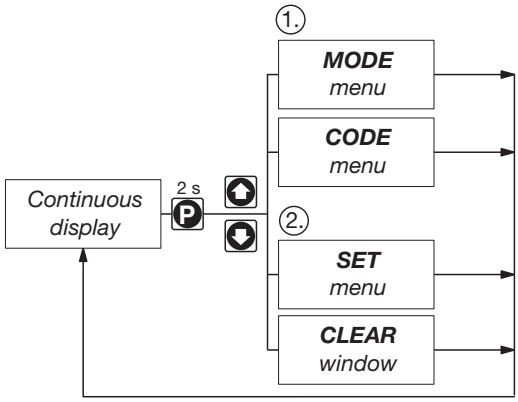
7.2 Change to settings mode

If you hold down the P key for 2 seconds in any continuous display, the gamma/ L will change to the settings mode.
If CODE 1 is set, the code must be entered after pressing the P key.

The following menu options appear first in the settings mode (see also overview “operating/ settings diagram”):

- MODE menu
- CODE menu (optional)
- SET menu
- CLEAR window

In order to adapt the gamma/ L to your process requirements you must:

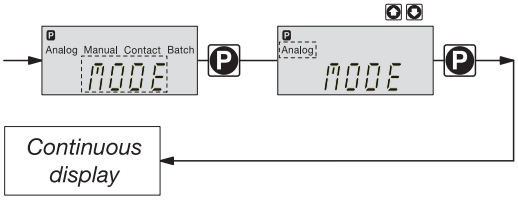


1. Select the operating mode in the MODE menu
2. Adjust settings to this operating mode in the SET menu

7.3 Select operating mode (MODE menu)

The following operating modes are selected via the MODE menu (depending upon identcode, some operating modes may be absent):

- Manual: for operation by hand
  (Identcode, control variant: manual, standard option)
- Analogue: for electronic control
  (Identcode, control variant: analogue current)
- Contact: for contact operation
  (Identcode, control variant: external 1:1 / external with pulse control)
- Batch: for batch operation
  (Identcode, control variant: external with pulse control)



7.4 Settings for operating mode (SET menu)

In the SET menu you can adjust various settings depending upon the selected operating mode.

The following programmable function settings menus appear in all operating modes:

- Calibrate (CALIB menu)
- Pressure levels (PRESS menu)
- Auxiliary frequency (AUX menu)
- Flow (FLOW menu, available only if flow monitor is connected)

See also section 7.5!

Further settings menus depend upon the selected operating mode.

7.4.1 Settings for “manual” operating mode

There are no other settings menus in the overall SET menu for the “manual” operating mode apart from those described in 7.5.

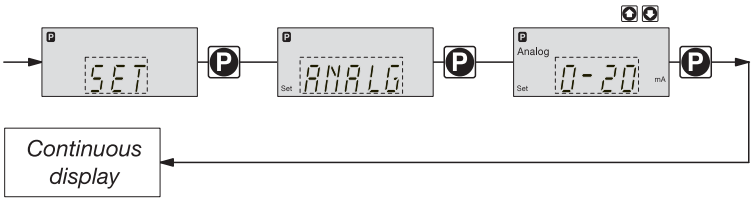
7.4.2 Settings for “analogue” operating mode (ANALG menu)

In addition to those settings menus described in 7.5, there is an additional ANALG menu in the overall SET menu for the “analogue” operating mode.

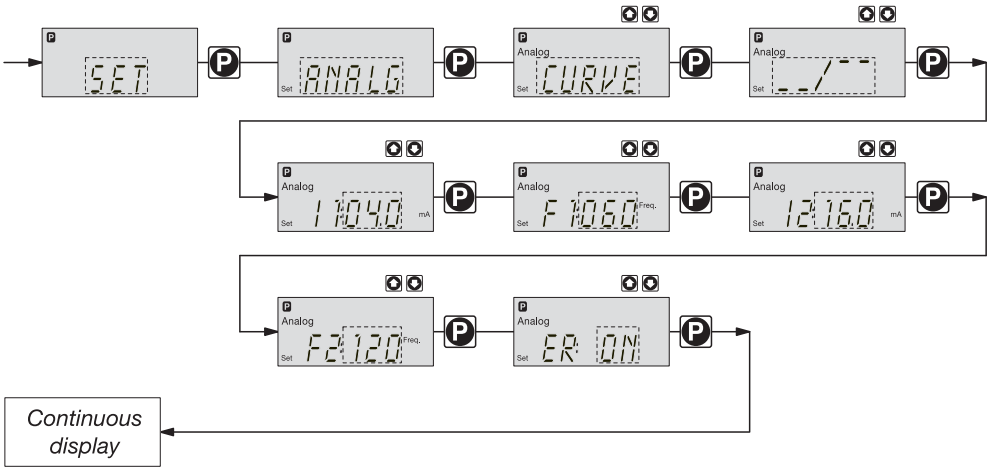
The stroke rate is controlled by an analogue electrical signal via the “external control” terminal.

You can select three signal-processing methods:

- 0 - 20 mA: at 0 mA the gamma/ L does not operate
  at 20 mA the gamma/ L operates at max. stroke rate
  Between these two extremes the stroke rate is proportional to the electrical signal.



- 4 - 20 mA: at 4 mA the gamma/ L does not operate
  at 20 mA the gamma/ L operates at max. stroke rate
  Between these two extremes the stroke rate is proportional to the electrical signal.
  For signals of below 3.8 mA a fault will be detected and the gamma/ L will stop (e.g. cable break).
- Curve: In the “curve” processing mode you can programme the gamma/ L ratios.
  There are 3 options available:
  - ----- = straight line
  - --\-- = lower band
  - --/-- = upper band



Straight line:

The following symbol appears in the LCD display: - - - - - .
You can enter any stroke frequency ratio for the gamma/ L in proportion to the electrical signal.
You must enter two points P1 (I1, F1) and P2 (I2, F2). F1 is the stroke rate at which the pump should operate at current I1: the straight line and the ratio are fixed accordingly:

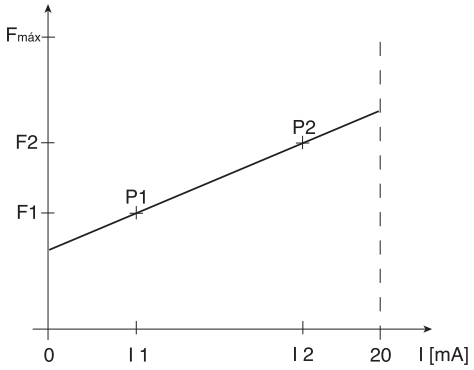


Fig. 17

NOTE

Draw a diagram like the one above - with values for (I1, F1) and (I2, F2) - in order to set the gamma/ L to your required stroke rate!

Lower/upper band:

This processing mode allows you to control a pump via an electrical signal as shown in the diagrams below.

You may also control two pumps for different feed chemicals from a single signal (e.g. one acid pump and one alkali pump from a pH sensor signal). The pumps must be connected electrically in series (see wiring plan in section 6.1).

Lower band
e.g. Alkali pump

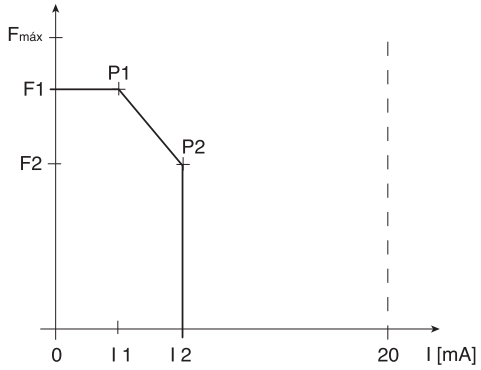


Fig. 18

Upper band
e.g. acid pump

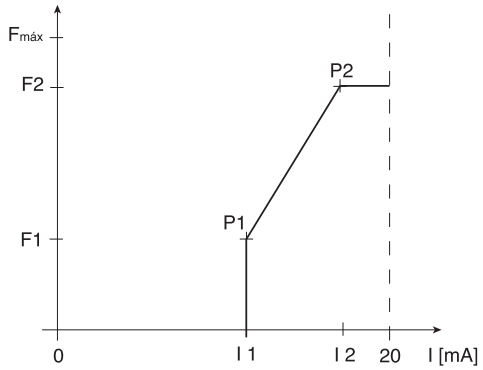


Fig. 19

Lower band:

The symbol ¯¯__ appears in the LCD display. The gamma/ L will operate below I1 at F1. Above I2, the gamma/ L ceases to operate. Between I1 and I2 the stroke rate is between F1 and F2, proportional to the signal current.

Upper band:

The signal __/¯¯ appears in the LCD display. The gamma/ L will cease to operate below I1. Above I2, the gamma/ L will operate at F2. Between I1 and I2 the stroke rate between is F1 and F2, proportional to the signal current.

The smallest processable difference between I1 and I2 is 4 mA.

Error processing In the “ER” (error) menu option you can activate an error processing function for the “curve” mode. An error message appears for signals below 3.8 mA and the gamma/ L stops.

7.4.3 Settings for “contact” operating mode (CONTCT menu)

In addition to those settings menus described in 7.5, there is an additional CONTCT in the overall SET menu for the “contact” operating mode.

The operating mode “contact” allows you to activate a single stroke or a series of strokes.
The strokes can be activated by a pulse or via the “external control” terminal. This operating mode is intended to transfer input pulses into a reduction (break) or small increase in strokes.

IMPORTANT

- **When switching to another operating mode the factor is reset to “1”.**
- **When switching from “Manual” to “Contact” operating mode, the gamma/ L maintains the stroke frequency.**
  The stroke frequency can also be adjusted in the “Contact” operating mode. It should normally be set at 180 strokes/min.

The following versions are available:

- Contact - identcode: external 1:1
- Contact - identcode: external with pulse control

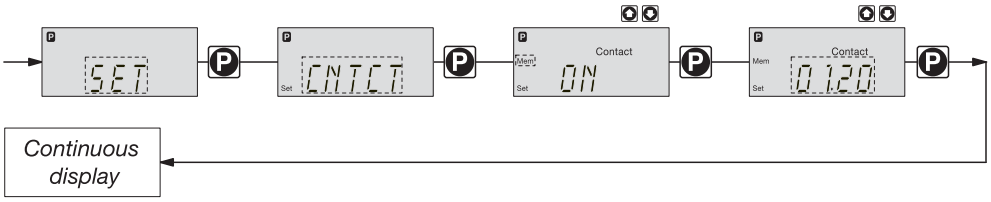
Contact – identcode: external 1:1

In the “contact - identcode: external 1:1” version the gamma/ L makes precisely 1 stroke per pulse (identcode: external 1:1).

No entry possible.

Contact – identcode: external with pulse control

In the “contact - identcode: external with external pulse control” you can enter the number of pulses after which a stroke should be carried out. “Contact - identcode: external with external pulse control” is intended for small dosing quantities.



The number of strokes per pulse depends upon the factor, which you can enter. This allows you to vary to a certain extent the input pulses by a factor of 1.01 to 99.99 and/or reduce by a factor of 0.01 to 0.99:
“Number of strokes activated = factor x number of input pulses”

Examples

	Factor	Pulse (sequential)	Stroke number (sequential)
Increase	1	1	1
	2	1	2
	25	1	25
	99.99	1	99.99
	1.50	1	1.5 (1 / 2)
	1.25	1	1.25 (1 / 1 / 1 / 2)
Reduction	1	1	1
	0.50	2	1
	0.10	10	1
	0.01	100	1
	0.25	4	1
	0.40	2.5 (3 / 2)	(1 / 1)
	0.75	1.33 (2 / 1 / 1)	(1 / 1 / 1)

Explanation of increase

At a factor of 1	For every 1 pulse, 1 stroke is activated
At a factor of 2	For every 1 pulse, 2 strokes are activated
At a factor of 25	For every 1 pulse, 25 strokes are activated

Explanation of decrease

At a factor of 1	After 1 pulse, 1 stroke is activated
At a factor of 0.5	After 2 pulses, 1 stroke is activated
At a factor of 0.1	After 10 pulses, 1 stroke is activated
At a factor of 0.75	After 2 pulses, 1 stroke is activated, then after 1 pulse, 1 stroke is activated, then after 2 pulses, 1 stroke is activated etc.

NOTE

If a remainder occurs when the factor is processed, the gamma/ L counts up the remainder values. When the sum reaches or exceeds “1” the gamma/ L will activate a stroke. This ensures that the stroke number corresponds exactly to the factor throughout the dosing operation.

The number of input pulses which have not been processed are stored by the gamma/ L in the stroke memory. When the STOP/START key is pressed or the “pause” function is activated, the stroke memory is deleted (this can be avoided using the “memory” extension function, see below).

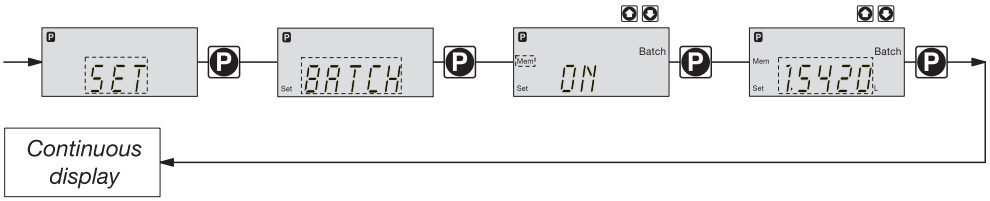
The “contact - identcode: external with pulse control” version allows optimum adaptation of the gamma/ L, in conjunction with e.g. water contact meters, to any process.

“Memory” extension function

The “memory” extension function can be optionally activated (“mem” appears in the LCD display). When “Memory“ is activated, the gamma/ L adds up the unused excess strokes, up to the stroke memory’s maximum capacity of 65535 strokes. If the maximum capacity is exceeded the pump will malfunction.

7.4.4 Settings for “batch” operating mode (BATCH menu)

In addition to those settings menus described in 7.5, there is an additional BATCH menu in the overall SET menu for the “batch” operating mode.



The “batch” operating mode is a variant of the “contact” operating mode (see 7.4.3).
You can pre-select a stroke number (no breaks, whole numbers only from 1 to 65535) as well as a feed quantity (batch). To switch between entries for “stroke number” and “feed quantity” press the i key 1x in the corresponding menu option (see also overview “operating/settings diagram”, fold-out page).
The “batch” operating mode is intended for large dosing quantities.

Metering is activated by pressing the P key or via a pulse from the "external control" terminal.

The number of input pulses which have not been processed are stored by the gamma/ L in the stroke memory. The stroke memory is limited to the batch size if “Memory“ is not activated (with “Memory“ this is 65535 strokes). You can clear it by changing to a different operating mode.

CAUTION

- **When switching from “Manual” to “Batch” operating mode, the gamma/ L maintains the stroke frequency.**
  The stroke frequency can also be adjusted in the “Batch” operating mode. It should normally be set at 180 strokes/min.

“Memory” extension function

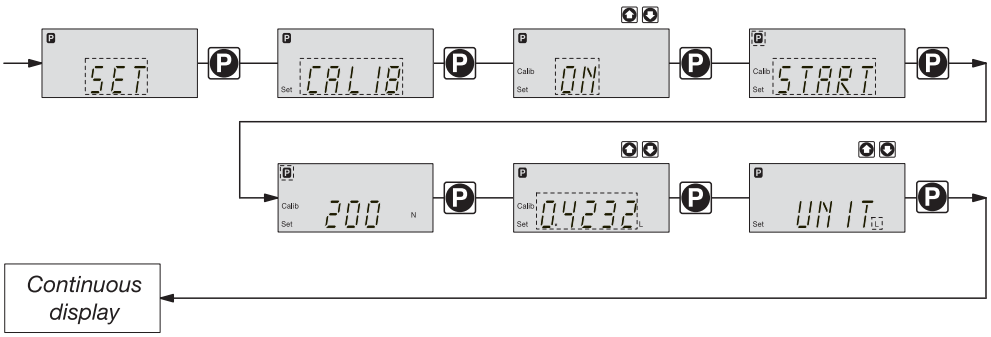
The “memory” extension function can be optionally activated (“mem” appears in the LCD display). When “Memory“ is activated, the gamma/ L adds up the unused excess strokes, up to the stroke memory’s maximum capacity of 65535 strokes. If the maximum capacity is exceeded the pump will malfunction.

7.5 Settings for programmable functions (SET menu)

The following programmable function settings menus appear in all operating modes:

- Calibrate (CALIB menu)
- Pressure levels (PRESS menu)
- Auxiliary frequency (AUX menu)
- Flow (FLOW menu, available only if flow monitor is connected)

7.5.1 Settings for “calibration” function (CALIB menu)



The gamma/ L can also run in calibration mode. The corresponding continuous displays show the current dosing quantities or the feed rate.

Calibration is maintained when a stroke rate is altered up to ±10 degrees (where the stroke length is set at 40 %, the range is 30-50 %). If the stroke rate is altered more than ±10 degrees the yellow warning light is lit, the continuous display flashes and the flashing message “calib” appears.

NOTE

- **Do not go below 30 % stroke length (SEK type: 50 %).**
  This will significantly affect accuracy of calibration.
- **Calibration becomes increasingly accurate the more strokes made by the gamma/ L during calibration (recommended: at least 200 strokes).**

WARNING

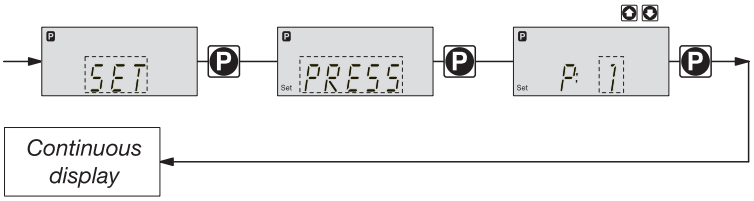
If using a hazardous feed chemical, the following setting instructions ensure adequate safety precautions have been taken!

Calibration

- ▶ Insert the suction tube into a measuring cylinder containing the feed chemical - the discharge tubing must also be correctly installed (operating pressure, …!)
- ▶ Suck up the feed chemical (press both arrow keys at the same time) when the suction tube is empty
- ▶ Note the liquid level in the measuring cylinder and the stroke length
- ▶ Select the CALIB menu and go to the first menu option using the P key
- ▶ Select “ON” using an arrow key and change to the next menu option using the P key
- ▶ To commence calibration, press the P key. The gamma/ L starts to pump and displays the number of strokes (“STOP” appears at regular intervals) (the gamma/ L works at the stroke frequency set under “MANUAL“).
- ▶ After a sufficient number of strokes, stop the gamma/ L with the P key
- ▶ Calculate the dosed quantity (difference between the original quantity and the quantity remaining)
- ▶ Enter this quantity in the next menu and then go to the next menu option using the P key
- ▶ Select the unit (“L” or “gal”) in the “UNIT” menu with an arrow key

The gamma/ L is calibrated.
The corresponding continuous displays show the calibrated values.
The total stroke number and total litres are set during calibration to “0”.
The gamma/ L is in the STOP state.

7.5.2 Settings for the “pressure levels” function (PRESS menu)



The programmable function “pressure levels” is used to reduce the rated pressure of the gamma/ L.

CAUTION

- **The rated pressure can be considerably exceeded at stroke lengths of below 100 %! The rated pressure relates to a stroke length of 100 %.**
- **If another liquid end size is installed the pump must be reprogrammed on factory premises!**
- **Select as large a rated pressure as required and as small as possible! This will increase system safety (reduces the risk of the tubing bursting when blocked)! This also protects the diaphragm and saves electricity.**

NOTE

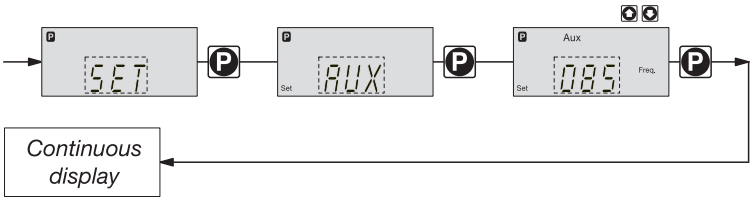
If installing another liquid end size the pump must be reprogrammed on factory premises.

The following rated pressures can be selected for these liquid end sizes (rated pressure in bar):

Liquid end size	Pressure level 1	Pressure level 2	Pressure level 3	Pressure level 4
1601, 1602, 1605	4	7	10	16
1000, 1005, 1008	4	7	10	
0708, 0713	4	7		

No adjustments can be made for pump types 0413, 0420, 0220, 0232.

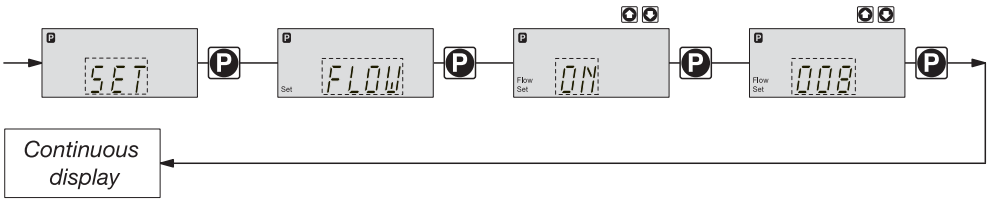
7.5.3 Settings for “auxiliary frequency” function (AUX menu)



The programmable function “auxiliary frequency” allows switching to a different stroke frequency, which can be set in the AUX menu. It can be activated via the “external control” terminal. When the auxiliary frequency is activated, “aux” appears in the LCD display.

This auxiliary frequency overrides the current stroke frequency set for the selected operating mode.

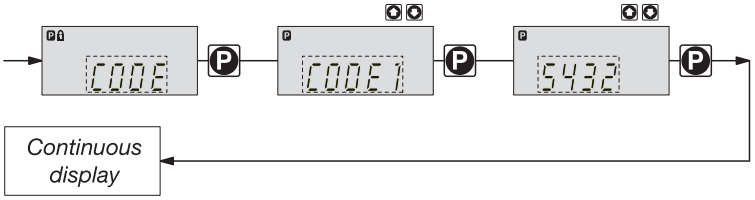
7.5.4 Settings for the “flow” function (FLOW menu)



The flow menu only appears when a dosing monitor is connected to the “dosing monitor” terminal. This dosing monitor registers each discharge stroke of the gamma/ L at the discharge connector and transmits it back to the gamma/ L. If this response transmission is serially omitted for a period set in the FLOW menu (due to failure or below-minimum dosing) the gamma/ L stops.

7.6 Setting code (CODE menu)

The code menu is used to select whether you want to prevent access to parts of the settings options.



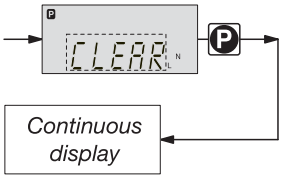
In the first menu option you can choose CODE 1 or CODE 2 (both use the same number).

- Select CODE 1 to prevent access to the settings mode (① in the overview “operating/ settings diagram”, fold-out page). In the next menu option, enter the number you wish to use as the code.
- Select CODE 2 to prevent access to the settings options for directly alterable values in the continuous displays (② in the overview “operating/settings diagram”, fold-out page). In the next menu option, enter the number you wish to use as the code.
- Select NONE to remove a pre-set security lock.

7.7 Cancel total stroke number or total litres (CLEAR window)

In the CLEAR window you can delete the stored total stroke number and simultaneously the total litres (= set to “0”). You may then press the P key briefly to exit this window.

The values displayed are counted incrementally from the point of commissioning the pump, or from the last delete action.



8 Operating

This section describes all operating options available to you when the gamma/ L is in continuous display mode (no P key symbol in the LCD display).

NOTE

- **Open out the fold-out page following the title page fully! There you will find the overviews “control elements and key functions” and “operating/settings diagram”.**
- **Look at the overview “continuous displays”. This page shows you which displays are available in which operating mode, and which values are directly alterable in the corresponding continuous displays.**

8.1 Manual operation

Set stroke length Stroke length is continually adjustable within a range of 0 - 100 %.
The recommended stroke length range, which will practically guarantee technical reproducibility, is 30 - 100 % (SEK type: 50 - 100 %).

The following operating options are available via the different keys (see also figure on the next page):

Stop/Start gamma/ L To stop gamma/ L: press STOP/START key.
To start gamma/ L: press STOP/START key.

Start batch Press the P key briefly in “batch” operating mode.

Load factory settings Press the P key for 15 s only if you wish to load factory calibration settings!
Current settings will be deleted.

Change to settings mode When you press the P key for 2 s in any continuous display the gamma/ L will change to settings mode (see section 7).
If CODE 1 is set, the code must be entered after pressing the P key.

Check adjustable values Each time you press the i key you will see a different continuous display.
The number of continuous displays depends upon the identity code, the selected operating mode and the connected accessories.

Change directly alterable values To change a value (see below) directly in the corresponding continuous display, press one of the arrow keys until “set” appears in the LCD display. The delay has been programmed in to prevent inadvertent changing of values.
If CODE 2 has been set, this code must be entered after pressing the arrow key.

Directly alterable values are as follows:

Stroke rate In “manual”, “contact” and “batch” operating modes:
The stroke rate can be altered in the “stroke rate” display.

Feed rate In “manual” operating mode
The feed rate can be altered in the “feed rate” display.

Factor The factor is the number of strokes activated by an external pulse or a press of the P key (in “batch” mode only).

In “batch” operating mode:

You can alter the factor from the “remaining strokes” display.

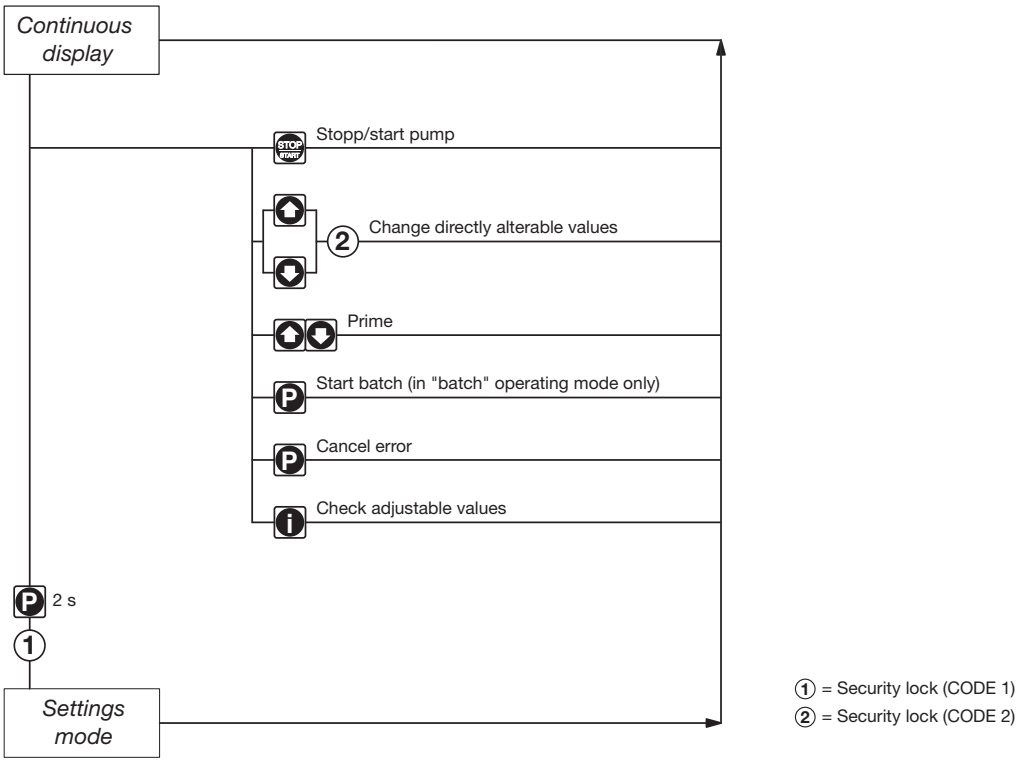
The gamma/ L returns to the original continuous display a few seconds after the factor has been reset.

Batch size In “batch” operating mode:
The batch size can by changed from the “batch size/remaining litres” display.
The gamma/ L returns to the original continuous display a few seconds after the batch size has been reset.

Priming The “priming” function is activated by pressing both arrow keys at the same time in “Stroke rate” permanent display.

Cancel error Error messages are cancelled by pressing the P key briefly.

Display programme versions Press on the P key for 10 seconds to display the programme versions.
Example: “V 1052“ + X 1010“.
Release the key on “LOAD 3“ immediately.



8.2 Remote control

It is possible to control the gamma/ L remotely via a signal cable or Profibus® (see section 6.1 and section 7, “Supplementary Instructions for ProMinent® gamma/ L and ProMinent® Sigma versions with Profibus®” and plant documentation).

9 Maintenance

Maintenance intervals

- Every quarter, when subject to normal usage (continuous operation - approx. 30 %)
- Shorter intervals when subject to heavier usage (e.g. continuous operation)

Maintenance actions

Standard liquid ends:

▶ Check the diaphragm for damage (see section 10)

▶ Check chemical seepage at vent hole

▶ Check that the discharge tubing is connected firmly to the liquid end

▶ Check that discharge and suction valves are firmly fixed

▶ Check that the liquid end is generally watertight (especially vent hole! See fig. 20)

▶ Check for correct feed: run the gamma/ L run for a short period (press both arrow keys together)

▶ Check electrical connections for wear

▶ Check that liquid end screws are fastened tightly (on coarse/fine bleeding versions, first remove knob and cover)

Screw fastening torque: 4,5 to 5 Nm

NOTE

- **For PP liquid end, check fastening torque every quarter!**

Additionally, for liquid ends with coarse/fine bleed function and SEK type:

- **Check that the bypass tubing is connected firmly to the liquid end**
- **Check that the bleed valve is firmly fixed in place**
- **Examine the discharge and bypass tubing for kinks**
- **Check that the coarse/fine bleed function is working correctly**

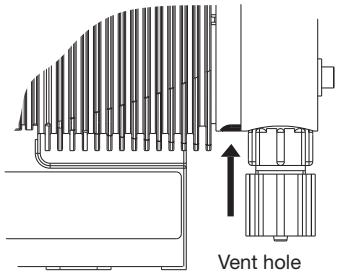


Fig. 20 Vent hole

10 Repairs

NOTE

Repair work may be carried out by authorised personnel only, or on factory premises:

- **Replacement of damaged mains cables**
- **Replacement of fuses and electronic controller.**

Only send the equipment for repair or maintenance in a cleaned condition and with the liquid end flushed. However, should any safety precautions be necessary even after careful draining and cleaning of the equipment, the required information must be listed in the Safety Declaration!

The Safety Declaration forms part of the inspection/repair contract.

Maintenance or repair work will only be carried out if a Safety Declaration - correctly and fully completed by an authorised and qualified member of the Operator's staff - is available.

A copy of the form is included in the "General operating instructions ProMinent solenoid metering pumps" or can be downloaded at www.prominent.com.

WARNING

Pumps used for radioactive materials cannot be returned to ProMinent after use! They will not be accepted by ProMinent!

Repairs: These should only be carried out by qualified personnel (in accordance with Safety section):

- Cleaning the valve
- Changing the diaphragm

WARNING

- **Always take suitable precautions when using hazardous chemicals!**
- **Ensure equipment is de-pressurised**

NOTE

Take the explosion drawings annexed t the help.

Cleaning the discharge valve (PP, NP, PV) for types 1000, 1005, 1605, 1601, 1602

NOTE

- **Discharge and suction valves are different! Dismantle one after the other to avoid confusion.**
- **Only use new parts, which fit your valve (in shape and chemical resistance)!**
- **The pump must be reset after replacing a valve.**
- **Insert an Allen key or similar into the smaller hole of the pressure connector and push out the valve inserts.**

Cleaning the sucction valve (PP, NP, PV) for types 1000, 1005, 1605, 1601, 1602

Dismantling, cleaning and reassembly of the suction valve is practically the same as for a discharge valve.

Notice however that:

- both valve inserts are actually identical
- an additional spacer is found under the valve inserts
- in the liquid end a shaped seal is used instead of an O-ring
- the flow direction of the suction connection is reversed as for the pressure connector.

Cleaning the discharge valve (PP, NP, PV) for types 0708, 1008, 0220, 0420, 0413, 0713, 0232

NOTE

- **Discharge and suction valves are different! Dismantle one after the other to avoid confusion!**
- **Only use new parts, which fit your valve (in shape and chemical resistance)!**
- **The pump must be reset after replacing a valve.**
- **Insert an Allen key or similar into the smaller hole of the pressure connector and push out the valve inserts.**

Cleaning the suction valve (PP, NP, PV) for types 0708, 1008, 0220, 0420, 0413, 0713, 0232

Dismantling, cleaning and reassembly of the suction valve is practically the same as for a discharge valve.

Notice however that:

- an additional spacer is found under the valve inserts
- in the liquid end the O-ring is used, not the shaped seal
- the flow direction of the suction connection is reversed as for the pressure connector.

Change diaphragm

WARNING

- **Always take suitable precautions when using hazardous chemicals!**
- **Ensure that the equipment is de-pressurised!**

▶ Empty the liquid end (turn the unit upside down and let the feed chemical run out, rinse with a suitable material: rinse the liquid end thoroughly after use with hazardous materials!).

▶ When gamma/ L is running set the stroke length to 0 % (the drive axis is then set).

▶ Switch off the gamma/ L.

▶ Unscrew the hydraulic connectors from the discharge and suction side.

▶ For versions with coarse/fine bleed function: firstly pull out the coarse/fine bleed (knob), then lift off the cover from the liquid end using a screwdriver.

▶ Remove the screws (1).

For pump types 0220, 0232 and 0420 see the following page (4 holes on the diaphragm rim)!

Supply unit types, except 0220, 0232 and 0420

▶ Loosen the liquid end (2) and the top plate (4) from the pump housing (6) (loosen only!).

▶ Hold the housing (6) in one hand and with the other, clamp the diaphragm (3) between the liquid end (2) and the top plate (4); release the diaphragm (3) from the drive spindle with a light anticlockwise turn of the liquid end (2) and top plate (4).

▶ Unscrew the diaphragm (3) completely from the drive spindle.

▶ Remove the top plate (4) from the housing (6).

▶ Check the condition of the safety diaphragm (5) and replace if necessary.

▶ Push the safety diaphragm (5) only as far onto the drive axis until it lies flat on the pump housing (6) – no further!

▶ Screw the new diaphragm (3) carefully up to the stop on the drive axis – this must be exact to ensure correct metering!

▶ Screw the diaphragm (3) tight once more.

▶ Position the top plate (4) on the pump housing (6).

IMPORTANT

- **The leakage hole must point downwards when the pump is fully assembled (see fig. 20).**
- **Position the top plate (4) correctly on the pump housing (6). Do not distort the top plate on the pump housing, otherwise the safety diaphragm (5) will not fit.**

▶ Lay the diaphragm (3) into the top plate (4).

▶ Hold the top plate (4) and screw the diaphragm (3) in a clockwise direction until it is firmly in position (you will feel the resistance of the return spring).

IMPORTANT

- **Do not overtighten the diaphragm (3) (particularly on type 1601).**
- **The top plate (4) must remain in position to prevent the safety diaphragm (5) from distorting.**

▶ Place the liquid end (2) with the screws (1) on the diaphragm (3) and the top plate (4) (the priming connector must point downwards once the pump is fully assembled).

▶ Screw on screws (1) lightly and tighten (starting torque, see below).

▶ For versions with coarse/fine bleed function, ensure that the liquid end cover engages in the liquid end, then push the coarse/fine bleed vent (knob) into the liquid end.

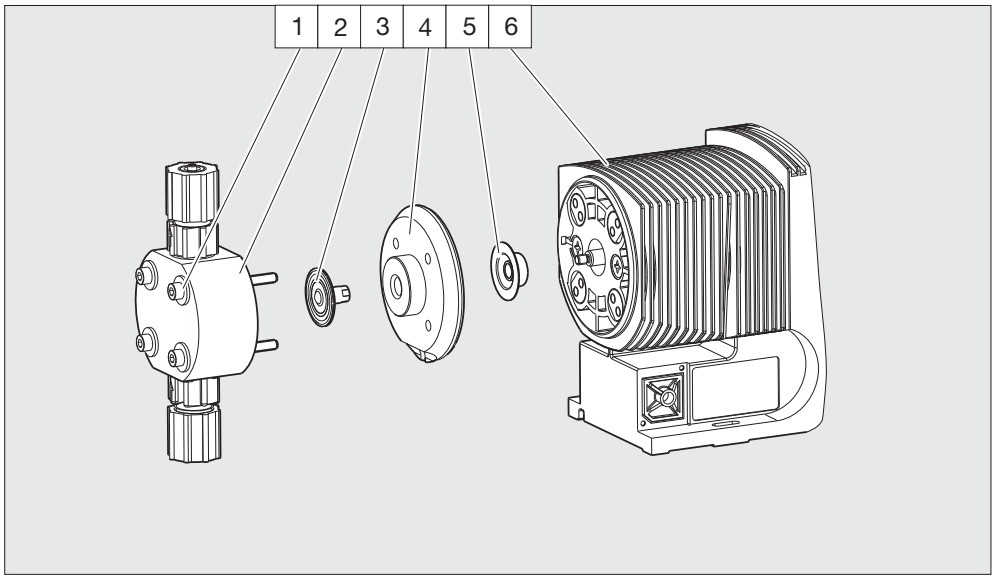


Fig. 21

1 Screws
2 Liquid end
3 Diaphragm
4 Top plate
5 Safety diaphragm
6 Pump housing

NOTE

- **Check the screw torques after 24 hours in operation**
- **For PP liquid ends check the screw torques again after three months.**

Screw torques: 4,5 to 5 Nm

Liquid ends - types 0220, 0232 and 0420

- ▶ Remove the metering head (2) with the screw (1) from the pump (see fig. 22).
- ▶ Only type 0232: Remove the screws of the set disk (4) below the diaphragm (3).
- ▶ The screws (1) should fit in the holes of the diaphragm (3), but not on the set disk.
- ▶ Hold the housing (6) in one hand and with the other hand, clamp the diaphragm (3) between the liquid end (2) and the top plate (4); release the diaphragm (3) from the drive spindle with a light anti-clockwise turn of the liquid end (2) and top plate (4).
- ▶ Remove the liquid end (2) with screws (1) from of the diaphragm and unscrew completely from the drive spindle.
- ▶ Remove the top plate (4) from the housing (6).
- ▶ Check the condition of the safety diaphragm (5) and replace it necessary.
- ▶ Push the safety diaphragm (5) only as far onto the drive axis until it lies flat on the pump housing (6) – no further!
- ▶ Screw the new diaphragm (3) carefully up to the stop on the drive axis – this must be exact to ensure correct metering!
- ▶ Check that the holes in the diaphragm are aligned with those in the pump housing.
- ▶ If not, start the pump and set the stroke length to 100 %.
- ▶ When the pump is running, turn the diaphragm (3) slowly in a clockwise direction until the four holes in the diaphragm are flush with those on the pump housing (6).
- ▶ Hold the diaphragm (3) in this position, set the stroke length to 0 % and stop the pump.
- ▶ Screw the diaphragm (3) tight once more.
- ▶ Position the top plate (4) on the pump housing (6).
- ▶ Only type 0232: Mount the set disk (4) with the screws.

IMPORTANT

- **The leakage hole must point downwards when the pump is fully assembled (see fig. 20).**
- **Position the top plate (4) correctly on the pump housing (6). Do not distort the top plate on the pump housing, otherwise the safety diaphragm (5) will not fit.**

▶ Lay the diaphragm (3) into the top plate (4).

▶ Hold the top plate and screw the diaphragm (3) in a clockwise direction until it is firmly in position (you will feel the resistance of the return spring).

IMPORTANT

- **Do not overtighten the diaphragm (3).**
- **The top plate (4) must remain in position to prevent the safety diaphragm (5) from distorting.**

▶ Position the liquid end (2) with the screws (1) on the diaphragm (3) and the top plate (4) (the priming connector must point downwards once the pump is fully assembled).

▶ Screw on screws (1) lightly and tighten (starting torque, see above).

▶ For coarse/fine bleed versions: ensure the liquid end cover engages in the liquid end, then push the coarse/fine bleed (knob) into the liquid end.

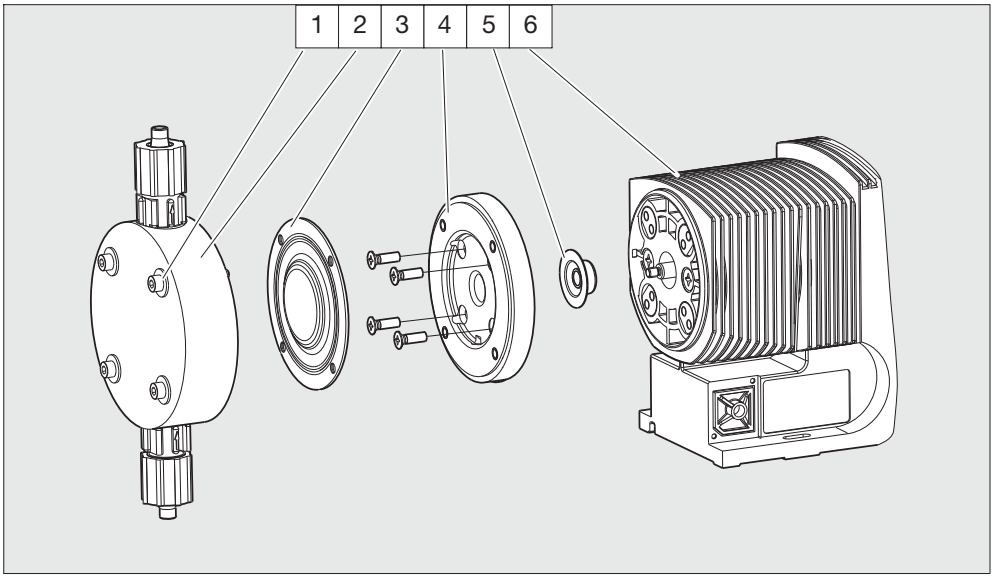


Fig. 22

1 Screws
2 Liquid end
3 Diaphragm
4 Top plate
5 Safety diaphragm
6 Pump housing

NOTE

- **Check the screw torque after 24 hours in operation!**
- **For PP liquid ends recheck the screw torque after three months!**

11 Troubleshooting

WARNING

- **Always take suitable precautions when using hazardous chemicals!**
- **Ensure the equipment is de-pressurised before working on the pump!**

gamma/ L does not prime despite full stroke and bleed function

Cause Crystalline deposits on the ball seat because valves have dried out

Remedy
- ▶ Remove the suction sleeve from the chemical supply container and rinse out the liquid end thoroughly
- ▶ If still unsuccessful, dismantle valves and clean (see section 9)

Fluid is seeping from the top plate

Cause The liquid end is not sealed against the pump diaphragm

Remedy
- ▶ Tighten screws in the liquid end (see section 9)
- ▶ If unsuccessful, replace the diaphragm (see section 10)

Green LED indicator (operating display) is not lit

Cause Incorrect or no mains voltage

Remedy
- ▶ Use the recommended mains voltage as given in the voltage specification on the nameplate

Error Messages

Red LED display is lit, “Error” appears and “MINIM” flashes in the display

Cause Fluid level in the chemical storage tank has reached “liquid level low, stage 2”

Remedy
- ▶ Fill the chemical supply container

Red LED display is lit, “Error” appears and “ANALG” flashes in the display

Cause gamma/ L is in “analogue” operating mode, a fault routine has been programmed in the ANALG menu and the operating current has fallen below 3.8 mA

Remedy
- ▶ Remedy low operating current
- ▶ Switch fault routine “OFF” (see Section 7.4.2.)

Red LED display is lit, “Error” appears and “CNTCT” flashes in the display

Cause gamma/ L is in “contact” or “batch” operating mode and the extended function “memory” has been set.
In addition a very large factor has been entered, too many contacts have been input or the P-key has been pressed too often, resulting in an overflow of the stroke memory.

Remedy
- ▶ Press the P-key, saved data will be deleted
- ▶ Change gamma/ L set up

Red LED display is lit, “Error” appears and “FLOW” flashes in the display

Cause Dosing monitor not properly connected

Remedy
- ▶ Connect dosing monitor properly
- ▶ Press P-key

Cause Dosing monitor has reported more defective strokes than have been set in the FLOW menu

Remedy
- ▶ Press P-key
- ▶ Investigate the cause and remedy

Red LED display is lit, “Error” appears and “Mem” flashes in the display

Cause Stroke memory full

Remedy
- ▶ Remove cause
- ▶ Press P-key (Consider the consequences this will have on your process)

Fault Signals

Yellow LED display is lit

Cause Liquid level in chemical storage tank has reached “liquid level low, stage 1”

Remedy ▶ Fill chemical storage tank

Yellow LED Display is lit and “calib” flashes

Cause The pump is calibrated and the stroke length deviates by more than ±10 % from the value at the time of calibration.

Remedy ▶ Reset the stroke length or calibrate the pump again to the desired stroke length

All other Errors

Please contact your ProMinent branch or representative!

12 Decommissioning and Disposal

Decommissioning

WARNING

- **When decommissioning the gamma/ L the housing and, in particular, the liquid end must be thoroughly cleaned to remove chemicals and dirt!**
- **Always take suitable precautions when using hazardous chemicals!**
- **Ensure that the equipment is de-pressurised!**

▶ Disconnect the gamma/ L from the power supply

▶ Empty the liquid end by turning the gamma/ L upside down and allow the feed chemical to pour out

▶ Rinse the liquid end with a suitable material, thoroughly rinse the liquid end after use with hazardous materials!

If decommissioning is only temporary, maintain the correct storage conditions:

Storage temperature: -10 to +50 °C

Air humidity: < 92 % relative humidity

Disposal

IMPORTANT

Electronic waste is classified as special waste!

Please observe all locally applicable directives!

13 Technical Data

13.1 Performance data and weights

gamma/ L at 180 strokes/minute and 100 % stroke length

Liquid end type	Max. feed rate at maximum operating pressure			max. feed rate at medium operating pressure			Connector size outer Ø x inner Ø	Suction-lift*	Priming-lift**	Admmis. priming pressure	Ship. Wt[1]
	bar	l/h	ml/str.	bar	l/h	ml/str.	mm	m Wg	m Wg	bar	approx. kg
1000	10	0.74	0.09	5	0.82	0.076	6x4	6	1.8	8	2.9 / 3.6
1601	16	1.1	0.10	8	1.4	0.13	6x4	6	2	8	2.9 / 3.6
1602	16	2.1	0.19	8	2.5	0.24	6x4	6	2	5.5	2.9 / 3.6
1005	10	4.4	0.41	5	5.0	0.46	8x5****	5	3	3	3.1 / 4.5
0708	7	7.1	0.66	3.5	8.4	0.78	8x5	6	2	2	3.1 / 4.5
0413	4	12.3	1.14	2	14.2	1.31	8x5	3	2	1.5	3.1 / 4.5
0220	2	19.0	1.76	1	20.9	1.94	12x9	2	2	1	3.1 / 4.5
1605	16	4.1	0.38	8	4.9	0.45	8x5****	4	3	3	4.5 / 5.9
1008	10	6.8	0.63	5	8.3	0.76	8x5	3	3	2	4.5 / 5.9
0713	7	11.0	1.02	3.5	13.1	1.21	8x5	3	3	1.5	4.5 / 5.9
0420	4	17.1	1.58	2	19.1	1.77	12x9	3	3	1	5.5 / 8.6
0232	2	32.0	2.96	1	36.2	3.35	12x9	2	2	0.8	5.5 / 8.6

gamma/ L with self-degassing liquid end * ** at 180 strokes/minute and 100 % stroke length

Liquid end type	Max. feed rate at maximum operating pressure			max. feed rate at medium operating pressure			Connector size outer Ø x inner Ø	Suction-lift*	Priming-lift**	Admmis. priming pressure	Ship. Wt[1]
	bar	l/h	ml/str.	bar	l/h	ml/str.	mm	m Wg	m Wg	bar	approx. kg
1601	16	0.59	0.055	8	0.78	0.072	6x4	–	1.8	0.5	2.9
1602	16	1.4	0.13	8	1.74	0.16	6x4	–	2.1	0.5	2.9
1005	10	3.6	0.33	5	4.0	0.37	8x5	–	2.7	0.5	3.1
0708	7	6.6	0.61	3.5	7.5	0.69	8x5	–	2	0.5	3.1
0413	4	10.8	1.00	2	12.6	1.17	8x5	–	2.5	0.5	3.1
0220	2	16.3	0.31	8	3.8	0.35	8x5	–	3.0	0.5	4.5
1008	10	6.3	0.58	5	7.5	0.69	8x5	–	3.0	0.5	4.5
0713	7	10.5	0.97	3.5	12.3	1.14	8x5	–	2.5	0.5	4.5
0420	4	15.6	1.44	2	17.4	1.61	12x9	–	2.5	0.5	4.5

* Lift when suction line and liquid end are full

** Priming lift with clean and wetted valves, priming lift at 100% stroke length and free flow or opened bleed valve

*** The feed rate values are for minimum feed rates, based on water at 20° C

**** For material versions SST : 6 x 4 mm

[1] For material versions PPE, PPB, NPE, NPB, PVT, TTT/SST

[2] For material versions PPE, PPB, NPE, NPB

13.2 Dosing reproducibility

Standard Liquid ends

Dosing precision -5 to +10 % at max. stroke length and max. operating pressure for all materials.

Reproducibility ±2 % at constant conditions and minimum 30 % stroke length.

Self-degassing liquid ends

Since self-degassing liquid ends are filled with air bubbles when in contact with gaseous chemicals and when in operation, no dosing reproducibility values can be given.
The recommended minimum stroke length with self-degassing liquid ends is 50 %.

13.3 Viscosity

The liquid ends are designed for liquids up to a maximum viscosity of

- 200 mPas for standard liquid ends
- 500 mPas for valves with springs
- 50 mPas for self-degassing liquid ends

13.4 Materials Data Liquid ends

Version	Liquid end	Valves	Seals	Balls
PPE	PP	PP	EPDM	Ceramic
PPB	PP	PP	FPM	Ceramic
NPE	Acrylic glass	PVC	EPDM	Ceramic
NPE	Acrylic glass	PVC	FPM	Ceramic
PVT	PVDF	PTFE with carbon	PTFE	Ceramic
TTT	PTFE with carbon	PTFE with carbon	PTFE	Ceramic
SST	Stainless steel 1.4571	Stainless steel 1.4571	PTFE	Ceramic

FPM = Fluorine Rubber

Pump

Housing	Polyphenylene ether (PPE with glass fibre)
Cover	Polycarbonate
Electronics	Electronic components

13.5 Electrical Data

Version: 100 - 230 V ±10 %, 50/60 Hz

Varants 100 - 230 V/AC	gamma/ L M70	gamma/ L M85
Power rating	17 W	22 W
Rated current	0.7 A	1 A
Switch on peak current	15 A (for approx. 1 ms)	15 A (for approx. 1 ms)
Fuse	0.8 AT	0.8 AT

Note Fuses must display VDE, UL and CSA certification, e.g. type 19195 from Wickmann in accordance with IEC publication 127 - 2/3

13.6 Ambient conditions

Temperatures

Storage and transport temperatures: -10 to +50 °C
Feed chemical temperature: -10 to +35 °C
Ambient temperature when in operation: -10 to +45 °C (drive and control)

Maximum ambient temperatures for liquid ends depending on material type:

max. ambient temperature	PPE, PPB	NPE, NPB	PVT	TTT	SST
Long-term at max. operating pressure	50 °C	45 °C	50 °C	50 °C	50 °C
Short term (max. 15 min) at max. 2 bar	100 °C	60 °C	120 °C	120 °C	120 °C

* Under extreme conditions such as maximum dosing temperatures, maximum stroke frequency and maximum operating pressure, leakage can occur on the liquid end at an ambient temperature of 35 °C.

Climate

Permissible air humidity: 92 % relative humidity, not condensing
Moist and fluctuating air conditions: FW 24 in accordance with DIN 50016

13.7 Enclosure rating and safety class

Enclosure Rating

Contact and moisture enclosure rating:
IP 65 in accordance with IEC 529, EN 60529, DIN VDE 0470 Part 1

Safety Requirements

Safety Class 1 - Mains connection with earth lead

13.8 Compatibility

The hydraulic parts of the gamma/ L are identical to those of the Beta®.
The following components and accessories for pumps from the product ranges Beta®, CONCEPT, gamma-Classic and gamma are all compatible:

- gamma/Vario signal cable; 2-, 4- and 5 core for “external” function
- 2 stage float switch (gamma/Vario)
- Discharge tubing diameters
- Standard gamma connector set
- gamma wall bracket
- Chemical feed containers and mounting plates
- Total height (distance between suction and discharge connector)
- Distance between the connectors and locating holes on the pumps
- Accessories such as pressure back pressure valve, multifunctional valve, dosing monitor and rinsing equipment

PPE, PPB material versions

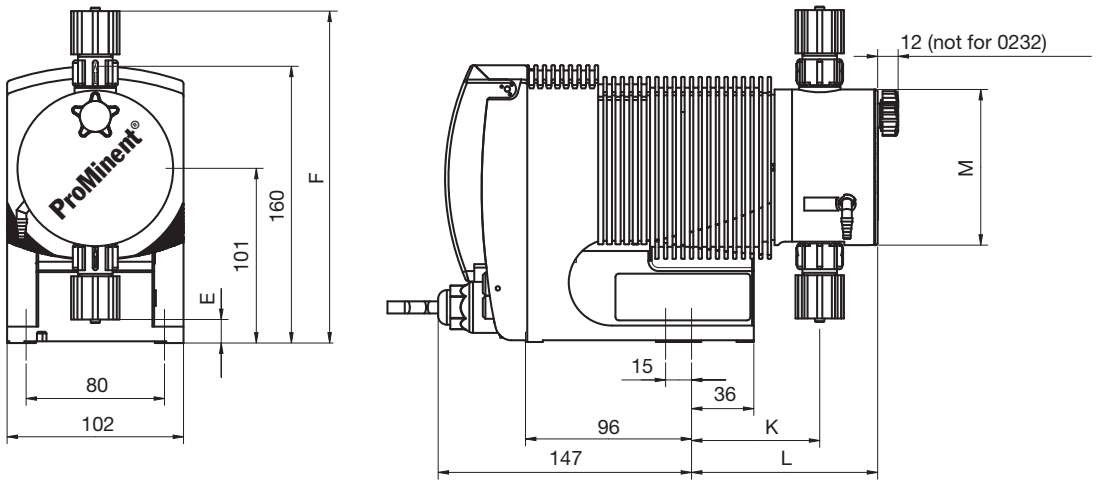


Fig. 23

Dimensions in mm

	gamma/ L M70 1000 - 1602	1005	0708 - 0413	0220	gamma/ L M85 1605	1008 - 0713	0420	0232
E	23	13	15	15	13	15	15	5
F	186	193	191	191	193	191	191	197
K	71	71	74	76	71	74	76	76
L	106	105	108	110	105	108	110	91
M	Ø 70	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 110

NPE, NPB material versions (non bleed)

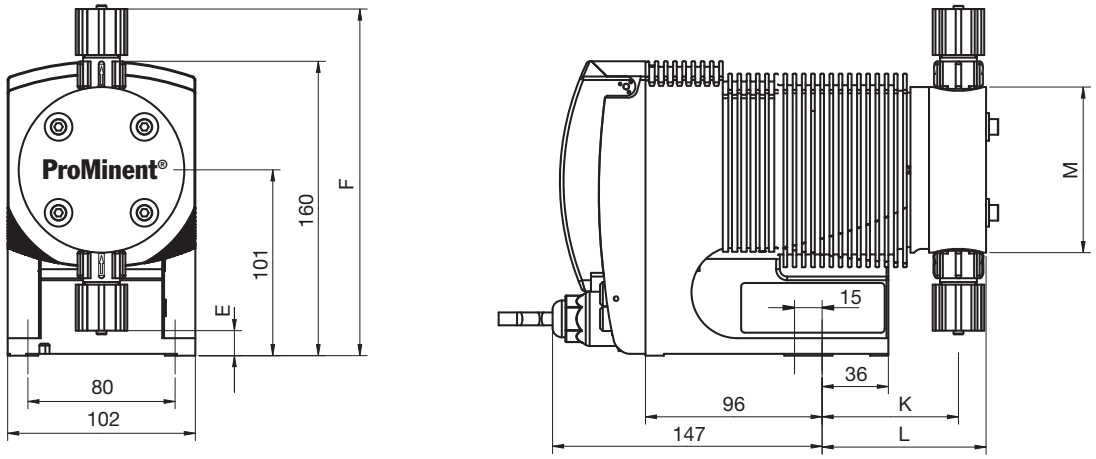


Fig. 24

Dimensions in mm

	gamma/ L M70 1000 - 1601	1602	1005	0708	0413 - 0220	gamma/ L M85 1605	1008 - 0713	0420	0232
E	25	23	16	15	15	16	15	15	5
F	177	179	188	189	189	188	189	189	199
K	77	77	74	74	76	74	74	76	76
L	92	92	89	89	91	89	89	91	91
M	62 (Ø 70)	66 (Ø 70)	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 110

NPE, NPB material versions (with bleed function)

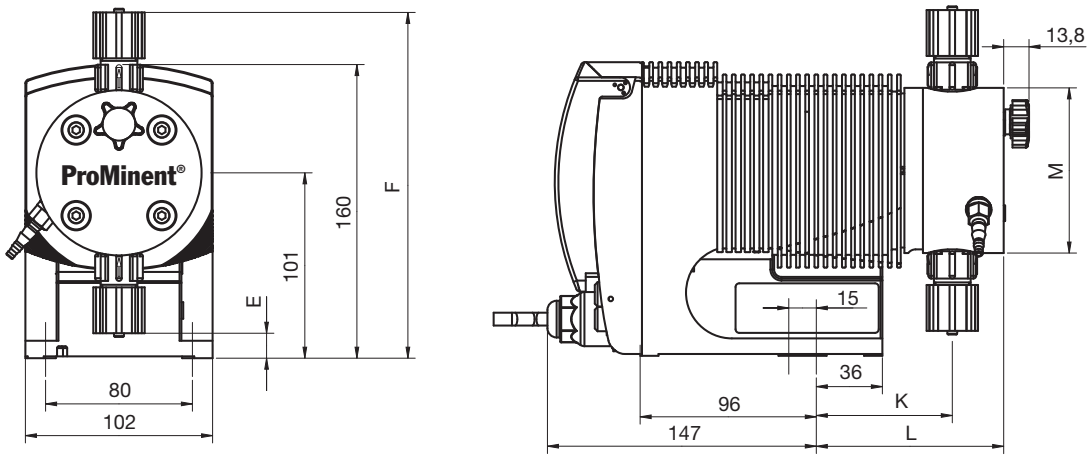


Fig. 25

Dimensions in mm

	gamma/ L M70 1000 - 1601	1602	1005	0708	0413 - 0220	gamma/ L M85 1605	1008	0713 - 0420	0232
E	25	23	16	13	15	16	13	15	5
F	177	179	188	189	189	188	189	189	199
K	77	77	74	74	76	74	74	76	76
L	105	105	102	102	104	102	102	104	105
M	62 (Ø 70)	66 (Ø 70)	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 110

PPE, PPB, NPE, NPB, SEK material versions

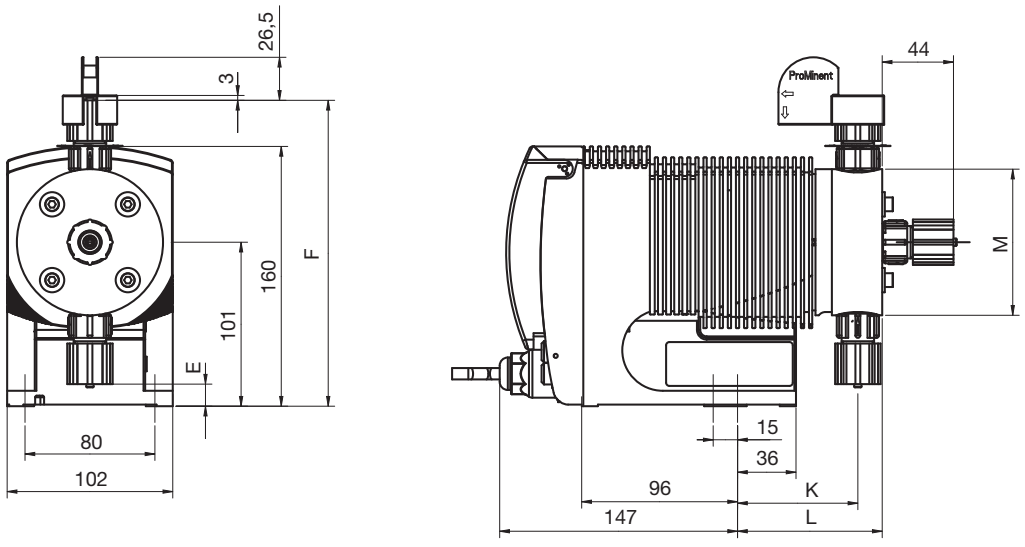


Fig. 26

Dimensions in mm

	gamma/ L M70 1601	1602	1005	0708	0413 - 0220	gamma/ L M85 1605	1008 - 0713	0420
E	25	23	16	15	15	16	15	15
F	177	179	188	189	189	188	189	189
K	77	77	74	74	76	74	74	76
L	92	92	89	89	91	89	89	91
M	62 (Ø 60)	66 (Ø 70)	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90

PVDF material version

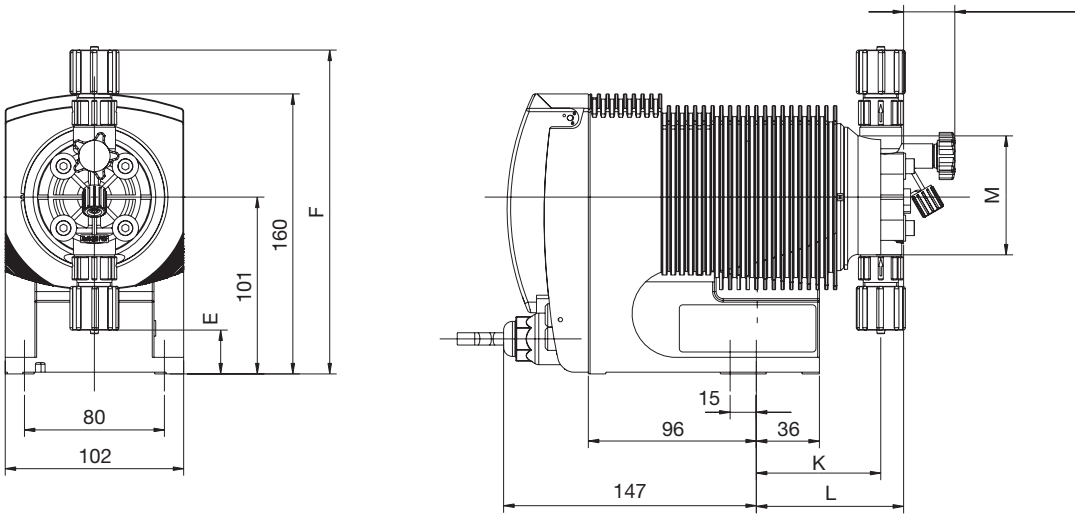


Fig. 27

Dimensions in mm

	gamma/ L M70 1000-1602	1005	0708-0413	0220	gamma/ L M85 1605	0408-0713	0420	0232
E	25	14	14	14	14	14	14	4
F	185	191	191	191	191	191	191	198
K	71	71	73	75	71	73	75	76
L	84	88	90	92	88	90	92	93
M	Ø 70	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 90	Ø 110

TTT material version

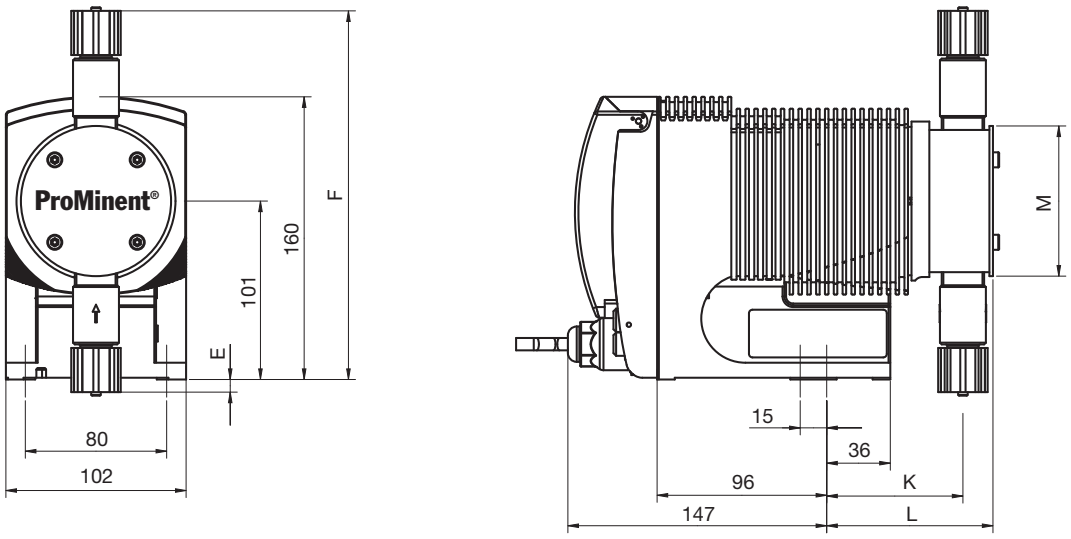


Fig. 28

Dimensions in mm

	gamma/ L M70 1000 - 1601	1602	1005	0708 - 0220	gamma/ L M85 1605	1008 - 0420	0232
E	32	25	23	-7	23	-7	-15
F	170	178	179	209	179	209	217
K	78	72	75	77	75	77	78
L	91	87	90	95	90	95	97
M	51 (Ø 60)	66 (Ø 70)	68 (Ø 80)	81 (Ø 85)	68 (Ø 80)	81 (Ø 85)	96 (Ø 100)

SST material version

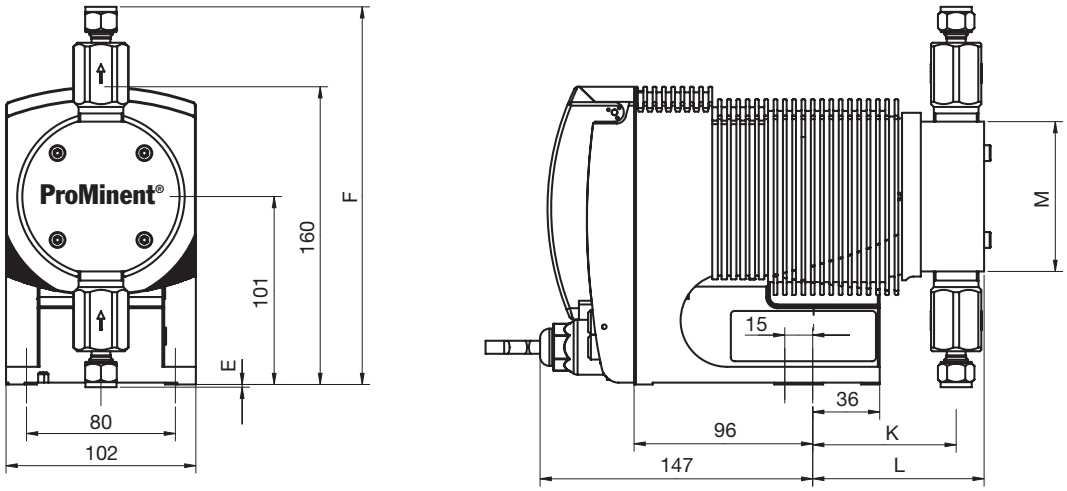
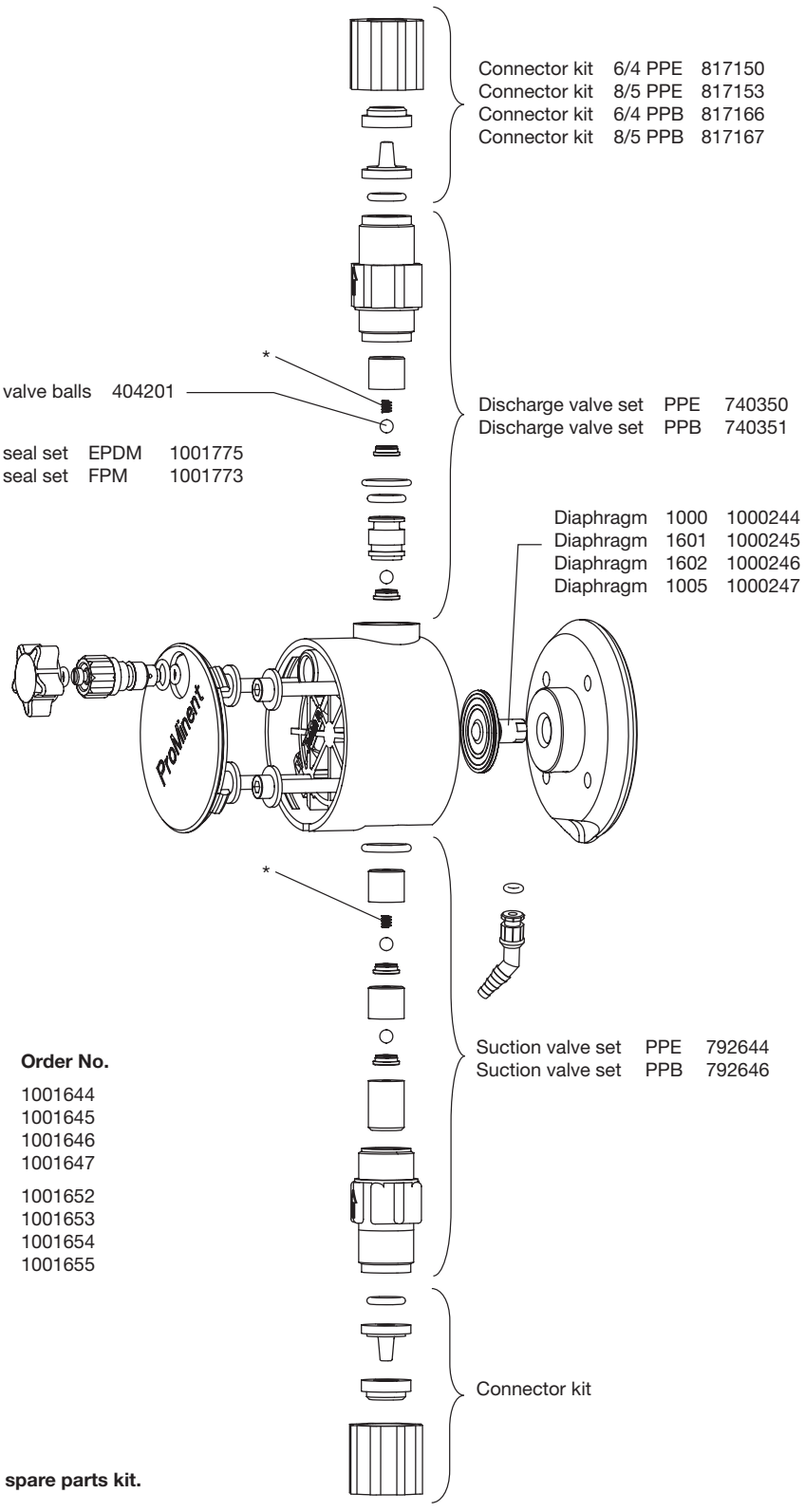


Fig. 29

Dimensions in mm

	gamma/ L M70					gamma/ L M85			
	1000 - 1601	1602	1005	0708 - 0413	0220	1605	1008 - 0713	0420	0232
E	40	33	31	-2	-3	31	-2	-3	-10
F	162	170	171	203	204	171	203	204	212
K	78	72	75	77	77	75	77	77	78
L	89	85	88	93	93	88	93	93	95
M	51 (Ø 60)	66 (Ø 70)	68 (Ø 80)	81 (Ø 85)	81 (Ø 85)	81 (Ø 80)	81 (Ø 85)	81 (Ø 85)	96 (Ø 100

Liquid end 1000 - 1005 (1605)
PP with coarse/fine bleed



Spare parts kits for:

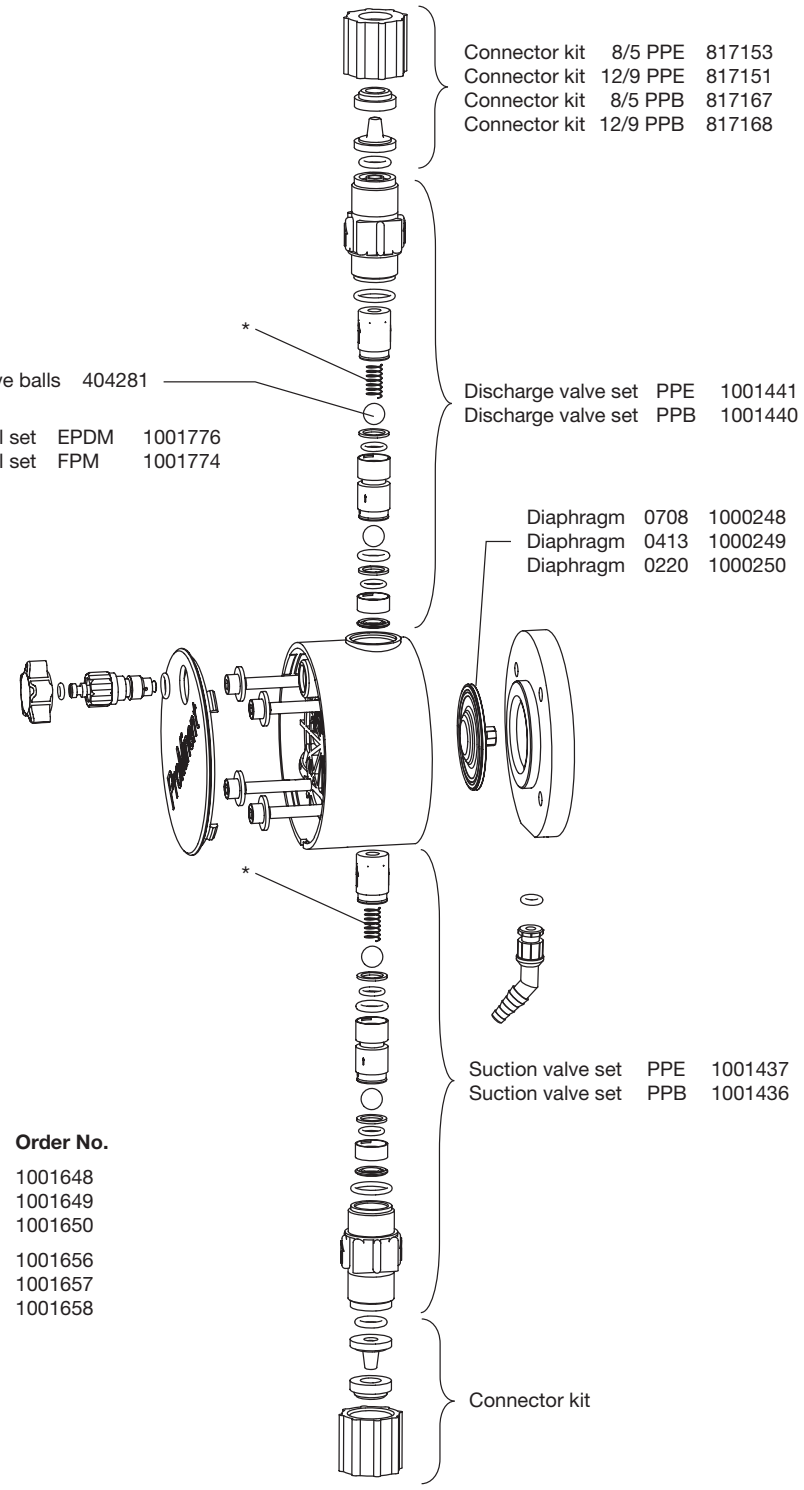
Type	Material	Order No.
1000	PPE	1001644
1601	PPE	1001645
1602	PPE	1001646
1005 (1605)	PPE	1001647
1000	PPB	1001652
1601	PPB	1001653
1602	PPB	1001654
1005 (1605)	PPB	1001655

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_18-04_2

Liquid end 0708 (1008) - 0220 (0420)
PP with coarse/fine bleed



Spare parts kits for:

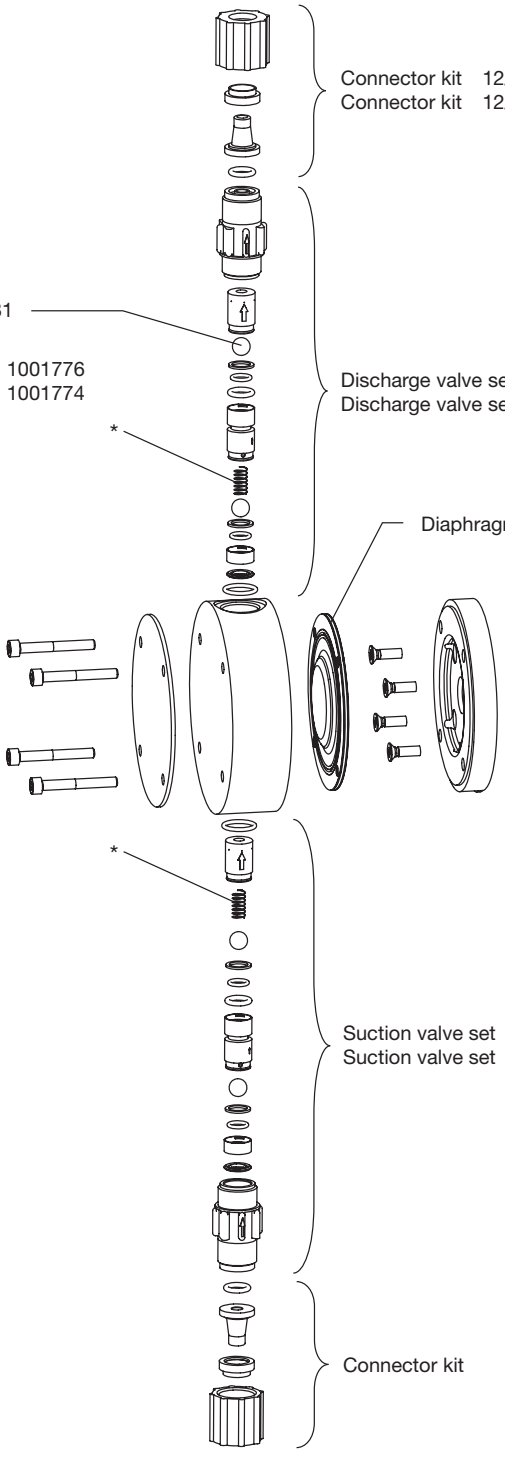
Type	Material	Order No.
0708 (1008)	PPE	1001648
0413 (0713)	PPE	1001649
0220 (0420)	PPE	1001650
0708 (1008)	PPB	1001656
0413 (0713)	PPB	1001657
0220 (0420)	PPB	1001658

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_19-04_2

Liquid end 0232
PP without coarse/fine bleed



Spare parts kits for:

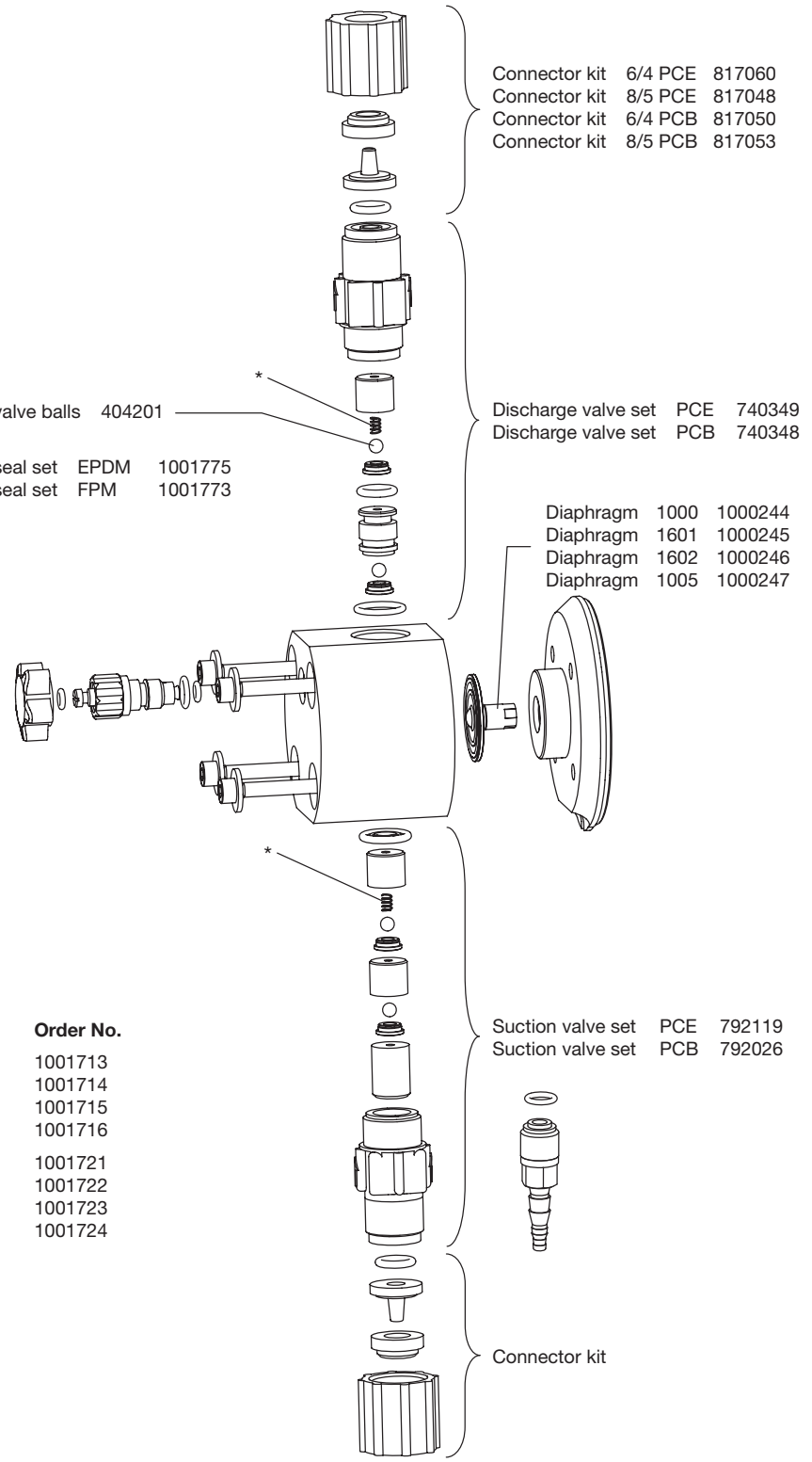
Type	Material	Order No.
0232	PPE	1001651
0232	PPB	1001659

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_40-04_2

Liquid end 1000 - 1005 (1605)
NP with coarse/fine bleed



Spare parts kits for:

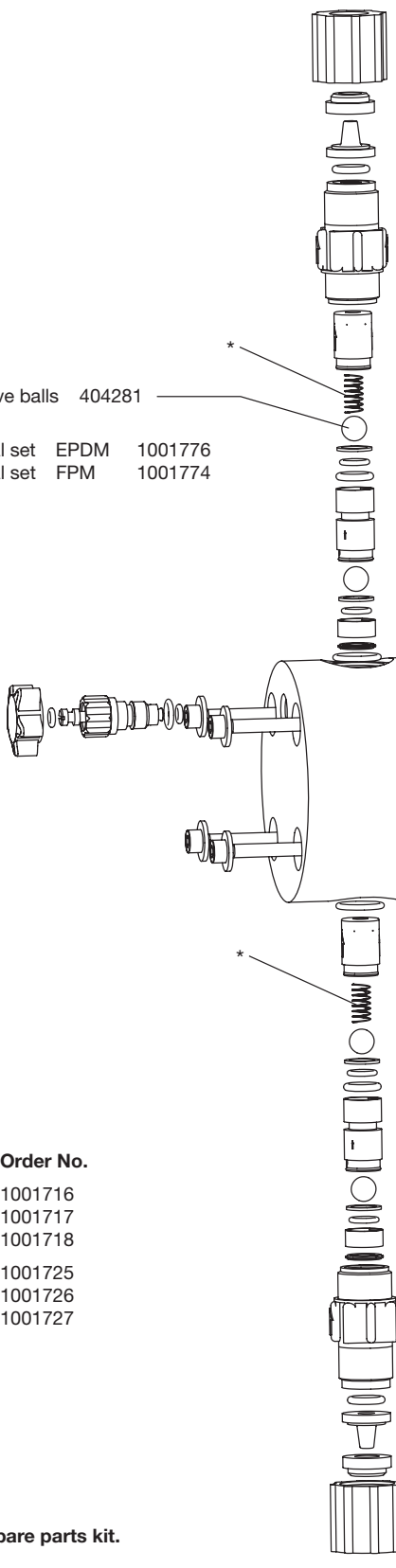
Type	Material	Order No.
1000	NPE	1001713
1601	NPE	1001714
1602	NPE	1001715
1005 (1605)	NPE	1001716
1000	NPB	1001721
1601	NPB	1001722
1602	NPB	1001723
1005 (1605)	NPB	1001724

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_23-04_2

Liquid end 0708 (1008) - 0220 (0420)
NP with coarse/fine bleed



Connector kit 8/5 PCE 817048
Connector kit 12/9 PCE 817049
Connector kit 8/5 PCB 817053
Connector kit 12/9 PCB 817051

*

4 valve balls 404281

1 seal set EPDM 1001776
1 seal set FPM 1001774

Discharge valve set PCE 1001439
Discharge valve set PCB 1001438

Diaphragm 0708 1000248
Diaphragm 0413 1000249
Diaphragm 0220 1000250

*

Suction valve set PCE 1001435
Suction valve set PCB 1001434

Connector kit

Spare parts kits for:

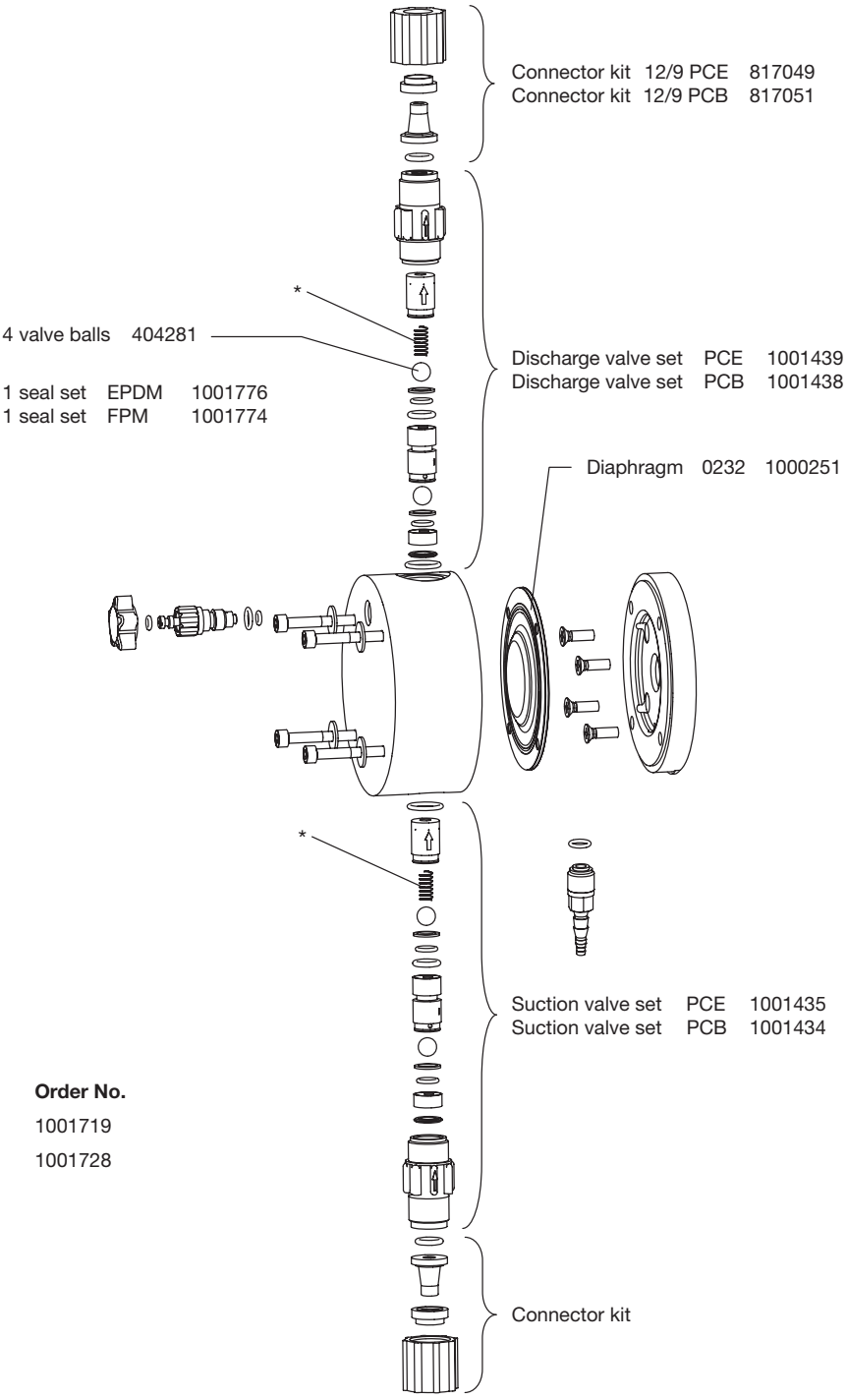
Type	Material	Order No.
0708 (1008)	NPE	1001716
0413 (0713)	NPE	1001717
0220 (0420)	NPE	1001718
0708 (1008)	NPB	1001725
0413 (0713)	NPB	1001726
0220 (0420)	NPB	1001727

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_24-04_2

Liquid end 0232
NP with coarse/fine bleed



Spare parts kits for:

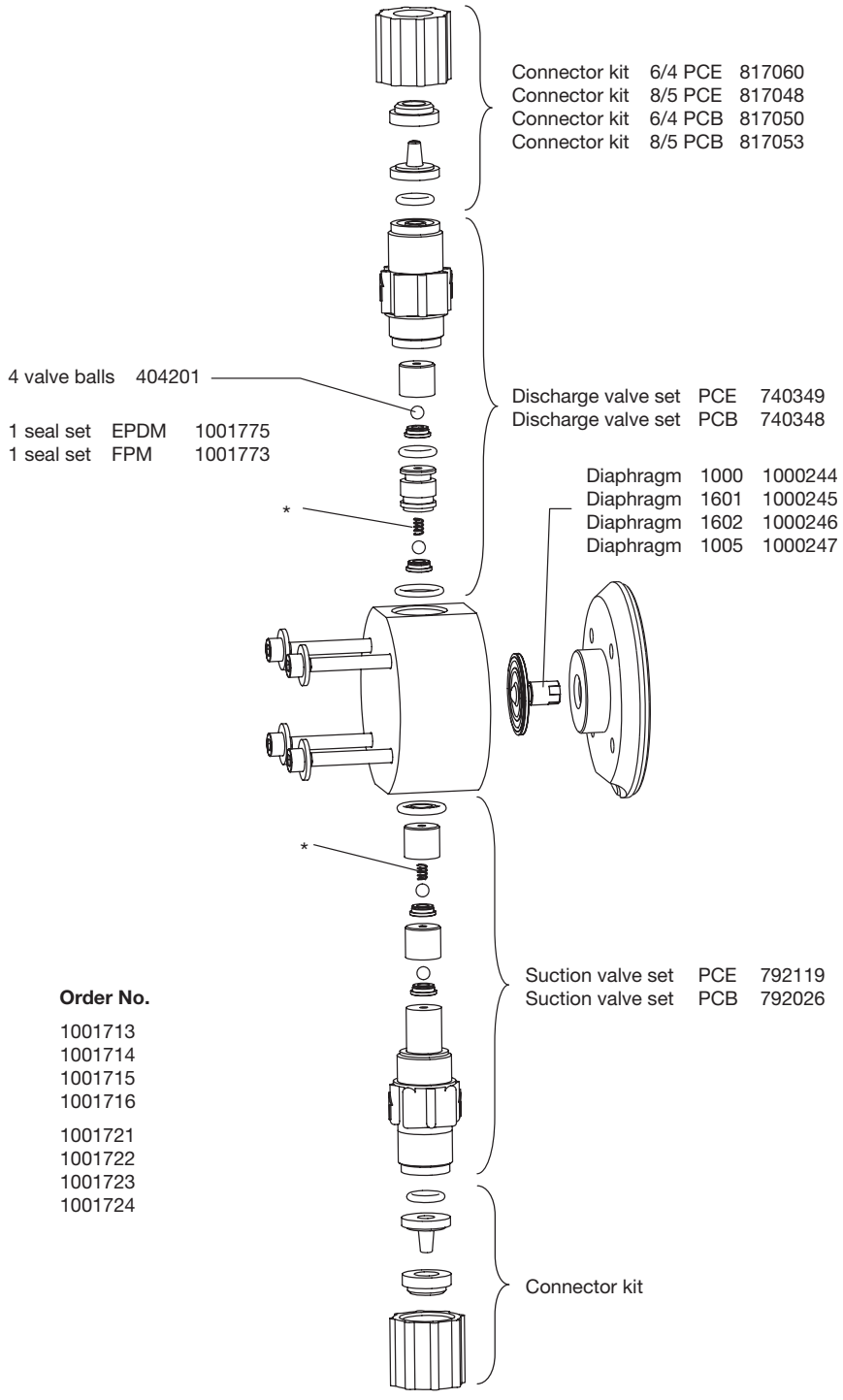
Type	Material	Order No.
0232	NPE	1001719
0232	NPB	1001728

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_34-04_2

Liquid end 1000 - 1005 (1605)
NP without coarse/fine bleed



Spare parts kits for:

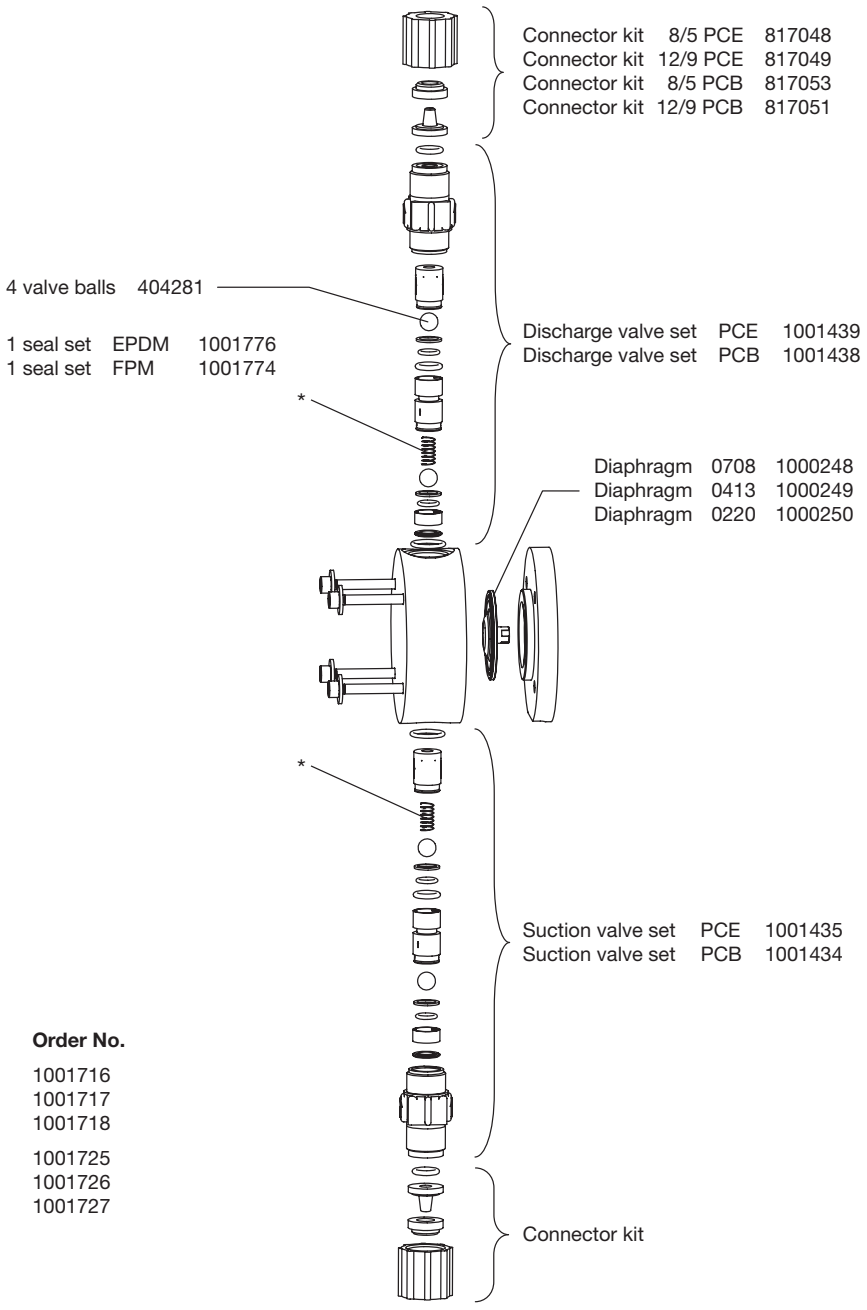
Type	Material	Order No.
1000	PCE / NPE	1001713
1601	PCE / NPE	1001714
1602	PCE / NPE	1001715
1005 (1605)	PCE / NPE	1001716
1000	PCB / NPB	1001721
1601	PCB / NPB	1001722
1602	PCB / NPB	1001723
1005 (1605)	PCB / NPB	1001724

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_21-04_2

Liquid end 0708 (1008) - 0220 (0420)
NP without coarse/fine bleed



Spare parts kits for:

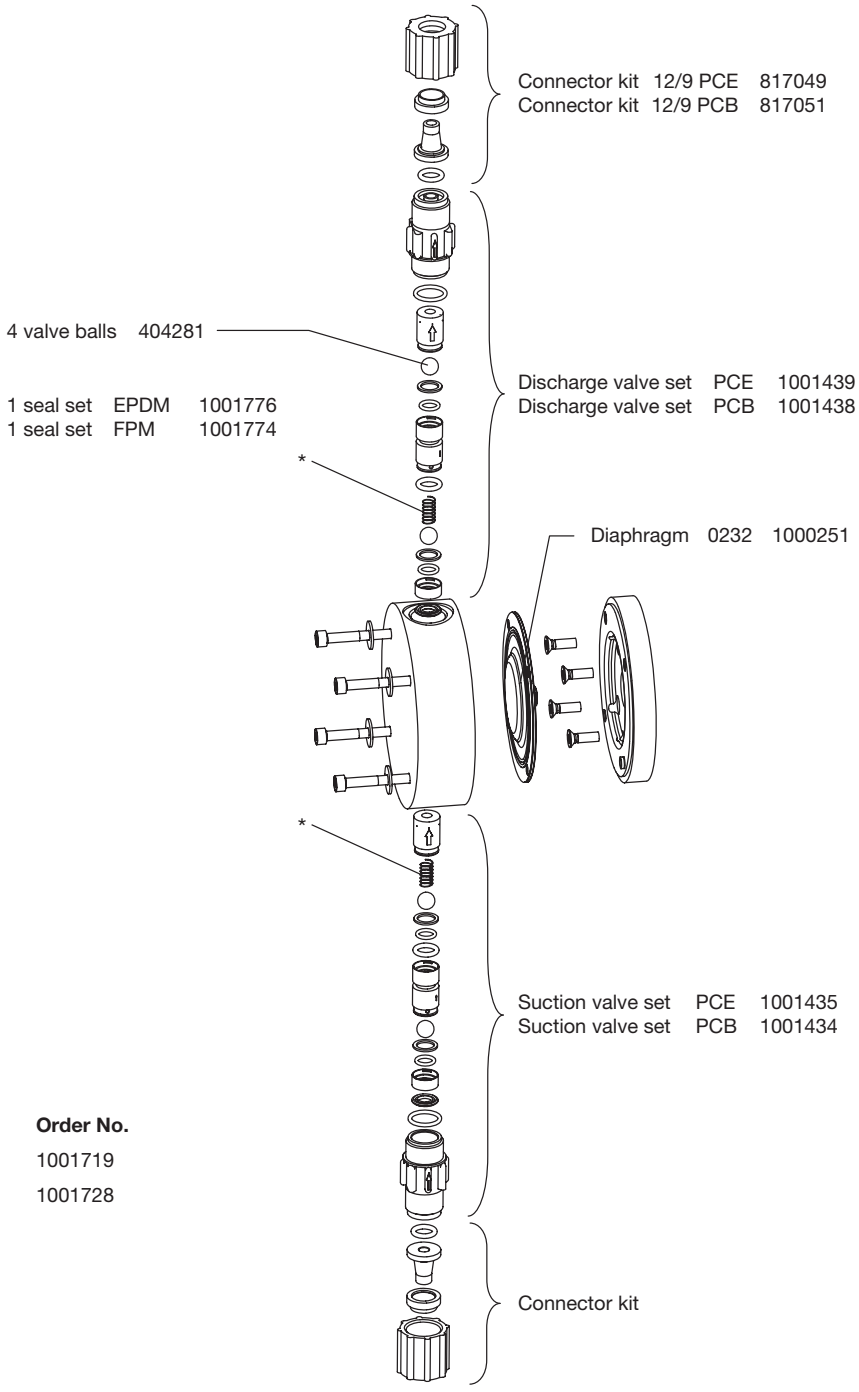
Type	Material	Order No.
0708 (1008)	NPE	1001716
0413 (0713)	NPE	1001717
0220 (0420)	NPE	1001718
0708 (1008)	NPB	1001725
0413 (0713)	NPB	1001726
0220 (0420)	NPB	1001727

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_22-04_2

Liquid end 0232
NP without coarse/fine bleed



Spare parts kits for:

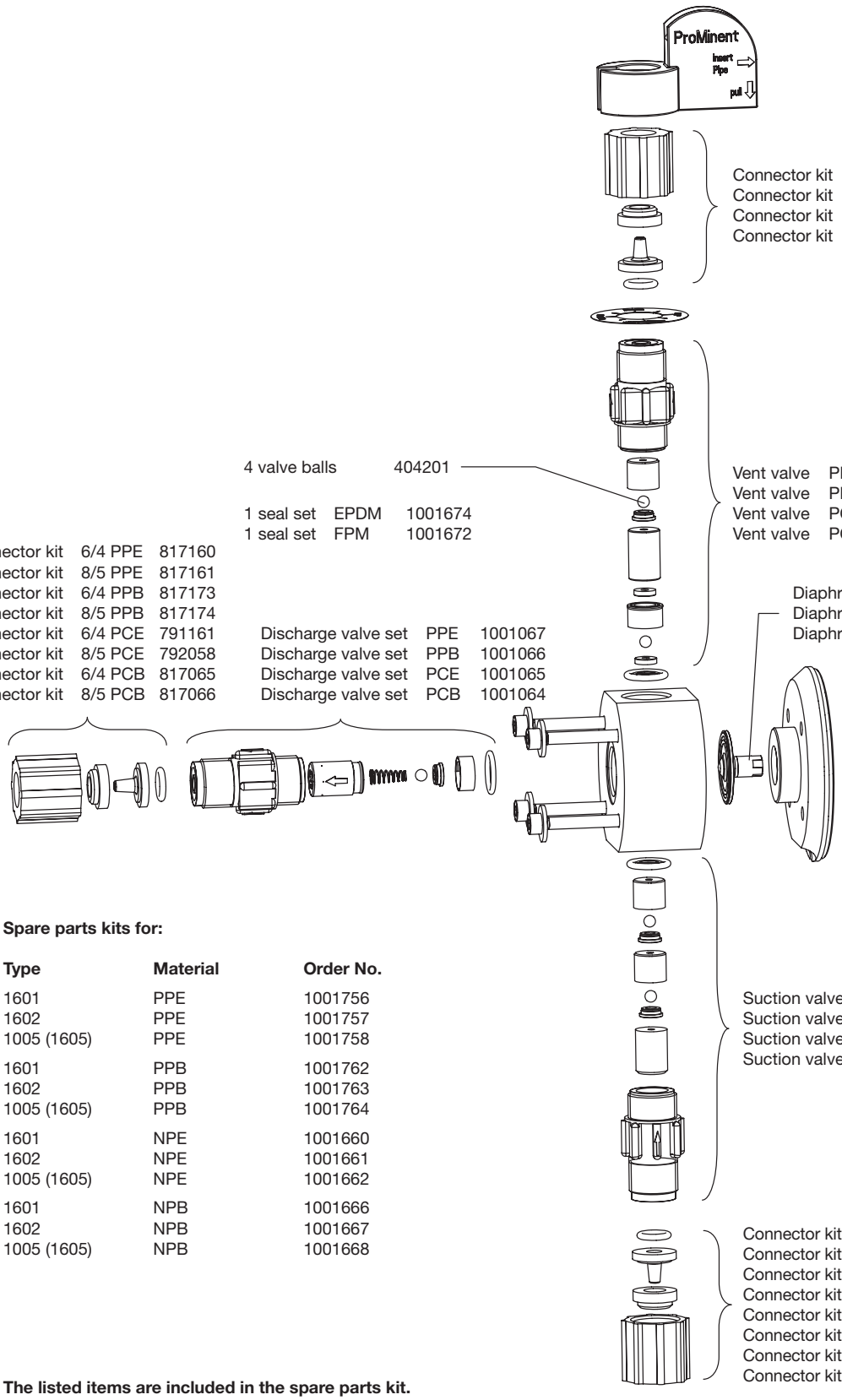
Type	Material	Order No.
0232	NPE	1001719
0232	NPB	1001728

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_20-04_2

Liquid end 1601 - 1005 (1605)
PP / NP self-degassing



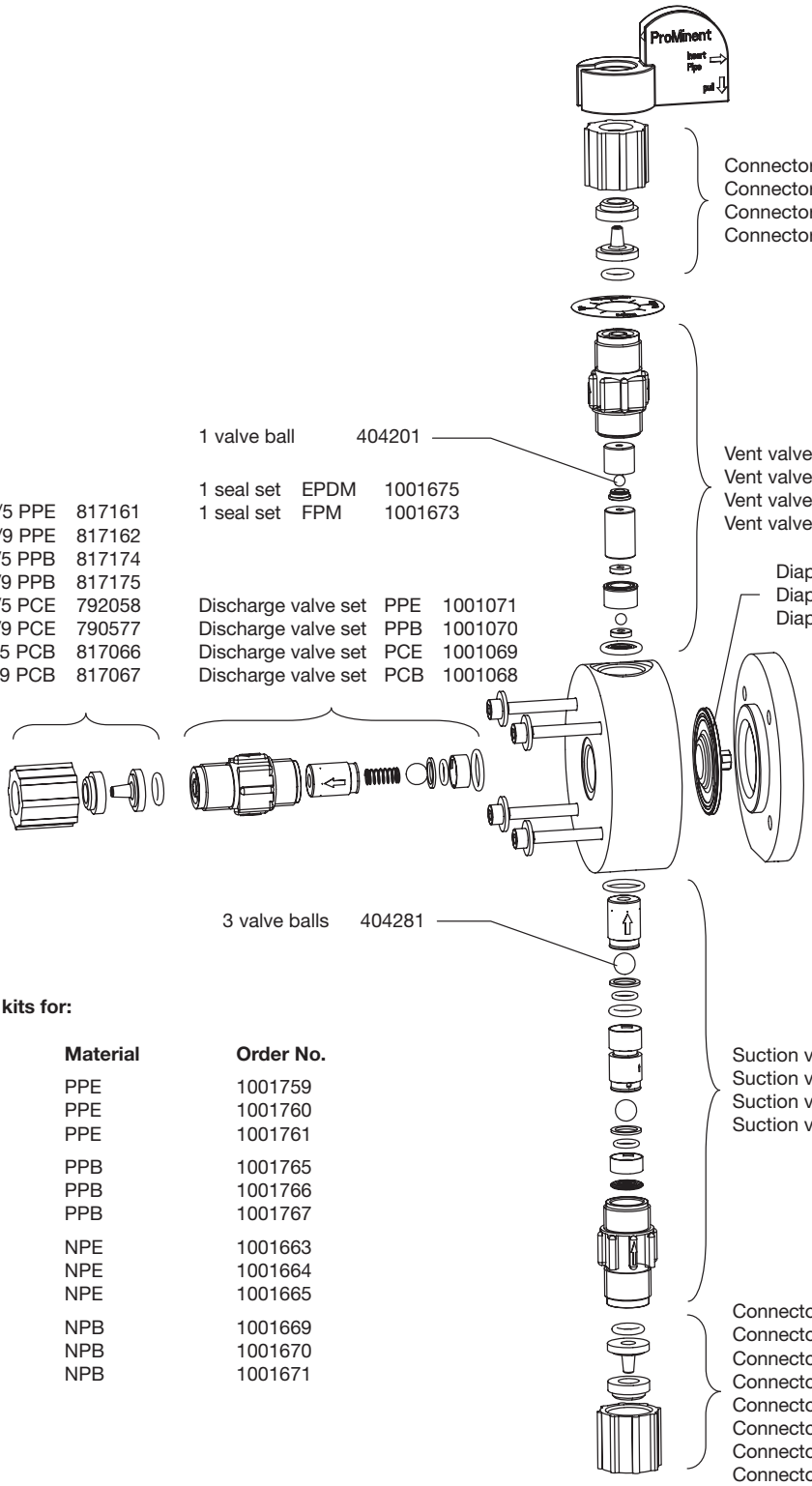
Spare parts kits for:

Type	Material	Order No.
1601	PPE	1001756
1602	PPE	1001757
1005 (1605)	PPE	1001758
1601	PPB	1001762
1602	PPB	1001763
1005 (1605)	PPB	1001764
1601	NPE	1001660
1602	NPE	1001661
1005 (1605)	NPE	1001662
1601	NPB	1001666
1602	NPB	1001667
1005 (1605)	NPB	1001668

The listed items are included in the spare parts kit.

Subject to technical alterations.

Liquid end 0708 (1008) - 0220 (0420)
PP / NP self-degassing



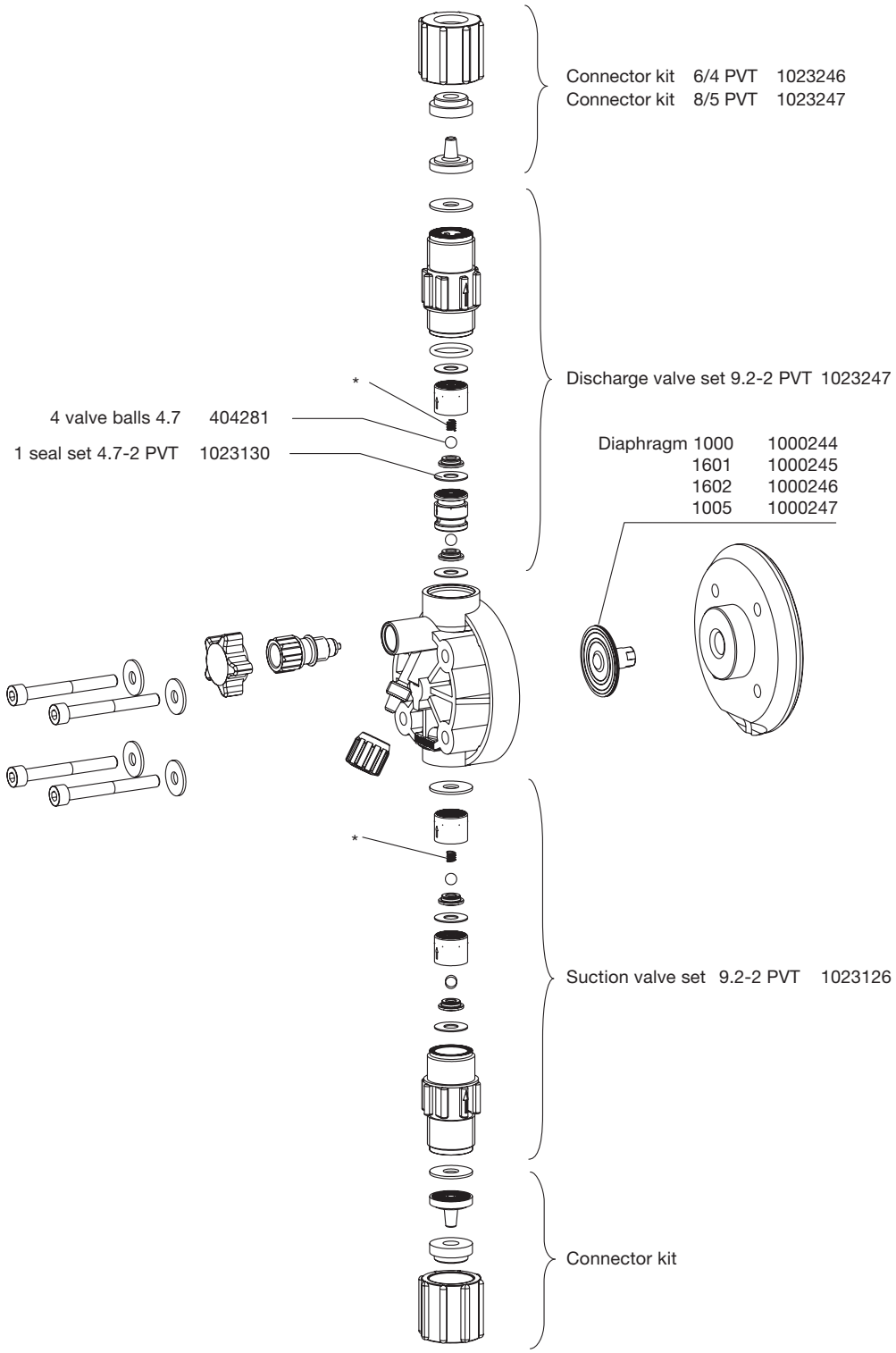
Spare parts kits for:

Type	Material	Order No.
0708 (1008)	PPE	1001759
0413 (0713)	PPE	1001760
0220 (0420)	PPE	1001761
0708 (1008)	PPB	1001765
0413 (0713)	PPB	1001766
0220 (0420)	PPB	1001767
0708 (1008)	NPE	1001663
0413 (0713)	NPE	1001664
0220 (0420)	NPE	1001665
0708 (1008)	NPB	1001669
0413 (0713)	NPB	1001670
0220 (0420)	NPB	1001671

The listed items are included in the spare parts kit.

Subject to technical alterations.

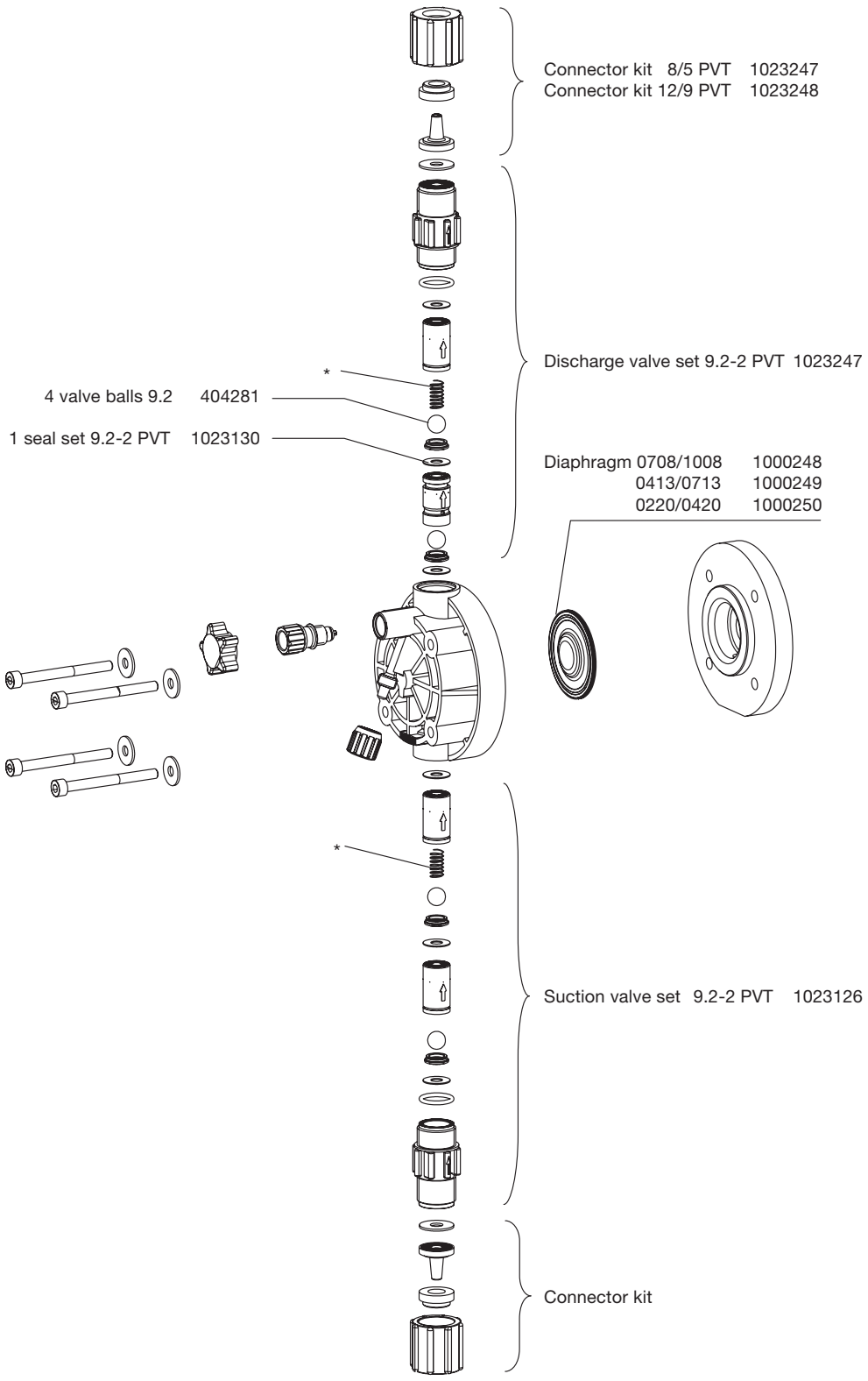
Liquid end 1000-1005 (1605)
PVT with bleed



The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

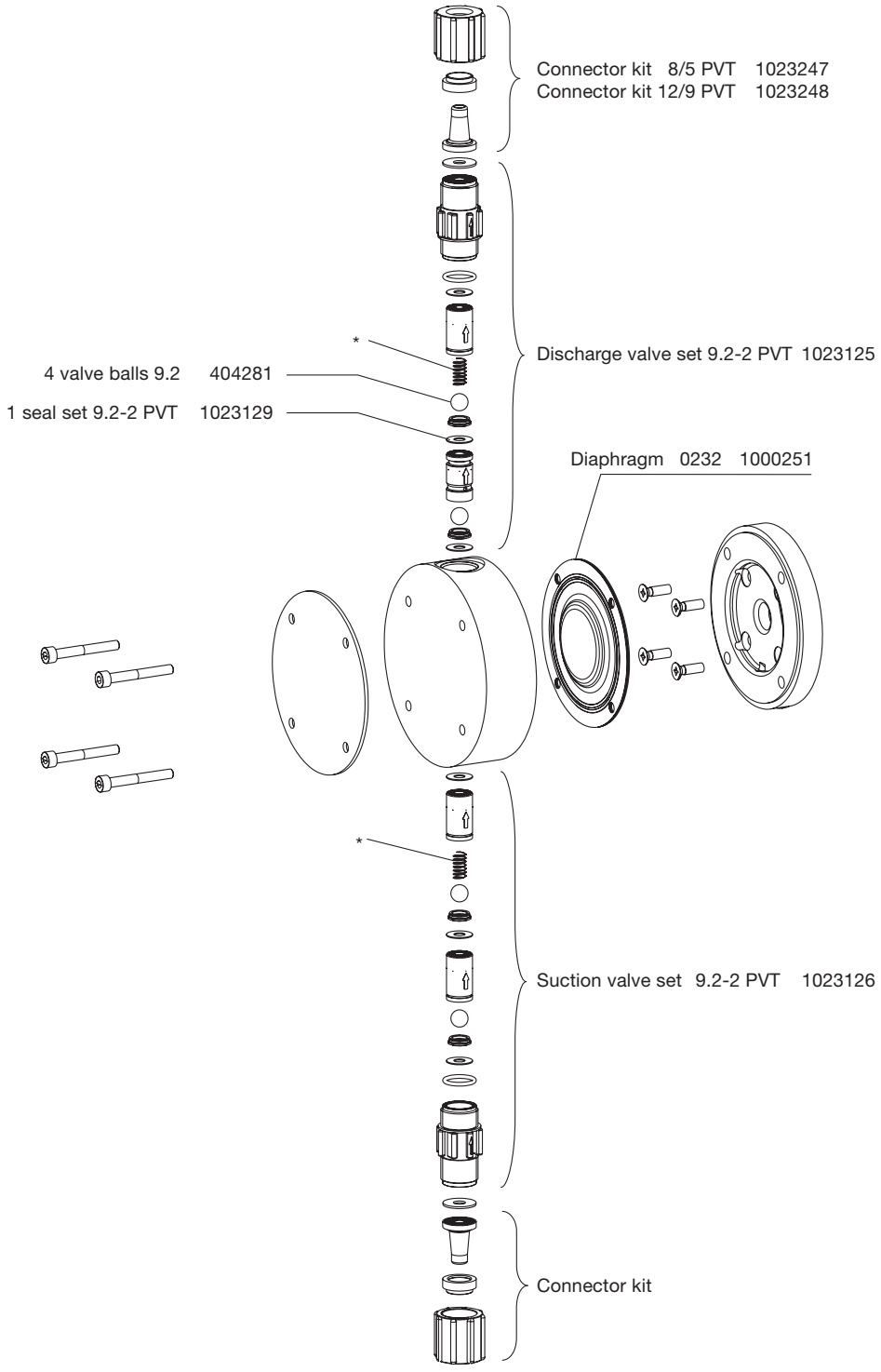
Liquid end 0708 (1008) - 0220 (0420)
PVT with bleed



The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

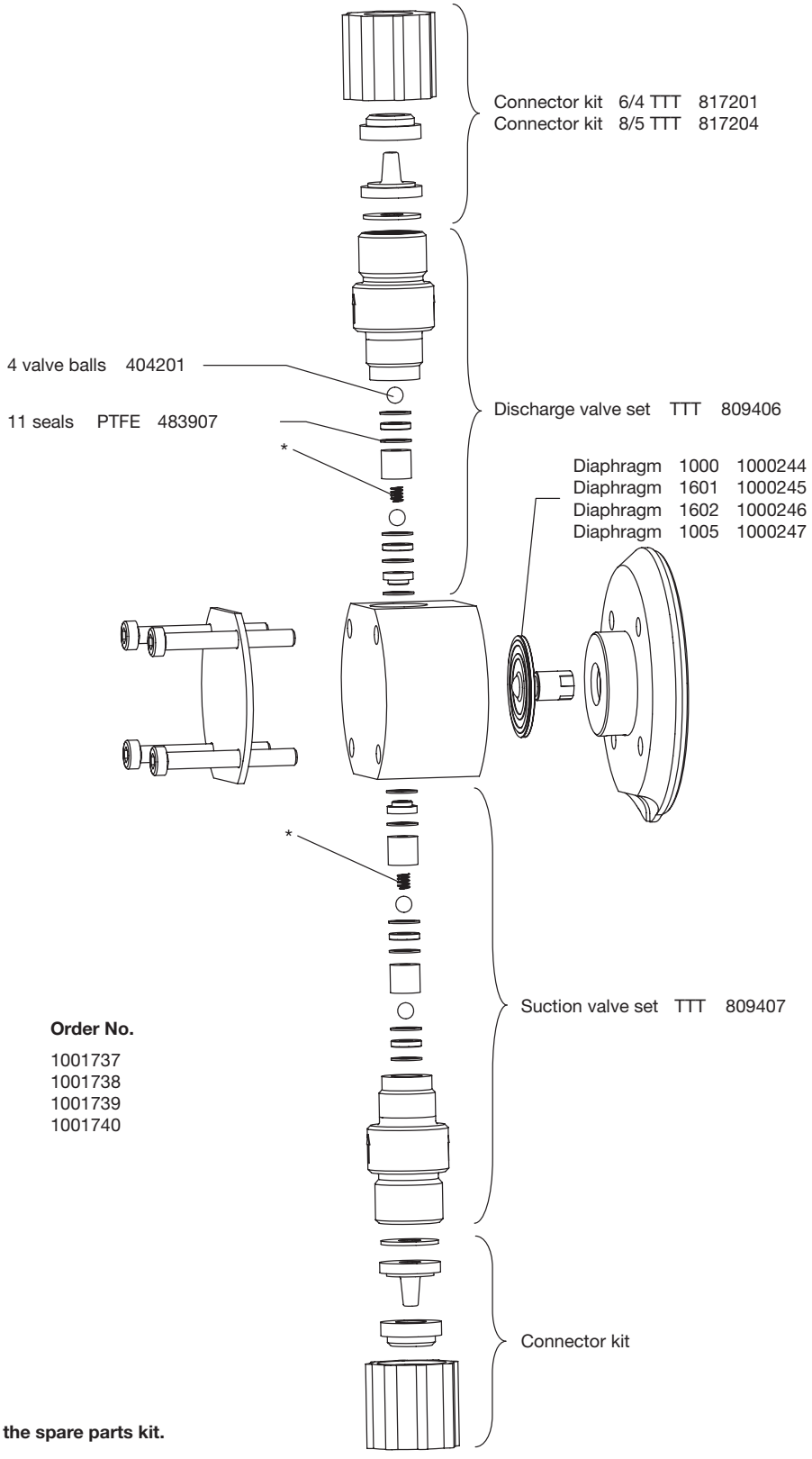
Liquid end 0232
PVT without bleed



The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

Liquid end 1000 - 1005 (1605)
TT



Spare parts kits for:

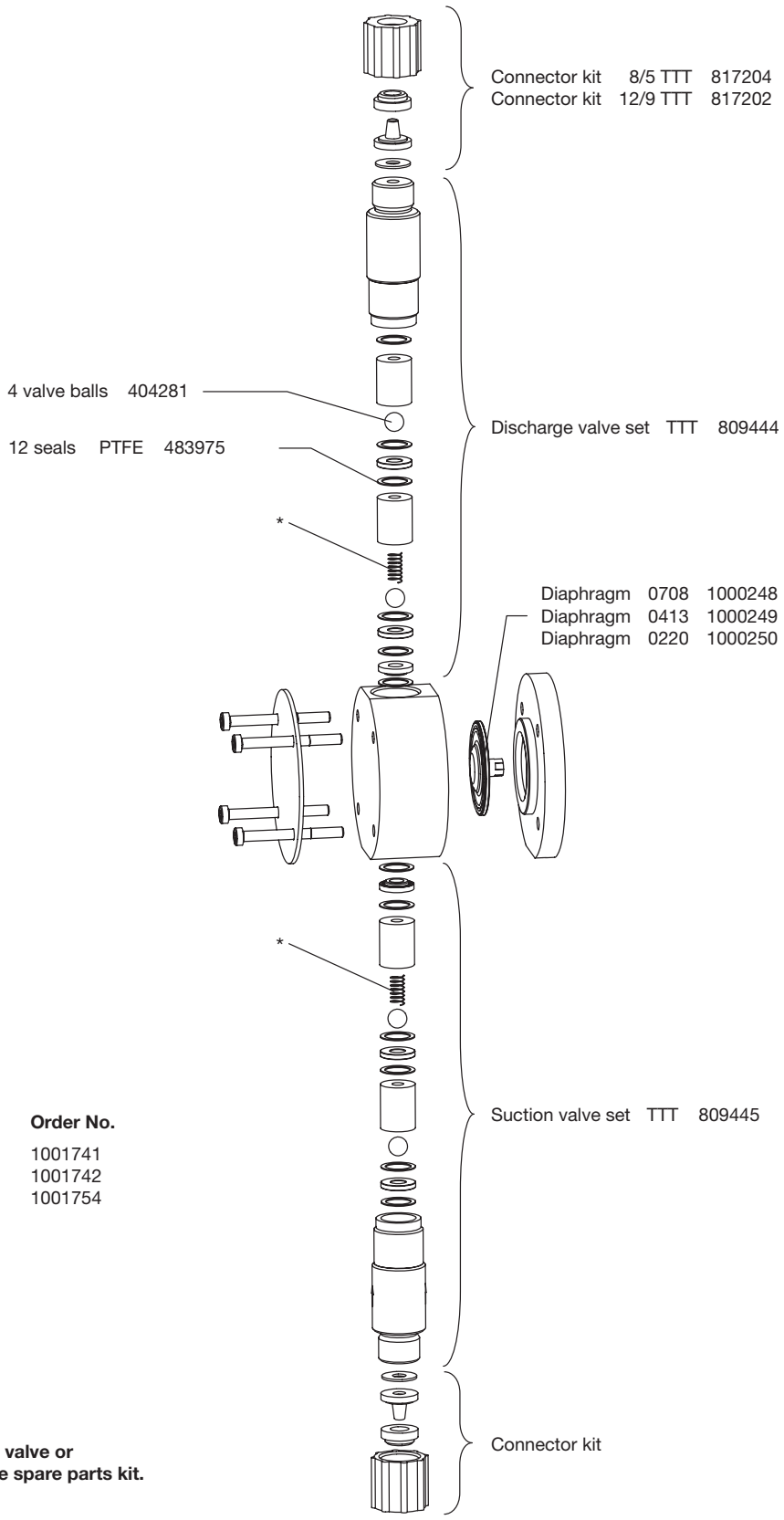
Type	Material	Order No.
1000	TTT	1001737
1601	TTT	1001738
1602	TTT	1001739
1005 (1605)	TTT	1001740

The listed items are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_29-04_2

Liquid end 0708 (1008) - 0220 (0420)
TT



Spare parts kits for:

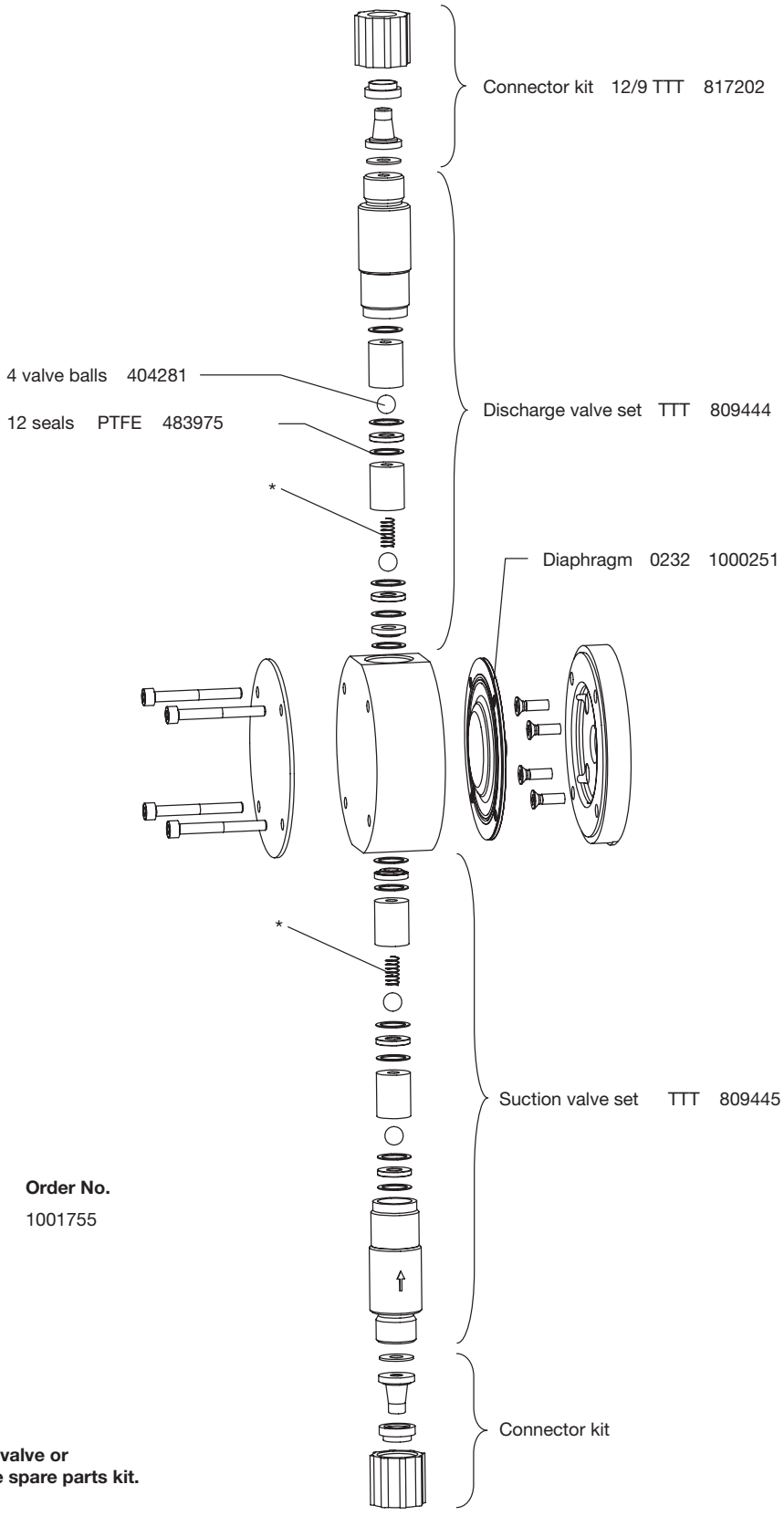
Type	Material	Order No.
0708 (1008)	TTT	1001741
0413 (0713)	TTT	1001742
0220 (0420)	TTT	1001754

The listed items without a suction valve or discharge valve are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_30-04_2

Liquid end 0232
TT



Spare parts kits for:

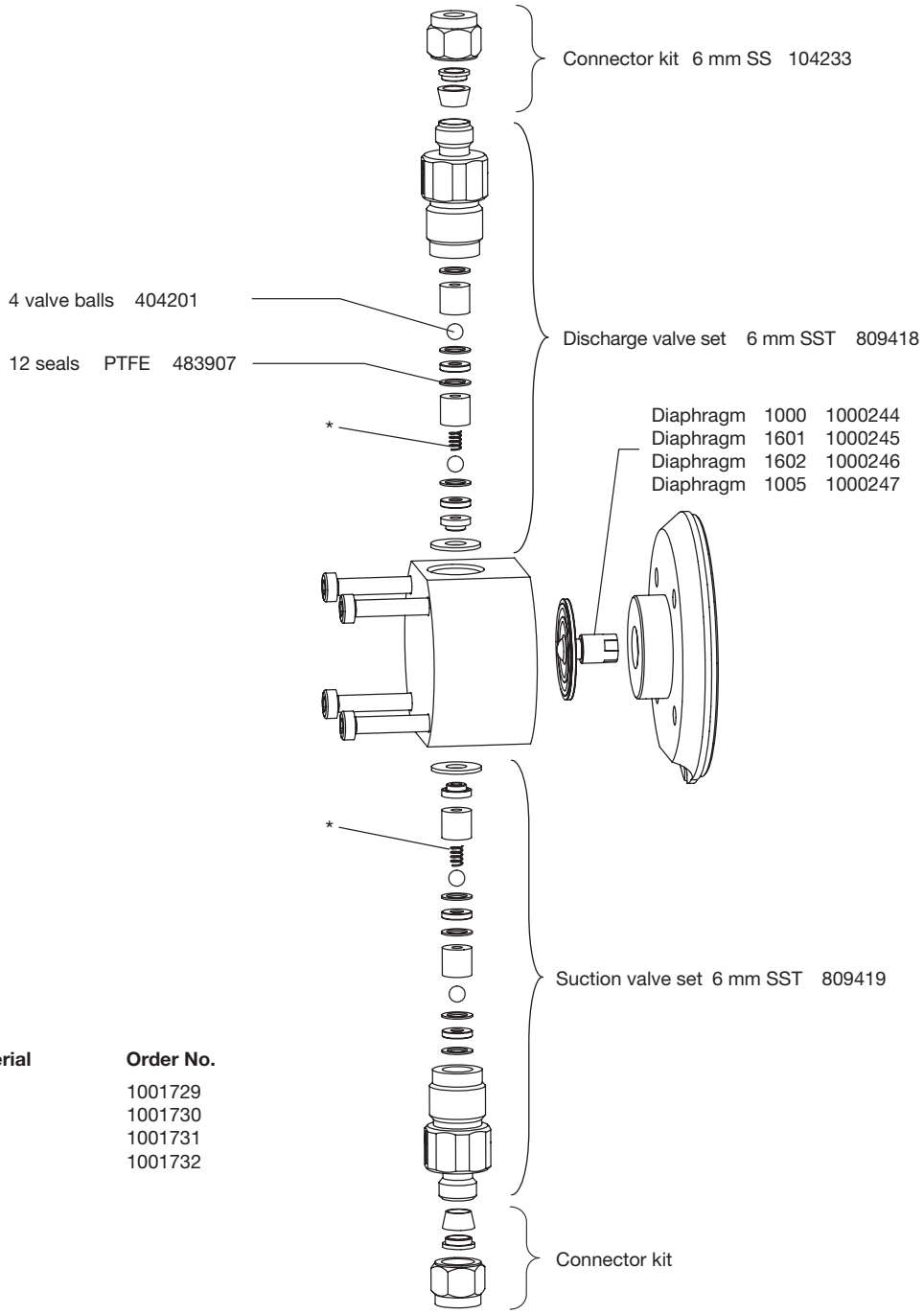
Type	Material	Order No.
0232	TTT	1001755

The listed items without a suction valve or discharge valve are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_35-04_2

Liquid end 1000 - 1005 (1605)
SS



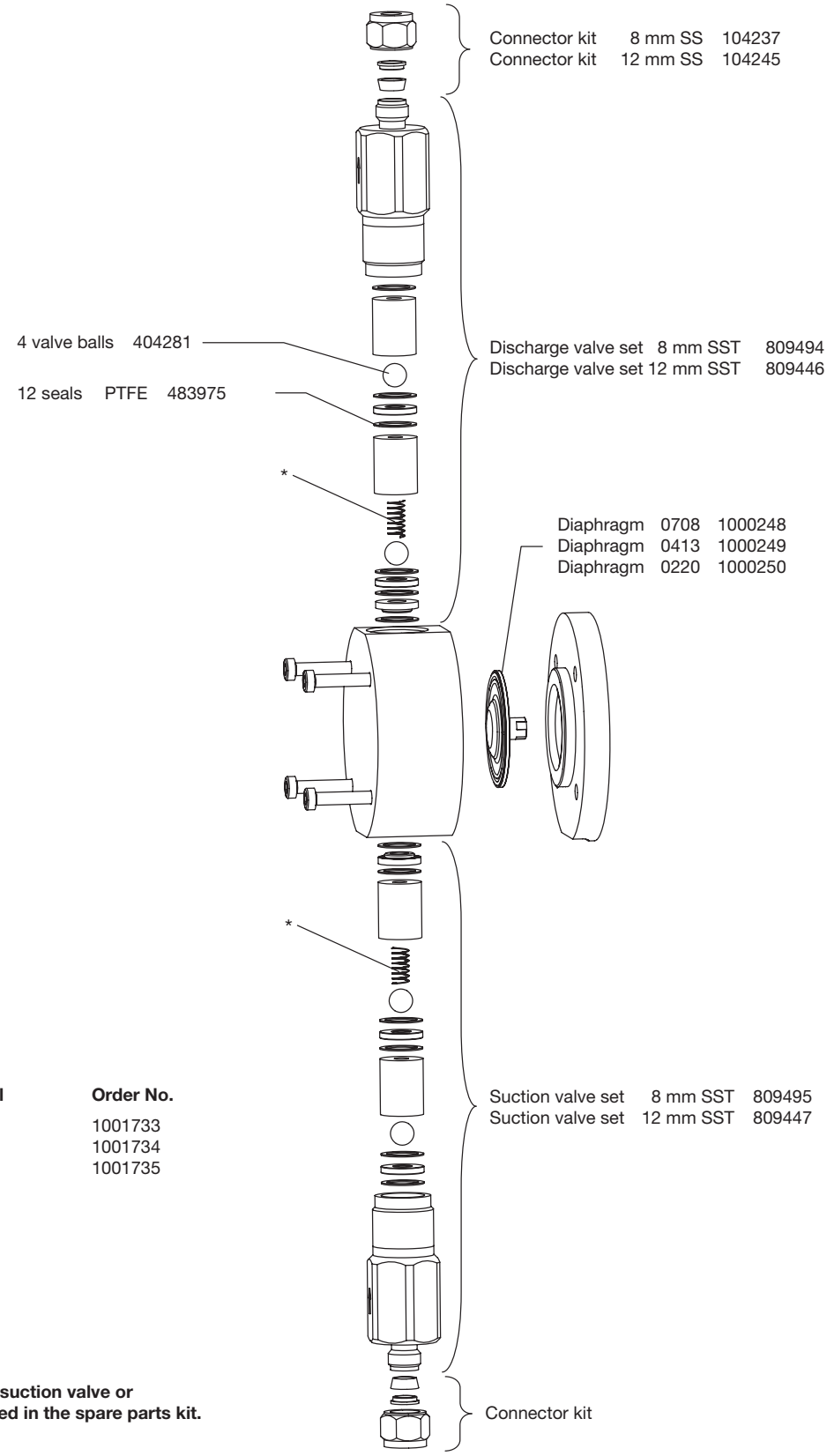
Spare parts kits for:

Type	Material	Order No.
1000	SST	1001729
1601	SST	1001730
1602	SST	1001731
1005 (1605)	SST	1001732

The listed items without a suction valve or discharge valve are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

Liquid end 0708 (1008) - 0220 (0420)
SS



Spare parts kits for:

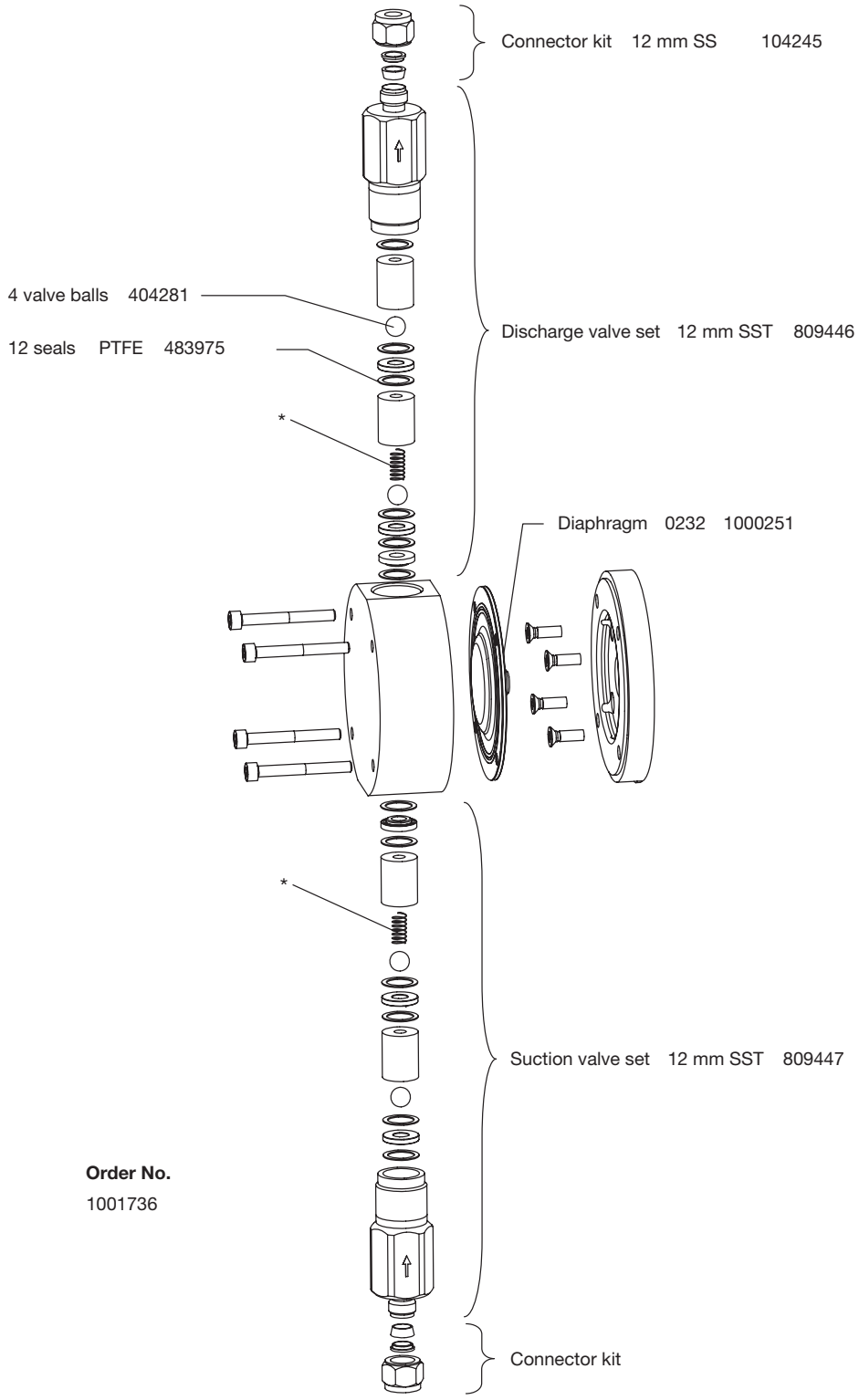
Type	Material	Order No.
0708 (1008)	SST	1001733
0413 (0713)	SST	1001734
0220 (0420)	SST	1001735

The listed items without a suction valve or discharge valve are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_26-04_2

Liquid end 0232
SS



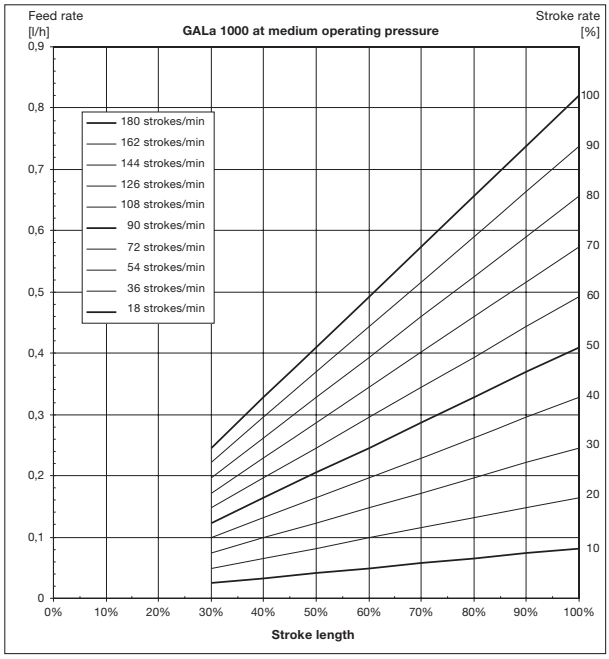
Spare parts kits for:

Type	Material	Order No.
0232	SST	1001736

The listed items without a suction valve or discharge valve are included in the spare parts kit.
*** Customer accessories**

Subject to technical alterations.

60_07-104_00_36-04_2


Feed rate
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GALa 1000 at medium operating pressure
Stroke rate
[%]
180 strokes/min
162 strokes/min
144 strokes/min
126 strokes/min
108 strokes/min
90 strokes/min
72 strokes/min
54 strokes/min
36 strokes/min
18 strokes/min
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
100
90
80
70
60
50
40
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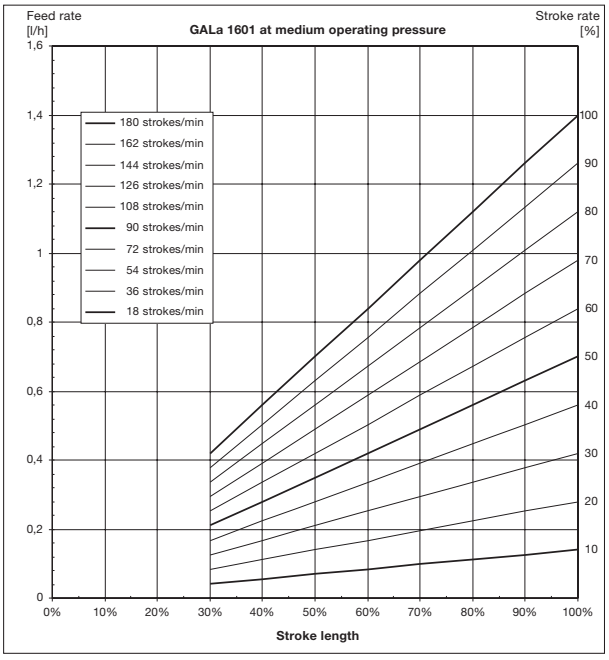
20%
30%
40%
50%
60%
70%
80%
90%
100%
Stroke length


Feed rate
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GALa 1601 at medium operating pressure
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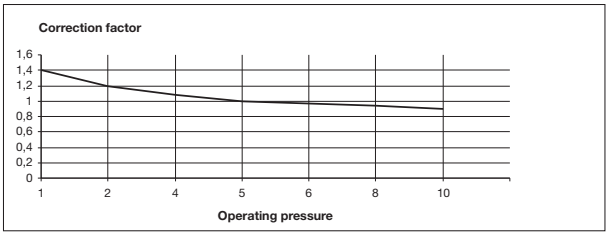
126 strokes/min
108 strokes/min
90 strokes/min
72 strokes/min
54 strokes/min
36 strokes/min
18 strokes/min
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
100
90
80
70
60
50
40
30
20
10
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Stroke length


Correction factor
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1
2
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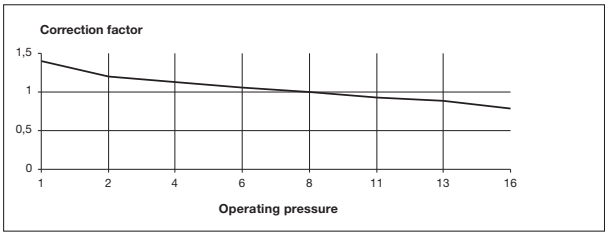
6
8
10
Operating pressure


Correction factor
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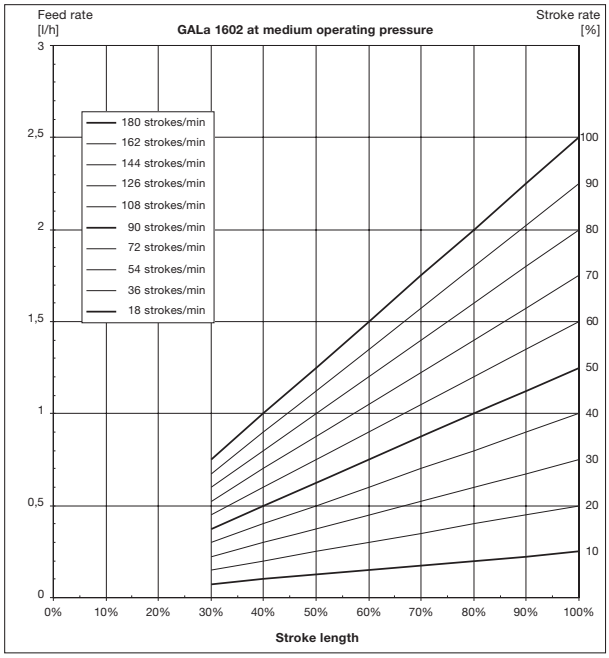
2
4
6
8
11
13
16
Operating pressure


Feed rate
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108 strokes/min
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72 strokes/min
54 strokes/min
36 strokes/min
18 strokes/min
3
2,5
2
1,5
1
0,5
0
100
90
80
70
60
50
40
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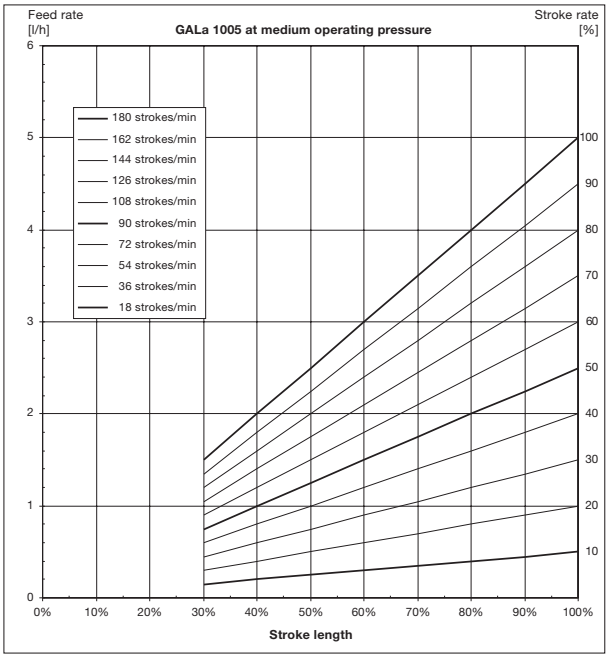
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Stroke length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5
4
3
2
1
0
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80
70
60
50
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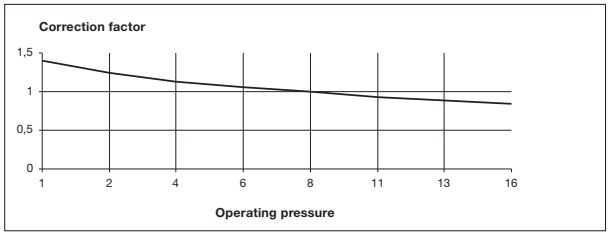
30%
40%
50%
60%
70%
80%
90%
100%
Stroke length


Correction factor
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0,5
0
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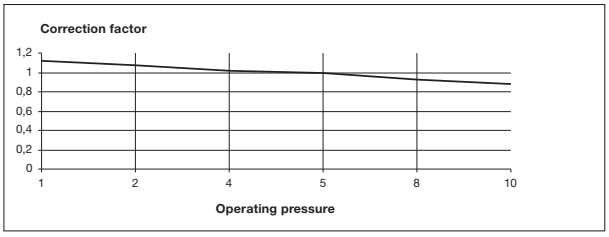
2
4
6
8
11
13
16
Operating pressure


Correction factor
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1
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0,6
0,4
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1
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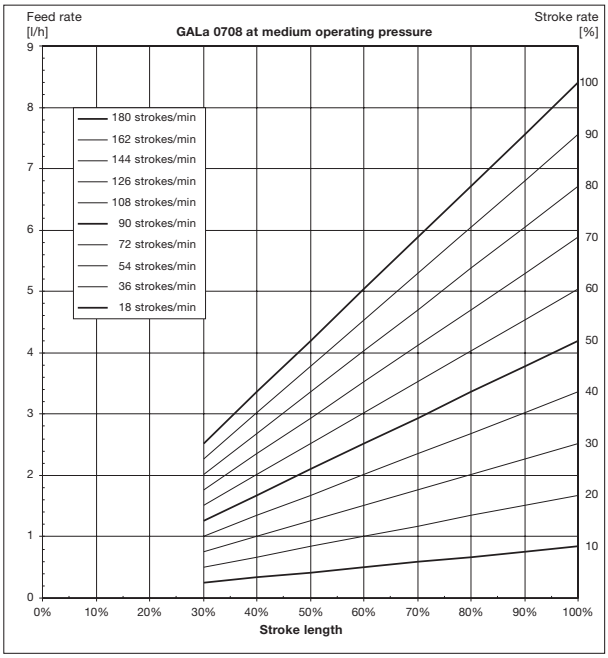
4
5
8
10
Operating pressure


Feed rate
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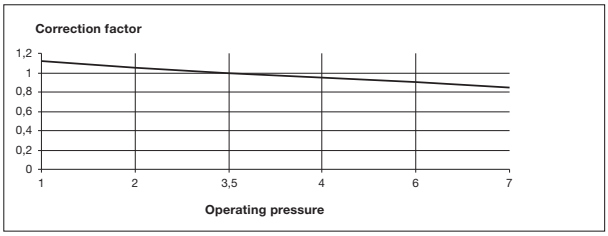
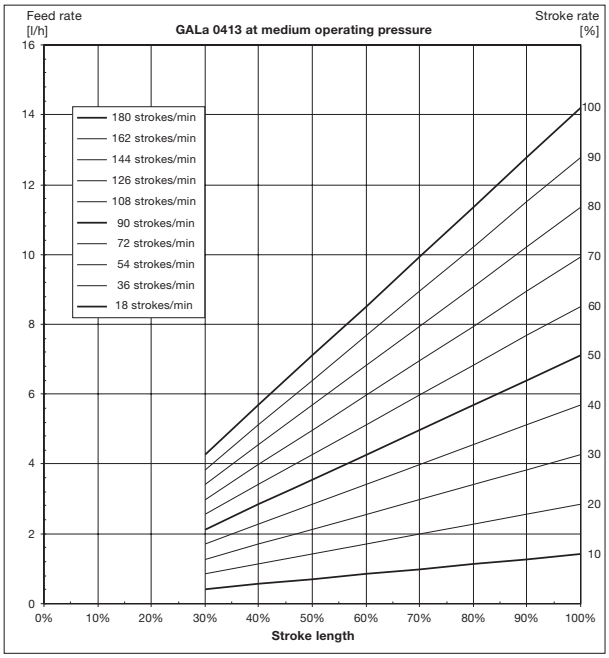
Stroke length


Correction factor
Operating pressure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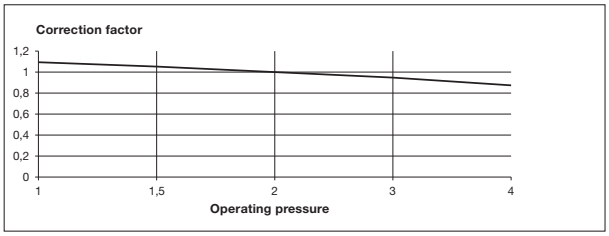
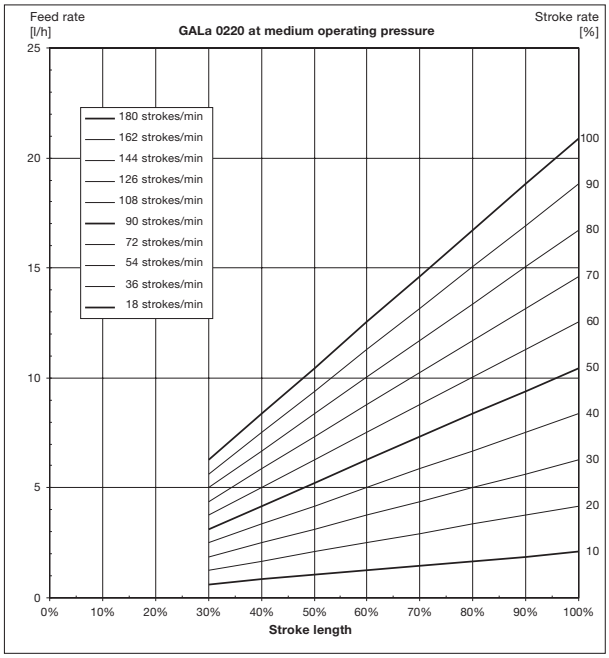

Correction factor
Operating pressure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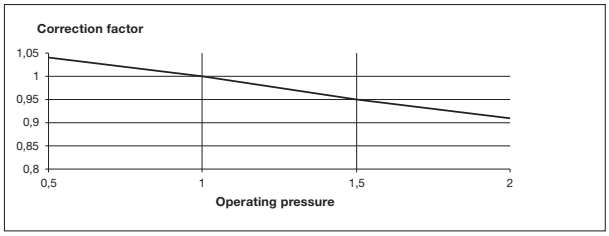
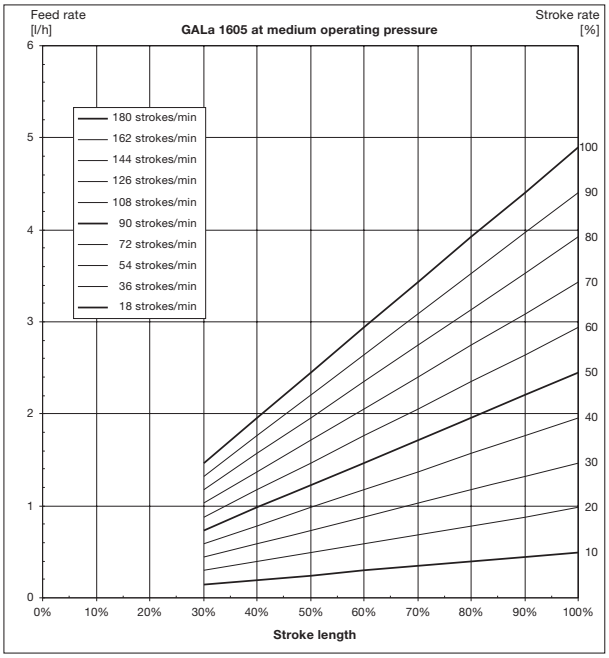
Stroke length


Correction factor
Operating pressure


Feed rate
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GALa 1605 at medium operating pressure
Stroke rate
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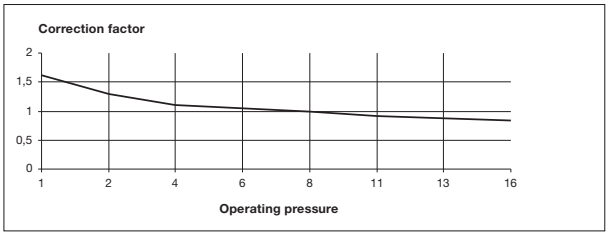
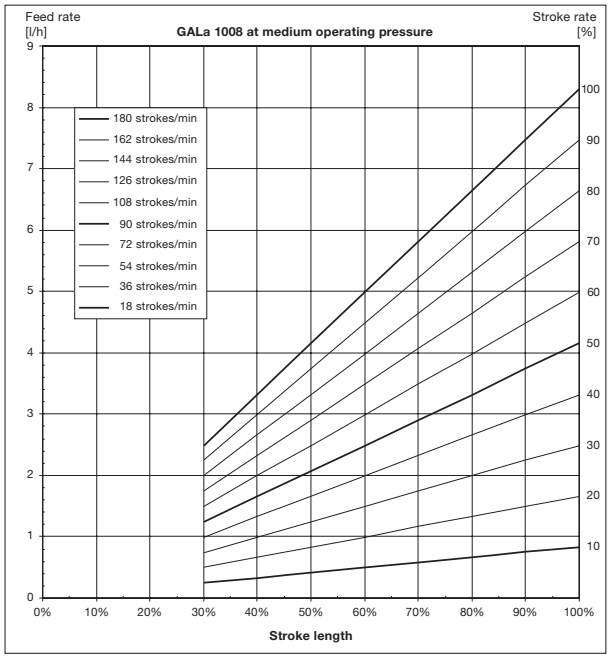
18 strokes/min
Stroke length


Correction factor
Operating pressure


Feed rate
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GALa 1008 at medium operating pressure
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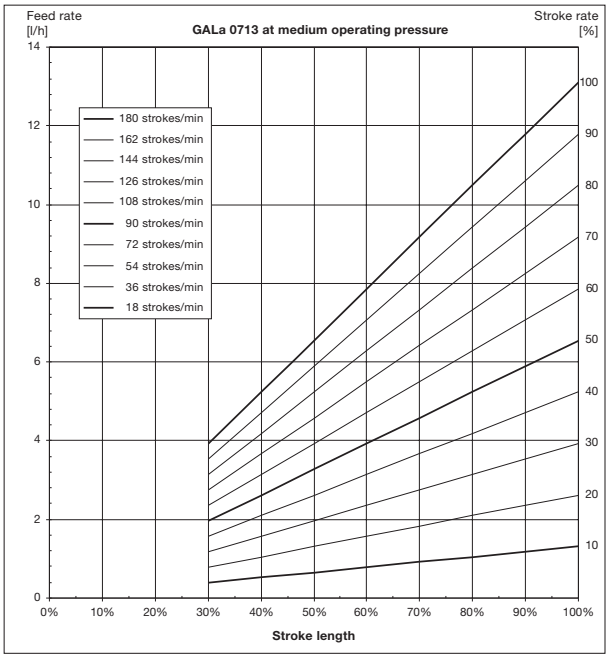
36 strokes/min
18 strokes/min
Stroke length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GALa 0713 at medium operating pressure
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108 strokes/min
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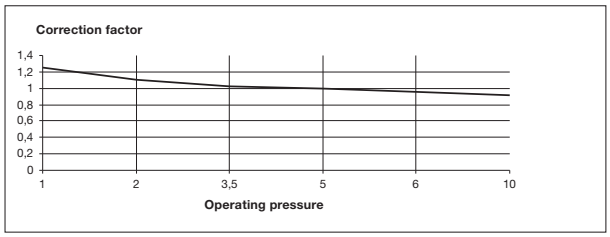
36 strokes/min
18 strokes/min
Stroke length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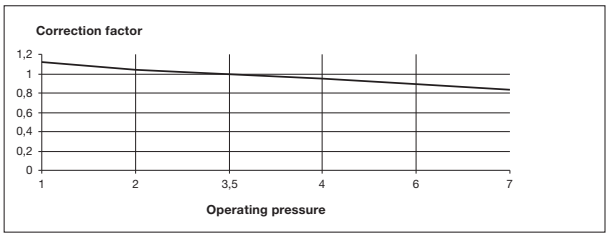
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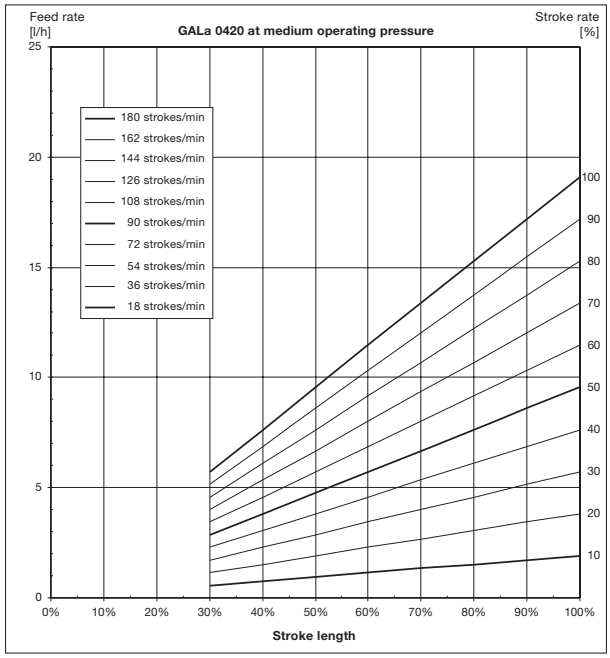
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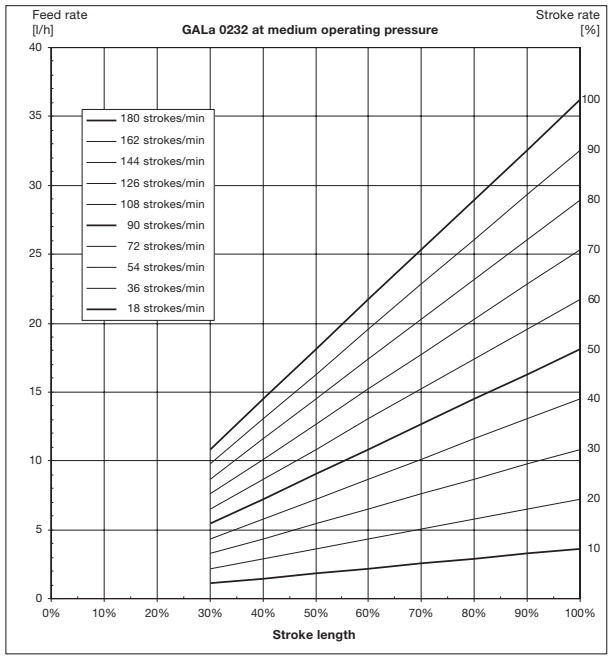
18 strokes/min
Stroke length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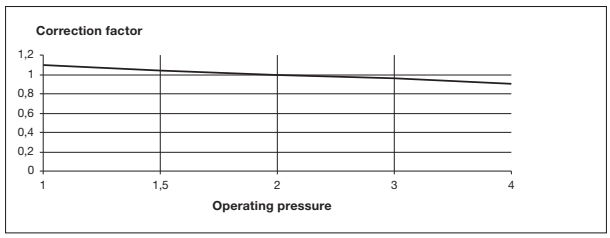
Stroke length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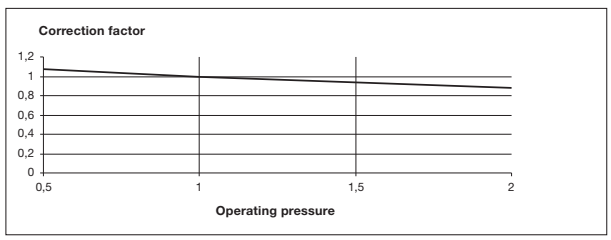
Correction factor
Operating pressure

EC Declaration of Conformity

We,

ProMinent Dosiertechnik GmbH
Im Schuhmachergewann 5 - 11
D - 69123 Heidelberg

hereby declare that, on the basis of its functional concept and design and in the version brought into circulation by us, the product specified in the following complies with the relevant, fundamental safety and health stipulations laid down by EC regulations.
Any modification to the product not approved by us will invalidate this declaration.

Product description :	***Metering pump, series Gamma L***
Product type :	***GALa***
Serial number :	***see type identification plate on device***
Relevant EC directives :	***EC - machine directive 98/37/EC*** ***EC - low voltage directive 73/23/EEC*** ***EC - EMC - directive (89/336/EEC) subsequently 92/31 EEC***
Harmonised standards used, in particular :	***DIN EN 292-1, DIN EN 292-2, DIN EN 809*** ***DIN EN 60335-1, DIN EN 60335-2-41, DIN EN 50106*** ***DIN EN 50081-1/2, DIN EN 55011, DIN EN 61000-3-3*** ***DIN EN 50082-1/2, DIN EN 61000-4-2/3/4/5/6/11***
National standards and other technical specifications used, in particular :	***DIN VDE 0700 T1*** ***DIN VDE 0700 T41*** ***DIN VDE 0700 T500*** ***IEC 1000-3-3, IEC 1000-4-2/3/4/5/6/11***
Date/manufacturer´s signature :	***02. Nov 99***
The undersigned :	*Dr. Rainer V. Dulger, Executive Vice President R&D and Production*

Die ProMinent Firmengruppe / The ProMinent Group

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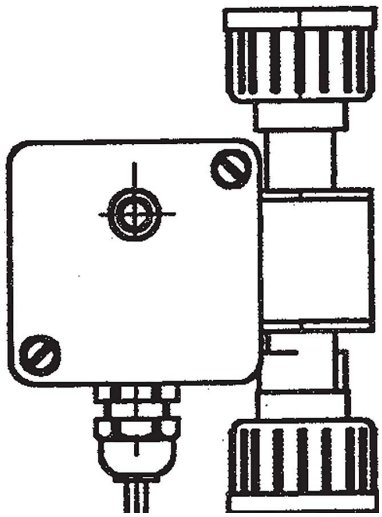
ProMinent®
Dosierüberwachung
ProMinent Flow Control

Betriebsanleitung
Instruction Manual



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T.Nr./P.No. 981409 ProMinent Dosiertechnik GmbH · D-69123 Heidelberg · Germany BA MAZ 007 1/97 G/GB

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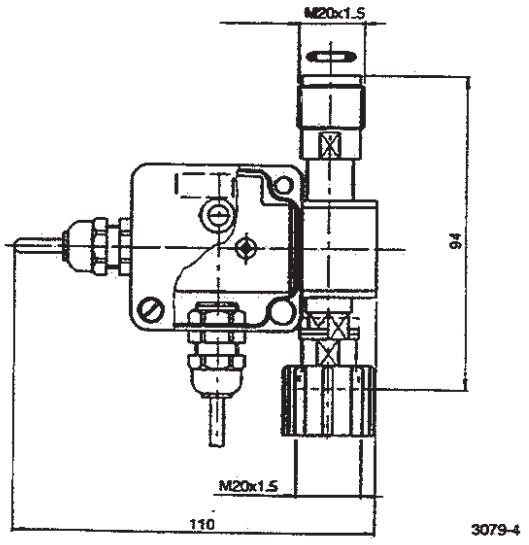


1. Description of the metering monitor "flow control"

The "flow control" type metering monitor is a turn-key monitor with a switching amplifier and connection cable with four-pin circular connector to be directly connected to the solenoid-driven gamma/ 4 and gamma/ 5 metering pumps and the motor-driven Vario type metering pump. It is used for monitoring the stroke volume of the individual stroke according to the floating body principle.

The materials in contact with the media are PVC/Viton or PP/EPDM. Please consult the table with the technical data for information regarding the respective pumps for the individual sizes.

1.1 Functional description

With every discharge stroke, the float in the pipe is raised upwards and in doing so dips into the ring initiator, whereby the electronics send on a pulse to the pump and the red LED illuminates for the period the float is submerged.

The height of the ring initiator can be adjusted and so it can be adapted to different stroke volumes within the limits specified.

If the capacity drops by a certain degree (approx. 20–30 % of the set displacement volume) no more pulses are sent to the pump by the flow monitor. The pump recognises this as a metering error and after 8 missing acknowledged pulses, a fault annuciation is emitted.

For pump g/4-1601, the metering monitor can only function at a stroke length of ≥ 50% under an operating pressure of 16 bar due to the low flow rate. A stroke length of ≥ 30% is achieved at an operating pressure of 3 bar. For pumps g/4-1201, g/4-1002 and g/5-1602 the minimum stroke length is 45% at the respective maximum operating pressure.

When pumping highly viscous media, the electronic control system can be set in such a way that with the float submerged, pulses at a rate of 3 Hz are constantly issued (outsmart switching), as with highly viscous media there is no guarantee that the float will sink after each stroke, i.e. the float possibly remains submerged over a longer period.

Please note:
The pressure loss, in particular arising in the case of the gamma/ 5 pump due to the characteristic stroke curve (for media with a similar viscosity to water), can amount up to 2 bar for the largest gamma and Vario models, in the case of highly viscous media this figure can of course be higher.

This is to be taken into consideration when selecting the pump and the layout of the discharge lines with additional pressure losses.

Caution: The metering monitor is not a substitute for the float switch. Depending on the set stroke quantity and backpressure there may be no fault indication during air delivery. For this reason, a minimum operating pressure of approx. 1 bar is recommended. Install a level switch if low level is signalled. Magnetic or magnetisable components in the metered medium can cause faults.

2. Installation

2.1 Safety instructions

- The maximum permissible operating pressure for the pumps used may not be exceeded in any operating condition.
- The unions of the flow monitor as well as the connections to the discharge line must be free of leaks when operating under maximum operating pressure.

2.2 Installation

2.2.1 Metering monitor with M 20 x 1.5 connection

- The metering monitor may only be installed in a vertical position.
- Usually the metering monitor is assembled directly onto the delivery connection of the metering pump.
- Before assembly, check by shaking whether the float is moving freely and if necessary blow air through the flow monitor in order to release the float.
- Unscrew the connection set from the delivery connection.
- Mount flow monitor on the delivery connection and screw on connection set.
- Plug in the plug into the socket marked ⊜.

2.2.2 Metering monitor with R 5/8'' connection

- A set of adapters is necessary to connect a metering monitor with R 5/8" internal thread.

Connection size of pump	Appropriate set of adapters	
	PP	PVC
M 20 x 1.5 (6-12 mm)	81.71.54.8	81.70.54.0
R 3/4'' (DN 10)	80.52.80.5	80.52.78.9

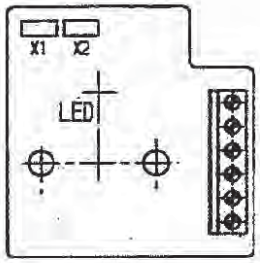
3. Initial operation

3.1 Safety instructions

- The maximum permissible operating pressure for the pumps used may not be exceeded in any operating condition.
- The unions of the flow monitor as well as the connections to the discharge line must be free of leaks when operating under maximum operating pressure.

3.2 Initial operation

- Deactivate the metering monitor on pump, see information in the operating manual of the corresponding pump.
- Start the metering pump.
- Supply the discharge line with the appropriate operating pressure.
- Set the capacity desired via the stroking rate or stroke on the pump.
- Bring the ring initiator into the upper most position until the stop; if no signal is issued in this setting with the pump operating, slowly push the ring initiator downwards until the red LED illuminates for a short time in pace with the metering strokes.
- Press the ring initiator a further 1 mm downwards.
- Reduce the stroke length as a test.
- At approx. 20–50 % reduced stroke length with max. flow and approx. 5–20 % reduced stroke length with min. flow the ring initiator should not issue any more pulses.
- Reset the stroke length to the setting desired. the ring initiator must once again issue pulses.
- If at high metering capacities double pulses should arise (LED illuminates several times in succession per metering stroke) this is not of any importance technically.
- Reactivate the metering monitor on pump.



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For media with a viscosity similar to water, both coding bridges X1 and X2 must be plugged in. For highly viscous media, X2 must be plugged in, not however X1, so that the outsmart switching is active.

4. Maintenance

The metering monitor is made from reliable and tried and proven components. The maintenance is thus essentially limited to observing that the metering monitor is operating correctly.

If it should be necessary to open the flow monitor, the inserts are to be unscrewed using pressure by hand. If it is not possible to unscrew them by hand, the flow monitor can be opened using two fork spanners (size 13 and 17).

When assembling the flow monitor, twist the insert parts by hand on the pipe and tighten about one quarter of a revolution with the fork spanners.

5. Technical data

5.1 Type overview

Operating range for pump type PP/NP/TT, minimum backpressure approx. 1 bar

Metering monitor		Part no.	For use for pump type		
flow Control Typ I, M 20 x 1.5	PP	792076.2	g/4 1601-1003	g/5 1602	
flow Control Typ II, M 20 x 1.5	PP	792077.0	g/4 0308, 0313	g/5 1605-1310	
flow Control Typ III, M 20 x 1.5	PP	792078.8	g/4 0215, 0223	g/5 0613-0423	Vario DN 10
flow Control Typ I, M 20 x 1.5	PVC	792073.9	g/4 1601-1003	g/5 1602	
flow Control Typ II, M 20 x 1.5	PVC	792074.7	g/4 0308, 0313	g/5 1605-1310	
flow Control Typ III, M 20 x 1.5	PVC	792075.4	g/4 0215, 0223	g/5 0613-0423	Vario DN 10
flow Control Typ I, R 5/8"	PP	807117.7	g/4 1601-1003	g/5 1602	
flow Control Typ II, R 5/8"	PP	807118.5	g/4 0308, 0313	g/5 1605-1310	
flow Control Typ III, R 5/8"	PP	807119.3	g/4 0215, 0223	g/5 0613-0423	Vario DN 10
flow Control Typ I, R 5/8"	PVC	807054.2	g/4 1601-1003	g/5 1602	
flow Control Typ II, R 5/8"	PVC	807058.3	g/4 0308, 0313	g/5 1605-1310	
flow Control Typ III, R 5/8"	PVC	807059.1	g/4 0215, 0223	g/5 0613-0423	Vario DN 10

5.2 Material specifications

The materials of the media-contaced parts are PVC/Viton or PP/EPDM

5.3 Dimensions and weights

Installed length R 5/8"
connection approx. 84 mm
Installed length M 20 x 1.5
connection approx. 94 mm
weight: approx. 200 gr

5.4 Electrical data

Supply voltage:	5V +/–5 %
Power drain (max.):	10 mA
Duration of periods with outsmart switching activated:	300 ms +/–150 ms
Pulse extension time:	80 ms +/–30 ms

5.5 Temperature specifications

- permis. storage temperature: –10 °C bis +50 °C
- permis. ambient temperature: –10 °C bis +45 °C
- permis. medium temperature under max. operating pressure: –10 °C bis +35 °C (acc. to IEC 335-2-41)

6. Enclosure ratings maintained

IP 65 acc. to DIN VDE 0470 part 1, corresponds EN 60529 and IEC 529

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MAINTENANCE & INSTALLATION INSTRUCTIONS
For Chemline Type 21 True Union Ball Valve Size 1/2”- 4”

Installation:

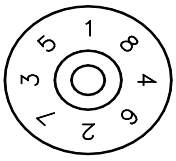
1. Make sure all surfaces are clear and free of debris prior to installing valve in pipeline. Pipeline should be empty at connection site.

2. Valve should be set to the closed position.

3. When installing valves with socket connections, ensure that only PVC solvent cement is used. Excessive use of cement can cause sticking in the valve interior, therefore use caution when applying cement, especially on vertical piping.

4. For threaded connections we recommend the use of sealing tape and, with the use of a strap wrench, to tighten no more than 2 full turns past finger-tight. Use of a pipe wrench can deform the pipe or union nut and cause damage to the valve and/or connection(s).

5. Flanged connections should be torqued evenly and in a symmetrical pattern with a torque wrench and as per the figure and chart below:



RECOMMENDED FLANGE BOLT TORQUES

VALVE SIZE	FLANGE	BOLT TORQUE	IN FT-LB	AXIAL MISALIGNMENT	PARALLELISM (INCH)
	PSI - 50	PSI - 100	PSI – 150		
1½	11	13	14	0.04	0.03
2	13	14	16	0.04	0.03
2½	13	14	16	0.04	0.03
3	18	20	22	0.04	0.03
4	20	20	22	0.04	0.04
5	22	15	29	0.04	0.04
6	25	15	32	0.04	0.04
8	25	32	40	0.06	0.04
10	25	32	40	0.06	0.04
12	29	36	43	0.06	0.04
14	32	36	43	0.06	0.04
16	36	[58-85 PSI]	58	0.06	0.04
18	36	[58-85 PSI]	-		
20	72	-	-		
24	72	-	-		

Maintenance Instructions Type 21 Ball Valve cont.

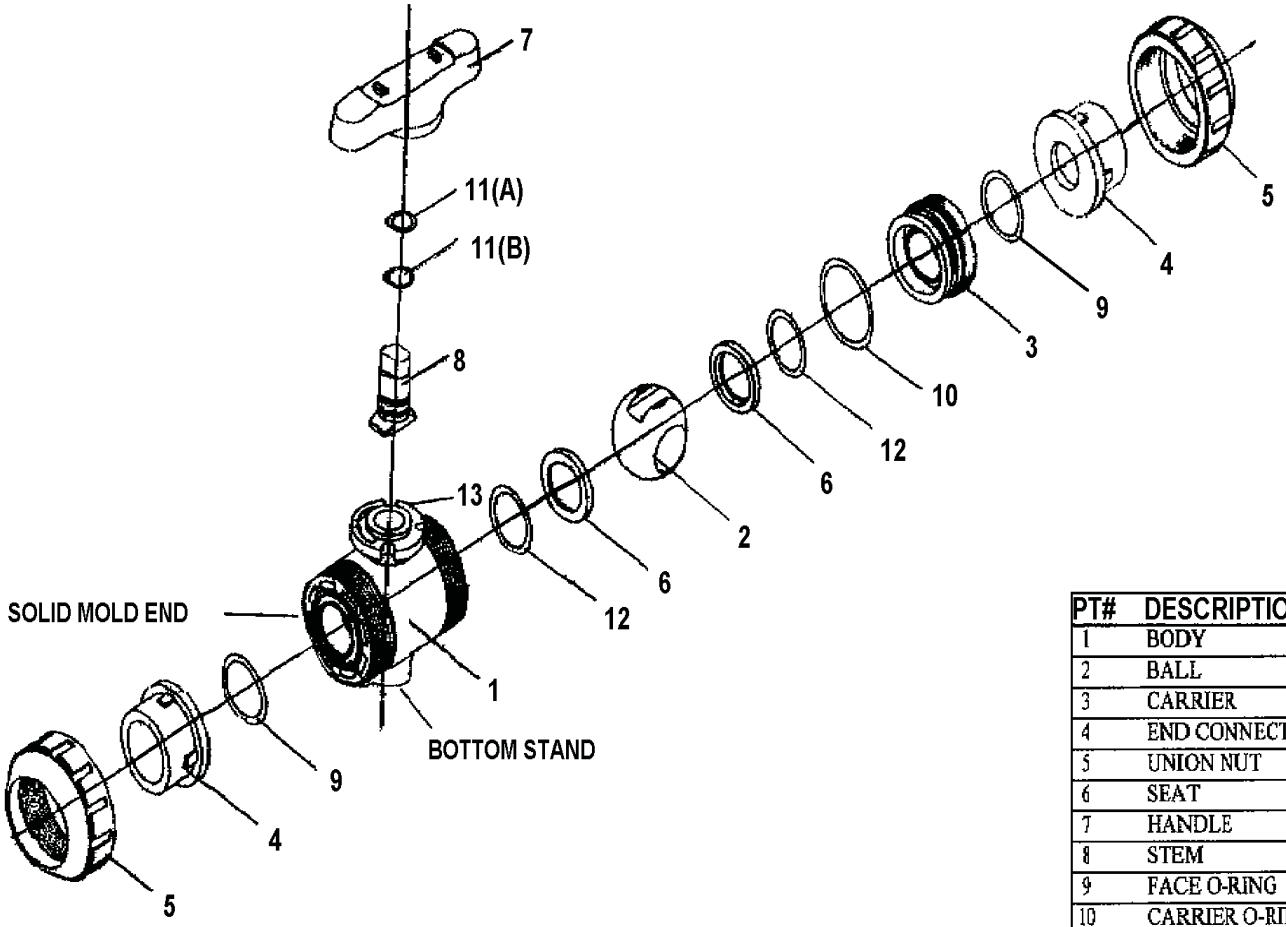
Maintenance:

Refer to **ASSEMBLY DRAWING T21V Rev. 0.** And proceed as follows:

1. Turn valve to the closed position.
2. Unscrew union nut (5) from both ends of valve.
3. Remove end connectors (4).
4. On solid mold end, remove face o-ring (9). This completely disassembles this end of valve.
5. Pull upward on handle (7) to remove.
6. On opposite end of valve, remove face o-ring (9) and use handle (7) as a spanner wrench to remove carrier (3).
7. Remove carrier o-ring (10).
8. Remove seat (6) and seat cushion (12) to expose ball (2).
9. Remove ball (2) by pushing from solid molded end of body.
10. Remove stem (6) by pushing it down into body (1).
11. Remove stem o-rings 11(A) and 11(B) from groves in stem.
12. Remove other seat (6) and seat cushion (12).
13. Inspect all parts for wear and replace as necessary.
14. Before re-assembling valve, lubricate all o-rings with Dow Corning III silicone compound or equivalent.
15. To re-assemble valve follow steps 1 through 10 in reverse order.

NOTE: If mounting actuator on mounting flange (13), make sure handle (7) is removed and stem (6) and actuator are aligned.

After replacing carrier (3), the face of the carrier should remain slightly projected from the end of the body. Make sure the ball rotates smoothly with only a touch of resistance.



PT#	DESCRIPTION	QTY	MATERIALS
1	BODY	1	PVC/PP/PVDF/CPVC
2	BALL	1	PVC/PP/PVDF/CPVC
3	CARRIER	1	CPE/EPDM/VITON/HYP.
4	END CONNECTOR	2	PVC/PP/PVDF/CPVC
5	UNION NUT	2	PVC/PP/PVDF/CPVC
6	SEAT	1	CPE/EPDM/CITON/HYP.
7	HANDLE	1	PVC/PP/PVDF/CPVC
8	STEM	1	PVC/PP/PVDF/CPVC
9	FACE O-RING	2	CPE/EPDM/VITON/HYP.
10	CARRIER O-RING	1	CPE/EPDM/VITON/HYP.
11(A)	STEM O-RING (Upper)	1	CPE/EPDM/VITON/HYP.
11(B)	STEM O-RING (Lower)	1	CPE/EPDM/VITON/HYP.
12	SEAT CUSHION	2	CPE/EPDM/VITON/HYP
13	MOUNTING FLANGE	1	PVC/PP/PVDF/CPVC

TITLE CHEMLINE TYPE 21 TRUE UNION BALL VALVE	SCALE		DATE	CHEMLINE PLASTICS	
	DR. BY				
REFERENCE SIZES 1/2" - 4"	CHKD BY			DWG. NO. T21V	REV. 0
	APP. BY				

CHEMLINE Plastics Limited

Your Pipeline To Quality Valves, Strainers, Flowmeters and Controls

55 Guardsman Road
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MAINTENANCE INSTRUCTIONS
For Chemline 3/8" - 1-1/2" SB Series Pressure Relief Valves

Installation:

1. Always mount a filter or strainer in the line immediately before the valve to avoid damage to the valve from dirt or particles. Valve is spring operated, therefore can be installed in any orientation.

2. **To adjust pressure use the adjustment screw (8) and a pressure gauge**.
   - the valve will be closed at the set pressure and will start to open when the operating pressure rises above the set pressure.
   - connect the compressed air supply to the inlet of the valve. Adjust the flow of the air to the desired set pressure by turning clockwise to increase the set pressure, counterclockwise to decrease it.
   - with the valve being closed, adjust the screw (8) until the valve starts to open. Fix the adjusting screw in place with the locking nut (9).

3. For installation in an application where the temperature is 0^{o} C or less. Check with Chemline Engineering
   Technical staff prior to installation.

Maintenance

Refer to **ASSEMBLY DRAWING SB10/11 rev 0.** And proceed as follows.

1. Loosen and remove cap (10).

2. Loosen counter nut (9) and remove adjustment screw (8).

3. Remove body cap (12a), body bolt (12b), body nut (12c) and washer (12d).

4. Lift up and remove bonnet (2).

5. Remove pressure plate (7a) and ball bearing (7b) to reach relief spring (3).

6. Loosen piston screw (11), remove spring plate (6) and draw piston assembly (5) downward and out of body (1).
   Note: Piston assembly (5) is all parts (5a) outer piston assembly
   (5b) inner piston assembly
   (5c) seat
   (5d) piston o-ring

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MAINTENANCE & INSTALLATION INSTRUCTIONS
For Chemline 2" – 4" SB Series Pressure Relief Valves

Installation:

1. Always mount a filter or strainer in the line immediately before the valve to avoid damage to the valve from dirt or particles. Valve is spring operated, therefore can be installed in any orientation.

2. **To adjust pressure use the adjustment screw (8) and a pressure gauge**.
   - the valve will be closed at the set pressure and will start to open when the operating pressure rises above the set pressure.
   - connect the compressed air supply to the inlet of the valve. Adjust the flow of the air to the desired set pressure by turning clockwise to increase the set pressure, counterclockwise to decrease it.
   - with the valve being closed, adjust the screw (8) until the valve starts to open. Fix the adjusting screw in place with the locking nut (9).

3. For installation in an application where the temperature is 0^{o} C or less. Check with Chemline Engineering
   Technical staff prior to installation.

Maintenance:

Refer to **ASEMBLY DRAWING SB1201 rev 0.** And proceed as follows:

1. Loosen and remove cap (10).

2. Loosen counter nut (9) and remove adjustment screw (8).

3. Remove body cap (12c), body nut and bolt (12a) and washer (12b).

4. Lift up and remove bonnet (2).

5. Remove pressure plate (7a) and ball bearing (7b) to reach relief spring (3).

Installation & Maintenance Instructions SB/12 Series cont.

6. Draw piston assembly (5) downward and out of body (1).
   Note: Piston assembly (5) is all parts (5a) outer piston assembly
   (5b) plug
   (5c) seat
   Piston assembly is removed from the body as a unit. It can then be further disassembled into the component parts listed above.

7. Remove diaphragm (4).

8. Remove seal (14) at intermediate flange (13).

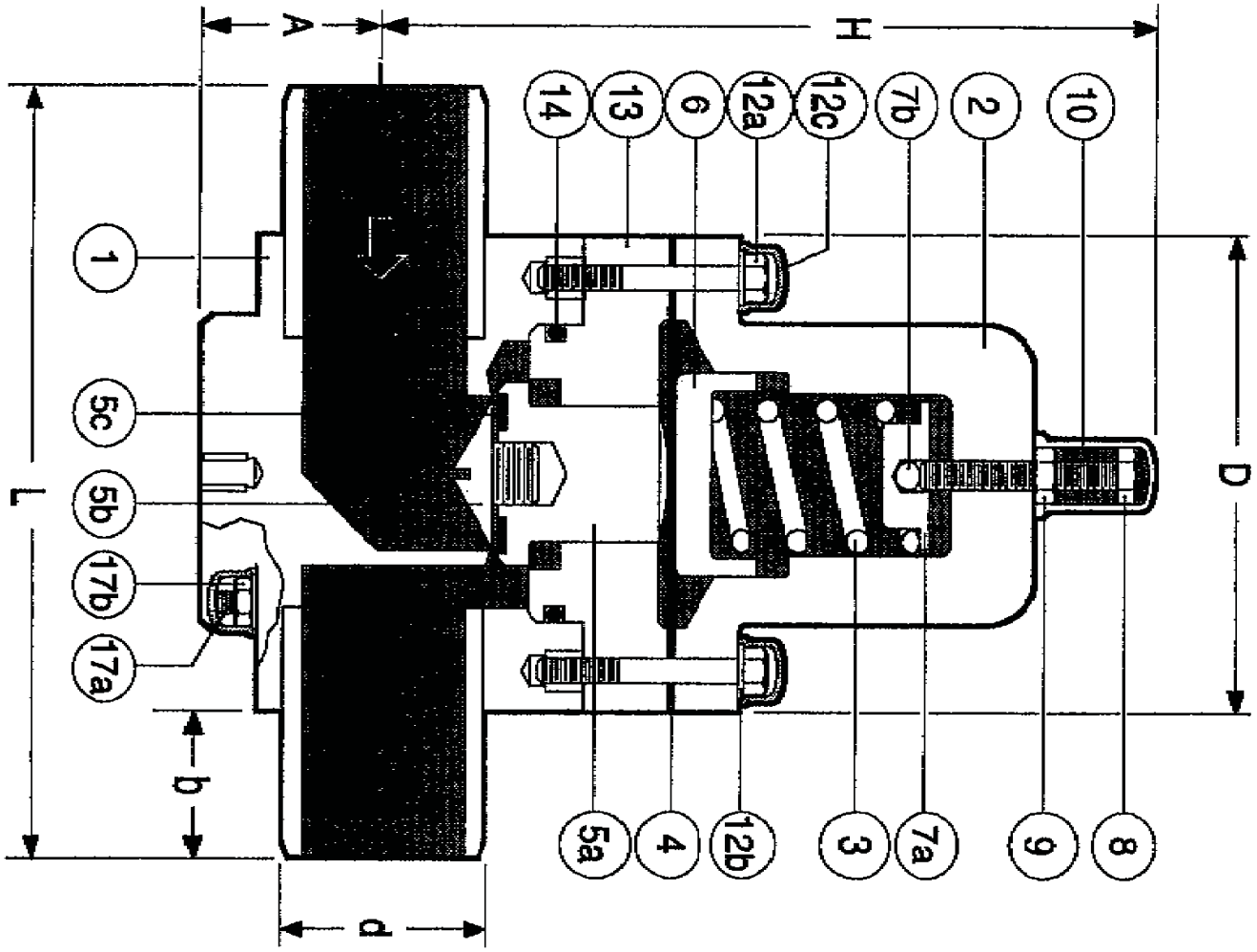
9. Inspect all parts for wear and abrasion, replace seals, diaphragms etc. if necessary.

10. To re-assemble valve follow steps 1 through 10 in reverse order.

TROUBLESHOOTING

FAILURE		REASON	REPAIR
VALVE LEAKS AT DIAPHGRAM (4)		CLAMPING PRESSURE FOR DIAPHRAGM (4) TOO LOW.	TIGHTEN SCREWS (12)
PRESSURE RISES ABOVE SET PRESSURE	{A)	VALVE SEAT (5c) & SEALS (14) ARE	CHECK SEALS OF PISTON (5) BODY (14) - REPLACE
	(B)	DEFECTIVE DIAPHRAGM (4) LEAKING	REPLACE.
	(C)	PISTON (5) BORE AT BODY (1) DIRTY	DISMANTLE PISTON (5) AND CLEAN BORE
VALVE CLOSED (DOES NOT OPEN)		VALVE MOUNTED IN WRONG DIRECTION.	TURN VALVE IN DIRECTION OF ARROWS
FLUIDS PENETRATE ADJUSTING SCREW (8)		DIAPHRAGM (4) DEFECTIVE.	REPLACE DIAPHRAGM (4)
LEAKING AT PLUG AT VALVE BODY		O-RING SEAL LEAKING	DISMANTLE PLUG AND REPLACE SEAL

PART	DESCRIPTION	PCS
1	BODY	1
2	BONNET	1
3	RELIEF SPRING	1
4	DIAPHRAGM	1
5 (a)	OUTER PISTON	1
5 (b)	PLUG	1
5 (c)	SEAT	2
6	SPRING PLATE	1
7 (a)	PRESSURE PLATE	1
7 (b)	BALL BEARING	1
8	ADJUSTING SCREW	1
9	COUNTER NUT	1
10	CAP	1
12 (a)	BODY NUT & BOLT	4/6
12 (b)	BODY WASHER	4/6
12 (c)	BODY CAP	4/6
13	INTERMED. FLANGE	2
14	SEAL	2



TITLE: CHEMLINE SB/12 SERIES	SCALE		DATE	CHEMLINE PLASTICS	
	DR. BY				
REFERENCE: PRESSURE RELIEF VALVES 2-4"	CHKD. BY			DWG. NO. SB1201	REV. 0
	APP. BY				

Piston assembly is removed from body as a unit. It can then be further disassembled into the component parts listed above.

7 Remove diaphragm (4).

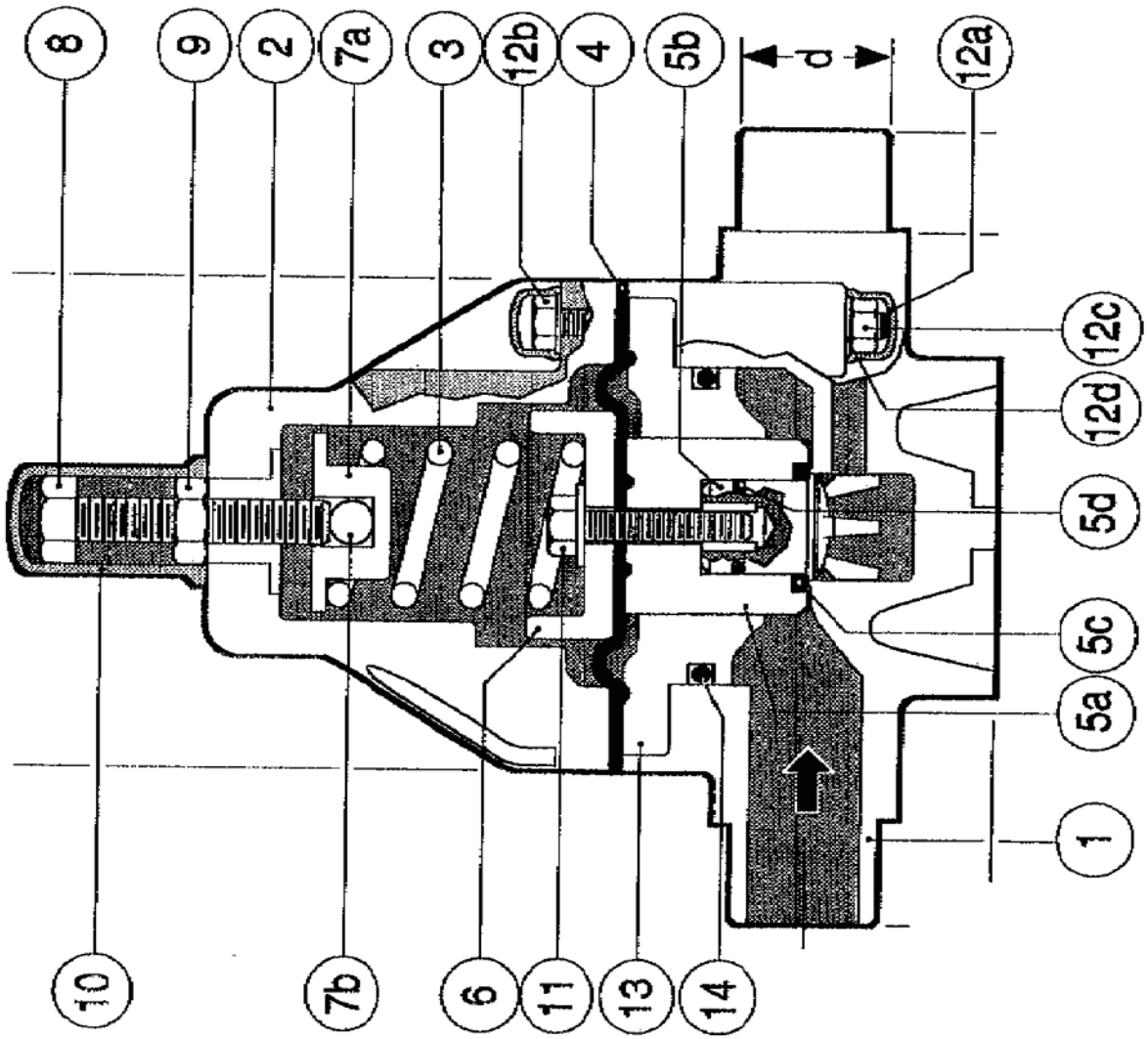
8. Remove seal (14) at intermediate flange (13).

9. Inspect all parts for wear and abrasion, replace seals, diaphragm etc. if necessary.

10. To re-assemble valve follow steps 1 through 9 in reverse order.

TROUBLESHOOTING

FAILURE		REASON	REPAIR
VALVE LEAKS AT DIAPHGRAM (4)		CLAMPING PRESSURE FOR DIAPHRAGM (4) TOO LOW.	TIGHTEN SCREWS (12)
PRESSURE RISES ABOVE SET PRESSURE	{A)	VALVE SEAT (5c) & SEALS (14) & (5d) ARE	CHECK SEALS OF PISTON (5) BODY (14) - REPLACE
	(B)	DEFECTIVE DIAPHRAGM (4) LEAKING	REPLACE.
	(C)	PISTON (5) BORE AT BODY (1) DIRTY	DISMANTLE PISTON (5) AND CLEAN BORE
VALVE CLOSED (DOES NOT OPEN)		VALVE MOUNTED IN WRONG DIRECTION.	TURN VALVE IN DIRECTION OF ARROWS
FLUIDS PENETRATE ADJUSTING SCREW (8)		DIAPHRAGM (4) DEFECTIVE.	REPLACE DIAPHRAGM (4)
LEAKING AT PLUG AT VALVE BODY		O-RING SEAL LEAKING	DISMANTLE PLUG AND REPLACE SEAL



Part	Description	Pcs
1	BODY	1
2	BONNET	1
3	RELIEF SPRING	1
4	DIAPHRAGM	1
5(a)	OUTER PISTON	1
	(PART OF ASSY)	
5(b)	INNER PISTON	1
	(PART OF ASSY)	
5(c)	SEAT	2
	(PART OF ASSY)	
5(d)	PISTON O-RING	2
	(PART OF ASSY)	
6	SPRING PLATE	1
7(a)	PRESS. PLATE	1
7(b)	BALL BEARING	1
8	ADJ. SCREW	1
9	COUNTER NUT	1
10	CAP	1
11	PISTON SCREW	1
12 (a)	BODY CAP	4/6
12 (b)	BODY BOLT	4/6
12 (c)	BODY NUT	4/6
12 (d)	BODY WASHER	4/6
13	INT. FLANGE	2
14	SEAL	2

TITLE: CHEMLINE SB PRESSURE RELIEF VALVES	SCALE		DATE	CHEMLINE PLASTICS
	DR. BY			
REFERENCE: 3/8" - 1-1/2"	CHKD. BY			DWG. NO. SB1011
	APP. BY			REV. 0

CHEMLINE Plastics Limited

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MAINTENANCE INSTRUCTIONS
For Chemline S.I. Series Gauge Isolator 1/4" - 1/2"

Maintenance:

Refer to **ASSEMBLY DRAWING GISI Rev 0.** And proceed as follows:

1. Gauge isolators can be mounted and mounted and filled with glycerine at Chemline prior to delivery, or isolators can be mounted and filled on site.
2. Remove isolator from valve.
3. To disassemble isolator remove gauge (4) from upper chamber (3).
4. Remove bolts, nuts and washers (5) and separate upper chamber (3) from lower chamber (1).
5. Drain glycerin (or other fluid) from both chambers (1 & 3), prior to removing diaphragm (2).
6. Check PTFE diaphragm (2) for wear and replace if necessary.
7. Refill upper chamber (3) and replace diaphragm (2).
8. To reassemble diaphragm follow steps 1 through 4 in reverse, to hand-tight plus ¼ turn.

DIMENSIONS (Inches)

Inlet Size	1/2
Instrument Connection	1/4

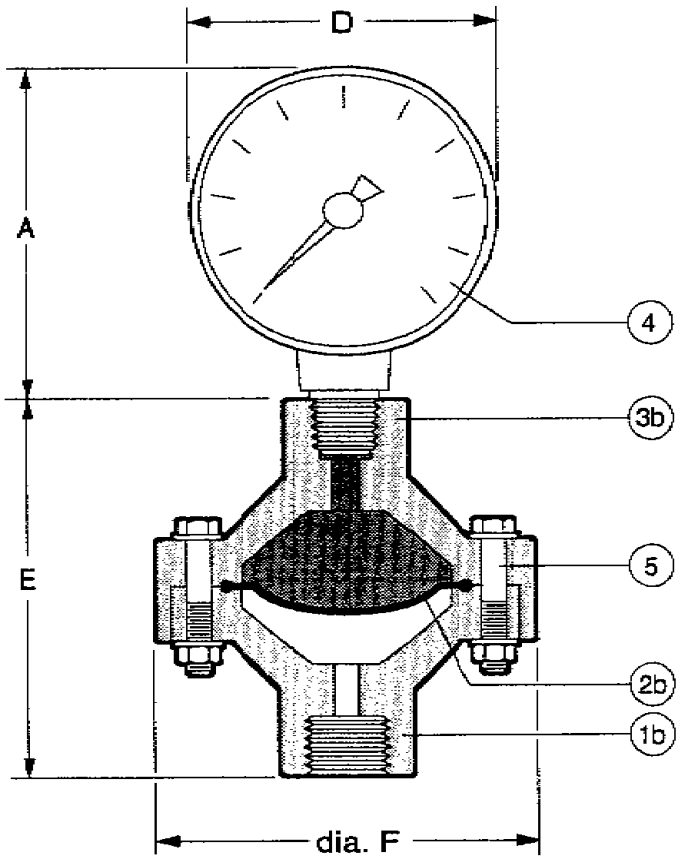
A	B	C	D	E	F
3.0	4.10	2.64	2.50	3.43	3.19

Gauge Isolators S.I. Series cont.

WORKING PRESSURES

TEMPERATURE				
F	C	PVC	PP	PVDF
0	-17	40	-	200
25	-4	130	70	200
50	10	180	130	200
75	24	185	150	200
100	38	160	140	200
125	51	110	120	180
150	66	-	90	160
175	79	-	60	130
200	93	-	-	100
250	120	-	-	60

PART	DESCRIPTION	QTY	MATERIAL
1	LOWER CHAMBER	1	PVC/PP/PVDF
2	DIAPHRAGM	1	TEFLON/PTFE
3	UPPER CHAMBER	1	PVC/PP/PVDF
4	OPTIONAL GAUGE	1	S.S. CASE
5	HEX BOLT/NUT/WASHERS	9	304 SS/M5x30



TITLE: CHEMLINE GAUGE ISOLATOR	SCALE		DATE	CHEMLINE PLASTICS	
	DR. BY				
REFERENCE: S.I. SERIES 1/4 AND 1/2	CHKD. BY			DWG. NO. GISI	REV. 0
	APP. BY				

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L3T 6L2
Canada
Tel: 905-889-7890
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MAINTENANCE INSTRUCTIONS
For Chemline Ball Check Valves and Ball Foot Valves Sizes 1/2" to 4"

Maintenance

Refer to dwg. **APR-050** or **ASSEMBLY DRAWING BC-003 rev.0** and proceed as follows:

1. Loosen union nut (5) and remove valve from line.
   (Note: make sure there is no pressure in line prior to removing valve.)

2. **Important** Hold seat/seal (3) in place while removing valve, as the seat, stop ring (6) and ball (2) may fall out.

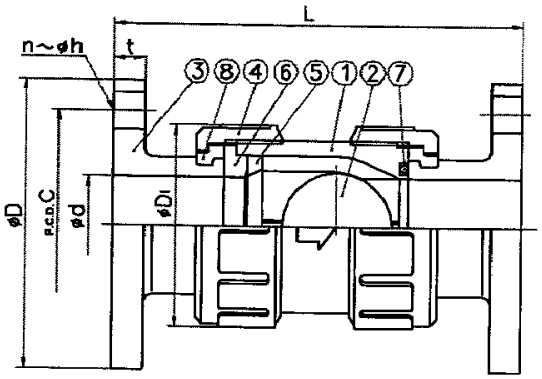
3. Remove seat (3), stop ring (6) and ball (2). Inspect for excessive wear. The ball should not show signs of wear or deformation.

4. When re-installing ball (2), stop ring (6) and seat (3), check inside body for any foreign debris that may have become lodged in the valve.

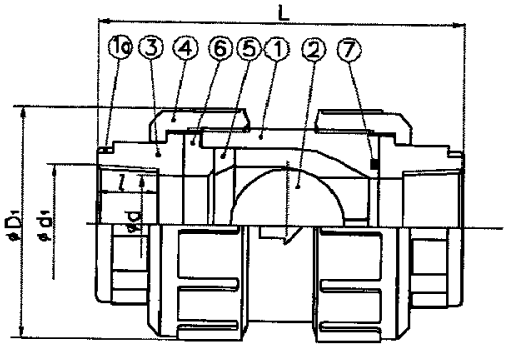
5. Replace union nut (5) and tighten.

6. For Foot Valves with strainer baskets, remove basket (7) and clean thoroughly.

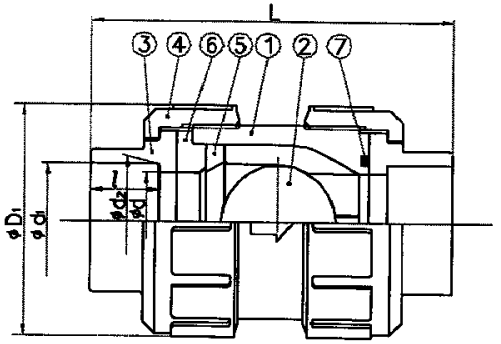
FLANGE END



THREAD CONNECTION



SOCKET CONNECTION



DIMENSIONS TABLE

NOMINAL SIZE		FLANGE □ ANSI 150LBS □ ANSI 125LBS						□ THREAD				
		D	C	n	h	L	t	d_1	l	L	d	D_1
½"	15	3.50	2.38	4	0.63	5.12	0.47	½– 14 NPT	0.59	3.39	0.59	1.89
¾	20	3.86	2.76	4	0.63	6.10	0.55	¾– 14 NPT	0.67	4.06	0.79	2.36
1	25	4.25	3.13	4	0.63	6.50	0.55	1 – 11½NPT	0.79	4.45	0.98	2.76
1¼	30	—	—	—	—	—	—	1¼– 11½NPT	0.87	5.00	1.22	3.78
1½	40	5.00	3.88	4	0.63	7.56	0.63	1½– 11½NPT	0.98	5.94	1.57	3.78
2	50	5.98	4.74	4	0.75	8.43	0.63	2 – 11½NPT	1.10	6.97	2.01	4.17

UNIT: inch

NOMINAL SIZE		SOCKET PVC . C–PVC □ ANSI SCH 40				PVC . C–PVC □ ANSI SCH 80				PVDF □ ANSI				PVDF,PP □ IPS			
		d_1	d_2	l	L	d_1	d_2	l	L	d_1	d_2	l	L	d_1	d_2	l	L
½"	15	0.848	0.836	0.688	3.43	0.848	0.836	0.875	3.80	0.825	—	0.890	3.83	0.831	—	0.625	3.31
¾	20	1.058	1.046	0.719	3.86	1.058	1.046	1.000	4.41	1.030	—	1.015	4.49	1.041	—	1.000	4.43
1	25	1.325	1.310	0.875	4.37	1.325	1.310	1.125	4.88	1.300	—	1.140	4.98	1.305	—	0.815	4.35
1¼	30	1.670	1.655	0.938	4.92	1.670	1.655	1.250	5.55	1.650	—	1.265	5.58	—	—	—	—
1½	40	1.912	1.894	1.094	5.94	1.912	1.894	1.375	6.50	1.890	—	1.390	6.57	1.889	—	1.250	5.57
2	50	2.387	2.369	1.156	6.77	2.387	2.369	1.500	7.44	2.360	—	1.515	7.57	2.364	—	1.250	6.49

NOTE. The shape and appearance of assembly differ a little with nominal size compared to this drawing.

Part No. _____
Body Material _____
Elastomer Material _____
End Connection _____

Customer _____
Customer PO# _____
Chemline PS# _____

No.	DESCRIPTION	No.REQ'D	MATERIAL	REMARKS
1a	RING	2	STAINLESS STEEL (SUS304)	C-PVC body(thread connection) used for ½"~1"
8	STOP RING (B)	2	PVDF	used for Flange end
7	O–RING	1	□EPDM, □FPM	
6	SEAT RING	1	□others( )	
5	STOP RING (A)	1	□ PVC	
4	UNION NUT	2	□ C–PVC	
3	END CONNECTOR	2	□ PP	
2	BALL	1	□ PVDF	
1	BODY	1		

TRUE UNION BALL CHECK VALVE ASS'LY
□FLANGE END, □SOCKET CONNECTION, □THREAD CONNECTION
ANSI : ½ ~ 2"

DRAWN	LC	DATE	SCALE
CHECKED		09/28/99	~
APPROVED		DRAWING No. APR–050	△

CHEMLINE PLASTICS LTD.

ACCU-PULSE Installation and Operation Instructions

Chargeable Models

ACCU-PULSE Unit Information

Serial Number: _____ **Model Number:** _____

Material of Construction: **Body:** _____

Bladder: _____

Pump Area & Number: _____

Date of Purchase: _____

Supplier: **Company:** _____

Contact: _____

Phone: _____

Notes:

- Primary Fluid Systems Inc. recommends installing a pressure relief valve such as TOP VALVE in all pump systems to ensure compliance with pressure limits on system equipment
- Mount ACCU-PULSE as close to pump discharge, inlet and/or quick closing valve as possible
- Temperature and pressure affect the strength and chemical resistancy of plastic and rubber; Consult Primary Fluid Systems Inc. for assistance
- Remove all pressure from ACCU-PULSE unit and pump system before attempting maintenance
- Do not exceed 150 PSI for standard models; 300 PSI for metallic units
- If a system pressure test is to be performed, ACCU-PULSE must be charged with 80% of the system test pressure, prior to test. This will avoid possible bladder damage.

Limited Warranty:

Primary Fluid Systems Inc. (Primary) warrants its products against defects in workmanship or materials for one (1) year under normal use.Primary's obligations and liabilities under this warranty shall be limited to replacement of the product, or a refund of an amount not to exceed the purchase price of the product(s) to which such warranty claim is made. Repairs or replacements are made subject to our inspection of the returned product(s). Primary's decision of one of these alternatives shall be the buyer's exclusive remedy.

This warranty does not extend to damage by corrosion or other decomposition by chemical action. Primary does not warrant damages caused by (a) improper use of the product, (b) unauthorized modification or attachment to product, (c) misuse, abuse, accident or negligent handling or installation of product, or (e) alterations or repairs made by purchaser.The materials of construction offered are recommendations subject in all cases to acceptance by purchaser. These recommendations do not constitute guarantee against corrosion or decomposition, but are based on previous experience and best available information of the industry.

Statements and instructions set forth herein are based on the best information and practices known to Primary, but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity Primary cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.

Except as specifically provided herein, Primary makes no warranty, representations, promise or guarantee, either express or implied, statutory or otherwise, with respect to the product and technical information including their quality, performance, merchantability, or fitness for a particular purpose.In no event will Primary be liable for indirect, special, incidental, economic, covert or consequential damages arising out of the use or inability to use the product, including without limitation, damages or costs relating to the loss of profits, business and goodwill even if advised of the possibility of such damages. In no event shall Primary's liability exceed the amount paid by you for the product.

The warranty and remedies set forth herein are exclusive and in lieu of all others, oral or written, express or implied. No Primary dealer, distributor, agent or employee is authorized to make any modification or addition to this warranty. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

PRIMARY FLUID SYSTEMS INC.

Call Toll Free 1-800-776-6580
Tel (905) 333-8743 Fax (905) 333-8746

E-Mail: primary@primary fluid.com
http: www.primaryfluid.com

Pump Discharge Installation: Chargeable Models

Step 1: Mounting Position

Mount ACCU-PULSE as close to the pump discharge as possible to absorb the pulse at its source. The pulsation dampener will optimally perform if mounted at the first 90 ° turn in the discharge piping. If using a flexible connector from the pump to your point of discharge, ACCU-PULSE should be hard piped to the pump discharge manifold, then continue with flexible tubing from dampener. Since pressure is equal in all directions, ACCU-PULSE can be installed in any position - vertically, horizontally, upside down. Primary Fluid Systems Inc. does recommend a vertical position for better draining of the unit.

Limitations for horizontal and upside down mounting include high specific gravity, high viscosity, settling of heavy material or possible air entrapment.

Step 2: Air Line Connection

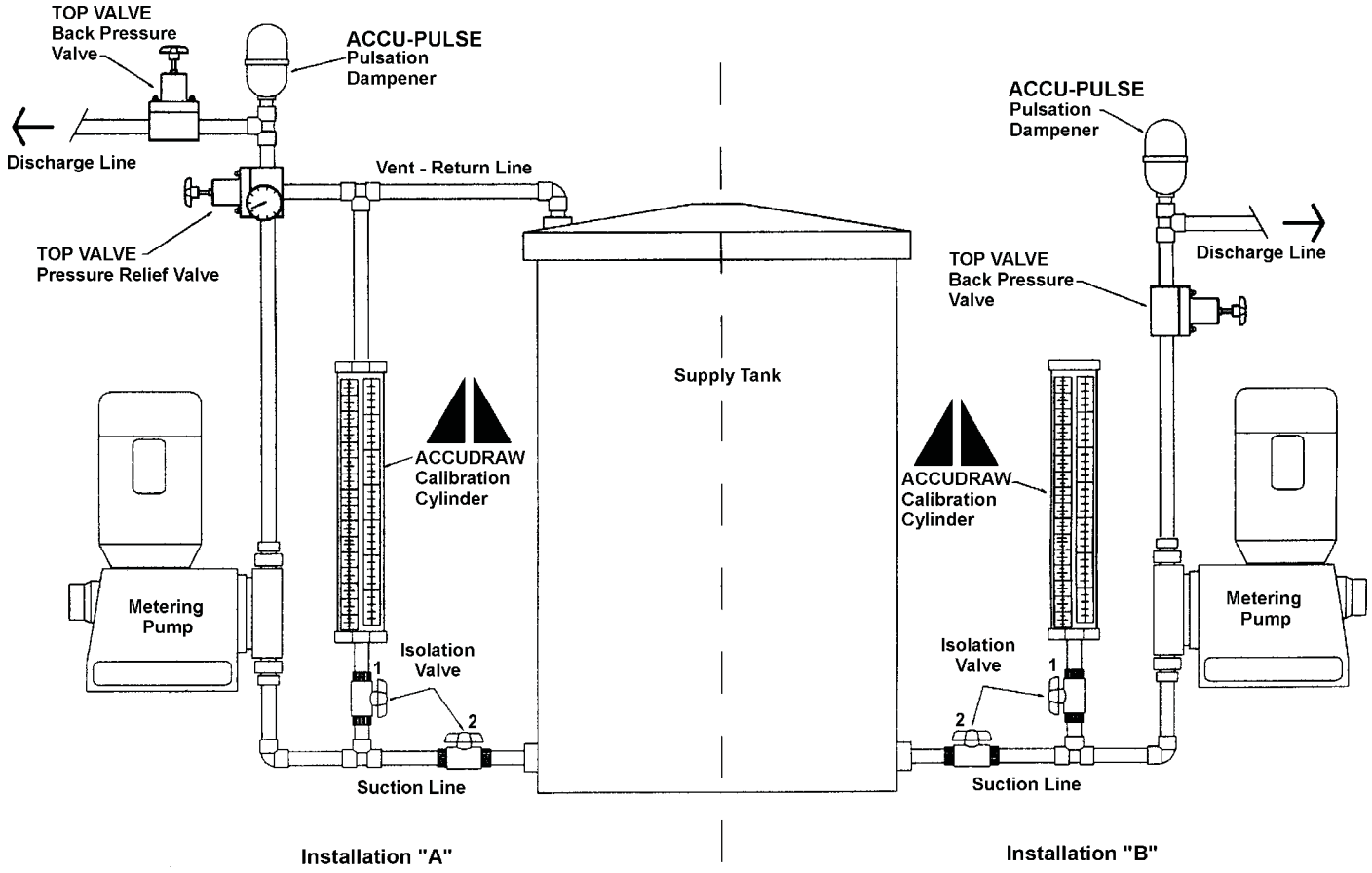
Chargeable models do not require an air line connection, the units must be charged with compressed air or nitrogen, using a hand pump, tank or compressor.

Step 3: Charging and Start Up

Prior to starting the pump, charge ACCU-PULSE with compressed air or nitrogen to approximately 70 to 85% of expected system pressure, to a maximum of 150 PSI for standard models; 300 PSI for metallic models. Start the pump to generate working or system pressure. Once working pressure is achieved, adjustment may be necessary; gradually increase or decrease the gas charge in the dampener by bleeding or filling through the gas valve. Allow the system to respond to each adjustment (this may take a minute or two) before continuing any further adjustments. Generally, pulsation is most effectively minimized when the gas charge is 80 to 85 % of system/pump discharge pressure. Pressure should be checked periodically. Recharge when necessary.

Typical Installations

The installations below are typical installation examples only. Consult your engineering department for the appropriate installation of your application or call the factory for advice.



ACCU-PULSE Safety Warnings

This dampener should only be installed and used by experienced and trained professional mechanics. Observe all safety warnings. Read all safety warnings and operating manuals before using or repairing this Pulsation Dampener (hereafter referred to as “dampener”).

General Safety

This dampener is not intended to be used as a stand alone machine. EU member states must note: Do not use this dampener before it is combined into another machine or assembly that complies with all relevant EU safety directives and that the assembler’s CE mark is affixed on completion.

The internal dampener pressure will equal the maximum fluid pressure of the system in which it is installed.

Do not exceed maximum pressure as stated on dampener tag. If tag is missing, do not use this dampener without consulting distributor or factory for maximum pressure rating.

Always make sure safety shut off valves, regulators, pressure relief valves, gauges etc. are working properly before starting system or assembly.

Always wear protective gloves, safety glasses, etc. when working on or near this dampener.

Before starting a system or assembly, make certain the discharge point of the piping system is clear and safe, and all persons have been warned to stand clear.

Always wear safety glasses when installing, charging or repairing this dampener.

Do not put your face or body near dampener when the system assembly is operating or dampener is pressurized.

Do not operate a dampener that is leaking, damaged, corroded or otherwise unable to contain internal fluid, air or gas pressure.

Do not pump incompatible fluids through the dampener. Consult your distributor or the factory if you are not sure of the compatibility of the fluids with the dampener materials.

Dampeners are designed to operate with compressed air or nitrogen. Other compressed gases have not been tested and may be unsafe to use in dampeners.

Bleed all pressure from system and dampener before removing equipment from the system.

Always shut off air supply, bleed internal dampener pressure and shut isolation valve before performing maintenance or repair on dampener.

Static spark can cause an explosion resulting in severe injury or death. Ground dampeners and pumping system when pumping flammable fluids.

Equipment Misuse Hazard

General Safety:
Any misuse of this equipment such as over pressurization, modifying parts, incompatible chemicals, using worn or damage parts or using gases other than air or nitrogen to charge dampener is not recommended. Any of these circumstances could result in serious bodily injury, death, fire, explosion or property damage.

Over-Pressurization:
Never exceed the maximum operating pressure recommended for the dampener model being used. Maximum operating pressure is stated on tag. Pressure limits are stated at 20°C / 70°F.

Temperature Limits
Do not exceed the recommended operating temperatures for the shell and elastomer materials, independently. Excessive temperature will result in dampener failure.
Temperature limits are stated at zero psig / bar.

Installation and Start Up Hazards:
Install dampener before charging or pressurizing.

Do not start system or assembly without first charging or pressurizing dampener. Failure to charge may result in damage to the elastomeric bladder.

Temperature & Pressure Hazard:
Temperature and pressure reduce the strength and chemical resistance of plastic, metal and rubber.

Charging / Pressurization:
Charge or pressurize the dampener with compressed air or nitrogen only. **Do NOT use oxygen.**

Dampener Bladder Failure:
Dampeners utilize an elastomeric membrane to separate system fluid from the air supply or gas charge. When this membrane ruptures, system fluid may be expelled from the air valve. Always perform preventive maintenance and replace elastomers before excessive wear occurs.

Maintenance Hazards:
Never over-tighten clamp bands. This may cause leakage of system fluid and damage to dampener shell.

ModMAG®
M-Series® | B-MAG Electromagnetic Flow Meters

M-Series® M2000

Electromagnetic Flow Meter

Badger Meter

MAG-UM-01272-EN-05 (February 2015)

User Manual

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SAFETY PRECAUTIONS AND INSTRUCTIONS

Some procedures in this manual require special safety considerations. In such cases, the text is emphasized with the following symbols:

Symbol	Explanation
⚠WARNING	Warning indicates the potential for severe personal injury, death or substantial property damage. Comply with the instructions and proceed with care.
⚠CAUTION	Caution indicates the potential for minor personal injury or property damage. Comply with the instructions and proceed with care.

SYSTEM DESCRIPTION

The Badger Meter M-Series®model M2000 electromagnetic flow meter is intended for fluid metering in most industries including water, wastewater, food and beverage, pharmaceutical and chemical.

The basic components of an electromagnetic flow meter are:

- The **detector**, which includes the flow tube, isolating liner and measuring electrodes.
- The **amplifier**, which is the electronic device responsible for the signal processing, flow calculation, display and output signals.

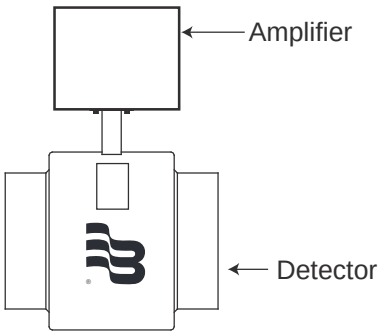


Figure 1: Amplifier and detector

The construction materials of the wetted parts (liner and electrodes) should be appropriate for the specifications on the intended type of service. We recommend that you review all of the compatibilities consistent with the specifications.

Each meter is factory tested and calibrated. A calibration certificate is included with each meter.

UNPACKING AND INSPECTION

Follow these guidelines when unpacking the M-Series equipment.

- If a shipping container shows any sign of damage, have the shipper present when you unpack the meter.
- Follow all unpacking, lifting and moving instructions associated with the shipping container.
- Open the container and remove all packing materials. Store the shipping container and packing materials in the event the unit needs to be shipped for service.
- Verify that the shipment matches the packing list and your order form.
- Inspect the meter for any signs of shipping damage, scratches, or loose or broken parts.

NOTE: If the unit was damaged in transit, it is your responsibility to request an inspection report from the carrier within 48 hours. You must then file a claim with the carrier and contact Badger Meter for appropriate repairs or replacement.

- All detectors with polytetrafluoroethylene (PTFE) liners are shipped with a liner protector on each end to maintain proper form of the PTFE material during shipping and storage.

NOTE: Do not remove the liner protectors until you are ready to install.

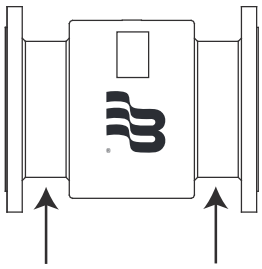
- Storage: If the meter is to be stored, place it in its original container in a dry, sheltered location. Storage temperature ranges are: –40…160° F (–40…70° C).

Rigging, Lifting and Moving Large Units

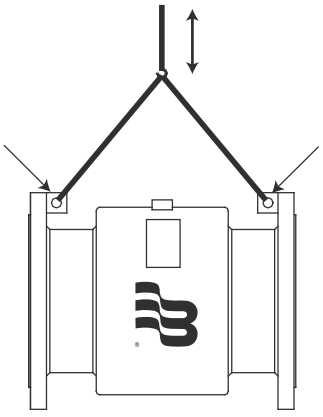
⚠CAUTION

When rigging, lifting or moving large units, follow these guidelines:

- DO NOT lift or move a meter by its amplifier, junction box or cables.
- Use a crane rigged with soft straps to lift and move meters with flow tubes that are between two inches and eight inches (50 mm and 200 mm). Place the straps around the detector body, between the flanges, on each side of the detector.
- Use the lifting lugs when lifting meter flow tubes that are 10 inches (250 mm) in diameter or larger.



Place straps between flanges.



Use lifting lugs with 10-inch or larger meters.

Figure 2: Rigging large units

- Use the sling-rigged method to lift large detectors into a vertical position while they are still crated. Use this method to position while they are still crated. Use this method to position large detectors vertically into pipelines.

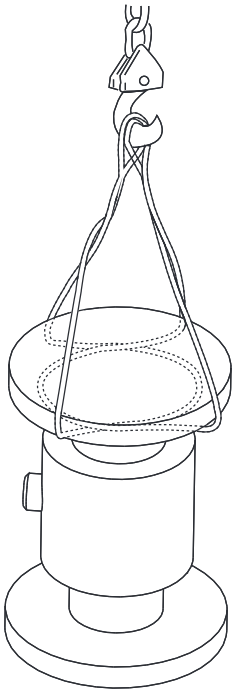
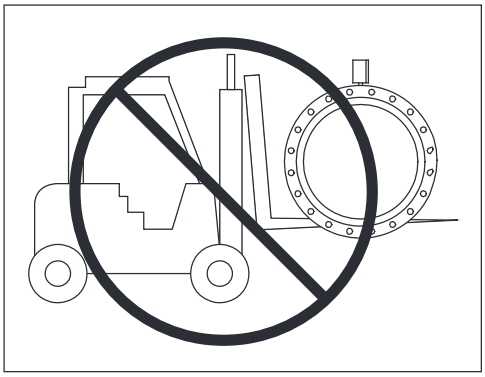
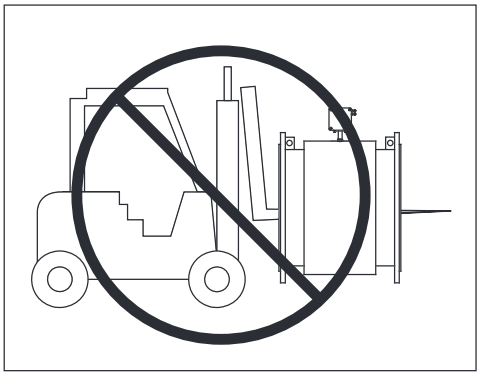


Figure 3: Sling-Rigged lifting methods

- Do not lift a detector with a forklift by positioning the detector body on the forks, with the flanges extending beyond the lift. This could dent the housing or damage the internal coil assemblies.
- Never place forklift forks, rigging chains, straps, slings, hooks or other lifting devices inside or through the detector's flow tube to hoist the unit. This could damage the isolating liner.



Do not lift detector with forklift.



Do not lift or rig lifting devices through detector.

Figure 4: Lifting and rigging cautions

METER LOCATION, ORIENTATION AND APPLICATIONS

The M2000 provides two amplifier mounting options: a meter mount option and a remote mount option.

Meter mount *Remote mount*

Figure 5: Amplifier mounting options

Remote Amplifier Outdoor Location

The amplifier can be installed and operated outdoors. However, it must be protected from the elements, as follows:

- The ambient environment/temperature rating for the unit is –4…140° F (–20…60° C).
- If an indoor location is within 500 feet (152 meters) of the detector, consider increasing the cable length and mounting the amplifier indoors.
- At minimum, fabricate a roof or shield over and/or around the amplifier to protect the LCD display screen from direct sunlight.

Pipelines and Fluid Flow

Take the following precautions during installation:

- Do not install the meter on pipes with extreme pipe vibrations. If pipes are vibrating, secure the piping with appropriate pipe supports in front of and behind the meter. If vibrations cannot be restrained, mount the amplifier in a remote location.
- Do not install the detector close to pipeline valves, fittings or impediments that can cause flow disturbances.
- For detectors with PTFE liners, do not install the detector on suction sides of pumps.
- Do not install the detector on outlet sides of piston or diaphragm pumps. Pulsating flow can affect meter performance.
- Avoid installing the detector near equipment that produces electrical interference such as electric motors, transformers, variable frequency, and power cables.
- Verify that both ends of the signal cables are securely fastened.
- Place power cables and signal cables in separate conduits.
- Place the meter where there is enough access for installation and maintenance tasks.

Meter Orientation

Mag meters can operate accurately in any pipeline orientation and can measure volumetric flow in forward and reverse directions as long as the pipe is completely full.

NOTE: A "Forward Flow" direction arrow is printed on the detector label.

Vertical Placement

Mag meters perform best when placed vertically, with liquid flowing upward and meter electrodes in a closed, full pipe.

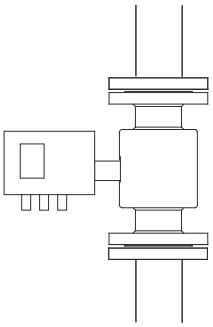


Figure 6: Vertical placement

Vertical placement allows the pipe to remain completely full, even in low flow, low pressure applications, and it prevents solids build-up, sediment deposit and accumulation on the liner and electrodes.

NOTE: Carefully observe the "Forward Flow" label on the meter body and install the meter accordingly. When installed vertically, rotate amplifier so that cable glands are facing down.

Horizontal Placement

M2000 meters are equipped with an *Empty Pipe Detection* feature. If an electrode mounted in the pipe is not covered by fluid for five seconds, the meter will display an Empty Pipe Detection condition. The meter will send out an error message and stop measuring flow. When the electrode is again covered with fluid, the error message disappears and the meter will begin measuring.

When installing the meter on a horizontal pipe, mount the detector to the pipe with the flow-measuring electrode axis in a horizontal plane (three and nine o'clock). This placement helps prevent solids build-up, sediment deposit and accumulation on the electrodes.

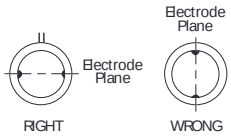


Figure 7: Horizontal placement

Straight Pipe Requirements

Sufficient straight-pipe runs are required at the detector inlet and outlet for optimum meter accuracy and performance. An equivalent of three diameters of straight pipe is required on the inlet (upstream) side. Two diameters are required on the outlet (downstream) side.

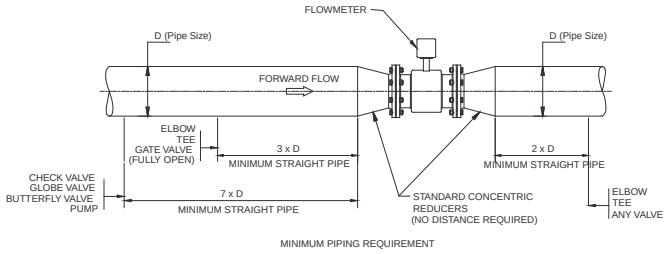


Figure 8: Straight pipe requirements

Pipe Reducer Requirements

With pipe reducers, a smaller meter can be mounted in larger pipelines. This arrangement may increase low-flow accuracy.

There are no special requirements for standard, concentric, pipe reducers.

Custom fabricated pipe reducers must have an approximate slope angle of 15 degrees to minimize flow disturbances and excessive loss of head. If this is not possible, install the custom pipe reducers as if they were fittings and install the required amount of straight pipe.

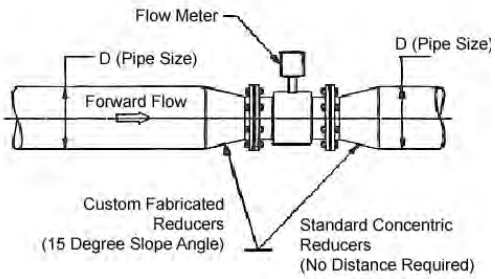


Figure 9: Pipe reducer requirements

Chemical Injection Applications

For water line applications with a chemical injection point, install the meter upstream of the injection point. This eliminates any meter performance issues.

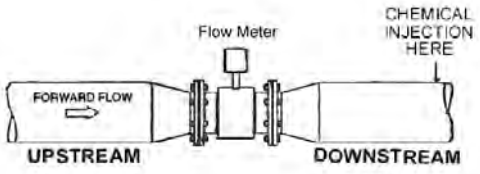


Figure 10: Chemical injection point upstream of meter

If a meter must be installed downstream of a chemical injection connection, the distance between the meter and the injection point should be between 50 and 100 feet (15 and 30 meters). The distance must be long enough to allow the water/chemical solution to reach the meter in a complete, homogeneous mixture. If the injection point is too close, the meter senses the two different conductivities for each liquid. This will likely result in inaccurate measurements. The injection method – spaced bursts, continuous stream of drips or liquid or gas – can also affect downstream readings by the meter.

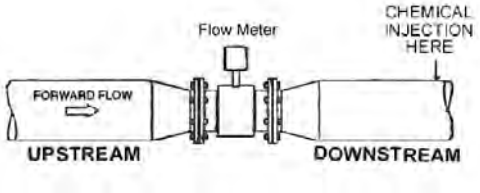


Figure 11: Chemical injection point downstream of meter

Sometimes, due to circumstances, it is difficult to specify the exact downstream placement distances. Contact Badger Meter Technical Support to review your application if necessary.

Partially-Filled Pipe Situations

In some locations, the process pipe may be momentarily only partially filled. Examples include: lack of back pressure, insufficient line pressure and gravity flow applications.

To eliminate these situations:

- Do not install the meter at the highest point of the pipeline.
- Do not install the meter in a vertical, downward flow section of pipe.
- Always position the ON/OFF valves on the downstream side of the meter.

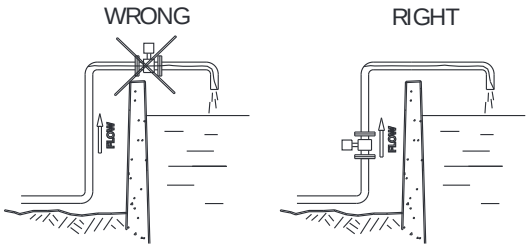


Figure 12: Incorrect meter placement

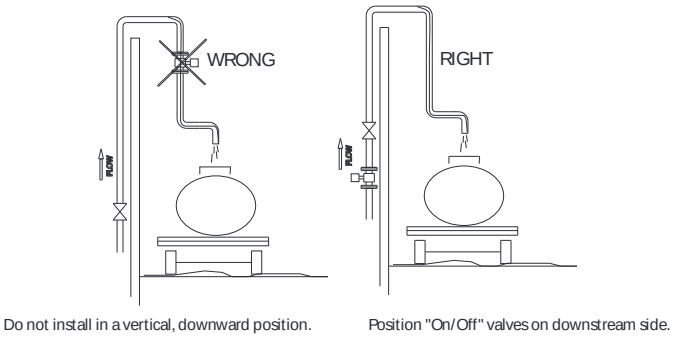


Figure 13: Position valves on downstream side

To minimize the possibility of partially-full pipe flows in horizontal, gravity or low pressure applications, create a pipe arrangement that ensures the detector remains full of liquid at all times.

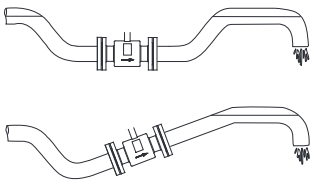


Figure 14: Pipe positioned to keep water in detector

METER GASKETS AND GROUNDING

Gasket and grounding requirements must be considered when determining the meter location, orientation and application.

Meter/Pipeline Connection Gaskets

You must install gaskets (not provided) between the detector's isolating liner and the pipeline flange to ensure a proper and secure hydraulic seal. Use gaskets that are compatible with the fluid. Center each gasket on the flange to avoid flow restrictions or turbulence in the line.

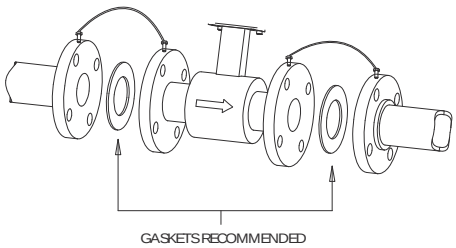


Figure 15: Meter/pipeline connection gaskets

During installation, do not use graphite or any electrically conductive sealing compound to hold the gaskets. This could compromise the accuracy of the measuring signal.

If you are using a grounding ring in the detector/pipeline connection, place the ring between two gaskets. (See *"Non-Conductive Pipe Grounding" on page 13*.)

Meter Grounding

Process pipeline material can be either electrically conductive (metal) or not electrically conductive (made of or lined with PVC, fiberglass or concrete).

IMPORTANT

It is essential that the mag meter amplifier's input ground (zero voltage reference) be electrically connected to the liquid media and to a good, solid earth ground reference.

Conductive Pipe Grounding

To achieve an adequate ground, the meter body MUST be electrically connected to the liquid media. The mag meter flanges are provided with grounding bolts for this purpose.

If the pipe material is electrically conductive, simply install grounding straps between these grounding bolts and the mating flanges.

To ensure a good electrical connection at the mating flanges, we recommend that you drill and tap the flanges and install a grounding screw (not provided).

These grounding straps must be copper wire, at least 12 AWG size. They must be connected on both sides (inlet and outlet) of the detector and to a local, earth ground.

Non-Conductive Pipe Grounding

IMPORTANT

If the process pipe is not electrically conductive (PVC, fiberglass, cement-lined pipes or any other non-conductive material) and the meter was not originally ordered with an optional grounding electrode, you must install a pair of grounding rings between the mating flanges at both ends of the meter. See the following illustration.

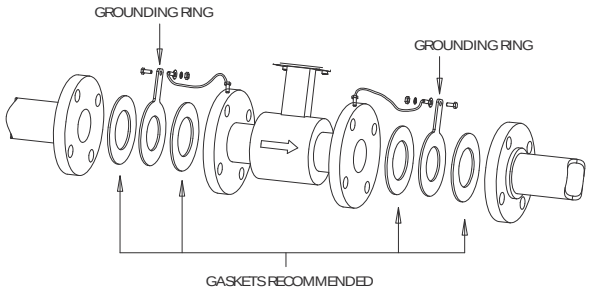


Figure 16: Non-conductive pipe grounding

In this case, the grounding straps should be connected to both of the grounding rings and to a good, solid earth ground. Grounding rings are available in stainless steel. If your fluid is too aggressive for stainless steel, order a meter with the optional grounding electrode in a material compatible with the fluid.

AMPLIFIER MOUNTING CONFIGURATION OPTIONS

There are two configuration options for mounting the amplifier. There are many options to accommodate a variety of meter-placement and environmental conditions.

Meter Mount Configuration

The meter mount configuration has the amplifier mounted directly on the detector. This compact, self-contained configuration minimizes installation wiring.

Remote Mount Configuration

The remote mount configuration places the amplifier at a location away from the fluid flow and detector. This is necessary in situations where process fluid temperature or the environment exceeds amplifier ratings.

The detector and amplifier are connected by wires, run through conduit, between junction boxes on the detector and the amplifier. The distance between the detector junction box and amplifier junction box can be up to 500 feet (152 meters). A remote mounting bracket is supplied.

Submersible Option

If you are installing the meter in a vault, you should order the remote amplifier option. You must not install the amplifier inside a vault. We also recommend ordering the remote meter package with the submersible option (NEMA 6P). This will eliminate any potential problems resulting from humidity or temporary flooding in the vault.

NOTE: The National Electronics Manufacturer's Association (NEMA) 6P enclosures are constructed for indoor or outdoor use to provide protection against access to hazardous parts; to provide a degree of protection against ingress of solid foreign objects and water (hose directed water and the entry of water during prolonged submersion at a limited depth); that provide an additional level of protection against corrosion and that will be undamaged by the external formation of ice on the enclosure.

WIRING

Wiring Safety

⚠WARNING

AT INSTALLATION, BE SURE TO COMPLY WITH THE FOLLOWING REQUIREMENTS:

- Disconnect power to the unit before attempting any connection or service to the unit.
- Do not bundle or route signal lines with power lines.
- Keep all lines as short as possible.
- Use twisted pair shielded wire for all output wiring.
- Observe all applicable, local electrical codes.

Opening the M2000 Cover

The M2000 amplifier's design lets you open the cover without completely removing it.

⚠WARNING

COVER IS ATTACHED WITH DISPLAY RIBBON CABLE.

To open the cover you will need a blade screwdriver.

Follow these steps:

1. Disconnect power to the unit.
2. Completely remove the two screws from either the left or the right side of the ampli er.
3. Loosen each of the remaining screws so that the round head of the screw clears the top edge of the cover.
4. Lift and pivot the cover into the open position.

Power Connections

External Disconnect

⚠CAUTION

- Install an external disconnect switch or circuit breaker that meets local standards.
- Position the M2000 in an accessible location.
- Position and identify the disconnect device so as to provide safe and easy operation.
- Label the disconnect device as being for the mag meter.

AC Power Wiring

For the AC power connections, use three wire-sheathed cable with an overall cable diameter of 0.2…0.45 inch (5…12 mm). For signal output, use 18…22 gauge (0.25…0.75 mm^2) shielded wire. Overall cable diameter between 0.12…0.35 inch (3…9 mm).

⚠CAUTION

TO PREVENT ACCIDENTS, CONNECT MAIN POWER ONLY AFTER ALL OTHER WIRING HAS BEEN COMPLETED.

The amplifier is a microprocessor device. It is important that the power supply be as "clean" as possible. Avoid using power lines that feed heavy loads: pumps, motors, *etc.* If dedicated lines are not available, a filtering or isolation system may be required.

Power wiring is the same for meter mount and remote mount amplifiers.

Remote Mount Installation

If you are installing the M2000 amplifier in a remote location, review the procedures in this section.

Mount Bracket to Amplifier

1. Align bracket-mounting holes with ampli er mounting holes.
2. Attach bracket to ampli er with supplied screws. Torque screws to 80 inch pounds.

Wiring Configuration

Wiring between the detector and the M2000 amplifier comes complete from the factory. If your installation requires the use of conduit, we recommend that you follow these steps when wiring the detector to the amplifier.

1. Remove the junction box lid. Carefully remove the wires connected to the terminal blocks that run to the M2000 ampli er. See the chart below for a reference of wire color to terminal connection.
2. Run cable through the conduit from the ampli er location while retaining the wiring of the cable to the ampli er, as supplied.
3. Complete conduit assembly on both ends and rewire the cable into the junction box as it was previously wired.

Wiring for Remote Configuration

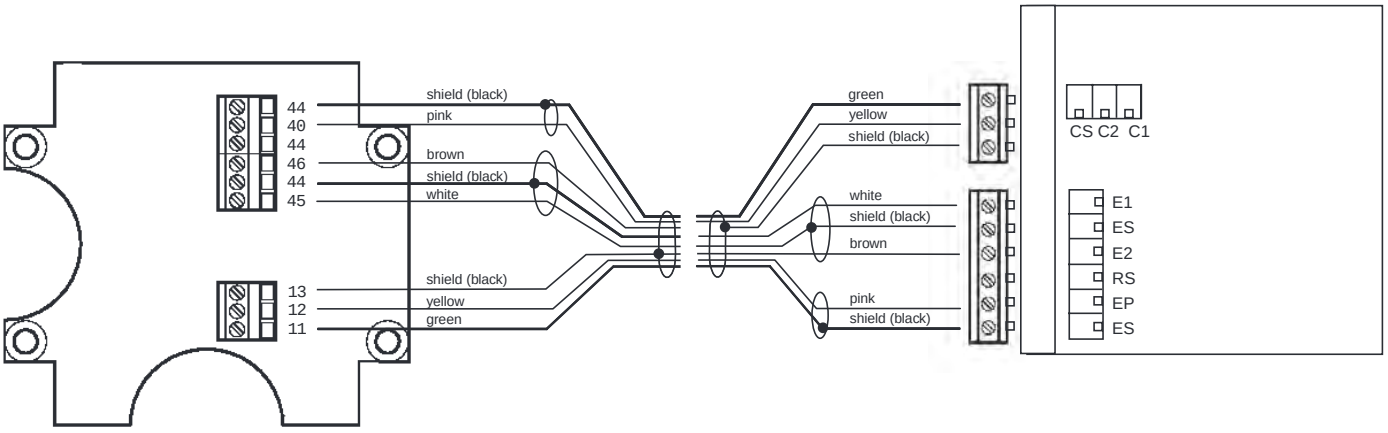


Figure 17: Wiring for remote configuration

Remote style M2000 amplifier models can be ordered with standard cables measuring 15, 30, 50,100 and 150 feet. In addition, cables up to 500 feet are available.

Junction Box			Amplifier
Connection No.	**Description**	**Wire Color**	**Connection**
11	Coil	Green	C1
12	Coil	Yellow	C2
13	Main Shield	Black (Red Ferrule)	CS
45	Electrode	White	E1
44*	Electrode Shield	Black	ES
46	Electrode	Brown	E2
40	**Empty Pipe**	Pink	EP
44*	**Empty Pipe Shield**	Black	ES

*Connections with the No. 44 are lying on the same potential.

Empty Pipe Detection Considerations

Take into account the following cable length and conductivity requirements, if you will be using empty pipe detection.

Cable Length (Feet)	Minimum Conductivity Required (µS/cm)
0*	5
100	20
500	100

*** Meter Mount**

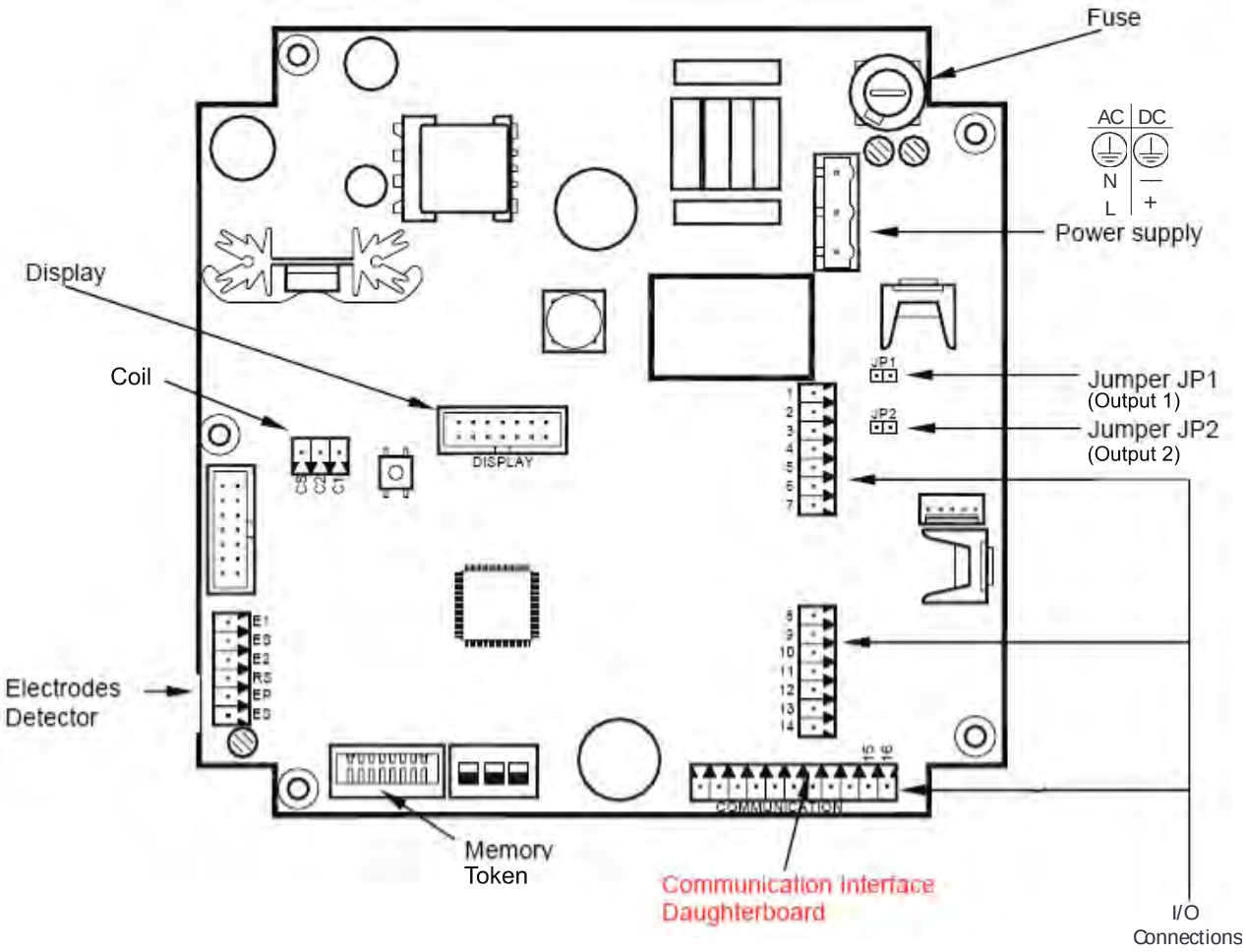
CONFIGURING INPUT/OUTPUT (I/O)

This section describes wiring the following M2000 inputs/outputs:

- Analog output
- Digital input
- Digital outputs
- Communication

Once the sensor and the amplifier have been wired, wire any inputs and outputs to the M2000 amplifier.

Do not connect the main power connection until you have made all other wiring connections. Follow all of the safety precautions and local code to prevent electrical shock and damage to the electronic components.



Supported protocols include:
RS485 MODBUS RTU
PROFIBUS DP
HART

Figure 18: Configuring input/output

Input/Output	Description	Terminal
Analog Output	0…20 mA Resistive Load < 800 ohms 4…20 mA Resistive Load < 800 ohms 0…10 mA Resistive Load < 800 ohms 2…10 mA Resistive Load < 800 ohms	16 (+) 15 (–)
Digital Output 1	Passive max. 30V DC, 100 mA Active 24V DC, 50 mA (set Jumper JP1) Max. Frequency 10 kHz	1 (+) and 2 (–)
Digital Output 2	Passive max. 30V DC, 100 mA Active 24V DC, 50 mA (set Jumper JP2) Max. Frequency 10 kHz	3 (+) and 4 (–)
Digital Output 3	Passive Max 30V DC, 100 mA, 10 kHz Solid State Relay 48V AC, 500 mA, 1 kHz * Software configurable	10 (+) and 9 (–) 10 (+) and 11 (–)
Digital Output 4	Passive Max 30V DC, 100 mA, 10 kHz Solid State Relay 48V AC, 500 mA, 1 kHz * Software configurable	13 (+) and 12 (–) 13 (+) and 14 (–)
Digital Input	5…30V DC	8 (+) and 9 (–)
Communications (Port A)	RS232, configurable, MODBUS RTU, Remote Menu, or Primo 3.1 Emulation.	7 GND 6 Rx 5 Tx

Analog Output Wiring Diagram

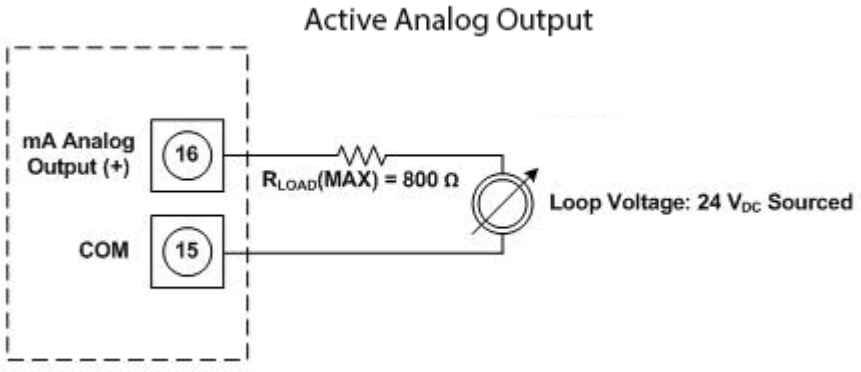
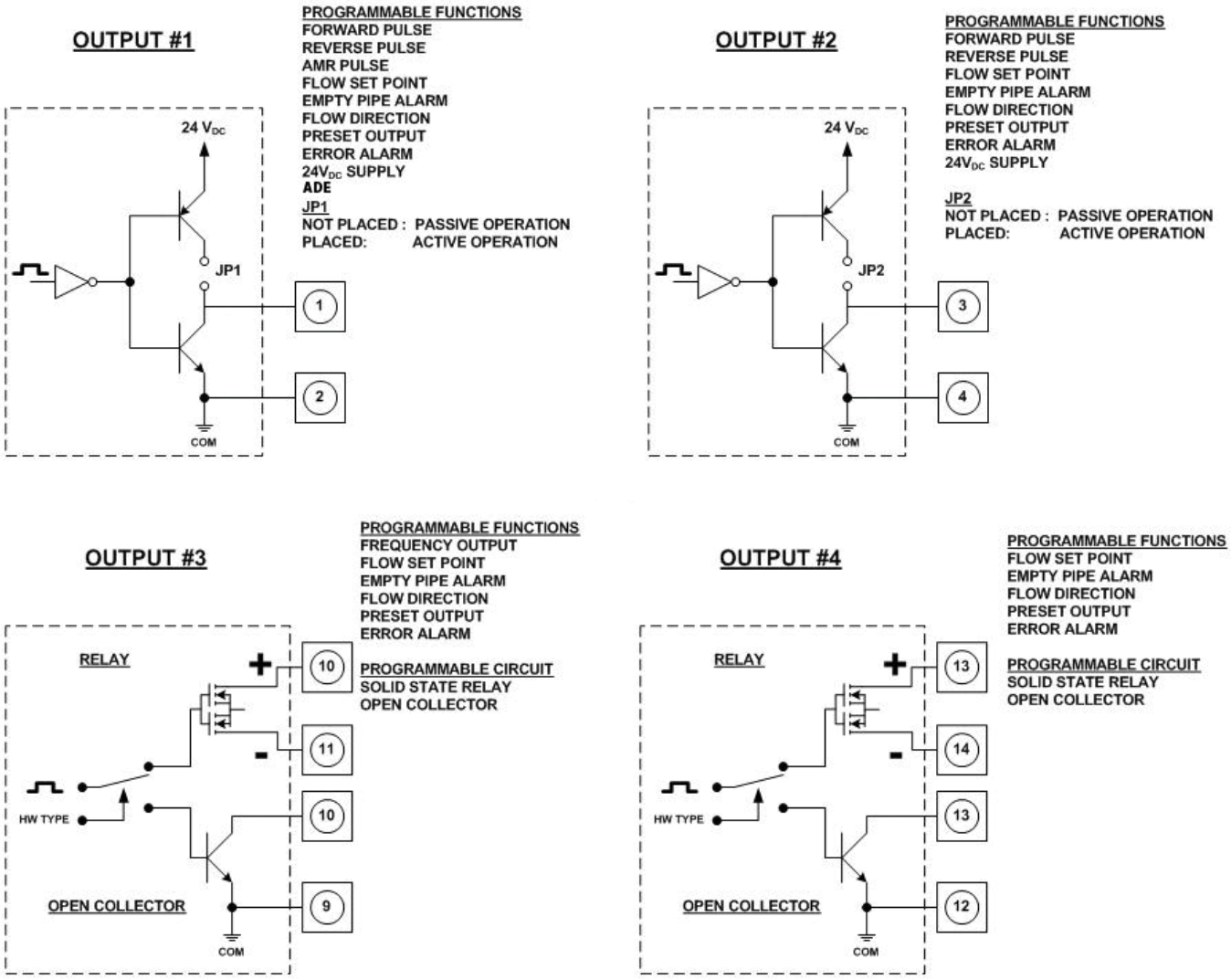
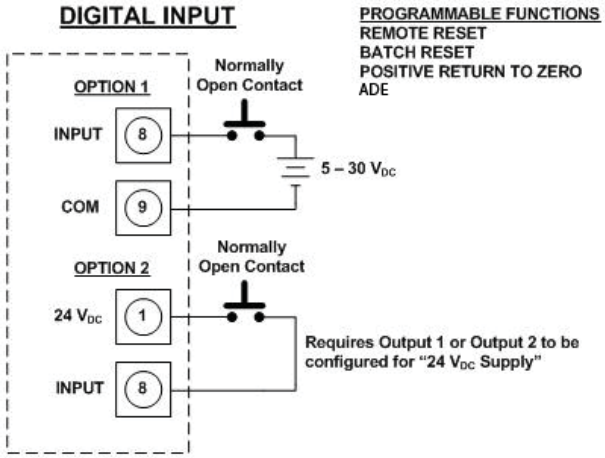


Figure 19: Analog output wiring diagram

Digital Output Wiring Diagrams



Digital Input Wiring Diagram



PROGRAMMING THE M2000

The M2000 amplifier comes preprogrammed from the factory. Typically, you will not need to do any additional programming. However, to take advantage of special features, you can program the meter for your specific needs. If you will be programming the meter, familiarize yourself with the M2000 Function Buttons and follow the procedures outlined below.

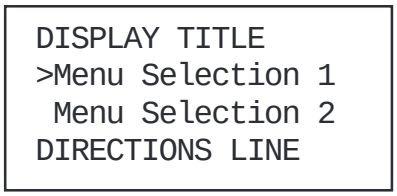
Displays

There are two types of displays on the M2000:

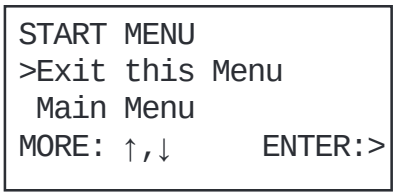
- Menu Selection
- Numeric Entry

Menu Selection Display

Menu selection displays will appear in the following format:



Display format



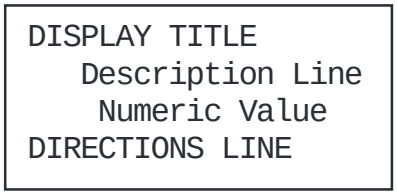
Example menu

The top line shows the title of the display screen. Below that are two visible menu selections. The bottom line provides directions for user input.

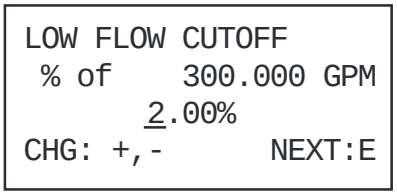
Typically, a menu contains more options than will fit in the two menu selection lines. Press the **[↑]** and **[↓]** buttons to scroll the display text up and down one line at a time. When the arrow is pointed to your desired menu option, press **[E]** to select the item and open its display.

Numeric Entry Display

Numeric entry displays will appear in the following format:



Display format



Example numeric entry display

The top line shows the title of the display screen. The second line is a description of the value. The third line shows the current value. The bottom line provides directions for user input.

NOTE: The bottom line of a numeric-value display provides prompts regarding the function of each button. The [+] or [–] button will change the value of the numeral. The [E] button will move the cursor one digit to the right. When the cursor is at the final, right-most digit, pressing [E] will reposition the cursor at the left-most digit. The bottom line display will change to reflect the new function of the [E] button. Press [E] to save the current entry. Press [+] to edit the current entry.

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       3.00%
EDIT:+          SAVE:E
```

Details on how to change and set numeric values are described in the following section.

Function Buttons

All M2000 programming is accomplished using the three function buttons located on the front of the amplifier:

NOTE: Throughout this manual, the buttons will be referred to as: [↑] or [+] and [↓] or [–], depending on the context. The "Enter" button will be referred to as [E].

Consider the **[+ | ↑]** button as the "next step" or "scroll text up" button. During programming, pressing this button will go to the next menu selection, or increment a numeral.

Example 1: The illustration below shows the M2000 *Main Menu*. The selection arrow is pointing to the Exit this Menu selection.

To scroll up to the menu's next selection, press **[↑]** once. The menu text scrolls up to the next menu selection, *Main Menu*.

```
START MENU
>Exit this Menu
 Main Menu
MORE: ↑,↓      ENTER:>
```

Press [↑]

```
START MENU
> Main Menu
  Quick Setup
MORE: ↑,↓      ENTER:>
```

Example 2: Some procedures require you to enter a numeric value. The [+] button is used to increment the selected numeral. The illustration below shows the *Low Flow Cutoff* parameter display. Notice the cursor under the 2 in the ones' place. In this case, press **[+]** once to increment the numeral to the value of 3.00%.

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       2.00%
CHG: +,-        NEXT:E
```

Press [+]

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       3.00%
CHG: +,-        NEXT:E
```

Consider the Down Arrow [– | ↓] button as the "previous step" button. During a procedure, pressing this button will go to the menu's previous selection or decrement a numeral.

Example 1: The illustration below shows the M2000 *Main Menu*. The selection arrow is pointing to the Meter Setup selection. To scroll the text down to the menu's previous selection, Exit this Menu (which is not visible on the display), press **[↓]** once.

```
MAIN MENU
>Meter Setup
 Measurements
MORE: ↑,↓      ENTER:>
```

Press [↓]

```
MAIN MENU
>Exit this Menu
 Meter Setup
MORE: ↑,↓      ENTER:>
```

Example 2: For procedures that require you to enter a numeric value, the [-] button is used to decrement the selected numeral. The illustration below shows the *Low Flow Cutoff* parameter display. Notice the cursor under the 3 in the ones' place. In this case, press the **[-]** once to decrement the numeral to the value of 2.00 %.

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       3.00%
CHG: +,-       NEXT:E
```

Press [–]

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       2.00%
CHG: +,-       NEXT:E
```

The [E] button functions as an "Enter" button, or "cursor right" button.

Example 1: The illustration below shows the M2000 *Main Menu*. The selection arrow is pointing to the Meter Setup selection. Press **[E]** to select Meter Setup, and open the *Meter Setup* display.

```
MAIN MENU
>Meter Setup
 Measurements
MORE: ↑,↓      ENTER:>
```

Press [E]

```
METER SETUP
>Exit this Menu
 Scale Factor
MORE:↑,↓      ENTER:>
```

In cases where you are entering a numeric value, the [E] button does not function as the "Enter" button, but rather, will move the cursor to the right. When the cursor is at the right-most position, the [E] will now serve as the Enter key.

Example 2: The illustration below shows the *Low Flow Cutoff* display. The cursor is under the 3 in the ones' place. In this case, press **[E]** to move the cursor to the right one digit.

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       3.00%
CHG: +,-       NEXT:E
```

Press [E]

```
LOW FLOW CUTOFF
 % of    300.000 GPM
       3.00%
CHG: +,-       NEXT:E
```

SECURITY

The M2000 security feature gives you the option to restrict access to the meter by way of a five-digit Personal Identification Number (PIN). The system administrator can set up a single PIN for each of the three different levels of access:

- **Administration** – allows access to all M2000 menu configuration screens.
- **Service** – allows access to service-level and user-level menu configuration screens.
- **User** – allows access only to user-level menu configuration screens.

Not all levels of access need to be set. If no PINs are set up, any M2000 user will have access to all functions.

NOTE: The security settings will also apply to remote access. All remote writes to the meter will be blocked unless the user is remotely logged in.

Setting the Administration PIN

Users logged in with the Administration PIN have access to all M2000 menu configuration screens.

To set the administrator's PIN, follow these steps from the *Advanced* menu:

1. Select **Security** to view the *Security* menu.
2. Select **Set Admin PIN** to view the *Admin PIN* display.
3. Set the ve-digit PIN number to the desired value.
4. Press **[E]** to save the PIN and to return to the *Security* menu.

Setting the Service PIN

Users logged in with the Service PIN have access to service level menu configuration screens. Service users will not have access to administrative screens.

NOTE: In order to set a service-level PIN, you must first set up an administration PIN.

To set the service PIN, follow these steps from the *Advanced* menu:

1. Select **Security** to view the *Security* menu.
2. Select **Set Service PIN** to view the *Service PIN* display.
3. Set the ve-digit PIN number to the desired value.
4. Press **[E]** to save the PIN and to return to the *Security* menu.

Setting the User PIN

Users logged in with this User PIN have access to user-level procedures. Users will not have access to administrative or service screens.

NOTE: In order to set a user-level PIN, you must first set up an administration PIN and a service PIN.

To set the user's PIN, follow these steps from the *Advanced* menu:

1. Select **Security** to view the *Security* menu.
2. Select **Set User PIN** to view the *User PIN* display.
3. Set the ve-digit PIN number to the desired value.
4. Press **[E]** to save the PIN and to return to the *Security* menu.

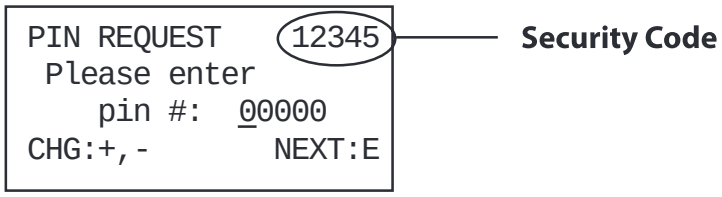
Entering Your Personal Identification Number (PIN)

If your system has been set up with PIN security, you will need to enter a PIN to access programming functions. There are three possible access levels, each with its own unique PIN: User, Service and Administration. Your system administrator will provide you with the appropriate PIN.

NOTE: All PINs are factory set to 00000. At this setting, you will not be required to enter a PIN. If the system administrator has not set the PIN, pressing [E] from the *Start Screen* opens the *Main Menu*.
If you forget or misplace your PIN, call Badger Meter Customer Service to get a master password. When you call, have the security code that appears in the upper right corner of the *PIN Request* display.

Follow these steps to enter your PIN in the M2000:

1. At the *Main Menu*, press **[E]**. The *PIN Request* display opens.



2. Press **[+]** to increment the numeral.
3. Press **[E]** to move the cursor to the next digit.
4. Repeat the steps to set each of the five digits to match your PIN.
5. Press **[E].** If you entered a valid PIN, the *Main Menu* opens indicating your level of access.

If you entered the wrong PIN, you will see the following display:

- Press **[E]** to return to the *PIN Request* display.
- Repeat Steps 1 through 5.

NOTE: Be sure to log off when you have completed work with the M2000. Otherwise, there will be a five-minute delay between your last activity and the time when the M2000 will automatically log you off.

SETTING UP THE M2000 WITH QUICK SETUP

The M2000 provides you with a Quick Setup utility that allows you to set or change your Flow Units, Totalizer Units, Full Scale Flow and Low Flow Cutoff settings. To open the Quick Setup, select **Quick Setup** from the *Start Menu*.

<table>
<tr><th colspan="2">Quick Setup</th></tr>
<tr><td>Flow Unit
[GPM]</td><td>
Flow Unit lets you set the unit of measure for the flow rate and full scale flow.
To change the Flow Unit value, follow these steps from the Quick Setup menu.
1. Select Flow Unit to view the Flow Unit display.
2. Press [↑] or [↓] to position the arrow next to one of the following Flow Units:
<table>
<tr><th>Code</th><th>Flow Unit</th></tr>
<tr><td>LPS</td><td>Liters/Second</td></tr>
<tr><td>LPM</td><td>Liters/Minute</td></tr>
<tr><td>LPH</td><td>Liters/Hour</td></tr>
<tr><td>M³S</td><td>Cubic Meters/Second</td></tr>
<tr><td>M³M</td><td>Cubic Meters/Minute</td></tr>
<tr><td>M³H</td><td>Cubic Meters/Hour</td></tr>
<tr><td>F³S</td><td>Cubic Feet/Second</td></tr>
<tr><td>F³M</td><td>Cubic Feet/Minute</td></tr>
<tr><td>F³H</td><td>Cubic Feet/Hour</td></tr>
<tr><td>GPS</td><td>Gallons/Second</td></tr>
</table>
<table>
<tr><th>Code</th><th>Flow Unit</th></tr>
<tr><td>GPM</td><td>Gallons/Minute</td></tr>
<tr><td>GPH</td><td>Gallons/Hour</td></tr>
<tr><td>MGD</td><td>Mega Gallons/Day</td></tr>
<tr><td>IGS</td><td>UKG/Second</td></tr>
<tr><td>IGM</td><td>UKG/Minute</td></tr>
<tr><td>IGH</td><td>UKG/Hour</td></tr>
<tr><td>LbM</td><td>Pounds/Minute</td></tr>
<tr><td>OPM</td><td>Ounces/Minute</td></tr>
<tr><td>BPM</td><td>Barrels/Minute</td></tr>
</table>
3. Press [E] to save the Flow Units setting.
</td></tr>
<tr><td>Totalizer Unit
[USG]</td><td>
Totalizer Unit establishes the units of measure for the totalizers.
To change the Totalizer Unit value, follow these steps from the Totalizer Unit display.
1. Press [↑] or [↓] to position the arrow next to one of the following Totalizer Units:
<table>
<tr><th>Code</th><th>Totalizer Unit</th></tr>
<tr><td>L</td><td>Liter</td></tr>
<tr><td>HL</td><td>Hectoliter</td></tr>
<tr><td>M³</td><td>Cubic Meter</td></tr>
<tr><td>CFt</td><td>Cubic Feet</td></tr>
<tr><td>USG</td><td>U.S. Gallon</td></tr>
<tr><td>MG</td><td>Mega Gallon</td></tr>
</table>
<table>
<tr><th>Code</th><th>Totalizer Unit</th></tr>
<tr><td>UKG</td><td>Imperial Gallon</td></tr>
<tr><td>Lb</td><td>Pound</td></tr>
<tr><td>Oz</td><td>Fluid Ounce</td></tr>
<tr><td>Aft</td><td>Acre Feet</td></tr>
<tr><td>BBL</td><td>Barrel</td></tr>
</table>
2. Press [E] to save the Totalizer Units setting.
</td></tr>
</table>

Quick Setup	
Full Scale Flow	Full Scale Flow sets the maximum flow the system is expected to measure. This parameter has influence on other system parameters. These parameters include: • Frequency Output – Full scale frequency is observed at full scale flow • Low Flow Cutoff – Changes to full scale flow affect the measuring cut-off threshold of the meter • Alarm Outputs – Changes to full scale flow adjusts the thresholds for generating set point alarms • Pulse Outputs – Changes to full scale flow adjusts the pulse frequency and duty cycle • Analog Outputs – Changes to full scale flow adjusts the interpretation of the analog output signal Change the full scale flow based on the meter size and the application's requirements. Verify that the full scale flow falls within the meter's suggested flow range limits. In terms of flow velocity, the meter's limits are from 0.1 to 39.4 feet/second. The full scale flow is valid for both flow directions. **NOTE:** If the flow rate exceeds the full scale setting, an error message indicates that the configured full scale range has been exceeded. However, the meter will continue to measure. This will affect the latency of the pulse outputs and possibly cause overflow. Furthermore, the analog output may also be placed in alarm mode. To set or change the Full Scale Flow, follow these steps from the *Quick Setup* menu: 1. Select **Full Scale Flow** to view the *Full Scale Flow* display. 2. Set the full scale flow value to the desired setting. 3. Press **[E]** to save the full scale flow value and return to the *Measurements* menu.
Low Flow Cutoff	Low Flow Cutoff defines the threshold at which flow measurement will be forced to zero. The cutoff value can be set from 0% to 10% of the full scale flow. Increasing this threshold will help prevent false readings during "no flow" conditions possibly caused by pipe vibration or inherent system noise. To change Low Flow Cutoff, follow these steps from the *Low Flow Cutoff* display. 1. Set the Low Flow Cutoff value to the desired setting, between 0% and 10%. 2. Press **[E]** to save the value.

QUICK REFERENCE

- Main Menu
  - Meter Setup
    - Scale Factor
    - Empty Pipe Detect
    - Power Line Freq
    - Excitation Freq
    - Pipe Diameter
    - Detector Factor
    - Detector Offset
  - Measurements
    - Velocity Unit
    - Flow Unit
    - Totalizer Unit
    - Full Scale Flow
    - Low Flow Cutoff
    - Flow Direction
    - Damping Factor
  - Inputs/Outputs
    - Analog Output
    - Digital Input 1
    - Digital Output 1
    - Digital Output 2
    - Digital Output 3
    - Digital Output 4
    - Flow Simulation
  - Clear Totals
    - T1
    - T2
    - T+
    - T–
    - TN
    - PS
    - Tpwroff
  - Communications
    - Port A Settings
    - Port B Settings
    - Diagnostics
  - Advanced
    - Data Logger
    - Token Copy
    - ADE
    - Unit Multiplier
    - Backlight Control
    - Analog Calibrate
    - Software Filter
    - Empty Pipe Cal.
    - Security
  - Info/Help
    - Error Counts
    - Rollover Counts
    - Power Up Counter
    - Power Off Totalizer
    - Version Info
    - Serial Number
    - Meter Tag Name
    - Daughterboard Info
    - Polarization Volt
    - Restore Defaults
  - Language Select
    - English
    - Espanol

USING THE M2000 MAIN MENU PROGRAMMING OPTIONS

The following M2000 programming options are available from the *Main Menu*:

- *Meter Setup*
- *Measurements*
- *Inputs/Outputs*
- *Clear Totals*
- *Communications*
- *Advanced*
- *Info/Help*
- *Language Select*

In the section that follows, the applicable security level for each menu option is indicated as follows:

Administrative

Service

User

Options that can be set at *Quick Setup* are indicated with:

The factory default values are shown, enclosed in brackets.

NOTE: Options that are listed [Factory Set] should not be changed without specific directions from authorized Badger Meter personnel.

Meter Setup	
Scale Factor [0.0%] 	Changing the scale factor lets you adjust the meter's accuracy without disturbing factory-set parameters. You can tune the meter to meet changing application requirements. For example, if the meter is under registering by 0.5 percent then set the scale factor to +0.5%. If the meter is over registering by 0.5 percent then set the scale factor to –0.5%. To set the Scale Factor, follow these steps from the *Meter Setup* menu: 1. Select **Scale Factor**, to open the *Scale Factor* display. 2. Set the Scale Factor value to the desired setting. 3. Press **[E]**, to save the new value and return to the *Meter Setup* menu.
Empty Pipe Detect [Off] 	When set to On, Empty Pipe Detect indicates to the outputs and the display that the meter is not completely filled. When set to Off, empty pipe detect is disabled. Enabling empty pipe detect requires a one-time calibration. Calibration is described in the *Advanced* menu section under Empty Pipe Cal. To set Empty Pipe Detect, follow these steps from the *Meter Setup* menu: 1. Select **Empty Pipe Detect** to view the *Empty Pipe Detect* display. 2. Position the arrow next to **On** or **Off**. 3. Press **[E]** to save the Empty Pipe Detect On or Off and return to the *Meter Setup* menu.

<table>
<tr><th colspan="2">Meter Setup</th></tr>
<tr><td>Power Line Freq
[60 Hz]
 </td><td>Power Line Freq provides measuring immunity to industrial noise from a power supply feed.
To set Power Line Frequency, follow these steps from the Meter Setup menu:
1. Select Power Line Freq to view the Power Line Frequency display.
2. Position the arrow next to 50 Hz or 60 Hz.
3. Press [E] to save the power line frequency and return to the Meter Setup menu.</td></tr>
<tr><td>Excitation Freq
[Factory Set]
 </td><td>The Excitation Freq parameter is set at the factory. You can change Excitation Freq to configure the DC excitation of the coils. Supported frequencies are dependent on the configured power line frequency:
<table><tr><th>50 Hz</th><th>60 Hz</th></tr><tr><td>1 Hz</td><td>1 Hz</td></tr><tr><td>3.125 Hz</td><td>3.75 Hz</td></tr><tr><td>6.25 Hz</td><td>7.5 Hz</td></tr><tr><td>12.5 Hz</td><td>15 Hz</td></tr></table>To change Excitation Frequency, follow these steps from the Meter Setup menu:
1. Select Excitation Freq to view the Excitation Frequency display.
2. Position the arrow next the desired frequency.
3. Press [E] to save the excitation frequency and return to the Meter Setup menu.</td></tr>
<tr><td>Pipe Diameter
[Factory Set]
 </td><td>The Pipe Diameter parameter is set at the factory. In the event the amplifier is replaced, verify that the pipe diameter matches the installed pipe size.
To change Pipe Diameter, follow these steps from the Meter Setup menu:
1. Select Pipe Diameter to open the Pipe Diameter display.
2. Position the arrow next to one of the pipe diameters.
3. Press [E] to save the pipe diameter and return to the Meter Setup menu.</td></tr>
<tr><td>Detector Factor
[Factory Set]
 </td><td>The Detector Factor parameter is set at the factory. This factor compensates for accuracy error as a result of the installed detector. If accuracy adjustment of the meter is required, please refer to the scale factor.
In the event the amplifier is replaced, this parameter must be reprogrammed with the original detector factor.</td></tr>
<tr><td>Detector Offset
[Factory Set]
 </td><td>The Detector Offset parameter is set at the factory. This parameter compensates for accuracy error as a result of the installed detector. If accuracy adjustment of the meter is required, please refer to the scale factor.</td></tr>
</table>

<table>
<tr><th colspan="2">Measurements</th></tr>
<tr><td>Velocity Units
[???]
 </td><td>Velocity Units lets you set the …</td></tr>
<tr><td>Flow Units
[GPM]
 </td><td>Flow Units lets you set the unit of measure for the flow rate and full scale flow. Changing the flow units parameter readjusts the full scale flow parameter. For example, changing from gpm to gps would change the full scale flow from 60 gpm to 1 gps.
To change the Flow Unit, follow these steps from the Measurements menu:
1. Select Flow Units to view the Flow Units display.
2. Position the arrow next to one of the following flow unit options:
<table><tr><th>Code</th><th>Flow Unit</th></tr><tr><td>LPS</td><td>Liters/Second</td></tr><tr><td>LPM</td><td>Liters/Minute</td></tr><tr><td>LPH</td><td>Liters/Hour</td></tr><tr><td>M³S</td><td>Cubic Meters/Second</td></tr><tr><td>M³M</td><td>Cubic Meters/Minute</td></tr><tr><td>M³H</td><td>Cubic Meters/Hour</td></tr><tr><td>F³S</td><td>Cubic Feet/Second</td></tr><tr><td>F³M</td><td>Cubic Feet/Minute</td></tr><tr><td>F³H</td><td>Cubic Feet/Hour</td></tr><tr><td>GPS</td><td>Gallons/Second</td></tr></table><table><tr><th>Code</th><th>Flow Unit</th></tr><tr><td>GPM</td><td>Gallons/Minute</td></tr><tr><td>GPH</td><td>Gallons/Hour</td></tr><tr><td>MGD</td><td>Mega Gallons/Day</td></tr><tr><td>IGS</td><td>UKG/Second</td></tr><tr><td>IGM</td><td>UKG/Minute</td></tr><tr><td>IGH</td><td>UKG/Hour</td></tr><tr><td>LbM</td><td>Pounds/Minute</td></tr><tr><td>OPM</td><td>Ounces/Minute</td></tr><tr><td>BPM</td><td>Barrels/Minute</td></tr></table>3. Press [E] to save the flow units and return to the Measurements menu.</td></tr>
</table>

<table>
<tr><th colspan="2">Measurements</th></tr>
<tr><td>Totalizer Unit
[USG]
 </td><td>
The Totalizer Unit parameter establishes the units of measure for the totalizers.
To change the Totalizer Unit value, follow these steps from the Measurements menu:
1. Select Totalizer Unit to view the Totalizer Unit display.
2. Position the arrow next to one of the following totalizer units:
<table>
<tr><th>Code</th><th>Totalizer Unit</th></tr>
<tr><td>L</td><td>Liters</td></tr>
<tr><td>HL</td><td>Hectoliters</td></tr>
<tr><td>M^3</td><td>Cubic Meters</td></tr>
<tr><td>CFt</td><td>Cubic Feet</td></tr>
<tr><td>USG</td><td>U.S. Gallons</td></tr>
<tr><td>MG</td><td>Mega Gallons</td></tr>
</table>
<table>
<tr><th>Code</th><th>Totalizer Unit</th></tr>
<tr><td>UKG</td><td>Imperial Gallons</td></tr>
<tr><td>Lb</td><td>Pounds</td></tr>
<tr><td>Oz</td><td>Fluid Ounces</td></tr>
<tr><td>Aft</td><td>Acre Feet</td></tr>
<tr><td>BBL</td><td>Barrels</td></tr>
</table>
3. Press [E] to save the totalizer unit and return to the Measurements menu.
</td></tr>
<tr><td>Full Scale Flow
[Factory Set]
 </td><td>
The Full Scale Flow parameter sets the maximum flow the system is expected to measure. This parameter has influence on other system parameters. These parameters include:
• Frequency Output – Full scale frequency is observed at full scale flow
• Low Flow Cutoff – Changes to full scale flow affect the measuring cut-off threshold of the meter
• Alarm Outputs – Changes to full scale flow adjusts the thresholds for generating set point alarms
• Pulse Outputs – Changes to full scale flow adjusts the pulse frequency and duty cycle
• Analog Outputs – Changes to full scale flow adjusts the interpretation of the analog output signal
Change the full scale flow based on the meter size and the application's requirements. Verify that the full scale flow falls within the meter's suggested flow range limits. In terms of flow velocity, the meter's limits are from 0.1…39.4 feet/second.
The full scale flow is valid for both flow directions.
NOTE: If the flow rate exceeds the full scale setting, an error message indicates that the configured full scale range has been exceeded. However, the meter will continue to measure. This will affect the latency of the pulse outputs and possibly cause overflow. Furthermore, the analog output may also be placed in alarm mode.
To change the Full Scale Flow, follow these steps from the Measurements menu:
1. Select Full Scale Flow to view the Full Scale Flow display.
2. Set the full scale flow value to the desired setting.
3. Press [E] to save the full scale flow value and return to the Measurements menu.
</td></tr>
</table>

Measurements	
Low Flow Cutoff [0.2%] 	Low flow cutoff defines the threshold at which flow measurement will be forced to zero. The cutoff value can be set from 0% to 10% of the full scale flow. Increasing this threshold will help prevent false readings during "no flow" conditions possibly caused by pipe vibration or inherent system noise. To change the Low Flow Cutoff value, follow these steps from the *Measurements* menu: 1. Select **Low Flow Cutoff** to view the *Low Flow Cutoff* display. 2. Set the low flow cutoff value to the desired setting. 3. Press **[E]** to save the new low flow cutoff value.
Flow Direction [Bi-Directional] 	Flow Direction lets you set the meter to measure forward flow only (uni-directional) or both forward and reverse flow (bi-directional). **Uni-Directional** Flow is totalized in only one direction. The flow direction is indicated by the arrow printed on the detector label. Uni-directional measurements on the main display screen include: • T1: Registers forward flow, resettable by menu or MODBUS RTU • T2: Registers forward flow, resettable by menu, MODBUS RTU, or digital input configured for Remote Reset **Bi-Directional** Flow is totalized in both directions. Bi-directional measurements on the main display screen include: • T+: Registers forward flow, resettable by menu or MODBUS RTU • T–: Registers reverse flow, resettable by menu or MODBUS RTU • TN: Registers total flow, T+ – T–, resettable by menu or MODBUS RTU To change the flow direction follow these steps from the *Measurements* menu. 1. Select **Flow Direction** to view the *Flow Direction* display. 2. Select **Uni-Directional** or **Bi-Directional**. 3. Press **[E]** to save the flow direction and return to the *Measurements* menu.
Damping Factor [No Damping] 	The damping factor establishes the stability of the measured flow rate. If back and forth oscillations of the flow rate are observed during normal flow conditions, increase this value incrementally until the flow rate stabilizes. This parameter has no affect on the totalizers. To change the Damping Factor value, follow these steps from the *Measurements* menu. 1. Select **Damping Factor** to view the *Damping Factor* display. 2. Select one of the following damping factors: 1 Second — 10 Seconds 2 Seconds — 20 Seconds 3 Seconds — 30 Seconds 4 Seconds — No Dampening 5 Seconds 3. Press **[E]** to save the damping factor and return to the *Measurements* menu.

Inputs/Outputs		
Analog Output	**Range** [4 to 20 mA] 	The Analog Output parameter establishes the range of the analog output signal. To change Analog Output range, follow these steps from the *Inputs/Outputs* menu: 1. Select **Analog Output** to view the *Analog Output* display. 2. Select one of the following options: • 4 to 20 mA • 0 to 20 mA • 2 to 10 mA • 0 to 10 mA 3. Press **[E]** to save the analog output and return to the *Inputs/Outputs* menu:
	Alarm Mode [OFF] 	This parameter configures the behavior of the analog output during alarm conditions. Three options exist for this parameter: OFF, LOW, and HIGH. **OFF:** Analog signal is based on flow rate and always within the configured range **LOW:** During alarm conditions, the analog signal will be 2 mA less than the configured lower range **HIGH:** During alarm conditions, the analog signal will be 2 mA more than the configured upper range For example, if the analog range is 4 to 20 mA and the alarm mode is set to HIGH, then during a full scale flow alarm condition, the analog output current will be 22 mA. To change the analog output alarm mode, follow these steps from the *Inputs/Outputs* menu: 1. Select **Alarm Mode** to view the *Alarm Mode* display. 2. Select one of the following options: • OFF • LOW • HIGH 3. Press **[E]** to save the alarm mode and return to the *Inputs/Outputs* menu.
Digital Input	Digital Input lets you configure the functional operation of the digital input. The following functions are supported: • Remote Reset – Clears totalizer T2 (uni-directional) • Batch Reset – Resets batch totalizer PS to preset amount and clears T2 (uni-directional) • Pos Zero Return – Forces flow rate to zero (does not totalize) • ADE – Input configured for ADE operation. See *"ADE Interface" on page 50*. To change Digital Input, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Input** to view the *Digital Input* display. 2. Select the desired function. 3. Press **[E]** to save the digital input and return to the *Inputs/Outputs* menu.	

Inputs/Outputs		
Digital Output	Pulses/Unit [1] 	The Pulses/Unit parameter lets you set how many pulses per unit of measure will be transmitted to remote applications. For example, assuming the unit of measure is gallons: • Setting the Pulses/Unit to 1 will transmit 1 pulse every gallon • Setting the Pulses/Unit to 0.01 will transmit 1 pulse every 100 gallons You must configure pulses/unit if the function of the selected output is to be forward, reverse or AMR pulse. This parameter must be considered with the Pulse Width and Full Scale Flow parameters. The maximum pulse frequency is 10 kHz. The frequency is correlated with the flow rate. Violation of output frequency limits will generate a configuration error. To change the pulses/unit, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Output 1** or **2** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Pulses/Unit**, and press **[E]** to open the *Pulses/Unit* display. 3. Enter the pulses/unit value. Press **[E]** to save the new parameter and return to the *Digital Output* menu.
	Pulse Width [0 ms] 	The Pulse Width parameter establishes the On duration of the transmitted pulse. The configurable range is from 0 to 1000 ms. • Non-zero pulse width configuration – the Off duration of the transmitted pulse is dependent on flow rate. The Off duration is to be at least the configured On duration. At full scale flow, the On duration equals the Off duration. The maximum configurable output frequency is limited to 500 Hz. • 0 ms pulse width configuration – the duty cycle of the transmitted pulse is at 50 percent allowing for a maximum configurable output frequency of 10 kHz. This parameter must be considered with the Pulses/Unit and Full Scale Flow parameters. The maximum pulse frequency is 10 kHz. The frequency is correlated with the flow rate. Violation of output frequency limits will generate a configuration error. To change the pulse width, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Output 1** or **2** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Pulse Width**, and press **[E]** to open the *Pulse Width* display. 3. Enter the pulse width value. Press **[E]** to save the new parameter and return to the *Digital Output* menu.

Inputs/Outputs		
Digital Output	Preset Amount [0.0] 	Preset amount lets you set the reset value for the associated PS totalizer when the digital input is set to Batch Reset. To change the preset amount, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Output 1**, **2, 3 or 4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Preset Amount**, and press **[E]** to open the *Preset Amount* display. 3. Enter the preset amount value. Press **[E]** to save the new parameter and return to the *Digital Output* menu. **NOTE:** You can only set one Preset Amount. If you set the Preset Amount for Digital Output 1, it will be the same for 2, 3 and 4.
	Set Point Min. [0%] 	This parameter establishes, as a percentage of full scale flow, the threshold at which the output alarm will be activated. Flow rates below the threshold will activate the output alarm. To change the set point minimum, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Output 1**, **2, 3 or 4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Set Point Min.**, and press **[E]** to open the *Set Point Min.* display. 3. Enter the set point minimum value. Press **[E]** to save the new parameter and return to the *Digital Output* menu.
	Set Point Max. [100%] 	This parameter establishes, as a percentage of full scale flow, the threshold at which the output alarm will be activated. Flow rates above the threshold will activate the output alarm. To change the maximum set point, follow these steps from the *Inputs/Outputs* menu: 1. Select **Digital Output 1**, **2, 3 or 4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Set Point Max.** and press **[E]** to open the *Set Point Max.* display. 3. Enter the set point maximum value and press **[E]** to save the new parameter and return to the *Digital Output* menu.

Inputs/Outputs		
Digital Output	Output Type [1: Normally Open] [2: Normally Open] [3: Normally Open] [4: Normally Closed] 	The Output Type parameter lets you set the output switch to normally open or normally closed. If normally open is selected, the output switch is open (no current) when the output is inactive, and closed (current flows) when the output is active. If normally closed is selected, the output switch is closed (current flows) when the output is inactive, and open (no current) when the output is active. To change the Output Type, follow these steps from the *Inputs/Outputs* main menu: 1. Select **Digital Output 1**, **2, 3 or 4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu**,** select **Output Type** and press **[E]** to open the *Output Type* display. 3. Select **Normally Open** or **Normally Closed**. 4. Press **[E]** to save the new parameter and return to the *Digital Output* menu.
	Hardware Type [3: Open Collector] [4: Open Collector] 	The Hardware Type parameter lets you select the type of hardware used to drive the output signal: either open collector or solid-state relay. To change the Hardware Type, follow these steps from the *Inputs/Outputs* main menu: 1. Select **Digital Output 3 or 4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Hardware Type**, and press **[E]** to open the *Hardware Type* display. 3. Select **Open Collector** or **Relay**. 4. Press **[E]** to save the new parameter and return to the *Digital Output* menu.
	Full Scale Frequency [3: 1000 Hz] 	The Full Scale Frequency parameter establishes the full scale flow output frequency when the flow rate equals the configured full scale flow. To change the Full Scale Frequency, follow these steps from the *Inputs/Outputs* main menu: 1. Select **Digital Output 3** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu select **Full Scale Frequency**, and press **[E]** to open the *Full Scale Frequency* display. 3. Set the full scale frequency value to the desired setting. 4. Press **[E]** to save the new parameter and return to the *Digital Output* menu.

Inputs/Outputs		
Digital Output	Select Function [1: Forward Pulse] [2: Reverse Pulse] [3: Frequency Pulse] [4: Error Alarm] 	Digital Output lets you configure the functional operation of the associated output. The following operations are supported: • Reverse Pulse – Generates pulses during reverse flow conditions. • Forward Pulse – Generates pulses during forward flow conditions. • Frequency Output – Generates pulses correlated to the absolute value of the flow rate. • Preset Output – Provides indication when preset batch amount has been realized. • Flow Set Point – Provides indication when flow rate exceeds thresholds defined by flow set points. • 24V DC Supply – Provides constant 24 volts on output (forces output type to normally open). • Error Alarm – Provides indication when meter has error condition. Error conditions include, empty pipe error, full scale flow error, and detector error. • Flow Direction – Provides indication on current flow direction (Inactive = Reverse or No Flow, Active = Forward). • Empty Pipe Alarm – Provides indication when pipe is empty. • ADE – Provides meter information in digital format. See *"ADE Interface" on page 50*. To change the Function Select, follow these steps from the *Inputs/Outputs* main menu: 1. Select **Digital Output 1**, **2, 3** or **4** and press **[E]** to open the *Digital Output* menu. 2. From the *Digital Output* menu choose **Select Function**, and press **[E]** to open the *Select Function* display. 3. Select the desired function. 4. Press **[E]** to save and return to the *Digital Output* menu.
Flow Simulation [Off] 	Flow Simulation provides output simulation based on a percentage of the full scale flow. Simulation will not accumulate the totalizers. The range of simulation includes –100% to 100% of the full scale flow. The Flow Simulation Parameter lets you set the range of simulation in 10% increments. To change the Flow Simulation, follow these steps from the *Inputs/Outputs* menu: 1. Select **Flow Simulation** to view the *Flow Simulation* display. 2. Click **[+]** to increment the percentage by 10, or click **[–]** to decrement the percentage by 10. 3. Press **[E]** to save the displayed setting and return to the *Inputs/Outputs* menu.	

Clear Totals	
T1	The uni-directional totalizer is reset within the menu manager or through remote communications. Clearing T1 also clears the associated rollover counter.
T2	The uni-directional totalizer is reset within the menu manager, through remote communications or with properly-configured digital input (function = remote reset). Clearing T2 also clears the associated rollover counter.
T+	The bi-directional forward flow totalizer is reset within the menu manager or through remote communications. Clearing T+ also clears the associated rollover counter.
T–	The bi-directional reverse flow totalizer is reset within the menu manager or through remote communications. Clearing T– also clears the associated rollover counter.
TN	The bi-directional net totalizer, when reset, clears both the forward and the reverse flow totalizers (T+ and T–). This is reset within the menu manager or through remote communications. Clearing TN also clears the associated rollover counter.
PS	The batch totalizer is reset to the configured preset amount value. It is reset within the menu manager, remote communications or through a properly-configured digital input (function = batch reset).
Tpwroff	The totalizer accumulating meter time without external power is reset with the menu manager or through remote communications.

Communication		
Port A Settings	Interface [MODBUS RTU]	The Interface parameter lets you configure how the RS232 communication port will be used. • MODBUS RTU • Remote menu (RDI – Remote Display Interface) • Primo 3.x • Disable port The remote menu interface will check for display updates once a second. If a change is detected, the display contents will be transmitted in ASCII format over the RS232 communication port. The remote menu interface also allows for menu navigation and control of the meter as if using the external push buttons. Keyboard control characters such as <UP>,<DWN>, and <ENTER> are supported to navigate the menus. The Primo 3.x interface will emulate the legacy Primo 3.x Protocol. This protocol will transmit an ASCII string in the following format every 500 ms: “RATE;0.0000; GPM; TOT1;150.0000; USG ; TOT2;150.0000; USG ;” – For Unidirectional Mode “RATE;0.0000; GPM; TOT+;10.0000; USG ; TOT-;50.0000; USG ;” – For Bidirectional Mode To change the Interface follow these steps from the *Port A Settings* menu: 1. Select **Interface** to view the *Interface* display. 2. Select the desired interface. 3. Press **[E]** to save and return to the *Port A Settings* menu.

Communication		
Port A Settings	Port Address [1] 	This parameter establishes the MODBUS RTU address. MODBUS RTU requests will only be processed if the configured port address of the meter matches the request address found in the MODBUS RTU packet. The range of addresses supported by MODBUS RTU is 1…247. MODBUS RTU request packets with an address of 0 imply the packet is to be treated as a broadcast packet. To change the port address, follow these steps from the *Port A Settings* menu: 1. Select **Port Address** to view the *Port Address* display. 2. Select the desired port address **(1…247)**. 3. Press **[E]** to save the option and to return to the *Port A Settings* menu.
	External Port Address [1] 	For PROFIBUS® use only. This parameter allows configuration of the PROFIBUS DP daughterboard address.
	Baud Rate [9600] 	The following Baud Rates are supported • 9600 • 19200 • 38400 To change the baud rate, follow these steps from the *Port A Settings* menu: 1. Select **Baud Rate** to view the *Baud Rate* display. 2. Select one of the following baud rates: **9600**, **19200** or **38400**. 3. Press **[E]** to save the option and to return to the *Port A Settings* menu.
	Data Bits [8 bits] 	The Data Bits parameter configures the port data bits. The following data bits are supported: • 8 bits • 7 bits • 5 bits To change the data bits, follow these steps from the *Port A Settings* menu: 1. Select **Data Bits** to view the *Data Bits* display. 2. Select one of the following: **8 Bits**, **7 Bits** or **5 Bits**. 3. Press **[E]** to save the option and to return to the *Port A Settings* menu.

<table>
<tr><th colspan="3">Communication</th></tr>
<tr><td rowspan="2">Port A Settings</td><td>Parity
[Even]
 </td><td>The following Parities are supported
• Even
• Odd
• None
To change the parity, follow these steps from the Port A Settings menu:
1. Select Parity to view the Parity display.
2. Select one of the following: None, Even or Odd.
3. Press [E] to save the option and to return to the Port A Settings menu.</td></tr>
<tr><td>Stop Bits
[1 Stop Bit]
 </td><td>The Stop Bits parameter configures the port stop bits. The following stop bits are supported:
• 1 Stop Bit
• 2 Stop Bits
To change the stop bits, follow these steps from the Port A Settings menu:
1. Select Stop Bits to view the Stop Bits display.
2. Select one of the following: 1 Stop Bit, or 2 Stop Bits.
3. Press [E] to save the option and to return to the Port A Settings menu.</td></tr>
<tr><td>Port B Settings</td><td>Port Address
[1]
 </td><td>An additional communication port, known as Port B, is used to offer enhanced communications with the meter. This port is located on the 11-pin terminal of the PCB. Enhanced protocols like Hart, Profibus DP or Modbus RTU over RS485 are available. In addition, this communication port has similar configurable properties as port A. Refer to the following user manuals for additional information regarding the enhanced communication capabilities of the M2000.
• HART® communication protocol.
• PROFIBUS DP communication protocol.
• MODBUS RTU communication protocol.</td></tr>
<tr><td>Diagnostics</td><td>Port Counters
[0]
 </td><td>Port counters are used for diagnostics when configured for MODBUS RTU. These counters are only cleared on power up.
<table>
<tr><th>Counter</th><th>Description</th></tr>
<tr><td>Pkts Processed</td><td>Number of packets processed by meter.</td></tr>
<tr><td>Broadcast Pkts</td><td>Number of broadcast packets (address = 0) processed by meter.</td></tr>
<tr><td>CRC Errors</td><td>Number of received packets with CRC error; packet is discarded.</td></tr>
<tr><td>Pkts Rcvd</td><td>Number of packets received with an address of the configured port address.</td></tr>
<tr><td>Pkts Sent</td><td>Number of packets transmitted in response to a received packet.</td></tr>
<tr><td>Parity Errors</td><td>Number of characters with parity errors (i.e., received character has a mismatch between the number of 1s and its parity bit); packet is discarded.</td></tr>
<tr><td>Framing Errors</td><td>Number of characters with framing errors (i.e. missing stop bit is not found – indicates that synchronization with the start bit has been lost and that the character is improperly framed); packet is discarded.</td></tr>
<tr><td>Overrun Errors</td><td>Number of characters received that were not processed due to degradation of system performance.</td></tr>
<tr><td>Break Detects</td><td>Number of detections that transmission line is locked (i.e., receive line is low for 10-bit transmissions following a missing stop bit).</td></tr>
</table></td></tr>
</table>

<table>
<tr><th colspan="2">Advanced Features</th></tr>
<tr><td>Unit Multiplier
[Off]
 </td><td>The Unit Multiplier establishes the number of units of measure that have to accumulate before the display totalizers are updated. This is also known as setting the number of “dead” zeroes in the display totalizer. For example:
<table>
<tr><th colspan="6">Unit Multiplier less than 1</th></tr>
<tr><td>Unit Multiplier</td><td colspan="5">Example</td></tr>
<tr><td>OFF</td><td>0.00000 USG</td><td>0.00012 USG</td><td>0.00123 USG</td><td>0.01234 USG</td><td>0.12345 USG</td></tr>
<tr><td>0.0001</td><td>0.0000 USG</td><td>0.0001 USG</td><td>0.0012 USG</td><td>0.0123 USG</td><td>0.1234 USG</td></tr>
<tr><td>0.001</td><td>0.000 USG</td><td>0.000 USG</td><td>0.001 USG</td><td>0.012 USG</td><td>0.123 USG</td></tr>
<tr><td>0.01</td><td>0.00 USG</td><td>0.00 USG</td><td>0.00 USG</td><td>0.01 USG</td><td>0.12 USG</td></tr>
<tr><td>0.1</td><td>0.0 USG</td><td>0.0 USG</td><td>0.0 USG</td><td>0.0 USG</td><td>0.1 USG</td></tr>
</table>
<table>
<tr><th colspan="6">Unit Multiplier greater than or equal to 1</th></tr>
<tr><td>Unit Multiplier</td><td colspan="5">Example</td></tr>
<tr><td>OFF</td><td>0.00000 USG</td><td>1.23456 USG</td><td>12.34567 USG</td><td>123.4567 USG</td><td>1234.456 USG</td></tr>
<tr><td>1</td><td>0 USG</td><td>1 USG</td><td>12 USG</td><td>123 USG</td><td>1234 USG</td></tr>
<tr><td>10</td><td>0 USG</td><td>0 USG</td><td>10 USG</td><td>120 USG</td><td>1230 USG</td></tr>
<tr><td>100</td><td>0 USG</td><td>0 USG</td><td>0 USG</td><td>100 USG</td><td>1200 USG</td></tr>
<tr><td>1000</td><td>0 USG</td><td>0 USG</td><td>0 USG</td><td>0 USG</td><td>1000 USG</td></tr>
</table>
To change the Unit Multiplier, follow these steps from the Advanced menu:
1. Select Unit Multiplier to view the Unit Multiplier display.
2. Select the desired unit multiplier.
3. Press [E] to save the option and to return to the Advanced menu.</td></tr>
<tr><td>Backlight Control
[Timed Off]
 </td><td>You can set the meter's backlight to: Always On, Always Off and Timed Off.
When set to Timed Off, the backlight will automatically turn off after one minute of inactivity (no buttons pressed). Pressing any button will turn the backlight on, but will not immediately navigate the menu.
To change the backlight control, follow these steps from the Advanced menu:
1. Select Backlight Control to view the Backlight Control display.
2. Select the desired option.
3. Press [E] to save the option and to return to the Advanced menu.</td></tr>
<tr><td>Token Copy</td><td>Configuration
Store to Token
Restore from Token</td><td>See the M2000 Store/Restore user manual for details on using the Token Copy features.</td></tr>
<tr><td>ADE</td><td>Protocol Type</td><td>The protocol type enables the ADE interface. Selecting S1 or S2 will automatically configure the Digital Input and Digital Output #1 for ADE operation. Manually configuring the input and output for ADE operation is not allowed and will result in a on-screen error.
See "ADE Interface" on page 50 for further details.
S1 – Standard ADE protocol
S2 – Enhanced ADE protocol, provides additional digital information
Disabled – disables and removed ADE configuration</td></tr>
<tr><td></td><td>Dial Type</td><td>4 – 8 dials</td></tr>
</table>

Analog Calibrate	Custom Settings [Zero Scale: 0 mA] [Full Scale: 0 mA] 	To set the analog calibration custom settings, follow these steps from the *Advanced* menu: 1. Select **Analog Calibrate** to view the *Analog Calibrate* menu. 2. Select **Custom Settings** to view the *Custom Settings* display. 3. Select one of the following: • **Offset 4 mA** • **Offset 20 mA** 4. Configure desired offset. 5. Press **[E]** to save the option and to return to the *Custom Settings* menu. 6. Press **[E]** to return to the *Analog Calibrate* menu.
	Factory Settings [Factory Set] 	To change the analog calibration factory settings, follow these steps from the *Advanced* menu: 1. Select **Analog Calibrate** to view the *Analog Calibrate* menu. 2. Select **Factory Settings** to view the *Factory Settings* display. 3. Select one of the following: • **Calibration Point A** • **Calibration Point B** 4. Set the calibration point to the measured output current. 5. Press **[E]** to save the option and to return to the *Factory Settings* menu. 6. Press **[E]** to return to the *Analog Calibrate* menu.

Advanced Features		
Software Filter	Description	The software filter operates as an acceleration filter. This filter when configured properly allows for filtering of fast changes in fluid flow. Generally, this filter is used in applications having highly conductive fluids. This filter is intended to help provide smoothing of the analog output and display fluctuations.
	Activation [Off] 	The Activation parameter setting enables or disables the software acceleration filter. To change the Activation setting, follow these steps from the *Advanced* menu: 1. Select **Activation** from the *Advanced* menu. 2. Select the desired setting. 3. Press **[E]** to save the option and to return to the *Advanced* menu.
	Filter Delay [1] 	The Filter Delay parameter lets you set the amount of time that the flow will be held constant once the filter is activated. The filter is activated by an acceleration component of the fluid exceeding the configured limit. To change the Filter Delay follow these steps from the *Advanced* menu: 1. Select **Filter Delay,** from the *Advanced* menu. 2. Select the desired setting. 3. Press **[E]** to save the option and to return to the *Advanced* menu.
	Acceleration Factor [1] 	The Acceleration Factor parameter lets you set the maximum acceleration for a given pipe diameter and is dependent on the excitation frequency. The maximum fluid velocity is 12 m/s. The following equation defines the maximum fluid acceleration: Acceleration(MAX) = Acceleration Factor * 12 m/s * Pipe Area * Excitation Frequency / 1.5 If the realized fluid acceleration exceeds the configured maximum acceleration, fluid flow will be held constant for the time set at the Filter Delay parameter. To change the Acceleration Factor setting, follow these steps from the *Advanced* menu: 1. Select **Acceleration Factor** from the *Advanced* menu. 2. Select the desired setting. 3. Press **[E]** to save the option and to return to the *Advanced* menu.

Advanced Features		
Software Filter	Constant Flow [150 M^3/Sec^2] 	During normal flow conditions, there is always a non-zero acceleration component. For example, if acceleration of the flow activates the filter, the meter will assume constant flow for the duration of the filter delay time unless the flow returns within limits. Properly configured, this parameter will help offset excessive impacts of the filter delay. The Constant Flow parameter lets you set the acceleration limit for constant flow. To change the Constant Flow setting, follow these steps from the *Advanced* menu: 1. Select **Constant Flow** from the *Advanced* menu. 2. Select the desired setting. 3. Press **[E]** to save the option and to return to the *Advanced* menu.
	Peak Detect [0 M^3/Sec^2] 	Peak Detect offers a diagnostic view of the acceleration components observed during flow conditions. This parameter records the "high water mark" of the measured accelerations component. This value will help to properly configure the Acceleration Factor parameter. Generally, you will set the acceleration factor at about 75% of the Peak Detect measurement. To reset the Peak Detect setting, follow these steps from the *Advanced* menu: 1. Select **Peak Detect** from the *Advanced* menu. 2. Press **[+]** to reset. 3. Press **[E]** to return to the *Advanced* menu.
MDN Filter	Description	This software filter operates as a Median filter. This filter is very responsive and can be used to help stabilize flow measurements. This filer is enabled by selecting a non-zero filter size. Supported filter sizes are: • S5 - Size 5 • S7 - Size 7 • S9 - Size 9 The filter technique will use the median value of the last Sx samples used for determining flow measurement.:

Advanced Features	

Empty Pipe Cal.
[Default]
 	
	Fluid conductivity impacts the performance of empty pipe measurements. If you require empty pipe detection, you should perform this empty pipe calibration procedure.
	Before starting the empty pipe calibration, verify that empty pipe detection is enabled. Also, run both the empty pipe and the full pipe calibration procedures.
	Calibrating an Empty Pipe
	Before calibrating an empty pipe, verify that the pipe is empty.
	To calibrate with an empty pipe, follow these steps from the *Advanced* menu:
	1. Select **Empty Pipe Cal** to view the *Calibration* menus.
	2. Select **Cal. Empty Pipe** to view the *Empty Pipe Calibrate* menu.
	3. To enable calibration, place the cursor on the calibration enable line and press **[E]**.
	`EMPTY PIPE CALIBRATE`
	` Volts = 3.00`
	`>Cal [ON]  E=OFF`
	` Exit with Save`
	4. Wait 30 seconds for voltage measurement to stabilize.
	5. To save the setting, place the cursor on **Exit with Save** and press **[E]**.
	Calibrating a Full Pipe
	Before calibrating a full pipe, verify that the pipe is full.
	To calibrate with a full pipe, follow these steps from the *Advanced* menu:
	1. Select **Empty Pipe Cal** to view the *Calibration* menus.
	2. Select **Cal. Full Pipe** to view the *Full Pipe Calibrate* menu.
	3. Enable calibration by placing the cursor on the calibration enable line and press **[E]**.
	`FULL PIPE CALIBRATE`
	` Volts = 1.515`
	`>Cal [OFF]  E=ON`
	` Exit with Save`
	4. Wait 30 seconds for voltage measurement to stabilize.
	5. To save the setting, place the cursor on **Exit with Save** and press **[E]**.

Advanced Features		
Security	Set Admin PIN [00000]	Users logged in with this PIN will have access to all M2000 procedures. To set the administrator's PIN, follow these steps from the *Advanced* Menu: 1. Select **Security** to view the *Security* menu. 2. Select **Set Admin PIN** to view the *Admin PIN* display. 3. Set the five-digit PIN number to the desired value. 4. Press **[E]** to save the PIN and to return to the *Security* menu.
	Set Service PIN [00000]	Users logged in with this PIN will have access to all service level and user-level procedures. Service users will not have access to administrative procedures. To set the service PIN, follow these steps from the *Advanced* Menu: 1. Select **Security** to view the *Security* menu. 2. Select **Set Service PIN** to view the *Service PIN* display. 3. Set the five-digit PIN number to the desired value. 4. Press **[E]** to save the PIN and to return to the *Security* menu.
	Set User PIN [00000]	Users logged in with this PIN will have access to user-level procedures. User at this level will not have access to administrative or service procedures. To set the user's PIN, follow these steps from the *Advanced* Menu: 1. Select **Security** to view the *Security* menu. 2. Select **Set User PIN** to view the *User PIN* display. 3. Set the five-digit PIN number to the desired value. 4. Press **[E]** to save the PIN and to return to the *Security* menu.

Info/Help		
Error Counts [0]	Description	This menu provides a diagnostic view of the meter's performance. Below are several system diagnostic counters and their definitions. Use discretion when interpreting these counters. These values could be altered during system setup or when using the verification device. We suggest that you reset these counters before you start monitoring your system and look for conditions possibly affecting performance.
	Detector	The number of times an invalid detector condition has been observed.
	Empty Pipe	The number of times an empty pipe condition has been observed by the meter.
	Full Scale	The number of times the flow has exceeded the full scale flow setting.
	Totalizer	The number of times the totalizers have exceeded limits of the meter.
	Pulse Sync.	The number of times the pulse outputs have fallen out of synchronization.
	ADC Interrupt	The number of times an analog input measurement has been missed.
	ADC Range	The number of times the analog input measurement range has been exceeded.
	System Error	A diagnostic system message indicating the reason for a system reset.
	System Resets	The number of times the meter has been reset.
	System Reset ID	Diagnostic information about a system reset as a result of expired internal timers.
	Token Errors	Indicates the number of parameter copies from a memory token that failed to be copied to the meter.

	Info/Help
Rollover Counts [0] 	The number of times the totalizers have rolled over 9,999,999,999 (10 billion). As the meter rolls over, a status indicator appears in the display. When this occurs, we suggest that you record the totalizers and rollover counter and reset the totalizers. Resetting totalizers will also clear the rollover counter. For a meter configured in bidirectional mode, rollover is represented by the net totalizer (TN) as "*********". During this condition, the net totalizer (TN) can be calculated using the following equation: $T(FWD) = [(ROLLOVER_{T+} \times 10{,}000{,}000{,}000) + T+]$ $T(REV) = [(ROLLOVER_{T-} \times 10{,}000{,}000{,}000) + T-]$ $TN = T(FWD) - T(REV)$ *Where $ROLLOVER_{Tx}$ is the rollover count for the appropriate totalizer* For a meter configured in unidirectional mode, the totalizer can be calculated using the following equation: $T1 = [(ROLLOVER_{T1} \times 10{,}000{,}000{,}000) + T1]$ $T2 = [(ROLLOVER_{T2} \times 10{,}000{,}000{,}000) + T2]$ *Where $ROLLOVER_{Tx}$ is the rollover count for the appropriate totalizer*
PowerUp Counter [Not applicable] 	The number of times that the unit has been powered on.
Power Off Totalizer [Not applicable] 	The length of time that the unit has been without power.
Version Info [Not applicable] 	The current software version.
Serial Number [Not applicable] 	The manufacturing serial number in the format YYMM####. Where YYMM indicates year and month of manufacturing and #### indicates the sequence number.

Info/Help	
Meter Tag Name	For PROFIBUS – This parameter is only programmable over external PROFIBUS communications.
Daughterboard Information	Describes current version of attached daughterboard. **NOTE:** RS485 daughterboard is not recognized because it is a pass-through device rather than an intelligent protocol converter like Hart-to-MODBUS.
Polarization Voltage	Diagnostic voltage to help determine if the meter or application is performing optimally.
Restore Defaults [Not applicable] 	Restores all non-calibrated parameters to the factory defaults.

Language Select	
Language Select [English] 	The M2000 supports one alternate language along with English. This alternate language choice is set at the factory. The options are: Spanish, German, Czech or French. To select the language, follow these steps from the **Language Select menu**: 1. Select **English** or the **Alternate Language**. 2. Press **[E]** to save the selection.

ADE INTERFACE

This feature requires firmware version 1.10 or later. Reference Badger Meter P/N 6734-003 to obtain a firmware upgrade kit. Enabling the meter as an ADE register requires three settings, all within the advanced menu, to be configured.

- Unit Multiplier – Selects the resolution of the display totalizer.
- Protocol Type – Selects the type of information to be transmitted to the ADE transmitter.
- Dial Type – Enables ADE and selects the number of significant totalizer digits to transmit.

Changing the dial type from Disabled will automatically configure the necessary digital inputs/outputs. It is not allowed to manually change the digital inputs/outputs within the *Input/Outputs* menu. Below is a wiring diagram for connecting an ADE transmitter to the meter.

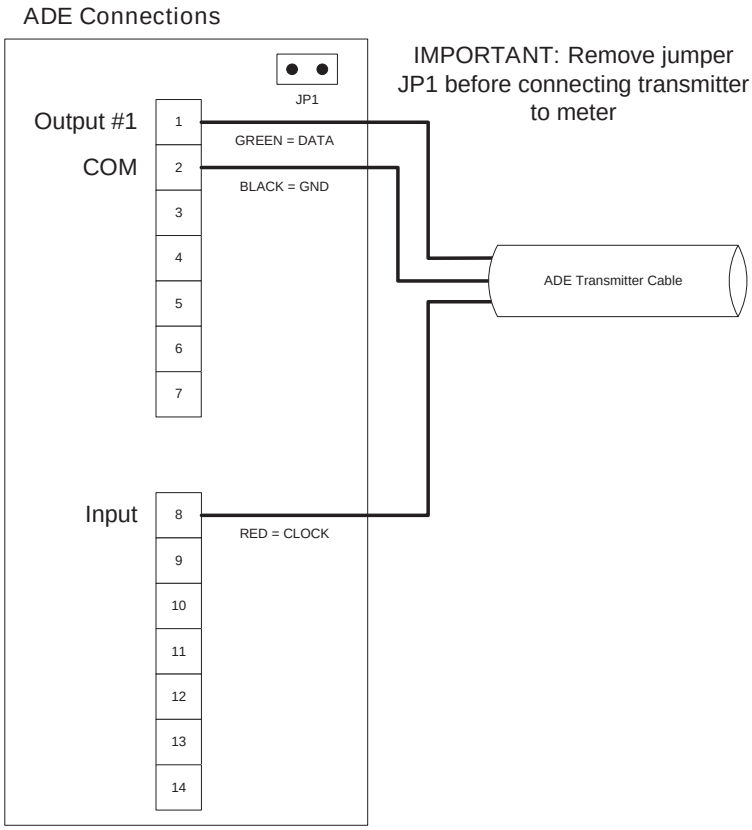


Figure 20: ADE interface

The following table demonstrates how the totalizers are displayed under various configurations of the Unit Multiplier (that is, resolution) and Dial Type. The non-shaded digits are transmitted as defined by the dial type.

For example, if the dial type is 4-dial and the resolution is 10000 then an arbitrary totalizer value of 99999999 is displayed on the meter as 9999**0000** and 9999 is transmitted to the receiving application. In this configuration it will take 10000 units (i.e. USG) before the display totalizer is updated to a new value. For this example the display totalizer will rollover to 0000**0000**.

Dial Type	Unit Multiplier (Resolution)	Display Digits									
		1	2	3	4	5	6	7	8	9	0
4 dial	10000			1	2	3	4	0	0	0	0
	1000				1	2	3	4	0	0	0
	100					1	2	3	4	0	0
	10						1	2	3	4	0
	1							1	2	3	4
	0.1						1	2	3	.	4
	0.01						1	2	.	3	4
	0.001						1	.	2	3	4
	0.0001					0	0	1	2	3	4
5 dial	10000		1	2	3	4	5	0	0	0	0
	1000			1	2	3	4	5	0	0	0
	100				1	2	3	4	5	0	0
	10					1	2	3	4	5	0
	1						1	2	3	4	5
	0.1					1	2	3	4	.	5
	0.01					1	2	3	.	4	5
	0.001					1	2	.	3	4	5
	0.0001					1	.	2	3	4	5
6 dial	10000	1	2	3	4	5	6	0	0	0	0
	1000		1	2	3	4	5	6	0	0	0
	100			1	2	3	4	5	6	0	0
	10				1	2	3	4	5	6	0
	1					1	2	3	4	5	6
	0.1				1	2	3	4	5	.	6
	0.01				1	2	3	4	.	5	6
	0.001				1	2	3	.	4	5	6
	0.0001				1	2	.	3	4	5	6
7 dial	10000	Not Applicable – Not enough display digits									
	1000	1	2	3	4	5	6	7	0	0	0
	100		1	2	3	4	5	6	7	0	0
	10			1	2	3	4	5	6	7	0
	1				1	2	3	4	5	6	7
	0.1			1	2	3	4	5	6	.	7
	0.01			1	2	3	4	5	.	6	7
	0.001			1	2	3	4	.	5	6	7
	0.0001			1	2	3	.	4	5	6	7

Dial Type	Unit Multiplier (Resolution)	Display Digits									
		1	2	3	4	5	6	7	8	9	0
8 dial	10000	Not Applicable – Not enough display digits									
	1000	Not Applicable – Not enough display digits									
	100	1	2	3	4	5	6	7	8	0	0
	10		1	2	3	4	5	6	7	8	0
	1			1	2	3	4	5	6	7	8
	0.1		1	2	3	4	5	6	7	.	8
	0.01		1	2	3	4	5	6	.	7	8
	0.001		1	2	3	4	5	.	6	7	8
	0.0001		1	2	3	4	.	5	6	7	8

It is important to understand that the totalizers will be represented in a manner equivalent to an actual ADE register. For example, 1 USG on a 4 dial will be transmitted/displayed as "0001". If in bidirectional mode, –1 USG will be transmitted/displayed as "9999".

The protocol type has two options:

- V1 – meter provides single totalizer, Tn (bi-directional) or T1 (uni-directional)
- V2 – meter provides extended information (For ORION Cellular, ORION Fixed Network (SE) or ORION Migratable (ME))

The additional information provided by protocol type V2 is only accessible for specific models of the ADE transmitter (i.e. ORION SE or ORION ME). The additional information of protocol type V2 includes, status information of the meter, meter identification, a second totalizer reading (T+ or T2), relative flow rate (0…100%), and flow direction.

STORE / RESTORE FEATURE

The Store/Restore feature is intended to save installation costs and reduce installation time. This feature is also intended to protect meter configuration and assure the operator that the meter is properly configured. Over time and handling of the meter, the meter configuration could change. The Store/Restore feature allows the meter to be quickly set to the operator's original configuration. Refer to the M2000 Store/Restore user manual for details on this feature.

DATA LOGGING FEATURE

The Data Logging feature records three types of events to a memory token:

- Totalizer/error events
- Configuration change events
- Startup events (power up, power down or reset events)

Each type of event is recorded into three separate files stored on the memory token. These files are extracted using the provided flow meter tool software over the RS232 communication link. Refer to the M2000 Data Logging user manual for details on this feature.

MAINTENANCE

Mandatory, routine or scheduled maintenance should not be required for the M2000 Mag Meter electronics or flow tube after proper installation.

However, some instances may require personnel to perform the following:

- Flow tube and electrode cleaning
- Fuse replacement
- Circuit board replacement

⚠WARNING

- DISCONNECT MAIN POWER TO THE UNIT BEFORE ATTEMPTING ANY DEVICE MAINTENANCE OR CLEANING.
- DO NOT CLEAN COMPONENTS INSIDE THE AMPLIFIER OR JUNCTION BOX.

Cleaning the Flow Tube and Electrode

At times flow tube, electrodes, amplifier/junction box housings and the amplifier window may need periodic cleaning, depending on process fluid properties, fluid flow rate and surrounding environment.

Clean the flow tube and electrodes by following the material handling and cleaning procedures documented in Material Safety Data Sheet (MSDS) guidelines for the product(s) that were in contact with the flow tube and electrodes.

Should flow tube and/or electrode cleaning become necessary:

1. Disconnect detector from pipeline.
2. Clean electrodes according to MSDS guidelines.
3. Reconnect detector to pipeline.

Replacing the Fuse

⚠WARNING

DISCONNECT MAIN POWER TO THE UNIT BEFORE ATTEMPTING ANY DEVICE MAINTENANCE. RISK OF ELECTRICAL SHOCK. REPLACE THE FUSE ONLY WITH 250V AC, 2 AMP, SLOW BLOW (5 X 20 MM). AUTHORIZED PERSONNEL MUST REPLACE FUSES.

Replacing the Circuit Board

Refer to the M-Series M2000 Interchangeability Procedure Application Brief for information on replacing circuit boards.

TROUBLESHOOTING

The M2000 mag meter is designed for many years of optimal performance. However, should it malfunction, there are certain things that we recommend you check before contacting our Technical Support department or your local Badger Meter Representative.

NOTE: If the fluid measured has a high concentration of conductive solids, deposits may accumulate on the internal liner walls and electrodes. These deposits will cause a reduction of the measuring output. Thus, Badger Meter recommends that you remove the meter and inspect the liner and electrodes after six months. If deposits are found, remove them with a soft brush. Repeat inspection process every six months or until an appropriate inspection cycle can be established for the specific application.

NOTE: Other general conditions include:

Description	Possible Cause	Recommended Action
Flow is present but display is "0"	Digital input is holding flow. Disconnected signal cable. Detector mounted opposite of the main flow direction (see arrow on the nameplate). Coil or electrode cables exchanged. Improper low flow cutoff or full scale flow.	Check signal cable. Turn detector by 180° or switch terminal E1 and E2 or reprogram to bidirectional mode. Check cable connections for cross wiring. Verify digital input configuration. Replace configuration defaults.
Inaccurate measuring	Improper calibration. Wrong calibration parameter. Pipe not fully filled, or air in pipe. Invalid fluid conductivity. Invalid fluid mixture.	Restore calibration defaults. Check the parameters (detector factor and size) according to supplied data sheet. Check if meter is completely filled with fluid. Purge line to eliminate air bubbles.
No display	No power. Incorrect power. Bad wiring connections. Blown fuse.	Apply power. Check power value. Replace fuse (2 amp, 250V AC, slow blow 5 x 20 mm). Check display ribbon cable.
Flow rate value known to be wrong	Detector factor. Deposits on electrodes and/or liner. Incorrect pipe size programmed.	Check value on label. Check and remove deposits. Check size if necessary.
Flow rate indication unstable	Cable issue. Grounding issue. Partially full pipe. Air in pipe. Amplifier location – outside electrical. Invalid fluid conductivity.	Make sure cable is shielded and not vibrating. Make sure meter is properly grounded to a good earth ground. Make sure pipe is full of fluid. Make sure fluid does not contain air bubbles. Make sure amplifier is not too close to sources of electrical interference.

Menu Manager Configuration Errors		
Error	**Description**	**Recommended Action**
100	**ADE: Configuration of the ADE interface is invalid.**	This error is displayed when an invalid modi cation to either of the following menu parameters is detected: Protocol Type, Dial Type, Unit Multiplier, Digital Input Function Type or Digital Output Function Type. 1. Con guring the M2000 as an ADE interface has the following limitations, Protocol Type V1 is only allowed if number of dials is less than 8. 2. The resolution of the totalizers (i.e. Unit Multiplier) must be set to something other than OFF. 3. For 8 dial con guration, a resolution of 10000 and 1000 are not supported. There are not enough display digits to accommodate 8 dials and greater than 100 units of resolution. 4. For 7 dial con guration, a resolution of 10000 is not supported. There are not enough display digits to accommodate 7 dials and greater than 1000 units of resolution.
101	**ADE: Enabling/Disabling ADE operation is invalid**	This error is observed when Digital input or output function is manually selected for ADE operation. Enabling or Disabling ADE operation can only be accomplished by setting the ADE protocol type.
110	**Output 1/2: Pulse Output Configuration Error**	This error is observed when improperly con guring either the full scale ow, pulse per unit, pulse width or digital output function type for pulse output operation. Preparing these parameters for pulse output operation (i.e. forward or reverse) has limitations that are monitored by the menu manager. This error can indicate the following con guration violations: 1. Pulse Frequency exceeds limits at full scale ow 2. Pulse duty cycle is less than 50% at full scale ow (i.e. pulse on time > pulse o time) 3. AMR Pulse Frequency exceeds limit at full scale ow The pulse frequency limit is 10 kHz when the pulse width is 0 (i.e. 50% duty cycle). The pulse frequency limit is 1 / (2 * Pulse Width) when the pulse width is non-zero in order to achieve a 50% duty cycle. For AMR operation, the frequency limit is 3 HZ. Follow these steps for configuring meter for pulse output operation: 1. Set PPU to zero for both output 1 and 2 2. If necessary, set full scale ow appropriately for application 3. Set PW as required by equipment receiving pulse transmissions from meter. Observe frequency limits for non-zero pulse widths. 4. Determine the desired pulse frequency at a typical ow rate (i.e. 1000 HZ @250 GPM 5. Calculate ratio of typical ow rate to full scale ow: ratio = typical ow rate / full scale ow (i.e. 250 GPM / 500 GPM = 0.5) 6. Calculate ow rate conversion factor: For GPM, conversion factor = 1/60, for GPH, conversion factor = 1/3600, for GPS, conversion factor = 1 7. Calculate PPU: PPU = (Desired pulse frequency at typical ow rate / ratio) / [Full Scale Flow * (conversion factor)]= (1000 / 0.5) / [500 * (1/60)] = 240 Pulse / Gallon 8. If an error is received consider reducing value of full scale ow and ensuring desired pulse frequency is within limits. Then redo steps 4-7 If not using the pulse outputs, set the pulses per unit to zero to allow for reconfiguration of the full scale flow. If it is required to use the pulse outputs, re-evaluate the pulse output configuration. Consider recording and clearing totalizers following pulse output configuration"
120	**Display: Totalizer Conversion Error – Totalizer cannot be properly converted for display**	This error is observed while trying to change the totalizer units. Limits of display will prevent improper con guration of the volume unit dependent on current totalizer values. Consider recording and cleaning totalizers prior to changing totalizer.
121	**Output 1/2: Pulse Output Configuration Error**	This error is observed when changing the totalizer units of measure. This error implies the pulse con guration exceeds limits (see error 110). Please note the pulses per unit is not automatically updated on volume unit recon guration. The pulses per unit should be manually changed to accommodate the desired units of measure. It may be necessary to set the pulses per unit to zero then change to the desired totalizer units.
140	**Output 3: Configuration Error – Full scale frequency exceeds limits of relay (1000 Hz)**	Reduce full scale frequency setting of output when hardware is con gured for relay operation.
150	**Output 3: Configuration Error – Full scale frequency exceeds limits (10 kHz)**	Reduce full scale frequency setting of output when hardware is con gured for open collector operation.
170	**Output 1/2: Output Type Configuration Error**	This error is observed when the function type is 24V DC and the output type is changed from Normally Open to Normally Closed. It is required for 24V DC output operation that the output type be Normally Open.

Menu Manager Configuration Errors		
Error	**Description**	**Recommended Action**
171	**Output 1/2: Output Type Configuration Error**	This error is observed when the function type is ADE and the output type is changed from Normally Open to Normally Closed. It is required for ADE operation that the output type be Normally Open
190	**Full Scale Flow: Entered Value exceeds limits**	Value entered exceeds the absolute maximum flow the meter supports. Reduce the value for this parameter or consider increasing pipe diameter.

Display Error / Status Messages		
Error Message	**Possible Cause**	**Recommended Action**
Err: Detector	No detector connection with ampli er.	Check detector and cable connections in accordance with this manual.
	Connection between ampli er and detector	Contact Technical Support.
	Supply voltage too low.	Contact Technical Support.
	Grounded coils in meter.	Contact Technical Support.
	Water in detector.	Contact Technical Support.
Err: Empty pipe	Pipe may not be full.	Make sure all trapped air is out of system. If uid or uid conductivity recalibrate the parameter.
Err: Full scale	Actual ow rate is exceeding programmed ow.	Reduce ow rate or increase the programmed full scale value by more than 5%.
Err: AD-Range	AD-Converter is exceeding signal limits.	Check the grounding scheme of the meter installation. See grounding section in this manual. Verify pipe is not empty.
Err: AD-INT	Initialization of AD-Converter unsuccessful.	Contact Technical Support.
Err: Rollover	Rollover counters have exceeded limit.	Clear all totalizers.
Err: Rollover Status	Totalizer rollover has occurred.	Reload totalizer then clear all totalizers.
Err: Simulation	I/O simulator is enabled.	Disable simulator in I/O menu.

SPECIFICATIONS

Flow Range	0.10…39.4 ft/s (0.03…12 m/s)
Accuracy	± 0.25 percent of rate for velocities greater than 1.64 ft/s (0.50 m/s) ± 0.004 ft/s (± 1 mm/s) for velocities less than 1.64 ft/s (0.50 m/s)
Repeatability	± 0.1%
Power Supply	**AC Power Supply:** 85…265V AC; Typical Power: 20V A or 15W; Maximum Power: 26V A or 20W **Optional DC Power Supply:** 10…36V DC; Typical Power: 10W; Maximum Power: 14W
Analog Output	4…20 mA, 0…20 mA, 0…10 mA, 2…10 mA (programmable and scalable) Voltage sourced 24V DC isolated. Maximum loop resistance < 800 ohms.
Digital Output	Four total, configurable 24V DC sourcing active output (up to 2),100 mA total, 50 mA each; sinking open collector output (up to four), 30V DC max, 100 mA each; AC solid-state relay (up to 2), 48V AC, 500 mA max
Digital Input	Max 30V DC (programmable – positive zero return, external totalizer reset or preset batch start)
Frequency Output	Scalable up to 10 kHz, open collector up to 1 kHz, solid-state relay
Misc Output	High/low flow alarm (0…100% of flow), error alarm, empty pipe alarm, flow direction, preset batch alarm, 24V DC supply, ADE
Communication	RS232 Modbus RTU; RS485 Modbus RTU, HART, Profibus DP require separate daughterboards
Pulse Width	Scalable up to 10 kHz, passive open collector up to 10 kHz, active switched 24V DC. Up to two outputs (forward and reverse). Pulse width programmable from 1…1000 ms or 50% duty cycle.
Processing	32-bit DSP
Empty Pipe Detection	Field tunable for optimum performance based on specific application
Excitation Frequency	1 Hz, 3.75 Hz, 7.5 Hz or 15 Hz (factory optimized to pipe diameter)
Noise Dampening	Programmable 0…30 seconds
Low Flow Cut-Off	Programmable 0…10% of maximum flow
Galvanic Separation	250V
Fluid Conductivity	Minimum 5.0 micromhos/cm
Fluid Temperature	**With Remote Amplifier:** PFA, PTFE & Halar 302° F (150° C) **With Meter-Mounted Amplifier:** Rubber 178° F, (80° C), PFA, PTFE & Halar 212° F (100° C)
Ambient Temperature	– 4…140° F (–20…60° C)
Relative Humidity	Up to 90 percent non-condensing
Flow Direction	Unidirectional or bidirectional two separate totalizers (programmable)
Totalization	Programmable/resettable
Units of Measure	Ounce, pound, liter, US gallon, imperial gallon, barrel, hectoliter, mega gallon, cubic meter, cubic feet, acre feet
Display	4 x 20 character display with backlight
Programming	Three-button, external manual or remote
Amplifier Housing	Cast aluminum, powder-coated paint
Detector Housing	Carbon steel welded
Pipe Spool Material	316 stainless steel
Flanges	**Standard**: ANSI B16.5 Class 150 RF cast steel; **Optional:** 300 lb cast steel, 316 stainless steel
Liner Material	PFA up to 3/8", PTFE 1/2…24", soft and hard rubber from 1…54", Halar® from 14…40"
Electrode Materials	**Standard:** Alloy C; **Optional:** 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium
Mounting	Meter mount or remote wall mount (bracket supplied)
Locations	Indoor and outdoor
Meter Enclosure Classification	NEMA 4X (IP66); **Optional:** Submersible NEMA 6P (IP67), remote amplifier required
Junction Box Enclosure Protection	For remote amplifier option: powder-coated die-cast aluminum, NEMA 4 (IP66)
Cable Entries	1/2" NPT cord grip (3)
Optional Stainless Steel Grounding Rings	**Meter Size** — **Thickness (of one ring)** Up through 10" — 0.135" 12…54" — 0.187"
NSF Listed	Models with hard rubber liner, 4" size and up; PTFE liner, all sizes
Token Features	Data Logging (Blue token); Store/Restore (Red token); Firmware Upgrade (Black token)

Instruction Manual - MicroChem®2 Transmitter and Controller Series 4000

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call Severn Trent Water Purification (STWP), Inc. for clarification before commencing any work at +1 215 997 4000 and ask for a Field Service Manager. Severn Trent Water Purification, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact STWP Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into STWP Inc. equipment is conditioned on the customer absolving STWP Inc. from any consequences of such a decision.

STWP Inc. has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. Severn Trent Water Purification, Inc. cannot be responsible for deviations from the recommended instructions that may result in a hazardous or unsafe condition.

STWP Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that STWP Inc.

STWP Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped “F.O.B. Colmar” or to STWP Inc. for equipment shipped “F.O.B Jobsite”. Do not install damaged equipment.

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COLMAR, PENNSYLVANIA, USA
ISO 9001: 2008 CERTIFIED

It is mandatory to carefully read the present manual before operating any action of the instrument.

Do not install any equipment if damage is such that faulty operation is likely to result.
Carefully inspect all packing material before discarding it, to prevent loss of mounting hardware, accessories, spare parts or instructions.

All instructions given on any attached tag should be followed.

WARNING

To ensure safe operation of MicroChem®2 equipment carefully follow use and installation instructions and recommendations illustrated in this manual. Improper use of the equipment may damage the equipment and endanger the safety of the operating personnel.

WARNING

All MicroChem®2 electronics are shipped with voltage selection jumper set to the 220 Vac position. Set the voltage selection jumper to match the local power source.

WARNING

If the equipment is used in a manner NOT specified by Severn Trent or NOT included in the present document, the protection provided by the equipment may be impaired.

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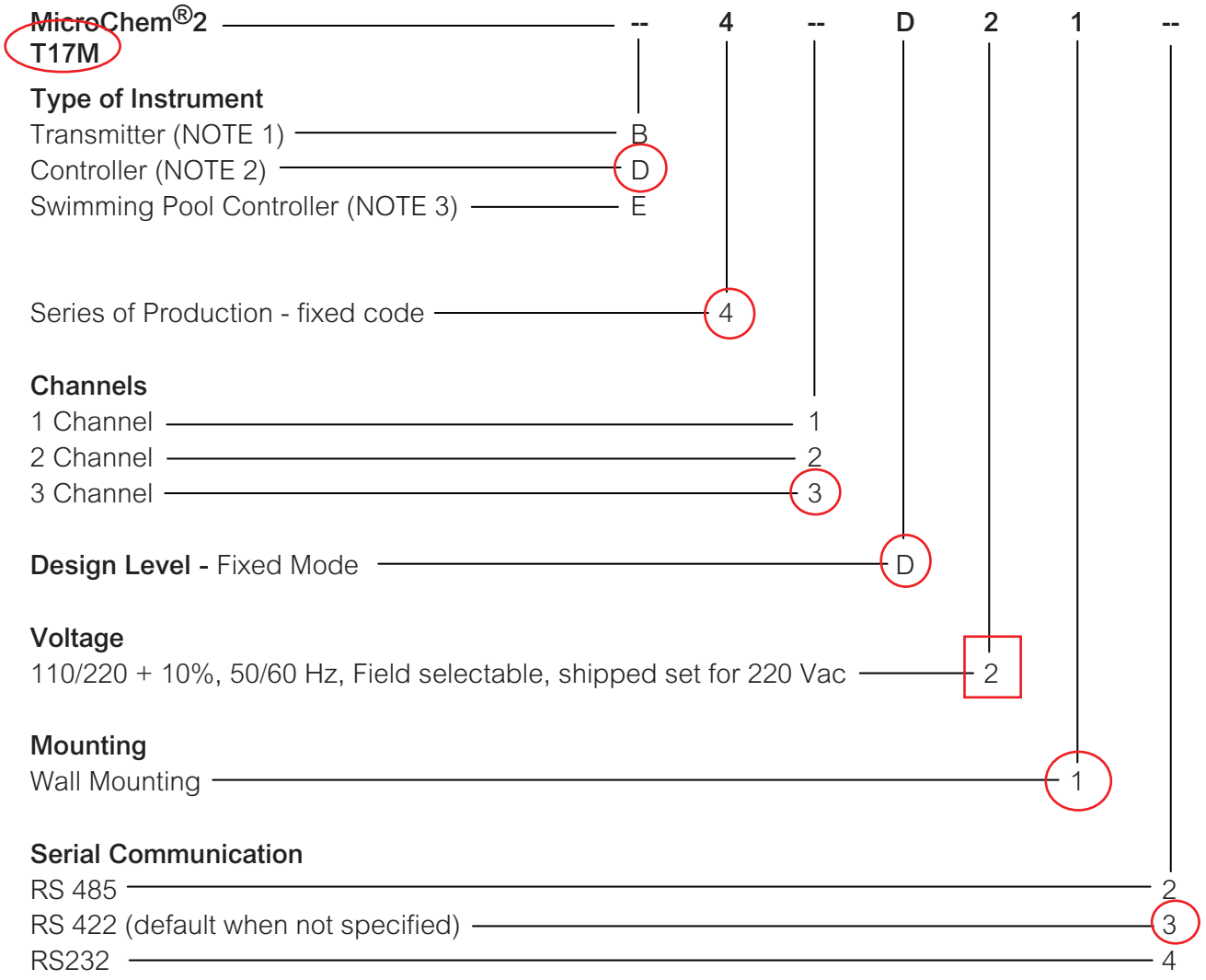
1 MODEL NUMBER BREAKDOWN



NOTES

1. Transmitter with the cleaning sequence enabled: alarm relays are possible only for Channels 1 and 2.
2. PID standard has 1 Channel; PID with Feed Forward requires two Channels installed: Channel 1 for the controlled variable, Channel 2 for the analog input 4-20 mA signal from the flow rate meter. A Third measurement-only sensor can be installed on Channel 3. A 2 channel instrument is also required if a PID output signal is configured on channel 1 and a retransmission of the measured value from the input signal on channel 1 is also required.

   The controller option D includes software for the instrument to average the input signals from 2 or 3 of the same type of sensor such as DO. The controller will then provide an output signal to control the blowers in an aeration basin based on the averaged signal. Any parameter the instrument is capable of receiving may be used with the averaging feature.
3. Swimming pool Controller is available in three different versions: pH and mV (ORP); pH and Cl; and pH, Cl and ORP. (In the latter case the controlled parameters are to be installed in Channels 1 and 3).

MODEL NUMBER BREAKDOWN (UK ORDERS ONLY)

MicroChem®2 Transmitter[1]

Description	Part Number
MicroChem®2 Transmitter – 1 Channel	01-4045
MicroChem®2 Transmitter – 2 Channel	01-4050
MicroChem®2 Transmitter – 3 Channel	01-4024

MicroChem®2 Controller[2]

Description	Part Number
MicroChem®2 Controller – 1 Channel	01-4013
MicroChem®2 Controller – 2 Channel	01-4015
MicroChem®2 Controller – 3 Channel	01-4018

MicroChem®2 Specific Controllers

Description	Part Number
MicroChem®2 Swimming Poop Controller[3] – Supplied as 2 Channel	01-4051
MicroChem®2 Aeration Basin Controller[4] – Supplied as 2 Channel	01-4052

MicroChem®2 Accessories

Description	Part Number
Sunshade Assembly – for wall mounting – 1T624B037U01	01-4055
Sunshade Assembly – for 2" Pipe mounting – 1T624B037U03	01-4056
S4000 Analog Board	71-4000

NOTE:

1 Supplied with software to initiate a sensor cleaning sequence activated by a relay.
Available with 1, 2 or 3 channels. When cleaning sequence is selected, alarm transmission is limited to channel 1 and channel 2 only. Relays are available for alarm transmission for channel 3 only if a cleaning sequence is not activated.

2 Combines a PID algorithm utilizing the sensor input signal or PID with Feed Forward control utilizing a 4-20mA input signal from a flow transmitter (channel 2). Control is achieved through a 4-20mA output or time proportional relay. Available with 2 or 3 channels (only Channel 1 is for control).

3 Combines 2 PID control algorithms to control a swimming pool. pH is controlled on channel 1, ORP or Chlorine is controlled on a second channel. A third channel, in this case channel 2, can be used for ORP or chlorine not controlled on a channel 3.
Supplied as standard with 2 channels, a third channel is available if ordered with a S4000 Analog Board P/N 71-4000.

4 Specifically designed for O_2 control. Signals from up to three DO sensors are averaged and computed, and then processed through a PID algorithm. Supplied as standard with 2 channels, a third channel is available if ordered with a S4000 Analog Board P/N 71-4000.

2 INTRODUCTION

2.1 Glossary

Symbol	Meaning
	ALTERNATING CURRENT SUPPLY ONLY
	DIRECT CURRENT SUPPLY ONLY
	PROTECTIVE EARTH (ground) terminal Both direct and alternating current supply.
	EARTH (ground) terminal
	WARNING – Refer to the manual for instructions
	CAUTION - Risk of electric shock
	WEEE SYMBOL: indicates the separated collection of electric and electronic equipment at the end of life.

PARAMETER	SYMBOL
pH	pH
ORP (oxidation reduction potential)	mV
Dissolved Oxygen	O2
Residual Chlorine	Cl
Chlorine Dioxide	CD
Ozone	O3
Temperature	T
Bromine	Br
Fluoride	F
Ammonia	NH_3
Nitrate	NO_3
Conductivity*	mA

These symbols are also used in displayed indications.

NOTE: Chlorine (CL4000) and conductivity probes are available in units running software version 2.8 or higher.

*Sensors with a 4-20mA output can be fed into the MicroChem®2 and the signal displayed as either mA or, for certain common sensors, converted into actual units e.g. conductivity (µS). A list of the configurable units available is shown below:

Symbol	Unit
mA	Milliamp
%	Percent
ppm	parts per million
mg/l	milligrams per liter
g/h	grams per hour
l/s	liters per second
l/h	liters per hour
m^3/h	cubic meter per hour
°C	degrees centigrade
°F	degrees Fahrenheit
µS	microsiemens
mS	millisiemens
KPa	Kilopascals
MPa	Megapascals
PSI	pounds per square inch
GPM	gallons per minute
GPD	gallons per day
MGD	Megagallons per day
NTU	Nephelometric units
FTU	Formazin turbidity units
m	meters
ft	feet
in	inches

2.2 General Description

MicroChem®2 is a family of microprocessor based transmitters controllers for analytical values used in drinking water plants, and in swimming pools.

MicroChem2, using Severn Trent Water Purification probes, is able to measure simultaneously up to three of the following parameters:

pH, ORP, Dissolved Oxygen, Chlorine, Chlorine Dioxide, Bromine, Ozone, Analog signal 0/4-20 mA, Temperature (Pt100).

The type and number of sensors (max 3) can be freely chosen in any combination. The analytical values are retransmitted with 4-20 mA analog signal. New types of analysis can be added or modified in the field at any time. MicroChem2 automatically detects the number of installed sensors. All the measurements and the sample temperatures are displayed. The transmitter/controller has automatic temperature compensation.

The cleaning sequence time setting allows an easy sensors' maintenance.

The MicroChem2 Family includes 3 Types of instrument:

- **Transmitter** (Instrument Type 1)

A group of transmitters: single channel, dual channel and triple channel.

- **Controller** (Instrument Type 2)

PID controller for the installed Sensor, with specific algorithms for each type of measured parameter. It can accept an optional 4-20 mA signal from a flow-meter on channel 2. This second input can be used as Feed Forward input in the PID algorithm.

- **Swimming Pool Controller** (Instrument Type 3)

Available in three different parameter combinations:

- three channels (pH, mV, Cl parameters)
- two channels (pH and mV)
- two channels (pH and Cl).

It performs PID control of two channels: pH (on channel 1) and the sensor installed on channel 3.

2.3 Technical Specifications

- **Display:** digital LCD display, dot matrix, 16 + 16 characters, with back light.

- **Power supply,** selectable through a jumper on the power supply pc board (see Sect. 3.4.1):
  115 V~ (Vac) ±10%, 50/60 Hz
  230 V~ (Vac) ±10%, 50/60 Hz

- **Power consumption:** 20 VA.

- **Fuses:** T100mAL 250V @ 230 V~ (Vac)
  T200mAL 250V @ 115 V~ (Vac)

- **Electrical classification:** for non hazardous area.

- **Casing:** NEMA 4X, material GREENLAC reinforced with fiberglass (17%), White RAL 9010, Class VØ (in accordance to UL94)

- **IP protection:** IP65 whether power and signal cables respect the indications in the following section 3.4.1.1

- **Mounting:** refer to Section 3.2

- **Isolating level:** Signal inlet isolated at 2224Vrms referring to the power supply.

- **Analog outputs:**
  one for each installed channel (analog I/O pc board); separately selectable for each channel as 0-20 mA or 4-20 mA (to be specified in the order).

- **Galvanically isolated outputs:** Load 0-1000 Ohm, protected against short circuits.

- **Digital outputs:**
  . 7 relay outputs: 24 V ⎓ (Vdc), 115/230 V ~ (Vac), 3A max.
  . Individually settable as Normally Open (NO) or Normally Closed (NC)

- **Digital inputs:** 2 free contacts

- **Serial communication port:** RS232, RS422 and RS485 with RJ11 plug-in sockets. The protocol used is illustrated in a dedicated section (Sect. 11).

- **Alarm setting:** High and Low alarm for channel 1, 2 and 3. Separate levels for each channel are field selectable. Dead band freely selectable for each channel.

- **Measuring ranges:** field selectable for each channel within the limits indicated for each parameter, as follows in the table below:

PARAMETER	MINIMUM SPAN	RANGE	DEFAULT SETTING
pH	1.00 pH	0.00 - 14.00 pH	2.00 - 12.00 pH
mV	100 mV	-1500 - +1500 mV	-500 - +500 mV
O2	2.0 ppm	0.00 - 20.00 ppm	0.00 - 10.00 ppm
O3	0.25 ppm	0.00 - 10.00 ppm	0.00 - 1.00 ppm
Cl	0.25 ppm	0.00 - 10.00 ppm	0.00 - 1.00 ppm
CD	0.25 ppm	0.00 - 10.00 ppm	0.00 - 1.00 ppm
T	5 °C	0 - +100 °C	0 - +100 °C
mA	2 mA	0/4 - 20 mA	4 - 20 mA
Br	0.25 ppm	0 – 10.00 ppm	0 – 1.00 ppm
ORP	100 mV	-1500 to +1500 mV	-500 to +500 mV
µS	+/- 5% of probe range	0 – 10,000 µS	4 – 20 µS

- **Sensors with a 4 to 20 mA output** can be connected to the transmitter, the units range set and then the sensor output can be displayed on the screen.
- **Analog Input:** up to 3 sensors (any of pH, ORP, Dissolved Oxygen, Residual Chlorine, Chlorine Dioxide, Ozone, 0/4-20 mA analog signal and temperature (Pt100)
- **Weight:** 3 kg (6.6 lbs).
- **Outline dimensions:** 220 mm x 250 mm x 120 mm (8.7 x 9.8 x 4.7 in). Refer to picture 6 for details.
- **Stocking temperature limits:** -40 °C - +65 °C (-40 °F - 150 °F).
- **Operative temperature limits:** -10 °C - +50 °C (15 °F - 122 °F)
- **Thermal drift:** within 0.2% of full scale for a 10 °C (50° F) temperature variation.
- **Relative humidity:** 80 % with temperature up to 31 °C (88 °F), with linear decrease down to 50% with temperature 40 °C (104 °F).
- **Accuracy:** within ± 0.2 % of full scale.
- **Repeatability**: 0.05 % of span.
- **Stability:** 0.05% of span.
- **Transmitter response time:** measure is refreshed at each microprocessor scan cycle (100 msec).
- **Microprocessor scan cycle:** 100 msec.
- **Smoothing:** separately set for each channel inside Configuration menu.
- **Languages:** Italian, English, French, German, Spanish.

2.4 Hardware structure of the system

The MicroChem®2 hardware is modularly structured. The different p.c. boards are mounted in four separate layers, according to the following scheme:

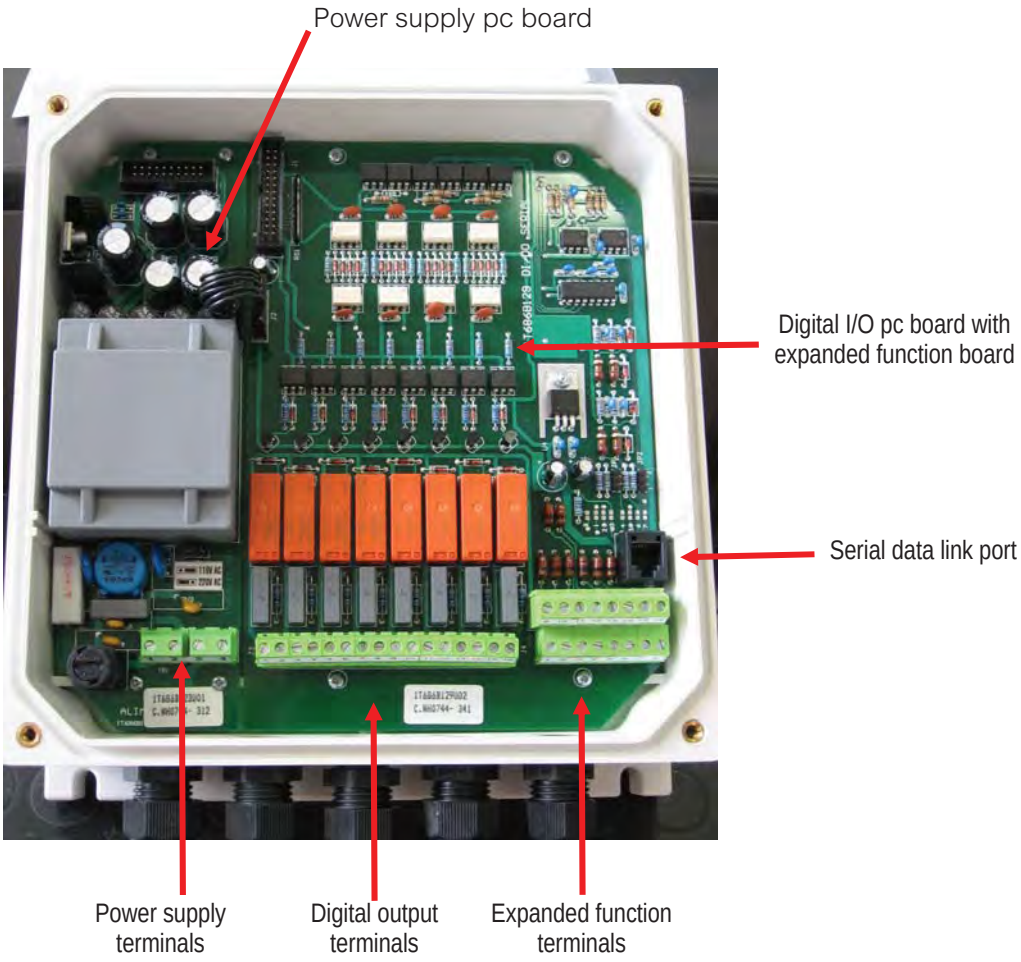


Figure 1 - First layer of p. c. board (bottom)

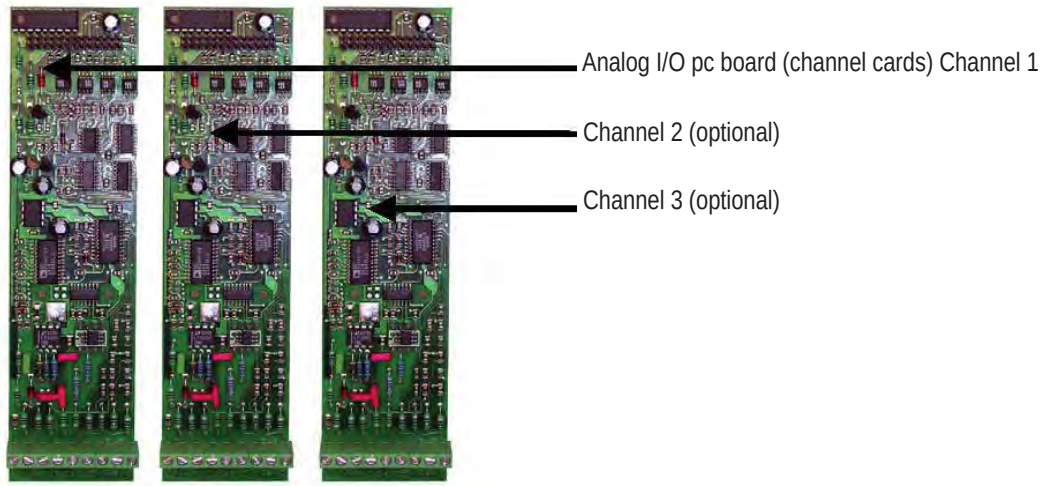


Figure 2 - Second layer of p. c. boards (Analog Input/Output)

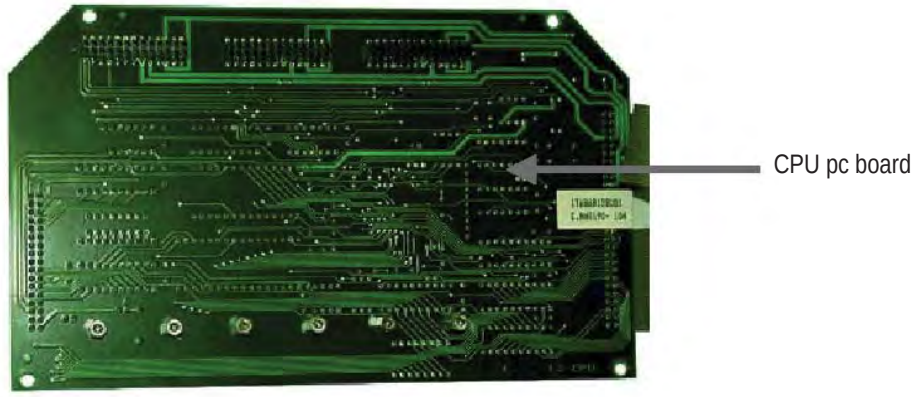


Figure 3 - Third layer of p. c. boards (Main Board)

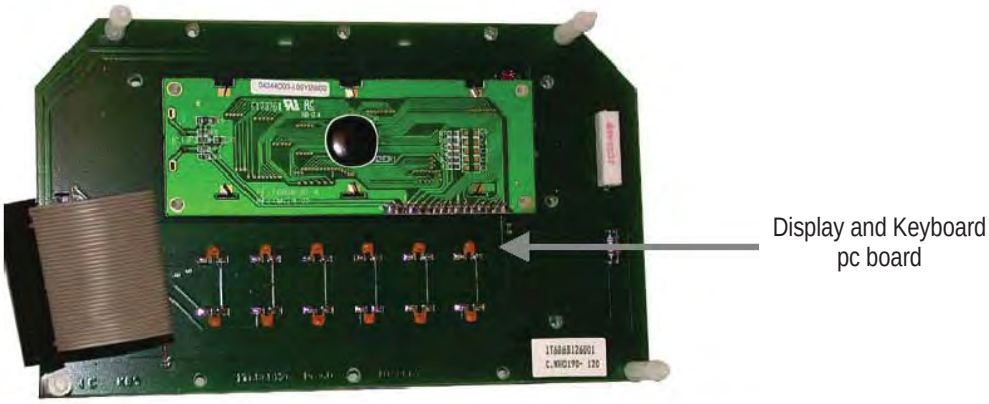


Figure 4 - Fourth layer of p. c. boards (Top)

3 INSTALLATION

3.1 Location

The transmitter location should meet the following requirements:

- the site of installation should be free of vibrations
- atmosphere should be free of corrosive substances
- enough space has to be left around the transmitter to allow easy operation and maintenance
- the transmitter should be mounted at a height of 1.6 m (64 in) from floor level to make normal reading and easier maintenance and calibration operations.
- in outdoors installations use of a sunshade is strongly recommended
- power supply matching the instrument tag should be available

3.2 Mounting

MicroChem®2 is supplied with the hardware for wall mounting.

3.2.1 Wall mounting

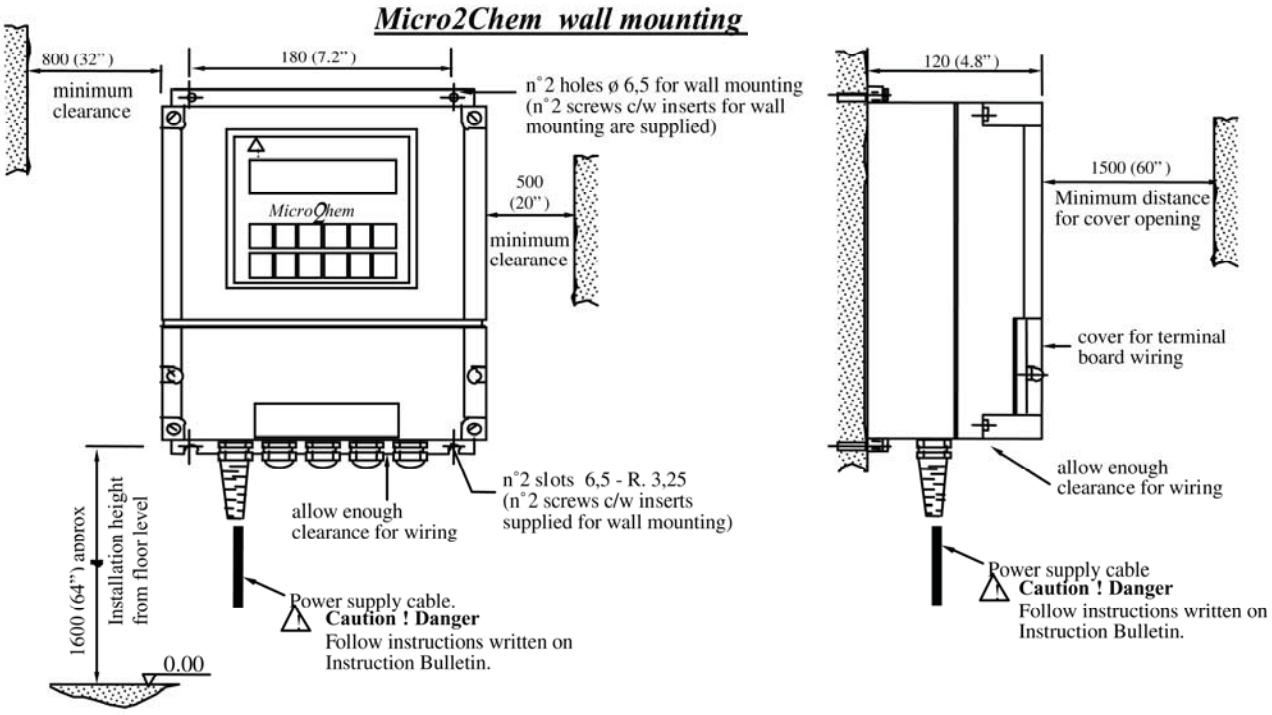


Figure 5 - Typical Wall-mounting Installations of MicroChem®2

3.3 Dimensions and mounting

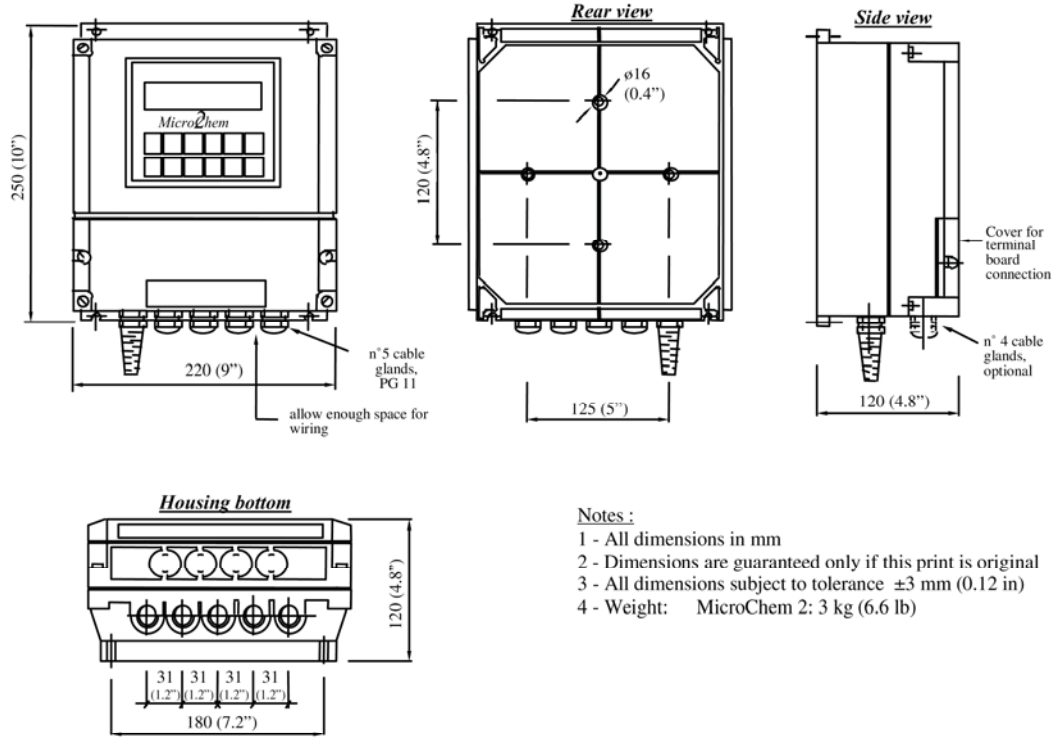


Figure 6 - MicroChem®2 dimensions

3.4 Electrical connections

3.4.1 Power supply p.c. board

Electrical Shock Hazard!

Remove power prior to servicing power supply board.

The power supply is connected to the terminal board TB1 (See Fig. 7).

The selection between the 115 V~ (Vac) or 230 V~ (Vac) power settings can be changed by moving a jumper (in position JP1) on the power supply pc board. Jumpers are represented in Fig. 7. The power supply is shipped with the voltage selector jumper in the 230 V~ (Vac) position. Should any modification be needed, proceed as per the following steps:

1. Always operate on an unpowered instrument.
2. Open the wiring access cover.
3. Locate the JP1 jumper on the power board (Fig. 7).
4. Set the jumper in the correct position using thin tapered pliers according to the input voltage required.
5. Insert the proper fuse F1 in the power supply depending on the voltage selector jumper position. (see below for details)
6. Connect power cable to Terminal board TB1 (Fig. 7). Reference Sections 3.4.1.1 and 3.4.1.2.
7. Close the cover.
8. It is now possible to connect the power to the instrument.

NOTE: Since the power supply is factory set for 230 V~ (Vac) operation, the T100 mA L fuse is installed in the power supply. The T200 mA L fuse has been provided with the instrument should a change of voltage be required during installation.

Fuse Rating: T100 mA L 250V @230V~ (Vac) Part Number: 1T151A003U06
T200mA L 250v @115V~ (Vac) Part Number: 1T151A003U09

CAUTION

Be sure to use the correct fuse rating when power supply setting is modified.

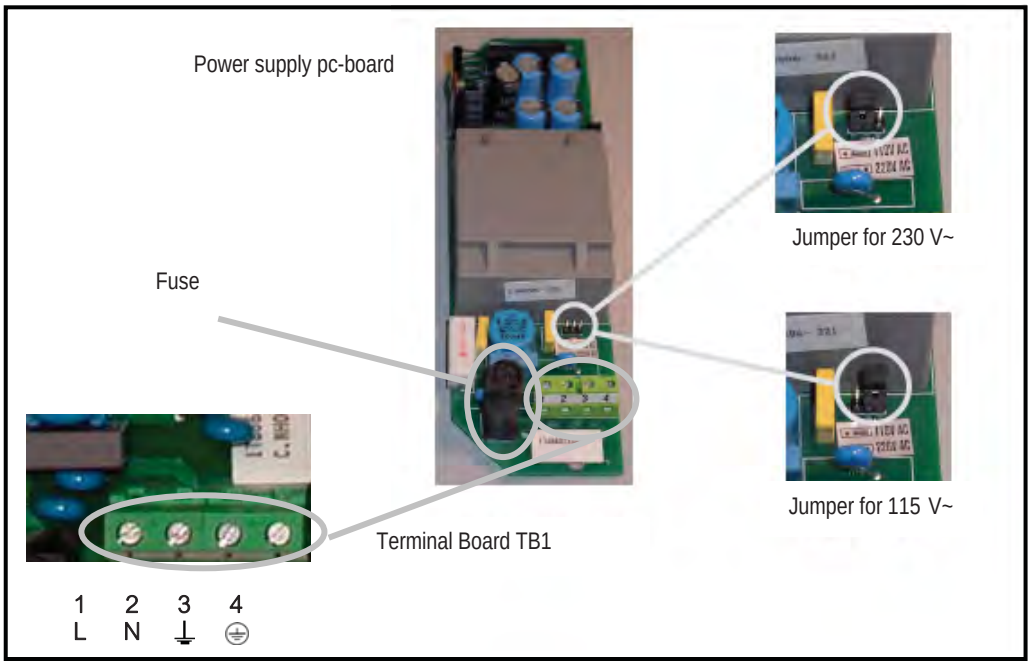


Figure 7 - Power supply selection

3.4.1.1 Power Cable

Power supply cable has to be supplied by the Customer and installed by qualified personnel.

The power supply cable has to satisfy the following requirements:

- Must be certified or approved by an official national/international testing bureau (IMQ, UL, CSA...) and according to the local law.
- Three-cores cable 16 AWG, (each core with section 1 mm^2 or 1.5 mm^2) and with specific colors required by local requirements.
- Must be suitable for ambient temperature up to 75°C (167°F)
- Must have a cross section of 6-10 mm to guarantee the casing IP65 protection.
- Must include ground wire that has to be properly connected.

3.4.1.2 Power cable installation

Electrical Shock hazard!
Power supply cables are connected to 115 V ~ (Vac)
or 230 V ~ (Vac)

Power cable inlet

The three-core power supply cable, as described in section 3.4.1.1, has to be wired to the board passing through the specific gland. The gland itself can not be removed as its specific action is to avoid cable abrasions and damages and to guarantee the IP protection.

The external wire sheathed shell should be removed for at least 1.5 inches (3-4 cm) from the termination to allow the three cores separation into the instrument while shell is kept in contact with the gland. Each wire shell is stripped for about .4 inches (1 cm) to allow for insertion into the power terminals.

Cable anchorage (Customer Care)

Cable anchorage must be designed to avoid stresses, included torsion stresses to the conductors at the point where they enter the transmitter. Cable anchorage has to satisfy the following requirements:

- Cable may not be secured by a screw acting directly on the cable itself.
- Never make knots on the cable itself.
- Cable anchoring must be designed to make cable replacement easy and safe.
- Cable has to be protected from any possible mechanical stress that may damage it or making it directly or indirectly dangerous.

Plug (not supplied)

The plug shall be certified and approved (IMQ, UL, CSA...) and have the ground connection.

CIRCUIT BREAKER (Customer care)

The instrument shall be equipped with a specific circuit breaker which have two main functions:

1. Main power supply disconnection
2. Over current protection.

Shall have the following characteristics:

- Shall be easily identifiable, easy to access and operate and shall be installed nearby the instrument.
- Shall be a certified and approved model according to the standard in use in the country where the instrument will be installed.
- Shall clearly indicate if the power is activated and present or not.
- Shall be specific characteristics for protective action (10A curve “C” type)
- When installed outdoor, shall have the appropriate IP protection rating.

3.4.2 Cable gland

MicroChem®2 is capable up to 9 holes that can be opened for electrical wires connection.
As standard 5 cable glands are installed on each unit.
Below, is an example of how to use the different cable glands (see Figure 8)

- 1 cable with three wires for power supply
- Cables from wet-end
- Cable for 4-20mA signal retransmission
- 10 cables for digital output (CCO1-7)
- Cables with two wires for digital input (CCI1-2)
- 1 cable RJ11 type for serial communication option.

RECOMMENDED: Do not put power supply cable alongside other cables.

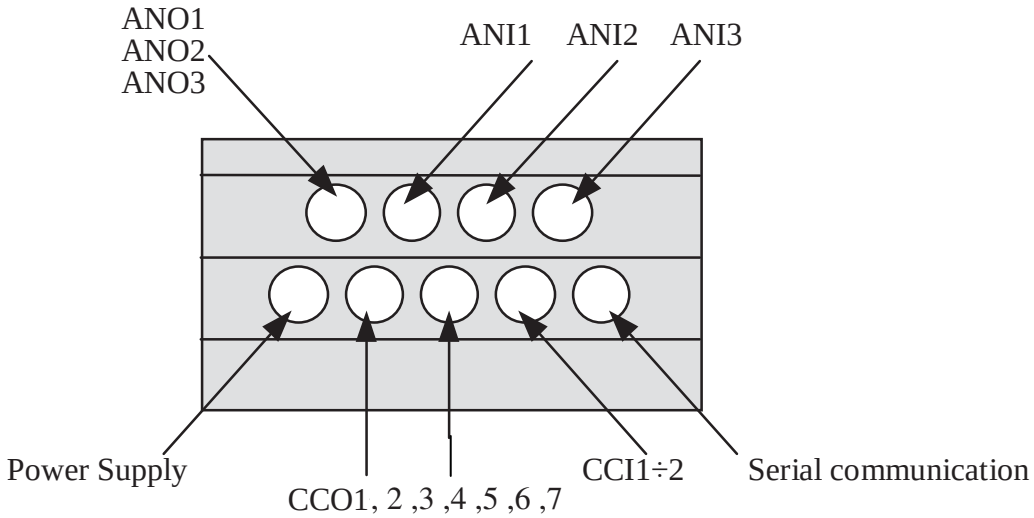


Figure 8 - Recommended use of cable glands

3.4.3 Digital I/O board

Characteristics of the cables for the input and output wiring are:

- Two wires shielded cable
- Two-cores, 18 AWG (0.5 - 1.0 mm^2)
- The shields have to be connected to ground shield terminal strip (⏚) on the MicroChem2 power supply board (see Fig. 7).
- Cables for digital outputs shall have an 80°C (176°F) rating.

3.4.3.1 Digital Outputs

Electrical Shock hazard!
Remove power from external circuits prior to connection or servicing of digital output terminals.

MicroChem®2 digital outputs are provided by 7 relays (physically 8 relays are installed but only 7 are available).

The function of each output contact depends on the type of instrument selected and its configuration. The different possibilities are detailed in the sections dedicated to each specific type of instrument. Figure 9 shows the terminal number assigned to each CCO on the I/O pc board.

The maximum rating of the relays are:

- Maximum Voltage: 24 V ⎓ (Vdc), 230 V ~ (Vac)
- Maximum Current: 3A

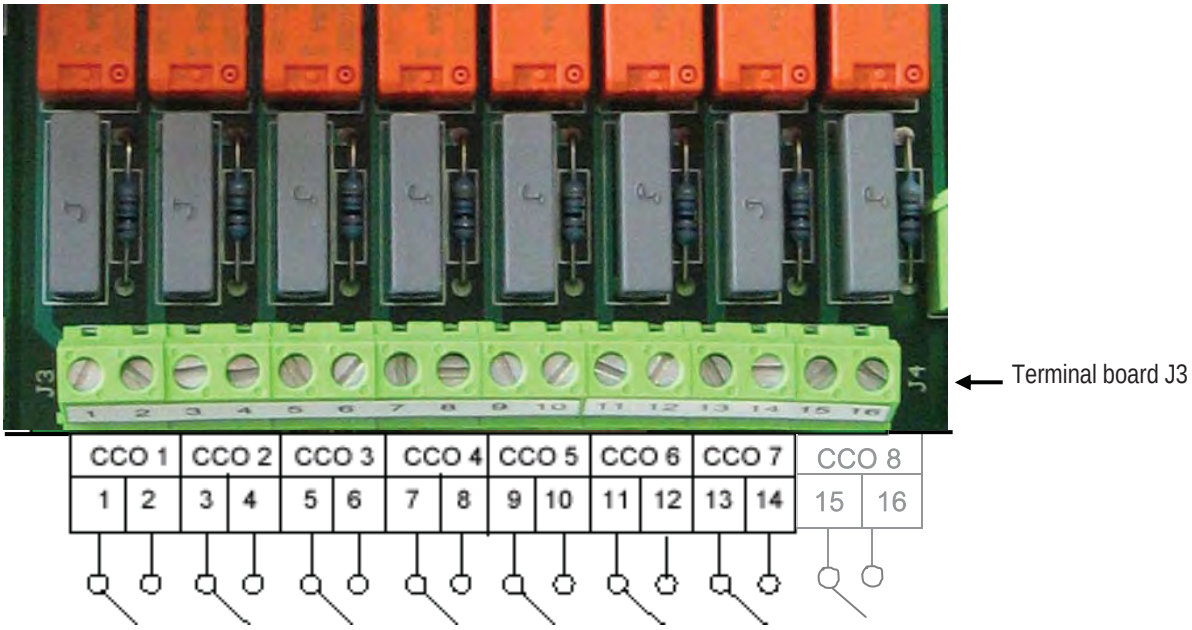


Figure 9 - Relays interconnection terminal barrier

3.4.3.2 Digital input

MicroChem2 digital input (free contacts) are represented in Figure 10.

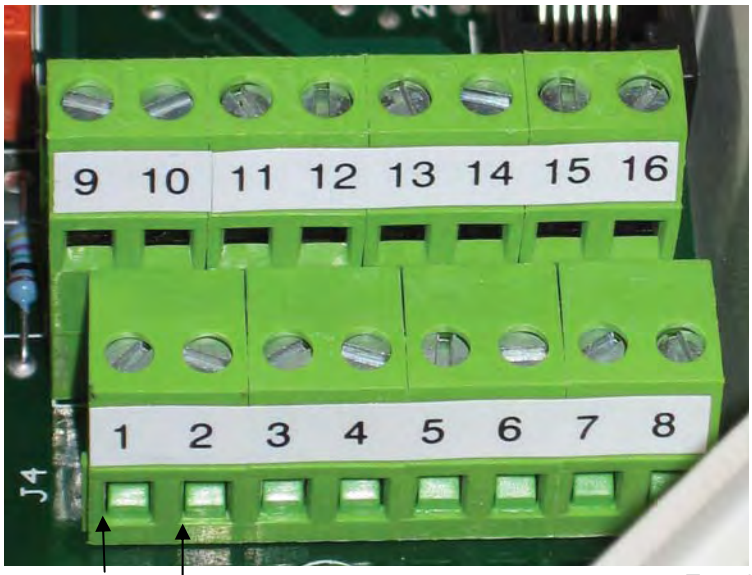


Figure 10 - Digital inputs terminal barrier

3.4.4 Analog input/output board

Refer to each sensor Instruction Bulletin for the color/number codification of the sensors wires. The Pt100 shield and the sensor shield, if present, has to be connected to ground shield terminal ⏚, (see Fig. 7), inside MicroChem®2. Please notice that, for pH, ORP and O2 sensors it is recommended to fix the cable near the sensor so that it doesn't move at the outlet of the cable gland. The wear of the cable at that point is thus prevented.

The 0-20 mA or 4-20 mA signal INPUT is on terminals 5 and 6: when these terminals are used for the 0/4-20 mA INPUT, install a 100 Ω resistor (0.1 % accuracy) across terminals 5 and 6.
The units and range can be set within the channel configuration software and then the sensor output can be displayed on the screen – see section 2.2 for the range of units that can be selected.

NOTE: The CL4000 and conductivity probe cables 78-4001, 2 and 3 have a resistor built in to the lead so do not require a further resistor.

Use two cores shielded cables for 4-20 mA output signals, section of each conductor 18 AWG (0.5 - 1.0 mm^2); connect shields to the shield ground terminal ⏚ , (see Fig. 7) inside MicroChem®2.

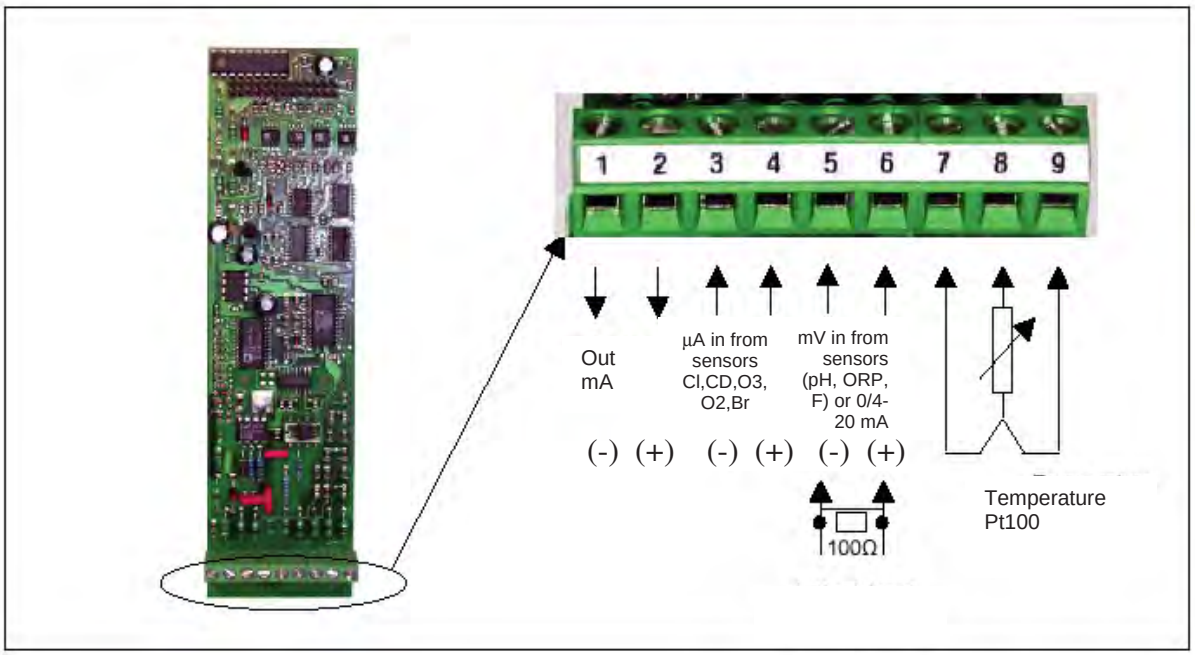


Figure 11 - Analog Input /Output terminal barrier

3.4.4.1 Temperature compensation

The temperature compensation Pt100 is not necessarily present in each sensor, in fact in some installations the different sensors are installed in the same cell, and therefore the reference temperature can be read from one input only, namely from the sensor connected to channel 1.

In the channel definition menu, when configuring channel 2 and 3, after the choice of the type of sensor, it is requested to specify if the reference temperature is to be "equal to first channel" or "independent". In the first case the reference temperature for that channel is taken from channel 1, in the second case it is read from its own PT100 thermistor which in this case must be present.

This option is not applicable for mA, ORP or Chlorine in CL4000 mode inputs measurements, as these parameters are not influenced by operating temperature or already compensated.

3.4.5 Serial communication board

MicroChem®2 supports serial communication standards RS232 and RS422/485 by connection of a modular telephone jack RJ11.

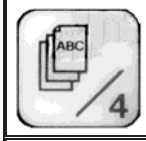
The 6 poles terminal board supports all three standards.

The pin-out of the RJ11 connectors and 6-pin terminal board is illustrated in Section 11.3 in this manual, dealing with the serial communication option.

4 SET-UP AND CONFIGURATION

4.1 Keyboard functionality

All the keys have dual functionality, except the ENTER key. Blue background keys are the ones whose second function is only used in Controllers options (instrument Type D, Type E). The selection between numbers and functions is automatically recognised by the instrument.

KEY	PRIMARY FUNCTION	SECONDARY FUNCTION
	MANUAL SELECTOR Selects manual mode in Controllers (instruments Type D, E).	0: digit zero when allowed
	DECREASE OUTPUT Decreases output in Controller (instruments Type D, E) when in manual mode.	1: digit 1 when allowed
	INCREASE OUTPUT Increases output in Controller (instruments Type D, E) when in manual mode.	2: digit 2 when allowed
	LIGHT Light up / down the display.	3: digit 3 when allowed
	MENU Calls for the menu and, inside a menu, cycles the parameters.	4: digit 4 when allowed
	ENTER: decimal point is not used; any parameter needing it already includes the decimal point in the correct position. Enter function: allows to enter the displayed menu or parameter; once entered the parameter, allows to modify it. A parameter can be changed (set) when the cursor appears on the display. Once the cursor has appeared, whether or not the parameter has been changed, the Enter key confirms the displayed value. In display mode Enter key allows to call the Warnings & Messages page.	None
	AUTOMATIC SELECTOR Selects Automatic operation mode in Controllers (instruments Type D, E).	5: digit 5 when allowed

SP 6	DECREASE SETPOINT Decreases Set Point in Controllers (instruments Type D, E).	6: digit 6 when allowed
SP 7	INCREASE SETPOINT Increases Set Point in Controllers (instruments Type D, E)	7: digit 7 when allowed
8	WASH Starts a cleaning sequence when this option is activated and allowed (timers set at any value different from zero).	8: digit 8 when allowed
CANCEL 9	CANCEL Cancel is used to modify a parameter wrongly written: when a parameter can be modified the cursor appears on the display; when the cursor is in the last right position pressing the Cancel key will delete the newly introduced value and allow to re-write a new one. Cancel is also used to load default parameters (Super-Reset, See Section 9.4).	9: digit 9 when allowed
END –	END End key in Display Mode allows to scroll different pages if present. In Menu Mode allows to step up menu.	-: negative sign when allowed

Table 1 - Keyboard functionality

Use of MENU, ENTER and END keys to move inside menus and change parameters:

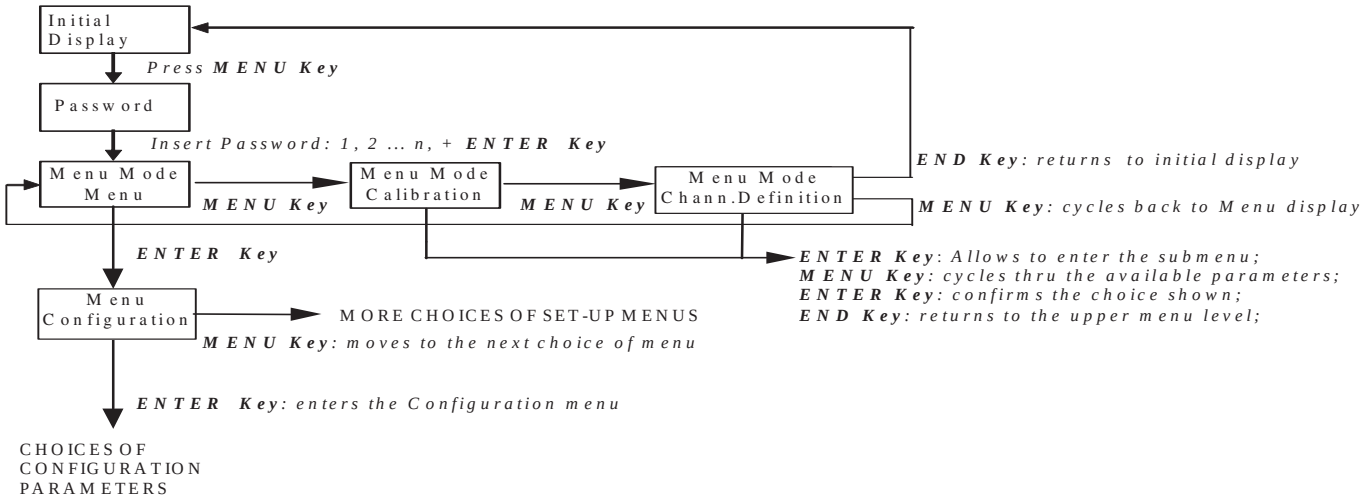
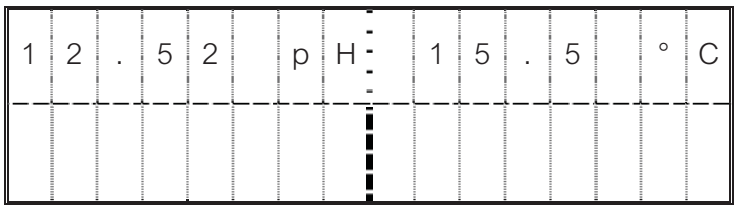


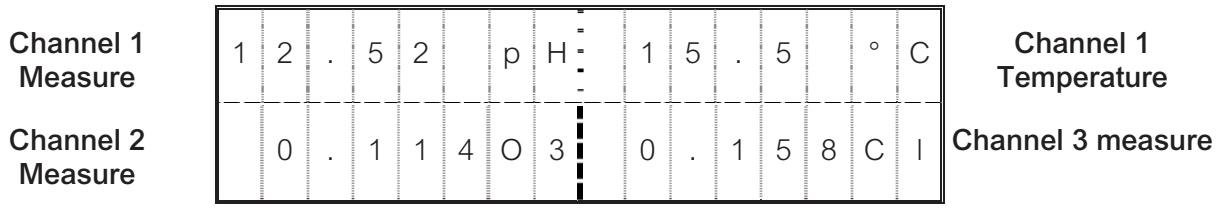
Figure 12 - Example of menus navigation

4.2 Display

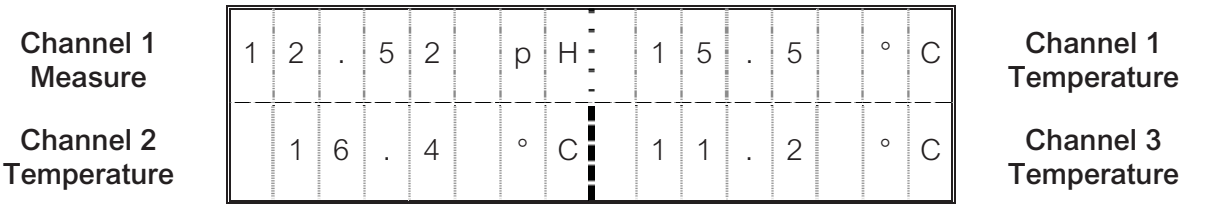
The MicroChem®2 display shows the instantaneous value of the parameter measured, its identification symbol and the temperature of the sampled liquid. Here is an example of the standard one-channel display:



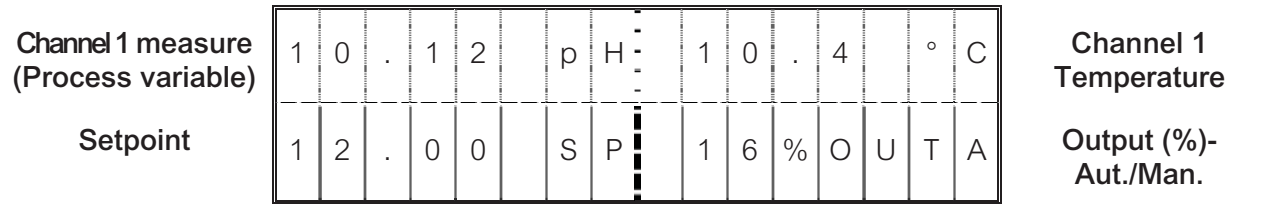
If the instrument is configured to support two sensors, the display shows on the top line the metered value and the temperature of parameter installed on Channel 1, and on the bottom line the metered value and the temperature of parameter installed on Channel 2. When three sensors are installed, the process values are displayed on two different pages. Press END key to toggle form one page to the other.



On the second page appears:



When MicroChem2 is configured as a Controller, the process information is displayed on a dedicated page, as per following example:



4.3 Channel definition

This menu allows to select the type of sensor associated to each channel.

The Channel definition menus are in accordance to the number of the channels installed (e.g. if only Channel 1 is installed, only Channel 1 definition menu appears; if two channels are installed, both Channel 1 definition menu and Channel 2 definition menu will appear. The same principle applies for Channel 3).

Select the type of channel according to the sensor installed (see Section 2.1 for the symbols used).

NOTES:

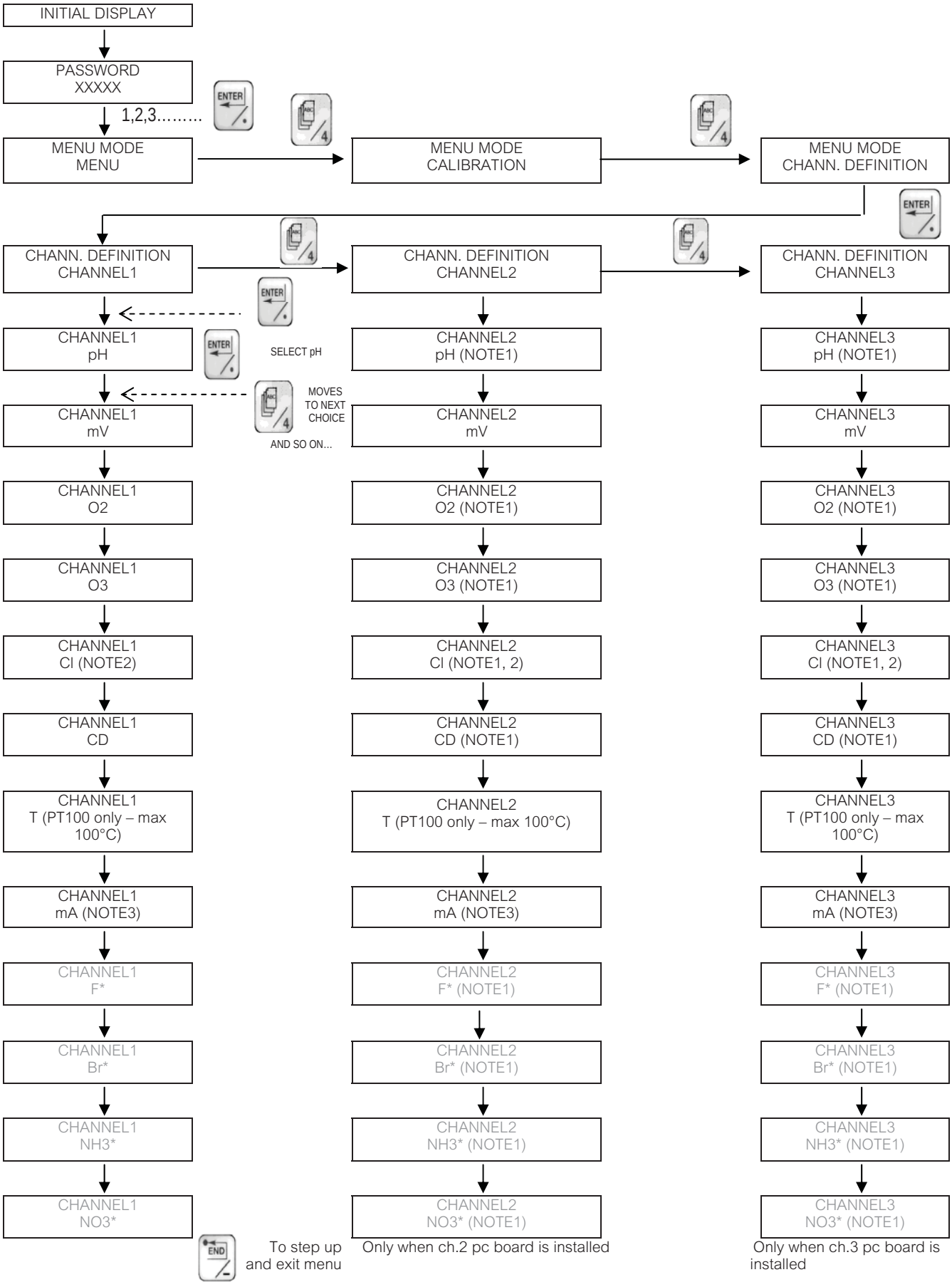
- When changing channel definition from one parameter to another, the MicroChem®2 transmitter/controller will set the alarm outputs and the PID parameters to the default values.
- At power-up, the instrument loads data in memory according to the last channel definition. When the Channel definition is modified, in order to have the new data properly stored, it is necessary to operate the Super-Reset procedure (See Section 9.4).

There are 3 different Channel definition menus depending on the type of instrument operating:
Channel definition – Transmitter: see section 4.3.1
Channel definition – Standard/Average controller: see section 4.3.2
Channel definition – Swimming pool controller: see section 4.3.3

4.3.1 Channel definition -Transmitter

(Please refer also to the menu trees in the appendices for an overview of how to navigate through the software).

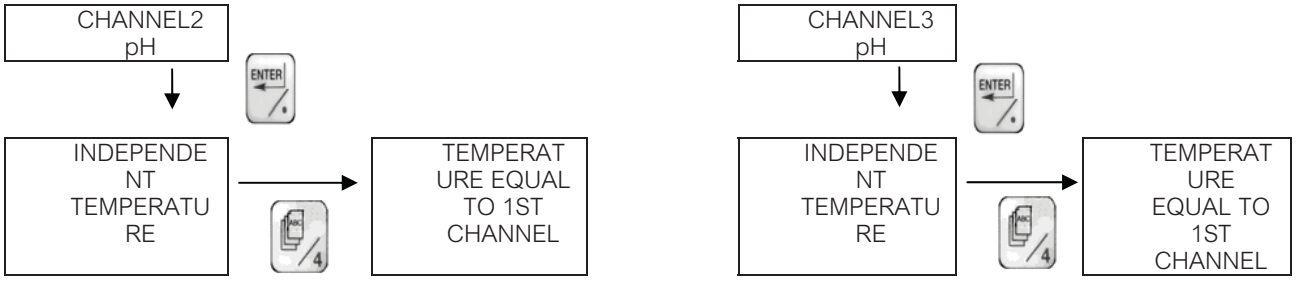
Please refer to step by step programming instructions in the appendix for instrument configuration examples.


INITIAL DISPLAY
PASSWORD
XXXXX
1,2,3.....
ENTER
MENU MODE
MENU
MENU MODE
CALIBRATION
MENU MODE
CHANN. DEFINITION
CHANN. DEFINITION
CHANNEL1
CHANN. DEFINITION
CHANNEL2
CHANN. DEFINITION
CHANNEL3
SELECT pH
MOVES
TO NEXT
CHOICE
AND SO ON...
CHANNEL1
pH
CHANNEL1
mV
CHANNEL1
O2
CHANNEL1
O3
CHANNEL1
Cl (NOTE2)
CHANNEL1
CD
CHANNEL1
T (PT100 only – max
100°C)
CHANNEL1
mA (NOTE3)
CHANNEL1
F*
CHANNEL1
Br*
CHANNEL1
NH3*
CHANNEL1
NO3*
CHANNEL2
pH (NOTE1)
CHANNEL2
mV
CHANNEL2
O2 (NOTE1)
CHANNEL2
O3 (NOTE1)
CHANNEL2
Cl (NOTE1, 2)
CHANNEL2
CD (NOTE1)
CHANNEL2
T (PT100 only – max 100°C)
CHANNEL2
mA (NOTE3)
CHANNEL2
F* (NOTE1)
CHANNEL2
Br* (NOTE1)
CHANNEL2
NH3* (NOTE1)
CHANNEL2
NO3* (NOTE1)
CHANNEL3
pH (NOTE1)
CHANNEL3
mV
CHANNEL3
O2 (NOTE1)
CHANNEL3
O3 (NOTE1)
CHANNEL3
Cl (NOTE1, 2)
CHANNEL3
CD (NOTE1)
CHANNEL3
T (PT100 only – max
100°C)
CHANNEL3
mA (NOTE3)
CHANNEL3
F* (NOTE1)
CHANNEL3
Br* (NOTE1)
CHANNEL3
NH3* (NOTE1)
CHANNEL3
NO3* (NOTE1)
END
To step up
and exit menu
Only when ch.2 pc board is installed
Only when ch.3 pc board is
installed

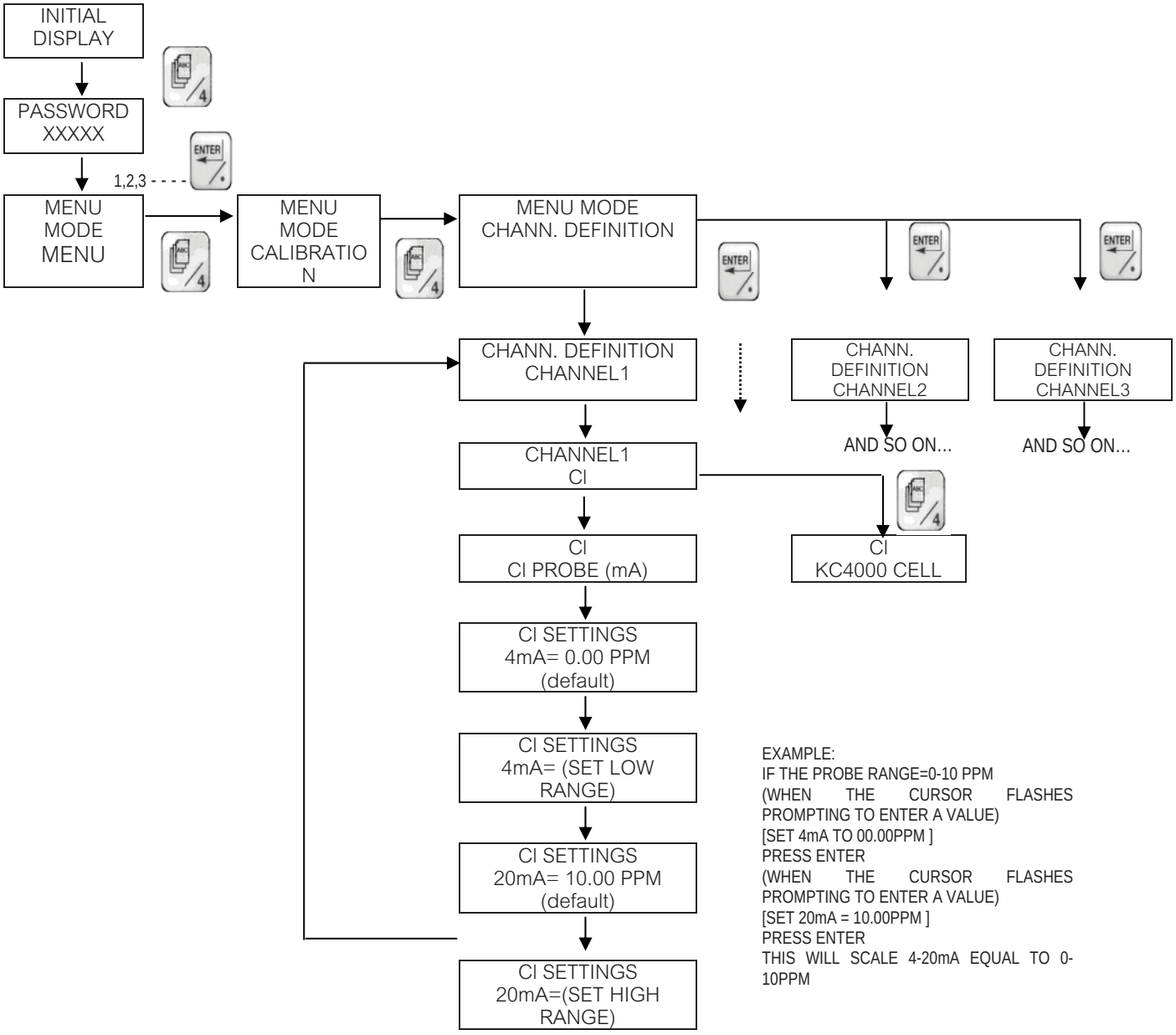
NOTES

* = Not available

NOTE 1: In 2nd and 3rd channel definition it's possible to choose between "Independent Temperature" or "Temperature equal to 1st channel":

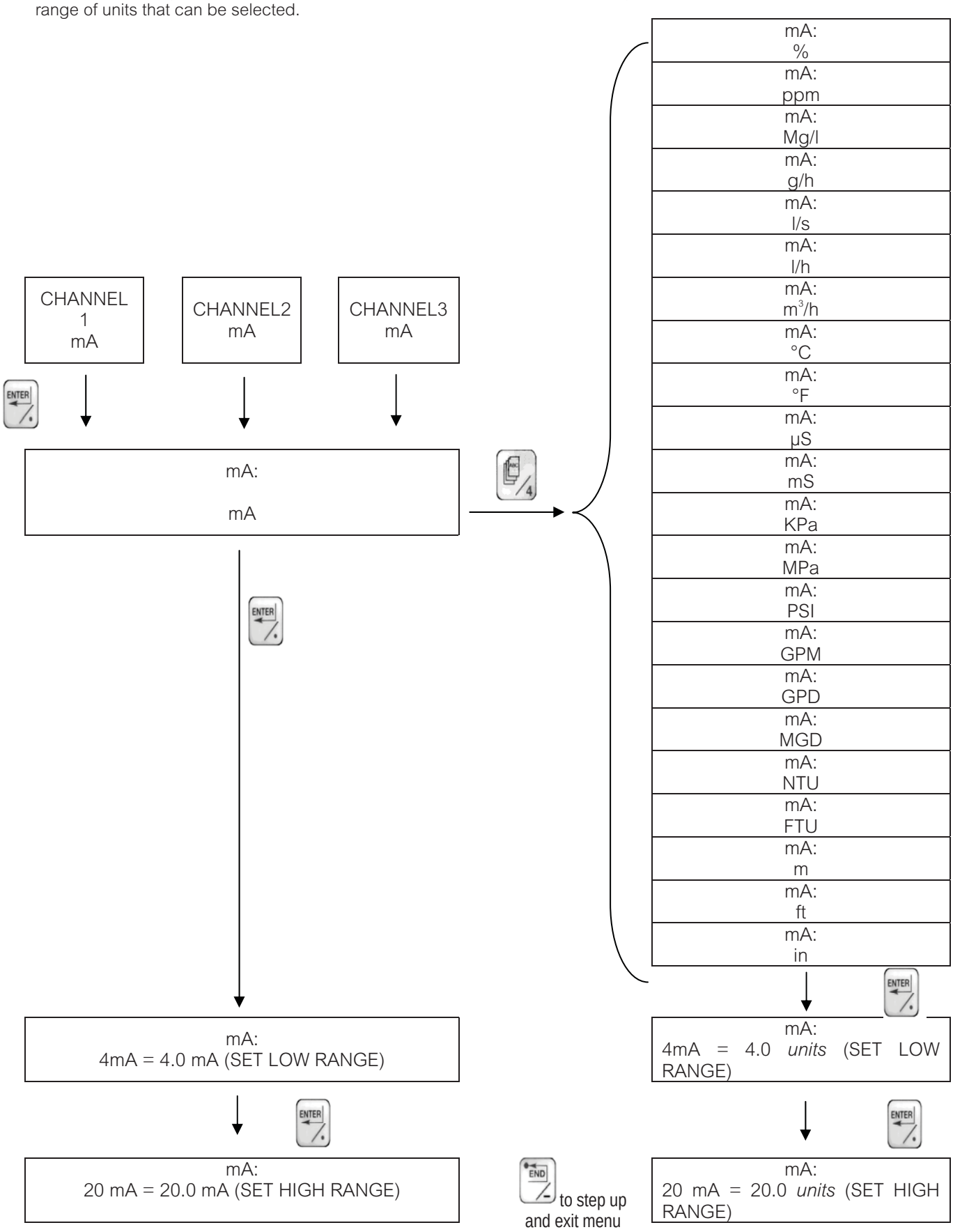


NOTE 2: If chlorine (CL) is selected, the type of CL measurement must be defined as either a cell (KC4000) or a probe (CL4000). When CL4000 probes are selected, you will be prompted to enter the (4mA and 20mA) probe settings to match the range of the probe supplied with the system (i.e. 0-2 or 0-10 ppm):

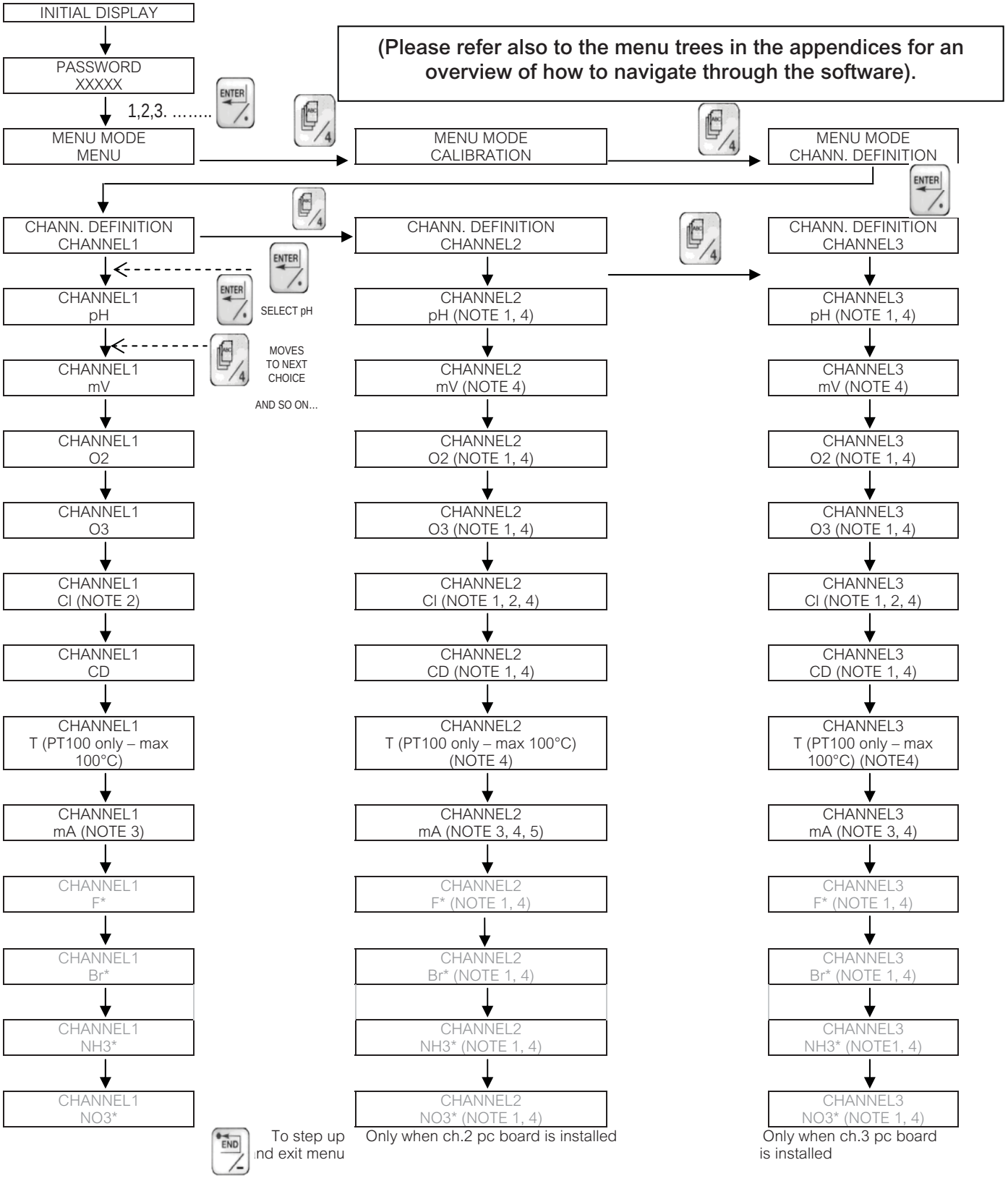


EXAMPLE:
IF THE PROBE RANGE=0-10 PPM
(WHEN THE CURSOR FLASHES PROMPTING TO ENTER A VALUE)
[SET 4mA TO 00.00PPM]
PRESS ENTER
(WHEN THE CURSOR FLASHES PROMPTING TO ENTER A VALUE)
[SET 20mA = 10.00PPM]
PRESS ENTER
THIS WILL SCALE 4-20mA EQUAL TO 0-10PPM

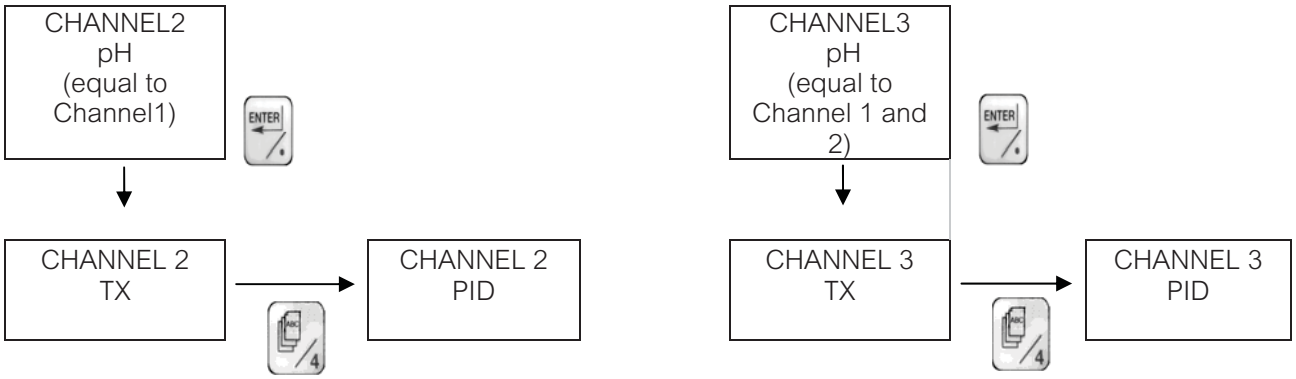
NOTE 3: Sensors with a 4 to 20 mA output can be connected to the transmitter and the units and range can be set within the channel configuration software and then the sensor output can be displayed on the screen – see Section 2.1 for the range of units that can be selected.



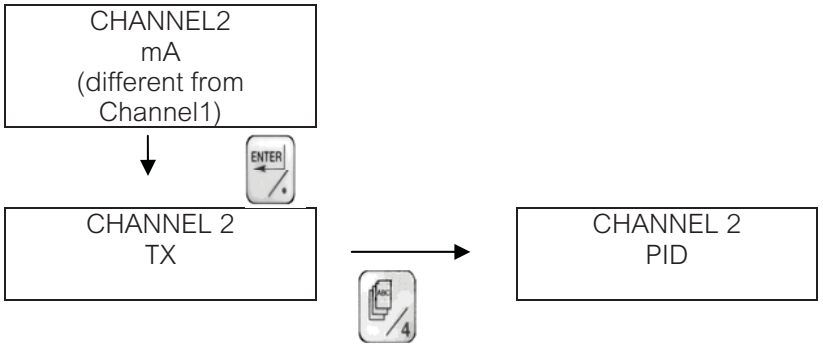
4.3.2 Channel definition-Standard/Average Controller



NOTES
* = Not available
NOTE 1, 2, 3: See NOTE 1, 2, 3 Section 4.3.1
NOTE 4: If channel 2 or channel 3 is selected equal to the first one, choose TX for stand alone channel or PID to include measurement into the computation of average process variable (PV)

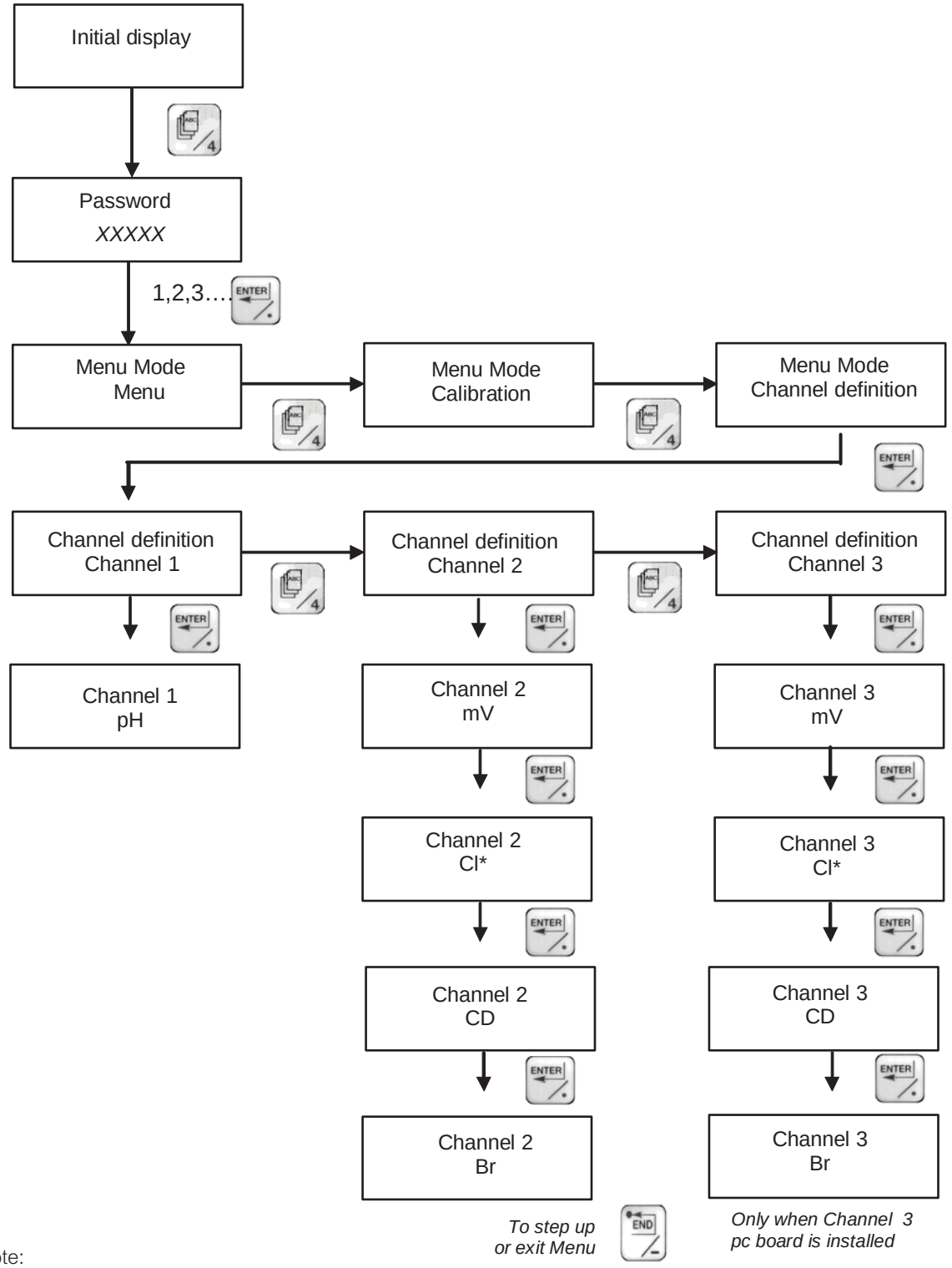


NOTE 5: If channel 2 is set as mA and different from the first channel, choose TX for stand alone channel or PID for feed forward flow rate value.



4.3.3 Channel definition-Swimming pool Controller

(Please refer also to the menu trees in the appendices for an overview of how to navigate through the software).



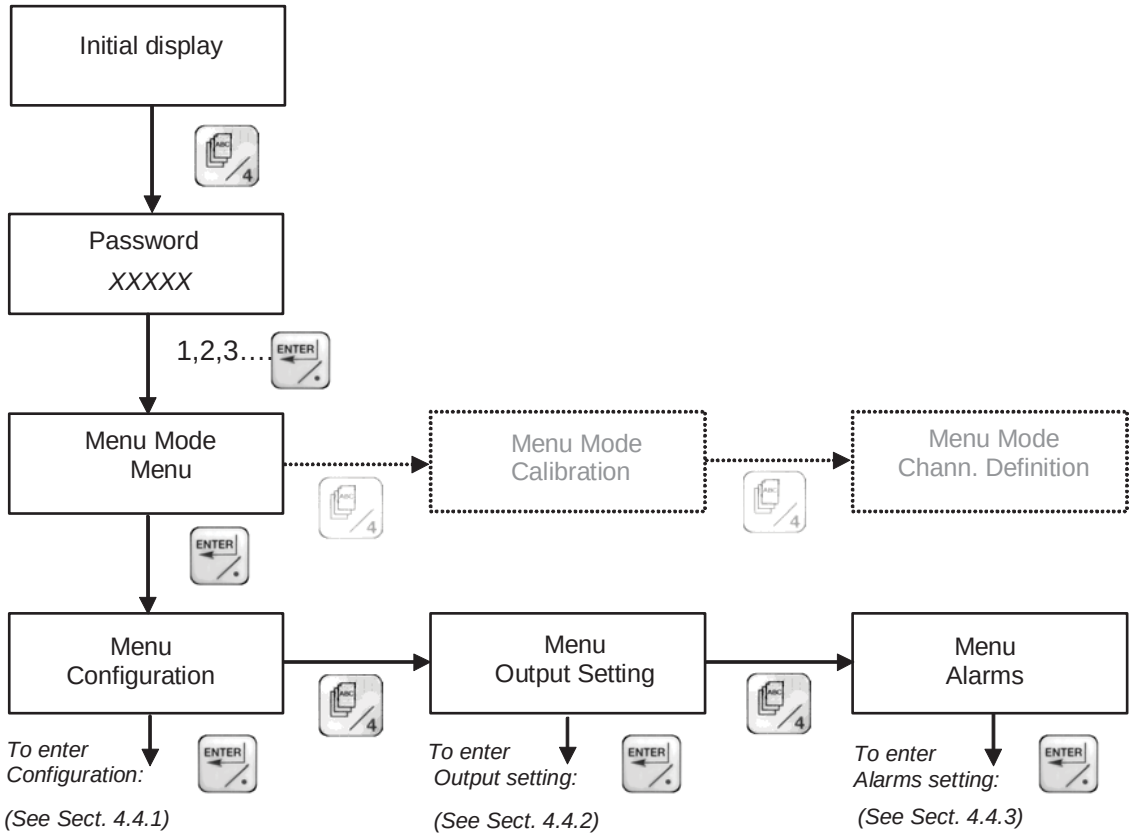
Note:
* = See Note 2 Section 4.3.1

4.4 Set-up menu

The set-up menu is structured in three different submenus and namely:

- Configuration: to set the general operating parameters of the instrument, see Sect. 4.4.1
- Output settings: to select 4-20 mA or 0-20 mA output for each channel, see Sect. 4.4.2
- Alarms: to set alarms level; see Sect. 4.4.3.

Each of them will be discussed in detail in the following pages.



4.4.1 Configuration

The configuration menu consents to set the general parameters of the instrument. Only those parameters which are pertinent to the selection made and to the hardware installed will appear in the menu. When a digital value is requested, pressing the ENTER key will cause a cursor to appear in the display: at this point a digital value may be entered using the second function of the keyboard pushbuttons. When ENTER key is pressed again, the value shown on the display will be confirmed, whether the latter has been modified or not.

Here is a description of the parameters appearing in the menu. A summary of the configuration menu flowchart follows in the next page.

4.4.1.1 Configuration parameters

Language: select the language of the displayed messages. Available languages: Italian, English, French, German, Spanish. Default: Selected language

Password: set the password, that is a numeric code composed of up to 5 characters. Default setting by Factory: 00000

Serial link: optional serial communication link
See Section 11 “Serial Communication” for detailed instructions

Cleaning: logical sequence for periodical cleaning of the sensors
See Section 4.4.1.3 for details

Temperature select: select measuring units for displayed temperature value: °C or °F; default: °C

Temperature set: define temperature at which operate temperature compensation when the thermistor is faulty; default: 20 °C (68°F)

Altitude: it appears when at least one channel is configured as O2. It's the altitude on sea level at which the instrument is installed. It must be set at start up and it does not need to be changed again. It is needed for automatic "in air" calibration procedure. Available units are feet (ft) and meter (m). Default Altitude: 200 m (666.6 ft)

CCI in ‘OR’: When CCI in OR option is chosen, if one or the other or both the CCI is/are closed the MicroChem2 freezes the output signals until CCI returns in the original state.
See Section 5.2.3.3

Average: for dual/triple channels transmitters, with identical sensors installed; the transmitter computes the average of the two/three input signals. The choice is Average NO or Average YES; default is NO (the average is not computed)

Delta: for dual/triple channels transmitters, same installed parameter; the transmitter displays an alarm when the difference between the two/three measured values is higher than the set value allowed for the deviation. Default: 0.0 (the delta is not active)

Sigma: for triple channels controller, with identical sensors installed; the controller verifies if one of the three input signals is incorrect in comparison with the others. The choice is Sigma NO or Sigma YES; default is NO (the check is not activated)

K1, K2 selectable numeric thresholds determining if probe maintenance is requested.
K1= maximum standard deviation value admitted. Default: 1.00; K2= maximum error value admitted for each probe. Default: 1.00;
Set numeric values in order to verify the following formulas:

$$= \bullet \overline{[\ (Vi - Vm)^2]/2}$$

If >K1 then verify for each probe:
If |Vi – Vsp| - |Vm – Vsp| > K2 then probe requires maintenance.
If not: probe works correctly.
(Vi= measured value; Vm= average value of the 3 measures; Vsp= set point value)
NOTE: the faulty condition message appears only on Alarms page (it is accessed by pressing the ENTER Key in display mode. See Sect. 9.2)

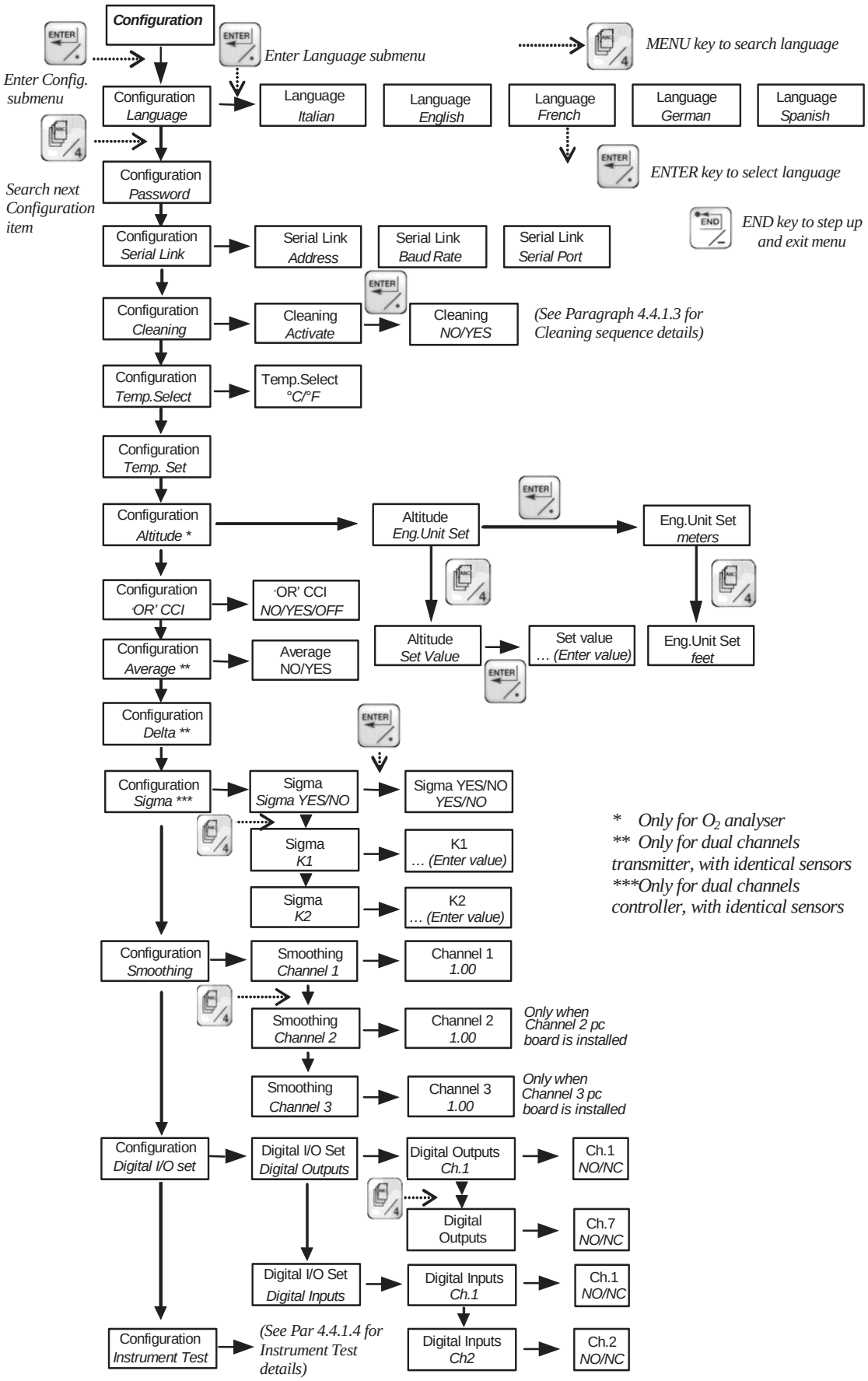
Smoothing: The number is the smoothing in seconds on the input signal. It can be separately set for the three channels. Allowed values are 0.00 - 10.00. Default: 1.0

Digital I/O Setting: allows to set the status of digital input and digital outputs: each CCI and each CCO can be separately set as NC or NO. Default: NO

Instrument test: see Section 4.4.1.4

4.4.1.2 Configuration menu flowchart

(Please refer also to the menu trees in the appendices for an overview of how to navigate through the software).


Configuration
Enter Config. submenu
Enter Language submenu
MENU key to search language
Configuration Language
Language Italian
Language English
Language French
Language German
Language Spanish
ENTER key to select language
Search next Configuration item
Configuration Password
END key to step up and exit menu
Configuration Serial Link
Serial Link Address
Serial Link Baud Rate
Serial Link Serial Port
Configuration Cleaning
Cleaning Activate
Cleaning NO/YES
(See Paragraph 4.4.1.3 for Cleaning sequence details)
Configuration Temp.Select
Temp.Select °C/°F
Configuration Temp. Set
Configuration Altitude *
Altitude Eng.Unit Set
Eng.Unit Set meters
Altitude Set Value
Set value … (Enter value)
Eng.Unit Set feet
Configuration 'OR' CCI
'OR' CCI NO/YES/OFF
Configuration Average **
Average NO/YES
Configuration Delta **
Configuration Sigma ***
Sigma Sigma YES/NO
Sigma YES/NO YES/NO
Sigma K1
K1 … (Enter value)
Sigma K2
K2 … (Enter value)
Configuration Smoothing
Smoothing Channel 1
Channel 1 1.00
Smoothing Channel 2
Channel 2 1.00
Only when Channel 2 pc board is installed
Smoothing Channel 3
Channel 3 1.00
Only when Channel 3 pc board is installed
Configuration Digital I/O set
Digital I/O Set Digital Outputs
Digital Outputs Ch.1
Ch.1 NO/NC
Digital Outputs
Ch.7 NO/NC
Digital I/O Set Digital Inputs
Digital Inputs Ch.1
Ch.1 NO/NC
Digital Inputs Ch2
Ch.2 NO/NC
Configuration Instrument Test
(See Par 4.4.1.4 for Instrument Test details)
* Only for O2 analyser
** Only for dual channels transmitter, with identical sensors
***Only for dual channels controller, with identical sensors

4.4.1.3 Cleaning functionality

The cleaning functionality implemented in the MicroChem®2 supports a sequence of operations necessary to perform a periodical cleaning of the sensors. This function is always present in the software and can be enabled or disabled by a YES/NO selection in the configuration menu (default setting is NO).

When the selection is set to “YES”, the instruments activates the cleaning sequence and operates the output contact relays associated to CCO5 and CCO6 to drive the solenoid valves for the washing and rinsing lines (see Fig. 15). Each phase of the cleaning sequence requires a different timing, and this can be freely configured in parameters T1, T2, T3 and T4 (see Table 2 below for details). During the cleaning sequence active phases, the measure is frozen to the last valid value, and when instrument is operating as a Controller (T17MD4000, T17ME4000) the latter is automatically forced in manual mode.

The cleaning sequence can be started locally with a manual command by pressing Key 8 / WASHING, or it can be triggered automatically by setting proper values in the timers T1-T4.
There are two cleaning sequences designed to work in conjunction with optional STWP devices: sequence “A” (Water Analytic Unit) and sequence “B” (Sequential Cleaning Unit). Select “B” option and use the output contacts as directed in Figure 15 to drive the solenoid valves.

The cleaning sequence consists of the following four phases:

T1 - Analysis: Normal operation phase of the sensor that is the time period between the end of a cleaning sequence and the start of the next one in automatic mode. Allowed time values are 1 second to 30 hours. Typical value is 23.5 hours.

T2 – Washing: Phase to be used to wash the sensor with chemical detergent. Allowed values are 0-30 minutes. Typical value is 10 min.

T3 – Rinsing: Phase to be used to rinse the sensor with pressurized clean water. Allowed values are 0-30 minutes. Typical value is 10 min.

T4 – Pause: Pause period usually allowed to consent the sensor to recover sensibility before starting a new measure. Allowed values are 0-30 minutes. Typical value is 10 min.

PHASES	TIME	CCO5	CCO6	MESSAGE
T1 Analysis	T1	•	•	
T2 Washing	T2	O	•	WASH!
T3 Rinsing	T3	•	O	WASH!
T4 Pause	T4	•	•	WASH!
T1 Analysis	T1	•	•	

Legend:
O = open
• = closed

Table 2 - Sequence of cleaning phases

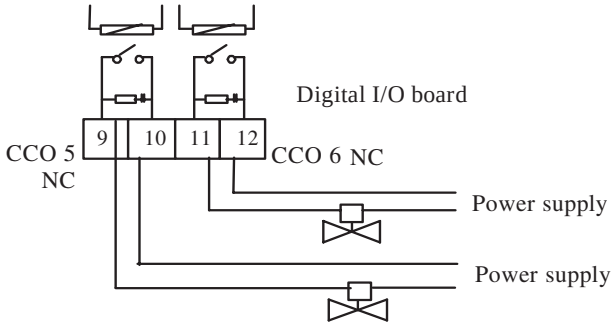
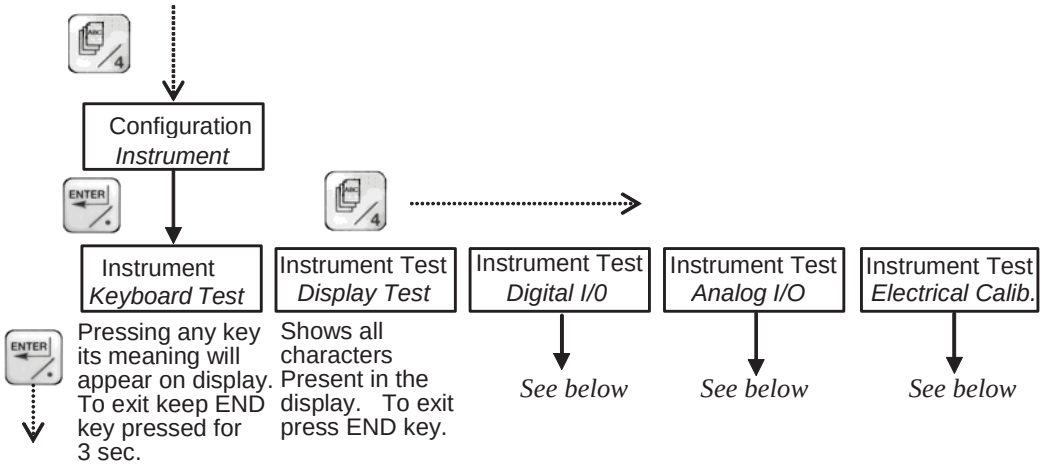


Figure 13 - Connection of solenoid valves

4.4.1.4 Instrument test

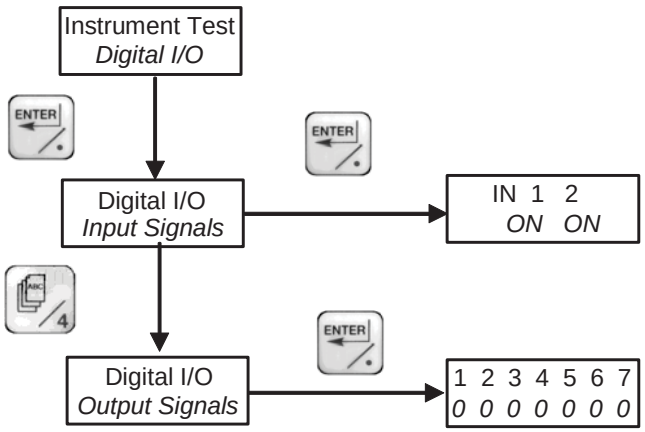
This submenu which is part of the Configuration menu, allows to perform self diagnostic routines on MicroChem®2 basic functions, sensor check and MicroChem2 electrical calibration:



- Keyboard test: pressing any key the display will show the corresponding number (0....9) or function (ENTER, END). To exit this submenu press END key and keep it pressed for 3 seconds, until the display shows - - -.

- Display test: once entered this submenu the display shows cyclically in all the 32 writing locations of the display all the characters present. To exit press END key.

- Digital I/O test: this submenu allows to verify the status and the correct functionality of the digital inputs and outputs:



Digital Input: Input signals submenu the display shows

" 1 2 "
" OFF OFF "

changing the status of one of the CCI by shorting the associated terminals (see Section 3.4.3.2) the display shows ON below the number of the associated CCI.

Digital Output: the display will show the status of the 7 output contacts (relay):

" 1 2 3 4 5 6 7 "
" 0 0 0 0 0 0 0 "

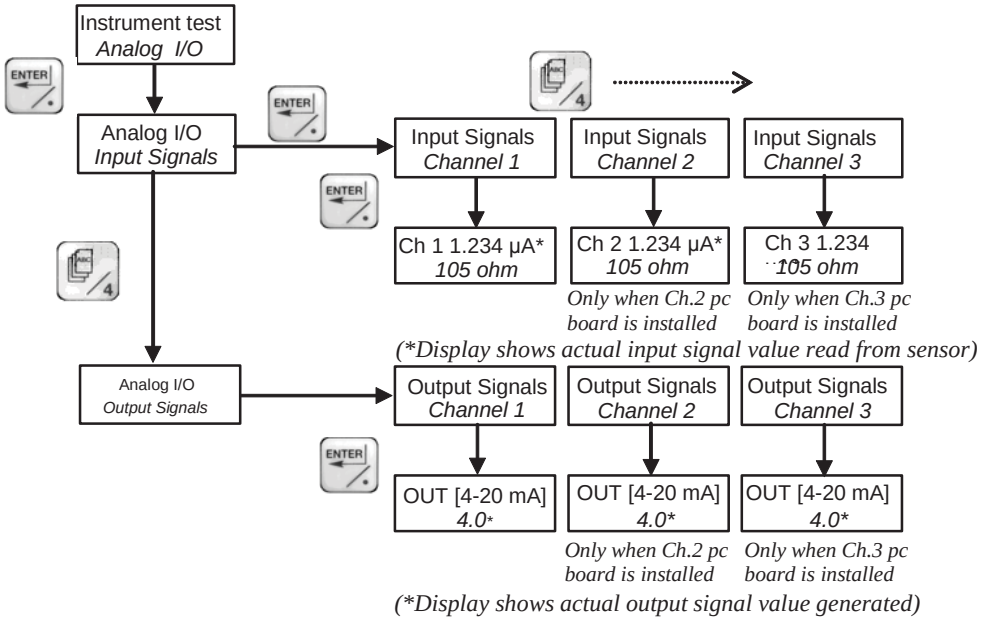
pressing the key corresponding to displayed number (from 1 to 7) the display will change the "0" in "1" or vice versa and the contact output status will change from "OPEN" to "CLOSE": verify with an ohmmeter the status of the pertinent CCO (see hereafter terminal numbers correspondence).

Contact Number (CCO)	CCO1		CCO2		CCO3		CCO4		CCO5		CCO6		CCO7	
Terminal identification (TB J3)	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Table 3 - CCO Terminal identification

- Analog I/O test: the Analog I/O test allows to verify the correct value of the input and output signals. In the analog "Input" mode, the display shows the value of the signal generated by the sensor and the pertinent Pt100, in order to verify the correct sensor operation in an easy and fast way.

In analog output mode the instrument allows to check correct functionality of the 4-20 mA output: operating the OUT increase and OUT decrease keys the output value indicated on display can be changed and with a multimeter connected to the pertinent channel output [terminals 1(-), 2(+)] it can be verified that the current output changes accordingly.



- Electrical Calibration: The access to this menu is protected by a password that is only known to Severn Trent personnel, because the included parameters must never be tampered with.

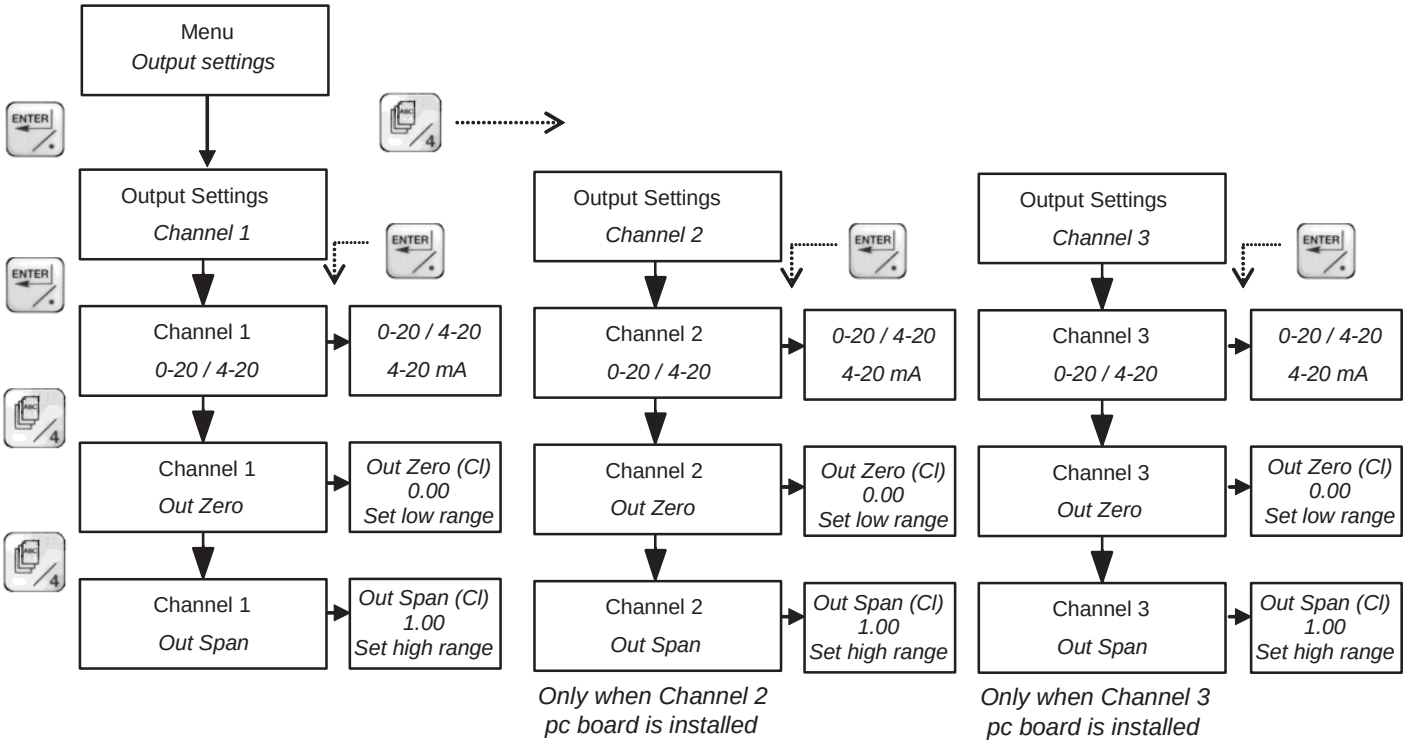
The electrical calibration is only performed in the Factory at the end of manufacturing process.

4.4.2 Output setting

The Output Settings menu allows to set current output (0-20 or 4-20 mA), zero (Out Zero) and full scale (Out Max) values, in engineering units. Out Zero value corresponds to 0 mA or 4 mA (according to the output chosen) and the Out Full Scale value to 20 mA.

WARNING! **The 0 or 4 mA selection is a hardware/software setting made during manufacturing process. Set 0-20 mA or 4-20 mA accordingly. To modify output signal change Jumper JP1-JP2 as shown in Figure 14.**

(See Sect. 4.4 to get here)



In the following table the default values of Out Zero and Out Max are presented. Minimum span and maximum ranges are also presented.

Parameter	Unit	Out Zero	Out Max	Minimum Span	Maximum range
pH	pH	2.00	12.00	1.00	0.00-14.00
mV	mV	-500	+500	100	-1500-+1500
O2	ppm	0.00	10.00	2.0	0-20.00
O3	ppm	0.00	10.00	0. 25	0.00-10.00
Cl	ppm	0.00	10.00	0.25	0.00-10.00
CD	ppm	0.00	10.00	0.25	0.00-10.00
T	°C	0.00	100.0	5	0.00-+100
mA	See Section 2.1	4.00	20.0	2	(0) 4-20.0
Br	ppm	0.00	1.00	1.00	0.00 -10.00

Table 4 – Output max and min range

4.4.2.1 Output signal hardware modification 4-20 to 0-20 mA

To modify output signal from 4-20 to 0-20 mA make following hardware modification on Analog Input/Output board:

- Identify Jumper JP1 and JP2 on board (see figure below);
- Remove JP1 (cut copper, this jumper is factory-made by default);
- Install Jumper in JP2 position.

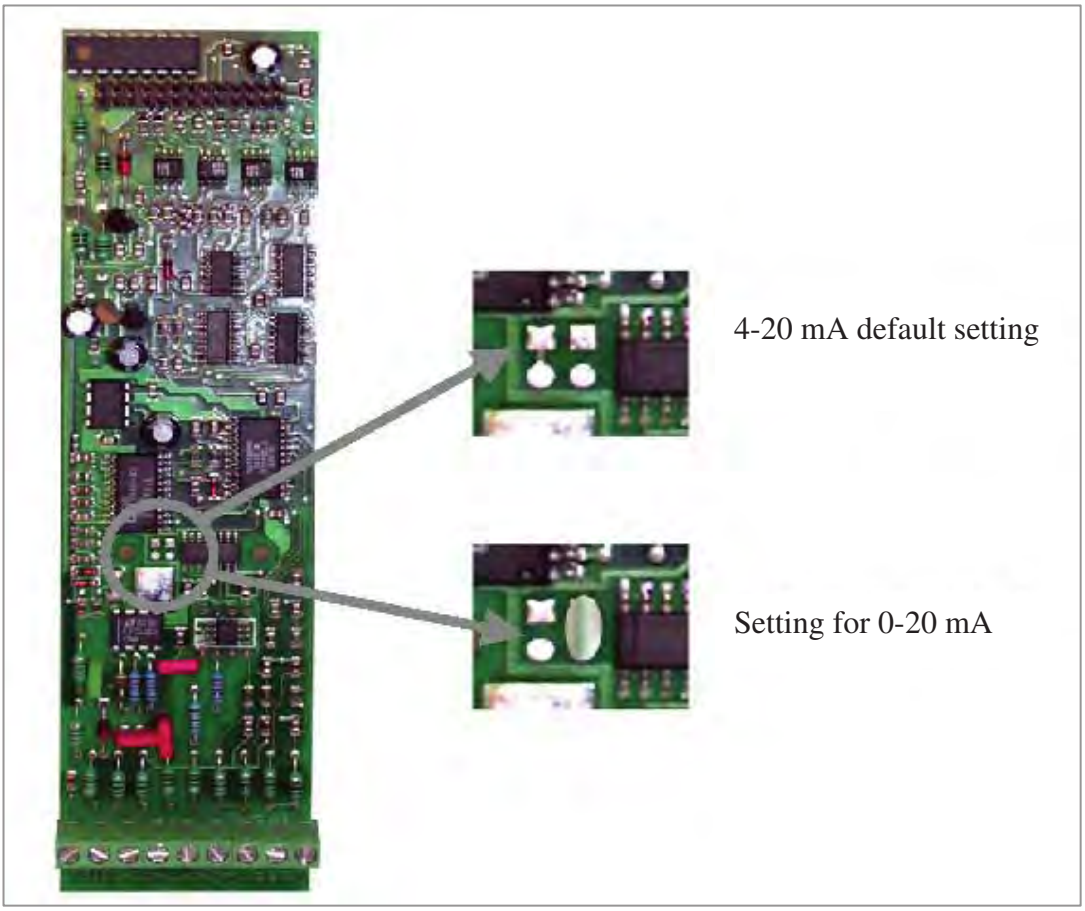


Figure 14 - Jumper position for 4-20 to 0-20 mA output signal modification

4.4.3 Alarms

This menu allows to set high and low alarm levels and the dead band. The alarm levels are freely selectable by the user. Select the channel and press Enter to select alarms and dead band. Default levels are automatically related to the set range of output: low alarm is set at 10 % of Out Zero and high alarm is set at 90 % of Out Max (see the following table for default alarm setting values).

Parameter	Unit	Alarm		
		low	*high*	*dead band*
pH	pH	3.00	11.00	0.00
mV	mV	-400	+400	0.00
O2	ppm	1.00	9.00	0.00
O3	ppm	0.10	0.90	0.00
Cl (KC4000)	ppm	0.10	0.90	0.00
Cl (CL4000 0-2 ppm)	ppm	0.20	1.80	0.00
Cl (CL4000 0-10 ppm)	ppm	1.00	9.00	0.00
CD	ppm	0.10	0.90	0.00
T	°C/°F	10.0	90.0	0.00
mA	mA	5.60	18.40	0.00

Table 5 – Default alarm setting

Dead band is useful to avoid a repeated switch on and off of an alarm condition. The operation principle is represented in Figure 15 below: if the measured value reaches the high alarm level, MicroChem®2 generates an alarm message, but a second alarm condition is triggered only after the measure lowers below the set dead band, and then rises again above the HI alarm level. A similar procedure of opposite sign is performed for low alarm.

To identify contacts for alarm retransmission, see the operation description for each instrument type in the following chapters.

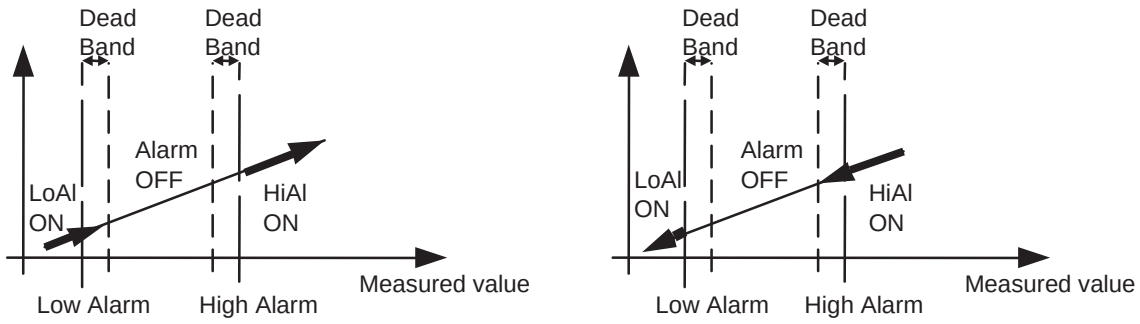


Figure 15 – Hi and LO alarm dead-band

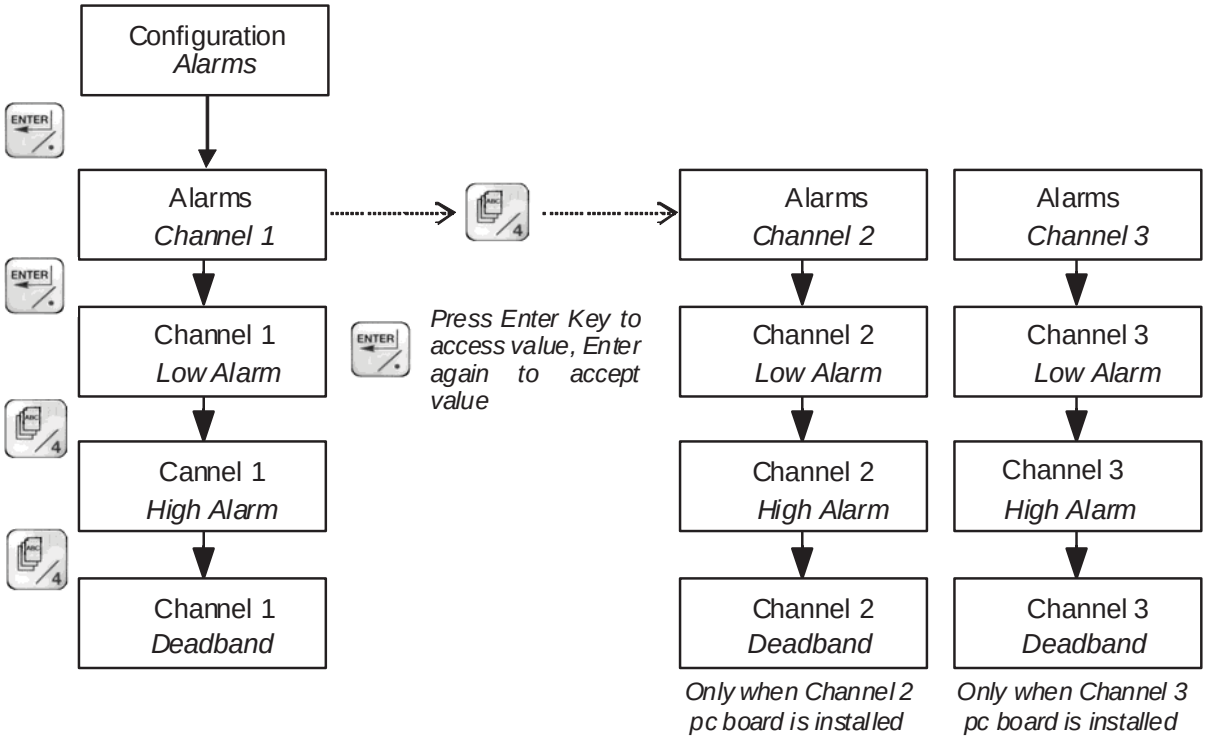
4.4.3.1 Alarm Display

When an alarm occurs, the display indication will flash on and off to signal the alarm condition.

By pressing the ENTER key, the alarm page will be called on display, and it will be possible to identify the channel and the alarm type .
See Sect. 9.2 for details.

4.4.3.2 Alarm setting Menu

(See Sect. 4.4 to get here)



5 FUNCTIONALITY

The different functionality of the instrument depends on the Model Number selected, and it can be classified in two main groups: Analyzer-Indicator-**Transmitter** or Analyzer-Indicator-Transmitter-**Controller.**

5.1 Transmitter

The transmitter can support up to three sensors, and the association of input/output signals depends on the configuration selected as per following tables.

Digital inputs:

CCI in 'OR' SELECTION	CCI1	CCI2
CCI in 'OR' = ***NO***	Freezes measured value of Channel 1	Freezes measured value of Channel 2 (Channel 3 alone cannot be frozen)
CCI in 'OR' = ***YES***	Freezes measured value of all Channels installed	Freezes measured value of all Channels installed
CCI in 'OR' = ***OFF***	CCI 1 inactivated	CCI 2 inactivated

Table 6 - Digital Inputs Functionality for Transmitter

Digital outputs:

Transmitter Type	CCO1	CCO2	CCO3	CCO4	CCO5	CCO6	CCO7
Without Cleaning	HI Alarm Ch. 1	LO Alarm Ch. 1	HI Alarm Ch. 2 (1)	LO Alarm Ch. 2 (1)	HI Alarm Ch. 3 (2)	LO Alarm Ch. 3 (2)	Watch dog
With Cleaning	HI Alarm Ch. 1	LO Alarm Ch. 1	HI Alarm Ch. 2 (1)	LO Alarm Ch. 2 (1)	Washing command	Washing command	Watch dog

Table 7 - Digital Outputs Functionality for Transmitter

Analog Signal output 0/4-20 mA:

Instrument	Channel 1	Channel 2	Channel 3
Transmitter	Retransmission of analysis value for Sensor on Ch. 1	Retransmission of analysis value for Sensor on Ch. 2 (1)	Retransmission of analysis value for Sensor on Ch. 3 (2)

Table 8 - Analog Outputs Functionality for Transmitter

(1) – Only when Channel 2 is installed
(2) – Only when Channel 3 is installed

5.2 Controller

The control strategies offered by the MicroChem®2 are basically:

- Standard PID Controller, with Feed Forward option
- Swimming Pool Controller
- Average Controller between 2 or 3 equal probes

These will be discussed in detail in the following paragraphs.

NOTE: MicroChem2 controller type must be specified at time of order. Hardware changes are required to convert from a standard transmitter to a standard PID controller or to a swimming pool controller.

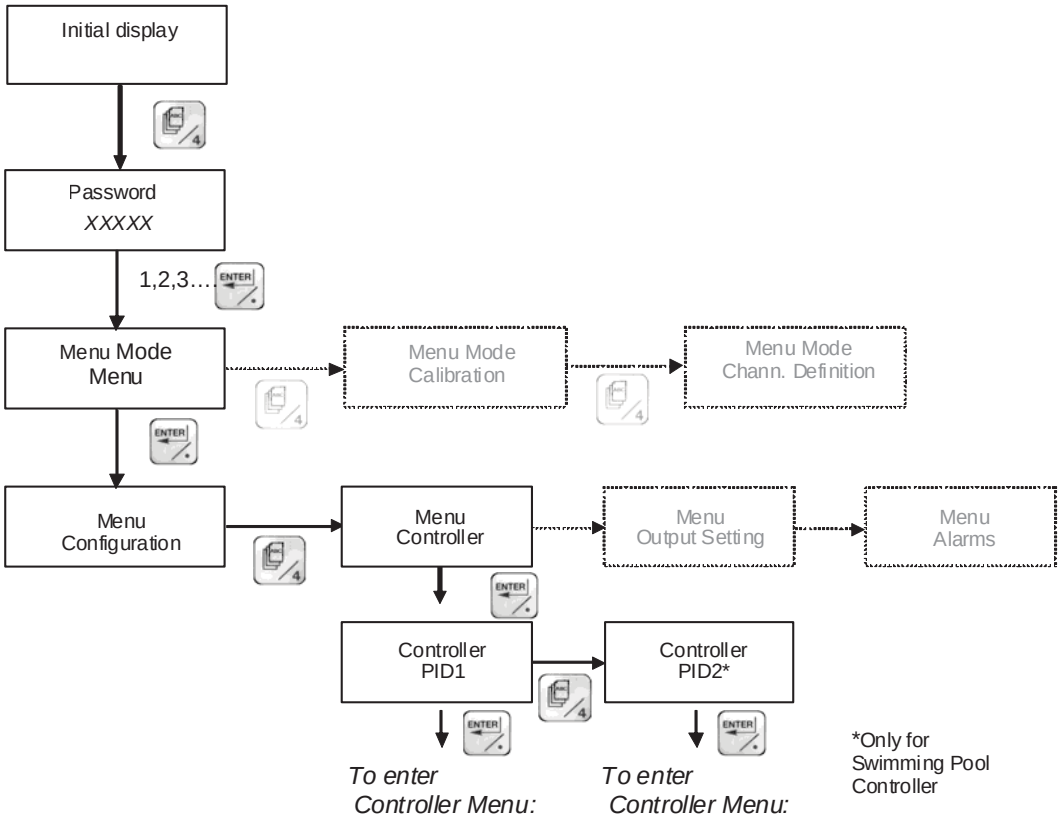
5.2.1 General description

The PID Controller of the MicroChem2 is usable in the majority of process applications. The controller calculates an output based on the difference between the analytic measure (Process Variable, PV), and a Set-point (SP) value, it calculates an Output (OUT), that is applied to a final control element (e. g. dosing pump) to restore actual process value to the set-point demand. The output is calculated with the PID algorithm, which has Proportional, Integral and Derivative actions. The effect these terms have on the calculated output is determined by the PID configuration.

The Controller can work in Automatic or Manual mode, pushing numbers 0 or 5. The Manual mode let the user modify the output manually, whereby the PID calculated output is not used. The output is driven with push-buttons 1 (decrease) and 2 (increase). The Automatic mode is selected pushing button 5. The set-point is modified with the push-buttons 6 (decrease) and 7 (increase). The output signal to drive the control element can be either a 4-20 mA analog signal or two contacts (increase-decrease). The user can choose to control the final element according to the characteristics of the device used.

5.2.2 Controller's Parameters

When the instrument is operating as a controller the following menu becomes accessible:



Entering the Controller Menu the accessible parameters are presented as per the following table:

1 - General Parameters (valid for all control strategies)		
Description	***Symbol***	***Configuration***
4/20 mA / Contacts	-	Selection of controller output as analog 4/20 mA signal or Contact closure (See 5.2.2.5). Default: 4 – 20 mA
Proportional Band	PB	Numeric entry in % (Integer positive) Default: 100% - Range: 0% - 999%
Time Reset or Integral action	TR	Numeric Entry in minutes per repetition Default: 0 min/rep – Range 0 -999.99 min/rep
Manual Reset (Active when TR=0)	MR	Numeric entry in % Default: 50% - Range 0-100%
Derivative	TD	Numeric Entry in minutes Default: 0 min – Range 0 -99.99 min
Process Variable (display only)	PV	Engineering units
Set Point	SP	Engineering units Default: 0.00
Control zone	CZ	Numeric entry in Engineering units Default: 0.00 - Range: 0.0 - 99999.99
Direct/Reverse Action	RSW	D = Direct; R = Reverse. Default = Reverse
Span	SPAN	Controller Span Default = According to channel configuration
(Feed Forward parameters appear here if this option has been selected. - See Section 2 below)		
High limit on controller's output	OH%	Numeric entry in % Default: 100% - Range 0-100%
Low limit on controller's output	OL%	Numeric entry in % Default: 0% - Range 0-100%

2 - Feed Forward action (this function available only when option is activated – See Par. 5.2.2.2)		
Limit output as function of flowrate?	OHLP	Enter No/Yes Default: No
Factor to compute Max output based on Flowrate value	FFH	Numeric entry in %/100 Default: 1.5 - Range: 0 - 999.99
Factor to compute Min output based on Flowrate value	FFL	Numeric entry in %/100 Default: 0.50 - Range: 0 - 999.99
Absolute High limit on output when limits based on flowrate are active	Absolute Max.	Numeric entry in % Default: 100% - Range 0-100%
Gain factor applied on flowrate signal	GAIN	Numeric entry in % Default: 100% - Range 0-999.99%

3 – Time Sampling and/or Flow Pacing Controller (Process with dead time - this menu available only when Chlorine input Channel is selected – See Par. 5.2.2.3)		
Sampling based on flow?	TATP	Enter No/Yes Default: No
Scaling factor for flow	K	Numeric entry in Engineering units Default: 0.0 - Range: 0 - 999999.9
Active time	Att.	Numeric Entry in minutes Default: 0.0 min – Range 0- 99999.99 min

Total Cycle time (or volume)	Cycle	Numeric Entry in minutes (or units sample) Default: 0.0 min - Range: 0 - 99999.99 min
4 - pH/ORP control (this parameter compares when pH/ORP is selected – See Par. 5.2.2.4)		
Squared error control band	Dead Band	Numeric entry in % Default: 100% - Range 0-100%

5 - Contact output controller – (this menu available when option is selected - See Par. 5.2.2.5)		
Frequency / Relay	DIGITAL OUTPUTS	Function not supported at this time, leave always the selection "Relay"
Gain	GAIN	Numeric entry in %/100 Default: 1.00 - Range: 0 - 99.99
Dead Zone	DZ	Numeric entry in Engineering units Default: 0 - Range: 0 - 99999.99
Cycle time	TIME CYCLE SEC	Numeric Entry in seconds Default: 0 sec - Range: 0 - 99999 sec

6 – Swimming Pool Controller / Dual PID – (See Par. 5.2.4)
When this option is implemented, the menu offers a choice of PID2 in addition of PID1. The parameters of PID2 are identical to those of PID1, except for the option not compatible with this configuration, and namely those of items 2-Feed Forward and 4-pH/ORP (which is on PID1).

Table 9 - Controller Parameters

5.2.2.1 PID Parameters

The MicroChem2 is capable of Proportional (P), Proportional Integral (PI) and Proportional Integral Derivative (PID) control. To do so, a chip written with controller software must be inserted in an open slot on the control board. Recall that each of the three channels has the ability to accept a 4-20mA input, a micro-amp input, or a mV input. The instrument also has digital relay contact outputs CCO1 through CCO7, which have different functions depending on how the instrument is configured. Each of the three channels also has a 4-20mA output.

4-20mA/Contacts

4-20mA/Contacts is selected to determine if the instruments will function as a PID controller or as a Relay Contacts controller. As a PID controller, the instrument sends a control signal to the equipment being controlled using its 4-20mA output. Contact relays CCO1 through CCO6 are used to provide Hi and Lo alarms. 4-20 mA output is set by default. Refer to Section 5.2.2.5.

NOTE: If you wish to control a given parameter and want to forward the measured value (via a 4-20 mA output) being controlled, a 2 channel system is required. The analog input on channel 1 will be the measured value. The analog output on channel 1 will be the control signal. The analog output on channel 2 configured as mA will be the retransmitted signal from the channel 1 input. The analog input on channel 2 can be a flow signal coming from a flow meter or not used. If contact closure control output is selected, a second channel is not needed for retransmission.

As a Relay Contacts controller, the control signal is sent via digital relay control contacts outputs, CCO3 and CCO4. CCO5 and CCO6 are used for washing if selected. Hi and Lo alarms are provided by CC01 through CCO6 depending on the configuration and the number of channels. Please refer to 5.2.3.4, Table 12.

Proportional Action (PB)

Percent Proportional Band is the full scale through which the error signal (the difference between the process variable and the setpoint) must vary to cause a full scale output variation due only to proportional control mode response. In Proportional Action there is a comparative relationship

between the controller loop output signal magnitude and the calculated error, which is the difference between the process variable and the setpoint.

Proportional Band determines the size of the incremental changes the controller makes. To set PB:

- Fast response to the error — if you want a small change in the process variable to cause a large response, set PB to a small number (a high Gain). If too low of a number is selected, the control action will change rapidly and may cause overshoot of the set point.
- Slow response to error — if you want a large change in the process variable to cause a small response, set PB to a large number (a small Gain). This will cause the control signal output to change in small steps taking longer to eliminate the error. This will lessen the possibility of an overshoot but will take longer to eliminate the error.

When setting PB you are telling the controller what percentage of the difference between the set-point and the process variable you want to use as steps to eliminate the error. Each step is equal to 100% divided by the % of the PB. If for example the PB setting is 200%, you are telling the controller to make incremental changes of 100/200 or 1/2 of the error. As the error decreases, so do the incremental changes

Minimum PB value is 0% (high Gain) and maximum value is 999% (small Gain)

Integral Action (TR)
Integral Action augments proportional action to cause a PID control loop to drive its final control element until the deviation is completely eliminated. In other words, TR produces a corrective signal proportional to the error and length of time the controlled variable is different from the set-point.

As in the last example, if PB is set at 200% the incremental change the controller will make is equal to 1/2 of the error. So if you set your TR to 5 minutes, every 5 minutes the controller will compare the set-point to the process variable and regulate the pump to turn on to eliminate 1/2 of the error. As the error is reduced the incremental change the controller makes is also reduced. This is actually done continuously, not in discrete steps as inferred above. Suggested range of values are 0.02 min/repetition (fastest response) to 30 min/rep (slowest).

To determine the TR value you need to measure the elapsed time between making a change to the process and the MicroChem2 reacting to this change.

For example in the case of a Chlorine Residual Analyzer, the equipment should be installed such that the system lag time is 3 to 5 minutes between chemical injection and residual analyzer detection of a change. Once the system is operational, change the chemical feed rate and start a stopwatch. When the analyzer displays the change in the process variable, stop the watch. Add 5 to 10 seconds to the time and this will now be the TR time to enter into the MicroChem2.

NOTE: Integral action is activated when sampling is not based on flow. TATP (see Section 5.2.2.3) must be set to NO, which is the default. If TATP is set to YES, then sampling is based on flow and TR has no meaning.

Derivative Action (TD)
Derivative action augments proportional action by responding to the rate of change of the process variable. It is used to make each controller PID loop more responsive to sudden process disturbances. The derivative time in minutes is the amount of time by which the proportional action (or proportional plus integral action) is advanced. The minimum value for derivative action is 0.01 minutes for the fastest response, and the maximum value is 8 minutes for the slowest response.

Control Zone (EZ)
This parameter is used to avoid continuous control adjustments for small fluctuation from set-point. If for example set-point is set to 7 and CZ = 1, control action is not active in the range 6.5 -7.5.

Manual Reset (MR)
This parameter represents the integral action set manually. It is activated by setting TR parameter to "0".

Direct/Reverse Action (RSW)
Direct/Reverse Action is used to have the controller respond directly or oppositely to the change in your process variable. For example if you are adding sulfur dioxide to lower your residual and you are measuring your residual to control the sulfur dioxide, set the RSW to direct. If you are controlling your residual by adding chlorine, set RSW to reverse.

Span
Span is the measuring range used by controller. This value is typically set to the maximum ranger of the sensor connector to Channel 1.

Output High and Low Limits(OH and OL)
Output High and Low Limits represent the absolute high and low limits at which you want the controller to run. If for example, you are using a pump with a higher capacity than your process requires and there is the possibility that you can overdose, you will need to set the OH to prevent this from occurring. Ranges for OH and OL are both 0-100%.

5.2.2.2 Feed Forward (FF) Configuration

The instrument will activate this function only if it detects the presence of a 4-20 mA input signal connected to Channel 2.

Feed Forward is used to modify the controller's output as a function of the flow rate. If the process flow rate is variable, the software will take the flow rate signal input from channel 2 and the measured value input from channel 1 to compute the PID output. The 4-20mA input flow rate signal is generated by an external flow meter connected to Channel 2.

To use this strategy you will need to do the following: The flowmeter must be connected to channel 2 and defined as mA. mA needs to be further defined as MODE PID, which is the default under the mA Channel Definition to take the flow into consideration.

MODE PID -- When the instrument is defined as MODE PID for flow proportional control, it allows the instrument to adjust the PID control signal depending upon the flow signal and the measured value of the process. MODE PID allows access to the feed forward control parameters OHLP, FFH, FFL and ABS Max. Please refer to the Controller Software Menu Tree Appendix D and the Step by Step instructions to easily navigate through the software.

MODE TX – is used when Channel 2 is not used to retransmit the 4-20 mA output signal from Channel 1 or when feed forward action is not desired. When MODE TX is selected Channel 2 can be used to independently measure another parameter.

NOTE: MODE PID and MODE TX only appear on Channel 2 and only if the instrument is configured as a controller.

Limit Factor as a Function of Flow Rate? (OHLP is set to NO):

A. If OHLP is set to **No** then FFH, FFL, and MAX ABS are off. OHLP controls the limit functions with respect to the flow signal. To mask the flow signal the Gain would also need to be set to 0.

Limit Factor as a Function of Flowrate? (OHLP)

B. If OHLP is set to **Yes** – The MicroChem2 calculates output limits as a function of the instantaneous flow rate. If Feed Forward control is implemented through the automatic detection of the 4-20mA input signal on Channel 2 configured as PID, the standard High(OH) and low(OL) limits on the controllers output are automatically disabled to allow for flow proportional control.

See 5.2.2.1 PID Parameters – Output High and Low Limits. Maximum and Minimum Output Limits as a function of flow rate must be determined to prevent over dosing or under dosing the process.

Maximum Output Limit as a Function of Flow Rate (FFH) – The Maximum output limit is calculated by multiplying the FFH by the Flow Rate. FFH is determined based on plant experience. If for example you have an oversized pump you would consider the overdosing possibility.

Minimum Output Limit as a Function of Flow Rate (FFL) – The Minimum Output Limit is calculated by multiplying the Flow Rate by the Feed Forward Low Factor.

Flow Rate is 20% FFH is 1.5 Output limit is 20% x 1.5 = 30%	Flow Rate is 20% FFL is 0.5 Output limit is 20% x 0.5 = 10%

Absolute High Limit on Output when limit based on flow rate is active (ABSOLUTE MAX) – The Max ABS parameter sets the absolute maximum limit on the output when the limits are based on flow. When OHLP is set to Yes, then OH and OL are not engaged and MAX ABS is used instead.

Gain – When using the Feed Forward control strategy, Gain is the factor applied to the flow rate signal contribution to control the coarse dosing and limit the flow action of the PID. In other words, Gain is the ratio of how much to open the valve or turn on the feed pump with respect to the process flow signal.

Example assuming no limits of FFH AND FFL

@100% Gain FF min in 0% at 4.00mA FF max is 100% at 20mA	@ 50% Gain FF min in 0% at 4.00mA FF max is 50% at 20mA

NOTE: If a 4-20mA input is connected to Channel 2, and FF control is not desired, set OHLP to NO, set GAIN to 0, and the PID output will be based on the residual value only.

5.2.2.3 Time Sampling and/or Flow Pacing Controller

The Time Sampling and/or the Flow Pacing menu is made available automatically when the MicroChem®2 detects that a Chlorine input channel has been selected. When a process has dead time, which is often the case for Chlorine dosage, it can best be controlled with this strategy using either Time Sampling or Volume Pacing. Time Sampling or Flow/Volume Pacing control updates the PID function on a periodic basis for a specific length of time or amount of flow.

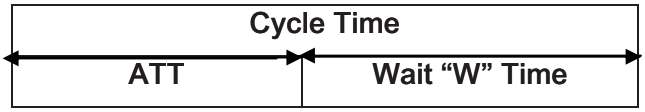
Time Sampling (TATP) is enabled by setting the TATP parameter to NO. TATP is an Italian acronym. The TATP parameter asks the question, is sampling based on flow?

When TATP is set to NO, the PID control output is updated based on Time, the Active (Att) and Cycle parameters.

Scaling Factor for Flow (K) Although the K parameter is available in the menu, it has no effect on Time Sampling and should be set to 0.

Active Time (Att) – Active time is defined as the amount of time that the PID is engaged and applied to the control output. Active Time – is a sample and hold control strategy used in a batch system i.e. in a contact tank, with a given volume of water. Set Active Time in whole minutes. The analyzer will not accept fractions of a minute.

Cycle Time (Cycle) Cycle Time sampling is defined as the total amount of Active time plus wait time. A "W" will appear on the bottom right corner of the display to indicate that the system is in wait mode. During the wait time the microprocessor does not update the residual portion of the PID output. For continuous PID control, set the Active time larger than the Cycle time. Set Cycle Time in whole minutes. The analyzer will not accept fractions of a minute.



Flow or Volume Pacing is enabled by setting the TATP parameter to YES. When TATP is set to YES, the PID control output is updated based on flow volume. To use Volume Pacing:

1. Channel 1 is configured for the specific parameter being measured and controlled. The 4-20mA output on channel 1 is used to provide the PID control signal.
2. The analog input for Channel 2 must be configured to 4-20mA, which further asks to configure channel 2 to Mode PID or Mode TX. Select Mode PID.

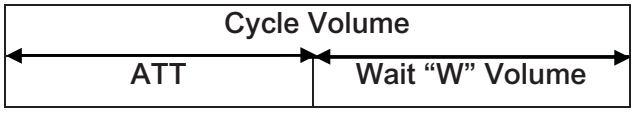
Scaling Factor for Flow (K) – The scaling factor (K) for flow is used by the MicroChem® 2 software to calculate the flow.

- set K factor to the flowmeter's full-scale value expressed in cubic meters (m3/h).
- K factor can be set between 0 and 17000 m3/h.

1 m^3/h=	6340.129 gallon/day
	219.9692 gallon/hr
	3.666153 gallon/minute

Active Time (ATT) – The ATT Parameter is defined as the Period (in m^3) that the PID is updated during the cycle and applied to the control output signal.

Cycle (for Flow) – is defined as the total volume of process flow expressed in cubic meters (m^3) for a complete cycle. A "W" will appear at the bottom right corner of the display to indicate the system is in the wait mode. During the wait time the microprocessor does not update the residual portion of the PID output.



5.2.2.4 Error Squared Controller (pH and ORP Applications)

When the instrument detects that pH or ORP sensor has been selected for the controller, it enables a special PID algorithm with an “Error Squared” function. The error squared function is applied only within a band defined in the “BAND” parameter of the controller’s configuration menu. When the error is outside this band, the effective error is a linear response (see Figure 16).

If “BAND” parameter is set to “0”, then the controller operates like a standard PID controller.

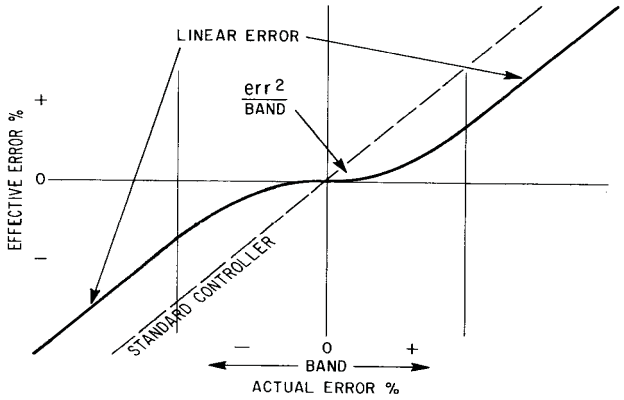


Figure 16 - Error versus control band

5.2.2.5 Contacts Output Controller

Contact output control is particularly suitable when using a dosing pump controlled by contacts (rather than 4-20mA analog signal) or for operation with an electrically motorized control valve.

NOTE: When the contact closure routines are being used the cycle time (Section 5, Table 9 - Control Parameters, number 6 - Contact output controller must be set (i.e. not left at 0).

Gain - For controllers operating in the contacts mode, the PID algorithm is NOT active and the output is calculated using the Gain parameter (similar in function to the proportional term in PID).

NOTE: The main screen still shows the calculated PID output even though it is not used in contact closure mode - ignore this.

The algorithm works by looking at how far away from the setpoint the measurement is and then switching the dosing pump on for a period of time (switched on for longer when the setpoint is a long way away).

1) A small percentage of deviation of the process variable will cause a full scale output if the gain is set to a low number, increasing the possibility of an overshoot.
2) A large percentage of deviation of the process variable will cause a small scale output if the gain is set to a high number decreasing the possibility of an overshoot. This will require the pump to operate more frequently in smaller steps as the instrument attempts to bring the measured value to the set point value.

Dead Zone (DZ) - Dead Zone parameter represents the range around the setpoint where control action has no effect. Similar to Deadband, this function is used when the process variable is near the setpoint when using the Contacts Output Controller. So, when the difference between the process variable and setpoint is lower than this value the contacts are kept open.

Time Cycle - When using contact closures for control, the amount of time the contact closure is closed is the amount of time the pump is on or the valve is open.

% output duty cycle (% time pump is on) = % deviation from setpoint x gain

e.g.: If the setpoint is 3 mg/l and the signal measured is 2 mg/l then the % deviation from the setpoint = (3-2)/3 = 1/3 = 33%

If the time cycle is set to 20 seconds and the gain =1, then in the 20 second period the contact closure will be on for 33% of 20 seconds (6.7 seconds).

If after this 20 seconds period the measurement is now 2.5 mg/l the new % deviation from the setpoint = (3-2.5)/3 = 17%. The contact closure will now be on for 17% of 20 seconds, i.e. 3.5 seconds.

By changing the gain to say 2, then the contact will be on for longer; 3.5 x 2 = 7 seconds, getting to the set point faster but possibly overshooting slightly.

The contacts used by the controller to drive the final element are assigned as per the following table:

PID 1		PID 2 (only for Swimming Pool Controller	
CCO 3	CCO 4	CCO 5	CCO6
Decrease	Increase	Decrease	Increase

Table 10 – Contacts Output Controller Assignment

5.2.3 Standard Controller

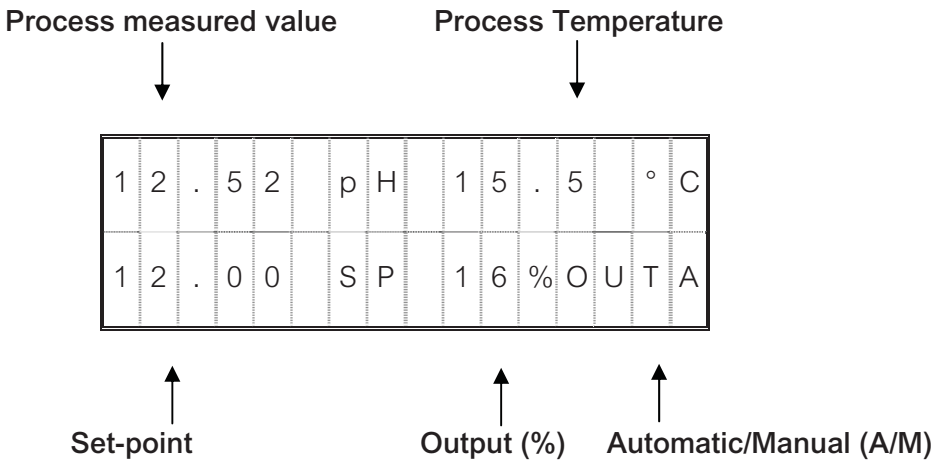
This section deals with the functionality which is specific of the standard controller.

5.2.3.1 Standard Controller Display

The standard controller display shows the following values:

- instantaneous value of process variable measure
- process variable temperature (not present for ORP or CL4000 sensor)
- set-point
- output signal value
- Controller status: A/M (A = Automatic, M = Manual).

Fields of display are configured as in the following draft:



If the instrument is configured to perform additional functions beside operating as a controller, for example to monitor another parameter with a second or third sensor installed on channel 2 or 3, the indication of these values can be called on display by pressing the key END, which will cycle through the different display available, and eventually back to the controller display.

5.2.3.2 Standard Controller Analog Output assignment

The assignment of the analog output signals depends on the number of channels installed and on the type of configuration selected for the controller output, whether it is to operate on a 4-20 analog signal or on contacts closure, as per the following table:

Type of Controller	Output option	4-20 mA Channel 1	4-20 mA Channel 2	4-20 mA Channel 3
Controller with 1 Channel installed	Analog output	PID Control output	---	---
	Contacts output	Measured value retransmission of Channel 1 analysis		
Controller with 2 Channels installed	Analog output	PID Control output	Measured value retransmission of Channel 1 analysis (1)	---
	Contacts output	Measured value retransmission of Channel 1 analysis	Measured value retransmission of Channel 2 analysis (1)	
Controller with 3 Channels installed	Analog output	PID Control output	Measured value retransmission of Channel 1 analysis (1)	Measured value retransmission of Channel 3 analysis
	Contacts output	Measured value retransmission of Channel 1 analysis	Measured value retransmission of Channel 2 analysis (1)	

(1) If the two sensors/channels are identical, and the PID option is selected on Channel 2, the output becomes the average of the two measured values

Table 11 - Std Controller Analog Outputs

5.2.3.3 Standard Controller Digital Input assignment

The Digital Input functionality is identical for all type of instrument selected, as per following table:

CCI in 'OR' SELECTION	CCI1	CCI2
CCI in 'OR' = ***NO***	Freezes measured value of Channel 1	Freezes measured value of Channel 2 (Channel 3 alone cannot be frozen)
CCI in 'OR' = ***YES***	Freezes measured value of all Channels installed	Forces to 0 PID1 output signal
CCI in 'OR' = ***OFF***	CCI1 inactivated	CCI2 inactivated

Table 12 - Digital Input Functionality for Controller

5.2.3.4 Standard Controller Digital Output assignment

The assignment of the digital output signals depends on the number of channels installed, on the type of configuration selected, for the controller output, whether it is to operate on a 4-20 analog signal or on contacts closure, and on the cleaning option configuration, as per the following table:

Controller Type	CCO1	CCO2	CCO3	CCO4	CCO5	CCO6	CCO7
Controller without Cleaning Analog output PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	HI Alarm Ch. 2 (2)	LO Alarm Ch. 2 (2)	HI Alarm Ch. 3 *(if Ch. 3 installed)*	LO Alarm Ch. 3 *(if Ch. 3 installed)*	Watch dog
Controller without Cleaning Contacts out PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	PID control output (*decrease*)	PID control output (*increase*)	HI Alarm Ch. 3 *(if Ch. 3 installed)*	LO Alarm Ch. 3 *(if Ch. 3 installed)*	Watch dog
Controller with Cleaning Analog output PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	HI Alarm Ch. 2 (2)	LO Alarm Ch. 2 (2)	Washing command *(See Par. 4.4.1.3)*	Washing command *(See Par. 4.4.1.3)*	Watch dog
Controller with Cleaning Contacts out PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	PID control output (*decrease*)	PID control output (*increase*)	Washing command *(See Par. 4.4.1.3)*	Washing command *(See Par. 4.4.1.3)*	Watch dog

(1) If two/three identical sensors/channels are installed, and PID option is selected on Channel 2/3, the alarm is based on the average of the two/three measured values
(2) If two/three identical sensors/channels are installed, and PID option is selected on Channel 2/3, the alarm is triggered by the first of the two/three measured values that reaches the alarm level configured (first-out functionality).

Table 13 - Std. Controller Digital Output assignments

5.2.4 Swimming Pool Controller

The Controller for swimming pool is a flexible instrument dedicated to the control of the principal parameters in the swimming pool: pH, ORP and Residual Chlorine. It is available in two different versions: two channels (pH + chlorine and pH + ORP) and three channels (pH, chlorine and ORP).

If the instrument has two channels, the dual controllers operate on the two channels installed. If the instrument has three channels, the control is operated on pH (channel 1) and on measure installed on channel 3 (see Section 2.5, for the position of channel 3). If ordered as a three channel instrument, Channel 2 will be available to measure the parameter not controlled via PID on Channel 1 and 3.

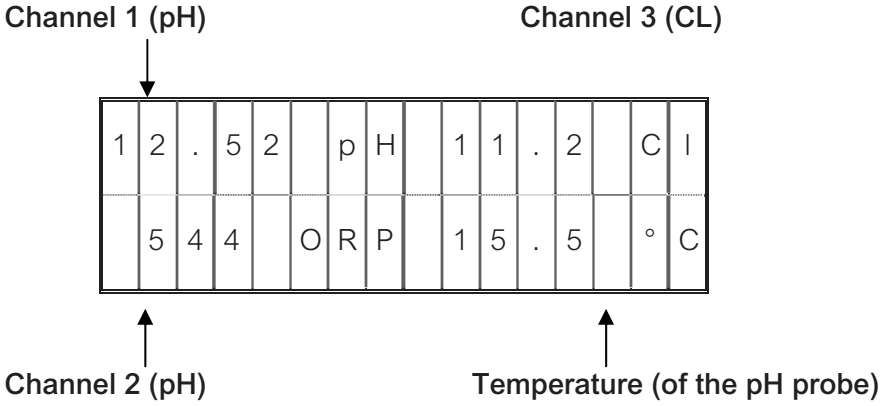
With this option, the Controller menu offers two submenus. PID 1 is associated with the configuration of pH control on channel 1, PID 2 with the configuration of either chlorine or ORP.

5.2.4.1 Swimming Pool Controller Display

MicroChem2 supports three different displays. The main one is meant to monitor the process and it shows the controlled variables measured, pH and ORP/chlorine. The secondary displays let the user modify set-point and output (in Manual mode) of pH and ORP/chlorine. To toggle from one display to the other, press the END key.

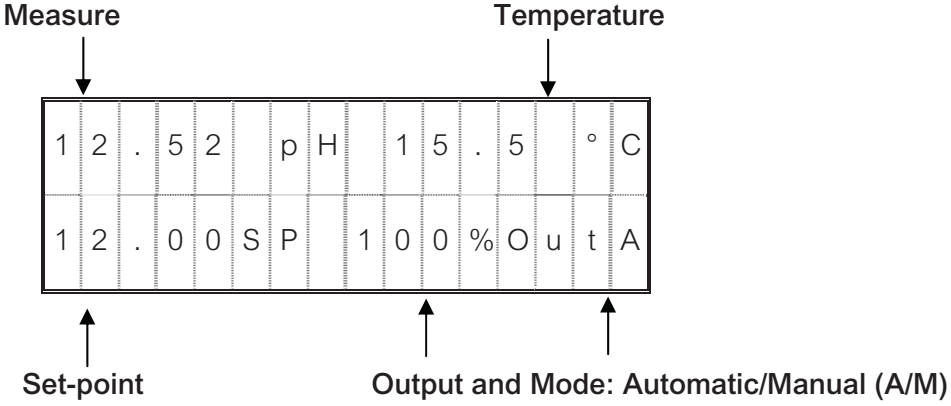
Main display (fields of display are assigned as in the following draft):

- measures of pH/ORP/chlorine
- temperature of the pH sensor



Secondary displays:

- measure of a single sensor (pH/ORP/chlorine)
- sample temperature
- set-point
- Output (%)
- Mode: A/M (A = Automatic, M = Manual).



5.2.4.2 Swimming Pool Controller Analog Output assignment

The assignment of the analog output signals depends on the number of channels installed and on the type of configuration selected for the controller output, whether it is to operate on a 4-20 analog signal or on contacts closure, as per the following table:

Type of Controller	Output option	4-20 mA Channel 1	4-20 mA Channel 2	4-20 mA Channel 3
Controller with 2 Channels installed	Analog output	PID1 Control output	PID2 Control output	---
	Contacts output	Measured value retransmission of Channel 1 analysis (pH)	Measured value retransmission of Channel 2 analysis	
Controller with 3 Channels installed	Analog output	PID1 Control output	Measured value retransmission of Channel 2 analysis	PID2 Control output
	Contacts output	Measured value retransmission of Channel 1 analysis (pH)		Measured value retransmission of Channel 3 analysis

Table 14 - Swimming Pool Controller Analog Outputs

If the 4-20 mA output is used to providing a PID control signal, the 4-20mA output is not available for transmission of the actual measurement value. However, if the control is done by activating the CC03, 04, 05, 06 contact closure (see 5.2.2.5) then the 4-20mA output is available and can transmit the measurement signal

5.2.4.3 Swimming Pool Controller Digital Input Assignment

The Digital Input functionality is identical for all type of instrument selected, as per following table:

CCI in 'OR' SELECTION	CCI1	CCI2
CCI in 'OR' = ***NO***	Freezes measured value of Channel 1[1]	Freezes measured value of Channel 2 [1] (Channel 3 alone cannot be frozen)
CCI in 'OR' = ***YES***	Freezes measured value of all Channels installed[1]	Forces to 0 PID1 & PID 2 output signals[2]
CCI in 'OR' = ***OFF***	CCI1 disabled	CCI2 disabled

Table 15 - Digital Input Functionality for Swimming pool Controller

NOTES:

1 Freezing the channels is typically used when performing maintenance.

2 As a safety precaution, as a swimming pool controller, the measurement is still made and displayed on the swimming pool controller

5.2.4.4 Swimming Pool Controller Digital Output assignment

The assignment of the digital output signals depends on the number of channels installed, on the type of configuration selected for the controller output, and whether it is to operate on a 4-20 mA analog signal or on contacts closure, as per the following table:

Controller Type	CCO1	CCO2	CCO3	CCO4	CCO5	CCO6	CCO7
Controller with 2 Sensors Analog out PID1& 2	HI Alarm Ch. 1	LO Alarm Ch. 1	HI Alarm Ch. 2	LO Alarm Ch. 2	----	----	Watch dog
Controller with 2 Sensors Contact out PID1or 2	HI Alarm First-out Ch. 1/2	LO Alarm First-out Ch. 1/2	PID1 control out (*decrease*)	PID1 control out (*increase*)	PID2 control out (*decrease*)	PID2 control out (*increase*)	Watch dog
Controller with 3 Sensors Analog out PID1& 2	HI Alarm Ch. 1	LO Alarm Ch. 1	HI Alarm Ch. 2	LO Alarm Ch. 2	HI Alarm Ch. 3	LO Alarm Ch. 3	Watch dog
Controller with 3 Sensors Contact out PID1or 2	HI Alarm First-out Ch. 1/2/3	LO Alarm First-out Ch. 1/2/3	PID1 control out (*decrease*)	PID1 control out (*increase*)	PID2 control out (*decrease*)	PID2 control out (*increase*)	Watch dog

Table 16 - Swimming Pool Controller Digital Output assignments

5.2.5 Average Controller

The average controller is dedicated to processes that need high reliability of the analysis values. MicroChem®2 supports two or three identical sensors and the calculated average value is used in the PID algorithm as process variable. In function of the difference between the average value (Process Variable, PV), and a Set-point (SP) value, an Output (OUT) signal is calculated, that is applied to a final control element to restore process analysis to the set-point value. The output is calculated with the PID algorithm, which has Proportional, Integral and Derivative terms. The effect these terms have on the output calculation is determined by the PID configuration selections.

The average value control strategy is activated by selecting “YES” in the *“Average”* parameter appearing in the Channel definition menu when two or three identical channels are configured.

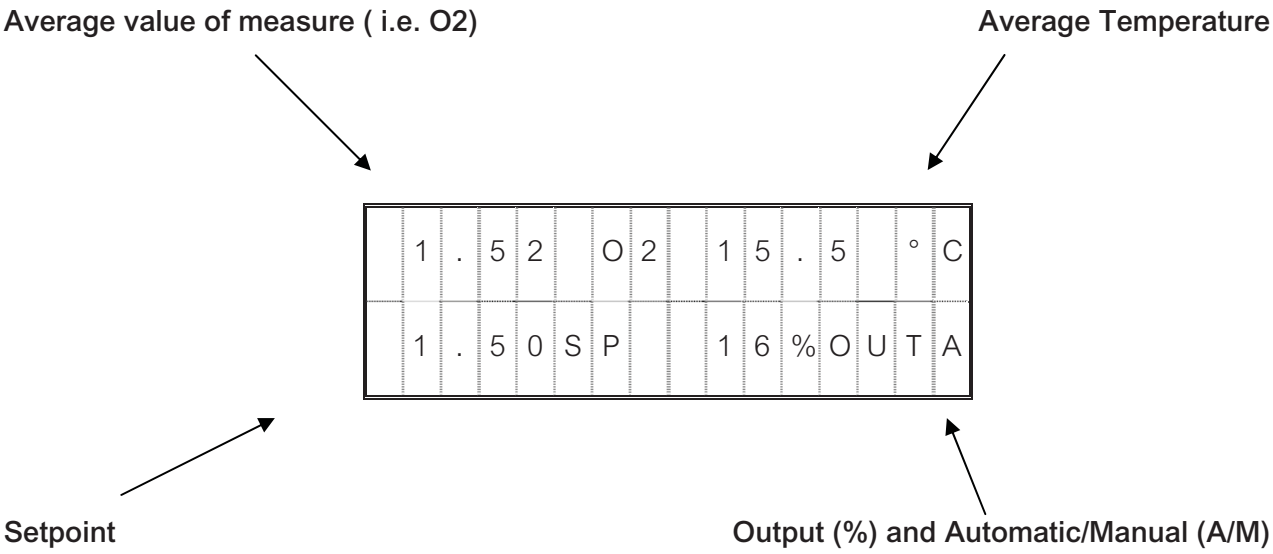
5.2.5.1 Average Controller Display

MicroChem2 supports two different displays. The main one shows the values used in the PID algorithm: the average measured value, the average value of the temperature, the set-point and the output. The three secondary displays show the measure and the temperature of each of the three probes. To toggle from a display to another, press the END key.

Main display:

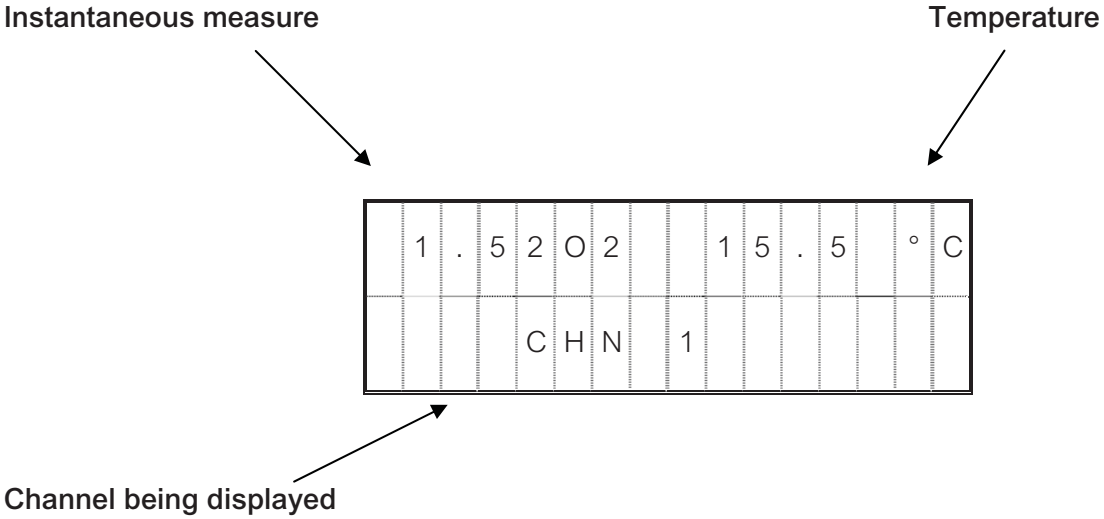
- average measured value, used in the PID algorithm
- average value of temperature
- set-point
- output (%)
- A/M (A = Automatic, M = Manual).

Display fields are illustrated below:



Secondary display:

- measure of each single probe
- temperature
- channel number on display



5.2.5.2 Average Controller Digital Input assignment

The Digital Input functionality is identical for all type of instrument selected, as per following table:

CCI in 'OR' SELECTION	CCI1	CCI2
CCI in 'OR' = ***NO***	Freezes measured value of Channel 1	Freezes measured value of Channel 2 (Channel 3 alone cannot be frozen)
CCI in 'OR' = ***YES***	Freezes measured value of all Channels installed	Freezes measured value of all Channels installed
CCI in 'OR' = ***OFF***	CCI1 disabled	CCI2 disabled

Table 17 - Average Controller Digital Inputs assignment

5.2.5.3 Average Controller Analog Output assignment

The assignment of the analog output signals depends on the number of channels installed and on the type of configuration selected for the controller output, whether it is to operate on a 4-20 analog signal or on contacts closure, as per the following:

Type of Controller	Output option	4-20 mA Channel 1	4-20 mA Channel 2	4-20 mA Channel 3
Controller with 2 Channels installed	Analog output	PID Control output	Measured value retransmission of Channel 1 analysis (1)	---
	Contacts output	Measured value retransmission of Channel 1 analysis	Measured value retransmission of Channel 2 analysis (1)	
Controller with 3 Channels installed	Analog output	PID Control output	Measured value retransmission of Channel 1 analysis (1)	Measured value retransmission of Channel 3 analysis
	Contacts output	Measured value retransmission of Channel 1 analysis	Measured value retransmission of Channel 2 analysis (1)	

(1) If the PID option is selected on Channel 2, the output becomes the average of the two measured values

Table 18 - Average Controller Analog Output assignments

5.2.5.4 Average Controller Digital Output assignment

The assignment of the digital output signals depends on the number of channels installed, on the type of configuration selected, for the controller output, whether it is to operate on a 4-20 analog signal or on contacts closure, and on the cleaning option configuration, as per the following table:

Controller Type	CCO1	CCO2	CCO3	CCO4	CCO5	CCO6	CCO7
Controller without Cleaning Analog output PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	HI Alarm Ch. 2 (2)	LO Alarm Ch. 2 (2)	HI Alarm Ch. 3 *(if Ch. 3 installed)*	LO Alarm Ch. 3 *(if Ch. 3 installed)*	Watch dog
Controller without Cleaning Contacts out PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	PID control output (*decrease*)	PID control output (*increase*)	HI Alarm Ch. 3 *(if Ch. 3 installed)*	LO Alarm Ch. 3 *(if Ch. 3 installed)*	Watch dog
Controller with Cleaning Analog output PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	HI Alarm Ch. 2 (2)	LO Alarm Ch. 2 (2)	Washing command *(See Par. 4.4.1.3)*	Washing command *(See Par. 4.4.1.3)*	Watch dog
Controller with Cleaning Contacts out PID	HI Alarm Ch. 1 (1)	LO Alarm Ch. 1 (1)	PID control output (*decrease*)	PID control output (*increase*)	Washing command *(See Par. 4.4.1.3)*	Washing command *(See Par. 4.4.1.3)*	Watch dog

(1) If two/three identical sensors/channels are installed, and PID option is selected on Channel 2/3, the alarm is based on the average of the two/three measured values.
(2) If two/three identical sensors/channels are installed, and PID option is selected on Channel 2/3, the alarm is triggered by the first of the two/three measured values that reaches the alarm level configured (first-out functionality).

Table 19 - Average Controller Digital Output assignments

6 CALIBRATION

Calibration is required to align the sensor sensitivity. This operation is necessary at the start-up of the instrument and at periodical intervals. New sensors have to be let in operation for at least 24 hours, to allow the electrode to recover complete sensitivity, before performing the calibration procedure.

WARNING

The calibration procedure must be accomplished having the sensor and the MicroChem®2 connected and powered.

6.1 Calibration Procedure

When the instrument is powered up or when a channel is changed, the following message is displayed:

-calib-

To access the calibration procedure press the button MENU and insert the password, as shown in the diagram at Paragraph 6.1.2.
If problems are encountered during the calibration procedure, pressing the END key the calibration procedure is aborted and the display returns to the main menu.

WARNING

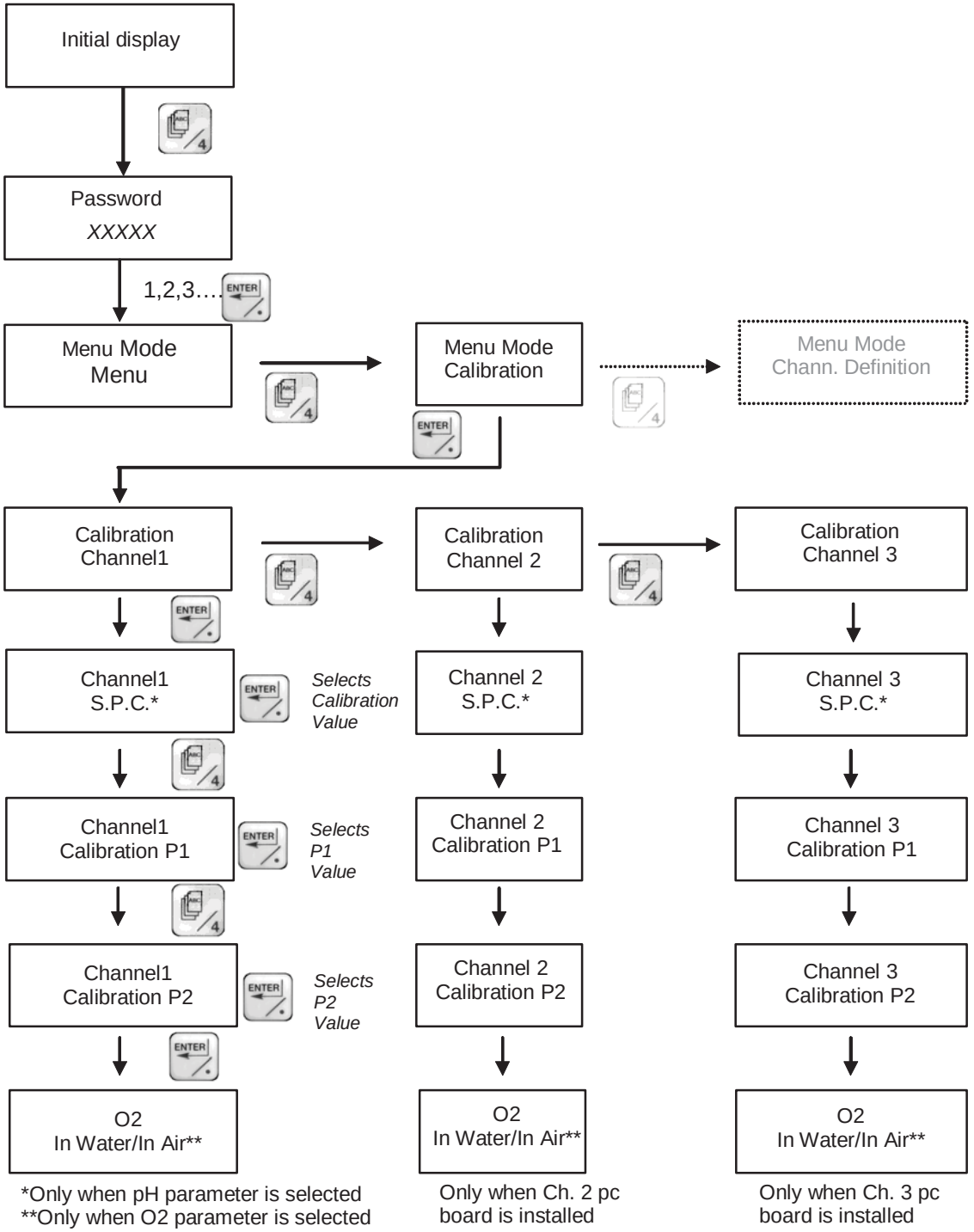
If the calibration procedure is aborted, the read out of value may become unreliable.

6.1.1 Calibration Menu

Calibration menu allows a dual point calibration procedure for the analyzers. In every dual point calibration, the first number (P1) is the lower value point, and the second (P2) is the higher value point. The instrument has P1 and P2 values assigned by default, as shown in the table 18. P1 and P2 values can be changed by the user and have to be distant enough. Single point calibration (S.P.C.) is available for pH analyzer. For O2 analyzer two calibration procedures are available: calibration in air and calibration in water.

Parameter	P1 point value	P2 point value
pH	7.00	4.00
mV	-500	+500
O2	0.00	10.00 (in water)
O3	0.00	1.00
Cl	0.00	1.00
CD	0.00	1.00
T	0.00	100.00
mA	4.00	20.00
Br	0.00	1.00

Table 20 - Default calibration values



6.1.2 pH Sensor Calibration

The calibration procedure is necessary to standardise the sensor sensitivity.
The double point calibration gives the maximum accuracy because it allows to set both the slope and the offset of the curve giving displayed pH value as a function of the mV from the probe (sensitivity), pH = f (mV).

The first point can be calibrated by 7 pH buffer solution and the second point can be calibrated by 4 pH buffer solution. Capsules for buffer solution's preparation can be optionally supplied by STWP; however the operator can use other commercially available buffer solutions.

6.1.2.1 Double point calibration

The calibration procedure involves a series of operation on the pH probe and the transmitter. The following description indicates step by step the calibration procedure, with the buffer solution supplied by STWP.

To operate the calibration the following material is required:
- two plastic or glass beakers
- capsules for buffer solution pH 7 and pH 4
- de-mineralised water

BUFFER SOLUTIONS PREPARATION

Severn Trent Services optionally supplies a calibration kit (P/N 1T141B008U02)

50 capsules of standard buffer solution pH7
50 capsules of standard buffer solution pH4
50 capsules of standard buffer solution pH9

Each of these capsules is suitable to prepare 100 ml of solution.

If the sensor is new and has been dry stored, leave it immersed in water for 24 hours to allow the hydration of the glass sensitive membrane and of the porous diaphragm. If it has been wet stored half an hour is enough for the stabilization.

Prepare the buffer solution in volumetric flasks: for the preparation of each buffer solution put one capsule into the flask. Add about 100 ml of distilled water in the flask and stir carefully till the capsule is completely dissolved. Put the two standard buffer solutions (pH 7 and pH 4) in two beakers in a sufficient amount to cover the sensor. Wash the probe with de-mineralised water, dry it and dip it in the standard pH 7 buffer solution. Stir the probe gently in the solution to decrease the stabilization time.

1. Press the MENU key to enter the Instrument Calibration submenu and enter the CALIBRATION menu and then the channel of the pH probe. The display will show:

X	X	.	X	X		p	H			2	3	.	5	°	C
P	1	:							Y	Y	.	Y			

   P1 indicates the first point of calibration at HIGHER pH (pH 7). XX.XX is not a REAL pH value, but it shows when stability of measure has been reached. YY.Y is a value set at the last calibration and can be freely modified according to the chosen buffer solution.

2. Press ENTER and insert the correct value. Wait 3 minutes after the measure in XX.XX has stabilised (XX.XX is stable).
3. Press ENTER to save the value (press END if you don't want to save the value).

   If the following message appears: **-Bad Input!-**

   It means the buffer solution is bad since the mV generated are too close.
4. Pass on to the second point (P2) of calibration pressing the MENU key. Take the sensor out of the pH 7 standard buffer solution, rinse it thoroughly with de-mineralised water, dry it and immerse it in the pH 4 buffer solution. Stir the probe gently in the solution to decrease the stabilization time.
5. Wait till the value in XX.XX is stabilized (XX.XX is stable) and correct the pH value in YY.Y.
6. Confirm by pressing the ENTER key. Previously stored values are overwritten in non volatile memory.
7. To start the measure press the END key and the display will show the actual measured value.

6.1.2.2 Single point calibration (S.P.C.)

The single point calibration may be performed ONLY IF A DOUBLE POINT CALIBRATION HAS ALREADY BEEN PERFORMED. The single point calibration is a fast procedure to correct the sensitivity of an instrument leaving it working in field; however it's less accurate than the double point calibration and must be performed as near as possible to the pH value of the process liquid. The single point calibration corrects the intercept of the pH = f(mV) curve, but doesn't vary its slope.

To perform the single point calibration:

1. Measure the pH value of the process fluid near the location of the sensor (if it is constant during the time interval needed for the calibration).
2. Insert the pH value in YY.YY. Entering the Calibration menu the following display will appear:

X	X	.	X	X		p	H			2	3	.	5	°	C
p	H		S	P	C	:		Y	Y	.	Y	Y			

When a double point calibration is performed the S.P. C. value is forced to 0.00.

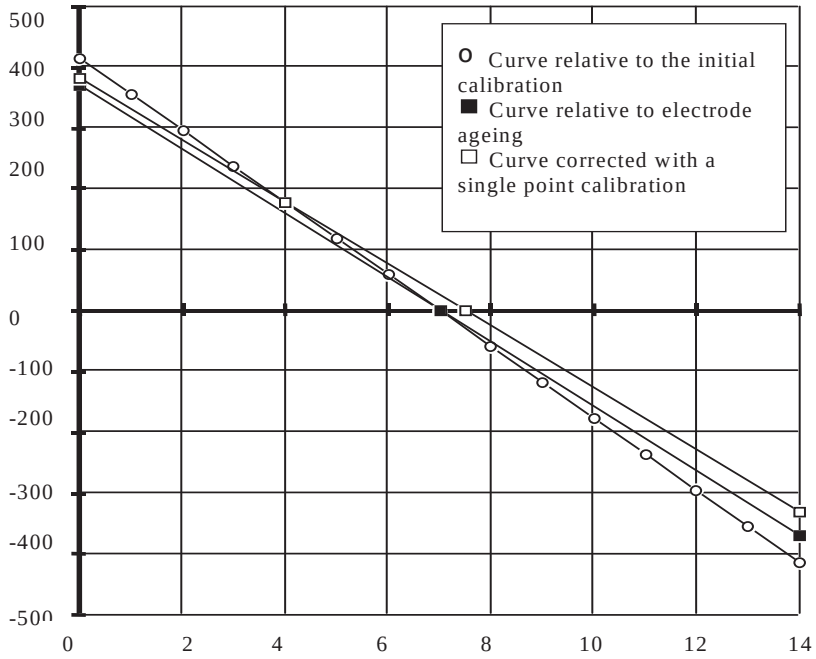


Figure 17 - pH Calibration curves examples

NOTE: Single point calibration corrects the sensitivity in the zone where the correction is made. It is therefore necessary to operate single point calibration as near as possible to the process fluid pH value.

IMPORTANT: THESE CURVES ARE ONLY A THEORETICAL REPRESENTATION, NOT BASED ON EXPERIMENTAL VALUES.

6.1.3 ORP Sensor Calibration

The calibration procedure is necessary to standardize the sensor sensitivity. The double point calibration gives the maximum accuracy because it allows to set both the slope and the offset of the curve giving displayed ORP value as a function of the mV from the probe (sensitivity).

STWP does not supply ORP buffer solution, they are however easily available on the market.
The calibration of ORP analyzer is not usually required, however the two point calibration procedure is foreseen in the transmitter software.

NOTE: Calibration procedures are different if the arrangement "oxidation potential with negative value" or "oxidation potential with positive value" is used. Both are described in the following pages.

The calibration procedures involve both the electronic transmitter and the sensor. The following description indicates step by step the double point calibration procedure:
To operate the calibration the following material is necessary:

- two plastic or glass beakers
- standard ORP solutions

Put the two standard ORP solutions in two beakers in a sufficient amount to cover the sensor. Wash the probe with de-mineralised water, dry it and dip it in the first buffer solution. Stir the probe gently in the solution to decrease the stabilization time.

6.1.3.1 "OXIDATION potential with NEGATIVE values" arrangement

P1 will be the value of the oxidant standard solution, and P2 the value of the reducing standard solution. In case both the standard solution have the same sign, P1 will be the standard solution with the lower value.

Press the MENU key to enter the Instrument Calibration submenu and enter the CALIBRATION menu and then the channel of the ORP probe. The following display will appear:

X	X	.	X	X		R	X			2	3	.	5	°	C
P	1	:							Y	Y	.	Y			

P1 indicates the first point of calibration. XX.XX is not a REAL value, but it shows when stability of measure has been reached. YY.Y is a value set at the last calibration and can be freely modified according to the chosen buffer solution. Press ENTER and insert the correct value. Wait about 3 minutes after the measure in XX.XX has stabilised (XX.XX is stable), then press ENTER to save the value (press END if you don't want to save the value).

Pass on to the second point (P2, higher value) of calibration pressing the button MENU. Take the sensor out of the first standard solution rinse it thoroughly with de-mineralised water, dry it and immerse it in the second standard solution. Stir softly but continuously the probe: in this way a shorter stabilization time would be required.

Wait till the measure is stabilized (no more variations of XX.XX shown on the display). If needed, correct the ORP value pressing the ENTER key and inserting the correct value, according to the second buffer solution ORP value. If you want to save these values push the ENTER key. If you don't want to save above mentioned calibration parameters press END. If the ENTER key is pressed new calibration data are overwritten to previously stored values in not volatile memory.

To start the measure press the END key and the display will show the measured value.

NOTE: The calibration procedure can be performed also at two values which are outside from the measuring range selected, depending on the buffer solutions which are available for the calibration.

6.1.3.2 "OXIDATION potential with POSITIVE values" arrangement

Calibration is similar to the previous one but P1 is the value of the reducing standard solution, and P2 the value of the oxidant standard solution. In case both the standard solution have the same sign, P1 will be the standard solution with the lower value.

6.1.4 Chlorine/ Chlorine Dioxide/ Ozone/ Bromine - KC4000 Cell or CL4000 Probes

The calibration procedure is necessary to stabilize the sensor sensitivity. The calibration procedure sets both the slope and the offset of the curve giving the chlorine/chlorine dioxide/ozone/bromine concentration as a function of the µA from the cell/probe (sensitivity).

Severn Trent Services analyzers allow an easy two point calibration and the two points can be freely chosen, provided they are distant enough and inside the selected measuring range. In this way the instrument is given all the parameters it needs to fix the calibration curve. The calibration procedures involve both the transmitter and the sensor.

If the cell is new or recently cleaned, leave it working for 24 hours so that the electrodes can gain the correct sensitivity.

The following description indicates step by step the calibration procedure:

1. **P1 — Low Calibration:** Enter the Instrument Calibration submenu and using the menu key, change the channel for calibration and press ENTER until the following display appears (Refer to Section 6.1.1):

X	X	.	X	X	X	C	L[1]			2	3	.	5	°	C[2]
P	1	:							Y	Y	.	Y			

NOTES:
1 = The name of the sensor chosen in the channel definition will appear where Cl is displayed.
2 = The temperature will appear if a temperature sensor is installed

P1 indicates the first point in calibration (the lower point). XX.XXX is the measured parameter concentration reading. This reading is based upon calibration parameters previously stored. XX.XXX serves as an indication of the stability of the measure. 0.000 is a default ppm value recommended but can be freely changed. YY. Y is a value set at the last calibration and can be freely modified.

NOTE: P1 calibration is only necessary for the initial calibration to set the zero point. When performing a recalibration it is only necessary to RESET the P2.

2. To zero the instrument, supply sample water from a point prior to adding the disinfection agent. In the case of chlorine measurement a dechlorinating filter can be inserted in the sample line to remove chlorine during the calibration procedure. Turn on the supply of zero process water to the measuring cell. Let the system stabilize until XX.XXX is stable (15-20 minutes can be required).
3. Take a water sample and perform an analysis to determine residual concentration.
4. Press enter and input YY.Y value according to the measured sample value (Typically 0.00)
5. Confirm entered data with ABC key

6. **P2 — High Calibration:** Press the ABC button to pass on the second point (P2) calibration:

X	X	.	X	X	X	C	L[1]			2	3	.	5	°	C[2]
P	2	:							Y	Y	.	Y			

NOTES:

1. The name of the sensor chosen in the channel definition will appear where CL is displayed.
2. The temperature will appear if a temperature sensor is installed.

P2 – High Calibration – P2 indicates the second point in the calibration (the higher point)
XX.XXX is the measured parameter concentration reading. This reading is based upon calibration parameters previously stored. XX.XXX serves as an indication of the stability of the measure. YY.Y is a value set at the last calibration and can be freely modified.

7. Allow a sample flow to the cell (with a concentration as near as possible to the chosen full scale) and let it stabilize (stabilization time depends on the plant configuration, 10 – 15 minutes may be required).

8. Take a water sample and perform an analysis to determine residual concentration.

9. Press ENTER and insert the correct high calibration point value (according to the value on step 8).

10. Press ENTER again to confirm. Press END key to return to measure mode.

WARNING

It is advisable to repeat the calibration after 24 hours and after 2/3 days.

6.1.5 Dissolved oxygen calibration

The calibration procedure is necessary to standardize the sensor sensitivity. The calibration procedure allows to set both the slope and the offset of the curve giving the dissolved oxygen concentration as a function of the µA from the cell (sensitivity). This analyzer allows an easy two point calibration and the two points can be freely chosen; usually the calibration is performed at 0 ppm O2 and either at the saturation point of water in the conditions (altitude, temperature) of the process or at the sample dissolved oxygen concentration measured with a O2 meter. In this way the instrument has all the parameters to fix the calibration curve.

The calibration procedures involve both the transmitter and the sensor. The following description indicates step by step the calibration procedure:

Prepare the sensor as described in Instruction Bulletin T17DO4000, then leave it working for approx. 2 hours so that the system can gain the correct sensitivity.

WARNING

When the sensor is disconnected from the transmitter and then reconnected, it polarises and generates a signal that is much higher than normal signal. The transmitter may in this case indicate a fixed value higher than the f.s. value. The reading becomes normal when the input signal returns to normal limits.

WARNING

It is advisable to repeat the calibration after 24 hours and after 2/3 days.

6.1.5.1 Calibration in water

Press the MENU key to enter the Instrument Calibration submenu and enter the CALIBRATION menu and then the channel of the ORP probe. Select “Calibration IN WATER”. The following display will appear:

X	X	.	X	X		O	2			2	3			°	C
P	1	:							Y	Y	.	Y			

P1 indicates the first point in calibration, XX.XX is a dissolved oxygen concentration reading. This reading, is not a REAL value, but it's based upon calibration parameters previously stored. XX.XX serves as an indication of the stability of the measure. 0.00 is a default ppm value and can be freely changed. YY.Y is a value set at the last calibration and can be freely modified.

Fill a beaker with distilled water and add about 1 g of sodium sulphite (Na_2SO_3). Let the salt dissolve and immerse the probe being careful not to damage the membrane and the electrode. Let the measure stabilise and confirm the zero ppm pushing the ENTER key.

If you want to save the value press ENTER. If you don't want to save the above mentioned calibration parameters press END. So forth, previously stored parameters aren't destroyed and they remain still valid for the computation (if the range setting has not been changed).

If **-Bad Input!-** appears, a second calibration attempt should be made. The probe may need additional time to stabilize. If the **-Bad Input!-** continues, check the probe membrane, connections, channel definitions, etc.

Pass on to the second point (P2) of calibration pressing the button MENU. Immerse the probe in the sample and wait till XX.XX is stabilized. Measure the dissolved oxygen concentration in the sample. Correct the displayed ppm value according to the O_2 value found in the sample.

Alternatively perform a calibration in water saturated with air: fill a vessel with distilled water and inject air for at least 10 minutes. Keep the dissolved oxygen probe immersed in the solution (be careful not to damage membrane and electrode). Once the reading has stabilized, read the temperature of the process from the instruments display. Table 21 can be used to determine the concentration of the saturated solution by looking up the current altitude and sample temperature. Once XX.XX is stable, enter the correct value in YY.YY and press the Enter key to save the result.

T °C	T °F	L.M. Sea Level	120m 390ft	240m 779ft	365m 1185ft	490m 1591ft	610m 1980ft	750m 2435ft	850m 2760ft	975m 3166ft	1100m 3571ft
0	32	14,60	14,40	14,10	13,90	13,70	13,50	13,20	12,90	12,70	12,50
1	33,8	14,20	14,00	13,80	13,60	13,30	13,10	12,90	12,60	12,40	12,20
2	35,6	13,90	13,70	13,40	13,20	13,00	12,90	12,60	12,30	12,10	11,80
3	37,4	13,50	13,30	13,10	12,90	12,70	12,40	12,20	12,00	11,80	11,50
4	39,2	13,20	12,90	12,70	12,50	12,30	12,10	11,90	11,70	11,40	11,20
5	41	12,80	12,60	12,40	12,20	12,00	11,80	11,60	11,40	11,10	10,90
6	42,8	12,50	12,30	12,10	11,90	11,70	11,50	11,30	11,10	10,90	10,70
7	44,6	12,20	12,00	11,80	11,60	11,40	11,20	11,00	10,80	10,60	10,40
8	46,4	11,90	11,70	11,50	11,30	11,10	10,90	10,70	10,50	10,30	10,10
9	48,2	11,60	11,40	11,20	11,10	10,90	10,70	10,50	10,30	10,10	9,90
10	50	11,30	11,10	10,90	10,80	10,60	10,40	10,20	10,00	9,90	9,70
11	51,8	11,10	10,80	10,60	10,50	10,30	10,10	9,90	9,70	9,60	9,40
12	53,6	10,80	10,60	10,40	10,30	10,10	9,90	9,70	9,50	9,40	9,20
13	55,4	10,60	10,30	10,20	10,00	9,80	9,70	9,50	9,40	9,20	9,10
14	57,2	10,40	10,10	10,00	9,80	9,70	9,50	9,30	9,20	9,00	8,90
15	59	10,20	9,90	9,80	9,60	9,50	9,30	9,10	9,00	8,80	8,70
16	60,8	10,00	9,70	9,60	9,40	9,30	9,10	8,90	8,70	8,60	8,50
17	62,6	9,70	9,50	9,40	9,20	9,10	8,90	8,70	8,60	8,40	8,40
18	64,4	9,50	9,40	9,20	9,10	8,90	8,80	8,60	8,50	8,30	8,20
19	66,2	9,40	9,20	9,00	8,90	8,70	8,60	8,40	8,30	8,10	8,00
20	68	9,20	9,00	8,80	8,70	8,50	8,40	8,20	8,10	7,90	7,80
21	69,8	9,00	8,80	8,60	8,50	8,30	8,20	8,00	7,90	7,70	7,60
22	71,6	8,80	8,70	8,50	8,40	8,20	8,10	7,90	7,80	7,60	7,50
23	73,4	8,70	8,50	8,30	8,20	8,00	7,90	7,70	7,60	7,40	7,30
24	75,2	8,50	8,30	8,10	8,00	7,80	7,70	7,50	7,40	7,20	7,10
25	77	8,40	8,20	8,00	7,80	7,70	7,60	7,40	7,30	7,10	7,00
26	78,8	8,20	8,00	7,80	7,70	7,50	7,40	7,20	7,10	6,90	6,80
27	80,6	8,10	7,90	7,70	7,60	7,40	7,30	7,10	7,00	6,80	6,70
28	82,4	7,90	7,70	7,60	7,40	7,30	7,20	7,10	6,90	6,80	6,70
29	84,2	7,80	7,60	7,50	7,30	7,20	7,10	7,00	6,80	6,70	6,60
30	86	7,60	7,40	7,10	7,10	7,00	6,90	6,80	6,60	6,50	6,40

Table 21 – DO concentration in air saturated water as function of temperature and altitude

NOTE:

* This table is referred to distilled water with no chlorides
* The atmospheric pressure at sea level is considered at 760mmHg
* The air is considered water saturated
* The error, using dry air, is negligible:

Example: at 25°C at sea level with relative humidity of 50%, the error is 0.15 ppm O_2, and with dry air the error is 0.3 ppm O_2.

6.1.5.2 Calibration in air

From the CALIBRATION menu, choose “Calibration IN AIR”. Calibrate P1 (zero) as described before.

Pass on to the second point (P2) of calibration pressing the button MENU. The following display will appear:

Y	Y	.	Y	Y		O	2			1	4	.	9	°	C
X	X	.	X	X			<	O	2	>					

Where YY.YY is the value of saturation of oxygen in air at the temperature measured by the thermo-resistance and at the set altitude.

Proceed in this way for the calibration IN AIR of P2: lift the O2 sensor and fix it suspend in air, keeping it over a vessel containing water (the sensor must not be in contact with the water). This operation allows to simulate a condition of "air saturated with water". Avoid direct exposition of the sensor to the sunlight that may increase too much the temperature on the point where the temperature compensation element is inserted. Wait 5' that the value in XX.XX is stable, then confirm the value determined via software displayed in YY.YY pressing ENTER. To pass to the display mode press the END key.

6.1.6 Calibration of Sensors with a mA input (e. g. Conductivity)

The calibration procedure is necessary to maximize sensor accuracy. The calibration procedure is very similar to the calibration procedure of any other of the sensors attached to the MicroChem®2.

The calibration procedure sets both the slope and the offset of the curve giving the sensor concentration (in chosen units) as a function of the mA input from the sensor.

Two calibration solutions are required – a low (P1) and a high (P2). The actual calibration procedure depends on the sensor used. Detailed below is a description of a typical calibration sequence for the 4-20mA input conductivity probes supplied by Severn Trent Services.

Prepare the two calibration solutions. If the sensor is new or has been stored dry please leave it immersed in water for 2 hours before calibrating. Another calibration is recommended 24 hours later.

1. Prepare the two calibration solutions and put enough of each in a beaker or bottle (it needs to cover the bottom 50 mm (2 inches) of the probe).

2. Press the MENU key on the transmitter. Enter the password and then press Enter to get to the Calibration submenu. Enter this screen and use the Menu key to scroll to the channel to be calibrated. Use the Enter key to select this channel. The Menu key can be used to scroll to either the measure P1 (low standard) or P2 (the high calibration standard). Enter the P1 screen. The display will show:

X	X	.	X	X		µ	S[1]			2	3	.	5	°	C
P	1	:							Y	Y	.	Y	Y		

1= Units will depend on those set by the customer – see Section 4.3.1

P1 indicates the first point of calibration at the LOWER concentration. XX.XX is the current value. It is useful as it shows when measurement stability has been reached. YY.YY is the value set at the last calibration and can be freely modified.

3. Place the probe in the P1 calibration standard. Press the ENTER key on the transmitter and insert the correct value. Wait 2 minutes or until the reading has stabilized (XX.XX is stable), then confirm by pressing the ENTER key to save the value or reject by pressing the END key.

4. Proceed to the second point (P2) by pressing the MENU key. Take the probe out of the low standard, rinse it with demineralized water, and put it in the high standard ensuring the bottom 50mm (2 inches) of the probe is covered. Wait 2 minutes or until the measured reading (XX.XX) has stabilized and type in the correct standard value in YY.YY. Confirm by pressing Enter or reject by pressing End.

5. To start the measurement press the End key repeatedly until you are in run mode, and put the probe back into the sample stream.
   If at anytime during the calibration procedure the following message appears:

   -Bad Input!-

   It means there was not enough difference in signal seen between standards. This message can be overwritten by pressing the END key. However the standards should be replaced and the probe recalibrated.

7 START UP

WARNING

If the equipment is used in a manner NOT specified by Severn Trent or NOT included in the present document, the protection provided by the equipment may be impaired.

CAUTION

Transmitter casing must be properly closed before being powered up

Before proceeding with the start-up, it is recommended to verify the following points:

- Verify that the installation has been performed according to the section 3.3 of the present manual.
- Verify that the power supply is in accordance with the value indicated in the instrument label.
- Verify that the electrical wiring has been properly completed according to the recommendations mentioned in section 3.4 of the present document.
- Verify that power-up of the instrument will not cause any uncontrolled action related to the items eventually connected to the output signals (i.e. dosing pumps, operating valves, fume extractors).
- Verify that the probes connected to the instrument are properly installed and wired according to the instructions indicated in the specific probe instruction manual.

7.1 Preliminary operations

7.1.1 Getting started

Power the transmitter up and perform the following steps:

1. Turn on power supply;
2. Enter Configuration menu and set the desired language for the display messages;
3. If the displayed measured value is not in agreement with the connected sensor(s) enter the Channel Definition menu, and set, for each installed channel, the correct type of measure (Refer to Sect. 4.3).
4. Verify that the selected measuring ranges correspond to the desired values; if not, modify ranges as needed.
5. If the alarm levels are required at values that are not the 10 % and 90 % of measuring range, enter the Alarms menu and set Low Alarm and High Alarm level as required. (Refer to Sect. 4.4.3).
6. Verify that all Configuration parameters are set as required (See Sect. 4.4 to 4.4.1.3).
7. If a Dissolved Oxygen Sensor (O2) is installed, set the installation altitude value, to allow automatic calibration in air.
8. Once the sensor(s) sensitivity is stabilised the calibration procedure(s) has to be performed to standardize the transmitter together with the connected sensor(s).
9. During the first 4 days of operation, it is suggested to verify every day the reading of the analyzer, and repeat calibration if necessary.
10. Now the analyzer is in operation. It is important to repeat periodically the maintenance procedures detailed in the instruction manual pertinent to each sensor.

7.1.2 Personalization of Parameters

1. If the Input / Output digital contacts are used, enter the Configuration menu and set the NO or NC status of the contact as desired.
2. It is important to remember that any device connected to the digital output must be arranged in order to operate in fail safe condition.
3. If the Serial Communication option has been selected, enter the Configuration menu and set the desired instrument address, baud rate and selected communication port.
4. Select the desired engineering unit for the temperature indication.
5. If it is desired to operate the controller with the average value of 2 or 3 identical sensors, select PID in the Channel installation menu.
6. If it is desired that the transmitter calculates the difference between two identical sensors input values, set a value in the “Delta” parameter.
7. If required, select a dumping value for each channel input.
8. Modify the “Password” in the Configuration menu, if it is desired to set a personalised access code.

7.2 Controller PID tuning

The PB, TR, and TD constants are preset to the default values shown in Table 7. If desired the control action setting can be optimized by using a trial and error method as outlined below.

1. Set process to approximately normal conditions in MANUAL.
2. Preset constants to some acceptable starting point for the process. For example
   PB = 500
   TR = 100
   TD = 0
3. Switch Controller to AUTO mode.
4. Decrease the PB setting to ½ the previous value. Then, alter the set point 2% by pressing one of the set point pushbuttons.
5. Check that the process indication value does not oscillate.
6. Continue to decrease the PB setting by a factor of 2, altering the set point between steps until a point is reached where process cycling is just evident. Then increase the PB setting by a factor of 2.
7. Introduce Automatic Reset slowly by decreasing TR until cycling starts.
8. Increase TR to approximately 1,5 times the value obtained in 7) above.

When PID tuning constants have been selected, the controller is ready for on-stream operation. Optional PID tuning methods may be desired for slow response processes. Consider recording all tuning parameters in the instruction manual for future reference should it become necessary to reprogram the instrument.

8 MAINTENANCE

MicroChem®2 housing can be externally cleaned with a cloth slightly wetted with alcohol and water, paying attention not to damage the keyboard.

Do not use acids or chemicals solvents for MicroChem2 cleaning.

CAUTION

8.1 Periodical operations

All analyzers need cleaning of the sensors at periodical intervals that depend on type of sensor and process characteristics. For further details refer to the specific sensor Instruction Manual. The analyzers also need periodical check of sensitivity and calibration if required.

8.1.1 Automatic sensitivity check during dual point calibration

During dual point calibration, MicroChem2 performs an automatic sensor sensitivity check. If the sensitivity is too low the display will show the message “Bad In”. Refer to the instruction manual. pertinent to each specific sensor for details on how to fix the problem. If the message “Fault” appears the signal generated by the sensor is abnormally high. Refer to the instruction manual pertinent to each specific sensor for details on how to fix the problem.

8.1.2 Sensor signal check

The signal generated by the sensor and by the temperature sensing element can be directly read (in µA or mV and in •) on MicroChem2 display simply by entering the Analog I/O, input signals submenu, under Instrument Test submenu. This is a very easy way to define if the sensor is correctly working just verifying its signal and comparing it to a lab analysis of the measured value. See the pertinent instruction manual for nominal signal to be expected from each type of sensor.

8.1.3 Other checks

Accessing to the menu at section INSTRUMENT TEST, is possible to verify the instrument features. Refer to section 4.4.1.4. for further details.

9 ERROR MESSAGES & TROUBLESHOOTING

Different levels of messages are generated by the instrument at need.

9.1 Messages

At power up, the instrument shows the following sequence of messages:

"MicroChem II"
"S.Rel...."
"Transmitter"

9.1.1 Operation messages

Messages displayed during operation to clarify what MicroChem2 is doing.

"Loading default database"

is shown when a reset has been performed. After few seconds the instrument goes to normal display mode.

"-calib-"

is shown when the instrument is powered up and when a Channel has been changed. After some seconds the instrument goes to normal display mode.

"---wash---"

flashing is displayed when the instrument is performing a cleaning sequence. "---wash---" is alternated to a value that is the last measure before the starting of the cleaning sequence.
Both the displayed measure and the 4-20 mA output signals are frozen at that last value.

"Access denied"

is displayed when the inserted password is not correct.

"password"

is displayed when the menu key is pressed: the correct password must be entered in order to access the menu.

9.1.2 Error messages

These messages are displayed when something is not correct in the unit.

"Error, no analog input"

is displayed when analog I/O pc board are missing (or contact in their connectors is failing).

"Bad In"

is displayed if the input signal generated by the sensor is too low, that is the sensitivity is too low.

"Fault"

is displayed if the signal generated by the sensor is too high.

"RTFault"

is displayed when the Thermo resistance is faulty and the instrument is currently using the default temperature value

"Red LED lit (Watchdog)"

When Red LED watchdog is lit it means the microprocessor circuit is faulty.

9.2 Alarms page

It is accessed by pressing the Enter key in display mode.

If no alarm or no abnormal condition is present the display will show nothing.

The following messages are displayed with the indicated meaning:

A1L = low alarm on channel 1
A2L = low alarm on channel 2
A3L = low alarm on channel 3

A1H = high alarm on channel 1
A2H = high alarm on channel 2
A3H = high alarm on channel 3

AML = low alarm on average value

AMH = high alarm on average value

Ch1 Bad = Bad value on channel 1
Ch2 Bad = Bad value on channel 2
Ch3 Bad = Bad value on channel 3

=•= = the value set for delta has been overcome

AVE = the instrument is computing the average of two measures (same parameter) and the averaged value is indicated on the first line of the display instead of the measure of the first channel

BLK = When CCI in OR parameter is set to YES it means that output(s) is (are) frozen because either CCI1 or CCI2 or both is (are) closed.

RUN = When CCI in OR parameter is set to YES it means that output(s) is (are) working (not frozen) because CCI1 and CCI2 are both open.

9.3 Troubleshooting

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
RT fault	Faulty thermistor or Incorrect connection	Replace thermistor assembly or Make correct connections
Low	Incorrect Calibration	Repeat calibration
Watchdog led lights	General fault	Super-Reset
Menu access denied	Wrong password	Super-Reset
Unstable measure	Incorrect Calibration	Repeat calibration
Erratic or absent analog output	Incorrect pc board or CPU calibration	Super-Reset or Replace pc board
Inaccurate PID regulation	PID parameters erratic configuration	Control PID parameters
Instrument doesn't light up	Boken fuse or erratic electrical connections	Control fuse or electrical connections
Erratic measure reading	Incorrect electrical connection Incorrect calibration CPU fault	Control electrical connections Perform calibration Super-Reset

9.4 Super-Reset

Super-Reset procedure returns MicroChem®2 to the factory default. Alarms, timers, password, digital output settings, engineering units and all other parameters have to be verified or reconfigured and channels calibration must be operated before using it in the process.

Super-Reset has to be operated:

- After an hardware upgrade
- To return password at default "00000"
- When a software problem occurs
- When Watch Dog led lights

How to operate:

- Switch the power supply OFF
- While keeping CANCEL button pressed, switch the power ON
- "Loading default database" will appear on display
- MicroChem2 is reconfigured to the default values

10 PARTS LIST

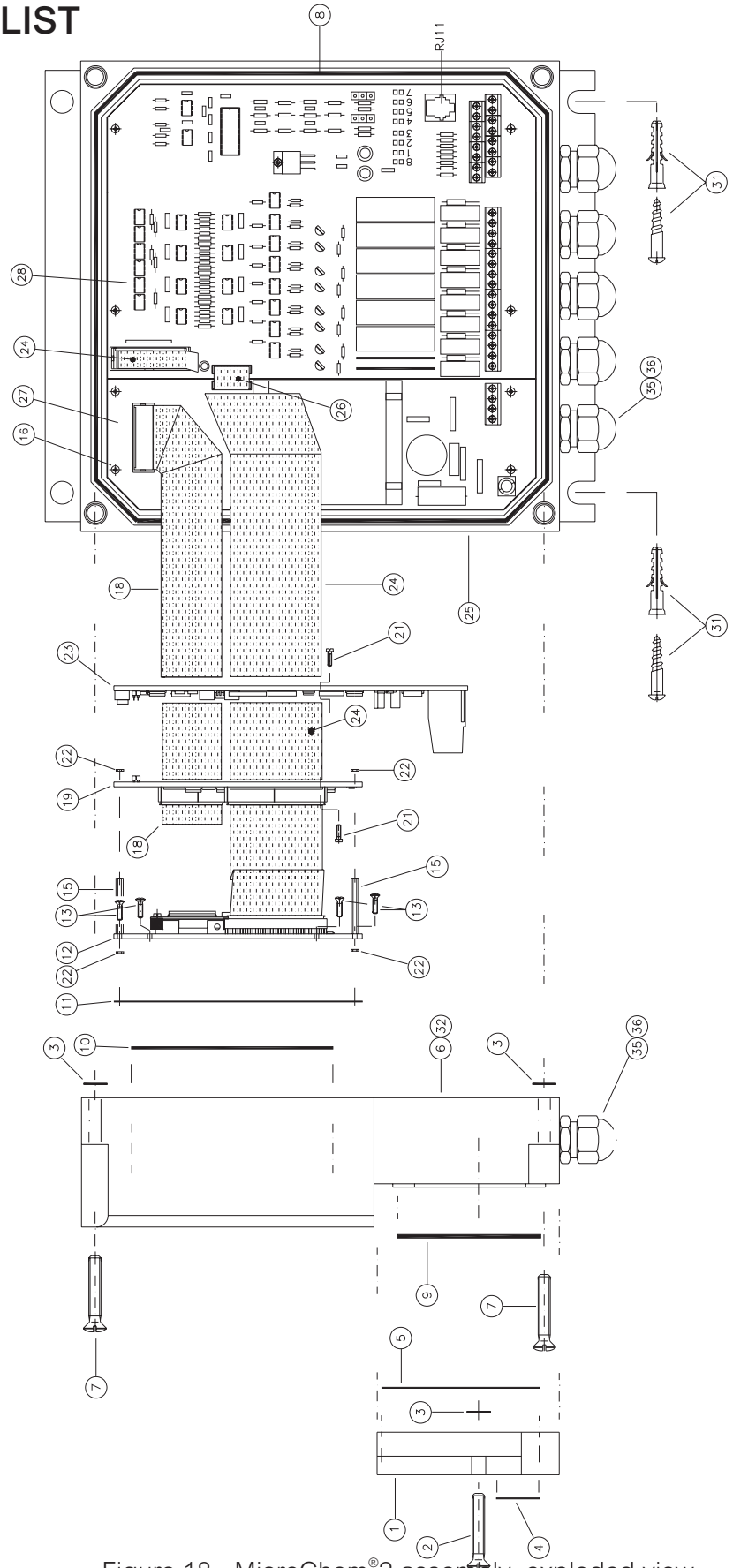


Figure 18 - MicroChem®2 assembly, exploded view

10.1 MicroChem®2 assembly, Parts List

ITEM	DESCRIPTION	PART NUMBER
1	Wire terminal cover	1T324C018U01
2	Screw M5 x 20	1T005L007T60
3	"O" Ring (Buna)	101A702U01
4	Warning label	1T338D152U01
5	Wiring label	1T338D151U02
6	Front cover	1T612B057U01
7	Screw M5 x 25	1T005L008T60
8	"O" Ring (Buna)	1T101A014U01
9	"O" Ring (Buna)	1T101A015U01
10	"O" Ring (Buna)	1T101A016U01
11	Membrane keypad	1T338D153U01
12	Display board	1T686B126U01
13	Screw with auto-thread mod. KB 30x10	1T094L001U06
14	/	/
15	Spacer length 22 mm	1T104D089U01
16	Screw with auto-thread mod. KB 30x8	1T094L001U05
17	/	/
18	Flat cable CPU/ Power supply board	1T677B117U01
19	CPU board	1T686B128U06
20	/	/
21	Screw M3 x 6	1T003E013T60
22	Screw nut M4 nylon	1T082A105N00
23	I/O analog board	1T686B125U01
24	Flat cable I/O CPU	1T677B118U01
25	Bottom enclosure	1T612B058U01
26	Flat cable Power supply I/O analog board	1T677B115U01
27	Power supply board, 115 VAC	1T686B123U11
	Power supply board, 230 VAC	1T686B123U10
28	Digital I/O board + expanded function board RS 232	1T686B129U22
28	Digital I/O board + expanded function board RS 422	1T686B129U24
28	Digital I/O board + expanded function board RS 485	1T686B129U23
29	Cable gland PG11	1T104B018U02
30	PG11 insert disk	1T114C006U03
31	Mounting kit transmitter box	1T614B017U01
	PIC for Mod. T17MD4000, controller	1T699B018U01
	PIC for Mod. T17ME4000, swimming pool controller	1T699B019U01
	Fuse F1 – 230 V~	1T151A003U06
	Fuse F1 – 115V~	1T151A003U09

11 SERIAL COMMUNICATION

NOTE: This section applies only to instruments equipped with the optional Serial Communication P.C. Board.

11.1 Standard of Communications

Two digital communication standards are supported by the serial communication board of MicroChem®2, one port is an RS232 serial interface and the other is an RS 422/485 serial interface. Only one port at a time can be activated, and the selection of the desired standard is made via software at the Configuration Menu.

The Factory default setting is RS 422/485, which allows up to a maximum of 32 instruments to be connected to the same Data-link, where each instrument must have a unique address number ranging from 00 to 31 (Factory setting is 00).

The RS 232 standard can be selected for a peer to peer communication mode.
Transmission speed can be adjusted between 1200 and 28800 baud in the Configuration Menu; default setting is 28800, asynchronous by character.

One character can be defined as either one of the following two modes:

Mode 1 - (Standard PC mode - Default setting by Factory):
- 1 Start bit;
- 8 Data Bits – the Least Significant Bit (LSB) is transmitted first;
- 1 Stop Bit.

Mode 2 - (Optional setting):
- 1 Start bit;
- 8 Data Bits – the Least Significant Bit (LSB) is transmitted first;
- 1 Even Parity bit
- 1 Stop Bit.

NOTE: When operating in RS232 mode, the character definition must be set as Mode 1.
Mode 2 is active optionally only when operating in RS485.
To modify this selection, enter the Configuration menu and select the RS485 mode: the menu will ask to select Mode 1 or Mode 2. When Mode 1 is selected and the communication is to work in RS232, remember to set RS232 again in the menu after having selected "Mode 1" from the RS485 menu.

11.1.1 Software characteristics

1. All transactions are initiated by the Host: The MicroChem2 can only work as a ***responder*** to Host commands (Interrogate or Change).
2. All MicroChem2 begin their response within 10 ms after the end of the transmission by the Host, otherwise a faulty transmission may be assumed.
3. The maximum number of data bytes per message is 32 (decimal).
4. Data type are made up of 1 (logical), 2 (integer), 4 (floating point) bytes or string type, with string length bytes, according to Intel Format.

11.1.2 Communication Protocol

The communication protocol requires the Host to initiate all transactions. There are two basic categories of message types: *Interrogate*, which is used to read data from an addressed MicroChem2, and *Change*, which is used to alter a value in an addressed MicroChem2. The addressed instrument decodes the message and provides an appropriate response.

The protocol definitions for the message types are provided in the following table:

Message Field Definition		
Symbol	***Title***	***Definition***
SOH	Start of Header	This character, 7E, denotes the beginning of a message
I.A.	MicroChem®2 Address	The address of the MicroChem2 responding to the transaction. It must be within a range of 00-1F (00-31 decimal).
CMD	Command	Is the operation to be performed or a description of the message that follows the Command-I.A. byte. The Command-I.A. byte has two fields: the Command field (3 bits), and the I.A. field (5 bits). There are the following commands type: Interrogate Change Acknowledge Response The command descriptions are covered in the following section.
NUM	Number	The number of data bytes transferred or requested. The NUM must be in a range of 00-32 decimal.
LO-ADD	Lower Address Bits	The least significant 8 bits of a 16 bit address in the MicroChem2 database (*)
HI-ADD	Higher Address Bits	The most significant 8 bits of a 16 bit address in the MicroChem2 database (*)
DATA		An 8 bit data type
XXXX		Represents a variable number of data bytes
LRC	Longitudinal Redundancy Character	Is a character written at the end of the message that represents the byte content of the message and is checked to ensure data was not lost in transmission. Is the sum of all bytes Modulo 256 of the message not including the SOH character or its own bit setting (LRC)

Table 22 - Message field definition

(*) The addresses of the single variables to be accessed in the MicroChem2 database are listed in the following pages.

11.1.3 Message Types and Commands Description

The types of messages that are sent between the host and the MicroChem2 are formatted as follows:

Host to MicroChem2

1. Interrogate – This message requests up to 20_H consecutively stored bytes, beginning at the specified memory address location of the addressed MicroChem2.
   01111110 E0H + I.A. NUM LO ADD HI ADD LRC

2. Change – This message sends up to 20 bytes of new data to the addressed MicroChem2.
   01111110 A0H + I.A. NUM LO ADD HI ADD Data 1 XXXXXXX Data N LRC

3. Acknowledge – This message signals the addressed MicroChem2 that it's last echoed change message was received correctly; the MicroChem2 performs the change requested.
   01111110 80H + I.A.

MicroChem®2 to Host

1. Response – This message furnishes the data requested by the INTERROGATE command of the Host. It is also used to echo back the previous CHANGE message of the Host.

01111110	20_H + I.A.	NUM	LO ADD	HI ADD	Data 1	XXXXXXX	Data N	LRC

11.2 Communication Transaction Examples

11.2.1 Transaction A Example

Host requests 9 bytes of data beginning at hexadecimal memory address 1000 from the MicroChem2 at data-link address 03:

1. Host sends **interrogate** message:

01111110	11100011	00001001	00000000	00010000	11111100
SOH	Command + I.A.	NUM	LO ADD	HI ADD	LRC

2. MicroChem2 sends **response** message:

01111110	00100011	00001001	00000000	00010000	XXXXXXXXXXXXLRC
SOH	Command + I.A.	NUM	LO ADD	HI ADD	Data 1 ……..Data 9

11.2.2 Transaction B Example

Host sends two bytes of new data, to be loaded into the MicroChem2 at data-link address 03 beginning at hexadecimal memory address 1000_H:

1. Host sends **change** message:

01111110	10100011	00000010	00000000	00010000	00001000	00001100	11001001
SOH	Command + I.A.	NUM	LO ADD	HI ADD	Data 1	Data 2	LRC

2. MicroChem2 sends **response** message:

01111110	00100011	00000010	00000000	00010000	00001000	00001100	01001001
SOH	Command + I.A.	NUM	LO ADD	HI ADD	Data 1	Data 2	LRC

3. Host sends **acknowledge** message:

01111110	10000011
SOH	Command + I.A.

4. MicroChem2 performs the change requested at end of the current program scan.

NOTE: Database address table is shown at the end of this section.

11.3 Serial link signal connection

The MicroChem®2 optional serial communication P.C. Board is equipped with modular telephone RJ11 type jack supporting both for RS 232 and RS 422/485 standards:

RJ11 TELEPHONE SIGNAL CONNECTION JACK LAY-OUT:			
Pin N.	**RS 232**	**RS 422**	**RS 485**
1	GND Ground	GND Ground	GND Ground
2	Rx IN Data transmission from PC	Tx + Data transmission to PC, +	-
3	Tx OUT Data transmission to PC	Tx – Data transmission to PC, -	-
4	-	Rx + Data transmission from PC, +	Tx Rx +
5	-	Rx – Data transmission from PC, -	Tx Rx -
6	GND Ground	GND Ground	GND Ground

Table 23 - RJ11 Jack serial Communication connector pin-out

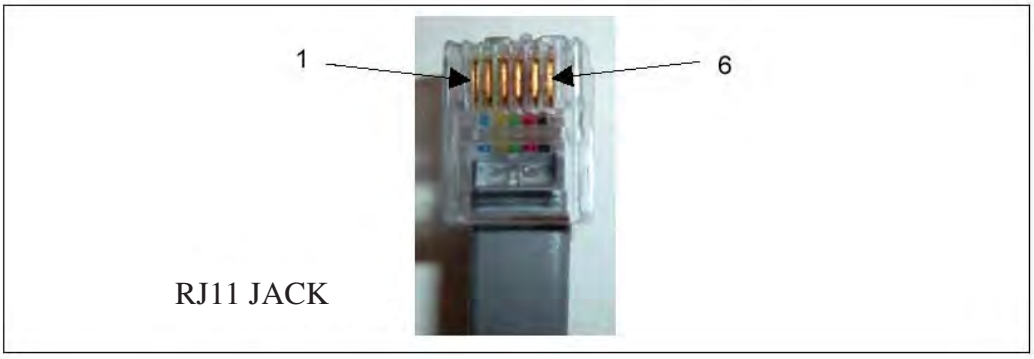


Figure 19 - RJ11 Connector layout

For RS232 and RS485 use shielded cables, two-cores twisted pair wire, section 0.5 ÷ 1.0 mm^2.
For RS422 use shielded cable, 4 cores, twisted pairs wire, section 0.5 ÷ 1.0 mm^2.
Connect shields to the ground shield terminal strip inside MicroChem2.

11.4 Data-link Terminator

The datalink impedance should be 110 Ohm. When the serial communication standard is selected as RS422 or RS485, and more than one MicroChem®2 are installed on the same datalink, it is necessary to activate a terminator resistance, which is available on the serial communication board.

This operation is to be made only on the last MicroChem2 connected on the serial link.
If the host computer serial port is already equipped with a 220 Ohm resistor, then an identical resistor is to be activated in parallel to obtain a 110 Ohm loop impedance. If no such resistor is present on the Host side, then a 110 Ohm resistor is selected on the MicroChem2 serial board.

The terminator resistance selection is made by installing a jumper on JP1 or JP2 for RS422 or RS485 respectively: the 110 Ohm resistor is selected by jumper between pin 1-2, while the 220 Ohm resistor is selected by jumper between pin 2-3.

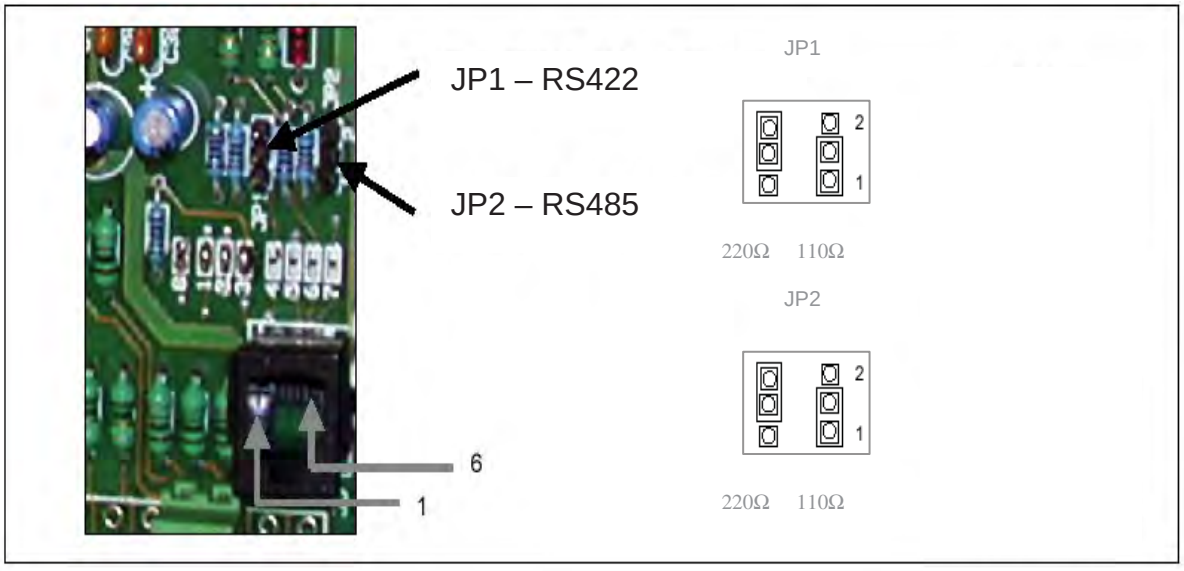


Figure 20 - Data link configuration

Please NOTE:
- to select RS232 weld jumpers onto position 1, 2, 3 and 8.
- to select RS485 weld jumpers onto position 6, 7 and 8.
- to select RS422 weld jumpers onto position 4, 5, 6, 7 and 8.

11.5 MicroChem®2 Memory Map

Increment: (figures between brackets '[x]' indicate the number of similar variables repeated).

Char	type:	1 byte
int	type:	2 bytes
float	type:	4 bytes
string	type:	1 byte x string length

Type	Hex addr.	Name	Description
Char	0X0000	PgmMode	Program mode (0-4) Transmitter, Washing, Regulator…
Char	0X0001	Lng	Language in use
String [6]	0X0002	AccCode[6]	MicroChem2 Password
String [4]	0X0008	TermAddr[4]	Serial line address
Char	0X000C	SerSpeed	Serial line speed
Char	0X000D	SerType	Serial line type
Float	0X000E	Altitude	Altitude where MicroChem2 is mounted
Char	0X0012	CClinOR	Set for CCI in OR mode
Char	0X0013	Average	Set for Average count
Float	0X0014	Delta	Delta limit
Float	0X0018	pH_offset[3]	Offset for PH (SPC), for 3 channels
Float	0X0024	P1[3]	Calibration P1 value for 3 channels
Float	0X0030	P2[3]	Calibration P2 value for 3 channels
Float	0X003C	P1U[3]	User Calibration P1 value for 3 channels
Float	0X0048	P2U[3]	User Calibration P2 value for 3 channels
Char	0X0054	Light	Set when back-light is ON
Char	0X0055	T_Units	Temperature units
Float	0X0056	DefTemp	Default temperature for termo-compensation
Char	0X005A	AltUnits	Altitude Units meters/feet
Char	0X005B	Sigma	Sigma enabled or not
Float	0X005C	sK1	Sigma K1 parameter
Float	0X0060	sK2	Sigma K2 parameter
Float	0X0064	Hyst[3]	Smoothing for each channel
String [9]	0X0070	wT[4]	Wash Wash Timers T1-T4
Float	0X0094	Out_LO[3]	Min. output value for 3 channels
Float	0X00A0	Out_HI[3]	Max. output value for 3 channels
Char	0X00AC	DacType[3]	Type of DAC output
Char	0X00AF	wType	Wash Type T17AU / T17SU
Float	0X00B0	AlLO[3]	Alarms low level
Float	0X00BC	AlHI[3]	Alarms high level
Float	0X00C8	AlBA[3]	Alarms Band
Float	0X00D4	DO_AIR[3]	Set when O2 is in air
String [3]	0X00E0	Res	Reserved
Char	0X00E3	SerMode	Type of RS485/422 serial line
Char	0X00E4	CCIO	0 = No I/O Board, 1 = Yes I/O Board
Char	0X00E5	DoWash	When set, TX has washing
Char	0X00E6	PidType	Determine program PID mode
String [2]	0X00E7	Res	Reserved
Char	0X00E9	UnEng[3]	Engineering unit mA
Char	0X00EC	Type Cl[3]	Chlorine type input
Float	0X00EF	LLmA[3]	mA low limit
Float	0X00FB	LLCl[3]	Chlorine low limit
Float	0X0107	HLCl[3]	Chlorine high limit
Float	0X0113	LLmVCl[3]	mV Chlorine low limit
Float	0X011F	HLmVCl[3]	mV Chlorine high limit
Char	0X012B	EnPID1	enable PID1
Char	0X012C	EnPID2	enable PID2
Int	0X012D	FFPID	Enable FFPID
Int	0X012E	ChInst[3]	Channel installed
Int	0X0134	ChMode[3]	Channel Mode
Float	0X013A	PV[3]	Process value
Float	0X0146	Temp[3]	Temperature value

Table 24 - General Data Memory Map

PID1	Hex addr.	Name	Description
String [2]	0X0152	Reserved	Reserved
Float	0X0154	PB	Proportional Band
Float	0X0158	TR	Reset Time
Float	0X015C	MR	Manual Reset
Float	0X0160	TD	Derivative Action
Float	0X0164	SP	Set Point
Float	0X0168	CZ	Control Zone
Char	0X016C	RSW	Direct/Reverse Action
Char	0X016D	OHLP	Flow dependent limits
Float	0X016E	SPAN	Span
Float	0X0172	FF HIGH	High output limit calculation factor
Float	0X0176	FF LOW	Low output limit calculation factor
Float	0X017A	FF ABS MAX	High output limit
Float	0X017E	FF GAIN	Flow rate gain
Float	0X0182	OH	Output high limit
Float	0X0186	OL	Output low limit
Float	0X018A	K	Scaling factor for flow
Float	0X018E	TATT	Activation time
Float	0X0192	TCYC	Cycle time
Float	0X0196	LH	Reserved
Float	0X019A	LL	Reserved
Float	0X019E	B	Reserved
Int	0X01A2	CT	Reserved
Float	0X01A4	CG	Reserved
Float	0X01A8	DZ	Reserved
Char	0X01AC	TATP	Reserved
Char	0X01AD	CY	Reserved
Char	0X01AE	PA	Reserved
Char	0X01AF	Reserved	Reserved

Table 25 - PID1 Data Memory Map

PID 2	Hex addr.	Name	Description
String [2]	0X01B0	Reserved	Reserved
Float	0X01B2	PB	Proportional Band
Float	0X01B6	TR	Reset Time
Float	0X01BA	MR	Manual Reset
Float	0X01BE	TD	Derivative Action
Float	0X01C2	SP	Set Point
Float	0X01C6	CZ	Control Zone
Float	0X01CA	SPAN	Span
Float	0X01CE	OH	High output limit
Float	0X01D2	OL	Low output limit
Float	0X01D6	TATT	Activation time
Float	0X01DA	TCYC	Cycle time
Float	0X01DF	LH	Reserved
Float	0X01E2	LL	Reserved
int	0X01E6	CT	Reserved
Float	0X01E8	CG	Contact Gain
Float	0X01EC	DZ	Reserved
Char	0X01F0	CY	Reserved
Char	0X01F1	TATP	Reserved
Char	0X01F2	PA	Reserved
Char	0X01F3	RSW	Reserved
Int	0X01F4	Seq_Lav	Actual washing phase
String[10]	0X01F6	T_Lav	Washing time
int	0X0200	CCO[8]	CCO state
int	0X0210	CCI[8]	CCI state
float	0X0220	PID_Dev[2]	PID 1,2 DEV
float	0X0228	PID_Out[2]	PID 1,2 OUT
float	0X0230	PID_FF[2]	PID 1,2 FF
float	0X0238	HiAl [3]	HI Alarm Channel 1-3
float	0X0244	LowAl [3]	LO Alarm Channel 1-3
int	0X0250	PID_ AM[2]	PID1,2 Auto/Manual

Table 26 - PID2 Data Memory Map

12 APPENDIX

12.1 APPENDIX A – WEEE Compliant

Severn Trent Water Purification S:pA., as manufacturer of the electronic instrument described in the present manaul (MicroChem®2 line) is registered at the WEEE register (Waste Electric and Electronic Equipment).

Member registration WEEE number: IT11040000007171

12.2 APPENDIX B – Step by Step Programming Instructions

Please Refer to 4.3 Channel Definition

The keys used to define the channels are:

ABC – moves you laterally through the software

Enter – moves you down into the software holding the Enter key is also used to display an alarm condition.

End – moves you up in the software. End is also used to toggle the process display conditions from channels 1, 2, 3 if they are installed

The following procedure is to configure a transmitter to analyze Chlorine on channel 1 using CL4000 probes:

Press ABC, see Password:/ Flashing Cursor

Type in 00000

Press Enter, see ------ Menu Mode ------/ Menu

Press ABC, see ------ Menu Mode ------/Calibration

Press ABC until you see - Menu Mode/Channel Definition

Press Enter, see Channel Definition/ Channel 1

Press Enter see Channel 1/ CL

Press ABC until you see Channel 1/CL. (Continual pressing of ABC will rotate/move you laterally through the various parameters that the MicroChem2 is capable of measuring CL, CD, T, mA, F, Br, NH_3, NO_3, pH, O_2, mV, and O_3.

NOTE: mA allows you to drill down another level. Then pressing ABC will rotate/move you laterally through mA, %, ppm, mg/l, g/h, L/s, L/h, m^3/h, °C, °F, µS, mS, Kpa, Mpa, PSI, GPM, GPD, MGD, NTU, FTU, m, ft, in.)

Press Enter, see CL/ KC4000 Cell

Press ABC, see CL/CL probe [mA]

Press Enter, see CL Settings/ 4mA = 0.00ppm (This is the low range of your chlorine probe)

Press Enter and Enter 00.00. You will see a flashing cursor.

Press Enter, see CL Settings 20mA = 10.00 ppm

Press Enter, see the flashing cursor, enter the upper limit of the range for the Chlorine probe.

Press Enter, see Channel Definition/ Channel 1

Press End two times and see the display for what is being measured on channel 1

Continual pressing of the End key will toggle through the process measurement screens for the number of channels that are installed and configured.

Please refer to 4.4.1 Set Up/ Instrument Configuration

The keys used to define the channels are:

ABC – moves you laterally through the software

Enter – moves you down into the software. Holding the Enter key is also used to display an alarm condition.

End – moves you up in the software. End is also used to toggle the process display conditions from channels 1, 2, 3 if they are installed.

The following procedure is to set the instruments basic configuration.

Please refer to 4.4.1.1 (Configuration Parameters)

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------ Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press Enter, see English

Continual pressing of the ABC key will rotate you through the languages that are available

When you see English press the End key twice, see Menu/ Configuration

Serial Link — Please refer to 4.4.1.1

The serial communications link to be used by the analyzer. This also requires a hardware change. Please refer to 4.4.2.1, Figure 8

At the process display screen

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Serial Link

Press Enter, see Serial Link/ Address

Press Enter, see Address/ 00 If using RS422 or RS485 you must identify the address of this instrument. RS422 and RS485 are used to link up to 31 instruments. Please refer to section 11 in the instruction manual. If you wish to identify the instrument press the Enter key and you will get a flashing cursor. Enter the numeric value to identify the instrument and press the Enter key.

Cleaning — Please refer to 4.4.1.3

To wash and rinse the sensors

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/Configuration

Press Enter, see Configuration/Language

Press ABC until you see Configuration/Cleaning

Press Enter, see Cleaning/Activate

Press Enter, see Activate/NO

Press ABC, see Activate/Yes

Press Enter, see Cleaning/Activate

Press ABC - see Cleaning/A or B, You must choose B.

Press Enter - see A or B/A

Press ABC - see A or B/A

Press ABC - see A or B/B

Press Enter - see Cleaning A or B

Press ABC - see Cleaning/Cleaning T1. This is the time period between the end of a cleaning sequence and the start time of the next one.

Press Enter - see Cleaning T1/00:00:00. This represents hours, minutes and seconds between cleanings.

Press Enter - see Cleaning T1/flashing cursor

Insert desired time between cleanings

Press Enter - see Cleaning/Cleaning T1

Press ABC - see Cleaning/Cleaning T2

Press Enter - see Cleaning T2/00:00:00. This represents the length of time for washing. Hours have no meaning. You can set cleaning to 30 minute maximum.

Press Enter - see Cleaning T2/flashing cursor

Insert desired time per T2

Follow the same sequence for T3 (Rinse Time) and T4 (Pause Time after cleaning for sensor recovery sensibility) if needed

Continual pressing of the End Key will bring you back to the process measuring display

Temperature Select °C or °F— Please refer to 4.4.1.1

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Temp. Select

Press Enter, see Temp. Select/ °C, another press of the ABC key will toggle you to °F

Press End until you see Menu/ Configuration

Temperature Set — Please refer to 4.4.1.1

This is a safety feature to tell the instrument the temperature to be used if the thermistor is faulty

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Temp. Set

Press Enter, see Temp. Set/ 20.00

Press Enter, see Temp. Set/ with the flashing cursor. Enter the value of the temperature you wish

Press the End Key until you return back to the process measurement display

Altitude (only used for Dissolved Oxygen) — Please refer to 4.4.1.1

This only appears when one of the channels is defined O2

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Altitude

Press Enter, see Altitude/ Eng. Unit Set

Press Enter, see Eng. Unit Set/ Meters by pressing ABC, and Enter you can select altitude in feet rather than meters

Press Enter see Altitude/ Eng. Unit Set

Press ABC, see Altitude/ Set Value

Press Enter, see Set Value/ Ft = 656.20

Press Enter, see Set Value/ Ft = 656.20 with a flashing cursor

Enter the altitude at your plant location and press Enter

Press the End Key until you return back to the process measurement display

CCI in OR — Please refer to 4.4.1.1

This function is used during cleaning to freeze the display.

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ OR CCI

Press Enter, see OR CCI/ NO

Press ABC, see OR CCI/ YES and press Enter to freeze the display of the analyzer.

Press the End key until you return back to the process measurement display

Average — Please refer to 4.4.1.1

This function is used if you have a 2 or a 3 channel instrument and 2 of the channels are configured to test the same parameter.

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Average

Press Enter, see Average/ NO

Pressing the ABC key will let you toggle between Average/ NO and Average/ Yes

Press the End key until you return back to the process measurement display

Delta — Please refer to 4.4.1.1

This function is used with 2 channel transmitters when both channels are configured to test the same parameter. It will cause an alarm if the difference between the two channels is greater than the set value.

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Delta

Press Enter, see Delta/ 0.000

Press Enter to see the flashing cursor and enter the desired Delta value31

Press Enter, see Configuration/ Delta

Press the End key until you return back to the process measurement display

Smoothing — Please refer to 4.4.1.1

This function lessens the degree of measurement fluctuation seen on the display

Press ABC, see Password:/ flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Smoothing

Press Enter, see Smoothing/ Channel 1. Press ABC to toggle between channels

Press Enter, see Channel 1/ 1.00.

Press Enter to see the flashing cursor. Set the smoothing to 30. This is a good place to start.

Press Enter to see Confirm, see Smoothing/Channel 1.

Press the End key until you return back to the process measurement display

Digital Input and Digital Output Settings — Please refer to 4.4.1.1 and 4.4.1.4

Each analyzer has 2 digital inputs CCI 1 and CCI 2. Each analyzer also has 7 digital outputs also referred to as Digital Relay Contact Closures. Each input and output is configured separately as normally opened (NO) or normally closed (NC).

Press ABC, see Password: / flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press Enter, see Configuration/ Language

Press ABC until you see Configuration/ Digital I/O Set

Digital Outputs:

Press Enter, see Digital I/O Set/ Digital Outputs

Press Enter, see Digital Outputs/ Ch. 1

Press ABC to rotate through channels 1 through 7 (CCO1 through CCO7)

Press Enter, see Ch. 1/ NO. Toggle between NO and NC by pressing the ABC key

Digital Inputs:

Press End until you see Digital I/O Set/ Digital Outputs. Press the ABC key to toggle between Digital Inputs and Digital Outputs

Press Enter, see Digital Inputs/ Ch. 1

Press ABC to toggle between channels 1 and 2

Press Enter, see Ch. 1/ NO. Toggle between NO and NC by pressing the ABC key

Output Setting – Please refer to 4.4.2 (Output Setting)

Press ABC, see Password:/flashing cursor and enter 00000

Press Enter, see ------ Menu Mode------/ Menu

Press Enter, see Menu configuration

Press ABC until you see Menu/Output Settings

Press Enter, see Output Settings/Channel 1

Press Enter, see Channel 1/0-20/4-20

Press Enter, see 0-20/4-20/4-20mA. Press Enter to confirm. The output setting for the instrument is now configured for 4-20mA.

Press ABC, see Channel 1/Out Zero

Press Enter, see Out Zero/0.00

Press Enter, see a flashing cursor. The number entered will correspond to the 4.0 mA output signal.

Press Enter, see Out Zero

Press ABC, see Channel 1/Out Span

Press Enter, see Out Span = 10.00

Press Enter, see the flashing cursor, enter the upper limit of your probe that you wish to correspond to 20.00 mA

Press Enter, see Out Span

Press End once, see Menu/Output Settings

Press End again and see -----Menu Mode-----/Menu

Press End again – will show the process display screen

Setting Alarms - Please refer to 4.4.3

The keys used to set the alarms are:

ABC – moves you laterally through the software

Enter – moves you down into the software. Enter is also used to display an alarm condition.

End – moves you up in the software. End is also used to toggle the process display conditions from channels 1, 2, 3 if they are installed

The Alarms Menu is used to set the alarms for each parameter the instrument is capable of analyzing. Alarms default to the default settings in 4.4.3 Table 4.

Low and High Alarms

To change the alarm settings:

Press ABC, see Password: / flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press ABC key to rotate to Alarms

Press Enter, see Alarms/ Channel 1

Press Enter, see Channel 1/ Low Alarm

Press Enter, see Low Alarm/ 1.000

Press Enter to see the flashing cursor and enter the desired low alarm value

Press the End Key see Menu/ Alarms

Press Enter, see Alarms/ Channel 1

Press Enter, see Channel 1/ Low Alarm

Press ABC, see Channel 1/ High Alarm

Press Enter, see High Alarm/ 9.000

To change the High Alarm press Enter and the flashing cursor will appear. Enter the desired value.

Press the End key until the measuring process display appears

Dead Band – Please refer to 4.4.3

Dead Band is used to avoid the alarms from oscillating around the Lo and Hi alarm set points

Press ABC, see Password: / flashing cursor and enter 00000

Press Enter, see ------Menu Mode ------/ Menu

Press Enter, see Menu/ Configuration

Press ABC until you see Menu/ Alarms

Press Enter, see Alarms/ Channel 1

Press Enter, see Channel 1/ Low Alarm

Press ABC until you rotate to Dead band

Press Enter, see Dead band/ 0.000

Press Enter, see Dead band/0.000 with the flashing cursor. Enter the desired value. Then press the End key until the measuring process display appears

ANALYZER CALIBRATION

The following procedure is to configure the instrument to analyze Chlorine on channel 1

The keys used to calibrate the instrument are

ABC – moves you laterally through the software

Enter – moves you down into the software. Enter is also used to display an alarm condition

End – moves you up in the software. End is also used to toggle the process display conditions from channels 1, 2, 3 if they are installed

Probe Calibration - General - Please refer to 6.1.1 for Calibration Menu

Calibration - Please refer to 6.1.4 for Chlorine Calibration

Press ABC, see Password:/ Flashing Cursor. Insert 00000

Press Enter, see ------Menu Mode ------/ Menu

Press ABC, until you see ------Menu Mode ------/Calibration

Press Enter, see Calibration/ Channel 1

Press Enter, see Channel 1/ Calibration P1

NOTE: P1calibration is only necessary for the initial calibration to set the zero point. When performing recalibration it is only necessary to set the P2; skip to the P2 calibration (4 lines below)

Press Enter, see the low calibration value/ P1: 0.000

Press Enter, see the flashing cursor and enter the calibration value (for your low sample that has been stripped of chlorine using a carbon filter)

Press Enter, see Channel 1/ Calibration P1

Press ABC, see Channel 1/ Calibration P2

Press Enter, see the high chlorine calibration value/ P2: 10.00

Press Enter, see the flashing cursor and enter the P2 value based on testing such as with DPD or titration

Press Enter, see Channel 1/ Calibration P2:

Press End 3 times to take you to the process measurement display

AUTOMATIC CONTROL METHODS: (Available in instruments configured as controllers)

A. RESIDUAL PID CONTROLLER PROPORTIONAL BAND (PB) - Please refer to 5.2.2, Table 9.

1. Press ABC key – see Password with a flashing indicator. Press Zero Key and enter 00000.

2. Press Enter, see ------ Menu Mode ------/ Menu

3. Press Enter, see Menu/Configuration

4. Press ABC and scroll to Menu / Controller

5. Press Enter to Controller / PID 1

6. Press Enter, see PID1 General/ 4-20 / Contacts

7. Press Enter, see 4-20 / Contacts / 4-20 mA. This is the default. In order to use the general PID parameters, the instrument must be set to 4-20.

8. Press Enter, see PID / General 4-20 / Contacts

9. Press ABC, see PID1 General/ PB

10. Press Enter, see PB/100. This is the default for PB.

11. Press Enter again to get the flashing cursor to allow you to change the Proportional Band.

12. Insert 250, press Enter and see PID1 General/ PB

TIME RESET/INTEGRAL ACTION (TR) - Please refer to 5.2.2, Table 9

13. Press ABC, see PID1 General/ TR m/r

14. Press Enter see TR m/r / 0.00

15. Press Enter to show the flashing cursor

16. Enter the previously determined TR value. If a higher number than the range is inserted, the instrument defaults to 30 minutes

17. Press Enter to confirm the value and see PID1 General/ TR m/r

MANUAL RESET (MR) - Please refer to 5.2.2.1, Table 9

18. Press ABC and see PID1 General/ MR %

Skip this function. Manual reset is rarely used. To use Manual Reset you must set TR = 0. It represents the output of the controller when the PV is in the Control Zone; when the PV is almost equal to the Set Point.

DERIVATIVE ACTION (TD) - Please refer to 5.2.2.1, Table 9

19. Press ABC and see PID1 General/ TD m

Skip this function, it is rarely used. It is used to allow for sudden changes in the PV

PROCESS VARIABLE (PV) - Please refer to 5.2.2.1, Table 9

20. Press ABC and see PID1 General/ PV

21. Press Enter and see PID1 PV: the analysis and the current Process Variable will be indicated at the top left of the display

22. Press End and see PID1 General/ PV

SET POINT (SP) - Please refer to 5.2.2.1, Table 9

23. Press ABC and see PID1 General/ SP

SP is the Set Point for the desired PV

24. Press Enter and see SP/ 0.00

25. Press Enter to see the flashing cursor and enter the desired Set Point for the process.

26. Press Enter and see PID1 General/ SP

NOTE: The Set Point can be adjusted manually using the blue buttons.

CONTROL ZONE (CZ) - Please refer to 5.2.2.1, Table 9

27. Press ABC and see PID1 General/ CZ

    Control Zone is used to avoid continuous control adjustments for small fluctuations from Set Point. Please refer to 5.2.2.1 for an explanation of Control Zone

28. Press Enter twice to see the flashing cursor and enter the desired value

29. Press Enter and see PID1 General/ CZ

DIRECT/REVERSE ACTION (RSW) - Please refer to 5.2.2.1 for an explanation of DIRECT/REVERSE ACTION (RSW).

30. Press ABC and see PID1 General/ RSW D/R

31. Press Enter and see RSW D/R/ Reverse

32. Press Enter to confirm and see PID1 General/ RSW D/R

SPAN - Range of Wet End/Probe

33. Press ABC and see PID1 General/ SPAN

34. Press Enter and see SPAN/ X.XX – see the numeric indication of the process variable.

35. Press Enter to see the flashing cursor and enter the desired range for the controller based on (in the case of chlorine using a CL4000 probe) the range of the probe

36. Press Enter to confirm and see PID1 General/ SPAN

HIGH LIMIT OUTPUT (OH)

37. Press ABC and see PID1 Limits/ OH%

38. Press Enter and see OH%/ 100.00

39. Press Enter again and see the flashing cursor, and enter the upper limit of the process

40. Press Enter to confirm and see PID1 Limits/ OH %

LOW LIMIT OUTPUT (OL)

41. Press ABC and see PID1 Limits/ OL %

42. Press Enter and see OL%/ 0.00

43. Press Enter to see the flashing cursor. Insert the desired low limit

44. Press Enter to confirm and see PID1 Limits/ OL%

45. Press End until you return to the process analysis/controller screen

Once the Process Variable is running as desired press the Blue 5 Key to switch to Automatic Mode

A.FEED FORWARD ACTION - Please refer to 5.2.2.2

Limit output as a function of Flowrate (OHLP)

A 2 channel unit is required

Channel 2 must previously have been configured as mA and further defined as mode PID

B.FEED FORWARD CONTROL - Please refer to 5.2.2.2

1. Press ABC, see Password/flashing cursor and enter 00000

2. Press Enter, see ------Menu Mode ------/ Menu

3. Press Enter, see Menu/Configuration

4. Press ABC, see Menu/Controller
5. Press Enter, see Controller/PID1
6. Press Enter, see PID General/4-20/Contacts
7. Press ABC, see PID1 General/PB. Continue to press ABC until PID1 Feed Flow/OHLP NO/YES appears on the display
8. Press Enter, see OHLP NO/YES/NO
9. Press ABC, see OHLP NO/YES/YES. OHLP must be set to Yes to limit the output as a function of the flow rate.

FACTOR TO COMPUTE MAX OUTPUT BASED ON FLOWRATE (FFH) - Please refer to 5.2.2.2

10. Press Enter, see PID1 Feed Forw./OHLP NO/YES
11. Press ABC, see PID1 Feed Forw./FFH
12. Press Enter, see FFH 1.50. This is the default
13. Press Enter, see FFH/flashing cursor
14. Enter the desired numeric value
15. Press Enter, see PID1 Feed Forward/FFH

FACTOR TO COMPUTE MINIMUM OUTPUT BASED ON FLOWRATE VALUE (FFL) - Please refer to 5.2.2.2

16. Press ABC, see PID1 Feed Forward/FFL
17. Press Enter, see FFL 0.50. This is the default value
18. Press Enter, see FFL/flashing cursor
19. Enter the desired numeric value
20. Press Enter, see PID1 Feed Forward/FFL

ABSOLUTE HIGH LIMIT ON OUTPUT WHEN LIMITS BASED ON FLOWRATE ARE ACTIVE (MAX. ABS) - Please refer to 5.2.2.2

21. Press ABC, see PID1 Feed Forward/Absolute Max
22. Press Enter, see Absolute Max/100.00. This is the default value
23. Press Enter, see Absolute Max/flashing cursor
24. Enter the desired Absolute Max value
25. Press Enter, see PID1 Feed Forward/Absolute Max.

GAIN FACTOR APPLIED ON FLOW RATE SIGNAL (GAIN) - Please refer to 5.2.2.2

26. Press ABC, see PID1 Feed Forward/Gain
27. Press Enter, see Gain/100.00. This is the default value
28. Press Enter, see Gain/flashing cursor
29. Enter the desired value
30. Press Enter, see PID1 Feed Forw./Gain
31. Press End until you return to the process analyzer/controller screen
32. Once the process is running as desired, press the Blue 5 Key to switch to automatic mode.

C. TIME SAMPLING OR FLOW-PACING CONTROLLER (TATP)- Please refer to 5.2.2.3

Define Channel 1 as chlorine or another parameter. The 4-20 mA output provides PID control. The channel definition for Channel 2 must be configured to 4-20 mA and further configured to mode PID.

TIME SAMPLING (TATP) - Please refer to 5.2.2.3

1. Press ABC, see Password:/flashing cursor and Enter 00000.
2. Press Enter, ---Menu Mode---/ Menu
3. Press Enter, see Menu/Configuration
4. Press ABC, see Menu/Controller
5. Press Enter, see Controller/PID1
6. Press Enter, see PID1 General/4-20/Contacts
7. Press ABC until you see PID1 Chlorine/TATP NO/YES
8. Press Enter, see TATP NO/YES/NO
9. Press ABC, see TATP NO/YES/YES
10. Press Enter, see PID1/Chlorine/TATP NO/YES, then OH and OL are not engaged, Absolute Max is used.

SCALING FACTOR FOR FLOW (K) - Please refer to 5.2.2.3

11. Press ABC, see PID1 Chlorine (if configured)/K
12. Press Enter, see K/O.O. This is the default value. K is not used in Time Sampling.
13. Press End and see PID1 Chlorine (if configured as such)/K

ACTIVE TIME (ATT) - Please refer to 5.2.2.3

14. Press ABC, see PID 1 Chlorine/ATT.
15. Press Enter, see ATT/0.00. This is the default value.
16. Press Enter, see ATT/flashing cursor.
17. Enter the desired numeric value
18. Press Enter, see PID1 Chlorine/ATT (if configured as such)

CYCLE (FOR FLOW) - Please refer to 5.2.2.3

19. Press ABC, see PID1 Chlorine/Cycle
20. Press Enter, see Cycle/0.00. This is the default value.
21. Press Enter, see Cycle/flashing cursor.
22. Enter the desired Cycle time.
23. Press Enter, see PID1 Chlorine/Cycle.
24. Press End until you return to the process analyzer/controller screen.
25. Once the process is running as desired, press the Blue 5 key to switch to automatic mode.

TIME CYCLE - Please refer to 5.2.2.3 - PID must be defined as Contacts instead of 4-20mA.

3. Press Enter, see ---Menu Mode---/ Configuration
4. Press ABC, see Menu/Controller
5. Press Enter, see Controller/PID1
6. Press Enter, see PID1 General/4-20/Contacts

7. Press Enter, see 4-20/Contacts/4-20mA
8. Press ABC, see 4-20/Contacts/Contacts
9. Press Enter, see PID1 General/4-20/Contacts
10. Press ABC until you see PID1 Contacts/Time Cycle sec
11. Press Enter, see Time Cycle sec/0. This is the default value
12. Press Enter, see Time Cycle sec/flashing cursor
13. Enter the desired value
14. Press Enter, see PID1 Contacts/Time Cycles sec
15. Press End until you return to the process Analyzer/Controller screen
16. Once the process is running as desired, press the Blue 5 key to switch to the automatic mode.

E. ERROR SQUARED CONTROLLER - Please refer to 5.2.2.4

Channel 1 must be defined for pH or mV

Set Point (SP) and process variable (PV) must have been previously defined

1. Press ABC, enter 00000
2. Press Enter, see ---Menu Mode---/ Menu
3. Press Enter, see Menu/Configuration
4. Press ABC, see Menu/Controller
5. Press Enter, see Controller/PID1
6. Press Enter, see PID1 General/4-20/Contacts
7. Press Enter, see 4-20/Contacts/4-20mA
8. Press End, see PID1 General/4-20/Contacts

DEAD BAND

9. Press ABC until you see PID1 pH/Dead Band
10. Press Enter, see Dead Band/100.00, this is the default value.
11. Press Enter, see Dead Band/flashing cursor
12. Enter the desired value
13. Press Enter, see PID1 pH/Dead Band
14. Press End until you return to the process Analyzer/Controller screen

F. CONTACT OUTPUT CONTROLLER - Please refer to 5.2.2.5

1. Press ABC, see Password:/flashing cursor and enter 00000
2. Press Enter, see ---Menu Mode---/ Menu
3. Press Enter, see Menu/Configuration
4. Press ABC, see Menu/Controller
5. Press Enter, see Controller/PID1
6. Press Enter, see PID1 General/4-20/Contacts
7. Press Enter, see 4-20/Contacts/4-20mA
8. Press ABC, see 4-20/Contacts/Contacts
9. Press Enter, see PID1 General/4-20/Contacts
10. Press End twice, see Menu/Controller

11. Press Enter, see Controller/PID1
12. Press Enter, see PID1 General/4-20/Contacts

GAIN - Please refer to 5.2.2.5

13. Press ABC until you see PID1 Contacts/Gain
14. Press Enter, see Gain 1.00, this is the default value.
15. Press Enter, see Gain/flashing cursor
16. Enter the desired Gain value.
17. Press Enter, see PID1 Contacts/Gain

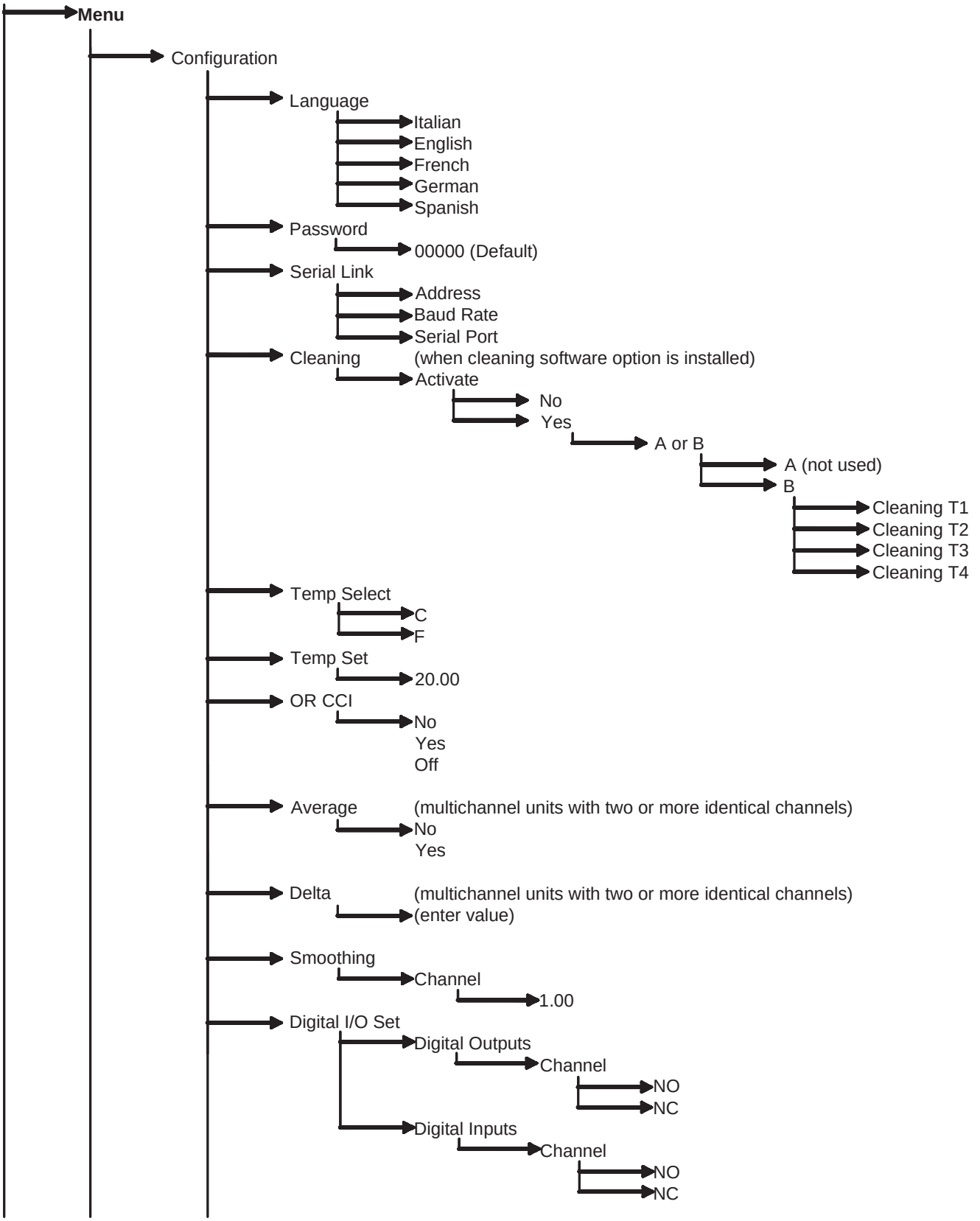
DEAD ZONE (DZ) - Please refer to 5.2.2.5

18. Press ABC, see PID/Contacts/DZ
19. Press Enter, see DZ/0.00, this is the default value.
20. Press Enter, see DZ/flashing cursor
21. Enter the desired value.
22. Press Enter, see PID1 Contacts/DZ

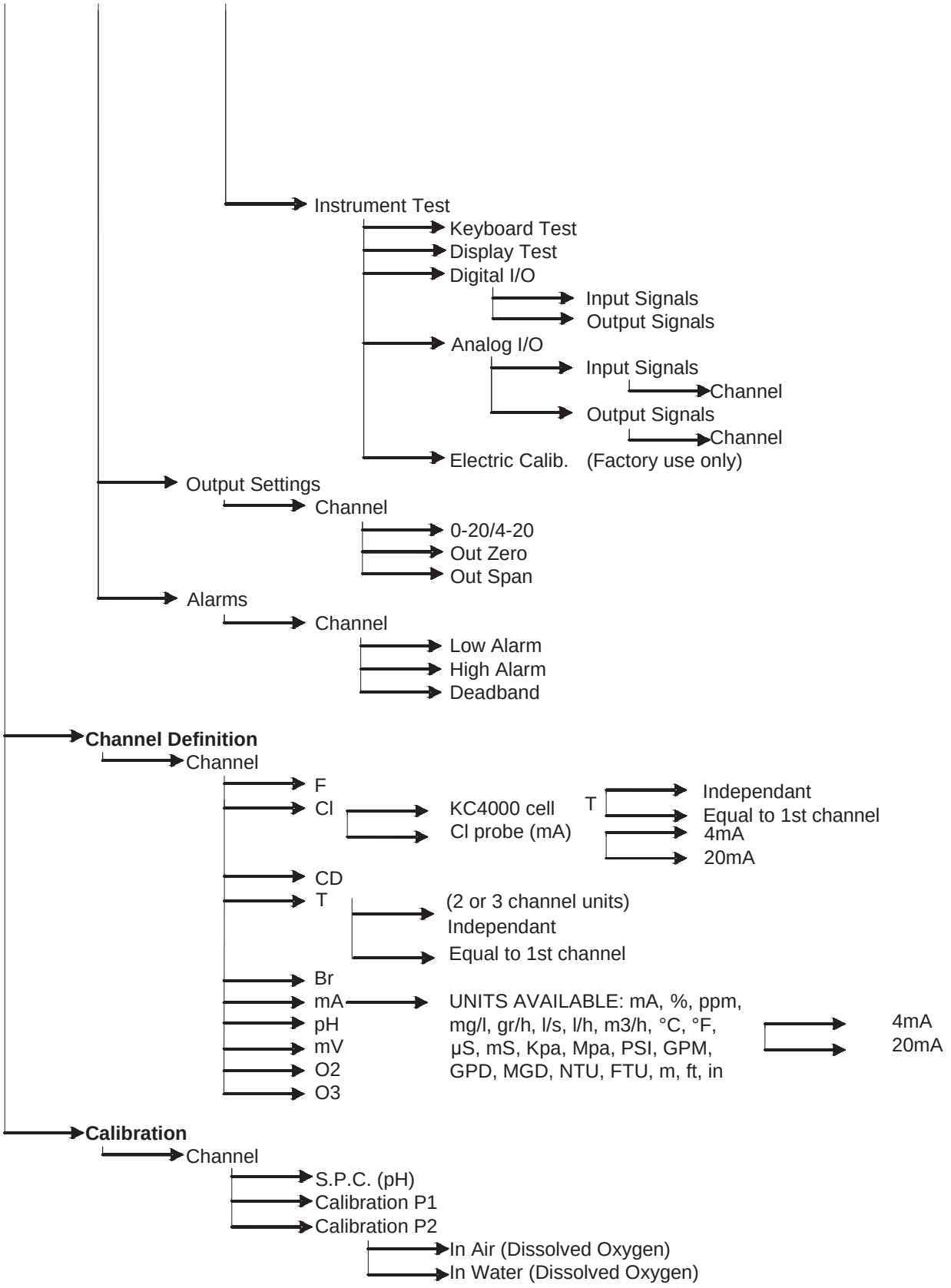
TIME CYCLE - Please refer to 5.2.2.5

23. Press ABC, see PID1 Contacts/Time Cycle Sec
24. Press Enter, see Time Cycle sec 10, this is the default value.
25. Press Enter, see Time Cycle sec/flashing cursor
26. Enter the desired value
27. Press Enter, see PID1 Contacts/Time Cycle sec
28. Press the End key until you return to the process Analyzer/Controller screen.

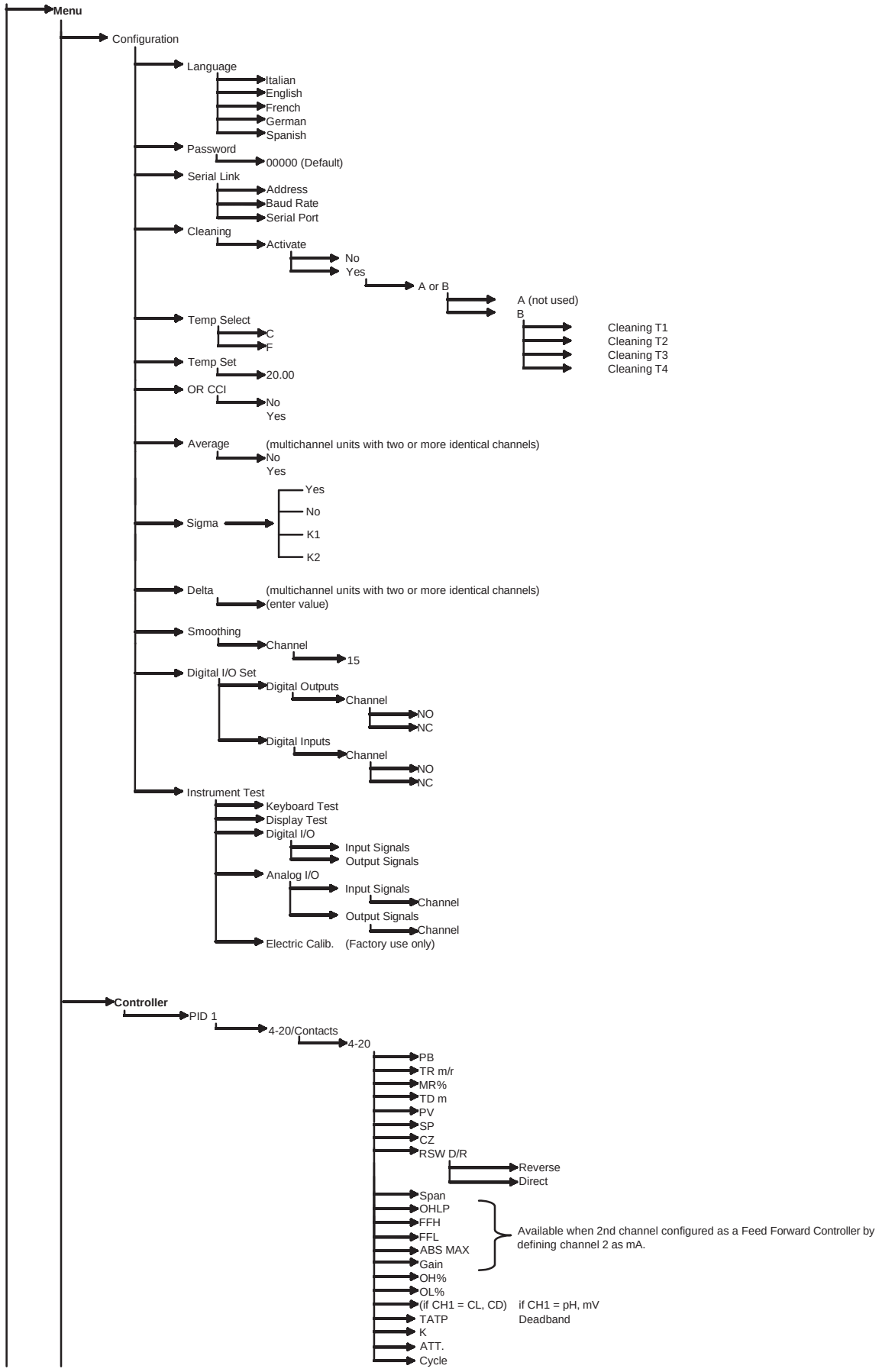
12.3 APPENDIX C - Analyzer/Transmitter Software Menu Tree



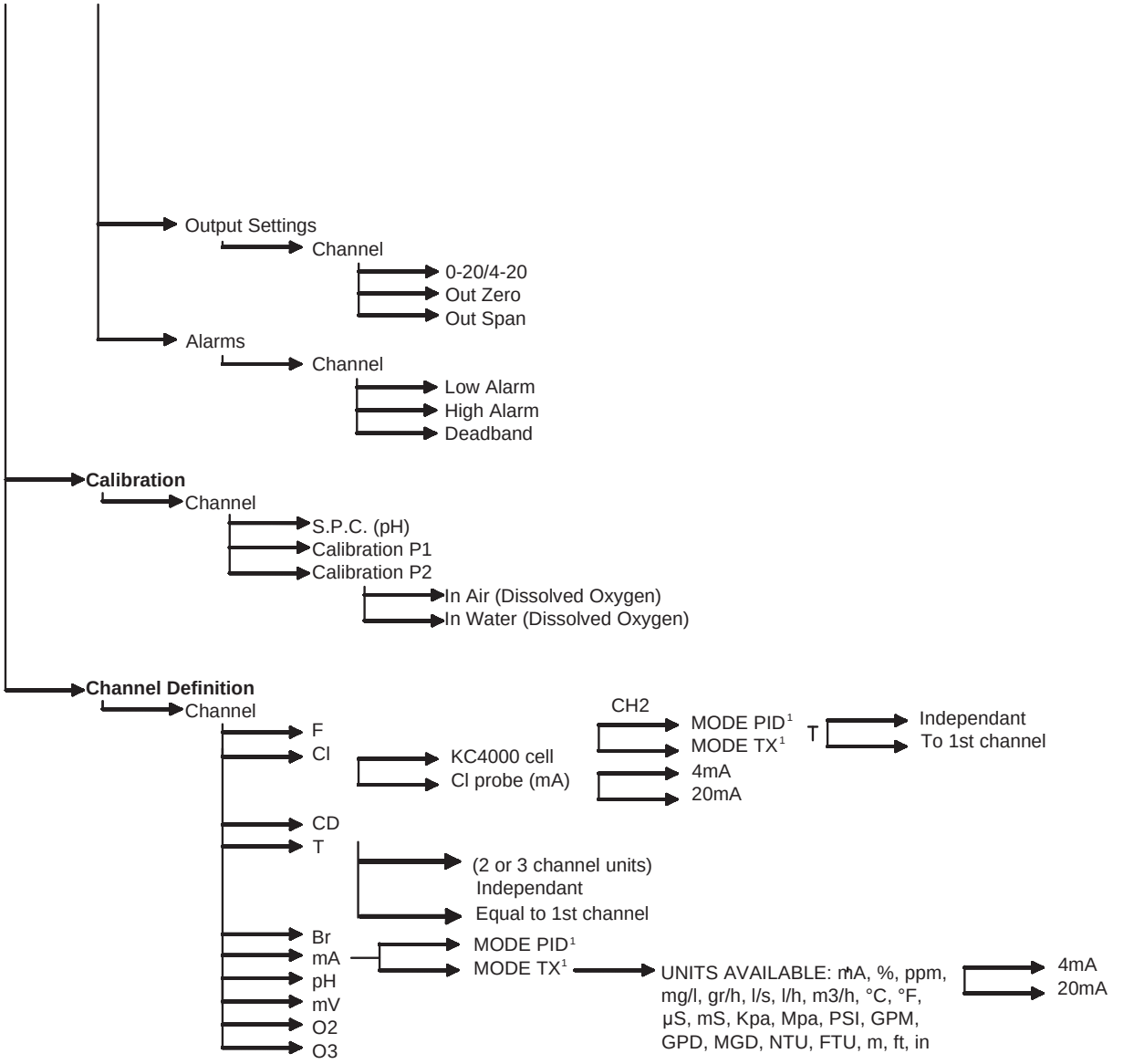
12.4 APPENDIX C (continued)



12.4 APPENDIX D - Standard/Average Controller Software Menu Tree



12.4 APPENDIX D (continued)

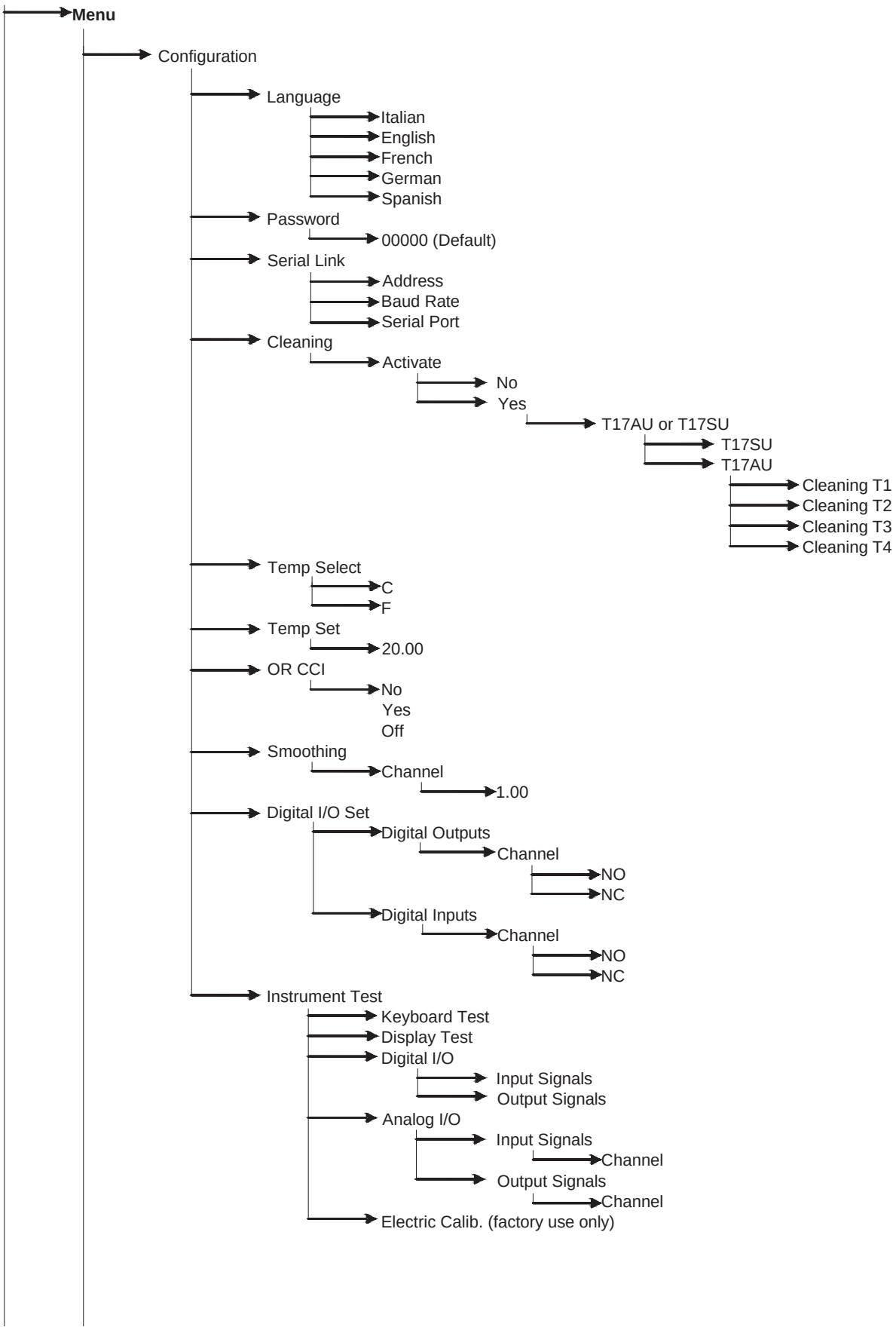


NOTE 1: ONLY APPEARS ON CHANNEL 2.
SEE SECTION 5.2.2.2.

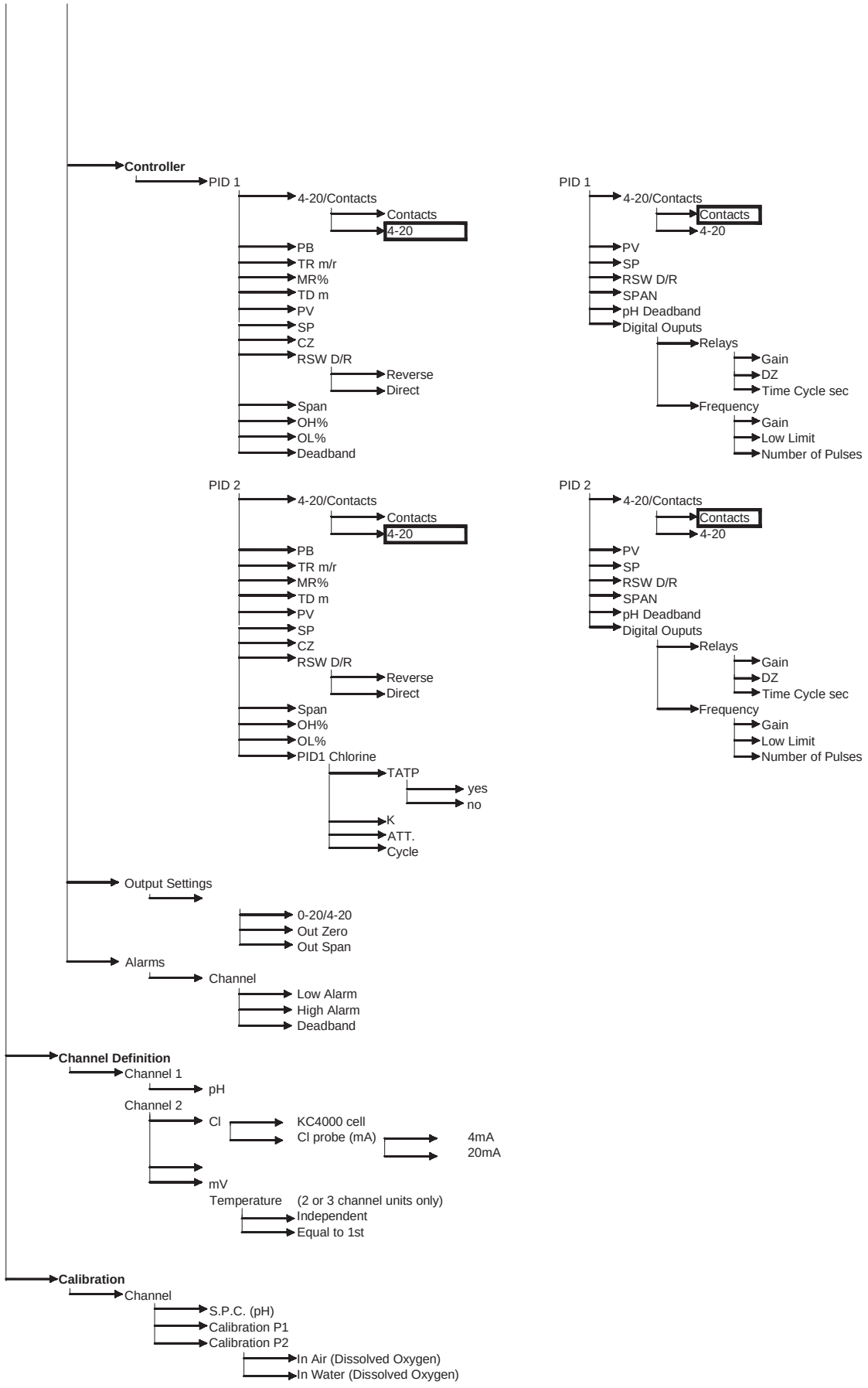
MODE PID ALLOWS INSTRUMENT TO ADJUST CONTROL SIGNAL BASED ON FLOW RATE AND THE MEASURED VALUE OF THE PROCESS.

MODE TX ALLOWS THE MEASUREMENT OF THE OTHER UNITS AVAILABLE WHEN CHANNEL 2 IS DEFINITED AS mA.

12.5 APPENDIX E - Swimming pool Controller –Software Menu Tree-



12.5 APPENDIX E – (continued)



Instruction Manual –
MicroChem®2 Chlorine Probes
Series CL4000

DE NORA

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call De Nora Water Technologies for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. De Nora Water Technologies, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact De Nora Water Technologies, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into De Nora Water Technologies equipment is conditioned on the customer absolving De Nora Water Technologies from any consequences of such a decision.

De Nora Water Technologies has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. De Nora Water Technologies, Inc. cannot be responsible for deviations from the recommended instructions that may result in a hazardous or unsafe condition.

De Nora Water Technologies, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that De Nora Water Technologies, Inc.

De Nora Water Technologies, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped “F.O.B. Colmar” or to De Nora Water Technologies for equipment shipped “F.O.B Jobsite”. Do not install damaged equipment.

De Nora Water Technologies, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
ISO 9001: 2008 CERTIFIED

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1 INTRODUCTION

1.1 General Description

This manual describes the general description, installation, operation and maintenance of the CL4000 Chlorine probes and accessories.

Chlorine is the most common chemical used in disinfection of municipal drinking water, cooling towers and many industrial applications. Once added to water the chlorine will react with chemicals already in the water forming combined chlorine or stay available as free chlorine.

A chlorine measuring system incorporating the CL4000 chlorine probes, connected to the MicroChem®2 transmitter, provides automatic measurement/control of chlorine dosage in such systems. The CL4000 chlorine probe measures free chlorine.

The transmitter is part of the MicroChem®2 series, which is capable of supporting up to three of the following measurements in all possible combinations: Dissolved Oxygen, Chlorine Dioxide, Residual Chlorine, Bromine, Ozone, ORP, Temperature, pH, Iodine and Conductivity. For a description and instructions regarding the transmitter see the MicroChem®2 transmitter instruction manual.

The chlorine probes are 3 electrode amperometric cells covered with a permeable membrane. The probe exterior is manufactured from a durable PVC and stainless steel and has a diameter of 25mm (1 inch). The probes are engineered to fit a specially designed flow cell.

De Nora Water Technologies chlorine probes can be used without the need for pH compensation.

All the CL4000 probes are designed to run without the need for reagents. The probes have no moving parts and are designed to require minimal maintenance.

Figure 1 - Chlorine Probe

1.2 Safety

The recommended operating procedures have been designed with careful attention to safety. De Nora Water Technologies has made formal safety reviews of the initial design and any subsequent changes. This procedure is followed for all new products and covers areas in addition to those included in applicable safety standards.

Observe the following safety precautions:

a. Observe all safety warnings marked on the equipment. These warnings identify areas of immediate hazard, which could result in personal injury, or loss of life.
b. Do not use this equipment for any purpose other than described in this manual.
c. Disconnect power prior to making any terminal connections within the enclosure.
d. Use the recommended connection procedures described in Section 2 of this manual.

This equipment should only be installed by suitably qualified personnel.

1.3 Chlorine Probes, Cables, Accessories and Consumables

Chlorine Probe 0-2 ppm, pH tolerable 4.0 - 9.5 (Note 1,2)	23183
Chlorine Probe 0-5 ppm, pH tolerable 4.0 - 9.5 (Note 1,2)	23184
Chlorine Probe 0-10 ppm, pH tolerable 4.0 - 9.5 (Note 1,2)	23185
4 Foot Cable (Note 3)	78-4001
12 Foot Cable (Note 3)	78-4002
40 Cable (Note 3)	78-4003
Sample/Drain Tubing, CLEAR, 3/16" ID X 5/16" OD	R-376
Flow Through Cell with integral shut off valve (Note 4)	23411
Flow Through Cell and Flow Control Kit (Note 4, 6)	23449
Sample Flow Control Kit (Note 7)	23318
Flow Control Panel Kit (Note 6)	23451
Y Strainer 80 mesh, Max Inlet 75 PSIG	22901
Pressure Reducing Valve Kit, 0-25 PSIG, Max Inlet 300 PSIG w/15 PSIG Gauge & Bracket	23425
Flow Meter Assembly w/Rate Valve, 0-10 GPH	23426
Flow Switch (Note 7)	22896
Carbon Dechlorinating Filter (Note 9)	23450
Annual Maintenance Kit for:	
01-4030 and 01-4031 Probes Includes: PN 77-4005 and PN 94-2135	10-4001
23183, 23184, 23185, 01-4032 and 01-4033 Probes Includes: PN 77-4004 and PN 94-2136	10-4002
01-4034 and 01-4035 Probes Includes: PN 77-4004 and PN 94-2137	10-4003
M48 Membrane Cap to fit 23183, 23184, 23185, 01-4032, 01-4033, 01-4034 and 01-4035 Probes	77-4004
M20 Membrane Cap to fit 01-4030 and 01-4031 Probes	77-4005
G-Holder for 23183, 23184, 23185, 01-4032 and 01-4033 Probes	77-4017
Electrolyte Solution (100ml) for 01-4030 and 01-4031 Probes	94-2135
Electrolyte Solution (100ml) for 23183, 23184, 23185, 01-4032 and 01-4033 Probes	94-2136
Electrolyte Solution (100ml) for 01-4034 and 01-4035 Probes	94-2137

Notes:

1. The MicroChem2 Transmitter/Controller must be fitted with the expanded function board (P/N 1T686B129U12, U13 or U14) in order to provide power to the probe and the software must be Version 2.8 or above. Consult factory on upgrading earlier versions of microchem2 transmitter/controllers to the latest revision.
2. 23183, 23184, and 23185, probes with 3-electrode sensor for the measurement of free available chlorine. Temperature compensated (0 to 40°C). pH tolerable within the operating range 4 to 9.5.
3. Cable 78-4001, 78-4002 or 78-4003 must be used for probe to function properly.
4. Flow cell 23411 includes a low pressure fitting (installed) and is also provided with a back pressure fitting to prevent the formation of air bubbles in the probe chamber at sample pressures of 6-8 PSIG (0.4-0.5 bar).
5. Flow Control Kit (P/N 23318) improves flow and pressure control of CL4000 probes. It includes a PRV Kit (P/N 23425), Flow Meter Assembly (P/N 23426), 10 ft of tubing and connectors.
6. The Flow Control Panel Kit (P/N 23451) (26" H X 28" W X 0.5" thick) is predrilled and tapped for mounting the Microchem2 and 2 acrylic flow cells for chlorine or for use with pH, conductivity, or ORP 12mm probes and is supplied with mounting hardware.
7. Flow Switch: dry contact opens on loss of sample flow.
8. Dechlorinating Filter provides a chlorine free sample stream, used for calibrating the MicroChem2.

1.4 Technical Data / Specifications

Quality Management System:	The design & manufacturing process of De Nora Water Technologies are certified to ISO9001.	
Range:	0 - 2 mg/l, 0 -5 mg/l or 0 - 10 mg/l (probe dependant)	
Type of measurement:	Free chlorine	
Temperature Compensation:	Internal	
Speed of Response:	Ninety (90)% step change < 2 minutes.	
Ambient/sample Temp:	32 °F - 104 °F (0 °C - 40 °C)	
Limit of Detection:	Probe, chlorine, 0-2 ppm : 0.01 ppm Probe, chlorine, 0-5 ppm : 0.03 ppm Probe, chlorine, 0-10 ppm : 0.05 ppm	
Reproducibility:	0.05 mg/l	
Accuracy:	± 5% of range	
Sample Inlet Pressure:	0 to 8 psi (0 to .5 bar)	
Sample Temperature:	32 °F - 104 °F (0 °C - 40 °C)	
Sample Flow:	8 gph (30 liters per hour)	
Electrodes:	Working Electrode - gold	
	Counter Electrode - stainless steel	
	Reference Electrode: Silver/Silver-Chloride	
pH:	Chlorine: independent of pH (pH 4 to pH 9.5) Signal loss is 5% per pH unit (pH greater than 7)	
Dimensions:	**I**n flow cell:	14.6” (h) x 2.25” (dia) 370mm x 55 mm
	Probe alone	1” (dia) x 9” (l), 25mm (dia) x 230mm (l)
Weight:	probe and flow cell	1lb (450g)
Connectors:	2 x compression fitting for flexible tubing ID 3/16”, OD 5/16”	
Cable:	Various lengths available	
Sample Limitations:	Samples containing particles 100 microns (0.004 inches) in diameter and larger may require pre-filtration. There should be no surfactants in the water.	
Ammonia Interference:	CL4000 probes in the presence of ammonia will measure free and/or combined chlorine.	
Permanganate Interference:	1 ppm permanganate = 0.5 ppm chlorine	

1.5 Principle of Operation

The chlorine probes are amperometric cells covered with a permeable membrane. The probes are engineered to fit a specially designed flow cell.

A sample of liquid is delivered to the input (bottom) of the flow cell at an approximate rate of 500 ml/min.

The sample passes the membrane on the tip of the membrane cap. Chlorine diffuses through the membrane and into the internal filling solution where a small DC current is generated between the stainless steel counter electrode and gold working electrode in direct linear proportion to the amount of residual present in the sample. A third reference electrode establishes a constant potential on the gold working electrode to provide an accurate and stable residual signal.

The signal is amplified and transmitted to the MicroChem®2 transmitter/controller via the sensor cable. The probe needs to be loop powered. This power is generated within the MicroChem®2 and supplied to the probe in the same cable which transmits the residual signal.

All the CL4000 chlorine probes are designed to run without the need for reagents. The probes have no moving parts and are designed to require minimal maintenance.

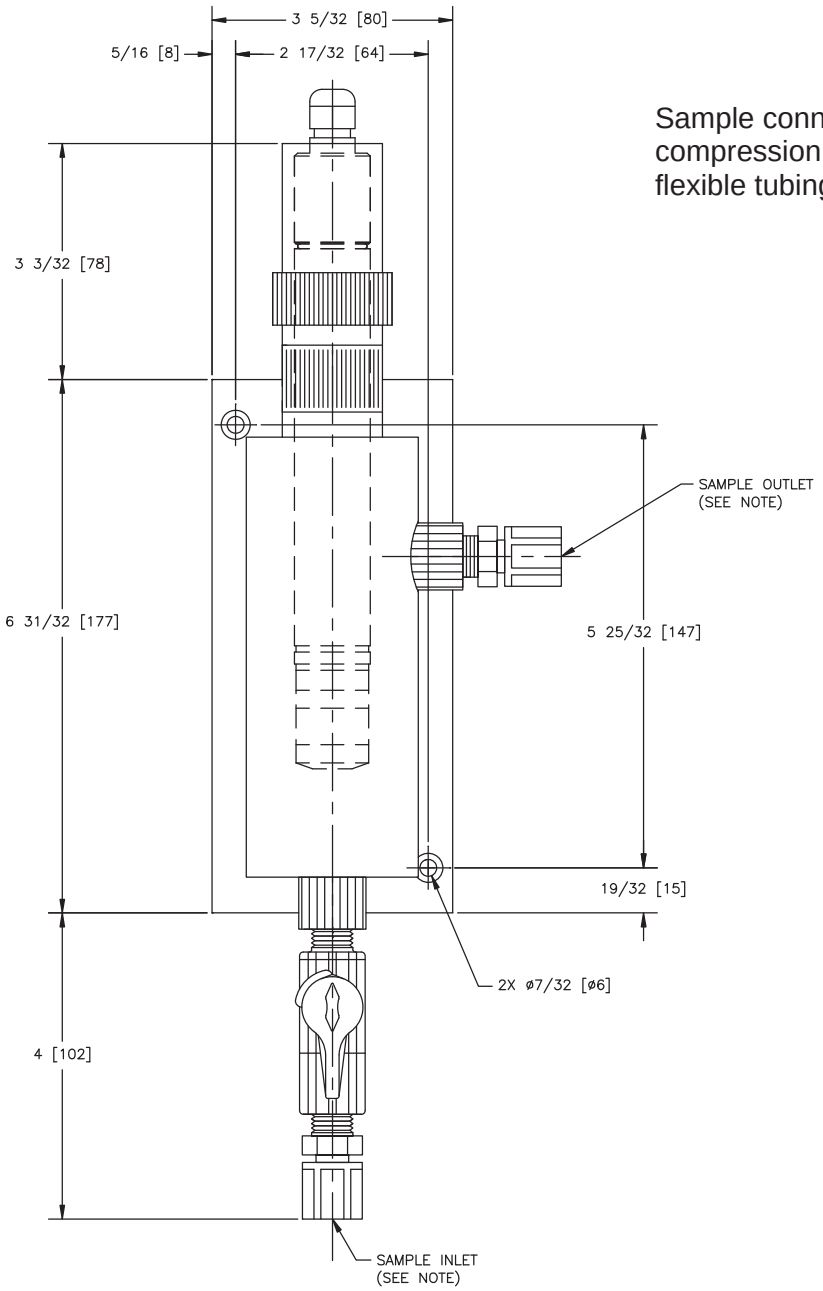
2 INSTALLATION

2.1 General

Remove the instrument from its box and carefully inspect each item and report damages immediately. The box will include the chlorine probe (electrode shaft, top cap and membrane cap), electrolyte bottle and a sheet of blue abrasive paper.

The chlorine probes are designed for general duty indoor installation. Outdoor installation is possible if the instrument is shielded from dripping water and not mounted in direct sunlight. Ensure that the process and environmental conditions are within specified limits (see specification).
Excessive heat and vibration will affect the sensors.

2.2 Mounting Dimensions



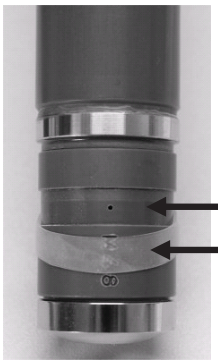
Sample connectors are compression fitting, requiring flexible tubing 3/16” ID x 5/16” OD

Figure 2 - Mounting Dimensions

2.3 Chlorine Probes

WARNING
Do not touch the electrode finger (see Figure 3)
Do not touch the bottom of the membrane cap (see Figure 3)

To assemble the probes for use:



When removing the membrane cap, move the vent seal away from the vent hole to allow air into the membrane cap. Not doing so may cause a vacuum to form and damage the membrane.

Fill the membrane cap to the top with electrode filling solution (note each electrode has a specially formulated filling solution which is unique to that sensor – see parts list for details). Tap the side of the membrane cap to remove any air bubbles that may have formed in the solution.

Reposition the vent seal, making sure that the vent hole is completely covered.

Fill up the G-holder with filling solution. Be careful that there are no bubbles.

Hold the electrode shaft upright and push the electrode finger carefully into the filled G-holder.

While holding the electrode shaft vertically with the G-holder in place, screw the filled membrane cap back on to the electrode shaft. Make sure not to press on the vent ring seal or cover the area of the vent hole with a finger when installing the membrane cap. Excess filling solution will escape from top or the vent in the membrane cap. Rinse off any filling solution that may have escaped during the installation with clean water.

Note: The G-holder is supplied and required for use with the chlorine probes and with the annual maintenance kits containing the M48 membrane cap. See parts list for details.

Note: When unscrewing the filled membrane cap from the electrode shaft, first remove the vent seal and ensure that the vent is not covered by a finger (air needs to be allowed through the vent hole to equalize the pressure).

Note: Make sure the membrane cap is tightly fastened to the electrode shaft ensuring that no gap remains between the electrode shaft and the membrane cap.

Note: It is best to wait 1 - 4 hours before the first calibration is performed. After one day repeat the calibration. See the MicroChem®2 electronics manual for calibration instructions.

Note: Calibration must be made with a continuous flow of liquid at 500 mL/min across the cell membrane.

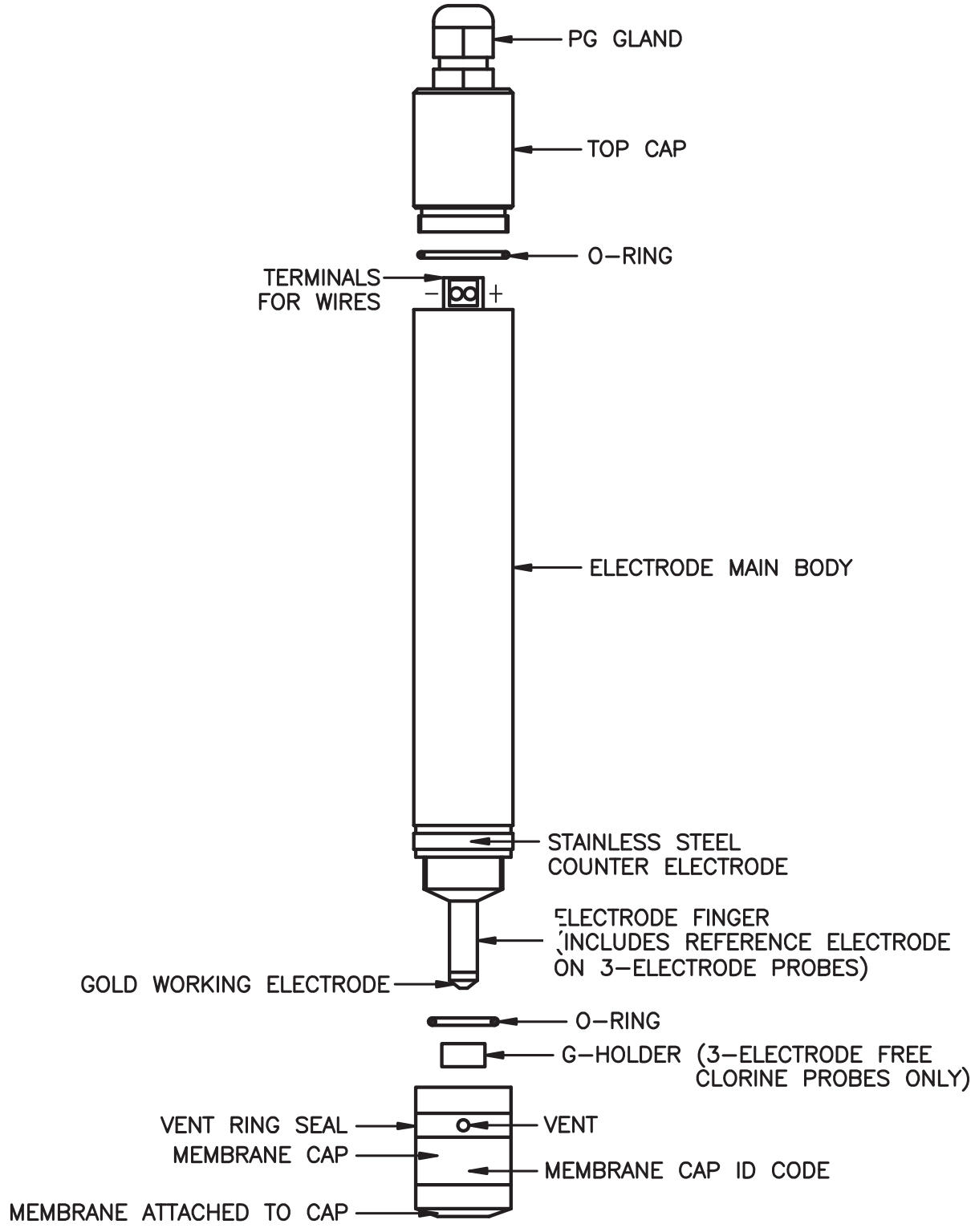


Figure 3 - Chlorine Probe Components.

2.4 Flow Cell

The probe is inserted through a fitting which includes a slide ring and o-ring. Loosen or disassemble the fitting to allow the probe to slide through the o-ring. The fitting may include a cap through which the probe cable must be fed. **Position the probe so it is about 1 inch (25 mm) from the bottom of the cell.** Tighten the fitting into the housing to compress the o-ring around the probe, providing a seal.

The inlet valve may be used to provide control the flow to the probe. It should be full open if the sample stream is controlled by other components.

The adapter to be used on the outlet from the cell and is dependent on the sample supply. The sample flow as noted in the section 1.4 is required. Excessive air in the sample may adversely affect the readings. The small orifice adapter may be used to provide back pressure to keep the air from outgasing from the sample stream.

2.5 Flow Regulation Components (See Figure 4)

To provide a sample to be measured for chlorine content with reduced potential for erratic readings and calibration problems, it is highly recommended that some or all of the components in Figure 4 are incorporated in the sample line. The Y-strainer is for particulate removal. The flow switch provides alarm when flow is not present. The remaining components through the back pressure assembly will ensure that you are providing the proper flow and pressure to allow optimum analysis. The back pressure assembly is used in applications where air bubbles effervesce from the sample.

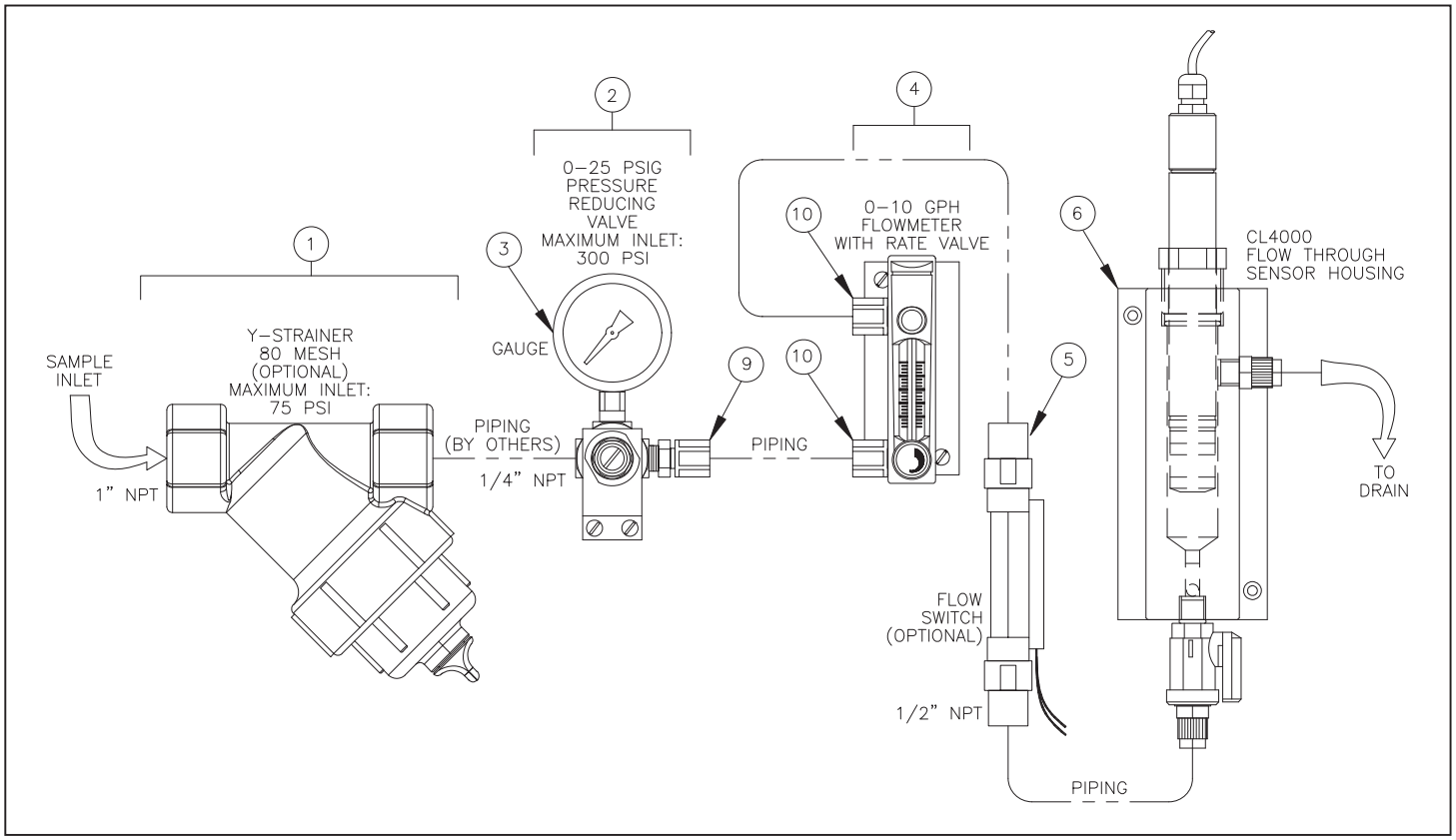


Figure 4 – Arrangement, Piping, CL4000 Sensor

Key	**Part Number**	**Description**
1	22901	Y-strainer - (optional) for particulate removal
2	22832 (See Note 1)	Pressure Reducing Valve, 0-25 PSIG
3	23101 (See Note 1)	Pressure Gauge, 0-15 PSIG, ¼" NPT SS
4	22834 (See Note 1)	Flowmeter with Rate Valve, 0-10 GPH
5	22896 (See Note 2)	Flow Switch
6	23411	CL4000 Flow Cell
9	23102	Fitting, ¼ MNPT x 5/16 Tube
10	23104	Fitting, 1/8 MNPT x 5/16 Tube 90 Deg

Notes:

1. Included in Flow Control Kit P/N 23068
2. Used to indicate if sample flow is present. For connection to external device or alarm contact.

2.6 Electrical

The chlorine probes are connected to the transmitter analog board at pin 5 and 6 AND to the 24v power supply terminals (see Figure 5). For more details on the analog board see the transmitter manual.

WARNING
The transmitter power **MUST** be switched **OFF** before the probe is attached.

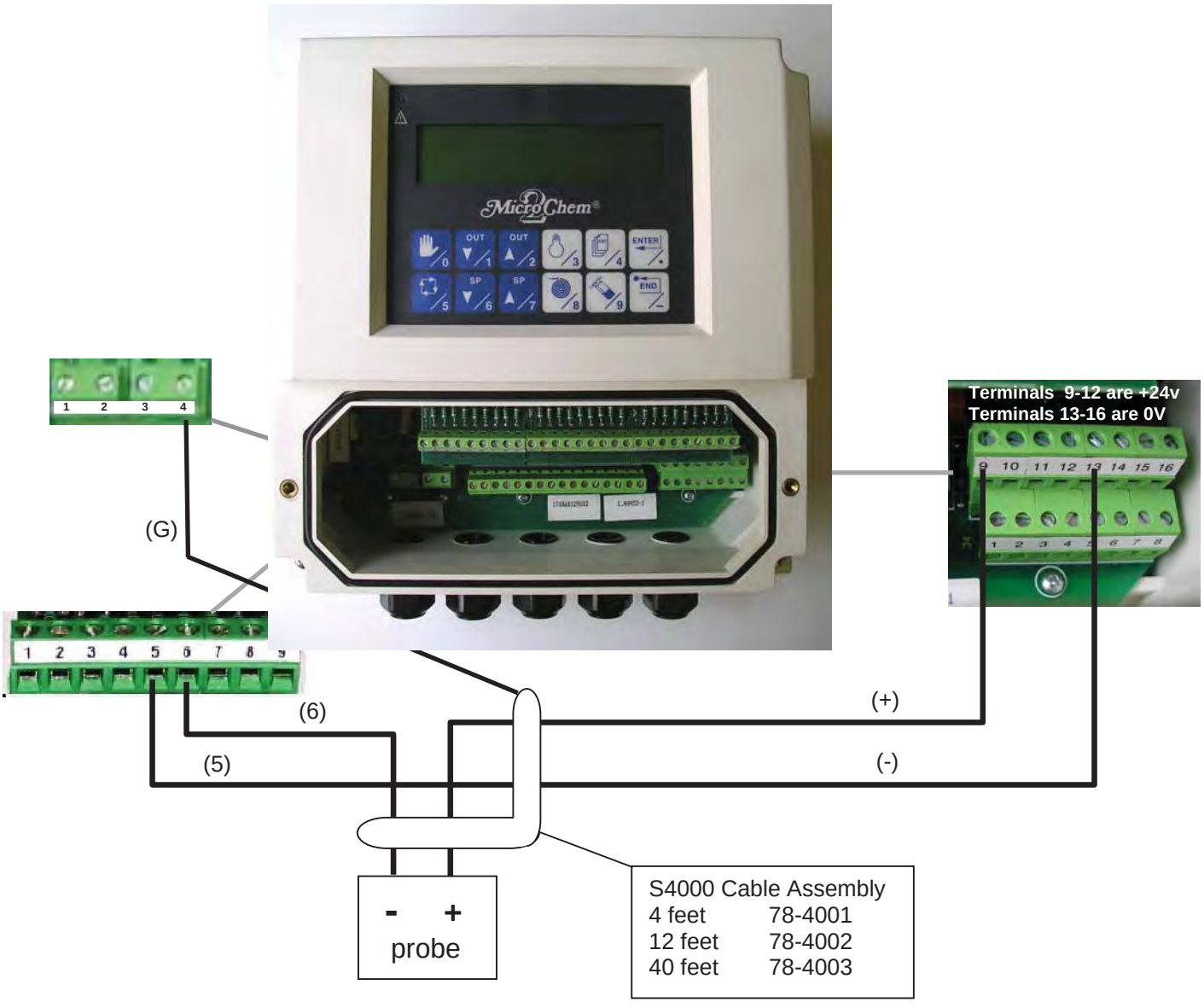


Figure 5 - Probe Cable Connections

WARNING
For proper operation of the chlorine probe, one of the above listed cable Assemblies must be used.

3 STARTUP

1. Check that the entire installation is connected properly. Check the electrode is properly connected via the supplied cable.
2. Configure the transmitter channel that the probe is connected to for CL (Chlorine). Select CL probe (mA) as the probe type. Set the probe range (0-2, 0-5 or 0-10 ppm) as indicated on the chlorine probe label. Refer to the MicroChem®2 Transmitter instruction manual for additional start-up information.
3. A calibration must be performed. Please find the instructions related to the procedure in the MicroChem®2 instruction bulletin.
4. Output from CL4000 probes is never below 3.8 mA. At start-up, the probes may have an output as low as 2 to 2.5 mA, but will rise to about 4 mA after half an hour. If output is less, the electrolyte will need to be changed and the gold probe cleaned. Momentary power losses will also result in low output, but will increase in about 30 minutes.

4 MAINTENANCE

4.1 Periodic Functional Check

The MicroChem®2 analyzer, like other analyzers, should be checked once per week to assure the best measurement accuracy.

4.2 Electrode Maintenance

There is very little maintenance required on a chlorine electrode. Periodically the electrode should be removed, and rinsed with de-ionised water.

CAUTION
Do not touch the tip of the electrode.

4.2.1 Electrode Membrane

The membrane cap needs to be replaced periodically (typically annually). The internal filling solution needs to be replaced at the same time (section 2.3)
Note: pay particular attention to the notes on removing the membrane cap.

If the membrane gets coated it is possible to clean it. Very carefully swirl the membrane in a 1% hydrochloric acid solution.

4.2.2 Cleaning the electrode surfaces

If the electrode has been stored for a long period of time the (gold) working electrode surface may become tarnished and require polishing.

Empty out the internal filling solution – (section 2.3). Dry the electrode finger carefully using a clean dry cloth .Holding the blue abrasive paper flat on a clean dry surface and holding the electrode body vertically move the tip of the electrode across the paper two or three times. Refill and reattach the membrane cap. (see section 2.3)

5 TROUBLE SHOOTING PROCEDURE

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
No indication	No power supply to the transmitter	Power the transmitter up or check the power supply fuse. Check power supply jumper setting.
Reading on Display is not in agreement with the chlorine level present in the sample	Faulty transmitter	Verify transmitter (especially analogue board)
	The sensor is not continuously in contact with the sample	Modify sensor installation
	The connection between the sensor and the transmitter is not correct.	Make correct connections
	Membrane is split or coated; internal filling solution contaminated or depleted	Replace membrane and filling solution
	The working electrode may be tarnished	Clean the electrode surface
	The chlorine cell has been selected rather than the chlorine probe. (RT Fault will be displayed with this error)	Reprogram the transmitter software
	The wrong chlorine range has been set up	Reprogram the transmitter software
Reading on Display is fluctuating or erratic	Not properly calibrated	Recalibrate P2
	Chlorine level is fluctuating	Check the process
	Sample flow rate is too low or variable	Resolve flow problems. Add Pressure Regulator and Flow meter for sample control.
	The sensor is not continuously in contact with the sample	Modify sensor installation
	Air bubbles in the sample	Eliminate the air bubbles or modify the installation
"RTD" Fault displayed	Incorrect chlorine channel definition – Wrong chlorine input selected	Refer to transmitter instruction manual. Select chlorine probe channel definition.

Design improvements may be made without notice.

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SEP 2015

invensys
Eurotherm

nanodac™
User Guide

nanodac™ recorder/controller
Versions 3 and later

HA030554/5
Feb 2012

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Eurotherm Limited pursues a policy of continuous development and product improvement. The specification in this document may therefore be changed without notice. The information in this document is given in good faith, but is intended for guidance only. Eurotherm Limited will accept no responsibility for any losses arising from errors in this document.

Declaration of Conformity

Manufacturer's name:	Eurotherm Limited
Manufacturer's address:	Faraday Close, Worthing, West Sussex, BN13 3PL, United Kingdom
Product type:	Recorder / controller
Models:	nanodac Status level A1 and above
Safety specification:	EN61010-1: 2001
EMC emissions specification:	EN61326-1: 2006 Class B (100 to 230V ac supply) EN61326-1: 2006 Class A (24V ac/dc supply)
EMC immunity specification:	EN61326-1: 2006 Industrial locations

Eurotherm Limited hereby declares that the above products conform to the safety and EMC specifications listed. Eurotherm Limited further declares that the above products comply with the EMC Directive 2004/108/EC, and also with the Low Voltage Directive 2006/95/EC.

Signed: K Shaw Dated: 11/11/10

Signed for and on behalf of Eurotherm Limited.
Kevin Shaw
(R&D Director)

CE

IA249986U790 Issue 2 Oct 10 (CN26774)

Restriction of Hazardous Substances (RoHS)

Product group nanodac

Table listing restricted substances

Chinese

限制使用材料一览表

产品 nanodac	有毒有害物质或元素					
	铅	汞	镉	六价铬	多溴联苯	多溴二苯醚
印刷线路板组件	X	O	O	O	O	O
附属物	O	O	O	X	O	O
显示器	O	O	O	O	O	O
O	表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。					
X	表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求。					

English

Restricted Materials Table

Product nanodac	Toxic and hazardous substances and elements					
	Pb	Hg	Cd	Cr(VI)	PBB	PBDE
PCBA	X	O	O	O	O	O
Enclosure	O	O	O	X	O	O
Display	O	O	O	O	O	O
O	Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.					
X	Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.					

Approval

Name:	Position:	Signature:	Date:
Martin Greenhalgh	Quality Manager	Martin Greenhalgh	11th APRIL 2010

IA029470U790/1 (CN26215)

nanodac Recorder/Controller

User Guide

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Associated documents

HA028838 Printable version of iTools Help
HA025464 EMC installation guidelines
HA027962 Printable version of 'Review' Help

Application notes

HA030817U001 Archiving data from the nanodac recorder/controller
HA030817U002 Heat/Cool with carbon potential or oxygen level monitoring
HA030817U003 Heat only temperature control and carbon potential control
HA030817U004 Virtual channels using the nanodac recorder/controller.

Software effectivity

This manual refers to instruments fitted with software version 3.0.
Software versions 2.20 onwards are 'backwards compatible' so that it can be used on all hardware versions of the unit.
Previous software versions are not compatible with instruments with hardware status greater than 2.
The status level may be found on the instrument label and consists of a letter indicating software status followed by a numeral indicating the hardware status (e.g. 'B2')

nanodac Recorder/Controller

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SAFETY NOTES

WARNINGS

1. Any interruption of the protective conductor inside or outside the apparatus, or disconnection of the protective earth terminal is likely to make the apparatus dangerous under some fault conditions. Intentional interruption is prohibited.
2. Live sensors: The unit is designed to operate if the temperature sensor is connected directly to an electrical heating element. It must be ensured that service personnel do not touch connections to such inputs whilst the inputs are live. With live sensors, all cables, connections and switches for connecting the sensor must be mains rated for use in 240V Cat II.
3. Grounding the temperature sensor shield: Where it is common practice to replace the temperature sensor whilst the instrument is live, it is recommended that the shield of the temperature sensor be grounded to safety earth, as an additional protection against electric shock.
4. The instrument must not be wired to a three-phase supply with an unearthed star connection, because, under fault conditions, such a supply could rise above 240V RMS with respect to ground, thus rendering the instrument unsafe.

Notes:

1. Safety requirements for permanently connected equipment state:
   a. A switch or circuit breaker shall be included in the building installation.
   b. It shall be in close proximity to the equipment and within easy reach of the operator.
   c. It shall be marked as the disconnecting device for the equipment.
2. Recommended external fuse ratings are: 2A Type T 250V.

1. This instrument is intended for industrial temperature and process control applications within the requirements of the European directives on safety and EMC.
2. Installation may be carried out only by qualified personnel.
3. To prevent hands or metal tools coming into contact with parts that are electrically live the instrument must be installed in an enclosure.
4. Where conductive pollution (e.g. condensation, carbon dust) is likely, adequate air conditioning/filtering/sealing etc. must be installed in the enclosure.
5. The mains supply fuse within the power supply is not replaceable. If it is suspected that the fuse is faulty, the manufacturer's local service centre should be contacted for advice.
6. Whenever it is likely that protection has been impaired, the unit shall be made inoperative, and secured against accidental operation. The manufacturer's nearest service centre should be contacted for advice.
7. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired.
8. The unit must be wired according to the instructions in this manual.
9. Before any other connection is made, the protective earth terminal shall be connected to a protective conductor. The mains (supply voltage) wiring must be terminated in such a way that, should it slip, the Earth wire would be the last wire to become disconnected. The protective earth terminal must remain connected (even if the equipment is isolated from the mains supply), if any of the I/O circuits are connected to hazardous voltages*.
   The protective earth connection must always be the first to be connected and the last to be disconnected.
   Wiring must comply with all local wiring regulations, e.g. in the UK, the latest IEEE wiring regulations (BS7671) and in the USA, NEC class 1 wiring methods.
10. Signal and supply voltage wiring should be kept separate from one another. Where this is impractical, shielded cables should be used for the signal wiring.

* A full definition of 'Hazardous' voltages appears under 'Hazardous live' in BS EN61010. Briefly, under normal operating conditions, hazardous voltages are defined as being > 30V RMS (42.2V peak) or > 60V dc.

SAFETY NOTES (Cont.)

11. The maximum continuous voltage applied between any of the following terminals must not exceed 240Vac.
    1. Relay output to logic, dc or sensor input connections
    2. Any connection to ground.

    The ac supply must not be connected to sensor input or low-level inputs or outputs.
12. Over temperature protection: A separate over-temperature protection unit (with an independent temperature sensor) should be fitted to isolate the process heating circuit should a fault condition arise.

    Alarm relays within the recorder/controller do not give protection under all fault conditions/
13. In order to allow the power supply capacitors to discharge to a safe voltage, the supply must be disconnected at least two minutes before the instrument is removed from its sleeve. The touching of the exposed electronics of an instrument which has been removed from its sleeve should be avoided.
14. Instrument labels may be cleaned using iso-propyl alcohol, or water or water-based products. A mild soap solution may be used to clean other exterior surfaces.

USB DEVICE PRECAUTIONS

Note: the use of U3 USB Flash drives is not recommended.

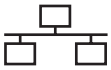
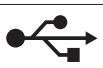
1. Precautions against electrostatic discharge should be taken when the instrument terminals are being accessed. The USB and Ethernet connections are particularly vulnerable.
2. Ideally, the USB device should be plugged directly into the instrument, as the use of extension leads may compromise the instrument's ESD compliance. Where the instrument is being used in an electrically 'noisy' environment however, it is recommended that the user brings the USB socket to the front of the panel using a short extension lead. This is because the USB may 'lock up' or reset in noisy environments and the only means of recovery is to remove the device, then re-insert it. For memory sticks, EMC-related failure during a write operation might cause corruption of the data held on the stick. For this reason, the data on the memory stick should be backed up before insertion and checked after removal.
3. When using a USB extension cable, a high quality screened cable must be used. The total length of USB cable between the device and the USB port must not exceed 3 metres (10 ft.)
4. Most barcode readers and keyboards are not designed for use in industrial EMC environments, and their operation in such environments may result in impaired performance of the recorder/controller.

32-BIT RESOLUTION

Floating point values are stored in IEEE 32-bit single precision format. Values which require greater resolution than is available in this format are rounded up or down.

SYMBOLS USED ON THE RECORDER LABELLING

One or more of the symbols below may appear as a part of the recorder labelling.

	Refer to manual for instructions		Risk of electric shock
	This unit is CE approved		Precautions against static electrical discharge must be taken when handling this unit
	C-Tick mark for Australia (ACA) and New Zealand (RSM)		Ethernet connector
	Underwriters laboratories listed mark for Canada and the U.S.A.		USB connector
	For environmental reasons, this unit must be recycled before its age exceeds the number of years shown in the circle.		Protective conductive terminal (Safety Earth)

1 INTRODUCTION

This document describes the installation, operation and configuration of a paperless graphic recorder/controller. The instrument comes, as standard with four input channels and is equipped, for secure archiving via FTP transfer and/or to USB memory stick.

1.1 UNPACKING THE INSTRUMENT

The instrument is despatched in a special pack, designed to give adequate protection during transit. Should the outer box show signs of damage, it should be opened immediately, and the contents examined. If there is evidence of damage, the instrument should not be operated and the local representative contacted for instructions. After the instrument has been removed from its packing, the packing should be examined to ensure that all accessories and documentation have been removed. The packing should then be stored against future transport requirements.

2 INSTALLATION

CAUTION

Before installation, ensure that the specified instrument supply voltage matches the facility supply.

2.1 MECHANICAL INSTALLATION

Figure 2.1 gives installation details.

2.1.1 Installation procedure

1. If it is not already in place, fit the IP65 sealing gasket behind the front bezel of the instrument.
2. Insert the instrument through the panel cutout, from the front of the panel.
3. Spring the retaining clips into place, and secure the instrument by holding it firmly in place whilst pushing both clips towards the rear face of the panel.
4. The protective membrane can now be removed from the display.

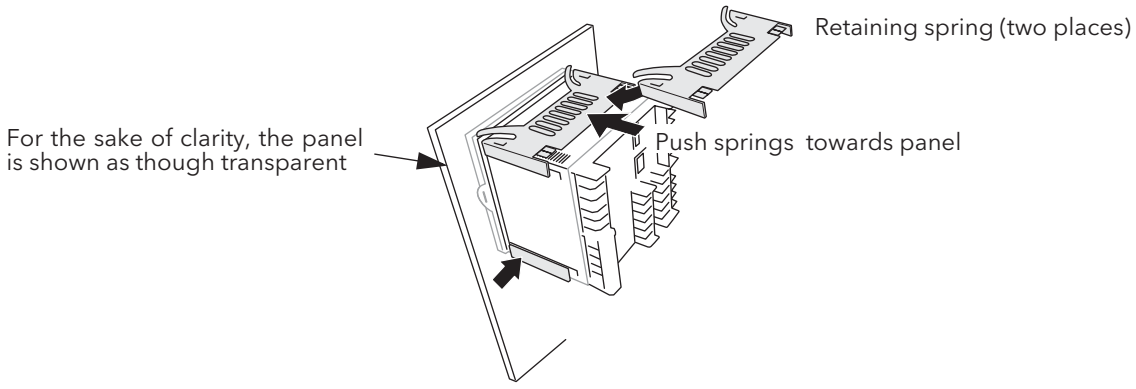


Figure 2.1.1 Securing the instrument

2.1.2 Demounting

WARNING

Before removing the supply voltage wiring, isolate the supply voltage and secure it against unintended operation.

1. Isolate the mains supply and secure it against accidental operation. Remove all wiring and the USB device and Ethernet cable (if any).
2. Remove the retaining springs by unhooking them from the sides using a small flat-blade screwdriver.
3. Pull the instrument forwards out of the panel.

Note: See section C1 (Battery replacement) for a more detailed description

2 MECHANICAL INSTALLATION (Cont.)

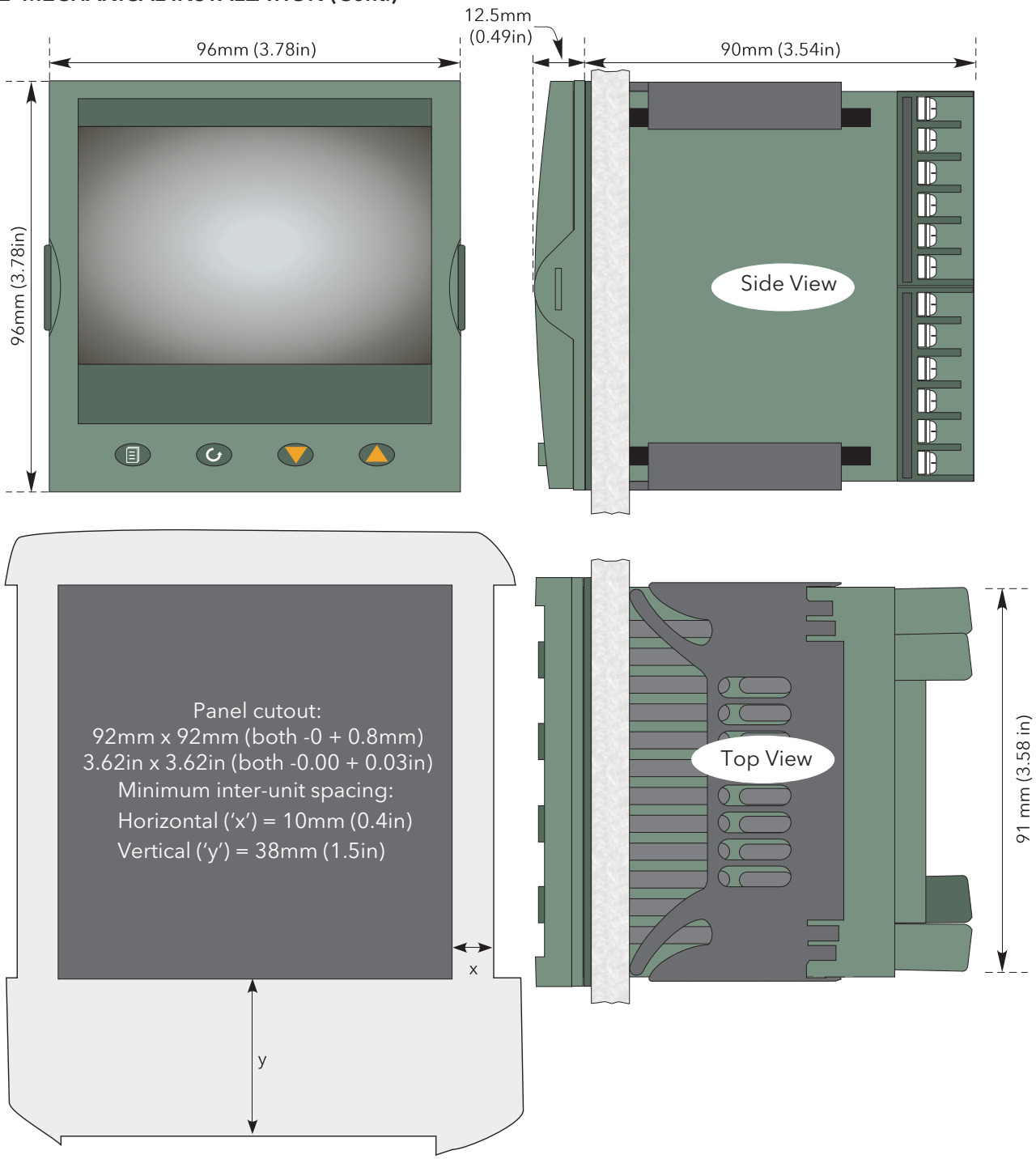


Figure 2.1a Mechanical installation details (standard case)

2.1 MECHANICAL INSTALLATION (Cont.)

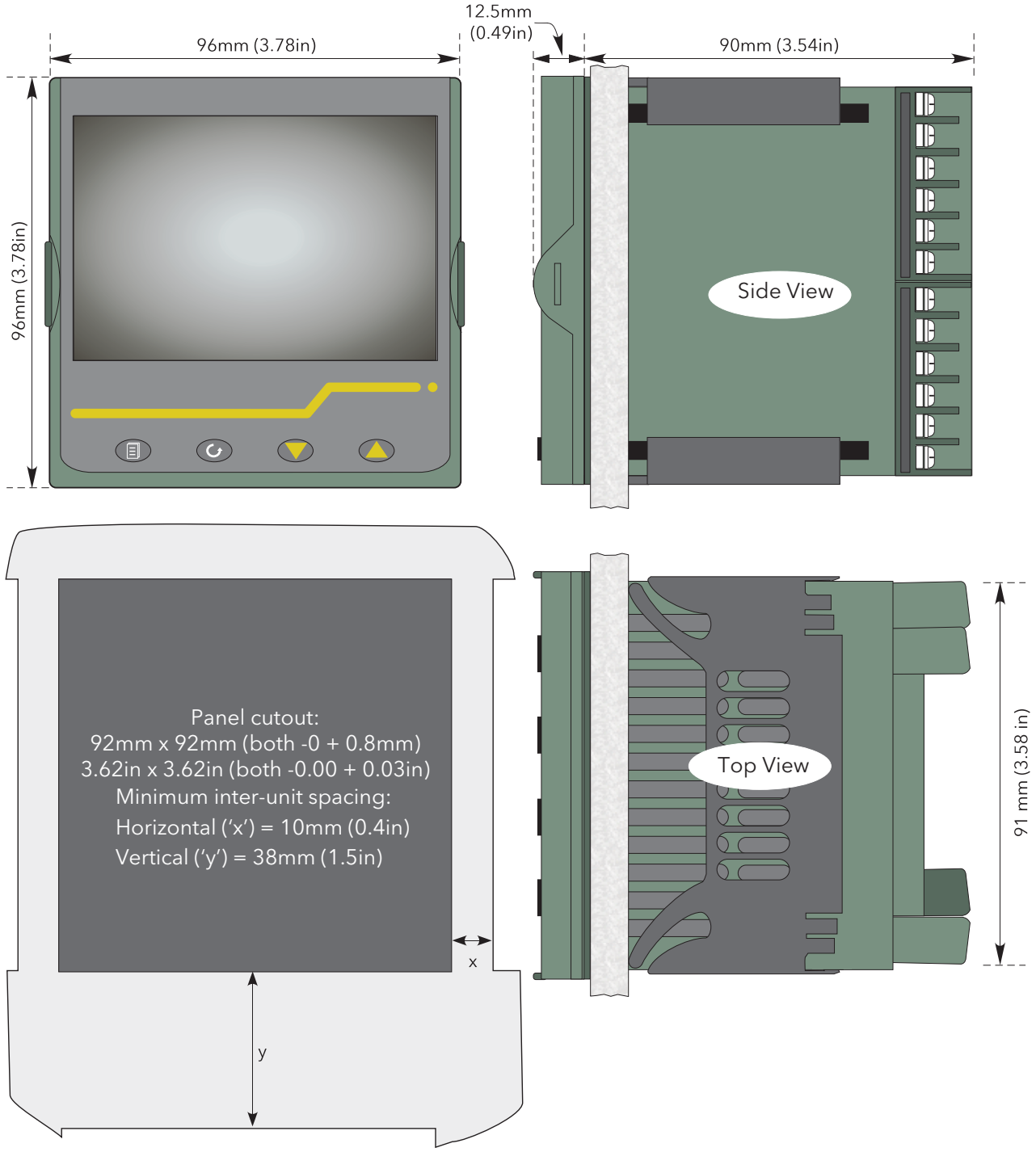


Figure 2.1b Mechanical installation details (wash down case option)

2.2 ELECTRICAL INSTALLATION

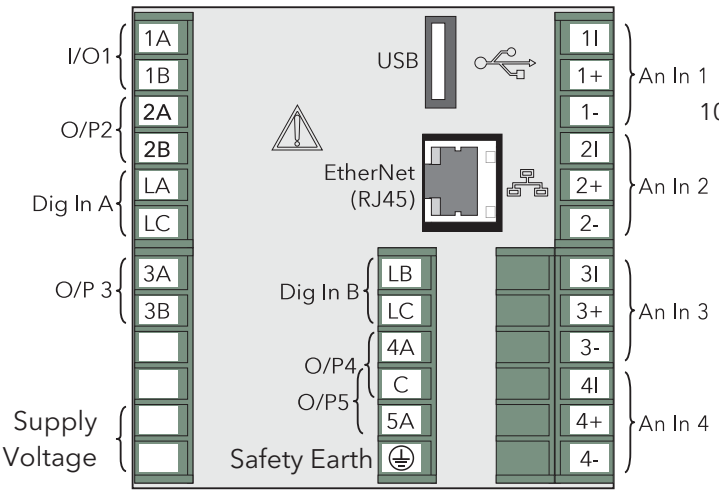
Figure 2.2 shows the locations of the various user terminations along with signal and supply wiring pinouts.

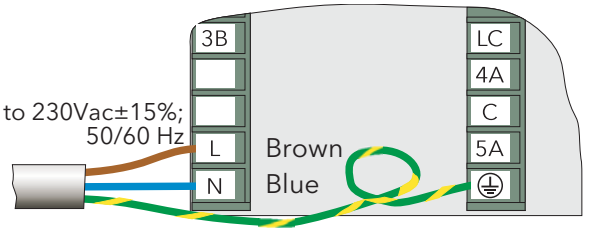
2.2.1 Termination details

The screw terminals accept single wires in the range 0.21 to 2.08 mm^2 (24 to 14 AWG) inclusive, or two wires each in the range 0.21 to 1.31 mm^2 (24 to 16 AWG) inclusive.

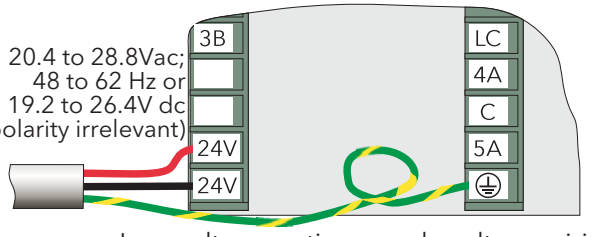
Screw terminals should be tightened to a torque not exceeding 0.4Nm (3.54 lb in)

2.2 ELECTRICAL INSTALLATION (Cont.)





Mains (Line) supply voltage wiring



Low voltage option supply voltage wiring

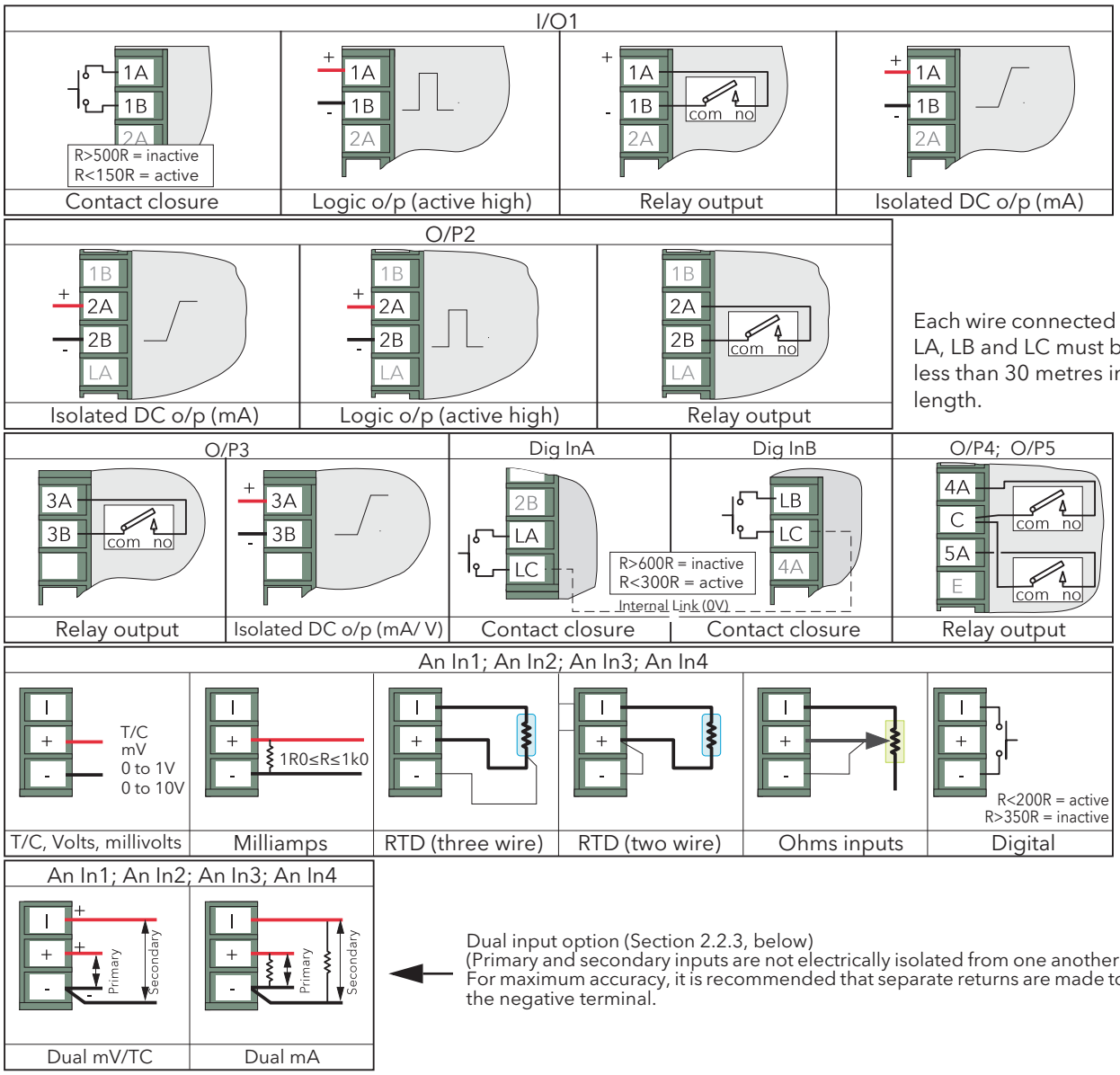


Figure 2.2 Connector locations and pinouts (rear panel)

2.2.2 Low Voltage option

This option allows the use of a low voltage ac or dc 24 V supply. The specification in Appendix A gives full details. The polarity of the dc supply connection is not important - it may be connected either way round.

2.2.3 Dual input option

This is a cost option, enabled on a channel-by-channel basis by means of entering the relevant password in the 'Feature3 Pass' field in Instrument.Security menu described in section 4.1.6.

For each enabled channel, a pair of thermocouple, mV or mA inputs can be connected to the instrument. These inputs are called 'primary' and 'secondary', and are terminated at the analogue input terminals (An In1 to An In 4) as shown in 'figure 2.2, above. The primary inputs 1 to 4 are assigned to channels 1 to 4, as normal. Each secondary input must be soft wired to a maths channel configured as Operation = 'Copy' if it is to be recorded/displayed/alarmed etc.

Note: Due to the nature of the input circuit, a large offset may appear for secondary thermocouple inputs. This offset can be removed only by using the input adjust feature described in section 4.1.9. Because of this offset, the dual thermocouple input option is not suitable for AMS2750D applications

Soft wiring is described in Section 7.

Maths channels are described in section 4.5.1.

Channel configuration is described in section 4.4.1.

Input adjust is carried out as described in section 4.1.9

SAMPLE RATE

For dual input channels, both primary and secondary sample rate is reduced to 4 Hz (250ms) from the normal 8Hz (125ms).

SENSOR BREAK DETECTION

Input sensor break detection is not supported for secondary inputs. The internal circuit acts as a 'pull up' on the secondary input which therefore saturates high in the event of a sensor break.

DUAL MILLIAMP INPUT OFFSET CORRECTION

If 'Dual mA' is selected as input type, then an automatic offset correction will be made, according to the shunt value entered in channel configuration.

INPUT RANGE LIMITATION

There is no 10V range associated with the secondary input. Any input greater than +2V or less than -2V is deemed to be 'bad range'.

2.2.4 Modbus Master communications

The master instrument can be connected directly to up to two slaves using standard ethernet network cable either directly (single slave only) or via a hub or switch (one or two slaves). In either case, 'straight through' or 'crossover' cable may be used. The cable is terminated at the RJ45 socket at the rear of the unit.

2.2.5 EtherNet/IP

The Client and Server are connected in the same way as described above for Modbus Master communications, except that there can be only one client and one server.

3 OPERATION

On power up a default or custom (section 4.1.5) splash screen appears and remains visible whilst the unit is initialising. If during this process a network broadcast storm is detected, the unit stops, displaying a network failure icon until the broadcast storm has cleared, after which the initialisation process resumes.

3.1 INTRODUCTION

The operator interface consists of a display screen and four push buttons.

3.1.1 Display screen

The display screen is used both to display channel information (in one of a number of display modes), and to display the various configuration screens which allow the user to setup the recorder to display the required channels, to set up alarms and so on. Display modes are described in section 3.4, below; configuration is described in section 4.

In display mode, the screen is split horizontally into three areas (figure 3.1.1)

1. a faceplate giving channel details.
2. the main display screen showing channel traces etc.
3. the status area, displaying instrument name, the current time and date and any system icons.

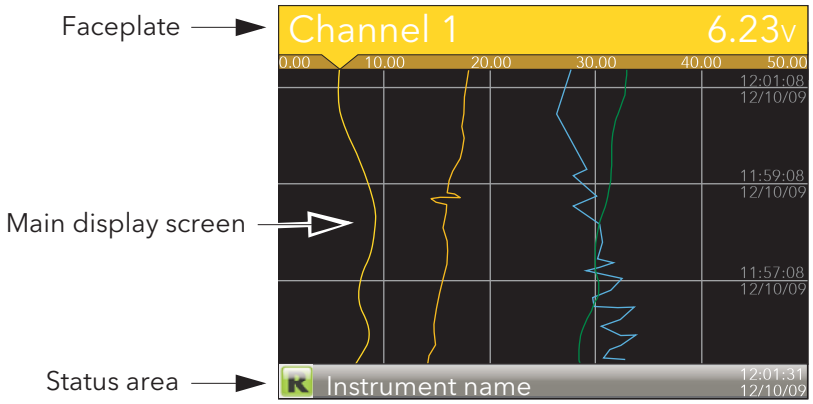


Figure 3.1.1 Display mode screen (vertical trend)

In configuration mode, the entire display screen is devoted to the selected configuration menu.

3.1.2 Navigation pushbuttons

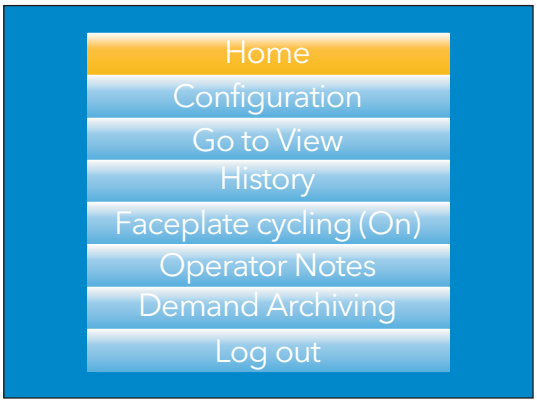


Figure 3.1.2 Top level menu (Engineer level access)

There are four navigation buttons, called 'Page', 'Scroll', 'Lower' and 'Raise' located below the screen. The general properties of these buttons are described in the remainder of this section, but some have additional, context sensitive functions, which, for the sake of clarity are not described here but in the relevant sections (e.g. 'Message summary') of the manual.

3.1.2 NAVIGATION PUSHBUTTONS (Cont.)

PAGE BUTTON

From any non-configuration page, pressing this push button causes the top level menu (figure 3.1.2) to appear. The figure shows the menu for a user logged in with 'Engineer' level access. Other access levels may have fewer menu items.

Within configuration pages, the Scroll button can be used as an enter key to select lower menu levels. In such cases the page button is used to reverse this action, moving the user up one menu level per operation.

SCROLL BUTTON

From trending pages, operation of the scroll push-button scrolls through the channels enabled in the group. The Faceplate cycling 'Off' selection can be used to keep a particular channel permanently displayed, and the scroll pushbuttons can then be used to select channels manually.

In configuration pages, the scroll key operates as an 'enter' key to enter the next menu level associated with the highlighted item. Once the lowest menu level is reached, operation of the scroll key allows the value of the selected item to be edited by the relevant means (for example, the raise/lower keys, or a keyboard entry).

The 'Page' key is used to move the user back up the menu structure, until the top level menu is reached, when the scroll key can be used again to return to the Home page.

The scroll button is also used to initiate user wiring as described in section 7

RAISE/LOWER BUTTONS

Within trending displays, the Raise and Lower keys can be used to scroll through the enabled display modes in the sequence: vertical trend, horizontal trend, vertical bargraph, horizontal bargraph, numeric, vertical trend... and so on.

Within configuration pages, these pushbuttons act as cursor keys, allowing, for example, the user to highlight menu items for selection using the scroll button, and in many cases allowing the user to select one from a number of alternative values within menu items. Theses keys are also used to navigate through the virtual keyboards (section 3.6) and number pads used to enter text or numeric strings.

3.1.3 On screen help

The top level configuration menu includes contextual help text on the right-hand half of the screen. Mostly this text fits within on screen height. Where this is not the case, the text can be moved up or down the screen by holding the Page button operated whilst using the up and down arrows to move the text.

The down arrow moves the text upwards on the screen; the up arrow moves it downwards.

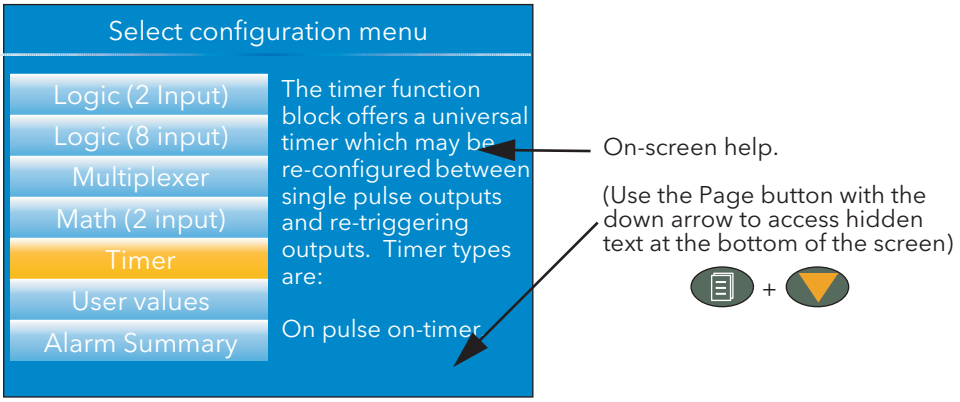


Figure 3.1.3 On-screen help (typical)

3.2 PROCESS VARIABLE DISPLAY

As discussed above, the operator interface consists of a display screen and associated push buttons. The display screen shows process variables in one of a number of formats, or operational details (notes or alarm history for example), or configuration details for use in setting up the recorder to produce the required displays and history formats. The remainder of section three discusses the process variable displays, alarm displays and so on; configuration details are to be found in section 4.

Note: Some of the items below can be selected for use only by users with a suitable permission level as set up in the 'Instrument' 'Security' menu described in section 4.1.6

Figure 3.2 below, depicts a typical trend display and gives details of the various areas of the display page.

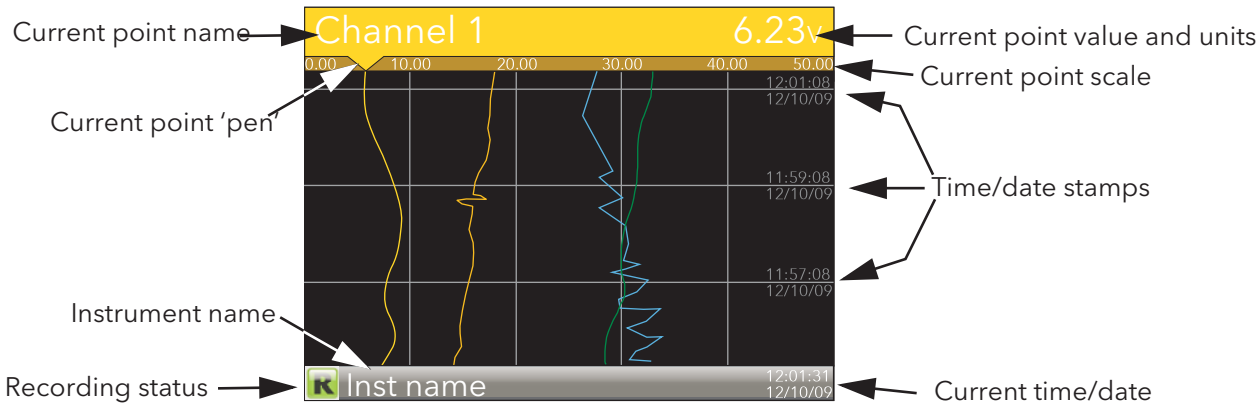


Figure 3.2 Typical display screen (Vertical trend)

Figure 3.2 shows a vertical trend page. Operating the Raise/Lower push-buttons allows the user to scroll through the other display modes: Horizontal trend, Vertical bargraph, horizontal bargraph, numeric, vertical trend... and so on. All these display modes are described in section 3.4, below.

A display mode can also be selected from the Top level menu 'Go To View' item which appears when the 'Page' key is operated.

The scroll button can be used to scroll through the points in the group, overriding the 'Faceplate Cycling' on or off selection

3.2.1 Alarm icons

Notes:

1. A full discussion of alarms is given in the Channel Configuration section of this manual (section 4.4.3)
2. Trigger alarms do not display threshold marks or bars, or faceplate symbols

The alarm icons shown below appear in some display modes. The icons on a channel faceplate show the status of that channel's alarm(s), as follows:

Icon is flashing	alarm is active but unacknowledged or it is an Auto alarm which is no longer active but which has not been acknowledged
Icon steadily illuminated	the alarm is active and has been acknowledged.

Alarm thresholds and deviation alarm bars appear for horizontal and vertical trend modes. For deviation bars, the bar stretches from (Reference - Deviation) to (Reference + Deviation). Vertical and Horizontal bargraph modes display only absolute alarm symbols.

3.2.1 ALARM ICONS (Cont.)

▲	Absolute High
▼	Absolute Low
▲	Deviation High
▼	Deviation Low
▲▼	Deviation Band
◢	Rising Rate of change
◣	Falling Rate of change
▲	Digital High
▼	Digital Low

Table 3.2.1 Alarm icons

3.2.2 Status bar Icons

The following items can appear in a dedicated window immediately to the left of the time and date, at the bottom right-hand corner of the display. The width of this window expands as the number of icons increases, and the instrument name is truncated, as necessary, to make room.

SYSTEM ALARMS

This indicator appears, flashing, if any one or more of the alarms listed below is active. The System Alarms summary page (accessed from 'Go to View in the top level menu) allows the user to view such system alarms as are active. It is not possible to 'acknowledge' system alarms

Archive Disabled	An unattended archiving strategy has temporarily been disabled.
Archiving Failed	An unattended archiving strategy has failed to complete.
Archiving Timeout	A configured archiving strategy has timed out.
Battery failure	Indicates that the battery is approaching the end of its useful life, or that it is missing or is completely exhausted. Immediate battery replacement is recommended (Appendix C; section C1).
Broadcast Storm detected	Networking is limited until the storm has passed.
Clock failure	The internal clock was found to be corrupt at power up, or that the time has never been set. Time is forced to 00:00 1/1/1900. Can be caused by battery failure, in which case a battery failure message appears. The error is cleared by setting the time and date.
Channel error	Indicates a hardware failure in the channel circuit or in the internal cold junction temperature measurement.
Database failure	Corrupted EEPROM or flash memory.
DHCP Server failure	For units with 'IP Type' set to 'DHCP' (Network.Interface configuration) this alarm occurs if the instrument is unable to obtain an IP address from the server.
FTP Archiving file lost	A file has been deleted that had not yet been archived. Possible causes: Communications with the server could not be established,; archive is disabled; archive rate too slow.
FTP Archiving to slow	The archive rate is too slow to prevent the internal memory from overflowing. The recorder effectively switches to 'Automatic' (Section 4.2.2) to ensure that data is not lost.

(Continued)

3.2.2 STATUS BAR ICONS (Cont.)

FTP Primary Server Failure	This error occurs if the recorder fails to establish connection with the primary server, after two attempts. After the second attempt fails, the recorder attempts to establish connection with the secondary server instead. Primary and secondary server details are entered in the Network.Archiving area of configuration (Section 4.2.2).
FTP Secondary Server Failure	This error occurs if the recorder fails to establish connection with the secondary server, after two attempts. Primary and secondary server details are entered in the Network.Archiving area of configuration (section 4.2.2).
Maths channel failure	Appears if, for example, the divisor of a divide function is zero.
Media archiving file lost	A file has been deleted that had not yet been archived. Possible causes: Memory stick missing, full or write protected; archiving has been disabled; archiving rate too slow.
Media archiving to slow	The archive rate is too slow to prevent the internal memory from overflowing. The recorder effectively switches to 'Automatic' (Section 4.2.2) to ensure that data is not lost.
Media full	Archive storage device is full. The alarm becomes active only when an archive is in progress.
Media missing	No archive storage device present when archive attempted.
Non-volatile memory failure	RAM copy of non-volatile parameters is corrupted.
Non-volatile Write Frequency warning	One or more parameters are being written frequently to non-volatile memory. If this continues, it may lead to 'memory depletion' (i.e. the memory will no longer be able to store values correctly). A common cause of this problem is frequent writes over Modbus comms.
Recording failure (message)	Message explains reason for failure.
USB overcurrent	USB power fault - too much current (i.e. >100mA) is being drawn by a USB device.
Wiring failure	The user wiring has failed to verify, i.e. one or more wires has been detected that does not have both a source and a destination defined. This may be the result, for example, of power loss during a download from iTools.

CHANNEL ALARM

This indicator appears if any channel (including channels not in the display group) is in an alarm state. The symbol is illuminated continuously if all alarms are acknowledged or flashes if any one or more alarms is unacknowledged. Alarms are acknowledged from the Root menu 'Alarm summary' item as described in section 3.3.3 or in the Channel configuration area (Section 4.4.3) if the user's access permission is appropriate.

USB

This icon appears whenever a memory stick (max. capacity 8GB) or other supported USB device (section 8) is plugged into the USB port at the rear of the recorder.

When data transfer is in progress between the instrument and the memory stick, the icon changes to a 'busy' version.

CAUTION

The Memory stick must not be removed while archiving (demand or automatic) is in progress, as to do so may irreparably damage the file system of the memory stick, rendering it unusable. It is recommended that all archiving be suspended before the memory stick is removed.

FTP ICON

The FTP icon appears whenever transfer activity is taking place.

3.2.2 STATUS BAR ICONS (Cont.)

RECORD ICON

One of four icons appears at the bottom left corner of the display to indicate recording status.

Record

This indicates that the recorder is recording the items selected in the Group Recording area of configuration (section 4.3).

Stopped

This means that 'Enable' has been set to 'no' in the Group Recording area of configuration (section 4.3). Trending is not affected.

Paused (Suspended)

This means that recording has been paused by a wire to the Suspend parameter (Group Recording area of configuration (section 4.3)) going true (high). Trending is not affected.

In Configuration

The recorder has been placed in configuration mode either at the user interface, or via iTools. Recording is stopped until the recorder is no longer in configuration mode. For each non-recording state (Stopped, Paused or In Configuration). A new history file is created when the unit comes out of configuration mode.

> Note: For recording to be enabled, configuration status must be 'logged out' both at the instrument and at iTools.

MESSAGE ICON

This 'envelope' icon appears when a message is generated and it remains on display until the Message Summary is accessed, when it is removed from the display until the next new message is generated.

AUTOTUNE ICON

For instruments fitted with the Loop option, this symbol appears during the Autotune process.

3.2.3 Breaks in recording

Breaks in recording can be caused by the unit being powered down, by the user entering configuration mode or when the recorder time is changed manually. In vertical and horizontal trend modes, a line is drawn across the width/height of the chart to indicate that recording has been interrupted.

On power up, a red line is drawn across the chart. In 'History', if messages are enabled the message:

`Date Time System power up`

is printed on the chart, together with the configuration and security revisions.

On exiting configuration mode, a blue line is drawn on the chart and in 'History', if messages are enabled, the messages:

`Date Time Logged out.`

`Date Time Config Revision: N was N-1` (assuming a configuration change was made)

`Date Time Logged in as: Engineer`

appear on the chart.

When the instrument time is changed (manually - not through daylight saving action) a green line is drawn on the chart and in 'History', if messages are enabled, the message:

`Date Time Time/Date changed`

appears on the chart.

3.3 TOP LEVEL MENU

This menu appears when the page key is operated from any non-configuration page. The menu items displayed depend on the access permission of the user. One of the menu items is highlighted, and if the scroll key is operated, then it is the highlighted item that is 'entered'.

Figure 3.3 shows the top level menu for Engineer level access.

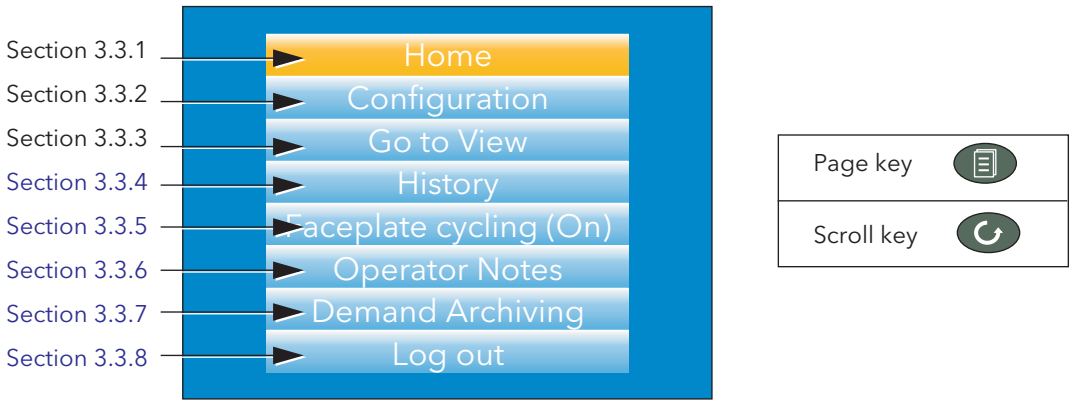


Figure 3.3 Top level menu

3.3.1 Home

Operating the scroll key whilst 'Home' is highlighted causes a return to the 'Home' page. By default, this is the vertical trend mode, but the mode can be changed in 'Instrument.Display' configuration (section 4.1.3)

3.3.2 Configuration

Operating the down arrow key highlights the 'Configuration' item. Operating the Scroll key enters the configuration submenu described in section 4 of this manual.

Note: 'Configuration' appears only if the user has an appropriate access level.

3.3.3 Go to View

Operating the scroll key whilst the 'Go to view' item is highlighted, calls the Go to view submenu (figure 3.3.3a). This allows the user to view channel alarms, system alarms, messages or to select a different display mode.

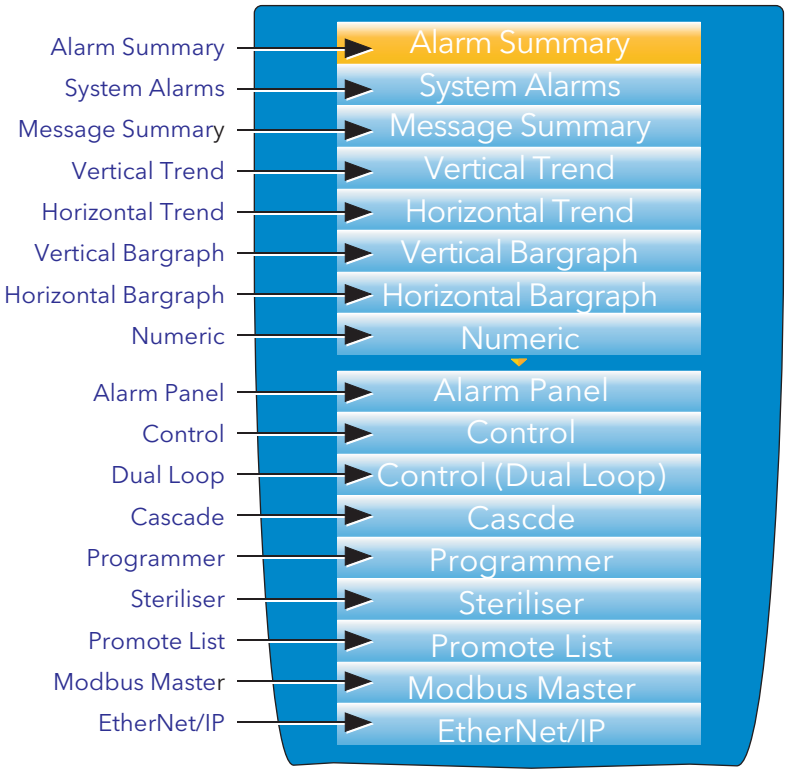


Figure 3.3.3a Go to view submenu

Notes:

1. If an option (e.g. 'Steriliser') is not fitted, its display mode does not appear in the list.
2. Some display modes must be enabled in Instrument.View configuration (section 4.1.3) before they become available.

3.3.3 GO TO VIEW (Cont.)

ALARM SUMMARY

For each active alarm, this page displays the channel identifier with alarm number (e.g. C1(2) = channel 1; alarm 2), the channel descriptor, the alarm threshold the current process value and an alarm type symbol.

To return to the top level menu, operate the Page key.

Notes:

1. The background colour to the channel ID is the same as that chosen for the channel.
2. A prefix 'C' in the channel ID means that this is a measuring channel; A prefix 'V' means that this is a virtual channel (i.e. a totaliser, counter or maths channel)

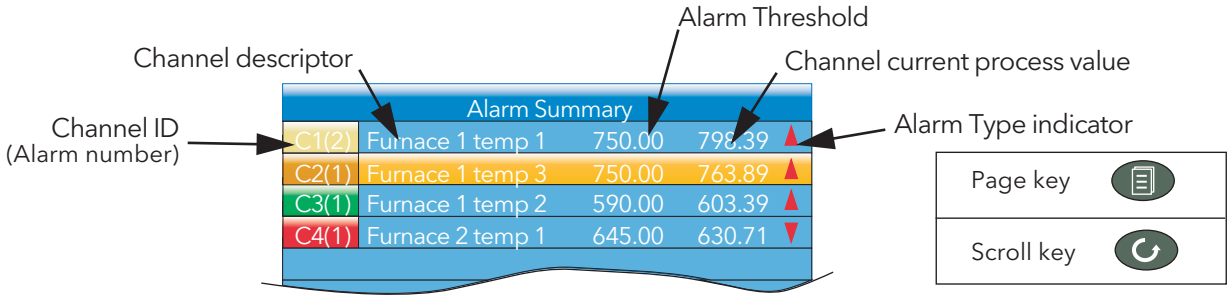


Figure 3.3.3b Alarm summary page with acknowledge confirmation display

ALARM ACKNOWLEDGEMENT

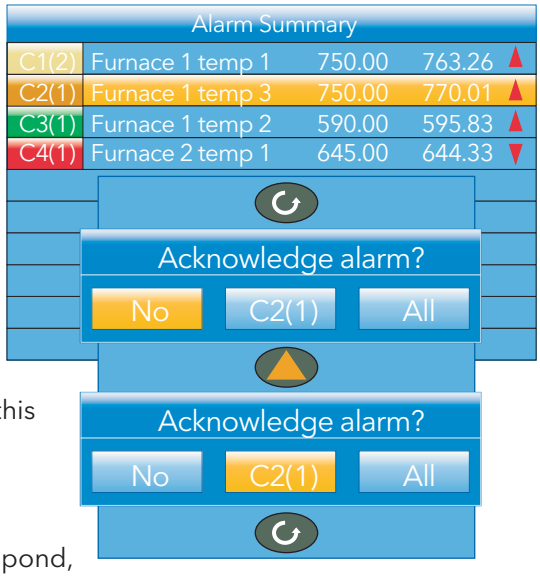
To acknowledge an alarm from this view:

1. Use the up and down arrows to highlight the required alarm

2. Operate the scroll button. The 'Acknowledge alarm' window appears.

3. Use the up arrow to highlight the relevant field (C2(1) in this example), or 'All' if all alarms are to be acknowledged.

4. Operate the scroll key to confirm. If the alarm fails to respond, this may be due to the fact that it has been configured as a 'Manual' alarm, and the trigger has not yet returned to a 'safe' (non-alarm) state, or it could be that the instrument is in a logged out state.



SYSTEM ALARMS

Operating the scroll button whilst the 'System Alarms' field is highlighted displays a list of all currently active system alarms. Section 3.2.2 contains a list of system alarms and their interpretations. To return to the top level menu, operate the Page key.

A further operation of the scroll button displays a 'Help Information' page, giving the reason for the highlighted alarm.

Operate the scroll button again to return to the system alarm display.

3.3.3 GO TO VIEW (Cont.)

MESSAGE SUMMARY

Operating the scroll key whilst the 'Message summary' field is highlighted displays the10 most recent messages.

Operating the scroll key whilst a message is highlighted shows the selected message in more detail (and using the up/down keys allows the other messages to be scrolled through). Whilst in this mode, operating the scroll key again, allows the user to choose to jump to the message's location in trend history mode (section 3.5) or to return to the summary page.

By default, the interface is set up such that:

1. all message types are included
2. the up and down arrow keys cause the highlighted selection to move up or down by one message at a time.

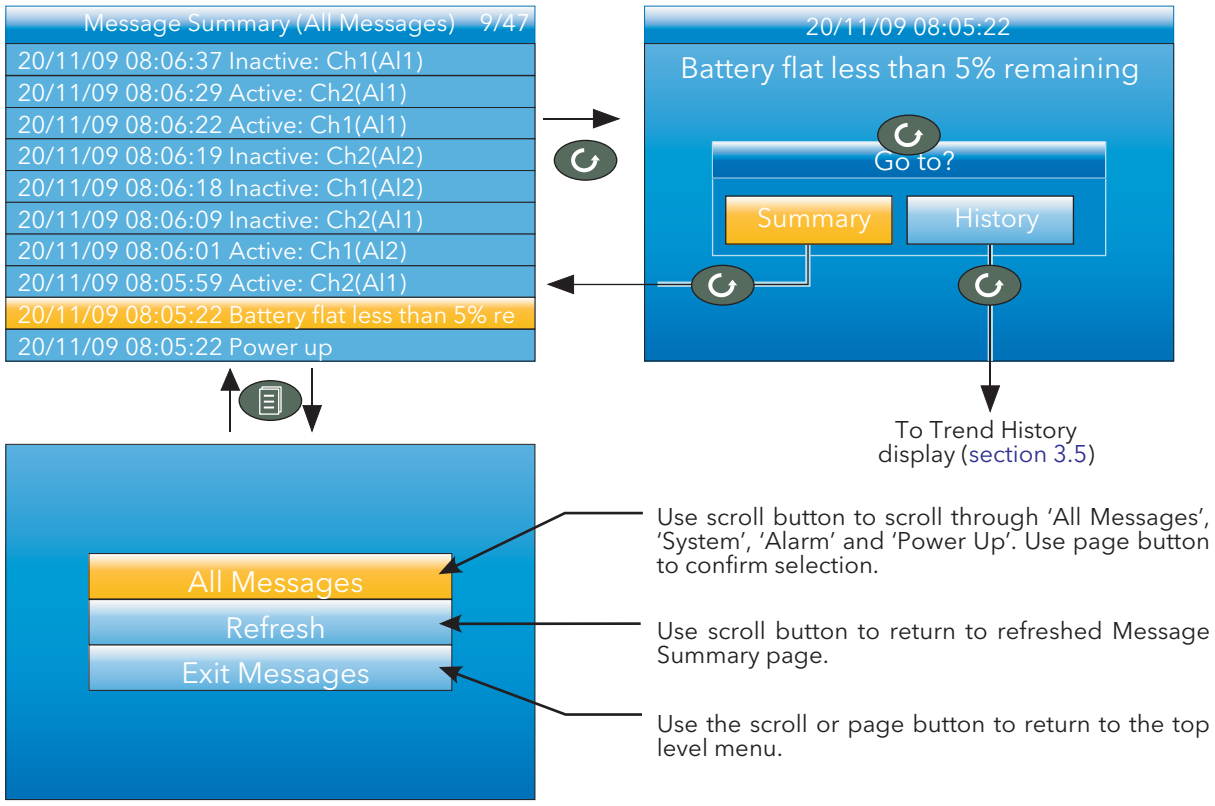
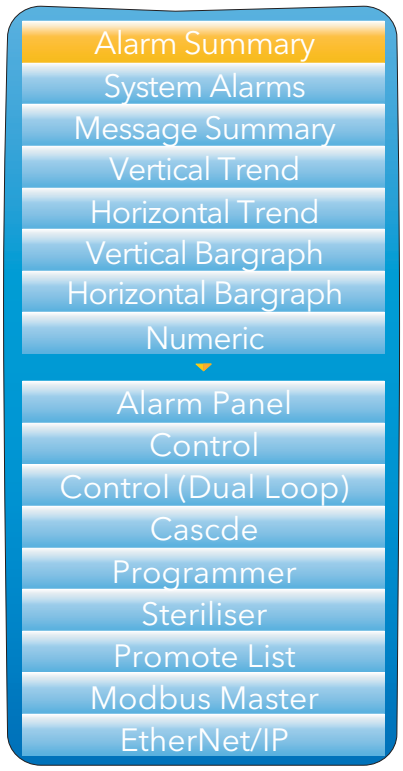


Figure 3.3.3c Message summary features

MESSAGE FILTERS

All Messages	Causes all messages to be displayed on the screen.
System	Shows only system alarms
Alarm	Shows only channel alarms
Power up	Shows only power up messages
Login/out	Limits the display to Log in and Log out events.

3.3.3 GO TO VIEW (Cont.)



DISPLAY MODE SELECTION

Use the up/down arrow buttons to highlight the required display mode. Once the required display mode is highlighted, operation of the scroll button causes the recorder to leave the 'Go to View' menu and to display channel values in the selected mode. See section 3.4 for a description of the various display modes.

Alternatively the up and down arrow buttons can be used from any of the display modes to cycle through the available modes in the order listed in the figure.

Notes:

1. If an option (e.g. 'Steriliser') is not fitted, its display mode is not available for selection.
2. Some display modes must be enabled in Instrument.Display configuration (section 4.1.3) before they become available.

3.3.4 History

This top level menu item allows the user to switch from real-time trending to review mode, where channel values, messages, alarm triggers etc. can be viewed back as far as the last significant configuration change. History mode is fully discussed in section 3.5.

3.3.5 Faceplate Cycling on/off

For the purposes of this document the channel whose faceplate is currently displayed and whose 'pen' symbol is visible is called the 'Active' channel.

By default, the recorder scrolls through all the channels in the display group, with each channel becoming the active channel in turn. This top level menu 'Faceplate Cycling' item allows the user to inhibit this scrolling action such that the currently active channel remains active permanently, or until a manual scroll is performed using the scroll button (or until Faceplate Cycling is re-enabled).

'Faceplate Cycling' is highlighted by using the up/down arrow buttons. Once highlighted, the status can be changed from 'On' to 'Off' or vice-versa using the scroll button. Operation of the 'Page' button returns the user to the trend display.

3.3.6 Operator Notes

This area allows up to 10 notes to be created when logged in as Engineer, using either the text entry techniques described in section 3.6, or 'iTools' described in section 6. Once logged out, operating the scroll button whilst a note is highlighted calls a selection box allowing the user either to send that note to the chart, or to write a Custom Note.

CUSTOM NOTE

The Custom Note is written using the text entry techniques described in section 3.6. Once the note is complete, operation of the page button calls a confirmation display. The down arrow is used to highlight 'Yes', and when the scroll key is then operated, the message is sent to the chart. This custom message is not retained for further use, so if it is required on a regular basis, it is suggested that one of the Operator Notes 1 to 10 be configured (Engineer access level required) so that it may be used instead.

Note: Each note can contain up to 100 characters.

3.3.7 Demand Archiving

This allows a user, with a high enough access level, to archive a selected portion of the recorder history, either to a 'memory stick' plugged into the USB port at the rear of the recorder (Local Archiving), or to a pc, by means of the FTP protocol (Remote Archiving). The archived data remains in the flash memory of the instrument. When the flash memory is full, new data causes the oldest file(s) to be discarded.

The up and down arrow keys are used to navigate to the required field.

3.3.7 DEMAND ARCHIVING (Cont.)

ARCHIVE MENU

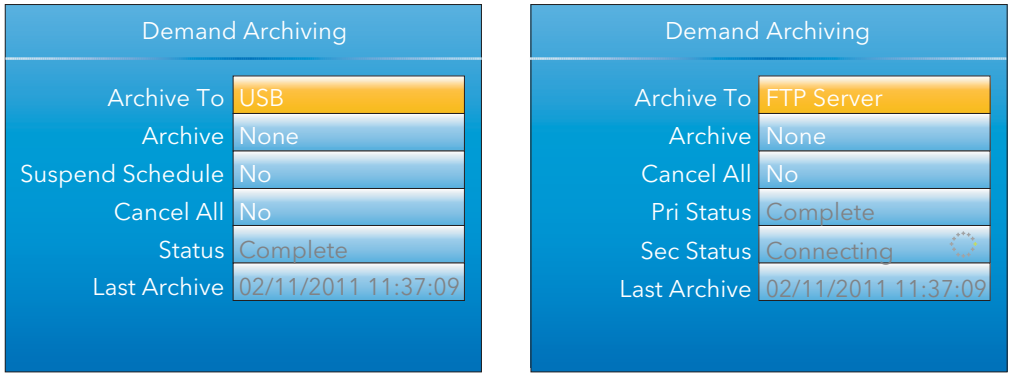


Figure 3.3.7 Demand Archiving menu (Local Archiving on left; Remote Archiving on right)

Archive To	With this item highlighted, the scroll button and the up/down arrows can be used to select 'USB' or 'FTP Server'. For 'USB', the archive will be made to the rear USB memory stick. For 'FTP Server' the archive will be made to the Primary or Secondary server (configured in the Network.Archive area of configuration described in section 4.2.2). For more details about remote archiving, see 'Remote archiving', below.
Archive	In a similar way, select the archive period: None: No archiving to take place. (Not editable when logged out) Last Hour: Archives all files created within the last 60 minutes. Last Day: Archive all files created in the last 24 hours. Last Week: Archives all files created in the past seven days. Last Month: Archives all files created in the past 31 days. Archive All: Archives all the files in the recorder's history. Bring To Date: Archives all files created or updated since the 'Last Archive' date and time.
Suspend Schedule	When set to 'Yes', automatic (scheduled) archiving is stopped, once the transfer of the current file is complete. Suspend Schedule must be set to 'No' again, to restart the suspended archive. Suspend can be used to allow the memory stick to be removed and re-fitted safely.
Cancel All	When set to 'Yes', this cancels USB archiving activity immediately, or cancels FTP archiving once transfer of the current file (if any) is complete.
Last Archive	Shows the date and time at which the last archive (demand or automatic) was attempted. If a demand archive is requested, or is in operation when an automatic archive is triggered, the automatic archive takes precedence.
Status	For Archive to USB only 'Complete' means that no archiving is currently taking place. 'Transferring' indicates that an archiving is in progress. Accompanied by an animated circular display. 'Suspended' means that archiving has been suspended as requested.
PriStatus	For Archive to FTP Server only, this shows the transfer status between the instrument and the primary host computer.
SecStatus	For Archive to FTP Server only, this shows the transfer status between the instrument and the secondary host computer.

3.3.7 DEMAND ARCHIVING (Cont.)

FTP SERVER ARCHIVING

This allows the archiving of recorder files to a remote computer via the RJ45 type connector at the rear of the recorder, either directly or via a network.

In order to carry out a successful transfer:

1. Details of the remote host must be entered in the Network.Archive area of configuration (section 4.2.2).
2. The remote computer must be set up as an FTP server. Help from the user's IT department may be necessary in order to achieve this. Appendix C, Section C2 to this manual suggests one way, using Filezilla.
3. The remote computer must also be set up to respond to 'pings'. This is because the instrument pings the host whilst establishing connection, and if it does not receive a response the archive attempt fails.

When accessing files using Microsoft® Internet Explorer, the address (URL) field can be in one of two formats:

1. ftp://<instrument IP address>. This allows a user to log in as the anonymous user (if the recorder has any account with the user name set to 'anonymous' with a blank password.
2. ftp://<user name>:<password>@<instrument IP address> to log in as a specific user.

For IE5 users, Microsoft® Internet Explorer displays, by default, history files only. To quit the history folder, either uncheck the Tools/Internet Options/Advanced/Browsing/'Enable folder view for FTP sites' option, or check the Tools/Internet Options/Advanced/Browsing/'Use Web based FTP' option.

REVIEW SOFTWARE

'Review' is a proprietary software package which allows the user to extract 'archive' data from one or more suitable instruments* and to present this data on a host computer, as if on a chart, or as a spreadsheet. The host computer must be set up as an ftp server (see Appendix C section C2 for a description of one way of doing this).

As described in the Review help system, 'Review' allows the user to set up a regular transfer of data (using ftp) from connected instruments into a database on the pc, and then from this database to the chart or spreadsheet. The chart/spreadsheet can be configured to include one or more 'points' from one or all connected instruments (where a 'point' is an umbrella term for channel, totaliser, counter etc.).

It is also possible to archive instrument history files to a memory stick, Compact Flash card etc. (depending on instrument type) and to use this to transfer the data to the pc.

Each type of instrument has its own remote user name and password configuration - for this instrument, the user name and password are both 'history and they are not editable.

*Suitable instruments are connected instruments, the archive files of which have the suffix '.uhh'.

3.3.8 Login

Login allows the user to enter a password in order to gain access to areas of the unit's configuration which are not available when the user is logged out.

LOGGED OUT ACCESS LEVEL

Logged out mode allows the user to select viewing mode, to view history, to view alarms, to toggle faceplate cycling on and off, to send notes, to suspend/resume USB archiving and to access the login process.

OPERATOR ACCESS LEVEL

In addition to the logged out features, Operator access level allows the user to acknowledge alarms, to edit notes and to perform demand archive operations.

By default, no password is required in order to enter Operator level, but a password can be set either at Supervisor level or at Engineer level.

3.3.8 LOGIN (Cont.)

SUPERVISOR ACCESS LEVEL

In addition to the logged out level function, this access level allows the user to view the recorder's configuration, and to edit some values (such as alarm thresholds). By default, there is no password required to enter Supervisor level, but a password can be set in the Instrument area of configuration, either at Supervisor level or at Engineer level.

ENGINEER ACCESS LEVEL

This allows full access to all areas of the recorder configuration. The default password is 100, but this can be edited in the Instrument area of configuration (section 4.1.5).

Note: recording is stopped for as long as the user is logged in at Engineer level, even if the recorder is not being configured. This is indicated by the Record icon at the bottom left corner of the process value display screen being replaced by the Configuration (wrench) icon.

Record icon

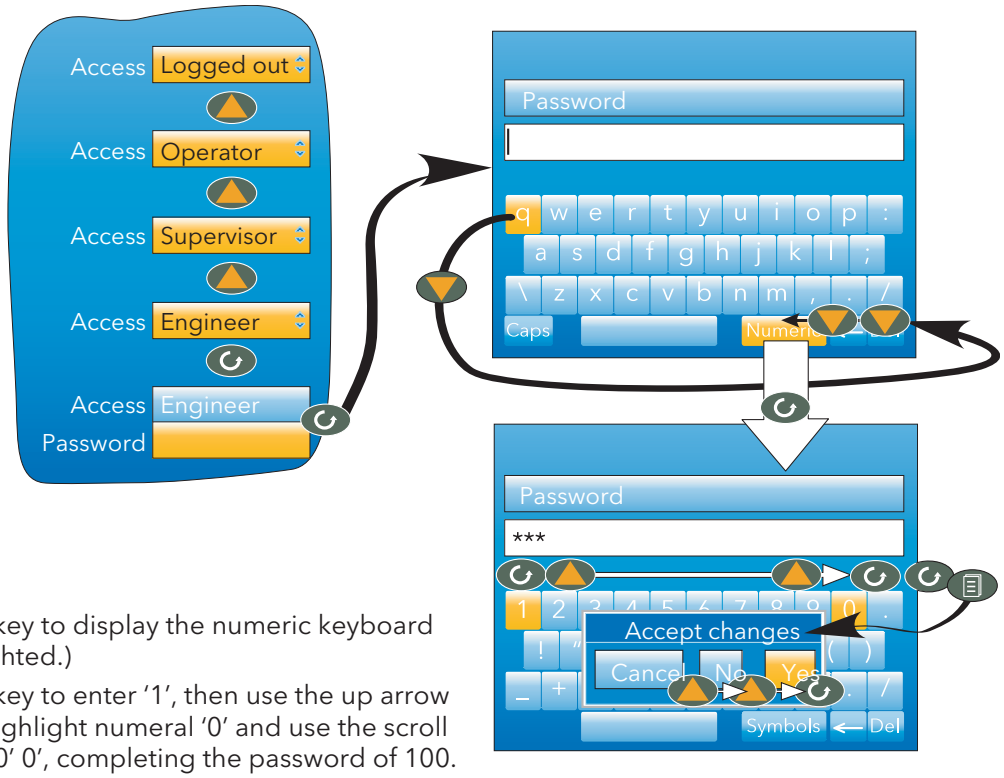
Configuration icon

LOGIN PROCEDURE

From the top level menu, use the up or down arrow keys as often as necessary in order to highlight 'Login', and then operate the Scroll key to produce the 'Access Logged out' display.

Note: this procedure describes how to login to an access level with a password associated with it. For non-password protected logins, the user needs only to select the required access level, and press the scroll key.

To log in as Engineer (password = 100):



1. Operate the up arrow key three times, to display 'Engineer'.
2. Press the scroll key to call the 'alpha' keyboard, with the letter 'q' highlighted.
3. Use the down arrow key three times to highlight 'Numeric'.
4. Operate the scroll key to display the numeric keyboard (numeral '1' highlighted.)
5. Operate the scroll key to enter '1', then use the up arrow key nine times to highlight numeral '0' and use the scroll key twice to enter '0' 0', completing the password of 100.
6. Use the Page key to call the confirmation display.
7. If the password entry is as required, use the up arrow twice (or the down arrow once) to highlight the word 'Yes' and operate the scroll key to confirm. The top level configuration menu appears. Otherwise, 'Cancel' can be used to clear the entry in order to start again, or 'No' can be used to quit login.

3.4 DISPLAY MODES

The following subsections describe the various display modes available to the user. By default, the 'Home' display mode is 'Vertical Trend', but this can be edited as a part of 'Instrument.Display' configuration. This configuration area also allows the user to disable one or more display modes should they not be required.

The current display mode can be chosen either by using the top level menu 'Go to View' item or, from any display mode, by scrolling through the enabled modes using the up or down arrow button.

Details of the various display modes are to be found in the following subsections:

Vertical trend .....section 3.4.1
Horizontal trend .....section 3.4.2
Vertical bargraph .....section 3.4.3
Horizontal bargraph .....section 3.4.4
Numeric .....section 3.4.5
Alarm panel .....section 3.4.6
Control loop 1/2 .....section 3.4.7
Cascade.....section 3.4.8
Programmer (inc. future trend) .....section 3.4.9
Steriliser.....section 3.4.10
Promote list.....section 3.4.11
Modbus Master .....section 3.4.12
EtherNet/IP .....Section 3.4.13

3.4.1 Vertical trend

In this mode, channel values are traced as though on a chart rolling downwards (i.e with the latest data at the top). The chart speed, and the number of major divisions are configured in the 'Group.Trend' area of configuration (section 4.3.1). By default, the chart background is black, but this can be changed to white or grey in the 'Instrument' 'Display' area of configuration (section 4.1.3).

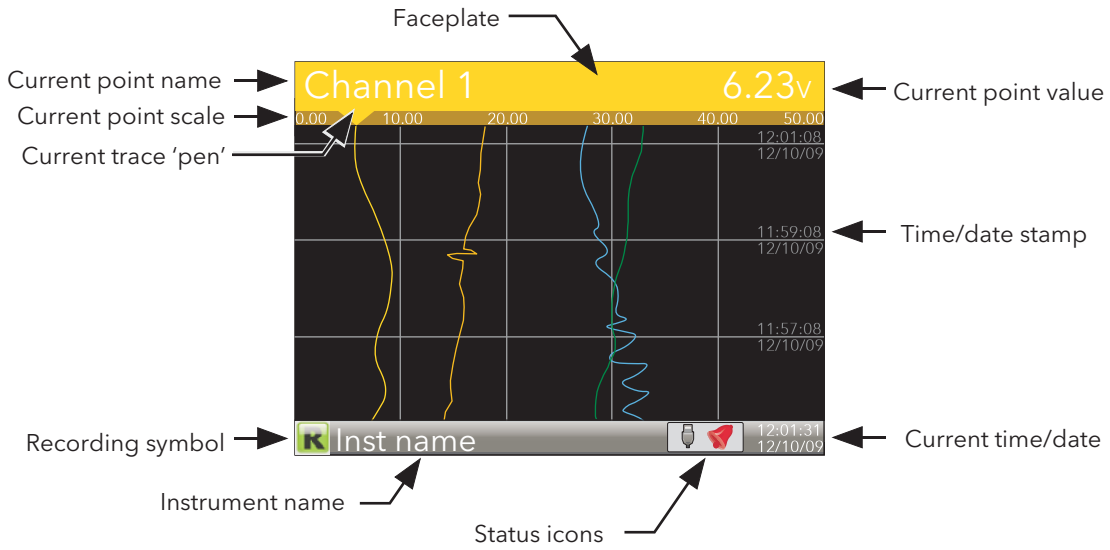


Figure 3.4 Vertical trend mode display elements

One of the channels is said to be the 'current' or 'scale' channel. This channel is identified by its pen icon being displayed, and by the channel descriptor, dynamic value and its scale being displayed on a 'faceplate' across the width of the display, above the chart.

Each channel in the Group becomes the 'current' channel in turn, for approximately five seconds -i.e. the channels are cycled through, starting with the lowest numbered channel. Once the final channel in the Group has ben displayed for five seconds, the first channel is returned-to and the process repeats. This scrolling behaviour can be enabled/disabled from the top level menu 'Faceplate Cycling (Off)' item described in section 3.3.5.

The scroll button can be used to cycle through the channels manually in both Faceplate cycle on and off modes.

Use of the up arrow button causes the next enabled display mode to be entered (default = horizontal trend).

The page key calls the top level menu.

3.4.2 Horizontal Trend mode

This view is similar to the vertical trend mode described in section 3.4.1 above, except that the traces are produced horizontally rather than vertically. Initially, as each channel appears, its scale appears at the left edge of the display (as shown below), but in order to show the maximum amount of trend data, the scale is overwritten after a few seconds.

By default, after a few seconds, the 'chart' expands leftwards to hide the scale. This feature can be disabled in the Instrument.Display area of configuration (section 4.1.3, H.Trend scaling) so that the scale is permanently on display.

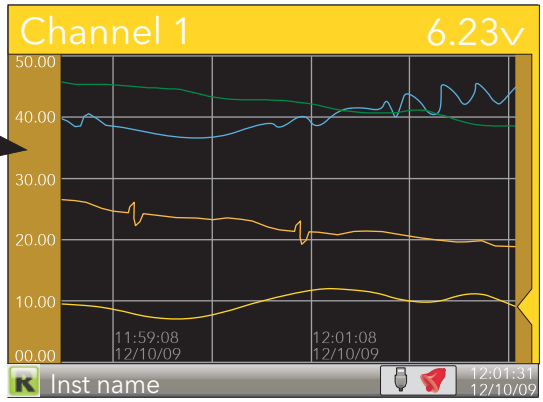


Figure 3.4.2 Horizontal trend display mode

Note: Timestamps appear to the right of the gridline to which they relate

Use of the up arrow button causes the next enabled display mode to be entered (default = vertical bargraph). Use of the page key calls the top level menu.

3.4.3 Vertical Bargraph mode

This display mode shows the channel values as a histogram. Absolute alarm threshold values appear as lines across the bars, grey if the alarm is not triggered; red if the alarm is triggered. Alarm symbols appear for active alarms.

Bargraph widths for four to six channels divide the width of the display screen equally between them. For one and two channels, the width is fixed, and the bars are centred on the screen. Figure 3.4.3 shows some examples (not to the same scale).

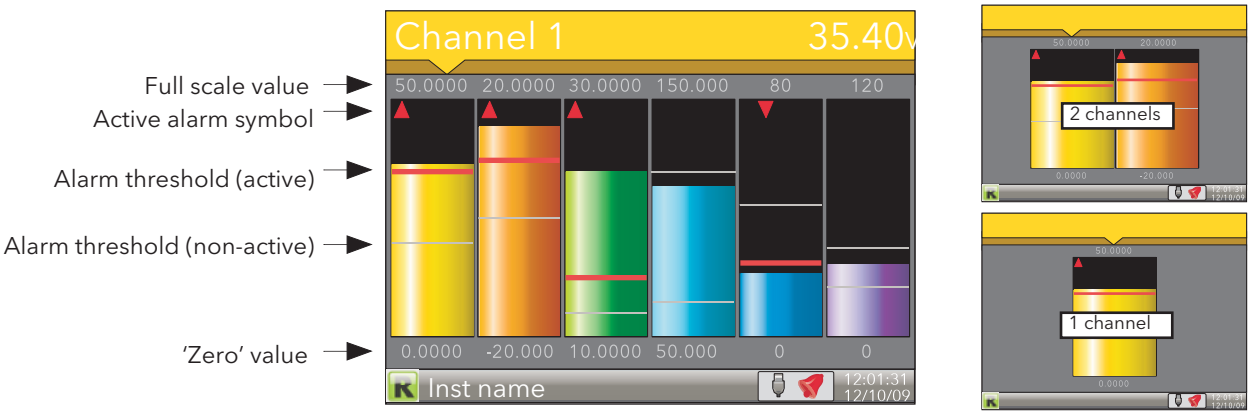


Figure 3.4.3 Vertical bargraph display mode

Use of the up arrow button causes the next enabled display mode to be entered (default = horizontal bargraph). Use of the page key calls the top level menu.

3.4.4 Horizontal Bargraph mode

Similar to the Vertical bargraph mode described in section 3.4.3, above, but includes channel descriptors.

The scroll button toggles the text between point descriptor (as shown) and point value.

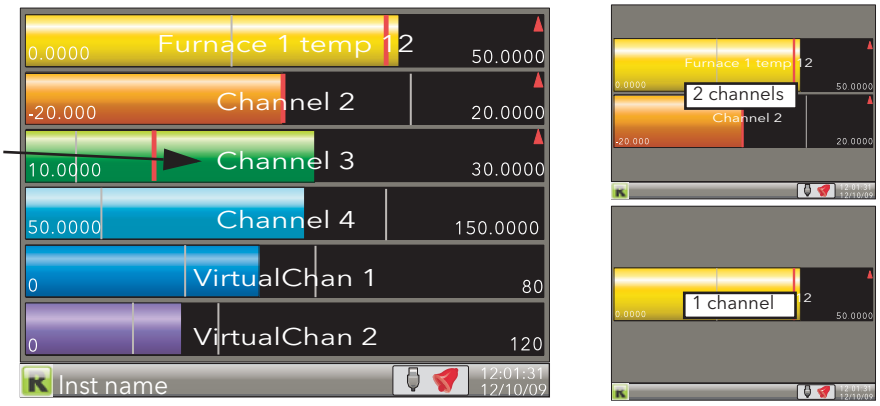


Figure 3.4.4 Horizontal bargraph mode

Use of the up arrow button causes the next enabled display mode to be entered (default = numeric).
Use of the page key calls the top level menu.

3.4.5 Numeric mode

Shows the enabled channels' values along with their descriptors and with indications of the type(s) of alarm configured for each channel.

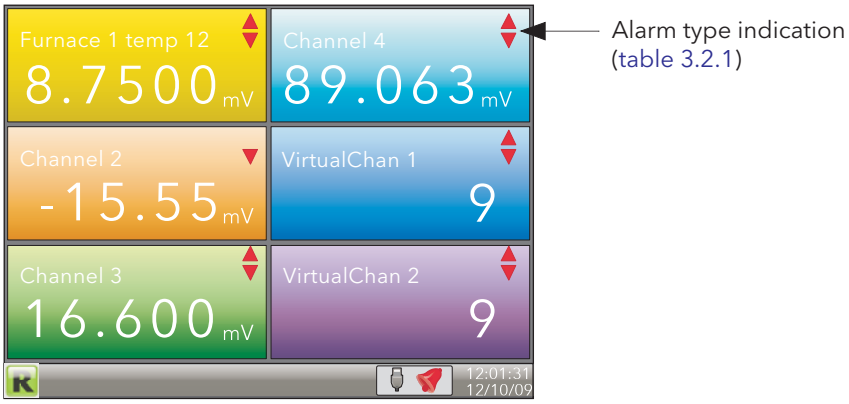


Figure 3.4.5a Numeric display mode (six enabled channels)

The figure above shows an example where the Trend group contains six channels. Figure 3.4.5b shows how the display appears for trend groups with fewer than six channels configured

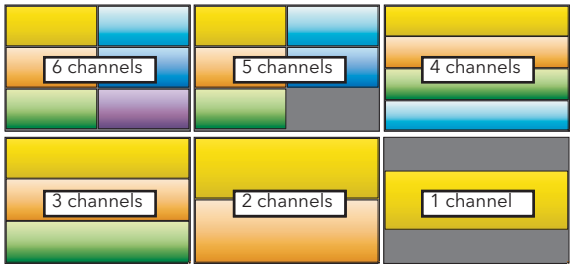


Figure 3.4.5b Display layout for different numbers of channels

The up arrow button returns to the vertical trend display mode; the page key calls the top level menu.

3.4.6 Alarm panel

This display appears only if enabled in the Instrument Display configuration (section 4.1.3) Alarm panel mode shows current value and alarm status for each channel enabled in the Trend Group. The status is shown in two ways, by the colour of the relevant bar, and by the alarm status indicators.

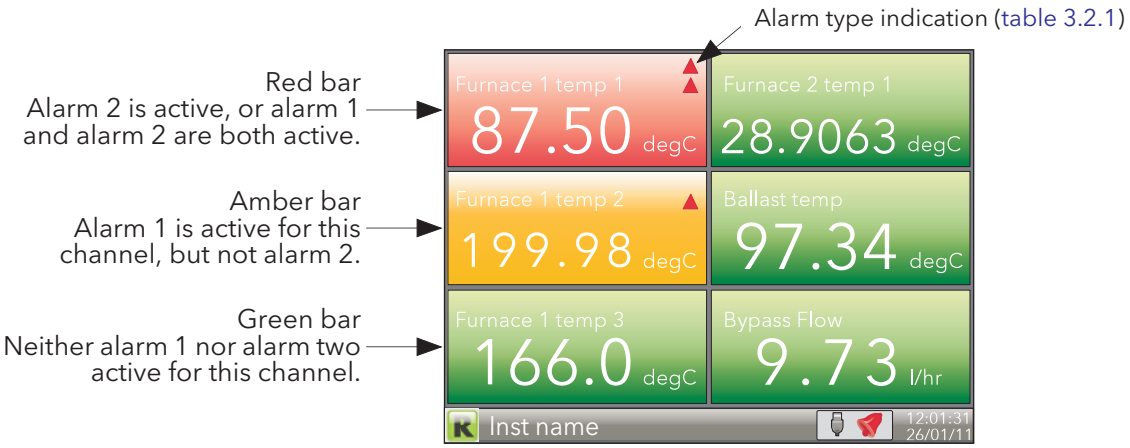


Figure 3.4.6a Alarm panel display (six channels)

The figure above shows an example where the Trend group contains six channels. Figure 3.4.6b shows how the display appears for trend groups with fewer than six channels configured.

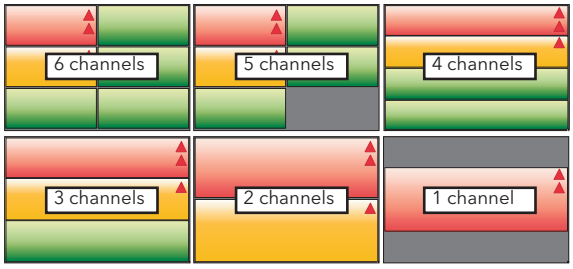


Figure 3.4.6b Alarm panel display layouts for trend groups with fewer than six channels

3.4.7 Control Loop1/Loop2

These displays appear only if the controller option is enabled (section 4.1.6).

The loop display modes are interactive, in that the setpoint, the Auto/Manual mode and the Manual Output value can be edited from the user interface. Full configuration is carried out in the Loop setup menus (section 4.6) and a fuller description of control loops is to be found as Appendix B to this manual.

Figure 3.4.7 depicts a single loop display and the dual loop display. The up and down arrow keys are used as normal to scroll through Loop1, Loop2 and Dual loop pages.

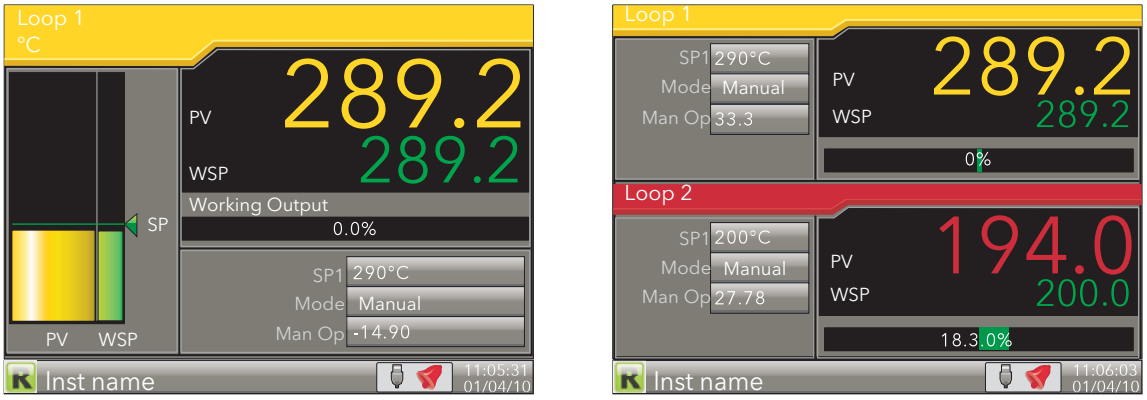
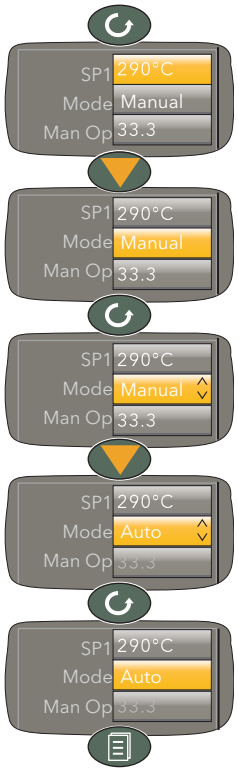


Figure 3.4.7 Loop displays

Note: The colours associated with the loops are those of the channels to which they are wired.

EDITING TECHNIQUES



1. With the loop page on display, operate the Scroll key. This highlights the first editable item (SP1). The scroll order includes both loop1 and loop 2 parameters in the dual loop display.

2. Use the up and down arrow keys to select the required field for editing. When the required field is highlighted, operate the scroll key again, to enter edit mode.

3. Use the up/down arrows to edit the current setting.

4. Operate the scroll key to confirm the edit.

5. Select a further parameter for editing, or operate the page key to return to normal operation.

Note: Edit permissions for Setpoint and Auto/Manual are set in the Loop Setup configuration menu (section 4.6.2).

3.4.8 Cascade display mode

This display mode appears only if 'Cascade' has been enabled in the Instrument.Display area of configuration (section 4.1.3). See also Advanced Loop configuration (section 4.7)

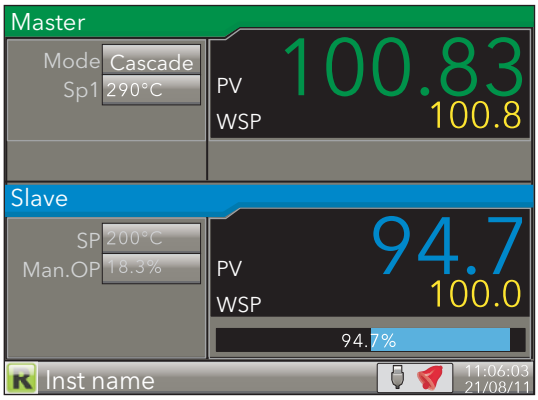


Figure 3.4.8a Cascade display mode

Operating the scroll button highlights the Master 'Mode' field. Operating the scroll button again, enters edit mode allowing the user to use the up/down arrow buttons to scroll through the available modes. Once the required mode appears, a further operation of the scroll button confirms the entry and quits edit mode.

Once out of edit mode, the down arrow key can be used to select Master 'SP1', Slave 'SP' and Slave 'Man OP'. The Mode selected determines how many of these items are editable by the operator.

Mode	Cascade: The master loop is in auto mode and provides the slave setpoint. Changing modes causes the slave to switch to the local slave setpoint. Slave: A simple single loop controlling with a local setpoint. Manual: Provides a single manual % power output.
SP1	Setpoint 1 is the primary setpoint of the controller. If the controller is in automatic control mode, then the difference between the setpoint and the process variable (PV) is continuously monitored by the control algorithm. The difference between the two is used to produce an output calculated to bring the PV to the setpoint as quickly as possible without causing overshoot.
SP	The slave setpoint, either local (Manual or Slave mode) in which case it can be edited, or supplied by the master loop (Cascade mode), in which case it is not editable.
Man.OP	The percentage output power to be applied when in Manual mode (100% = full on; 0% = off).

Note: The default loop names ('Master' and 'Slave') can be replaced by user-entered strings of up to 10 characters in Advanced Loop Setup configuration (section 4.7.2).

3.4.9 Programmer display mode

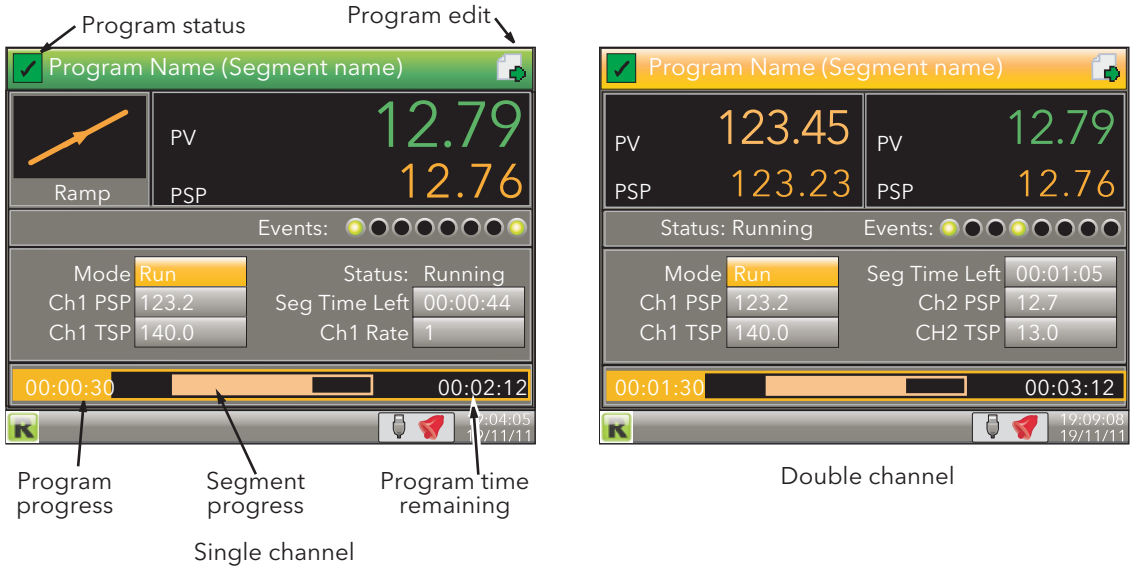


Figure 3.4.9a Programmer displays (typical)

This display mode (if enabled - see section 4.1.3) allows the user to monitor the progress of a single or dual-channel setpoint program, and if logged-in as 'Operator*', to reset or run the program. The program itself is created in the Program edit page (described below) and in Programmer configuration (section 4.8 or 'iTools').

*Note: Operator is the default access level - to edit, see ' Prog Mode Access' in section 4.8.3)

The displays contain the following features:

Program name — This is the name of the loaded program. If the program has been modified since being saved, an asterisk (*) appears after the name. Default background colour shown. This colour changes to that assigned to the input channel when this is configured.

Segment name — This is the name of the current segment. If not named in Segment configuration, then the segment number appears instead.

Program status — At the top right hand corner of the display, this can be any one of the following:

The program is running (or ran last time) without any PV 'Alarm' events or user intervention.

The user has intervened in the running of the program, by placing it in 'hold' or 'reset', or by advancing a segment, or by adjusting a duration, target setpoint, ramp rate or time-to-target value.

A PV 'Alarm' Event has activated. A PV 'Alarm' Event is an absolute high/low or a deviation alarm on the PV input.

There is no program loaded, or if a program is loaded, it has not yet run.

Program edit — This icon appears for users with appropriate access permissions, to indicate that setpoint programs can be configured (as described in Program edit, below).

Segment type — For single channel displays, this indicates the type of segment currently being run:

Dwell. The segment value remains constant for the duration of the dwell period.

End (dwell). Displayed on completion of the program. The segment value remains at the final value until reset

End (reset). Displayed on completion of the program. The program resets.

Ramp. The segment value ramps at a fixed rate or over a fixed period to the Target setpoint. Ramp up icon shown; ramp down is similar but inverted.

Step. The segment value switches immediately to the new Target setpoint. Step down shown; step up similar but inverted.

Wait. The segment value remains constant until the wait criteria are satisfied.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PV	The current process value of the signal wired to Ch1(2) PV Input.
Ch1(2)PSP	This is the output setpoint from the programmer for the channel. In reset this value tracks the configured servo parameter.
Ch1(2)TSP	The channel target setpoint. The target set-point may be edited while the program is in hold (in such cases, for ramp rate segments the time remaining is recalculated.
Events	Up to eight events can be configured in the Program Edit page. Any one or more of these events may be deemed to be active for the duration of each individual segment.
Mode	Shows the current run mode of the program. If the user has the correct access level, the mode can be set to 'hold', reset' etc. by using the scroll key twice (first to highlight the run mode, then again to enter edit mode) and then using the up/down arrow keys to select the required mode. Run, reset, hold etc. can also be selected by inputs from other parameters, switch inputs etc.
Status	Shows the status of the current segment.
Ch1 Rate	The channel 1 rate-of-change of segment value for 'Rate' ramp segments.
Ch1 Time	Shows the channel 1 duration configured for the segment to ramp, dwell etc. for 'Time' ramp segments. For two-channel programs, see the note below.
Seg Time Left	Shows the time that the segment has to run before completion.
Program progress	The numerals show program elapsed time, and the bar gives an indication of progress so far. For two-channel programs, see the note below.
Segment progress	For each segment as it runs, this gives a visual indication of the proportion of total segment time which has elapsed so far. For two-channel programs, see the note below.
Program time remaining	Shows the time remaining until the program completes. For two-channel programs, see the note below.

Note: For two-channel programs, in 'Hold' mode, the 'program progress', 'segment progress' and 'program time remaining' areas of the display are replaced by 'Ch1 Time' and 'Ch2 Time', as shown below.

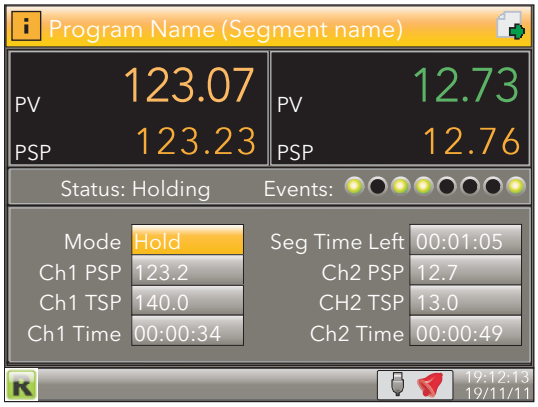


Figure 3.4.9b two channel program in Hold mode

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PROGRAM RUN/RESET/HOLD

Programs can be controlled by users with the correct access level (defined in Programmer configuration - section 4.24). The display page is placed in edit mode by operation of the scroll key ('Mode' highlights). A second operation of the scroll key followed by operation of the up/down arrows allows the user to select 'Run', 'Hold' or 'Reset'. A further operation of the scroll key initiates the selected action.

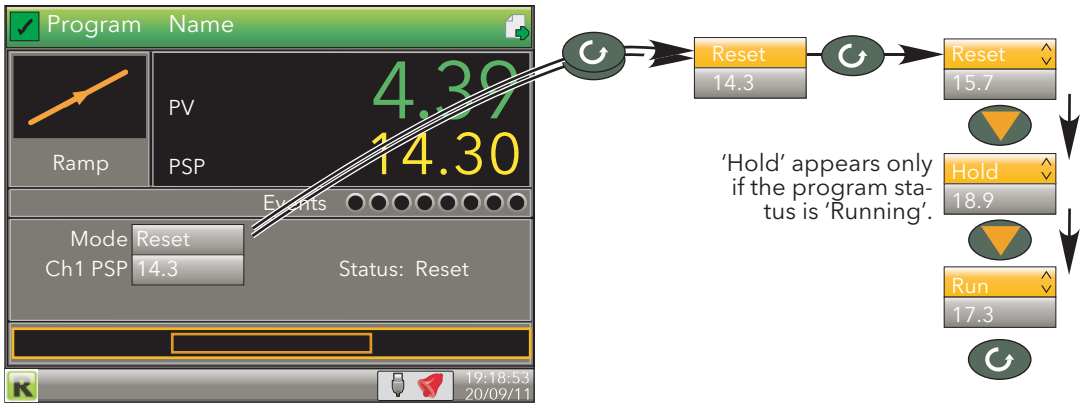


Figure 3.4.9c Setting the Mode

Notes:

1. These functions can also be carried out by wiring relevant inputs to the 'Run', 'Hold' or 'Reset' parameters in Programmer configuration (section 4.8).
2. The user must have either 'Logged off', 'Operator' or 'Supervisor' level access as defined in 'Prog Mode Access' in the Programmer.Setup menu described in section 4.8.3 . The program cannot run if the unit is logged into at 'Engineer' level.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PROGRAM EDITING

The program edit page is accessed by operating the scroll button once to highlight the Mode, then using the up arrow key to highlight the page symbol at the top right hand corner of the display and then the scroll button again to enter the program editor.

By default, Program Edit is available only to users with Supervisor or Engineer level access. The required access level can be edited in Programmer.Set Up configuration as described in section 4.8.3.

Figure 3.4.9d Access to the program editor

As can be seen from the figure above, the initial Program Edit page is divided into two areas - the top part contains program details; the lower part (figure 3.4.9f) contains individual segment details. The editable items that appear in the program details area depend on the features enabled in the Programmer Features configuration menu (section 4.8.1).

Note: Access to some program operations is restricted to users with the correct access level, as defined in the 'Prog Mode Access', the 'Prog Edit Access' and the 'Prog Store Access' parameters in the Programmer.Set Up area of configuration described in section 4.8.3. Access to some items also depends on whether or not the program is running.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PROGRAM DETAILS

Operation	This allows the user to select one of the following (see also 'Program Store, below): Load. Opens the program store and allows the user to select a program to be loaded. The program must have the same number of channels as defined in Programmer.Set Up (section 4.8.3). Store. Allows the current program to be saved to the internal program drive. Delete. Allows the selected program to be deleted. Delete All. Deletes all programs. Copy. Copies the selected program for 'pasting' either from the internal drive to the USB device, or vice-versa. Copy All. As above, for 'Copy', but copies all the programs in the selected directory.

Note: If a 'Store', 'Copy' or 'Copy All' operation would result in there being a total of more than 100 program files in the internal drive, the operation fails and an error message is displayed.

Status	Success. Previous operation was successful. Failed. Previous operation failed. Loading. The program is loading. Copying. The program copy process is underway. Deleting. The relevant program is being deleted.
Program	The name of the program currently loaded.
Holdback Style	Appears only if 'Holdback' is enabled in the Programmer Features configuration (section 4.8.1). See also 'Holdback', below. Program: Holdback applies to all appropriate segments. Per Segment: Holdback enabled on a segment by segment basis as described in 'Segment configuration below.
Ch1 Holdback	Appears only if 'Holdback Style' (above) is set to 'Program'. Off: Holdback is disabled Low: Holdback is entered when PV < (PSP - Holdback Value) High: Holdback is entered when PV > (PSP + Holdback Value) Band: Holdback is entered when PV < (PSP - Holdback Value) or PV > (PSP + Holdback Value)
Ch1 Holdback value	The value to be used in triggering holdback.
Ch2 Holdback	As for Ch1 Holdback, above but for channel 2. Appears only if 'Channels' is set to '2' in Programmer Set Up configuration (section 4.8.3).
Ch2 Holdback value	As for 'Ch1 Holdback value', above, but for channel 2. Appears only if 'Channels' is set to '2' in Programmer Set Up configuration (section 4.8.3).
Ramp Style	Ramp style applies to all ramp segments in the program. Ramp Style can be edited only when the program is in Reset mode. Setpoints, rates, times etc. are set in the individual segment configurations Rate. A Ramp Rate segment is specified by a target set-point and the rate at which to ascend/descend to that set-point. Time. A Ramp Time segment is specified by a target set-point and a time in which to achieve that set-point.
Ch1 Ramp Units	Select 'Per Second', 'Per Minute' or 'Per Hour' for ramp timing units. Ramp Units can be edited only when the program is in Reset mode.
Ch2 Ramp Units	As for 'Ch1 Ramp Units' above. Appears only for two channel programs and allows different ramp units to be selected for the two channels, if required. Ramp Units can be edited only when the program is in Reset mode.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PROGRAM DETAILS (Cont.)

HOLDBACK

Holdback pauses the program (freezes the Programmer setpoint (PSP) and the time remaining parameters) if the difference between the Process value (PV) and the PSP exceeds a user-specified amount (Holdback value). The program remains paused until the PV returns to within the specified deviation.
In ramp or step segments, holdback indicates that the PV is lagging the SP by more than the specified amount and that the program is waiting for the process to catch up. In a dwell segment, holdback is used to guarantee that a work piece stays at set-point within a specified tolerance for the specified dwell duration.

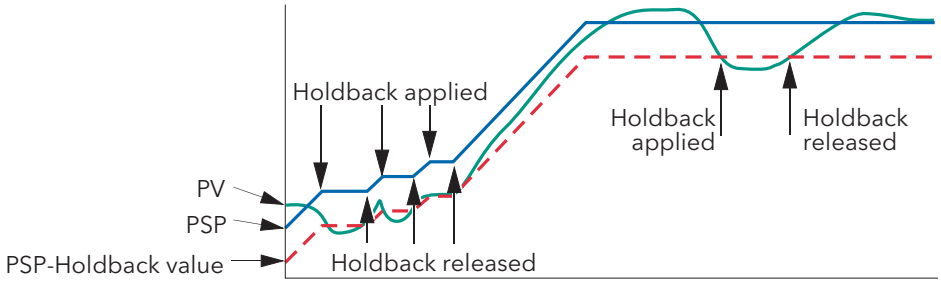


Figure 3.4.9e Holdback

SEGMENT CONFIGURATION

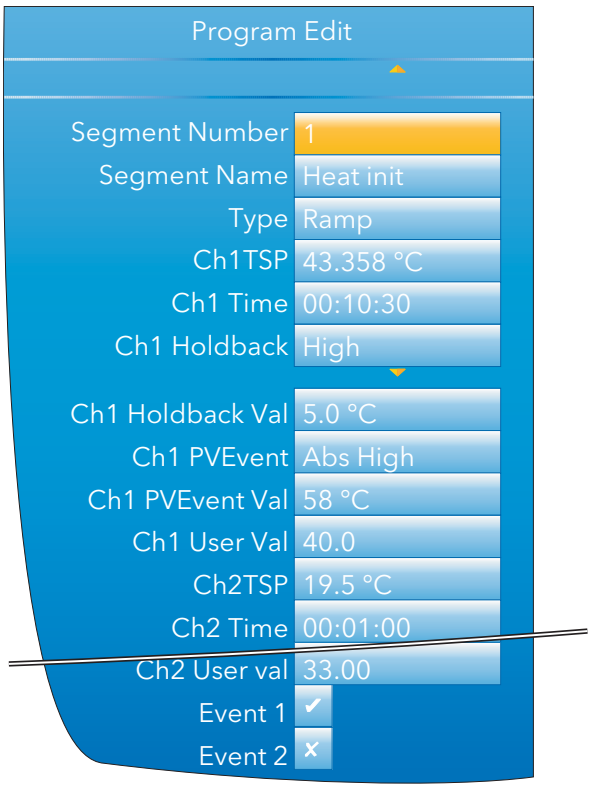


Figure 3.4.9f Segment configuration

Segment Number	Select the relevant segment for configuration.
Segment Name	Enter a segment name of up to 20 characters. This name will be truncated on the display page if it, together with the program name, are too long to fit the width of the display area.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

SEGMENT CONFIGURATION (Cont.)

Type	Select a segment type. Default is 'End'. Ramp. For any program, Ramp segments can be either 'Ramp Rate' segments or 'Ramp Time' segments according to the 'Ramp Style' setting described above. See also 'Ch1(2) Time' or 'Ch1(2) Rate', below. Dwell. The setpoint is maintained at its current value for the period defined in 'Duration' (see below). Step. A step segment allows a step change to be entered for the target set-points Ch1 TSP and Ch2 TSP. Wait. A wait segment causes the program to wait for a certain event to occur before continuing. See 'Wait For', below. Go Back. A Go Back segment allows a specifiable number of iterations to be performed of a group of segments. This could be used, for example, to cycle an entire program by having a Go Back segment immediately before the end segment and specifying segment 1 as the 'Go Back To' point. Setting 'Cycles' to 'Continuous' causes the program to loop indefinitely, until interrupted by the user. 'Nested' loops are not permitted i.e. 'Go Back' is not available as a segment type for segments inside an existing GoBack loop. End. The final segment of a program allows the user to select 'Dwell' or 'Reset' as the action to be taken at the end of the program (see 'End Type', below)
Ch1(2) TSP	Target setpoint. The value that Ramp or Step segments seek to attain, for channel 1(2).
Ch1(2) Rate	For Ramp Rate segments, this specifies the speed at which the process value ramps towards the target, for Channel 1(2). The ramp units (per second, per minute, per hour) are set in Ch1(2) ramp units described above.
Ch1(2) Time	For Ramp Time segments, this allows the user to specify the time to be taken by the segment for the process value to reach the target.
Duration	For Dwell segments, this allows the entry of the time for which the segment dwells.
Go Back To	For 'Go Back' segments, this defines the number of the segment to which the program is to return.
Cycles	The number of times the 'Go Back' instruction is to be carried out. If set to 'Continuous', the program continues until the user intervenes to stop it.
End Type	Allows the user to select the action to be taken at the end of the program: Dwell: the set-point is maintained indefinitely and event outputs remain at their configured state. Reset: the set-point reverts to the value used by the control loop before the program was started and the event outputs return to their default states.
Wait For	Digital High: Wait segments can be configured to wait for 'Wait Digital' to go 'high' before allowing the program to continue. Analog 1(2): The segment waits for 'Wait Analog1(2) to meet an Absolute High or Low, or Deviation High or Low condition before allowing the program to continue. Analog Both: As Analog 1(2) above, but waits for both Channels' conditions to be true before continuing.

Note: 'Wait Digital', Wait Analog 1' and 'Wait Analog 2' parameters are configured in the Programmer.Set Up menu described in section 4.8.3.

Ch1 Wait	Select 'Abs High', 'Abs Low', 'Dev High' or 'Dev Low' as the wait criterion for channel 1. Appears only if 'Wait For' (above) is set to 'Analog 1' or 'Analog Both'.
Ch2 Wait	Select 'Abs High', 'Abs Low', 'Dev High' or 'Dev Low' as the wait criterion for channel 2. Appears only if 'Wait For' (above) is set to 'Analog 2' or 'Analog Both'.
Ch1(2) Wait Val	Enter the trigger value for 'Ch1(2) Wait'
Ch1(2) Holdback	Select 'Off', 'Low', High', or 'Band' (see description in Program details above).
Ch1(2) Holdback Val	The value to be used in triggering holdback.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

SEGMENT CONFIGURATION (Cont.)

Ch1(2) PV Event

Appear only if 'PV Events' have been enabled in the Programmer Features menu (section 4.8.1). A PV Event (an analogue alarm on the channel PV) is available for each channel in every segment (excluding Wait and Go Back segment types). The following PV Events are supported:

Off: The PV Event is disabled

Abs High: The event is triggered when the channel PV exceeds PVEvent Val for the relevant channel.

Abs Low: Triggered when the channel PV becomes less than PVEvent Val for the relevant channel.

Dev High: This event is triggered when the channel PV exceeds (PSP + PVEvent Val) for the relevant channel

Dev Low: Triggered when the channel PV becomes less than (PSP - PVEvent Val) for the relevant channel.

Dev Band - This event is triggered when the channel PV differs from the PSP by more than the configured deviation value (either above or below)

In the following example, in segment 1 Ch1 PV Event has been configured as Dev Band and in segment 2 it has been configured as an Abs low:

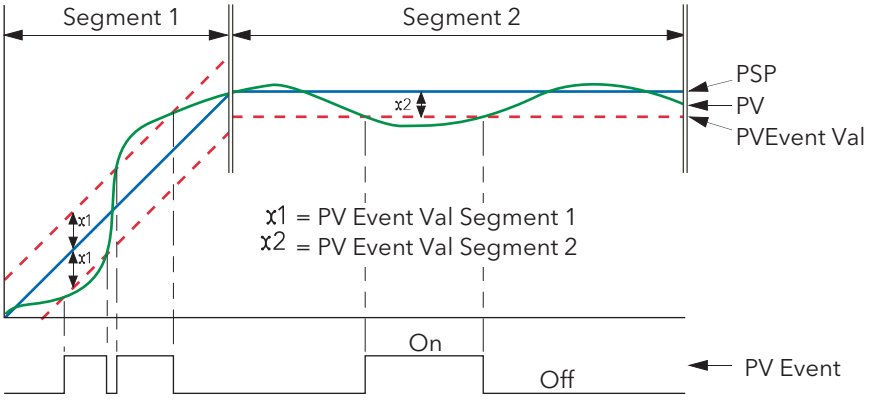


Figure 3.4.9g PV Events

Ch1 PVEvent Val

Appears only if 'Ch1 PVEvent' is not 'Off'. Sets the level at which Ch1 PV Event becomes active.

Ch2 PVEvent Val

Appears only if 'Ch2 PVEvent' is not 'Off' and if 'Channels' is set to '2' in Programmer Set Up configuration (section 4.8.3). Sets the level at which Ch2 PV Event becomes active.

Ch1 (2) Event Use

When PV events become active, they can be used either to Trigger a secondary process or as a simple analogue alarm on the PV input. Appears only if the relevant PV Event parameter is not set to 'Off'.

Ch1 (2) User Val

Specifies the User Value for this segment, for channel 1(2). Appears only if 'User Value' has been enabled in the Programmer Features menu (section 4.8.1).

The example below (from iTools) shows this parameter wired to the trigger 1 input of the Custom Messages block, so that, if a User value >0 is entered, then every time the segment runs, Custom message 1 is generated.

Event 1 to 8

The number of Events available (Max Events) is defined in Programmer Set Up configuration (section 4.8.3). Enabling an event causes the relevant indicator on the display page to be illuminated for the duration of the segment. As with 'User Val', above, Events can be wired to the inputs of other parameters if required.

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

SEGMENT CONFIGURATION (Cont.)

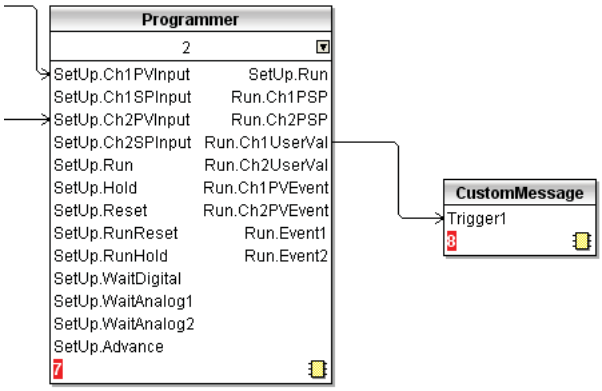


Figure 3.4.9h iTools example showing Ch1 UserVal being used to trigger custom message 1.

FUTURE TREND DISPLAY MODE

If enabled in Instrument.Display configuration (section 4.1.3), this allows the user to view the actual value of the PSP alongside the expected value, so the two can be compared to see how the process is performing.

Future trend is an enhancement of the horizontal trend mode, with the display being divided into two parts, with the instantaneous current value located at the divide, with past trends to the left and the next few program segments to come, to the right.

Notes:

1. For the future trend mode to appear, the programmer must be wired to the loop or advanced loop feature.
2. Both historic and future trends move from right to left with the present anchored at the screen centre.
3. The amount of history and of future trending displayed on the screen depends on the trend interval set in Group.Trend configuration (section 4.3.1)

Figure 3.4.9i shows a typical future trend display

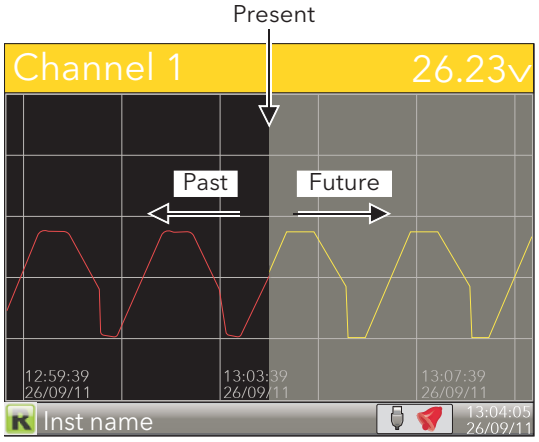


Figure 3.4.9i Future trend display

3.4.9 PROGRAMMER DISPLAY MODE (cont.)

PROGRAM STORE

Note: The access levels required for the operations described below are configured in the Programmer Set Up menu 'Prog Edit Access' and 'Prog Store Access' parameters, described in section 4.8.3.

The program store allows access to the instrument's local program storage area and to programs stored on a USB memory stick (if any) and to those stored in a pc (if any), via FTP. Programs may be saved to (Stored) or retrieved from (Loaded) from the program store, or they can be copied or deleted.

Selecting any of the program operations (except 'Delete All'), from the Program Edit page (Engineer access level required) opens the file explorer page. Figure 3.4.9j depicts this page, with just a couple of example entries after a 'Load' operation has been requested.

On entry, use the up/down arrow button to select 'User', 'USB' or 'FTP' (selection highlights yellow), then use the scroll button to confirm. Use the up/down arrow buttons to select the required file, and then use the scroll button again to confirm. Other operations are similar.

The file explorer supports 100 entries, which may be directories or files.

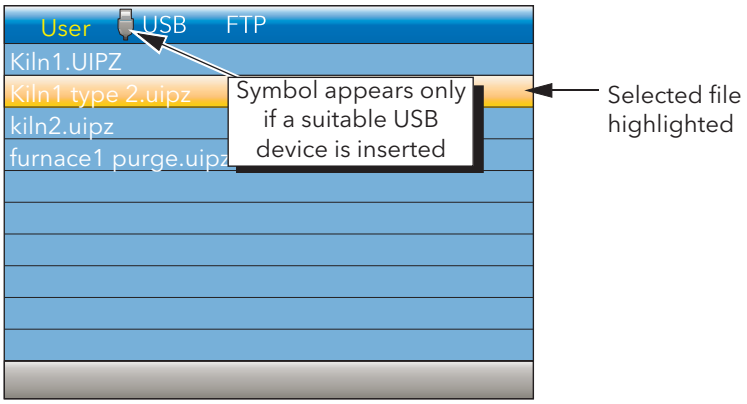
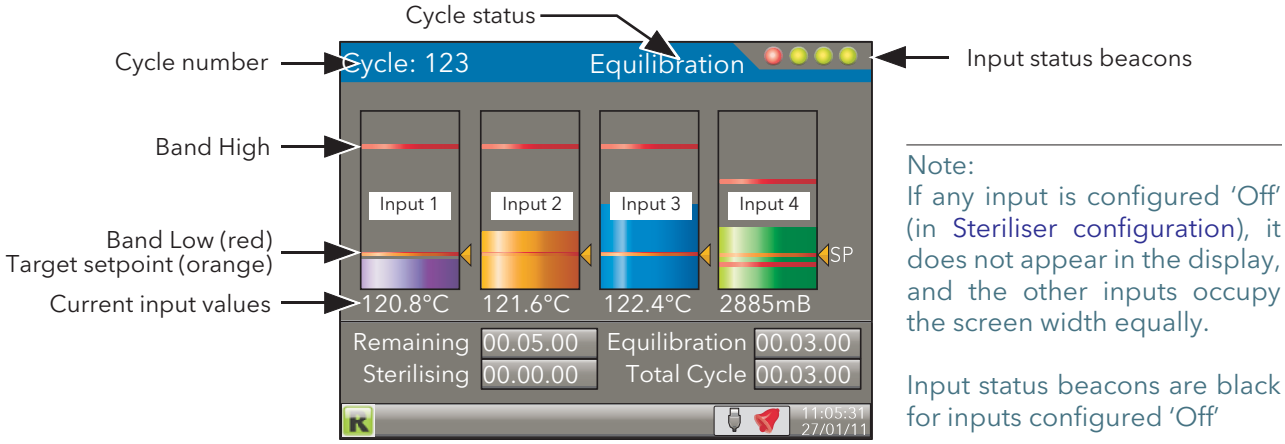


Figure 3.4.9j Program store display

Note: A 'busy' icon (rotating green flash) appears whilst directory listings are being accessed.

3.4.10 Steriliser display mode

This display mode appears only if the Steriliser option is fitted and if the display mode has been enabled in the Instrument Display configuration (section 4.1.3) Steriliser configuration parameters are to be found in section 4.16



Note:
If any input is configured 'Off' (in Steriliser configuration), it does not appear in the display, and the other inputs occupy the screen width equally.

Input status beacons are black for inputs configured 'Off'

Figure 3.4.10a Steriliser display mode (typical) (four inputs)

OPERATION

A sterilising cycle cannot be initiated whilst the unit is in Configuration (Engineer) mode.

A steriliser cycle is started by setting its relevant 'Start' input to 'Yes' for the duration of the cycle. The cycle waits (status 'Waiting') until input 1 reaches its setpoint, at which point the cycle enters the equilibration period (status 'Equilibration'), and remains there until all the configured inputs are valid. The cycle then enters the sterilising period and stays in this mode until the sterilising period has expired (status 'Passed') or until one of the inputs becomes invalid (status 'Failed') for longer than its configured 'Failure Dwell' time.

Note: The cycle stops (status 'Failed') if the trigger source is removed.

TERMINOLOGY

Holding time	Most operating cycles have a stage in which the load must be exposed to sterilisation conditions for a specified length of time, known as the 'Holding time'.
Equilibration time	The holding time (above) is preceded by a period during which, although the sterilising condition is present in the chamber, the load has not yet attained that temperature due to its thermal inertia. 'Equilibration time' is defined as the time between the attainment of sterilisation temperature in the chamber, and the attainment of that temperature in all parts of the load.
Bands	For steam and dry heat sterilisers, sterilisation conditions are specified by a sterilisation temperature band, defined by a minimum acceptable temperature (known as the sterilisation temperature) and a maximum allowable temperature. A sterilisation band is normally quoted for each steriliser type.

BEACONS

There are four input status beacons near the top right hand corner of the display, one for each input.

During equilibration, the beacons are flashing red for inputs that have not attained the Target setpoint, and go green when the target setpoint is reached, remaining green even if the input value rises above the Band High value The beacons revert to red if input falls below* the target setpoint.

During sterilisation, the beacons go red for any input whose value rises above Band High or falls below* setpoint for a duration exceeding the configured 'Failure Dwell' period.

Beacons are black for inputs that are configured as 'Off'.

* 'rises above' for input types 'Falling Pressure' or 'Fall Air Detect'

3.4.10 STERILISER DISPLAY MODE (Cont.)

DISPLAYED INFORMATION

Cycle	A five-digit counter to indicate the total number of cycles started.
Status	Wait start: The initial state at power up. This status remains until the first cycle is initiated Waiting: Waiting for input 1 to reach its target setpoint. The cycle then enters Equilibration. Equilibration: Currently in the equilibration period, during which the cycle waits until all inputs have reached sterilisation conditions. Sterilising: Currently in the decontamination phase Passed: The cycle has completed successfully Failed: The cycle has failed either through one or more inputs becoming invalid, or because the 'Start' signal was removed. Test cycle: A test cycle is in progress
Remaining	The sterilising time remaining for the current cycle. Display field is replaced by 'Target Time' (below) when the cycle is not running.
Target time	The intended sterilisation time. This can be configured by operating the scroll button twice (once to highlight the field, and again to enter edit mode), and then using the up and/or down arrows to edit the time. Use the Scroll button again to quit edit mode, and the page key to 'unhighlight' the field. Replaced by 'Remaining' (above) when the cycle is running.
Equilibration	The equilibration time period for the current cycle
Sterilising	The time for which the load has currently been at sterilisation conditions
Total Cycle	The elapsed time since the initiation of the current cycle. This time increments from the time the cycle is triggered until the time the trigger is removed.
Input values	Temperature are required in °C; pressure inputs in mBar. If necessary, maths channels and user values can be used to convert from other units (see 'Note' overleaf).

STERILISING CYCLE DIAGRAM

Figure 3.4.10b, below, shows a steriliser cycle in diagrammatic form.

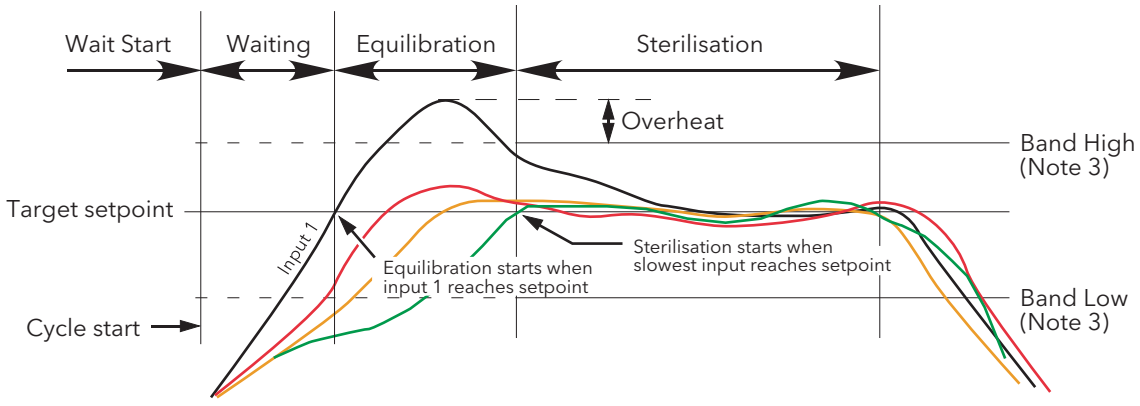


Figure 3.4.10b Steriliser cycle

Notes:

1. For temperature inputs in most applications, the Setpoint value is the same as the Band Low value For the sake of clarity, this is not as shown in the figure above.
2. For the sake of clarity all four inputs in the figure above are shown with the same Band High, Band Low and Setpoint value. This would not be unusual for temperature units, but the pressure input would normally have a different set of values from temperature inputs.
3. Band High and Band Low are effective only during Sterilisation phase.

3.4.10 STERILISER DISPLAY MODE (Cont.)

APPLICATION DETAILS

Figure 3.4.10c shows a typical steriliser application, with temperature and pressure signals from the sterilisation chamber being applied directly to the rear terminals of the controller/recorder, and control signals connected from the controller to both the chamber and the controller/recorder.

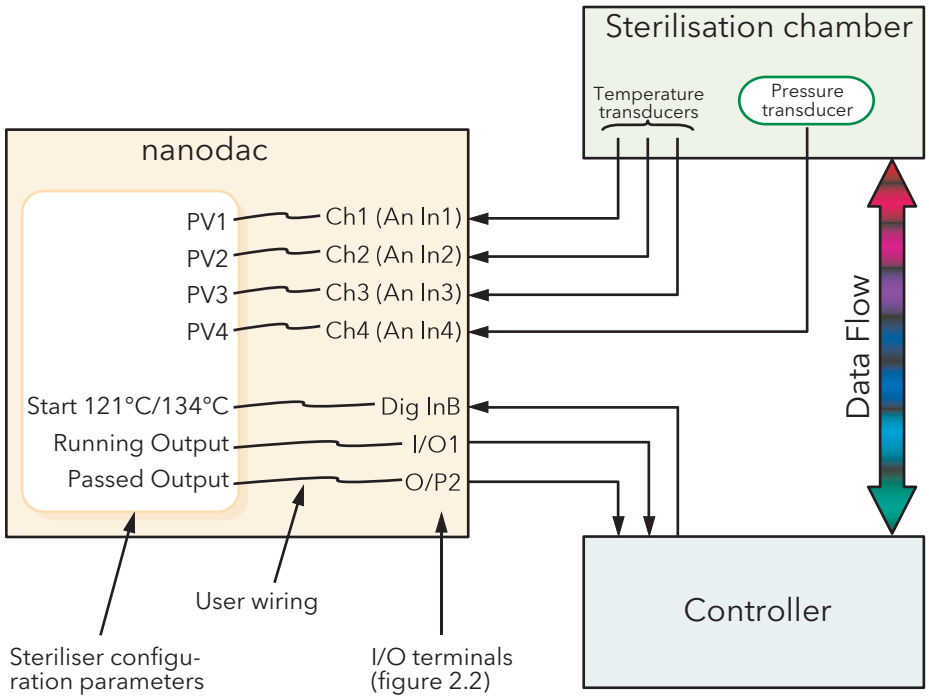


Figure 3.4.10c Typical steriliser application

Analogue inputs 1 to 3 receive signals from temperature transducers (typically thermocouples) within the chamber. These inputs are internally connected to channels 1 to 3 respectively, allowing transducer type, ranges, alarms etc. to be configured (section 4.4). Inputs are assumed to be degrees Celsius*.

The pressure transducer is connected to channel 4 and can be configured in the same way. The input is assumed to be in milliBar. Other pressure inputs should be converted using virtual channels*.

PV1 to PV4 in the Steriliser configuration is software wired (section 7) to Ch 1 to Ch4.

Start cycle input and the 'Running Output' and 'Passed Output' signals are software wired to suitable DIO terminals, for connection to the Controller.

*Note: For Fahrenheit inputs, use one virtual channel to subtract 32, and a second to divide the result by 1.8 (where 32 and 1.8 can be configured as user values). Similar techniques should be used to convert pressure input units if necessary.

TEST CYCLES

A 'Test' cycle is initiated by initiating a 121°C cycle and a 134°C cycle simultaneously. A test cycle allows the user to check actual performance against expected performance.

3.4.10 STERILISER DISPLAY MODE (Cont.)

F_0

F_0 is a means of calculating 'equivalent time at sterilising temperature' for temperatures below, at and above sterilizing temperature, using the equation below.

$$F_0 = \text{Sterilisation time} \times 10^{\frac{Temp-Ts}{Z}}$$

Where:

Sterilisation time	Depends on the application, typically 15 minutes at Ts = 121°C
Temp	The value of the temperature measuring input.
Ts	Desired Sterilising temperature
Z	Temperature interval representing a factor-of-10 reduction in killing efficiency. Z = 10 for steam sterilising (F_0), or Z=20 for dry heat sterilising (FH). Z = 10 for thermal disinfection (A_0).

To ensure that steriliser loads which contain materials with different thermal inertias are thoroughly sterilised, a number of sensors are located withing the load. The F value should be calculated using the sensor closest to that part of the load which has the highest thermal inertia. For maximum accuracy, the temperature sensor should be calibrated and the input adjust function used to compensate for any inaccuracy found.

F0 calculation examples

For all the examples following, the following are assumed: Sterilisation time = 15 minutes; Sterilisation target temperature =121°C and Z = 10.

1. For an actual sterilising temperature of 111°C

$$Fval = 15 \times 10^{\frac{111-121}{10}} = 15 \times 10^{\frac{-10}{10}} = 1.5 \text{minutes}$$

Which means that 15 minutes at 111°C is equivalent to 1.5 minutes at 121°C

2. For a sterilising temperature of 121°C

$$Fval = 15 \times 10^{\frac{121-121}{10}} = 15 \times 10^{\frac{0}{10}} = 15 \text{minutes}$$

Which means that the sterilising temperature is ideal (by definition)

3. For a sterilising temperature of 124°C

$$Fval = 15 \times 10^{\frac{124-121}{10}} = 15 \times 10^{\frac{3}{10}} = 15 \times 1.995 = 29.925 \text{minutes}$$

Which means that 15 minutes at 124°C is equivalent to nearly 30 minutes at 121°C.

Normally sterilising temperatures would not remain constant at temperatures below or above the target value, so the above equations are illustrative only of the facts:

1 Temperatures below the target have some killing efficacy

2 Temperatures above the target value have a greater killing efficiency, so that the sterilising time can be reduced.

In order to calculate the value dynamically, the instrument uses the equation:

$$Fval_t = Fval_{t-1} + T \times 10^{\frac{ma_t - \text{Target temp}}{Z}}$$

where

$Fval_t$	= F value this iteration
$Fval_{t-1}$	= F value last time
T	= Iteration period (minutes)
ma_t	= input temperature value this iteration
Target Temp	= 121°C for F_0, 170°C for F_H, 80°C for A_0
Z	= 10°C for F_0, 20C for F_H, 10°C for A_0

3.4.11 Promote list

This display page allows the user to display up to 10 of the parameters that appear anywhere in the operator interface. The parameters can be selected only by using iTools, as described below.

Notes:

1. 'Promote List' must be enabled (in 'Instrument.Display' configuration), before it appears in the 'Go to View' list.
2. There are more parameters visible in iTools than appear at the operator interface. If non-operator interface parameters are selected for inclusion in the promote list, they do not appear.
3. If parameters which appear only in certain circumstances are selected, then they appear in the promote list only when they appear in the Operator interface. For example, a channel PV is not visible unless that channel is enabled (i.e. it is not 'Off').

PARAMETER SELECTION

1. Open iTools and scan for the instrument, (see section 6).
2. Once the instrument has been found, stop the scan. When the instrument has synchronised, click on the 'Access' button near the top of the display to set the unit into configuration mode (a password may be required).
3. Click on the '+' sign to the left of the Instrument folder in the tree list (left-most pane) to expand the folder. Double-click on 'Promote List', to display the Promote list in the main pane. The list contains 20 entries, 1 to 10 being for parameters, 11 to 20 being available to the user to add descriptors for parameters 1 to 10 respectively.
4. Expand further folders, as necessary, to access the required parameters, and click-drag these parameters into the promote list. Enter a descriptor for the parameter if the default is not as required. As each parameter is dragged into the list, it appears in the Promote list.
5. If the parameters are modified at the operator interface, the changes are reflected in iTools, and vice-versa.
6. Once all the parameters have been added, it is recommended that the Access button be used to quit configuration mode, as otherwise it will not subsequently be possible to quit from the operator interface.

Figure 3.4.11 shows typical displays.

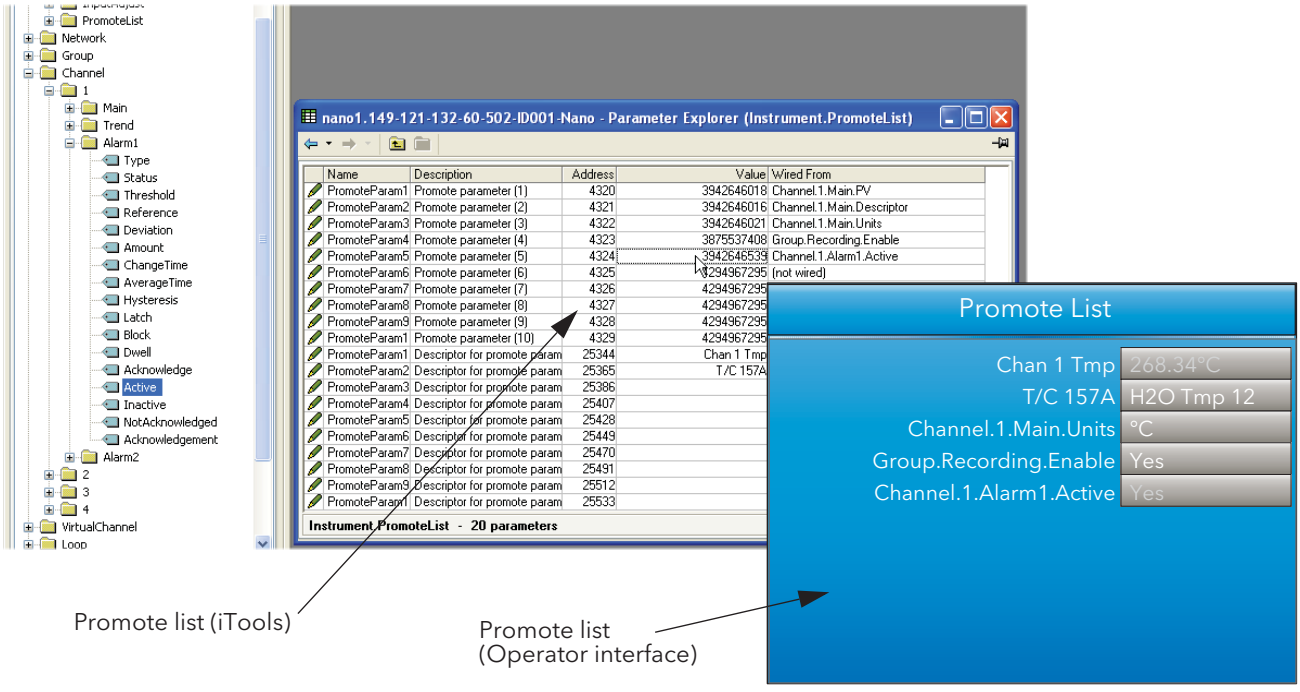


Figure 3.4.11 Promote list displays.

3.4.12 Modbus Master display mode

This display mode consists of two pages, as shown below.

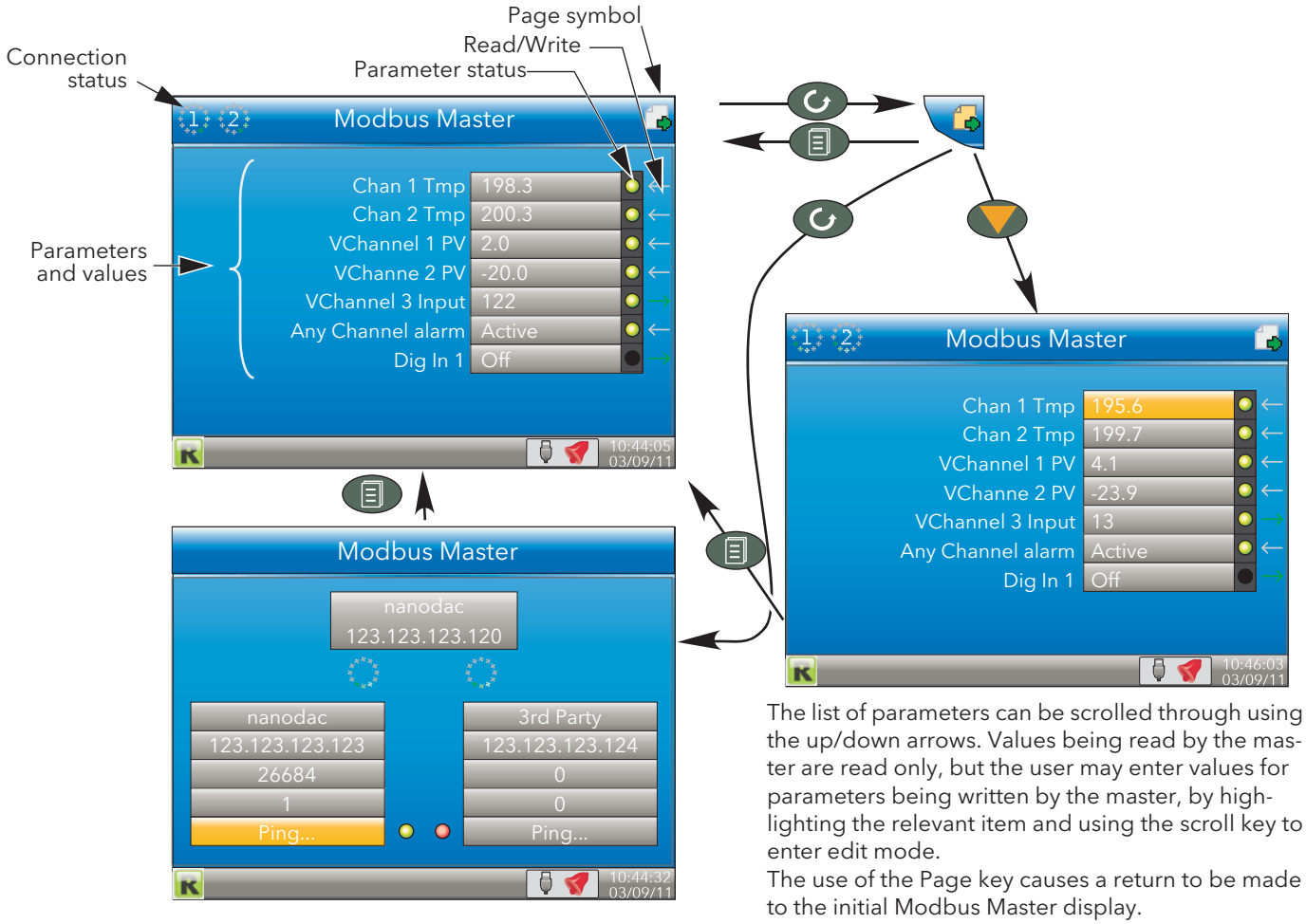
Page one opens by default and shows the first eight parameters being read from (left pointing arrow) or written to (right pointing arrow) the relevant slave. These items are configured in the Modbus Master configuration described in section 4.9. Hidden parameters may be viewed by operating the scroll key, then using the arrow keys to scroll through the list. A green arrow means that the item may be edited by the user when logged in.

A pair of animated indicators in the top left-hand corner of the screen show the connection status of the two possible slaves. A green moving 'streak' indicates that successful communications are being carried out. A red flashing circle indicates that there is a break in the transmission line or that the slave is switched off. A grey, non-animated display indicates that that slave has not yet been configured as a part of the communications link (i.e it is 'off line').

A 'traffic light' indicator appears to the right of each parameter. Green indicates that the parameter is being read from or written to successfully. Orange indicates that a write of the value is pending. Red indicates that there is an error and that no value is currently being read or written; the value displayed is the last good value read or written depending on whether the data item is a read or write. If the indicator is black, the parameter is 'off'.

Operation of the scroll key highlights the page symbol in the top right-hand corner of the screen, and a further operation of the scroll key calls page two to the screen.

Page two contains the IP address of the Modbus master and of any slaves connected to it, together with some diagnostic information, as described in 'PING DETAILS' below.



The list of parameters can be scrolled through using the up/down arrows. Values being read by the master are read only, but the user may enter values for parameters being written by the master, by highlighting the relevant item and using the scroll key to enter edit mode.

The use of the Page key causes a return to be made to the initial Modbus Master display.

Figure 3.4.12a Modbus Master display pages

3.4.12 MODBUS MASTER DISPLAY MODE (Cont.)

PING DETAILS

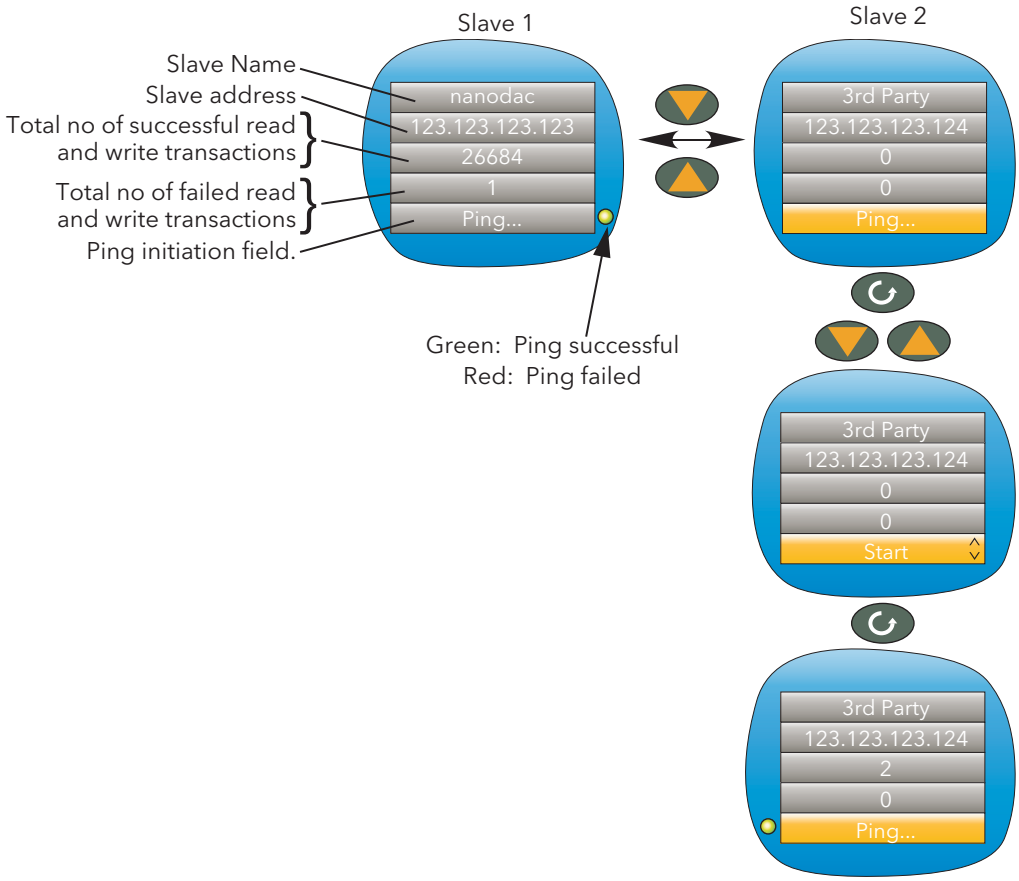


Figure 3.4.12b Slave 2 ping initiation (Slave 1 similar)

The 'Ping...' field of the first slave is highlighted by default. As shown above, the down (or up) arrow can be used to highlight the 'Ping...' field of the other slave instead.

Once the relevant 'Ping...' field is highlighted, the scroll key can be used to enter edit mode and the up/down arrow key used to select 'Start'. A further operation of the scroll key initiates the 'Ping' and if this is successful, a green indicator appears alongside the field (and the text returns to 'Ping...'). If the Ping is unsuccessful, then the indicator is coloured red.

The up or down arrow can now be used to return to slave 1, or the page key can be used to return to the previous parameter display page.

As shown in the figure above, some diagnostic information is given. This includes the total number of successful attempts that the master has made to communicate with the relevant slave, and the total number of failed attempts. Fuller diagnostic details are to be found in the Modbus Master Communications configuration description (section 4.9)

3.4.13 EtherNet/IP display mode

This display mode appears only if enabled in Instrument.Display configuration (Section 4.1.3) and is used to display the input and output parameters assigned to the Client and Server input and output tables. Parameters which have been configured with descriptors are identified by these descriptors instead of their 'opc' names (shown below).

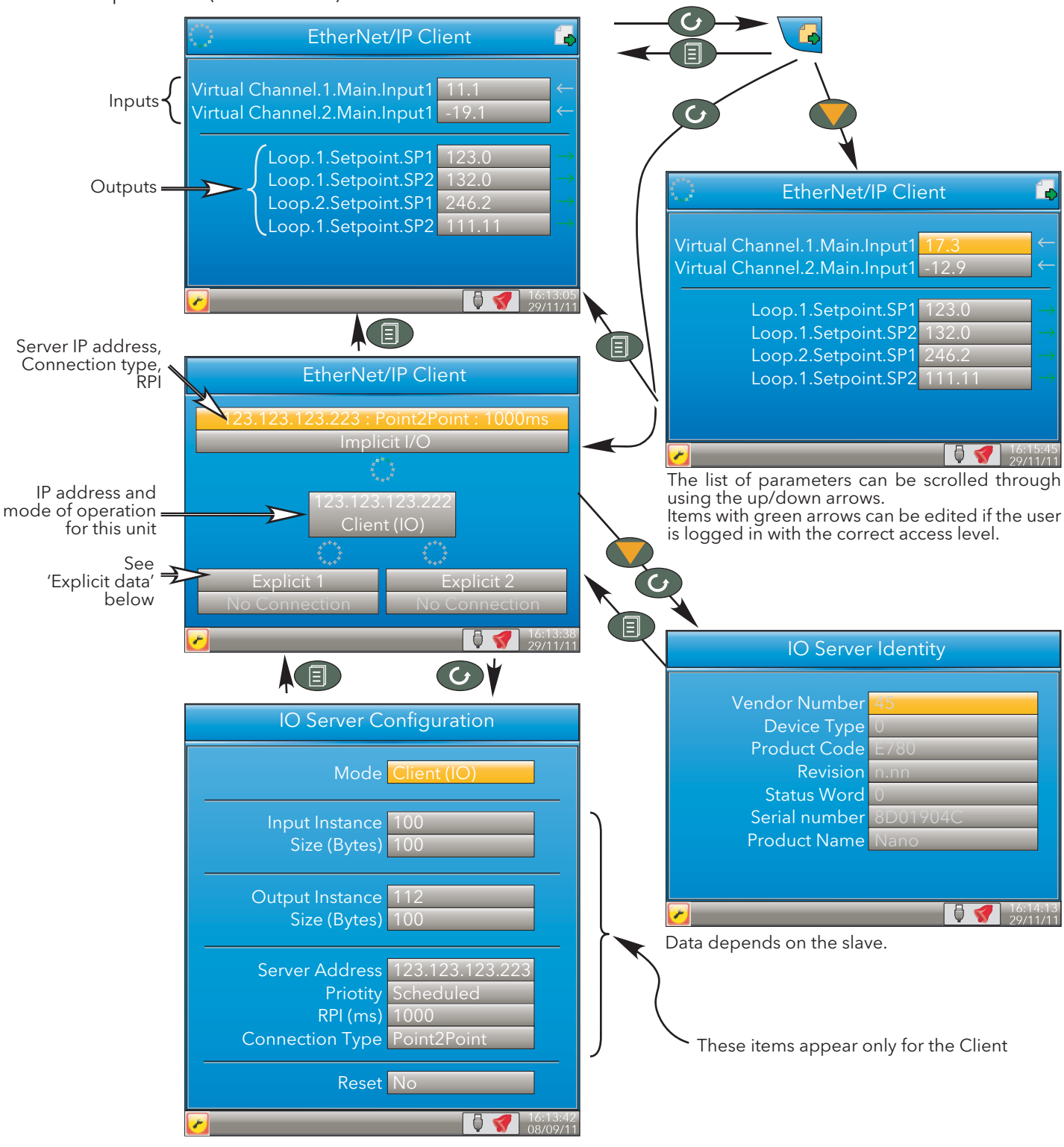


Figure 3.4.13a Typical EtherNet/IP display

3.4.13 ETHERNET/IP DISPLAY MODE (Cont.)

If the EtherNet/IP option is fitted, the nanodac can be configured as either a client (master) or a server (slave) (see section 4.10). The client and server displays are identical except that the configuration area of the client display is more extensive than that of the server display.

Figure 3.4.13a, above shows a typical set of display pages for an EtherNet/IP client.

CONFIGURATION OF IMPLICIT INPUT/OUTPUT TABLES

Configuration of the input and output tables is carried out by:

a. Entering the parameters to be read by the client into the server output table.

b Entering the destination parameter into the equivalent location in the client input table.

c. Entering the parameters to be written by the client into the client output table.

d Entering the destination parameter into the equivalent location in the server input table.

The example in figure 3.4.13b attempts to show this (using the nanodac as the client) in graphical form, using just a few parameters (there can be up to 50 in each table).

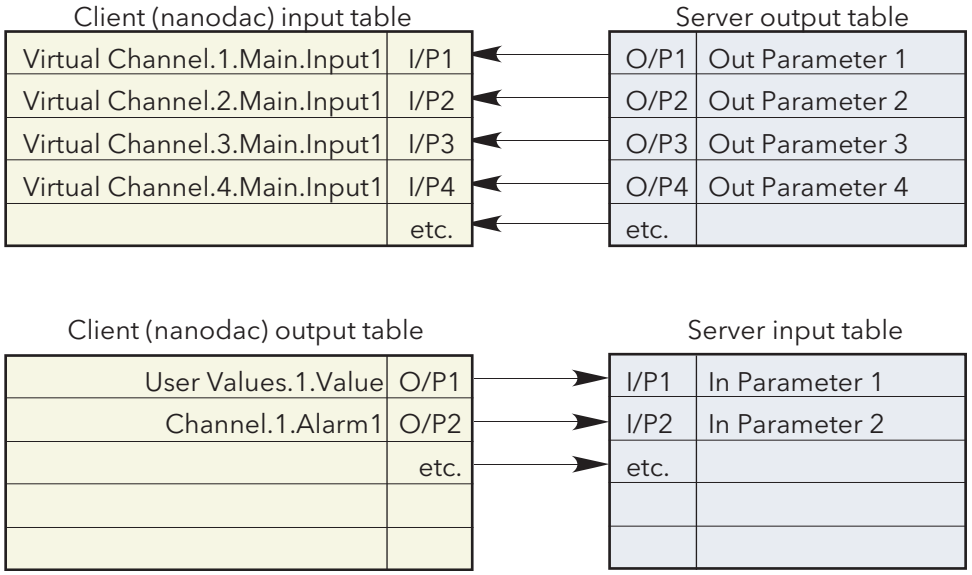


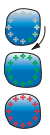
Figure 3.4.13b Input/Output table entries

Notes:

1. Channel values from the Server can be 'wired' into nanodac Virtual channel inputs (as shown above) so that they can be traced and/or recorded. In such cases the virtual channel 'Operation' must be set to 'Copy' (see section 4.5.1).
2. Inputs and outputs would normally be given suitable descriptors (e.g. 'Reset timer' instead of 'Channel.1.Alarm1').

CONNECTION STATUS INDICATOR

A circular status indicator appears in a number of the EtherNet/IP display pages. This indicator can indicate the following states:



Green rotating 'flash': the instrument is on line and at least one CIP connection is established.

Green flashing circle: the instrument is on line but no CIP connections have been established.

Red flashing circle: there is a break in the physical connection between the client and the server, or the remote unit is switched off or is initialising.

3.4.13 ETHERNET/IP DISPLAY MODE (Cont.)

Adding parameters to the input and output tables can be achieved only through the proprietary software package 'iTools', running on a pc. The following description assumes that the user is familiar with 'iTools'. Section 6 of this manual shows how to set up an iTools link to the unit and the iTools on-line help system and its pdf version (HA028838) should be referred-to as necessary.

Note: the client/server and the pc must all be on the same network.

Once iTools has started up and the 'Scan' process has 'found' the relevant instrument, the scan process should be stopped and the instrument (s) allowed to synchronise. (The scan may be left to run its course, but the speed at which iTools operates is reduced for the duration of the scan process.)

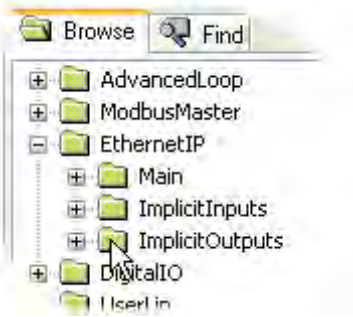
EXAMPLE

To add Loop 2 Setpoint 2 to Output 4 of the Client Output table.

In the example shown below, the instruments have both synchronised, and the 'Access' tool button clicked-on for both instruments to set them into configuration mode.

With the client selected, expand the EtherNet/IP folder in the Browse list, then double-click on the 'ImplicitOutputs' folder.

Locate and expand the Loop 2 SP folder in the Browse window, and click-drag SP2 to 'Output 4' and release.



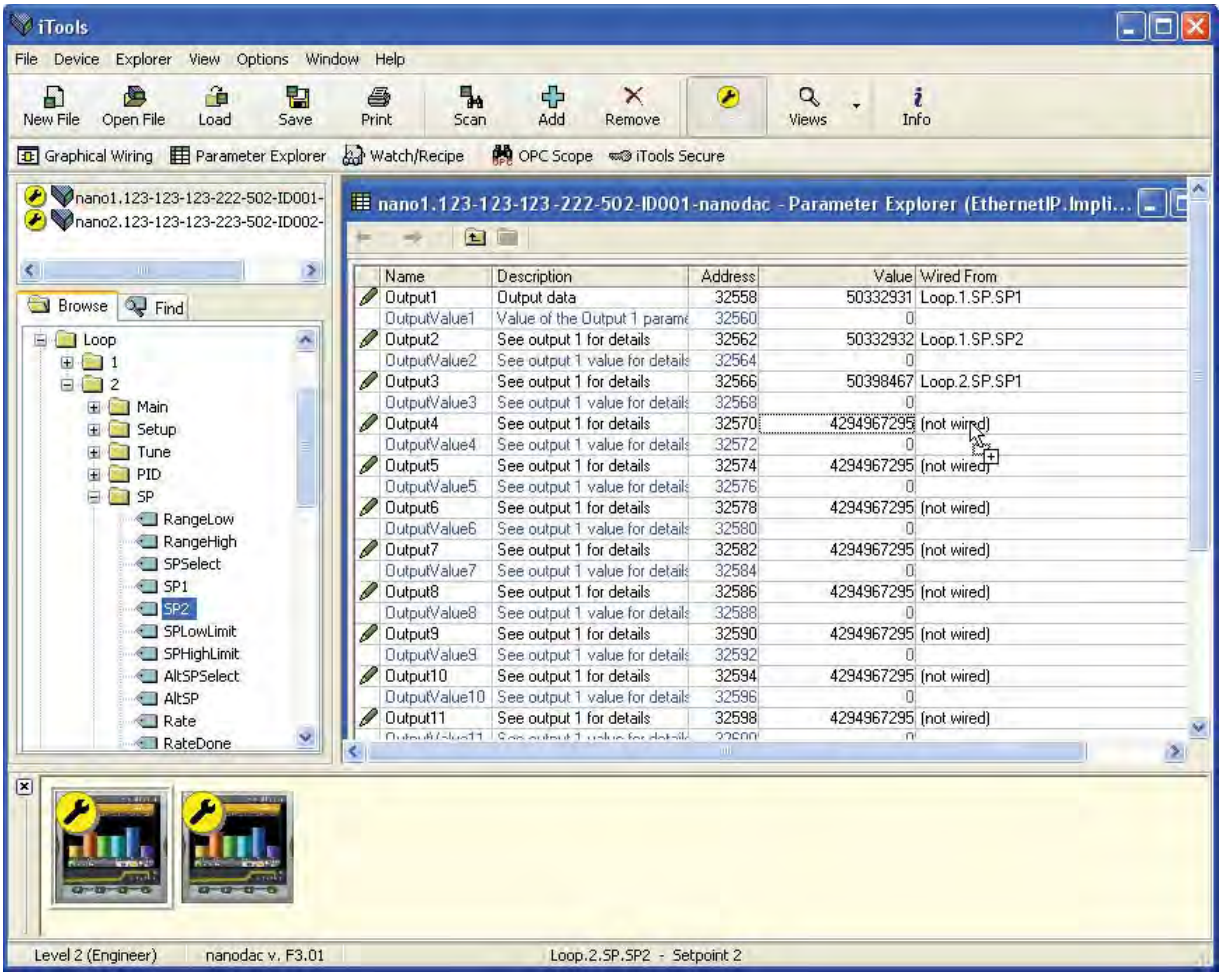


Figure 3.14.3c Dragging a parameter to the Output table

3.4.13 ETHERNET/IP DISPLAY MODE (Cont.)

An alternative to the click-drag technique is to right click on the required output (five in the example below), and select 'Edit Wire...' from the context menu that appears. A browse window pops up, allowing the user to navigate to the required parameter. This technique can be used both on previously empty inputs or outputs and on those previously filled.

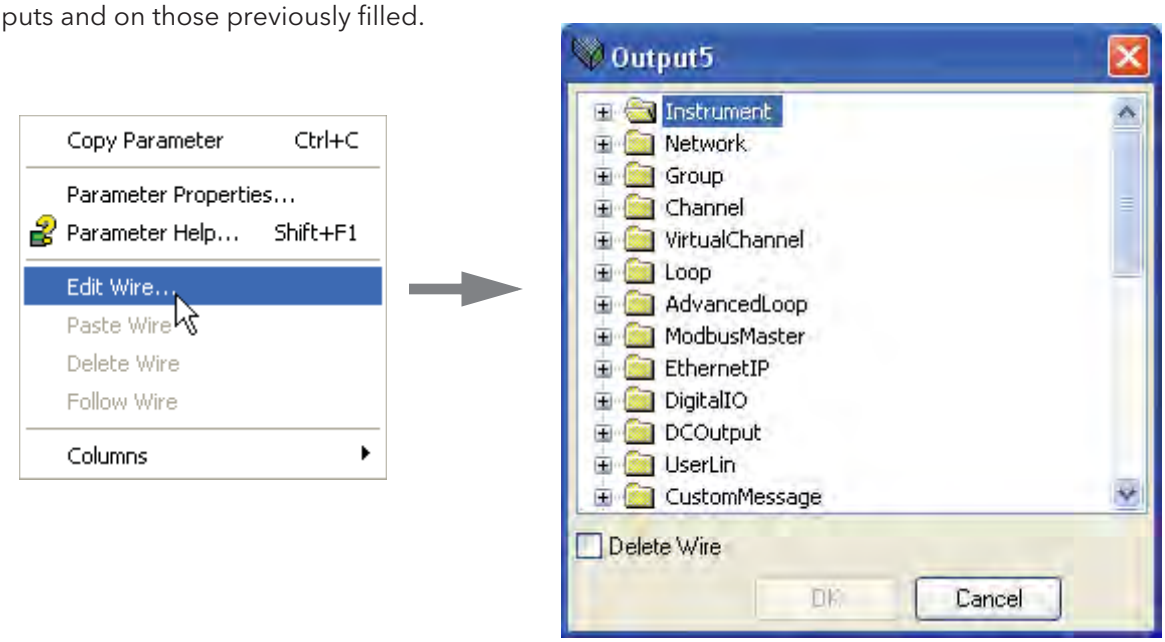


Figure 3.4.13d Context menu details

EXPLICIT DATA

As shown in table 3.4.13, when configured as a server, there is only one explicit application object, and that has the class ID= A2 (162 decimal). The instance ID is the Modbus address of the parameter and the Attribute is always = 1. Explicit service codes hex10 (decimal 16) and 0E (14) are both supported, for writing and reading single attributes respectively.

Service code		Class ID		Instance ID	Attribute
Hex	Dec	Hex	Dec	Decimal	
0010	16	A2	162	1-65535	1
000E	14	A2	162	1-65535	1

Table 3.4.13 Explicit data specification

When configured as a client, two separate connections are available allowing the user to produce two independent explicit read or write messages to different server devices.

Figure 3.4.13e below, shows an example of how to configure an explicit message request. The instance ID and the data type are taken from the server manufacturer's data. In this example a read request is configured to determine the Group recording status of a nanodac server, and it can be seen from table 5.3 that the decimal modbus address for this parameter is 4150 and the data type is int16. It is this address which is used as the instance ID.

Once all the information has been entered, the read is requested by setting 'Send' to 'Yes'. The Data field changes to '3' for this example and from table 5.3 it can be seen that the recording status is 'Recording enabled'.

Note: The nanodac supports only 16 bit data types for reading and writing of explicit messages.

3.4.13 ETHERNET/IP DISPLAY MODE (Cont.)

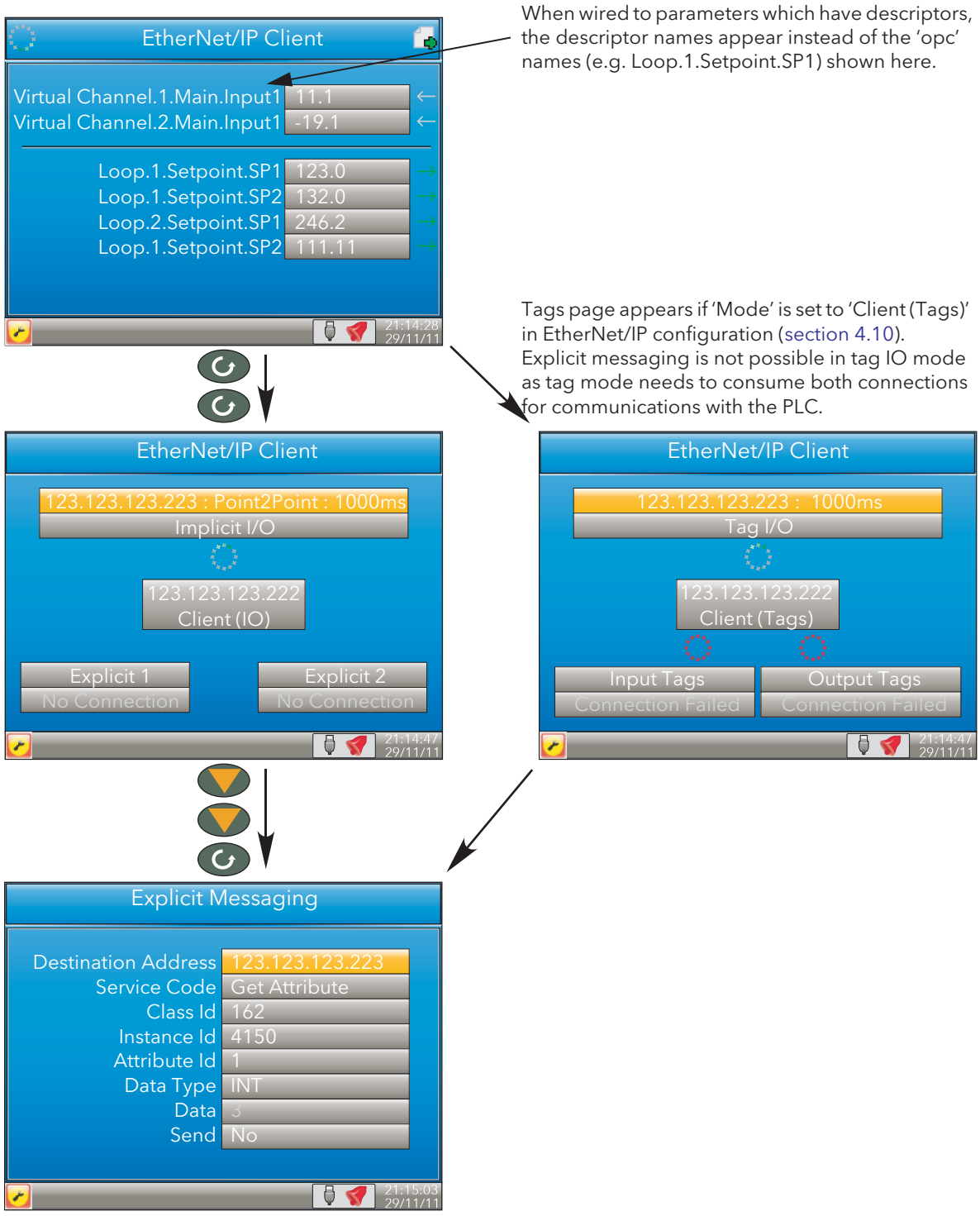


Figure 3.4.13e explicit messaging example

3.4.13 ETHERNET/IP DISPLAY MODE (Cont.)

USING TAGS

When acting as servers, many PLCs present their data in a tag format instead of implicit data format. For this reason, when the client is configured as 'Client (Tags)', (section 4.10) 30 input and 30 output tags become available to the user via iTools (figure 3.4.13f).

This allows tag names to be typed in, input tags 1 to 30 being associated with implicit inputs 1to 30 respectively and output tags 1 to 30 being associated with implicit outputs 1to 30 respectively.

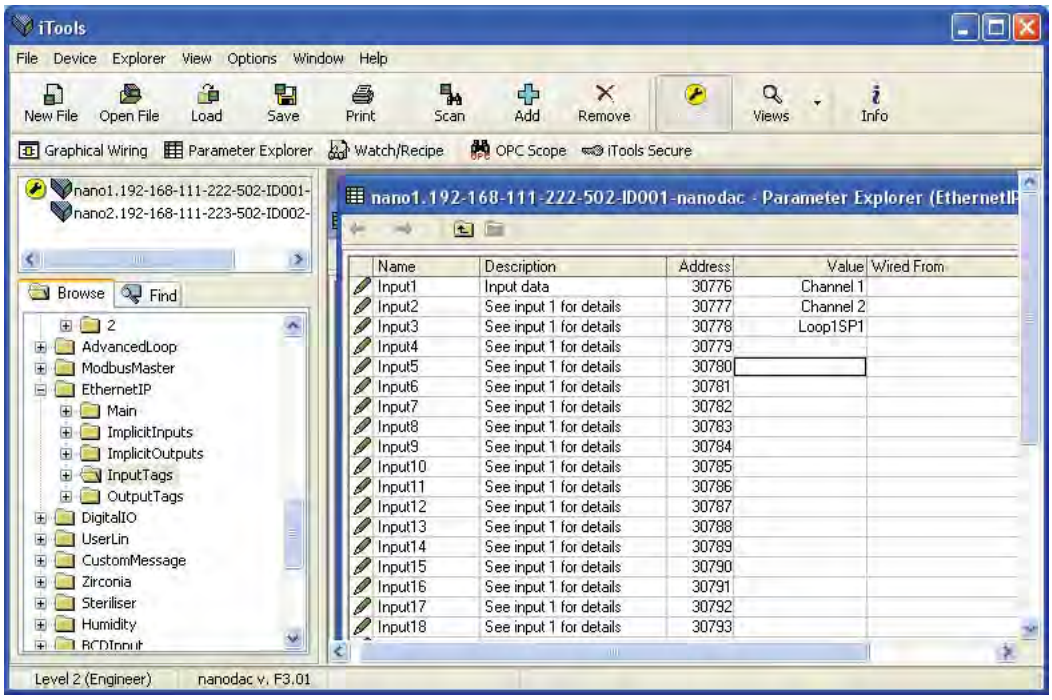


Figure 3.4.13f iTools display showing input tags.

In the example above, the value of the parameter with the tag 'Channel 1' will be written to implicit input 1.

Notes:

1. Most PLCs have a data buffer limit of 500 Bytes. The total number of bytes being used is given by the equation: Total number of data bytes = (tag length + 10) × the number of requested tags.
2. Input data direction is always to the nanodac:
   in server mode input data is written to the nanodac from the client
   in client mode, input data is read by the nanodac from the server device.
3. Output data direction is always from the nanodac:
   in server mode output data is written to the client from the nanodac
   in client mode, output data is read by the server from the nanodac.

3.5 TREND HISTORY

Entered from the top level menu (section 3.1), this allows vertical and horizontal traces to be reviewed for Trend group channels. The amount of data displayed in one screen depends on the 'Zoom In/Out' setting in the History menu (section 3.5.2) and on the recording interval selected in Group Recording configuration (section 4.3.2). It is also possible to enter a time and date to which the history then jumps.

The history display is identical in appearance with the trend display except:

1. History displays can include messages if so configured in the History menu.
2. For horizontal trends, the scale is displayed permanently at the left edge of the display.

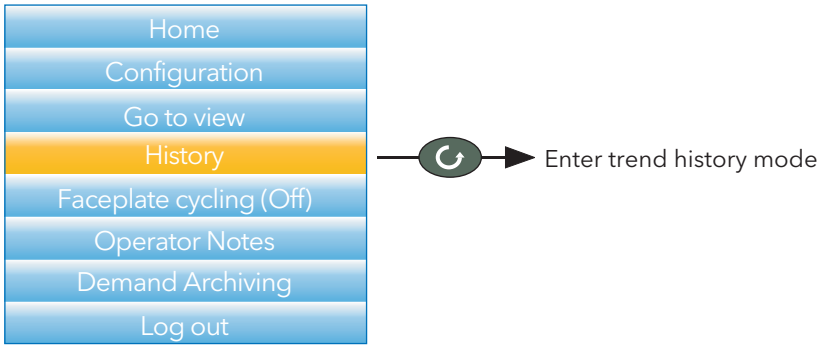


Figure 3.5a Top level menu

3.5.1 Navigation

The down arrow button moves the display backwards in time by $^1/_3$ screen-full per operation (assuming that the current display is not the earliest). See also 'SEARCH FOR', below.

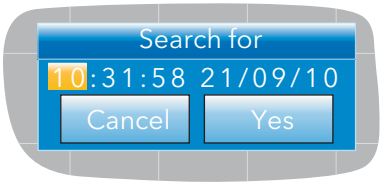
The up arrow button moves the display forwards in time by $^1/_3$ screen-full per operation (assuming that the current display is not the latest). See also 'SEARCH FOR', below

The scroll key scrolls through the trend group channels, emphasizing each channel (and displaying its faceplate) as it is selected.

The page key calls the History Menu, described in section 3.5.2, below.

SEARCH FOR

In the history display, holding the up or down arrow key operated for approximately two seconds produces a 'Search for' display which allows the user to enter a time and date. Once a time and date have been entered, 'Yes' then causes the history display to jump to that time and date (if such history exists).



To enter a time and date:

1. Use the up/down arrows to highlight the item to be edited.
2. When highlighted (orange background), operate the scroll button. The highlighted text turns black.
3. Use the up and down arrow keys to scroll to the required value for the field, then operate the scroll button again. The text goes white.
4. Repeat the above editing process for all the remaining items which are to be edited.
5. Use the up/down keys to select 'Yes'. The 'Search for' window closes, and the history display jumps to the selected time and date.

Notes:

1. If no history exists for the selected time and/or date 'No History Available' is displayed.
2. The time and date format and Daylight Savings Time (DST) effects are as set in the 'Locale' area of Instrument configuration. See section 4.1.2 for further details.

3.5.2 History Options Menu

Operating the page key from within a history display, causes the History Options menu to appear.

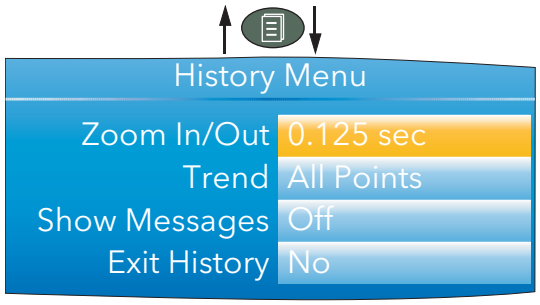


Figure 3.5.2 History Options menu

PARAMETERS

Zoom In/out	Allows the user to select the amount of history displayed on the screen.
Trend	Select either 'All Points' or 'Each Point'. 'All points' displays all channels in the trend group, with the first channel emphasized on the screen and its faceplate displayed. The Scroll button is used to select the next channel in the group. 'Each Point' initially displays only the first point in the trace group. The scroll key is used to cycle through individual group channels in turn.
Show Messages	'Off' disable the inclusion of messages in history display. 'On' causes messages to appear, superimposed upon the point traces (vertical trend mode only).
Exit History	Selecting 'Yes' for this item causes a return to the top level menu or to the message summary page.

Note: Operating the page key from the History menu causes a return to the history display.

3.6 TEXT ENTRY

The user is often required to enter text characters or numbers (when editing operator notes, for example). This is done using the pop-up keyboards which are displayed when required. When only numerals are required a special keyboard is presented which contains only numerals.

Figure 3.6 shows the three standard keyboards, along with a 'scan' direction for operations of both up arrow and down arrow keys. To change keyboards, use the arrow pushbuttons to highlight the keyboard name ('Numeric', 'Symbols' or 'Alpha'), and then operate the scroll button.

Generally, to enter text, the required character is highlighted using the up and down arrows and the scroll button is used as an 'Enter' key. Once text entry is complete, the Page button is used to confirm the edit (use the down arrow to select 'Yes' then operate the scroll button).

Pressing and holding the scroll button and then immediately operating the up or down arrow, causes the character insertion point to move to the left (down arrow) or to the right (up arrow).

The user can press and hold the scroll key to display variations on certain characters (the letter 'e' in the figure). Once displayed, the up and down arrows can again be used to scroll through auxiliary list, allowing capital letters, and characters with diacriticals (e.g. accents, umlauts, tildes, cedillas) to be selected and entered using the scroll button.

The backarrow key is used as a back space key - i.e. it deletes the character to the left of the cursor position. The 'Del' key deletes the character to the right of the cursor.

Note: Leading and trailing space characters are automatically removed from text strings.

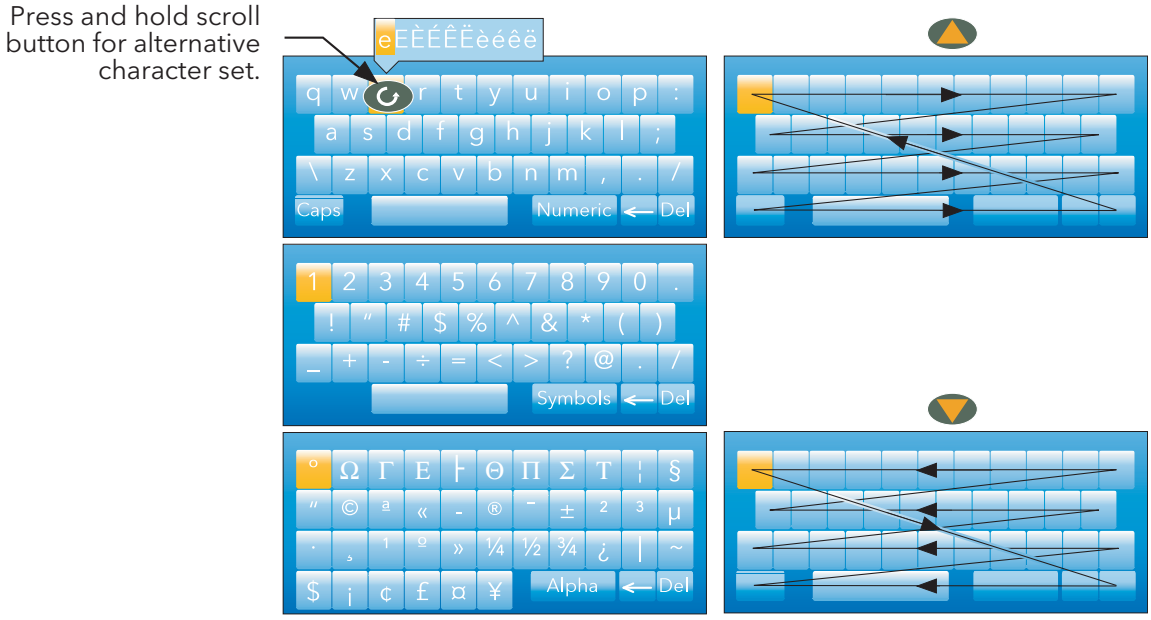


Figure 3.6 Standard Keyboards

3.6.1 Numeric keyboard

As mentioned previously, for functions which can take only numerals, a special numeric keyboard appears, as depicted in figure 3.6.1.

Figure 3.6.1 Numeric keyboard

3.6.2 USB keyboard

Text and numeric entry can also be carried out using a USB keyboard as described in section 8.3.

4 CONFIGURATION

Entered from the top level menu (section 3.1) this allows the recorder configuration to be accessed and edited ('Engineer' access level required for full editing).

CAUTION

Recording is stopped for as long as the recorder login is at Engineer level. This means that Input/output circuits are switched off during configuration.

As shown in figure 4, below, the recorder configuration is arranged in a number of 'areas', each of which is allocated its own sub-section within section 4.

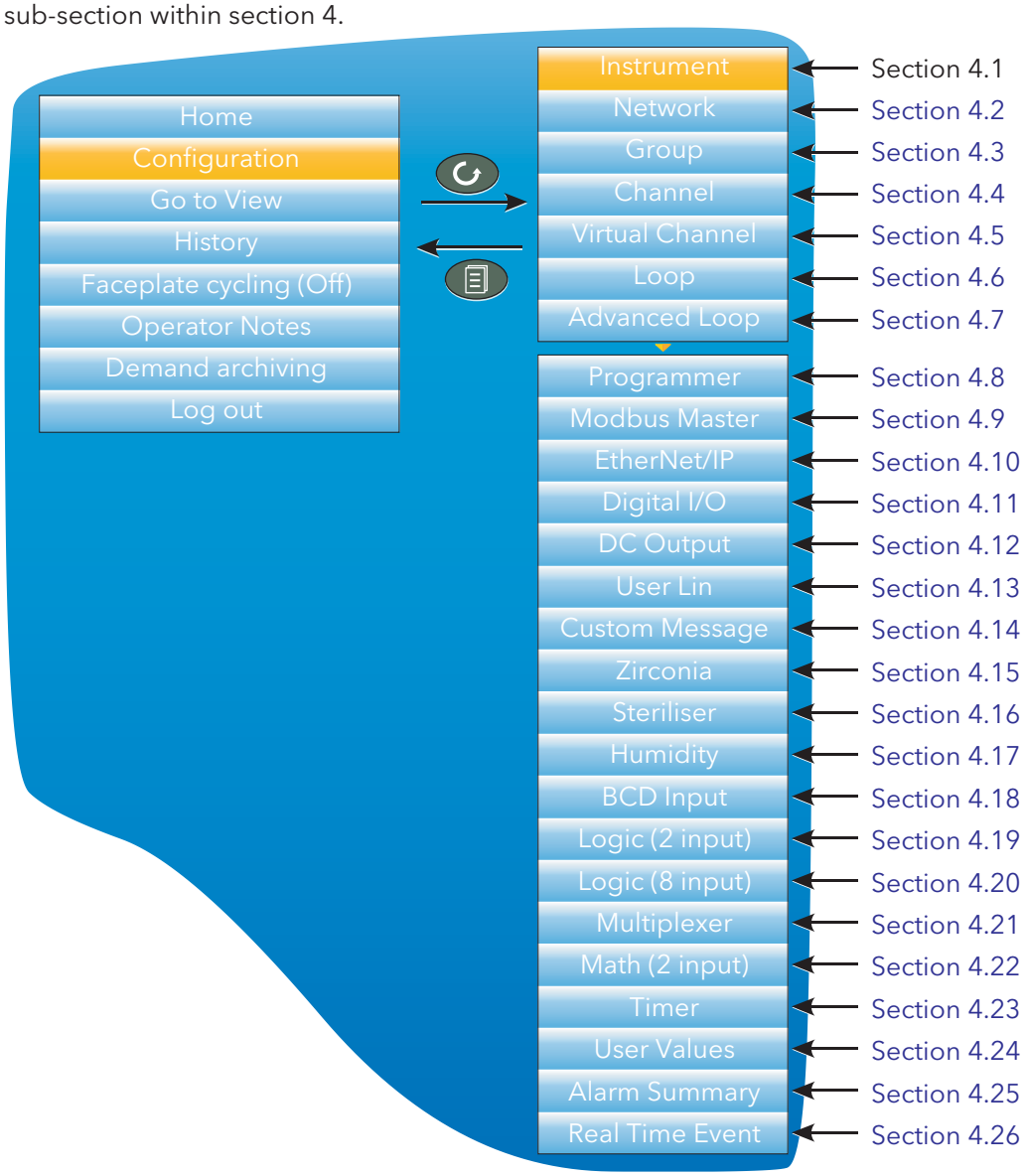
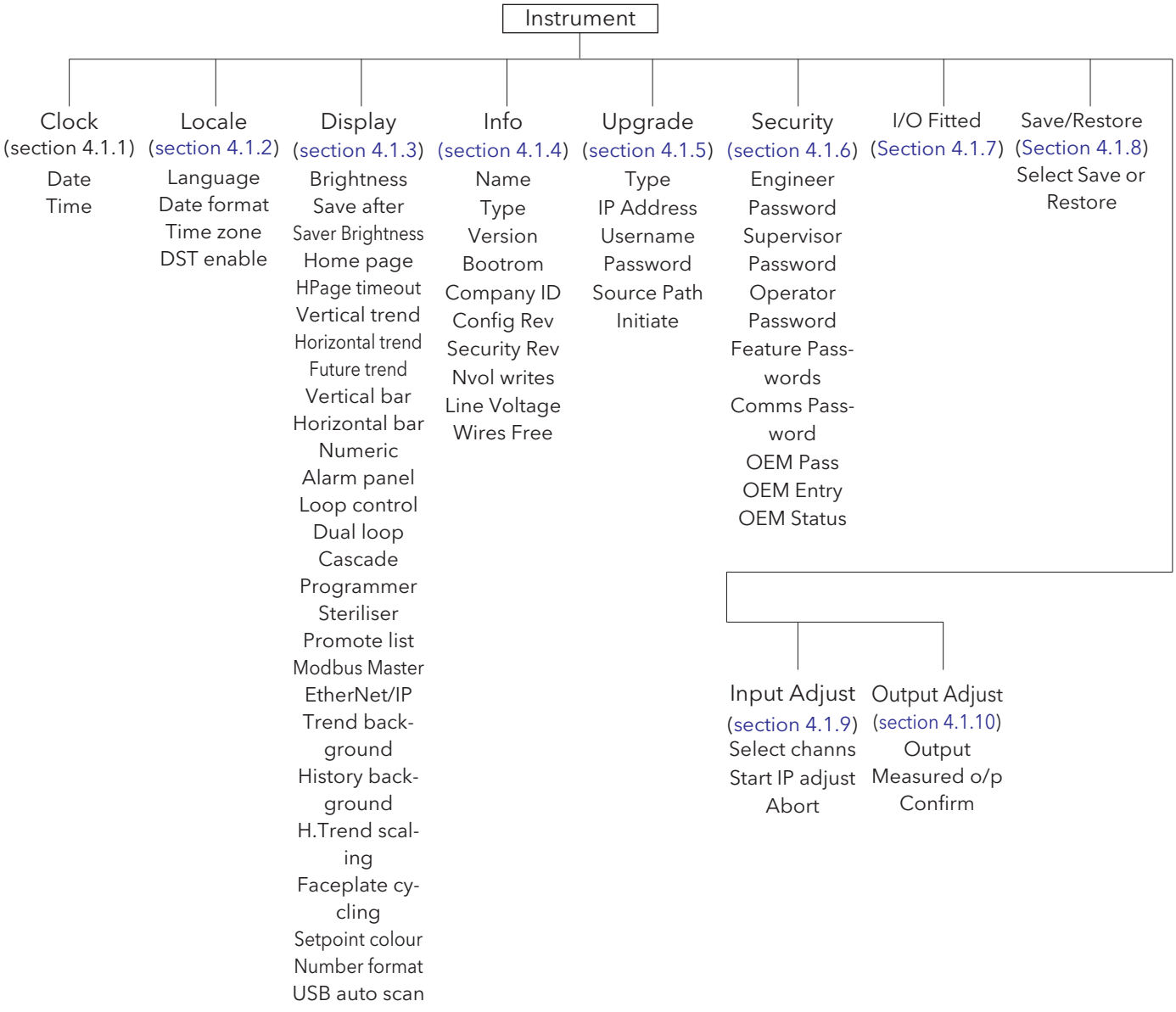


Figure 4 Top level configuration menu

The factory default configuration can be returned-to, if required, by entering a special Engineer password, as described in section 4.1.6.

4.1 INSTRUMENT MENU



4.1.1 Clock

The up and down arrows are used to highlight 'Date' (default) or 'Time'.

To set the date, the scroll button is used to display the numeric keyboard described in section 3.6.1. The up and down arrows are used to highlight the relevant numeral or separator ('/' or ':') and the scroll key used to enter it into the display window.

To set the time, the scroll button is operated to enter edit mode, then the up and down buttons are used to scroll to display a time, say 15 seconds later than the current time. Once the current time matches the display, the scroll button is pressed to confirm the time and to start the clock.

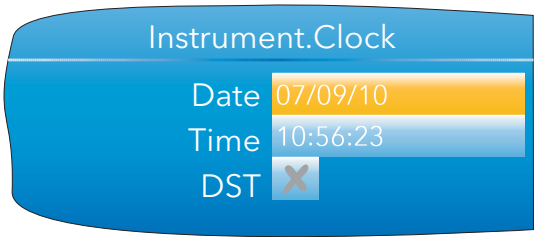


Figure 4.1.1 Clock menu

The 'DST' field appears only If 'DST Enable' is selected 'Yes', in 'Locale' (section 4.1.2). If the 'box' contains a cross (as shown) then Daylight Saving Time (DST) is not currently active. A 'tick' means that the time shown has been advanced by an hour because DST is active.

4.1.2 Locale

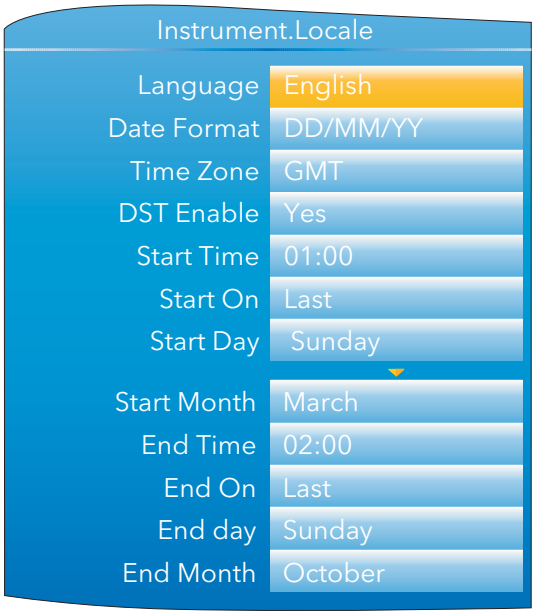


Figure 4.1.2 Typical Instrument configuration menu (expanded to show all fields)

Language	Select the language to be used for displays etc.
Date format	Select MM/DD/YY, YY/MM/DD as the required format.
Time Zone	Select the required offset from GMT (UTC). This setting affects only the displayed time. Archiving, recording etc. times remain in GMT.
DST Enable	Daylight Saving Time enable. Once the selection is enabled, the following (previously hidden) fields appear, allowing the start and end dates for Daylight Saving Time (DST) to be configured. DST affects only the displayed time. Archiving, recording etc. times remain in GMT.
Start Time	Appears only when 'DST Enable' (above) is set to 'Yes'. Use the up/down keys to scroll to the required start time.
Start On	Select 'Last', 'First', 'Second', 'Third' or 'Fourth' as the required week. Used in conjunction with the 'Start Day' and 'Start Month' entries following.
Start Day	Select the day of the week on which DST is to commence.
Start Month	Select the month in which DST is to commence.
End Time, End On, End Day, End Month	As for 'Start Time' etc. above, but specifies the end time and date for daylight savings.

4.1.3 Display configuration

This allows the user to set display brightnesses and screen saver details, to select a display mode as the 'Home' page, and to enable/ disable the various display modes. The normal 'Select, Scroll, Enter' editing technique is used as has been previously described.

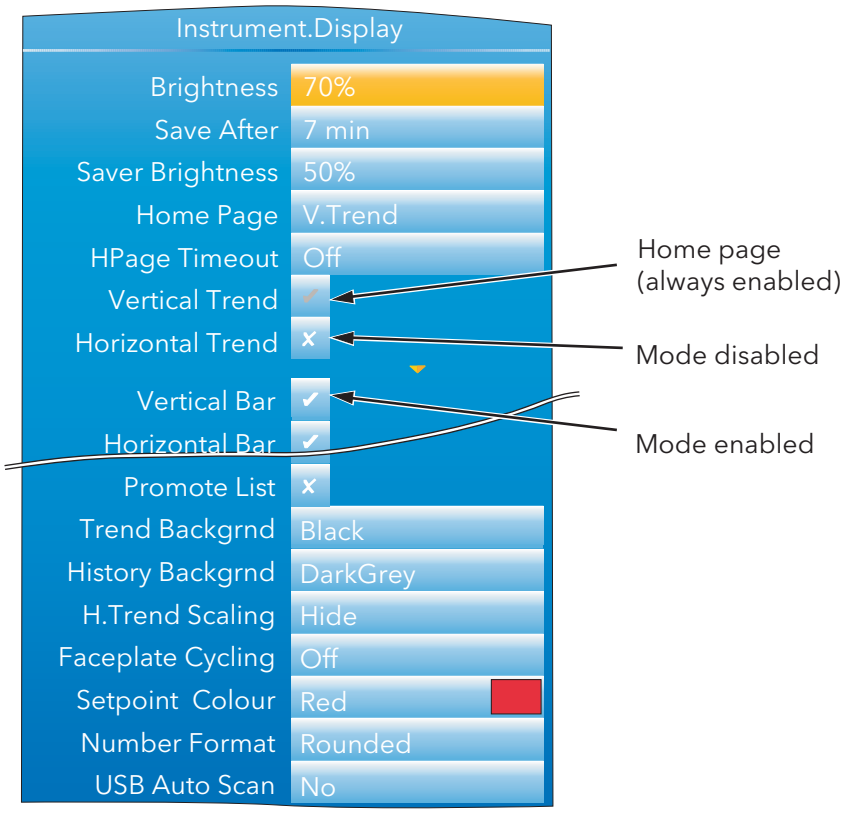


Figure 4.1.3 Display menu (expanded to show all fields)

Brightness	Allows the user to select a normal operating brightness for the screen from 10% to 100%, in 10% steps.
Save After	The elapsed time (since last button press) before the screen switches from 'Brightness' to 'Saver Brightness'. (Off = saver function disabled)
Saver Brightness	The screen saver brightness. Valid entries are 10% to 100% inclusive, in 10% steps. Using a lower power when not 'in use' not only saves power, but also increases display life. Typical screen power consumption is 0.5W at 100%, falling in a linear fashion to 0.05W at 10%.
Home page	Allows any display mode to be chosen as the 'Home' page. This is the page that the recorder displays at power up, and also the page displayed when the 'Home' key is selected from the top level menu (section 3.3). The selected display mode (vertical trend in figure 4.1.3) is always enabled in the following display mode enable fields (its 'tick' is greyed out and cannot be edited). See section 3.4 for a description of the available modes.
HPage Timeout	The elapsed time (since last button press) before the display returns to the home screen. (Off = disabled)
Vertical Trend	This is the default home page, and its tick is greyed. If this is not the home page, the tick can be changed to a cross, by highlighting it and operating the scroll button.

4.1.3 DISPLAY CONFIGURATION (Cont.)

Horizontal Trend, Vertical Bar, Horizontal bar, Numeric, Alarm Panel, Loop control, Dual Loop, Cascade, Programmer, Steriliser, Promote List, Modbus Master, EtherNet/IP. As for Vertical Trend, above. By default some display modes are disabled (grey cross). In order to enable such display modes the relevant cross is highlighted using the up/down arrow buttons, and the scroll button then used to change the grey cross to a white tick.
The tick associated with the selected home page is always grey.

Note: Some display modes are available only if the relevant option is fitted.

Future Trend	This and the associated colour selections appear only if the Programmer option is fitted. See section 3.4.9 for more details.
Trend Background	Allows the user to select black (default), white dark grey or light gray as the 'chart' colour.
History Background	As above for 'Trend background', but for history displays.
H.Trend Scaling	As described in section 3.4.2, by default, the scale for horizontal trends appears at the left edge of the chart for a few seconds before the chart expands leftwards to occupy the scale area. Setting 'H.Trend Scaling' to 'Permanent', ensures that the scale remains permanently on display.
Faceplate cycling	Allows the default faceplate cycling state to be defined as 'On' or 'Off' (section 3.3.5)
Setpoint colour	The colour for the setpoint in Control Loop display pages (section 3.4.7).
Number Format	Rounded: Truncated:
USB Auto Scan	If set to 'Yes', bar code data messages are automatically generated and appear on the display and in the Message list without operator intervention. If set to 'No', the Message appears on the screen for editing and/or confirmation, before being displayed etc. Section 8.2 provides further details.

There is a new paramter been added to the Instrument.Display list - Number format.

The options are to "Round" or "Truncate" values. On the previous phases of the nano, numbers were truncated (in the same was as the 6000).

With phase 3 there is an option to allow numbers to be rounded. The reason for this is driven primarily from a control point-of-view. With truncation, it is quite likely that the PV will look as though it never settles onto setpoint. The rounding/truncation affects the UI display and MODBUS scaled integers, the underlying numbers are not affected, nor the values saved in the history files. Over MODBUS comms, all floating point parameters that are read via scaled integer comms will take note of the configured setting for rounding or truncating and reflect this. On the UI, ALL floating point values rendered will adhere to the configured setting of rounding or truncating.

4.1.4 Info menu

Gives information about the recorder hardware and software, and allows the user to enter a descriptor for the instrument. The normal 'Select, Scroll, Enter' editing technique, previously described) is used to edit those fields that are not read only.

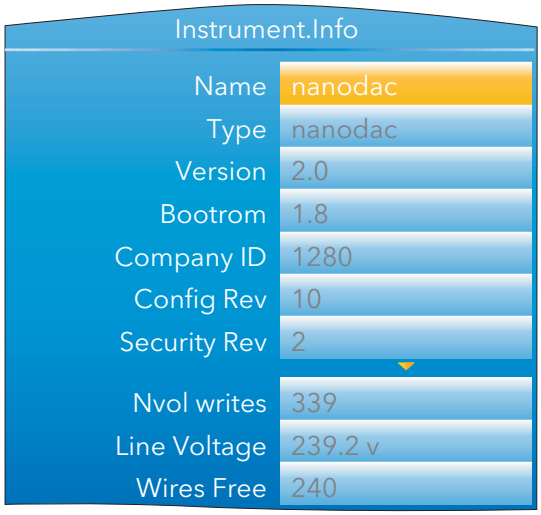


Figure 4.1.4 Info menu (expanded to show all fields)

Name	Allows the user to enter a descriptor of up to 20 characters, using the text entry techniques described in section 3.6. The number of characters visible in the display mode pages varies according to the number of alarm symbols on display.
Type	Nano. Read only display of the instrument model (used by 'iTools').
Version	Read only. The software version of the instrument.
Bootrom	Read only. Instrument software Boot ROM version
Company ID	Read only. For CNOMO* purposes over Modbus (1280 decimal; 0500 hex).
Config Rev	Read only. This value is updated, and a message including this value generated, every time configuration is quit, if any one or more configuration parameter has been changed.
Security Rev	Read only. This number is incremented every time configuration is quit, if any one or more passwords has been changed, or if the FTP Server username has been changed, or if the Comms Enable field has been edited.
Nvol writes	Number of non volatile write operations for diagnostic purposes.
Line voltage	The instantaneous value of the supply voltage applied to the instrument. Used in some control loop operations.
Wires Free	This shows the number of wires free to be used. The value takes into account all user wiring whether carried out at the instrument or downloaded from the iTools graphical wiring editor.

* CNOMO = Comité de normalisation des moyens de production.

4.1.5 Upgrade

CAUTION

1. Power must not be removed from the unit whilst upgrade is in progress, as to do so will cause permanent damage to the unit.
2. For USB upgrades, the memory stick must not be removed whilst upgrade is in progress or the instrument will be permanently damaged.

This item allows the user to update the instrument firmware, either from a memory stick in the USB socket at the rear of the unit, or via FTP transfer from a host computer. Firmware upgrade files are downloaded from the recorder manufacturer and transferred to the instrument by memory stick or by FTP transfer. Splash screens are prepared by the user and transferred using a memory stick. The unit restarts automatically after an upgrade or splash screen replacement.

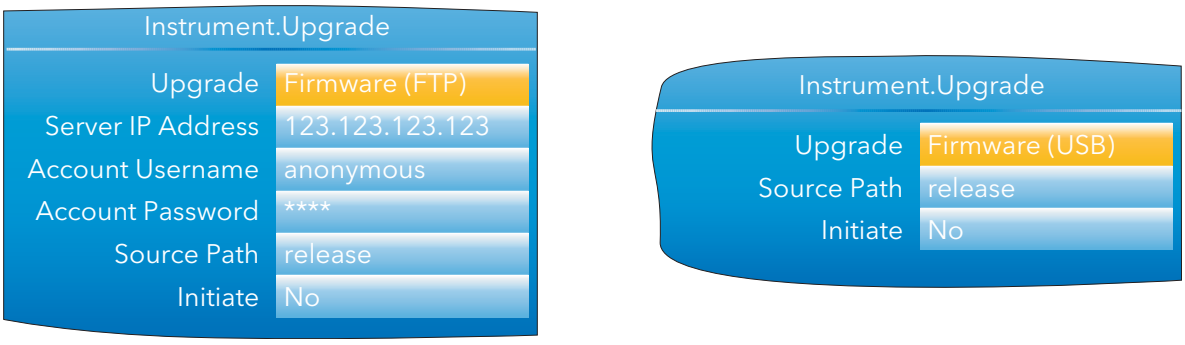


Figure 4.1.5 Typical Upgrade menus

Upgrade	Select 'Firmware (USB)', 'Firmware (FTP)', 'Bootrom (USB)' or 'Splash (USB)' as the source of the upgrade.
Server IP Address	For 'Upgrade' = 'Firmware (FTP)' only, this field must contain the IP address of the pc which is to supply the upgrade file.
Account Username	For 'Type' = 'Firmware (FTP)' only, the username set up in the host ftp server
Account Password	For 'Type' = 'Firmware (FTP)' only, the password set up in the host ftp server
Source Path	The name of the directory from which the upgrade file is to be read. This is only the name of the directory without any path elements (e.g. '/') included unless the path is 'release/upgrade/files'.
Initiate	Select 'Yes' to initiate the upgrade.

CUSTOMISING THE SPLASH SCREEN

'Splash (USB)' allows the user to select a new image for the splash screen (i.e. the screen that appears at power up or restart). When 'Initiate' is set to 'Yes', the instrument searches the USB device for a file called 'splash.bmp' located in the 'release' folder. If such a file is found, it is loaded, and the instrument re-starts with the new image as the 'splash' screen. If no file is found, the request is ignored. If the image is not of the correct type or size, the instrument re-starts with the default splash screen.

The original splash screen is included on the 'tools' DVD, so that it can be restored if required.

Rules:

1. This feature is available only with Bootrom versions 2.0 and above.
2. The file must be located in a folder called 'release' and the file name must be 'splash.bmp'.
3. The image must be 320 x 240; 24-bit resolution.
4. The image must be in bitmap (suffix.bmp) format.
5. The image may not exceed 256kB.

4.1.6 Security menu

This allows the user to enter passwords for all security levels (except logged out), and to enable/disable serial communications security.

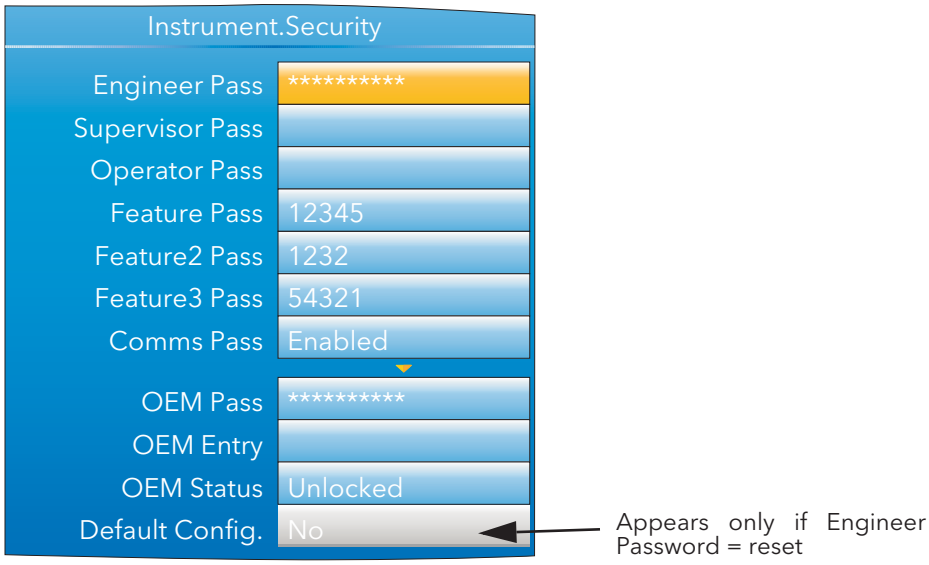


Figure 4.1.6 Security menu

Engineer Pass	Gives access to configuration menus. Set to 100 when despatched, but can be edited here, if required, by entering an alternative of up to 20 characters (note 1). If 'reset' (case sensitive) is entered as the Engineer Password, the 'Default Config.' field appears allowing the instrument default configuration to be restored (note 2).
Supervisor Pass	A password (none by default) of up to 20 characters can be entered here to protect Supervisor level access.
Operator Pass	A password (none by default) of up to 20 characters can be entered here to protect Operator level access.
Feature Pass	This is a password supplied by the manufacturer to enable the software options (e.g. Loop, Zirconia block, Toolkit blocks etc.). When applying for this code, the manufacturer will require the instrument's MAC address (Network.Interface menu section 4.2.1) and the instrument's firmware Version (Instrument.info menu - section 4.1.4). The password is MAC address dependent so that it cannot be used on any other instrument.
Feature2/3 Pass	Similar to 'Feature Pass' above, but for additional features.
Comms Pass	Enables/disables password security for external communications (including via iTools). If set to 'Enabled', the Engineer level password will be required if an attempt is made to enter the configuration menus from a remote pc. If set to 'Disabled', then access to configuration can be gained over a communications link, without a password. If enabled, then entry to configuration mode via the Instrument Mode (IM) parameter must be completed within 5 seconds of entering the password, or the attempt will fail.

Notes:

1. It is recommended that only such characters as appear on the user's pc keyboard be used in the Engineer password. The use of other characters makes it necessary to use 'Escape' codes (e.g. Alt 0247 for the '÷' sign) when trying to enter configuration mode from iTools, for example.
2. Restoring factory default configuration can also be carried out in iTools, using the Engineer password 'reset' and selecting Default Config to 'Yes'.

4.1.6 SECURITY MENU (Cont.)

OEM Pass	The configured pass phrase used to enable / disable the OEM security option. This field is editable whilst the OEM Status is 'Unlocked' and the user has 'Engineer' access.
OEM entry	To lock or unlock the OEM security feature, the user must enter the pass phrase entered in 'OEM Pass' above.
OEM Status	Read only 'Locked' or 'Unlocked' status display.
Default Config	This field appears only if 'reset' has been entered as the Engineer Password. Selecting 'Yes' Causes the instrument to restart with default configuration (i.e. the instrument 'cold starts'). See note 2 above.

OEM SECURITY

In products that incorporate user wiring, the value of an application may lie more in the user wiring (connecting the function blocks together) than in the configuration of the instrument's parameters.

OEM Security allows the user to prevent the application from being copied either via comms (by iTools or a third party comms package) or via the instrument's user interface.

When OEM security is enabled, users are prevented from accessing wiring (for reading or writing) from any source (comms or user interface), and it is not possible to Load or Save the configuration of the instrument via iTools or by using the Save/Restore facility (section 4.1.8).

4.1.7 I/O fitted

This provides a read only display showing what type of input or output circuit is associated with each set of rear terminals.

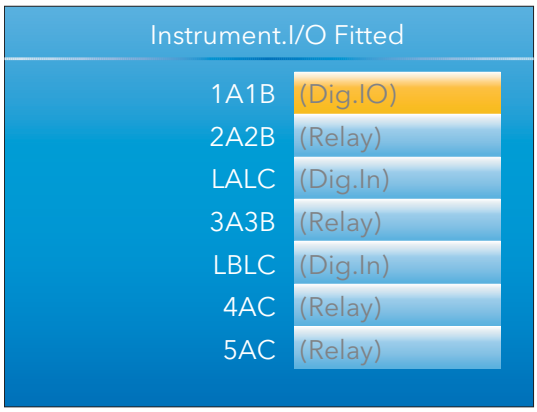


Figure 4.1.7 I/O fitted display

I/O TYPES

Dig.IO	Digital input/output
Relay	Relay output
Dig.In	Digital input
Dig.Out	Digital output
DC.Op	DC output

Note: The I/O types fitted in locations LALC, LBLC, 4AC and 5AC are always as shown above. The types of I/O fitted in locations 1A1B, 2A2B and 3A3B depends on the options specified at time of order.

4.1.8 Save/Restore

This allows the user to save and/or restore instrument clone configurations to a memory stick inserted into the USB connector at the rear of the unit. The format of the saved/restored files is iTools clone files (*.uic)

Selecting 'Restore' presents a list of clone files in the configured directory on the USB device. (In the example below, the file is located in the basic usb0 directory - it has not been saved to a particular configuration directory.)

When 'Save' is selected, the virtual keyboard must be used to enter the filename. If the file already exists on the USB device, a warning appears offering 'Cancel' or 'Overwrite' alternatives.

Notes:

1. The ability to save and restore is disabled if OEM security is enabled.
2. Configuration save/restore is available only when the unit is logged into at 'Engineer' access level.
3. During USB cloning (USB save/restore), the priority of modbus slave comms is lowered. This allows the save/restore process to complete in a minimal time (around 60 seconds). During this period, modbus slave comms response times will be extended and may result in the master device timing-out.

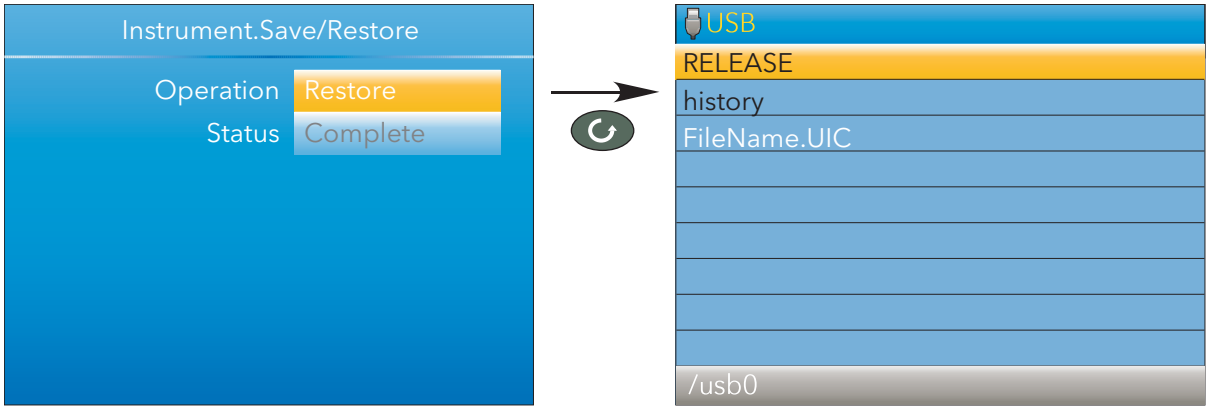


Figure 4.1.8 Save/Restore display

Operation	Select 'Save' or 'Restore'. Use the up/down arrow keys to highlight the required .UIC file, then use the scroll key to initiate the operation.
Status	Shows the status of the operation, as follows: Inactive: Neither saving or restoring a clone file has occurred since the last time the instrument was power cycled. Complete: Indicates that the cloning process has completed. Restoring: Restore operation is currently in progress. Saving: A clone file is currently being saved. Cold started: A power-cycle of the product occurred whilst a Restore operation was in progress. The product configuration is unreliable and has been reset to factory default.

The 'Restoring' and 'Saving' status text is accompanied by an animated display (circling green 'flash') to indicate that the operation is in progress.

4.1.9 Input adjust

Notes

1. Input adjust cannot be applied to input channels with input type of 'Digital', 'Test' or 'Off'.
2. Input adjustments can be carried out only by users logged in as 'Engineer' (see section 3.3.7).
3. The instrument must be powered for a sufficient time (e.g. 30 minutes) for it to reach thermal equilibrium before an input adjust is performed.

This facility allows the user to compensate for tolerance errors etc. The technique used is to select those channels to which adjust is to be applied, then for each channel to:

a apply a known low level signal (at or close to the low input range value) to the relevant input. When the recorder reading is steady, press 'Apply'.

b. apply a known high level signal (at, or close to, the high input range value) to the relevant input. When the recorder reading is steady, press 'Apply'.

Figure 4.1.9a shows a typical display when 'Input adjust' is selected from the Instrument menu, and Apply adjust has been selected. As can be seen, channel 3 has previously been adjusted.

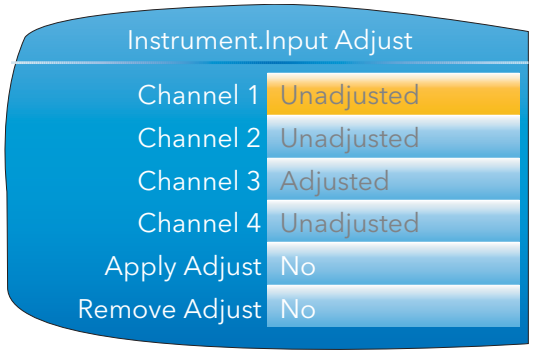


Figure 4.1.9a Input adjust top level display

Channel 1 to 4	Shows the adjust status of each channel
Apply Adjust	Selecting 'Yes' initiates the adjustment procedure described below.
Remove Adjust	Selecting 'Yes' initiates the adjustment removal procedure described below.
Abort	Allows the user to abandon input adjustment at any point in the procedure.

ADJUSTMENT PROCEDURE

1. As shown in figure 4.1.9b, highlight the 'Apply Adjust' field, and operate the scroll key to enter edit mode. Use the up or down arrow key to select 'Yes'. Use the scroll button to change Channel 1 'cross' to a 'tick' (check mark). Similarly select any other channels which require adjustment.

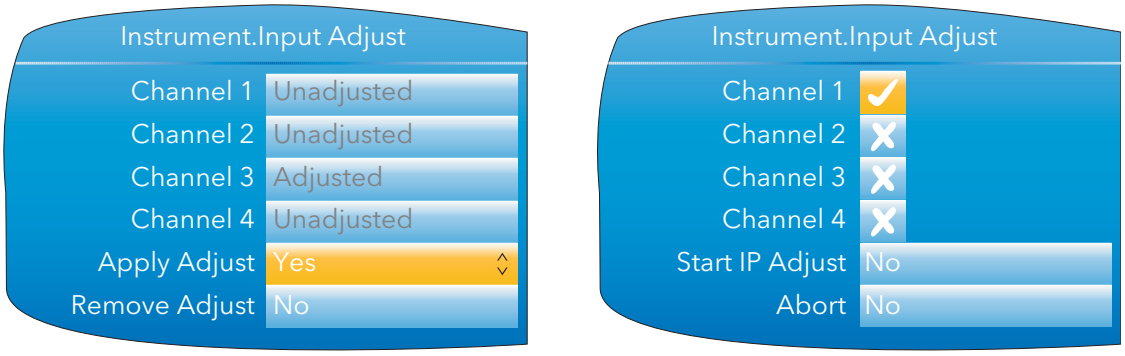


Figure 4.1.9b Channel adjustment procedure (1)

4.1.9 INPUT ADJUST (Cont.)

ADJUSTMENT PROCEDURE (Cont.)

2. Highlight the 'Start IP 'Adjust' field and use the scroll and up/down arrow to select 'Yes'. Use the scroll key again to enter the low value adjust page.
3. Apply the known low value and wait for the value to stabilise. Enter the 'Low Target Value' (the value that the recorder is to read for the applied input). When all is steady, use the scroll and up/down arrow to set the 'Confirm Low' field to 'Yes', then operate the scroll button again.

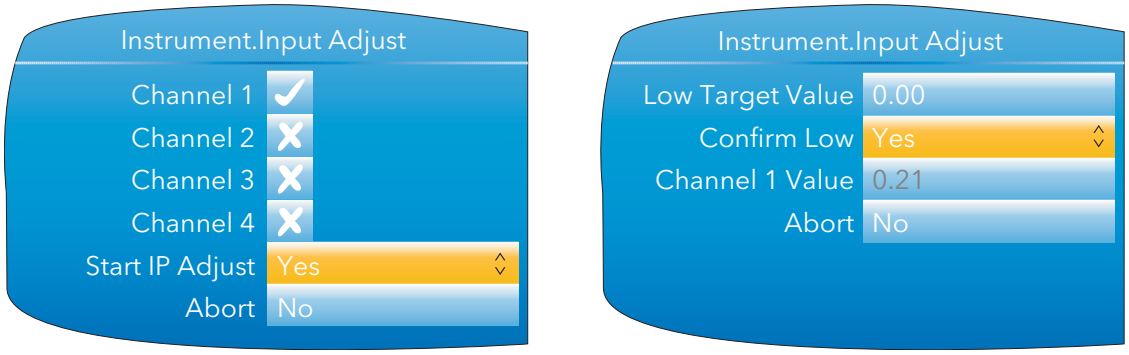


Figure 4.1.9c Channel adjustment procedure (2)

4. The display changes to the high value adjust page.
5. Apply the known high value and wait for the value to stabilise. Enter the High Target Value (the value that the recorder is to read for the applied input). When all is steady, set 'Confirm High' to 'Yes'.

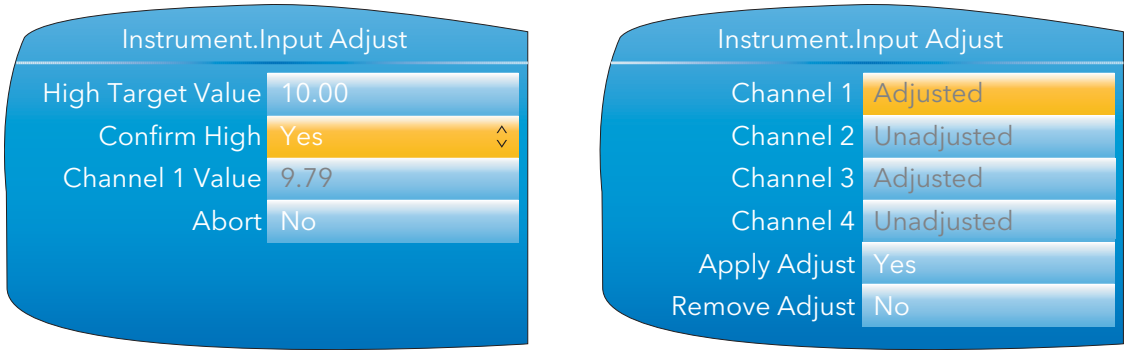


Figure 4.1.9d Channel adjustment procedure (3)

REMOVAL PROCEDURE

1. Set 'Remove Adjust' to 'Yes' and operate the scroll button.
2. Use the scroll and up/down arrow buttons to change the required channel icons from crosses to ticks.
3. Select Remove IP Adjust to 'Yes' and operate the scroll key. The adjustment is removed from all selected channels without further confirmation.

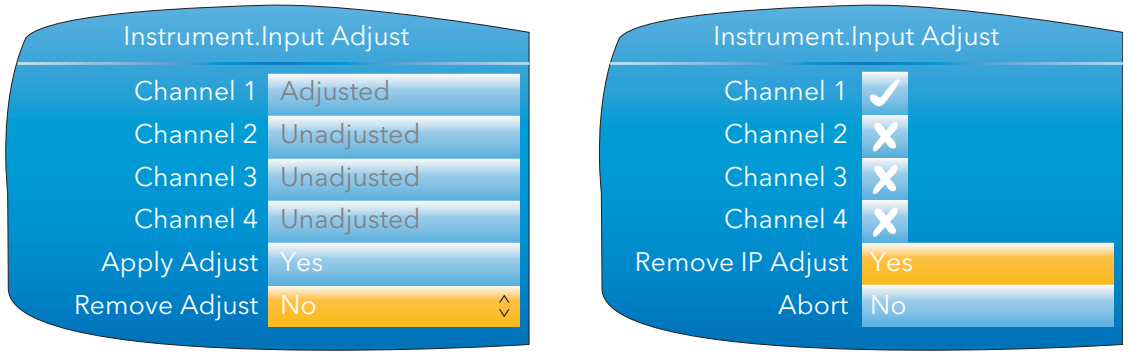
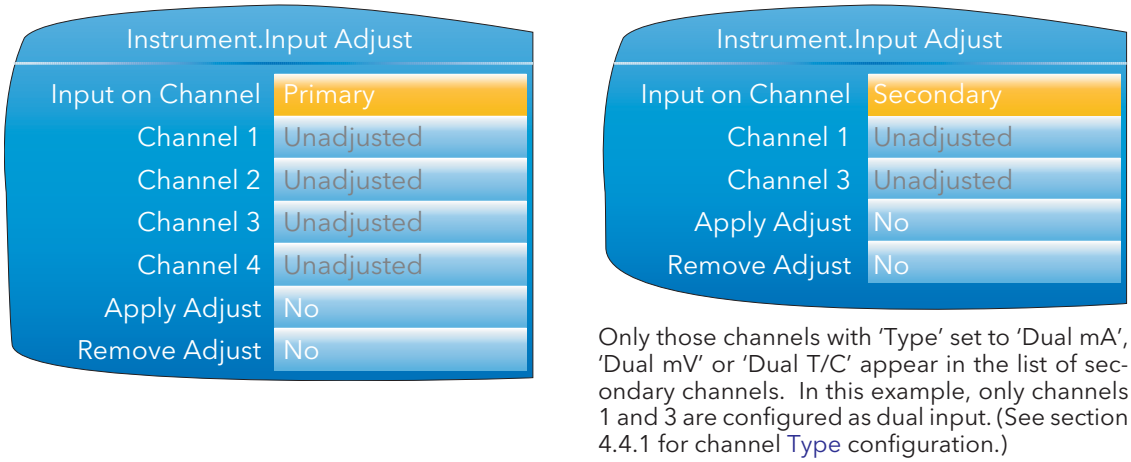


Figure 4.1.9e Channel adjustment removal

4.1.9 INPUT ADJUST (Cont.)

DUAL INPUT CHANNELS

For the dual input channel option, input adjust is carried out as described above, except that for any channel where dual inputs are configured, the user must initiate adjustment to primary and secondary inputs separately. As shown in figure 4.1.9f, a new field 'Input on Channel' is introduced for this purpose.



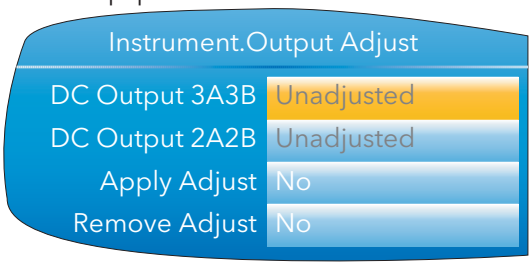
Only those channels with 'Type' set to 'Dual mA', 'Dual mV' or 'Dual T/C' appear in the list of secondary channels. In this example, only channels 1 and 3 are configured as dual input. (See section 4.4.1 for channel Type configuration.)

Figure 4.1.9f Input adjust top level display (dual input channels)

For primary inputs, all four channels are included in the list and can therefore be selected for adjustment. For secondary inputs, only those channels which have been configured as dual input are included.

4.1.10 Output adjust

This item appears only if one or more of I/O type DC Output is fitted and allows the user to compensate for tolerance errors etc. in connected equipment.



1A1B and 2A2B can be configured only as mA outputs.

3A3B can be configured as mA or Volts.

See section 4.12 for configuration details.

Figure 4.1.10a Output adjust initial display

ADJUST PROCEDURE

1. Highlight the 'Apply Adjust' field, and operate the scroll key to enter edit mode. Use the up or down arrow key to select the required output and confirm with the scroll key. The output adjust page appears for the low point.
2. Measure the output at the required point, and enter this value in the 'Measured Output' field using the text entry techniques described in section 3.6. To skip this stage go to step 3.
3. Set 'Confirm Low' to 'Yes'. The output adjust page appears for the high point.
4. Measure the output at the required point, and enter this value in the 'Measured Output' field as described for the low point. To skip this stage go to step 5.
5. Set 'Confirm High' to 'Yes'. The output adjust initial display reappears, with the word 'Adjusted' in the relevant DC Output field.

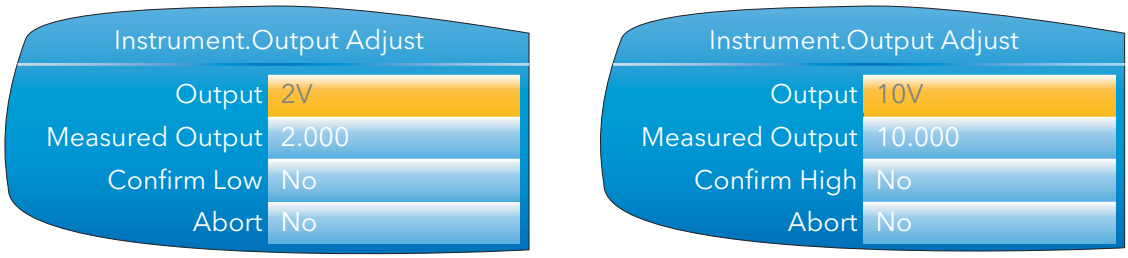


Figure 4.1.10b Low and High adjust point displays

Notes:

1 The figures above show the displays when the DC output is set to 'Volts' (section 4.12) (3A3B only). The mA displays are similar, but the fixed low and high values are 4mA and 20mA respectively.

2. 'Abort' cancels operations so far and returns to the output adjust initial display (figure 4.1.10a).

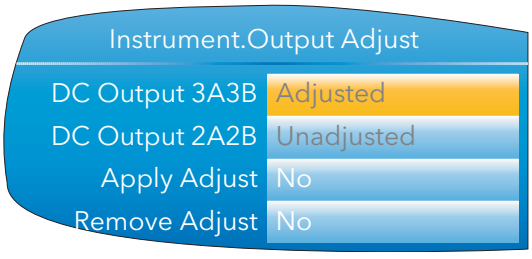
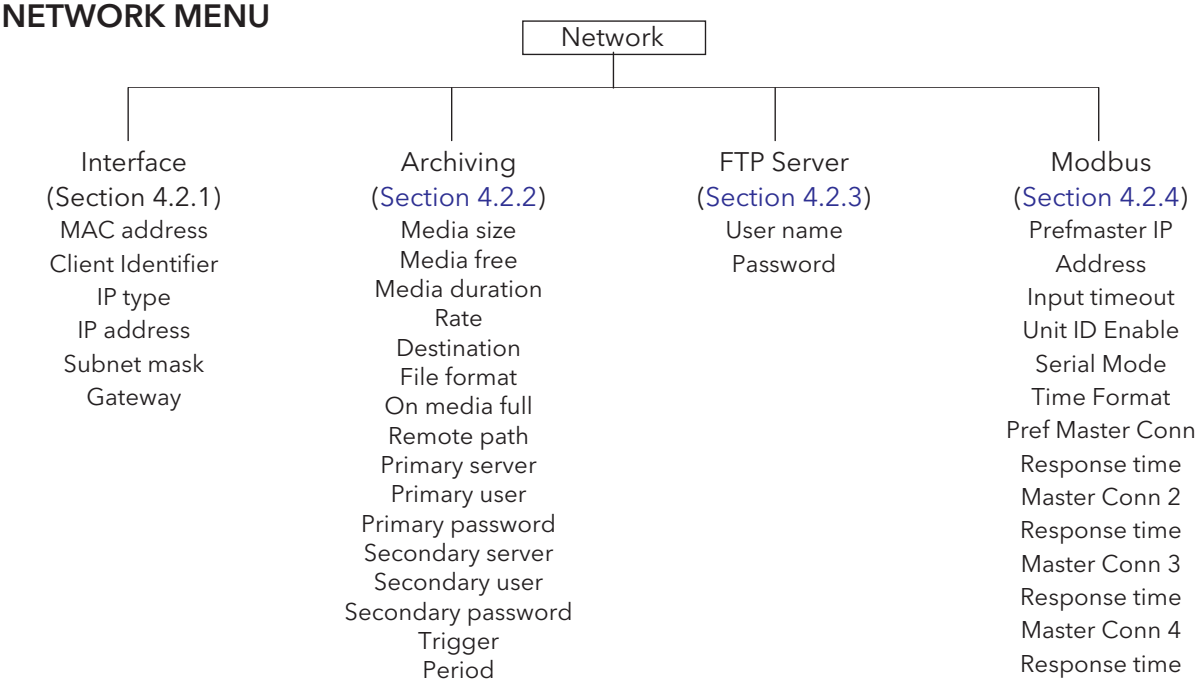


Figure 4.1.10c Adjusted display

ADJUST REMOVAL

In the output adjust initial display (figure 4.1.10c) highlight the 'Remove Adjust' field, and operate the scroll key to enter edit mode. Use the up or down arrow key to select the required output and confirm with the scroll key. The output adjustment is removed, without confirmation. The initial display returns to 'Unadjusted' as in figure 4.1.10a.

4.2 NETWORK MENU



4.2.1 Interface

This area of configuration allows the user to set up an IP address for the instrument, either by typing one in (Fixed), or automatically (DHCP), assuming a DHCP server is running.

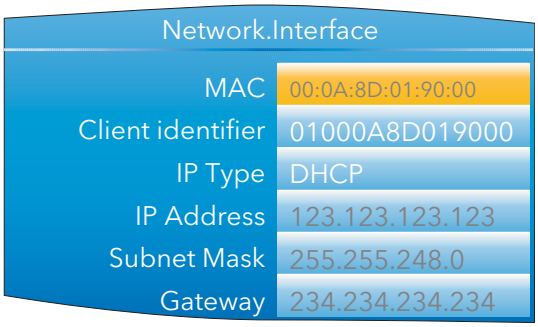


Figure 4.2.1 Network Interface menu

MAC	Read only. Media Access Control. A unique address for each instrument, entered at the factory.
Client Identifier	The client identifier is a unique id used by DHCP servers that implement option 61. Each nano product will have a unique ID built up from its MAC address. If the DHCP server is configured to use option 61, then it will use this id instead of the MAC address to assign a dynamic IP address.
IP Type	If 'Fixed', the user needs to enter an IP address and Subnet Mask in the following fields, and a Gateway address if required. If 'DHCP' the subsequent fields become read only, with the entries automatically generated by the DHCP server. When set to DHCP, it takes several seconds before the IP address is obtained from the DHCP server.
IP Address	Read only if 'IP Type' = 'DHCP'. If 'IP Type' = 'Fixed', the user may enter an IP address (IPV4 dot notation). This would normally be supplied by the user's IT department, or from the Network supervisor.
Subnet Mask	Read only if 'IP Type' = 'DHCP'. If 'IP Type' = 'Fixed', this sets a range of IP addresses that can be accessed. Normally supplied by the user's IT department, or from the Network supervisor.

4.2.1 INTERFACE (Cont.)

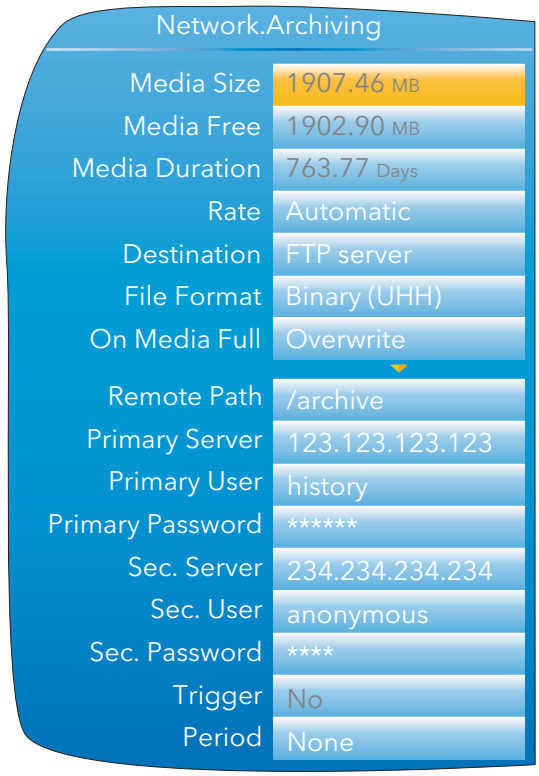
Gateway — Read only if 'IP Type' = 'DHCP'.
If 'IP Type' = 'Fixed' this allows the user to enter a gateway address for use when the unit is to communicate outside the local network. Normally supplied by the user's IT department, or from the Network supervisor.

4.2.2 Archiving

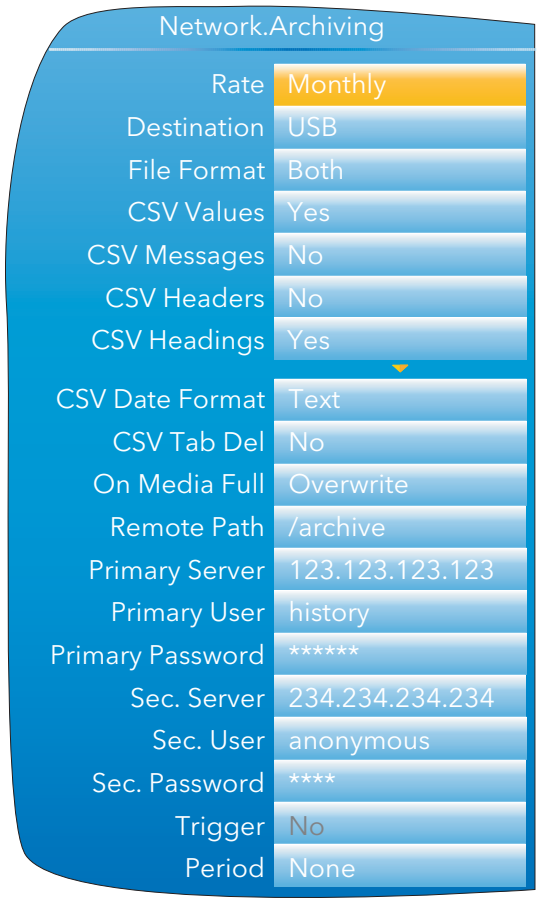
This area of configuration is used to set up the parameters for use during unattended archiving. Some of the fields appear only if other fields are set to a particular value. For example, the CSV fields appear only if 'File Format' is set to 'CSV' or to 'Both'.

The archived data is not removed from the flash memory of the instrument. When the flash memory is full, new data causes the oldest file(s) to be discarded.

Note: For remote archiving, the host computer must be set up to respond to 'pings'. This is because the nano pings the host whilst establishing connection, and if it does not receive a response the archive attempt fails.



Remote with Binary file format



Local with CSV files included

Figure 4.2.2a Unattended Archive configuration (typical settings)

Media Size — Appears only for File Format = 'Binary (UHH)'. A read only value showing the capacity of the memory stick inserted in the USB port at the rear of the unit. Shows zero if no memory stick is present.

Media Free — Appears only for File Format = 'Binary (UHH)'. A read only value showing the space remaining in the memory stick inserted in the USB port at the rear of the unit. Shows zero if no memory stick is present.

Media Duration — Appears only for File Format = 'Binary (UHH)'. A read only value showing the time it will take to fill the Memory stick if the recorder configuration remains unchanged.

4.2.2 ARCHIVING (Cont.)

Rate — Allows the user to specify the frequency at which the contents of the Flash memory are archived to the USB port or, via FTP, to a pc. Scrollable settings are:

- **None** — Automatic archiving is disabled. Any archiving must be initiated by the user using Demand Archiving, as described in section 3.3.7.
- **Hourly** — Archive occurs on the hour, every hour.
- **Daily** — Archive initiated at 00:00* each day
- **Weekly** — Archive is initiated at midnight* every Sunday
- **Monthly** — Archive is initiated at 00:00* on the 1st of every month.
- **Automatic** — The recorder selects the least frequent of the above archive periods which is guaranteed not to lose data as a result of the internal flash memory's running out of space.

*Note: Archive times are not adjusted for daylight saving time (DST). Thus, if the archive is set to 'Daily', 'Weekly' or 'Monthly', then during summer time, the archive will be triggered an hour late (i.e at 01:00 hours instead of midnight).

Destination — Select 'FTP Server' for archive to a remote pc, or 'USB' to archive to the USB port device.

File format — Select 'Binary (UHH)' 'CSV' or 'Both'.

- **Binary (UHH)** — A proprietary format used by the instrument that needs other software (e.g. Review', to interpret the data before it can be presented in spreadsheets etc. Binary files have the extension '.uhh'.
- **CSV** — This format is a standard open-file format for numeric data. A simple ASCII-based format, it is readable by a wide range of pc applications as well as being suitable for direct import into many commercial databases. CSV files have the extension '.csv'.
- **Both** — Archiving includes both .uhh and .csv files.

Note: CSV is ASCII based and cannot interpret Unicode characters. For this reason, some characters available to the user will not be displayed correctly in .csv files.

CSV Values — Appears only if 'File Format' is set to 'CSV' or 'Both'. If 'Yes' is selected, then process values are included in the file (see figure 4.2.2b for details).

CSV Messages — Appears only if 'File Format' is set to 'CSV' or 'Both'. If 'Yes' is selected, then messages are included in the file (see figure 4.2.2b for details).

CSV Headers — Appears only if 'File Format' is set to 'CSV' or 'Both'. If 'Yes' is selected, then Header details are included in the file (see figure 4.2.2b for details).

CSV Headings — Appears only if 'File Format' is set to 'CSV' or 'Both'. If 'Yes' is selected, then column headers are included in the file (see figure 4.2.2b for details).

CSV Date Format — Appears only if 'File Format' is set to 'CSV' or 'Both'. Allows 'Text' or 'Spreadsheet' to be selected. Text causes a time/date to appear in the spreadsheet. 'Spreadsheet Nu' displays the number of days since December 30th 1899. The decimal part of the number represents the latest six hours. For example: DDD--- --DD.25 represents 06:00 hours and DDD--- --DD.5 represents 12:00 hours. Spreadsheet Numeric format is more easily interpreted than 'Text' by some spreadsheet applications.

CSV Tab Del — Appears only if 'File Format' is set to 'CSV' or 'Both'.
CSV (Comma Separated Variables) does not always use commas as separators. For example, in some countries the decimal point is represented by a full stop (period), whilst in others a comma is used. In order to avoid confusion between a comma as a decimal point and a comma as a separator, a different separator can be used. This field allows the 'tab' character (^t) to be used instead of a comma.

4.2.2 ARCHIVING (Cont.)

On Media Full — For 'Destination' = 'USB' only, this allows the user to select 'Overwrite' or 'Stop' as the action to be taken when the memory stick is full. 'Overwrite' causes the oldest data to be discarded from the memory stick to make room for newer data. 'Stop' inhibits archiving activity.

Remote Path — Left blank if the archive destination is the home folder. If the destination is to a subfolder within the home folder, then the name of the subfolder is entered here, preceded by a '/' character (e.g. '/history').

Primary Server — Allows the user to enter the IP address for the pc to be used as the primary FTP server.

Primary User/Password — These are the Login name and password of the remote host account, assigned either by the Network administrator, or set up in the 'Guest' account of the remote host's 'FTP server' or 'User Manager' configuration.

Sec. Server/user/password — As Primary server details above, but for the secondary FTP server used when the primary is not available for any reason.

Trigger — This parameter can be 'wired' to, say, an alarm going active, or a digital input, to allow an archive to be triggered remotely. Can also be set to 'yes' manually.

Period — Appears only if 'Trigger' is wired (section 7). Allows a period of history to be selected for archiving when 'Trigger' goes 'true. Selections are: None, Last Hour, Last Day, Last Week, Last Month, All, Bring to Date. ('Last Month' archives the last 31 days of history.)

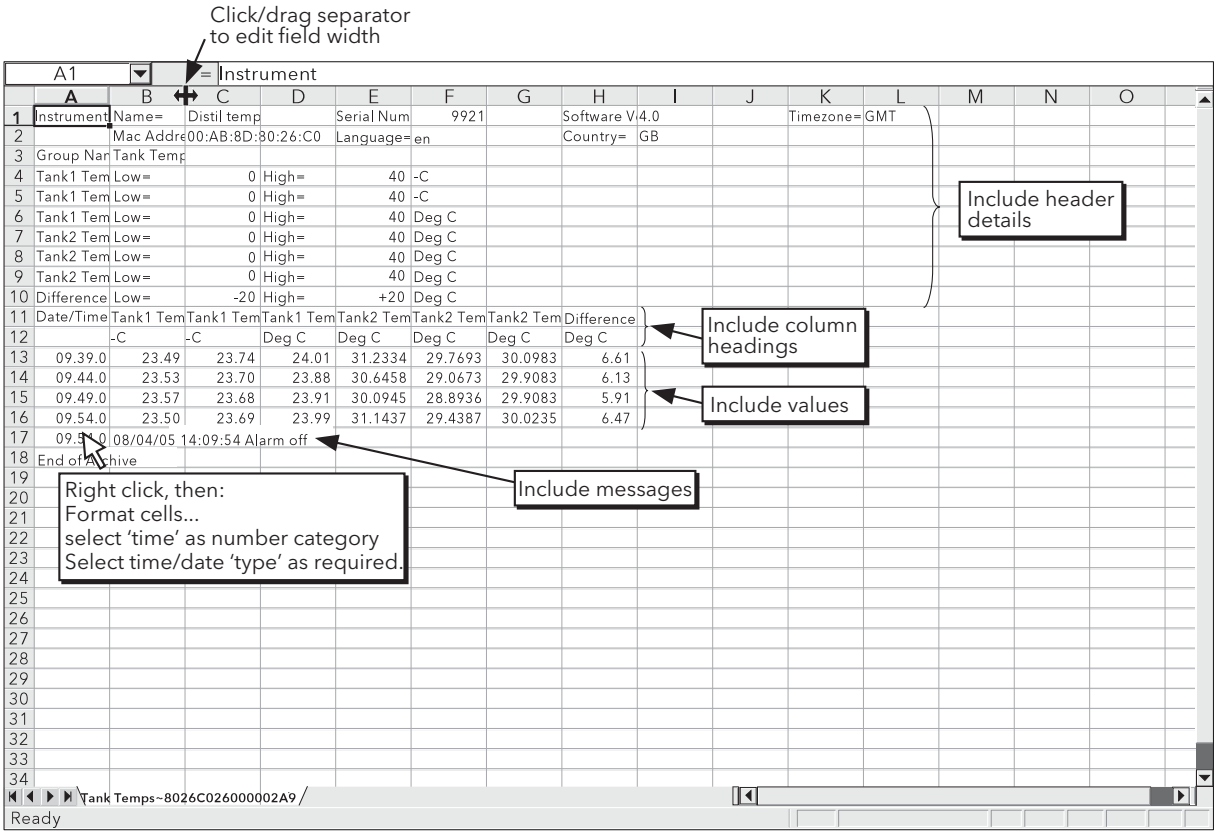


Figure 4.2.2b CSV data example

4.2.3 FTP Server

This area of configuration allows the user to enter the Username and Password used to access the instrument from a remote FTP client.

4.2.4 Modbus TCP

This allows the user to configure the recorder so as to allow it to communicate using Modbus Transmission Control Protocol.

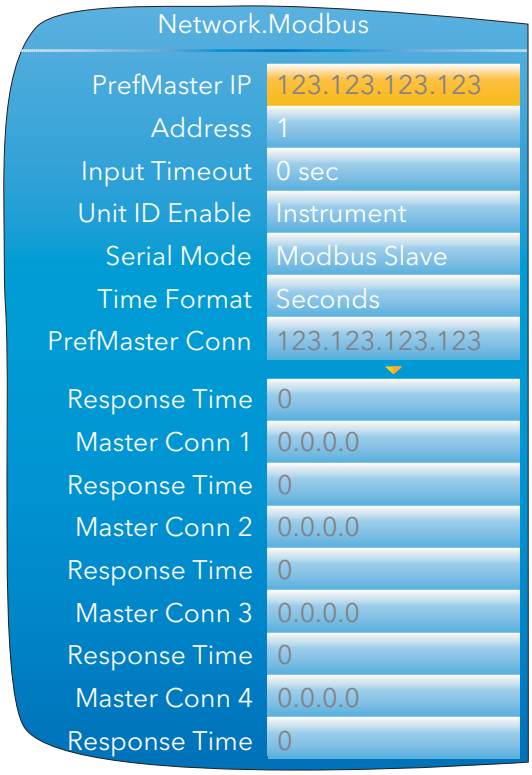


Figure 4.2.4 Modbus TCP configuration menu

PrefMaster IP — The IP address of the relevant Modbus master. The Preferred master is guaranteed to be able to connect, even if all slave connections (max. = 4 for TCP) are in use.

Address — The Modbus address for this slave. This address must be unique for the network to which it is attached. The recorder will respond to this address and to Address 255.

Input Timeout — Allows a value of between 0 and 3600 seconds to be entered to set the timeout period for modbus input channels. If a modbus input is not written to within this period the value of the channel is set to -9999.0 with a 'No Data' status. A value of 0 disables the comms inactivity timeout feature.

Unit ID Enable — Enables/Disables the checking of the Modbus TCP unit identity field.

- Strict — The Modbus TCP Unit Identity Field (UIF) does not have to match the instrument address. The instrument responds only to Hex value FF in the UIF. iTools finds this instrument only at location 255, and then stops scanning.
- Loose — The Modbus TCP Unit Identity Field (UIF) does not have to match the instrument address. The instrument responds to any value in the UIF
- Instrument — The Modbus TCP Unit Identity Field (UIF) must match the instrument address or no response will be made to messages.

Serial Mode — Slave communications via the side mounted configuration port interface (CPI) clip (for iTools use.) Parameters: Baud rate 19,200; Parity = none; Number of data bits = 8; Number of stop bits = 1; no flow control. Can be set to 'Modbus Slave' or 'Off'. The unit must be restarted before any change takes effect.

Time Format — Allows the user to choose milliseconds, seconds, minutes or hours as the time format. Sets the resolution for the reading and writing of time format parameters.

PrefMaster Conn — Read only. Shows the IP address of the preferred master, when connected.

Response Time — Read only. Shows the response time for a single communications request to the relevant master.

Master Conn 1 to 4 — Read only. Shows the IP addresses of any other masters connected to this recorder.

4.3 GROUP CONFIGURATION

Group configuration is separated into two areas, one which defines trending characteristics (for display channels) the other defining the recording characteristics for saving data to the Flash memory ready for archiving.

4.3.1 Group Trend configuration

This allows the user to define which points are to be traced on the display and at what interval, and also allows the number of chart divisions to be set up. Figure 4.3.1 shows a typical configuration page.

Note: The background chart colour is set up as a part of Instrument Display configuration (section 4.1.3)

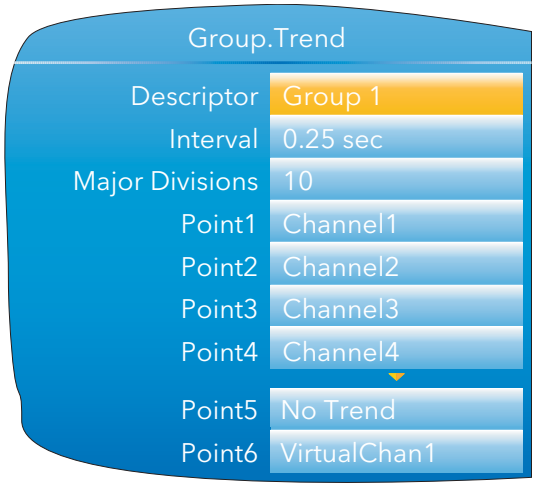


Figure 4.3.1 Group Trend Configuration

Descriptor	Allows the user to enter a descriptor (20 characters max.) for the group.
Interval	The trending interval which defines how much data appears on one screen height or width. A number of discrete intervals can be chosen between 0.125 seconds to 1 hour. The selection should be made according to how much detail is required, and how much data is to be visible on the screen.
Major Divisions	Allows the user to select the number of divisions into which the scale is divided and how many gridlines are displayed. Setting the value to 1 results in just the zero and full scale values appearing. Setting the value to 10 (the maximum) results in a scale with zero, full scale and nine intermediate values appearing, with associated grid lines.
Point1 to Point6	Allows the user to select which channels and virtual channels are to be traced. The maximum number of traces is six.

4.3.2 Group Recording configuration

Similar to Trend configuration, above, but for saving the data to Flash memory history files. Each point can individually be enabled or disabled for recording, or recording can be disabled for the whole group.

Figure 4.3.2 shows a typical page.

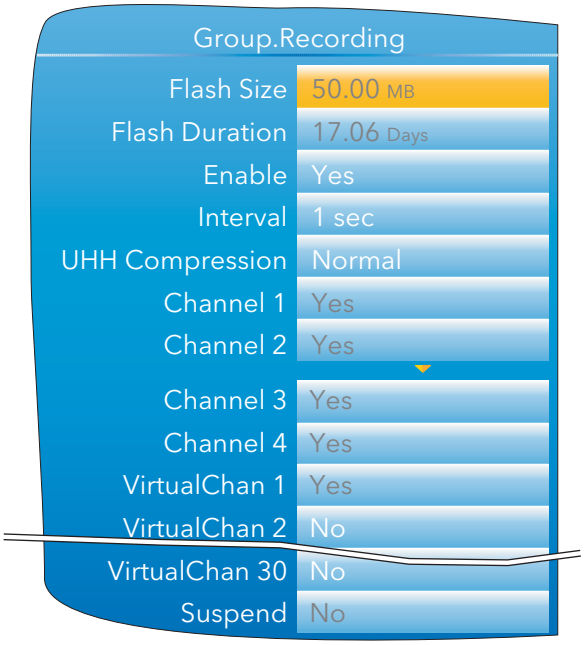


Figure 4.3.2 Group trend recording configuration

Flash Size	Read only. Shows the size of the Flash memory fitted in MB.
Flash Duration	Read only. Shows the time it will take to fill the Flash memory if the recorder configuration remains unchanged.
Enable	'Yes' enables group recording so that all points set to 'Yes' are stored in the recorder's flash memory. 'No' disables group recording.
Interval	Defines the rate at which data is saved to the recorder's Flash memory. The value affects how much trace history appears on the screen in trend history mode.
UHH Compression	Select 'Normal' or 'High'. 'Normal' compresses the data, but still provides an exact copy. 'High' compresses more, but values are saved only to 1 part in 10^8 resolution. See also note 1, below.
Channel 1 to VirtualChan 30 (see note 2, below)	Read only (greyed 'yes') for points being trended, (these are automatically recorded). For non-trending points the user may enable or disable each point individually.
Suspend	Ignored unless the user has wired to this field. If wired then when set to 'No' recording is active, when set to 'Yes' recording is paused.

Notes:

1. Where very high values are involved, such as in some totaliser values, 'High' compression may cause the value displayed at the recorder, and held in the history file, to be incorrect. The problem may be resolved by changing to 'Normal' compression, or, in the case of a totaliser, by re-scaling it (for example from MegaWatt hours to TeraWatt hours).
2. Virtual channels 1 to 15 are included in the standard build. Channels 16 to 30 are included only if the Modbus Master and / or EtherNet/IP option is fitted.

4.4 INPUT CHANNEL CONFIGURATION

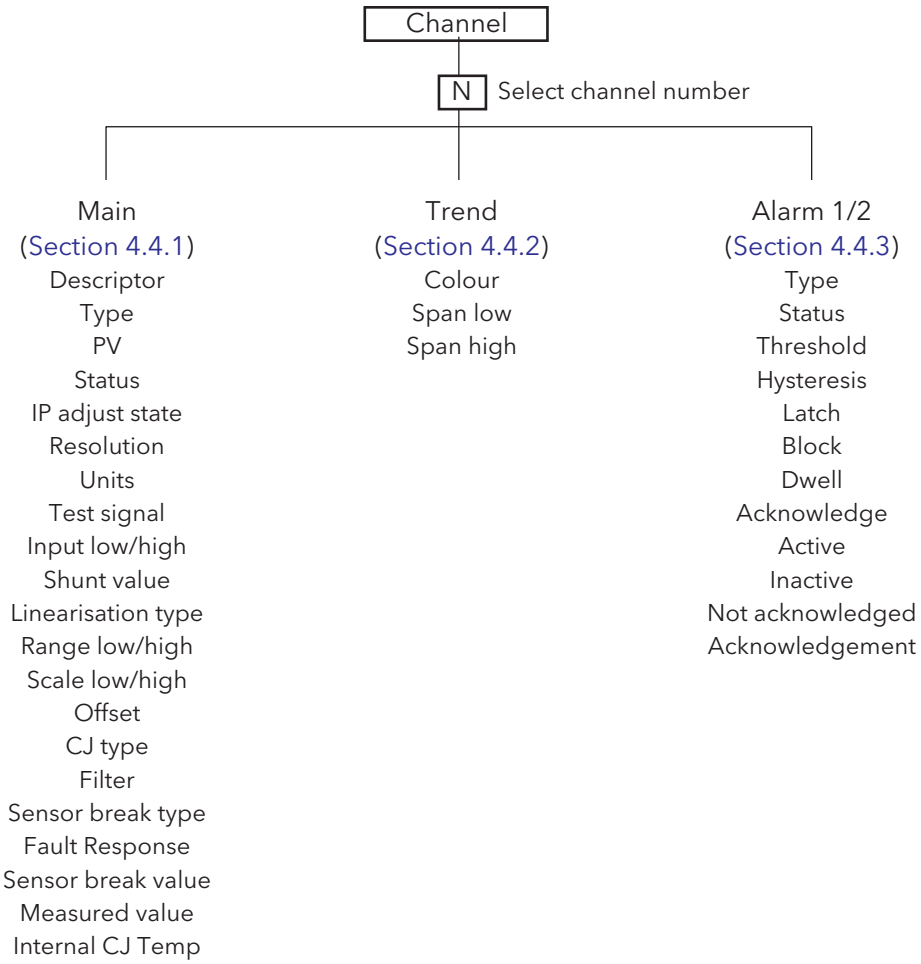


Figure 4.4 Channel configuration menu

4.4.1 Channel Main

This section describes all possible menu items, but it should be noted that some items are context dependent (e.g. Cold Junction settings appear only for Type = 'Thermocouple').

Channels one to four in the configuration relate to An In 1 (terminals 1I, 1+ and 1-) to An In 4 (terminals 4I, 4+ and 4-) respectively - see figure 2.2.

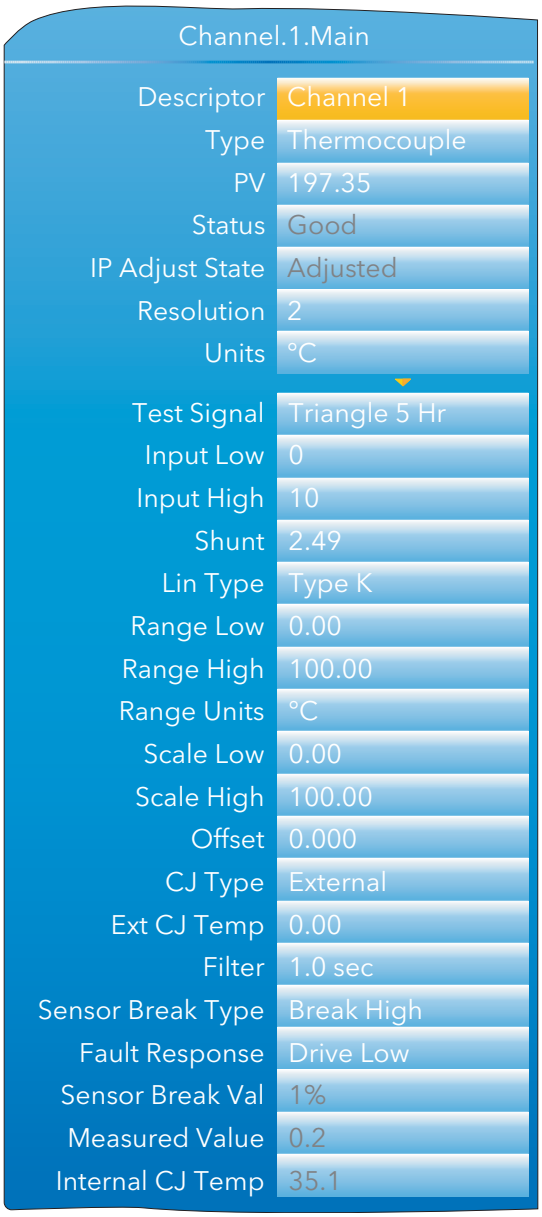


Figure 4.4.1a Channel main menu (expanded)

Note: For the sake of completeness, the figure above shows all possible fields, even though many are mutually exclusive. For example, 'Test signal' appears only when 'Test' is selected as Type. It would never appear when Type = thermocouple (as shown). Similarly, 'Shunt' would appear only for Type = mA.

4.4.1 CHANNEL MAIN (Cont.)

Descriptor	Allows a (20 character max.) descriptor to be entered for the channel. Some thought should be given to ensure that the descriptor is meaningful because in some display screens it is truncated. For example, 'Furnace 1 area 1' and 'Furnace 1 area 2' might both appear as 'Furnace 1 a' and thus be indistinguishable from one another, except in background colour.
PV	Read only. Displays the current value of the channel.
Status	Read only. Shows the channel status as one of: 'Good', 'Channel Off', 'Over range', 'Under range', 'HW error', 'Ranging', 'HW (capability) exceeded'.
PV2	Read only. For dual inputs only, displays the current value of the secondary input.
Status2	Read only. For dual inputs only, shows the secondary input status (as 'Status' above).
IP Adjust State	Appears only for channels which have been included in the 'Adjust Input' procedure described in section 4.1.9.
IP Adjust State2	As 'IP Adjust State', above but for secondary channels.
Resolution	Allows the number of decimal places to be defined for the channel. Valid entries are zero to nine.
Units	Allows a units string of up to five characters to be entered.
Type	Allows the user to select an input type for the channel. Available selections are: 'Off', 'Thermocouple', 'mV', 'V', 'mA', 'RTD', 'Digital', 'Test' or 'Ohms'. If the Dual Input option is fitted, Dual mV, Dual mA, Dual T/C (if enabled) are also available.

Note : If Dual T/C is selected then it is essential that the secondary T/C input is field calibrated using the Input Adjust procedure (section 4.1.9)

Test signal	Appears only if 'Test' is selected as 'Type'. Allows either a sinusoidal or a triangular waveform to be selected at one of a number of cycle times between 40 seconds and five hours.
Input Low*	For Type = mV, Dual mV, V, mA, Dual mA or Ohms, the lowest value of the applied signal in electrical units.
Input High*	As 'Input Low', but the highest value of the applied signal in electrical units.
Shunt value	For mA and Dual mA input types only, this allows the value of the shunt resistor (in Ohms) to be entered. The recorder does not validate this value - it is up to the user to ensure that the value entered here matches that of the shunt resistor(s) fitted. For Dual mA input type, both primary and secondary inputs must have independent shunts each of the same value.
Lin type	Linear, Square root, x3/2, x5/2, User Lin. Thermocouple types (alphabetical order): B, C, D, E, G2, J, K, L, N, R, S, T, U, NiMo/NiCo, Platinel, Ni/MiMo, Pt20%Rh/Pt40%Rh. User 1 to User 4 Resistance thermometer types: Cu10, Pt100, Pt100A, JPT100, Ni100, Ni120, Cu53. See Appendix A for input ranges, accuracies etc. associated with the above thermocouple and RTD types. See section 4.13 for details of user linearisations.
Range Low*	For thermocouples, RTDs, User linearisations and retransmitted signals only, the lowest value of the required linearisation range.
Range High*	For thermocouples, RTDs, User linearisations and retransmitted signals only, the highest value of the required linearisation range.
Range Units	For thermocouples only and RTDs, Select °C, °F or K.
Scale Low/High	Maps the process value to (Scale High - Scale Low). For example, an input of 4 to 20mA may be scaled as 0 to 100% by setting Scale low to 0 and Scale High to 100.
Scale Low2/High2	As 'Scale Low/High but for the secondary input (PV2).
Offset	Allows a fixed value to be added to or subtracted from the process variable.

*Note: See section 4.13 for details of the configuration of Range High/Low and Input High/Low when 'Type' = User 1 to User 4.

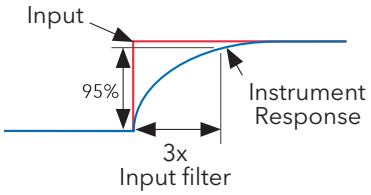
4.4.1 CHANNEL MAIN (Cont.)

Offset2

The nature of the secondary input results in an offset being introduced into the process variable value.
For mA inputs this offset is removed automatically, without user intervention.
For mV inputs the offset depends on the value of the voltage source impedance and is equal to 199.9µV/Ω. This offset can be compensated for either by using this Offset2 parameter, or by carrying out the 'Input Adjust' procedure (Section 4.1.9).
For Dual T/C inputs, it is recommended that the 'Input Adjust' procedure be used instead of Offset2 as the use of Offset2 results in an offset which is non-linear over the thermocouple range.

Input filter

Damping can be used to filter out noise from slowly changing signals so that the underlying trend can be seen more clearly. Valid input values are between 0 and 60 seconds.



Note: Applying a filter to an input channel can affect the operation of any Rate-of-change alarms configured to act on that channel.

CJC Type

For thermocouple input types only, this allows the user to select 'None', 'Internal', 'External' or 'Remote 1' to 'Remote 4'. For Dual T/C inputs, both primary and secondary inputs use the same cold junction.
None: No Cold junction compensation applied.
'Internal' uses the recorder's internal cold junction temperature measurement.
'External' means that the cold junction is to be maintained by the user, at a fixed, known temperature. This temperature is entered in the 'External CJ Temp' field which appears when 'External' is selected.
Remote 1 (2) (3) (4) means that the cold junction temperature is being measured by input channel 1 (2) (3) (4) respectively. (This must be a different channel from that currently being configured).

Ext. CJ Temp

Appears only if CJC type is set to 'External', and allows the user to enter the temperature at which the external cold junction is being maintained.

Sensor Break Type

Defines whether the sensor break becomes active for circuit impedances greater than expected.
'Off' disables Sensor Break detection.
Break Low: Sensor break active if measured impedance is greater than the 'Break Low impedance' value given in table 4.4.1.
Break High: Sensor break active if measured impedance is greater than the 'Break High Impedance' value given in table 4.4.1.
For mA inputs, limits are applied, such that if the process value lies outside these limits, a sensor break is assumed to have occurred. These limits are (Input lo - 4% Span) and (Input high + 6% Span). For example, for a 4 to 20mA signal, an input below 3.36mA or above 20.96mA will trigger a sensor break event

Range	Break Low impedance	Break High Impedance
40mV	~5kΩ	~20kΩ
80mV	~5kΩ	~20kΩ
2V	~12.5kΩ	~70kΩ
10V	~12.5kΩ	~120kΩ

Table 4.4.1 Minimum impedances for sensor break detection

Note: Break High impedance values would be used typically for sensors which have a high nominal impedance when working normally

4.4.1 CHANNEL MAIN (Cont.)

Sensor Break type (Cont.)

Input sensor break detection is not supported for secondary inputs. The internal circuit acts as a 'pull up' on the secondary input which therefore saturates high in the event of a sensor break.

Fault Response — Specifies the behaviour of the recorder if a sensor break is detected or if the input is over driven (saturated high or low).
'None' means that the input drifts, with the wiring acting as an aerial.
'Drive High' means that the trace moves to (Scale High +10%). 'Drive Low' means that the trace moves to (Scale Low -10%), where the 10% values represent 10% of (Scale High - Scale Low).

Sensor Break Val — A diagnostic representation of how close the sensor break detection circuitry is to tripping.
Measured ValueThe (read only) input channel measured value before any scaling or linearisation is applied.

Measured Value2 — As 'Measured Value', above but for the secondary input.

Internal CJ temp — The (read only) temperature of the internal cold junction associated with this channel.

4.4.2 Channel Trend configuration

This area allows the configuration of channel colour and span.

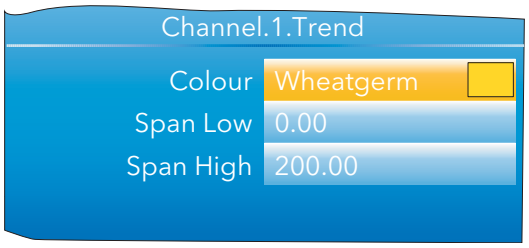


Figure 4.4.2a Channel Trend menu

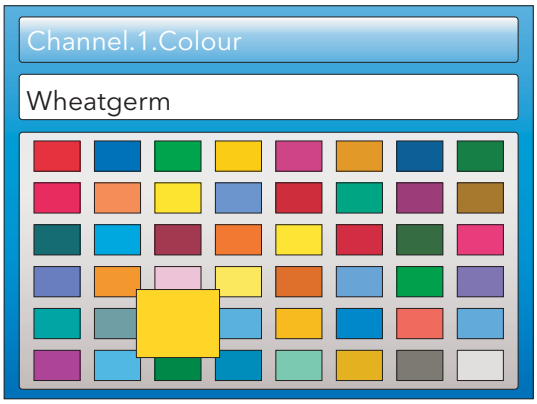


Figure 4.4.2b Colour selection

Colour	Allows a colour to be specified for the channel. The Scroll key is used to enter the colour swatch page. The up and down arrows are used to scroll through the available colours, with each colour being enlarged for as long as it is 'selected'. Once the required colour, is reached, the scroll key is used again to return to the Trend Configuration.
Span Low/High	Span low and high values.

Note: Trend colours and alarm settings for secondary inputs are configured in the maths channels to which they are wired.

SPAN EXAMPLE

In an input range of 0 to 600 degrees C, the temperature range between 500 and 600 degrees is of most interest. In such a case, Span Low is set to 500 and Span High to 600 so that the recorder trends only the required part of the temperature range, effectively magnifying the area of interest.

Note: Trending is restricted to the PV range (Span High - Span Low), but the instrument can display values outside this range.

CHANNEL CONFIGURATION EXAMPLE

A type J thermocouple is used to measure a temperature range of 100 to 200 degrees Celsius. This thermocouple output is transmitted to the recorder by a 4 to 20mA transmitter, for display as a value between 0 and 100%.

In Channel.Main, set the following for the relevant channel:

Type	= mA
Units	= %
Input Low	= 4.00
Input high	= 20.00
Shunt	= 250 Ohms
Lin Type	= Type J
Range Low	= 100.00
Range High	= 200.00
Range Units	= °C
Scale Low	= 0
Scale High	= 100

Other items may be left at their defaults.

4.4.3 Alarm 1 menu

Allows the alarm characteristics for Alarm 1 to be configured. The figure below shows a typical configuration page (expanded for clarity). Actual configuration parameters are context sensitive.

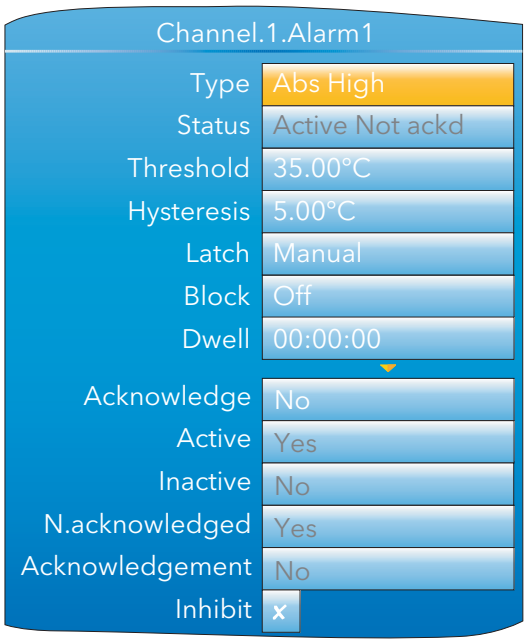


Figure 4.4.3 Typical alarm 1 configuration menu

Type	Select an alarm type from: 'Off', 'Abs. High' (absolute high). 'Abs. Low' (absolute low), 'Dev. High' (deviation high), 'Dev. Low' (deviation low), 'Dev. Band' (deviation band), 'Rise ROC' (rate-of-change: rising), 'Fall ROC' (rate-of-change: falling), 'Digital High', 'Digital Low'. See 'Alarm types', below, for definitions.
Status	Read only. This shows that the alarm is Off, Active, SafeNotAcked or ActiveNotAcked. For 'Auto' and 'Manual' alarms only, 'SafeNotAcked' means that the alarm trigger source has returned to a non-alarm state, but the alarm is still active because it has not been acknowledged. Similarly, 'ActiveNotAcked' means that the source is still active and the alarm has not been acknowledged. Always shows 'Off' when the alarm is inhibited (see below).
Threshold	For absolute alarms only, this is the trip point for the alarm. For absolute high alarms, if the threshold value is exceeded by the process value (PV) of this channel, then the alarm becomes active, and remains active until the PV falls below the value (threshold - hysteresis). For absolute low alarms, if the PV of this channel falls below the threshold value, then the alarm becomes active and remains active until the PV rises above (Threshold + Hysteresis).
Reference	For deviation alarms only, this provides a 'centre point' for the deviation band. For 'deviation high' alarms, the alarm becomes active if the process value (PV) rises above the value (Reference + Deviation) and remains active until the PV falls below (Reference + Deviation - Hysteresis). For 'deviation low' alarms, the alarm becomes active if the process value (PV) falls below the value (Reference - Deviation) and remains active until the PV rises above (Reference - Deviation + Hysteresis). For 'deviation band' alarms, the alarm is active whenever the process value (PV) lies outside the value (Reference ± Deviation) and remains active until the PV returns to within the band, minus or plus Hysteresis as appropriate.
Deviation	For deviation alarms only, 'Deviation' defines the width of the deviation band, each side of the Reference value, as described immediately above.

4.4.3 ALARM 1 MENU (Cont.)

Hysteresis	For absolute and deviation alarms, this provides a means of preventing multiple alarm triggering, if the process value is drifting close to the trigger value.
Amount	For rate-of-change alarms only. The alarm becomes active if the process value rises (Rise ROC) or falls (Fall ROC) by more than the specified 'Amount' within the time period defined in 'Change Time', below. The alarm remains active until the rate of change falls below the value (Amount/Change Time) in the relevant sense.
Change Time	Settable to 1 second, 1 minute or 1 hour. See 'Amount' (above).
Average Time	For rate-of-change alarms only. This allows an averaging period (for the process value) to be entered to reduce nuisance trips due to signal noise, or if the rate of change is hovering around the trip value.
Latch	None: the alarm remains active until the monitored value has returned to a non alarm state, when it becomes inactive. Auto: The alarm remains active until the monitored value has returned to a non alarm state and the alarm has been acknowledged. Acknowledgement can take place either before or after the value has returned a non alarm state. Manual: The alarm remains active until the monitored value has returned to a non alarm state and the alarm has been acknowledged. Acknowledgement is permitted only after the value has returned a non alarm state. Trigger: Not enunciated, this mode is used only to initiate an action defined by user wiring either using iTools or using the user interface.
Block	Alarms with 'Block' set to 'On' are inhibited until the monitored value has entered the 'safe' condition after a start-up. This prevents such alarms from becoming active whilst the process is brought into control. If a latching alarm is not acknowledged then the alarm is re-asserted (not blocked), unless the alarm's threshold or reference value is changed, in which case the alarm is blocked again.
Dwell	Initiates a delay between the trigger source becoming active, and the alarm becoming active. If the trigger source returns to a non alarm state before the dwell time has elapsed, then the alarm is not triggered and the dwell timer is reset.
Acknowledge	Select 'yes' to acknowledge the alarm. Display returns to 'No'.
Active	Read only. Shows the status of the alarm as 'Yes' if it is active, or No, if inactive. The active/inactive state depends on the Latch type (above) and acknowledgment status of the alarm. Always shows 'No' if the alarm is inbited (below).
Inactive	As for 'Active' above, but shows 'Yes' if the alarm in inactive and 'No' if the alarm is active. Always shows 'Yes' if the alarm is inbited (below).
N.acknowledged	As for 'Active' above but shows 'Yes' for as long as the alarm is unacknowledged, and 'No' as soon as it is acknowledged. Always shows 'No' if the alarm is inbited (below).
Acknowledgement	Fleetingly goes 'Yes' on alarm acknowledgement, and then returns to 'No'.
Inhibit	When 'Inhibit' is enabled, (tick symbol), the alarm is inhibited. Status is set to 'Off'; 'Active' and 'N.acknowledged' are set to 'No', and 'Inactive' is set to 'Yes'. If the alarm is active when inhibit is enabled, then it becomes inactive until inhibit is disabled, when its status depends on its configuration. Similarly if the alarm trigger becomes active when the alarm is inhibited, the alarm remains 'off' until inhibit is disabled, when its status depends on its configuration.

4.4.4 Alarm 2 menu

As above for Alarm 1 menu.

Note: The parameters 'Acknowledge', 'Active', 'Inactive', 'N(ot) Acknowledged' and, 'Acknowledgement' can all be 'wired' to other parameters, so, for example, a relay can be made to operate whilst the alarm is inactive or whilst it is active or on acknowledgement etc. by wiring the relevant parameter to the relay's 'PV' input. See section 7 for details of user wiring.

4.4.5 Alarm types

The following figures attempt to show graphically the meanings of the alarm parameters which can be set for the various alarm types available.

ABSOLUTE ALARMS

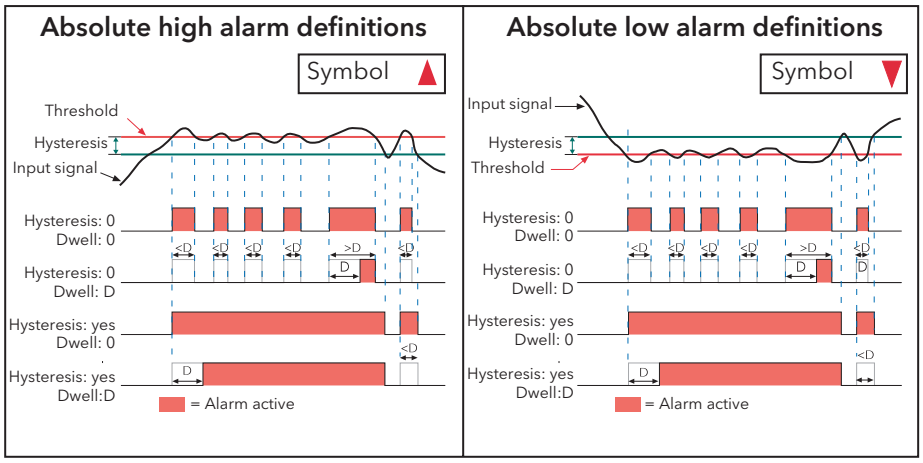


Figure 4.4.5a absolute alarm parameters

DEVIATION ALARMS

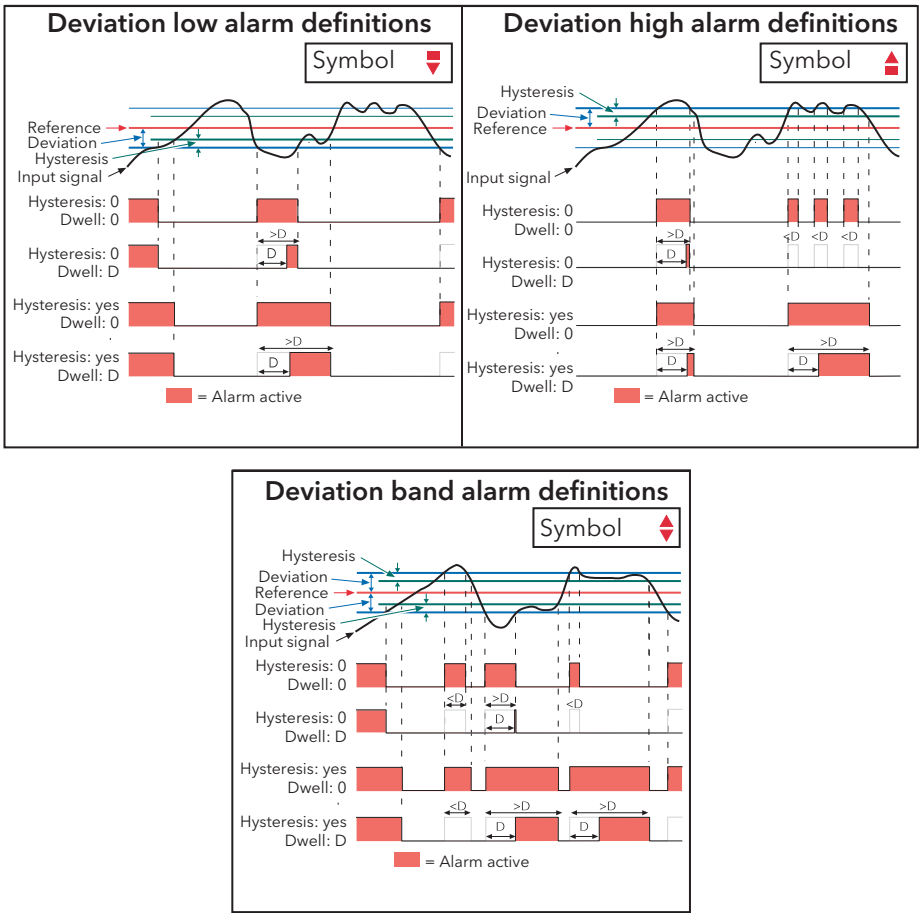


Figure 4.4.5b Deviation alarm parameters

4.4.5 ALARM TYPES (Cont.)

RATE-OF-CHANGE ALARMS

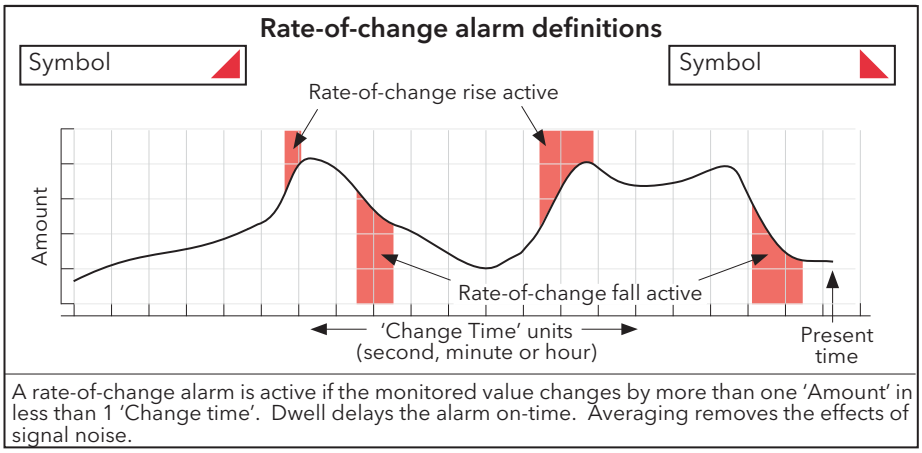


Figure 4.4.5c Rate-of-change alarm parameters

Note: Operation of rate-of-change alarms may be affected if an input filter (section 4.4.1) is applied to the input signal.

4.5 VIRTUAL CHANNEL CONFIGURATION

This allows the configuration of maths channels, totalisers and counters. The configuration is divided into the following areas: 'Main', 'Trend', 'Alarm 1*' and 'Alarm 2*'. Items appearing in the 'Trend', Alarm 1' and 'Alarm 2' areas are identical with the equivalent items described in section 4.4 (Input channels), above.

*Note: Virtual channels 16 to 30 (supplied with Modbus Master and EtherNet/IP options only) come without alarms.

4.5.1 Maths channel configuration

The following maths functions are available (listed in up-arrow scroll order)

Off, Add, Subtract, Multiply, Divide, Group Average, Group minimum, Group maximum, Modbus input, Copy, Group minimum (latch), Group maximum (latch), Channel maximum, Channel minimum, Channel Average, Configuration revision, Off.

Figure 4.5.1 shows a typical maths channel configuration

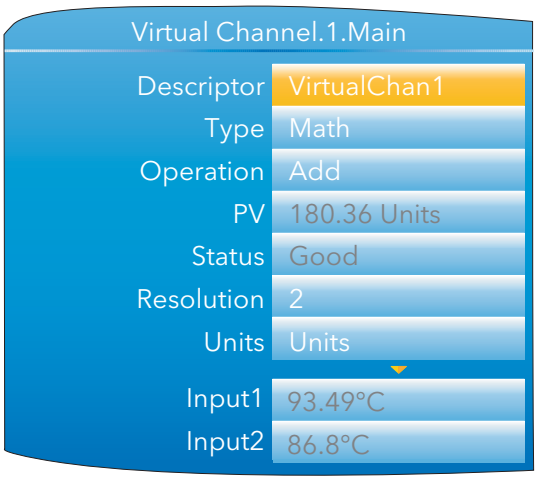


Figure 4.5.1 Maths channel configuration (typical)

Descriptor	Allows the user to enter a descriptor (20 characters max.) for the maths channel
Type	Math selected for this example. (See sections 4.5.2 and 4.5.3 for totalisers and counters respectively.)
Operation	Allows the user to select the required maths function. See 'Maths Functions', below.
PV	Read only. Shows the dynamic value of this channel in the units entered in 'Units' below.
Status	Read only. Shows the status of this channel, reflecting the status of the input sources.
Resolution	Enter the number of decimal places required
Units	Allows a five character string to be entered to be used as the channel units.
Input1	The value of input 1. May be entered manually, or it may be wired from another parameter (section 7). Uses the resolution of the source.
Input 2	As for 'Input 1', Appears only when the operation requires two inputs.
Reset	Allows the user to reset latching functions (e.g. Channel Max) or averaging functions (e.g. Channel Avg). Reset is carried out by setting the field to 'Yes', then operating the scroll key. The display returns to 'No'. Alternatively the function can be reset by another parameter wired to 'Reset'.
Time Remaining	The period of time remaining before the virtual channel performs its operation. For example, the time remaining for the maths channel average operation to sample the input before performing the calculation.
Period	For averaging functions, this allows a period to be entered, over which the value is to be averaged. Selectable periods are: 0.125, 0.25, 0.5, 1, 2, 5, 10, 20, 30 seconds, 1, 2, 5, 10, 20, 30 minutes, 1, 2, 6, 12, 24 hours

4.5.1 MATHS CHANNEL CONFIGURATION (Cont.)

MATHS FUNCTIONS

Off	Out = -9999; status = Off
Add	Out = Input1 + Input2
Subtract	Out = Input1 - Input2
Multiply	Out = Input1 x Input2
Divide	Out = Input1 ÷ Input2. If Input2 = 0, Out = -9999; Status = 'Bad'.
Group Avg*	Out = Instantaneous sum of all points in the recording group (except this one and any channel that has been configured with operation = group average, group minimum, group maximum, group minimum (latched), group maximum (latched), channel maximum or channel minimum), divided by the number of points in the group (excluding this one). Any point that has a status other than 'Good' is excluded from the calculation. If the group contains no channels, Out = -9999; Status = 'No data'.
Group Min*	Out = Instantaneous value of whichever point (except this one) in the recording group has the lowest value. Any point that has a status other than 'Good' is excluded from the calculation. If the group contains no channels, Out = -9999; Status = 'No data'.
Group Max*	Out = Instantaneous value of whichever point (except this one) in the recording group has the highest value. Any point that has a status other than 'Good' is excluded from the calculation. If the group contains no channels, Out = -9999; Status = 'No data'.
Modbus Input	Out = value written to this channel's modbus input. If the comms timeout expires, Out = -9999; status = 'No data'.
Copy	Allows an input or other derived channel to be copied.
Grp Min Latch*	Out = Lowest value reached by any point in the recording group (except this one) since last reset. Any point that has a status other than 'Good' is excluded from the calculation. If the group contains no channels, Out = -9999; Status = 'No data'.
Grp Max Latch*	Out = Highest value reached by any point in the recording group (except this one) since last reset. Any point that has a status other than 'Good' is excluded from the calculation. If the group contains no channels, Out = -9999; Status = 'No data'.
Channel Max	Out = Highest value reached by Input1 since last reset. If Input1 has a status other than 'Good', then Out = -9999 and 'Status' depends on the status of Input1.
Channel Min	Out = Lowest value reached by Input1 since last reset. If Input1 has a status other than 'Good', then Out = -9999 and 'Status' depends on the status of Input1.
Channel Avg	Out = the average value of Input1 over the time specified in 'Period'. If Input1 has a status other than 'Good', then Out = -9999 and 'Status' depends on the status of Input1.
Config Revision	Out = current Configuration Revision value.

*Note: All 'Group' functions operate on the 'Recording' group, not on the 'Trend' group.

4.5.2 Totaliser configuration

Totalisers allow the user to maintain a running total of any input channel, or of any maths channel. Using maths channels, it is possible to totalise combinations of input channels so that, for example, the sum of two channels or the difference between them could be totalised if required.

The maximum capacity for each totaliser is 1,000,000. This range can be expanded by wiring from the 'Roll-over' output of the totaliser to the 'trigger' input of a counter. Wiring is carried out either at the operator interface (section 7) or in iTools (section 6).

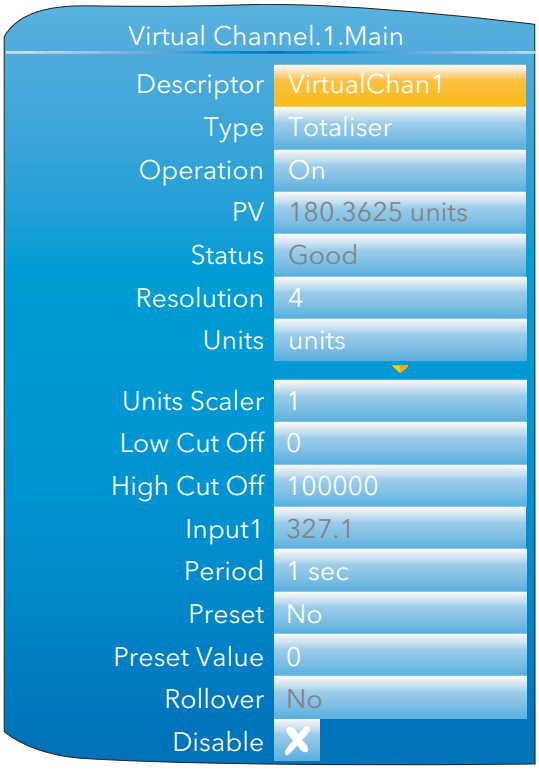
The totaliser equation is:

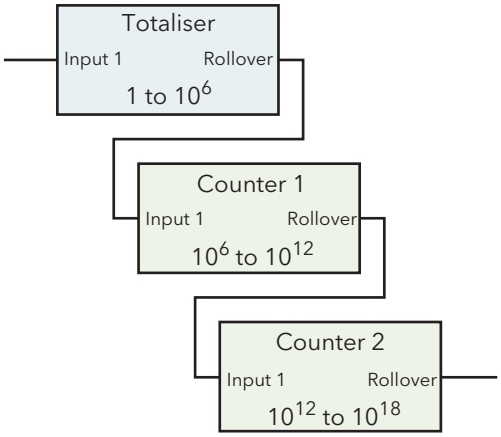
$$tot_t = tot_{t-1} + \frac{ma_t}{PSF \times USF}$$ where,

tot_t = totaliser value this sample
tot_{t-1} = totaliser value last sample
ma_t = process value this sample
PSF = Period Scaling Factor (Period)
USF = Units Scaling Factor (Units scaler)

Note: the time between samples is 125ms.

Figure 4.5.2 shows a typical configuration page.





Using cascaded counters to expand the totalisation range.

Figure 4.5.2 Typical totaliser configuration menu

Descriptor	Allows the user to enter a descriptor (20 characters max.) for the totaliser.
Type	Select: Math, Counter or Totaliser.
Operation	Allows the user to enable ('On') or disable ('Off') the totaliser.
PV	Read only. Shows the dynamic value of the totaliser.

4.5.2 TOTALISER CONFIGURATION (Cont.)

Status	Read only. Shows the status of the totaliser.

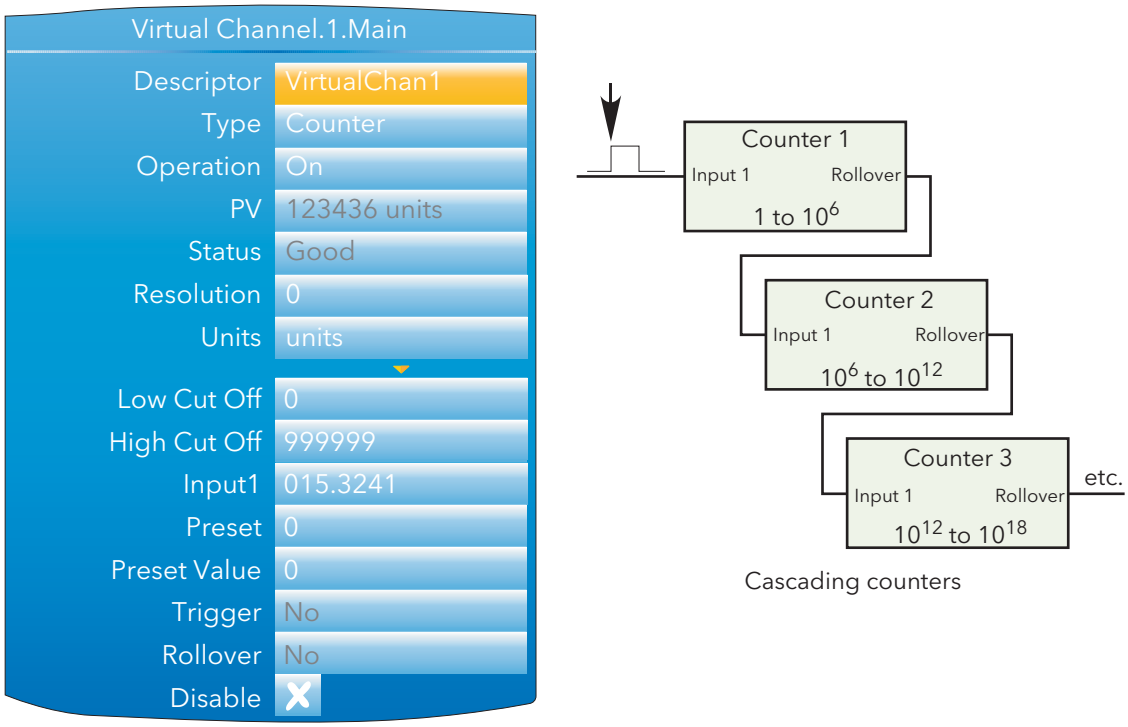
Notes:

1. Because of the way in which the totaliser value is stored (IEEE 32-bit floating point), it is possible that if the current totaliser value is very large, then very small input values can be smaller than the minimum that can be resolved. In such a case the small value is not totalised, and the status 'Overflow' is set. This should not be confused with 'Rollover', described below.
2. The incremental value (ma/(PSF*USF)) at the rollover point (1,000,000) should be ≥ 1.

Resolution	Allows the number of decimal places (up to 6) to be selected for the totaliser.
Units	Allows a units string of up to five characters to be entered for the totalised value.
Units Scaler	Allows a units scaler to be selected. If, for example, the input channel has units of litres per hour, then, if the Units Scaler is set to one, the totalised value will be in litres. If the Units Scaler is set to 1000, then the totalised value will be in thousands of litres. Setting the Units Scaler to a negative value, causes the totaliser to decrement rather than increment.
Low Cut Off	Used to restrict the input operating range of the totaliser. Minimum value = -100 000
High Cut Off	Used to restrict the input operating range of the totaliser. Maximum value = 100 000
Input1	The value of the source. May be entered manually, or this parameter can be wired from an external channel PV.
Period	The totaliser equation works in seconds. If the totalised channel units are other than 'per second', a period scaler different from the default (1 sec) must be used. The 'Period' field presents a number of fixed periods from 0.125 seconds to 24 hours for selection.
Preset	Setting this to 'Yes' causes the totaliser to adopt the Preset Value. The field returns immediately to 'No'. The totaliser can also be preset by an external source 'wired' to this parameter.
Preset Value	Allows the entry of a value, from which the totaliser is to start incrementing or decrementing. The direction of the count is set by the sign of the units scaler: positive = increment; negative = decrement.
Rollover	The maximum capacity of the totaliser is 1 000 000. If, for example, the current totaliser value is 999 999 and 'Input 1' = 10, then the next sample will set the totaliser value to (999,999 +10 - 1,000,000 = 9) and 'Rollover' is set to 'Yes' for one iteration period. This can be used to increment a counter by wiring the totaliser 'Rollover' parameter to the 'Trigger' parameter of the counter. The maximum capacity of each counter is also 1 million and if necessary, counters can be cascaded in a similar way, the first counter counting in millions, the second in units of 10^{12}, the third in units of 10^{18}, and so on.
Disable	Allows the user temporarily to suspend totalising action. The output retains the pre-disabled value until the totaliser is re-enabled, when it resumes from that value. The totaliser is toggled between being enabled (cross symbol) and disabled (tick symbol) by means of the scroll key.

4.5.3 Counter configuration

This allows the user to set up a counter to count trigger inputs (or it may be incremented from the Configuration page. Maximum count is 1 000 000. Counters can be cascaded by wiring from 'Rollover' of one counter to 'trigger' of the next. Wiring is carried out from the operator interface (section 7) or in iTools (section 6). For 'Trend', 'Alarm 1' and 'Alarm 2' configurations please see the relevant parts of section 4.4.



Cascading counters

Figure 4.5.3 Typical Counter configuration

Descriptor	Allows the user to enter a descriptor (20 characters max.) for the counter.
Type	Select: Math, Counter or Totaliser.
Operation	Allows the user to enable ('On') or disable ('Off') the counter.
PV	Read only. Shows the dynamic value of the counter.
Status	Read only. Reflects the status of the input channel.
Resolution	Allows the number of decimal places (up to six) to be defined for the channel.
Units	Allows a units string of up to five characters to be entered for the counter value
Low Cut Off	Specifies a value below which the counter will not decrement.
High Cut Off	Specifies a value above which the counter will not increment.
Input1	The amount by which the counter is incremented each time 'Trigger' goes high. The value may be entered manually, or wired from another parameter. Negative values cause the counter to decrement.
Preset	Setting this to 'Yes' causes the counter to adopt its Preset Value. The field returns immediately to 'No'. The counter can also be preset by wiring from another parameter.
Preset Val	Allows the entry of a value, from which the counter is to start incrementing or decrementing.
Trigger	Setting this to 1, causes the current value of the input source to be added to the Counter value. This function can be carried out manually, or the input can be wired from another parameter (section 7.2).
Rollover	The maximum capacity of the counter is 1 000 000. If, for example, the current value is 999 999 and Input 1 = 15, then the next sample will set the totaliser value to 14 (999,999 +15 - 1,000,000) and 'Rollover' is set to 'Yes' for one iteration period. This can be used to increment a further counter by wiring 'Rollover' to 'Trigger'.
Disable	Allows the user temporarily to suspend counting. The output retains the pre-disabled value until the counter is re-enabled, when it resumes counting from that value. The counter is toggled between being enabled (cross symbol) and disabled (tick symbol) by means of the scroll key.

4.6 LOOP OPTION CONFIGURATION

This configuration area allows the user to set up two control loops. This description refers to temperature control loops, but the configuration parameters apply equally to other types of control. For each loop, channel 1 is assumed to be a heating channel; channel 2 a cooling channel.

The configuration is divided into a number of areas, as shown in the overview below.

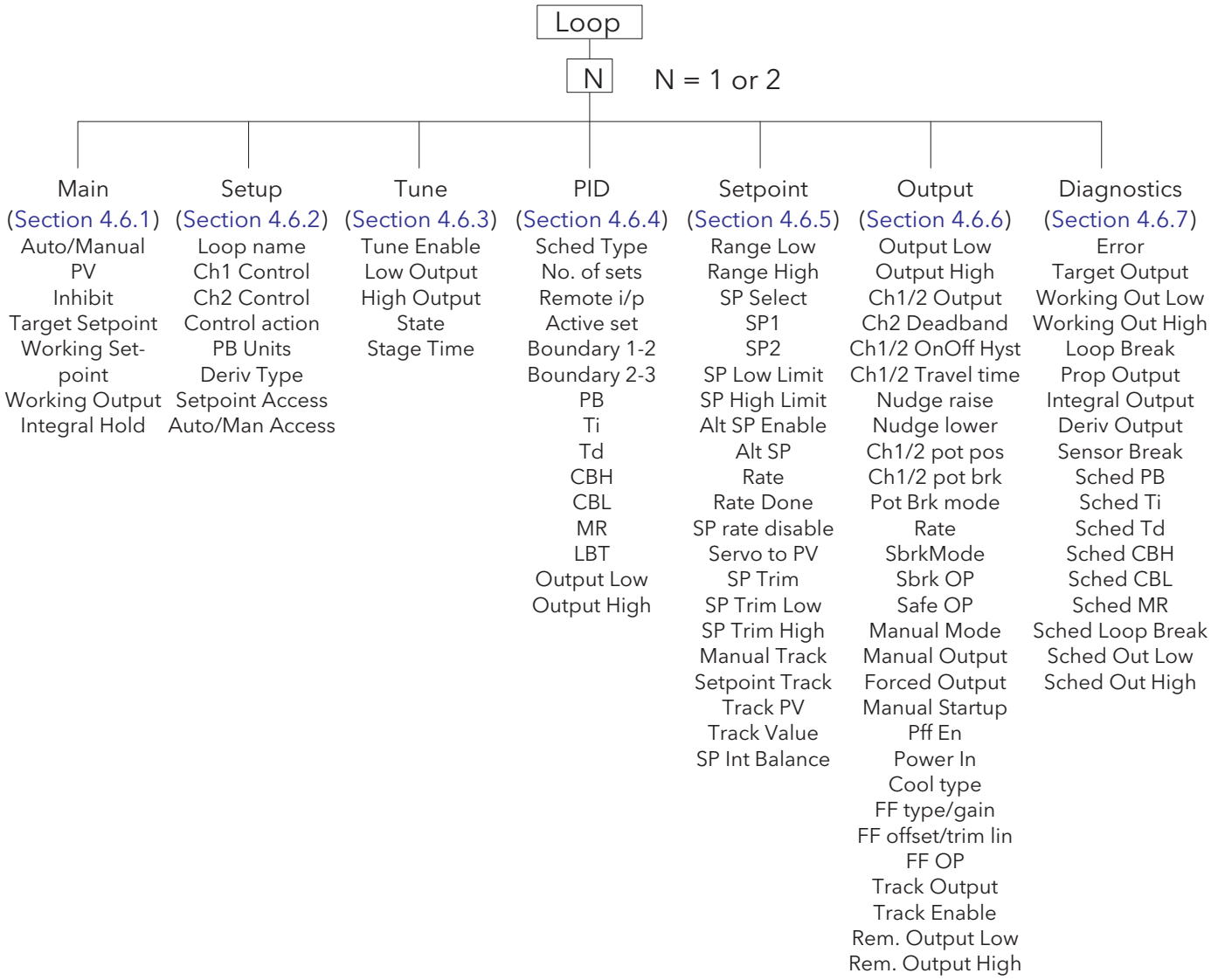


Figure 4.6 Loop configuration overview

For a general discussion of control loops, please see Appendix B to this manual.

4.6.1 Main menu parameters

Auto/Manual	Selects Auto(matic) or Manual operation. 'Auto' automatically controls output power in a closed loop configuration. In manual mode, the operator controls the output power.
PV	The Process Variable input value. The value can be entered by the user, but is most often 'wired' from an analogue input.
Inhibit	Select 'No' or 'Yes'. 'Yes' stops the loop and sets the output to a 'safe' value, this value being entered as a part of the Output configuration (section 4.6.6). If an output rate limit is set, then the output ramps to the safe level at that rate, otherwise it performs a step change. If setpoint or manual tracking is enabled (in setpoint configuration section 4.6.5), Inhibit overrides tracking. If 'No' is selected, the loop operates normally. Inhibit can be enabled/disabled from an external source.
Target Setpoint	The value at which the control loop is aiming. SP may be derived from a number of sources, as described in Appendix B, section B2.5. The value range limited by the setpoint limits (SP High Limit and SP Low Limit) described in section 4.6.5.
Working Setpoint	A read-only value displaying the current value of setpoint being used by the loop. This might or might not be the Target setpoint. The value may come from a number of sources, but is limited by the setpoint limits (SP High Lim and SP Low Lim) described in section 4.6.5.
Working Output	The actual working output value before being split into channel 1 and 2 outputs.
Integral Hold	Select 'Yes' or 'No'. 'Yes' freezes the integral term at its current value. IntHold ensures that the power is reapplied smoothly after the loop has been broken for service reasons, for example.

4.6.2 Setup menu parameters

Loop Name	Allows entry of an 11 character name for the loop.
Ch1 Control	Selects the type of control for channel one from: Off: Channel is turned off OnOff: Channel uses on/off control PID: Proportional + integral + derivative (three-term) control. VPU: Valve positioning unbounded VPB: Valve positioning bounded. Appendix B, Section B2.2 provides more details.
Ch2 Control	As above, but for loop channel two.
Control Action	Select 'Reverse' or 'Direct'. 'Reverse' means that the output is 'on' when the process value (PV) is below the target setpoint (SP). This is normal for heating control. 'Direct' means that the output is on when PV is above SP. This is normal for cooling control.
PB Units *	Select 'Engineering' or 'Percent'. 'Engineering' displays values in (for example) temperature units (e.g. °C or °F). 'Percent' displays values as a percentage of loop span (Range Hi - Range Lo).
Deriv Type *	'Error' means that changes to PV or SP cause changes to the derivative output. Derivative on error should be used with a programmer since it tends to reduce ramp overshoot. 'Error' provides rapid response to small setpoint changes which makes it ideal for temperature control systems. 'PV' means that changes in PV alone cause changes to the derivative output. Typically used for process systems using valve control, as it reduces wear on the valve mechanics.
Setpoint Access	Allows setpoint editing permission in the loop display pages (section 3.4.7). 'Read/Write' allows free access to all users 'Read Only' allows editing only in Configuration or Supervisor modes. 'Operator R/W' allows editing in all modes except 'Logged out'.

4.6.2 SETUP MENU PARAMETERS (Cont.)

Auto/Man Access — As 'Setpoint Access' above, but for Auto/manual parameter.

*Note: 'PB Units' and 'Deriv Type' appear only if at least one of Ch1 Control and Ch2 Control is set to 'PID', 'VPU' or' VPB'.

4.6.3 Tune menu parameters

Tune Enable	'On' initiates autotune. Legend changes to 'Off' when autotune is complete. Can be set to 'Off' manually, to stop the tuning process.
Low Output	Sets a low limit to be imposed whilst autotune is running. The value must be greater than or equal to the 'Output Low' value, specified in the Output menu (section 4.6.6).
High Output	Sets a high limit to be imposed whilst autotune is running. The value must be less than or equal to the 'Output High' value, specified in the Output menu (section 4.6.6).
State	Read only display of autotune progress: Off. Autotune not running Ready. Fleeting display. Changes immediately to 'Running'. Running. Autotune is in progress. Complete. Autotune completed successfully. This is a fleeting display which changes immediately to 'Off'. Timeout, TI Limit and R2G Limit are error conditions described in Appendix B section B2.4.5. If any of these occurs, tuning is aborted and the PID settings remain unchanged.
Stage	A read only display showing the progress of the autotune: Settling. Displayed during the first minute whilst loop stability is checked (Appendix B, section B2.4.5) To SP. Heating or cooling switched on. Wait min. Power output off. Wait max. Power output on. Timeout, TI Limit and R2G Limit are error conditions described in Appendix B section B2.4.5.
Stage Time	Time into the current stage of the autotune process. 0 to 99999 seconds.
AT.R2G	Autotune at R2G. 'Yes' means that the control loop uses the R2G value calculated by autotune. 'No' causes the loop to use the R2G value entered by the user (PID menu) calculated as described in Appendix B section B2.4.5.

4.6.4 PID menu parameters

Note: If control type is set to 'Off', or 'OnOff' in the Setup menu, the PID menu contains only the Loop Break time parameter 'LBT'.

Sched Type	Selects the type of gain scheduling (section B2.3.7) to be applied. Off. Gain scheduling not active Set. The user selects the PID parameter set to be used. Setpoint. Transfer from one set to the next depends on the setpoint value PV. The transfer from one set to another depends on the PV value Error. The transfer between sets depends on the value of the error signal OP. Transfer depends on the value of the output. Rem. Transfer is controlled by a remote input.
Number of Sets	Allows the number of sets of PID parameters for use in Gain scheduling to be selected.
Remote input	For 'Sched Type' = 'Rem' only, this shows the current value of the remote input channel being used to select which set is active. If the remote input value ≤ the Boundary 1-2 value (see below) then set 1 is selected. If it is > Boundary 1-2 value but ≤ Boundary 2-3 value then set 2 is used. If the remote value is > Boundary 2-3 value, then set three is used. If the Remote input is not 'wired', the value is user editable from the front panel.
Active Set	The set number currently in use.
Boundary 1-2	For all Sched Types except 'Set', this allows the user to enter a 'boundary' value, which means that if the relevant value (SP, PV, Error etc.) rises above this boundary, the loop switches from PID set 1 to PID set 2. If it falls below the boundary value, the loop switches from set 2 to set 1.
Boundary 2-3	As above but for switching between sets 2 and 3.
PB/PB2/PB3	Proportional band for set one/two/three. The proportional term in the units (Engineering units or %) set in 'PBUnits' in the Setup menu. See Appendix B section B2.2.2 for more details.
Ti/Ti2/Ti3	Integral time constant for set one/two/three. Valid entries are1 to 9999.9 seconds, or 'Off'. If set Off, then integral action is disabled. Removes steady state control offsets by moving the output up or down at a rate proportional to the error signal.
Td/Td2/Td3	Derivative time constant for set one/two/three. Valid entries are 1 to 9999.9 seconds, or 'Off'. If set Off, then derivative action is disabled. Determines how strongly the controller reacts to a change in the PV. Used to control overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.
R2G/R2G2/R2G3	Relative cool gain for set one/two/three. Appears only if cooling has been configured (Ch2 Control not 'Off' or 'OnOff' in Setup menu). Valid entries are 0.1 to 10. Sets the cooling proportional band which compensates for differences between heating and cooling power gains.
CBH/CBH2/CBH3	Cutback high for set one/two/three. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units above setpoint at which the controller output is forced to 0% or -100% (OP min), in order to modify undershoot on cool down. See section B2.3.2 for more details.
CBL/CBL2/CBL3	Cutback low for set one/two/three. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units below setpoint at which the controller output is forced to 100% (OP max), in order to modify overshoot on heat up. See section B2.3.2 for more details.
MR/MR2/MR3	Manual reset for set one/two/three. Valid entries 0 to 100%. Introduces a fixed additional power level to the output in order to eliminate steady state error from proportional only control. Applied instead of the integral component when Ti is set to 'Off'.
LBT/LBT2/LBT3	Loop break time for set one/two/three. valid entries are 1 to 99999 seconds, or 'Off'. See section B2.3.6 for more details.
Output Low/2/3	Output low limit for set one/two/three. Valid entries are in the range Output High/2/3 to -100.
Output High/2/3	Output high limit for set one/two/three. Valid entries are in the range Output Low/2/3 to +100

4.6.5 Setpoint menu parameters

Range High/Low	Range limits. Valid entries from 99999 to -99999. Range limits set absolute maxima and minima for control loop setpoints. If the proportional band is configured as a % span, the span is derived from the range limits.
SP select	Select SP1 or SP2. SP1 is considered to be the primary setpoint for the controller, and SP2 a secondary (standby) setpoint.
SP1, SP2	Allows values for Setpoints 1 and 2 to be entered. Valid entries are any within the range 'SPHigh Limit' to 'SPLowLim'.
SP Low Limit	Minimum setpoint limit for SP1 and SP2. Valid entries are in the range 'Range Lo' and 'SP High Limit'
SP High Limit	Maximum setpoint limit for SP1 and SP2. Valid entries are in the range 'Range Hi' and 'SP Low Limit'
Alt SP Enable	'Yes' enables the alternative setpoint; 'No' disables it. May be wired to an external or internal source.
Alt SP	When wired this is a read only display of the alternative setpoint value. Otherwise, the user may insert a value. Valid values are limited by 'Range Hi' and 'Range Lo'.
Rate	Sets the maximum rate at which the working setpoint may change in Engineering units per minute. Often used to protect the load from thermal shock cause by large step changes in setpoint. 'Off' disables rate limiting.
Rate Done	Read only display. 'Yes' indicates that the working setpoint has completed its change. 'No' indicates that the setpoint is still ramping.
SP Rate Disable	Appears only if Rate is not 'Off'. 'Yes' disables rate limiting; 'No' enables rate limiting.
Servo To PV	If 'Rate' is set to any value other than 'Off', and if 'Servo to PV' is set to 'Yes' then any change in the current setpoint value causes the working setpoint to servo to the current PV before ramping to the new setpoint value.
SP Trim	A positive or negative value added to the setpoint, for local fine tuning. Valid entries are any value between 'SP Trim High' and 'SP Trim Low'.
SP Trim High/Low	Setpoint trim high and low limits
Manual Track	'On' enables manual tracking to allow the local SP to follow the value of the current PV. See section B2.5.5 for more details. 'Off' disables manual tracking.
Setpoint Track	'On' enables setpoint tracking to allow the local SP to follow the value of the alternative SP. See section B2.5.4 for more details. 'Off' disables setpoint tracking.
Track PV	The unit tracks the PV when it is servoing or tracking.
Track Value	The SP to track in manual tracking
SP Int Balance	Allows the user to enable (tick) or disable (cross) debump on PV change.

4.6.6 Output menu items

Appendix B section B2.6 contains details of the output functions.

Output Low	The minimum power, or the maximum 'negative' (i.e. cooling) power to be delivered by the system. The valid input range is -100% and Output High.
Output High	The maximum output power to be delivered by channels 1 and 2, where 100% is full power. The valid input range is Output Low to 100.0%. Reducing this value reduces the rate of change of the process, but it also reduces the controller's ability to react to perturbations.
Ch1 Output	Displays the positive power values used by the heat output. Values range from Output low to Output high
Ch2 Output	Displays the cooling power values for channel two. Appears as a value between Output high and -100%, where -100% represents full cooling power.
Ch2 Deadband	A gap (in %) between output 1 switching off, and output 2 switching on, and *vice-versa*. Valid inputs are 0 (off) to 100%.
Rate	Limit on the rate at which the output from the PID can change. Can be useful in preventing rapid changes in output that could damage the process, heater elements etc.
Ch1 OnOff Hyst	Appears only if 'Ch1 Control' has been set to 'OnOff' in the Setup menu. Allows the user to enter a hysteresis value for channel one. Valid entries are 0.0 to 200.0.
Ch2 OnOff Hyst	Appears only if 'Ch2 Control' has been set to 'OnOff' in the Setup menu. Allows the user to enter a hysteresis value for channel two. Valid entries are 0.0 to 200.0.
Ch1 Travel Time	Appears only if Setup menu parameter 'Ch1 Control' is set to 'VPB' or 'VPU'. This is the valve travel time from closed (0%) to open (100%). In a valve positioning application, channel 1 output is connected by a single software 'wire' to a Valve Raise/Valve Lower relay pair. For heat/cool applications, channel 1 is associated with the heating valve. Valid entries: 0.0 to 1000.0 seconds.
Ch2 Travel Time	Appears only if Setup menu parameter 'Ch2 Control' is set to 'VPB' or 'VPU'. This is the valve travel time from closed (0%) to open (100%). For heat/cool applications, channel 2 is associated with the cooling valve. Valid entries: 0.0 to 1000.0 seconds.
Nudge Raise	Appears only if Setup menu parameter 'Ch1 Control' or Ch2 Control is set to 'VPU'. If set to 'Yes', the valve can be moved towards the open position by, for example, a contact closure, an up arrow button operation or a serial communications command. The default minimum nudge time is 125 ms, but this can be edited in the relevant relay configuration - see section 4.11.2. See also Section B2.6.10 for more 'Nudge' details.
Nudge Lower	As for 'Nudge Raise', above but moves the valve towards the closed position.
Ch1 Pot Pos*	The position of the channel one actuator as measured by the feedback potentiometer.
Ch1 Pot Brk*	'On' indicates that the input to the relevant channel is open circuit.
Ch2 Pot Pos*	The position of the channel two actuator as measured by the feedback potentiometer.
Ch2 Pot Brk*	'On' indicates that the input to the relevant channel is open circuit.
Pot Brk Mode*	Defines the action to be taken if a potentiometer break is detected: Raise: opens the valve Lower: closes the valve Rest: the valve remains in its current state. Model: the controller tracks the position of the valve and sets up a model of the system so that it continues to function if the potentiometer becomes faulty.

* Note: These parameters appear only if the 'Setup' menu parameter 'Ch1 Control' or 'Ch2 control' (as appropriate) is set to 'VBP'. The Setup menu is described in section 4.6.2.

4.6.6 OUTPUT MENU PARAMETERS (Cont.)

SBrk Mode	Defines the action to be taken in the event of a sensor break. Safe: The output adopts the value configured in 'Sbrk OP', below. Hold: The output remains at its current level.
Sbrk OP	The value to be output if a sensor break occurs, and SBrk Mode (above) is set to 'Safe'.
Safe OP	The output level adopted when the loop is inhibited (Main menu section 4.6.1).
Manual Mode	Selects the type of transition to occur when changing to manual mode (section 4.6.1): Track: Whilst in Auto mode, the manual output tracks the control output so that there is no change of output when manual mode is switched to. Step: On transition to manual mode, the output is set to the value entered for 'Forced-OP' (below). Last Man. Out: On transition to manual mode, the output adopts the manual output value as last set by the operator.
Manual Output	The output when the loop is in manual mode. In manual mode the controller limits the maximum power, but it is not recommended that it be left unattended at high power settings. It is important that over range alarms are fitted to protect the process.

Note: It is recommended that all processes are fitted with an independent over range detection system.

Forced Output	Forced Manual output value. When 'Manual Mode' = 'Step', this is the output value adopted when changing from Auto to Manual mode.
Manual Startup	When set to off (cross symbol), the controller powers up in the same (auto or manual) mode that obtained when it was switched off. When set to on (tick symbol) the controller always powers up in manual mode.
Pff En	Power feed forward enable. 'Yes' enables power feed forward (adjusts the output signal to compensate for variations is supply voltage. 'No' disables Pff. See section B2.6.6 for further details.
Power In	Read only display of the current supply voltage.
Cool Type	Appears only if 'Ch2 Control' = 'PID' in the setup menu (section 4.6.2) and allows the user to enter the appropriate type of cooling (section B2.6.7): Linear: For use when controller output changes linearly with PID demand. Oil: For oil cooled applications Water: For water cooled applications Fan: For forced air cooling.
FF Type	Feed forward type (section B2.6.8): None: No signal fed forward. Remote: A remote signal fed forward. SP: Setpoint is fed forward. PV: PV is fed forward.
FF Gain	For FF types 'PV' and 'SP', this scales the feed forward signal.
FF Offset	For FF types 'PV' and 'SP', this defines the offset of the scaled feed forward signal.
FF Trim lim	For FF types 'PV' and 'SP', defines symmetrical limits about the PID output which are applied to the scaled feed forward signal.
FF OP	For FF types 'PV' and 'SP', this is the calculated (scaled, offset and trimmed) feed forward signal. FF OP = FF gain (input + FF Offset)
Track Output	If 'Track Enable' (below) is set to 'Yes', this is the value for the control output. PID remains in Auto mode and tracks the output. The Track OP value can be wired to an external source, or can be entered via the front panel. Similar to entering manual mode.
Track Enable	When set to 'Yes', the output follows the Track OP value (above). When subsequently set to 'Off' the loop makes a bump less return to control.
Rem. Output Low/High	Used to limit the output using a remote source. These limits cannot exceed the 'Output Low' and 'Output High' values described earlier in this section.

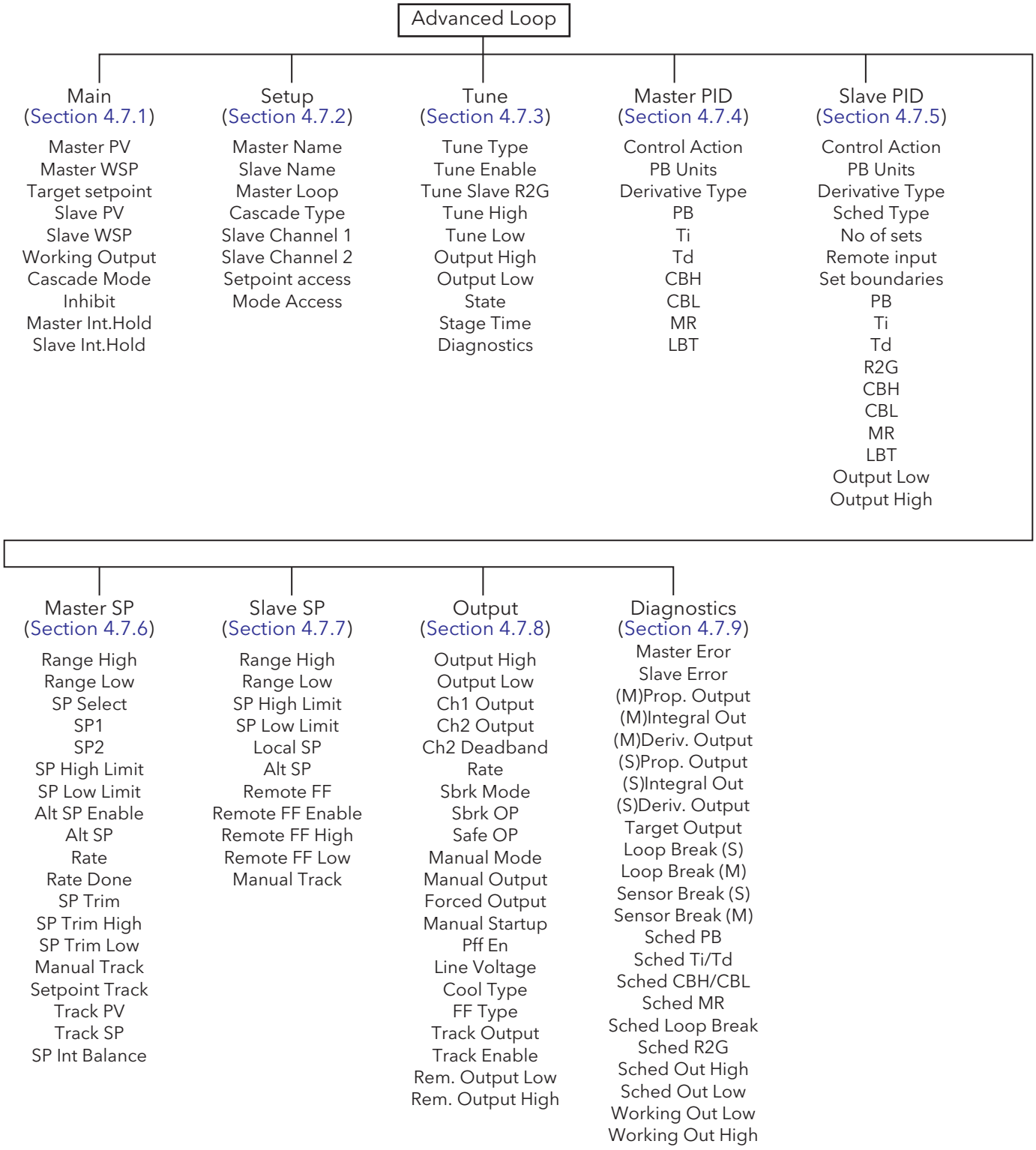
4.6.7 Loop diagnostics

These 'parameters' are read only unless otherwise stated.

Error	The difference in value between the setpoint and the PV.
Target Output	The requested control output. The target of the active output if rate limiting is active.
Working Out Low	The low limit for the working output. This is the value used to limit the output power of the loop and is derived from the gain scheduled limit, the remote limit and the safety limit.
Working Out High	The high limit for the working output. This is the value used to limit the output power of the loop and is derived from the gain scheduled limit, the remote limit and the safety limit.
Loop Break	Loop Break Alarm. Becomes active 'Yes' if the loop break time (LBT), set in the PID menu (section 4.6.4) is exceeded, otherwise 'No' is displayed.
Prop. Output	Shows the proportional term contribution to the control output
Integral Output	Shows the integral term contribution to the control output
Deriv. Output	Shows the derivative term contribution to the control output
Sensor Break	Indicates sensor break status. On (tick symbol) indicates a sensor break has occurred; Off (cross symbol) shows that no sensor breaks have been detected.
Sched PB	The scheduled proportional band for the current PID set.
Sched Ti	The scheduled integral time for the current PID set.
Sched Td	The scheduled derivative time for the current PID set.
Sched R2G	The scheduled relative cool gain value for the current PID set.
Sched CBH	The scheduled cutback high value for the current PID set.
Sched CBL	The scheduled cutback low value for the current PID set.
Sched MR	The scheduled manual reset value for the current PID set.
Sched Loop Break	The scheduled loop break time for the current PID set.
Sched Out Low	The scheduled output low limit for the current PID set.
Sched Out High	The scheduled output high limit for the current PID set.

4.7 ADVANCED LOOP CONFIGURATION

Similar to the Loop option described above, advanced loop includes the ability to run a cascade loop. Figure 4.7 is an overview of the configuration menu structure.



4.7.1 Advanced Loop Main menu

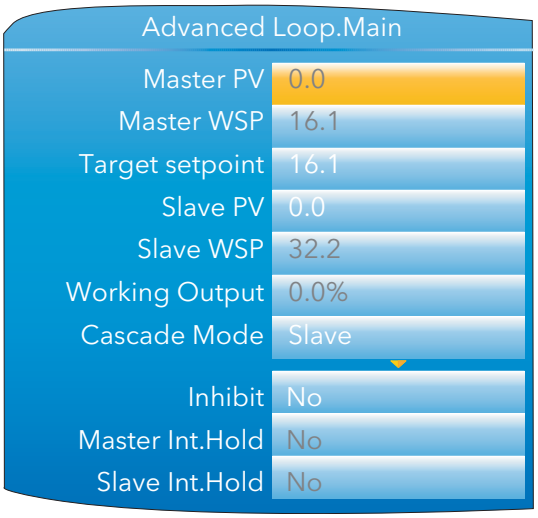


Figure 4.7.1 Main menu

Master PV	This is the process value for the outer (master) loop of cascade control, typically obtained from an analogue input.
Master WSP	This is the (read only) working setpoint for the outer (master) loop of cascade control. The Master WSP can obtain its value from one of a number of sources such as 'Internal SP' or 'Remote SP'.
Target setpoint	The target setpoint is the value which the outer (master) control loop is attempting to reach. The value may come from one of a number of sources, such as internal SP or remote SP
Slave PV	This is the process value for the inner (slave) loop of cascade control, typically wired from an analogue input.
Slave WSP	This is the (read only) working setpoint for the inner (slave) loop. The value may come from one of a number of sources, such as the output from the master loop or the local slave setpoint.
Working Output	The actual output of the inner (slave) loop before it is split into channel 1 and channel 2 outputs.
Cascade Mode	Slave: Also known as 'Slave Local Auto', this is a single loop controlling with a local setpoint. Manual: Also known as 'Slave Manual', this provides a single manual power setting for the slave. Cascade: (Full) cascade. In this mode, the master is in 'Auto' mode and provides the setpoint for the slave.
Inhibit	If set to 'Yes', both outer (master) loop and inner (slave) loops stop controlling and the output of the slave loop is set to the safe output value (SafeOp) set in the Output menu (section 4.7.8).
Master Int.Hold	If set to 'Yes', the integral component of the outer (master) loop PID calculation is held at its current value and does not integrate any further disturbances in the plant. Essentially this is equivalent to switching into PD control with a manual reset value pre-configured.
Slave Int.Hold	As for Master.IntHold, above, but for the inner (slave) loop.

4.7.2 Advanced Loop Setup menu

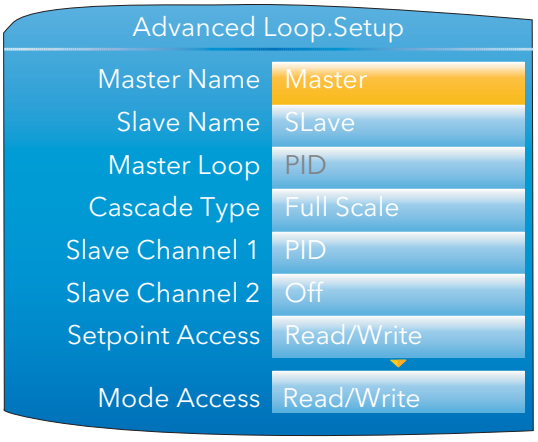


Figure 4.7.2 Advanced Loop Setup menu

Master Name	Allows the user to enter a 10-character string for the Master loop name in the Cascade display page (section 3.4.8)
Slave Name	As above, but for the slave loop.
Master Loop	The control algorithm for the master control loop (PID only for this software release).
Cascade Type	Full Scale: The master generates a setpoint (between SP High limit and SP Low limit) for the slave. Trim: The master working setpoint is used as the base setpoint of the slave. This is then modified by the addition of a setpoint trim, to become the target setpoint for the slave. The PID output from the master is mapped to range set by Trim Range High and Trim Range Low.
Slave Channel 1	Selects the channel 1 control algorithm. Different algorithms can be selected for channels 1 and 2. In temperature control applications, channel 1 is usually the heating channel, and channel 2 the cooling channel. PID: Control Output Configured as PID VPB: Control Output Configured as Bounded VP. Bounded VP is implemented as a PID algorithm driving a position loop and is used in systems with position feedback.
Slave Channel 2	Selects the channel 2 control algorithm. Different algorithms can be selected for channels 1 and 2. In temperature control applications, channel 1 is usually the heating channel, channel 2 the cooling channel. Off: Control output is not configured PID: Control Output Configured as PID
Setpoint Access	Allows the user to select 'Read Only', 'Read/Write', or 'Operator R/W' for setpoint access, where 'Operator R/W means that the setpoint is read write for access levels operator and above, but read only in Logged out mode.
Mode Access	As for 'Setpoint Access', above, but for Auto/Manual mode switching.

4.7.3 Advanced Loop Tune menu

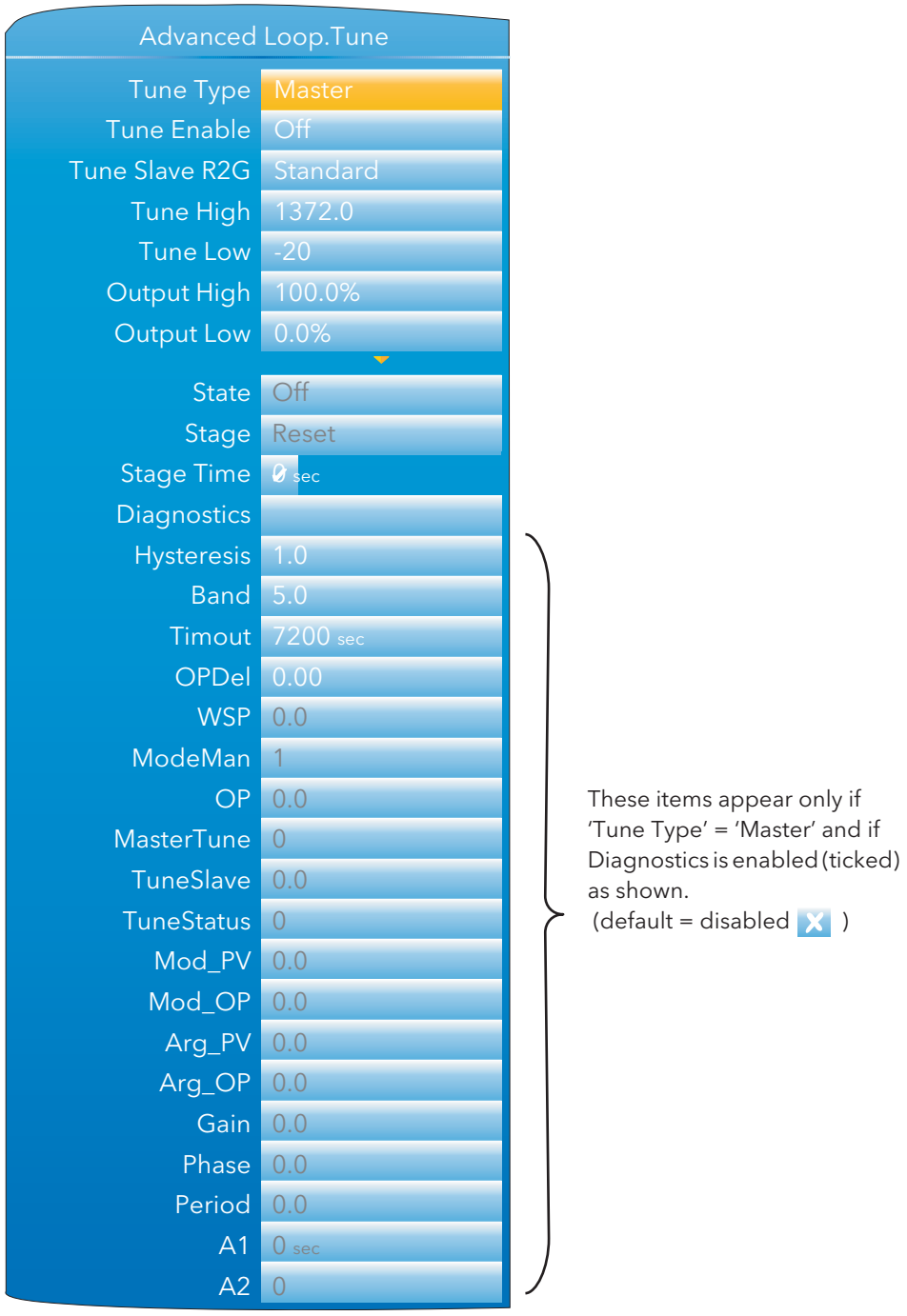


Figure 4.7.3 Advanced Loop Tune menu

Tune Type	Select 'Master' or 'Slave' for the Tuning process.
Tune Enable	Allows the user to initiate an autotune.
Tune Slave R2G	Appears only if the Slave channel 2 is set to 'PID' in the Setup menu (section 4.7.2). Standard: Normal compensation applied to account for differences in heating and cooling efficiencies between the heating and cooling channels. R2GPD: Typically used in heavily lagged systems.
Tune High	Sets the maximum value for the master loop setpoint during the tuning process.
Tune Low	Sets the maximum value for the master loop setpoint during the tuning process.

4.7.3 ADVANCED LOOP TUNE MENU (Cont.)

Output High	The maximum output power level which the controller may supply during the tuning process. If 'Output High' in the Output menu (section 4.7.8) is lower than 'High Output' then the maximum output is clipped to the 'Output High' value.
Output Low	The minimum output power level which the controller may supply during the tuning process. If 'Output Low' in the Output menu ((section 4.7.8) is higher than 'Low Output' then the minimum output is clipped to the 'Output Low' value.
State	The current autotune state. Off: Autotune not enabled Ready: Running: Autotune running Complete: The tune process completed successfully. Fleeting display before returning to 'Off'. Time-Out: A timeout error has occurred and the autotune has been aborted. Ti Limit R2G Limit
Stage	Reset None Settling Current SP New SP To SP Wait Max Wait Min Store CoolT PID Abort Complete NewR2G 1:Half Cycle 2:Full Cycle 3:Full Cycle 4:FinalCycle 5:Calc.
Stage Time	Elapsed time since entering this stage of the tuning.
Diagnostics	If this is enabled, a number of further parameters become visible.
Hysteresis	This defines the hysteresis of the switch used during master autotuning to generate the oscillation. It is set as a % of the master PV range (High Range - Low Range) in engineering units being +/- Hysteresis/2 about the tuning setpoint
Band	This defines the band between which the setpoint of the slave controller will be switched during the master autotune oscillation. It is set as a % of the master PV (High Range - Low Range) in engineering units being +/- Band/2 about the tuning setpoint. The actual values applied to the slave may actually be constrained inside this band by the wind-up control mechanism
Timeout	Defines the maximum time permitted for each stage of the master tuning.
OPDel	This is an internal setting of the order of 0.5 during tuning.
WSP	This is the actual setpoint around which the autotuning oscillation of the master takes place. It is used for the calculations associated with the Hysteresis and Band parameters.

4.7.3 ADVANCED LOOP TUNE MENU (Cont.)

ModeMan	This parameter is used by the master autotune algorithm to communicate with the master loop. Puts master controller into 'Not-Auto' mode
OP	This signal is generated within the master loop during the autotune oscillation. It is used only as an input to the calculations which generate the slave loop setpoint. It is not the overall loop output to the load which at all times is under the control of the slave PID calculations.
MasterTune	Master tune in progress
TuneSlave	The autotune process is requesting a slave tune.
Tune Status	This indicates the internal stage of tuning. 0 = Not tuning 1 = Tuning the slave 2 = Tuning the master 3 = Tuning completed -1 = Tuning has aborted or timed-out
Mod_PV	This is the amplitude of the fundamental component of the master PV during the last cycle of the tuning oscillation.
Mod_OP	This is the amplitude of the fundamental component of the master OP during the last cycle of the tuning oscillation.
Arg_PV	This is the argument (phase) of the fundamental component of the master PV during the last cycle of the tuning oscillation. Value in radians.
Arg_OP	This is the argument (phase) of the fundamental component of the master OP during the last cycle of the tuning oscillation. Value in radians.
Gain	This is the gain between the master OP and the master PV over the path via the slave loop and the load, measured at the fundamental frequency of the autotuning oscillation.
Phase	The phase shift in radians between the master OP and the master PV over the path via the slave loop and the load, measured at the fundamental frequency of the autotuning oscillation
Period	This is the period of the last cycle of the autotune oscillation, in seconds.
A1	This is the number of samples actually taken in order to determine the fundamental components of the master PV and OP. The target number is around 100 samples but the actual number taken may differ slightly from this depending on the load's behaviour.
A2	The A2 parameter is a used for diagnostic purposes. Its value indicates the design method chosen by the algorithm which depends on the characteristics of the master tuning oscillation and the measured values of frequency, gain, and phase shift around the master loop. This influences the choices of the P, I and D values set into the master loop.
Alpha_p	R2GPD tuning diagnostic parameter: Heat time / cool time.
OPss	R2GPD tuning diagnostic parameter: Steady state output at the end of the settling period.
Alpha	R2GPD tuning diagnostic parameter: 1/R2G.
Debug	R2GPD tuning diagnostic parameter: 0-PID, 1-PI, 2-PD, 3-P.
CycleNo	R2GPD tuning diagnostic parameter: Number of cycles in auto tune sequence.
PBs	R2GPD tuning diagnostic parameter: PBs scales the proportional band which will be used in the PD settling period.
TDs	R2GPD tuning diagnostic parameter: TDs scales the derivative value which will be used during the PD settling period.
Settle	R2GPD tuning diagnostic parameter: Used to scale the last cycle time. The result will be used for the PD settling time.

4.7.4 Advanced Loop Master PID menu

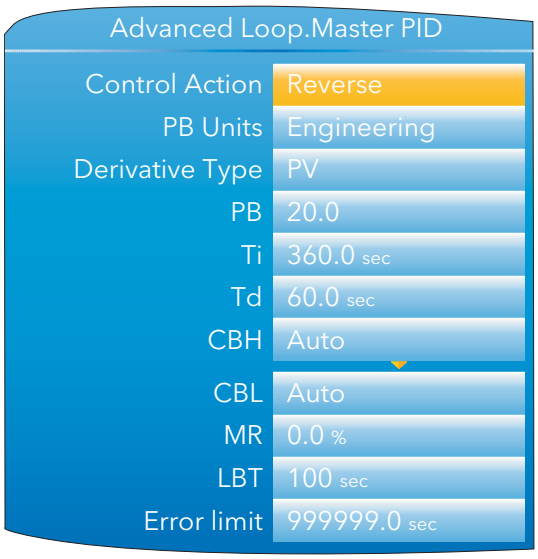


Figure 4.7.4 Advanced Loop master PID menu

Control Action	Select 'Reverse' or 'Direct'. 'Reverse' means that the output is 'on' when the process value (PV) is below the target setpoint (SP). This is normal for heating control. 'Direct' means that the output is on when PV is above SP. This is normal for cooling control.
PB Units	Select 'Engineering' or 'Percent'. 'Engineering' displays values in (for example) temperature units (e.g. °C or °F). 'Percent' displays values as a percentage of loop span (Range High - Range Low).
Deriv Type	'Error' means that changes to PV or SP cause changes to the derivative output. Derivative on error should be used with a programmer since it tends to reduce ramp overshoot. 'Error' provides rapid response to small setpoint changes which makes it ideal for temperature control systems. 'PV' means that changes in PV alone cause changes to the derivative output. Typically used for process systems using valve control, as it reduces wear on the valve mechanics.
PB	Proportional band. The proportional term in the units (Engineering units or %) set in 'PBUnits' above. See Appendix B section B2.2.2 for more details.
Ti	Integral time constant. Valid entries are1 to 9999.9 seconds, or 'Off'. If set Off, then integral action is disabled. Removes steady state control offsets by moving the output up or down at a rate proportional to the error signal.
Td	Derivative time constant. Valid entries are 1 to 9999.9 seconds, or 'Off'. If set Off, then derivative action is disabled. Determines how strongly the controller reacts to the rate-of-change in the PV. Used to control overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.
CBH	Cutback high. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units above setpoint at which the controller output is forced to 0% or -100% (OP min), in order to modify undershoot on cool down. See section B2.3.2 for more details.
CBL	Cutback low. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units below setpoint at which the controller output is forced to 100% (OP max), in order to modify overshoot on heat up. See section B2.3.2 for more details.
MR	Manual reset. Valid entries -100% to +100%. Introduces a fixed additional power level to the output in order to eliminate steady state error from proportional only control. Applied instead of the integral component when Ti is set to 'Off'.
LBT	Loop break time. valid entries are 1 to 99999 seconds, or 'Off'. See section B2.3.6 for more details

4.7.5 Advanced Loop Slave PID menu

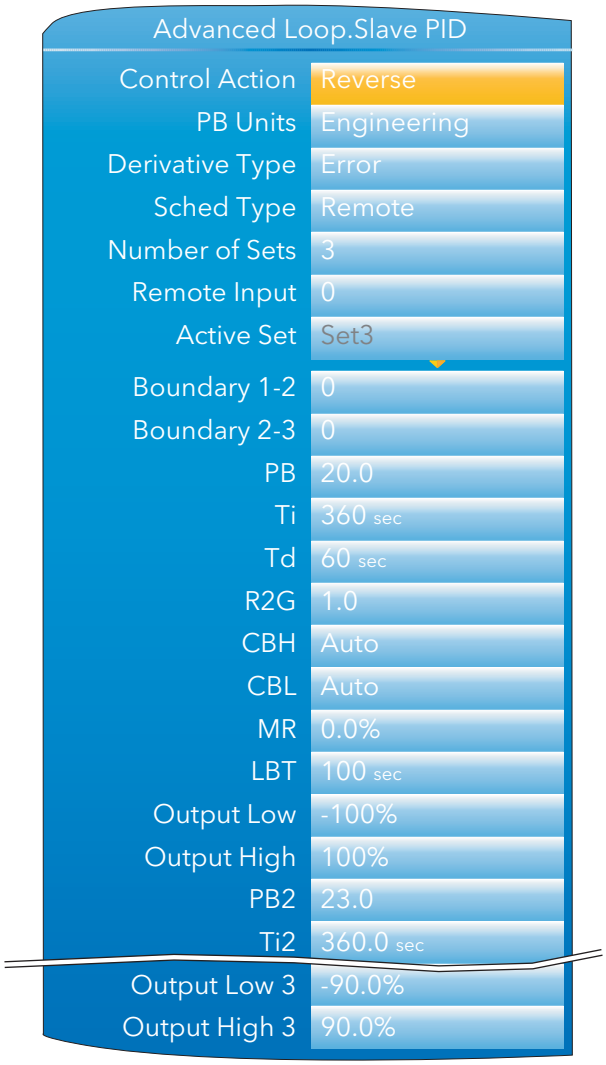


Figure 4.7.5 Advanced Loop Slave PID Menu (Typical)

Control Action	Select 'Reverse' or 'Direct'. 'Reverse' means that the output is 'on' when the process value (PV) is below the target setpoint (SP). This is normal for heating control. 'Direct' means that the output is on when PV is above SP. This is normal for cooling control.
PB Units	Select 'Engineering' or 'Percent'. 'Engineering' displays values in (for example) temperature units (e.g. °C or °F). 'Percent' displays values as a percentage of loop span (Range High - Range Low).
Deriv Type	'Error' means that changes to PV or SP cause changes to the derivative output. Derivative on error should be used with a programmer since it tends to reduce ramp overshoot. 'Error' provides rapid response to small setpoint changes which makes it ideal for temperature control systems. 'PV' means that changes in PV alone cause changes to the derivative output. Typically used for process systems using valve control, as it reduces wear on the valve mechanics.

4.7.5 ADVANCED LOOP SLAVE PID MENU (Cont.)

Sched Type	Selects the type of Gain Scheduling (section B2.3.7) to be applied. Off. Gain Scheduling not active Set. The user selects the PID parameter set to be used. Setpoint. Transfer from one set to the next depends on the setpoint value PV. The transfer from one set to another depends on the PV value Error. The transfer between sets depends on the value of the error signal OP. Transfer depends on the value of the output. Rem. Transfer is controlled by a remote input.
Number of Sets	Allows the number of sets of PID parameters for use in Gain scheduling to be selected.
Remote input	For 'Sched Type' = 'Rem' only, this shows the current value of the remote input channel being used to select which set is active. If the remote input value ≤ the Boundary 1-2 value (see below) then set 1 is selected. If it is > Boundary 1-2 value but ≤ Boundary 2-3 value then set 2 is used. If the remote value is > Boundary 2-3 value, then set three is used. If the Remote input is not 'wired', the value is user editable from the front panel.
Active Set	The set number currently in use.
Boundary 1-2	For all Sched Types except 'Set', this allows the user to enter a 'boundary' value, which means that if the relevant value (SP, PV, Error etc.) rises above this boundary, the loop switches from PID set 1 to PID set 2. If it falls below the boundary value, the loop switches from set 2 to set 1.
Boundary 2-3	As above but for switching between sets 2 and 3.
PB/PB2/PB3	Proportional band for set one/two/three. The proportional term in the units (Engineering units or %) set in 'PBUnits' in the Setup menu. See Appendix B section B2.2.2 for more details.
Ti/Ti2/Ti3	Integral time constant for set one/two/three. Valid entries are1 to 9999.9 seconds, or 'Off'. If set Off, then integral action is disabled. Removes steady state control offsets by moving the output up or down at a rate proportional to the error signal.
Td/Td2/Td3	Derivative time constant for set one/two/three. Valid entries are 1 to 9999.9 seconds, or 'Off'. If set Off, then derivative action is disabled. Determines how strongly the controller reacts to the rate-of-change in the PV. Used to control overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.
R2G/R2G2/R2G3	Relative cool gain for set one/two/three. Appears only if cooling has been configured (Ch2 Control not 'Off' in the Setup menu). Valid entries are 0.1 to 10. Sets the cooling proportional band which compensates for differences between heating and cooling power gains.
CBH/CBH2/CBH3	Cutback high for set one/two/three. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units above setpoint at which the controller output is forced to 0% or -100% (OP min), in order to modify undershoot on cool down. See section B2.3.2 for more details.
CBL/CBL2/CBL3	Cutback low for set one/two/three. Valid entries 'Auto' (3×PB) or 0.1 to 9999.9. The number of display units below setpoint at which the controller output is forced to 100% (OP max), in order to modify overshoot on heat up. See section B2.3.2 for more details.
MR/MR2/MR3	Manual reset for set one/two/three. Valid entries 0 to 100%. Introduces a fixed additional power level to the output in order to eliminate steady state error from proportional only control. Applied instead of the integral component when Ti is set to 'Off'.
LBT/LBT2/LBT3	Loop break time for set one/two/three. valid entries are 1 to 99999 seconds, or 'Off'. See section B2.3.6 for more details.
Output Low/2/3	Output low limit for set one/two/three. Valid entries are in the range Output High/2/3 to -100.
Output High/2/3	Output high limit for set one/two/three. Valid entries are in the range Output Low/2/3 to +100

4.7.6 Advanced Loop Master SP menu

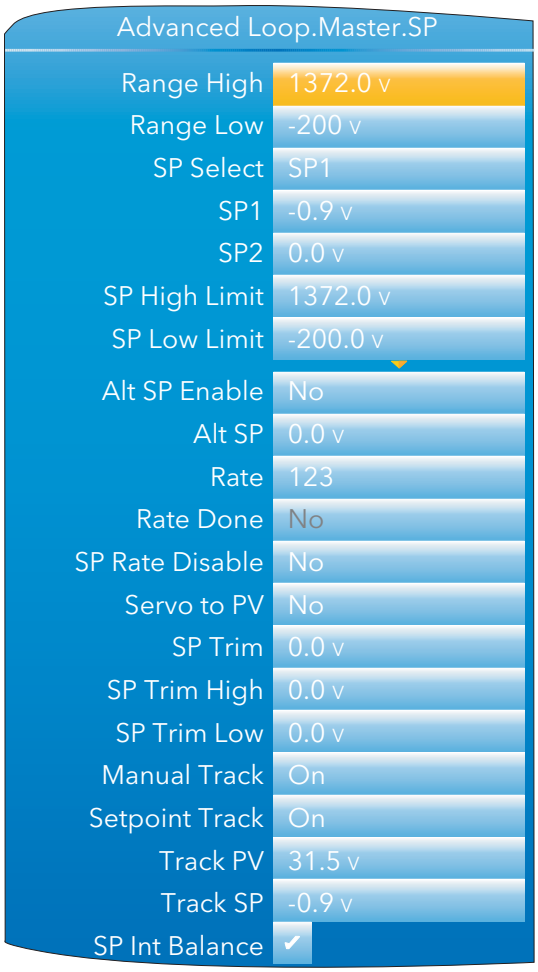


Figure 4.7.6 Advanced Loop Master SP menu

Range High/Low	Range limits. Range limits set absolute maxima and minima for control loop setpoints. If the proportional band is configured as a % span, the span is derived from the range limits.
SP select	Select SP1 or SP2. SP1 is often considered to be the primary setpoint for the controller, and SP2 a secondary setpoint.
SP1, SP2	Allows values for Setpoints 1 and 2 to be entered. Valid entries are any within the range 'SPHigh Limit' to 'SPLowLim'.
SP High Limit	Maximum setpoint limit for SP1 and SP2. Valid entries are in the range 'Range Hi' and 'SP Low Limit'
SP Low Limit	Minimum setpoint limit for SP1 and SP2. Valid entries are in the range 'Range Lo' and 'SP High Limit'
Alt SP Enable	'Yes' enables the alternative setpoint; 'No' disables it. May be wired to an external or internal source.
Alt SP	When wired this is a read only display of the alternative setpoint value. Otherwise, the user may insert a value. Valid values are limited by 'Range Hi' and 'Range Lo'.
Rate	Sets the maximum rate at which the working setpoint may change in Engineering units per minute. Often used to protect the load from thermal shock caused by large step changes in setpoint. 'Off' disables rate limiting.
Rate Done	Read only display. 'Yes' indicates that the working setpoint has completed its change. 'No' indicates that the setpoint is still ramping.

4.7.6 ADVANCED LOOP MASTER SP MENU (Cont.)

SP Rate Disable	Appears only if Rate is not 'Off'. 'Yes' disables rate limiting; 'No' enables rate limiting.
Servo To PV	If 'Rate' is set to any value other than 'Off', and if 'Servo to PV' is set to 'Yes' then any change in the current setpoint value causes the working setpoint to servo to the current PV before ramping to the new setpoint value.
SP Trim	A positive or negative value added to the setpoint, for local fine tuning. Valid entries are any value between 'SP Trim High' and 'SP Trim Low'.
SP Trim High/Low	Setpoint trim high and low limits
Manual Track	'On' enables manual tracking. Manual tracking removes steps in setpoint when switching between M'Man' and 'Auto' modes. When the loop is switched from manual to auto the target setpoint is set to the current PV. See section B2.5.5 for more details. 'Off' disables manual tracking.
Setpoint Track	'On' enables setpoint tracking. When setpoint tracking is enabled, it ensures 'bumpless' transfer in setpoint when seitching from Alternative setpoint to a local setpoint. See section B2.5.4 for more details. 'Off' disables setpoint tracking.
Track PV	The unit tracks the PV when it is servoing or tracking.
Track SP	The SP to track in manual tracking - see 'Setpoint Track', above.
SP Int Balance	Allows the user to enable (tick) or disable (cross) debump on PV change.

4.7.7 Advanced Loop Slave SP menu

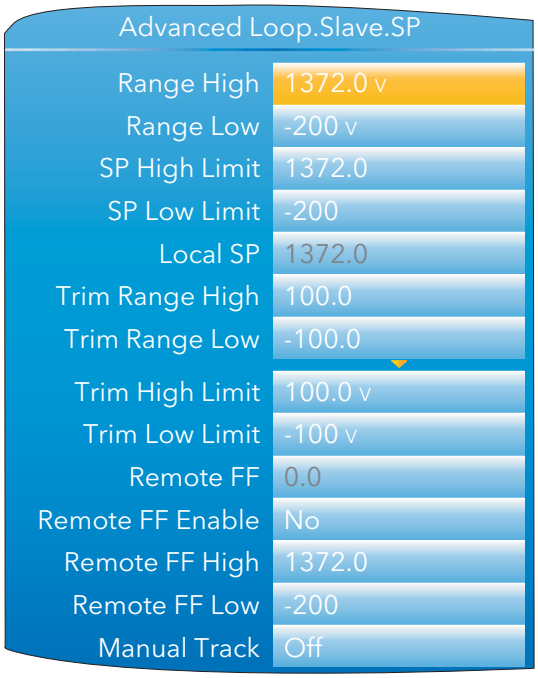


Figure 4.7.7a Advanced Loop Slave Setpint menu

Range High/Low	Range limits. Valid entries from 99999 to -99999. Range limits set absolute maxima and minima for control loop setpoints. If the proportional band is configured as a % span, the span is derived from the range limits.
SP High Limit	Maximum setpoint limit for the local setpoint. Valid entries are in the range 'Range Hi' and 'SP Low Limit'
SP Low Limit	Minimum setpoint limit for the local setpoint. Valid entries are in the range 'Range Lo' and 'SP High Limit'
Local SP	The Slave local setpoint
Trim Range High	Trim Range upper limit. Appears only if 'Cascade type' has been set to 'Trim' in the Set-up menu.
Trim Range Low	Trim Range upper limit. Appears only if 'Cascade type' has been set to 'Trim' in the Set-up menu.
Trim High Limit	Maximum value for Trim High value. Appears only if 'Cascade type' has been set to 'Trim' in the Setup menu.
Trim Low Limit	Minimum value for Trim Low value. Appears only if 'Cascade type' has been set to 'Trim' in the Setup menu.
Remote FF	The current remote feedforward value
Remote FF Enable	Enables or disables the use of a remote Feedforward signal. Appears only if 'Cascade type' has been set to 'Full Scale' in the Setup menu.
Remote FF High	High limit for the remote feedforward signal value. Appears only if 'Cascade type' has been set to 'Full Scale' in the Setup menu.
Remote FF Low	Low limit for the remote feedforward signal value. Appears only if 'Cascade type' has been set to 'Full Scale' in the Setup menu.
FF Select	Allows the user to select the source of the feedforward signal from 'master PV', Master working setpoint' or Remote FF'. Appears only if 'Cascade type' has been set to 'Trim' in the Setup menu.
Manual Track	'On' enables manual tracking to allow the local SP to follow the value of the current PV to allow bumpless transfer when switching to Auto. See section B2.5.5 for more details. 'Off' disables manual tracking.

4.7.7 ADVANCED LOOP SLAVE SP MENU (Cont.)

Sbrk Mode	This defines the behaviour when the master loop process variable is bad, i.e. the sensor has failed.
Sbrk SP	The setpoint for the slave loop when the master sensor has gone into sensor break and the sensor break mode for the master is set to SbrkSP

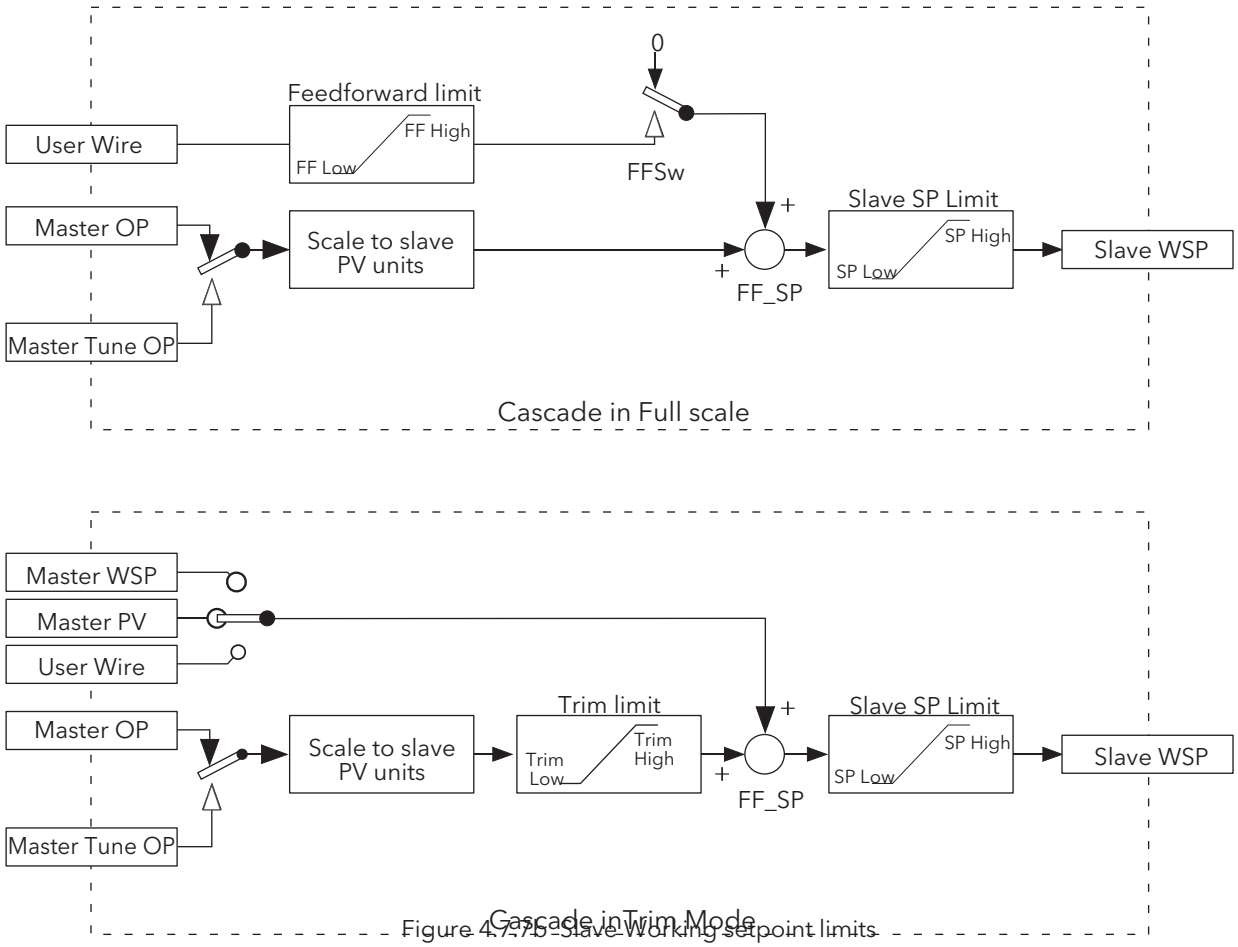


Figure 4.7.75 Slave Working setpoint limits

4.7.8 Advanced Loop Output menu

Appendix B section B2.6 contains details of the output functions.

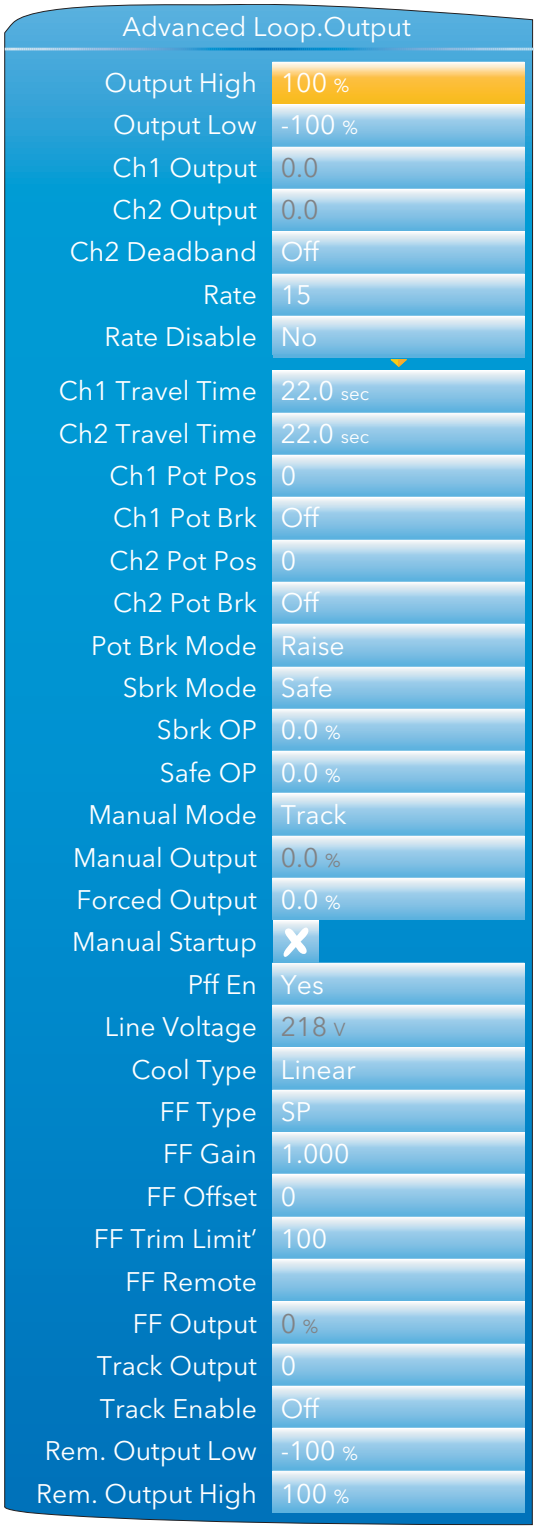


Figure 4.7.8 Advanced Loop Output menu

4.7.8 ADVANCED LOOP OUTPUT MENU (Cont.)

Output High	The maximum output power to be delivered by channels 1 and 2, where 100% is full power. The valid input range is Output Low to 100.0%. Reducing this value reduces the rate of change of the process, but it also reduces the controller's ability to react to perturbations and can even cause it to fail to achieve setpoint.
Output Low	The minimum power, or the maximum 'negative' (i.e. cooling) power to be delivered by the system.
Ch1 Output	Displays the positive power values used by the heat output.
Ch2 Output	Displays the cooling power values for channel two. Appears as a value between Output High and -100%, where -100% represents full cooling power.
Ch2 Deadband	A gap (in %) between output 1 switching off, and output 2 switching on, and *vice-versa*. Valid inputs are 0 (off) to 100%.
Rate	Limit on the rate at which the output from the PID can change. Can be useful in preventing rapid changes in output that could damage the process, heater elements etc.
Rate Disable	The Output Rate limit may be disabled by setting its value to 0.0. Alternatively, for some applications it is useful to be able to wire to the Output Rate Disable so that 'Rate' can be switched on/off during stages of the process. For example, Rate Disable can be used with the programmer event outputs to control the output rate of change during a particular segment.
Ch1 Travel Time	Appears only if Setup menu parameter 'Slave Channel 1' is set to 'VPB'. This is the valve travel time from closed (0%) to open (100%). In a valve positioning application, channel 1 output is connected by a single software 'wire' to a Valve Raise/Valve Lower relay pair. For heat/cool applications, channel 1 is associated with the heating valve. Valid entries: 0.0 to 1000.0 seconds.
Ch2 Travel Time	Appears only if Setup menu parameter 'Slave Channel 2' is set to 'VPB' . This is the valve travel time from closed (0%) to open (100%). For heat/cool applications, channel 2 is associated with the cooling valve. Valid entries: 0.0 to 1000.0 seconds.
Ch1 Pot Pos*	The position of the channel one actuator as measured by the feedback potentiometer.
Ch1 Pot Brk*	'On' indicates that the input to the relevant channel is open circuit.
Ch2 Pot Pos*	The position of the channel two actuator as measured by the feedback potentiometer.
Ch2 Pot Brk*	'On' indicates that the input to the relevant channel is open circuit.
Pot Brk Mode*	Defines the action to be taken if a potentiometer break is detected: Raise: opens the valve Lower: closes the valve Rest: the valve remains in its current state. Model: the controller tracks the position of the valve and sets up a model of the system so that it continues to function if the potentiometer becomes faulty. This does not mean that the potentiometer can be omitted with VPB, as the accuracy of valve position control is reduced without it.

* Note: These parameters appear only if the 'Setup' menu parameter 'Slave Channel 1' or 'Slave Channel 2' (as appropriate) is set to 'VPB'. The Setup menu is described in section 4.7.2.

SBrk Mode	Defines the action to be taken in the event of a sensor break. Safe: The output adopts the value configured in 'Sbrk OP', below. Hold: The output remains at its current level.
Sbrk OP	The value to be output if a Slave sensor break occurs, and SBrk Mode (above) is set to 'Safe'.
Safe OP	The output level adopted when the loop is inhibited (Main menu section 4.7.1).

4.7.8 ADVANCED LOOP OUTPUT MENU (Cont.)

Manual Mode	Selects the type of transition to occur when changing to manual cascade mode (section 4.7.1): Track: Whilst in Auto mode, the manual output tracks the control output so that there is no change of output when manual mode is switched to. Step: On transition to manual mode, the output is set to the value entered for 'Forced-OP' (below). Last Man. Out: On transition to manual mode, the output adopts the manual output value as last set by the operator.
Manual Output	The output when the loop is in manual mode. In manual mode the controller limits the maximum power, but it is not recommended that it be left unattended at high power settings. It is important that over range alarms are fitted to protect the process.

Note: It is recommended that all processes are fitted with an independent over range detection system.

Forced Output	Forced Manual output value. When 'Manual Mode' = 'Step', this is the output value adopted when changing from Auto to Manual mode.
Manual Startup	When set to off (cross symbol), the controller powers up in the same (auto or manual) mode that obtained when it was switched off. When set to on (tick symbol) the controller always powers up in manual mode.
Pff En	Power feed forward enable. 'Yes' enables power feed forward (adjusts the output signal to compensate for variations is supply voltage. 'No' disables Pff. See section B2.6.6 for further details.
Line Voltage	Read only display of the current supply voltage.
Cool Type	Appears only if 'Ch2 Control' = 'PID' in the setup menu (section 4.7.2) and allows the user to enter the appropriate type of cooling (section B2.6.7): Linear: For use when controller output changes linearly with PID demand. Oil: For oil cooled applications Water: For water cooled applications Fan: For forced air cooling.
FF Type	Feed forward type (section B2.6.8): None: No signal fed forward. Remote: A remote signal is fed forward. SP: Setpoint is fed forward. PV: PV is fed forward.
FF Gain	For FF types 'PV' and 'SP', this scales the feed forward signal.
FF Offset	For FF types 'PV' and 'SP', this defines the offset of the scaled feed forward signal.
FF Trim Limit	For FF types 'PV' and 'SP', defines symmetrical limits about the PID output which are applied to the scaled feed forward signal.
FF Remote	Allows another value from the strategy to be used as the primary control variable in the feed forward strategy. The gain and offset are not applied to the remote value.
FF Output	For FF types 'PV' and 'SP', this is the calculated (scaled, offset and trimmed) feed forward signal. FF OP = FF gain (input + FF Offset)
Track Output	If 'Track Enable' (below) is set to 'Yes', this is the value for the loop output to track when output track is enabled.
Track Enable	When set to 'Yes', the output follows the Track OP value (above). When subsequently set to 'Off' the loop makes a bumpless return to control.
Rem. Output Low/High	Used to limit the output when using a remote source. These limits cannot exceed the 'Output Low' and 'Output High' values described earlier in this section.

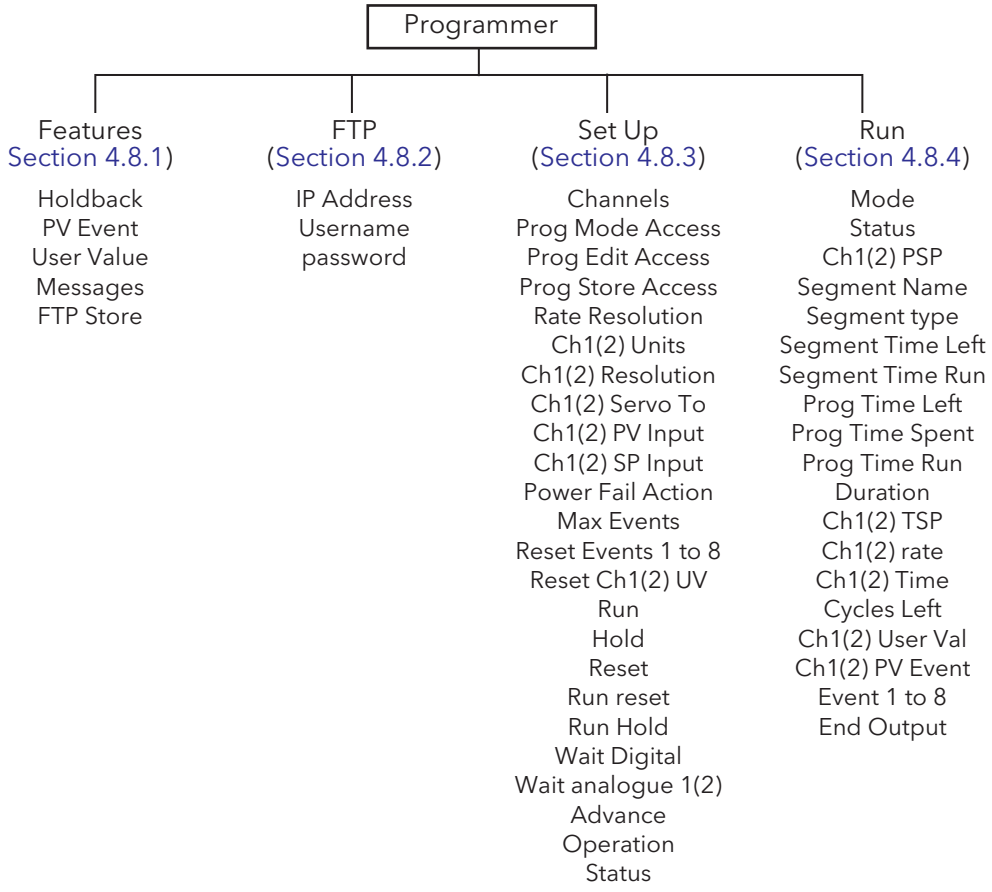
4.7.9 Advanced Loop Diagnostics menu

Master Error	The difference in value between the setpoint and the PV for the Master (Read only).
Slave Error	The difference in value between the setpoint and the PV for the Slave (Read only).
(M)Prop. Output	Shows the proportional term contribution to the control output of the Master (Read only).
(M)Integral Out	Shows the integral term contribution to the control output of the Master (Read only).
(M)Deriv. Output	Shows the derivative term contribution to the control output of the Master (Read only).
(S)Prop. Output	Shows the proportional term contribution to the control output of the Slave (Read only).
(S)Integral Out	Shows the integral term contribution to the control output of the Slave (Read only).
(S)Deriv. Output	Shows the derivative term contribution to the control output of the Slave (Read only).
Target Output	The requested control output. The target of the active output if rate limiting is active. (Read only.)
Loop Break (S)	Loop Break Alarm (Read only). Becomes active 'Yes' if the relevant loop break time (LBT1/2/3), set in the Slave PID menu (section 4.7.5) is exceeded, otherwise 'No' is displayed.
Loop Break (M)	Loop Break Alarm (Read only). Becomes active 'Yes' if the Master loop break time (LBT), set in the Master PID menu (section 4.7.4) is exceeded, otherwise 'No' is displayed.
Sensor Break (S)	Indicates Slave sensor break status (Read only). On (tick symbol) indicates a sensor break has occurred; Off (cross symbol) shows that no sensor breaks have been detected.
Sensor Break (M)	Indicates Master sensor break status (Read only). On (tick symbol) indicates a sensor break has occurred; Off (cross symbol) shows that no sensor breaks have been detected.
Sched PB	The scheduled proportional band for the current PID set.
Sched Ti	The scheduled integral time for the current PID set.
Sched Td	The scheduled derivative time for the current PID set.
Sched CBH	The scheduled cutback high value for the current PID set.
Sched CBL	The scheduled cutback low value for the current PID set.
Sched MR	The scheduled manual reset value for the current PID set.
Sched Loop Break	The scheduled loop break time for the current PID set.
Sched R2G	The scheduled relative cool gain value for the current PID set.
Sched Out High	The scheduled output high limit for the current PID set.
Sched Out Low	The scheduled output low limit for the current PID set.
Working Out Low	The low limit for the working output (Read only). This is the value used to limit the output power of the loop and is derived from the gain scheduled limit, the remote limit and the safety limit.
Working Out High	The high limit for the working output (Read only). This is the value used to limit the output power of the loop and is derived from the gain scheduled limit, the remote limit and the safety limit.
Master FB	Master FB is the value of the master control output after limiting and is used for Integral desaturation.
Calc OP	Master P+I+D
HiSatLim	HiSatLim is an internally generated limit
LoSatLim	LoSatLim is an internally generated limit
OPPID	Master control output It will be the same as Calc OP if the master is not in Cutback

4.8 PROGRAMMER CONFIGURATION

The programmer option allows the user to configure a setpoint program with one or two channels, as required. The program can be run from the Programmer operator display page (section 3.4.9) or can be controlled by inputs received from other parameters. In particular, the programmer is intended for use with the loop or advanced loop options.

The programmer configuration is separated into a number of areas as depicted in the overview below. The segment configuration (ramp type etc.) is carried out from the programmer edit page, also described in section 3.4.9.



4.8.1 Programmer Features menu

This menu allows the user to enable/disable some of the items presented to the user in the Programmer edit page described in section 3.4.9. Features are enabled/disabled by using the up/down arrow keys to highlight the required item and then using the scroll button to toggle between enabled (tick) and disabled (cross). Typically, items would be left disabled in order to reduce the number of configuration fields presented to a user who may not need all such features.

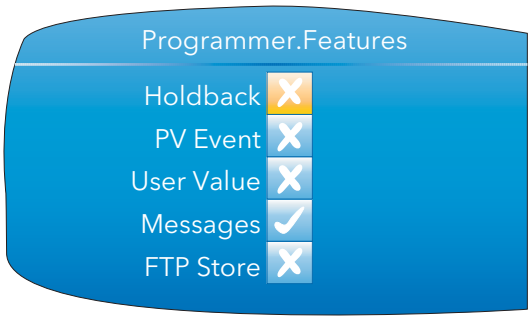


Figure 4.8.1 Programmer features menu

Holdback	Holdback pauses the program (freezes the Programmer setpoint (PSP) and the time remaining parameters) if the difference between the Process value (PV) and the PSP exceeds a user-specified amount (deviation). The program remains paused until the PV returns to within the specified deviation. In ramp or step segments, holdback indicates that the PV is lagging the SP by more than the specified amount and that the program is waiting for the process to catch up. In a dwell segment, holdback is used to guarantee that a work piece stays at set-point within a specified tolerance for the specified dwell duration. Holdback type and deviation value are configured, on a per program basis, to be applied to either the entire program or to individual segments. See Program edit (section 3.4.9) for details.
PV Event	A PV Event is available for each channel in every segment except for Wait and Go Back segment types. A PV Event is an absolute or deviation analogue alarm on the channel PV, and can be used to trigger a secondary process, or to trigger an analogue alarm.
User Value	A user value can be entered for every segment (except for Wait or Go Back types) and when the segment is entered, this value is transferred to the associated User Value Output parameter, which could be wired to another parameter to form part of an application strategy.
Messages	Table 4.8.1, below, lists the programmer specific events that generate messages that are displayed in the message summary and recorded into the history file. It is also possible to trigger custom messages from any of the programmer outputs via user wiring. The program name and segment name can be embedded in custom messages by inserting the modbus address for the current program / segment name parameters in square brackets i.e.: [<current_program_name_modbus_address>] [<current_segment_name_modbus_address>]

4.8.1 PROGRAMMER FEATURES CONFIGURATION (Cont.)

Event	Message
Program Run	<program_name>: Run
Program End	<program_name>: Complete
Program Hold	<program_name>: <segment_name>: Hold
Program Resume	<program_name>: <segment_name>: Resume
Program Reset	<program_name>: <segment_name>: Reset
Segment Start	<program_name>: <segment_name>: Segment Start
Advance	<program_name>: <segment_name>: Advanced
Holdback	<program_name>: <segment_name>: Holdback:Channel No.
PV Event	<program_name>: <segment_name>: PV Event:Channel No.

Table 4.8.1 Programmer messages

FTP Store

If this feature is enabled, an FTP menu item appears in the top level Programmer configuration menu. 'FTP' allows the user to enter communications parameters for the host computer which is to act as the ftp server.
FTP Store allows the user to set-up a centralised program store from which several instruments can select their program.

Notes

1 A maximum of 100 entries is supported on all drives. Directory trees are supported for both USB and FTP, and if the root of the drive contains only files (no directories), then up to 100 files are listed. If the root of the drive contains directories then each directory can contain 100 entries (but one of these entries will be taken up by '..' to return to the directory above).
2 Program files are in compressed XML (.uipz) file format.
3 When a program is selected from an FTP server a local copy of the program file is made within the instrument before being processed. It should be noted that the number of program files in the internal 'user' drive does not affect this local copy, and therefore a program from an FTP server can be loaded, even when the internal user drive is full.
4 As the loaded program resides in the current program database it is automatically included in a clone file. In addition, program files stored in the internal program drive are included in a clone file (refer to 'Cloning', below).
5. On the internal program drive only a flat directory structure is supported. However, full tree directories are supported on both the USB memory stick and FTP server (accessed via the HMI File Explorer).
6. It is not possible to store program files on an external device. Programs selected from an external device can, however, be stored in the internal program store.
7. It is not possible to select a program from an external device over comms and iTools.

CLONING

Each program file stored locally on the instrument IS included in a clone file as a Binary Large Object (BLOB), similar to the Graphical Wiring Editor layout. Each program file BLOB contains the program filename.

When loading a clone file, existing programs in the instrument's internal drive are deleted, and program file BLOB(s) in the clone are reformatted into program files by the instrument.

4.8.2 Programmer FTP menu

Note: This menu item is accessible only if 'FTP' has been enabled in the Programmer features menu described above.

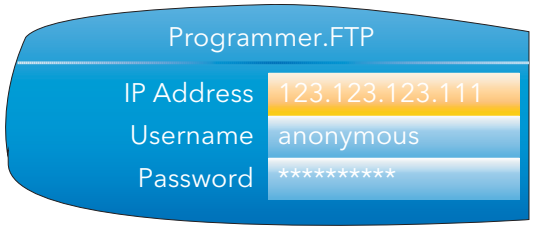


Figure 4.8.2 Programmer FTP menu

IP Address	The IP address of the FTP server.
Username	The User Name entered when setting up the FTP server
Password	The password associated with the above User Name.

Section C2 gives an example of how to set up an FTP server using 'Filezilla'

4.8.3 Programmer Setup menu

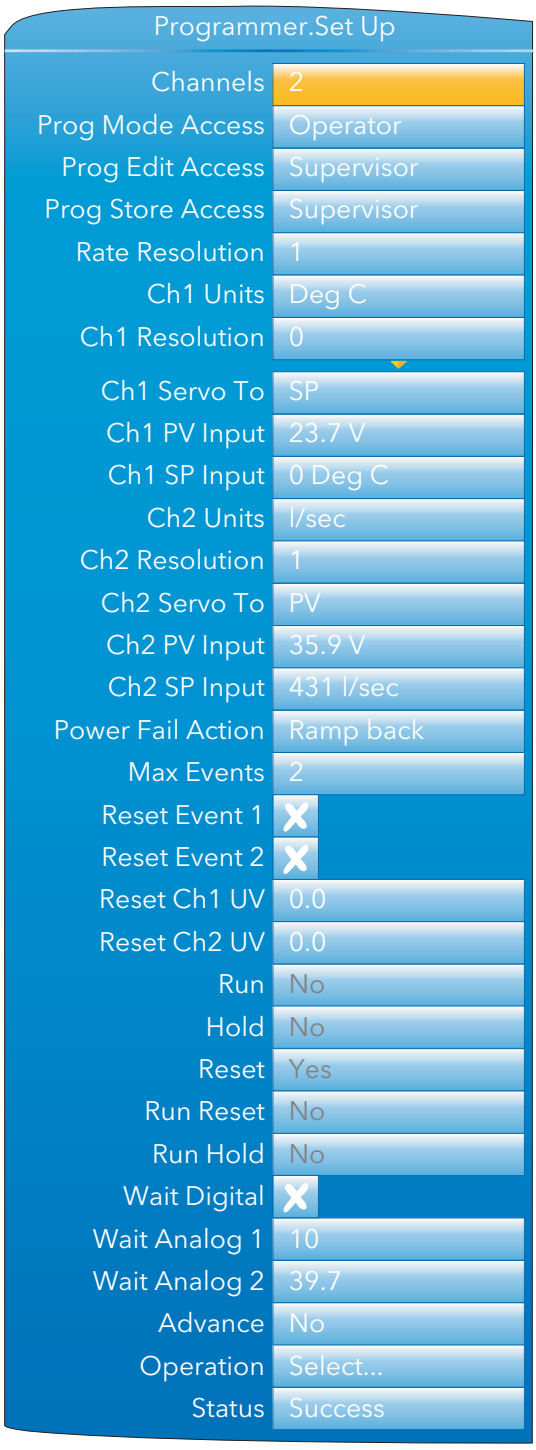


Figure 4.8.3 Programmer Set Up menu

Channels	The number of channels to be profiled. 1 = single channel mode, 2 = dual channel sync-all mode
Prog Mode Access	Sets the minimum access level (Logged off, Operator, Supervisor) for allowing changes to the current program mode (run, hold or reset)

4.8.3 PROGRAMMER SET UP MENU (Cont.)

Prog Edit Access	Sets the minimum access level (Logged off, Operator, Supervisor, Engineer) for loading programs, and for allowing edits to the current program including permission to advance a segment.
Prog Store Access	Sets the minimum access level (Logged off, Operator, Supervisor, Engineer) that allows users to copy, store and delete programs.
Rate Resolution	Sets the resolution (0 to 4 decimal places) of ramp rates when read from / written to via scaled integer comms.
Ch1 Units	Five-character (max.) descriptor for channel 1 units. If wired, the units will be those of the wire source.
Ch1 Resolution	Number of decimal places for channel 1 value. If wired, the value will be that of the wire source.
Ch1 Servo To	Determines whether the programmer starts running channel 1 from the control loop's configured set-point (servo to SP), or from the current process value (servo to PV).
Ch1 PV Input	Various programmer functions (for example Ch1 Servo to PV), require the PV value of the loop that the programmer is trying to control. The parameter is normally wired from the loop's Track PV parameter.
Ch1 SP Input	Various programmer functions (for example Ch1 Servo to SP), require the SP value of the loop that the programmer is trying to control - it is normally wired from the loop's Track SP parameter.
Ch2 Units	As 'Ch1 Units', above but for channel 2. Appears only if 'Channels' is set to '2'.
Ch2 Resolution	As 'Ch1 Resolution', above, but for channel 2. Appears only if 'Channels' is set to '2'.
Ch2 Servo To	As 'Ch1 Servo To', above, but for channel 2. Appears only if 'Channels' is set to '2'.
Ch2 PV Input	As 'Ch1 PV Input', above, but for channel 2. Appears only if 'Channels' is set to '2'.
Ch1 SP Input	As 'Ch1 SP Input', above, but for channel 2. Appears only if 'Channels' is set to '2'.
Power Fail Action	If the power supplied to the instrument is interrupted, the program status is retained and when power is restored, the instrument performs the selected power fail action. Continue: The programmer set-point returns immediately to its last value prior to the power down and the program continue to run from that point. Reset: The program resets. Ramp Back: The programmer servos the programmer set-point to the channel PV, and ramps to the target set-point at the rate prior to the power-fail. The time remaining for the segment is recalculated.

Notes:

1. If the interrupted segment was a 'time to target' ramp, then when power is returned the calculated ramp rate prior to the interruption is used.
2. If the interrupted segment was 'Dwell', then the ramp rate is determined by the previous ramp segment. On achieving the dwell set-point, the dwell period continues.
3. If a previous ramp segment does not exist (i.e. the first segment of a program is a dwell), the dwell continues at the 'servo to PV' programmer set-point.

Max Events	Configures the maximum number of event outputs (0 to 8).
Reset Event N	Sets the state of event output 'N' when the program is in reset. Appears only if 'Max Events' is > (N-1).
Reset Ch1 UV	Enter the value to be written to user value 1 when the program is in reset. Appears only if 'User Value' feature is enabled in Programmer.Features configuration (section 4.8.1).
Reset Ch2 UV	Enter the value to be written to user value 2 when the program is in reset. Appears only if 'User Value' feature is enabled in Programmer.Features configuration (section 4.8.1) and 'Channels' = '2'
Run	The input that causes the programmer to place the current program in Run mode.
Hold	The input that causes the programmer to place the current program in Hold mode.

4.8.3 PROGRAMMER SET UP MENU (Cont.)

Reset	The input that causes the programmer to place the current program in Reset mode.
Run Reset	Dual functionality input, that causes the programmer to place the current program in Run or Reset mode.
Run Hold	Dual functionality input, that causes the programmer to place the current program in Run or Hold mode.
Wait Digital	The Boolean input that is used in Wait segments.
Wait Analog 1	The analogue input associated with channel 1 that is used in wait segments.
Wait Analog 2	The analogue input associated with channel 2 that is used in wait segments. Appears only if 'Channels' = '2'
Advance	The input to advance the current segment
Operation	Program file operation selection parameter. See 'Program editing' (section 3.4.9) for further details
Status	Status indication of the selected file operation.See 'Program editing' (section 3.4.9) for further details
Amended	Indicates whether the current program has been amended since being loaded (Comms only)
File Error Status	File operation error status (Busy, OK, Load Open File Error, Store Open File Error, Delete File Fail, Copy File Fail, Invalid Format, Invalid Device, Invalid Version, Invalid Num Channels, Parameter Write Fail, Store Operation Did Not Complete, Load Operation Did Not Complete, Delete Operation Did Not Complete, Copy Operation Did Not Complete, Invalid Filename, Unspecified Error). Available only over Comms as the error is displayed on the display screen. 'Parameter Write Fail' indicates that one or more program/segment parameters failed to be written to during a 'Load' operation. This is generally caused by a program that contains features (i.e. Holdback, User Values, PV Events) which are disabled in the instrument's Programmer block, or the program contains more Event Outputs than configured in the instrument's Programmer block.

4.8.4 Programmer Run menu

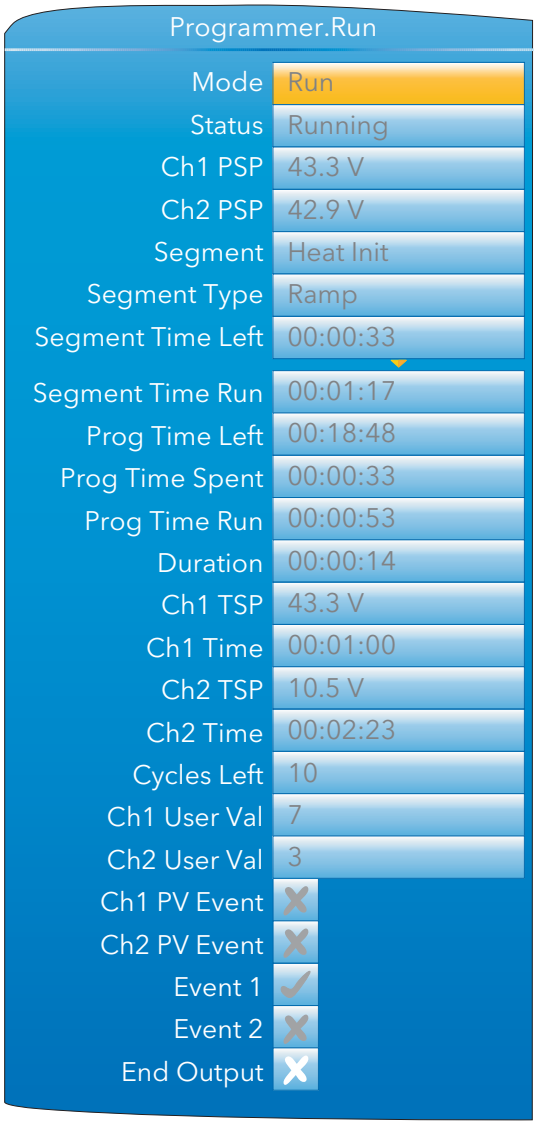


Figure 4.8.4 Programmer Run menu

Mode	Current program mode (Run, Hold, Reset).
Status	Current program status (Running, Holding, Holdback, Waiting, Reset, Complete)
Ch1 PSP	The output setpoint for channel 1.
Ch2 PSP	The output setpoint for channel 2. Appears only if 'Channels' = '2' in the Set Up menu (section 4.8.3).
Segment	Name of the current segment as entered in the Program Edit page (section 3.4.9)
Segment Type	Current segment type as entered in the Program Edit page (section 3.4.9)
Seg Time Left	Indicates the minimum amount of time left in the current segment.
Seg Time Run	The length of time that the current segment has been running. This value does not include time spent in Hold, Holdback or Waiting
Prog Time Left	Shows the minimum amount of time left before the program completes. Each segment can be up to 500 hours in length. The maximum display is 500 hours, and if the length of the entire program is greater than this, the display remains at 500 until the remaining time falls below 500 hours.
Prog Time Spent	Indicates the length of time the current program has been running, including time spent in Hold, Holdback or Waiting

4.8.4 PROGRAMMER RUN MENU (Cont.)

Prog Time Run	The length of time the current program has been running. This value does not include time spent in Hold, Holdback or Waiting
Duration	For Dwell segments only, this is the dwell duration.
Ch1 TSP	For Ramp and Step segments, this is the current target setpoint for channel 1.
Ch1 Time	For Ramp segments, this is the configured time for channel 1 to reach it's Target Setpoint (TSP)
Ch2 TSP	For Ramp and Step segments, this is the current target setpoint for channel 2. Appears only if 'Channels' = '2' in the Programmer Set Up menu (section 4.8.3).
Ch2 Time	For Ramp segments, this is the configured time for channel 2 to reach it's Target Setpoint (TSP). Appears only if 'Channels' = '2' in the Programmer Set Up menu (section 4.8.3)
Cycles Left	The number of Go Back cycles remaining before the Go Back loop ends.
Ch1 User Val	The value of user value 1 in the current segment. Appears only if the 'User Value' feature is enabled in the Programmer Features menu (section 4.8.1).
Ch2 User Val	The value of user value 2 in the current segment. Appears only if the 'User Value' feature is enabled in the Programmer Features menu (section 4.8.1) and if 'Channels' = '2' in the Programmer Set Up menu (section 4.8.3)
Ch1 PV Event	The state of channel 1 PV event (Off = Cross symbol, On = Tick). Appears only if the 'PV Event' feature is enabled
Ch2 PV Event	The state of channel 2 PV event (Off = Cross symbol, On = Tick). Appears only if the 'PV Event' feature is enabled and if 'Channels' = '2' in the Programmer Set Up menu (section 4.8.3).
Event 1 to 8	The state of event output 1 to 8 for the current segment (Off = Cross symbol, On = Tick). The number of events appearing is defined in the Programmer Set Up menu (section 4.8.3) (Max Events)
End Output	The output that is set by the end segment (Off = Cross symbol, On = Tick).

4.8.5 Connecting the programmer to a loop

Below are some examples of how programmers and loops may be soft-wired together so that the programmer has access to the Loop PV and Loop setpoint. The examples are taken from iTools (section 6), but may be carried out through User Wiring (section 7) if more convenient.

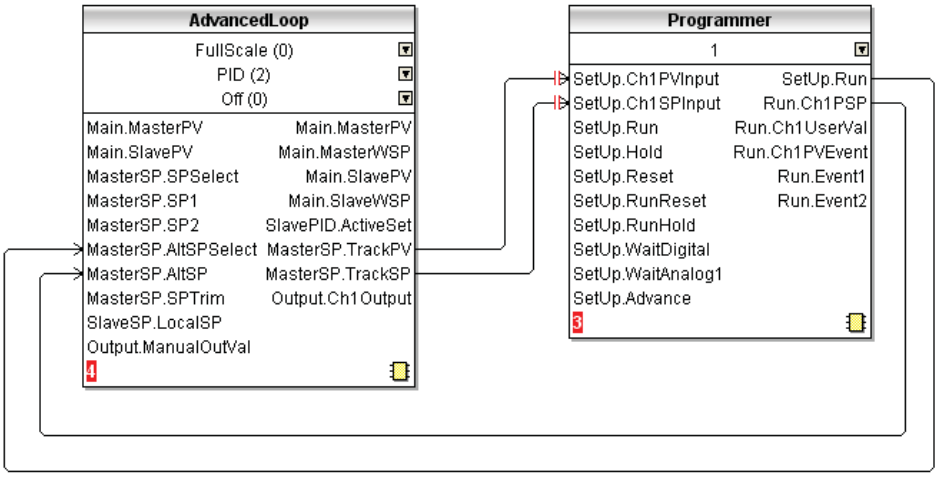


Figure 4.8.5a Advanced loop to Programmer basic wiring

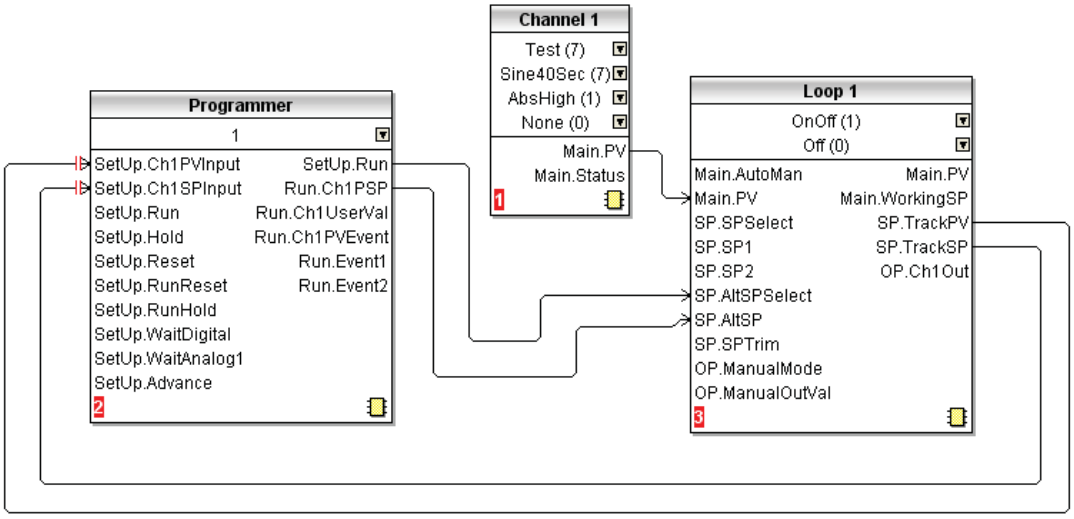


Figure 4.8.5b Programmer to Loop basic wiring

4.8.5 CONNECTING THE PROGRAMMER TO A LOOP (Cont.)

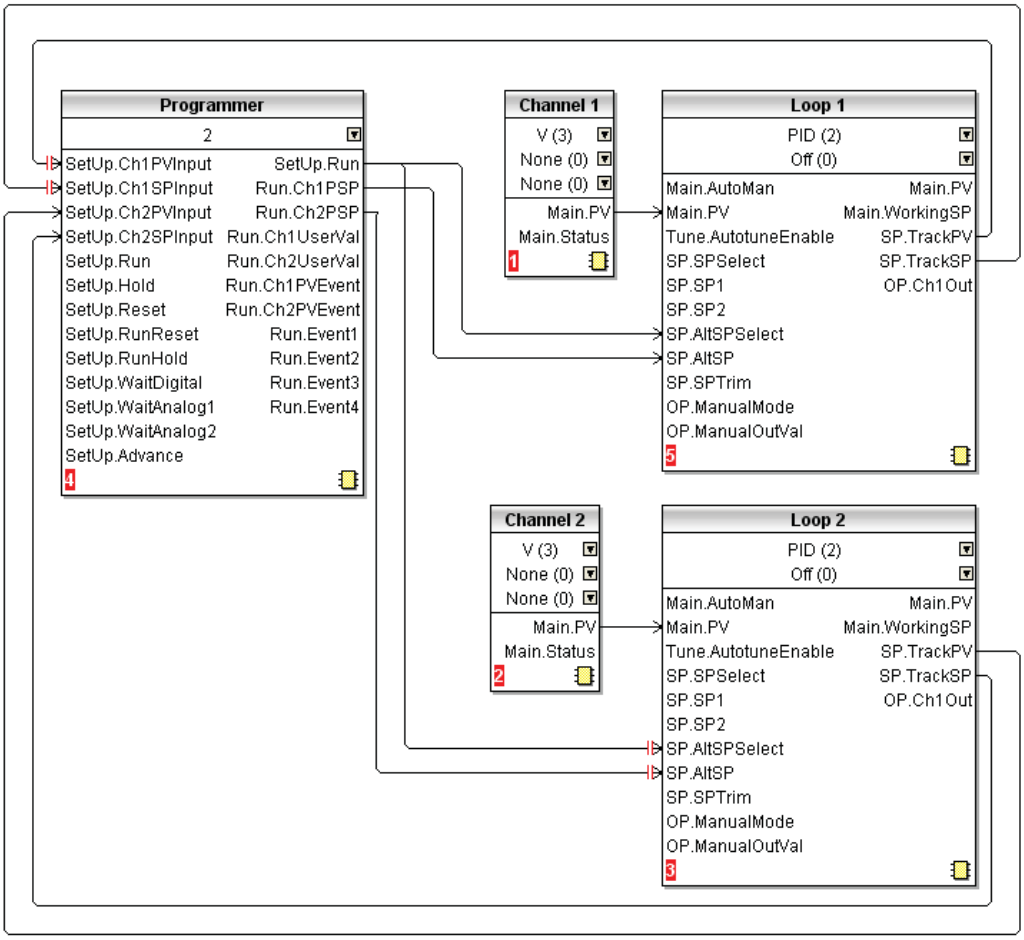


Figure 4.8.5c Dual programmer to two loops basic wiring

4.8.6 Configuration by Modbus Comms

It is possible to configure, store, delete, or load a program via Modbus comms by setting the Program and Segment parameters using either their scaled integer or native modbus addresses (section 5.3).

EXAMPLE 1: CONFIGURE A PROGRAM

To configure a simple Ramp-Dwell-Ramp program via modbus comms:

Set Segment.1.Type (address 15040) to Ramp (1)

Set Segment.1.Ch1TSP (address 15042) to 60.0 (600 - 1dp)

Set Segment.1.Ch1Time (address 15044) to 60s (60s)

Set Segment.2.Type (address 15088) to Dwell (2)

Set Segment.2.Duration (address 15089) to 120s (120)

Set Segment.3.Type (address 15136) to Ramp (1)

Set Segment.3.Ch1TSP (address 15138) to 0.0 (0 - 1dp)

Set Segment.3.Ch1Time (address 15140) to 180s (180)

EXAMPLE 2: STORE A PROGRAM

To store the current program:

Set Programmer.FileList.FilenameEntry (address 27281) to required filename (e.g. George)

Set Programmer.Setup.Operation (address 14912) to Store (4)

Read Programmer.Setup.Operation (address 14912) until it returns Select (1)

Read Programmer.Setup.Status (address 14913) to get the status of the store operation (Success = 1, Failed = 2)

EXAMPLE 3 LIST STORED PROGRAMS

To get a listing of stored program files:

Set Programmer.FileList.Operation (address 14976) to Get Listing (1)

Read Programmer.FileList.Operation (address 14976) until it returns Complete (0)

Read Programmer.FileList.Filename1 to 100 parameters (address 30976 - 31075)

Note: for each filename parameter perform a 21 register block read starting from the base address of the parameter, 1st null string indicates end of List.

EXAMPLE 4: LOADING PROGRAMS

To load a program:

Get a listing as described above

Set Programmer.FileList.FilenameEntry (address 27281) to the filename to be loaded (e.g. George)

Set Programmer.Setup.Operation (address 14912) to Load (2)

Read Programmer.Setup.Operation (address 14912) until it returns Select (1)

Read Programmer.Setup.Status (address 14913) to get the status of the store operation (Success = 1, Failed = 2)

4.9 MODBUS MASTER CONFIGURATION

Modbus master configuration is divided into two areas: a) setting up the slave(s), including diagnostics, and b) defining the locations of the parameters to be read. Figure 4.9 shows an overview.

Section 3.4.12 shows the Modbus Master display page, and describes the configuration options available there.

Note: Versions 2.40 to 2.50 of the Mini8 Controller, and versions 2.70 to 3.20 of the Model 3550 controller are supported. It is not guaranteed that later software versions of these instruments will be fully compatible.

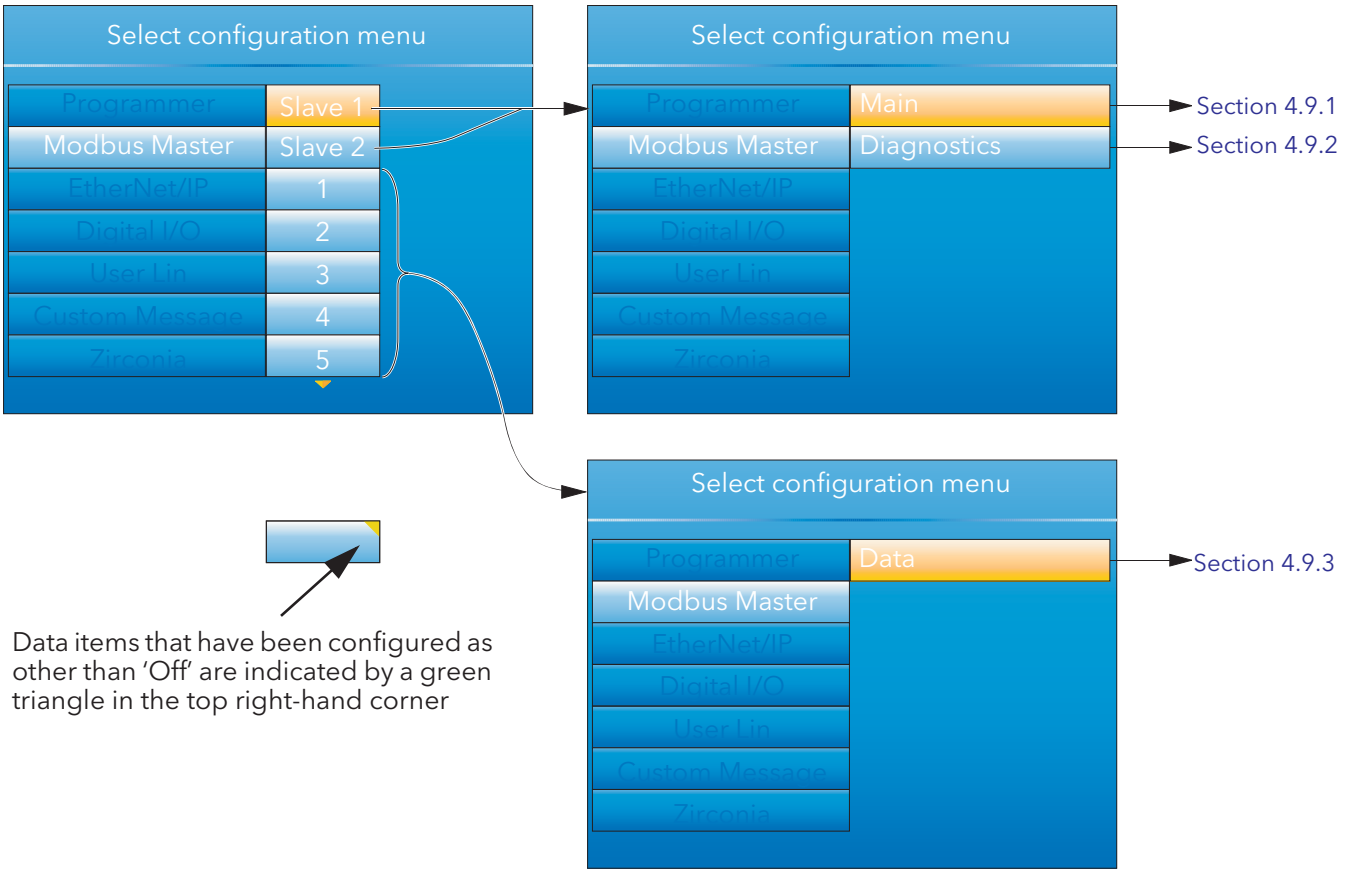


Figure 4.9 Modbus Master configuration top level menus

4.9.1 Slave Main menu

This allows the IP address, Unit ID and other communications parameters to be entered for Slaves 1 and 2.

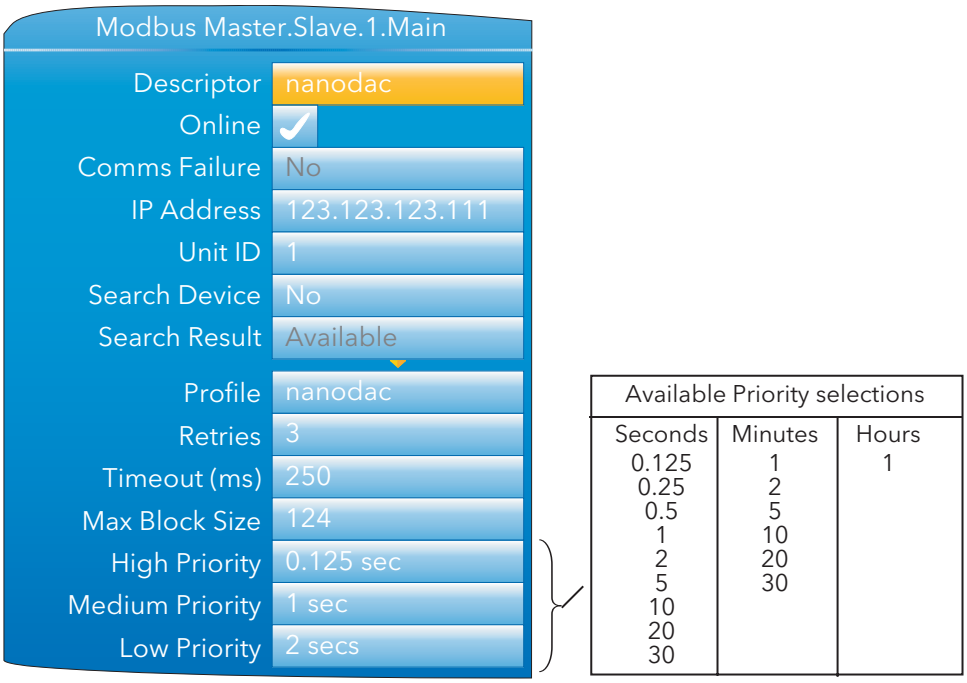


Figure 4.9.1 Modbus Master Slave 1 configuration (Slave 2 similar)

Descriptor	A descriptor for this instrument. For use in Modbus communications, this is not the same as the 'Name' which appears in the Instrument Info configuration (section 4.14).
Online	Disabled by default (Cross symbol). Must be enabled (highlighted using the down arrow, then edited by the scroll button) to allow the remaining configuration items to appear and to allow data transactions be processed. Setting the slave offline temporarily disables data transactions - it does not reconfigure them.
Comms Failure	Active (yes) if a data item has failed to respond after all retries.
IP Address	The IP address of the Slave device
Unit ID	The Unit Id or Modbus address to use in each data transaction with the slave device. Limits are 1 to 255
Search Device	Setting this to 'Yes' searches the network to see if the device with the specified IP address and Unit ID is available. If so, the descriptor will be overwritten to indicate what type of device has been found.
Search Result	The status of the selected 'Search Device' request (Searching, Available, Unreachable). Search activity is indicated by a rotating animated display in the 'Searching' field.
Profile	A number of profiles are held within the instrument that match a selection of known devices. If the device is 'known', its type, model number etc. is displayed. If the device is unknown, '3rd Party' appears instead.
Retries	The number of times (0 to 3) to re-send a data transaction to the device if no response is received within the configured timeout period (below).
Timeout	The timeout period for each Modbus transaction in ms
Max Block Size	The maximum number of registers (16bit words) that a single data transaction is permitted to contain
High Priority	The interval rate between each high priority data transaction. Default = 0.125 second.
Medium Priority	The interval rate between each medium priority data transaction. Default = 1 second.
Low Priority	The interval rate between each low priority data transaction. Default = 2 seconds.

4.9.1 SLAVE MAIN MENU (Cont.)

PRIORITY LEVELS

Three levels of update rate can be entered for use in data configuration (section 4.9.3), to define how often a value is read or written. In order to optimise performance, it is recommended that the slowest rate consistent with requirements be selected. The intervals are selected from a scroll list see figure 4.9.1 above.

4.9.2 Slave Diagnostics menu

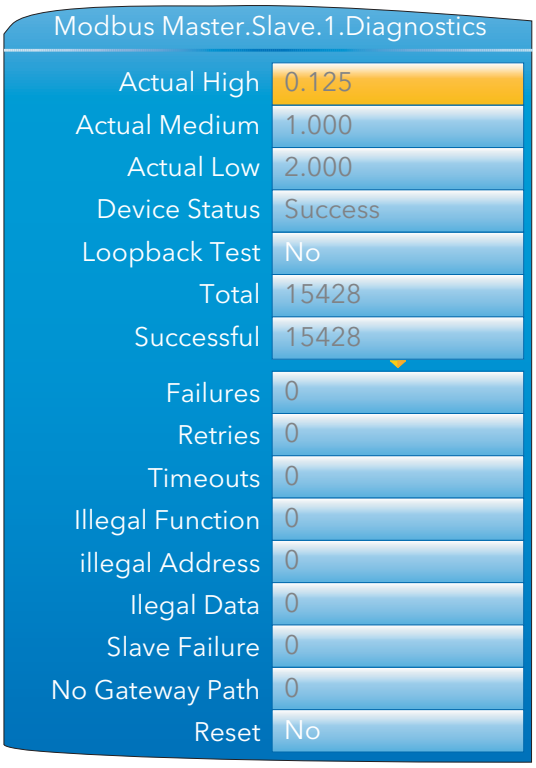


Figure 4.9.2 Diagnostics menu

Note: Diagnostic values are reset on power up

Actual High	The high priority rate that this slave is actually running at. This can never be faster than the high priority rate that was configured for this device (Slave Main menu, above), but if the master is heavily loaded the rate may be lower than that specified.
Actual Medium	The medium priority rate that this slave is running at. This can never be faster than the medium priority rate that was configured for this device (Slave Main menu, above), but if the master is heavily loaded the rate may be lower than that specified.
Actual Low	The actual low priority rate that this slave is running at. This can never be faster than the low priority rate that was configured for this device (Slave Main menu, above), but if the master is heavily loaded the rate may be lower than that specified.
Device Status	The status of the last transaction to this slave Success: The transaction was successfully actioned by the slave device Timeout: There was no response from the slave device to a given request within the configured time Illegal Address: The request to the slave device contained an invalid modbus address. The address may be for a read only parameter Illegal Value: The request to the slave device contained invalid data for the specified parameter Bad Sub: The sub function code in the request was invalid

4.9.2 SLAVE DIAGNOSTICS MENU (Cont.)

DEVICE STATUS (Cont.)

	Idle: This data item is currently idle and not communicating with the slave device
	Illegal Code: The slave does not support the function code transmitted by the master.
	Pending: The request is waiting to be sent, the most likely cause being that the slave device has not been set to online
Loopback Test	If set to 'Yes', Sends a function code 8 transaction to the slave, and waits for a response.
Total	A count of all the transactions sent to the slave including reads, writes both good and failed transactions.
Successful	A count of all the successful transactions sent to the slave.
Failures	A count of all the unsuccessful (failed) transactions sent to the slave. May be caused by Illegal Function, Illegal Address etc. failures, as detailed below
Retries	The number of transactions that were re-sent because of timed out responses from the slave devices.
Timeouts	A count of all the transactions sent to the slave for which no response was received within the configured timeout period.
Illegal Function	A count of all the transactions sent to the slave that the slave claimed contained an invalid function code. Exception code (1).
Illegal Address	A count of all the transactions sent to the slave that the slave claimed contained an invalid Modbus register address. Exception code (2).
Illegal Data	A count of all the transactions sent to the slave that the slave claimed contained an invalid value. Exception code (3)
Slave Failure	A count of all the times this slave device has failed to communicate. Exception code (4)
No Gateway Path	A count of all the times it has not been possible to access the slave device as it is on another network that requires a gateway for access
Master Rejects	A count of all the transactions that the Modbus Master has refused to send to the slave due to invalid configuration data
Reset	A one shot action that immediately resets all diagnostics counts.

4.9.3 Modbus master data configuration

This is the area of configuration in which the individual data items are selected for transmission across the Modbus master communications link. The configuration fields that appear depends on the parameter selected, so the examples given here will probably not match those that appear to the user. The parameters that appear in the 'parameter List' scroll menu depends on the slave model.

EXAMPLE 1: TARGET SP1 WITH NANODAC SLAVE

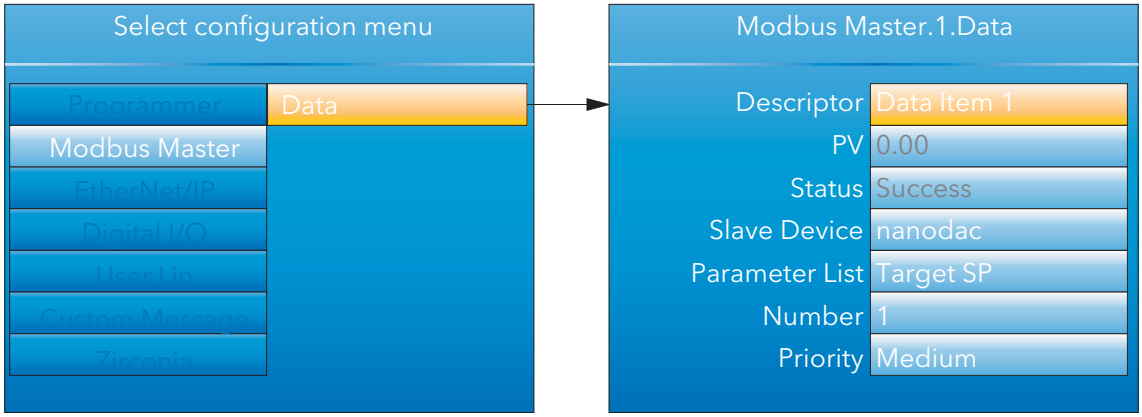


Figure 4.9.3a Target Setpoint

4.9.3 MODBUS MASTER DATA CONFIGURATION (Cont.)

EXAMPLE 2 USER DEFINED PARAMETER

This allows the user to enter a Modbus address (decimal) and a data type in order to read the value of a parameter from or write a parameter value to the slave. Modbus address and data types must be obtained from the documentation supplied with the slave device. For convenience, this example uses a nanodac as the slave; table 5.3 of this document providing the required data.

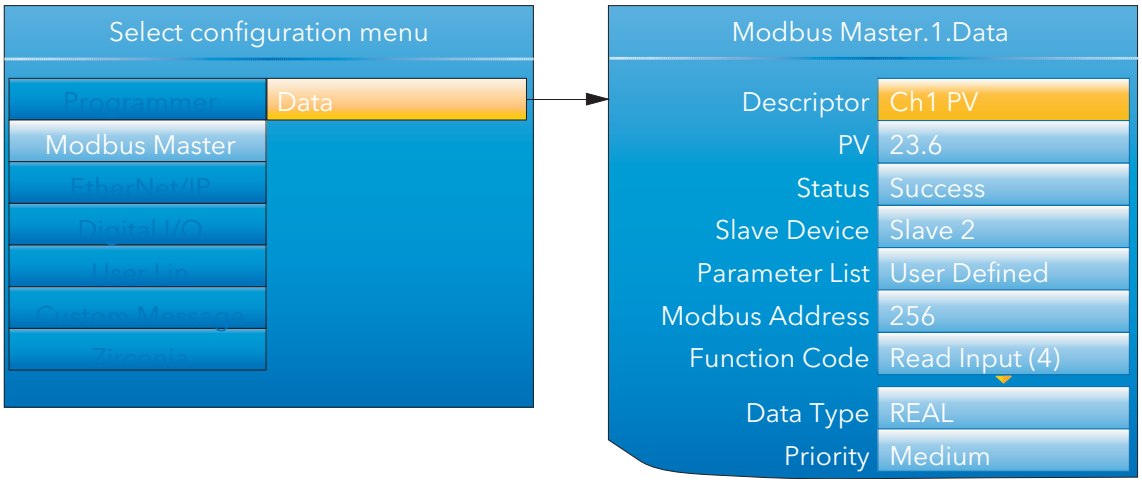


Figure 4.9.3b User defined parameters

DATA PARAMETERS

This lists all possible configuration fields that might appear, not just those shown in the examples above.

Descriptor	Up to 20 characters used to describe the current data item (used in the Modbus Master user page (section 3.4.12)).
PV	The process value currently being read from the selected slave. Visible only if data item is not an alarm type. The value must be wired to a virtual channel with 'Operation' = 'Copy' if it is to be trended and/or recorded.
Sys Alm status	The status (e.g. None, Active) of the data item. Visible only for specific read profiles. The value must be wired to a virtual channel with 'Operation' = 'Copy' if it is to be trended and/or recorded.
Chan. Alm Status	The status of the data item. Visible only for specific read profiles. The value must be wired to a virtual channel with 'Operation' = 'Copy' if it is to be trended and/or recorded.
Set	Allows the user to set an on/off value. Visible only for specific write profiles.
Mode	Allows the user to set an auto/manual value. Visible only for specific write profiles.
Value	Configured or wired value to be sent to the selected slave. This parameter is available only with function codes 6 & 16
Fall Back Value	The value to be sent to the selected slave if the 'Value' parameter is wired and has a status other than GOOD_PV. This parameter is available only with function codes 6 & 16 It is not possible to wire Fall Back Value from another parameter and it can be configured only manually
Send	A one shot action that sends the data in the 'Value' parameter or the 'Fall Back Value' parameter (depending upon the status of 'Value') to the selected slave. This is classed as an acyclic write and so is available only for function codes 6 & 16. The 'Priority' parameter must be set to 'Acyclic'

4.9.3 MODBUS MASTER DATA CONFIGURATION (Cont.)

Status
The status of the last transaction sent to the selected slave
Success: The transaction was successfully actioned by the slave device
Timeout: There was no response from the slave device to a given request within the configured time
Illegal Address: The request to the slave device contained an invalid modbus address. The address may be for a read only parameter
Illegal Value: The request to the slave device contained invalid data for the specified parameter
Bad Sub: The sub function code in the request was invalid
Idle: This data item is currently idle and not communicating with the slave device
Illegal Code: The slave does not support the function code transmitted by the master.
Pending: The request is waiting to be sent, the most likely cause being that the slave device has not been set to online.

Slave Device
A list of available slaves that this data is to communicate with.

Parameter List
List of parameters available for the selected slave devices profile. These parameters require no user configuration.

Number
The channel, loop or group etc. instance.

Modbus Address
The Modbus register address that this data is to be read or written to. Limits are 0 - 65535

Function Code
The function code to use, this determines if the data is going to be read or written to the selected slave. Supported function codes are:

Code	Description	Code	Description
1	Read contiguous status coils	5	Write a single coil on or off
2	Read contiguous discrete inputs	6	Write to a single register
3	Read contiguous holding registers	8	Loopback test
4	Read contiguous input registers	16	Write to contiguous registers

Data Type
The data type that defines how this data is going to be represented. The data types listed below are supported.
8-bit signed byte (BYTE)
8-bit unsigned byte (UBYTE)
16-bit signed integer (INT)
16-bit unsigned integer (UINT)
32-bit signed long (DINT)
32-bit unsigned long (UDINT)
32-bit floating point IEEE (REAL)
32-bit signed long (little Endian, word swapped) (DINT (Swap))
32-bit unsigned long (little Endian, word swapped) (UDINT (Swap))
32-bit floating point IEEE (little Endian, word swapped) (REAL (swap))
Bit from register (BIT)
By default all 16 & 32 bit data types (unless specified) will be transmitted in Big Endian format, where the most significant byte in the value is sent first. Byte Ordering: (for big Endian) (0x12 sent first)

16-bit	0x1234	0x12, 0x34
32-bit	0x12345678	0x12, 0x34, 0x56, 0x78

Bit Position
The bit in the register to be extracted, this is only available if the 'Data Type' selected is 'BIT In Register'

Scaling
The decimal placing for scaled 16 bit data types. Visible depending on the 'Data Type' selected.

Priority
The frequency with which this data will be managed. See 'Priority Levels', in section 4.9.1, above.

4.10 ETHERNET/IP CONFIGURATION

This area of configuration allows the 'Client' user to set up an EtherNet/IP communications link with up to two Server units. The 'Server' user has a more limited range of configurable items.

> Note: Implicit I/O is used for continuous real-time transfer of multiple data items from instrument to instrument. Explicit I/O is used as a 'one-shot' transfer of a single data item. See section 3.4.13 for further details.

Figure 4.10 shows that the configuration is split into three areas: Main, Implicit Inputs and Implicit Outputs, but it should be noted that the implicit inputs and implicit outputs are read only, as these can be configured only by using iTools, as described in the EtherNet/IP display mode description (section 3.4.13).

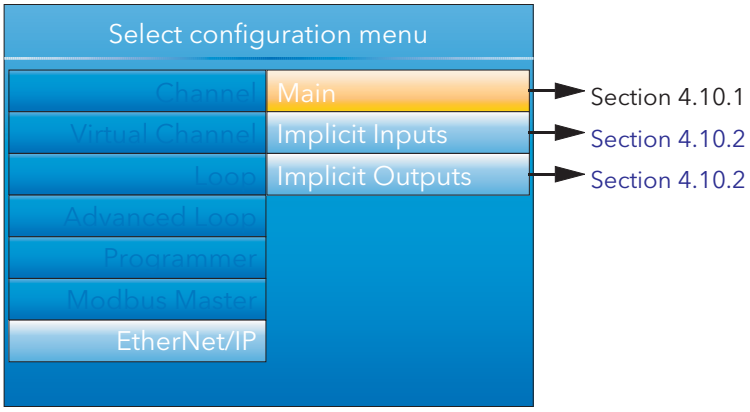


Figure 4.10 Client configuration

4.10.1 Ethernet/IP Configuration Main menu

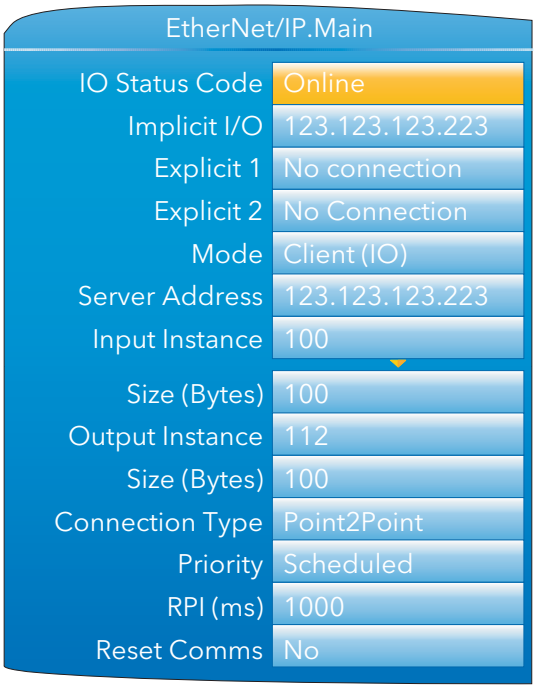


Figure 4.10.1 Ethernet/IP Main menu

4.10.1 ETHERNET/IP CONFIGURATION MAIN MENU (Cont.)

Net Status Code	Network status (Server only) Offline: nanodac online but there are currently no CIP connections Online: nanodac online with at least 1 CIP connection Connection Timeout: The connection has timed out Duplicate IP: A duplicate IP address has been detected on the network Initialisation: nanodac is initialising comms
IO Status Code	IO status (Client (IO) only). As above.
Tag Status code	Tag status (Client (Tags) only. See table 4.10.1, below.
Implicit I/O	Connected IO server IP address
Multicast	Connected IO server IP address (only if multicast selected)
Explicit 1	Connected client/server IP address
Explicit 2	Connected client/server IP address
Mode	Modes of operation: Server, Client (IO) or Client (Tags)
Server Address	IO Server IP address (Client mode only)
Input Instance	Input class instance number (client mode only)
Size (bytes)	The size in bytes of data that the client is expecting to read from the implicit input.
Output Instance	Output class instance number (client mode only)
Size (bytes)	The size of data that the client is expecting to write to the server.
Connection Type	Connection type (client mode only)
Priority	Connection priority (client mode only)
Rpi	IO connection speed (client mode only)
Reset Comms	Applies all changes to the EtherNet/IP stack at the same time. Or can be used to reset communications using the current configuration
Slot Number	PLC slot number (zero indexed) when communicating using tags

4.10.2 Implicit inputs/outputs

This display provides a read-only display of the values in the input and output data tables. Parameters are placed in the input and output tables using the proprietary software tool called 'iTools', as described in section 3.4.13.

4.10.3 Explicit inputs/outputs

See section 3.4.13 for details.

4.10 ETHERNET/IP CONFIGURATION (Cont.)

0	Success. Service was successful
1	Connection Failed. A connection in the path failed
2	Invalid Parameter. A parameter associated with the request was invalid
3	Memory Unavailable. No available resources in the server to service the request
4	Path Segment Error. The syntax of all or some of the path was not understood
5	Path Dest. Error. The path references an unknown object, class or instance
6	Partial Transfer. Only part of the expected data was transferred
7	Connection Lost. The messaging connection was lost
8	Service Unsupported. Undefined service for requested object
9	Invalid Attribute. Invalid attribute data detected
10	Attribute Error. An attribute in the response has a non zero status
11	Already Requested. The object is already in the mode/state being requested
12	Object Conflict. The object cannot perform the requested service
13	Already Exists. The requested instance or object already exists
14	Attribute Error. Request to modify a non modifiable attribute received
15	No Privileges. Permission/Privilege check failed
16	State Conflict. The current state or mode prohibits the execution of the requested service
17	Reply To Large. Response buffer too small for response data
18	Fragmented Value. For example this service request will return only half a REAL data type
19	Not Enough Data. The service does not provide enough data to complete the request
20	Invalid Attribute. Requested attribute is not supported
21	Too Much Data. The service supplied more than was expected
22	Object Non-Exist. The object specified does not exist in the device
23	Seq. Fragmentation. The fragmentation sequence for this service is not active
24	No Attribute Data. The attribute data for this object was not saved at the server prior to this request service
25	Data Store Failure. The attribute data for this object was not saved due to a failure during the attempt
26	Routing Failed. The service request packet was too large for transmission on a network in the path to the destination. The routing device was forced to abort the service
27	Routing Failed. The service request packet was too large for transmission on a network in the path to the destination. The routing device was forced to abort the service
28	Missing Attribute. The service did not supply an attribute in a list of attributes that was needed by the service to perform the requested behaviour
29	Invalid Attribute. The service is returning the list of attributes supplied with status information for those attributes that were invalid
30	Embedded Tag Error. An embedded service resulted in an error. This is most commonly an incorrectly formatted tag name
31	Vendor Error. A vendor specific error has encountered
32	Invalid Parameter. A parameter associated with the request was invalid
33	Write Once Error. An attempt to write to a write once only parameter occured
34	Invalid Reply. An invalid reply was received
35	Buffer Overflow. The message received is larger than the receiving buffer
36	Format Error. The format of the received message is not supported
37	Key Path Failure. The key segement in the path does not match destination key
38	Path Size Error. The size of the path in the request is too large
39	Unexpected Attribute. Unable to set the attribute at this time
40	Invalid Member Id. The requested member id does not match class object
41	Member Is R/O. A request to modify a R/O member was received
42	Group 2 Server. Group 2 DeviceNet server response
43	Translation Error. A CIP modbus translator request failed
44	Attribute Is R/O. A request to read a non readable attribute was received
64	No Tags Found. There were no tags configured in the input or output tables
65	Invalid Config. The total length in characters of all the tags in this table will cause the PLC to exceed its internal buffer of 500 bytes. To eliminate this problem, reduce the length of some or all tag names

Table 4.10.1 Tag Status code definition

4.11 DIGITAL I/O

This area of configuration allows the digital I/O types to be selected.

Notes:

1. If 2A2B is set to 'Valve Raise', then 3A3B is set to 'Valve Lower'. Similarly, if relay 4AC is set to 'Valve Raise', then relay 5AC is set to 'Valve Lower'.
   When the loop channel output is wired to the PV input of a Valve Raise function, then the PV input of the associated Valve Lower function becomes unavailable for wiring, and both outputs are controlled by the loop as a pair, using only the single wire.
2. See section B2.6.11 for a description of time proportioning.

Note: These fields do not appear if they contain I/O type 'DC output'.

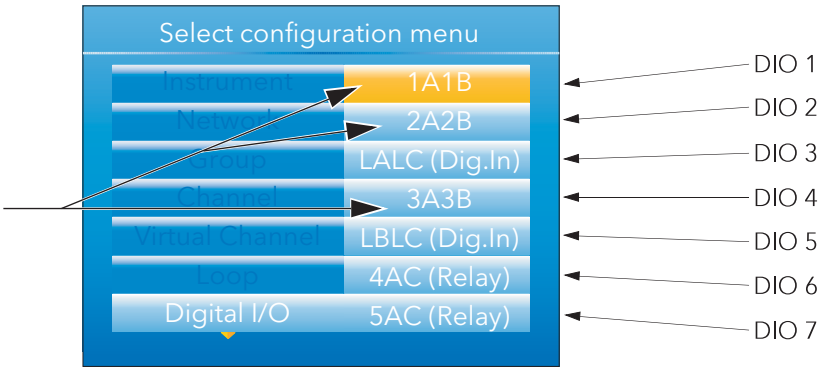


Figure 4.11 Digital I/O top level menu

4.11.1 Digital input/output

This applies to signals at terminals 1A/1B (figure 2.2). Highlight '1A1B', then operate the scroll key to reveal the configuration menu.

Module Ident	Dig IO
Type	On Off O/P, Time Prop O/P or Contact I/P (default)
PV	For inputs, 0 = contact is open; 1 = contact is closed. For On Off O/P, a value ≥ 0.5 drives the output high, otherwise, the output is driven low. For Time Prop O/P, the value is the demanded output %.
Min On Time	For Type = Time Prop O/P only, this allows a minimum on time to be specified. Configurable range = 0.1 to 150 seconds
Invert	Inverts the output sense for digital outputs; or the input signal for digital inputs.
Output	Off = output being driven low; On = output being driven high. Does not appear for Type = Contact I/P

4.11.2 Relay outputs

This may apply to terminal pairs 1A1B, 2A2B, 3A3B, 4AC, 5AC (figure 2.2). Highlight the relevant terminal pair, then operate the scroll key to reveal the configuration menu.

Module Ident	Relay
Type (2A2B, 4AC)	On Off O/P (default), Time Prop O/P, Valve Raise (not if DC output I/O fitted).
Type (3A3B, 5AC)	'On Off O/P' (default), 'Time Prop O/P'. The 3A3B relay is not fitted if 'DC Output' I/O is fitted.
PV	For On Off O/P, a value ≥ 0.5 closes the relay contacts, otherwise, the contacts are open. For Time Prop O/P, the value is the demanded output %.
Min On Time	For Type = Time Prop O/P only, this allows a minimum on time to be specified to reduce relay wear. Configurable range = 0.1 to 150 seconds
Invert	Inverts the output sense for the relays (not applicable if Type = Valve Raise).

(Continued)

4.11.2 RELAY OUTPUTS (Cont.)

Inertia	For Type = Valve Raise only, this allows a value to be entered (in seconds) to take into account valve run-on.
Backlash	For Type = Valve Raise only, this allows a value to be entered (in seconds) in order to compensate for backlash in the valve linkage.
Standby action	For Type = Valve Raise only, this specifies the valve action when the instrument is in standby mode. Continue: Output continues at the demanded level Freeze: The valve stops being driven.
Output	Off = relay contacts open; On = relay contacts closed.

4.11.3 Digital inputs

This applies to terminals pairs LALC, LBLC (figure 2.2). Highlight the relevant terminal pair, then operate the scroll key to reveal the configuration menu.

Module Ident	Dig.In
Type	Contact I/P
PV	0 = contact is open; 1 = contact is closed.
Invert	Inverts the sense of the input.

4.11.4 Digital outputs

This applies to terminal pair 2A2B (figure 2.2). Highlight 2A2B, then operate the scroll key to reveal the configuration menu.

Module Ident	Dig.Out
Type	On Off O/P, Time Prop O/P or Valve Raise
PV	For On Off O/P, a value ≥ 0.5 drives the output high, otherwise, the output is driven low. For Time Prop O/P, the value is the demanded output %.
Min On Time	For Type = Time Prop O/P only, this allows a minimum on time to be specified. Configurable range = 0.1 to 150 seconds
Invert	Inverts the output sense for digital outputs; or the input signal for digital inputs.
Inertia	For Type = Valve Raise only, this allows a value to be entered (in seconds) to take into account valve run-on.
Backlash	For Type = Valve Raise only, this allows a value to be entered (in seconds) in order to compensate for backlash in the valve linkage.
Standby action	For Type = Valve Raise only, this specifies the valve action when the instrument is in standby mode. Continue: Output continues at the demanded level Freeze: The valve stops being driven.
Output	Off = output being driven low; On = output being driven high.

4.12 DC OUTPUT

This option provides a voltage (terminals 3A3B only) or mA output. Terminal location is shown in figure 2.2.

CAUTION

There are no mechanical interlocks to prevent a chassis with the dc output option being fitted into a 'sleeve' or 'case' which has previously been wired for the standard relay output. Before fitting the chassis into the case, it should be ensured that the terminal wiring is not attached to live voltage supplies, as such voltages may cause permanent damage to the instrument.

4.12.1 Configuration display

As shown in the figure below, highlight the required DC output, then operate the scroll button to reveal the configuration page.

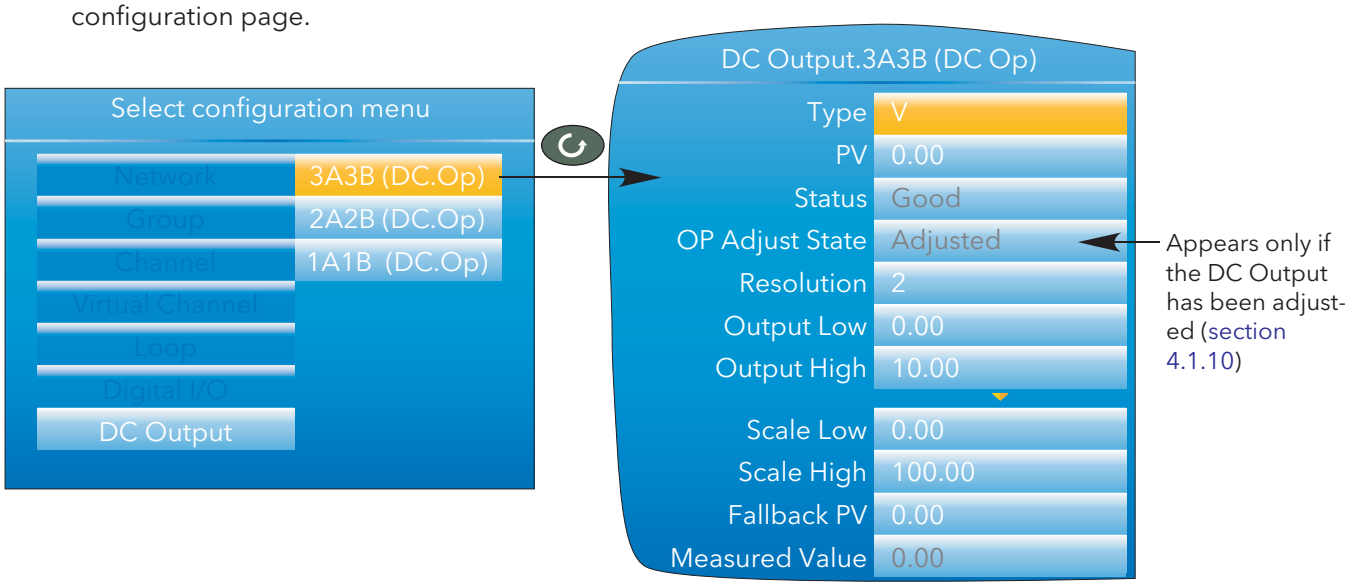


Figure 4.12.1 DC Output option configuration page (typical)

PARAMETERS

Type	Select V(olts) (3A3B only) or mA as the output type.
PV	Input value to the function. Normally 'wired' to a suitable parameter.
Status	The status of the input parameter.
OP Adjust State	Adjusted. Appears only if the Output Adjust facility (section 4.1.10) has been used.
Resolution	The number of decimal places to be used for this configuration item.
Output Low	The minimum output value in Volts or mA as appropriate
Output High	The maximum output value to be output in Volts or mA as appropriate.
Scale Low	See 'SCALING INFORMATION' below.
Scale High	See 'SCALING INFORMATION' below.
Fallback PV	The output value when the status of the input parameter is not 'good'.
Measured Value	The Voltage or mA value appearing at the output terminals

Note: The output voltage or current can be calibrated by using the output adjust procedure described in section 4.1.10.

SCALING INFORMATION

When PV = Scale Low, Output = output low value. When PV = Scale high, Output = output high value. The PV is mapped via the scale range onto the output range according to the equation:

$$\text{Output} = \left(\frac{\text{PV - Scale Low}}{\text{Scale High - Scale Low}}\right)(\text{Output High - Output Low}) + \text{Output Low}$$

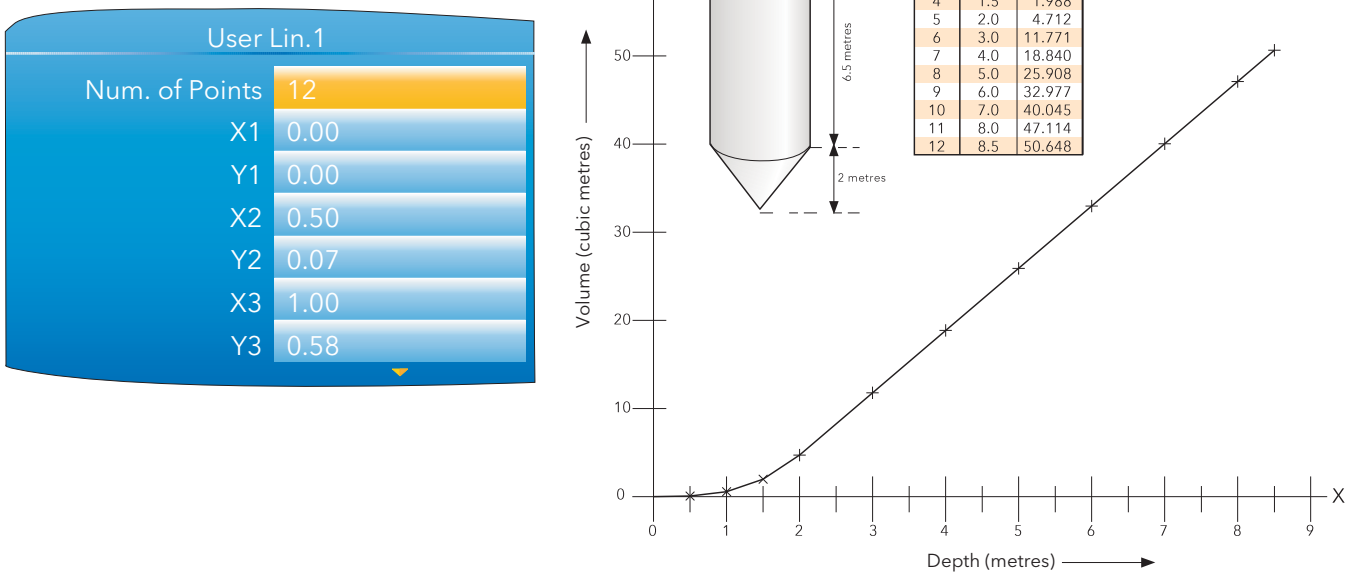
4.13 USER LIN

Allows the entry of up to four user linearisation tables, any one of which can be selected as 'Lin Type' in Channel configuration (section 4.4.1). Configuration consists of defining the number of points to be included (2 to 32) and then entering an X and a Y value for each point, where X values are the inputs and the Y values are the resulting outputs.

4.13.1 User linearisation table rules

1. Tables must be monotonic - i.e. there may not be more than one X value with the same Y value assigned to it.
2 Each X value must be greater than the preceding one.
3. Each Y value must be greater than the preceding one.
4. If units other than temperature units are to be displayed, the channel scale high and scale low values should be set to the same as the range high and low values, and the required scale units entered.

Figure 4.13.1 shows the first part of the configuration table for an imaginary cylinder example.



Point pair	X	Y
1	0.0	0.0
2	0.5	0.074
3	1.0	0.589
4	1.5	1.988
5	2.0	4.712
6	3.0	11.771
7	4.0	18.840
8	5.0	25.908
9	6.0	32.977
10	7.0	40.045
11	8.0	47.114
12	8.5	50.648

Figure 4.13.1 User Linearisation table example

When configuring a channel (section 4.4.1) to use a User linearisation table:

If Type = Thermocouple or RTD, then Range High/Low must be set to the highest and lowest 'Y' values to be used, respectively. The instrument automatically looks up the associated 'X' mV or Ohms values.

If Type = mV, V or mA, then Range High/Low must be set to the highest and lowest 'Y' values to be used, respectively. Input High/Low should be set to the highest and lowest 'X' values in the table, respectively.

4.14 CUSTOM MESSAGES

This feature allows the entry of up to 10 messages for sending to the history file, when triggered by a wired source (e.g. an alarm going active).

The messages of up to 100 characters each are entered using either the virtual keyboard, described in section 3.6, or by means of iTools configuration software.

Up to three parameter values may be embedded in messages in the format [Address], where 'Address' is the decimal Modbus address of the parameter (section5.3). E.G. [256] embeds Channel 1 PV.

4.15 ZIRCONIA BLOCK OPTION

This option allows the calculation of Carbon Potential, Dew point or Oxygen concentration. A zirconia (oxygen) probe consists of two platinum electrodes bonded to a pellet or cylinder of zirconia. At elevated temperatures, such a probe develops an emf across it which is proportional to the probe absolute temperature and to the log of the difference in oxygen partial pressure between its two ends.

The temperature of the probe is normally measured using a type K or type R thermocouple. The temperature effect on the thermocouple is such, that for successful operation, the probe temperature must be greater than 973K (700°C).

4.15.1 Definitions

TEMPERATURE CONTROL

The sensor input of the temperature loop may come from the zirconia probe but it is common for a separate thermocouple to be used. The controller provides a heating output which may be used to control gas burners. In some applications a cooling output may also be connected to a circulation fan or exhaust damper.

CARBON POTENTIAL CONTROL

The zirconia probe generates a millivolt signal based on the ratio of oxygen concentrations on the reference side of the probe (outside the furnace) to the amount of oxygen in the furnace.

The controller uses the temperature and carbon potential signals to calculate the actual percentage of carbon in the furnace. This second loop generally has two outputs. One output is connected to a valve which controls the amount of an enrichment gas supplied to the furnace. The second output controls the level of dilution air.

SOOTING ALARM

In addition to other alarms which may be detected by the controller, the instrument can trigger an alarm when the atmospheric conditions are such that carbon will be deposited as soot on all surfaces inside the furnace. The alarm may be wired to an output (e.g. relay) to initiate an external alarm.

AUTOMATIC PROBE CLEANING

The instrument has a probe clean and recovery strategy that can be programmed to occur between batches or be manually requested. At the start of the cleaning process a 'snapshot' of the probe mV is taken, and a short blast of compressed air is used to remove any soot and other particles that may have accumulated on the probe. A minimum and maximum cleaning time can be set by the user. If the probe mV has not recovered to within 5% of the snapshot value within the maximum recovery time set then an alarm is given. This indicates that the probe is ageing and replacement or refurbishment is due. During the cleaning and recovery cycle the PV is frozen, thereby ensuring continuous furnace operation. The 'Pv Frozen' parameter can be used in an individual strategy, for example to hold the integral action during cleaning.

ENDOTHERMIC GAS CORRECTION

A gas analyser may be used to determine the carbon monoxide (CO) concentration of the endothermic gas. If a 4 to 20mA output is available from the analyser, this can be applied to the instrument to adjust the calculated % carbon reading automatically. Alternatively, this value can be entered manually.

CLEAN PROBE

As these sensors are used in furnace environments they require regular cleaning. Cleaning (Burn Off) is performed by forcing compressed air through the probe. Cleaning can be initiated either manually or automatically using a timed period. During cleaning 'PV Frozen' is set to 'Yes'.

OXYGEN CONCENTRATION

In order to measure oxygen concentrations, one end of the probe is inserted into the atmosphere to be measured, whilst the other is subjected to a reference atmosphere. For most applications, air provides a suitable reference (reference input = 20.95 for air).

4.15.2 Configuration

The configuration parameters appear in one of three lists as shown in Figure 4.15.2a.

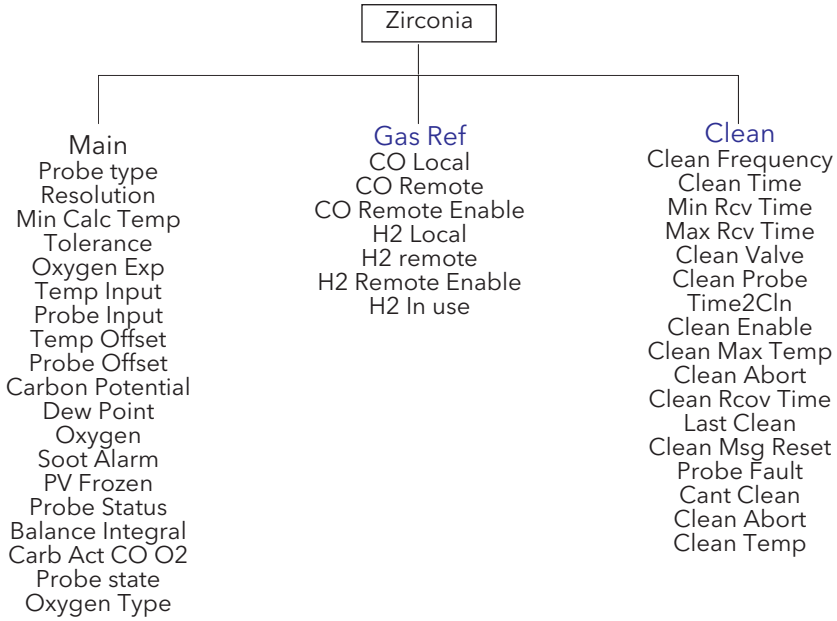


Figure 4.15.2a Zirconia probe configuration layout.

ZIRCONIA MAIN

The parameters that appear depend on the 'Probe Type' setting. For this reason, not all the parameters listed appear for all probe types. Figure 4.15.2b shows a typical configuration page.

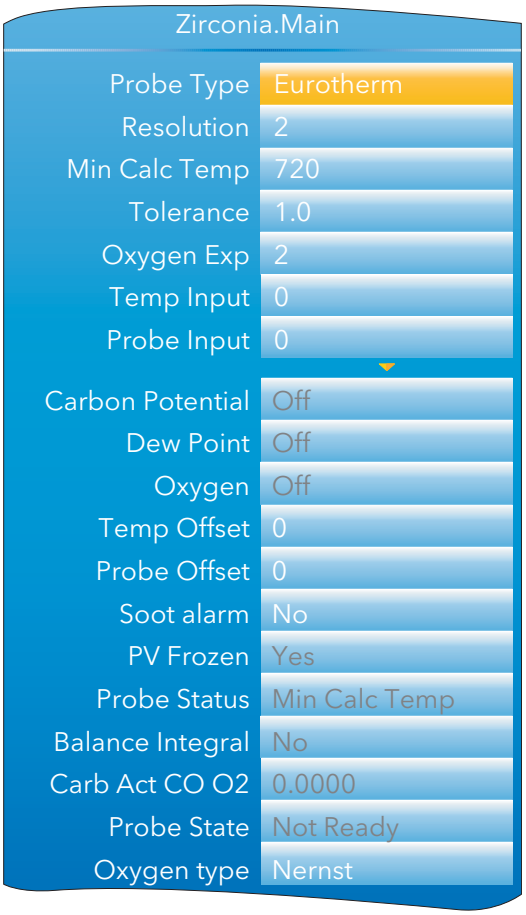


Figure 4.15.2b Zirconia Probe configuration (typical)

4.15.2 CONFIGURATION (Cont.)

MAIN PARAMETERS

Probe Type	Select from a variety of probe manufacturers. The subsequent parameter list depends on which manufacturer is selected.
Resolution	Enter the number of decimal places to be used for the value display
Gas Reference	Reference value for the hydrogen concentration in the atmosphere.
Rem Gas Ref	Remote reference value for hydrogen concentration in the atmosphere. Allows hydrogen concentration to be read from an external source.
Rem Gas Enable	'Yes' allows remote gas measurement. 'No' uses the internal Gas Reference value.
Working Gas	Read only. Working Reference Gas value
Min Calc Temp*	The minimum temperature in at which the calculation is valid.
Oxygen Exp	The exponent units of the log oxygen type calculation. valid entries -24 to +24.
Tolerance	Sooting tolerance multiplier. Allows the user to adjust the sensitivity of the Sooting alarm, in order to reduce the incidence of nuisance alarms.
Process Factor	Process factor defined by the probe manufacturer.
Clean Frequency	Allows the interval between probe cleaning cycles to be entered in hours and minutes.
Clean Time	Allows Probe clean time to be entered in hours and minutes.
Min Rcov Time	The minimum recovery time after purging in hours and minutes.
Max Rcov Time	The maximum recovery time after purging in hours and minutes.
Temp Input*	Zirconia probe temperature input value
Temp Offset*	Allows a temperature offset to be entered for the probe.
Probe Input	Zirconia probe mV input
Probe mV Offset	Allows an offset to be entered for the probe mV input
Oxygen	Read only. calculated oxygen value
Carbon Potential	Read only. The calculated carbon potential.
Dew Point	Read only. The dew point value derived from temperature and remote gas reference inputs.
Soot Alarm	Read only. Sooting alarm. Active if sooting is likely to take place. The sensitivity of the alarm can be adjusted by using the 'Tolerance' parameter, above.
Probe Fault	'Yes' indicates a sensor break.
PV Frozen	Read only. Parameter set to 'Yes' during Probe cleaning.
Clean Valve	Read only. Enable the Clean valve.
Clean State	Read only. The burn off state of the zirconia probe: 'Waiting', 'Cleaning' or 'Recovering'.Clean Probe'Yes' = Initiate probe cleaning. 'No' = Do not clean probe.
Time to Clean	Read only. The time remaining, in hours and minutes until the next cleaning cycle is due.
Probe Status	Read only. Current probe status OK — Normal working mV Sensor Brk — Probe input sensor break Temp Sensor Brk — Temperature input sensor break Min Calc Temp — Probe deteriorating
Balance Integral	This output goes 'true' when a step change in the output occurs, which requires an integral re-balance if the readings are used for PID control.
Carb Act CO O2	The carbon activity for the surface gas reaction between Carbon monoxide (CO) and Oxygen (O2)
Probe State	Read only. The current state of the probe. If 'Measuring', then the outputs are updated. For any other state (Clean, Clean Recovery, Test impedance, Impedance Recovery, Waiting), the outputs are not updated.
Oxygen Type	Oxygen equation being used.

* Temperature units are those configured for the channel to which the temperature measuring transducer is connected.

4.15.2 CONFIGURATION (Cont.)

GAS REFERENCES PARAMETERS

CO Local	Reference value for the carbon monoxide (CO) concentration in the atmosphere.
CO Remote	Remote reference value for the carbon monoxide concentration in the atmosphere. allows the value to be read remotely.
CO Remote En	'Yes' allows remote CO measurement. 'No' uses the internal value.
CO in Use	The CO gas measurement value currently being used.
H2 Local	Reference value for the hydrogen (H) concentration in the atmosphere.
H2 Remote	Remote reference value for the hydrogen concentration in the atmosphere. allows the value to be read remotely.
H2 Remote En	'Yes' allows remote H measurement. 'No' uses the internal value.
H2 In Use	The H gas measurement value currently being used.

CLEAN PARAMETERS

Clean Frequency	Allows the interval between probe cleaning cycles to be entered in hours and minutes.
Clean Time	Allows Probe clean time to be entered in hours and minutes.
Min Rcov Time	The minimum recovery time after purging in hours and minutes.
Max Rcov time	The maximum recovery time after purging in hours and minutes.
Clean Valve	Read only. Enable the Clean valve.
Clean Probe	Initiate probe cleaning
Time to Clean	Read only. The time remaining, in hours and minutes until the next cleaning cycle is due.
Clean Enable	Enable probe cleaning
Clean Max Temp	Maximum temperature for cleaning. If the temperature exceeds this value, cleaning is aborted.
Clean Abort	Abort probe cleaning
Clean Rcov Time	The time taken for the probe to recover to 95% of its original value after the last clean. If the last clean did not recover within the Max Rcov time, this value is set to 0.
Last Clean	The mV output from the probe after the last clean.
Clean Msg Reset	'Yes' clears cleaning related alarms
Probe Fault	'Yes' means that the probe failed to recover to 95% of its original output, following a clean,
Cant Clean	Conditions exist which prevent a clean cycle starting. Can be cleared using 'Clean Msg Reset'.
Clean Abort	A clean cycle was aborted. Can be cleared using 'Clean Msg Reset'.
Clean Temp	A clean cycle was aborted because the temperature was too high. Can be cleared using 'Clean Msg Reset'.

4.15.3 Wiring

Figure 4.15.3 shows a typical wiring arrangement for a Zirconia probe.

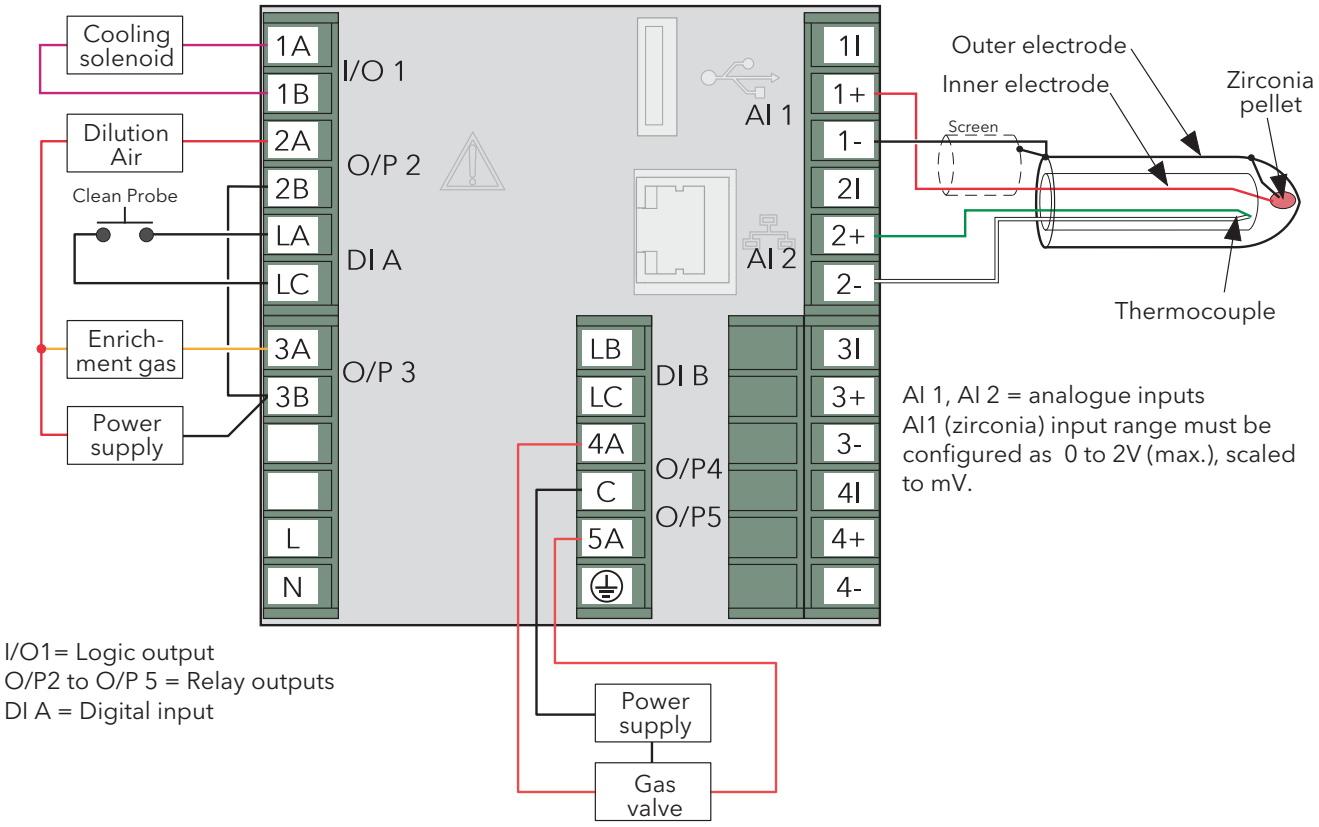


Figure 4.15.3 Typical zirconia probe wiring

4.16 STERILISER OPTION

This block provides a means of recording complete sterilisation cycles, including for example, venting and pumping as well as the actual sterilising period. See section 3.4.10 for display mode details.

Data is stored in .uhh history files for viewing in Review software.

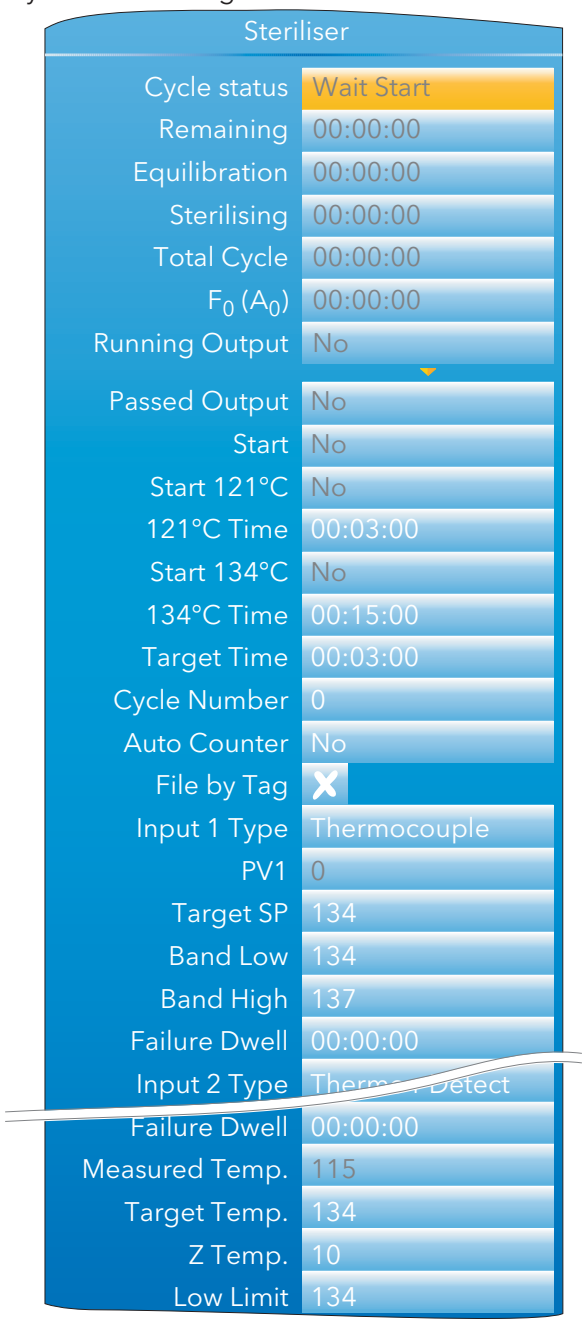


Figure 4.16 Steriliser block configuration menu

4.16.1 Configuration parameters

Cycle Status

Wait start: The cycle is waiting to be started
Waiting: Waiting for input 1 to reach its target setpoint.
Equilibration: Currently in the equilibration period
Sterilising: Currently in the sterilising phase
Passed: The cycle has completed successfully
Failed: The cycle has failed
Test cycle: A test cycle is in progress

4.16.1 CONFIGURATION PARAMETERS (Cont.)

Remaining	The sterilising time remaining for the current cycle
Equilibration	The equilibration time period for the current cycle
Sterilising	The time for which the load has currently been at sterilisation conditions
Total Cycle	The total cycle time
F_0 (A_0)	The current F_0, F_H or A_0 value
Running Output	'Yes' = Cycle running; 'No' = Cycle not running
Passed Output	'Yes' = Output passed; 'No' = Output did not pass
Start	Trigger to start a custom cycle (i.e. one for which High and Low band and / or Target setpoint have been changed from their default values.)
Start 121°C	Trigger to start a pre-defined 121°C cycle (Setpoint, Band Low/Band High etc. values are set to their 121° defaults when the cycle is initiated).
121°C Time	Target time for a121°C cycle. Automatically copied to the 'Target Time' field when Start 121°C requested. Scrollable value in hh:mm:ss format.
Start 134°C	Trigger to start a pre-defined 134°C cycle (Setpoint, Band Low/Band High etc. values are set to their 134° defaults when the cycle is initiated)
134°C Time	Target time for a134°C cycle. Automatically copied to the 'Target Time' field when Start 134°C requested. Scrollable value in hh:mm:ss format.
Target Time	The time for which the input values must remain at their sterilisation values in order that the cycle shall pass. The cycle fails if any input moves outside its specified band limits during the Target Time. Scrollable value in hh:mm:ss format.
Cycle Number	Each execution of the Steriliser block uses a unique cycle number. This may be entered manually, or can be set to increment automatically by setting 'Auto Counter' (below) to 'Yes'.
Auto Counter	'Yes' causes the Cycle Number (above) to increment automatically each time a new cycle is initiated. If Auto counter = 'Yes', the Cycle Number forms part of the historical data and can be used to help identify data during later review.
File By Tag	'Tick' ensures that each cycle is recorded in its own unique history file identified by cycle number and 'File tag' (below).
File tag	This field appears only if 'File By Tag' is enabled (tick symbol). File tag allows a four-character identifier to be entered to be used with the Cycle Number (above) to identify the history file
Input n Type	Select 'Off', 'Thermocouple', 'Rising Pressure', 'Falling pressure', 'Rise Air Detect', or 'Fall Air Detect'.
	Off — This input will not be included in steriliser monitoring calculations
	Thermocouple — Degrees Celsius input
	Rising pressure — A mBar pressure input with a rising pressure expected during the cycle. This pressure input would normally be synchronised with a temperature input, in the same chamber, when performing a 121°C or 134°C cycle.
	Falling pressure — As 'Rising Pressure' above, but with a falling pressure expected during the cycle
	Rise Air Detect — A mBar pressure input with a rising pressure expected during the cycle. This pressure input is not synchronised with a temperature input when performing a 121°C or 134°C cycle, as it is (typically) an outside chamber pressure.
	Fall Air Detect — As 'Rise Air Detect' above, but with a falling pressure expected during the cycle
PV n	Input value (wireable only). See note 1 below.
Target SP	Target setpoint for this input. (Does not appear if relevant Input Type = 'Off'.) See note 2 below.
Band Low/High	The low and high steriliser temperature or pressure band for this input. (Does not appear if relevant Input Type = 'Off'.) See note 2 below. Values are effective only during Sterilisation mode.

4.16.1 CONFIGURATION PARAMETERS (Cont.)

Failure Dwell — A failure alarm is set if this input is out of band range for more than the Failure Dwell time. Scrollable value in hh:mm:ss format.

Notes
1. n = 1 to 4, where typically, inputs 1 to 3 are temperature inputs and input 4 is a pressure input.
2. Target SP and Band High/Low values are set to their relevant default values when a 121°C or 134°C cycle is initiated.

Measured Temp. — For F_0 or A_0 calculations, this value must be in °C. Typically wired to an input channel PV .

Target Temp. — For F_0 or A_0 calculations, the target temperature (see section 3.4.10 for details). This typically is the same value as the Target SP (above).

Z Temp. — For F_0 or A_0 calculations this is a temperature interval representing a factor-of-10 increase in killing efficiency. Z = 10°C for F_0 and A_0, and 20°C for F_H

Low Limit — The temperature below which F_0 or A_0 calculations are suspended.

4.17 HUMIDITY BLOCK OPTION

This block uses wet and dry bulb temperatures, and atmospheric pressure inputs to derive values for relative humidity and dew point.

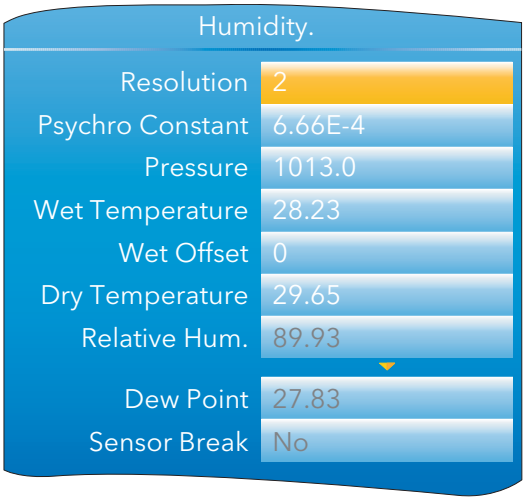


Figure 4.17 Humidity calculation configuration

4.17.1 Configuration parameters

Resolution — The number of decimal places for the Relative humidity and Dew point displays.

Psychro constant — The psychrometric constant (default = 6.66×10^{-4}) (See note below).

Pressure — The current atmospheric pressure in mBar.

Wet Temperature — The wet bulb thermometer temperature.

Wet Offset — Offset for the wet bulb temperature.

Dry Temperature — The dry bulb thermometer temperature.

Relative Hum. — The relative humidity value calculated from the Wet temperature, the Dry temperature and the Pressure inputs. The number of decimal places depends on the Resolution setting.

Dew Point — The dew point value calculated from the Wet temperature, the Dry temperature and the Pressure inputs. The number of decimal places depends on the Resolution setting.

Sensor Break — 'Yes' implies that a break has occurred between one (or more) of the temperature or pressure transducer and its input.

Note: The default value 6.66 may be edited, but the multiplier is always 10^{-4} (i.e. it cannot be edited).

4.18 BCD INPUT

Part of the 'Toolkit Blocks' option, this block derives decimal and two-decade binary coded decimal (BCD) values from eight discrete inputs, where input 1 is the least significant input ($2^0 = 1$) and input 8 is the most significant ($2^7 = 128$). The example below shows that for inputs 2, 4, 6 and 8 high, the decimal input value is 170, but the BCD value is invalid. In any such case, the maximum BCD value for each decade is limited to 9.

Input number	8	7	6	5	4	3	2	1	
Input status	1	0	1	0	1	0	1	0	
Decimal input	128	0	32	0	8	0	2	0	(=170)
BCD output	1	0	1	0	1	0	1	0	(=10, 10)

Figure 4.18 BCD block example

4.18.1 Input rules

Valid BCD outputs are produced only with the following inputs set:

1. Any combination of inputs 1, 2, 3, 5, 6 and 7
2. Any combination of Inputs 1, 4, 5 and 8

4.18.2 Configuration

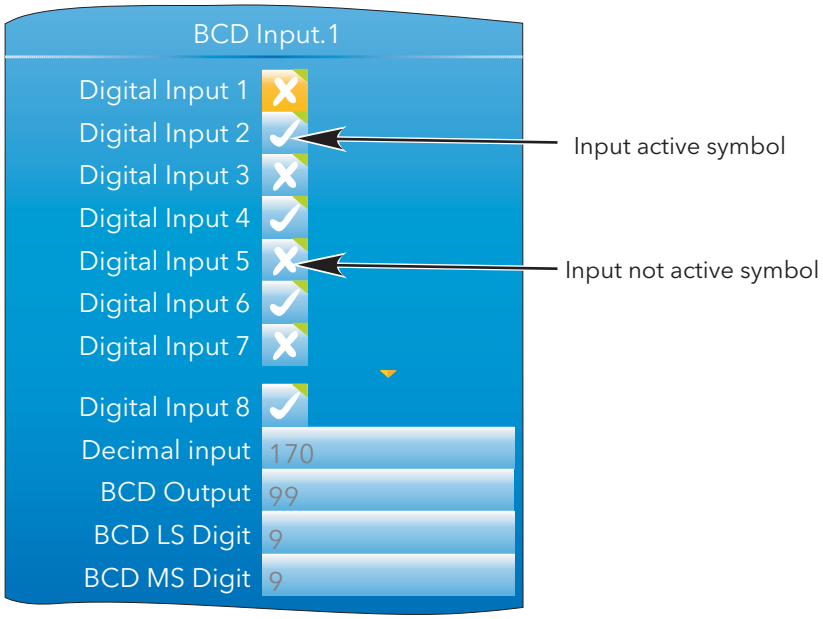


Figure 4.18.2 BCD block configuration

PARAMETERS

Digital Input N	Digital inputs, wired (for example) to contact inputs at the rear panel or to other suitable parameter outputs.
Decimal input	The value defined by the active inputs, where input 1 = 1, when active, input 2 = 2, input 3 = 4, input 4 = 8 and so on.
BCD Output	A two digit output being the binary coded decimal version of the input.
BCD LS Digit	This least significant (right-most) digit represents the value of inputs 1 to 4, where input 1 = 1, input 2 = 2, input 3 = 4, input 4 = 8. Maximum value = 9, even if input is greater than 9.
BCD MS Digit	This most significant (left-most) digit represents the value of inputs 5 to 8, where input 5 = 1, input 6 = 2, input 7 = 4, input 8 = 8. Maximum value = 9, even if input is greater than 9.

4.19 LOGIC (2 INPUT) BLOCK

Part of the 'Toolkit Blocks' option, this block allows a number of logic and comparison operations to be performed on a pair of inputs. For logic functions, the inputs can be inverted to allow, for example, a NOR function to be implemented by inverting the inputs to an AND function. 12 two-input logic blocks are available.

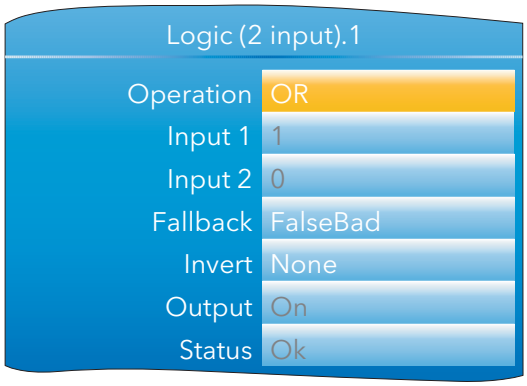


Figure 4.19 Two-input logic block configuration

4.19.1 Parameters

Operation	AND, OR, XOR, LATCH (boolean values only) == (Input 1 = Input 2) <> (Input 1 ≠ Input 2) < (Input 1 < Input 2} <= (Input 1 ≤ Input 2) > (Input 1 > Input 2) => (Input 1 ≥ Input 2)
Input 1(2)	The inputs to the specified operation. For inverted inputs (below), this shows the 'real' (non-inverted) state.
Fallback	Configures the output and status values to be used if either input has a status other than 'Good'. FalseBad: Output = False; Status = Bad TrueBad: Output = True; Status = Bad FalseGood: Output = False; Status = Good TrueGood: Output = True; Status = Good
Invert	For logic operators only allows neither, either or both inputs to be inverted. Input 1 and Input 2 show the non-inverted state.
Output	On or Off depending on input states etc.
Status	The status of the result ('Ok' or 'Error').

4.20 LOGIC (8 INPUT) BLOCK

Part of the 'Toolkit Blocks' option, this block allows AND, OR and cascading* XOR logic operations to be carried out on up to eight inputs.

*Cascading XOR example for inputs 1 to 4: (((Input1 ⊕ Input2) ⊕ Input3) ⊕ Input4).

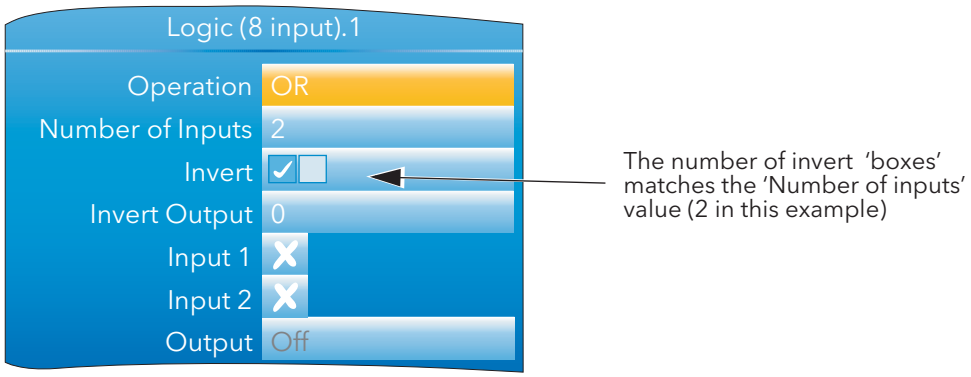


Figure 4.20 Eight input logic block configuration

4.20.1 Parameters

Operation	AND, OR or XOR
Number of inputs	The number of inputs to the logic operator
Invert	Allows the user to invert individual inputs, as described below.
Invert Output	'Yes' inverts the output status
Input 1	The status of input 1, ignoring the Invert status. Cross = off; Tick = on.
Inputs 2 to N	As for input 1, where N = the value of the 'Number of Inputs' parameter.
Output	On or Off. Includes the effect of 'Invert Output' status.

INPUT INVERSION

1. Use the down arrow key to highlight the 'Invert' field and operate the scroll key to enter edit mode
2. Use the up arrow key to highlight the first input to be inverted (the relevant input numbers appear in the display boxes for uninverted inputs when highlighted).
3. Once the required input box is highlighted, use the scroll key to change the numeric character to a tick symbol (to invert) or change the tick character to a numeric character (to remove a previous inversion).
4. Repeat for any further inputs, then operate the page key to confirm the changes and to quit edit mode.

4.20.2 Schematic

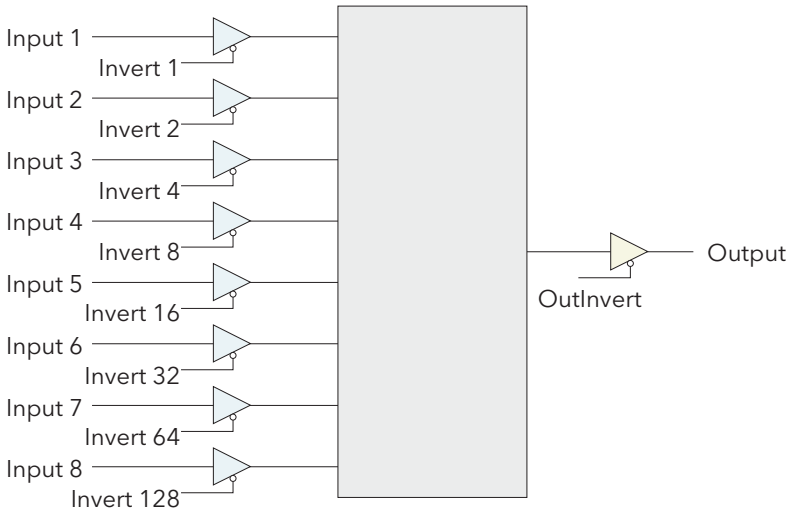


Figure 4.20.2 Logic (8 input) block schematic

4.20.3 Invert input decoding table

Over a communications link, the inversion status is transmitted as a decimal value, which can be encoded/ decoded using the following table

Input 8	7	6	5	4	3	2	1	Hex	Dec	Input 8	7	6	5	4	3	2	1	Hex	Dec	Input 8	7	6	5	4	3	2	1	Hex	Dec	Input 8	7	6	5	4	3	2	1	Hex	Dec
N	N	N	N	N	N	N	N	00	0	N	**7**	N	N	N	N	N	N	40	64	**8**	N	N	N	N	N	N	N	80	128	**8**	**7**	N	N	N	N	N	C0	192
N	N	N	N	N	N	N	**1**	01	1	N	**7**	N	N	N	N	N	**1**	41	65	**8**	N	N	N	N	N	N	**1**	81	129	**8**	**7**	N	N	N	N	N	**1**	C1	193
N	N	N	N	N	N	**2**	N	02	2	N	**7**	N	N	N	N	**2**	N	42	66	**8**	N	N	N	N	N	**2**	N	82	130	**8**	**7**	N	N	N	N	**2**	N	C2	194
N	N	N	N	N	N	**2**	**1**	03	3	N	**7**	N	N	N	N	**2**	**1**	43	67	**8**	N	N	N	N	N	**2**	**1**	83	131	**8**	**7**	N	N	N	N	**2**	**1**	C3	195
N	N	N	N	N	**3**	N	N	04	4	N	**7**	N	N	N	**3**	N	N	44	68	**8**	N	N	N	N	**3**	N	N	84	132	**8**	**7**	N	N	N	**3**	N	N	C4	196
N	N	N	N	N	**3**	N	**1**	05	5	N	**7**	N	N	N	**3**	N	**1**	45	69	**8**	N	N	N	N	**3**	N	**1**	85	133	**8**	**7**	N	N	N	**3**	N	**1**	C5	197
N	N	N	N	N	**3**	**2**	N	06	6	N	**7**	N	N	N	**3**	**2**	N	46	70	**8**	N	N	N	N	**3**	**2**	N	86	134	**8**	**7**	N	N	N	**3**	**2**	N	C6	198
N	N	N	N	N	**3**	**2**	**1**	07	7	N	**7**	N	N	N	**3**	**2**	**1**	47	71	**8**	N	N	N	N	**3**	**2**	**1**	87	135	**8**	**7**	N	N	N	**3**	**2**	**1**	C7	199
N	N	N	N	**4**	N	N	N	08	8	N	**7**	N	N	**4**	N	N	N	48	72	**8**	N	N	N	**4**	N	N	N	88	136	**8**	**7**	N	N	**4**	N	N	N	C8	200
N	N	N	N	**4**	N	N	**1**	09	9	N	**7**	N	N	**4**	N	N	**1**	49	73	**8**	N	N	N	**4**	N	N	**1**	89	137	**8**	**7**	N	N	**4**	N	N	**1**	C9	201
N	N	N	N	**4**	N	**2**	N	0A	10	N	**7**	N	N	**4**	N	**2**	N	4A	74	**8**	N	N	N	**4**	N	**2**	N	8A	138	**8**	**7**	N	N	**4**	N	**2**	N	CA	202
N	N	N	N	**4**	N	**2**	**1**	0B	11	N	**7**	N	N	**4**	N	**2**	**1**	4B	75	**8**	N	N	N	**4**	N	**2**	**1**	8B	139	**8**	**7**	N	N	**4**	N	**2**	**1**	CB	203
N	N	N	N	**4**	**3**	N	N	0C	12	N	**7**	N	N	**4**	**3**	N	N	4C	76	**8**	N	N	N	**4**	**3**	N	N	8C	140	**8**	**7**	N	N	**4**	**3**	N	N	CC	204
N	N	N	N	**4**	**3**	N	**1**	0D	13	N	**7**	N	N	**4**	**3**	N	**1**	4D	77	**8**	N	N	N	**4**	**3**	N	**1**	8D	141	**8**	**7**	N	N	**4**	**3**	N	**1**	CD	205
N	N	N	N	**4**	**3**	**2**	N	0E	14	N	**7**	N	N	**4**	**3**	**2**	N	4E	78	**8**	N	N	N	**4**	**3**	**2**	N	8E	142	**8**	**7**	N	N	**4**	**3**	**2**	N	CE	206
N	N	N	N	**4**	**3**	**2**	**1**	0F	15	N	**7**	N	N	**4**	**3**	**2**	**1**	4F	79	**8**	N	N	N	**4**	**3**	**2**	**1**	8F	143	**8**	**7**	N	N	**4**	**3**	**2**	**1**	CF	207
N	N	N	**5**	N	N	N	N	10	16	N	**7**	N	**5**	N	N	N	N	50	80	**8**	N	N	**5**	N	N	N	N	90	144	**8**	**7**	N	**5**	N	N	N	N	D0	208
N	N	N	**5**	N	N	N	**1**	11	17	N	**7**	N	**5**	N	N	N	**1**	51	81	**8**	N	N	**5**	N	N	N	**1**	91	145	**8**	**7**	N	**5**	N	N	N	**1**	D1	209
N	N	N	**5**	N	N	**2**	N	12	18	N	**7**	N	**5**	N	N	**2**	N	52	82	**8**	N	N	**5**	N	N	**2**	N	92	146	**8**	**7**	N	**5**	N	N	**2**	N	D2	210
N	N	N	**5**	N	N	**2**	**1**	13	19	N	**7**	N	**5**	N	N	**2**	**1**	53	83	**8**	N	N	**5**	N	N	**2**	**1**	93	147	**8**	**7**	N	**5**	N	N	**2**	**1**	D3	211
N	N	N	**5**	N	**3**	N	N	14	20	N	**7**	N	**5**	N	**3**	N	N	54	84	**8**	N	N	**5**	N	**3**	N	N	94	148	**8**	**7**	N	**5**	N	**3**	N	N	D4	212
N	N	N	**5**	N	**3**	N	**1**	15	21	N	**7**	N	**5**	N	**3**	N	**1**	55	85	**8**	N	N	**5**	N	**3**	N	**1**	95	149	**8**	**7**	N	**5**	N	**3**	N	**1**	D5	213
N	N	N	**5**	N	**3**	**2**	N	16	22	N	**7**	N	**5**	N	**3**	**2**	N	56	86	**8**	N	N	**5**	N	**3**	**2**	N	96	150	**8**	**7**	N	**5**	N	**3**	**2**	N	D6	214
N	N	N	**5**	N	**3**	**2**	**1**	17	23	N	**7**	N	**5**	N	**3**	**2**	**1**	57	87	**8**	N	N	**5**	N	**3**	**2**	**1**	97	151	**8**	**7**	N	**5**	N	**3**	**2**	**1**	D7	215
N	N	N	**5**	**4**	N	N	N	18	24	N	**7**	N	**5**	**4**	N	N	N	58	88	**8**	N	N	**5**	**4**	N	N	N	98	152	**8**	**7**	N	**5**	**4**	N	N	N	D8	216
N	N	N	**5**	**4**	N	N	**1**	19	25	N	**7**	N	**5**	**4**	N	N	**1**	59	89	**8**	N	N	**5**	**4**	N	N	**1**	99	153	**8**	**7**	N	**5**	**4**	N	N	**1**	D9	217
N	N	N	**5**	**4**	N	**2**	N	1A	26	N	**7**	N	**5**	**4**	N	**2**	N	5A	90	**8**	N	N	**5**	**4**	N	**2**	N	9A	154	**8**	**7**	N	**5**	**4**	N	**2**	N	DA	218
N	N	N	**5**	**4**	N	**2**	**1**	1B	27	N	**7**	N	**5**	**4**	N	**2**	**1**	5B	91	**8**	N	N	**5**	**4**	N	**2**	**1**	9B	155	**8**	**7**	N	**5**	**4**	N	**2**	**1**	DB	219
N	N	N	**5**	**4**	**3**	N	N	1C	28	N	**7**	N	**5**	**4**	**3**	N	N	5C	92	**8**	N	N	**5**	**4**	**3**	N	N	9C	156	**8**	**7**	N	**5**	**4**	**3**	N	N	DC	220
N	N	N	**5**	**4**	**3**	N	**1**	1D	29	N	**7**	N	**5**	**4**	**3**	N	**1**	5D	93	**8**	N	N	**5**	**4**	**3**	N	**1**	9D	157	**8**	**7**	N	**5**	**4**	**3**	N	**1**	DD	221
N	N	N	**5**	**4**	**3**	**2**	N	1E	30	N	**7**	N	**5**	**4**	**3**	**2**	N	5E	94	**8**	N	N	**5**	**4**	**3**	**2**	N	9E	158	**8**	**7**	N	**5**	**4**	**3**	**2**	N	DE	222
N	N	N	**5**	**4**	**3**	**2**	**1**	1F	31	N	**7**	N	**5**	**4**	**3**	**2**	**1**	5F	95	**8**	N	N	**5**	**4**	**3**	**2**	**1**	9F	159	**8**	**7**	N	**5**	**4**	**3**	**2**	**1**	DF	223
N	N	**6**	N	N	N	N	N	20	32	N	**7**	**6**	N	N	N	N	N	60	96	**8**	N	**6**	N	N	N	N	N	A0	160	**8**	**7**	**6**	N	N	N	N	N	E0	224
N	N	**6**	N	N	N	N	**1**	21	33	N	**7**	**6**	N	N	N	N	**1**	61	97	**8**	N	**6**	N	N	N	N	**1**	A1	161	**8**	**7**	**6**	N	N	N	N	**1**	E1	225
N	N	**6**	N	N	N	**2**	N	22	34	N	**7**	**6**	N	N	N	**2**	N	62	98	**8**	N	**6**	N	N	N	**2**	N	A2	162	**8**	**7**	**6**	N	N	N	**2**	N	E2	226
N	N	**6**	N	N	N	**2**	**1**	23	35	N	**7**	**6**	N	N	N	**2**	**1**	63	99	**8**	N	**6**	N	N	N	**2**	**1**	A3	163	**8**	**7**	**6**	N	N	N	**2**	**1**	E3	227
N	N	**6**	N	N	**3**	N	N	24	36	N	**7**	**6**	N	N	**3**	N	N	64	100	**8**	N	**6**	N	N	**3**	N	N	A4	164	**8**	**7**	**6**	N	N	**3**	N	N	E4	228
N	N	**6**	N	N	**3**	N	**1**	25	37	N	**7**	**6**	N	N	**3**	N	**1**	65	101	**8**	N	**6**	N	N	**3**	N	**1**	A5	165	**8**	**7**	**6**	N	N	**3**	N	**1**	E5	229
N	N	**6**	N	N	**3**	**2**	N	26	38	N	**7**	**6**	N	N	**3**	**2**	N	66	102	**8**	N	**6**	N	N	**3**	**2**	N	A6	166	**8**	**7**	**6**	N	N	**3**	**2**	N	E6	230
N	N	**6**	N	N	**3**	**2**	**1**	27	39	N	**7**	**6**	N	N	**3**	**2**	**1**	67	103	**8**	N	**6**	N	N	**3**	**2**	**1**	A7	167	**8**	**7**	**6**	N	N	**3**	**2**	**1**	E7	231
N	N	**6**	N	**4**	N	N	N	28	40	N	**7**	**6**	N	**4**	N	N	N	68	104	**8**	N	**6**	N	**4**	N	N	N	A8	168	**8**	**7**	**6**	N	**4**	N	N	N	E8	232
N	N	**6**	N	**4**	N	N	**1**	29	41	N	**7**	**6**	N	**4**	N	N	**1**	69	105	**8**	N	**6**	N	**4**	N	N	**1**	A9	169	**8**	**7**	**6**	N	**4**	N	N	**1**	E9	233
N	N	**6**	N	**4**	N	**2**	N	2A	42	N	**7**	**6**	N	**4**	N	**2**	N	6A	106	**8**	N	**6**	N	**4**	N	**2**	N	AA	170	**8**	**7**	**6**	N	**4**	N	**2**	N	EA	234
N	N	**6**	N	**4**	N	**2**	**1**	2B	43	N	**7**	**6**	N	**4**	N	**2**	**1**	6B	107	**8**	N	**6**	N	**4**	N	**2**	**1**	AB	171	**8**	**7**	**6**	N	**4**	N	**2**	**1**	EB	235
N	N	**6**	N	**4**	**3**	N	N	2C	44	N	**7**	**6**	N	**4**	**3**	N	N	6C	108	**8**	N	**6**	N	**4**	**3**	N	N	AC	172	**8**	**7**	**6**	N	**4**	**3**	N	N	EC	236
N	N	**6**	N	**4**	**3**	N	**1**	2D	45	N	**7**	**6**	N	**4**	**3**	N	**1**	6D	109	**8**	N	**6**	N	**4**	**3**	N	**1**	AD	173	**8**	**7**	**6**	N	**4**	**3**	N	**1**	ED	237
N	N	**6**	N	**4**	**3**	**2**	N	2E	46	N	**7**	**6**	N	**4**	**3**	**2**	N	6E	110	**8**	N	**6**	N	**4**	**3**	**2**	N	AE	174	**8**	**7**	**6**	N	**4**	**3**	**2**	N	EE	238
N	N	**6**	N	**4**	**3**	**2**	**1**	2F	47	N	**7**	**6**	N	**4**	**3**	**2**	**1**	6F	111	**8**	N	**6**	N	**4**	**3**	**2**	**1**	AF	175	**8**	**7**	**6**	N	**4**	**3**	**2**	**1**	EF	239
N	N	**6**	**5**	N	N	N	N	30	48	N	**7**	**6**	**5**	N	N	N	N	70	112	**8**	N	**6**	**5**	N	N	N	N	B0	176	**8**	**7**	**6**	**5**	N	N	N	N	F0	240
N	N	**6**	**5**	N	N	N	**1**	31	49	N	**7**	**6**	**5**	N	N	N	**1**	71	113	**8**	N	**6**	**5**	N	N	N	**1**	B1	177	**8**	**7**	**6**	**5**	N	N	N	**1**	F1	241
N	N	**6**	**5**	N	N	2	N	32	50	N	**7**	**6**	**5**	N	N	**2**	N	72	114	**8**	N	**6**	**5**	N	N	**2**	N	B2	178	**8**	**7**	**6**	**5**	N	N	**2**	N	F2	242
N	N	**6**	**5**	N	N	**2**	**1**	33	51	N	**7**	**6**	**5**	N	N	**2**	**1**	73	115	**8**	N	**6**	**5**	N	N	**2**	**1**	B3	179	**8**	**7**	**6**	**5**	N	N	**2**	**1**	F3	243
N	N	**6**	**5**	N	**3**	N	N	34	52	N	**7**	**6**	**5**	N	**3**	N	N	74	116	**8**	N	**6**	**5**	N	**3**	N	N	B4	180	**8**	**7**	**6**	**5**	N	**3**	N	N	F4	244
N	N	**6**	**5**	N	**3**	N	**1**	35	53	N	**7**	**6**	**5**	N	**3**	N	**1**	75	117	**8**	N	**6**	**5**	N	**3**	N	**1**	B5	181	**8**	**7**	**6**	**5**	N	**3**	N	**1**	F5	245
N	N	**6**	**5**	N	**3**	**2**	N	36	54	N	**7**	**6**	**5**	N	**3**	**2**	N	76	118	**8**	N	**6**	**5**	N	**3**	**2**	N	B6	182	**8**	**7**	**6**	**5**	N	**3**	**2**	N	F6	246
N	N	**6**	**5**	N	**3**	**2**	**1**	37	55	N	**7**	**6**	**5**	N	**3**	**2**	**1**	77	119	**8**	N	**6**	**5**	N	**3**	**2**	**1**	B7	183	**8**	**7**	**6**	**5**	N	**3**	**2**	**1**	F7	247
N	N	**6**	**5**	**4**	N	N	N	38	56	N	**7**	**6**	**5**	**4**	N	N	N	78	120	**8**	N	**6**	**5**	**4**	N	N	N	B8	184	**8**	**7**	**6**	**5**	**4**	N	N	N	F8	248
N	N	**6**	**5**	**4**	N	N	**1**	39	57	N	**7**	**6**	**5**	**4**	N	N	**1**	79	121	**8**	N	**6**	**5**	**4**	N	N	**1**	B9	185	**8**	**7**	**6**	**5**	**4**	N	N	**1**	F9	249
N	N	**6**	**5**	**4**	N	**2**	N	3A	58	N	**7**	**6**	**5**	**4**	N	**2**	N	7A	122	**8**	N	**6**	**5**	**4**	N	**2**	N	BA	186	**8**	**7**	**6**	**5**	**4**	N	**2**	N	FA	250
N	N	**6**	**5**	**4**	N	**2**	**1**	3B	59	N	**7**	**6**	**5**	**4**	N	**2**	**1**	7B	123	**8**	N	**6**	**5**	**4**	N	**2**	**1**	BB	187	**8**	**7**	**6**	**5**	**4**	N	**2**	**1**	FB	251
N	N	**6**	**5**	**4**	**3**	N	N	3C	60	N	**7**	**6**	**5**	**4**	**3**	N	N	7C	124	**8**	N	**6**	**5**	**4**	**3**	N	N	BC	188	**8**	**7**	**6**	**5**	**4**	**3**	N	N	FC	252
N	N	**6**	**5**	**4**	**3**	N	**1**	3D	61	N	**7**	**6**	**5**	**4**	**3**	N	**1**	7D	125	**8**	N	**6**	**5**	**4**	**3**	N	**1**	BD	189	**8**	**7**	**6**	**5**	**4**	**3**	N	**1**	FD	253
N	N	**6**	**5**	**4**	**3**	**2**	N	3E	62	N	**7**	**6**	**5**	**4**	**3**	**2**	N	7E	126	**8**	N	**6**	**5**	**4**	**3**	**2**	N	BE	190	**8**	**7**	**6**	**5**	**4**	**3**	**2**	N	FE	254
N	N	**6**	**5**	**4**	**3**	**2**	**1**	3F	63	N	**7**	**6**	**5**	**4**	**3**	**2**	**1**	7F	127	**8**	N	**6**	**5**	**4**	**3**	**2**	**1**	BF	191	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	FF	255

Example: Decimal 146 means that inputs 8, 5 and 2 are inverted.

4.21 Multiplexer block

This 'Toolkit' option block selects one of eight analogue inputs to appear at its output

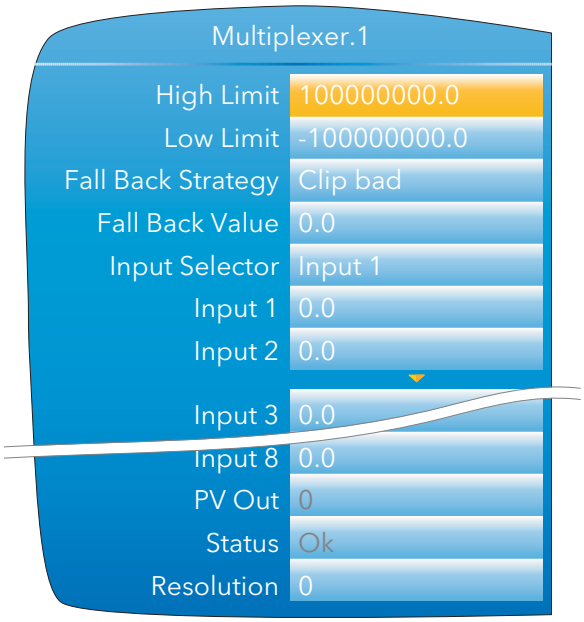


Figure 4.21 Multiplexer block configuration

4.21.1 Configuration parameters

High Limit	The high limit for input, output and fallback values. Minimum value is Low Limit.
Low Limit	The low limit for input and fallback values. Maximum value is High Limit.
Fallback Strategy	Clip Bad: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the appropriate limit, and the status is set to 'Bad'. If the input signal is within the limits, but its status is bad, the output is set to the Fallback value. Clip Good: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the appropriate limit, and the status is set to 'Good'. If the input signal is within the limits, but its status is bad, the output is set to the Fallback value. Fall Bad: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the Fallback value, and the status is set to 'Bad' Fall Good: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the Fallback value, and the status is set to 'Good' Upscale: If the input status is bad, or if the input signal is above 'High Limit' or below 'Low Limit', the output value is set to the High limit. Downscale: If the input status is bad, or if the input signal is above 'High Limit' or below 'Low Limit', the output value is set to the Low limit.
Fallback Value	The value to be adopted by the output, under error conditions, if 'Fallback Status' is set to 'Fall Good' or 'Fall Bad'.
Input Selector	Selects which of the eight inputs is presented at the output. When wired to a suitable parameter, Input Selector becomes read only. Input 1 is selected for an Input Selector value of 1, Input 2 for a value of 2 and so on. Input Selector values greater than 8 are ignored. If not wired, the user may select the required input using the scroll keys.
Input 1 to 8	Wired to the relevant analogue inputs.
PV Out	The output from the multiplexer block.
Status	Indicates the status of the operation as 'Ok' or 'Error'.
Resolution	The number of decimal places for the output value (maximum = 6)

4.22 MATH (2 INPUT)

This 'Toolkit' option block allows one of a number of operations to be carried out using two input values which may be analogue or digital in nature. Either or both of the inputs can be scaled, using a 'Multiplier'.

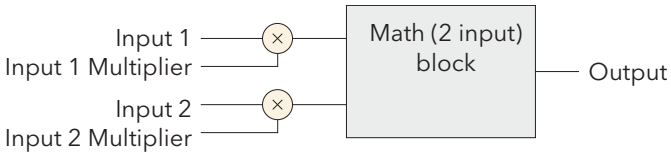


Figure 4.22a Block schematic

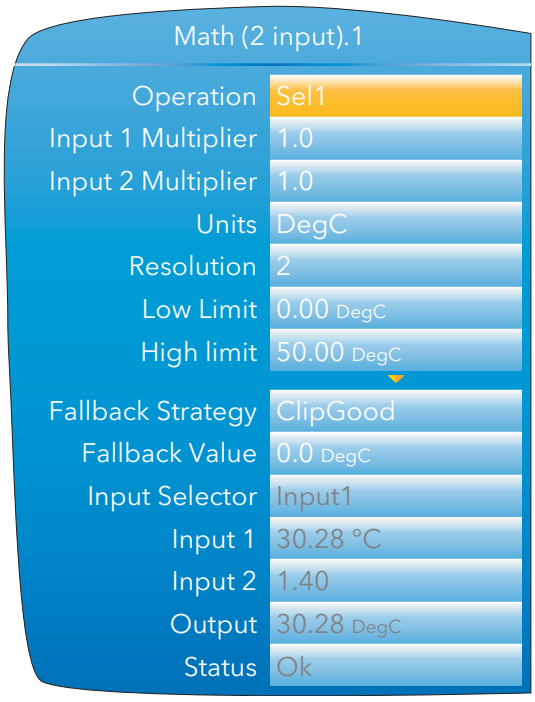


Figure 4.22b Block configuration (typical)

4.22.1 Parameters

Operation	Add	Output = Input 1 + Input 2
	Subtract	Output = Input 1 - Input 2
	Multiply	Output = Input 1 x Input 2
	Divide	Output = Input 1 ÷ Input 2
	Abs Diff	Output = the difference between Input 1 and Input 2, ignoring sign
	Select Max	Output = whichever is the larger of Input 1 or Input 2
	Select Min	Output = whichever is the smaller of Input 1 or Input 2
	Hot Swap	Output = Input 2 if Input 1 is 'Bad'; otherwise Output = Input 1
	Sample/Hold	Output tracks Input 1 whilst Input 2 = 1. Output value is held whilst Input 2 = 0 (See section 4.22.2, below, for more details)
	Power*	Output = Input 1 to the power of Input 2. (Output = Input $1^{Input\ 2}$)
	Square Root	Output = √Input 1 (Input 2 ignored)
	Log Base 10	Output = Log_{10} Input 1 (Input 2 ignored)
	Log Base e	Output = Ln Input 1 (Input 2 ignored)
	Exponential	Output = e^{Input1} (Input 2 ignored)
	10 to the X	Output = $10^{Input\ 1}$ (Input 2 ignored)
	Sel1	Output = Input 1 if Input Selector = Input1 Output = Input 2 if Input Selector = Input2

* Note... For this implementation:
0 to the power 0 = 1.
Negative values raised to any power result in bad status.
0 raised to a negative power results in bad status.

4.22.1 PARAMETERS (Cont.)

Input 1(2) Multiplier	The scaling factor for input 1(2). This multiplying factor is applied to the input of the function, but does not affect the displayed values of Input1 and Input 2 (below).
Units	Allows a five-character string to be entered for the function
Resolution	Sets the number of decimal places for the Output value. Input resolution (if applicable) is that of the relevant input.
High Limit	The high limit for input, output and fallback values. Minimum value is Low Limit.
Low Limit	The low limit for input and fallback values. Maximum value is High Limit.
Fallback Strategy	Clip Bad: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the appropriate limit, and the status is set to 'Bad'. If the input signal is within the limits, but its status is bad, the output is set to the Fall Back value. Clip Good: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the appropriate limit, and the status is set to 'Good'. If the input signal is within the limits, but its status is bad, the output is set to the Fall Back value. Fall Bad: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the Fall Back value, and the status is set to 'Bad' Fall Good: If the input value is above 'High Limit' or below 'Low Limit', then the output value is set to the Fall Back value, and the status is set to 'Good' Upscale: If the input status is bad, or if the input signal is above 'High Limit' or below 'Low Limit', the output value is set to the High limit. Downscale: If the input status is bad, or if the input signal is above 'High Limit' or below 'Low Limit', the output value is set to the Low limit.
Fallback Value	The value to be adopted by the output, under error conditions, if 'Fallback Status' is set to 'Fall Good' or 'Fall Bad'.
Input Selector	For 'Select' operation only. When wired to a suitable parameter, Input Select becomes read only. Input 1 is selected if 'Input Select' = 1; Input 2 is selected if 'Input Select' = 2. Input Select values greater than 2 are ignored. If not wired, the user may select the required input using the scroll keys.
Input 1(2)	Wired to suitable input parameters. Displayed values ignore any input multiplier effects.
Output	Gives the output value for the operation.
Status	Shows the status of the output value, as 'Ok' or 'Error'

4.22.2 Sample and Hold details

As described above, Output follows Input1 as long as Input 2 is 'High'. When Input 2 goes Low, the output adopts the instantaneous value of Input 1 until Input 2 goes High again. When Input 2 goes high the output jumps to the current value of Input 1 and tracks it until Input 2 goes low.

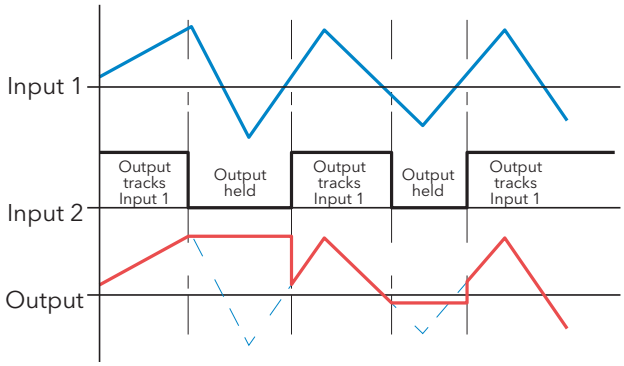


Figure 4.22.2 Sample and Hold example

4.23 TIMER

This 'Toolkit' option allows the user to configure up to four timers as: 'On Pulse', 'On Delay', 'One Shot' or 'Min On' types. The different types are described in section 4.23.2, below.

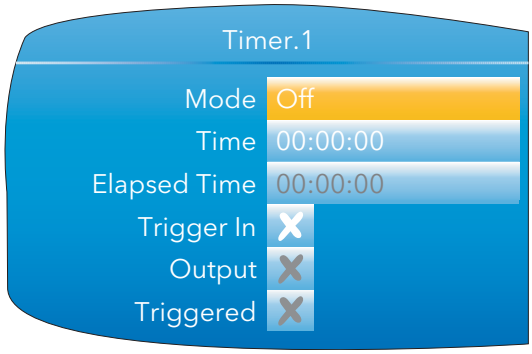


Figure 4.23 Timer configuration

4.23.1 Parameters

Mode	Select 'On pulse', 'On delay', 'One shot' or 'Min On'
Time	Allows the user to enter a period for the timer.
Elapsed time	This read-only parameter shows timing progress
Trigger in	Shows if the trigger source is active (tick) or inactive (cross)
Output	Shows if the output is on (tick) or off (cross)
Triggered	Shows if the timer is currently triggered (can remain triggered even after the trigger source has returned to off).

4.23.2 Timer modes

ON PULSE

Output goes 'on' as soon as the trigger input goes active, and remains on until the time period has elapsed. If the timer is re-triggered during the timing period, the timer restarts.

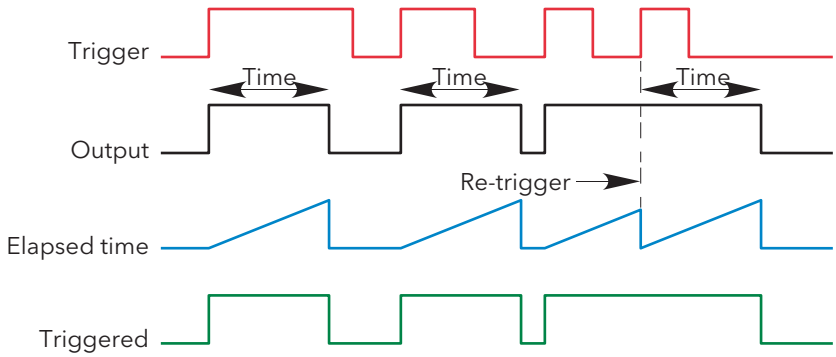


Figure 4.23.2a 'On Pulse' definitions

4.23.2 TIMER MODES (Cont.)

ON DELAY

Provides a delay between the trigger point and the timer output becoming active.

Rules

1. After the trigger goes active, the output switches on after the delay time has elapsed, and stays on until the trigger goes inactive.
2. If the trigger goes inactive before the delay time has elapsed, the output does not switch on.

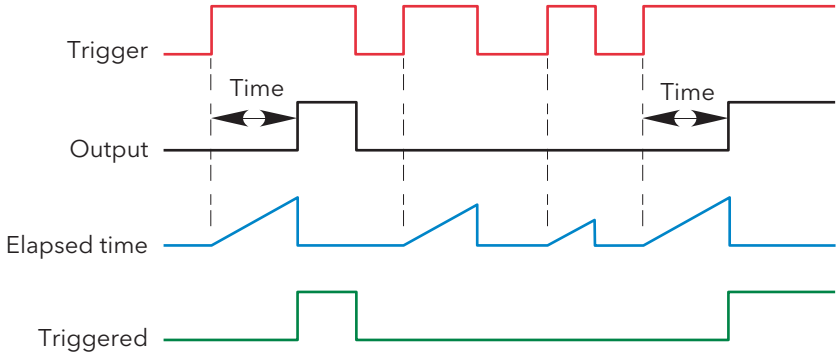


Figure 4.23.2b 'On Delay' definitions

ONE SHOT

If the trigger input is active, countdown timing is initiated as soon as the entered time value is confirmed (scroll key). The entered time decrements to zero, and must be re-entered by the user before any further timer function can be initiated.

Rules

1. The time value decrements only when the trigger input is active.
2. The output is On only when the trigger value is active (and the entered time value has not elapsed).
3. The entered time value can be edited at any time to increase or decrease the remaining time period.

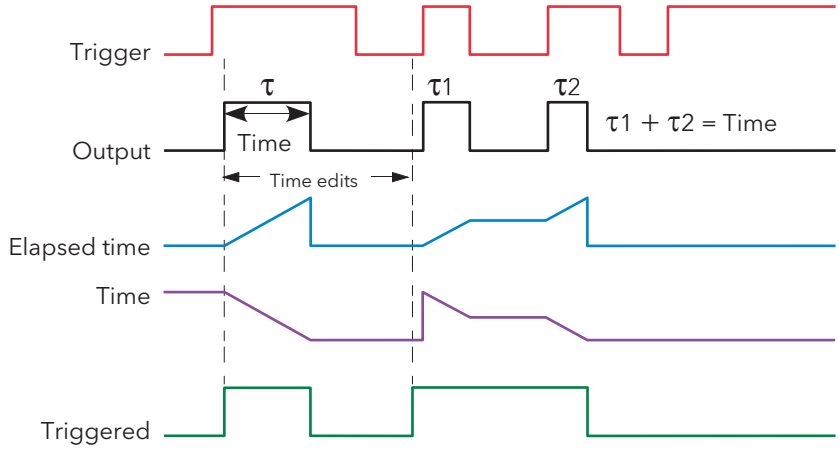


Figure 4.23.2c 'One Shot' timer definitions

Note: For ease of comparison the two time edits in the figure above were both to the same value. This is not a necessary condition.

4.23.2 TIMER MODES (Cont.)

MIN ON

This 'Off delay' function provides an output signal that goes 'on' when the trigger goes active and remains on for a specified period after the trigger goes inactive.

If the trigger goes inactive, then active again before the time period has elapsed, then the elapsed time is reset to zero and the output remains on.

The 'Triggered' parameter is on whenever the elapsed time is counting down.

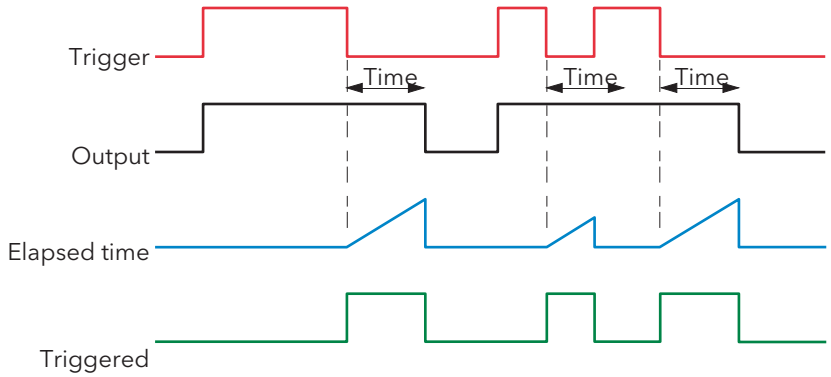


Figure 4.23.2d 'Min On' timer definitions

4.24 USER VALUES

This 'Toolkit' option block allows up to 12 values to be configured for use as inputs to other parameters.

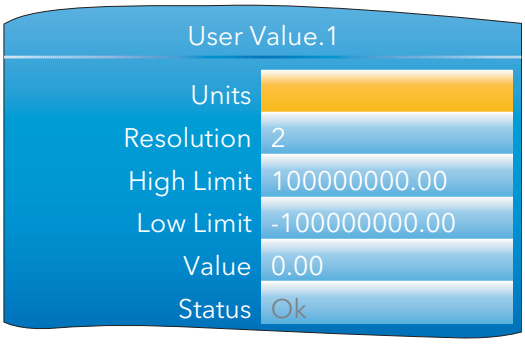


Figure 4.24 User value configuration

4.24.1 Parameters

Units	Allows a five-character string to be entered for the user value units
Resolution	The number of decimal places for the user value (max. = 6)
High/Low Limit	Sets maximum and minimum values that the User value can be set to
Value	The user value, either entered manually, or wired to another appropriate parameter
Status	The output status for the User Value.

4.25 ALARM SUMMARY

Allows the user to view the overall status of the unit's alarms, and to carry out a global acknowledgement of active alarms if required.

Global Ack	Allows the user to acknowledge all applicable alarms simultaneously. 'Manual' alarms must be non-active before they can be acknowledged.
Any Channel alarm	Indicates if there are any channel alarms active, acknowledged etc.
Any Sys Alarm	Indicates if there are any active system alarms.
Any Alarm	Indicates if there are any channel or system alarms active.

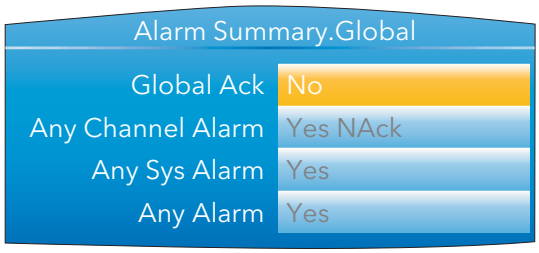


Figure 4.25 Alarm summary display

4.26 REAL TIME EVENT CONFIGURATION

This allows the user to configure up to two events to trigger at a specific time and date, or on a particular day, and to remain active for a configurable time, either measured as a duration, or as a specific 'Off' time.

Typical applications would be to start and/or stop a programmer at a particular time, or to act as an input to a 'Wait' segment.

Figure 4.26 shows the two types of timer: 'Time and Date', and 'Time and Day', for Event 1.

Figure 4.26 Real Time Events (typical)

Type	Selects the type of the real time event (Off, Time and Day, Time and Date
On Month	For 'Time and Date' only, this is the month that the event is to switch on.
On Date	For 'Time and Date' only, this is the date in the month that the event is to switch on.
On Day	For 'Time and Day' only, this is the day(s) of the week that the event output is to switch on (Mon, Tue, Wed, Thu, Fri, Sat, Sun, Mon-Fri, Sat-Sun, Everyday).
On Time	The time of day that the event output is to switch on (00:00:00 to 23:59:59)
Off Type	Selects the action that will switch the event off (Duration, Time)
Off Month	For 'Time and Date' only and with 'Off Type' set to 'Time', this is the month that the event is to switch off.
Off Date	For 'Time and Date' only and with 'Off Type' set to 'Time', this is the day number in the month that the event is to switch off.
Off Day	For 'Time and Day' only and with 'Off Type' set to 'Time', this is the day of the week that the event output is to switch off (Mon, Tue, Wed, Thu, Fri, Sat, Sun, Mon-Fri, Sat-Sun, Everyday).
Off Time	The time at which the event output is to switch off (00:00:00 - 23:59:59)
Duration	For 'Off type' set to 'Duration', this specifies the duration for which the event output is to remain on (00:00:01 to 23:59:59 for Time and Day, or 00:00:01 to 500:00:00 for Time and Date)
Output	The output for the real time event (Cross symbol = Off, Tick = On) (Read only)

5 MODBUS TCP SLAVE COMMS

5.1 INSTALLATION

The installation of the Modbus link consists of connecting a standard Ethernet cable between the RJ45 connector at the rear of the unit to a host computer either directly or via a network. A 'straight-through' cable can be used in either case (i.e. a cross-over cable is not required).

5.2 INTRODUCTION

MODBUS TCP allows the instrument to act as a 'slave' device to one or more host computers connected via the RJ45 connector at the rear of the recorder. Each recorder must have a unique Internet Protocol (IP) address, set up as described in Section 4.2.1 (Network.Interface).

MODBUS TCP (Transmission Control Protocol) is a variant of the MODBUS family of communications protocols intended for supervision and control of automated equipment specifically covering the use of MODBUS messaging in an intranet or internet environment, using TCP/IP protocols. Much of the MODBUS detail in this manual is derived from the document openmbus.doc, available at http://www.modbus.org/default.htm The above mentioned document also includes implementation guidelines for users.

Note: The Modbus protocol allows a maximum of 255 data bytes to be read from or written to in one transaction. For this reason, the maximum number of standard (16 bit) registers that can be accessed in one transaction is 255/2 = 127 and the maximum number of IEEE (32-bit) registers is 127/2 = 63.

5.2.1 Function Codes

MODBUS function codes 3, 4, 6, 8 and 16, defined in table 8.2.1a below, are supported and are fully described in section 5.5, below.

Code	Modbus definition	Description
03	Read holding registers	Reads the binary contents if holding registers. In this implementation codes 3 and 4 are identical in operation.
04	Read input registers	Reads the binary contents if holding registers. In this implementation codes 3 and 4 are identical in operation.
06	Preset single register	Writes a single value to a single register.
08	Diagnostics	Performs a simple loop back test.
16	Preset multiple registers	Writes values to multiple holding registers.

Table 5.2.1a MODBUS Function code definition

DIAGNOSTIC CODES

Function code 08, subfunction 00 (Return query data) echoes the query (Loop back).

5.2.1 FUNCTION CODES (Cont.)

EXCEPTION CODES

MODBUS TCP provides reserved codes used for exceptions. These codes provide error information relating to failed requests. Exceptions are signalled by hex 80 being added to the function code of the request, followed by one of the codes listed in table 8.2.1b, below.

Code		Modbus definition	Description (see Modbus specification for full details)
Dec	Hex		
01	01	Illegal function	An invalid function code was received
02	02	Illegal Data Address	An invalid data address was received
03	03	Illegal Data Value	An invalid data value was received
04	04	Slave Device Failure	An unrecoverable error occurred in the instrument
09	09	Illegal Sub Function	An invalid sub function was received
10	0A	Gateway path unavailable	Gateway misconfigured or overloaded
11	0B	Gateway target device failed to respond	Device not present on the network

Table 5.2.1b Exception codes

5.2.2 Data types

The following data types are supported:

1. 2's complement signed 16-bit analogue values with implied decimal point. The decimal point position must be configured in both the recorder and the host computer.
2. 16, 32 and 64 bit signed integers.
3. 16-bit unsigned integer values.
4. 32 bit IEEE Floating point values.
5. Strings of limited size, can be transferred across Modbus TCP in Unicode format using a single non-multiplexed set of consecutive registers.

DATA ENCODING

MODBUS uses what is called a 'Big endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. For example a 32-bit hex value of 12345678 would be transmitted as 12, followed by 34, followed by 56 and finally 78.

5.2.3 Invalid multiple register writes

When a recorder receives a multi-register write request, it is possible that one or more requests will be rejected. Under such a circumstance, the recorder accepts all valid write requests and ignores any invalid writes. No error response is produced.

5.2.4 Master communications timeout

Whilst the instrument is archiving, it is possible that communications responses slow sufficiently to cause communications timouts. The Modbus master device should be configured with a timout value large enough to ensure against nuisance timeouts during archiving.

5.2.4 Non-volatile parameters in EEPROM

CAUTION

The parameters in the following list must not be written-to on a continuous basis as to do so will damage the EEPROM, greatly shortening its useful life.

Note: 'nvol' = 'non-volatile'. Loop 'N' = Loop1 and Loop2; Channel 'N' = Channel 1, 2, 3 and 4 etc.

AdvancedLoop.MasterPID.ControlAction	AdvancedLoop.SlaveSP.RangeHigh	DigitalIO.2A2B.Inertia
AdvancedLoop.MasterPID.CutbackHigh	AdvancedLoop.SlaveSP.RangeLow	DigitalIO.2A2B.Invert
AdvancedLoop.MasterPID.CutbackLow	AdvancedLoop.SlaveSP.SbrkSP	DigitalIO.2A2B.MinOnTime
AdvancedLoop.MasterPID.DerivativeTime	AdvancedLoop.Tune.Band	DigitalIO.2A2B.StandbyAction
AdvancedLoop.MasterPID.DerivativeType	AdvancedLoop.Tune.CycleNo	DigitalIO.2A2B.Type
AdvancedLoop.MasterPID.ErrorLimit	AdvancedLoop.Tune.Hysteresis	DigitalIO.3A3B.Backlash
AdvancedLoop.MasterPID.IntegralTime	AdvancedLoop.Tune.OutputHighLimit	DigitalIO.3A3B.Inertia
AdvancedLoop.MasterPID.LoopBreakTime	AdvancedLoop.Tune.OutputLowLimit	DigitalIO.3A3B.Invert
AdvancedLoop.MasterPID.ManualReset	AdvancedLoop.Tune.PBs	DigitalIO.3A3B.MinOnTime
AdvancedLoop.MasterPID.PBUnits	AdvancedLoop.Tune.Settle	DigitalIO.3A3B.StandbyAction
AdvancedLoop.MasterPID.ProportionalBand	AdvancedLoop.Tune.TDs	DigitalIO.3A3B.Type
AdvancedLoop.MasterSP.ManualTrack	AdvancedLoop.Tune.Timeout	DigitalIO.DI_LALC.Backlash
AdvancedLoop.MasterSP.RangeHigh	AdvancedLoop.Tune.TuneHigh	DigitalIO.DI_LALC.Inertia
AdvancedLoop.MasterSP.RangeLow	AdvancedLoop.Tune.TuneLow	DigitalIO.DI_LALC.Invert
AdvancedLoop.MasterSP.ServoToPV	AdvancedLoop.Tune.TuneR2G	DigitalIO.DI_LALC.MinOnTime
AdvancedLoop.MasterSP.SPHighLimit	AdvancedLoop.Tune.TuneType	DigitalIO.DI_LALC.StandbyAction
AdvancedLoop.MasterSP.SPIntBal	BCDInput.N.InN	DigitalIO.DI_LALC.Type
AdvancedLoop.MasterSP.SPLowLimit	Channel.N.AlarmN.Amount	DigitalIO.DI_LBLC.Backlash
AdvancedLoop.MasterSP.SPTrack	Channel.N.AlarmN.AverageTime	DigitalIO.DI_LBLC.Inertia
AdvancedLoop.MasterSP.SPTrimHighLimit	Channel.N.AlarmN.Block	DigitalIO.DI_LBLC.Invert
AdvancedLoop.MasterSP.SPTrimLowLimit	Channel.N.AlarmN.ChangeTime	DigitalIO.DI_LBLC.MinOnTime
AdvancedLoop.Output.Ch1OnOffHysteresis	Channel.N.AlarmN.Deviation	DigitalIO.DI_LBLC.StandbyAction
AdvancedLoop.Output.Ch1TravelTime	Channel.N.AlarmN.Dwell	DigitalIO.DI_LBLC.Type
AdvancedLoop.Output.Ch2Deadband	Channel.N.AlarmN.Hysteresis	DigitalIO.RELAY_4AC.Backlash
AdvancedLoop.Output.Ch2OnOffHysteresis	Channel.N.AlarmN.Latch	DigitalIO.RELAY_4AC.Inertia
AdvancedLoop.Output.Ch2TravelTime	Channel.N.AlarmN.Threshold	DigitalIO.RELAY_4AC.Invert
AdvancedLoop.Output.CoolType	Channel.N.AlarmN.Type	DigitalIO.RELAY_4AC.MinOnTime
AdvancedLoop.Output.EnablePowerFeedforward	Channel.N.Main.CJType	DigitalIO.RELAY_4AC.StandbyAction
AdvancedLoop.Output.FeedForwardGain	Channel.N.Main.CloseString	DigitalIO.RELAY_4AC.Type
AdvancedLoop.Output.FeedForwardOffset	Channel.N.Main.Descriptor	DigitalIO.RELAY_5AC.Backlash
AdvancedLoop.Output.FeedForwardTrimLimit	Channel.N.Main.ExtCJTemp	DigitalIO.RELAY_5AC.Inertia
AdvancedLoop.Output.FeedForwardType	Channel.N.Main.FaultResponse	DigitalIO.RELAY_5AC.Invert
AdvancedLoop.Output.ManualMode	Channel.N.Main.Filter	DigitalIO.RELAY_5AC.MinOnTime
AdvancedLoop.Output.ManualStartup	Channel.N.Main.InputHigh	DigitalIO.RELAY_5AC.StandbyAction
AdvancedLoop.Output.OutputHighLimit	Channel.N.Main.InputLow	DigitalIO.RELAY_5AC.Type
AdvancedLoop.Output.OutputLowLimit	Channel.N.Main.LinType	EthernetIP.ImplicitInputs.InputN
AdvancedLoop.Output.PotBreakMode	Channel.N.Main.Offset	EthernetIP.ImplicitOutputs.OutputN
AdvancedLoop.Output.Rate	Channel.N.Main.Offset2	EthernetIP.InputTags.InputN
AdvancedLoop.Output.RateDisable	Channel.N.Main.OpenString	EthernetIP.Main.ConfigInstance
AdvancedLoop.Output.SafeOutVal	Channel.N.Main.RangeHigh	EthernetIP.Main.ConfigSize
AdvancedLoop.Output.SbrkOP	Channel.N.Main.RangeLow	EthernetIP.Main.ConnectionType
AdvancedLoop.Output.SlaveSensorBreakMode	Channel.N.Main.RangeUnits	EthernetIP.Main.InputInstance
AdvancedLoop.Setup.CascadeType	Channel.N.Main.Resolution	EthernetIP.Main.InputSize
AdvancedLoop.Setup.MasterName	Channel.N.Main.ScaleHigh	EthernetIP.Main.Mode
AdvancedLoop.Setup.ModeAccess	Channel.N.Main.ScaleHigh2	EthernetIP.Main.OutputInstance
AdvancedLoop.Setup.SetpointAccess	Channel.N.Main.ScaleLow	EthernetIP.Main.OutputSize
AdvancedLoop.Setup.SlaveChannel1	Channel.N.Main.ScaleLow2	EthernetIP.Main.Priority
AdvancedLoop.Setup.SlaveChannel2	Channel.N.Main.SensorBreakType	EthernetIP.Main.Rpi
AdvancedLoop.Setup.SlaveName	Channel.N.Main.Shunt	EthernetIP.Main.ServerAddress
AdvancedLoop.SlavePID.Boundary1-2	Channel.N.Main.TestSignal	EthernetIP.Main.SlotNumber
AdvancedLoop.SlavePID.Boundary2-3	Channel.N.Main.Type	EthernetIP.OutputTags.OutputN
AdvancedLoop.SlavePID.ControlAction	Channel.N.Main.Units	EthernetIP.OutputTags.Output2
AdvancedLoop.SlavePID.CutbackHigh	Channel.N.Trend.Colour	Group.Recording.ChannelNEn
AdvancedLoop.SlavePID.CutbackHigh2	Channel.N.Trend.SpanHigh	Group.Recording.Compression
AdvancedLoop.SlavePID.CutbackHigh3	Channel.N.Trend.SpanLow	Group.Recording.Enable
AdvancedLoop.SlavePID.CutbackLow	CustomMessage.MessageN	Group.Recording.Interval
AdvancedLoop.SlavePID.CutbackLow2	DCOutput.1A1B_DCOP.FallbackPV	Group.Recording.VirtualChanNEn
AdvancedLoop.SlavePID.CutbackLow3	DCOutput.1A1B_DCOP.OutputHigh	Group.Recording.VirtualChan28En
AdvancedLoop.SlavePID.DerivativeTime	DCOutput.1A1B_DCOP.OutputLow	Group.Trend.Descriptor
AdvancedLoop.SlavePID.DerivativeTime2	DCOutput.1A1B_DCOP.Resolution	Group.Trend.Interval
AdvancedLoop.SlavePID.DerivativeTime3	DCOutput.1A1B_DCOP.ScaleHigh	Group.Trend.MajorDivisions
AdvancedLoop.SlavePID.DerivativeType	DCOutput.1A1B_DCOP.ScaleLow	Group.Trend.PointN
AdvancedLoop.SlavePID.IntegralTime	DCOutput.1A1B_DCOP.Type	Humidity.Pressure
AdvancedLoop.SlavePID.IntegralTime2	DCOutput.2A2B_DCOP.FallbackPV	Humidity.PsychroConst
AdvancedLoop.SlavePID.IntegralTime3	DCOutput.2A2B_DCOP.OutputHigh	Humidity.Resolution
AdvancedLoop.SlavePID.LoopBreakTime	DCOutput.2A2B_DCOP.OutputLow	Humidity.WetOffset
AdvancedLoop.SlavePID.LoopBreakTime2	DCOutput.2A2B_DCOP.Resolution	Instrument.Display.AlarmPanel
AdvancedLoop.SlavePID.LoopBreakTime3	DCOutput.2A2B_DCOP.ScaleHigh	Instrument.Display.Brightness
AdvancedLoop.SlavePID.ManualReset	DCOutput.2A2B_DCOP.ScaleLow	Instrument.Display.Cascade
AdvancedLoop.SlavePID.ManualReset2	DCOutput.2A2B_DCOP.Type	Instrument.Display.DualLoopControl
AdvancedLoop.SlavePID.ManualReset3	DCOutput.3A3B_DCOP.FallbackPV	Instrument.Display.EIPServerPage
AdvancedLoop.SlavePID.NumberOfSets	DCOutput.3A3B_DCOP.OutputHigh	Instrument.Display.FutureTrend
AdvancedLoop.SlavePID.PBUnits	DCOutput.3A3B_DCOP.OutputLow	Instrument.Display.FutureTrend1Colour
AdvancedLoop.SlavePID.ProportionalBand	DCOutput.3A3B_DCOP.Resolution	Instrument.Display.FutureTrend2Colour
AdvancedLoop.SlavePID.ProportionalBand2	DCOutput.3A3B_DCOP.ScaleHigh	Instrument.Display.HistoryBackground
AdvancedLoop.SlavePID.ProportionalBand3	DCOutput.3A3B_DCOP.ScaleLow	Instrument.Display.HomePage
AdvancedLoop.SlavePID.RelCh2Gain	DCOutput.3A3B_DCOP.Type	Instrument.Display.HorizontalBar
AdvancedLoop.SlavePID.RelCh2Gain2	DigitalIO.1A1B.Backlash	Instrument.Display.HorizontalTrend
AdvancedLoop.SlavePID.RelCh2Gain3	DigitalIO.1A1B.Inertia	Instrument.Display.HPageTimeout
AdvancedLoop.SlavePID.RemoteInput	DigitalIO.1A1B.Invert	Instrument.Display.HTrendScaling
AdvancedLoop.SlavePID.SchedulerType	DigitalIO.1A1B.MinOnTime	Instrument.Display.LoopControl
AdvancedLoop.SlaveSP.FFSelect	DigitalIO.1A1B.StandbyAction	Instrument.Display.LoopSetpointColour
AdvancedLoop.SlaveSP.ManualTrack	DigitalIO.1A1B.Type	Instrument.Display.ModbusMaster
AdvancedLoop.SlaveSP.MasterSensorBreakMode	DigitalIO.2A2B.Backlash	Instrument.Display.NumberFormat

5.2.4 NON-VOLATILE PARAMETERS IN EEPROM (Cont.)

Instrument.Display.Numeric
Instrument.Display.Programmer
Instrument.Display.PromoteListView
Instrument.Display.ScreenSaverAfter
Instrument.Display.ScreenSaverBrightness
Instrument.Display.SteriliserPage
Instrument.Display.TrendBackground
Instrument.Display.USBAutoScan
Instrument.Display.VerticalBar
Instrument.Display.VerticalTrend
Instrument.Info.CloneState
Instrument.Info.Name
Instrument.Locale.DateFormat
Instrument.Locale.DSTenable
Instrument.Locale.EndDay
Instrument.Locale.EndMonth
Instrument.Locale.EndOn
Instrument.Locale.EndTime
Instrument.Locale.Language
Instrument.Locale.StartDay
Instrument.Locale.StartMonth
Instrument.Locale.StartOn
Instrument.Locale.StartTime
Instrument.Locale.TimeZone
Instrument.Notes.NoteN
Instrument.PromoteList.PromoteListName
Instrument.PromoteList.PromoteParamN
Instrument.PromoteList.PromoteParamNDesc
Instrument.Security.CommsPass
Instrument.Security.DefaultConfig
Instrument.Security.EngineerPassword
Instrument.Security.OEMPass
Instrument.Security.OperatorPassword
Instrument.Security.SupervisorPassword
Lgc2.N.FallbackType
Lgc2.N.In1
Lgc2.N.In2
Lgc2.N.Invert
Lgc2.N.Oper
Lgc8.N.InN
Lgc8.N.InInvert
Lgc8.N.NumIn
Lgc8.N.Oper
Lgc8.N.OutInvert
Loop.N.Diag.LoopMode
Loop.N.OP.Ch1OnOffHysteresis
Loop.N.OP.Ch1TravelTime
Loop.N.OP.Ch2Deadband
Loop.N.OP.Ch2OnOffHysteresis
Loop.N.OP.Ch2TravelTime
Loop.N.OP.CoolType
Loop.N.OP.EnablePowerFeedforward
Loop.N.OP.FeedForwardGain
Loop.N.OP.FeedForwardOffset
Loop.N.OP.FeedForwardTrimLimit
Loop.N.OP.FeedForwardType
Loop.N.OP.ManStartup
Loop.N.OP.ManualMode
Loop.N.OP.OutputHighLimit
Loop.N.OP.OutputLowLimit
Loop.N.OP.PotBreakMode
Loop.N.OP.Rate
Loop.N.OP.RateDisable
Loop.N.OP.SafeOutVal
Loop.N.OP.SbrkOP
Loop.N.OP.SensorBreakMode
Loop.N.PID.Boundary1-2
Loop.N.PID.Boundary2-3
Loop.N.PID.CutbackHigh
Loop.N.PID.CutbackHighN
Loop.N.PID.CutbackLow
Loop.N.PID.CutbackLowN
Loop.N.PID.DerivativeTime
Loop.N.PID.DerivativeTimeN
Loop.N.PID.IntegralTime
Loop.N.PID.IntegralTimeN
Loop.N.PID.LoopBreakTime
Loop.N.PID.LoopBreakTimeN
Loop.N.PID.ManualReset
Loop.N.PID.ManualResetN
Loop.N.PID.NumSets
Loop.N.PID.ProportionalBand
Loop.N.PID.ProportionalBandN
Loop.N.PID.RelCh2Gain
Loop.N.PID.RelCh2GainN
Loop.N.PID.SchedulerRemoteInput
Loop.N.PID.SchedulerType
Loop.N.Setup.AutoManAccess
Loop.N.Setup.CH1ControlType
Loop.N.Setup.CH2ControlType
Loop.N.Setup.ControlAction
Loop.N.Setup.DerivativeType
Loop.N.Setup.LoopName
Loop.N.Setup.PBUnits
Loop.N.Setup.SPAccess
Loop.N.SP.ManualTrack
Loop.N.SP.RangeHigh
Loop.N.SP.RangeLow
Loop.N.SP.ServoToPV
Loop.N.SP.SPHighLimit
Loop.N.SP.SPIntBal
Loop.N.SP.SPLowLimit
Loop.N.SP.SPTrack
Loop.N.SP.SPTrimHighLimit
Loop.N.SP.SPTrimLowLimit
Loop.N.Tune.CycleNo
Loop.N.Tune.Diagnostics
Loop.N.Tune.OutputHighLimit
Loop.N.Tune.OutputLowLimit
Loop.N.Tune.PBs
Loop.N.Tune.Settle
Loop.N.Tune.TDs
Loop.N.Tune.TuneR2G
Loop.N.Tune.Type
Math2.N.Fallback
Math2.N.FallbackVal
Math2.N.HighLimit
Math2.N.InN
Math2.N.InNMul
Math2.N.LowLimit
Math2.N.Oper
Math2.N.Resolution
Math2.N.Select
Math2.N.Units
ModbusMaster.N.Data.BitPosition
ModbusMaster.N.Data.DataType
ModbusMaster.N.Data.Descriptor
ModbusMaster.N.Data.FallBackValue
ModbusMaster.N.Data.FunctionCode
ModbusMaster.N.Data.ModbusAddress
ModbusMaster.N.Data.Mode
ModbusMaster.N.Data.Number
ModbusMaster.N.Data.ParameterList
ModbusMaster.N.Data.Priority
ModbusMaster.N.Data.Scaling
ModbusMaster.N.Data.Set
ModbusMaster.N.Data.SlaveDevice
ModbusMaster.N.Data.Value
ModbusMaster.SlaveN.Data.BitPosition
ModbusMaster.SlaveN.Data.DataType
ModbusMaster.SlaveN.Data.Descriptor
ModbusMaster.SlaveN.Data.FallBackValue
ModbusMaster.SlaveN.Data.FunctionCode
ModbusMaster.SlaveN.Data.ModbusAddress
ModbusMaster.SlaveN.Data.Mode
ModbusMaster.SlaveN.Data.Number
ModbusMaster.SlaveN.Data.ParameterList
ModbusMaster.SlaveN.Data.Priority
ModbusMaster.SlaveN.Data.Scaling
ModbusMaster.SlaveN.Data.Set
ModbusMaster.SlaveN.Data.SlaveDevice
ModbusMaster.SlaveN.Data.Value
ModbusMaster.SlaveN.Main.Descriptor
ModbusMaster.SlaveN.Main.HighPriority
ModbusMaster.SlaveN.Main.IPAddress
ModbusMaster.SlaveN.Main.LowPriority
ModbusMaster.SlaveN.Main.MaxBlockSize
ModbusMaster.SlaveN.Main.MediumPriority
ModbusMaster.SlaveN.Main.Online
ModbusMaster.SlaveN.Main.Profile
ModbusMaster.SlaveN.Main.Retries
ModbusMaster.SlaveN.Main.Timeout
ModbusMaster.SlaveN.Main.UnitId
Mux8.N.Fallback
Mux8.N.FallbackVal
Mux8.N.HighLimit
Mux8.N.InN
Mux8.N.LowLimit
Mux8.N.Select
Network.Archive.ArchiveRate
Network.Archive.CSVDateFormat
Network.Archive.CSVHeaders
Network.Archive.CSVHeadings
Network.Archive.CSVIncludeValues
Network.Archive.CSVMessages
Network.Archive.CSVTabDelimiter
Network.Archive.Destination
Network.Archive.FileFormat
Network.Archive.OnFull
Network.Archive.Period
Network.Archive.PrimaryPassword
Network.Archive.PrimaryUser
Network.Archive.PServerIPAddress
Network.Archive.RemotePath
Network.Archive.SecondaryPassword
Network.Archive.SecondaryUser
Network.Archive.SServerIPAddress
Network.FTPserver.Password
Network.FTPserver.Username
Network.Interface.DNSserver
Network.Interface.Gateway
Network.Interface.IPaddress
Network.Interface.IPType
Network.Interface.SubnetMask
Network.Modbus.Address
Network.Modbus.InputTimeout
Network.Modbus.PrefMasterIP
Network.Modbus.SerialMode
Network.Modbus.TimeFormat
Network.Modbus.UnitIdEnable
Program.ChNHoldback
Program.ChNHoldbackVal
Program.ChNRampUnits
Program.HoldbackStyle
Program.RampStyle
Programmer.Features.FTPStore
Programmer.Features.Holdback
Programmer.Features.Messages
Programmer.Features.PVEvent
Programmer.Features.UserValue
Programmer.FTP.IPAddress
Programmer.FTP.Password
Programmer.FTP.Username
Programmer.SetUp.ChNResolution
Programmer.SetUp.ChNServoTo
Programmer.SetUp.ChNUnits
Programmer.SetUp.Channels
Programmer.SetUp.MaxEvents
Programmer.SetUp.PowerFailAction
Programmer.SetUp.ProgEditAccess
Programmer.SetUp.ProgModeAccess
Programmer.SetUp.ProgStoreAccess
Programmer.SetUp.RateResolution
Programmer.SetUp.ResetCh1UserVal
Programmer.SetUp.ResetCh2UserVal
Programmer.SetUp.ResetEventN
RealTimeEvent.N.Duration
RealTimeEvent.N.OffDate
RealTimeEvent.N.OffDay
RealTimeEvent.N.OffMonth
RealTimeEvent.N.OffTime
RealTimeEvent.N.OffType
RealTimeEvent.N.OnDate
RealTimeEvent.N.OnDay
RealTimeEvent.N.OnMonth
RealTimeEvent.N.OnTime
RealTimeEvent.N.Type
Segment.N.ChNHoldback
Segment.N.ChNHoldbackVal
Segment.N.ChNPVEvent
Segment.N.ChNPVEventUse
Segment.N.ChNPVEventVal
Segment.N.ChNRate
Segment.N.ChNTime
Segment.N.ChNTSP
Segment.N.ChNUserVal
Segment.N.ChNWait
Segment.N.ChNWaitVal
Segment.N.Cycles
Segment.N.Duration
Segment.N.EndType
Segment.N.EventN
Segment.N.GoBackTo
Segment.N.SegmentName
Segment.N.Type
Segment.N.WaitFor
Steriliser.AutoCounter
Steriliser.FailureDwellN
Steriliser.FileByTag
Steriliser.FileTag
Steriliser.InputNPV
Steriliser.InputTypeN
Steriliser.IP1BandHigh
Steriliser.IP1BandLow
Steriliser.IP1TargetSP
Steriliser.IP2BandHigh
Steriliser.IP2BandLow
Steriliser.IP2TargetSP
Steriliser.IP3BandHigh
Steriliser.IP3BandLow
Steriliser.IP3TargetSP
Steriliser.IP4BandHigh
Steriliser.IP4BandLow
Steriliser.IP4TargetSP
Steriliser.LowLimit
Steriliser.MeasuredTemp
Steriliser.TargetTemperature
Steriliser.TargetTime
Steriliser.TargetTime121
Steriliser.TargetTime134
Steriliser.ZTemperatureInterval
Timer.N.In
Timer.N.Type
UserLin.N.NumberOfBreakpoints
UserLin.N.XN

5.2.4 NON-VOLATILE PARAMETERS IN EEPROM (Cont.)

UserLin.N.YN
UsrVal.N.HighLimit
UsrVal.N.LowLimit
UsrVal.N.Resolution
UsrVal.N.Units
VirtualChannel.N.AlarmN.Amount
VirtualChannel.N.AlarmN.AverageTime
VirtualChannel.N.AlarmN.Block
VirtualChannel.N.AlarmN.ChangeTime
VirtualChannel.N.AlarmN.Deviation
VirtualChannel.N.AlarmN.Dwell
VirtualChannel.N.AlarmN.Hysteresis
VirtualChannel.N.AlarmN.Latch
VirtualChannel.N.AlarmN.Threshold
VirtualChannel.N.AlarmN.Type
VirtualChannel.N.Main.Descriptor
VirtualChannel.N.Main.HighCutOff
VirtualChannel.N.Main.LowCutOff
VirtualChannel.N.Main.Operation
VirtualChannel.N.Main.Period
VirtualChannel.N.Main.PresetValue
VirtualChannel.N.Main.Resolution
VirtualChannel.N.Main.Type
VirtualChannel.N.Main.Units
VirtualChannel.N.Main.UnitsScaler
VirtualChannel.N.Trend.Colour
VirtualChannel.N.Trend.SpanHigh
VirtualChannel.N.Trend.SpanLow
Zirconia.Clean.CleanEnable
Zirconia.Clean.CleanFreq
Zirconia.Clean.CleanMaxTemp
Zirconia.Clean.CleanTime
Zirconia.Clean.MaxRcovTime
Zirconia.Clean.MinRcovTime
Zirconia.CleanFreq
Zirconia.CleanTime
Zirconia.GasRef
Zirconia.GasRefs.CO_Ideal
Zirconia.GasRefs.CO_Local
Zirconia.GasRefs.CO_RemoteEn
Zirconia.GasRefs.H2_Local
Zirconia.GasRefs.H2_RemoteEn
Zirconia.MaxRcovTime
Zirconia.MinCalTemp
Zirconia.MinRcovTime
Zirconia.NumResolution
Zirconia.OxygenExp
Zirconia.OxygenType
Zirconia.ProbeOffset
Zirconia.ProbeType
Zirconia.ProcFactor
Zirconia.RemGasEn
Zirconia.TempOffset
Zirconia.Tolerance

UserLin.N.YN
UsrVal.N.HighLimit
UsrVal.N.LowLimit
UsrVal.N.Resolution
UsrVal.N.Units
VirtualChannel.N.AlarmN.Amount
VirtualChannel.N.AlarmN.AverageTime
VirtualChannel.N.AlarmN.Block
VirtualChannel.N.AlarmN.ChangeTime
VirtualChannel.N.AlarmN.Deviation
VirtualChannel.N.AlarmN.Dwell
VirtualChannel.N.AlarmN.Hysteresis
VirtualChannel.N.AlarmN.Latch
VirtualChannel.N.AlarmN.Threshold
VirtualChannel.N.AlarmN.Type
VirtualChannel.N.Main.Descriptor
VirtualChannel.N.Main.HighCutOff
VirtualChannel.N.Main.LowCutOff
VirtualChannel.N.Main.Operation
VirtualChannel.N.Main.Period
VirtualChannel.N.Main.PresetValue
VirtualChannel.N.Main.Resolution
VirtualChannel.N.Main.Type
VirtualChannel.N.Main.Units
VirtualChannel.N.Main.UnitsScaler
VirtualChannel.N.Trend.Colour
VirtualChannel.N.Trend.SpanHigh
VirtualChannel.N.Trend.SpanLow
Zirconia.Clean.CleanEnable
Zirconia.Clean.CleanFreq
Zirconia.Clean.CleanMaxTemp
Zirconia.Clean.CleanTime
Zirconia.Clean.MaxRcovTime
Zirconia.Clean.MinRcovTime
Zirconia.CleanFreq
Zirconia.CleanTime
Zirconia.GasRef
Zirconia.GasRefs.CO_Ideal
Zirconia.GasRefs.CO_Local
Zirconia.GasRefs.CO_RemoteEn
Zirconia.GasRefs.H2_Local
Zirconia.GasRefs.H2_RemoteEn
Zirconia.MaxRcovTime
Zirconia.MinCalTemp
Zirconia.MinRcovTime
Zirconia.NumResolution
Zirconia.OxygenExp
Zirconia.OxygenType
Zirconia.ProbeOffset
Zirconia.ProbeType
Zirconia.ProcFactor
Zirconia.RemGasEn
Zirconia.TempOffset
Zirconia.Tolerance

5.3 PARAMETER LIST

This list is arranged in alphabetical block order and gives the memory address for each parameter in both hex and decimal.

The Modbus addresses, in the range 0x0001 - 0x3FFF, listed in the table below give access to the parameter values in a scaled integer format. It is possible to gain access to the parameter values in native format by using the following formula:

Native address = (scaled integer address x 2) + 0x8000

The blocks are ordered as follows:

Advanced Loop
Alarm summary
BCD Input
Channel 1
Channel 2
Channel 3
Channel 4
Custom messages
DC Output
Digital I/O
Ether|Net/!P
Group
Humidity
Instrument
Logic (2 Input)
Logic (8 input)
Loop 1
Loop 2
Math (2 input)
Modbus Master
Multiplexer
Network
OR block
Program
Programmer
Real Time Events
Segments
Steriliser
Timer
User Lin 1
User Lin 2
User Lin 3
User Lin 4
User values
Virtual chan 1
Virtual chan 2
Virtual chan 3
Virtual chan 4
Virtual chan 5
Virtual chan 6
Virtual chan 7
Virtual chan 8
Virtual chan 9
Virtual chan 10
Virtual chan 11
Virtual chan 12
Virtual chan 13
Virtual chan 14
Virtual chan 15
Virtual chan 16
Virtual chan 17
Virtual chan 18
Virtual chan 19
Virtual chan 20
Virtual chan 21
Virtual chan 22
Virtual chan 23
Virtual chan 24
Virtual chan 25
Virtual chan 26
Virtual chan 27
Virtual chan 28
Virtual chan 29
Virtual chan 30
Zirconia

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AdvancedLoop.Diag.CalcOP	Calc OP	float32	031f	799	1dp
AdvancedLoop.Diag.HiSatLim	HiSatLim	float32	0320	800	1dp
AdvancedLoop.Diag.LoSatLim	LoSatLim	float32	0321	801	1dp
AdvancedLoop.Diag.MasterDerivativeOutContrib	Master derivative output contribution	float32	0312	786	0dp
AdvancedLoop.Diag.MasterError	Master error	float32	030d	781	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.Diag.MasterFB	Master feedback	float32	031e	798	1dp
AdvancedLoop.Diag.MasterIntegralOutContrib	Master integral output contribution	float32	0311	785	4dp
AdvancedLoop.Diag.MasterLoopBreakAlarm	Master loop break (0 = No; 1 = Yes)	bool	0323	803	Not applicable
AdvancedLoop.Diag.MasterPropOutContrib	Master loop proportional output contribution	float32	0310	784	0dp
AdvancedLoop.Diag.MasterSensorBreak	Master sensor break (0 = Off, 1 = On)	bool	0313	787	Not applicable
AdvancedLoop.Diag.OPPid	OPPID	float32	0322	802	1dp
AdvancedLoop.Diag.SchedCBH	Scheduled cutback high	float32	3195	12693	0dp
AdvancedLoop.Diag.SchedCBL	Scheduled cutback low	float32	3196	12694	0dp
AdvancedLoop.Diag.SchedLPBrk	Scheduled loop break time	float32	3198	12696	0dp
AdvancedLoop.Diag.SchedMR	Scheduled manual reset	float32	3197	12695	1dp
AdvancedLoop.Diag.SchedOutputHigh	Scheduled output high limit	float32	319a	12698	1dp
AdvancedLoop.Diag.SchedOutputLow	Scheduled output low limit	float32	319b	12699	1dp
AdvancedLoop.Diag.SchedPB	Scheduled proportional band	float32	3192	12690	1dp
AdvancedLoop.Diag.SchedR2G	Scheduled relative cool gain	float32	3199	12697	1dp
AdvancedLoop.Diag.SchedTd	Scheduled derivative time	float32	3194	12692	1dp
AdvancedLoop.Diag.SchedTi	Scheduled integral time	float32	3193	12691	1dp
AdvancedLoop.Diag.SlaveDerivativeOutContrib	Slave derivative output contribution	float32	031d	797	0dp
AdvancedLoop.Diag.SlaveError	Slave error	float32	031a	794	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.Diag.SlaveIntegralOutContrib	Slave integral output contribution	float32	031c	796	4dp
AdvancedLoop.Diag.SlaveLoopBreakAlarm	Slave loop break (0 = No; 1 = Yes)	bool	030f	783	Not applicable
AdvancedLoop.Diag.SlavePropOutContrib	Slave loop proportional output contribution	float32	031b	795	0dp
AdvancedLoop.Diag.SlaveSensorBreak	Slave sensor break (0 = Off; 1 = On)	bool	0325	805	Not applicable
AdvancedLoop.Diag.TargetOutput	Target output	float32	030e	782	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Diag.WorkingOutputHigh	Slave output high limit	float32	0315	789	0dp
AdvancedLoop.Diag.WorkingOutputLow	Slave output low limit	float32	0314	788	0dp
AdvancedLoop.Main.ActiveOut	Working output	float32	0303	771	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Main.CascadeMode	Cascade mode (0 = Cascade; 1 = Slave; 2 = Manual)	uint8	0316	790	Not applicable
AdvancedLoop.Main.Inhibit	Control inhibit (0 = No; 1 = Yes)	bool	0304	772	Not applicable
AdvancedLoop.Main.MasterIntHold	Master integral hold (0 = No; 1 = Yes)	uint8	0305	773	Not applicable
AdvancedLoop.Main.MasterPV	Master loop process variable	float32	0317	791	1dp
AdvancedLoop.Main.MasterWSP	Master loop working setpoint	float32	0318	792	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.Main.SlaveIntHold	Slave integral hold (0 = No; 1 = Yes)	uint8	0306	774	Not applicable
AdvancedLoop.Main.SlavePV	Slave loop process variable	float32	0300	768	1dp
AdvancedLoop.Main.SlaveWSP	Slave loop working setpoint	float32	0302	770	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.Main.TargetSetpoint	Target setpoint	float32	0301	769	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterPID.ControlAction	Control action (0 = Reverse acting; 1 = Direct acting)	uint8	3103	12547	Not applicable
AdvancedLoop.MasterPID.CutbackHigh	Cutback high (0 = Auto)	float32	31af	12719	1dp
AdvancedLoop.MasterPID.CutbackLow	Cutback low (0 = Auto)	float32	31b0	12720	1dp
AdvancedLoop.MasterPID.DerivativeTime	Derivative time (0 = Off)	float32	31ae	12718	1dp
AdvancedLoop.MasterPID.DerivativeType	Derivative type (0 = PV; 1 = Eror)	uint8	3105	12549	Not applicable
AdvancedLoop.MasterPID.ErrorLimit	Error limit	float32	31cc	12748	1dp
AdvancedLoop.MasterPID.IntegralTime	Integral time (0 = Off)	float32	31ad	12717	1dp
AdvancedLoop.MasterPID.LoopBreakTime	Loop break time (0 = Off)	float32	31b2	12722	0dp
AdvancedLoop.MasterPID.ManualReset	Manual reset	float32	31b1	12721	1dp
AdvancedLoop.MasterPID.PBUnits	Proportional band units (0 = Engineering; 1 = Percentage)	uint8	3104	12548	Not applicable
AdvancedLoop.MasterPID.ProportionalBand	Proportional band	float32	31ac	12716	1dp
AdvancedLoop.MasterSP.AltSP	Alternative setpoint	float32	3160	12640	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.AltSPSelect	Alternative setpoint enable (0 = No; 1 = Yes)	uint8	3161	12641	Not applicable
AdvancedLoop.MasterSP.ManualTrack	Manual track enable (0 = Off; 1 = On)	uint8	3167	12647	Not applicable
AdvancedLoop.MasterSP.RangeHigh	Range high	float32	3159	12633	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.RangeLow	Range low	float32	315a	12634	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.Rate	Setpoint rate limit value (0 = Off)	float32	3162	12642	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.RateDisable	Setpoint rate limit disable (0 = No; 1 = Yes)	bool	3163	12643	Not applicable
AdvancedLoop.MasterSP.RateDone	Setpoint rate limit complete (0 = No; 1 = Yes)	bool	030a	778	Not applicable
AdvancedLoop.MasterSP.ServoToPV	Servo to PV enable (0 = No; 1 = Yes)	bool	316c	12652	Not applicable
AdvancedLoop.MasterSP.SP1	Setpoint 1	float32	315c	12636	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SP2	Setpoint 2	float32	315d	12637	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SPHighLimit	Setpoint high limit	float32	315e	12638	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SPIntBal	SP integral balance (0 = Off; 1 = On)	bool	316b	12651	Not applicable
AdvancedLoop.MasterSP.SPLowLimit	Setpoint low limit	float32	315f	12639	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SPSelect	Active setpoint select (0 - Setpoint 1; 1 = Setpoint 2)	uint8	315b	12635	Not applicable
AdvancedLoop.MasterSP.SPTrack	Setpoint tracking enable (0 = Off; 1 = On)	uint8	3168	12648	Not applicable
AdvancedLoop.MasterSP.SPTrim	Setpoint trim	float32	3164	12644	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SPTrimHighLimit	Setpoint trim high limit	float32	3165	12645	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.SPTrimLowLimit	Setpoint trim low limit	float32	3166	12646	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.TrackPV	Track PV	float32	3169	12649	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.MasterSP.TrackSP	Track SP	float32	316a	12650	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.Output.Ch1OnOffHysteresis	Channel 1 on/off hysteresis	float32	3172	12658	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.Output.Ch1Output	Channel 1 output value	float32	030b	779	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.Ch1PotBreak	Channel 1 potentiometer break (0 = Off; 1 = On)	uint8	3179	12665	Not applicable
AdvancedLoop.Output.Ch1PotPosition	Channel 1 valve position	float32	3178	12664	0dp
AdvancedLoop.Output.Ch1TravelTime	Channel 1 travel time	float32	3174	12660	1dp
AdvancedLoop.Output.Ch2Deadband	Channel 2 deadband (0 = Off)	float32	316f	12655	Same as AdvancedLoop.Output.OutputHighLimit

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AdvancedLoop.Output.Ch2OnOffHysteresis	Channel 2 on/off hysteresis	float32	3173	12659	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.Output.Ch2Output	Channel 2 (cool) output value	float32	030c	780	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.Ch2PotBreak	Channel 2 potentiometer break (0 = Off; 1 = On)	uint8	317b	12667	Not applicable
AdvancedLoop.Output.Ch2PotPosition	Channel 2 valve position	float32	317a	12666	0dp
AdvancedLoop.Output.Ch2TravelTime	Channel 2 travel time	float32	3175	12661	1dp
AdvancedLoop.Output.CoolType	Cooling algorithm type 0 = Linear 1 = Oil 2 = Water 3 = Fan	uint8	3183	12675	Not applicable
AdvancedLoop.Output.EnablePowerFeedforward	Power feed forward enable (0 = No; 1 = Yes)	uint8	3181	12673	Not applicable
AdvancedLoop.Output.FeedForwardGain	Feedforward gain	float32	3185	12677	3dp
AdvancedLoop.Output.FeedForwardOffset	Feedforward offset	float32	3186	12678	0dp
AdvancedLoop.Output.FeedForwardOutput	Feedforward output	float32	3188	12680	0dp
AdvancedLoop.Output.FeedForwardRemote	Feedforward remote	float32	318d	12685	0dp
AdvancedLoop.Output.FeedForwardTrimLimit	Feedforward trim limit	float32	3187	12679	0dp
AdvancedLoop.Output.FeedForwardType	Feedforward type 0 = None 1 = Remote 2 = SP 3 = PV	uint8	3184	12676	Not applicable
AdvancedLoop.Output.ForcedOP	Forced manual output value	float32	318f	12687	1dp
AdvancedLoop.Output.ManualMode	Manual output mode (0 = Track; 1 = Step; 2 = LastMOP)	uint8	317f	12671	Not applicable
AdvancedLoop.Output.ManualOutVal	Manual output value	float32	3180	12672	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.ManualStartup	Manual startup mode (0 = Off; 1 = On)	bool	3190	12688	Not applicable
AdvancedLoop.Output.MeasuredPower	Measured mains voltage	float32	3182	12674	0dp
AdvancedLoop.Output.NudgeLower	Valve nudge lower (0 = No; 1 = Yes)	uint8	3177	12663	Not applicable
AdvancedLoop.Output.NudgeRaise	Valve nudge raise (0 = No; 1 = Yes)	uint8	3176	12662	Not applicable
AdvancedLoop.Output.OutputHighLimit	Output high limit	float32	316d	12653	1dp
AdvancedLoop.Output.OutputLowLimit	Output low limit	float32	316e	12654	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.PotBreakMode	Potentiometer break mode 0 = Raise 1 = Lower 2 = Reset 3 = Model	uint8	317c	12668	Not applicable
AdvancedLoop.Output.Rate	Output rate limit value (0 = Off)	float32	3170	12656	1dp
AdvancedLoop.Output.RateDisable	Rate disable (0 = No; 1 = Yes)	bool	3171	12657	Not applicable
AdvancedLoop.Output.RemoteOutputHigh	Remote output high limit	float32	318c	12684	Same as AdvancedLoop.Main.ActiveOut
AdvancedLoop.Output.RemoteOutputLow	Remote output low limit	float32	318b	12683	Same as AdvancedLoop.Main.ActiveOut
AdvancedLoop.Output.SafeOutVal	Safe output value	float32	317e	12670	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.SbrkOP	Sensor break output	float32	318e	12686	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Output.SlaveSensorBreakMode	Slave sensor break mode (0 = SbrkOP; 1 = Hold)	uint8	317d	12669	Not applicable
AdvancedLoop.Output.TrackEnable	Enable output tracking (0 = Off; 1 = On)	uint8	318a	12682	Not applicable
AdvancedLoop.Output.TrackOutput	Output track value	float32	3189	12681	0dp
AdvancedLoop.Setup.CascadeType	Cascade type (0 = Full scale; 1 = Trim)	uint8	1606	5638	Not applicable
AdvancedLoop.Setup.MasterLoop	Master loop type (0 = PID)	uint8	31b3	12723	Not applicable
AdvancedLoop.Setup.MasterName	Master loop name	string_t	7010	28688	Not applicable
AdvancedLoop.Setup.ModeAccess	Mode access 0 = R/W (Logged out) 1 = R/W (Operator) 2 = Read Only	uint8	31a8	12712	Not applicable
AdvancedLoop.Setup.SetpointAccess	Setpoint access (as Mode Access, above)	uint8	31a7	12711	Not applicable
AdvancedLoop.Setup.SlaveChannel1	Slave heat/channel 1 control type 0 = Off 1 = On/Off 2 = PID 3 = VPU 4 = VPB	uint8	3101	12545	Not applicable
AdvancedLoop.Setup.SlaveChannel2	Slave cool/channel 2 control type (as above)	uint8	3102	12546	Not applicable
AdvancedLoop.Setup.SlaveName	Slave loop name	string_t	7020	28704	Not applicable
AdvancedLoop.SlavePID.ActiveSet	Active set (1 = Set 1; 2 = Set 2; 3 = Set 3)	uint8	3138	12600	Not applicable
AdvancedLoop.SlavePID.Boundary1-2	Scheduler boundary 1-2	float32	3139	12601	0dp
AdvancedLoop.SlavePID.Boundary2-3	Scheduler boundary 2-3	float32	133a	4922	0dp
AdvancedLoop.SlavePID.ControlAction	Control action (0 = Reverse acting; 1 = Direct acting)	uint8	3106	12550	Not applicable
AdvancedLoop.SlavePID.CutbackHigh	Cutback high set 1 (0 = Auto)	float32	313f	12607	1dp
AdvancedLoop.SlavePID.CutbackHigh2	Cutback high set 2 (0 = Auto)	float32	3147	12615	1dp
AdvancedLoop.SlavePID.CutbackHigh3	Cutback high set 3 (0 = Auto)	float32	314f	12623	1dp
AdvancedLoop.SlavePID.CutbackLow	Cutback low set 1 (0 = Auto)	float32	3140	12608	1dp
AdvancedLoop.SlavePID.CutbackLow2	Cutback low set 2 (0 = Auto)	float32	3148	12616	1dp
AdvancedLoop.SlavePID.CutbackLow3	Cutback low set 3 (0 = Auto)	float32	3150	12624	1dp
AdvancedLoop.SlavePID.DerivativeTime	Derivative time set 1 (0 = Off)	float32	313d	12605	1dp
AdvancedLoop.SlavePID.DerivativeTime2	Derivative time set 2 (0 = Off)	float32	3145	12613	1dp
AdvancedLoop.SlavePID.DerivativeTime3	Derivative time set 3 (0 = Off)	float32	314d	12621	1dp
AdvancedLoop.SlavePID.DerivativeType	Derivative type (0 = PV; 1 = Error)	uint8	3305	13061	Not applicable
AdvancedLoop.SlavePID.IntegralTime	Integral time set 1 (0 = Off)	float32	313c	12604	1dp
AdvancedLoop.SlavePID.IntegralTime2	Integral time set 2 (0 = Off)	float32	3144	12612	1dp
AdvancedLoop.SlavePID.IntegralTime3	Integral time set 3 (0 = Off)	float32	314c	12620	1dp
AdvancedLoop.SlavePID.LoopBreakTime	Loop break time set 1 (0 = Off)	float32	3142	12610	0dp
AdvancedLoop.SlavePID.LoopBreakTime2	Loop break time set 2 (0 = Off)	float32	314a	12618	0dp
AdvancedLoop.SlavePID.LoopBreakTime3	Loop break time set 3 (0 = Off)	float32	3152	12626	0dp
AdvancedLoop.SlavePID.ManualReset	Manual reset	float32	3141	12609	1dp
AdvancedLoop.SlavePID.ManualReset2	Manual reset 2	float32	3149	12617	1dp
AdvancedLoop.SlavePID.ManualReset3	Manual reset 3	float32	3151	12625	1dp
AdvancedLoop.SlavePID.NumberOfSets	Number of PID sets	uint8	3136	12598	Not applicable
AdvancedLoop.SlavePID.OutputHi2	Output high limit	float32	3155	12629	1dp
AdvancedLoop.SlavePID.OutputHi3	Output high limit	float32	3157	12631	1dp
AdvancedLoop.SlavePID.OutputHigh	Output high limit	float32	3153	12627	1dp
AdvancedLoop.SlavePID.OutputLo2	Output low limit 2	float32	3156	12630	1dp
AdvancedLoop.SlavePID.OutputLo3	Output low limit	float32	3158	12632	1dp
AdvancedLoop.SlavePID.OutputLow	Output low limit	float32	3154	12628	1dp
AdvancedLoop.SlavePID.PBUnits	Proportional band units (0 = Engineering; 1 = Percentage)	uint8	3304	13060	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AdvancedLoop.SlavePID.ProportionalBand	Proportional band set 1	float32	313b	12603	1dp
AdvancedLoop.SlavePID.ProportionalBand2	Proportional band set 2	float32	3143	12611	1dp
AdvancedLoop.SlavePID.ProportionalBand3	Proportional band set 3	float32	314b	12619	1dp
AdvancedLoop.SlavePID.RelCh2Gain	Relative cool/channel 2 gain	float32	313e	12606	1dp
AdvancedLoop.SlavePID.RelCh2Gain2	Relative cool/channel 2 gain 2	float32	3146	12614	1dp
AdvancedLoop.SlavePID.RelCh2Gain3	Relative cool/channel 2 gain 3	float32	314e	12622	1dp
AdvancedLoop.SlavePID.RemoteInput	Scheduler remote input	float32	3137	12599	0dp
AdvancedLoop.SlavePID.SchedulerType	Scheduler type 0 = Off 1 = Manually set 2 = Setpoint 3 = PV 4 = Error 5 = Output 6 = Remote	uint8	3135	12597	Not applicable
AdvancedLoop.SlaveSP.FFSelect	Feedforward select 0 = Master PV 1 = Master WSP 2 = Remote FF	uint8	31bf	12735	Not applicable
AdvancedLoop.SlaveSP.LocalSP	Local setpoint	float32	31b4	12724	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.ManualTrack	Manual track enable (0 = Off; 1 = On)	uint8	31ca	12746	Not applicable
AdvancedLoop.SlaveSP.MasterSensorBreakMode	Master sensor break mode 0 = SbrkSP 1 = Hold 2 = SlaveSB	uint8	31c2	12738	Not applicable
AdvancedLoop.SlaveSP.RangeHigh	Range high	float32	31c0	12736	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.RangeLow	Range low	float32	31c1	12737	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.RemoteFeedForward	Remote feedforward input	float32	31bb	12731	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.RemoteFFEnable	Remote feedforward enable (0 = No; 1 = Yes)	bool	31be	12734	Not applicable
AdvancedLoop.SlaveSP.RemoteFFHigh	Remote feedforward high	float32	31bc	12732	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.RemoteFFLow	Remote feddforward low	float32	31bd	12733	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.SbrkSP	Sensor break setpoint	float32	31c3	12739	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.SPHighLimit	Setpoint high limit	float32	31b5	12725	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.SPLowLimit	Setpoint low limit	float32	31b6	12726	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.TrimHighLimit	Trim high limit	float32	31b9	12729	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.SlaveSP.TrimLowLimit	Trim low limit	float32	31ba	12730	Same as AdvancedLoop.Main.MasterPV
AdvancedLoop.SlaveSP.TrimRangeHigh	Trim range high	float32	31b7	12727	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.SlaveSP.TrimRangeLow	Trim range low	float32	31b8	12728	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.Tune.A1	A1	float32	320d	12813	0dp
AdvancedLoop.Tune.A2	A2	float32	320e	12814	0dp
AdvancedLoop.Tune.Alpha	Alpha	float32	3211	12817	4dp
AdvancedLoop.Tune.Alpha_p	Alpha_p	float32	320f	12815	2dp
AdvancedLoop.Tune.ArgOP	Argument Output	float32	3209	12809	1dp
AdvancedLoop.Tune.ArgPV	Argument PV	float32	3208	12808	1dp
AdvancedLoop.Tune.Band	Band	float32	31c7	12743	1dp
AdvancedLoop.Tune.CycleNo	CycleNo	float32	3213	12819	0dp
AdvancedLoop.Tune.Debug	Debug	float32	3212	12818	2dp
AdvancedLoop.Tune.Diagnostics	Tuning diagnostics	bool	31cb	12747	Not applicable
AdvancedLoop.Tune.Gain	Gain	float32	320a	12810	1dp
AdvancedLoop.Tune.Hysteresis	Hysteresis	float32	31c6	12742	1dp
AdvancedLoop.Tune.MasterTune	Master tune	float32	3203	12803	0dp
AdvancedLoop.Tune.ModeMan	Mode Man	float32	3201	12801	0dp
AdvancedLoop.Tune.ModOP	Modulus OP	float32	3207	12807	1dp
AdvancedLoop.Tune.ModPV	Modulus PV	float32	3206	12806	1dp
AdvancedLoop.Tune.OP	Output	float32	3202	12802	1dp
AdvancedLoop.Tune.OPDel	OPDel	float32	0319	793	2dp
AdvancedLoop.Tune.OPss	OPss	float32	3210	12816	2dp
AdvancedLoop.Tune.OutputHighLimit	Output high	float32	3132	12594	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Tune.OutputLowLimit	Output low	float32	3133	12595	Same as AdvancedLoop.Output.OutputHighLimit
AdvancedLoop.Tune.PBs	PBs	float32	3214	12820	2dp
AdvancedLoop.Tune.Period	Period	float32	320c	12812	0dp
AdvancedLoop.Tune.Phase	Phase	float32	320b	12811	1dp
AdvancedLoop.Tune.Settle	Settle	float32	3216	12822	2dp
AdvancedLoop.Tune.Stage	Stage 0 = Reset 1 = None 2 = Settling 3 = Current SP 4 = New PP 5 = To SP 6 = Wait Max. 7 = Wait Min 8 = Store 9 = CoolT 10 = PID 11 = Abort 12 = Complete 13 = New R2g 14 = 1: Half Cycle 15 = 2: Full Cycle 16 = 3: Full Cycle 17 = 4: Final cycle 18 = 5: Calculating	uint8	0308	776	Not applicable
AdvancedLoop.Tune.StageTime	Stage time	float32	0309	777	0dp
AdvancedLoop.Tune.State	State 0 = Off 1 = Ready 2 - Running 3 = Complete 4 = Time-out 5 = Ti Limit 6 = R2G limit	uint8	0307	775	Not applicable
AdvancedLoop.Tune.TDs	TDs	float32	3215	12821	2dp
AdvancedLoop.Tune.Timeout	Timeout	float32	0326	806	0dp
AdvancedLoop.Tune.TuneEnable	Autotune enable (0 = Off; 1 = On)	bool	3131	12593	Not applicable
AdvancedLoop.Tune.TuneHigh	Tune high	float32	31c8	12744	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.Tune.TuneLow	Tune low	float32	31c9	12745	Same as AdvancedLoop.Main.SlavePV
AdvancedLoop.Tune.TuneR2G	Slave R2G tuning type 0 = Standard R2G tuning 1 = R2GPD tuning 2 = Off	uint8	3130	12592	Not applicable
AdvancedLoop.Tune.TuneSlave	Tune slave	float32	3204	12804	1dp
AdvancedLoop.Tune.TuneStatus	Tune Status 0 = Not tuning 1 = Tuning the slave 2 = Tuning the master 3 = Tuning complete -1 = Tuning aborted or timed-out	float32	3205	12805	0dp
AdvancedLoop.Tune.TuneType	Autotune algorithm type (0 = Slave; 1 = Master)	uint8	31c5	12741	Not applicable
AdvancedLoop.Tune.WSP	Working setpoint	float32	3200	12800	Same as AdvancedLoop.Main.MasterPV

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AlarmSummary.AnyAlarm	0 = No active alarms; 1 = one or more alarms active	bool	01a2	418	Not applicable
AlarmSummary.AnyChanAlarm	0 = No channel alarms 1 = Channel alarm(s) active but all ack'd. 2 = Channel alarm(s) active but not all ack'd	uint8	01a0	416	Not applicable
AlarmSummary.AnySystemAlarm	0 = No system alarms; 1 = 1 or more system alm(s)	bool	01a1	417	Not applicable
AlarmSummary.Channel.Alarm1Ack	Acknowledge the most recent channel alarm	bool	1192	4498	Not applicable
AlarmSummary.Channel.Alarm1Num	Channel and alarm number of most recent alarm 0 = No alarm 4 = Ch1;Al1 5 =Ch1;Al2 8 = Ch2;Al1 9 = Ch2Al2 12 = Ch3;Al1 13 = Ch3;Al2 16 = Ch4;Al1 17 = Ch4;Al2 132 = VC1;Al1 133 = VC1;Al2 136 = VC2;Al1 137 = VC2;Al2 140 = VC3;Al1 141 = VC3;Al2 144 = VC4;Al1 145 = VC4;Al2 148 = VC5;Al1 149 = VC5;Al2 152 = VC6;Al1 153 = VC6;Al2 156 = VC7;Al1 157 = VC7;Al2 160 = VC8;Al1 161 = VC8;Al2 164 = VC9;Al1 165 = VC9;Al2 168 = VC10;Al1 169 = VC10;Al2 172 = VC11;Al1 173 = VC11;Al2 176 = VC12;Al1 177 = VC12;Al2 180 = VC13;Al1 181 = VC13;Al2 184 = VC14;Al1 185 = VC14;Al2 188 = VC15;Al1 189 = VC15:Al2	uint8	1190	4496	Not applicable
AlarmSummary.Channel.Alarm1Status	Status of most recent alarm 0 = Off 1 = Active 2 = Safe unack 3 = Active unack	uint8	1191	4497	Not applicable
AlarmSummary.Channel.Alarm2Ack	Acknowledge the 2nd most recent channel alarm	bool	1195	4501	Not applicable
AlarmSummary.Channel.Alarm2Num	As Alarm1Num, but for 2nd most recent alarm	uint8	1193	4499	Not applicable
AlarmSummary.Channel.Alarm2Status	As Alarm1Status, but for 2nd most recent alarm	uint8	1194	4500	Not applicable
AlarmSummary.Channel.Alarm3Ack	Acknowledge the 3rd most recent channel alarm	bool	1198	4504	Not applicable
AlarmSummary.Channel.Alarm3Num	As Alarm1Num, but for 3rd most recent alarm	uint8	1196	4502	Not applicable
AlarmSummary.Channel.Alarm3Status	As Alarm1Status, but for 3rd most recent alarm	uint8	1197	4503	Not applicable
AlarmSummary.Channel.Alarm4Ack	Acknowledge the 4th most recent channel alarm	bool	119b	4507	Not applicable
AlarmSummary.Channel.Alarm4Num	As Alarm1Num, but for 4th most recent alarm	uint8	1199	4505	Not applicable
AlarmSummary.Channel.Alarm4Status	As Alarm1Status, but for 4th most recent alarm	uint8	119a	4506	Not applicable
AlarmSummary.Channel.Alarm5Ack	Acknowledge the 5th most recent channel alarm	bool	119e	4510	Not applicable
AlarmSummary.Channel.Alarm5Num	As Alarm1Num, but for 5th most recent alarm	uint8	119c	4508	Not applicable
AlarmSummary.Channel.Alarm5Status	As Alarm1Status, but for 5th most recent alarm	uint8	119d	4509	Not applicable
AlarmSummary.Channel.Alarm6Ack	Acknowledge the 6th most recent channel alarm	bool	11a1	4513	Not applicable
AlarmSummary.Channel.Alarm6Num	As Alarm1Num, but for 6th most recent alarm	uint8	119f	4511	Not applicable
AlarmSummary.Channel.Alarm6Status	As Alarm1Status, but for 6th most recent alarm	uint8	11a0	4512	Not applicable
AlarmSummary.Channel.Alarm7Ack	Acknowledge the 7th most recent channel alarm	bool	11a4	4516	Not applicable
AlarmSummary.Channel.Alarm7Num	As Alarm1Num, but for 7th most recent alarm	uint8	11a2	4514	Not applicable
AlarmSummary.Channel.Alarm7Status	As Alarm1Status, but for 7th most recent alarm	uint8	11a3	4515	Not applicable
AlarmSummary.Channel.Alarm8Ack	Acknowledge the 8th most recent channel alarm	bool	11a7	4519	Not applicable
AlarmSummary.Channel.Alarm8Num	As Alarm1Num, but for 8th most recent alarm	uint8	11a5	4517	Not applicable
AlarmSummary.Channel.Alarm8Status	As Alarm1Status, but for 8th most recent alarm	uint8	11a6	4518	Not applicable
AlarmSummary.Channel.Alarm9Ack	Acknowledge the 9th most recent channel alarm	bool	11aa	4522	Not applicable
AlarmSummary.Channel.Alarm9Num	As Alarm1Num, but for 9th most recent alarm	uint8	11a8	4520	Not applicable
AlarmSummary.Channel.Alarm9Status	As Alarm1Status, but for 9th most recent alarm	uint8	11a9	4521	Not applicable
AlarmSummary.Channel.Alarm10Ack	Acknowledge the 10th most recent channel alarm	bool	11ad	4525	Not applicable
AlarmSummary.Channel.Alarm10Num	As Alarm1Num, but for 10th most recent alarm	uint8	11ab	4523	Not applicable
AlarmSummary.Channel.Alarm10Status	As Alarm1Status, but for 10th most recent alarm	uint8	11ac	4524	Not applicable
AlarmSummary.Channel.Alarm11Ack	Acknowledge the 11th most recent channel alarm	bool	11b0	4528	Not applicable
AlarmSummary.Channel.Alarm11Num	As Alarm1Num, but for 11th most recent alarm	uint8	11ae	4526	Not applicable
AlarmSummary.Channel.Alarm11Status	As Alarm1Status, but for 11th most recent alarm	uint8	11af	4527	Not applicable
AlarmSummary.Channel.Alarm12Ack	Acknowledge the 12th most recent channel alarm	bool	11b3	4531	Not applicable
AlarmSummary.Channel.Alarm12Num	As Alarm1Num, but for 12th most recent alarm	uint8	11b1	4529	Not applicable
AlarmSummary.Channel.Alarm12Status	As Alarm1Status, but for 12th most recent alarm	uint8	11b2	4530	Not applicable
AlarmSummary.Channel.Alarm13Ack	Acknowledge the 13th most recent channel alarm	bool	11b6	4534	Not applicable
AlarmSummary.Channel.Alarm13Num	As Alarm1Num, but for 13th most recent alarmr	uint8	11b4	4532	Not applicable
AlarmSummary.Channel.Alarm13Status	As Alarm1Status, but for 13th most recent alarm	uint8	11b5	4533	Not applicable
AlarmSummary.Channel.Alarm14Ack	Acknowledge the 14th most recent channel alarm	bool	11b9	4537	Not applicable
AlarmSummary.Channel.Alarm14Num	As Alarm1Num, but for 14th most recent alarmr	uint8	11b7	4535	Not applicable
AlarmSummary.Channel.Alarm14Status	As Alarm1Status, but for 14th most recent alarm	uint8	11b8	4536	Not applicable
AlarmSummary.Channel.Alarm15Ack	Acknowledge the 15th most recent channel alarm	bool	11bc	4540	Not applicable
AlarmSummary.Channel.Alarm15Num	As Alarm1Num, but for 15th most recent alarm	uint8	11ba	4538	Not applicable
AlarmSummary.Channel.Alarm15Status	As Alarm1Status, but for 15th most recent alarm	uint8	11bb	4539	Not applicable
AlarmSummary.Channel.Alarm16Ack	Acknowledge the 16th most recent channel alarm	bool	11bf	4543	Not applicable
AlarmSummary.Channel.Alarm16Num	As Alarm1Num, but for 16th most recent alarm	uint8	11bd	4541	Not applicable
AlarmSummary.Channel.Alarm16Status	As Alarm1Status, but for 16th most recent alarm	uint8	11be	4542	Not applicable
AlarmSummary.Channel.Alarm17Ack	Acknowledge the 17th most recent channel alarm	bool	11c2	4546	Not applicable
AlarmSummary.Channel.Alarm17Num	As Alarm1Num, but for 17th most recent alarm	uint8	11c0	4544	Not applicable
AlarmSummary.Channel.Alarm17Status	As Alarm1Status, but for 17th most recent alarm	uint8	11c1	4545	Not applicable
AlarmSummary.Channel.Alarm18Ack	Acknowledge the 18th most recent channel alarm	bool	11c5	4549	Not applicable
AlarmSummary.Channel.Alarm18Num	As Alarm1Num, but for 18th most recent alarm	uint8	11c3	4547	Not applicable
AlarmSummary.Channel.Alarm18Status	As Alarm1Status, but for 18th most recent alarm	uint8	11c4	4548	Not applicable
AlarmSummary.Channel.Alarm19Ack	Acknowledge the 19th most recent channel alarm	bool	11c8	4552	Not applicable
AlarmSummary.Channel.Alarm19Num	As Alarm1Num, but for 19th most recent alarm	uint8	11c6	4550	Not applicable
AlarmSummary.Channel.Alarm19Status	As Alarm1Status, but for 19th most recent alarm	uint8	11c7	4551	Not applicable
AlarmSummary.Channel.Alarm20Ack	Acknowledge the 20th most recent channel alarm	bool	11cb	4555	Not applicable
AlarmSummary.Channel.Alarm20Num	As Alarm1Num, but for 20th most recent alarm	uint8	11c9	4553	Not applicable
AlarmSummary.Channel.Alarm20Status	As Alarm1Status, but for 20th most recent alarm	uint8	11ca	4554	Not applicable
AlarmSummary.Channel.Alarm21Ack	Acknowledge the 21st most recent channel alarm	bool	11ce	4558	Not applicable
AlarmSummary.Channel.Alarm21Num	As Alarm1Num, but for 21st most recent alarm	uint8	11cc	4556	Not applicable
AlarmSummary.Channel.Alarm21Status	As Alarm1Status, but for 21st most recent alarm	uint8	11cd	4557	Not applicable
AlarmSummary.Channel.Alarm22Ack	Acknowledge the 22nd most recent channel alarm	bool	11d1	4561	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AlarmSummary.Channel.Alarm22Num	As Alarm1Num, but for 22nd most recent alarm	uint8	11cf	4559	Not applicable
AlarmSummary.Channel.Alarm22Status	As Alarm1Status, but for 22nd most recent alarm	uint8	11d0	4560	Not applicable
AlarmSummary.Channel.Alarm23Ack	Acknowledge the 23rd most recent channel alarm	bool	11d4	4564	Not applicable
AlarmSummary.Channel.Alarm23Num	As Alarm1Num, but for 23th most recent alarm	uint8	11d2	4562	Not applicable
AlarmSummary.Channel.Alarm23Status	As Alarm1Status, but for 23rd most recent alarm	uint8	11d3	4563	Not applicable
AlarmSummary.Channel.Alarm24Ack	Acknowledge the 24th most recent channel alarm	bool	11d7	4567	Not applicable
AlarmSummary.Channel.Alarm24Num	As Alarm1Num, but for 24th most recent alarm	uint8	11d5	4565	Not applicable
AlarmSummary.Channel.Alarm24Status	As Alarm1Status, but for 24th most recent alarm	uint8	11d6	4566	Not applicable
AlarmSummary.Channel.Alarm25Ack	Acknowledge the 25th most recent channel alarm	bool	11da	4570	Not applicable
AlarmSummary.Channel.Alarm25Num	As Alarm1Num, but for 25th most recent alarm	uint8	11d8	4568	Not applicable
AlarmSummary.Channel.Alarm25Status	As Alarm1Status, but for 25th most recent alarm	uint8	11d9	4569	Not applicable
AlarmSummary.Channel.Alarm26Ack	Acknowledge the 26th most recent channel alarm	bool	11dd	4573	Not applicable
AlarmSummary.Channel.Alarm26Num	As Alarm1Num, but for 26th most recent alarm	uint8	11db	4571	Not applicable
AlarmSummary.Channel.Alarm26Status	As Alarm1Status, but for 26th most recent alarm	uint8	11dc	4572	Not applicable
AlarmSummary.Channel.Alarm27Ack	Acknowledge the 27th most recent channel alarm	bool	11e0	4576	Not applicable
AlarmSummary.Channel.Alarm27Num	As Alarm1Num, but for 27th most recent alarm	uint8	11de	4574	Not applicable
AlarmSummary.Channel.Alarm27Status	As Alarm1Status, but for 27th most recent alarm	uint8	11df	4575	Not applicable
AlarmSummary.Channel.Alarm28Ack	Acknowledge the 28th most recent channel alarm	bool	11e3	4579	Not applicable
AlarmSummary.Channel.Alarm28Num	As Alarm1Num, but for 28th most recent alarm	uint8	11e1	4577	Not applicable
AlarmSummary.Channel.Alarm28Status	As Alarm1Status, but for 28th most recent alarm	uint8	11e2	4578	Not applicable
AlarmSummary.Channel.Alarm29Ack	Acknowledge the 29th most recent channel alarm	bool	11e6	4582	Not applicable
AlarmSummary.Channel.Alarm29Num	As Alarm1Num, but for 29th most recent alarm	uint8	11e4	4580	Not applicable
AlarmSummary.Channel.Alarm29Status	As Alarm1Status, but for 29th most recent alarm	uint8	11e5	4581	Not applicable
AlarmSummary.Channel.Alarm30Ack	Acknowledge the 30th most recent channel alarm	bool	11e9	4585	Not applicable
AlarmSummary.Channel.Alarm30Num	As Alarm1Num, but for 30th most recent alarm	uint8	11e7	4583	Not applicable
AlarmSummary.Channel.Alarm30Status	As Alarm1Status, but for 30th most recent alarm	uint8	11e8	4584	Not applicable
AlarmSummary.Channel.Alarm31Ack	Acknowledge the 31st most recent channel alarm	bool	11ec	4588	Not applicable
AlarmSummary.Channel.Alarm31Num	As Alarm1Num, but for 31st most recent alarm	uint8	11ea	4586	Not applicable
AlarmSummary.Channel.Alarm31Status	As Alarm1Status, but for 31st most recent alarm	uint8	11eb	4587	Not applicable
AlarmSummary.Channel.Alarm32Ack	Acknowledge the 32nd most recent channel alarm	bool	11ef	4591	Not applicable
AlarmSummary.Channel.Alarm32Num	As Alarm1Num, but for 32nd most recent alarm	uint8	11ed	4589	Not applicable
AlarmSummary.Channel.Alarm32Status	As Alarm1Status, but for 32nd most recent alarm	uint8	11ee	4590	Not applicable
AlarmSummary.Channel.Alarm33Ack	Acknowledge the 33rd most recent channel alarm	bool	11f2	4594	Not applicable
AlarmSummary.Channel.Alarm33Num	As Alarm1Num, but for 33rd most recent alarm	uint8	11f0	4592	Not applicable
AlarmSummary.Channel.Alarm33Status	As Alarm1Status, but for 33rd most recent alarm	uint8	11f1	4593	Not applicable
AlarmSummary.Channel.Alarm34Ack	Acknowledge the 34th most recent channel alarm	bool	11f5	4597	Not applicable
AlarmSummary.Channel.Alarm34Num	As Alarm1Num, but for 34th most recent alarm	uint8	11f3	4595	Not applicable
AlarmSummary.Channel.Alarm34Status	As Alarm1Status, but for 34th most recent alarm	uint8	11f4	4596	Not applicable
AlarmSummary.Channel.Alarm35Ack	Acknowledge the 35th most recent channel alarm	bool	11f8	4600	Not applicable
AlarmSummary.Channel.Alarm35Num	As Alarm1Num, but for 35th most recent alarm	uint8	11f6	4598	Not applicable
AlarmSummary.Channel.Alarm35Status	As Alarm1Status, but for 35th most recent alarm	uint8	11f7	4599	Not applicable
AlarmSummary.Channel.Alarm36Ack	Acknowledge the 36th most recent channel alarm	bool	11fb	4603	Not applicable
AlarmSummary.Channel.Alarm36Num	As Alarm1Num, but for 36th most recent alarm	uint8	11f9	4601	Not applicable
AlarmSummary.Channel.Alarm36Status	As Alarm1Status, but for 36th most recent alarm	uint8	11fa	4602	Not applicable
AlarmSummary.Channel.Alarm37Ack	Acknowledge the 37th most recent channel alarm	bool	11fe	4606	Not applicable
AlarmSummary.Channel.Alarm37Num	As Alarm1Num, but for 37th most recent alarm	uint8	11fc	4604	Not applicable
AlarmSummary.Channel.Alarm37Status	As Alarm1Status, but for 38th most recent alarm	uint8	11fd	4605	Not applicable
AlarmSummary.Channel.Alarm38Ack	Acknowledge the 38th most recent channel alarm	bool	1201	4609	Not applicable
AlarmSummary.Channel.Alarm38Num	As Alarm1Num, but for 38th most recent alarm	uint8	11ff	4607	Not applicable
AlarmSummary.Channel.Alarm38Status	As Alarm1Status, but for 38th most recent alarm	uint8	1200	4608	Not applicable
AlarmSummary.GlobalAck	Acknowledge all alarms. 0=No;1 = yes	bool	01a3	419	Not applicable
AlarmSummary.StatusWord1	A summary of Channel 1-4 alarms Bit 0: 1 = Channel 1 Alarm 1 active Bit 1: 1 = Channel 1 Alarm 1 not acknowledged Bit 2: 1 = Channel 1 Alarm 2 active Bit 3: 1 = Channel 1 Alarm 2 not acknowledged Bit 4: 1 = Channel 2 Alarm 1 active Bit 5: 1 = Channel 2 Alarm 1 not acknowledged Bit 6: 1 = Channel 2 Alarm 2 active Bit 7: 1 = Channel 2 Alarm 2 not acknowledged Bit 8: 1 = Channel 3 Alarm 1 active Bit 9: 1 = Channel 3 Alarm 1 not acknowledged Bit 10: 1 = Channel 3 Alarm 2 active Bit 11: 1 = Channel 3 Alarm 2 not acknowledged Bit 12: 1 = Channel 4 Alarm 1 active Bit 13: 1 = Channel 4 Alarm 1 not acknowledged Bit 14: 1 = Channel 4 Alarm 2 active Bit 15: 1 = Channel 4 Alarm 2 not acknowledged	int16	01a4	420	Not applicable
AlarmSummary.StatusWord2	A summary of Virtual Channel 1 to 4 alarms Bit 0: 1 = Virtual channel 1 Alarm 1 active Bit 1: 1 = Virtual channel 1 Alarm 1 not ack'd Bit 2: 1 = Virtual channel 1 Alarm 2 active Bit 3: 1 = Virtual channel 1 Alarm 2 not ack'd Bit 4: 1 = Virtual channel 2 Alarm 1 active Bit 5: 1 = Virtual channel 2 Alarm 1 not ack'd Bit 6: 1 = Virtual channel 2 Alarm 2 active Bit 7: 1 = Virtual channel 2 Alarm 2 not ack'd Bit 8: 1 = Virtual channel 3 Alarm 1 active Bit 9: 1 = Virtual channel 3 Alarm 1 not ack'd Bit 10: 1 = Virtual channel 3 Alarm 2 active Bit 11: 1 = Virtual channel 3 Alarm 2 not ack'd	int16	01a5	421	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
AlarmSummary.StatusWord2 (Cont.)	Bit 12: 1 = Virtual channel 4 Alarm 1 active Bit 13: 1 = Virtual channel 4 Alarm 1 not ack'd Bit 14: 1 = Virtual channel 4 Alarm 2 active Bit 15: 1 = Virtual channel 4 Alarm 2 not ack'd				
AlarmSummary.StatusWord3	A summary of Virtual Channel 5 to 8 alarms As for Status Word 2 but for virtual channs 5 to 8	int16	01a6	422	Not applicable
AlarmSummary.StatusWord4	A summary of Virtual Channel 9 to 12 alarms As for Status Word 2 but for virtual channs 9 to 12	int16	01a7	423	Not applicable
AlarmSummary.StatusWord5	A summary of Virtual Channel 13 to 14 alarms As for Status Word 2 but for virtual channs 13 to 15	int16	01a8	424	Not applicable
AlarmSummary.System.Alarm1ID	Most recent active system alarm 0 = No Alarm 1 = Low battery 2 = Battery failure 3 = System clock fail 4 = Channel error 5 = Channel fail 6 = DHCP server fail 7 = FTP Archive file lost 8 = FTP Archive slow 9 = FTP Primary server failure 10 = FTP Secondary server failure 11 = Insufficient non-volatile memory 12 = Maths channel failure 13 = Media archive file lost 14 = Media archive slow 15 = Network boot failure 16 = DC Output Cal. Error 17 = Recording failure 18 = Media failure 19: = Media full 20 =SNTP failure 21 = Time synchronisation failure 22 = Media missing 23: Archive disabled 24 = Archiving failed 25 = Archiving timed out 26 = USB Over Current 27 = USB unsuported 28 = Invalid parameter database 29 = Invalid non-volatile data 30 = Flash write failure 31 = Wiring failure 32 = Broadcast Storm 33 = Non-volatile memory write frequency warning	uint8	1210	4624	Not applicable
AlarmSummary.System.Alarm2ID	2nd most recent active system alarm (as Alarm1ID)	uint8	1211	4625	Not applicable
AlarmSummary.System.Alarm3ID	3rd most recent active system alarm (as Alarm1ID)	uint8	1212	4626	Not applicable
AlarmSummary.System.Alarm4ID	4th most recent active system alarm (as Alarm1ID)	uint8	1213	4627	Not applicable
AlarmSummary.System.Alarm5ID	5th most recent active system alarm (as Alarm1ID)	uint8	1214	4628	Not applicable
AlarmSummary.System.Alarm6ID	6th most recent active system alarm (as Alarm1ID)	uint8	1215	4629	Not applicable
AlarmSummary.System.Alarm7ID	7th most recent active system alarm (as Alarm1ID)	uint8	1216	4630	Not applicable
AlarmSummary.System.Alarm8ID	8th most recent active system alarm (as Alarm1ID)	uint8	1217	4631	Not applicable
AlarmSummary.System.Alarm9ID	9th most recent active system alarm (as Alarm1ID)	uint8	1218	4632	Not applicable
AlarmSummary.System.Alarm10ID	10th most recent active system alarm (as Alarm1ID)	uint8	1219	4633	Not applicable
AlarmSummary.System.Alarm11ID	11th most recent active system alarm (as Alarm1ID)	uint8	121a	4634	Not applicable
AlarmSummary.System.Alarm12ID	12th most recent active system alarm (as Alarm1ID)	uint8	121b	4635	Not applicable
AlarmSummary.System.Alarm13ID	13th most recent active system alarm (as Alarm1ID)	uint8	121c	4636	Not applicable
AlarmSummary.System.Alarm14ID	14th most recent active system alarm (as Alarm1ID)	uint8	121d	4637	Not applicable
AlarmSummary.System.Alarm15ID	15th most recent active system alarm (as Alarm1ID)	uint8	121e	4638	Not applicable
AlarmSummary.System.Alarm16ID	16th most recent active system alarm (as Alarm1ID)	uint8	121f	4639	Not applicable
AlarmSummary.System.Alarm17ID	17th most recent active system alarm (as Alarm1ID)	uint8	1220	4640	Not applicable
AlarmSummary.System.Alarm18ID	18th most recent active system alarm (as Alarm1ID)	uint8	1221	4641	Not applicable
AlarmSummary.System.Alarm19ID	19th most recent active system alarm (as Alarm1ID)	uint8	1222	4642	Not applicable
AlarmSummary.System.Alarm20ID	20th most recent active system alarm (as Alarm1ID)	uint8	1223	4643	Not applicable
AlarmSummary.System.Alarm21ID	21st most recent active system alarm (as Alarm1ID)	uint8	1224	4644	Not applicable
AlarmSummary.System.Alarm22ID	22nd most recent active system alarm (as Alarm1ID)	uint8	1225	4645	Not applicable
AlarmSummary.System.Alarm23ID	23rd most recent active system alarm (as Alarm1ID)	uint8	1226	4646	Not applicable
AlarmSummary.System.Alarm24ID	24th most recent active system alarm (as Alarm1ID)	uint8	1227	4647	Not applicable
AlarmSummary.System.Alarm25ID	25th most recent active system alarm (as Alarm1ID)	uint8	1228	4648	Not applicable
AlarmSummary.System.Alarm26ID	26th most recent active system alarm (as Alarm1ID)	uint8	1229	4649	Not applicable
AlarmSummary.System.Alarm27ID	27th most recent active system alarm (as Alarm1ID)	uint8	122a	4650	Not applicable
AlarmSummary.System.Alarm28ID	28th most recent active system alarm (as Alarm1ID)	uint8	122b	4651	Not applicable
AlarmSummary.System.Alarm29ID	29th most recent active system alarm (as Alarm1ID)	uint8	122c	4652	Not applicable
AlarmSummary.System.Alarm30ID	30th most recent active system alarm (as Alarm1ID)	uint8	122d	4653	Not applicable
AlarmSummary.System.Alarm31ID	31st most recent active system alarm (as Alarm1ID)	uint8	122e	4654	Not applicable
AlarmSummary.System.Alarm32ID	32nd most recent active system alarm (as Alarm1ID)	uint8	122f	4655	Not applicable
BCDInput.1.BCDVal	BCD1 BCD Value	uint8	2ed1	11985	Not applicable
BCDInput.1.DecByte	BCD1 Decimal Value	uint8	2ed0	11984	Not applicable
BCDInput.1.In1	BCD1 Input 1 (0 = Off; 1 = On)	bool	2ec8	11976	Not applicable
BCDInput.1.In2	BCD1 Input 2 (0 = Off; 1 = On)	bool	2ec9	11977	Not applicable
BCDInput.1.In3	BCD1 Input 3 (0 = Off; 1 = On)	bool	2eca	11978	Not applicable
BCDInput.1.In4	BCD1 Input 4 (0 = Off; 1 = On)	bool	2ecb	11979	Not applicable
BCDInput.1.In5	BCD1 Input 5 (0 = Off; 1 = On)	bool	2ecc	11980	Not applicable
BCDInput.1.In6	BCD1 Input 6 (0 = Off; 1 = On)	bool	2ecd	11981	Not applicable
BCDInput.1.In7	BCD1 Input 7 (0 = Off; 1 = On)	bool	2ece	11982	Not applicable
BCDInput.1.In8	BCD1 Input 8 (0 = Off; 1 = On)	bool	2ecf	11983	Not applicable
BCDInput.1.Tens	BCD1 Tens (MSD)	uint8	2ed3	11987	Not applicable
BCDInput.1.Units	BCD1 Units (LSD)	uint8	2ed2	11986	Not applicable
BCDInput.2.BCDVal	BCD2 BCD Value	uint8	2edd	11997	Not applicable
BCDInput.2.DecByte	BCD2 Decimal Value	uint8	2edc	11996	Not applicable
BCDInput.2.In1	BCD2 Input 1 (0 = Off; 1 = On)	bool	2ed4	11988	Not applicable
BCDInput.2.In2	BCD2 Input 2 (0 = Off; 1 = On)	bool	2ed5	11989	Not applicable
BCDInput.2.In3	BCD2 Input 3 (0 = Off; 1 = On)	bool	2ed6	11990	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
BCDInput.2.In4	BCD2 Input 4 (0 = Off; 1 = On)	bool	2ed7	11991	Not applicable
BCDInput.2.In5	BCD2 Input 5 (0 = Off; 1 = On)	bool	2ed8	11992	Not applicable
BCDInput.2.In6	BCD2 Input 6 (0 = Off; 1 = On)	bool	2ed9	11993	Not applicable
BCDInput.2.In7	BCD2 Input 7 (0 = Off; 1 = On)	bool	2eda	11994	Not applicable
BCDInput.2.In8	BCD2 Input 8 (0 = Off; 1 = On)	bool	2edb	11995	Not applicable
BCDInput.2.Tens	BCD2 Tens (MSD)	uint8	2edf	11999	Not applicable
BCDInput.2.Units	BCD2 Units (LSD)	uint8	2ede	11998	Not applicable
Channel.1.Alarm1.Acknowledge	1 = Acknowledge alarm	bool	01b0	432	Not applicable
Channel.1.Alarm1.Acknowledgement	1 = Alarm acknowledged	bool	1850	6224	Not applicable
Channel.1.Alarm1.Active	1 = Alarm source active, or safe but not ack'd	bool	184b	6219	Not applicable
Channel.1.Alarm1.Amount	Alarm amount	float32	1848	6216	Same as Channel.1.Main.PV
Channel.1.Alarm1.AverageTime	Average time	time_t	184a	6218	Set by Network.Modbus.TimeFormat
Channel.1.Alarm1.Block	Blocking enable (0 = Off; 1 = On)	uint8	1842	6210	Not applicable
Channel.1.Alarm1.ChangeTime	Change time (0 = Per second; 1= Per minute; 2 =Per hour)	uint8	1849	6217	Not applicable
Channel.1.Alarm1.Deviation	Alarm deviation	float32	1847	6215	Same as Channel.1.Main.PV
Channel.1.Alarm1.Dwell	Alarm dwell	time_t	1845	6213	Set by Network.Modbus.TimeFormat
Channel.1.Alarm1.Hysteresis	Alarm hysteresis	float32	1844	6212	Same as Channel.1.Main.PV
Channel.1.Alarm1.Inactive	1 = the alarm is safe and acknowledged	bool	184e	6222	Not applicable
Channel.1.Alarm1.Inhibit	1 = the alarm is inhibited	bool	1851	6225	Not applicable
Channel.1.Alarm1.Latch	Alarm latch type 0 = None 1 = Auto 2 = Manual 3 = Trigger	uint8	1841	6209	Not applicable
Channel.1.Alarm1.NotAcknowledged	1 = the alarm has not been acknowledged	bool	184f	6223	Not applicable
Channel.1.Alarm1.Reference	Alarm reference	float32	1846	6214	Same as Channel.1.Main.PV
Channel.1.Alarm1.Status	Alarm status 0 = Off 1 = Active 2 = Safe not acknowledged 3 = Active not acknowledged	uint8	0102	258	Not applicable
Channel.1.Alarm1.Threshold	Alarm threshold	float32	1843	6211	Same as Channel.1.Main.PV
Channel.1.Alarm1.Type	Alarm type 0 = None 1 = Abs High 2 = Abs Low 3 = Dev high 4 = Dev Low 5 = Dev band 6 = ROC rising 7 = ROC falling 10 = Dig Off 11 = Dig high 12 = Dig Low	uint8	1840	6208	Not applicable
Channel.1.Alarm2.Acknowledge	1 = Acknowledge alarm	bool	01b1	433	Not applicable
Channel.1.Alarm2.Acknowledgement	1 = Alarm acknowledged	bool	1870	6256	Not applicable
Channel.1.Alarm2.Active	1 = Alarm source active, or safe but not ack'd	bool	186b	6251	Not applicable
Channel.1.Alarm2.Amount	Alarm amount	float32	1868	6248	Same as Channel.1.Main.PV
Channel.1.Alarm2.AverageTime	Average time	time_t	186a	6250	Set by Network.Modbus.TimeFormat
Channel.1.Alarm2.Block	Blocking enable (0 = Off; 1 = On)	uint8	1862	6242	Not applicable
Channel.1.Alarm2.ChangeTime	Change time (0 = Per second; 1= Per minute; 2 =Per hour)	uint8	1869	6249	Not applicable
Channel.1.Alarm2.Deviation	Alarm deviation	float32	1867	6247	Same as Channel.1.Main.PV
Channel.1.Alarm2.Dwell	Alarm dwell	time_t	1865	6245	Set by Network.Modbus.TimeFormat
Channel.1.Alarm2.Hysteresis	Alarm hysteresis	float32	1864	6244	Same as Channel.1.Main.PV
Channel.1.Alarm2.Inactive	1 = the alarm is safe and acknowledged	bool	186e	6254	Not applicable
Channel.1.Alarm2.Inhibit	1 = the alarm is inhibited	bool	1871	6257	Not applicable
Channel.1.Alarm2.Latch	Configures the latching type of the alarm (As Alarm1.Latch)	uint8	1861	6241	Not applicable
Channel.1.Alarm2.NotAcknowledged	1 = the alarm has not been acknowledged	bool	186f	6255	Not applicable
Channel.1.Alarm2.Reference	Alarm reference	float32	1866	6246	Same as Channel.1.Main.PV
Channel.1.Alarm2.Status	As Alarm1.Status	uint8	0103	259	Not applicable
Channel.1.Alarm2.Threshold	Alarm threshold	float32	1863	6243	Same as Channel.1.Main.PV
Channel.1.Alarm2.Type	Alarm type (as Alarm1.Type	uint8	1860	6240	Not applicable
Channel.1.Main.CJType	Cold junction compensation type 0 = None 1 = Internal 2 = External 3 = Remote (Ch1) 4 = Remote (Ch2) 5 = Remote (Ch3) 6 = Remote (Ch4)	uint8	180c	6156	Not applicable
Channel.1.Main.CloseString	Close String	string_t	4990	18832	Not applicable
Channel.1.Main.Descriptor	Text string to describe the channel	string_t	4900	18688	Not applicable
Channel.1.Main.ExtCJTemp	External CJ temperature	float32	180d	6157	1dp
Channel.1.Main.FaultResponse	Fault response. 0 = none; 1 = Drive high; 2 = Drive low	uint8	1810	6160	Not applicable
Channel.1.Main.Filter	Filter time constant	float32	180e	6158	1dp
Channel.1.Main.InputHigh	Input range high value	float32	1804	6148	1dp
Channel.1.Main.InputLow	Input range low value	float32	1803	6147	1dp
Channel.1.Main.InternalCJTemp	Channel internal cold junction temperature	float32	1815	6165	1dp
Channel.1.Main.IPAdjustState	Input Adjust state (0 = Unadjusted; 1 = Adjusted)	bool	1816	6166	Not applicable
Channel.1.Main.IPAdjustState2	Secondary Input Adjust state (0 = Unadjusted; 1 = Adjusted)	bool	181c	6172	Not applicable
Channel.1.Main.LinType	Linearisation type 0 =Type B 1 = Type C 2 = Type D 3 = Type E 4 = Type G2 5 = Type J 6 =Type K 7 = Type L 8 = Type N 9 = Type R 10 = Type S 11 = Type T 12 = Type U 13 = NiMoNiCo 14 = Platinel 15 = NiNiMo 16 = Pt20RhPt40Rh 17 = User 1 18 = User 2 19 = User 3 20 = User 4 21 = Cu10 22 = Pt100 23 = Pt100A 24 = JPT100 25 = Ni100 26 = Ni120 27 = Cu53 28 = Linear 29 = Sqrt 30 = $x^{3/2}$ 32 = $x^{5/2}$	uint8	1806	6150	Not applicable
Channel.1.Main.MeasuredValue	Input value before linearisation, scaling, adjust etc.	float32	1814	6164	Set by Channel.1.Main.Resolution
Channel.1.Main.MeasuredValue2	Measured value of the secondary input	float32	1819	6169	Set by Channel.1.Main.Resolution
Channel.1.Main.Offset	Fixed value to be added to/subtracted from PV	float32	1817	6167	3dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Channel.1.Main.Offset2	Secondary input offset (as above).	float32	1818	6168	3dp
Channel.1.Main.OpenString	Open String	string_t	496c	18796	Not applicable
Channel.1.Main.PV	The process variable (output) of the channel	float32	0100	256	Set by Channel.1.Main.Resolution
Channel.1.Main.PV2	The secondary input process variable (output) of the channel	float32	0110	272	Set by Channel.1.Main.Resolution
Channel.1.Main.RangeHigh	Range high value	float32	1808	6152	Set by Channel.1.Main.Resolution
Channel.1.Main.RangeLow	Range low value	float32	1807	6151	Set by Channel.1.Main.Resolution
Channel.1.Main.RangeUnits	Range units: 0 = °C; 1 = °F; 2 = Kelvins	uint8	1809	6153	Not applicable
Channel.1.Main.Resolution	Specifies the resolution/number of decimal places	uint8	1801	6145	Not applicable
Channel.1.Main.ScaleHigh	Scale high value	float32	180b	6155	Set by Channel.1.Main.Resolution
Channel.1.Main.ScaleHigh2	Scale high value for the secondary input	float32	181b	6171	Set by Channel.1.Main.Resolution
Channel.1.Main.ScaleLow	Scale low value	float32	180a	6154	Set by Channel.1.Main.Resolution
Channel.1.Main.ScaleLow2	Scale low value for the secondary input	float32	181a	6170	Set by Channel.1.Main.Resolution
Channel.1.Main.SensorBreakType	Sensor break type: 0 =Off; 1 = Low; 2 = High	uint8	180f	6159	Not applicable
Channel.1.Main.SensorBreakVal	Sensor break value	uint8	1811	6161	Not applicable
Channel.1.Main.Shunt	Shunt value (Ohms)	float32	1805	6149	2dp
Channel.1.Main.Status	The PV (output) status 0 =Good 1 = Off 2 = Over range 3 = Under range 4 = HW error 5 = Ranging 6 = Overflow 7 = bad 8 = HW exceeded 9 = No data 12 = Comm channel error	uint8	0101	257	Not applicable
Channel.1.Main.Status2	The secondary input PV (output) status (as above)	uint8	0111	273	Not applicable
Channel.1.Main.TestSignal	Channel test waveform 0 = Triangle 5hr 1 = Triangle 40 min 2 = Triangle 4 min 3 = Triangle 40 sec 4 = Sine 5 hr 5 = Sine 40 min 6 = Sine 4 min 7 = Sine 40 sec	uint8	1802	6146	Not applicable
Channel.1.Main.Type	Specifies the type of channel 0 = Off 1 = TC 2 = mV 3 = V 4 = mA 5 = RTD 6 = Digital 7 = Test 8 = Ohms 9 = Dual mV 10 = Dual mA 11 = Dual TC	uint8	1800	6144	Not applicable
Channel.1.Main.Units	Units descriptor	string_t	4915	18709	Not applicable
Channel.1.Trend.Colour	Configures the trend colour for this channel 0 = Red 1 = Blue 2 = Green 3 = Honey 4 = Violet 5 = Russet 6 = Dark blue 7 = Jade 8 = Magenta 9 = Dusky rose 10 = Yellow 11 = Powder blue 12 = Dark red 13 = Avocado 14 = Indigo 15 = Dark brown 16 = Aegean 17 = Cyan 18 = Aubergine 19 = Dark orange 20 = Pale yellow 21 = Hyacinth 22 = Dark green 23 = Sugar pink 24 = Bluebell 25 = Orange 26 = Pink 27 = Buttersilk 28 = Terracotta 29 = Blue babe 30 = Lime 31 = Blue jive 32 = Cucumber 33 = Eurogreen 34 = Wheatgerm 35 = Sea Blue 36 = Ginger 37 = Aqua pool 38 = Pale red 39 = Pale blue 40 = Lilac 41 = Sky blue 42 = Wild moss 43 = Turquoise 44 = Pale green 45 = Coffee 49 = Dark Grey 53 = Light grey	uint8	1820	6176	Not applicable
Channel.1.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1822	6178	Same as Channel.1.Main.PV
Channel.1.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1821	6177	Same as Channel.1.Main.PV
Channel.2.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01b2	434	Not applicable
Channel.2.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	18d0	6352	Not applicable
Channel.2.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	18cb	6347	Not applicable
Channel.2.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	18c8	6344	Same as Channel.2.Main.PV
Channel.2.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	18ca	6346	Set by Network.Modbus.TimeFormat
Channel.2.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	18c2	6338	Not applicable
Channel.2.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	18c9	6345	Not applicable
Channel.2.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	18c7	6343	Same as Channel.2.Main.PV
Channel.2.Alarm1.Dwell	Alarm dwell time	time_t	18c5	6341	Set by Network.Modbus.TimeFormat
Channel.2.Alarm1.Hysteresis	Alarm hysteresis value	float32	18c4	6340	Same as Channel.2.Main.PV
Channel.2.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	18ce	6350	Not applicable
Channel.2.Alarm1.Inhibit	1 = Alarm inhibited	bool	18d1	6353	Not applicable
Channel.2.Alarm1.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	18c1	6337	Not applicable
Channel.2.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	18cf	6351	Not applicable
Channel.2.Alarm1.Reference	Deviation alarm 'Reference' value	float32	18c6	6342	Same as Channel.2.Main.PV
Channel.2.Alarm1.Status	Alarm status (as for Channel.1.Alarm1)	uint8	0106	262	Not applicable
Channel.2.Alarm1.Threshold	Alarm trigger threshold	float32	18c3	6339	Same as Channel.2.Main.PV
Channel.2.Alarm1.Type	Alarn type (as for Channel.1.Alarm1)	uint8	18c0	6336	Not applicable
Channel.2.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01b3	435	Not applicable
Channel.2.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	18f0	6384	Not applicable
Channel.2.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	18eb	6379	Not applicable
Channel.2.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	18e8	6376	Same as Channel.2.Main.PV
Channel.2.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	18ea	6378	Set by Network.Modbus.TimeFormat
Channel.2.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	18e2	6370	Not applicable
Channel.2.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	18e9	6377	Not applicable
Channel.2.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	18e7	6375	Same as Channel.2.Main.PV
Channel.2.Alarm2.Dwell	Alarm dwell time	time_t	18e5	6373	Set by Network.Modbus.TimeFormat
Channel.2.Alarm2.Hysteresis	Alarm hysteresis value	float32	18e4	6372	Same as Channel.2.Main.PV
Channel.2.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	18ee	6382	Not applicable
Channel.2.Alarm2.Inhibit	1 = Alarm inhibited	bool	18f1	6385	Not applicable
Channel.2.Alarm2.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	18e1	6369	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Channel.2.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	18ef	6383	Not applicable
Channel.2.Alarm2.Reference	Deviation alarm 'Reference' value	float32	18e6	6374	Same as Channel.2.Main.PV
Channel.2.Alarm2.Status	Alarm status (as for Channel.1.Alarm1)	uint8	0107	263	Not applicable
Channel.2.Alarm2.Threshold	Alarm trigger threshold	float32	18e3	6371	Same as Channel.2.Main.PV
Channel.2.Alarm2.Type	Alarn type (as for Channel.1.Alarm1)	uint8	18e0	6368	Not applicable
Channel.2.Main.CJType	Cold junction compensation type (as for Channel.1.Main)	uint8	188c	6284	Not applicable
Channel.2.Main.CloseString	Close String	string_t	4999	18841	Not applicable
Channel.2.Main.Descriptor	Text string to describe the channel	string_t	491b	18715	Not applicable
Channel.2.Main.ExtCJTemp	External CJ temperature	float32	188d	6285	1dp
Channel.2.Main.FaultResponse	Input fault response	uint8	1890	6288	Not applicable
Channel.2.Main.Filter	Filter time constant	float32	188e	6286	1dp
Channel.2.Main.InputHigh	Input range high value	float32	1884	6276	1dp
Channel.2.Main.InputLow	Input range low value	float32	1883	6275	1dp
Channel.2.Main.InternalCJTemp	Channel 2 internal cold junction temperature	float32	1895	6293	1dp
Channel.2.Main.IPAdjustState	Input Adjust state (0 = Unadjusted; 1 =Adjusted)	bool	1896	6294	Not applicable
Channel.2.Main.IPAdjustState2	Secondary Input Adjust state (0 = Unadjusted; 1 = Adjusted)	bool	189c	6300	Not applicable
Channel.2.Main.LinType	Linearisation type (as for Channel.1.Main)	uint8	1886	6278	Not applicable
Channel.2.Main.MeasuredValue	Input value before linearisation, scaling, adjust etc.	float32	1894	6292	Set by Channel.2.Main.Resolution
Channel.2.Main.MeasuredValue2	Measured value of the secondary input	float32	1899	6297	Set by Channel.2.Main.Resolution
Channel.2.Main.Offset	Fixed value to be added to/subtracted from PV	float32	1897	6295	3dp
Channel.2.Main.Offset2	Secondary input offset	float32	1898	6296	3dp
Channel.2.Main.OpenString	Open String	string_t	4975	18805	Not applicable
Channel.2.Main.PV	The output (displayed) value of the channel.	float32	0104	260	Set by Channel.2.Main.Resolution
Channel.2.Main.PV2	The secondary input process variable (output) of the channel	float32	0114	276	Set by Channel.2.Main.Resolution
Channel.2.Main.RangeHigh	Range high value	float32	1888	6280	Set by Channel.2.Main.Resolution
Channel.2.Main.RangeLow	Range low value	float32	1887	6279	Set by Channel.2.Main.Resolution
Channel.2.Main.RangeUnits	Range units (as channel.1.Main)	uint8	1889	6281	Not applicable
Channel.2.Main.Resolution	Specifies the resolution/number of decimal places	uint8	1881	6273	Not applicable
Channel.2.Main.ScaleHigh	Scale high value	float32	188b	6283	Set by Channel.2.Main.Resolution
Channel.2.Main.ScaleHigh2	Scale high value for the secondary input	float32	189b	6299	Set by Channel.2.Main.Resolution
Channel.2.Main.ScaleLow	Scale low value	float32	188a	6282	Set by Channel.2.Main.Resolution
Channel.2.Main.ScaleLow2	Scale low value for the secondary input	float32	189a	6298	Set by Channel.2.Main.Resolution
Channel.2.Main.SensorBreakType	Sensor break type (as for Channel.1.Main)	uint8	188f	6287	Not applicable
Channel.2.Main.SensorBreakVal	Sensor break value	uint8	1891	6289	Not applicable
Channel.2.Main.Shunt	Shunt value in Ohms	float32	1885	6277	2dp
Channel.2.Main.Status	Channel status (as for Channel.1.Main.Status)	uint8	0105	261	Not applicable
Channel.2.Main.Status2	The secondary input PV (output) status (as above)	uint8	0115	277	Not applicable
Channel.2.Main.TestSignal	Channel test waveform (as for Channel.1.Main)	uint8	1882	6274	Not applicable
Channel.2.Main.Type	Channel function (as for Channel.1.Main.Type)	uint8	1880	6272	Not applicable
Channel.2.Main.Units	Channel units string	string_t	4930	18736	Not applicable
Channel.2.Trend.Colour	Trend colour (as for Channel.1.Trend.Colour)	uint8	18a0	6304	Not applicable
Channel.2.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	18a2	6306	Same as Channel.2.Main.PV
Channel.2.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	18a1	6305	Same as Channel.2.Main.PV
Channel.3.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1950	6480	Not applicable
Channel.3.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	194b	6475	Not applicable
Channel.3.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1948	6472	Same as Channel.3.Main.PV
Channel.3.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	194a	6474	Set by Network.Modbus.TimeFormat
Channel.3.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on.	uint8	1942	6466	Not applicable
Channel.3.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1949	6473	Not applicable
Channel.3.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1947	6471	Same as Channel.3.Main.PV
Channel.3.Alarm1.Dwell	Alarm dwell time	time_t	1945	6469	Set by Network.Modbus.TimeFormat
Channel.3.Alarm1.Hysteresis	Alarm hysteresis value	float32	1944	6468	Same as Channel.3.Main.PV
Channel.3.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	194e	6478	Not applicable
Channel.3.Alarm1.Inhibit	1 = alarm inhibited	bool	1951	6481	Not applicable
Channel.3.Alarm1.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	1941	6465	Not applicable
Channel.3.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	194f	6479	Not applicable
Channel.3.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1946	6470	Same as Channel.3.Main.PV
Channel.3.Alarm1.Status	Alarm status (as for Channel.1.Alarm1)	uint8	010a	266	Not applicable
Channel.3.Alarm1.Threshold	Alarm trigger threshold	float32	1943	6467	Same as Channel.3.Main.PV
Channel.3.Alarm1.Type	Alarn type (as for Channel.1.Alarm1)	uint8	1940	6464	Not applicable
Channel.3.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01b5	437	Not applicable
Channel.3.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1970	6512	Not applicable
Channel.3.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	196b	6507	Not applicable
Channel.3.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1968	6504	Same as Channel.3.Main.PV
Channel.3.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	196a	6506	Set by Network.Modbus.TimeFormat
Channel.3.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on.	uint8	1962	6498	Not applicable
Channel.3.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1969	6505	Not applicable
Channel.3.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1967	6503	Same as Channel.3.Main.PV
Channel.3.Alarm2.Dwell	Alarm dwell time	time_t	1965	6501	Set by Network.Modbus.TimeFormat
Channel.3.Alarm2.Hysteresis	Alarm hysteresis value	float32	1964	6500	Same as Channel.3.Main.PV
Channel.3.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	196e	6510	Not applicable
Channel.3.Alarm2.Inhibit	1 = Alarm inhibited	bool	1971	6513	Not applicable
Channel.3.Alarm2.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	1961	6497	Not applicable
Channel.3.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	196f	6511	Not applicable
Channel.3.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1966	6502	Same as Channel.3.Main.PV
Channel.3.Alarm2.Status	Alarm status (as for Channel.1.Alarm1)	uint8	010b	267	Not applicable
Channel.3.Alarm2.Threshold	Alarm trigger threshold	float32	1963	6499	Same as Channel.3.Main.PV
Channel.3.Alarm2.Type	Alarn type (as for Channel.1.Alarm1)	uint8	1960	6496	Not applicable
Channel.3.Main.CJType	Cold junction compensation type (as for Channel.1.Main)	uint8	190c	6412	Not applicable
Channel.3.Main.CloseString	Close String	string_t	49a2	18850	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Channel.3.Main.Descriptor	Text string to describe the channel	string_t	4936	18742	Not applicable
Channel.3.Main.ExtCJTemp	External CJ temperature	float32	190d	6413	1dp
Channel.3.Main.FaultResponse	Input fault response (As for Channel.1.Main)	uint8	1910	6416	Not applicable
Channel.3.Main.Filter	Filter time constant	float32	190e	6414	1dp
Channel.3.Main.InputHigh	Input range maximum value	float32	1904	6404	1dp
Channel.3.Main.InputLow	Input range minimum value	float32	1903	6403	1dp
Channel.3.Main.InternalCJTemp	Channel internal cold junction temperature	float32	1915	6421	1dp
Channel.3.Main.IPAdjustState	Input Adjust state (0 = Unadjusted; 1 = Adjusted)	bool	1916	6422	Not applicable
Channel.3.Main.IPAdjustState2	Secondary Input Adjust state (0 = Unadjusted; 1 = Adjusted)	bool	191c	6428	Not applicable
Channel.3.Main.LinType	Linearisation type (as for Channel.1.Main.LinType)	uint8	1906	6406	Not applicable
Channel.3.Main.MeasuredValue	Input value before linearisation, scaling, adjust etc.	float32	1914	6420	Set by Channel.3.Main.Resolution
Channel.3.Main.MeasuredValue2	Measured value of the secondary input	float32	1919	6425	Set by Channel.3.Main.Resolution
Channel.3.Main.Offset	Input offset	float32	1917	6423	3dp
Channel.3.Main.Offset2	Secondary input offset	float32	1918	6424	3dp
Channel.3.Main.OpenString	Open String	string_t	497e	18814	Not applicable
Channel.3.Main.PV	The output (displayed) value of the channel.	float32	0108	264	Set by Channel.3.Main.Resolution
Channel.3.Main.PV2	The secondary input process variable (output) of the channel	float32	0118	280	Set by Channel.3.Main.Resolution
Channel.3.Main.RangeHigh	Range high value	float32	1908	6408	Set by Channel.3.Main.Resolution
Channel.3.Main.RangeLow	Range low value	float32	1907	6407	Set by Channel.3.Main.Resolution
Channel.3.Main.RangeUnits	Range units	uint8	1909	6409	Not applicable
Channel.3.Main.Resolution	Specifies the resolution/number of decimal places	uint8	1901	6401	Not applicable
Channel.3.Main.ScaleHigh	Scale high value	float32	190b	6411	Set by Channel.3.Main.Resolution
Channel.3.Main.ScaleHigh2	Scale high value for the secondary input	float32	191b	6427	Set by Channel.3.Main.Resolution
Channel.3.Main.ScaleLow	Scale low value	float32	190a	6410	Set by Channel.3.Main.Resolution
Channel.3.Main.ScaleLow2	Scale low value for the secondary input	float32	191a	6426	Set by Channel.3.Main.Resolution
Channel.3.Main.SensorBreakType	Sensor break type (as for Channel.1.Main)	uint8	190f	6415	Not applicable
Channel.3.Main.SensorBreakVal	Sensor break value	uint8	1911	6417	Not applicable
Channel.3.Main.Shunt	Shunt value in Ohms	float32	1905	6405	2dp
Channel.3.Main.Status	Channel status (as for Channel.1.Main.Status)	uint8	0109	265	Not applicable
Channel.3.Main.Status2	The secondary input PV (output) status	uint8	0119	281	Not applicable
Channel.3.Main.TestSignal	Channel test waveform (as for Channel.1.Main)	uint8	1902	6402	Not applicable
Channel.3.Main.Type	Channel function (as for Channel.1.Main.Type)	uint8	1900	6400	Not applicable
Channel.3.Main.Units	Units descriptor	string_t	494b	18763	Not applicable
Channel.3.Trend.Colour	Trend colour (as for Channel.1.Trend.Colour)	uint8	1920	6432	Not applicable
Channel.3.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1922	6434	Same as Channel.3.Main.PV
Channel.3.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1921	6433	Same as Channel.3.Main.PV
Channel.4.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01b6	438	Not applicable
Channel.4.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	19d0	6608	Not applicable
Channel.4.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	19cb	6603	Not applicable
Channel.4.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	19c8	6600	Same as Channel.4.Main.PV
Channel.4.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	19ca	6602	Set by Network.Modbus.TimeFormat
Channel.4.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on.	uint8	19c2	6594	Not applicable
Channel.4.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	19c9	6601	Not applicable
Channel.4.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	19c7	6599	Same as Channel.4.Main.PV
Channel.4.Alarm1.Dwell	Alarm dwell time	time_t	19c5	6597	Set by Network.Modbus.TimeFormat
Channel.4.Alarm1.Hysteresis	Alarm hysteresis value	float32	19c4	6596	Same as Channel.4.Main.PV
Channel.4.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	19ce	6606	Not applicable
Channel.4.Alarm1.Inhibit	1 = alarm inhibited	bool	19d1	6609	Not applicable
Channel.4.Alarm1.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	19c1	6593	Not applicable
Channel.4.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	19cf	6607	Not applicable
Channel.4.Alarm1.Reference	Deviation alarm 'Reference' value	float32	19c6	6598	Same as Channel.4.Main.PV
Channel.4.Alarm1.Status	Alarm status (as for Channel.1.Alarm1)	uint8	010e	270	Not applicable
Channel.4.Alarm1.Threshold	Alarm trigger threshold	float32	19c3	6595	Same as Channel.4.Main.PV
Channel.4.Alarm1.Type	Alarn type (as for Channel.1.Alarm1)	uint8	19c0	6592	Not applicable
Channel.4.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01b7	439	Not applicable
Channel.4.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	19f0	6640	Not applicable
Channel.4.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	19eb	6635	Not applicable
Channel.4.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	19e8	6632	Same as Channel.4.Main.PV
Channel.4.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	19ea	6634	Set by Network.Modbus.TimeFormat
Channel.4.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	19e2	6626	Not applicable
Channel.4.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	19e9	6633	Not applicable
Channel.4.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	19e7	6631	Same as Channel.4.Main.PV
Channel.4.Alarm2.Dwell	Alarm dwell time	time_t	19e5	6629	Set by Network.Modbus.TimeFormat
Channel.4.Alarm2.Hysteresis	Alarm hysteresis value	float32	19e4	6628	Same as Channel.4.Main.PV
Channel.4.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	19ee	6638	Not applicable
Channel.4.Alarm2.Latch	Alarm latch type (as for Channel.1.Alarm1)	uint8	19e1	6625	Not applicable
Channel.4.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	19ef	6639	Not applicable
Channel.4.Alarm2.Reference	Deviation alarm 'Reference' value	float32	19e6	6630	Same as Channel.4.Main.PV
Channel.4.Alarm2.Status	Alarm status (as for Channel.1.Alarm1)	uint8	010f	271	Not applicable
Channel.4.Alarm2.Threshold	Alarm trigger threshold	float32	19e3	6627	Same as Channel.4.Main.PV
Channel.4.Alarm2.Type	Alarn type (as for Channel.1.Alarm1)	uint8	19e0	6624	Not applicable
Channel.4.Main.CJType	Cold junction compensation type(as for Channel.1.Main)	uint8	198c	6540	Not applicable
Channel.4.Main.CloseString	Close String	string_t	49ab	18859	Not applicable
Channel.4.Main.Descriptor	Text string to describe the channel	string_t	4951	18769	Not applicable
Channel.4.Main.ExtCJTemp	External CJ temperature	float32	198d	6541	1dp
Channel.4.Main.FaultResponse	Input fault response (as for Channel.1.Main)	uint8	1990	6544	Not applicable
Channel.4.Main.Filter	Filter time constant	float32	198e	6542	1dp
Channel.4.Main.InputHigh	Input range maximum value	float32	1984	6532	1dp
Channel.4.Main.InputLow	Input range minimum value	float32	1983	6531	1dp
Channel.4.Main.InternalCJTemp	Channel internal cold junction temperature	float32	1995	6549	1dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Channel.4.Main.IPAdjustState	Input Adjust state (0 = Unadjusted;1 =Adjusted)	bool	1996	6550	Not applicable
Channel.4.Main.IPAdjustState2	Secondary Input Adjust state (0 = Unadjusted; 1 = Adjusted	bool	199c	6556	Not applicable
Channel.4.Main.LinType	Linearisation type (as for Channel.1.Main.LinType)	uint8	1986	6534	Not applicable
Channel.4.Main.MeasuredValue	Input value before linearisation, scaling, adjust etc.	float32	1994	6548	Set by Channel.4.Main.Resolution
Channel.4.Main.MeasuredValue2	Measured value of the secondary input	float32	1999	6553	Set by Channel.4.Main.Resolution
Channel.4.Main.Offset	Fixed value to be added to/subtracted from PV	float32	1997	6551	3dp
Channel.4.Main.Offset2	Secondary input offset	float32	1998	6552	3dp
Channel.4.Main.OpenString	Open String	string_t	4987	18823	Not applicable
Channel.4.Main.PV	The output (displayed) value of the channel.	float32	010c	268	Set by Channel.4.Main.Resolution
Channel.4.Main.PV2	The secondary input process variable (output) of the channel	float32	011c	284	Set by Channel.4.Main.Resolution
Channel.4.Main.RangeHigh	Range high value	float32	1988	6536	Set by Channel.4.Main.Resolution
Channel.4.Main.RangeLow	Range low value	float32	1987	6535	Set by Channel.4.Main.Resolution
Channel.4.Main.RangeUnits	Range units (as channel.1.Main.RangeUnits)	uint8	1989	6537	Not applicable
Channel.4.Main.Resolution	Specifies the resolution/number of decimal places	uint8	1981	6529	Not applicable
Channel.4.Main.ScaleHigh	Scale high value	float32	198b	6539	Set by Channel.4.Main.Resolution
Channel.4.Main.ScaleHigh2	Scale high value for the secondary input	float32	199b	6555	Set by Channel.4.Main.Resolution
Channel.4.Main.ScaleLow	Scale low value	float32	198a	6538	Set by Channel.4.Main.Resolution
Channel.4.Main.ScaleLow2	Scale low value for the secondary input	float32	199a	6554	Set by Channel.4.Main.Resolution
Channel.4.Main.SensorBreakType	Sensor break type (as for Channel.1.Main)	uint8	198f	6543	Not applicable
Channel.4.Main.SensorBreakVal	Sensor break value	uint8	1991	6545	Not applicable
Channel.4.Main.Shunt	Shunt value in Ohms	float32	1985	6533	2dp
Channel.4.Main.Status	Channel status (as for Channel.1.Main.Status)	uint8	010d	269	Not applicable
Channel.4.Main.Status2	The secondary input PV (output) status	uint8	011d	285	Not applicable
Channel.4.Main.TestSignal	Channel test waveform (as for Channel.1.Main.TestSignal)	uint8	1982	6530	Not applicable
Channel.4.Main.Type	Channel function (as for Channel.1.Main.Type)	uint8	1980	6528	Not applicable
Channel.4.Main.Units	Units descriptor	string_t	4966	18790	Not applicable
Channel.4.Trend.Colour	Trend colour (as for Channel.1.Trend.Colour)uint8	19a0		6560	Not applicable
Channel.4.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	19a2	6562	Same as Channel.4.Main.PV
Channel.4.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	19a1	6561	Same as Channel.4.Main.PV
CustomMessage.Message1	Custom message No 1	string_t	5e00	24064	Not applicable
CustomMessage.Message2	Custom message No 2	string_t	5e65	24165	Not applicable
CustomMessage.Message3	Custom message No 3	string_t	5eca	24266	Not applicable
CustomMessage.Message4	Custom message No 4	string_t	5f2f	24367	Not applicable
CustomMessage.Message5	Custom message No 5	string_t	5f94	24468	Not applicable
CustomMessage.Message6	Custom message No 6	string_t	5ff9	24569	Not applicable
CustomMessage.Message7	Custom message No 7	string_t	605e	24670	Not applicable
CustomMessage.Message8	Custom message No 8	string_t	60c3	24771	Not applicable
CustomMessage.Message9	Custom message No 9	string_t	6128	24872	Not applicable
CustomMessage.Message10	Custom message No 10	string_t	618d	24973	Not applicable
CustomMessage.Trigger1	Trigger for custom message No 1	bool	28f0	10480	Not applicable
CustomMessage.Trigger2	Trigger for custom message No 2	bool	28f1	10481	Not applicable
CustomMessage.Trigger3	Trigger for custom message No 3	bool	28f2	10482	Not applicable
CustomMessage.Trigger4	Trigger for custom message No 4	bool	28f3	10483	Not applicable
CustomMessage.Trigger5	Trigger for custom message No 5	bool	28f4	10484	Not applicable
CustomMessage.Trigger6	Trigger for custom message No 6	bool	28f5	10485	Not applicable
CustomMessage.Trigger7	Trigger for custom message No 7	bool	28f6	10486	Not applicable
CustomMessage.Trigger8	Trigger for custom message No 8	bool	28f7	10487	Not applicable
CustomMessage.Trigger9	Trigger for custom message No 9	bool	28f8	10488	Not applicable
CustomMessage.Trigger10	Trigger for custom message No 10	bool	28f9	10489	Not applicable
DCOutput.1A1B_DCOP.FallbackPV	Fallback PV value	float32	15c9	5577	Set by DCOutput.1A1B_DCOP.Resolution
DCOutput.1A1B_DCOP.MeasuredValue	Measured Value	float32	15ca	5578	2dp
DCOutput.1A1B_DCOP.OPAdjustState	0 = Unadjusted, 1 = Adjusted	bool	15c3	5571	Not applicable
DCOutput.1A1B_DCOP.OutputHigh	DC Output High value	float32	15c6	5574	2dp
DCOutput.1A1B_DCOP.OutputLow	DC Output Low value	float32	15c5	5573	2dp
DCOutput.1A1B_DCOP.PV	DC Output PV	float32	15c1	5569	Set by DCOutput.1A1B_DCOP.Resolution
DCOutput.1A1B_DCOP.Resolution	Specifies the resolution/number of decimal places	uint8	15c4	5572	Not applicable
DCOutput.1A1B_DCOP.ScaleHigh	Scale High value	float32	15c8	5576	Set by DCOutput.1A1B_DCOP.Resolution
DCOutput.1A1B_DCOP.ScaleLow	Scale Low value	float32	15c7	5575	Set by DCOutput.1A1B_DCOP.Resolution
DCOutput.1A1B_DCOP.Status	PV Status	uint8	15c2	5570	Not applicable
	0 = Good 1 = Off 2 = Over range				
	3 = Under range 4 = HW error 5 = Ranging				
	6 = Overflow 7 = Bad 8 = HW exceeded				
	9 = No data 10 = Comms channel error				
DCOutput.1A1B_DCOP.Type	DC Output Type (0 = Volts; 1 = mA)	uint8	15c0	5568	Not applicable
DCOutput.2A2B_DCOP.FallbackPV	Fallback PV value	float32	15b9	5561	Set by DCOutput.2A2B_DCOP.Resolution
DCOutput.2A2B_DCOP.MeasuredValue	Measured Value	float32	15ba	5562	2dp
DCOutput.2A2B_DCOP.OPAdjustState	0 = Unadjusted, 1 = Adjusted	bool	15b3	5555	Not applicable
DCOutput.2A2B_DCOP.OutputHigh	DC Output High value	float32	15b6	5558	2dp
DCOutput.2A2B_DCOP.OutputLow	DC Output Low value	float32	15b5	5557	2dp
DCOutput.2A2B_DCOP.PV	DC Output PV	float32	15b1	5553	Set by DCOutput.2A2B_DCOP.Resolution
DCOutput.2A2B_DCOP.Resolution	Specifies the resolution/number of decimal places	uint8	15b4	5556	Not applicable
DCOutput.2A2B_DCOP.ScaleHigh	Scale High value	float32	15b8	5560	Set by DCOutput.2A2B_DCOP.Resolution
DCOutput.2A2B_DCOP.ScaleLow	Scale Low value	float32	15b7	5559	Set by DCOutput.2A2B_DCOP.Resolution
DCOutput.2A2B_DCOP.Status	PV Status (as DCOutput.1A1B_DCOP.Status)	uint8	15b2	5554	Not applicable
DCOutput.2A2B_DCOP.Type	DC Output Type (0 = Volts; 1 = mA)	uint8	15b0	5552	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
DCOutput.3A3B_DCOP.FallbackPV	Fallback PV value	float32	15a9	5545	Set by DCOutput.3A3B_DCOP.Resolution
DCOutput.3A3B_DCOP.MeasuredValue	Measured Value	float32	15aa	5546	2dp
DCOutput.3A3B_DCOP.OPAdjustState	0 = Unadjusted, 1 = Adjusted	bool	15a3	5539	Not applicable
DCOutput.3A3B_DCOP.OutputHigh	DC Output High value	float32	15a6	5542	2dp
DCOutput.3A3B_DCOP.OutputLow	DC Output Low value	float32	15a5	5541	2dp
DCOutput.3A3B_DCOP.PV	DC Output PV	float32	15a1	5537	Set by DCOutput.3A3B_DCOP.Resolution
DCOutput.3A3B_DCOP.Resolution	Specifies the resolution/number of decimal places	uint8	15a4	5540	Not applicable
DCOutput.3A3B_DCOP.ScaleHigh	Scale High value	float32	15a8	5544	Set by DCOutput.3A3B_DCOP.Resolution
DCOutput.3A3B_DCOP.ScaleLow	Scale Low value	float32	15a7	5543	Set by DCOutput.3A3B_DCOP.Resolution
DCOutput.3A3B_DCOP.Status	PV Status (as DCOutput.1A1B_DCOP.Status)	uint8	15a2	5538	Not applicable
DCOutput.3A3B_DCOP.Type	DC Output Type (0 = Volts; 1 = mA)	uint8	15a0	5536	Not applicable
DigitalIO.1A1B.Backlash	Valve positioning backlash compensation (seconds)	float32	1508	5384	1dp
DigitalIO.1A1B.Inertia	Inertia value for the valve	float32	1507	5383	1dp
DigitalIO.1A1B.Invert	1 = Invert; 0 = Do not invert	bool	1503	5379	Not applicable
DigitalIO.1A1B.MinOnTime	Time proportioned output minimum on time	float32	1502	5378	2dp
DigitalIO.1A1B.ModuleIdent	Module Identification 0 = Digital I/O 1 = Relay output 2 = Triac output 3 = Digital input 4 = Digital output	uint8	150a	5386	Not applicable
DigitalIO.1A1B.Output	0 = Output off, 1 = Output on	bool	1504	5380	Not applicable
DigitalIO.1A1B.PV	For contact inputs, 0 = Open, 1 = Closed. For On Off outputs, <0.5 = Drive low, else drive high For Time Proportional outputs, PV = demanded output %	float32	1501	5377	0dp
DigitalIO.1A1B.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1509	5385	Not applicable
DigitalIO.1A1B.Type	Specifies the type of the digital input / output 0 = Contact closure input 1 = On Off output 2 = Time proportioniing output 3 = Valve raise 4 = Valve lower	uint8	1500	5376	Not applicable
DigitalIO.2A2B.Backlash	Valve positioning backlash compensation (seconds)	float32	1518	5400	1dp
DigitalIO.2A2B.Inertia	Inertia value for the valve	float32	1517	5399	1dp
DigitalIO.2A2B.Invert	1 = Invert; 0 = Do not invert	bool	1513	5395	Not applicable
DigitalIO.2A2B.MinOnTime	Time proportioned output minimum on time	float32	1512	5394	2dp
DigitalIO.2A2B.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	151a	5402	Not applicable
DigitalIO.2A2B.Output	0 = Output off, 1 = Output on	bool	1514	5396	Not applicable
DigitalIO.2A2B.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1511	5393	0dp
DigitalIO.2A2B.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1519	5401	Not applicable
DigitalIO.2A2B.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1510	5392	Not applicable
DigitalIO.3A3B.Backlash	Valve positioning backlash compensation (seconds)	float32	1538	5432	1dp
DigitalIO.3A3B.Inertia	Inertia value for the valve	float32	1537	5431	1dp
DigitalIO.3A3B.Invert	1 = Invert; 0 = Do not invert	bool	1533	5427	Not applicable
DigitalIO.3A3B.MinOnTime	Time proportioned output minimum on time	float32	1532	5426	2dp
DigitalIO.3A3B.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	153a	5434	Not applicable
DigitalIO.3A3B.Output	0 = Output off, 1 = Output on	bool	1534	5428	Not applicable
DigitalIO.3A3B.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1531	5425	0dp
DigitalIO.3A3B.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1539	5433	Not applicable
DigitalIO.3A3B.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1530	5424	Not applicable
DigitalIO.DI_LALC.Backlash	Valve positioning backlash compensation (seconds)	float32	1528	5416	1dp
DigitalIO.DI_LALC.Inertia	Inertia value for the valve	float32	1527	5415	1dp
DigitalIO.DI_LALC.Invert	1 = Invert; 0 = Do not invert	bool	1523	5411	Not applicable
DigitalIO.DI_LALC.MinOnTime	Time proportioned output minimum on time	float32	1522	5410	2dp
DigitalIO.DI_LALC.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	152a	5418	Not applicable
DigitalIO.DI_LALC.Output	0 = Output off, 1 = Output on	bool	1524	5412	Not applicable
DigitalIO.DI_LALC.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1521	5409	0dp
DigitalIO.DI_LALC.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1529	5417	Not applicable
DigitalIO.DI_LALC.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1520	5408	Not applicable
DigitalIO.DI_LBLC.Backlash	Valve positioning backlash compensation (seconds)	float32	1548	5448	1dp
DigitalIO.DI_LBLC.Inertia	Inertia value for the valve	float32	1547	5447	1dp
DigitalIO.DI_LBLC.Invert	1 = Invert; 0 = Do not invert	bool	1543	5443	Not applicable
DigitalIO.DI_LBLC.MinOnTime	Time proportioned output minimum on time	float32	1542	5442	2dp
DigitalIO.DI_LBLC.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	154a	5450	Not applicable
DigitalIO.DI_LBLC.Output	0 = Output off, 1 = Output on	bool	1544	5444	Not applicable
DigitalIO.DI_LBLC.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1541	5441	0dp
DigitalIO.DI_LBLC.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1549	5449	Not applicable
DigitalIO.DI_LBLC.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1540	5440	Not applicable
DigitalIO.RELAY_4AC.Backlash	Valve positioning backlash compensation (seconds)	float32	1558	5464	1dp
DigitalIO.RELAY_4AC.Inertia	Inertia value for the valve	float32	1557	5463	1dp
DigitalIO.RELAY_4AC.Invert	1 = Invert; 0 = Do not invert	bool	1553	5459	Not applicable
DigitalIO.RELAY_4AC.MinOnTime	Time proportioned output minimum on time	float32	1552	5458	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
DigitalIO.RELAY_4AC.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	155a	5466	Not applicable
DigitalIO.RELAY_4AC.Output	0 = Output off, 1 = Output on	bool	1554	5460	Not applicable
DigitalIO.RELAY_4AC.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1551	5457	0dp
DigitalIO.RELAY_4AC.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1559	5465	Not applicable
DigitalIO.RELAY_4AC.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1550	5456	Not applicable
DigitalIO.RELAY_5AC.Backlash	Valve positioning backlash compensation (seconds)	float32	1568	5480	1dp
DigitalIO.RELAY_5AC.Inertia	Inertia value for the valve	float32	1567	5479	1dp
DigitalIO.RELAY_5AC.Invert	1 = Invert; 0 = Do not invert	bool	1563	5475	Not applicable
DigitalIO.RELAY_5AC.MinOnTime	Time proportioned output minimum on time	float32	1562	5474	2dp
DigitalIO.RELAY_5AC.ModuleIdent	As DigitalIO.1A1B.ModuleIdent	uint8	156a	5482	Not applicable
DigitalIO.RELAY_5AC.Output	0 = Output off, 1 = Output on	bool	1564	5476	Not applicable
DigitalIO.RELAY_5AC.PV	Digital I/O process value (as DigitalIO.1A1B.PV)	float32	1561	5473	0dp
DigitalIO.RELAY_5AC.StandbyAction	Valve positioning standby action (0 = Continue; 1 = Freeze).	uint8	1569	5481	Not applicable
DigitalIO.RELAY_5AC.Type	Digital I/O type (as DigitalIO.1A1B.Type).	uint8	1560	5472	Not applicable
EthernetIP.ImplicitInputs.Input1	Read only input from an EtherNet/IP client	eint32	7e66	32358	Not applicable
EthernetIP.ImplicitInputs.Input2	See input 1 for details	eint32	7e6a	32362	Not applicable
EthernetIP.ImplicitInputs.Input3	See input 1 for details	eint32	7e6e	32366	Not applicable
EthernetIP.ImplicitInputs.Input4	See input 1 for details	eint32	7e72	32370	Not applicable
EthernetIP.ImplicitInputs.Input5	See input 1 for details	eint32	7e76	32374	Not applicable
EthernetIP.ImplicitInputs.Input6	See input 1 for details	eint32	7e7a	32378	Not applicable
EthernetIP.ImplicitInputs.Input7	See input 1 for details	eint32	7e7e	32382	Not applicable
EthernetIP.ImplicitInputs.Input8	See input 1 for details	eint32	7e82	32386	Not applicable
EthernetIP.ImplicitInputs.Input9	See input 1 for details	eint32	7e86	32390	Not applicable
EthernetIP.ImplicitInputs.Input10	See input 1 for details	eint32	7e8a	32394	Not applicable
EthernetIP.ImplicitInputs.Input11	See input 1 for details	eint32	7e8e	32398	Not applicable
EthernetIP.ImplicitInputs.Input12	See input 1 for details	eint32	7e92	32402	Not applicable
EthernetIP.ImplicitInputs.Input13	See input 1 for details	eint32	7e96	32406	Not applicable
EthernetIP.ImplicitInputs.Input14	See input 1 for details	eint32	7e9a	32410	Not applicable
EthernetIP.ImplicitInputs.Input15	See input 1 for details	eint32	7e9e	32414	Not applicable
EthernetIP.ImplicitInputs.Input16	See input 1 for details	eint32	7ea2	32418	Not applicable
EthernetIP.ImplicitInputs.Input17	See input 1 for details	eint32	7ea6	32422	Not applicable
EthernetIP.ImplicitInputs.Input18	See input 1 for details	eint32	7eaa	32426	Not applicable
EthernetIP.ImplicitInputs.Input19	See input 1 for details	eint32	7eae	32430	Not applicable
EthernetIP.ImplicitInputs.Input20	See input 1 for details	eint32	7eb2	32434	Not applicable
EthernetIP.ImplicitInputs.Input21	See input 1 for details	eint32	7eb6	32438	Not applicable
EthernetIP.ImplicitInputs.Input22	See input 1 for details	eint32	7eba	32442	Not applicable
EthernetIP.ImplicitInputs.Input23	See input 1 for details	eint32	7ebe	32446	Not applicable
EthernetIP.ImplicitInputs.Input24	See input 1 for details	eint32	7ec2	32450	Not applicable
EthernetIP.ImplicitInputs.Input25	See input 1 for details	eint32	7ec6	32454	Not applicable
EthernetIP.ImplicitInputs.Input26	See input 1 for details	eint32	7eca	32458	Not applicable
EthernetIP.ImplicitInputs.Input27	See input 1 for details	eint32	7ece	32462	Not applicable
EthernetIP.ImplicitInputs.Input28	See input 1 for details	eint32	7ed2	32466	Not applicable
EthernetIP.ImplicitInputs.Input29	See input 1 for details	eint32	7ed6	32470	Not applicable
EthernetIP.ImplicitInputs.Input30	See input 1 for details	eint32	7eda	32474	Not applicable
EthernetIP.ImplicitInputs.Input31	See input 1 for details	eint32	7ede	32478	Not applicable
EthernetIP.ImplicitInputs.Input32	See input 1 for details	eint32	7ee2	32482	Not applicable
EthernetIP.ImplicitInputs.Input33	See input 1 for details	eint32	7ee6	32486	Not applicable
EthernetIP.ImplicitInputs.Input34	See input 1 for details	eint32	7eea	32490	Not applicable
EthernetIP.ImplicitInputs.Input35	See input 1 for details	eint32	7eee	32494	Not applicable
EthernetIP.ImplicitInputs.Input36	See input 1 for details	eint32	7ef2	32498	Not applicable
EthernetIP.ImplicitInputs.Input37	See input 1 for details	eint32	7ef6	32502	Not applicable
EthernetIP.ImplicitInputs.Input38	See input 1 for details	eint32	7efa	32506	Not applicable
EthernetIP.ImplicitInputs.Input39	See input 1 for details	eint32	7efe	32510	Not applicable
EthernetIP.ImplicitInputs.Input40	See input 1 for details	eint32	7f02	32514	Not applicable
EthernetIP.ImplicitInputs.Input41	See input 1 for details	eint32	7f06	32518	Not applicable
EthernetIP.ImplicitInputs.Input42	See input 1 for details	eint32	7f0a	32522	Not applicable
EthernetIP.ImplicitInputs.Input43	See input 1 for details	eint32	7f0e	32526	Not applicable
EthernetIP.ImplicitInputs.Input44	See input 1 for details	eint32	7f12	32530	Not applicable
EthernetIP.ImplicitInputs.Input45	See input 1 for details	eint32	7f16	32534	Not applicable
EthernetIP.ImplicitInputs.Input46	See input 1 for details	eint32	7f1a	32538	Not applicable
EthernetIP.ImplicitInputs.Input47	See input 1 for details	eint32	7f1e	32542	Not applicable
EthernetIP.ImplicitInputs.Input48	See input 1 for details	eint32	7f22	32546	Not applicable
EthernetIP.ImplicitInputs.Input49	See input 1 for details	eint32	7f26	32550	Not applicable
EthernetIP.ImplicitInputs.Input50	See input 1 for details	eint32	7f2a	32554	Not applicable
EthernetIP.ImplicitInputs.InputValue1	Value of the Input 1 parameter	int16	7e68	32360	Not applicable
EthernetIP.ImplicitInputs.InputValue2	See input 1 value for details	int16	7e6c	32364	Not applicable
EthernetIP.ImplicitInputs.InputValue3	See input 1 value for details	int16	7e70	32368	Not applicable
EthernetIP.ImplicitInputs.InputValue4	See input 1 value for details	int16	7e74	32372	Not applicable
EthernetIP.ImplicitInputs.InputValue5	See input 1 value for details	int16	7e78	32376	Not applicable
EthernetIP.ImplicitInputs.InputValue6	See input 1 value for details	int16	7e7c	32380	Not applicable
EthernetIP.ImplicitInputs.InputValue7	See input 1 value for details	int16	7e80	32384	Not applicable
EthernetIP.ImplicitInputs.InputValue8	See input 1 value for details	int16	7e84	32388	Not applicable
EthernetIP.ImplicitInputs.InputValue9	See input 1 value for details	int16	7e88	32392	Not applicable
EthernetIP.ImplicitInputs.InputValue10	See input 1 value for details	int16	7e8c	32396	Not applicable
EthernetIP.ImplicitInputs.InputValue11	See input 1 value for details	int16	7e90	32400	Not applicable
EthernetIP.ImplicitInputs.InputValue12	See input 1 value for details	int16	7e94	32404	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
EthernetIP.ImplicitInputs.InputValue13	See input 1 value for details	int16	7e98	32408	Not applicable
EthernetIP.ImplicitInputs.InputValue14	See input 1 value for details	int16	7e9c	32412	Not applicable
EthernetIP.ImplicitInputs.InputValue15	See input 1 value for details	int16	7ea0	32416	Not applicable
EthernetIP.ImplicitInputs.InputValue16	See input 1 value for details	int16	7ea4	32420	Not applicable
EthernetIP.ImplicitInputs.InputValue17	See input 1 value for details	int16	7ea8	32424	Not applicable
EthernetIP.ImplicitInputs.InputValue18	See input 1 value for details	int16	7eac	32428	Not applicable
EthernetIP.ImplicitInputs.InputValue19	See input 1 value for details	int16	7eb0	32432	Not applicable
EthernetIP.ImplicitInputs.InputValue20	See input 1 value for details	int16	7eb4	32436	Not applicable
EthernetIP.ImplicitInputs.InputValue21	See input 1 value for details	int16	7eb8	32440	Not applicable
EthernetIP.ImplicitInputs.InputValue22	See input 1 value for details	int16	7ebc	32444	Not applicable
EthernetIP.ImplicitInputs.InputValue23	See input 1 value for details	int16	7ec0	32448	Not applicable
EthernetIP.ImplicitInputs.InputValue24	See input 1 value for details	int16	7ec4	32452	Not applicable
EthernetIP.ImplicitInputs.InputValue25	See input 1 value for details	int16	7ec8	32456	Not applicable
EthernetIP.ImplicitInputs.InputValue26	See input 1 value for details	int16	7ecc	32460	Not applicable
EthernetIP.ImplicitInputs.InputValue27	See input 1 value for details	int16	7ed0	32464	Not applicable
EthernetIP.ImplicitInputs.InputValue28	See input 1 value for details	int16	7ed4	32468	Not applicable
EthernetIP.ImplicitInputs.InputValue29	See input 1 value for details	int16	7ed8	32472	Not applicable
EthernetIP.ImplicitInputs.InputValue30	See input 1 value for details	int16	7edc	32476	Not applicable
EthernetIP.ImplicitInputs.InputValue31	See input 1 value for details	int16	7ee0	32480	Not applicable
EthernetIP.ImplicitInputs.InputValue32	See input 1 value for details	int16	7ee4	32484	Not applicable
EthernetIP.ImplicitInputs.InputValue33	See input 1 value for details	int16	7ee8	32488	Not applicable
EthernetIP.ImplicitInputs.InputValue34	See input 1 value for details	int16	7eec	32492	Not applicable
EthernetIP.ImplicitInputs.InputValue35	See input 1 value for details	int16	7ef0	32496	Not applicable
EthernetIP.ImplicitInputs.InputValue36	See input 1 value for details	int16	7ef4	32500	Not applicable
EthernetIP.ImplicitInputs.InputValue37	See input 1 value for details	int16	7ef8	32504	Not applicable
EthernetIP.ImplicitInputs.InputValue38	See input 1 value for details	int16	7efc	32508	Not applicable
EthernetIP.ImplicitInputs.InputValue39	See input 1 value for details	int16	7f00	32512	Not applicable
EthernetIP.ImplicitInputs.InputValue40	See input 1 value for details	int16	7f04	32516	Not applicable
EthernetIP.ImplicitInputs.InputValue41	See input 1 value for details	int16	7f08	32520	Not applicable
EthernetIP.ImplicitInputs.InputValue42	See input 1 value for details	int16	7f0c	32524	Not applicable
EthernetIP.ImplicitInputs.InputValue43	See input 1 value for details	int16	7f10	32528	Not applicable
EthernetIP.ImplicitInputs.InputValue44	See input 1 value for details	int16	7f14	32532	Not applicable
EthernetIP.ImplicitInputs.InputValue45	See input 1 value for details	int16	7f18	32536	Not applicable
EthernetIP.ImplicitInputs.InputValue46	See input 1 value for details	int16	7f1c	32540	Not applicable
EthernetIP.ImplicitInputs.InputValue47	See input 1 value for details	int16	7f20	32544	Not applicable
EthernetIP.ImplicitInputs.InputValue48	See input 1 value for details	int16	7f24	32548	Not applicable
EthernetIP.ImplicitInputs.InputValue49	See input 1 value for details	int16	7f28	32552	Not applicable
EthernetIP.ImplicitInputs.InputValue50	See input 1 value for details	int16	7f2c	32556	Not applicable
EthernetIP.ImplicitOutputs.Output1	Writable output to the EtherNet/IP client	eint32	7f2e	32558	Not applicable
EthernetIP.ImplicitOutputs.Output2	See output 1 for details	eint32	7f32	32562	Not applicable
EthernetIP.ImplicitOutputs.Output3	See output 1 for details	eint32	7f36	32566	Not applicable
EthernetIP.ImplicitOutputs.Output4	See output 1 for details	eint32	7f3a	32570	Not applicable
EthernetIP.ImplicitOutputs.Output5	See output 1 for details	eint32	7f3e	32574	Not applicable
EthernetIP.ImplicitOutputs.Output6	See output 1 for details	eint32	7f42	32578	Not applicable
EthernetIP.ImplicitOutputs.Output7	See output 1 for details	eint32	7f46	32582	Not applicable
EthernetIP.ImplicitOutputs.Output8	See output 1 for details	eint32	7f4a	32586	Not applicable
EthernetIP.ImplicitOutputs.Output9	See output 1 for details	eint32	7f4e	32590	Not applicable
EthernetIP.ImplicitOutputs.Output10	See output 1 for details	eint32	7f52	32594	Not applicable
EthernetIP.ImplicitOutputs.Output11	See output 1 for details	eint32	7f56	32598	Not applicable
EthernetIP.ImplicitOutputs.Output12	See output 1 for details	eint32	7f5a	32602	Not applicable
EthernetIP.ImplicitOutputs.Output13	See output 1 for details	eint32	7f5e	32606	Not applicable
EthernetIP.ImplicitOutputs.Output14	See output 1 for details	eint32	7f62	32610	Not applicable
EthernetIP.ImplicitOutputs.Output15	See output 1 for details	eint32	7f66	32614	Not applicable
EthernetIP.ImplicitOutputs.Output16	See output 1 for details	eint32	7f6a	32618	Not applicable
EthernetIP.ImplicitOutputs.Output17	See output 1 for details	eint32	7f6e	32622	Not applicable
EthernetIP.ImplicitOutputs.Output18	See output 1 for details	eint32	7f72	32626	Not applicable
EthernetIP.ImplicitOutputs.Output19	See output 1 for details	eint32	7f76	32630	Not applicable
EthernetIP.ImplicitOutputs.Output20	See output 1 for details	eint32	7f7a	32634	Not applicable
EthernetIP.ImplicitOutputs.Output21	See output 1 for details	eint32	7f7e	32638	Not applicable
EthernetIP.ImplicitOutputs.Output22	See output 1 for details	eint32	7f82	32642	Not applicable
EthernetIP.ImplicitOutputs.Output23	See output 1 for details	eint32	7f86	32646	Not applicable
EthernetIP.ImplicitOutputs.Output24	See output 1 for details	eint32	7f8a	32650	Not applicable
EthernetIP.ImplicitOutputs.Output25	See output 1 for details	eint32	7f8e	32654	Not applicable
EthernetIP.ImplicitOutputs.Output26	See output 1 for details	eint32	7f92	32658	Not applicable
EthernetIP.ImplicitOutputs.Output27	See output 1 for details	eint32	7f96	32662	Not applicable
EthernetIP.ImplicitOutputs.Output28	See output 1 for details	eint32	7f9a	32666	Not applicable
EthernetIP.ImplicitOutputs.Output29	See output 1 for details	eint32	7f9e	32670	Not applicable
EthernetIP.ImplicitOutputs.Output30	See output 1 for details	eint32	7fa2	32674	Not applicable
EthernetIP.ImplicitOutputs.Output31	See output 1 for details	eint32	7fa6	32678	Not applicable
EthernetIP.ImplicitOutputs.Output32	See output 1 for details	eint32	7faa	32682	Not applicable
EthernetIP.ImplicitOutputs.Output33	See output 1 for details	eint32	7fae	32686	Not applicable
EthernetIP.ImplicitOutputs.Output34	See output 1 for details	eint32	7fb2	32690	Not applicable
EthernetIP.ImplicitOutputs.Output35	See output 1 for details	eint32	7fb6	32694	Not applicable
EthernetIP.ImplicitOutputs.Output36	See output 1 for details	eint32	7fba	32698	Not applicable
EthernetIP.ImplicitOutputs.Output37	See output 1 for details	eint32	7fbe	32702	Not applicable
EthernetIP.ImplicitOutputs.Output38	See output 1 for details	eint32	7fc2	32706	Not applicable
EthernetIP.ImplicitOutputs.Output39	See output 1 for details	eint32	7fc6	32710	Not applicable
EthernetIP.ImplicitOutputs.Output40	See output 1 for details	eint32	7fca	32714	Not applicable
EthernetIP.ImplicitOutputs.Output41	See output 1 for details	eint32	7fce	32718	Not applicable
EthernetIP.ImplicitOutputs.Output42	See output 1 for details	eint32	7fd2	32722	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
EthernetIP.ImplicitOutputs.Output43	See output 1 for details	eint32	7fd6	32726	Not applicable
EthernetIP.ImplicitOutputs.Output44	See output 1 for details	eint32	7fda	32730	Not applicable
EthernetIP.ImplicitOutputs.Output45	See output 1 for details	eint32	7fde	32734	Not applicable
EthernetIP.ImplicitOutputs.Output46	See output 1 for details	eint32	7fe2	32738	Not applicable
EthernetIP.ImplicitOutputs.Output47	See output 1 for details	eint32	7fe6	32742	Not applicable
EthernetIP.ImplicitOutputs.Output48	See output 1 for details	eint32	7fea	32746	Not applicable
EthernetIP.ImplicitOutputs.Output49	See output 1 for details	eint32	7fee	32750	Not applicable
EthernetIP.ImplicitOutputs.Output50	See output 1 for details	eint32	7ff2	32754	Not applicable
EthernetIP.ImplicitOutputs.OutputValue1	Value of the Output 1 parameter	int16	7f30	32560	Not applicable
EthernetIP.ImplicitOutputs.OutputValue2	See output 1 value for details	int16	7f34	32564	Not applicable
EthernetIP.ImplicitOutputs.OutputValue3	See output 1 value for details	int16	7f38	32568	Not applicable
EthernetIP.ImplicitOutputs.OutputValue4	See output 1 value for details	int16	7f3c	32572	Not applicable
EthernetIP.ImplicitOutputs.OutputValue5	See output 1 value for details	int16	7f40	32576	Not applicable
EthernetIP.ImplicitOutputs.OutputValue6	See output 1 value for details	int16	7f44	32580	Not applicable
EthernetIP.ImplicitOutputs.OutputValue7	See output 1 value for details	int16	7f48	32584	Not applicable
EthernetIP.ImplicitOutputs.OutputValue8	See output 1 value for details	int16	7f4c	32588	Not applicable
EthernetIP.ImplicitOutputs.OutputValue9	See output 1 value for details	int16	7f50	32592	Not applicable
EthernetIP.ImplicitOutputs.OutputValue10	See output 1 value for details	int16	7f54	32596	Not applicable
EthernetIP.ImplicitOutputs.OutputValue11	See output 1 value for details	int16	7f58	32600	Not applicable
EthernetIP.ImplicitOutputs.OutputValue12	See output 1 value for details	int16	7f5c	32604	Not applicable
EthernetIP.ImplicitOutputs.OutputValue13	See output 1 value for details	int16	7f60	32608	Not applicable
EthernetIP.ImplicitOutputs.OutputValue14	See output 1 value for details	int16	7f64	32612	Not applicable
EthernetIP.ImplicitOutputs.OutputValue15	See output 1 value for details	int16	7f68	32616	Not applicable
EthernetIP.ImplicitOutputs.OutputValue16	See output 1 value for details	int16	7f6c	32620	Not applicable
EthernetIP.ImplicitOutputs.OutputValue17	See output 1 value for details	int16	7f70	32624	Not applicable
EthernetIP.ImplicitOutputs.OutputValue18	See output 1 value for details	int16	7f74	32628	Not applicable
EthernetIP.ImplicitOutputs.OutputValue19	See output 1 value for details	int16	7f78	32632	Not applicable
EthernetIP.ImplicitOutputs.OutputValue20	See output 1 value for details	int16	7f7c	32636	Not applicable
EthernetIP.ImplicitOutputs.OutputValue21	See output 1 value for details	int16	7f80	32640	Not applicable
EthernetIP.ImplicitOutputs.OutputValue22	See output 1 value for details	int16	7f84	32644	Not applicable
EthernetIP.ImplicitOutputs.OutputValue23	See output 1 value for details	int16	7f88	32648	Not applicable
EthernetIP.ImplicitOutputs.OutputValue24	See output 1 value for details	int16	7f8c	32652	Not applicable
EthernetIP.ImplicitOutputs.OutputValue25	See output 1 value for details	int16	7f90	32656	Not applicable
EthernetIP.ImplicitOutputs.OutputValue26	See output 1 value for details	int16	7f94	32660	Not applicable
EthernetIP.ImplicitOutputs.OutputValue27	See output 1 value for details	int16	7f98	32664	Not applicable
EthernetIP.ImplicitOutputs.OutputValue28	See output 1 value for details	int16	7f9c	32668	Not applicable
EthernetIP.ImplicitOutputs.OutputValue29	See output 1 value for details	int16	7fa0	32672	Not applicable
EthernetIP.ImplicitOutputs.OutputValue30	See output 1 value for details	int16	7fa4	32676	Not applicable
EthernetIP.ImplicitOutputs.OutputValue31	See output 1 value for details	int16	7fa8	32680	Not applicable
EthernetIP.ImplicitOutputs.OutputValue32	See output 1 value for details	int16	7fac	32684	Not applicable
EthernetIP.ImplicitOutputs.OutputValue33	See output 1 value for details	int16	7fb0	32688	Not applicable
EthernetIP.ImplicitOutputs.OutputValue34	See output 1 value for details	int16	7fb4	32692	Not applicable
EthernetIP.ImplicitOutputs.OutputValue35	See output 1 value for details	int16	7fb8	32696	Not applicable
EthernetIP.ImplicitOutputs.OutputValue36	See output 1 value for details	int16	7fbc	32700	Not applicable
EthernetIP.ImplicitOutputs.OutputValue37	See output 1 value for details	int16	7fc0	32704	Not applicable
EthernetIP.ImplicitOutputs.OutputValue38	See output 1 value for details	int16	7fc4	32708	Not applicable
EthernetIP.ImplicitOutputs.OutputValue39	See output 1 value for details	int16	7fc8	32712	Not applicable
EthernetIP.ImplicitOutputs.OutputValue40	See output 1 value for details	int16	7fcc	32716	Not applicable
EthernetIP.ImplicitOutputs.OutputValue41	See output 1 value for details	int16	7fd0	32720	Not applicable
EthernetIP.ImplicitOutputs.OutputValue42	See output 1 value for details	int16	7fd4	32724	Not applicable
EthernetIP.ImplicitOutputs.OutputValue43	See output 1 value for details	int16	7fd8	32728	Not applicable
EthernetIP.ImplicitOutputs.OutputValue44	See output 1 value for details	int16	7fdc	32732	Not applicable
EthernetIP.ImplicitOutputs.OutputValue45	See output 1 value for details	int16	7fe0	32736	Not applicable
EthernetIP.ImplicitOutputs.OutputValue46	See output 1 value for details	int16	7fe4	32740	Not applicable
EthernetIP.ImplicitOutputs.OutputValue47	See output 1 value for details	int16	7fe8	32744	Not applicable
EthernetIP.ImplicitOutputs.OutputValue48	See output 1 value for details	int16	7fec	32748	Not applicable
EthernetIP.ImplicitOutputs.OutputValue49	See output 1 value for details	int16	7ff0	32752	Not applicable
EthernetIP.ImplicitOutputs.OutputValue50	See output 1 value for details	int16	7ff4	32756	Not applicable
EthernetIP.InputTags.Input1	A read only input from a PLC device	string_t	7838	30776	Not applicable
EthernetIP.InputTags.Input2	See input 1 for details	string_t	7839	30777	Not applicable
EthernetIP.InputTags.Input3	See input 1 for details	string_t	783a	30778	Not applicable
EthernetIP.InputTags.Input4	See input 1 for details	string_t	783b	30779	Not applicable
EthernetIP.InputTags.Input5	See input 1 for details	string_t	783c	30780	Not applicable
EthernetIP.InputTags.Input6	See input 1 for details	string_t	783d	30781	Not applicable
EthernetIP.InputTags.Input7	See input 1 for details	string_t	783e	30782	Not applicable
EthernetIP.InputTags.Input8	See input 1 for details	string_t	783f	30783	Not applicable
EthernetIP.InputTags.Input9	See input 1 for details	string_t	7840	30784	Not applicable
EthernetIP.InputTags.Input10	See input 1 for details	string_t	7841	30785	Not applicable
EthernetIP.InputTags.Input11	See input 1 for details	string_t	7842	30786	Not applicable
EthernetIP.InputTags.Input12	See input 1 for details	string_t	7843	30787	Not applicable
EthernetIP.InputTags.Input13	See input 1 for details	string_t	7844	30788	Not applicable
EthernetIP.InputTags.Input14	See input 1 for details	string_t	7845	30789	Not applicable
EthernetIP.InputTags.Input15	See input 1 for details	string_t	7846	30790	Not applicable
EthernetIP.InputTags.Input16	See input 1 for details	string_t	7847	30791	Not applicable
EthernetIP.InputTags.Input17	See input 1 for details	string_t	7848	30792	Not applicable
EthernetIP.InputTags.Input18	See input 1 for details	string_t	7849	30793	Not applicable
EthernetIP.InputTags.Input19	See input 1 for details	string_t	784a	30794	Not applicable
EthernetIP.InputTags.Input20	See input 1 for details	string_t	784b	30795	Not applicable
EthernetIP.InputTags.Input21	See input 1 for details	string_t	784c	30796	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
EthernetIP.InputTags.Input22	See input 1 for details	string_t	784d	30797	Not applicable
EthernetIP.InputTags.Input23	See input 1 for details	string_t	784e	30798	Not applicable
EthernetIP.InputTags.Input24	See input 1 for details	string_t	784f	30799	Not applicable
EthernetIP.InputTags.Input25	See input 1 for details	string_t	7850	30800	Not applicable
EthernetIP.InputTags.Input26	See input 1 for details	string_t	7851	30801	Not applicable
EthernetIP.InputTags.Input27	See input 1 for details	string_t	7852	30802	Not applicable
EthernetIP.InputTags.Input28	See input 1 for details	string_t	7853	30803	Not applicable
EthernetIP.InputTags.Input29	See input 1 for details	string_t	7854	30804	Not applicable
EthernetIP.InputTags.Input30	See input 1 for details	string_t	7855	30805	Not applicable
EthernetIP.Main.ConfigInstance	Configuration assembly instance number	int16	7ffa	32762	Not applicable
EthernetIP.Main.ConfigSize	Configuration assembly data size in bytes	int16	7ffb	32763	Not applicable
EthernetIP.Main.ConnectionType	Implicit I/O connection type (0 = Point to point; 1 = Multicast)	uint8	7ffe	32766	Not applicable
EthernetIP.Main.Explicit1	Explicit TCP connection 1	string_t	65f1	26097	Not applicable
EthernetIP.Main.Explicit2	Explicit TCP connection 2	string_t	6601	26113	Not applicable
EthernetIP.Main.ImplicitIO	Implicit I/O data channel	string_t	65e1	26081	Not applicable
EthernetIP.Main.InputInstance	Implicit input assembly instance number	int16	7ff6	32758	Not applicable
EthernetIP.Main.InputSize	Implicit input assembly data size in bytes	int16	7ff7	32759	Not applicable
EthernetIP.Main.Mode	EtherNet/IP operation mode 0 = Server 1 = Client (IO) 2 = Client (Tags)	uint8	7fff	32767	Not applicable
EthernetIP.Main.Multicast	Implicit I/O data channel multicast address	string_t	6611	26129	Not applicable
EthernetIP.Main.NetworkStatusCode	EtherNet/IP communications network status 0 = Offline 2 = On line 3 = Connection timout 4 = Duplicate IP address 5 = Inistialisation	uint8	7e64	32356	Not applicable
EthernetIP.Main.OutputInstance	Implicit output assembly instance number	int16	7ff8	32760	Not applicable
EthernetIP.Main.OutputSize	Implicit output assembly data size in bytes	int16	7ff9	32761	Not applicable
EthernetIP.Main.Priority	Level of message priority 0 = Low 1 = High 2 = Scheduled 3 = Urgent	uint8	7ffc	32764	Not applicable
EthernetIP.Main.ResetComms	Resets the client or server communications (0 = No; 1 = Yes)	uint8	7e63	32355	Not applicable
EthernetIP.Main.Rpi	Requested Packet Interval (milliseconds)	int16	7ffd	32765	Not applicable
EthernetIP.Main.ServerAddress	IP address of a server device	string_t	7129	28969	Not applicable
EthernetIP.Main.SlotNumber	PLC slot number	int16	7e60	32352	Not applicable
EthernetIP.Main.TagStatusCode	EtherNet/IP Tag server status code (see table 4.10.1)	uint8	7e62	32354	Not applicable
EthernetIP.Main.UCMM	Unconnected Message Manager (UCMM)	string_t	65d1	26065	Not applicable
EthernetIP.OutputTags.Output1	Writable output to the PLC device	string_t	7880	30848	Not applicable
EthernetIP.OutputTags.Output2	See output 1 for details	string_t	7881	30849	Not applicable
EthernetIP.OutputTags.Output3	See output 1 for details	string_t	7882	30850	Not applicable
EthernetIP.OutputTags.Output4	See output 1 for details	string_t	7883	30851	Not applicable
EthernetIP.OutputTags.Output5	See output 1 for details	string_t	7884	30852	Not applicable
EthernetIP.OutputTags.Output6	See output 1 for details	string_t	7885	30853	Not applicable
EthernetIP.OutputTags.Output7	See output 1 for details	string_t	7886	30854	Not applicable
EthernetIP.OutputTags.Output8	See output 1 for details	string_t	7887	30855	Not applicable
EthernetIP.OutputTags.Output9	See output 1 for details	string_t	7888	30856	Not applicable
EthernetIP.OutputTags.Output10	See output 1 for details	string_t	7889	30857	Not applicable
EthernetIP.OutputTags.Output11	See output 1 for details	string_t	788a	30858	Not applicable
EthernetIP.OutputTags.Output12	See output 1 for details	string_t	788b	30859	Not applicable
EthernetIP.OutputTags.Output13	See output 1 for details	string_t	788c	30860	Not applicable
EthernetIP.OutputTags.Output14	See output 1 for details	string_t	788d	30861	Not applicable
EthernetIP.OutputTags.Output15	See output 1 for details	string_t	788e	30862	Not applicable
EthernetIP.OutputTags.Output16	See output 1 for details	string_t	788f	30863	Not applicable
EthernetIP.OutputTags.Output17	See output 1 for details	string_t	7890	30864	Not applicable
EthernetIP.OutputTags.Output18	See output 1 for details	string_t	7891	30865	Not applicable
EthernetIP.OutputTags.Output19	See output 1 for details	string_t	7892	30866	Not applicable
EthernetIP.OutputTags.Output20	See output 1 for details	string_t	7893	30867	Not applicable
EthernetIP.OutputTags.Output21	See output 1 for details	string_t	7894	30868	Not applicable
EthernetIP.OutputTags.Output22	See output 1 for details	string_t	7895	30869	Not applicable
EthernetIP.OutputTags.Output23	See output 1 for details	string_t	7896	30870	Not applicable
EthernetIP.OutputTags.Output24	See output 1 for details	string_t	7897	30871	Not applicable
EthernetIP.OutputTags.Output25	See output 1 for details	string_t	7898	30872	Not applicable
EthernetIP.OutputTags.Output26	See output 1 for details	string_t	7899	30873	Not applicable
EthernetIP.OutputTags.Output27	See output 1 for details	string_t	789a	30874	Not applicable
EthernetIP.OutputTags.Output28	See output 1 for details	string_t	789b	30875	Not applicable
EthernetIP.OutputTags.Output29	See output 1 for details	string_t	789c	30876	Not applicable
EthernetIP.OutputTags.Output30	See output 1 for details	string_t	789d	30877	Not applicable
Group.Recording.Channel1En	Channel 1 enable (0 = Disabled; 1 = Enabled)	bool	1023	4131	Not applicable
Group.Recording.Channel2En	Channel 2 enable (0 = Disabled; 1 = Enabled)	bool	1024	4132	Not applicable
Group.Recording.Channel3En	Channel 3 enable (0 = Disabled; 1 = Enabled)	bool	1025	4133	Not applicable
Group.Recording.Channel4En	Channel 4 enable (0 = Disabled; 1 = Enabled)	bool	1026	4134	Not applicable
Group.Recording.Compression	The UHH file compression rate (0 = Normal; 1 = High)	uint8	1040	4160	Not applicable
Group.Recording.Enable	0 = Recording disabled; 1 = Recording enabled	uint8	1020	4128	Not applicable
Group.Recording.FlashDuration	Time in days until flash history files begin to be overwitten	float32	1039	4153	2dp
Group.Recording.FlashFree	Size of the internal flash in MBytes	float32	1038	4152	2dp
Group.Recording.FlashSize	Size of the internal flash in MBytes	float32	1037	4151	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Group.Recording.Interval	Recording interval 0 = 125 secs 1 = .25 secs 2 = 0.5 secs 3 = 1Hz 4 = 2 sec 5 = 5 sec 6 = 10 sec 7 = 20 sec 8 = 30 sec 9 = 1 min 10 = 2 min 11 = 5 min 12 = 10 min 13 = 20 min 14 = 30 min 15 = 1 hr	int32	1022	4130	Not applicable
Group.Recording.Status	Recording status 0 = Not recording 1 = Disabled 2 = Messages only 3 = Recording enabled 4 = Recording paused	int16	1036	4150	Not applicable
Group.Recording.Suspend	1 = Suspend recording	bool	1035	4149	Not applicable
Group.Recording.VirtualChan1En	Virtual Channel 1 enable (0 = Disabled; 1 = Enabled)	bool	1027	4135	Not applicable
Group.Recording.VirtualChan2En	Virtual Channel 2 enable (0 = Disabled; 1 = Enabled)	bool	1028	4136	Not applicable
Group.Recording.VirtualChan3En	Virtual Channel 3 enable (0 = Disabled; 1 = Enabled)	bool	1029	4137	Not applicable
Group.Recording.VirtualChan4En	Virtual Channel 4 enable (0 = Disabled; 1 = Enabled)	bool	102a	4138	Not applicable
Group.Recording.VirtualChan5En	Virtual Channel 5 enable (0 = Disabled; 1 = Enabled)	bool	102b	4139	Not applicable
Group.Recording.VirtualChan6En	Virtual Channel 6 enable (0 = Disabled; 1 = Enabled)	bool	102c	4140	Not applicable
Group.Recording.VirtualChan7En	Virtual Channel 7 enable (0 = Disabled; 1 = Enabled)	bool	102d	4141	Not applicable
Group.Recording.VirtualChan8En	Virtual Channel 8 enable (0 = Disabled; 1 = Enabled)	bool	102e	4142	Not applicable
Group.Recording.VirtualChan9En	Virtual Channel 9 enable (0 = Disabled; 1 = Enabled)	bool	102f	4143	Not applicable
Group.Recording.VirtualChan10En	Virtual Channel 10 enable (0 = Disabled; 1 = Enabled)	bool	1030	4144	Not applicable
Group.Recording.VirtualChan11En	Virtual Channel 11 enable (0 = Disabled; 1 = Enabled)	bool	1031	4145	Not applicable
Group.Recording.VirtualChan12En	Virtual Channel 12 enable (0 = Disabled; 1 = Enabled)	bool	1032	4146	Not applicable
Group.Recording.VirtualChan13En	Virtual Channel 13 enable (0 = Disabled; 1 = Enabled)	bool	1033	4147	Not applicable
Group.Recording.VirtualChan14En	Virtual Channel 14 enable (0 = Disabled; 1 = Enabled)	bool	1034	4148	Not applicable
Group.Recording.VirtualChan15En	Virtual Channel 15 enable (0 = Disabled; 1 = Enabled)	bool	103a	4154	Not applicable
Group.Recording.VirtualChan16En	Virtual Channel 16 enable (0 = Disabled; 1 = Enabled)	bool	103b	4155	Not applicable
Group.Recording.VirtualChan17En	Virtual Channel 17 enable (0 = Disabled; 1 = Enabled)	bool	103c	4156	Not applicable
Group.Recording.VirtualChan18En	Virtual Channel 18 enable (0 = Disabled; 1 = Enabled)	bool	103d	4157	Not applicable
Group.Recording.VirtualChan19En	Virtual Channel 19 enable (0 = Disabled; 1 = Enabled)	bool	103e	4158	Not applicable
Group.Recording.VirtualChan20En	Virtual Channel 20 enable (0 = Disabled; 1 = Enabled)	bool	103f	4159	Not applicable
Group.Recording.VirtualChan21En	Virtual Channel 21 enable (0 = Disabled; 1 = Enabled)	bool	1041	4161	Not applicable
Group.Recording.VirtualChan22En	Virtual Channel 22 enable (0 = Disabled; 1 = Enabled)	bool	1042	4162	Not applicable
Group.Recording.VirtualChan23En	Virtual Channel 23 enable (0 = Disabled; 1 = Enabled)	bool	1043	4163	Not applicable
Group.Recording.VirtualChan24En	Virtual Channel 24 enable (0 = Disabled; 1 = Enabled)	bool	1044	4164	Not applicable
Group.Recording.VirtualChan25En	Virtual Channel 25 enable (0 = Disabled; 1 = Enabled)	bool	1045	4165	Not applicable
Group.Recording.VirtualChan26En	Virtual Channel 26 enable (0 = Disabled; 1 = Enabled)	bool	1046	4166	Not applicable
Group.Recording.VirtualChan27En	Virtual Channel 27 enable (0 = Disabled; 1 = Enabled)	bool	1047	4167	Not applicable
Group.Recording.VirtualChan28En	Virtual Channel 28 enable (0 = Disabled; 1 = Enabled)	bool	1048	4168	Not applicable
Group.Recording.VirtualChan29En	Virtual Channel 29 enable (0 = Disabled; 1 = Enabled)	bool	1049	4169	Not applicable
Group.Recording.VirtualChan30En	Virtual Channel 30 enable (0 = Disabled; 1 = Enabled)	bool	104a	4170	Not applicable
Group.Trend.Descriptor	Group descriptor	string_t	5b00	23296	Not applicable
Group.Trend.Interval	Trend interval. As Group.Recording.Interval, above	int32	1002	4098	Not applicable
Group.Trend.MajorDivisions	Number of major divisions	uint8	1004	4100	Not applicable
Group.Trend.Point1	1st point in the group (VCh = Virtual channel)uint8 0 =No trend 1 = Channel 1 2 = Channel 2 3 = Channel 3 4 = Channel 4 5 = VCh1 6 = VCh2 7 = VCh3 8 = VCh4 9 = VCh5 10 = VCh6 11 = VCh7 12 = VCh8 13 = VCh9 14 = VCh10 15 = VCh11 16 = VCh12 17 = VCH13 18 = VCh14 19 = VCh15 20 = VCh 16 21 = VCh17 22 = VCh18 23 = VCh 19 24 = VCh20 25 = VCh21 26 = VCh 22 27 = VCh23 28 = VCh24 29 = VCh 25 30 = VCh26 31 = VCh27 32 = VCh 28 33 = VCh29 34 = VCh30	1006		4102	Not applicable
Group.Trend.Point2	As Group.Trend.Point1 but for 2nd point in group	uint8	1007	4103	Not applicable
Group.Trend.Point3	As Group.Trend.Point1 but for 3rd point in group	uint8	1008	4104	Not applicable
Group.Trend.Point4	As Group.Trend.Point1 but for 4th point in group	uint8	1009	4105	Not applicable
Group.Trend.Point5	As Group.Trend.Point1 but for 5th point in group	uint8	100a	4106	Not applicable
Group.Trend.Point6	As Group.Trend.Point1 but for 6th point in group	uint8	100b	4107	Not applicable
IHumidity.DewPoint	Dewpoint	float32	2e79	11897	Set by Humidity.Resolution
Humidity.DryTemp	Dry Bulb Temperature Measurement	float32	2e7d	11901	0dp
Humidity.Pressure	Current Atmospheric Pressure	float32	2e80	11904	1dp
Humidity.PsychroConst	Psychrometric Constant	float32	2e7f	11903	2dp
Humidity.RelHumid	Calculated Relative Humidity	float32	2e78	11896	Set by Humidity.Resolution
Humidity.Resolution	Result Resolution	uint8	2e81	11905	Not applicable
Humidity.SBrk	Sensor Broken (0 = No; 1 = Yes)	bool	2e7e	11902	Not applicable
Humidity.WetOffset	Offset of the Wet Bulb Temperature	float32	2e7b	11899	Same as Humidity.WetTemp
Humidity.WetTemp	Wet Bulb Temperature Measurement	float32	2e7c	11900	0dp
Instrument.Clock.Date	Local Date	string_t	4400	17408	Not applicable
Instrument.Clock.DST	1 = DST active; 0 = DST not active	bool	1082	4226	Not applicable
Instrument.Clock.Time	Local time (including Zone and DST effects)	time_t	1081	4225	Set by Network.Modbus.TimeFormat
Instrument.Display.AlarmPanel	1 = Alarm Panel display mode enabled	bool	10eb	4331	Not applicable
Instrument.Display.Brightness	Display brightness 10 = 10%; 20 = 20% etc. (whole decades)	uint8	1090	4240	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Instrument.Display.Cascade	1 = Cascade control display mode enabled	bool	10f2	4338	Not applicable
Instrument.Display.DualLoopControl	1 = Dual loop control display mode enabled	bool	109b	4251	Not applicable
Instrument.Display.EIPServerPage	1 = EtherNet/IPdisplay mode enabled	bool	10ef	4335	Not applicable
Instrument.Display.FaceplateCycling	1 = Faceplate cycling On	bool	109e	4254	Not applicable
Instrument.Display.FutureTrend	1 = Future trend display mode enabled	bool	10fb	4347	Not applicable
Instrument.Display.FutureTrend1Colour	Future trend colour(1) (As Channel.1.Trend.Colour)	uint8	10fc	4348	Not applicable
Instrument.Display.FutureTrend2Colour	Future trend colour(2) (As Channel.1.Trend.Colour)	uint8	10fd	4349	Not applicable
Instrument.Display.HistoryBackground	History background colour 0 = Black; 1 = Dark grey; 2 = Light grey; 3 = White	uint8	10a8	4264	Not applicable
Instrument.Display.HomePage	Home page	uint8	1093	4243	Not applicable
Instrument.Display.HorizontalBar	1 = Horizontal bar mode enabled	bool	1098	4248	Not applicable
Instrument.Display.HorizontalTrend	1 = Horizontal trend mode enabled	bool	1096	4246	Not applicable
Instrument.Display.HPageTimeout	Home time out value in minutes (0 = no timeout)	int16	1094	4244	Not applicable
Instrument.Display.HTrendScaling	0 = hide horizontal trend scale; 1 = scale permanent	uint8	109d	4253	Not applicable
Instrument.Display.LoopControl	1 = Loop control display mode enabled	bool	109a	4250	Not applicable
Instrument.Display.LoopSetpointColour	Loop setpoint colour (As Channel.1.Trend.Colour)	uint8	109f	4255	Not applicable
Instrument.Display.ModbusMaster	1 = Modbus Master display mode enabled	bool	10ee	4334	Not applicable
Instrument.Display.NumberFormat	Number format (0 = Rounded; 1 - Truncated)	uint8	10fe	4350	Not applicable
Instrument.Display.Numeric	1 = Numeric display mode enabled	bool	1099	4249	Not applicable
Instrument.Display.Programmer	1 = Programmer interface display mode enabled	bool	10f3	4339	Not applicable
Instrument.Display.PromoteListView	1 = Promote list display mode enabled	bool	10ea	4330	Not applicable
Instrument.Display.ScreenSaverAfter	Screen save after (in minutes)	int16	1091	4241	Not applicable
Instrument.Display.ScreenSaverBrightness	Screen saver brightness 10 = 10%; 20 = 20% etc. (whole decades only)	uint8	1092	4242	Not applicable
Instrument.Display.SteriliserPage	1 = Steriliser display mode enabled	bool	10ec	4332	Not applicable
Instrument.Display.TrendBackground	Trend chart colour: 0 = Black; 1 = Dark Grey; 2 = Light grey; 3 = White.	uint8	109c	4252	Not applicable
Instrument.Display.VerticalBar	1 = Vertical bar display mode enabled	bool	1097	4247	Not applicable
Instrument.Display.VerticalTrend	1 = Vertical trend display mode enabled	bool	1095	4245	Not applicable
Instrument.Info.Bootrom	Instrument bootrom version	string_t	447a	17530	Not applicable
Instrument.Info.CompanyID	Company identification. Always returns 1280	int16	0079	121	Not applicable
Instrument.Info.ConfigRev	The instrument configuration revision number	int32	10a0	4256	Not applicable
Instrument.Info.IM	Instrument mode Operating: All algorithms and I/O active. Standby: Control o/p off. Absolute alarms active Engineer: All outputs inactive.	uint8	00c7	199	Not applicable
Instrument.Info.LineVoltage	Displays the current line voltage	float32	10a6	4262	1dp
Instrument.Info.MicroBoardIssue	Micro Board Issue	uint8	10aa	4266	Not applicable
Instrument.Info.Name	The instrument descriptor	string_t	445f	17503	Not applicable
Instrument.Info.NvolWrites	Displays the number of non-volatile writes performed	int32	10a5	4261	Not applicable
Instrument.Info.PSUType	PSU type. 0 = 240Vac; 1 = 24v ac/dc	uint8	10a9	4265	Not applicable
Instrument.Info.SecurityRev	The instrument security revision number	int32	10a4	4260	Not applicable
Instrument.Info.Type	Instrument type	uint8	10a2	4258	Not applicable
Instrument.Info.Version	Instrument version	string_t	4474	17524	Not applicable
Instrument.Info.WiresFree	Number of wires free	int16	10ab	4267	Not applicable
Instrument.IOFitted.1A1B	I/O fitted at terminals 1A1Buint8 0 = Digital IO 1= Non-isolated dc op (mA only) 2 = Relay op 3 = TRIAC 1a1b 4 = Relay OP 5 = Isolated dc op (V/mA) 6 = Digital ip 7 = Isolated dc output (mA only) 8 = Digital op 9 = Relay op 10 = Triac 2A2B	10f4		4340	Not applicable
Instrument.IOFitted.2A2B	I/O fitted at terminals 2A2B (as for 1A1B above)	uint8	10f5	4341	Not applicable
Instrument.IOFitted.3A3B	I/O type fitted at terminals 3A3B (as for 1A1B above)	uint8	10f7	4343	Not applicable
Instrument.IOFitted.4AC	I/O type fitted at terminals 4AC (as for 1A1B above)	uint8	10f9	4345	Not applicable
Instrument.IOFitted.5AC	I/O type fitted at terminals 5AC (as for 1A1B above)	uint8	10fa	4346	Not applicable
Instrument.IOFitted.LALC	I/O type fitted at terminals LALC (as for 1A1B above)	uint8	10f6	4342	Not applicable
Instrument.IOFitted.LBLC	I/O type fitted at terminals LBLC (as for 1A1B above)	uint8	10f8	4344	Not applicable
Instrument.Locale.DateFormat	Date format (0 = DDMMYY. 1 = MMDDYY; 2 = YYMMDD)	uint8	10b1	4273	Not applicable
Instrument.Locale.DSTenable	1 = Daylight Saving Time enabled	bool	10b3	4275	Not applicable
Instrument.Locale.EndDay	Daylight savings: End day 0 = Sunday 1= Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday	uint8	10ba	4282	Not applicable
Instrument.Locale.EndMonth	Daylight savings: End month 0 = Febuary 1= February 2 = March 3 = April 4 = May 5 = June 6 = July 7 = August 8 = September 9 = October 10 = November 11 = December	uint8	10bb	4283	Not applicable
Instrument.Locale.EndOn	Week for changing to/from DST 0 = First 1= Second 2 = Third 3 = Fourth 4 = Last 5 = Second to last	uint8	10b9	4281	Not applicable
Instrument.Locale.EndTime	DST end time in hours, minutes, seconds and milliseconds	time_t	10b8	4280	Set by Network.Modbus.TimeFormat
Instrument.Locale.Language	Language (0 = English)	uint8	10b0	4272	Not applicable
Instrument.Locale.StartDay	DST start day. As Instrument.Locale.EndDay, above	uint8	10b6	4278	Not applicable
Instrument.Locale.StartMonth	DST start month As Instrument.Locale.EndMonth, above	uint8	10b7	4279	Not applicable
Instrument.Locale.StartOn	Start DST on. As Instrument.Locale.EndOn, above	uint8	10b5	4277	Not applicable
Instrument.Locale.StartTime	DST start time. As Instrument.Locale.EndTime above	time_t	10b4	4276	Set by Network.Modbus.TimeFormat

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Instrument.Locale.TimeZone	Time zone 0 = GMT - 12 hours 1 = GMT - 11 hours 2 = GMT - 10 hours 3 = GMT - 9 hours 4 = GMT - 8 hours 5 = GMT - 7 hours 6 = GMT - 6 hours 7 = GMT - 5 hours 8 = GMT - 4 hours 9 = GMT - 3.5 hours 10 = GMT - 3 hours 11 = GMT - 2 hours 12 = GMT - 1 hour 13 = GMT 14 = GMT + 1 hour 15 = GMT + 2 hours 16 = GMT + 3 hours 17 = GMT + 3.5 hours 18 = GMT + 4 hours 19 = GMT + 4.5 hours 20 = GMT + 5 hours 21 = GMT + 5.5 hours 22 = GMT + 5.75 hours 23 = GMT + 6 hours 24 = GMT + 6.5 hours 25 = GMT + 7 hours 26 = GMT + 8 hours 27 = GMT + 9 hours 28 = GMT + 9.5 hours 29 = GMT + 10 hours 30 = GMT + 11 hours 31 = GMT + 12 hours 32 = GMT + 13 hours	uint8	10b2	4274	Not applicable
Instrument.Notes.Note	Operator Note	string_t	5500	21760	Not applicable
Instrument.Notes.Note1	Operator note 1	string_t	5580	21888	Not applicable
Instrument.Notes.Note2	Operator note 2	string_t	5600	22016	Not applicable
Instrument.Notes.Note3	Operator note 3	string_t	5680	22144	Not applicable
Instrument.Notes.Note4	Operator note 4	string_t	5700	22272	Not applicable
Instrument.Notes.Note5	Operator note 5	string_t	5780	22400	Not applicable
Instrument.Notes.Note6	Operator note 6	string_t	5800	22528	Not applicable
Instrument.Notes.Note7	Operator note 7	string_t	5880	22656	Not applicable
Instrument.Notes.Note8	Operator note 8	string_t	5900	22784	Not applicable
Instrument.Notes.Note9	Operator note 9	string_t	5980	22912	Not applicable
Instrument.Notes.Note10	Operator note 10	string_t	5a00	23040	Not applicable
Instrument.PromoteList.PromoteListName	Promote list (operator view) title	string_t	6d07	27911	Not applicable
Instrument.PromoteList.PromoteParam1	Promote parameter (1)	eint32	10e0	4320	Not applicable
strument.PromoteList.PromoteParam1Desc	Descriptor for promote parameter (1)	string_t	6300	25344	Not applicable
Instrument.PromoteList.PromoteParam2	Promote parameter (2)	eint32	10e1	4321	Not applicable
Instrument.PromoteList.PromoteParam2Desc	Descriptor for promote parameter (2)	string_t	6315	25365	Not applicable
Instrument.PromoteList.PromoteParam3	Promote parameter (3)	eint32	10e2	4322	Not applicable
Instrument.PromoteList.PromoteParam3Desc	Descriptor for promote parameter (3)	string_t	632a	25386	Not applicable
Instrument.PromoteList.PromoteParam4	Promote parameter (4)	eint32	10e3	4323	Not applicable
Instrument.PromoteList.PromoteParam4Desc	Descriptor for promote parameter (4)	string_t	633f	25407	Not applicable
Instrument.PromoteList.PromoteParam5	Promote parameter (5)	eint32	10e4	4324	Not applicable
Instrument.PromoteList.PromoteParam5Desc	Descriptor for promote parameter (5)	string_t	6354	25428	Not applicable
Instrument.PromoteList.PromoteParam6	Promote parameter (6)	eint32	10e5	4325	Not applicable
Instrument.PromoteList.PromoteParam6Desc	Descriptor for promote parameter (6)	string_t	6369	25449	Not applicable
Instrument.PromoteList.PromoteParam7	Promote parameter (7)	eint32	10e6	4326	Not applicable
Instrument.PromoteList.PromoteParam7Desc	Descriptor for promote parameter (7)	string_t	637e	25470	Not applicable
Instrument.PromoteList.PromoteParam8	Promote parameter (8)	eint32	10e7	4327	Not applicable
Instrument.PromoteList.PromoteParam8Desc	Descriptor for promote parameter (8)	string_t	6393	25491	Not applicable
Instrument.PromoteList.PromoteParam9	Promote parameter (9)	eint32	10e8	4328	Not applicable
Instrument.PromoteList.PromoteParam9Desc	Descriptor for promote parameter (9)	string_t	63a8	25512	Not applicable
Instrument.PromoteList.PromoteParam10	Promote parameter (10)	eint32	10e9	4329	Not applicable
Instrument.PromoteList.PromoteParam10Desc	Descriptor for promote parameter (10)	string_t	63bd	25533	Not applicable
InInstrument.Security.CommsPass	1 = Password required for comms access	bool	10c1	4289	Not applicable
Instrument.Security.DefaultConfig	1 = set all parameters to factory settings	bool	10c2	4290	Not applicable
Instrument.Security.EngineerAccess	1 = Engineer access required	bool	10c0	4288	Not applicable
Instrument.Security.EngineerPassword	Engineer pass phrase (default 100)	string_t	63d3	25555	Not applicable
Instrument.Security.Feature2Pass	Features2 pass code	int32	10c4	4292	Not applicable
Instrument.Security.Feature3Pass	Features3 pass code	int32	10c5	4293	Not applicable
Instrument.Security.FeaturePass	Features pass code	int32	10c3	4291	Not applicable
Instrument.Security.OEMEntry	OEM pass phrase entry	string_t	6d61	28001	Not applicable
Instrument.Security.OEMPass	OEM pass phrase	string_t	6d30	27952	Not applicable
Instrument.Security.OEMStatus	OEM status (0 = Unlocked; 1 = Locked)	bool	10c6	4294	Not applicable
Instrument.Security.OperatorPassword	Operator pass phrase (default = blank	string_t	6437	25655	Not applicable
Instrument.Security.PassPhrase	The parameter to be written to if comms security is enabled	string_t	4416	17430	Not applicable
Instrument.Security.SupervisorPassword	Supervisor pass phrase (default = blank	string_t	6405	25605	Not applicable
Lgc2.1.FallbackType	Fallback Condition 0 = Output False; Status Bad. 1 = Output True; Status Bad 2 = Output False; Status Good. 3 = Output True; Status good	uint8	2efb	12027	Not applicable
Lgc2.1.In1	Input Value 1	float32	2ef9	12025	0dp
Lgc2.1.In2	Input Value 2	float32	2efa	12026	0dp
Lgc2.1.Invert	Sense of Input Values 0 = Neither input inverted 1 = Input 1 inverted 2 = Input 2 inverted 3 = Both inputs inverted	uint8	2efc	12028	Not applicable
Lgc2.1.Oper	Logic Operation 0 = Off; 1 = AND; 2 = OR; 3 = XOR; 4 = 1 set/2 reset 5 = Input 1 = Input 2? 6 = Input 1 ≠ Input 2 7 = Input 1 > Input 2? 8 = Input 1< Input 2? 9 = Input 1 ≥ Input 2?; 10 = Input 1 ≤ Input 2?	uint8	2ef8	12024	Not applicable
Lgc2.1.Out	Output Value (0 = Off (false); 1 = On (true))	bool	2efd	12029	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Lgc2.1.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2efe	12030	Not applicable
Lgc2.2.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f02	12034	Not applicable
Lgc2.2.In1	Input Value 1	float32	2f00	12032	0dp
Lgc2.2.In2	Input Value 2	float32	2f01	12033	0dp
Lgc2.2.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f03	12035	Not applicable
Lgc2.2.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2eff	12031	Not applicable
Lgc2.2.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f04	12036	Not applicable
Lgc2.2.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f05	12037	Not applicable
Lgc2.3.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f09	12041	Not applicable
Lgc2.3.In1	Input Value 1	float32	2f07	12039	0dp
Lgc2.3.In2	Input Value 2	float32	2f08	12040	0dp
Lgc2.3.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f0a	12042	Not applicable
Lgc2.3.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f06	12038	Not applicable
Lgc2.3.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f0b	12043	Not applicable
Lgc2.3.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f0c	12044	Not applicable
Lgc2.4.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f10	12048	Not applicable
Lgc2.4.In1	Input Value 1	float32	2f0e	12046	0dp
Lgc2.4.In2	Input Value 2	float32	2f0f	12047	0dp
Lgc2.4.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f11	12049	Not applicable
Lgc2.4.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f0d	12045	Not applicable
Lgc2.4.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f12	12050	Not applicable
Lgc2.4.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f13	12051	Not applicable
Lgc2.5.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f17	12055	Not applicable
Lgc2.5.In1	Input Value 1	float32	2f15	12053	0dp
Lgc2.5.In2	Input Value 2	float32	2f16	12054	0dp
Lgc2.5.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f18	12056	Not applicable
Lgc2.5.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f14	12052	Not applicable
Lgc2.5.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f19	12057	Not applicable
Lgc2.5.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f1a	12058	Not applicable
Lgc2.6.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f1e	12062	Not applicable
Lgc2.6.In1	Input Value 1	float32	2f1c	12060	0dp
Lgc2.6.In2	Input Value 2	float32	2f1d	12061	0dp
Lgc2.6.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f1f	12063	Not applicable
Lgc2.6.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f1b	12059	Not applicable
Lgc2.6.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f20	12064	Not applicable
Lgc2.6.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f21	12065	Not applicable
Lgc2.7.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f25	12069	Not applicable
Lgc2.7.In1	Input Value 1	float32	2f23	12067	0dp
Lgc2.7.In2	Input Value 2	float32	2f24	12068	0dp
Lgc2.7.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f26	12070	Not applicable
Lgc2.7.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f22	12066	Not applicable
Lgc2.7.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f27	12071	Not applicable
Lgc2.7.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f28	12072	Not applicable
Lgc2.8.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f2c	12076	Not applicable
Lgc2.8.In1	Input Value 1	float32	2f2a	12074	0dp
Lgc2.8.In2	Input Value 2	float32	2f2b	12075	0dp
Lgc2.8.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f2d	12077	Not applicable
Lgc2.8.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f29	12073	Not applicable
Lgc2.8.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f2e	12078	Not applicable
Lgc2.8.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f2f	12079	Not applicable
Lgc2.9.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f33	12083	Not applicable
Lgc2.9.In1	Input Value 1	float32	2f31	12081	0dp
Lgc2.9.In2	Input Value 2	float32	2f32	12082	0dp
Lgc2.9.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f34	12084	Not applicable
Lgc2.9.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f30	12080	Not applicable
Lgc2.9.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f35	12085	Not applicable
Lgc2.9.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f36	12086	Not applicable
Lgc2.10.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f3a	12090	Not applicable
Lgc2.10.In1	Input Value 1	float32	2f38	12088	0dp
Lgc2.10.In2	Input Value 2	float32	2f39	12089	0dp
Lgc2.10.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f3b	12091	Not applicable
Lgc2.10.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f37	12087	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Lgc2.10.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f3c	12092	Not applicable
Lgc2.10.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f3d	12093	Not applicable
Lgc2.11.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f41	12097	Not applicable
Lgc2.11.In1	Input Value 1	float32	2f3f	12095	0dp
Lgc2.11.In2	Input Value 2	float32	2f40	12096	0dp
Lgc2.11.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f42	12098	Not applicable
Lgc2.11.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f3e	12094	Not applicable
Lgc2.11.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f43	12099	Not applicable
Lgc2.11.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f44	12100	Not applicable
Lgc2.12.FallbackType	Fallback Condition (as Lgc2.1.FallbackType)	uint8	2f48	12104	Not applicable
Lgc2.12.In1	Input Value 1	float32	2f46	12102	0dp
Lgc2.12.In2	Input Value 2	float32	2f47	12103	0dp
Lgc2.12.Invert	Sense of Input Value (as Lgc2.1.Invert)	uint8	2f49	12105	Not applicable
Lgc2.12.Oper	Logic Operation (as Lgc2.1.Oper)	uint8	2f45	12101	Not applicable
Lgc2.12.Out	The result of the logic operation (as Lgc2.1.Out)	bool	2f4a	12106	Not applicable
Lgc2.12.OutputStatus	Output Status (0 = Good; 1 = Bad)	uint8	2f4b	12107	Not applicable
Lgc8.1.In1	Input 1 Value (0 = Off; 1 = On)	bool	2f4f	12111	Not applicable
Lgc8.1.In2	Input 2 Value (0 = Off; 1 = On)	bool	2f50	12112	Not applicable
Lgc8.1.In3	Input 3 Value (0 = Off; 1 = On)	bool	2f51	12113	Not applicable
Lgc8.1.In4	Input 4 Value (0 = Off; 1 = On)	bool	2f52	12114	Not applicable
Lgc8.1.In5	Input 5 Value (0 = Off; 1 = On)	bool	2f53	12115	Not applicable
Lgc8.1.In6	Input 6 Value (0 = Off; 1 = On)	bool	2f54	12116	Not applicable
Lgc8.1.In7	Input 7 Value (0 = Off; 1 = On)	bool	2f55	12117	Not applicable
Lgc8.1.In8	Input 8 Value (0 = Off; 1 = On)	bool	2f56	12118	Not applicable
Lgc8.1.InInvert	Invert Selected Inputs (See also section 4.20.3) Hex0001 = Invert input 1 Hex0010 = invert input 5 Hex0002 = Invert input 2 Hex0020 = invert input 6 Hex0003 = Invert input 3 Hex0030 = invert input 7 Hex0004 = invert input 4 Hex0040 = invert input 8	uint8	2f4d	12109	Not applicable
Lgc8.1.NumIn	Number of Inputs	uint8	2f4e	12110	Not applicable
Lgc8.1.Oper	Logic Operation (0 = Off; 1 = AND; 2 = OR; 3 = XOR)	uint8	2f4c	12108	Not applicable
Lgc8.1.Out	Output Value (0 = Off (false); 1 = On (true))	bool	2f57	12119	Not applicable
Lgc8.1.OutInvert	Invert the Output (0 = No; 1 = Yes)	bool	2f58	12120	Not applicable
Lgc8.2.In1	Input 1 Value (0 = Off; 1 = On)	bool	2f5c	12124	Not applicable
Lgc8.2.In2	Input 2 Value (0 = Off; 1 = On)	bool	2f5d	12125	Not applicable
Lgc8.2.In3	Input 3 Value (0 = Off; 1 = On)	bool	2f5e	12126	Not applicable
Lgc8.2.In4	Input 4 Value (0 = Off; 1 = On)	bool	2f5f	12127	Not applicable
Lgc8.2.In5	Input 5 Value (0 = Off; 1 = On)	bool	2f60	12128	Not applicable
Lgc8.2.In6	Input 6 Value (0 = Off; 1 = On)	bool	2f61	12129	Not applicable
Lgc8.2.In7	Input 7 Value (0 = Off; 1 = On)	bool	2f62	12130	Not applicable
Lgc8.2.In8	Input 8 Value (0 = Off; 1 = On)	bool	2f63	12131	Not applicable
Lgc8.2.InInvert	Invert Selected Inputs (as Lgc8.1.InInvert)	uint8	2f5a	12122	Not applicable
Lgc8.2.NumIn	Number of Inputs	uint8	2f5b	12123	Not applicable
Lgc8.2.Oper	Logic Operation (0 = Off; 1 = AND; 2 = OR; 3 = XOR)	uint8	2f59	12121	Not applicable
Lgc8.2.Out	Output Value (as Lgc8.1.Out)	bool	2f64	12132	Not applicable
Lgc8.2.OutInvert	Invert the Output (0 = No; 1 = Yes)	bool	2f65	12133	Not applicable
Loop.1.Diag.DerivativeOutContrib	Derivative Output Contribution	float32	0212	530	0dp
Loop.1.Diag.Error	Calculated error	float32	020d	525	Same as Loop.1.Main.PV
Loop.1.Diag.IntegralOutContrib	Integral Output Contribution	float32	0211	529	0dp
Loop.1.Diag.LoopBreakAlarm	Loop Break (0 = No break; 1 = Break)	bool	020f	527	Not applicable
Loop.1.Diag.LoopMode	Mode of the Loop (0 = Auto; 1 = Man; 2 = Off)	uint8	1691	5777	Not applicable
Loop.1.Diag.PropOutContrib	Proportional Output Contribution	float32	0210	528	0dp
Loop.1.Diag.SBrk	Sensor Break Status (0 = No break; 1 = Break)	bool	0213	531	Not applicable
Loop.1.Diag.SchedCBH	The Scheduled Cutback High (0 = Auto)	float32	1695	5781	0dp
Loop.1.Diag.SchedCBL	The Scheduled Cutback Low (0 = Auto)	float32	1696	5782	0dp
Loop.1.Diag.SchedLPBrk	The Scheduled Loop Break Time (0 = Off)	float32	1698	5784	0dp
Loop.1.Diag.SchedMR	The Scheduled Manual Reset	float32	1697	5783	1dp
Loop.1.Diag.SchedOPHi	The Scheduled Output High Limit	float32	169a	5786	1dp
Loop.1.Diag.SchedOPLo	The Scheduled Output Low Limit	float32	169b	5787	1dp
Loop.1.Diag.SchedPB	The Scheduled Proportional Band	float32	1692	5778	1dp
Loop.1.Diag.SchedR2G	The Scheduled Relative Cool Gain	float32	1699	5785	1dp
Loop.1.Diag.SchedTd	The Scheduled Derivative Time (0 = Off)	float32	1694	5780	0dp
Loop.1.Diag.SchedTi	The Scheduled Integral Time (0 = Off)	float32	1693	5779	0dp
Loop.1.Diag.TargetOutVal	Target Output value	float32	020e	526	Same as Loop.1.OP.OutputHighLimit
Loop.1.Diag.WrkOPHi	Working Output High Limit	float32	0215	533	0dp
Loop.1.Diag.WrkOPLo	Working Output Low Limit	float32	0214	532	0dp
Loop.1.Main.ActiveOut	Working Output	float32	0204	516	Same as Loop.1.OP.OutputHighLimit
Loop.1.Main.AutoMan	Auto/Manual Mode (0 = Auto; 1 = Man)	bool	0201	513	Not applicable
Loop.1.Main.Inhibit	Control Inhibit (0 = No; 1 = Yes)	bool	0205	517	Not applicable
Loop.1.Main.IntHold	Integral action inhibit. 0 = No; 1 = Yes	uint8	0206	518	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Loop1.Maim.PV	Process varaible	float32	0200	512	1dp
Loop.1.Main.TargetSP	Target Setpoint	float32	0202	514	Same as Loop.1.Main.PV
Loop.1.Main.WorkingSP	Working Setpoint	float32	0203	515	Same as Loop.1.Main.PV
Loop.1.OP.Ch1OnOffHysteresis	Ch1 On/Off Hysteresis in Engineering Units	float32	1672	5746	Same as Loop.1.Main.PV
Loop.1.OP.Ch1Out	Channel 1 Output Value	float32	020b	523	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.Ch1PotBreak	Ch1 Potentiometer Break (0 = Off; 1 = On)	uint8	1679	5753	Not applicable
Loop.1.OP.Ch1PotPosition	Ch1 Valve Position	float32	1678	5752	0dp
Loop.1.OP.Ch1TravelTime	Channel 1 Travel Time	float32	1674	5748	1dp
Loop.1.OP.Ch2Deadband	Channel 2 Deadband	float32	166f	5743	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.Ch2OnOffHysteresis	Ch2 On/Off Hysteresis in Eng Units	float32	1673	5747	Same as Loop.1.Main.PV
Loop.1.OP.Ch2Out	Channel 2 (Cool) Output Value	float32	020c	524	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.Ch2PotBreak	Ch2 Potentiometer Break (0 = Off; 1 = On)	uint8	167b	5755	Not applicable
Loop.1.OP.Ch2PotPosition	Ch2 Valve Position	float32	167a	5754	0dp
Loop.1.OP.Ch2TravelTime	Channel 2 Travel Time	float32	1675	5749	1dp
Loop.1.OP.CoolType	Cooling Algorithm Type 0 = Linear 1 = Oil 2 = Water 3 = Fan	uint8	1683	5763	Not applicable
Loop.1.OP.EnablePowerFeedforward	0 = Power Feedforward disabled; 1 = PFF enabled	uint8	1681	5761	Not applicable
Loop.1.OP.FeedForwardGain	Feedforward Gain	float32	1685	5765	3dp
Loop.1.OP.FeedForwardOffset	Feedforward Offset	float32	1686	5766	0dp
Loop.1.OP.FeedForwardTrimLimit	Feedforward Trim Limit	float32	1687	5767	0dp
Loop.1.OP.FeedForwardType	Feedforward Type (0 = None; 1 = Remote; 2 = SP; 3 = PV)	uint8	1684	5764	Not applicable
Loop.1.OP.FeedForwardVal	Feedforward Value	float32	1688	5768	0dp
Loop.1.OP.FF_Rem	Remote Feed Forward Input	float32	168d	5773	0dp
Loop.1.OP.ForcedOP	Forced manual output value	float32	168f	5775	1dp
Loop.1.OP.ManStartup	Manual Startup Mode (0 = Off; 1 = On)	bool	1690	5776	Not applicable
Loop.1.OP.ManualMode	Manual Output Mode (0 = Track; 1 = Step; 2 = Last MOP)	uint8	167f	5759	Not applicable
Loop.1.OP.ManualOutVal	Manual Output Value	float32	1680	5760	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.MeasuredPower	Measured Mains Voltage	float32	1682	5762	0dp
Loop.1.OP.NudgeLower	Valve Nudge Lower (1 = Lower)	uint8	1677	5751	Not applicable
Loop.1.OP.NudgeRaise	Valve Nudge Raise (1 = Raise)	uint8	1676	5750	Not applicable
Loop.1.OP.OutputHighLimit	Output High Limit	float32	166d	5741	1dp
Loop.1.OP.OutputLowLimit	Output Low Limit	float32	166e	5742	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.PotBreakMode	Potentiometer Break Mode (0 = Raise; 1 = Lower; 2 = Rest: 3 = Model)	uint8	167c	5756	Not applicable
Loop.1.OP.Rate	Output Rate Limit Value (0 = Off)	float32	1670	5744	1dp
Loop.1.OP.RateDisable	Output Rate Limit Disable (1 = Disabled)	bool	1671	5745	Not applicable
Loop.1.OP.RemOPH	Remote Output High Limit	float32	168c	5772	Same as Loop.1.Main.ActiveOut
Loop.1.OP.RemOPL	Remote Output Low Limit	float32	168b	5771	Same as Loop.1.Main.ActiveOut
Loop.1.OP.SafeOutVal	Safe Output Value	float32	167e	5758	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.SbrkOP	The output power in sensor break	float32	168e	5774	Same as Loop.1.OP.OutputHighLimit
Loop.1.OP.SensorBreakMode	Sensor Break Mode (0 = SbrkOP; 1 = Hold)	uint8	167d	5757	Not applicable
Loop.1.OP.TrackEnable	Enable Output Tracking (0 = Disabled; 1 = Enabled)	uint8	168a	5770	Not applicable
Loop.1.OP.TrackOutVal	Output Track Value	float32	1689	5769	0dp
Loop.1.PID.ActiveSet	Current PID Set	uint8	1638	5688	Not applicable
Loop.1.PID.Boundary1-2	Threshold for swapping between set 1 and set 2	float32	1639	5689	0dp
Loop.1.PID.Boundary2-3	Threshold for swapping between set 2 and set 3	float32	163a	5690	0dp
Loop.1.PID.CutbackHigh	Cutback high value for PID set 1 (0 = Auto)	float32	163f	5695	1dp
Loop.1.PID.CutbackHigh2	Cutback high value for PID set 2 (0 = Auto)	float32	1647	5703	1dp
Loop.1.PID.CutbackHigh3	Cutback high value for PID set 3 (0 = Auto)	float32	164f	5711	1dp
Loop.1.PID.CutbackLow	Cutback low value for PID set 1 (0 = Auto)	float32	1640	5696	1dp
Loop.1.PID.CutbackLow2	Cutback low value for PID set 2 (0 = Auto)	float32	1648	5704	1dp
Loop.1.PID.CutbackLow3	Cutback low value for PID set 3 (0 = Auto)	float32	1650	5712	1dp
Loop.1.PID.DerivativeTime	Derivative time for PID set 1	float32	163d	5693	0dp
Loop.1.PID.DerivativeTime2	Derivative time for PID set 2	float32	1645	5701	0dp
Loop.1.PID.DerivativeTime3	Derivative time for PID set 3	float32	164d	5709	0dp
Loop.1.PID.IntegralTime	Integral time for PID set 1	float32	163c	5692	0dp
Loop.1.PID.IntegralTime2	Integral time for PID set 2	float32	1644	5700	0dp
Loop.1.PID.IntegralTime3	Integral time for PID set 3	float32	164c	5708	0dp
Loop.1.PID.LoopBreakTime	Loop break time for PID set 1	float32	1642	5698	0dp
Loop.1.PID.LoopBreakTime2	Loop break time for PID set 2	float32	164a	5706	0dp
Loop.1.PID.LoopBreakTime3	Loop break time for PID set 3	float32	1652	5714	0dp
Loop.1.PID.ManualReset	Manual reset value for PID set 1	float32	1641	5697	1dp
Loop.1.PID.ManualReset2	Manual reset value for PID set 2	float32	1649	5705	1dp
Loop.1.PID.ManualReset3	Manual reset value for PID set 3	float32	1651	5713	1dp
Loop.1.PID.NumSets	Number of PID Sets to be used (max = 3)	uint8	1636	5686	Not applicable
Loop.1.PID.OutputHi	Gain scheduled output high limit for PID set 1	float32	1653	5715	1dp
Loop.1.PID.OutputHi2	Gain scheduled output high limit for PID set 2	float32	1655	5717	1dp
Loop.1.PID.OutputHi3	Gain scheduled output high limit for PID set 3	float32	1657	5719	1dp
Loop.1.PID.OutputLo	Gain scheduled output low limit for PID set 1	float32	1654	5716	1dp
Loop.1.PID.OutputLo2	Gain scheduled output low limit for PID set 2	float32	1656	5718	1dp
Loop.1.PID.OutputLo3	Gain scheduled output low limit for PID set 3	float32	1658	5720	1dp
Loop.1.PID.ProportionalBand	Proportional band value for PID set 1	float32	163b	5691	1dp
Loop.1.PID.ProportionalBand2	Proportional band value for PID set 2	float32	1643	5699	1dp
Loop.1.PID.ProportionalBand3	Proportional band value for PID set 3	float32	164b	5707	1dp
Loop.1.PID.RelCh2Gain	Channel 2 relative cool gain value for PID set 1	float32	163e	5694	1dp
Loop.1.PID.RelCh2Gain2	Channel 2 relative cool gain value for PID set 2	float32	1646	5702	1dp
Loop.1.PID.RelCh2Gain3	Channel 2 relative cool gain value for PID set 3	float32	164e	5710	1dp
Loop.1.PID.SchedulerRemoteInput	Scheduler Remote Input	float32	1637	5687	0dp
Loop.1.PID.SchedulerType	Scheduler Type 0 = Off 1 = Set 2 = SP 3 = PV 4 = Error 5 = OP 6 = Rem	uint8	1635	5685	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Loop.1.Setup.AutoManAccess	Edit access to 'Auto Man' in Loop display page 0 = Read/Write (R/W) all modes 1 = Editable in all modes except 'Logged out' 2 = Editable only at Engineer and Supervisor levels	uint8	16a8	5800	Not applicable
Loop.1.Setup.CH1ControlType	Heat/Ch1 Control Type 0 =Off; 1 = On Off; 2 = PID; 3 = VPU; 4 = VPB	uint8	1601	5633	Not applicable
Loop.1.Setup.CH2ControlType	Channel 2 control type (As channel 1, above)	uint8	1602	5634	Not applicable
Loop.1.Setup.ControlAction	Control Action (0 = Reverse; 1 = Direct)	uint8	1603	5635	Not applicable
Loop.1.Setup.DerivativeType	Derivative Type (0 = PV; 1 = Error)	uint8	1605	5637	Not applicable
Loop.1.Setup.LoopName	Loop Name	string_t	5d00	23808	Not applicable
Loop.1.Setup.LoopType	Loop Type (0 = Single; 1 = Cascade; 2 = Override; 3 = Ratio)	uint8	1600	5632	Not applicable
Loop.1.Setup.PBUnits	Proportional Band Units	uint8	1604	5636	Not applicable
Loop.1.Setup.SPAccess	Edit access to 'SP' in Loop display page 0 = Read/Write (R/W) all modes 1 = Editable in all modes except 'Logged out' 2 = Editable only at Engineer and Supervisor levels	uint8	16a7	5799	Not applicable
Loop.1.SP.AltSP	Alternative Setpoint	float32	1660	5728	Same as Loop.1.Main.PV
Loop.1.SP.AltSPSelect	Alternative Setpoint Enable (0 = disable; 1 = enable)	uint8	1661	5729	Not applicable
Loop.1.SP.ManualTrack	Manual Track Enable (0 = disable; 1 = enable)	uint8	1667	5735	Not applicable
Loop.1.SP.RangeHigh	Setpoint Range High Limit	float32	1659	5721	Same as Loop.1.Main.PV
Loop.1.SP.RangeLow	Setpoimt Range Low Limit	float32	165a	5722	Same as Loop.1.Main.PV
Loop.1.SP.Rate	Setpoint Rate Limit Value (0 = Rate limit off)	float32	1662	5730	Same as Loop.1.Main.PV
Loop.1.SP.RateDisable	Setpoint Rate Limit Disable (0 = No; 1 = Yes)	bool	1663	5731	Not applicable
Loop.1.SP.RateDone	Setpoint Rate Limit Complete (0 = No; 1 = Yes)	bool	020a	522	Not applicable
Loop.1.SP.ServoToPV	Servo to PV Enable (0 = No; 1 = Yes)	bool	166c	5740	Not applicable
Loop.1.SP.SP1	Setpoint 1	float32	165c	5724	Same as Loop.1.Main.PV
Loop.1.SP.SP2	Setpoint 2	float32	165d	5725	Same as Loop.1.Main.PV
Loop.1.SP.SPHighLimit	Setpoint High Limit	float32	165e	5726	Same as Loop.1.Main.PV
Loop.1.SP.SPIntBal	SP Integral Balance (0 = Off; 1 = On)	bool	166b	5739	Not applicable
Loop.1.SP.SPLowLimit	Setpoint Low Limit	float32	165f	5727	Same as Loop.1.Main.PV
Loop.1.SP.SPSelect	Active Setpoint Select (0 = SP1; 1 = SP2)	uint8	165b	5723	Not applicable
Loop.1.SP.SPTrack	Enables setpoint tracking (0 = Off; 1 = On)	uint8	1668	5736	Not applicable
Loop.1.SP.SPTrim	Setpoint Trim value	float32	1664	5732	Same as Loop.1.Main.PV
Loop.1.SP.SPTrimHighLimit	Setpoint Trim High Limit	float32	1665	5733	Same as Loop.1.Main.PV
Loop.1.SP.SPTrimLowLimit	Setpoint Trim Low Limit	float32	1666	5734	Same as Loop.1.Main.PV
Loop.1.SP.TrackPV	Track PV	float32	1669	5737	Same as Loop.1.Main.PV
Loop.1.SP.TrackSP	Manual Tracking Value	float32	166a	5738	Same as Loop.1.Main.PV
Loop.1.Tune.Alpha	Alpha	float32	16ad	5805	4dp
Loop.1.Tune.Alpha_p	Alpha_p	float32	16ab	5803	2dp
Loop.1.Tune.AutotuneEnable	Autotune Enable (0 = Autotune Off; 1 = on)	bool	1631	5681	Not applicable
Loop.1.Tune.CycleNo	CycleNo	float32	16af	5807	0dp
Loop.1.Tune.Debug	Debug	float32	16ae	5806	2dp
Loop.1.Tune.Diagnostics	Tuning diagnostics	bool	31cd	12749	Not applicable
Loop.1.Tune.OPss	OPss	float32	16ac	5804	2dp
Loop.1.Tune.OutputHighLimit	Autotune High Output Power Limit	float32	1632	5682	Same as Loop.1.OP.OutputHighLimit
Loop.1.Tune.OutputLowLimit	Autotune Low Output Power Limit	float32	1633	5683	Same as Loop.1.OP.OutputHighLimit
Loop.1.Tune.PBs	PBs	float32	16b0	5808	2dp
Loop.1.Tune.Settle	Settle	float32	16b2	5810	2dp
Loop.1.Tune.Stage	Autotune stage uint8 0 = Reset 1 = None 2 = Monitor 3 = Current SP 4 = NewSP 5 = ToSp 6 = Max 7 = Min	0208		520	Not applicable
Loop.1.Tune.StageTime	Time in this Stage of Tune	float32	0209	521	0dp
Loop.1.Tune.State	Tune status 0 = Off 1 = Ready 2 = Running 3 = Complete 4 = Timeout 5 = Ti Lmit 6 = R2g limit	uint8	0207	519	Not applicable
Loop.1.Tune.TDs	TDs	float32	16b1	5809	2dp
Loop.1.Tune.TuneR2G	R2G Tuning Type	uint8	1607	5639	Not applicable
Loop.1.Tune.Tuning	Tuning	float32	16aa	5802	0dp
Loop.1.Tune.Type	Autotune Algorithm Type (0 = Cycle; 1 = Single; 2 = Adaptive; 3 = R2GPD)	uint8	1630	5680	Not applicable
Loop.2.Diag.DerivativeOutContrib	Derivative Output Contribution	float32	0292	658	0dp
Loop.2.Diag.Error	Calculated Error	float32	028d	653	Same as Loop.2.Main.PV
Loop.2.Diag.IntegralOutContrib	Integral Output Contribution	float32	0291	657	0dp
Loop.2.Diag.LoopBreakAlarm	Loop Break (0 = No break; 1 = Break)	bool	028f	655	Not applicable
Loop.2.Diag.LoopMode	Loop mode (0 = Auto; 1 = Man; 2 = Off)	uint8	1791	6033	Not applicable
Loop.2.Diag.PropOutContrib	Proportional Output Contribution	float32	0290	656	0dp
Loop.2.Diag.SBrk	Sensor break status (0 = No break; 1 = Break)	bool	0293	659	Not applicable
Loop.2.Diag.SchedCBH	The Scheduled Cutback Hi (0 = Auto)	float32	1795	6037	0dp
Loop.2.Diag.SchedCBL	The Scheduled Cutback Lo (0 = Auto)	float32	1796	6038	0dp
Loop.2.Diag.SchedLPBrk	The Scheduled Loop Break Time	float32	1798	6040	0dp
Loop.2.Diag.SchedMR	The Scheduled Manual Reset	float32	1797	6039	1dp
Loop.2.Diag.SchedOPHi	The Scheduled Output High Limit	float32	179a	6042	1dp
Loop.2.Diag.SchedOPLo	The Scheduled Output Low Limit	float32	179b	6043	1dp
Loop.2.Diag.SchedPB	The Scheduled Proportional Band	float32	1792	6034	1dp
Loop.2.Diag.SchedR2G	The Scheduled Relative Cool Gain	float32	1799	6041	1dp
Loop.2.Diag.SchedTd	The Scheduled Derivative Time (0 = Off)	float32	1794	6036	0dp
Loop.2.Diag.SchedTi	The Scheduled Integral Time (0 = Off)	float32	1793	6035	0dp
Loop.2.Diag.TargetOutVal	Target Output	float32	028e	654	Same as Loop.2.OP.OutputHighLimit

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Loop.2.Diag.WrkOPHi	Working Output Hi Limit	float32	0295	661	0dp
Loop.2.Diag.WrkOPLo	Working Output Lo Limit	float32	0294	660	0dp
Loop.2.Main.ActiveOut	Working Output	float32	0284	644	Same as Loop.2.OP.OutputHighLimit
Loop.2.Main.AutoMan	Auto/Manual Mode (Mode. 0 = Auto; 1 = Man)	bool	0281	641	Not applicable
Loop.2.Main.Inhibit	Control Inhibit (0 = No; 1 = Yes)	bool	0285	645	Not applicable
Loop.2.Main.IntHold	Integral action inhibit. 0 = No; 1 = Yes	uint8	0286	646	Not applicable
Loop.2.Main.PV	Process Variable value	float32	0280	640	1dp
Loop.2.Main.TargetSP	Target Setpoint	float32	0282	642	Same as Loop.2.Main.PV
Loop.2.Main.WorkingSP	Working Setpoint	float32	0283	643	Same as Loop.2.Main.PV
Loop.2.OP.Ch1OnOffHysteresis	Channel 1 hysteresis in engineering units	float32	1772	6002	Same as Loop.2.Main.PV
Loop.2.OP.Ch1Out	Channel 1 Output Value	float32	028b	651	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.Ch1PotBreak	Ch1 Potentiometer Break (0 = Off; 1 = On)	uint8	1779	6009	Not applicable
Loop.2.OP.Ch1PotPosition	Ch1 Valve Position	float32	1778	6008	0dp
Loop.2.OP.Ch1TravelTime	Channel 1 Travel Time	float32	1774	6004	1dp
Loop.2.OP.Ch2Deadband	Channel 2 Deadband	float32	176f	5999	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.Ch2OnOffHysteresis	Channel 2 hysteresis in engineering units	float32	1773	6003	Same as Loop.2.Main.PV
Loop.2.OP.Ch2Out	Channel 2 output value	float32	028c	652	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.Ch2PotBreak	Channel 2 Potentiometer Break (0 = Off; 1 = On)	uint8	177b	6011	Not applicable
Loop.2.OP.Ch2PotPosition	Channel 2 Valve Position	float32	177a	6010	0dp
Loop.2.OP.Ch2TravelTime	Channel 2 Travel Time	float32	1775	6005	1dp
Loop.2.OP.CoolType	Cooling Algorithm Type 0 = Linear; 1 = Oil; 2 = Water; 3 = Fan	uint8	1783	6019	Not applicable
Loop.2.OP.EnablePowerFeedforward	0 = Power Feedforward disabled; 1 = PFF enabled	uint8	1781	6017	Not applicable
Loop.2.OP.FeedForwardGain	Feedforward Gain	float32	1785	6021	3dp
Loop.2.OP.FeedForwardOffset	Feedforward Offset	float32	1786	6022	0dp
Loop.2.OP.FeedForwardTrimLimit	Feedforward Trim Limit	float32	1787	6023	0dp
Loop.2.OP.FeedForwardType	Feedforward Type (0 = None; 1 = Remote; 2 = SP; 3 = PV)	uint8	1784	6020	Not applicable
Loop.2.OP.FeedForwardVal	Feedforward Value	float32	1788	6024	0dp
Loop.2.OP.FF_Rem	Remote Feed Forward Input	float32	178d	6029	0dp
Loop.2.OP.ForcedOP	Forced manual output value	float32	178f	6031	1dp
Loop.2.OP.ManStartup	Manual Startup Mode (0 = Off; 1 = On)	bool	1790	6032	Not applicable
Loop.2.OP.ManualMode	Manual Output Mode (0 = Track; 1 = Step; 2 = Last MOP)	uint8	177f	6015	Not applicable
Loop.2.OP.ManualOutVal	Manual Output Value	float32	1780	6016	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.MeasuredPower	Measured Mains Voltage	float32	1782	6018	0dp
Loop.2.OP.NudgeLower	Valve Nudge Lower (1 = Lower)	uint8	1777	6007	Not applicable
Loop.2.OP.NudgeRaise	Valve Nudge Raise (1 = Raise)	uint8	1776	6006	Not applicable
Loop.2.OP.OutputHighLimit	Output High Limit	float32	176d	5997	1dp
Loop.2.OP.OutputLowLimit	Output Low Limit	float32	176e	5998	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.PotBreakMode	Potentiometer Break Mode (0 = Raise; 1 = Lower; 2 = Rest; 3 = Model)	uint8	177c	6012	Not applicable
Loop.2.OP.Rate	Output Rate Limit Value (0 = off)	float32	1770	6000	1dp
Loop.2.OP.RateDisable	Output Rate Limit Disable (0 = No, 1 = Yes)	bool	1771	6001	Not applicable
Loop.2.OP.RemOPH	Remote Output High Limit	float32	178c	6028	Same as Loop.2.Main.ActiveOut
Loop.2.OP.RemOPL	Remote Output Low Limit	float32	178b	6027	Same as Loop.2.Main.ActiveOut
Loop.2.OP.SafeOutVal	Safe Output Value	float32	177e	6014	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.SbrkOP	The output power under sensor break conditions	float32	178e	6030	Same as Loop.2.OP.OutputHighLimit
Loop.2.OP.SensorBreakMode	Sensor Break Mode (0 = SbrkOP; 1 = Hold)	uint8	177d	6013	Not applicable
Loop.2.OP.TrackEnable	Enable Output Tracking (0 = Off; 1 = On)	uint8	178a	6026	Not applicable
Loop.2.OP.TrackOutVal	Output Track Value	float32	1789	6025	0dp
Loop.2.PID.ActiveSet	Current PID set	uint8	1738	5944	Not applicable
Loop.2.PID.Boundary1-2	Threshold for swapping between set 1 and set 2	float32	1739	5945	0dp
Loop.2.PID.Boundary2-3	Threshold for swapping between set 2 and set 3	float32	173a	5946	0dp
Loop.2.PID.CutbackHigh	Cutback high value for PID set 1 (0 = Auto)	float32	173f	5951	1dp
Loop.2.PID.CutbackHigh2	Cutback high value for PID set 2 (0 = Auto)	float32	1747	5959	1dp
Loop.2.PID.CutbackHigh3	Cutback high value for PID set 3 (0 = Auto)	float32	174f	5967	1dp
Loop.2.PID.CutbackLow	Cutback low value for PID set 1 (0 = Auto)	float32	1740	5952	1dp
Loop.2.PID.CutbackLow2	Cutback low value for PID set 2 (0 = Auto)	float32	1748	5960	1dp
Loop.2.PID.CutbackLow3	Cutback low value for PID set 3 (0 = Auto)	float32	1750	5968	1dp
Loop.2.PID.DerivativeTime	Derivative time for PID set 1	float32	173d	5949	0dp
Loop.2.PID.DerivativeTime2	Derivative time for PID set 2	float32	1745	5957	0dp
Loop.2.PID.DerivativeTime3	Derivative time for PID set 3	float32	174d	5965	0dp
Loop.2.PID.IntegralTime	Integral time for PID set 1	float32	173c	5948	0dp
Loop.2.PID.IntegralTime2	Integral time for PID set 2	float32	1744	5956	0dp
Loop.2.PID.IntegralTime3	Integral time for PID set 3	float32	174c	5964	0dp
Loop.2.PID.LoopBreakTime	Loop break time for PID set 1	float32	1742	5954	0dp
Loop.2.PID.LoopBreakTime2	Loop break time for PID set 2	float32	174a	5962	0dp
Loop.2.PID.LoopBreakTime3	Loop break time for PID set 3	float32	1752	5970	0dp
Loop.2.PID.ManualReset	Manual reset value for PID set 1	float32	1741	5953	1dp
Loop.2.PID.ManualReset2	Manual reset value for PID set 2	float32	1749	5961	1dp
Loop.2.PID.ManualReset3	Manual reset value for PID set 3	float32	1751	5969	1dp
Loop.2.PID.NumSets	Number of PID sets to be used (max. 3)	uint8	1736	5942	Not applicable
Loop.2.PID.OutputHi	Gain scheduled output high limit for PID set 1	float32	1753	5971	1dp
Loop.2.PID.OutputHi2	Gain scheduled output high limit for PID set 2	float32	1755	5973	1dp
Loop.2.PID.OutputHi3	Gain scheduled output high limit for PID set 3	float32	1757	5975	1dp
Loop.2.PID.OutputLo	Gain scheduled output low limit for PID set 1	float32	1754	5972	1dp
Loop.2.PID.OutputLo2	Gain scheduled output low limit for PID set 2	float32	1756	5974	1dp
Loop.2.PID.OutputLo3	Gain scheduled output low limit for PID set 3	float32	1758	5976	1dp
Loop.2.PID.ProportionalBand	Proportional band value for PID set 1	float32	173b	5947	1dp
Loop.2.PID.ProportionalBand2	Proportional band value for PID set 2	float32	1743	5955	1dp
Loop.2.PID.ProportionalBand3	Proportional band value for PID set 3	float32	174b	5963	1dp
Loop.2.PID.RelCh2Gain	Channel 2 relative cool gain value for PID set 1	float32	173e	5950	1dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Loop.2.PID.RelCh2Gain2	Channel 2 relative cool gain value for PID set 2	float32	1746	5958	1dp
Loop.2.PID.RelCh2Gain3	Channel 2 relative cool gain value for PID set 3	float32	174e	5966	1dp
Loop.2.PID.SchedulerRemoteInput	Scheduler Remote Input	float32	1737	5943	0dp
Loop.2.PID.SchedulerType	Scheduler Type 0 = Off 1 = Set 2 = SP 3 = PV 4 = Error 5 = OP 6 = Rem	uint8	1735	5941	Not applicable
Loop.2.Setup.AutoManAccess	Edit access to 'Auto Man' in Loop display page 0 = Read/Write (R/W) all modes 1 = Editable in all modes except 'Logged out' 2 = Editable only at Engineer and Supervisor levels	uint8	17a8	6056	Not applicable
Loop.2.Setup.CH1ControlType	Channel 1 Control Type 0 =Off; 1 = On Off; 2 = PID; 3 = VPU; 4 = VPB	uint8	1701	5889	Not applicable
Loop.2.Setup.CH2ControlType	Channel 2 Control Type (As channel 1, above)	uint8	1702	5890	Not applicable
Loop.2.Setup.ControlAction	Control Action (0 = Reverse; 1 = Direct)	uint8	1703	5891	Not applicable
Loop.2.Setup.DerivativeType	Derivative Type (0 = PV; 1 = Error)	uint8	1705	5893	Not applicable
Loop.2.Setup.LoopName	Loop Name	string_t	5d10	23824	Not applicable
Loop.2.Setup.LoopType	Loop Type (0 = single; 1 = cascade; 2 = override; 3 = ratio)	uint8	1700	5888	Not applicable
Loop.2.Setup.PBUnits	Proportional Band Units (0 = Engineering units; 1 = percent)	uint8	1704	5892	Not applicable
Loop.2.Setup.SPAccess	Edit access to 'SP' in Loop display page 0 = Read/Write (R/W) all modes 1 = Editable in all modes except 'Logged out' 2 = Editable only at Engineer and Supervisor levels	uint8	17a7	6055	Not applicable
Loop.2.SP.AltSP	Alternative Setpoint	float32	1760	5984	Same as Loop.2.Main.PV
Loop.2.SP.AltSPSelect	Select alternative setpoint (0 = No; 1 = Yes)	uint8	1761	5985	Not applicable
Loop.2.SP.ManualTrack	Manual Track Enable (0 = disable; 1 = enable)	uint8	1767	5991	Not applicable
Loop.2.SP.RangeHigh	Setpoint Range High Limit	float32	1759	5977	Same as Loop.2.Main.PV
Loop.2.SP.RangeLow	Setpoint Range Low Limit	float32	175a	5978	Same as Loop.2.Main.PV
Loop.2.SP.Rate	Setpoint Rate Limit Value (0 = Rate limit off)	float32	1762	5986	Same as Loop.2.Main.PV
Loop.2.SP.RateDisable	Setpoint Rate Limit Disable (0 = No; 1 = Yes)	bool	1763	5987	Not applicable
Loop.2.SP.RateDone	Setpoint Rate Limit Complete (0 = No; 1 = Yes)	bool	028a	650	Not applicable
Loop.2.SP.ServoToPV	Servo to PV Enable (0 = No; 1 = Yes)	bool	176c	5996	Not applicable
Loop.2.SP.SP1	Setpoint 1	float32	175c	5980	Same as Loop.2.Main.PV
Loop.2.SP.SP2	Setpoint 2	float32	175d	5981	Same as Loop.2.Main.PV
Loop.2.SP.SPHighLimit	Setpoint High Limit	float32	175e	5982	Same as Loop.2.Main.PV
Loop.2.SP.SPIntBal	SP Integral Balance (0 = Off; 1 = On)	bool	176b	5995	Not applicable
Loop.2.SP.SPLowLimit	Setpoint Low Limit	float32	175f	5983	Same as Loop.2.Main.PV
Loop.2.SP.SPSelect	Active Setpoint Select (0 = SP1; 1 = SP2)	uint8	175b	5979	Not applicable
Loop.2.SP.SPTrack	Enables setpoint tracking (0 = Off; 1 = On)	uint8	1768	5992	Not applicable
Loop.2.SP.SPTrim	Setpoint Trim	float32	1764	5988	Same as Loop.2.Main.PV
Loop.2.SP.SPTrimHighLimit	Setpoint Trim High Limit	float32	1765	5989	Same as Loop.2.Main.PV
Loop.2.SP.SPTrimLowLimit	Setpoint Trim Low Limit	float32	1766	5990	Same as Loop.2.Main.PV
Loop.2.SP.TrackPV	PV for Programmer to Track	float32	1769	5993	Same as Loop.2.Main.PV
Loop.2.SP.TrackSP	Manual Tracking Value	float32	176a	5994	Same as Loop.2.Main.PV
Loop.2.Tune.Alpha	Alpha	float32	17ad	6061	4dp
Loop.2.Tune.Alpha_p	Alpha_p	float32	17ab	6059	2dp
Loop.2.Tune.AutotuneEnable	Initiate autotune (0 = Autotune Off; 1 = on)	bool	1731	5937	Not applicable
Loop.2.Tune.CycleNo	CycleNo	float32	17af	6063	0dp
Loop.2.Tune.Debug	Debug	float32	17ae	6062	2dp
Loop.2.Tune.Diagnostics	Tuning diagnostics	bool	31ce	12750	Not applicable
Loop.2.Tune.OPss	OPss	float32	17ac	6060	2dp
Loop.2.Tune.OutputHighLimit	Autotune High Output Power Limit	float32	1732	5938	Same as Loop.2.OP.OutputHighLimit
Loop.2.Tune.OutputLowLimit	Autotune Low Output Power Limit	float32	1733	5939	Same as Loop.2.OP.OutputHighLimit
Loop.2.Tune.PBs	PBs	float32	17b0	6064	2dp
Loop.2.Tune.Settle	Settle	float32	17b2	6066	2dp
Loop.2.Tune.Stage	Stage of Tune 0 = Reset 1 = None 2 = Monitor 3 = Current SP 4 = NewSP 5 = ToSp 6 = Max 7 = Min	uint8	0288	648	Not applicable
Loop.2.Tune.StageTime	Time in this Stage of Tune	float32	0289	649	0dp
Loop.2.Tune.State	Autotune state 0 = Off 1 = Ready 2 = Complete 3 = Timeout 4 = Ti Lmit 5 = R2g limit	uint8	0287	647	Not applicable
Loop.2.Tune.TDs	TDs	float32	17b1	6065	2dp
Loop.2.Tune.TuneR2G	R2G Tuning Type	uint8	1608	5640	Not applicable
Loop.2.Tune.Tuning	Tuning	float32	17aa	6058	0dp
Loop.2.Tune.Type	Autotune Algorithm Type (0 = Cycle; 1 = Single; 2 = Adaptive; 3 = R2GPD)	uint8	1730	5936	Not applicable
Math2.1.Fallback	Fallback strategy 0 = Clip Bad; 1 = Clip Good; 2 = Fallback Bad 3 = Fallback Good; 4 = Up scale; 5 = Down scale.	uint8	2faf	12207	Not applicable
Math2.1.FallbackVal	Fallback Value	float32	2fab	12203	Same as Math2.1.Out
Math2.1.HighLimit	Output High Limit	float32	2fac	12204	Same as Math2.1.Out
Math2.1.In1	Input 1 Value	float32	2fa7	12199	0dp
Math2.1.In1Mul	Input 1 Multiplier	float32	2fa6	12198	1dp
Math2.1.In2	Input 2 Value	float32	2fa9	12201	0dp
Math2.1.In2Mul	Input 2 Multiplier	float32	2fa8	12200	1dp
Math2.1.LowLimit	Output Low Limit	float32	2fad	12205	Same as Math2.1.Out

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Math2.1.Oper	Operation 0 = Off 1 = Add 2 = Subtract 3 = Multiply 4 =Divide 5 = Abs diff 6 = Select Max 7 = Select Min 8 = Hot Swap 9 = Sample & Hold 10 = Power 11 = Square root 12 = Log 13 = Ln 14 = Exponential 15 = 10 to the X 51 = Select	uint8	2faa	12202	Not applicable
Math2.1.Out	Output Value	float32	2fae	12206	Set by Math2.1.Resolution
Math2.1.Resolution	Output Resolution	uint8	2fb2	12210	Not applicable
Math2.1.Select	Select Input 1 or Input 2	bool	2fb0	12208	Not applicable
Math2.1.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fb1	12209	Not applicable
Math2.1.Units	Output Units	string_t	6944	26948	Not applicable
Math2.2.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2fbc	12220	Not applicable
Math2.2.FallbackVal	Fallback Value	float32	2fb8	12216	Same as Math2.2.Out
Math2.2.HighLimit	Output High Limit	float32	2fb9	12217	Same as Math2.2.Out
Math2.2.In1	Input 1 Value	float32	2fb4	12212	0dp
Math2.2.In1Mul	Input 1 Scale	float32	2fb3	12211	1dp
Math2.2.In2	Input 2 Value	float32	2fb6	12214	0dp
Math2.2.In2Mul	Input 2 Scale	float32	2fb5	12213	1dp
Math2.2.LowLimit	Output Low Limit	float32	2fba	12218	Same as Math2.2.Out
Math2.2.Oper	Operation (as Math2.1.Oper)	uint8	2fb7	12215	Not applicable
Math2.2.Out	Output Value	float32	2fbb	12219	Set by Math2.2.Resolution
Math2.2.Resolution	Output Resolution	uint8	2fbf	12223	Not applicable
Math2.2.Select	Select Input 1 or Input 2	bool	2fbd	12221	Not applicable
Math2.2.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fbe	12222	Not applicable
Math2.2.Units	Output Units	string_t	694a	26954	Not applicable
Math2.3.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2fc9	12233	Not applicable
Math2.3.FallbackVal	Fallback Value	float32	2fc5	12229	Same as Math2.3.Out
Math2.3.HighLimit	Output High Limit	float32	2fc6	12230	Same as Math2.3.Out
Math2.3.In1	Input 1 Value	float32	2fc1	12225	0dp
Math2.3.In1Mul	Input 1 Scale	float32	2fc0	12224	1dp
Math2.3.In2	Input 2 Value	float32	2fc3	12227	0dp
Math2.3.In2Mul	Input 2 Scale	float32	2fc2	12226	1dp
Math2.3.LowLimit	Output Low Limit	float32	2fc7	12231	Same as Math2.3.Out
Math2.3.Oper	Operation (as Math2.1.Oper)	uint8	2fc4	12228	Not applicable
Math2.3.Out	Output Value	float32	2fc8	12232	Set by Math2.3.Resolution
Math2.3.Resolution	Output Resolution	uint8	2fcc	12236	Not applicable
Math2.3.Select	Select Between Input 1 and Input 2	bool	2fca	12234	Not applicable
Math2.3.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fcb	12235	Not applicable
Math2.3.Units	Output Units	string_t	6950	26960	Not applicable
Math2.4.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2fd6	12246	Not applicable
Math2.4.FallbackVal	Fallback Value	float32	2fd2	12242	Same as Math2.4.Out
Math2.4.HighLimit	Output High Limit	float32	2fd3	12243	Same as Math2.4.Out
Math2.4.In1	Input 1 Value	float32	2fce	12238	0dp
Math2.4.In1Mul	Input 1 Scale	float32	2fcd	12237	1dp
Math2.4.In2	Input 2 Value	float32	2fd0	12240	0dp
Math2.4.In2Mul	Input 2 Scale	float32	2fcf	12239	1dp
Math2.4.LowLimit	Output Low Limit	float32	2fd4	12244	Same as Math2.4.Out
Math2.4.Oper	Operation (as Math2.1.Oper)	uint8	2fd1	12241	Not applicable
Math2.4.Out	Output Value	float32	2fd5	12245	Set by Math2.4.Resolution
Math2.4.Resolution	Output Resolution	uint8	2fd9	12249	Not applicable
Math2.4.Select	Select Between Input 1 and Input 2	bool	2fd7	12247	Not applicable
Math2.4.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fd8	12248	Not applicable
Math2.4.Units	Output Units	string_t	6956	26966	Not applicable
Math2.5.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2fe3	12259	Not applicable
Math2.5.FallbackVal	Fallback Value	float32	2fdf	12255	Same as Math2.5.Out
Math2.5.HighLimit	Output High Limit	float32	2fe0	12256	Same as Math2.5.Out
Math2.5.In1	Input 1 Value	float32	2fdb	12251	0dp
Math2.5.In1Mul	Input 1 Scale	float32	2fda	12250	1dp
Math2.5.In2	Input 2 Value	float32	2fdd	12253	0dp
Math2.5.In2Mul	Input 2 Scale	float32	2fdc	12252	1dp
Math2.5.LowLimit	Output Low Limit	float32	2fe1	12257	Same as Math2.5.Out
Math2.5.Oper	Operation (as Math2.1.Oper)	uint8	2fde	12254	Not applicable
Math2.5.Out	Output Value	float32	2fe2	12258	Set by Math2.5.Resolution
Math2.5.Resolution	Output Resolution	uint8	2fe6	12262	Not applicable
Math2.5.Select	Select Between Input 1 and Input 2	bool	2fe4	12260	Not applicable
Math2.5.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fe5	12261	Not applicable
Math2.5.Units	Output Units	string_t	695c	26972	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Math2.6.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2ff0	12272	Not applicable
Math2.6.FallbackVal	Fallback Value	float32	2fec	12268	Same as Math2.6.Out
Math2.6.HighLimit	Output High Limit	float32	2fed	12269	Same as Math2.6.Out
Math2.6.In1	Input 1 Value	float32	2fe8	12264	0dp
Math2.6.In1Mul	Input 1 Scale	float32	2fe7	12263	1dp
Math2.6.In2	Input 2 Value	float32	2fea	12266	0dp
Math2.6.In2Mul	Input 2 Scale	float32	2fe9	12265	1dp
Math2.6.LowLimit	Output Low Limit	float32	2fee	12270	Same as Math2.6.Out
Math2.6.Oper	Operation (as Math2.1.Oper)	uint8	2feb	12267	Not applicable
Math2.6.Out	Output Value	float32	2fef	12271	Set by Math2.6.Resolution
Math2.6.Resolution	Output Resolution	uint8	2ff3	12275	Not applicable
Math2.6.Select	Select Between Input 1 and Input 2	bool	2ff1	12273	Not applicable
Math2.6.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2ff2	12274	Not applicable
Math2.6.Units	Output Units	string_t	6962	26978	Not applicable
Math2.7.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	2ffd	12285	Not applicable
Math2.7.FallbackVal	Fallback Value	float32	2ff9	12281	Same as Math2.7.Out
Math2.7.HighLimit	Output High Limit	float32	2ffa	12282	Same as Math2.7.Out
Math2.7.In1	Input 1 Value	float32	2ff5	12277	0dp
Math2.7.In1Mul	Input 1 Scale	float32	2ff4	12276	1dp
Math2.7.In2	Input 2 Value	float32	2ff7	12279	0dp
Math2.7.In2Mul	Input 2 Scale	float32	2ff6	12278	1dp
Math2.7.LowLimit	Output Low Limit	float32	2ffb	12283	Same as Math2.7.Out
Math2.7.Oper	Operation (as Math2.1.Oper)	uint8	2ff8	12280	Not applicable
Math2.7.Out	Output Value	float32	2ffc	12284	Set by Math2.7.Resolution
Math2.7.Resolution	Output Resolution	uint8	3000	12288	Not applicable
Math2.7.Select	Select Between Input 1 and Input 2	bool	2ffe	12286	Not applicable
Math2.7.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	2fff	12287	Not applicable
Math2.7.Units	Output Units	string_t	6968	26984	Not applicable
Math2.8.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	300a	12298	Not applicable
Math2.8.FallbackVal	Fallback Value	float32	3006	12294	Same as Math2.8.Out
Math2.8.HighLimit	Output High Limit	float32	3007	12295	Same as Math2.8.Out
Math2.8.In1	Input 1 Value	float32	3002	12290	0dp
Math2.8.In1Mul	Input 1 Scale	float32	3001	12289	1dp
Math2.8.In2	Input 2 Value	float32	3004	12292	0dp
Math2.8.In2Mul	Input 2 Scale	float32	3003	12291	1dp
Math2.8.LowLimit	Output Low Limit	float32	3008	12296	Same as Math2.8.Out
Math2.8.Oper	Operation (as Math2.1.Oper)	uint8	3005	12293	Not applicable
Math2.8.Out	Output Value	float32	3009	12297	Set by Math2.8.Resolution
Math2.8.Resolution	Output Resolution	uint8	300d	12301	Not applicable
Math2.8.Select	Select Between Input 1 and Input 2	bool	300b	12299	Not applicable
Math2.8.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	300c	12300	Not applicable
Math2.8.Units	Output Units	string_t	696e	26990	Not applicable
Math2.9.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	3017	12311	Not applicable
Math2.9.FallbackVal	Fallback Value	float32	3013	12307	Same as Math2.9.Out
Math2.9.HighLimit	Output High Limit	float32	3014	12308	Same as Math2.9.Out
Math2.9.In1	Input 1 Value	float32	300f	12303	0dp
Math2.9.In1Mul	Input 1 Scale	float32	300e	12302	1dp
Math2.9.In2	Input 2 Value	float32	3011	12305	0dp
Math2.9.In2Mul	Input 2 Scale	float32	3010	12304	1dp
Math2.9.LowLimit	Output Low Limit	float32	3015	12309	Same as Math2.9.Out
Math2.9.Oper	Operation (as Math2.1.Oper)	uint8	3012	12306	Not applicable
Math2.9.Out	Output Value	float32	3016	12310	Set by Math2.9.Resolution
Math2.9.Resolution	Output Resolution	uint8	301a	12314	Not applicable
Math2.9.Select	Select Between Input 1 and Input 2	bool	3018	12312	Not applicable
Math2.9.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	3019	12313	Not applicable
Math2.9.Units	Output Units	string_t	6974	26996	Not applicable
Math2.10.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	3024	12324	Not applicable
Math2.10.FallbackVal	Fallback Value	float32	3020	12320	Same as Math2.10.Out
Math2.10.HighLimit	Output High Limit	float32	3021	12321	Same as Math2.10.Out
Math2.10.In1	Input 1 Value	float32	301c	12316	0dp
Math2.10.In1Mul	Input 1 Scale	float32	301b	12315	1dp
Math2.10.In2	Input 2 Value	float32	301e	12318	0dp
Math2.10.In2Mul	Input 2 Scale	float32	301d	12317	1dp
Math2.10.LowLimit	Output Low Limit	float32	3022	12322	Same as Math2.10.Out
Math2.10.Oper	Operation (as Math2.1.Oper)	uint8	301f	12319	Not applicable
Math2.10.Out	Output Value	float32	3023	12323	Set by Math2.10.Resolution
Math2.10.Resolution	Output Resolution	uint8	3027	12327	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Math2.10.Select	Select Between Input 1 and Input 2	bool	3025	12325	Not applicable
Math2.10.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	3026	12326	Not applicable
Math2.10.Units	Output Units	string_t	697a	27002	Not applicable
Math2.11.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	3031	12337	Not applicable
Math2.11.FallbackVal	Fallback Value	float32	302d	12333	Same as Math2.11.Out
Math2.11.HighLimit	Output High Limit	float32	302e	12334	Same as Math2.11.Out
Math2.11.In1	Input 1 Value	float32	3029	12329	0dp
Math2.11.In1Mul	Input 1 Scale	float32	3028	12328	1dp
Math2.11.In2	Input 2 Value	float32	302b	12331	0dp
Math2.11.In2Mul	Input 2 Scale	float32	302a	12330	1dp
Math2.11.LowLimit	Output Low Limit	float32	302f	12335	Same as Math2.11.Out
Math2.11.Oper	Operation (as Math2.1.Oper)	uint8	302c	12332	Not applicable
Math2.11.Out	Output Value	float32	3030	12336	Set by Math2.11.Resolution
Math2.11.Resolution	Output Resolution	uint8	3034	12340	Not applicable
Math2.11.Select	Select Between Input 1 and Input 2	bool	3032	12338	Not applicable
Math2.11.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	3033	12339	Not applicable
Math2.11.Units	Output Units	string_t	6980	27008	Not applicable
Math2.12.Fallback	Fallback strategy (as Math2.1.Fallback)	uint8	303e	12350	Not applicable
Math2.12.FallbackVal	Fallback Value	float32	303a	12346	Same as Math2.12.Out
Math2.12.HighLimit	Output High Limit	float32	303b	12347	Same as Math2.12.Out
Math2.12.In1	Input 1 Value	float32	3036	12342	0dp
Math2.12.In1Mul	Input 1 Scale	float32	3035	12341	1dp
Math2.12.In2	Input 2 Value	float32	3038	12344	0dp
Math2.12.In2Mul	Input 2 Scale	float32	3037	12343	1dp
Math2.12.LowLimit	Output Low Limit	float32	303c	12348	Same as Math2.12.Out
Math2.12.Oper	Operation (as Math2.1.Oper)	uint8	3039	12345	Not applicable
Math2.12.Out	Output Value	float32	303d	12349	Set by Math2.12.Resolution
Math2.12.Resolution	Output Resolution	uint8	3041	12353	Not applicable
Math2.12.Select	Select Between Input 1 and Input 2	bool	303f	12351	Not applicable
Math2.12.Status	Status. 0 = Good (OK); 7 = Bad (Error)	uint8	3040	12352	Not applicable
Math2.12.Units	Output Units	string_t	6986	27014	Not applicable
ModbusMaster.1.Data.AlarmStatus	Alarm status (0 = No alarms; 1 = one or more alarms active)	uint8	7dbb	32187	Not applicable
ModbusMaster.1.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d4f	32079	Not applicable
ModbusMaster.1.Data.ChanAlarmStatus	Channel alarm status 0 = Off 1 = Active 2 = Safe Nackd 3 = Active Nackd	uint8	7ddb	32219	Not applicable
ModbusMaster.1.Data.DataType	Data type of the data being read/written 0 = Real 1 = DINT 2 = INT 3 = Byte 4 = UDINT 5 = UINT 6 = UBYTE 8 = Real (Swap) 9 = DINT (Swap) 10 = UDINT (Swap) 11 = BIT	uint8	7c06	31750	Not applicable
ModbusMaster.1.Data.Descriptor	Description for this data item	string_t	6687	26247	Not applicable
ModbusMaster.1.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e1b	32283	Not applicable
ModbusMaster.1.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c7e	31870	2dp
ModbusMaster.1.Data.FunctionCode	The modbus function codeuint8 1 = Read coil 2 = Read discrete 3 = Read holding 4 = Read input 5 = Write coil 6 = Write single 16 = Write multiple	7be8		31720	Not applicable
ModbusMaster.1.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b8c	31628	0dp
ModbusMaster.1.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d9b	32155	Not applicable
ModbusMaster.1.Data.Number	Used for multiple instance parameters	uint8	7d13	32019	Not applicable
ModbusMaster.1.Data.ParameterList	Parameter list for a specific slave device	uint8	7cf5	31989	Not applicable
ModbusMaster.1.Data.Priority	Frequency at which the data is read/written 0 = High 1 = Medium 2 = Low 3 = Acyclic	uint8	7c24	31780	Not applicable
ModbusMaster.1.Data.PV	Process value recieved from slave device	float32	7b32	31538	2dp
ModbusMaster.1.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d31	32049	Not applicable
ModbusMaster.1.Data.Send	1 = send the write value to the slave	bool	7cb9	31929	Not applicable
ModbusMaster.1.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7dfb	32251	Not applicable
ModbusMaster.1.Data.SlaveDevice	Slave device to communicate with.	uint8	7b14	31508	Not applicable
ModbusMaster.1.Data.Status	Transaction status 0 = Success 1 = Illegal function 2 = Ilegal address 6 = Slave busy 8 = Parity error 9 = Bad sub 10 = Bad gateway 11 = No response 12 = Idle 13 = Pending 14 = Timeout 15 = Unknown host 16 = Connect fail 17 = No sockets 18 = Loopback fail 19 = Login fail 20 = Unknown error 22 = Write fail 23 = Master reject	uint8	7cd7	31959	Not applicable
ModbusMaster.1.Data.Value	The value to be written to the slave device	float32	7c42	31810	2dp
ModbusMaster.2.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dbc	32188	Not applicable
ModbusMaster.2.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d50	32080	Not applicable
ModbusMaster.2.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7ddc	32220	Not applicable
ModbusMaster.2.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c07	31751	Not applicable
ModbusMaster.2.Data.Descriptor	Description for this data item	string_t	669c	26268	Not applicable
ModbusMaster.2.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e1c	32284	Not applicable
ModbusMaster.2.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c80	31872	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.2.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7be9	31721	Not applicable
ModbusMaster.2.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b8e	31630	0dp
ModbusMaster.2.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d9c	32156	Not applicable
ModbusMaster.2.Data.Number	Used for multiple instance parameters	uint8	7d14	32020	Not applicable
ModbusMaster.2.Data.ParameterList	Parameter list for a specific slave device	uint8	7cf6	31990	Not applicable
ModbusMaster.2.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c25	31781	Not applicable
ModbusMaster.2.Data.PV	Process value recieved from slave device	float32	7b34	31540	2dp
ModbusMaster.2.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d32	32050	Not applicable
ModbusMaster.2.Data.Send	1 = send the write value to the slave	bool	7cba	31930	Not applicable
ModbusMaster.2.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7dfc	32252	Not applicable
ModbusMaster.2.Data.SlaveDevice	Slave device to communicate with.	uint8	7b15	31509	Not applicable
ModbusMaster.2.Data.Status	Transaction status (as for Modbus Master.1)	uint8	7cd8	31960	Not applicable
ModbusMaster.2.Data.Value	The value to be written to the slave device	float32	7c44	31812	2dp
ModbusMaster.3.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dbd	32189	Not applicable
ModbusMaster.3.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d51	32081	Not applicable
ModbusMaster.3.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7ddd	32221	Not applicable
ModbusMaster.3.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c08	31752	Not applicable
ModbusMaster.3.Data.Descriptor	Description for this data item	string_t	66b1	26289	Not applicable
ModbusMaster.3.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e1d	32285	Not applicable
ModbusMaster.3.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c82	31874	2dp
ModbusMaster.3.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bea	31722	Not applicable
ModbusMaster.3.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b90	31632	0dp
ModbusMaster.3.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d9d	32157	Not applicable
ModbusMaster.3.Data.Number	Used for multiple instance parameters	uint8	7d15	32021	Not applicable
ModbusMaster.3.Data.ParameterList	Parameter list for a specific slave device	uint8	7cf7	31991	Not applicable
ModbusMaster.3.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c26	31782	Not applicable
ModbusMaster.3.Data.PV	Process value recieved from slave device	float32	7b36	31542	2dp
ModbusMaster.3.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d33	32051	Not applicable
ModbusMaster.3.Data.Send	1 = send the write value to the slave	bool	7cbb	31931	Not applicable
ModbusMaster.3.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7dfd	32253	Not applicable
ModbusMaster.3.Data.SlaveDevice	Slave device to communicate with.	uint8	7b16	31510	Not applicable
ModbusMaster.3.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cd9	31961	Not applicable
ModbusMaster.3.Data.Value	The value to be written to the slave device	float32	7c46	31814	2dp
ModbusMaster.4.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dbe	32190	Not applicable
ModbusMaster.4.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d52	32082	Not applicable
ModbusMaster.4.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7dde	32222	Not applicable
ModbusMaster.4.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c09	31753	Not applicable
ModbusMaster.4.Data.Descriptor	Description for this data item	string_t	66c6	26310	Not applicable
ModbusMaster.4.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e1e	32286	Not applicable
ModbusMaster.4.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c84	31876	2dp
ModbusMaster.4.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7beb	31723	Not applicable
ModbusMaster.4.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b92	31634	0dp
ModbusMaster.4.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d9e	32158	Not applicable
ModbusMaster.4.Data.Number	Used for multiple instance parameters	uint8	7d16	32022	Not applicable
ModbusMaster.4.Data.ParameterList	Parameter list for a specific slave device	uint8	7cf8	31992	Not applicable
ModbusMaster.4.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c27	31783	Not applicable
ModbusMaster.4.Data.PV	Process value recieved from slave device	float32	7b38	31544	2dp
ModbusMaster.4.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d34	32052	Not applicable
ModbusMaster.4.Data.Send	1 = send the write value to the slave	bool	7cbc	31932	Not applicable
ModbusMaster.4.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7dfe	32254	Not applicable
ModbusMaster.4.Data.SlaveDevice	Slave device to communicate with.	uint8	7b17	31511	Not applicable
ModbusMaster.4.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cda	31962	Not applicable
ModbusMaster.4.Data.Value	The value to be written to the slave device	float32	7c48	31816	2dp
ModbusMaster.5.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dbf	32191	Not applicable
ModbusMaster.5.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d53	32083	Not applicable
ModbusMaster.5.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7ddf	32223	Not applicable
ModbusMaster.5.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0a	31754	Not applicable
ModbusMaster.5.Data.Descriptor	Description for this data item	string_t	66db	26331	Not applicable
ModbusMaster.5.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e1f	32287	Not applicable
ModbusMaster.5.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c86	31878	2dp
ModbusMaster.5.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bec	31724	Not applicable
ModbusMaster.5.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b94	31636	0dp
ModbusMaster.5.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d9f	32159	Not applicable
ModbusMaster.5.Data.Number	Used for multiple instance parameters	uint8	7d17	32023	Not applicable
ModbusMaster.5.Data.ParameterList	Parameter list for a specific slave device	uint8	7cf9	31993	Not applicable
ModbusMaster.5.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c28	31784	Not applicable
ModbusMaster.5.Data.PV	Process value recieved from slave device	float32	7b3a	31546	2dp
ModbusMaster.5.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d35	32053	Not applicable
ModbusMaster.5.Data.Send	1 = send the write value to the slave	bool	7cbd	31933	Not applicable
ModbusMaster.5.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7dff	32255	Not applicable
ModbusMaster.5.Data.SlaveDevice	Slave device to communicate with.	uint8	7b18	31512	Not applicable
ModbusMaster.5.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cdb	31963	Not applicable
ModbusMaster.5.Data.Value	The value to be written to the slave device	float32	7c4a	31818	2dp
ModbusMaster.6.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc0	32192	Not applicable
ModbusMaster.6.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d54	32084	Not applicable
ModbusMaster.6.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de0	32224	Not applicable
ModbusMaster.6.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0b	31755	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.6.Data.Descriptor	Description for this data item	string_t	66f0	26352	Not applicable
ModbusMaster.6.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e20	32288	Not applicable
ModbusMaster.6.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c88	31880	2dp
ModbusMaster.6.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bed	31725	Not applicable
ModbusMaster.6.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b96	31638	0dp
ModbusMaster.6.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da0	32160	Not applicable
ModbusMaster.6.Data.Number	Used for multiple instance parameters	uint8	7d18	32024	Not applicable
ModbusMaster.6.Data.ParameterList	Parameter list for a specific slave device	uint8	7cfa	31994	Not applicable
ModbusMaster.6.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c29	31785	Not applicable
ModbusMaster.6.Data.PV	Process value recieved from slave device	float32	7b3c	31548	2dp
ModbusMaster.6.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d36	32054	Not applicable
ModbusMaster.6.Data.Send	1 = send the write value to the slave	bool	7cbe	31934	Not applicable
ModbusMaster.6.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e00	32256	Not applicable
ModbusMaster.6.Data.SlaveDevice	Slave device to communicate with.	uint8	7b19	31513	Not applicable
ModbusMaster.6.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cdc	31964	Not applicable
ModbusMaster.6.Data.Value	The value to be written to the slave device	float32	7c4c	31820	2dp
ModbusMaster.7.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc1	32193	Not applicable
ModbusMaster.7.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d55	32085	Not applicable
ModbusMaster.7.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de1	32225	Not applicable
ModbusMaster.7.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0c	31756	Not applicable
ModbusMaster.7.Data.Descriptor	Description for this data item	string_t	6705	26373	Not applicable
ModbusMaster.7.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e21	32289	Not applicable
ModbusMaster.7.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c8a	31882	2dp
ModbusMaster.7.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bee	31726	Not applicable
ModbusMaster.7.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b98	31640	0dp
ModbusMaster.7.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da1	32161	Not applicable
ModbusMaster.7.Data.Number	Used for multiple instance parameters	uint8	7d19	32025	Not applicable
ModbusMaster.7.Data.ParameterList	Parameter list for a specific slave device	uint8	7cfb	31995	Not applicable
ModbusMaster.7.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c2a	31786	Not applicable
ModbusMaster.7.Data.PV	Process value recieved from slave device	float32	7b3e	31550	2dp
ModbusMaster.7.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d37	32055	Not applicable
ModbusMaster.7.Data.Send	1 = send the write value to the slave	bool	7cbf	31935	Not applicable
ModbusMaster.7.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e01	32257	Not applicable
ModbusMaster.7.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1a	31514	Not applicable
ModbusMaster.7.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cdd	31965	Not applicable
ModbusMaster.7.Data.Value	The value to be written to the slave device	float32	7c4e	31822	2dp
ModbusMaster.8.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc2	32194	Not applicable
ModbusMaster.8.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d56	32086	Not applicable
ModbusMaster.8.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de2	32226	Not applicable
ModbusMaster.8.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0d	31757	Not applicable
ModbusMaster.8.Data.Descriptor	Description for this data item	string_t	671a	26394	Not applicable
ModbusMaster.8.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e22	32290	Not applicable
ModbusMaster.8.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c8c	31884	2dp
ModbusMaster.8.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bef	31727	Not applicable
ModbusMaster.8.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b9a	31642	0dp
ModbusMaster.8.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da2	32162	Not applicable
ModbusMaster.8.Data.Number	Used for multiple instance parameters	uint8	7d1a	32026	Not applicable
ModbusMaster.8.Data.ParameterList	Parameter list for a specific slave device	uint8	7cfc	31996	Not applicable
ModbusMaster.8.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c2b	31787	Not applicable
ModbusMaster.8.Data.PV	Process value recieved from slave device	float32	7b40	31552	2dp
ModbusMaster.8.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d38	32056	Not applicable
ModbusMaster.8.Data.Send	1 = send the write value to the slave	bool	7cc0	31936	Not applicable
ModbusMaster.8.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e02	32258	Not applicable
ModbusMaster.8.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1b	31515	Not applicable
ModbusMaster.8.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cde	31966	Not applicable
ModbusMaster.8.Data.Value	The value to be written to the slave device	float32	7c50	31824	2dp
ModbusMaster.9.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc3	32195	Not applicable
ModbusMaster.9.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d57	32087	Not applicable
ModbusMaster.9.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de3	32227	Not applicable
ModbusMaster.9.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0e	31758	Not applicable
ModbusMaster.9.Data.Descriptor	Description for this data item	string_t	672f	26415	Not applicable
ModbusMaster.9.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e23	32291	Not applicable
ModbusMaster.9.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c8e	31886	2dp
ModbusMaster.9.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf0	31728	Not applicable
ModbusMaster.9.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b9c	31644	0dp
ModbusMaster.9.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da3	32163	Not applicable
ModbusMaster.9.Data.Number	Used for multiple instance parameters	uint8	7d1b	32027	Not applicable
ModbusMaster.9.Data.ParameterList	Parameter list for a specific slave device	uint8	7cfd	31997	Not applicable
ModbusMaster.9.Data.Priority	FRead/Write frequency (as for Modbus Master.1)	uint8	7c2c	31788	Not applicable
ModbusMaster.9.Data.PV	Process value recieved from slave device	float32	7b42	31554	2dp
ModbusMaster.9.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d39	32057	Not applicable
ModbusMaster.9.Data.Send	1 = send the write value to the slave	bool	7cc1	31937	Not applicable
ModbusMaster.9.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e03	32259	Not applicable
ModbusMaster.9.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1c	31516	Not applicable
ModbusMaster.9.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cdf	31967	Not applicable
ModbusMaster.9.Data.Value	The value to be written to the slave device	float32	7c52	31826	2dp
ModbusMaster.10.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc4	32196	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.10.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d58	32088	Not applicable
ModbusMaster.10.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de4	32228	Not applicable
ModbusMaster.10.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c0f	31759	Not applicable
ModbusMaster.10.Data.Descriptor	Description for this data item	string_t	6744	26436	Not applicable
ModbusMaster.10.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e24	32292	Not applicable
ModbusMaster.10.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c90	31888	2dp
ModbusMaster.10.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf1	31729	Not applicable
ModbusMaster.10.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7b9e	31646	0dp
ModbusMaster.10.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da4	32164	Not applicable
ModbusMaster.10.Data.Number	Used for multiple instance parameters	uint8	7d1c	32028	Not applicable
ModbusMaster.10.Data.ParameterList	Parameter list for a specific slave device	uint8	7cfe	31998	Not applicable
ModbusMaster.10.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c2d	31789	Not applicable
ModbusMaster.10.Data.PV	Process value recieved from slave device	float32	7b44	31556	2dp
ModbusMaster.10.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3a	32058	Not applicable
ModbusMaster.10.Data.Send	1 = send the write value to the slave	bool	7cc2	31938	Not applicable
ModbusMaster.10.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e04	32260	Not applicable
ModbusMaster.10.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1d	31517	Not applicable
ModbusMaster.10.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce0	31968	Not applicable
ModbusMaster.10.Data.Value	The value to be written to the slave device	float32	7c54	31828	2dp
ModbusMaster.11.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc5	32197	Not applicable
ModbusMaster.11.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d59	32089	Not applicable
ModbusMaster.11.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de5	32229	Not applicable
ModbusMaster.11.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c10	31760	Not applicable
ModbusMaster.11.Data.Descriptor	Description for this data item	string_t	6759	26457	Not applicable
ModbusMaster.11.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e25	32293	Not applicable
ModbusMaster.11.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c92	31890	2dp
ModbusMaster.11.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf2	31730	Not applicable
ModbusMaster.11.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bc0	31680	0dp
ModbusMaster.11.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da5	32165	Not applicable
ModbusMaster.11.Data.Number	Used for multiple instance parameters	uint8	7d1d	32029	Not applicable
ModbusMaster.11.Data.ParameterList	Parameter list for a specific slave device	uint8	7cff	31999	Not applicable
ModbusMaster.11.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c2e	31790	Not applicable
ModbusMaster.11.Data.PV	Process value recieved from slave device	float32	7b46	31558	2dp
ModbusMaster.11.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3b	32059	Not applicable
ModbusMaster.11.Data.Send	1 = send the write value to the slave	bool	7cc3	31939	Not applicable
ModbusMaster.11.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e05	32261	Not applicable
ModbusMaster.11.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1e	31518	Not applicable
ModbusMaster.11.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce1	31969	Not applicable
ModbusMaster.11.Data.Value	The value to be written to the slave device	float32	7c56	31830	2dp
ModbusMaster.12.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc6	32198	Not applicable
ModbusMaster.12.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5a	32090	Not applicable
ModbusMaster.12.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de6	32230	Not applicable
ModbusMaster.12.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c11	31761	Not applicable
ModbusMaster.12.Data.Descriptor	Description for this data item	string_t	676e	26478	Not applicable
ModbusMaster.12.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e26	32294	Not applicable
ModbusMaster.12.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c94	31892	2dp
ModbusMaster.12.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf3	31731	Not applicable
ModbusMaster.12.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bc2	31682	0dp
ModbusMaster.12.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da6	32166	Not applicable
ModbusMaster.12.Data.Number	Used for multiple instance parameters	uint8	7d1e	32030	Not applicable
ModbusMaster.12.Data.ParameterList	Parameter list for a specific slave device	uint8	7d00	32000	Not applicable
ModbusMaster.12.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c2f	31791	Not applicable
ModbusMaster.12.Data.PV	Process value recieved from slave device	float32	7b48	31560	2dp
ModbusMaster.12.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3c	32060	Not applicable
ModbusMaster.12.Data.Send	1 = send the write value to the slave	bool	7cc4	31940	Not applicable
ModbusMaster.12.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e06	32262	Not applicable
ModbusMaster.12.Data.SlaveDevice	Slave device to communicate with.	uint8	7b1f	31519	Not applicable
ModbusMaster.12.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce2	31970	Not applicable
ModbusMaster.12.Data.Value	The value to be written to the slave device	float32	7c58	31832	2dp
ModbusMaster.13.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc7	32199	Not applicable
ModbusMaster.13.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5b	32091	Not applicable
ModbusMaster.13.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de7	32231	Not applicable
ModbusMaster.13.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c12	31762	Not applicable
ModbusMaster.13.Data.Descriptor	Description for this data item	string_t	6783	26499	Not applicable
ModbusMaster.13.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e27	32295	Not applicable
ModbusMaster.13.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c96	31894	2dp
ModbusMaster.13.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf4	31732	Not applicable
ModbusMaster.13.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bc4	31684	0dp
ModbusMaster.13.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da7	32167	Not applicable
ModbusMaster.13.Data.Number	Used for multiple instance parameters	uint8	7d1f	32031	Not applicable
ModbusMaster.13.Data.ParameterList	Parameter list for a specific slave device	uint8	7d01	32001	Not applicable
ModbusMaster.13.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c30	31792	Not applicable
ModbusMaster.13.Data.PV	Process value recieved from slave device	float32	7b4a	31562	2dp
ModbusMaster.13.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3d	32061	Not applicable
ModbusMaster.13.Data.Send	1 = send the write value to the slave	bool	7cc5	31941	Not applicable
ModbusMaster.13.Data.Set	SSets a digital value (1 = on; 0 = off)	bool	7e07	32263	Not applicable
ModbusMaster.13.Data.SlaveDevice	Slave device to communicate with.	uint8	7b20	31520	Not applicable
ModbusMaster.13.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce3	31971	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.13.Data.Value	The value to be written to the slave device	float32	7c5a	31834	2dp
ModbusMaster.14.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc8	32200	Not applicable
ModbusMaster.14.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5c	32092	Not applicable
ModbusMaster.14.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de8	32232	Not applicable
ModbusMaster.14.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c13	31763	Not applicable
ModbusMaster.14.Data.Descriptor	Description for this data item	string_t	6798	26520	Not applicable
ModbusMaster.14.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e28	32296	Not applicable
ModbusMaster.14.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c98	31896	2dp
ModbusMaster.14.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf5	31733	Not applicable
ModbusMaster.14.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bc6	31686	0dp
ModbusMaster.14.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da8	32168	Not applicable
ModbusMaster.14.Data.Number	Used for multiple instance parameters	uint8	7d20	32032	Not applicable
ModbusMaster.14.Data.ParameterList	Parameter list for a specific slave device	uint8	7d02	32002	Not applicable
ModbusMaster.14.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c31	31793	Not applicable
ModbusMaster.14.Data.PV	Process value recieved from slave device	float32	7b4c	31564	2dp
ModbusMaster.14.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3e	32062	Not applicable
ModbusMaster.14.Data.Send	1 = send the write value to the slave	bool	7cc6	31942	Not applicable
ModbusMaster.14.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e08	32264	Not applicable
ModbusMaster.14.Data.SlaveDevice	Slave device to communicate with.	uint8	7b21	31521	Not applicable
ModbusMaster.14.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce4	31972	Not applicable
ModbusMaster.14.Data.Value	The value to be written to the slave device	float32	7c5c	31836	2dp
ModbusMaster.15.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dc9	32201	Not applicable
ModbusMaster.15.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5d	32093	Not applicable
ModbusMaster.15.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7de9	32233	Not applicable
ModbusMaster.15.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c14	31764	Not applicable
ModbusMaster.15.Data.Descriptor	Description for this data item	string_t	67ad	26541	Not applicable
ModbusMaster.15.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e29	32297	Not applicable
ModbusMaster.15.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c9a	31898	2dp
ModbusMaster.15.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf6	31734	Not applicable
ModbusMaster.15.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bc8	31688	0dp
ModbusMaster.15.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7da9	32169	Not applicable
ModbusMaster.15.Data.Number	Used for multiple instance parameters	uint8	7d21	32033	Not applicable
ModbusMaster.15.Data.ParameterList	Parameter list for a specific slave device	uint8	7d03	32003	Not applicable
ModbusMaster.15.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c32	31794	Not applicable
ModbusMaster.15.Data.PV	Process value recieved from slave device	float32	7b4e	31566	2dp
ModbusMaster.15.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d3f	32063	Not applicable
ModbusMaster.15.Data.Send	1 = send the write value to the slave	bool	7cc7	31943	Not applicable
ModbusMaster.15.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e09	32265	Not applicable
ModbusMaster.15.Data.SlaveDevice	Slave device to communicate with.	uint8	7b22	31522	Not applicable
ModbusMaster.15.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce5	31973	Not applicable
ModbusMaster.15.Data.Value	The value to be written to the slave device	float32	7c5e	31838	2dp
ModbusMaster.16.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dca	32202	Not applicable
ModbusMaster.16.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5e	32094	Not applicable
ModbusMaster.16.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7dea	32234	Not applicable
ModbusMaster.16.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c15	31765	Not applicable
ModbusMaster.16.Data.Descriptor	Description for this data item	string_t	67c2	26562	Not applicable
ModbusMaster.16.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2a	32298	Not applicable
ModbusMaster.16.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c9c	31900	2dp
ModbusMaster.16.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf7	31735	Not applicable
ModbusMaster.16.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bca	31690	0dp
ModbusMaster.16.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7daa	32170	Not applicable
ModbusMaster.16.Data.Number	Used for multiple instance parameters	uint8	7d22	32034	Not applicable
ModbusMaster.16.Data.ParameterList	Parameter list for a specific slave device	uint8	7d04	32004	Not applicable
ModbusMaster.16.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c33	31795	Not applicable
ModbusMaster.16.Data.PV	Process value recieved from slave device	float32	7b50	31568	2dp
ModbusMaster.16.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d40	32064	Not applicable
ModbusMaster.16.Data.Send	1 = send the write value to the slave	bool	7cc8	31944	Not applicable
ModbusMaster.16.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e0a	32266	Not applicable
ModbusMaster.16.Data.SlaveDevice	Slave device to communicate with.	uint8	7b23	31523	Not applicable
ModbusMaster.16.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce6	31974	Not applicable
ModbusMaster.16.Data.Value	The value to be written to the slave device	float32	7c60	31840	2dp
ModbusMaster.17.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dcb	32203	Not applicable
ModbusMaster.17.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d5f	32095	Not applicable
ModbusMaster.17.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7deb	32235	Not applicable
ModbusMaster.17.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c16	31766	Not applicable
ModbusMaster.17.Data.Descriptor	Description for this data item	string_t	67d7	26583	Not applicable
ModbusMaster.17.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2b	32299	Not applicable
ModbusMaster.17.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7c9e	31902	2dp
ModbusMaster.17.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf8	31736	Not applicable
ModbusMaster.17.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bcc	31692	0dp
ModbusMaster.17.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7dab	32171	Not applicable
ModbusMaster.17.Data.Number	Used for multiple instance parameters	uint8	7d23	32035	Not applicable
ModbusMaster.17.Data.ParameterList	Parameter list for a specific slave device	uint8	7d05	32005	Not applicable
ModbusMaster.17.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c34	31796	Not applicable
ModbusMaster.17.Data.PV	Process value recieved from slave device	float32	7b52	31570	2dp
ModbusMaster.17.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d41	32065	Not applicable
ModbusMaster.17.Data.Send	1 = send the write value to the slave	bool	7cc9	31945	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.17.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e0b	32267	Not applicable
ModbusMaster.17.Data.SlaveDevice	Slave device to communicate with.	uint8	7b24	31524	Not applicable
ModbusMaster.17.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce7	31975	Not applicable
ModbusMaster.17.Data.Value	The value to be written to the slave device	float32	7c62	31842	2dp
ModbusMaster.18.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dcc	32204	Not applicable
ModbusMaster.18.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d60	32096	Not applicable
ModbusMaster.18.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7dec	32236	Not applicable
ModbusMaster.18.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c17	31767	Not applicable
ModbusMaster.18.Data.Descriptor	Description for this data item	string_t	67ec	26604	Not applicable
ModbusMaster.18.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2c	32300	Not applicable
ModbusMaster.18.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7ca0	31904	2dp
ModbusMaster.18.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bf9	31737	Not applicable
ModbusMaster.18.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bce	31694	0dp
ModbusMaster.18.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7dac	32172	Not applicable
ModbusMaster.18.Data.Number	Used for multiple instance parameters	uint8	7d24	32036	Not applicable
ModbusMaster.18.Data.ParameterList	Parameter list for a specific slave device	uint8	7d06	32006	Not applicable
ModbusMaster.18.Data.Priority	FRead/Write frequency (as for Modbus Master.1)	uint8	7c35	31797	Not applicable
ModbusMaster.18.Data.PV	Process value recieved from slave device	float32	7b54	31572	2dp
ModbusMaster.18.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d42	32066	Not applicable
ModbusMaster.18.Data.Send	1 = send the write value to the slave	bool	7cca	31946	Not applicable
ModbusMaster.18.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e0c	32268	Not applicable
ModbusMaster.18.Data.SlaveDevice	Slave device to communicate with.	uint8	7b25	31525	Not applicable
ModbusMaster.18.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce8	31976	Not applicable
ModbusMaster.18.Data.Value	The value to be written to the slave device	float32	7c64	31844	2dp
ModbusMaster.19.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dcd	32205	Not applicable
ModbusMaster.19.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d61	32097	Not applicable
ModbusMaster.19.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7ded	32237	Not applicable
ModbusMaster.19.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c18	31768	Not applicable
ModbusMaster.19.Data.Descriptor	Description for this data item	string_t	6801	26625	Not applicable
ModbusMaster.19.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2d	32301	Not applicable
ModbusMaster.19.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7ca2	31906	2dp
ModbusMaster.19.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bfa	31738	Not applicable
ModbusMaster.19.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bd0	31696	0dp
ModbusMaster.19.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7dad	32173	Not applicable
ModbusMaster.19.Data.Number	Used for multiple instance parameters	uint8	7d25	32037	Not applicable
ModbusMaster.19.Data.ParameterList	Parameter list for a specific slave device	uint8	7d07	32007	Not applicable
ModbusMaster.19.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c36	31798	Not applicable
ModbusMaster.19.Data.PV	Process value recieved from slave device	float32	7b56	31574	2dp
ModbusMaster.19.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d43	32067	Not applicable
ModbusMaster.19.Data.Send	1 = send the write value to the slave	bool	7ccb	31947	Not applicable
ModbusMaster.19.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e0d	32269	Not applicable
ModbusMaster.19.Data.SlaveDevice	Slave device to communicate with.	uint8	7b26	31526	Not applicable
ModbusMaster.19.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ce9	31977	Not applicable
ModbusMaster.19.Data.Value	The value to be written to the slave device	float32	7c66	31846	2dp
ModbusMaster.20.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dce	32206	Not applicable
ModbusMaster.20.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d62	32098	Not applicable
ModbusMaster.20.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7dee	32238	Not applicable
ModbusMaster.20.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c19	31769	Not applicable
ModbusMaster.20.Data.Descriptor	Description for this data item	string_t	6816	26646	Not applicable
ModbusMaster.20.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2e	32302	Not applicable
ModbusMaster.20.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7ca4	31908	2dp
ModbusMaster.20.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bfb	31739	Not applicable
ModbusMaster.20.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bd2	31698	0dp
ModbusMaster.20.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7dae	32174	Not applicable
ModbusMaster.20.Data.Number	Used for multiple instance parameters	uint8	7d26	32038	Not applicable
ModbusMaster.20.Data.ParameterList	Parameter list for a specific slave device	uint8	7d08	32008	Not applicable
ModbusMaster.20.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c37	31799	Not applicable
ModbusMaster.20.Data.PV	Process value recieved from slave device	float32	7b58	31576	2dp
ModbusMaster.20.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d44	32068	Not applicable
ModbusMaster.20.Data.Send	1 = send the write value to the slave	bool	7ccc	31948	Not applicable
ModbusMaster.20.Data.Set	SSets a digital value (1 = on; 0 = off)	bool	7e0e	32270	Not applicable
ModbusMaster.20.Data.SlaveDevice	Slave device to communicate with.	uint8	7b27	31527	Not applicable
ModbusMaster.20.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cea	31978	Not applicable
ModbusMaster.20.Data.Value	The value to be written to the slave device	float32	7c68	31848	2dp
ModbusMaster.21.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dcf	32207	Not applicable
ModbusMaster.21.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d63	32099	Not applicable
ModbusMaster.21.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7def	32239	Not applicable
ModbusMaster.21.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1a	31770	Not applicable
ModbusMaster.21.Data.Descriptor	Description for this data item	string_t	682b	26667	Not applicable
ModbusMaster.21.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e2f	32303	Not applicable
ModbusMaster.21.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7ca6	31910	2dp
ModbusMaster.21.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bfc	31740	Not applicable
ModbusMaster.21.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bd4	31700	0dp
ModbusMaster.21.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7daf	32175	Not applicable
ModbusMaster.21.Data.Number	Used for multiple instance parameters	uint8	7d27	32039	Not applicable
ModbusMaster.21.Data.ParameterList	Parameter list for a specific slave device	uint8	7d09	32009	Not applicable
ModbusMaster.21.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c38	31800	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.21.Data.PV	Process value recieved from slave device	float32	7b5a	31578	2dp
ModbusMaster.21.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d45	32069	Not applicable
ModbusMaster.21.Data.Send	1 = send the write value to the slave	bool	7ccd	31949	Not applicable
ModbusMaster.21.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e0f	32271	Not applicable
ModbusMaster.21.Data.SlaveDevice	Slave device to communicate with.	uint8	7b28	31528	Not applicable
ModbusMaster.21.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ceb	31979	Not applicable
ModbusMaster.21.Data.Value	The value to be written to the slave device	float32	7c6a	31850	2dp
ModbusMaster.22.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd0	32208	Not applicable
ModbusMaster.22.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d64	32100	Not applicable
ModbusMaster.22.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df0	32240	Not applicable
ModbusMaster.22.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1b	31771	Not applicable
ModbusMaster.22.Data.Descriptor	Description for this data item	string_t	6840	26688	Not applicable
ModbusMaster.22.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e30	32304	Not applicable
ModbusMaster.22.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7ca8	31912	2dp
ModbusMaster.22.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bfd	31741	Not applicable
ModbusMaster.22.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bd6	31702	0dp
ModbusMaster.22.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db0	32176	Not applicable
ModbusMaster.22.Data.Number	Used for multiple instance parameters	uint8	7d28	32040	Not applicable
ModbusMaster.22.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0a	32010	Not applicable
ModbusMaster.22.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c39	31801	Not applicable
ModbusMaster.22.Data.PV	Process value recieved from slave device	float32	7b5c	31580	2dp
ModbusMaster.22.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d46	32070	Not applicable
ModbusMaster.22.Data.Send	1 = send the write value to the slave	bool	7cce	31950	Not applicable
ModbusMaster.22.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e10	32272	Not applicable
ModbusMaster.22.Data.SlaveDevice	Slave device to communicate with.	uint8	7b29	31529	Not applicable
ModbusMaster.22.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cec	31980	Not applicable
ModbusMaster.22.Data.Value	The value to be written to the slave device	float32	7c6c	31852	2dp
ModbusMaster.23.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd1	32209	Not applicable
ModbusMaster.23.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d65	32101	Not applicable
ModbusMaster.23.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df1	32241	Not applicable
ModbusMaster.23.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1c	31772	Not applicable
ModbusMaster.23.Data.Descriptor	Description for this data item	string_t	6855	26709	Not applicable
ModbusMaster.23.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e31	32305	Not applicable
ModbusMaster.23.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7caa	31914	2dp
ModbusMaster.23.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bfe	31742	Not applicable
ModbusMaster.23.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bd8	31704	0dp
ModbusMaster.23.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db1	32177	Not applicable
ModbusMaster.23.Data.Number	Used for multiple instance parameters	uint8	7d29	32041	Not applicable
ModbusMaster.23.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0b	32011	Not applicable
ModbusMaster.23.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3a	31802	Not applicable
ModbusMaster.23.Data.PV	Process value recieved from slave device	float32	7b5e	31582	2dp
ModbusMaster.23.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d47	32071	Not applicable
ModbusMaster.23.Data.Send	1 = send the write value to the slave	bool	7ccf	31951	Not applicable
ModbusMaster.23.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e11	32273	Not applicable
ModbusMaster.23.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2a	31530	Not applicable
ModbusMaster.23.Data.Status	Transaction status (as for Modbus Master.1	uint8	7ced	31981	Not applicable
ModbusMaster.23.Data.Value	The value to be written to the slave device	float32	7c6e	31854	2dp
ModbusMaster.24.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd2	32210	Not applicable
ModbusMaster.24.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d66	32102	Not applicable
ModbusMaster.24.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df2	32242	Not applicable
ModbusMaster.24.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1d	31773	Not applicable
ModbusMaster.24.Data.Descriptor	Description for this data item	string_t	686a	26730	Not applicable
ModbusMaster.24.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e32	32306	Not applicable
ModbusMaster.24.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cac	31916	2dp
ModbusMaster.24.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7bff	31743	Not applicable
ModbusMaster.24.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bda	31706	0dp
ModbusMaster.24.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db2	32178	Not applicable
ModbusMaster.24.Data.Number	Used for multiple instance parameters	uint8	7d2a	32042	Not applicable
ModbusMaster.24.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0c	32012	Not applicable
ModbusMaster.24.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3b	31803	Not applicable
ModbusMaster.24.Data.PV	Process value recieved from slave device	float32	7b60	31584	2dp
ModbusMaster.24.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d48	32072	Not applicable
ModbusMaster.24.Data.Send	1 = send the write value to the slave	bool	7cd0	31952	Not applicable
ModbusMaster.24.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e12	32274	Not applicable
ModbusMaster.24.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2b	31531	Not applicable
ModbusMaster.24.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cee	31982	Not applicable
ModbusMaster.24.Data.Value	The value to be written to the slave device	float32	7c70	31856	2dp
ModbusMaster.25.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd3	32211	Not applicable
ModbusMaster.25.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d67	32103	Not applicable
ModbusMaster.25.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df3	32243	Not applicable
ModbusMaster.25.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1e	31774	Not applicable
ModbusMaster.25.Data.Descriptor	Description for this data item	string_t	687f	26751	Not applicable
ModbusMaster.25.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e33	32307	Not applicable
ModbusMaster.25.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cae	31918	2dp
ModbusMaster.25.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c00	31744	Not applicable
ModbusMaster.25.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bdc	31708	0dp
ModbusMaster.25.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db3	32179	Not applicable
ModbusMaster.25.Data.Number	Used for multiple instance parameters	uint8	7d2b	32043	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.25.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0d	32013	Not applicable
ModbusMaster.25.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3c	31804	Not applicable
ModbusMaster.25.Data.PV	Process value recieved from slave device	float32	7b62	31586	2dp
ModbusMaster.25.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d49	32073	Not applicable
ModbusMaster.25.Data.Send	1 = send the write value to the slave	bool	7cd1	31953	Not applicable
ModbusMaster.25.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e13	32275	Not applicable
ModbusMaster.25.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2c	31532	Not applicable
ModbusMaster.25.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cef	31983	Not applicable
ModbusMaster.25.Data.Value	The value to be written to the slave device	float32	7c72	31858	2dp
ModbusMaster.26.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd4	32212	Not applicable
ModbusMaster.26.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d68	32104	Not applicable
ModbusMaster.26.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df4	32244	Not applicable
ModbusMaster.26.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c1f	31775	Not applicable
ModbusMaster.26.Data.Descriptor	Description for this data item	string_t	6894	26772	Not applicable
ModbusMaster.26.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e34	32308	Not applicable
ModbusMaster.26.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cb0	31920	2dp
ModbusMaster.26.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c01	31745	Not applicable
ModbusMaster.26.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7bde	31710	0dp
ModbusMaster.26.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db4	32180	Not applicable
ModbusMaster.26.Data.Number	Used for multiple instance parameters	uint8	7d2c	32044	Not applicable
ModbusMaster.26.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0e	32014	Not applicable
ModbusMaster.26.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3d	31805	Not applicable
ModbusMaster.26.Data.PV	Process value recieved from slave device	float32	7b64	31588	2dp
ModbusMaster.26.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d4a	32074	Not applicable
ModbusMaster.26.Data.Send	1 = send the write value to the slave	bool	7cd2	31954	Not applicable
ModbusMaster.26.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e14	32276	Not applicable
ModbusMaster.26.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2d	31533	Not applicable
ModbusMaster.26.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cf0	31984	Not applicable
ModbusMaster.26.Data.Value	The value to be written to the slave device	float32	7c74	31860	2dp
ModbusMaster.27.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd5	32213	Not applicable
ModbusMaster.27.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d69	32105	Not applicable
ModbusMaster.27.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df5	32245	Not applicable
ModbusMaster.27.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c20	31776	Not applicable
ModbusMaster.27.Data.Descriptor	Description for this data item	string_t	68a9	26793	Not applicable
ModbusMaster.27.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e35	32309	Not applicable
ModbusMaster.27.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cb2	31922	2dp
ModbusMaster.27.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c02	31746	Not applicable
ModbusMaster.27.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7be0	31712	0dp
ModbusMaster.27.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db5	32181	Not applicable
ModbusMaster.27.Data.Number	Used for multiple instance parameters	uint8	7d2d	32045	Not applicable
ModbusMaster.27.Data.ParameterList	Parameter list for a specific slave device	uint8	7d0f	32015	Not applicable
ModbusMaster.27.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3e	31806	Not applicable
ModbusMaster.27.Data.PV	Process value recieved from slave device	float32	7b66	31590	2dp
ModbusMaster.27.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d4b	32075	Not applicable
ModbusMaster.27.Data.Send	1 = send the write value to the slave	bool	7cd3	31955	Not applicable
ModbusMaster.27.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e15	32277	Not applicable
ModbusMaster.27.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2e	31534	Not applicable
ModbusMaster.27.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cf1	31985	Not applicable
ModbusMaster.27.Data.Value	The value to be written to the slave device	float32	7c76	31862	2dp
ModbusMaster.28.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd6	32214	Not applicable
ModbusMaster.28.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d6a	32106	Not applicable
ModbusMaster.28.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df6	32246	Not applicable
ModbusMaster.28.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c21	31777	Not applicable
ModbusMaster.28.Data.Descriptor	Description for this data item	string_t	68be	26814	Not applicable
ModbusMaster.28.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e36	32310	Not applicable
ModbusMaster.28.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cb4	31924	2dp
ModbusMaster.28.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c03	31747	Not applicable
ModbusMaster.28.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7be2	31714	0dp
ModbusMaster.28.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db6	32182	Not applicable
ModbusMaster.28.Data.Number	Used for multiple instance parameters	uint8	7d2e	32046	Not applicable
ModbusMaster.28.Data.ParameterList	Parameter list for a specific slave device	uint8	7d10	32016	Not applicable
ModbusMaster.28.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c3f	31807	Not applicable
ModbusMaster.28.Data.PV	Process value recieved from slave device	float32	7b68	31592	2dp
ModbusMaster.28.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d4c	32076	Not applicable
ModbusMaster.28.Data.Send	1 = send the write value to the slave	bool	7cd4	31956	Not applicable
ModbusMaster.28.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e16	32278	Not applicable
ModbusMaster.28.Data.SlaveDevice	Slave device to communicate with.	uint8	7b2f	31535	Not applicable
ModbusMaster.28.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cf2	31986	Not applicable
ModbusMaster.28.Data.Value	The value to be written to the slave device	float32	7c78	31864	2dp
ModbusMaster.29.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd7	32215	Not applicable
ModbusMaster.29.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d6b	32107	Not applicable
ModbusMaster.29.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df7	32247	Not applicable
ModbusMaster.29.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c22	31778	Not applicable
ModbusMaster.29.Data.Descriptor	Description for this data item	string_t	70ff	28927	Not applicable
ModbusMaster.29.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e37	32311	Not applicable
ModbusMaster.29.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cb6	31926	2dp
ModbusMaster.29.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c04	31748	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.29.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7be4	31716	0dp
ModbusMaster.29.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db7	32183	Not applicable
ModbusMaster.29.Data.Number	Used for multiple instance parameters	uint8	7d2f	32047	Not applicable
ModbusMaster.29.Data.ParameterList	Parameter list for a specific slave device	uint8	7d11	32017	Not applicable
ModbusMaster.29.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c40	31808	Not applicable
ModbusMaster.29.Data.PV	Process value recieved from slave device	float32	7b6a	31594	2dp
ModbusMaster.29.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d4d	32077	Not applicable
ModbusMaster.29.Data.Send	1 = send the write value to the slave	bool	7cd5	31957	Not applicable
ModbusMaster.29.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e17	32279	Not applicable
ModbusMaster.29.Data.SlaveDevice	Slave device to communicate with.	uint8	7b30	31536	Not applicable
ModbusMaster.29.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cf3	31987	Not applicable
ModbusMaster.29.Data.Value	The value to be written to the slave device	float32	7c7a	31866	2dp
ModbusMaster.30.Data.AlarmStatus	Alarm status (as for Modbus Master.1)	uint8	7dd8	32216	Not applicable
ModbusMaster.30.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d6c	32108	Not applicable
ModbusMaster.30.Data.ChanAlarmStatus	Channel alarm status (as for Modbus Master.1)	uint8	7df8	32248	Not applicable
ModbusMaster.30.Data.DataType	Type of data being read/written (as for Modbus Master.1)	uint8	7c23	31779	Not applicable
ModbusMaster.30.Data.Descriptor	Description for this data item	string_t	7114	28948	Not applicable
ModbusMaster.30.Data.Digital	Digital status (0 = Off, 1 = On)	bool	7e38	32312	Not applicable
ModbusMaster.30.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7cb8	31928	2dp
ModbusMaster.30.Data.FunctionCode	The modbus function code (as for Modbus Master.1)	uint8	7c05	31749	Not applicable
ModbusMaster.30.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7be6	31718	0dp
ModbusMaster.30.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7db8	32184	Not applicable
ModbusMaster.30.Data.Number	Used for multiple instance parameters	uint8	7d30	32048	Not applicable
ModbusMaster.30.Data.ParameterList	Parameter list for a specific slave device	uint8	7d12	32018	Not applicable
ModbusMaster.30.Data.Priority	Read/Write frequency (as for Modbus Master.1)	uint8	7c41	31809	Not applicable
ModbusMaster.30.Data.PV	Process value recieved from slave device	float32	7b6c	31596	2dp
ModbusMaster.30.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d4e	32078	Not applicable
ModbusMaster.30.Data.Send	1 = send the write value to the slave	bool	7cd6	31958	Not applicable
ModbusMaster.30.Data.Set	Sets a digital value (1 = on; 0 = off)	bool	7e18	32280	Not applicable
ModbusMaster.30.Data.SlaveDevice	Slave device to communicate with.	uint8	7b31	31537	Not applicable
ModbusMaster.30.Data.Status	Transaction status (as for Modbus Master.1	uint8	7cf4	31988	Not applicable
ModbusMaster.30.Data.Value	The value to be written to the slave device	float32	7c7c	31868	2dp
ModbusMaster.Slave1.Data.AlarmStatus	Alarm status (0 = none; 1 = one or more alarms active)	uint8	7db9	32185	Not applicable
ModbusMaster.Slave1.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d95	32149	Not applicable
ModbusMaster.Slave1.Data.ChanAlarmStatus	Channel alarm status 0 = Off 1 = Active 2 = Safe Nak'd 3 = Active Nack'd	uint8	7dd9	32217	Not applicable
ModbusMaster.Slave1.Data.DataType	Data type of the data being read/written 0 = Real 1 = DINT 2 = INT 3 = Byte 4 = UDINT 5 = UINT 6 = UBYTE 8 = Real (Swap) 9 = DINT (Swap) 10 = UDINT (Swap) 11 = BIT	uint8	7d7f	32127	Not applicable
ModbusMaster.Slave1.Data.Descriptor	Description for this data item	string_t	665d	26205	Not applicable
ModbusMaster.Slave1.Data.Digital	Digital status (0 = Off; 1 = On)	bool	7e19	32281	Not applicable
ModbusMaster.Slave1.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7d87	32135	2dp
ModbusMaster.Slave1.Data.FunctionCode	The modbus function code 1 = Read coil 2 = Read discrete 3 = Read holding 4 = Read input 5 = Write coil 6 = Write single 16 = Write multiple	uint8	7d7d	32125	Not applicable
ModbusMaster.Slave1.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7d79	32121	0dp
ModbusMaster.Slave1.Data.Mode	Auto Manual mode selection (0 = Auto; 1 = Manual)	uint8	7d99	32153	Not applicable
ModbusMaster.Slave1.Data.Number	Used for multiple instance parameters	uint8	7d91	32145	Not applicable
ModbusMaster.Slave1.Data.ParameterList	Parameter list for a specific slave device	uint8	7d8f	32143	Not applicable
ModbusMaster.Slave1.Data.Priority	Frequency at which the data is read/written 0 = High 1 = Medium 2 = Low 3 = Acyclic	uint8	7d81	32129	Not applicable
ModbusMaster.Slave1.Data.PV	Process value recieved from slave device	float32	7d73	32115	2dp
ModbusMaster.Slave1.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d93	32147	Not applicable
ModbusMaster.Slave1.Data.Send	1 = send the write value to the slave	bool	7d8b	32139	Not applicable
ModbusMaster.Slave1.Data.Set	Sets a digital value to on (1) or off (0)	bool	7df9	32249	Not applicable
ModbusMaster.Slave1.Data.SlaveDevice	Slave device to communicate with.	uint8	7d71	32113	Not applicable
ModbusMaster.Slave1.Data.Status	Transaction status 0 = Success 1 = Illegal function 2 = Illegal address 3 = Illegal value 6 = Slave busy 8 = Parity error 9 = Bad sub 10 = Bad gateway 11 = No response 12 = Idle 13 = Pending 14 = Timeout 15 = Unknown host 16 = Connect fail 17 = No sockets 18 = Loopback fail 19 = Login fail 20 = Unknown error 22 = Write fail 23 = Master reject	uint8	7d8d	32141	Not applicable
ModbusMaster.Slave1.Data.Value	The value to be written to the slave device	float32	7d83	32131	2dp
ModbusMaster.Slave1.Main.CommsFailure	1 = a device communications failure	bool	7d97	32151	Not applicable
ModbusMaster.Slave1.Main.Descriptor	Device descriptor	string_t	6633	26163	Not applicable
ModbusMaster.Slave1.Main.HighPriority	High priority rate 0 = 125ms 1 = 250ms 2 = 500 ms 3 = 1 sec 4 = 2 secs 5 = 5 secs 6 = 10 secs 7 = 20 secs 8 = 30 secs 9 = 1 min 10 = 2 mins 11 = 5 mins 12 = 10 mins 13 = 20 mins 14 = 30 mins 15 = 1 hr	uint8	7b0c	31500	Not applicable
ModbusMaster.Slave1.Main.IPAddress	Internet Protocol (IP) address for a slave device	string_t	68d3	26835	Not applicable
ModbusMaster.Slave1.Main.LowPriority	Low priority rate (as 'high priority' above)	uint8	7b10	31504	Not applicable
ModbusMaster.Slave1.Main.MaxBlockSize	Maximum amount of data in a single transaction	uint8	7b0a	31498	Not applicable
ModbusMaster.Slave1.Main.MediumPriority	Medium priority rate (as 'high priority' above)	uint8	7b0e	31502	Not applicable
ModbusMaster.Slave1.Main.Online	Enables communications (0 = offline; 1 = online)	bool	7b00	31488	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
ModbusMaster.Slave1.Main.Profile	A profile that defines the device type 0 = 3rd party 1 = Mini8 2 = 3xxx 3 = 35xx 4 = 2xxx 5 = 2500 6 = 5000 7 = 6000 8 = nanodac 9 = EPower	uint8	7b12	31506	Not applicable
ModbusMaster.Slave1.Main.Retries	Transaction retries	uint8	7b04	31492	Not applicable
ModbusMaster.Slave1.Main.SearchDevice	Initiates a slave search (0 = No; 1 = Yes)	bool	7d6d	32109	Not applicable
ModbusMaster.Slave1.Main.SearchResult	Current search status 0 = Searching 1 = Available 2 = Unavailable 3 = Unreachable 4 = Aborted	uint8	7d6f	32111	Not applicable
ModbusMaster.Slave1.Main.Timeout	Time in milliseconds the master will wait for a response	float32	7b06	31494	0dp
ModbusMaster.Slave1.Main.UnitId	Unit id for a slave device	uint8	7b02	31490	Not applicable
ModbusMaster.Slave2.Data.AlarmStatus	Alarm status (0 = none; 1 = one or more alarms active)	uint8	7dba	32186	Not applicable
ModbusMaster.Slave2.Data.BitPosition	Bit position of the bit of interest in a 16 bit data type	uint8	7d96	32150	Not applicable
ModbusMaster.Slave2.Data.ChanAlarmStatus	Channel alarm status (as Slave1.Data)	uint8	7dda	32218	Not applicable
ModbusMaster.Slave2.Data.DataType	Data type of the data being read/written (as Slave1.Data)	uint8	7d80	32128	Not applicable
ModbusMaster.Slave2.Data.Descriptor	Description for this data item	string_t	6672	26226	Not applicable
ModbusMaster.Slave2.Data.Digital	Digital status (0 = Off; 1 = On)	bool	7e1a	32282	Not applicable
ModbusMaster.Slave2.Data.FallBackValue	Fall back value to be writen to the slave device	float32	7d89	32137	2dp
ModbusMaster.Slave2.Data.FunctionCode	The modbus function code (as Slave1.Data)	uint8	7d7e	32126	Not applicable
ModbusMaster.Slave2.Data.ModbusAddress	Modbus register address of the data to be read/written	float32	7d7b	32123	0dp
ModbusMaster.Slave2.Data.Mode	Auto Manual mode selectionn (0 = Auto; 1 = Manual)	uint8	7d9a	32154	Not applicable
ModbusMaster.Slave2.Data.Number	Used for multiple instance parameters	uint8	7d92	32146	Not applicable
ModbusMaster.Slave2.Data.ParameterList	Parameter list for a specific slave device	uint8	7d90	32144	Not applicable
ModbusMaster.Slave2.Data.Priority	Frequency at which the data is read/written (as Slave1.Data)	uint8	7d82	32130	Not applicable
ModbusMaster.Slave2.Data.PV	Process value recieved from slave device	float32	7d75	32117	2dp
ModbusMaster.Slave2.Data.Scaling	Scaling in decimal places for non floating point data types	uint8	7d94	32148	Not applicable
ModbusMaster.Slave2.Data.Send	1 = send the write value to the slave	bool	7d8c	32140	Not applicable
ModbusMaster.Slave2.Data.Set	SSets a digital value to on (1) or off (0)	bool	7dfa	32250	Not applicable
ModbusMaster.Slave2.Data.SlaveDevice	Slave device to communicate with.	uint8	7d72	32114	Not applicable
ModbusMaster.Slave2.Data.Status	Transaction status (as for Slave 1)	uint8	7d8e	32142	Not applicable
ModbusMaster.Slave2.Data.Value	The value to be written to the slave device	float32	7d85	32133	2dp
ModbusMaster.Slave2.Main.CommsFailure	1 = a device communications failure	bool	7d98	32152	Not applicable
ModbusMaster.Slave2.Main.Descriptor	Device descriptor	string_t	6648	26184	Not applicable
ModbusMaster.Slave2.Main.HighPriority	High priority rate (as for Slave 1)	uint8	7b0d	31501	Not applicable
ModbusMaster.Slave2.Main.IPAddress	Internet Protocol (IP) address for a slave device	string_t	68e5	26853	Not applicable
ModbusMaster.Slave2.Main.LowPriority	Low priority rate (as for Slave 1)	uint8	7b11	31505	Not applicable
ModbusMaster.Slave2.Main.MaxBlockSize	Maximum amount of data in a single transaction	uint8	7b0b	31499	Not applicable
ModbusMaster.Slave2.Main.MediumPriority	Medium priority rate (as for Slave 1)	uint8	7b0f	31503	Not applicable
ModbusMaster.Slave2.Main.Online	Enables communications (0 = offline; 1 = online)	bool	7b01	31489	Not applicable
ModbusMaster.Slave2.Main.Profile	A profile that defines the device type (as Slave1.Data)	uint8	7b13	31507	Not applicable
ModbusMaster.Slave2.Main.Retries	Transaction retries	uint8	7b05	31493	Not applicable
ModbusMaster.Slave2.Main.SearchDevice	Initiates a slave search (0 = No; 1 = Yes)	bool	7d6e	32110	Not applicable
ModbusMaster.Slave2.Main.SearchResult	Current search status (as Slave1.Data)	uint8	7d70	32112	Not applicable
ModbusMaster.Slave2.Main.Timeout	Time in milliseconds the master will wait for a response	float32	7b08	31496	0dp
ModbusMaster.Slave2.Main.UnitId	Unit id for a slave device	uint8	7b03	31491	Not applicable
Mux8.1.Fallback	Fallback Strategy 0 = Clip Bad; 1 = Clip Good; 2 = Fallback Good 3 = Fallback Good; 4 = Up scale; 5 = Down scale.	uint8	2f66	12134	Not applicable
Mux8.1.FallbackVal	Fallback Value	float32	2f67	12135	1dp
Mux8.1.HighLimit	High Limit	float32	2f69	12137	1dp
Mux8.1.In1	Input 1	float32	2f6b	12139	1dp
Mux8.1.In2	Input 2	float32	2f6c	12140	1dp
Mux8.1.In3	Input 3	float32	2f6d	12141	1dp
Mux8.1.In4	Input 4	float32	2f6e	12142	1dp
Mux8.1.In5	Input 5	float32	2f6f	12143	1dp
Mux8.1.In6	Input 6	float32	2f70	12144	1dp
Mux8.1.In7	Input 7	float32	2f71	12145	1dp
Mux8.1.In8	Input 8	float32	2f72	12146	1dp
Mux8.1.LowLimit	Low Limit	float32	2f6a	12138	1dp
Mux8.1.Out	Output	float32	2f73	12147	Set by Mux8.1.Resolution
Mux8.1.Resolution	Resolution	uint8	2f75	12149	Not applicable
Mux8.1.Select	Input Selection Switch 1 to 8 = input 1 to 8 (respectively) selected for output	uint8	2f68	12136	Not applicable
Mux8.1.Status	Status. 0 = Good (OK); 7 = Bad (Error)	bool	2f74	12148	Not applicable
Mux8.2.Fallback	Fallback Strategy (as Mux8.1.Fallback)	uint8	2f76	12150	Not applicable
Mux8.2.FallbackVal	Fallback Value	float32	2f77	12151	1dp
Mux8.2.HighLimit	High Limit	float32	2f79	12153	1dp
Mux8.2.In1	Input 1	float32	2f7b	12155	1dp
Mux8.2.In2	Input 2	float32	2f7c	12156	1dp
Mux8.2.In3	Input 3	float32	2f7d	12157	1dp
Mux8.2.In4	Input 4	float32	2f7e	12158	1dp
Mux8.2.In5	Input 5	float32	2f7f	12159	1dp
Mux8.2.In6	Input 6	float32	2f80	12160	1dp
Mux8.2.In7	Input 7	float32	2f81	12161	1dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Mux8.2.In8	Input 8	float32	2f82	12162	1dp
Mux8.2.LowLimit	Low Limit	float32	2f7a	12154	1dp
Mux8.2.Out	Output	float32	2f83	12163	Set by Mux8.2.Resolution
Mux8.2.Resolution	Resolution	uint8	2f85	12165	Not applicable
Mux8.2.Select	Input Selection (as Mux8.1.Select)	uint8	2f78	12152	Not applicable
Mux8.2.Status	Status. 0 = Good (OK); 7 = Bad (Error)	bool	2f84	12164	Not applicable
Mux8.3.Fallback	Fallback Strategy (as Mux8.1.Fallback)	uint8	2f86	12166	Not applicable
Mux8.3.FallbackVal	Fallback Value	float32	2f87	12167	1dp
Mux8.3.HighLimit	High Limit	float32	2f89	12169	1dp
Mux8.3.In1	Input 1	float32	2f8b	12171	1dp
Mux8.3.In2	Input 2	float32	2f8c	12172	1dp
Mux8.3.In3	Input 3	float32	2f8d	12173	1dp
Mux8.3.In4	Input 4	float32	2f8e	12174	1dp
Mux8.3.In5	Input 5	float32	2f8f	12175	1dp
Mux8.3.In6	Input 6	float32	2f90	12176	1dp
Mux8.3.In7	Input 7	float32	2f91	12177	1dp
Mux8.3.In8	Input 8	float32	2f92	12178	1dp
Mux8.3.LowLimit	Low Limit	float32	2f8a	12170	1dp
Mux8.3.Out	Output	float32	2f93	12179	Set by Mux8.3.Resolution
Mux8.3.Resolution	Resolution	uint8	2f95	12181	Not applicable
Mux8.3.Select	Input Selection (as Mux8.1.Select)	uint8	2f88	12168	Not applicable
Mux8.3.Status	Status. 0 = Good (OK); 7 = Bad (Error)	bool	2f94	12180	Not applicable
Mux8.4.Fallback	Fallback Strategy (as Mux8.1.Fallback)	uint8	2f96	12182	Not applicable
Mux8.4.FallbackVal	Fallback Value	float32	2f97	12183	1dp
Mux8.4.HighLimit	High Limit	float32	2f99	12185	1dp
Mux8.4.In1	Input 1	float32	2f9b	12187	1dp
Mux8.4.In2	Input 2	float32	2f9c	12188	1dp
Mux8.4.In3	Input 3	float32	2f9d	12189	1dp
Mux8.4.In4	Input 4	float32	2f9e	12190	1dp
Mux8.4.In5	Input 5	float32	2f9f	12191	1dp
Mux8.4.In6	Input 6	float32	2fa0	12192	1dp
Mux8.4.In7	Input 7	float32	2fa1	12193	1dp
Mux8.4.In8	Input 8	float32	2fa2	12194	1dp
Mux8.4.LowLimit	Low Limit	float32	2f9a	12186	1dp
Mux8.4.Out	Output	float32	2fa3	12195	Set by Mux8.4.Resolution
Mux8.4.Resolution	Resolution	uint8	2fa5	12197	Not applicable
Mux8.4.Select	Input Selection (as Mux8.1.Select)	uint8	2f98	12184	Not applicable
Mux8.4.Status	Status. 0 = Good (OK); 7 = Bad (Error)	bool	2fa4	12196	Not applicable
nano_ui.Access	Access level 0 = Logged out; 1 = Operator; 2 = Supervisor; 3 = Engineer	uint8	2c00	11264	Not applicable
nano_ui.Password	Password	string_t	5400	21504	Not applicable
Network.Archive.ArchiveRate	Rate at which to archive history files 0 = None 1 = Every minute 2 = Hourly 3 = Daily 4 = Weekly 5 = Monthly 6 = Automatic	uint8	1114	4372	Not applicable
Network.Archive.CSVDateFormat	Date/Time format (0 = Text; 1 = spreadsheet numeric)	uint8	111d	4381	Not applicable
Network.Archive.CSVHeaders	Include header details (0 = No; 1 = Yes)	bool	111b	4379	Not applicable
Network.Archive.CSVHeadings	Include headings (0 = No; 1 = Yes)	bool	111c	4380	Not applicable
Network.Archive.CSVIncludeValues	Include process values (0 = No; 1 = Yes)	bool	1119	4377	Not applicable
Network.Archive.CSVMessages	Include messages (0 = No; 1 = Yes)	bool	111a	4378	Not applicable
Network.Archive.CSVTabDelimiter	Use Tab delimeter instead of comma (0 = No; 1 = Yes)	bool	111e	4382	Not applicable
Network.Archive.Destination	Archive destination. 0 = USB; 1 = FTP Server	uint8	1111	4369	Not applicable
Network.Archive.FileFormat	Archive file format (0 = Binary; 1 = CSV; 2 = both)	uint8	1115	4373	Not applicable
Network.Archive.MediaDuration	Time in days until the USB is full	float32	1118	4376	2dp
Network.Interface.Gateway	Default gateway internet protocol address	string_t	4524	17700	Not applicable
Network.Interface.IPaddress	Internet Protocol (IP) address of this instrument	string_t	4500	17664	Not applicable
Network.Interface.IPType	IP Lookup. 0 = DHCP, 1 = Fixed	uint8	1102	4354	Not applicable
Network.Interface.MAC	Media Access Control (MAC) address of this instrument	string_t	4548	17736	Not applicable
Network.Interface.SubnetMask	Sub network identification mask	string_t	4512	17682	Not applicable
Network.Modbus.Address	Modbus address for this instrument	uint8	1140	4416	Not applicable
Network.Modbus.InputTimeout	Modbus Input inactivity timeout (in seconds)	int16	1141	4417	Not applicable
Network.Modbus.PrefMasterIP	Preferred master IP	string_t	469c	18076	Not applicable
Network.Modbus.SerialMode	Modbus serial port mode	uint8	1143	4419	Not applicable
Network.Modbus.TimeFormat	Time parameter comms resolution	uint8	1144	4420	Not applicable
Network.Modbus.UnitIdEnable	Unit ident enable	uint8	1142	4418	Not applicable
OR.1.Input1	OR Block 1, input 1. 0 = off; 1 = on	bool	2d00	11520	Not applicable
OR.1.Input2	OR Block 1, input 2. 0 = off; 1 = on	bool	2d01	11521	Not applicable
OR.1.Input3	OR Block 1, input 3. 0 = off; 1 = on	bool	2d02	11522	Not applicable
OR.1.Input4	OR Block 1, input 4. 0 = off; 1 = on	bool	2d03	11523	Not applicable
OR.1.Input5	OR Block 1, input 5. 0 = off; 1 = on	bool	2d04	11524	Not applicable
OR.1.Input6	OR Block 1, input 6. 0 = off; 1 = on	bool	2d05	11525	Not applicable
OR.1.Input7	OR Block 1, input 7. 0 = off; 1 = on	bool	2d06	11526	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
OR.1.Input8	OR Block 1, input 8. 0 = off; 1 = on	bool	2d07	11527	Not applicable
OR.1.Output	OR Block 1, output. 0 = off; 1 = on	bool	2d08	11528	Not applicable
OR.2.Input1	OR Block 2, input 1. 0 = off; 1 = on	bool	2d10	11536	Not applicable
OR.2.Input2	OR Block 2, input 2. 0 = off; 1 = on	bool	2d11	11537	Not applicable
OR.2.Input3	OR Block 2, input 3. 0 = off; 1 = on	bool	2d12	11538	Not applicable
OR.2.Input4	OR Block 2, input 4. 0 = off; 1 = on	bool	2d13	11539	Not applicable
OR.2.Input5	OR Block 2, input 5. 0 = off; 1 = on	bool	2d14	11540	Not applicable
OR.2.Input6	OR Block 2, input 6. 0 = off; 1 = on	bool	2d15	11541	Not applicable
OR.2.Input7	OR Block 2, input 7. 0 = off; 1 = on	bool	2d16	11542	Not applicable
OR.2.Input8	OR Block 2, input 8. 0 = off; 1 = on	bool	2d17	11543	Not applicable
OR.2.Output	OR Block 1, output. 0 = off; 1 = on	bool	2d18	11544	Not applicable
OR.3.Input1	OR Block 3, input 1. 0 = off; 1 = on	bool	2d20	11552	Not applicable
OR.3.Input2	OR Block 3, input 2. 0 = off; 1 = on	bool	2d21	11553	Not applicable
OR.3.Input3	OR Block 3, input 3. 0 = off; 1 = on	bool	2d22	11554	Not applicable
OR.3.Input4	OR Block 3, input 4. 0 = off; 1 = on	bool	2d23	11555	Not applicable
OR.3.Input5	OR Block 3, input 5. 0 = off; 1 = on	bool	2d24	11556	Not applicable
OR.3.Input6	OR Block 3, input 6. 0 = off; 1 = on	bool	2d25	11557	Not applicable
OR.3.Input7	OR Block 3, input 7. 0 = off; 1 = on	bool	2d26	11558	Not applicable
OR.3.Input8	OR Block 3, input 8. 0 = off; 1 = on	bool	2d27	11559	Not applicable
OR.3.Output	OR Block 3, output. 0 = off; 1 = on	bool	2d28	11560	Not applicable
OR.4.Input1	OR Block 4, input 1. 0 = off; 1 = on	bool	2d30	11568	Not applicable
OR.4.Input2	OR Block 4, input 2. 0 = off; 1 = on	bool	2d31	11569	Not applicable
OR.4.Input3	OR Block 4, input 3. 0 = off; 1 = on	bool	2d32	11570	Not applicable
OR.4.Input4	OR Block 4, input 4. 0 = off; 1 = on	bool	2d33	11571	Not applicable
OR.4.Input5	OR Block 4, input 5. 0 = off; 1 = on	bool	2d34	11572	Not applicable
OR.4.Input6	OR Block 4, input 6. 0 = off; 1 = on	bool	2d35	11573	Not applicable
OR.4.Input7	OR Block 4, input 7. 0 = off; 1 = on	bool	2d36	11574	Not applicable
OR.4.Input8	OR Block 4, input 8. 0 = off; 1 = on	bool	2d37	11575	Not applicable
OR.4.Output	OR Block 4, output. 0 = off; 1 = on	bool	2d38	11576	Not applicable
OR.5.Input1	OR Block 5, input 1. 0 = off; 1 = on	bool	2d40	11584	Not applicable
OR.5.Input2	OR Block 5, input 2. 0 = off; 1 = on	bool	2d41	11585	Not applicable
OR.5.Input3	OR Block 5, input 3. 0 = off; 1 = on	bool	2d42	11586	Not applicable
OR.5.Input4	OR Block 5, input 4. 0 = off; 1 = on	bool	2d43	11587	Not applicable
OR.5.Input5	OR Block 5, input 5. 0 = off; 1 = on	bool	2d44	11588	Not applicable
OR.5.Input6	OR Block 5, input 6. 0 = off; 1 = on	bool	2d45	11589	Not applicable
OR.5.Input7	OR Block 5, input 7. 0 = off; 1 = on	bool	2d46	11590	Not applicable
OR.5.Input8	OR Block 5, input 8. 0 = off; 1 = on	bool	2d47	11591	Not applicable
OR.5.Output	OR Block 5, output. 0 = off; 1 = on	bool	2d48	11592	Not applicable
OR.6.Input1	OR Block 6, input 1. 0 = off; 1 = on	bool	2d50	11600	Not applicable
OR.6.Input2	OR Block 6, input 2. 0 = off; 1 = on	bool	2d51	11601	Not applicable
OR.6.Input3	OR Block 6, input 3. 0 = off; 1 = on	bool	2d52	11602	Not applicable
OR.6.Input4	OR Block 6, input 4. 0 = off; 1 = on	bool	2d53	11603	Not applicable
OR.6.Input5	OR Block 6, input 5. 0 = off; 1 = on	bool	2d54	11604	Not applicable
OR.6.Input6	OR Block 6, input 6. 0 = off; 1 = on	bool	2d55	11605	Not applicable
OR.6.Input7	OR Block 6, input 7. 0 = off; 1 = on	bool	2d56	11606	Not applicable
OR.6.Input8	OR Block 6, input 8. 0 = off; 1 = on	bool	2d57	11607	Not applicable
OR.6.Output	OR Block 6, output. 0 = off; 1 = on	bool	2d58	11608	Not applicable
OR.7.Input1	OR Block 7, input 1. 0 = off; 1 = on	bool	2d60	11616	Not applicable
OR.7.Input2	OR Block 7, input 2. 0 = off; 1 = on	bool	2d61	11617	Not applicable
OR.7.Input3	OR Block 7, input 3. 0 = off; 1 = on	bool	2d62	11618	Not applicable
OR.7.Input4	OR Block 7, input 4. 0 = off; 1 = on	bool	2d63	11619	Not applicable
OR.7.Input5	OR Block 7, input 5. 0 = off; 1 = on	bool	2d64	11620	Not applicable
OR.7.Input6	OR Block 7, input 6. 0 = off; 1 = on	bool	2d65	11621	Not applicable
OR.7.Input7	OR Block 7, input 7. 0 = off; 1 = on	bool	2d66	11622	Not applicable
OR.7.Input8	OR Block 7, input 8. 0 = off; 1 = on	bool	2d67	11623	Not applicable
OR.7.Output	OR Block 7, output. 0 = off; 1 = on	bool	2d68	11624	Not applicable
OR.8.Input1	OR Block 8, input 1. 0 = off; 1 = on	bool	2d70	11632	Not applicable
OR.8.Input2	OR Block 8, input 2. 0 = off; 1 = on	bool	2d71	11633	Not applicable
OR.8.Input3	OR Block 8, input 3. 0 = off; 1 = on	bool	2d72	11634	Not applicable
OR.8.Input4	OR Block 8, input 4. 0 = off; 1 = on	bool	2d73	11635	Not applicable
OR.8.Input5	OR Block 8, input 5. 0 = off; 1 = on	bool	2d74	11636	Not applicable
OR.8.Input6	OR Block 8, input 6. 0 = off; 1 = on	bool	2d75	11637	Not applicable
OR.8.Input7	OR Block 8, input 7. 0 = off; 1 = on	bool	2d76	11638	Not applicable
OR.8.Input8	OR Block 8, input 8. 0 = off; 1 = on	bool	2d77	11639	Not applicable
OR.8.Output	OR Block 8, output. 0 = off; 1 = on	bool	2d78	11640	Not applicable
OR.9.Input1	OR Block 9, input 1. 0 = off; 1 = on	bool	2d80	11648	Not applicable
OR.9.Input2	OR Block 9, input 2. 0 = off; 1 = on	bool	2d81	11649	Not applicable
OR.9.Input3	OR Block 9, input 3. 0 = off; 1 = on	bool	2d82	11650	Not applicable
OR.9.Input4	OR Block 9, input 4. 0 = off; 1 = on	bool	2d83	11651	Not applicable
OR.9.Input5	OR Block 9, input 5. 0 = off; 1 = on	bool	2d84	11652	Not applicable
OR.9.Input6	OR Block 9, input 6. 0 = off; 1 = on	bool	2d85	11653	Not applicable
OR.9.Input7	OR Block 9, input 7. 0 = off; 1 = on	bool	2d86	11654	Not applicable
OR.9.Input8	OR Block 9, input 8. 0 = off; 1 = on	bool	2d87	11655	Not applicable
OR.9.Output	OR Block 9, output. 0 = off; 1 = on	bool	2d88	11656	Not applicable
OR.10.Input1	OR Block 10, input 1. 0 = off; 1 = on	bool	2d90	11664	Not applicable
OR.10.Input2	OR Block 10, input 2. 0 = off; 1 = on	bool	2d91	11665	Not applicable
OR.10.Input3	OR Block 10, input 3. 0 = off; 1 = on	bool	2d92	11666	Not applicable
OR.10.Input4	OR Block 10, input 4. 0 = off; 1 = on	bool	2d93	11667	Not applicable
OR.10.Input5	OR Block 10, input 5. 0 = off; 1 = on	bool	2d94	11668	Not applicable
OR.10.Input6	OR Block 10, input 6. 0 = off; 1 = on	bool	2d95	11669	Not applicable
OR.10.Input7	OR Block 10, input 7. 0 = off; 1 = on	bool	2d96	11670	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
OR.10.Input8	OR Block 10, input 8. 0 = off; 1 = on	bool	2d97	11671	Not applicable
OR.10.Output	OR Block 10, output. 0 = off; 1 = on	bool	2d98	11672	Not applicable
OR.11.Input1	OR Block 11, input 1. 0 = off; 1 = on	bool	2da0	11680	Not applicable
OR.11.Input2	OR Block 11, input 2. 0 = off; 1 = on	bool	2da1	11681	Not applicable
OR.11.Input3	OR Block 11, input 3. 0 = off; 1 = on	bool	2da2	11682	Not applicable
OR.11.Input4	OR Block 11, input 4. 0 = off; 1 = on	bool	2da3	11683	Not applicable
OR.11.Input5	OR Block 11, input 5. 0 = off; 1 = on	bool	2da4	11684	Not applicable
OR.11.Input6	OR Block 11, input 6. 0 = off; 1 = on	bool	2da5	11685	Not applicable
OR.11.Input7	OR Block 11, input 7. 0 = off; 1 = on	bool	2da6	11686	Not applicable
OR.11.Input8	OR Block 11, input 8. 0 = off; 1 = on	bool	2da7	11687	Not applicable
OR.11.Output	OR Block 11, output. 0 = off; 1 = on	bool	2da8	11688	Not applicable
OR.12.Input1	OR Block 12, input 1. 0 = off; 1 = on	bool	2db0	11696	Not applicable
OR.12.Input2	OR Block 12, input 2. 0 = off; 1 = on	bool	2db1	11697	Not applicable
OR.12.Input3	OR Block 12, input 3. 0 = off; 1 = on	bool	2db2	11698	Not applicable
OR.12.Input4	OR Block 12, input 4. 0 = off; 1 = on	bool	2db3	11699	Not applicable
OR.12.Input5	OR Block 12, input 5. 0 = off; 1 = on	bool	2db4	11700	Not applicable
OR.12.Input6	OR Block 12, input 6. 0 = off; 1 = on	bool	2db5	11701	Not applicable
OR.12.Input7	OR Block 12, input 7. 0 = off; 1 = on	bool	2db6	11702	Not applicable
OR.12.Input8	OR Block 12, input 8. 0 = off; 1 = on	bool	2db7	11703	Not applicable
OR.12.Output	OR Block 12, output. 0 = off; 1 = on	bool	2db8	11704	Not applicable
Program.Ch1Holdback	Channel 1 holdback type 0 = Off 1 = Low 2 = High 3 = Band	uint8	3aa1	15009	Not applicable
Program.Ch1HoldbackVal	Channel 1 holdback value	float32	3aa3	15011	Same as Programmer.SetUp.Ch1PVInput
Program.Ch1RampUnits	Channel 1 ramp units	uint8	3aa6	15014	Not applicable
Program.Ch2Holdback	Channel 2 holdback type (as for Program.Ch1, above)	uint8	3aa2	15010	Not applicable
Program.Ch2HoldbackVal	Channel 2 holdback value	float32	3aa4	15012	Same as Programmer.SetUp.Ch2PVInput
Program.Ch2RampUnits	Channel 2 ramp units	uint8	3aa7	15015	Not applicable
Program.HoldbackStyle	Holdback style (0 = per segment; 1 = per program)	uint8	3aa0	15008	Not applicable
Program.Program	Program	string_t	6abb	27323	Not applicable
Program.RampStyle	Ramp style (0 = Time; 1 = Rate)	uint8	3aa5	15013	Not applicable
Programmer.Features.FTPStore	FTP store feature enable	bool	3a04	14852	Not applicable
Programmer.Features.Holdback	Holdback feature enable	bool	3a00	14848	Not applicable
Programmer.Features.Messages	Messages feature enable	bool	3a03	14851	Not applicable
Programmer.Features.PVEvent	PV Event feature enable	bool	3a01	14849	Not applicable
Programmer.Features.UserValue	User value feature enable	bool	3a02	14850	Not applicable
Programmer.FileList.Filename1	Filename	string_t	7900	30976	Not applicable
Programmer.FileList.Filename2	Filename	string_t	7901	30977	Not applicable
Programmer.FileList.Filename3	Filename	string_t	7902	30978	Not applicable
Programmer.FileList.Filename4	Filename	string_t	7903	30979	Not applicable
Programmer.FileList.Filename5	Filename	string_t	7904	30980	Not applicable
Programmer.FileList.Filename6	Filename	string_t	7905	30981	Not applicable
Programmer.FileList.Filename7	Filename	string_t	7906	30982	Not applicable
Programmer.FileList.Filename8	Filename	string_t	7907	30983	Not applicable
Programmer.FileList.Filename9	Filename	string_t	7908	30984	Not applicable
Programmer.FileList.Filename10	Filename	string_t	7909	30985	Not applicable
Programmer.FileList.Filename11	Filename	string_t	790a	30986	Not applicable
Programmer.FileList.Filename12	Filename	string_t	790b	30987	Not applicable
Programmer.FileList.Filename13	Filename	string_t	790c	30988	Not applicable
Programmer.FileList.Filename14	Filename	string_t	790d	30989	Not applicable
Programmer.FileList.Filename15	Filename	string_t	790e	30990	Not applicable
Programmer.FileList.Filename16	Filename	string_t	790f	30991	Not applicable
Programmer.FileList.Filename17	Filename	string_t	7910	30992	Not applicable
Programmer.FileList.Filename18	Filename	string_t	7911	30993	Not applicable
Programmer.FileList.Filename19	Filename	string_t	7912	30994	Not applicable
Programmer.FileList.Filename20	Filename	string_t	7913	30995	Not applicable
Programmer.FileList.Filename21	Filename	string_t	7914	30996	Not applicable
Programmer.FileList.Filename22	Filename	string_t	7915	30997	Not applicable
Programmer.FileList.Filename23	Filename	string_t	7916	30998	Not applicable
Programmer.FileList.Filename24	Filename	string_t	7917	30999	Not applicable
Programmer.FileList.Filename25	Filename	string_t	7918	31000	Not applicable
Programmer.FileList.Filename26	Filename	string_t	7919	31001	Not applicable
Programmer.FileList.Filename27	Filename	string_t	791a	31002	Not applicable
Programmer.FileList.Filename28	Filename	string_t	791b	31003	Not applicable
Programmer.FileList.Filename29	Filename	string_t	791c	31004	Not applicable
Programmer.FileList.Filename30	Filename	string_t	791d	31005	Not applicable
Programmer.FileList.Filename31	Filename	string_t	791e	31006	Not applicable
Programmer.FileList.Filename32	Filename	string_t	791f	31007	Not applicable
Programmer.FileList.Filename33	Filename	string_t	7920	31008	Not applicable
Programmer.FileList.Filename34	Filename	string_t	7921	31009	Not applicable
Programmer.FileList.Filename35	Filename	string_t	7922	31010	Not applicable
Programmer.FileList.Filename36	Filename	string_t	7923	31011	Not applicable
Programmer.FileList.Filename37	Filename	string_t	7924	31012	Not applicable
Programmer.FileList.Filename38	Filename	string_t	7925	31013	Not applicable
Programmer.FileList.Filename39	Filename	string_t	7926	31014	Not applicable
Programmer.FileList.Filename40	Filename	string_t	7927	31015	Not applicable
Programmer.FileList.Filename41	Filename	string_t	7928	31016	Not applicable
Programmer.FileList.Filename42	Filename	string_t	7929	31017	Not applicable
Programmer.FileList.Filename43	Filename	string_t	792a	31018	Not applicable
Programmer.FileList.Filename44	Filename	string_t	792b	31019	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Programmer.FileList.Filename45	Filename	string_t	792c	31020	Not applicable
Programmer.FileList.Filename46	Filename	string_t	792d	31021	Not applicable
Programmer.FileList.Filename47	Filename	string_t	792e	31022	Not applicable
Programmer.FileList.Filename48	Filename	string_t	792f	31023	Not applicable
Programmer.FileList.Filename49	Filename	string_t	7930	31024	Not applicable
Programmer.FileList.Filename50	Filename	string_t	7931	31025	Not applicable
Programmer.FileList.Filename51	Filename	string_t	7932	31026	Not applicable
Programmer.FileList.Filename52	Filename	string_t	7933	31027	Not applicable
Programmer.FileList.Filename53	Filename	string_t	7934	31028	Not applicable
Programmer.FileList.Filename54	Filename	string_t	7935	31029	Not applicable
Programmer.FileList.Filename55	Filename	string_t	7936	31030	Not applicable
Programmer.FileList.Filename56	Filename	string_t	7937	31031	Not applicable
Programmer.FileList.Filename57	Filename	string_t	7938	31032	Not applicable
Programmer.FileList.Filename58	Filename	string_t	7939	31033	Not applicable
Programmer.FileList.Filename59	Filename	string_t	793a	31034	Not applicable
Programmer.FileList.Filename60	Filename	string_t	793b	31035	Not applicable
Programmer.FileList.Filename61	Filename	string_t	793c	31036	Not applicable
Programmer.FileList.Filename62	Filename	string_t	793d	31037	Not applicable
Programmer.FileList.Filename63	Filename	string_t	793e	31038	Not applicable
Programmer.FileList.Filename64	Filename	string_t	793f	31039	Not applicable
Programmer.FileList.Filename65	Filename	string_t	7940	31040	Not applicable
Programmer.FileList.Filename66	Filename	string_t	7941	31041	Not applicable
Programmer.FileList.Filename67	Filename	string_t	7942	31042	Not applicable
Programmer.FileList.Filename68	Filename	string_t	7943	31043	Not applicable
Programmer.FileList.Filename69	Filename	string_t	7944	31044	Not applicable
Programmer.FileList.Filename70	Filename	string_t	7945	31045	Not applicable
Programmer.FileList.Filename71	Filename	string_t	7946	31046	Not applicable
Programmer.FileList.Filename72	Filename	string_t	7947	31047	Not applicable
Programmer.FileList.Filename73	Filename	string_t	7948	31048	Not applicable
Programmer.FileList.Filename74	Filename	string_t	7949	31049	Not applicable
Programmer.FileList.Filename75	Filename	string_t	794a	31050	Not applicable
Programmer.FileList.Filename76	Filename	string_t	794b	31051	Not applicable
Programmer.FileList.Filename77	Filename	string_t	794c	31052	Not applicable
Programmer.FileList.Filename78	Filename	string_t	794d	31053	Not applicable
Programmer.FileList.Filename79	Filename	string_t	794e	31054	Not applicable
Programmer.FileList.Filename80	Filename	string_t	794f	31055	Not applicable
Programmer.FileList.Filename81	Filename	string_t	7950	31056	Not applicable
Programmer.FileList.Filename82	Filename	string_t	7951	31057	Not applicable
Programmer.FileList.Filename83	Filename	string_t	7952	31058	Not applicable
Programmer.FileList.Filename84	Filename	string_t	7953	31059	Not applicable
Programmer.FileList.Filename85	Filename	string_t	7954	31060	Not applicable
Programmer.FileList.Filename86	Filename	string_t	7955	31061	Not applicable
Programmer.FileList.Filename87	Filename	string_t	7956	31062	Not applicable
Programmer.FileList.Filename88	Filename	string_t	7957	31063	Not applicable
Programmer.FileList.Filename89	Filename	string_t	7958	31064	Not applicable
Programmer.FileList.Filename90	Filename	string_t	7959	31065	Not applicable
Programmer.FileList.Filename91	Filename	string_t	795a	31066	Not applicable
Programmer.FileList.Filename92	Filename	string_t	795b	31067	Not applicable
Programmer.FileList.Filename93	Filename	string_t	795c	31068	Not applicable
Programmer.FileList.Filename94	Filename	string_t	795d	31069	Not applicable
Programmer.FileList.Filename95	Filename	string_t	795e	31070	Not applicable
Programmer.FileList.Filename96	Filename	string_t	795f	31071	Not applicable
Programmer.FileList.Filename97	Filename	string_t	7960	31072	Not applicable
Programmer.FileList.Filename98	Filename	string_t	7961	31073	Not applicable
Programmer.FileList.Filename99	Filename	string_t	7962	31074	Not applicable
Programmer.FileList.Filename100	Filename	string_t	7963	31075	Not applicable
Programmer.FileList.FilenameEntry	Filename of the program to loaded or stored	string_t	6a91	27281	Not applicable
Programmer.FileList.Operation	Operation (0 = Complete; 1 = Get listing; 2 = iTools only)	uint8	3a80	14976	Not applicable
Programmer.FileList.RefreshList	Refresh list (0 = No; 1 = Yes)	bool	3a81	14977	Not applicable
Programmer.FTP.IPAddress	Internet Protocol address	string_t	698c	27020	Not applicable
Programmer.FTP.Password	Password	string_t	6a2c	27180	Not applicable
Programmer.FTP.Username	Username	string_t	6a03	27139	Not applicable
Programmer.Run.Ch1PSP	Channel 1 programmer set-point	float32	3a53	14931	Same as Programmer.SetUp.Ch1PVInput
Programmer.Run.Ch1PVEvent	Channel 1 PV event (0 = Off; 1 = On)	bool	3a6c	14956	Not applicable
Programmer.Run.Ch1Rate	Channel 1 rate	float32	3a5e	14942	Set by Programmer.SetUp.RateResolution
Programmer.Run.Ch1Time	Channel 1 time	time_t	3a5c	14940	Set by Network.Modbus.TimeFormat
Programmer.Run.Ch1TSP	Channel 1 target set-point	float32	3a5a	14938	Same as Programmer.SetUp.Ch1PVInput
Programmer.Run.Ch1UserVal	Channel 1 user value	float32	3a6a	14954	0dp
Programmer.Run.Ch2PSP	Channel 2 programmer set-point	float32	3a54	14932	Same as Programmer.SetUp.Ch2PVInput
Programmer.Run.Ch2PVEvent	Channel 2 PV event (0 = Off; 1 = On)	bool	3a6d	14957	Not applicable
Programmer.Run.Ch2Rate	Channel 2 rate	float32	3a5f	14943	Set by Programmer.SetUp.RateResolution
Programmer.Run.Ch2Time	Channel 2 time	time_t	3a5d	14941	Set by Network.Modbus.TimeFormat
Programmer.Run.Ch2TSP	Channel 2 target set-point	float32	3a5b	14939	Same as Programmer.SetUp.Ch2PVInput
Programmer.Run.Ch2UserVal	Channel 2 user value	float32	3a6b	14955	0dp
Programmer.Run.CyclesLeft	Cycles left (-1 = continuous)	int16	3a60	14944	Not applicable
Programmer.Run.Duration	Duration	time_t	3a59	14937	Set by Network.Modbus.TimeFormat
Programmer.Run.EndOutput	End output (0 = Off; 1 = On)	bool	3a61	14945	Not applicable
Programmer.Run.Event1	Event 1 (0 = Off; 1 = On)	bool	3a62	14946	Not applicable
Programmer.Run.Event2	Event 2 (0 = Off; 1 = On)	bool	3a63	14947	Not applicable
Programmer.Run.Event3	Event 3 (0 = Off; 1 = On)	bool	3a64	14948	Not applicable
Programmer.Run.Event4	Event 4 (0 = Off; 1 = On)	bool	3a65	14949	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Programmer.Run.Event5	Event 5 (0 = Off; 1 = On)	bool	3a66	14950	Not applicable
Programmer.Run.Event6	Event 6 (0 = Off; 1 = On)	bool	3a67	14951	Not applicable
Programmer.Run.Event7	Event 7 (0 = Off; 1 = On)	bool	3a68	14952	Not applicable
Programmer.Run.Event8	Event 8 (0 = Off; 1 = On)	bool	3a69	14953	Not applicable
Programmer.Run.Intervention	Intervention 0 = No Program 1 = None 2 = User intervention 4 = PV Event	uint8	3a6f	14959	Not applicable
Programmer.Run.Mode	Mode (1 = Reset; 2 = Run; 4 = Hold)	uint8	3a50	14928	Not applicable
Programmer.Run.ProgTimeLeft	Program time left	time_t	3a57	14935	Set by Network.Modbus.TimeFormat
Programmer.Run.ProgTimeRunning	Program time running	time_t	3a70	14960	Set by Network.Modbus.TimeFormat
Programmer.Run.ProgTimeSpent	Program time spent	time_t	3a58	14936	Set by Network.Modbus.TimeFormat
Programmer.Run.Segment	Segment	string_t	6aa6	27302	Not applicable
Programmer.Run.SegmentType	Segment type 0 = End 1 = Ramp 2 = Dwell 3 = Step 4 = Wait 5 = Go back	uint8	3a52	14930	Not applicable
Programmer.Run.SegTimeLeft	Segment time left	time_t	3a55	14933	Set by Network.Modbus.TimeFormat
Programmer.Run.SegTimeRun	Segment time run	time_t	3a56	14934	Set by Network.Modbus.TimeFormat
Programmer.Run.Status	Status 1 = Reset 2 = Running 4 = Holding 8 = Holdback 16 = Waiting 32 = Complete	uint8	3a51	14929	Not applicable
Programmer.SetUp.Advance	Advance (0 = No 1 = Yes)	bool	3a42	14914	Not applicable
Programmer.SetUp.Amended	Amended (0 = No 1 = Yes)	bool	3a44	14916	Not applicable
Programmer.SetUp.Ch1PVInput	Channel 1 PV input	float32	3a26	14886	Set by Programmer.SetUp.Ch1Resolution
Programmer.SetUp.Ch1Resolution	Channel 1 Resolution	uint8	3a46	14918	Not applicable
Programmer.SetUp.Ch1ServoTo	Channel 1 servo to (0 = PV; 1 = SP)	uint8	3a2a	14890	Not applicable
Programmer.SetUp.Ch1SPInput	Channel 1 SP input	float32	3a28	14888	0dp
Programmer.SetUp.Ch1Units	Channel 1 units	string_t	6a85	27269	Not applicable
Programmer.SetUp.Ch2PVInput	Channel 2 PV input	float32	3a27	14887	Set by Programmer.SetUp.Ch2Resolution
Programmer.SetUp.Ch2Resolution	Channel 2 Resolution	uint8	3a47	14919	Not applicable
Programmer.SetUp.Ch2ServoTo	Channel 2 servo to (0 = PV; 1 = SP)	uint8	3a2b	14891	Not applicable
Programmer.SetUp.Ch2SPInput	Channel 2 SP input	float32	3a29	14889	0dp
Programmer.SetUp.Ch2Units	Channel 2 units	string_t	6a8b	27275	Not applicable
Programmer.SetUp.Channels	Number of channels	uint8	3a20	14880	Not applicable
Programmer.SetUp.FileErrorStatus	File error status 0 = Busy 1 = OK 2 = Load open file 3 = Store open file 4 =Delete fail 5 = Copy fail 6 = Invalid format 7 = Invalid device 8 = Invalid version 9 = Invalid number of channels 10 = Parameter write failed 11 = Store operation failed to complete 12 = Load operation failed to complete 13 = Delete operation failed to complete 14 = Copy operation failed to complete 15 = Invalid filename entered or selected 16 = General file operation error 17 = Would result in more than the ma.x no. of program files	uint8	3a45	14917	Not applicable
Programmer.SetUp.Hold	Hold (0 = No 1 = Yes)	bool	3a39	14905	Not applicable
Programmer.SetUp.MaxEvents	Maximum events	uint8	3a2d	14893	Not applicable
Programmer.SetUp.Operation	Operation uint8 1 = Select 2 =Load 4 = Store 8 = Delete 16 = Delete All 32=Copy 64 = Copy All	3a40		14912	Not applicable
Programmer.SetUp.PowerFailAction	Power fail action (0 = ramp back; 1 = Reset; 2 = Continue)	uint8	3a2c	14892	Not applicable
Programmer.SetUp.ProgEditAccess	Program edit access level 0 = Logged out 1 = Operator 2 = Supervisor 3 = Engineer	uint8	3a22	14882	Not applicable
Programmer.SetUp.ProgModeAccess	Program mode access level (as Program Edit Access, above)	uint8	3a21	14881	Not applicable
Programmer.SetUp.ProgStoreAccess	Program store access level (as Program Edit Access, above)	uint8	3a23	14883	Not applicable
Programmer.SetUp.RateResolution	Rate resolution	uint8	3a24	14884	Not applicable
Programmer.SetUp.Reset	Reset (0 = No 1 = Yes)	bool	3a3a	14906	Not applicable
Programmer.SetUp.ResetCh1UserVal	Reset channel 1 user value	float32	3a36	14902	1dp
Programmer.SetUp.ResetCh2UserVal	Reset channel 2 user value	float32	3a37	14903	1dp
Programmer.SetUp.ResetEvent1	Reset event 1 (0 = Off, 1 = On)	bool	3a2e	14894	Not applicable
Programmer.SetUp.ResetEvent2	Reset event 2 (0 = Off, 1 = On)	bool	3a2f	14895	Not applicable
Programmer.SetUp.ResetEvent3	Reset event 3 (0 = Off, 1 = On)	bool	3a30	14896	Not applicable
Programmer.SetUp.ResetEvent4	Reset event 4 (0 = Off, 1 = On)	bool	3a31	14897	Not applicable
Programmer.SetUp.ResetEvent5	Reset event 5 (0 = Off, 1 = On)	bool	3a32	14898	Not applicable
Programmer.SetUp.ResetEvent6	Reset event 6 (0 = Off, 1 = On)	bool	3a33	14899	Not applicable
Programmer.SetUp.ResetEvent7	Reset event 7 (0 = Off, 1 = On)	bool	3a34	14900	Not applicable
Programmer.SetUp.ResetEvent8	Reset event 8 (0 = Off, 1 = On)	bool	3a35	14901	Not applicable
Programmer.SetUp.Run	Run (0 = No 1 = Yes)	bool	3a38	14904	Not applicable
Programmer.SetUp.RunHold	Run Hold (0 = No 1 = Yes)	bool	3a3c	14908	Not applicable
Programmer.SetUp.RunReset	Run Rese (0 = No 1 = Yes)t	bool	3a3b	14907	Not applicable
Programmer.SetUp.Status	Status 0 = Inactive 1 = Success 2 = Failed 3 = Loading 4 = Storing 5 = Deleting 6 = Copying	uint8	3a41	14913	Not applicable
Programmer.SetUp.WaitAnalog1	Wait analog input 1	float32	3a3e	14910	0dp
Programmer.SetUp.WaitAnalog2	Wait analog input 2	float32	3a3f	14911	0dp
Programmer.SetUp.WaitDigital	Wait Digital (0 = Off 1 = On)	bool	3a3d	14909	Not applicable
RealTimeEvent.1.Duration	Sets the duration for the event to remain On	time_t	30e6	12518	Set by Network.Modbus.TimeFormat

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
RealTimeEvent.1.OffDate	Sets the date in the month that the event is to switch off	uint8	30e8	12520	Not applicable
RealTimeEvent.1.OffDay	Sets the day the the event is to switch Off 0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday 7 = Monday to Friday 8 = Saturday to Sunday 9 = Every day	uint8	30e9	12521	Not applicable
RealTimeEvent.1.OffMonth	The month number when the event is to switch off	uint8	30e7	12519	Not applicable
RealTimeEvent.1.OffTime	Sets the time that the event is to switch Off	time_t	30ea	12522	Set by Network.Modbus.TimeFormat
RealTimeEvent.1.OffType	0 = Duration; 1 = Time	uint8	30e5	12517	Not applicable
RealTimeEvent.1.OnDate	Sets the date in the month that the event is to switch on	uint8	30e2	12514	Not applicable
RealTimeEvent.1.OnDay	Sets the day on which event is to switch on (as 'OffDay', above)	uint8	30e3	12515	Not applicable
RealTimeEvent.1.OnMonth	The month number when the event is to switch on	uint8	30e1	12513	Not applicable
RealTimeEvent.1.OnTime	Sets the time that the event is to switch On	time_t	30e4	12516	Set by Network.Modbus.TimeFormat
RealTimeEvent.1.Output	The output from the real time event (0 = Off; 1 = On)	bool	30eb	12523	Not applicable
RealTimeEvent.1.Type	Selects the type of Real Time Event 0 = Off 1 = Time and Day 2 = Time and Date	uint8	30e0	12512	Not applicable
RealTimeEvent.2.Duration	Sets the duration for the event to remain On	time_t	30f6	12534	Set by Network.Modbus.TimeFormat
RealTimeEvent.2.OffDate	Sets the date in the month that the event is to switch off	uint8	30f8	12536	Not applicable
RealTimeEvent.2.OffDay	Sets the day the the event is to switch Off (as for Event 1)	uint8	30f9	12537	Not applicable
RealTimeEvent.2.OffMonth	Sets the month that the event is to switch off	uint8	30f7	12535	Not applicable
RealTimeEvent.2.OffTime	Sets the time that the event is to switch Off	time_t	30fa	12538	Set by Network.Modbus.TimeFormat
RealTimeEvent.2.OffType	Selects the type that will switch off the event (as for Event 1)	uint8	30f5	12533	Not applicable
RealTimeEvent.2.OnDate	Sets the date in the month that the event is to switch on	uint8	30f2	12530	Not applicable
RealTimeEvent.2.OnDay	Sets the day the event is to switch on (as for Event 1)	uint8	30f3	12531	Not applicable
RealTimeEvent.2.OnMonth	Sets the month that the event is to switch on	uint8	30f1	12529	Not applicable
RealTimeEvent.2.OnTime	Sets the time that the event is to switch On	time_t	30f4	12532	Set by Network.Modbus.TimeFormat
RealTimeEvent.2.Output	The output from the real time event (0 = Off; 1 = On)	bool	30fb	12539	Not applicable
RealTimeEvent.2.Type	Selects the type of Real Time Event 0 = Off 1 = Time and Day 2 = Time and Date	uint8	30f0	12528	Not applicable
Segment.1.Ch1Holdback	Channel 1 holdback type 0 = Off 1 = Low 2= High 3 = Band	uint8	3ac9	15049	Not applicable
Segment.1.Ch1HoldbackVal	Channel 1 holdback value	float32	3acb	15051	Same as Programmer.SetUp.Ch1PVInput
Segment.1.Ch1PVEvent	Channel 1 PV event 0 = Off 1 = Absolute High 2 = Absolute Low 3 = Deviation High 4 = Deviation Low 5 = Deviation Band	uint8	3ad4	15060	Not applicable
Segment.1.Ch1PVEventUse	Channel 1 PV event use (0 = Trigger; 1 = Alarm)	bool	3ae2	15074	Not applicable
Segment.1.Ch1PVEventVal	Channel 1 PV event value	float32	3ad6	15062	Same as Programmer.SetUp.Ch1PVInput
Segment.1.Ch1Rate	Channel 1 rate	float32	3ac6	15046	Set by Programmer.SetUp.RateResolution
Segment.1.Ch1Time	Channel 1 time	time_t	3ac4	15044	Set by Network.Modbus.TimeFormat
Segment.1.Ch1TSP	Channel 1 target set-point	float32	3ac2	15042	Same as Programmer.SetUp.Ch1PVInput
Segment.1.Ch1UserVal	Channel 1 user value	float32	3ad8	15064	Same as Programmer.SetUp.ResetCh1UserVal
Segment.1.Ch1Wait	Channel 1 Wait (Analogue 1 criterion) 1= Abs high 2 = Abs low 3 = Dev high 4 = Dev Low	uint8	3ace	15054	Not applicable
Segment.1.Ch1WaitVal	Channel 1 wait value	float32	3ad0	15056	Same as Programmer.SetUp.PVWait1
Segment.1.Ch2Holdback	Channel 2 holdback type (as for Ch1Holdback, above)	uint8	3aca	15050	Not applicable
Segment.1.Ch2HoldbackVal	Channel 2 holdback value	float32	3acc	15052	Same as Programmer.SetUp.Ch2PVInput
Segment.1.Ch2PVEvent	Channel 2 PV event (as for Ch1PVEvent, above)	uint8	3ad5	15061	Not applicable
Segment.1.Ch2PVEventUse	Channel 2 PV event use (as for Ch1PVEventUse, above)	bool	3ae3	15075	Not applicable
Segment.1.Ch2PVEventVal	Channel 2 PV event value	float32	3ad7	15063	Same as Programmer.SetUp.Ch2PVInput
Segment.1.Ch2Rate	Channel 2 rate	float32	3ac7	15047	Set by Programmer.SetUp.RateResolution
Segment.1.Ch2Time	Channel 2 time	time_t	3ac5	15045	Set by Network.Modbus.TimeFormat
Segment.1.Ch2TSP	Channel 2 target set-point	float32	3ac3	15043	Same as Programmer.SetUp.Ch2PVInput
Segment.1.Ch2UserVal	Channel 2 user value	float32	3ad9	15065	Same as Programmer.SetUp.ResetCh2UserVal
Segment.1.Ch2Wait	Channel 2 Wait (analogue 2 criterion; as for Ch1Wait, above)	uint8	3acf	15055	Not applicable
Segment.1.Ch2WaitVal	Channel 2 wait value	float32	3ad1	15057	Same as Programmer.SetUp.PVWait2
Segment.1.Cycles	Cycles (0 = Continuous)	int16	3ad3	15059	Not applicable
Segment.1.Duration	Duration	time_t	3ac1	15041	Set by Network.Modbus.TimeFormat
Segment.1.EndType	End type (0 = Dwell; 1 = Reset)	uint8	3ac8	15048	Not applicable
Segment.1.Event1	Event 1 (0 = Off; 1 = On)	bool	3ada	15066	Not applicable
Segment.1.Event2	Event 2 (0 = Off; 1 = On)	bool	3adb	15067	Not applicable
Segment.1.Event3	Event 3 (0 = Off; 1 = On)	bool	3adc	15068	Not applicable
Segment.1.Event4	Event 4 (0 = Off; 1 = On)	bool	3add	15069	Not applicable
Segment.1.Event5	Event 5 (0 = Off; 1 = On)	bool	3ade	15070	Not applicable
Segment.1.Event6	Event 6 (0 = Off; 1 = On)	bool	3adf	15071	Not applicable
Segment.1.Event7	Event 7 (0 = Off; 1 = On)	bool	3ae0	15072	Not applicable
Segment.1.Event8	Event 8 (0 = Off; 1 = On)	bool	3ae1	15073	Not applicable
Segment.1.GoBackTo	Go back to	uint8	3ad2	15058	Not applicable
Segment.1.SegmentName	Segment name	string_t	6ad0	27344	Not applicable
Segment.1.Type	Type 0 = End 1 = Ramp 2 = Dwell 3 = Step 4 = Wait 5 = GoBack	uint8	3ac0	15040	Not applicable
Segment.1.WaitFor	Wait for 0 = Digital High 1 = Wait analogue 1 2 = Wait analogue 2 3 = Wait analogue 1 and analogue 2	uint8	3acd	15053	Not applicable
Segment.2.Ch1Holdback	Channel 1 holdback type	uint8	3af9	15097	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.2.Ch1HoldbackVal	Channel 1 holdback value	float32	3afb	15099	Same as Programmer.SetUp.Ch1PVInput
Segment.2.Ch1PVEvent	Channel 1 PV event	uint8	3b04	15108	Not applicable
Segment.2.Ch1PVEventUse	Channel 1 PV event use	bool	3b12	15122	Not applicable
Segment.2.Ch1PVEventVal	Channel 1 PV event value	float32	3b06	15110	Same as Programmer.SetUp.Ch1PVInput
Segment.2.Ch1Rate	Channel 1 rate	float32	3af6	15094	Set by Programmer.SetUp.RateResolution
Segment.2.Ch1Time	Channel 1 time	time_t	3af4	15092	Set by Network.Modbus.TimeFormat
Segment.2.Ch1TSP	Channel 1 target set-point	float32	3af2	15090	Same as Programmer.SetUp.Ch1PVInput
Segment.2.Ch1UserVal	Channel 1 user value	float32	3b08	15112	Same as Programmer.SetUp.ResetCh1UserVal
Segment.2.Ch1Wait	Channel 1 Wait	uint8	3afe	15102	Not applicable
Segment.2.Ch1WaitVal	Channel 1 wait value	float32	3b00	15104	Same as Programmer.SetUp.PVWait1
Segment.2.Ch2Holdback	Channel 2 holdback type	uint8	3afa	15098	Not applicable
Segment.2.Ch2HoldbackVal	Channel 2 holdback value	float32	3afc	15100	Same as Programmer.SetUp.Ch2PVInput
Segment.2.Ch2PVEvent	Channel 2 PV event	uint8	3b05	15109	Not applicable
Segment.2.Ch2PVEventUse	Channel 2 PV event use	bool	3b13	15123	Not applicable
Segment.2.Ch2PVEventVal	Channel 2 PV event value	float32	3b07	15111	Same as Programmer.SetUp.Ch2PVInput
Segment.2.Ch2Rate	Channel 2 rate	float32	3af7	15095	Set by Programmer.SetUp.RateResolution
Segment.2.Ch2Time	Channel 2 time	time_t	3af5	15093	Set by Network.Modbus.TimeFormat
Segment.2.Ch2TSP	Channel 2 target set-point	float32	3af3	15091	Same as Programmer.SetUp.Ch2PVInput
Segment.2.Ch2UserVal	Channel 2 user value	float32	3b09	15113	Same as Programmer.SetUp.ResetCh2UserVal
Segment.2.Ch2Wait	Channel 2 Wait	uint8	3aff	15103	Not applicable
Segment.2.Ch2WaitVal	Channel 2 wait value	float32	3b01	15105	Same as Programmer.SetUp.PVWait2
Segment.2.Cycles	Cycles	int16	3b03	15107	Not applicable
Segment.2.Duration	Duration	time_t	3af1	15089	Set by Network.Modbus.TimeFormat
Segment.2.EndType	End type	uint8	3af8	15096	Not applicable
Segment.2.Event1	Event 1	bool	3b0a	15114	Not applicable
Segment.2.Event2	Event 2	bool	3b0b	15115	Not applicable
Segment.2.Event3	Event 3	bool	3b0c	15116	Not applicable
Segment.2.Event4	Event 4	bool	3b0d	15117	Not applicable
Segment.2.Event5	Event 5	bool	3b0e	15118	Not applicable
Segment.2.Event6	Event 6	bool	3b0f	15119	Not applicable
Segment.2.Event7	Event 7	bool	3b10	15120	Not applicable
Segment.2.Event8	Event 8	bool	3b11	15121	Not applicable
Segment.2.GoBackTo	Go back to	uint8	3b02	15106	Not applicable
Segment.2.SegmentName	Segment name	string_t	6ae5	27365	Not applicable
Segment.2.Type	Type	uint8	3af0	15088	Not applicable
Segment.2.WaitFor	Wait for	uint8	3afd	15101	Not applicable
Segment.3.Ch1Holdback	Channel 1 holdback type	uint8	3b29	15145	Not applicable
Segment.3.Ch1HoldbackVal	Channel 1 holdback value	float32	3b2b	15147	Same as Programmer.SetUp.Ch1PVInput
Segment.3.Ch1PVEvent	Channel 1 PV event	uint8	3b34	15156	Not applicable
Segment.3.Ch1PVEventUse	Channel 1 PV event use	bool	3b42	15170	Not applicable
Segment.3.Ch1PVEventVal	Channel 1 PV event value	float32	3b36	15158	Same as Programmer.SetUp.Ch1PVInput
Segment.3.Ch1Rate	Channel 1 rate	float32	3b26	15142	Set by Programmer.SetUp.RateResolution
Segment.3.Ch1Time	Channel 1 time	time_t	3b24	15140	Set by Network.Modbus.TimeFormat
Segment.3.Ch1TSP	Channel 1 target set-point	float32	3b22	15138	Same as Programmer.SetUp.Ch1PVInput
Segment.3.Ch1UserVal	Channel 1 user value	float32	3b38	15160	Same as Programmer.SetUp.ResetCh1UserVal
Segment.3.Ch1Wait	Channel 1 Wait	uint8	3b2e	15150	Not applicable
Segment.3.Ch1WaitVal	Channel 1 wait value	float32	3b30	15152	Same as Programmer.SetUp.PVWait1
Segment.3.Ch2Holdback	Channel 2 holdback type	uint8	3b2a	15146	Not applicable
Segment.3.Ch2HoldbackVal	Channel 2 holdback value	float32	3b2c	15148	Same as Programmer.SetUp.Ch2PVInput
Segment.3.Ch2PVEvent	Channel 2 PV event	uint8	3b35	15157	Not applicable
Segment.3.Ch2PVEventUse	Channel 2 PV event use	bool	3b43	15171	Not applicable
Segment.3.Ch2PVEventVal	Channel 2 PV event value	float32	3b37	15159	Same as Programmer.SetUp.Ch2PVInput
Segment.3.Ch2Rate	Channel 2 rate	float32	3b27	15143	Set by Programmer.SetUp.RateResolution
Segment.3.Ch2Time	Channel 2 time	time_t	3b25	15141	Set by Network.Modbus.TimeFormat
Segment.3.Ch2TSP	Channel 2 target set-point	float32	3b23	15139	Same as Programmer.SetUp.Ch2PVInput
Segment.3.Ch2UserVal	Channel 2 user value	float32	3b39	15161	Same as Programmer.SetUp.ResetCh2UserVal
Segment.3.Ch2Wait	Channel 2 Wait	uint8	3b2f	15151	Not applicable
Segment.3.Ch2WaitVal	Channel 2 wait value	float32	3b31	15153	Same as Programmer.SetUp.PVWait2
Segment.3.Cycles	Cycles	int16	3b33	15155	Not applicable
Segment.3.Duration	Duration	time_t	3b21	15137	Set by Network.Modbus.TimeFormat
Segment.3.EndType	End type	uint8	3b28	15144	Not applicable
Segment.3.Event1	Event 1	bool	3b3a	15162	Not applicable
Segment.3.Event2	Event 2	bool	3b3b	15163	Not applicable
Segment.3.Event3	Event 3	bool	3b3c	15164	Not applicable
Segment.3.Event4	Event 4	bool	3b3d	15165	Not applicable
Segment.3.Event5	Event 5	bool	3b3e	15166	Not applicable
Segment.3.Event6	Event 6	bool	3b3f	15167	Not applicable
Segment.3.Event7	Event 7	bool	3b40	15168	Not applicable
Segment.3.Event8	Event 8	bool	3b41	15169	Not applicable
Segment.3.GoBackTo	Go back to	uint8	3b32	15154	Not applicable
Segment.3.SegmentName	Segment name	string_t	6afa	27386	Not applicable
Segment.3.Type	Type	uint8	3b20	15136	Not applicable
Segment.3.WaitFor	Wait for	uint8	3b2d	15149	Not applicable
Segment.4.Ch1Holdback	Channel 1 holdback type	uint8	3b59	15193	Not applicable
Segment.4.Ch1HoldbackVal	Channel 1 holdback value	float32	3b5b	15195	Same as Programmer.SetUp.Ch1PVInput
Segment.4.Ch1PVEvent	Channel 1 PV event	uint8	3b64	15204	Not applicable
Segment.4.Ch1PVEventUse	Channel 1 PV event use	bool	3b72	15218	Not applicable
Segment.4.Ch1PVEventVal	Channel 1 PV event value	float32	3b66	15206	Same as Programmer.SetUp.Ch1PVInput
Segment.4.Ch1Rate	Channel 1 rate	float32	3b56	15190	Set by Programmer.SetUp.RateResolution

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.4.Ch1Time	Channel 1 time	time_t	3b54	15188	Set by Network.Modbus.TimeFormat
Segment.4.Ch1TSP	Channel 1 target set-point	float32	3b52	15186	Same as Programmer.SetUp.Ch1PVInput
Segment.4.Ch1UserVal	Channel 1 user value	float32	3b68	15208	Same as Programmer.SetUp.ResetCh1UserVal
Segment.4.Ch1Wait	Channel 1 Wait	uint8	3b5e	15198	Not applicable
Segment.4.Ch1WaitVal	Channel 1 wait value	float32	3b60	15200	Same as Programmer.SetUp.PVWait1
Segment.4.Ch2Holdback	Channel 2 holdback type	uint8	3b5a	15194	Not applicable
Segment.4.Ch2HoldbackVal	Channel 2 holdback value	float32	3b5c	15196	Same as Programmer.SetUp.Ch2PVInput
Segment.4.Ch2PVEvent	Channel 2 PV event	uint8	3b65	15205	Not applicable
Segment.4.Ch2PVEventUse	Channel 2 PV event use	bool	3b73	15219	Not applicable
Segment.4.Ch2PVEventVal	Channel 2 PV event value	float32	3b67	15207	Same as Programmer.SetUp.Ch2PVInput
Segment.4.Ch2Rate	Channel 2 rate	float32	3b57	15191	Set by Programmer.SetUp.RateResolution
Segment.4.Ch2Time	Channel 2 time	time_t	3b55	15189	Set by Network.Modbus.TimeFormat
Segment.4.Ch2TSP	Channel 2 target set-point	float32	3b53	15187	Same as Programmer.SetUp.Ch2PVInput
Segment.4.Ch2UserVal	Channel 2 user value	float32	3b69	15209	Same as Programmer.SetUp.ResetCh2UserVal
Segment.4.Ch2Wait	Channel 2 Wait	uint8	3b5f	15199	Not applicable
Segment.4.Ch2WaitVal	Channel 2 wait value	float32	3b61	15201	Same as Programmer.SetUp.PVWait2
Segment.4.Cycles	Cycles	int16	3b63	15203	Not applicable
Segment.4.Duration	Duration	time_t	3b51	15185	Set by Network.Modbus.TimeFormat
Segment.4.EndType	End type	uint8	3b58	15192	Not applicable
Segment.4.Event1	Event 1	bool	3b6a	15210	Not applicable
Segment.4.Event2	Event 2	bool	3b6b	15211	Not applicable
Segment.4.Event3	Event 3	bool	3b6c	15212	Not applicable
Segment.4.Event4	Event 4	bool	3b6d	15213	Not applicable
Segment.4.Event5	Event 5	bool	3b6e	15214	Not applicable
Segment.4.Event6	Event 6	bool	3b6f	15215	Not applicable
Segment.4.Event7	Event 7	bool	3b70	15216	Not applicable
Segment.4.Event8	Event 8	bool	3b71	15217	Not applicable
Segment.4.GoBackTo	Go back to	uint8	3b62	15202	Not applicable
Segment.4.SegmentName	Segment name	string_t	6b0f	27407	Not applicable
Segment.4.Type	Type	uint8	3b50	15184	Not applicable
Segment.4.WaitFor	Wait for	uint8	3b5d	15197	Not applicable
Segment.5.Ch1Holdback	Channel 1 holdback type	uint8	3b89	15241	Not applicable
Segment.5.Ch1HoldbackVal	Channel 1 holdback value	float32	3b8b	15243	Same as Programmer.SetUp.Ch1PVInput
Segment.5.Ch1PVEvent	Channel 1 PV event	uint8	3b94	15252	Not applicable
Segment.5.Ch1PVEventUse	Channel 1 PV event use	bool	3ba2	15266	Not applicable
Segment.5.Ch1PVEventVal	Channel 1 PV event value	float32	3b96	15254	Same as Programmer.SetUp.Ch1PVInput
Segment.5.Ch1Rate	Channel 1 rate	float32	3b86	15238	Set by Programmer.SetUp.RateResolution
Segment.5.Ch1Time	Channel 1 time	time_t	3b84	15236	Set by Network.Modbus.TimeFormat
Segment.5.Ch1TSP	Channel 1 target set-point	float32	3b82	15234	Same as Programmer.SetUp.Ch1PVInput
Segment.5.Ch1UserVal	Channel 1 user value	float32	3b98	15256	Same as Programmer.SetUp.ResetCh1UserVal
Segment.5.Ch1Wait	Channel 1 Wait	uint8	3b8e	15246	Not applicable
Segment.5.Ch1WaitVal	Channel 1 wait value	float32	3b90	15248	Same as Programmer.SetUp.PVWait1
Segment.5.Ch2Holdback	Channel 2 holdback type	uint8	3b8a	15242	Not applicable
Segment.5.Ch2HoldbackVal	Channel 2 holdback value	float32	3b8c	15244	Same as Programmer.SetUp.Ch2PVInput
Segment.5.Ch2PVEvent	Channel 2 PV event	uint8	3b95	15253	Not applicable
Segment.5.Ch2PVEventUse	Channel 2 PV event use	bool	3ba3	15267	Not applicable
Segment.5.Ch2PVEventVal	Channel 2 PV event value	float32	3b97	15255	Same as Programmer.SetUp.Ch2PVInput
Segment.5.Ch2Rate	Channel 2 rate	float32	3b87	15239	Set by Programmer.SetUp.RateResolution
Segment.5.Ch2Time	Channel 2 time	time_t	3b85	15237	Set by Network.Modbus.TimeFormat
Segment.5.Ch2TSP	Channel 2 target set-point	float32	3b83	15235	Same as Programmer.SetUp.Ch2PVInput
Segment.5.Ch2UserVal	Channel 2 user value	float32	3b99	15257	Same as Programmer.SetUp.ResetCh2UserVal
Segment.5.Ch2Wait	Channel 2 Wait	uint8	3b8f	15247	Not applicable
Segment.5.Ch2WaitVal	Channel 2 wait value	float32	3b91	15249	Same as Programmer.SetUp.PVWait2
Segment.5.Cycles	Cycles	int16	3b93	15251	Not applicable
Segment.5.Duration	Duration	time_t	3b81	15233	Set by Network.Modbus.TimeFormat
Segment.5.EndType	End type	uint8	3b88	15240	Not applicable
Segment.5.Event1	Event 1	bool	3b9a	15258	Not applicable
Segment.5.Event2	Event 2	bool	3b9b	15259	Not applicable
Segment.5.Event3	Event 3	bool	3b9c	15260	Not applicable
Segment.5.Event4	Event 4	bool	3b9d	15261	Not applicable
Segment.5.Event5	Event 5	bool	3b9e	15262	Not applicable
Segment.5.Event6	Event 6	bool	3b9f	15263	Not applicable
Segment.5.Event7	Event 7	bool	3ba0	15264	Not applicable
Segment.5.Event8	Event 8	bool	3ba1	15265	Not applicable
Segment.5.GoBackTo	Go back to	uint8	3b92	15250	Not applicable
Segment.5.SegmentName	Segment name	string_t	6b24	27428	Not applicable
Segment.5.Type	Type	uint8	3b80	15232	Not applicable
Segment.5.WaitFor	Wait for	uint8	3b8d	15245	Not applicable
Segment.6.Ch1Holdback	Channel 1 holdback type	uint8	3bb9	15289	Not applicable
Segment.6.Ch1HoldbackVal	Channel 1 holdback value	float32	3bbb	15291	Same as Programmer.SetUp.Ch1PVInput
Segment.6.Ch1PVEvent	Channel 1 PV event	uint8	3bc4	15300	Not applicable
Segment.6.Ch1PVEventUse	Channel 1 PV event use	bool	3bd2	15314	Not applicable
Segment.6.Ch1PVEventVal	Channel 1 PV event value	float32	3bc6	15302	Same as Programmer.SetUp.Ch1PVInput
Segment.6.Ch1Rate	Channel 1 rate	float32	3bb6	15286	Set by Programmer.SetUp.RateResolution
Segment.6.Ch1Time	Channel 1 time	time_t	3bb4	15284	Set by Network.Modbus.TimeFormat
Segment.6.Ch1TSP	Channel 1 target set-point	float32	3bb2	15282	Same as Programmer.SetUp.Ch1PVInput
Segment.6.Ch1UserVal	Channel 1 user value	float32	3bc8	15304	Same as Programmer.SetUp.ResetCh1UserVal
Segment.6.Ch1Wait	Channel 1 Wait	uint8	3bbe	15294	Not applicable
Segment.6.Ch1WaitVal	Channel 1 wait value	float32	3bc0	15296	Same as Programmer.SetUp.PVWait1

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.6.Ch2Holdback	Channel 2 holdback type	uint8	3bba	15290	Not applicable
Segment.6.Ch2HoldbackVal	Channel 2 holdback value	float32	3bbc	15292	Same as Programmer.SetUp.Ch2PVInput
Segment.6.Ch2PVEvent	Channel 2 PV event	uint8	3bc5	15301	Not applicable
Segment.6.Ch2PVEventUse	Channel 2 PV event use	bool	3bd3	15315	Not applicable
Segment.6.Ch2PVEventVal	Channel 2 PV event value	float32	3bc7	15303	Same as Programmer.SetUp.Ch2PVInput
Segment.6.Ch2Rate	Channel 2 rate	float32	3bb7	15287	Set by Programmer.SetUp.RateResolution
Segment.6.Ch2Time	Channel 2 time	time_t	3bb5	15285	Set by Network.Modbus.TimeFormat
Segment.6.Ch2TSP	Channel 2 target set-point	float32	3bb3	15283	Same as Programmer.SetUp.Ch2PVInput
Segment.6.Ch2UserVal	Channel 2 user value	float32	3bc9	15305	Same as Programmer.SetUp.ResetCh2UserVal
Segment.6.Ch2Wait	Channel 2 Wait	uint8	3bbf	15295	Not applicable
Segment.6.Ch2WaitVal	Channel 2 wait value	float32	3bc1	15297	Same as Programmer.SetUp.PVWait2
Segment.6.Cycles	Cycles	int16	3bc3	15299	Not applicable
Segment.6.Duration	Duration	time_t	3bb1	15281	Set by Network.Modbus.TimeFormat
Segment.6.EndType	End type	uint8	3bb8	15288	Not applicable
Segment.6.Event1	Event 1	bool	3bca	15306	Not applicable
Segment.6.Event2	Event 2	bool	3bcb	15307	Not applicable
Segment.6.Event3	Event 3	bool	3bcc	15308	Not applicable
Segment.6.Event4	Event 4	bool	3bcd	15309	Not applicable
Segment.6.Event5	Event 5	bool	3bce	15310	Not applicable
Segment.6.Event6	Event 6	bool	3bcf	15311	Not applicable
Segment.6.Event7	Event 7	bool	3bd0	15312	Not applicable
Segment.6.Event8	Event 8	bool	3bd1	15313	Not applicable
Segment.6.GoBackTo	Go back to	uint8	3bc2	15298	Not applicable
Segment.6.SegmentName	Segment name	string_t	6b39	27449	Not applicable
Segment.6.Type	Type	uint8	3bb0	15280	Not applicable
Segment.6.WaitFor	Wait for	uint8	3bbd	15293	Not applicable
Segment.7.Ch1Holdback	Channel 1 holdback type	uint8	3be9	15337	Not applicable
Segment.7.Ch1HoldbackVal	Channel 1 holdback value	float32	3beb	15339	Same as Programmer.SetUp.Ch1PVInput
Segment.7.Ch1PVEvent	Channel 1 PV event	uint8	3bf4	15348	Not applicable
Segment.7.Ch1PVEventUse	Channel 1 PV event use	bool	3c02	15362	Not applicable
Segment.7.Ch1PVEventVal	Channel 1 PV event value	float32	3bf6	15350	Same as Programmer.SetUp.Ch1PVInput
Segment.7.Ch1Rate	Channel 1 rate	float32	3be6	15334	Set by Programmer.SetUp.RateResolution
Segment.7.Ch1Time	Channel 1 time	time_t	3be4	15332	Set by Network.Modbus.TimeFormat
Segment.7.Ch1TSP	Channel 1 target set-point	float32	3be2	15330	Same as Programmer.SetUp.Ch1PVInput
Segment.7.Ch1UserVal	Channel 1 user value	float32	3bf8	15352	Same as Programmer.SetUp.ResetCh1UserVal
Segment.7.Ch1Wait	Channel 1 Wait	uint8	3bee	15342	Not applicable
Segment.7.Ch1WaitVal	Channel 1 wait value	float32	3bf0	15344	Same as Programmer.SetUp.PVWait1
Segment.7.Ch2Holdback	Channel 2 holdback type	uint8	3bea	15338	Not applicable
Segment.7.Ch2HoldbackVal	Channel 2 holdback value	float32	3bec	15340	Same as Programmer.SetUp.Ch2PVInput
Segment.7.Ch2PVEvent	Channel 2 PV event	uint8	3bf5	15349	Not applicable
Segment.7.Ch2PVEventUse	Channel 2 PV event use	bool	3c03	15363	Not applicable
Segment.7.Ch2PVEventVal	Channel 2 PV event value	float32	3bf7	15351	Same as Programmer.SetUp.Ch2PVInput
Segment.7.Ch2Rate	Channel 2 rate	float32	3be7	15335	Set by Programmer.SetUp.RateResolution
Segment.7.Ch2Time	Channel 2 time	time_t	3be5	15333	Set by Network.Modbus.TimeFormat
Segment.7.Ch2TSP	Channel 2 target set-point	float32	3be3	15331	Same as Programmer.SetUp.Ch2PVInput
Segment.7.Ch2UserVal	Channel 2 user value	float32	3bf9	15353	Same as Programmer.SetUp.ResetCh2UserVal
Segment.7.Ch2Wait	Channel 2 Wait	uint8	3bef	15343	Not applicable
Segment.7.Ch2WaitVal	Channel 2 wait value	float32	3bf1	15345	Same as Programmer.SetUp.PVWait2
Segment.7.Cycles	Cycles	int16	3bf3	15347	Not applicable
Segment.7.Duration	Duration	time_t	3be1	15329	Set by Network.Modbus.TimeFormat
Segment.7.EndType	End type	uint8	3be8	15336	Not applicable
Segment.7.Event1	Event 1	bool	3bfa	15354	Not applicable
Segment.7.Event2	Event 2	bool	3bfb	15355	Not applicable
Segment.7.Event3	Event 3	bool	3bfc	15356	Not applicable
Segment.7.Event4	Event 4	bool	3bfd	15357	Not applicable
Segment.7.Event5	Event 5	bool	3bfe	15358	Not applicable
Segment.7.Event6	Event 6	bool	3bff	15359	Not applicable
Segment.7.Event7	Event 7	bool	3c00	15360	Not applicable
Segment.7.Event8	Event 8	bool	3c01	15361	Not applicable
Segment.7.GoBackTo	Go back to	uint8	3bf2	15346	Not applicable
Segment.7.SegmentName	Segment name	string_t	6b4e	27470	Not applicable
Segment.7.Type	Type	uint8	3be0	15328	Not applicable
Segment.7.WaitFor	Wait for	uint8	3bed	15341	Not applicable
Segment.8.Ch1Holdback	Channel 1 holdback type	uint8	3c19	15385	Not applicable
Segment.8.Ch1HoldbackVal	Channel 1 holdback value	float32	3c1b	15387	Same as Programmer.SetUp.Ch1PVInput
Segment.8.Ch1PVEvent	Channel 1 PV event	uint8	3c24	15396	Not applicable
Segment.8.Ch1PVEventUse	Channel 1 PV event use	bool	3c32	15410	Not applicable
Segment.8.Ch1PVEventVal	Channel 1 PV event value	float32	3c26	15398	Same as Programmer.SetUp.Ch1PVInput
Segment.8.Ch1Rate	Channel 1 rate	float32	3c16	15382	Set by Programmer.SetUp.RateResolution
Segment.8.Ch1Time	Channel 1 time	time_t	3c14	15380	Set by Network.Modbus.TimeFormat
Segment.8.Ch1TSP	Channel 1 target set-point	float32	3c12	15378	Same as Programmer.SetUp.Ch1PVInput
Segment.8.Ch1UserVal	Channel 1 user value	float32	3c28	15400	Same as Programmer.SetUp.ResetCh1UserVal
Segment.8.Ch1Wait	Channel 1 Wait	uint8	3c1e	15390	Not applicable
Segment.8.Ch1WaitVal	Channel 1 wait value	float32	3c20	15392	Same as Programmer.SetUp.PVWait1
Segment.8.Ch2Holdback	Channel 2 holdback type	uint8	3c1a	15386	Not applicable
Segment.8.Ch2HoldbackVal	Channel 2 holdback value	float32	3c1c	15388	Same as Programmer.SetUp.Ch2PVInput
Segment.8.Ch2PVEvent	Channel 2 PV event	uint8	3c25	15397	Not applicable
Segment.8.Ch2PVEventUse	Channel 2 PV event use	bool	3c33	15411	Not applicable
Segment.8.Ch2PVEventVal	Channel 2 PV event value	float32	3c27	15399	Same as Programmer.SetUp.Ch2PVInput

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.8.Ch2Rate	Channel 2 rate	float32	3c17	15383	Set by Programmer.SetUp.RateResolution
Segment.8.Ch2Time	Channel 2 time	time_t	3c15	15381	Set by Network.Modbus.TimeFormat
Segment.8.Ch2TSP	Channel 2 target set-point	float32	3c13	15379	Same as Programmer.SetUp.Ch2PVInput
Segment.8.Ch2UserVal	Channel 2 user value	float32	3c29	15401	Same as Programmer.SetUp.ResetCh2UserVal
Segment.8.Ch2Wait	Channel 2 Wait	uint8	3c1f	15391	Not applicable
Segment.8.Ch2WaitVal	Channel 2 wait value	float32	3c21	15393	Same as Programmer.SetUp.PVWait2
Segment.8.Cycles	Cycles	int16	3c23	15395	Not applicable
Segment.8.Duration	Duration	time_t	3c11	15377	Set by Network.Modbus.TimeFormat
Segment.8.EndType	End type	uint8	3c18	15384	Not applicable
Segment.8.Event1	Event 1	bool	3c2a	15402	Not applicable
Segment.8.Event2	Event 2	bool	3c2b	15403	Not applicable
Segment.8.Event3	Event 3	bool	3c2c	15404	Not applicable
Segment.8.Event4	Event 4	bool	3c2d	15405	Not applicable
Segment.8.Event5	Event 5	bool	3c2e	15406	Not applicable
Segment.8.Event6	Event 6	bool	3c2f	15407	Not applicable
Segment.8.Event7	Event 7	bool	3c30	15408	Not applicable
Segment.8.Event8	Event 8	bool	3c31	15409	Not applicable
Segment.8.GoBackTo	Go back to	uint8	3c22	15394	Not applicable
Segment.8.SegmentName	Segment name	string_t	6b63	27491	Not applicable
Segment.8.Type	Type	uint8	3c10	15376	Not applicable
Segment.8.WaitFor	Wait for	uint8	3c1d	15389	Not applicable
Segment.9.Ch1Holdback	Channel 1 holdback type	uint8	3c49	15433	Not applicable
Segment.9.Ch1HoldbackVal	Channel 1 holdback value	float32	3c4b	15435	Same as Programmer.SetUp.Ch1PVInput
Segment.9.Ch1PVEvent	Channel 1 PV event	uint8	3c54	15444	Not applicable
Segment.9.Ch1PVEventUse	Channel 1 PV event use	bool	3c62	15458	Not applicable
Segment.9.Ch1PVEventVal	Channel 1 PV event value	float32	3c56	15446	Same as Programmer.SetUp.Ch1PVInput
Segment.9.Ch1Rate	Channel 1 rate	float32	3c46	15430	Set by Programmer.SetUp.RateResolution
Segment.9.Ch1Time	Channel 1 time	time_t	3c44	15428	Set by Network.Modbus.TimeFormat
Segment.9.Ch1TSP	Channel 1 target set-point	float32	3c42	15426	Same as Programmer.SetUp.Ch1PVInput
Segment.9.Ch1UserVal	Channel 1 user value	float32	3c58	15448	Same as Programmer.SetUp.ResetCh1UserVal
Segment.9.Ch1Wait	Channel 1 Wait	uint8	3c4e	15438	Not applicable
Segment.9.Ch1WaitVal	Channel 1 wait value	float32	3c50	15440	Same as Programmer.SetUp.PVWait1
Segment.9.Ch2Holdback	Channel 2 holdback type	uint8	3c4a	15434	Not applicable
Segment.9.Ch2HoldbackVal	Channel 2 holdback value	float32	3c4c	15436	Same as Programmer.SetUp.Ch2PVInput
Segment.9.Ch2PVEvent	Channel 2 PV event	uint8	3c55	15445	Not applicable
Segment.9.Ch2PVEventUse	Channel 2 PV event use	bool	3c63	15459	Not applicable
Segment.9.Ch2PVEventVal	Channel 2 PV event value	float32	3c57	15447	Same as Programmer.SetUp.Ch2PVInput
Segment.9.Ch2Rate	Channel 2 rate	float32	3c47	15431	Set by Programmer.SetUp.RateResolution
Segment.9.Ch2Time	Channel 2 time	time_t	3c45	15429	Set by Network.Modbus.TimeFormat
Segment.9.Ch2TSP	Channel 2 target set-point	float32	3c43	15427	Same as Programmer.SetUp.Ch2PVInput
Segment.9.Ch2UserVal	Channel 2 user value	float32	3c59	15449	Same as Programmer.SetUp.ResetCh2UserVal
Segment.9.Ch2Wait	Channel 2 Wait	uint8	3c4f	15439	Not applicable
Segment.9.Ch2WaitVal	Channel 2 wait value	float32	3c51	15441	Same as Programmer.SetUp.PVWait2
Segment.9.Cycles	Cycles	int16	3c53	15443	Not applicable
Segment.9.Duration	Duration	time_t	3c41	15425	Set by Network.Modbus.TimeFormat
Segment.9.EndType	End type	uint8	3c48	15432	Not applicable
Segment.9.Event1	Event 1	bool	3c5a	15450	Not applicable
Segment.9.Event2	Event 2	bool	3c5b	15451	Not applicable
Segment.9.Event3	Event 3	bool	3c5c	15452	Not applicable
Segment.9.Event4	Event 4	bool	3c5d	15453	Not applicable
Segment.9.Event5	Event 5	bool	3c5e	15454	Not applicable
Segment.9.Event6	Event 6	bool	3c5f	15455	Not applicable
Segment.9.Event7	Event 7	bool	3c60	15456	Not applicable
Segment.9.Event8	Event 8	bool	3c61	15457	Not applicable
Segment.9.GoBackTo	Go back to	uint8	3c52	15442	Not applicable
Segment.9.SegmentName	Segment name	string_t	6b78	27512	Not applicable
Segment.9.Type	Type	uint8	3c40	15424	Not applicable
Segment.9.WaitFor	Wait for	uint8	3c4d	15437	Not applicable
Segment.10.Ch1Holdback	Channel 1 holdback type	uint8	3c79	15481	Not applicable
Segment.10.Ch1HoldbackVal	Channel 1 holdback value	float32	3c7b	15483	Same as Programmer.SetUp.Ch1PVInput
Segment.10.Ch1PVEvent	Channel 1 PV event	uint8	3c84	15492	Not applicable
Segment.10.Ch1PVEventUse	Channel 1 PV event use	bool	3c92	15506	Not applicable
Segment.10.Ch1PVEventVal	Channel 1 PV event value	float32	3c86	15494	Same as Programmer.SetUp.Ch1PVInput
Segment.10.Ch1Rate	Channel 1 rate	float32	3c76	15478	Set by Programmer.SetUp.RateResolution
Segment.10.Ch1Time	Channel 1 time	time_t	3c74	15476	Set by Network.Modbus.TimeFormat
Segment.10.Ch1TSP	Channel 1 target set-point	float32	3c72	15474	Same as Programmer.SetUp.Ch1PVInput
Segment.10.Ch1UserVal	Channel 1 user value	float32	3c88	15496	Same as Programmer.SetUp.ResetCh1UserVal
Segment.10.Ch1Wait	Channel 1 Wait	uint8	3c7e	15486	Not applicable
Segment.10.Ch1WaitVal	Channel 1 wait value	float32	3c80	15488	Same as Programmer.SetUp.PVWait1
Segment.10.Ch2Holdback	Channel 2 holdback type	uint8	3c7a	15482	Not applicable
Segment.10.Ch2HoldbackVal	Channel 2 holdback value	float32	3c7c	15484	Same as Programmer.SetUp.Ch2PVInput
Segment.10.Ch2PVEvent	Channel 2 PV event	uint8	3c85	15493	Not applicable
Segment.10.Ch2PVEventUse	Channel 2 PV event use	bool	3c93	15507	Not applicable
Segment.10.Ch2PVEventVal	Channel 2 PV event value	float32	3c87	15495	Same as Programmer.SetUp.Ch2PVInput
Segment.10.Ch2Rate	Channel 2 rate	float32	3c77	15479	Set by Programmer.SetUp.RateResolution
Segment.10.Ch2Time	Channel 2 time	time_t	3c75	15477	Set by Network.Modbus.TimeFormat
Segment.10.Ch2TSP	Channel 2 target set-point	float32	3c73	15475	Same as Programmer.SetUp.Ch2PVInput
Segment.10.Ch2UserVal	Channel 2 user value	float32	3c89	15497	Same as Programmer.SetUp.ResetCh2UserVal
Segment.10.Ch2Wait	Channel 2 Wait	uint8	3c7f	15487	Not applicable

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.10.Ch2WaitVal	Channel 2 wait value	float32	3c81	15489	Same as Programmer.SetUp.PVWait2
Segment.10.Cycles	Cycles	int16	3c83	15491	Not applicable
Segment.10.Duration	Duration	time_t	3c71	15473	Set by Network.Modbus.TimeFormat
Segment.10.EndType	End type	uint8	3c78	15480	Not applicable
Segment.10.Event1	Event 1	bool	3c8a	15498	Not applicable
Segment.10.Event2	Event 2	bool	3c8b	15499	Not applicable
Segment.10.Event3	Event 3	bool	3c8c	15500	Not applicable
Segment.10.Event4	Event 4	bool	3c8d	15501	Not applicable
Segment.10.Event5	Event 5	bool	3c8e	15502	Not applicable
Segment.10.Event6	Event 6	bool	3c8f	15503	Not applicable
Segment.10.Event7	Event 7	bool	3c90	15504	Not applicable
Segment.10.Event8	Event 8	bool	3c91	15505	Not applicable
Segment.10.GoBackTo	Go back to	uint8	3c82	15490	Not applicable
Segment.10.SegmentName	Segment name	string_t	6b8d	27533	Not applicable
Segment.10.Type	Type	uint8	3c70	15472	Not applicable
Segment.10.WaitFor	Wait for	uint8	3c7d	15485	Not applicable
Segment.11.Ch1Holdback	Channel 1 holdback type	uint8	3ca9	15529	Not applicable
Segment.11.Ch1HoldbackVal	Channel 1 holdback value	float32	3cab	15531	Same as Programmer.SetUp.Ch1PVInput
Segment.11.Ch1PVEvent	Channel 1 PV event	uint8	3cb4	15540	Not applicable
Segment.11.Ch1PVEventUse	Channel 1 PV event use	bool	3cc2	15554	Not applicable
Segment.11.Ch1PVEventVal	Channel 1 PV event value	float32	3cb6	15542	Same as Programmer.SetUp.Ch1PVInput
Segment.11.Ch1Rate	Channel 1 rate	float32	3ca6	15526	Set by Programmer.SetUp.RateResolution
Segment.11.Ch1Time	Channel 1 time	time_t	3ca4	15524	Set by Network.Modbus.TimeFormat
Segment.11.Ch1TSP	Channel 1 target set-point	float32	3ca2	15522	Same as Programmer.SetUp.Ch1PVInput
Segment.11.Ch1UserVal	Channel 1 user value	float32	3cb8	15544	Same as Programmer.SetUp.ResetCh1UserVal
Segment.11.Ch1Wait	Channel 1 Wait	uint8	3cae	15534	Not applicable
Segment.11.Ch1WaitVal	Channel 1 wait value	float32	3cb0	15536	Same as Programmer.SetUp.PVWait1
Segment.11.Ch2Holdback	Channel 2 holdback type	uint8	3caa	15530	Not applicable
Segment.11.Ch2HoldbackVal	Channel 2 holdback value	float32	3cac	15532	Same as Programmer.SetUp.Ch2PVInput
Segment.11.Ch2PVEvent	Channel 2 PV event	uint8	3cb5	15541	Not applicable
Segment.11.Ch2PVEventUse	Channel 2 PV event use	bool	3cc3	15555	Not applicable
Segment.11.Ch2PVEventVal	Channel 2 PV event value	float32	3cb7	15543	Same as Programmer.SetUp.Ch2PVInput
Segment.11.Ch2Rate	Channel 2 rate	float32	3ca7	15527	Set by Programmer.SetUp.RateResolution
Segment.11.Ch2Time	Channel 2 time	time_t	3ca5	15525	Set by Network.Modbus.TimeFormat
Segment.11.Ch2TSP	Channel 2 target set-point	float32	3ca3	15523	Same as Programmer.SetUp.Ch2PVInput
Segment.11.Ch2UserVal	Channel 2 user value	float32	3cb9	15545	Same as Programmer.SetUp.ResetCh2UserVal
Segment.11.Ch2Wait	Channel 2 Wait	uint8	3caf	15535	Not applicable
Segment.11.Ch2WaitVal	Channel 2 wait value	float32	3cb1	15537	Same as Programmer.SetUp.PVWait2
Segment.11.Cycles	Cycles	int16	3cb3	15539	Not applicable
Segment.11.Duration	Duration	time_t	3ca1	15521	Set by Network.Modbus.TimeFormat
Segment.11.EndType	End type	uint8	3ca8	15528	Not applicable
Segment.11.Event1	Event 1	bool	3cba	15546	Not applicable
Segment.11.Event2	Event 2	bool	3cbb	15547	Not applicable
Segment.11.Event3	Event 3	bool	3cbc	15548	Not applicable
Segment.11.Event4	Event 4	bool	3cbd	15549	Not applicable
Segment.11.Event5	Event 5	bool	3cbe	15550	Not applicable
Segment.11.Event6	Event 6	bool	3cbf	15551	Not applicable
Segment.11.Event7	Event 7	bool	3cc0	15552	Not applicable
Segment.11.Event8	Event 8	bool	3cc1	15553	Not applicable
Segment.11.GoBackTo	Go back to	uint8	3cb2	15538	Not applicable
Segment.11.SegmentName	Segment name	string_t	6ba2	27554	Not applicable
Segment.11.Type	Type	uint8	3ca0	15520	Not applicable
Segment.11.WaitFor	Wait for	uint8	3cad	15533	Not applicable
Segment.12.Ch1Holdback	Channel 1 holdback type	uint8	3cd9	15577	Not applicable
Segment.12.Ch1HoldbackVal	Channel 1 holdback value	float32	3cdb	15579	Same as Programmer.SetUp.Ch1PVInput
Segment.12.Ch1PVEvent	Channel 1 PV event	uint8	3ce4	15588	Not applicable
Segment.12.Ch1PVEventUse	Channel 1 PV event use	bool	3cf2	15602	Not applicable
Segment.12.Ch1PVEventVal	Channel 1 PV event value	float32	3ce6	15590	Same as Programmer.SetUp.Ch1PVInput
Segment.12.Ch1Rate	Channel 1 rate	float32	3cd6	15574	Set by Programmer.SetUp.RateResolution
Segment.12.Ch1Time	Channel 1 time	time_t	3cd4	15572	Set by Network.Modbus.TimeFormat
Segment.12.Ch1TSP	Channel 1 target set-point	float32	3cd2	15570	Same as Programmer.SetUp.Ch1PVInput
Segment.12.Ch1UserVal	Channel 1 user value	float32	3ce8	15592	Same as Programmer.SetUp.ResetCh1UserVal
Segment.12.Ch1Wait	Channel 1 Wait	uint8	3cde	15582	Not applicable
Segment.12.Ch1WaitVal	Channel 1 wait value	float32	3ce0	15584	Same as Programmer.SetUp.PVWait1
Segment.12.Ch2Holdback	Channel 2 holdback type	uint8	3cda	15578	Not applicable
Segment.12.Ch2HoldbackVal	Channel 2 holdback value	float32	3cdc	15580	Same as Programmer.SetUp.Ch2PVInput
Segment.12.Ch2PVEvent	Channel 2 PV event	uint8	3ce5	15589	Not applicable
Segment.12.Ch2PVEventUse	Channel 2 PV event use	bool	3cf3	15603	Not applicable
Segment.12.Ch2PVEventVal	Channel 2 PV event value	float32	3ce7	15591	Same as Programmer.SetUp.Ch2PVInput
Segment.12.Ch2Rate	Channel 2 rate	float32	3cd7	15575	Set by Programmer.SetUp.RateResolution
Segment.12.Ch2Time	Channel 2 time	time_t	3cd5	15573	Set by Network.Modbus.TimeFormat
Segment.12.Ch2TSP	Channel 2 target set-point	float32	3cd3	15571	Same as Programmer.SetUp.Ch2PVInput
Segment.12.Ch2UserVal	Channel 2 user value	float32	3ce9	15593	Same as Programmer.SetUp.ResetCh2UserVal
Segment.12.Ch2Wait	Channel 2 Wait	uint8	3cdf	15583	Not applicable
Segment.12.Ch2WaitVal	Channel 2 wait value	float32	3ce1	15585	Same as Programmer.SetUp.PVWait2
Segment.12.Cycles	Cycles	int16	3ce3	15587	Not applicable
Segment.12.Duration	Duration	time_t	3cd1	15569	Set by Network.Modbus.TimeFormat
Segment.12.EndType	End type	uint8	3cd8	15576	Not applicable
Segment.12.Event1	Event 1	bool	3cea	15594	Not applicable

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.12.Event2	Event 2	bool	3ceb	15595	Not applicable
Segment.12.Event3	Event 3	bool	3cec	15596	Not applicable
Segment.12.Event4	Event 4	bool	3ced	15597	Not applicable
Segment.12.Event5	Event 5	bool	3cee	15598	Not applicable
Segment.12.Event6	Event 6	bool	3cef	15599	Not applicable
Segment.12.Event7	Event 7	bool	3cf0	15600	Not applicable
Segment.12.Event8	Event 8	bool	3cf1	15601	Not applicable
Segment.12.GoBackTo	Go back to	uint8	3ce2	15586	Not applicable
Segment.12.SegmentName	Segment name	string_t	6bb7	27575	Not applicable
Segment.12.Type	Type	uint8	3cd0	15568	Not applicable
Segment.12.WaitFor	Wait for	uint8	3cdd	15581	Not applicable
Segment.13.Ch1Holdback	Channel 1 holdback type	uint8	3d09	15625	Not applicable
Segment.13.Ch1HoldbackVal	Channel 1 holdback value	float32	3d0b	15627	Same as Programmer.SetUp.Ch1PVInput
Segment.13.Ch1PVEvent	Channel 1 PV event	uint8	3d14	15636	Not applicable
Segment.13.Ch1PVEventUse	Channel 1 PV event use	bool	3d22	15650	Not applicable
Segment.13.Ch1PVEventVal	Channel 1 PV event value	float32	3d16	15638	Same as Programmer.SetUp.Ch1PVInput
Segment.13.Ch1Rate	Channel 1 rate	float32	3d06	15622	Set by Programmer.SetUp.RateResolution
Segment.13.Ch1Time	Channel 1 time	time_t	3d04	15620	Set by Network.Modbus.TimeFormat
Segment.13.Ch1TSP	Channel 1 target set-point	float32	3d02	15618	Same as Programmer.SetUp.Ch1PVInput
Segment.13.Ch1UserVal	Channel 1 user value	float32	3d18	15640	Same as Programmer.SetUp.ResetCh1UserVal
Segment.13.Ch1Wait	Channel 1 Wait	uint8	3d0e	15630	Not applicable
Segment.13.Ch1WaitVal	Channel 1 wait value	float32	3d10	15632	Same as Programmer.SetUp.PVWait1
Segment.13.Ch2Holdback	Channel 2 holdback type	uint8	3d0a	15626	Not applicable
Segment.13.Ch2HoldbackVal	Channel 2 holdback value	float32	3d0c	15628	Same as Programmer.SetUp.Ch2PVInput
Segment.13.Ch2PVEvent	Channel 2 PV event	uint8	3d15	15637	Not applicable
Segment.13.Ch2PVEventUse	Channel 2 PV event use	bool	3d23	15651	Not applicable
Segment.13.Ch2PVEventVal	Channel 2 PV event value	float32	3d17	15639	Same as Programmer.SetUp.Ch2PVInput
Segment.13.Ch2Rate	Channel 2 rate	float32	3d07	15623	Set by Programmer.SetUp.RateResolution
Segment.13.Ch2Time	Channel 2 time	time_t	3d05	15621	Set by Network.Modbus.TimeFormat
Segment.13.Ch2TSP	Channel 2 target set-point	float32	3d03	15619	Same as Programmer.SetUp.Ch2PVInput
Segment.13.Ch2UserVal	Channel 2 user value	float32	3d19	15641	Same as Programmer.SetUp.ResetCh2UserVal
Segment.13.Ch2Wait	Channel 2 Wait	uint8	3d0f	15631	Not applicable
Segment.13.Ch2WaitVal	Channel 2 wait value	float32	3d11	15633	Same as Programmer.SetUp.PVWait2
Segment.13.Cycles	Cycles	int16	3d13	15635	Not applicable
Segment.13.Duration	Duration	time_t	3d01	15617	Set by Network.Modbus.TimeFormat
Segment.13.EndType	End type	uint8	3d08	15624	Not applicable
Segment.13.Event1	Event 1	bool	3d1a	15642	Not applicable
Segment.13.Event2	Event 2	bool	3d1b	15643	Not applicable
Segment.13.Event3	Event 3	bool	3d1c	15644	Not applicable
Segment.13.Event4	Event 4	bool	3d1d	15645	Not applicable
Segment.13.Event5	Event 5	bool	3d1e	15646	Not applicable
Segment.13.Event6	Event 6	bool	3d1f	15647	Not applicable
Segment.13.Event7	Event 7	bool	3d20	15648	Not applicable
Segment.13.Event8	Event 8	bool	3d21	15649	Not applicable
Segment.13.GoBackTo	Go back to	uint8	3d12	15634	Not applicable
Segment.13.SegmentName	Segment name	string_t	6bcc	27596	Not applicable
Segment.13.Type	Type	uint8	3d00	15616	Not applicable
Segment.13.WaitFor	Wait for	uint8	3d0d	15629	Not applicable
Segment.14.Ch1Holdback	Channel 1 holdback type	uint8	3d39	15673	Not applicable
Segment.14.Ch1HoldbackVal	Channel 1 holdback value	float32	3d3b	15675	Same as Programmer.SetUp.Ch1PVInput
Segment.14.Ch1PVEvent	Channel 1 PV event	uint8	3d44	15684	Not applicable
Segment.14.Ch1PVEventUse	Channel 1 PV event use	bool	3d52	15698	Not applicable
Segment.14.Ch1PVEventVal	Channel 1 PV event value	float32	3d46	15686	Same as Programmer.SetUp.Ch1PVInput
Segment.14.Ch1Rate	Channel 1 rate	float32	3d36	15670	Set by Programmer.SetUp.RateResolution
Segment.14.Ch1Time	Channel 1 time	time_t	3d34	15668	Set by Network.Modbus.TimeFormat
Segment.14.Ch1TSP	Channel 1 target set-point	float32	3d32	15666	Same as Programmer.SetUp.Ch1PVInput
Segment.14.Ch1UserVal	Channel 1 user value	float32	3d48	15688	Same as Programmer.SetUp.ResetCh1UserVal
Segment.14.Ch1Wait	Channel 1 Wait	uint8	3d3e	15678	Not applicable
Segment.14.Ch1WaitVal	Channel 1 wait value	float32	3d40	15680	Same as Programmer.SetUp.PVWait1
Segment.14.Ch2Holdback	Channel 2 holdback type	uint8	3d3a	15674	Not applicable
Segment.14.Ch2HoldbackVal	Channel 2 holdback value	float32	3d3c	15676	Same as Programmer.SetUp.Ch2PVInput
Segment.14.Ch2PVEvent	Channel 2 PV event	uint8	3d45	15685	Not applicable
Segment.14.Ch2PVEventUse	Channel 2 PV event use	bool	3d53	15699	Not applicable
Segment.14.Ch2PVEventVal	Channel 2 PV event value	float32	3d47	15687	Same as Programmer.SetUp.Ch2PVInput
Segment.14.Ch2Rate	Channel 2 rate	float32	3d37	15671	Set by Programmer.SetUp.RateResolution
Segment.14.Ch2Time	Channel 2 time	time_t	3d35	15669	Set by Network.Modbus.TimeFormat
Segment.14.Ch2TSP	Channel 2 target set-point	float32	3d33	15667	Same as Programmer.SetUp.Ch2PVInput
Segment.14.Ch2UserVal	Channel 2 user value	float32	3d49	15689	Same as Programmer.SetUp.ResetCh2UserVal
Segment.14.Ch2Wait	Channel 2 Wait	uint8	3d3f	15679	Not applicable
Segment.14.Ch2WaitVal	Channel 2 wait value	float32	3d41	15681	Same as Programmer.SetUp.PVWait2
Segment.14.Cycles	Cycles	int16	3d43	15683	Not applicable
Segment.14.Duration	Duration	time_t	3d31	15665	Set by Network.Modbus.TimeFormat
Segment.14.EndType	End type	uint8	3d38	15672	Not applicable
Segment.14.Event1	Event 1	bool	3d4a	15690	Not applicable
Segment.14.Event2	Event 2	bool	3d4b	15691	Not applicable
Segment.14.Event3	Event 3	bool	3d4c	15692	Not applicable
Segment.14.Event4	Event 4	bool	3d4d	15693	Not applicable
Segment.14.Event5	Event 5	bool	3d4e	15694	Not applicable
Segment.14.Event6	Event 6	bool	3d4f	15695	Not applicable

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.14.Event7	Event 7	bool	3d50	15696	Not applicable
Segment.14.Event8	Event 8	bool	3d51	15697	Not applicable
Segment.14.GoBackTo	Go back to	uint8	3d42	15682	Not applicable
Segment.14.SegmentName	Segment name	string_t	6be1	27617	Not applicable
Segment.14.Type	Type	uint8	3d30	15664	Not applicable
Segment.14.WaitFor	Wait for	uint8	3d3d	15677	Not applicable
Segment.15.Ch1Holdback	Channel 1 holdback type	uint8	3d69	15721	Not applicable
Segment.15.Ch1HoldbackVal	Channel 1 holdback value	float32	3d6b	15723	Same as Programmer.SetUp.Ch1PVInput
Segment.15.Ch1PVEvent	Channel 1 PV event	uint8	3d74	15732	Not applicable
Segment.15.Ch1PVEventUse	Channel 1 PV event use	bool	3d82	15746	Not applicable
Segment.15.Ch1PVEventVal	Channel 1 PV event value	float32	3d76	15734	Same as Programmer.SetUp.Ch1PVInput
Segment.15.Ch1Rate	Channel 1 rate	float32	3d66	15718	Set by Programmer.SetUp.RateResolution
Segment.15.Ch1Time	Channel 1 time	time_t	3d64	15716	Set by Network.Modbus.TimeFormat
Segment.15.Ch1TSP	Channel 1 target set-point	float32	3d62	15714	Same as Programmer.SetUp.Ch1PVInput
Segment.15.Ch1UserVal	Channel 1 user value	float32	3d78	15736	Same as Programmer.SetUp.ResetCh1UserVal
Segment.15.Ch1Wait	Channel 1 Wait	uint8	3d6e	15726	Not applicable
Segment.15.Ch1WaitVal	Channel 1 wait value	float32	3d70	15728	Same as Programmer.SetUp.PVWait1
Segment.15.Ch2Holdback	Channel 2 holdback type	uint8	3d6a	15722	Not applicable
Segment.15.Ch2HoldbackVal	Channel 2 holdback value	float32	3d6c	15724	Same as Programmer.SetUp.Ch2PVInput
Segment.15.Ch2PVEvent	Channel 2 PV event	uint8	3d75	15733	Not applicable
Segment.15.Ch2PVEventUse	Channel 2 PV event use	bool	3d83	15747	Not applicable
Segment.15.Ch2PVEventVal	Channel 2 PV event value	float32	3d77	15735	Same as Programmer.SetUp.Ch2PVInput
Segment.15.Ch2Rate	Channel 2 rate	float32	3d67	15719	Set by Programmer.SetUp.RateResolution
Segment.15.Ch2Time	Channel 2 time	time_t	3d65	15717	Set by Network.Modbus.TimeFormat
Segment.15.Ch2TSP	Channel 2 target set-point	float32	3d63	15715	Same as Programmer.SetUp.Ch2PVInput
Segment.15.Ch2UserVal	Channel 2 user value	float32	3d79	15737	Same as Programmer.SetUp.ResetCh2UserVal
Segment.15.Ch2Wait	Channel 2 Wait	uint8	3d6f	15727	Not applicable
Segment.15.Ch2WaitVal	Channel 2 wait value	float32	3d71	15729	Same as Programmer.SetUp.PVWait2
Segment.15.Cycles	Cycles	int16	3d73	15731	Not applicable
Segment.15.Duration	Duration	time_t	3d61	15713	Set by Network.Modbus.TimeFormat
Segment.15.EndType	End type	uint8	3d68	15720	Not applicable
Segment.15.Event1	Event 1	bool	3d7a	15738	Not applicable
Segment.15.Event2	Event 2	bool	3d7b	15739	Not applicable
Segment.15.Event3	Event 3	bool	3d7c	15740	Not applicable
Segment.15.Event4	Event 4	bool	3d7d	15741	Not applicable
Segment.15.Event5	Event 5	bool	3d7e	15742	Not applicable
Segment.15.Event6	Event 6	bool	3d7f	15743	Not applicable
Segment.15.Event7	Event 7	bool	3d80	15744	Not applicable
Segment.15.Event8	Event 8	bool	3d81	15745	Not applicable
Segment.15.GoBackTo	Go back to	uint8	3d72	15730	Not applicable
Segment.15.SegmentName	Segment name	string_t	6bf6	27638	Not applicable
Segment.15.Type	Type	uint8	3d60	15712	Not applicable
Segment.15.WaitFor	Wait for	uint8	3d6d	15725	Not applicable
Segment.16.Ch1Holdback	Channel 1 holdback type	uint8	3d99	15769	Not applicable
Segment.16.Ch1HoldbackVal	Channel 1 holdback value	float32	3d9b	15771	Same as Programmer.SetUp.Ch1PVInput
Segment.16.Ch1PVEvent	Channel 1 PV event	uint8	3da4	15780	Not applicable
Segment.16.Ch1PVEventUse	Channel 1 PV event use	bool	3db2	15794	Not applicable
Segment.16.Ch1PVEventVal	Channel 1 PV event value	float32	3da6	15782	Same as Programmer.SetUp.Ch1PVInput
Segment.16.Ch1Rate	Channel 1 rate	float32	3d96	15766	Set by Programmer.SetUp.RateResolution
Segment.16.Ch1Time	Channel 1 time	time_t	3d94	15764	Set by Network.Modbus.TimeFormat
Segment.16.Ch1TSP	Channel 1 target set-point	float32	3d92	15762	Same as Programmer.SetUp.Ch1PVInput
Segment.16.Ch1UserVal	Channel 1 user value	float32	3da8	15784	Same as Programmer.SetUp.ResetCh1UserVal
Segment.16.Ch1Wait	Channel 1 Wait	uint8	3d9e	15774	Not applicable
Segment.16.Ch1WaitVal	Channel 1 wait value	float32	3da0	15776	Same as Programmer.SetUp.PVWait1
Segment.16.Ch2Holdback	Channel 2 holdback type	uint8	3d9a	15770	Not applicable
Segment.16.Ch2HoldbackVal	Channel 2 holdback value	float32	3d9c	15772	Same as Programmer.SetUp.Ch2PVInput
Segment.16.Ch2PVEvent	Channel 2 PV event	uint8	3da5	15781	Not applicable
Segment.16.Ch2PVEventUse	Channel 2 PV event use	bool	3db3	15795	Not applicable
Segment.16.Ch2PVEventVal	Channel 2 PV event value	float32	3da7	15783	Same as Programmer.SetUp.Ch2PVInput
Segment.16.Ch2Rate	Channel 2 rate	float32	3d97	15767	Set by Programmer.SetUp.RateResolution
Segment.16.Ch2Time	Channel 2 time	time_t	3d95	15765	Set by Network.Modbus.TimeFormat
Segment.16.Ch2TSP	Channel 2 target set-point	float32	3d93	15763	Same as Programmer.SetUp.Ch2PVInput
Segment.16.Ch2UserVal	Channel 2 user value	float32	3da9	15785	Same as Programmer.SetUp.ResetCh2UserVal
Segment.16.Ch2Wait	Channel 2 Wait	uint8	3d9f	15775	Not applicable
Segment.16.Ch2WaitVal	Channel 2 wait value	float32	3da1	15777	Same as Programmer.SetUp.PVWait2
Segment.16.Cycles	Cycles	int16	3da3	15779	Not applicable
Segment.16.Duration	Duration	time_t	3d91	15761	Set by Network.Modbus.TimeFormat
Segment.16.EndType	End type	uint8	3d98	15768	Not applicable
Segment.16.Event1	Event 1	bool	3daa	15786	Not applicable
Segment.16.Event2	Event 2	bool	3dab	15787	Not applicable
Segment.16.Event3	Event 3	bool	3dac	15788	Not applicable
Segment.16.Event4	Event 4	bool	3dad	15789	Not applicable
Segment.16.Event5	Event 5	bool	3dae	15790	Not applicable
Segment.16.Event6	Event 6	bool	3daf	15791	Not applicable
Segment.16.Event7	Event 7	bool	3db0	15792	Not applicable
Segment.16.Event8	Event 8	bool	3db1	15793	Not applicable
Segment.16.GoBackTo	Go back to	uint8	3da2	15778	Not applicable
Segment.16.SegmentName	Segment name	string_t	6c0b	27659	Not applicable
Segment.16.Type	Type	uint8	3d90	15760	Not applicable

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.16.WaitFor	Wait for	uint8	3d9d	15773	Not applicable
Segment.17.Ch1Holdback	Channel 1 holdback type	uint8	3dc9	15817	Not applicable
Segment.17.Ch1HoldbackVal	Channel 1 holdback value	float32	3dcb	15819	Same as Programmer.SetUp.Ch1PVInput
Segment.17.Ch1PVEvent	Channel 1 PV event	uint8	3dd4	15828	Not applicable
Segment.17.Ch1PVEventUse	Channel 1 PV event use	bool	3de2	15842	Not applicable
Segment.17.Ch1PVEventVal	Channel 1 PV event value	float32	3dd6	15830	Same as Programmer.SetUp.Ch1PVInput
Segment.17.Ch1Rate	Channel 1 rate	float32	3dc6	15814	Set by Programmer.SetUp.RateResolution
Segment.17.Ch1Time	Channel 1 time	time_t	3dc4	15812	Set by Network.Modbus.TimeFormat
Segment.17.Ch1TSP	Channel 1 target set-point	float32	3dc2	15810	Same as Programmer.SetUp.Ch1PVInput
Segment.17.Ch1UserVal	Channel 1 user value	float32	3dd8	15832	Same as Programmer.SetUp.ResetCh1UserVal
Segment.17.Ch1Wait	Channel 1 Wait	uint8	3dce	15822	Not applicable
Segment.17.Ch1WaitVal	Channel 1 wait value	float32	3dd0	15824	Same as Programmer.SetUp.PVWait1
Segment.17.Ch2Holdback	Channel 2 holdback type	uint8	3dca	15818	Not applicable
Segment.17.Ch2HoldbackVal	Channel 2 holdback value	float32	3dcc	15820	Same as Programmer.SetUp.Ch2PVInput
Segment.17.Ch2PVEvent	Channel 2 PV event	uint8	3dd5	15829	Not applicable
Segment.17.Ch2PVEventUse	Channel 2 PV event use	bool	3de3	15843	Not applicable
Segment.17.Ch2PVEventVal	Channel 2 PV event value	float32	3dd7	15831	Same as Programmer.SetUp.Ch2PVInput
Segment.17.Ch2Rate	Channel 2 rate	float32	3dc7	15815	Set by Programmer.SetUp.RateResolution
Segment.17.Ch2Time	Channel 2 time	time_t	3dc5	15813	Set by Network.Modbus.TimeFormat
Segment.17.Ch2TSP	Channel 2 target set-point	float32	3dc3	15811	Same as Programmer.SetUp.Ch2PVInput
Segment.17.Ch2UserVal	Channel 2 user value	float32	3dd9	15833	Same as Programmer.SetUp.ResetCh2UserVal
Segment.17.Ch2Wait	Channel 2 Wait	uint8	3dcf	15823	Not applicable
Segment.17.Ch2WaitVal	Channel 2 wait value	float32	3dd1	15825	Same as Programmer.SetUp.PVWait2
Segment.17.Cycles	Cycles	int16	3dd3	15827	Not applicable
Segment.17.Duration	Duration	time_t	3dc1	15809	Set by Network.Modbus.TimeFormat
Segment.17.EndType	End type	uint8	3dc8	15816	Not applicable
Segment.17.Event1	Event 1	bool	3dda	15834	Not applicable
Segment.17.Event2	Event 2	bool	3ddb	15835	Not applicable
Segment.17.Event3	Event 3	bool	3ddc	15836	Not applicable
Segment.17.Event4	Event 4	bool	3ddd	15837	Not applicable
Segment.17.Event5	Event 5	bool	3dde	15838	Not applicable
Segment.17.Event6	Event 6	bool	3ddf	15839	Not applicable
Segment.17.Event7	Event 7	bool	3de0	15840	Not applicable
Segment.17.Event8	Event 8	bool	3de1	15841	Not applicable
Segment.17.GoBackTo	Go back to	uint8	3dd2	15826	Not applicable
Segment.17.SegmentName	Segment name	string_t	6c20	27680	Not applicable
Segment.17.Type	Type	uint8	3dc0	15808	Not applicable
Segment.17.WaitFor	Wait for	uint8	3dcd	15821	Not applicable
Segment.18.Ch1Holdback	Channel 1 holdback type	uint8	3df9	15865	Not applicable
Segment.18.Ch1HoldbackVal	Channel 1 holdback value	float32	3dfb	15867	Same as Programmer.SetUp.Ch1PVInput
Segment.18.Ch1PVEvent	Channel 1 PV event	uint8	3e04	15876	Not applicable
Segment.18.Ch1PVEventUse	Channel 1 PV event use	bool	3e12	15890	Not applicable
Segment.18.Ch1PVEventVal	Channel 1 PV event value	float32	3e06	15878	Same as Programmer.SetUp.Ch1PVInput
Segment.18.Ch1Rate	Channel 1 rate	float32	3df6	15862	Set by Programmer.SetUp.RateResolution
Segment.18.Ch1Time	Channel 1 time	time_t	3df4	15860	Set by Network.Modbus.TimeFormat
Segment.18.Ch1TSP	Channel 1 target set-point	float32	3df2	15858	Same as Programmer.SetUp.Ch1PVInput
Segment.18.Ch1UserVal	Channel 1 user value	float32	3e08	15880	Same as Programmer.SetUp.ResetCh1UserVal
Segment.18.Ch1Wait	Channel 1 Wait	uint8	3dfe	15870	Not applicable
Segment.18.Ch1WaitVal	Channel 1 wait value	float32	3e00	15872	Same as Programmer.SetUp.PVWait1
Segment.18.Ch2Holdback	Channel 2 holdback type	uint8	3dfa	15866	Not applicable
Segment.18.Ch2HoldbackVal	Channel 2 holdback value	float32	3dfc	15868	Same as Programmer.SetUp.Ch2PVInput
Segment.18.Ch2PVEvent	Channel 2 PV event	uint8	3e05	15877	Not applicable
Segment.18.Ch2PVEventUse	Channel 2 PV event use	bool	3e13	15891	Not applicable
Segment.18.Ch2PVEventVal	Channel 2 PV event value	float32	3e07	15879	Same as Programmer.SetUp.Ch2PVInput
Segment.18.Ch2Rate	Channel 2 rate	float32	3df7	15863	Set by Programmer.SetUp.RateResolution
Segment.18.Ch2Time	Channel 2 time	time_t	3df5	15861	Set by Network.Modbus.TimeFormat
Segment.18.Ch2TSP	Channel 2 target set-point	float32	3df3	15859	Same as Programmer.SetUp.Ch2PVInput
Segment.18.Ch2UserVal	Channel 2 user value	float32	3e09	15881	Same as Programmer.SetUp.ResetCh2UserVal
Segment.18.Ch2Wait	Channel 2 Wait	uint8	3dff	15871	Not applicable
Segment.18.Ch2WaitVal	Channel 2 wait value	float32	3e01	15873	Same as Programmer.SetUp.PVWait2
Segment.18.Cycles	Cycles	int16	3e03	15875	Not applicable
Segment.18.Duration	Duration	time_t	3df1	15857	Set by Network.Modbus.TimeFormat
Segment.18.EndType	End type	uint8	3df8	15864	Not applicable
Segment.18.Event1	Event 1	bool	3e0a	15882	Not applicable
Segment.18.Event2	Event 2	bool	3e0b	15883	Not applicable
Segment.18.Event3	Event 3	bool	3e0c	15884	Not applicable
Segment.18.Event4	Event 4	bool	3e0d	15885	Not applicable
Segment.18.Event5	Event 5	bool	3e0e	15886	Not applicable
Segment.18.Event6	Event 6	bool	3e0f	15887	Not applicable
Segment.18.Event7	Event 7	bool	3e10	15888	Not applicable
Segment.18.Event8	Event 8	bool	3e11	15889	Not applicable
Segment.18.GoBackTo	Go back to	uint8	3e02	15874	Not applicable
Segment.18.SegmentName	Segment name	string_t	6c35	27701	Not applicable
Segment.18.Type	Type	uint8	3df0	15856	Not applicable
Segment.18.WaitFor	Wait for	uint8	3dfd	15869	Not applicable
Segment.19.Ch1Holdback	Channel 1 holdback type	uint8	3e29	15913	Not applicable
Segment.19.Ch1HoldbackVal	Channel 1 holdback value	float32	3e2b	15915	Same as Programmer.SetUp.Ch1PVInput
Segment.19.Ch1PVEvent	Channel 1 PV event	uint8	3e34	15924	Not applicable

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.19.Ch1PVEventUse	Channel 1 PV event use	bool	3e42	15938	Not applicable
Segment.19.Ch1PVEventVal	Channel 1 PV event value	float32	3e36	15926	Same as Programmer.SetUp.Ch1PVInput
Segment.19.Ch1Rate	Channel 1 rate	float32	3e26	15910	Set by Programmer.SetUp.RateResolution
Segment.19.Ch1Time	Channel 1 time	time_t	3e24	15908	Set by Network.Modbus.TimeFormat
Segment.19.Ch1TSP	Channel 1 target set-point	float32	3e22	15906	Same as Programmer.SetUp.Ch1PVInput
Segment.19.Ch1UserVal	Channel 1 user value	float32	3e38	15928	Same as Programmer.SetUp.ResetCh1UserVal
Segment.19.Ch1Wait	Channel 1 Wait	uint8	3e2e	15918	Not applicable
Segment.19.Ch1WaitVal	Channel 1 wait value	float32	3e30	15920	Same as Programmer.SetUp.PVWait1
Segment.19.Ch2Holdback	Channel 2 holdback type	uint8	3e2a	15914	Not applicable
Segment.19.Ch2HoldbackVal	Channel 2 holdback value	float32	3e2c	15916	Same as Programmer.SetUp.Ch2PVInput
Segment.19.Ch2PVEvent	Channel 2 PV event	uint8	3e35	15925	Not applicable
Segment.19.Ch2PVEventUse	Channel 2 PV event use	bool	3e43	15939	Not applicable
Segment.19.Ch2PVEventVal	Channel 2 PV event value	float32	3e37	15927	Same as Programmer.SetUp.Ch2PVInput
Segment.19.Ch2Rate	Channel 2 rate	float32	3e27	15911	Set by Programmer.SetUp.RateResolution
Segment.19.Ch2Time	Channel 2 time	time_t	3e25	15909	Set by Network.Modbus.TimeFormat
Segment.19.Ch2TSP	Channel 2 target set-point	float32	3e23	15907	Same as Programmer.SetUp.Ch2PVInput
Segment.19.Ch2UserVal	Channel 2 user value	float32	3e39	15929	Same as Programmer.SetUp.ResetCh2UserVal
Segment.19.Ch2Wait	Channel 2 Wait	uint8	3e2f	15919	Not applicable
Segment.19.Ch2WaitVal	Channel 2 wait value	float32	3e31	15921	Same as Programmer.SetUp.PVWait2
Segment.19.Cycles	Cycles	int16	3e33	15923	Not applicable
Segment.19.Duration	Duration	time_t	3e21	15905	Set by Network.Modbus.TimeFormat
Segment.19.EndType	End type	uint8	3e28	15912	Not applicable
Segment.19.Event1	Event 1	bool	3e3a	15930	Not applicable
Segment.19.Event2	Event 2	bool	3e3b	15931	Not applicable
Segment.19.Event3	Event 3	bool	3e3c	15932	Not applicable
Segment.19.Event4	Event 4	bool	3e3d	15933	Not applicable
Segment.19.Event5	Event 5	bool	3e3e	15934	Not applicable
Segment.19.Event6	Event 6	bool	3e3f	15935	Not applicable
Segment.19.Event7	Event 7	bool	3e40	15936	Not applicable
Segment.19.Event8	Event 8	bool	3e41	15937	Not applicable
Segment.19.GoBackTo	Go back to	uint8	3e32	15922	Not applicable
Segment.19.SegmentName	Segment name	string_t	6c4a	27722	Not applicable
Segment.19.Type	Type	uint8	3e20	15904	Not applicable
Segment.19.WaitFor	Wait for	uint8	3e2d	15917	Not applicable
Segment.20.Ch1Holdback	Channel 1 holdback type	uint8	3e59	15961	Not applicable
Segment.20.Ch1HoldbackVal	Channel 1 holdback value	float32	3e5b	15963	Same as Programmer.SetUp.Ch1PVInput
Segment.20.Ch1PVEvent	Channel 1 PV event	uint8	3e64	15972	Not applicable
Segment.20.Ch1PVEventUse	Channel 1 PV event use	bool	3e72	15986	Not applicable
Segment.20.Ch1PVEventVal	Channel 1 PV event value	float32	3e66	15974	Same as Programmer.SetUp.Ch1PVInput
Segment.20.Ch1Rate	Channel 1 rate	float32	3e56	15958	Set by Programmer.SetUp.RateResolution
Segment.20.Ch1Time	Channel 1 time	time_t	3e54	15956	Set by Network.Modbus.TimeFormat
Segment.20.Ch1TSP	Channel 1 target set-point	float32	3e52	15954	Same as Programmer.SetUp.Ch1PVInput
Segment.20.Ch1UserVal	Channel 1 user value	float32	3e68	15976	Same as Programmer.SetUp.ResetCh1UserVal
Segment.20.Ch1Wait	Channel 1 Wait	uint8	3e5e	15966	Not applicable
Segment.20.Ch1WaitVal	Channel 1 wait value	float32	3e60	15968	Same as Programmer.SetUp.PVWait1
Segment.20.Ch2Holdback	Channel 2 holdback type	uint8	3e5a	15962	Not applicable
Segment.20.Ch2HoldbackVal	Channel 2 holdback value	float32	3e5c	15964	Same as Programmer.SetUp.Ch2PVInput
Segment.20.Ch2PVEvent	Channel 2 PV event	uint8	3e65	15973	Not applicable
Segment.20.Ch2PVEventUse	Channel 2 PV event use	bool	3e73	15987	Not applicable
Segment.20.Ch2PVEventVal	Channel 2 PV event value	float32	3e67	15975	Same as Programmer.SetUp.Ch2PVInput
Segment.20.Ch2Rate	Channel 2 rate	float32	3e57	15959	Set by Programmer.SetUp.RateResolution
Segment.20.Ch2Time	Channel 2 time	time_t	3e55	15957	Set by Network.Modbus.TimeFormat
Segment.20.Ch2TSP	Channel 2 target set-point	float32	3e53	15955	Same as Programmer.SetUp.Ch2PVInput
Segment.20.Ch2UserVal	Channel 2 user value	float32	3e69	15977	Same as Programmer.SetUp.ResetCh2UserVal
Segment.20.Ch2Wait	Channel 2 Wait	uint8	3e5f	15967	Not applicable
Segment.20.Ch2WaitVal	Channel 2 wait value	float32	3e61	15969	Same as Programmer.SetUp.PVWait2
Segment.20.Cycles	Cycles	int16	3e63	15971	Not applicable
Segment.20.Duration	Duration	time_t	3e51	15953	Set by Network.Modbus.TimeFormat
Segment.20.EndType	End type	uint8	3e58	15960	Not applicable
Segment.20.Event1	Event 1	bool	3e6a	15978	Not applicable
Segment.20.Event2	Event 2	bool	3e6b	15979	Not applicable
Segment.20.Event3	Event 3	bool	3e6c	15980	Not applicable
Segment.20.Event4	Event 4	bool	3e6d	15981	Not applicable
Segment.20.Event5	Event 5	bool	3e6e	15982	Not applicable
Segment.20.Event6	Event 6	bool	3e6f	15983	Not applicable
Segment.20.Event7	Event 7	bool	3e70	15984	Not applicable
Segment.20.Event8	Event 8	bool	3e71	15985	Not applicable
Segment.20.GoBackTo	Go back to	uint8	3e62	15970	Not applicable
Segment.20.SegmentName	Segment name	string_t	6c5f	27743	Not applicable
Segment.20.Type	Type	uint8	3e50	15952	Not applicable
Segment.20.WaitFor	Wait for	uint8	3e5d	15965	Not applicable
Segment.21.Ch1Holdback	Channel 1 holdback type	uint8	3e89	16009	Not applicable
Segment.21.Ch1HoldbackVal	Channel 1 holdback value	float32	3e8b	16011	Same as Programmer.SetUp.Ch1PVInput
Segment.21.Ch1PVEvent	Channel 1 PV event	uint8	3e94	16020	Not applicable
Segment.21.Ch1PVEventUse	Channel 1 PV event use	bool	3ea2	16034	Not applicable
Segment.21.Ch1PVEventVal	Channel 1 PV event value	float32	3e96	16022	Same as Programmer.SetUp.Ch1PVInput
Segment.21.Ch1Rate	Channel 1 rate	float32	3e86	16006	Set by Programmer.SetUp.RateResolution
Segment.21.Ch1Time	Channel 1 time	time_t	3e84	16004	Set by Network.Modbus.TimeFormat
Segment.21.Ch1TSP	Channel 1 target set-point	float32	3e82	16002	Same as Programmer.SetUp.Ch1PVInput

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.21.Ch1UserVal	Channel 1 user value	float32	3e98	16024	Same as Programmer.SetUp.ResetCh1UserVal
Segment.21.Ch1Wait	Channel 1 Wait	uint8	3e8e	16014	Not applicable
Segment.21.Ch1WaitVal	Channel 1 wait value	float32	3e90	16016	Same as Programmer.SetUp.PVWait1
Segment.21.Ch2Holdback	Channel 2 holdback type	uint8	3e8a	16010	Not applicable
Segment.21.Ch2HoldbackVal	Channel 2 holdback value	float32	3e8c	16012	Same as Programmer.SetUp.Ch2PVInput
Segment.21.Ch2PVEvent	Channel 2 PV event	uint8	3e95	16021	Not applicable
Segment.21.Ch2PVEventUse	Channel 2 PV event use	bool	3ea3	16035	Not applicable
Segment.21.Ch2PVEventVal	Channel 2 PV event value	float32	3e97	16023	Same as Programmer.SetUp.Ch2PVInput
Segment.21.Ch2Rate	Channel 2 rate	float32	3e87	16007	Set by Programmer.SetUp.RateResolution
Segment.21.Ch2Time	Channel 2 time	time_t	3e85	16005	Set by Network.Modbus.TimeFormat
Segment.21.Ch2TSP	Channel 2 target set-point	float32	3e83	16003	Same as Programmer.SetUp.Ch2PVInput
Segment.21.Ch2UserVal	Channel 2 user value	float32	3e99	16025	Same as Programmer.SetUp.ResetCh2UserVal
Segment.21.Ch2Wait	Channel 2 Wait	uint8	3e8f	16015	Not applicable
Segment.21.Ch2WaitVal	Channel 2 wait value	float32	3e91	16017	Same as Programmer.SetUp.PVWait2
Segment.21.Cycles	Cycles	int16	3e93	16019	Not applicable
Segment.21.Duration	Duration	time_t	3e81	16001	Set by Network.Modbus.TimeFormat
Segment.21.EndType	End type	uint8	3e88	16008	Not applicable
Segment.21.Event1	Event 1	bool	3e9a	16026	Not applicable
Segment.21.Event2	Event 2	bool	3e9b	16027	Not applicable
Segment.21.Event3	Event 3	bool	3e9c	16028	Not applicable
Segment.21.Event4	Event 4	bool	3e9d	16029	Not applicable
Segment.21.Event5	Event 5	bool	3e9e	16030	Not applicable
Segment.21.Event6	Event 6	bool	3e9f	16031	Not applicable
Segment.21.Event7	Event 7	bool	3ea0	16032	Not applicable
Segment.21.Event8	Event 8	bool	3ea1	16033	Not applicable
Segment.21.GoBackTo	Go back to	uint8	3e92	16018	Not applicable
Segment.21.SegmentName	Segment name	string_t	6c74	27764	Not applicable
Segment.21.Type	Type	uint8	3e80	16000	Not applicable
Segment.21.WaitFor	Wait for	uint8	3e8d	16013	Not applicable
Segment.22.Ch1Holdback	Channel 1 holdback type	uint8	3eb9	16057	Not applicable
Segment.22.Ch1HoldbackVal	Channel 1 holdback value	float32	3ebb	16059	Same as Programmer.SetUp.Ch1PVInput
Segment.22.Ch1PVEvent	Channel 1 PV event	uint8	3ec4	16068	Not applicable
Segment.22.Ch1PVEventUse	Channel 1 PV event use	bool	3ed2	16082	Not applicable
Segment.22.Ch1PVEventVal	Channel 1 PV event value	float32	3ec6	16070	Same as Programmer.SetUp.Ch1PVInput
Segment.22.Ch1Rate	Channel 1 rate	float32	3eb6	16054	Set by Programmer.SetUp.RateResolution
Segment.22.Ch1Time	Channel 1 time	time_t	3eb4	16052	Set by Network.Modbus.TimeFormat
Segment.22.Ch1TSP	Channel 1 target set-point	float32	3eb2	16050	Same as Programmer.SetUp.Ch1PVInput
Segment.22.Ch1UserVal	Channel 1 user value	float32	3ec8	16072	Same as Programmer.SetUp.ResetCh1UserVal
Segment.22.Ch1Wait	Channel 1 Wait	uint8	3ebe	16062	Not applicable
Segment.22.Ch1WaitVal	Channel 1 wait value	float32	3ec0	16064	Same as Programmer.SetUp.PVWait1
Segment.22.Ch2Holdback	Channel 2 holdback type	uint8	3eba	16058	Not applicable
Segment.22.Ch2HoldbackVal	Channel 2 holdback value	float32	3ebc	16060	Same as Programmer.SetUp.Ch2PVInput
Segment.22.Ch2PVEvent	Channel 2 PV event	uint8	3ec5	16069	Not applicable
Segment.22.Ch2PVEventUse	Channel 2 PV event use	bool	3ed3	16083	Not applicable
Segment.22.Ch2PVEventVal	Channel 2 PV event value	float32	3ec7	16071	Same as Programmer.SetUp.Ch2PVInput
Segment.22.Ch2Rate	Channel 2 rate	float32	3eb7	16055	Set by Programmer.SetUp.RateResolution
Segment.22.Ch2Time	Channel 2 time	time_t	3eb5	16053	Set by Network.Modbus.TimeFormat
Segment.22.Ch2TSP	Channel 2 target set-point	float32	3eb3	16051	Same as Programmer.SetUp.Ch2PVInput
Segment.22.Ch2UserVal	Channel 2 user value	float32	3ec9	16073	Same as Programmer.SetUp.ResetCh2UserVal
Segment.22.Ch2Wait	Channel 2 Wait	uint8	3ebf	16063	Not applicable
Segment.22.Ch2WaitVal	Channel 2 wait value	float32	3ec1	16065	Same as Programmer.SetUp.PVWait2
Segment.22.Cycles	Cycles	int16	3ec3	16067	Not applicable
Segment.22.Duration	Duration	time_t	3eb1	16049	Set by Network.Modbus.TimeFormat
Segment.22.EndType	End type	uint8	3eb8	16056	Not applicable
Segment.22.Event1	Event 1	bool	3eca	16074	Not applicable
Segment.22.Event2	Event 2	bool	3ecb	16075	Not applicable
Segment.22.Event3	Event 3	bool	3ecc	16076	Not applicable
Segment.22.Event4	Event 4	bool	3ecd	16077	Not applicable
Segment.22.Event5	Event 5	bool	3ece	16078	Not applicable
Segment.22.Event6	Event 6	bool	3ecf	16079	Not applicable
Segment.22.Event7	Event 7	bool	3ed0	16080	Not applicable
Segment.22.Event8	Event 8	bool	3ed1	16081	Not applicable
Segment.22.GoBackTo	Go back to	uint8	3ec2	16066	Not applicable
Segment.22.SegmentName	Segment name	string_t	6c89	27785	Not applicable
Segment.22.Type	Type	uint8	3eb0	16048	Not applicable
Segment.22.WaitFor	Wait for	uint8	3ebd	16061	Not applicable
Segment.23.Ch1Holdback	Channel 1 holdback type	uint8	3ee9	16105	Not applicable
Segment.23.Ch1HoldbackVal	Channel 1 holdback value	float32	3eeb	16107	Same as Programmer.SetUp.Ch1PVInput
Segment.23.Ch1PVEvent	Channel 1 PV event	uint8	3ef4	16116	Not applicable
Segment.23.Ch1PVEventUse	Channel 1 PV event use	bool	3f02	16130	Not applicable
Segment.23.Ch1PVEventVal	Channel 1 PV event value	float32	3ef6	16118	Same as Programmer.SetUp.Ch1PVInput
Segment.23.Ch1Rate	Channel 1 rate	float32	3ee6	16102	Set by Programmer.SetUp.RateResolution
Segment.23.Ch1Time	Channel 1 time	time_t	3ee4	16100	Set by Network.Modbus.TimeFormat
Segment.23.Ch1TSP	Channel 1 target set-point	float32	3ee2	16098	Same as Programmer.SetUp.Ch1PVInput
Segment.23.Ch1UserVal	Channel 1 user value	float32	3ef8	16120	Same as Programmer.SetUp.ResetCh1UserVal
Segment.23.Ch1Wait	Channel 1 Wait	uint8	3eee	16110	Not applicable
Segment.23.Ch1WaitVal	Channel 1 wait value	float32	3ef0	16112	Same as Programmer.SetUp.PVWait1
Segment.23.Ch2Holdback	Channel 2 holdback type	uint8	3eea	16106	Not applicable
Segment.23.Ch2HoldbackVal	Channel 2 holdback value	float32	3eec	16108	Same as Programmer.SetUp.Ch2PVInput

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.23.Ch2PVEvent	Channel 2 PV event	uint8	3ef5	16117	Not applicable
Segment.23.Ch2PVEventUse	Channel 2 PV event use	bool	3f03	16131	Not applicable
Segment.23.Ch2PVEventVal	Channel 2 PV event value	float32	3ef7	16119	Same as Programmer.SetUp.Ch2PVInput
Segment.23.Ch2Rate	Channel 2 rate	float32	3ee7	16103	Set by Programmer.SetUp.RateResolution
Segment.23.Ch2Time	Channel 2 time	time_t	3ee5	16101	Set by Network.Modbus.TimeFormat
Segment.23.Ch2TSP	Channel 2 target set-point	float32	3ee3	16099	Same as Programmer.SetUp.Ch2PVInput
Segment.23.Ch2UserVal	Channel 2 user value	float32	3ef9	16121	Same as Programmer.SetUp.ResetCh2UserVal
Segment.23.Ch2Wait	Channel 2 Wait	uint8	3eef	16111	Not applicable
Segment.23.Ch2WaitVal	Channel 2 wait value	float32	3ef1	16113	Same as Programmer.SetUp.PVWait2
Segment.23.Cycles	Cycles	int16	3ef3	16115	Not applicable
Segment.23.Duration	Duration	time_t	3ee1	16097	Set by Network.Modbus.TimeFormat
Segment.23.EndType	End type	uint8	3ee8	16104	Not applicable
Segment.23.Event1	Event 1	bool	3efa	16122	Not applicable
Segment.23.Event2	Event 2	bool	3efb	16123	Not applicable
Segment.23.Event3	Event 3	bool	3efc	16124	Not applicable
Segment.23.Event4	Event 4	bool	3efd	16125	Not applicable
Segment.23.Event5	Event 5	bool	3efe	16126	Not applicable
Segment.23.Event6	Event 6	bool	3eff	16127	Not applicable
Segment.23.Event7	Event 7	bool	3f00	16128	Not applicable
Segment.23.Event8	Event 8	bool	3f01	16129	Not applicable
Segment.23.GoBackTo	Go back to	uint8	3ef2	16114	Not applicable
Segment.23.SegmentName	Segment name	string_t	6c9e	27806	Not applicable
Segment.23.Type	Type	uint8	3ee0	16096	Not applicable
Segment.23.WaitFor	Wait for	uint8	3eed	16109	Not applicable
Segment.24.Ch1Holdback	Channel 1 holdback type	uint8	3f19	16153	Not applicable
Segment.24.Ch1HoldbackVal	Channel 1 holdback value	float32	3f1b	16155	Same as Programmer.SetUp.Ch1PVInput
Segment.24.Ch1PVEvent	Channel 1 PV event	uint8	3f24	16164	Not applicable
Segment.24.Ch1PVEventUse	Channel 1 PV event use	bool	3f32	16178	Not applicable
Segment.24.Ch1PVEventVal	Channel 1 PV event value	float32	3f26	16166	Same as Programmer.SetUp.Ch1PVInput
Segment.24.Ch1Rate	Channel 1 rate	float32	3f16	16150	Set by Programmer.SetUp.RateResolution
Segment.24.Ch1Time	Channel 1 time	time_t	3f14	16148	Set by Network.Modbus.TimeFormat
Segment.24.Ch1TSP	Channel 1 target set-point	float32	3f12	16146	Same as Programmer.SetUp.Ch1PVInput
Segment.24.Ch1UserVal	Channel 1 user value	float32	3f28	16168	Same as Programmer.SetUp.ResetCh1UserVal
Segment.24.Ch1Wait	Channel 1 Wait	uint8	3f1e	16158	Not applicable
Segment.24.Ch1WaitVal	Channel 1 wait value	float32	3f20	16160	Same as Programmer.SetUp.PVWait1
Segment.24.Ch2Holdback	Channel 2 holdback type	uint8	3f1a	16154	Not applicable
Segment.24.Ch2HoldbackVal	Channel 2 holdback value	float32	3f1c	16156	Same as Programmer.SetUp.Ch2PVInput
Segment.24.Ch2PVEvent	Channel 2 PV event	uint8	3f25	16165	Not applicable
Segment.24.Ch2PVEventUse	Channel 2 PV event use	bool	3f33	16179	Not applicable
Segment.24.Ch2PVEventVal	Channel 2 PV event value	float32	3f27	16167	Same as Programmer.SetUp.Ch2PVInput
Segment.24.Ch2Rate	Channel 2 rate	float32	3f17	16151	Set by Programmer.SetUp.RateResolution
Segment.24.Ch2Time	Channel 2 time	time_t	3f15	16149	Set by Network.Modbus.TimeFormat
Segment.24.Ch2TSP	Channel 2 target set-point	float32	3f13	16147	Same as Programmer.SetUp.Ch2PVInput
Segment.24.Ch2UserVal	Channel 2 user value	float32	3f29	16169	Same as Programmer.SetUp.ResetCh2UserVal
Segment.24.Ch2Wait	Channel 2 Wait	uint8	3f1f	16159	Not applicable
Segment.24.Ch2WaitVal	Channel 2 wait value	float32	3f21	16161	Same as Programmer.SetUp.PVWait2
Segment.24.Cycles	Cycles	int16	3f23	16163	Not applicable
Segment.24.Duration	Duration	time_t	3f11	16145	Set by Network.Modbus.TimeFormat
Segment.24.EndType	End type	uint8	3f18	16152	Not applicable
Segment.24.Event1	Event 1	bool	3f2a	16170	Not applicable
Segment.24.Event2	Event 2	bool	3f2b	16171	Not applicable
Segment.24.Event3	Event 3	bool	3f2c	16172	Not applicable
Segment.24.Event4	Event 4	bool	3f2d	16173	Not applicable
Segment.24.Event5	Event 5	bool	3f2e	16174	Not applicable
Segment.24.Event6	Event 6	bool	3f2f	16175	Not applicable
Segment.24.Event7	Event 7	bool	3f30	16176	Not applicable
Segment.24.Event8	Event 8	bool	3f31	16177	Not applicable
Segment.24.GoBackTo	Go back to	uint8	3f22	16162	Not applicable
Segment.24.SegmentName	Segment name	string_t	6cb3	27827	Not applicable
Segment.24.Type	Type	uint8	3f10	16144	Not applicable
Segment.24.WaitFor	Wait for	uint8	3f1d	16157	Not applicable
Segment.25.Ch1Holdback	Channel 1 holdback type	uint8	3f49	16201	Not applicable
Segment.25.Ch1HoldbackVal	Channel 1 holdback value	float32	3f4b	16203	Same as Programmer.SetUp.Ch1PVInput
Segment.25.Ch1PVEvent	Channel 1 PV event	uint8	3f54	16212	Not applicable
Segment.25.Ch1PVEventUse	Channel 1 PV event use	bool	3f62	16226	Not applicable
Segment.25.Ch1PVEventVal	Channel 1 PV event value	float32	3f56	16214	Same as Programmer.SetUp.Ch1PVInput
Segment.25.Ch1Rate	Channel 1 rate	float32	3f46	16198	Set by Programmer.SetUp.RateResolution
Segment.25.Ch1Time	Channel 1 time	time_t	3f44	16196	Set by Network.Modbus.TimeFormat
Segment.25.Ch1TSP	Channel 1 target set-point	float32	3f42	16194	Same as Programmer.SetUp.Ch1PVInput
Segment.25.Ch1UserVal	Channel 1 user value	float32	3f58	16216	Same as Programmer.SetUp.ResetCh1UserVal
Segment.25.Ch1Wait	Channel 1 Wait	uint8	3f4e	16206	Not applicable
Segment.25.Ch1WaitVal	Channel 1 wait value	float32	3f50	16208	Same as Programmer.SetUp.PVWait1
Segment.25.Ch2Holdback	Channel 2 holdback type	uint8	3f4a	16202	Not applicable
Segment.25.Ch2HoldbackVal	Channel 2 holdback value	float32	3f4c	16204	Same as Programmer.SetUp.Ch2PVInput
Segment.25.Ch2PVEvent	Channel 2 PV event	uint8	3f55	16213	Not applicable
Segment.25.Ch2PVEventUse	Channel 2 PV event use	bool	3f63	16227	Not applicable
Segment.25.Ch2PVEventVal	Channel 2 PV event value	float32	3f57	16215	Same as Programmer.SetUp.Ch2PVInput
Segment.25.Ch2Rate	Channel 2 rate	float32	3f47	16199	Set by Programmer.SetUp.RateResolution
Segment.25.Ch2Time	Channel 2 time	time_t	3f45	16197	Set by Network.Modbus.TimeFormat

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Segment.25.Ch2TSP	Channel 2 target set-point	float32	3f43	16195	Same as Programmer.SetUp.Ch2PVInput
Segment.25.Ch2UserVal	Channel 2 user value	float32	3f59	16217	Same as Programmer.SetUp.ResetCh2UserVal
Segment.25.Ch2Wait	Channel 2 Wait	uint8	3f4f	16207	Not applicable
Segment.25.Ch2WaitVal	Channel 2 wait value	float32	3f51	16209	Same as Programmer.SetUp.PVWait2
Segment.25.Cycles	Cycles	int16	3f53	16211	Not applicable
Segment.25.Duration	Duration	time_t	3f41	16193	Set by Network.Modbus.TimeFormat
Segment.25.EndType	End type	uint8	3f48	16200	Not applicable
Segment.25.Event1	Event 1	bool	3f5a	16218	Not applicable
Segment.25.Event2	Event 2	bool	3f5b	16219	Not applicable
Segment.25.Event3	Event 3	bool	3f5c	16220	Not applicable
Segment.25.Event4	Event 4	bool	3f5d	16221	Not applicable
Segment.25.Event5	Event 5	bool	3f5e	16222	Not applicable
Segment.25.Event6	Event 6	bool	3f5f	16223	Not applicable
Segment.25.Event7	Event 7	bool	3f60	16224	Not applicable
Segment.25.Event8	Event 8	bool	3f61	16225	Not applicable
Segment.25.GoBackTo	Go back to	uint8	3f52	16210	Not applicable
Segment.25.SegmentName	Segment name	string_t	6cc8	27848	Not applicable
Segment.25.Type	Type	uint8	3f40	16192	Not applicable
Segment.25.WaitFor	Wait for	uint8	3f4d	16205	Not applicable
Segment.26.Ch1Holdback	Channel 1 holdback type	uint8	3f79	16249	Not applicable
Segment.26.Ch1HoldbackVal	Channel 1 holdback value	float32	3f7b	16251	Same as Programmer.SetUp.Ch1PVInput
Segment.26.Ch1PVEvent	Channel 1 PV event	uint8	3f84	16260	Not applicable
Segment.26.Ch1PVEventUse	Channel 1 PV event use	bool	3f92	16274	Not applicable
Segment.26.Ch1PVEventVal	Channel 1 PV event value	float32	3f86	16262	Same as Programmer.SetUp.Ch1PVInput
Segment.26.Ch1Rate	Channel 1 rate	float32	3f76	16246	Set by Programmer.SetUp.RateResolution
Segment.26.Ch1Time	Channel 1 time	time_t	3f74	16244	Set by Network.Modbus.TimeFormat
Segment.26.Ch1TSP	Channel 1 target set-point	float32	3f72	16242	Same as Programmer.SetUp.Ch1PVInput
Segment.26.Ch1UserVal	Channel 1 user value	float32	3f88	16264	Same as Programmer.SetUp.ResetCh1UserVal
Segment.26.Ch1Wait	Channel 1 Wait	uint8	3f7e	16254	Not applicable
Segment.26.Ch1WaitVal	Channel 1 wait value	float32	3f80	16256	Same as Programmer.SetUp.PVWait1
Segment.26.Ch2Holdback	Channel 2 holdback type	uint8	3f7a	16250	Not applicable
Segment.26.Ch2HoldbackVal	Channel 2 holdback value	float32	3f7c	16252	Same as Programmer.SetUp.Ch2PVInput
Segment.26.Ch2PVEvent	Channel 2 PV event	uint8	3f85	16261	Not applicable
Segment.26.Ch2PVEventUse	Channel 2 PV event use	bool	3f93	16275	Not applicable
Segment.26.Ch2PVEventVal	Channel 2 PV event value	float32	3f87	16263	Same as Programmer.SetUp.Ch2PVInput
Segment.26.Ch2Rate	Channel 2 rate	float32	3f77	16247	Set by Programmer.SetUp.RateResolution
Segment.26.Ch2Time	Channel 2 time	time_t	3f75	16245	Set by Network.Modbus.TimeFormat
Segment.26.Ch2TSP	Channel 2 target set-point	float32	3f73	16243	Same as Programmer.SetUp.Ch2PVInput
Segment.26.Ch2UserVal	Channel 2 user value	float32	3f89	16265	Same as Programmer.SetUp.ResetCh2UserVal
Segment.26.Ch2Wait	Channel 2 Wait	uint8	3f7f	16255	Not applicable
Segment.26.Ch2WaitVal	Channel 2 wait value	float32	3f81	16257	Same as Programmer.SetUp.PVWait2
Segment.26.Cycles	Cycles	int16	3f83	16259	Not applicable
Segment.26.Duration	Duration	time_t	3f71	16241	Set by Network.Modbus.TimeFormat
Segment.26.EndType	End type	uint8	3f78	16248	Not applicable
Segment.26.Event1	Event 1	bool	3f8a	16266	Not applicable
Segment.26.Event2	Event 2	bool	3f8b	16267	Not applicable
Segment.26.Event3	Event 3	bool	3f8c	16268	Not applicable
Segment.26.Event4	Event 4	bool	3f8d	16269	Not applicable
Segment.26.Event5	Event 5	bool	3f8e	16270	Not applicable
Segment.26.Event6	Event 6	bool	3f8f	16271	Not applicable
Segment.26.Event7	Event 7	bool	3f90	16272	Not applicable
Segment.26.Event8	Event 8	bool	3f91	16273	Not applicable
Segment.26.GoBackTo	Go back to	uint8	3f82	16258	Not applicable
Segment.26.SegmentName	Segment name	string_t	6cdd	27869	Not applicable
Segment.26.Type	Type	uint8	3f70	16240	Not applicable
Segment.26.WaitFor	Wait for	uint8	3f7d	16253	Not applicable
Steriliser.AutoCounter	Automatically increments the cycle number	bool	2e0f	11791	Not applicable
Steriliser.CycleNumber	Current cycle number	int32	2e04	11780	Not applicable
Steriliser.CycleStatus	The current cycle status. 0 = Waiting start 1 = Waiting 2 = Equilibrisation 3 = Sterilising 4 = Passed 5 = Failed 6 = Aborted 7 = Test cycle	uint8	2e08	11784	Not applicable
Steriliser.CycleTime	The total cycle time	time_t	2e25	11813	Set by Network.Modbus.TimeFormat
Steriliser.EquilibrationTime	The equilibration time period for the current cycle.	time_t	2e0c	11788	Set by Network.Modbus.TimeFormat
Steriliser.FailureDwell1	Failure alarm dwell time for input 1	time_t	2e22	11810	Set by Network.Modbus.TimeFormat
Steriliser.FailureDwell2	Failure alarm dwell time for input 2	time_t	2e2b	11819	Set by Network.Modbus.TimeFormat
Steriliser.FailureDwell3	Failure alarm dwell time for input 3	time_t	2e2c	11820	Set by Network.Modbus.TimeFormat
Steriliser.FailureDwell4	Failure alarm dwell time for input 4	time_t	2e2d	11821	Set by Network.Modbus.TimeFormat
Steriliser.FileByTag	Name historical files by cycle number and tagbool 0 = File by Tag Off; 1 = File by Tag On	2e21		11809	Not applicable
Steriliser.FileTag	Used as part of the historical filename	string_t	68f7	26871	Not applicable
Steriliser.Fvalue	F0 (A0)	time_t	2e26	11814	Set by Network.Modbus.TimeFormat
Steriliser.Input1PV	Input 1	float32	2e00	11776	0dp
Steriliser.Input2PV	Input 2	float32	2e01	11777	0dp
Steriliser.Input3PV	Input 3	float32	2e02	11778	0dp
Steriliser.Input4PV	Input 4	float32	2e03	11779	0dp

For parameter values and settings (enumerations), see Segment 1

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Steriliser.InputType1	Input type 1 0 = Off 1 = thermocouple 2 = Rising pressure 3 = Falling pressure 4 = Rise air detect 5 = Fall air detect	uint8	2e1d	11805	Not applicable
Steriliser.InputType2	Input type 2 (as Input type 1, above)	uint8	2e1e	11806	Not applicable
Steriliser.InputType3	Input type 3 (as Input type 1, above)	uint8	2e1f	11807	Not applicable
Steriliser.InputType4	Input type 4 (as Input type 1, above)	uint8	2e20	11808	Not applicable
Steriliser.IP1BandHigh	Sterilisation temperature input 1 band high.	float32	2e0a	11786	Same as Steriliser.Input1PV
Steriliser.IP1BandLow	Sterilisation temperature input 1 band low.	float32	2e0b	11787	Same as Steriliser.Input1PV
Steriliser.IP1TargetSP	Input 1 target setpoint	float32	2e07	11783	Same as Steriliser.Input1PV
Steriliser.IP2BandHigh	Sterilisation temperature input 2 band high.	float32	2e10	11792	Same as Steriliser.Input2PV
Steriliser.IP2BandLow	Sterilisation temperature input 2 band low.	float32	2e11	11793	Same as Steriliser.Input2PV
Steriliser.IP2TargetSP	Input 2 target setpoint	float32	2e16	11798	Same as Steriliser.Input2PV
Steriliser.IP3BandHigh	Sterilisation temperature input 3 band high.	float32	2e12	11794	Same as Steriliser.Input3PV
Steriliser.IP3BandLow	Sterilisation temperature input 3 band low.	float32	2e13	11795	Same as Steriliser.Input3PV
Steriliser.IP3TargetSP	Input 3 target setpoint	float32	2e17	11799	Same as Steriliser.Input3PV
Steriliser.IP4BandHigh	Sterilisation temperature input 4 band high.	float32	2e14	11796	Same as Steriliser.Input4PV
Steriliser.IP4BandLow	Sterilisation temperature input 4 band low.	float32	2e15	11797	Same as Steriliser.Input3PV
Steriliser.IP4TargetSP	Input 4 target setpoint	float32	2e18	11800	Same as Steriliser.Input4PV
Steriliser.LowLimit	Low temperature limit for the F0 calculation.	float32	2e2a	11818	0dp
Steriliser.MeasuredTemp	Measured Temperature used in the F0 calculation.	float32	2e27	11815	0dp
Steriliser.PassedOutput	1 = cycle passed; 0 = cycle failed.	uint8	2e1c	11804	Not applicable
Steriliser.Remaining	The holding time remaining for the current cycle.	time_t	2e0e	11790	Set by Network.Modbus.TimeFormat
Steriliser.RunningOutput	1 = cycle running; 0 = cycle not running	uint8	2e1b	11803	Not applicable
Steriliser.Start121	Start a predefined 121°C cycle	bool	2e19	11801	Not applicable
Steriliser.Start134	Start a predefined 134°C cycle	bool	2e1a	11802	Not applicable
Steriliser.StartCycle	Start a custom cycle	bool	2e05	11781	Not applicable
Steriliser.SterilisingTime	The total time the load was at sterilisation conditions.	time_t	2e0d	11789	Set by Network.Modbus.TimeFormat
Steriliser.TargetTemperature	Target Temperature for the F0 calculation.	float32	2e29	11817	0dp
Steriliser.TargetTime	The target time of the sterilisation period.	time_t	2e09	11785	Set by Network.Modbus.TimeFormat
Steriliser.TargetTime121	The target time for a 121°C cycle	time_t	2e23	11811	Set by Network.Modbus.TimeFormat
Steriliser.TargetTime134	The target time for a 134°C cycle	time_t	2e24	11812	Set by Network.Modbus.TimeFormat
Steriliser.ZTemperatureInterval	The Z temperature interval for the F0 calculation.	float32	2e28	11816	0dp
Timer.1.ElapsedTime	Elapsed Time	time_t	2ee0	12000	Set by Network.Modbus.TimeFormat
Timer.1.In	Trigger/Gate input	bool	2ee5	12005	Not applicable
Timer.1.Out	Output (1 = On; 0 = Off)	bool	2ee1	12001	Not applicable
Timer.1.Time	Period for the timer (hh:mm:ss)	time_t	2ee2	12002	Set by Network.Modbus.TimeFormat
Timer.1.Triggered	1 = Timer triggered; 0 = Timer not triggered	bool	2ee3	12003	Not applicable
Timer.1.Type	Type of Timer 0 = Disabled (off) 1 = On Pulse 2 = On delay 3 = One shot 4 = Min on.	uint8	2ee4	12004	Not applicable
Timer.2.ElapsedTime	Elapsed Time	time_t	2ee6	12006	Set by Network.Modbus.TimeFormat
Timer.2.In	Trigger/Gate input	bool	2eeb	12011	Not applicable
Timer.2.Out	Output (1 = On; 0 = Off)	bool	2ee7	12007	Not applicable
Timer.2.Time	Period for the timer (hh:mm:ss)	time_t	2ee8	12008	Set by Network.Modbus.TimeFormat
Timer.2.Triggered	1 = Timer triggered; 0 = Timer not triggered	bool	2ee9	12009	Not applicable
Timer.2.Type	Type of Timer (as Timer.1.Type)	uint8	2eea	12010	Not applicable
Timer.3.ElapsedTime	Elapsed Time	time_t	2eec	12012	Set by Network.Modbus.TimeFormat
Timer.3.In	Trigger/Gate input	bool	2ef1	12017	Not applicable
Timer.3.Out	Output (1 = On; 0 = Off)	bool	2eed	12013	Not applicable
Timer.3.Time	Period for the timer (hh:mm:ss)	time_t	2eee	12014	Set by Network.Modbus.TimeFormat
Timer.3.Triggered	1 = Timer triggered; 0 = Timer not triggered	bool	2eef	12015	Not applicable
Timer.3.Type	Type of Timer (as Timer.1.Type)	uint8	2ef0	12016	Not applicable
Timer.4.ElapsedTime	Elapsed Time	time_t	2ef2	12018	Set by Network.Modbus.TimeFormat
Timer.4.In	Trigger/Gate input	bool	2ef7	12023	Not applicable
Timer.4.Out	Output (1 = On; 0 = Off)	bool	2ef3	12019	Not applicable
Timer.4.Time	Period for the timer (hh:mm:ss)	time_t	2ef4	12020	Set by Network.Modbus.TimeFormat
Timer.4.Triggered	1 = Timer triggered; 0 = Timer not triggered	bool	2ef5	12021	Not applicable
Timer.4.Type	Type of Timer (as Timer.1.Type)	uint8	2ef6	12022	Not applicable
UserLin.1.NumberOfBreakpoints	Number of points in user linearisation table 1	uint8	2900	10496	Not applicable
UserLin.1.X1	User linearisation table 1 'X' value 1	float32	2901	10497	2dp
UserLin.1.X2	User linearisation table 1 'X' value 2	float32	2903	10499	2dp
UserLin.1.X3	User linearisation table 1 'X' value 3	float32	2905	10501	2dp
UserLin.1.X4	User linearisation table 1 'X' value 4	float32	2907	10503	2dp
UserLin.1.X5	User linearisation table 1 'X' value 5	float32	2909	10505	2dp
UserLin.1.X6	User linearisation table 1 'X' value 6	float32	290b	10507	2dp
UserLin.1.X7	User linearisation table 1 'X' value 7	float32	290d	10509	2dp
UserLin.1.X8	User linearisation table 1 'X' value 8	float32	290f	10511	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
UserLin.1.X9	User linearisation table 1 'X' value 9	float32	2911	10513	2dp
UserLin.1.X10	User linearisation table 1 'X' value 10	float32	2913	10515	2dp
UserLin.1.X11	User linearisation table 1 'X' value 11	float32	2915	10517	2dp
UserLin.1.X12	User linearisation table 1 'X' value 12	float32	2917	10519	2dp
UserLin.1.X13	User linearisation table 1 'X' value 13	float32	2919	10521	2dp
UserLin.1.X14	User linearisation table 1 'X' value 14	float32	291b	10523	2dp
UserLin.1.X15	User linearisation table 1 'X' value 15	float32	291d	10525	2dp
UserLin.1.X16	User linearisation table 1 'X' value 16	float32	291f	10527	2dp
UserLin.1.X17	User linearisation table 1 'X' value 17	float32	2921	10529	2dp
UserLin.1.X18	User linearisation table 1 'X' value 18	float32	2923	10531	2dp
UserLin.1.X19	User linearisation table 1 'X' value 19	float32	2925	10533	2dp
UserLin.1.X20	User linearisation table 1 'X' value 20	float32	2927	10535	2dp
UserLin.1.X21	User linearisation table 1 'X' value 21	float32	2929	10537	2dp
UserLin.1.X22	User linearisation table 1 'X' value 22	float32	292b	10539	2dp
UserLin.1.X23	User linearisation table 1 'X' value 23	float32	292d	10541	2dp
UserLin.1.X24	User linearisation table 1 'X' value 24	float32	292f	10543	2dp
UserLin.1.X25	User linearisation table 1 'X' value 25	float32	2931	10545	2dp
UserLin.1.X26	User linearisation table 1 'X' value 26	float32	2933	10547	2dp
UserLin.1.X27	User linearisation table 1 'X' value 27	float32	2935	10549	2dp
UserLin.1.X28	User linearisation table 1 'X' value 28	float32	2937	10551	2dp
UserLin.1.X29	User linearisation table 1 'X' value 29	float32	2939	10553	2dp
UserLin.1.X30	User linearisation table 1 'X' value 30	float32	293b	10555	2dp
UserLin.1.X31	User linearisation table 1 'X' value 31	float32	293d	10557	2dp
UserLin.1.X32	User linearisation table 1 'X' value 32	float32	293f	10559	2dp
UserLin.1.Y1	User linearisation table 1 'Y' value 1	float32	2902	10498	2dp
UserLin.1.Y2	User linearisation table 1 'Y' value 2	float32	2904	10500	2dp
UserLin.1.Y3	User linearisation table 1 'Y' value 3	float32	2906	10502	2dp
UserLin.1.Y4	User linearisation table 1 'Y' value 4	float32	2908	10504	2dp
UserLin.1.Y5	User linearisation table 1 'Y' value 5	float32	290a	10506	2dp
UserLin.1.Y6	User linearisation table 1 'Y' value 6	float32	290c	10508	2dp
UserLin.1.Y7	User linearisation table 1 'Y' value 7	float32	290e	10510	2dp
UserLin.1.Y8	User linearisation table 1 'Y' value 8	float32	2910	10512	2dp
UserLin.1.Y9	User linearisation table 1 'Y' value 9	float32	2912	10514	2dp
UserLin.1.Y10	User linearisation table 1 'Y' value 10	float32	2914	10516	2dp
UserLin.1.Y11	User linearisation table 1 'Y' value 11	float32	2916	10518	2dp
UserLin.1.Y12	User linearisation table 1 'Y' value 12	float32	2918	10520	2dp
UserLin.1.Y13	User linearisation table 1 'Y' value 13	float32	291a	10522	2dp
UserLin.1.Y14	User linearisation table 1 'Y' value 14	float32	291c	10524	2dp
UserLin.1.Y15	User linearisation table 1 'Y' value 15	float32	291e	10526	2dp
UserLin.1.Y16	User linearisation table 1 'Y' value 16	float32	2920	10528	2dp
UserLin.1.Y17	User linearisation table 1 'Y' value 17	float32	2922	10530	2dp
UserLin.1.Y18	User linearisation table 1 'Y' value 18	float32	2924	10532	2dp
UserLin.1.Y19	User linearisation table 1 'Y' value 19	float32	2926	10534	2dp
UserLin.1.Y20	User linearisation table 1 'Y' value 20	float32	2928	10536	2dp
UserLin.1.Y21	User linearisation table 1 'Y' value 21	float32	292a	10538	2dp
UserLin.1.Y22	User linearisation table 1 'Y' value 22	float32	292c	10540	2dp
UserLin.1.Y23	User linearisation table 1 'Y' value 23	float32	292e	10542	2dp
UserLin.1.Y24	User linearisation table 1 'Y' value 24	float32	2930	10544	2dp
UserLin.1.Y25	User linearisation table 1 'Y' value 25	float32	2932	10546	2dp
UserLin.1.Y26	User linearisation table 1 'Y' value 26	float32	2934	10548	2dp
UserLin.1.Y27	User linearisation table 1 'Y' value 27	float32	2936	10550	2dp
UserLin.1.Y28	User linearisation table 1 'Y' value 28	float32	2938	10552	2dp
UserLin.1.Y29	User linearisation table 1 'Y' value 29	float32	293a	10554	2dp
UserLin.1.Y30	User linearisation table 1 'Y' value 30	float32	293c	10556	2dp
UserLin.1.Y31	User linearisation table 1 'Y' value 31	float32	293e	10558	2dp
UserLin.1.Y32	User linearisation table 1 'Y' value 32	float32	2940	10560	2dp
UserLin.2.NumberOfBreakpoints	Number of points in user linearisation table 2	uint8	29c0	10688	Not applicable
UserLin.2.X1	User linearisation table 2 'X' value 1	float32	29c1	10689	2dp
UserLin.2.X2	User linearisation table 2 'X' value 2	float32	29c3	10691	2dp
UserLin.2.X3	User linearisation table 2 'X' value 3	float32	29c5	10693	2dp
UserLin.2.X4	User linearisation table 2 'X' value 4	float32	29c7	10695	2dp
UserLin.2.X5	User linearisation table 2 'X' value 5	float32	29c9	10697	2dp
UserLin.2.X6	User linearisation table 2 'X' value 6	float32	29cb	10699	2dp
UserLin.2.X7	User linearisation table 2 'X' value 7	float32	29cd	10701	2dp
UserLin.2.X8	User linearisation table 2 'X' value 8	float32	29cf	10703	2dp
UserLin.2.X9	User linearisation table 2 'X' value 9	float32	29d1	10705	2dp
UserLin.2.X10	User linearisation table 2 'X' value 10	float32	29d3	10707	2dp
UserLin.2.X11	User linearisation table 2 'X' value 11	float32	29d5	10709	2dp
UserLin.2.X12	User linearisation table 2 'X' value 12	float32	29d7	10711	2dp
UserLin.2.X13	User linearisation table 2 'X' value 13	float32	29d9	10713	2dp
UserLin.2.X14	User linearisation table 2 'X' value 14	float32	29db	10715	2dp
UserLin.2.X15	User linearisation table 2 'X' value 15	float32	29dd	10717	2dp
UserLin.2.X16	User linearisation table 2 'X' value 16	float32	29df	10719	2dp
UserLin.2.X17	User linearisation table 2 'X' value 17	float32	29e1	10721	2dp
UserLin.2.X18	User linearisation table 2 'X' value 18	float32	29e3	10723	2dp
UserLin.2.X19	User linearisation table 2 'X' value 19	float32	29e5	10725	2dp
UserLin.2.X20	User linearisation table 2 'X' value 20	float32	29e7	10727	2dp
UserLin.2.X21	User linearisation table 2 'X' value 21	float32	29e9	10729	2dp
UserLin.2.X22	User linearisation table 2 'X' value 22	float32	29eb	10731	2dp
UserLin.2.X23	User linearisation table 2 'X' value 23	float32	29ed	10733	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
UserLin.2.X24	User linearisation table 2 'X' value 24	float32	29ef	10735	2dp
UserLin.2.X25	User linearisation table 2 'X' value 25	float32	29f1	10737	2dp
UserLin.2.X26	User linearisation table 2 'X' value 26	float32	29f3	10739	2dp
UserLin.2.X27	User linearisation table 2 'X' value 27	float32	29f5	10741	2dp
UserLin.2.X28	User linearisation table 2 'X' value 28	float32	29f7	10743	2dp
UserLin.2.X29	User linearisation table 2 'X' value 29	float32	29f9	10745	2dp
UserLin.2.X30	User linearisation table 2 'X' value 30	float32	29fb	10747	2dp
UserLin.2.X31	User linearisation table 2 'X' value 31	float32	29fd	10749	2dp
UserLin.2.X32	User linearisation table 2 'X' value 32	float32	29ff	10751	2dp
UserLin.2.Y1	User linearisation table 2 'Y' value 1	float32	29c2	10690	2dp
UserLin.2.Y2	User linearisation table 4 'Y' value 2	float32	29c4	10692	2dp
UserLin.2.Y3	User linearisation table 4 'Y' value 3	float32	29c6	10694	2dp
UserLin.2.Y4	User linearisation table 4 'Y' value 4	float32	29c8	10696	2dp
UserLin.2.Y5	User linearisation table 4 'Y' value 5	float32	29ca	10698	2dp
UserLin.2.Y6	User linearisation table 4 'Y' value 6	float32	29cc	10700	2dp
UserLin.2.Y7	User linearisation table 4 'Y' value 7	float32	29ce	10702	2dp
UserLin.2.Y8	User linearisation table 4 'Y' value 8	float32	29d0	10704	2dp
UserLin.2.Y9	User linearisation table 4 'Y' value 9	float32	29d2	10706	2dp
UserLin.2.Y10	User linearisation table 4 'Y' value 10	float32	29d4	10708	2dp
UserLin.2.Y11	User linearisation table 4 'Y' value 11	float32	29d6	10710	2dp
UserLin.2.Y12	User linearisation table 4 'Y' value 12	float32	29d8	10712	2dp
UserLin.2.Y13	User linearisation table 4 'Y' value 13	float32	29da	10714	2dp
UserLin.2.Y14	User linearisation table 4 'Y' value 14	float32	29dc	10716	2dp
UserLin.2.Y15	User linearisation table 4 'Y' value 15	float32	29de	10718	2dp
UserLin.2.Y16	User linearisation table 4 'Y' value 16	float32	29e0	10720	2dp
UserLin.2.Y17	User linearisation table 4 'Y' value 17	float32	29e2	10722	2dp
UserLin.2.Y18	User linearisation table 4 'Y' value 18	float32	29e4	10724	2dp
UserLin.2.Y19	User linearisation table 4 'Y' value 19	float32	29e6	10726	2dp
UserLin.2.Y20	User linearisation table 4 'Y' value 20	float32	29e8	10728	2dp
UserLin.2.Y21	User linearisation table 4 'Y' value 21	float32	29ea	10730	2dp
UserLin.2.Y22	User linearisation table 4 'Y' value 22	float32	29ec	10732	2dp
UserLin.2.Y23	User linearisation table 4 'Y' value 23	float32	29ee	10734	2dp
UserLin.2.Y24	User linearisation table 4 'Y' value 24	float32	29f0	10736	2dp
UserLin.2.Y25	User linearisation table 4 'Y' value 25	float32	29f2	10738	2dp
UserLin.2.Y26	User linearisation table 4 'Y' value 26	float32	29f4	10740	2dp
UserLin.2.Y27	User linearisation table 4 'Y' value 27	float32	29f6	10742	2dp
UserLin.2.Y28	User linearisation table 4 'Y' value 28	float32	29f8	10744	2dp
UserLin.2.Y29	User linearisation table 4 'Y' value 29	float32	29fa	10746	2dp
UserLin.2.Y30	User linearisation table 4 'Y' value 30	float32	29fc	10748	2dp
UserLin.2.Y31	User linearisation table 4 'Y' value 31	float32	29fe	10750	2dp
UserLin.2.Y32	User linearisation table 4 'Y' value 32	float32	2a00	10752	2dp
UserLin.3.NumberOfBreakpoints	Number of points in user linearisation table 32	uint8	2a80	10880	Not applicable
UserLin.3.X1	User linearisation table 3 'X' value 1	float32	2a81	10881	2dp
UserLin.3.X2	User linearisation table 3 'X' value 2	float32	2a83	10883	2dp
UserLin.3.X3	User linearisation table 3 'X' value 3	float32	2a85	10885	2dp
UserLin.3.X4	User linearisation table 3 'X' value 4	float32	2a87	10887	2dp
UserLin.3.X5	User linearisation table 3 'X' value 5	float32	2a89	10889	2dp
UserLin.3.X6	User linearisation table 3 'X' value 6	float32	2a8b	10891	2dp
UserLin.3.X7	User linearisation table 3 'X' value 7	float32	2a8d	10893	2dp
UserLin.3.X8	User linearisation table 3 'X' value 8	float32	2a8f	10895	2dp
UserLin.3.X9	User linearisation table 3 'X' value 9	float32	2a91	10897	2dp
UserLin.3.X10	User linearisation table 3 'X' value 10	float32	2a93	10899	2dp
UserLin.3.X11	User linearisation table 3 'X' value 11	float32	2a95	10901	2dp
UserLin.3.X12	User linearisation table 3 'X' value 12	float32	2a97	10903	2dp
UserLin.3.X13	User linearisation table 3 'X' value 13	float32	2a99	10905	2dp
UserLin.3.X14	User linearisation table 3 'X' value 14	float32	2a9b	10907	2dp
UserLin.3.X15	User linearisation table 3 'X' value 15	float32	2a9d	10909	2dp
UserLin.3.X16	User linearisation table 3 'X' value 16	float32	2a9f	10911	2dp
UserLin.3.X17	User linearisation table 3 'X' value 17	float32	2aa1	10913	2dp
UserLin.3.X18	User linearisation table 3 'X' value 18	float32	2aa3	10915	2dp
UserLin.3.X19	User linearisation table 3 'X' value 19	float32	2aa5	10917	2dp
UserLin.3.X20	User linearisation table 3 'X' value 20	float32	2aa7	10919	2dp
UserLin.3.X21	User linearisation table 3 'X' value 21	float32	2aa9	10921	2dp
UserLin.3.X22	User linearisation table 3 'X' value 22	float32	2aab	10923	2dp
UserLin.3.X23	User linearisation table 3 'X' value 23	float32	2aad	10925	2dp
UserLin.3.X24	User linearisation table 3 'X' value 24	float32	2aaf	10927	2dp
UserLin.3.X25	User linearisation table 3 'X' value 25	float32	2ab1	10929	2dp
UserLin.3.X26	User linearisation table 3 'X' value 26	float32	2ab3	10931	2dp
UserLin.3.X27	User linearisation table 3 'X' value 27	float32	2ab5	10933	2dp
UserLin.3.X28	User linearisation table 3 'X' value 28	float32	2ab7	10935	2dp
UserLin.3.X29	User linearisation table 3 'X' value 29	float32	2ab9	10937	2dp
UserLin.3.X30	User linearisation table 3 'X' value 30	float32	2abb	10939	2dp
UserLin.3.X31	User linearisation table 3 'X' value 31	float32	2abd	10941	2dp
UserLin.3.X32	User linearisation table 3 'X' value 32	float32	2abf	10943	2dp
UserLin.3.Y1	User linearisation table 4 'Y' value 1	float32	2a82	10882	2dp
UserLin.3.Y2	User linearisation table 4 'Y' value 2	float32	2a84	10884	2dp
UserLin.3.Y3	User linearisation table 4 'Y' value 3	float32	2a86	10886	2dp
UserLin.3.Y4	User linearisation table 4 'Y' value 4	float32	2a88	10888	2dp
UserLin.3.Y5	User linearisation table 4 'Y' value 5	float32	2a8a	10890	2dp
UserLin.3.Y6	User linearisation table 4 'Y' value 6	float32	2a8c	10892	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
UserLin.3.Y7	User linearisation table 4 'Y' value 7	float32	2a8e	10894	2dp
UserLin.3.Y8	User linearisation table 4 'Y' value 8	float32	2a90	10896	2dp
UserLin.3.Y9	User linearisation table 4 'Y' value 9	float32	2a92	10898	2dp
UserLin.3.Y10	User linearisation table 4 'Y' value 10	float32	2a94	10900	2dp
UserLin.3.Y11	User linearisation table 4 'Y' value 11	float32	2a96	10902	2dp
UserLin.3.Y12	User linearisation table 4 'Y' value 12	float32	2a98	10904	2dp
UserLin.3.Y13	User linearisation table 4 'Y' value 13	float32	2a9a	10906	2dp
UserLin.3.Y14	User linearisation table 4 'Y' value 14	float32	2a9c	10908	2dp
UserLin.3.Y15	User linearisation table 4 'Y' value 15	float32	2a9e	10910	2dp
UserLin.3.Y16	User linearisation table 4 'Y' value 16	float32	2aa0	10912	2dp
UserLin.3.Y17	User linearisation table 4 'Y' value 17	float32	2aa2	10914	2dp
UserLin.3.Y18	User linearisation table 4 'Y' value 18	float32	2aa4	10916	2dp
UserLin.3.Y19	User linearisation table 4 'Y' value 19	float32	2aa6	10918	2dp
UserLin.3.Y20	User linearisation table 4 'Y' value 20	float32	2aa8	10920	2dp
UserLin.3.Y21	User linearisation table 4 'Y' value 21	float32	2aaa	10922	2dp
UserLin.3.Y22	User linearisation table 4 'Y' value 22	float32	2aac	10924	2dp
UserLin.3.Y23	User linearisation table 4 'Y' value 23	float32	2aae	10926	2dp
UserLin.3.Y24	User linearisation table 4 'Y' value 24	float32	2ab0	10928	2dp
UserLin.3.Y25	User linearisation table 4 'Y' value 25	float32	2ab2	10930	2dp
UserLin.3.Y26	User linearisation table 4 'Y' value 26	float32	2ab4	10932	2dp
UserLin.3.Y27	User linearisation table 4 'Y' value 27	float32	2ab6	10934	2dp
UserLin.3.Y28	User linearisation table 4 'Y' value 28	float32	2ab8	10936	2dp
UserLin.3.Y29	User linearisation table 4 'Y' value 29	float32	2aba	10938	2dp
UserLin.3.Y30	User linearisation table 4 'Y' value 30	float32	2abc	10940	2dp
UserLin.3.Y31	User linearisation table 4 'Y' value 31	float32	2abe	10942	2dp
UserLin.3.Y32	User linearisation table 4 'Y' value 32	float32	2ac0	10944	2dp
UserLin.4.NumberOfBreakpoints	Number of points in user linearisation table 4	uint8	2b40	11072	Not applicable
UserLin.4.X1	User linearisation table 4 'X' value 1	float32	2b41	11073	2dp
UserLin.4.X2	User linearisation table 4 'X' value 2	float32	2b43	11075	2dp
UserLin.4.X3	User linearisation table 4 'X' value 3	float32	2b45	11077	2dp
UserLin.4.X4	User linearisation table 4 'X' value 4	float32	2b47	11079	2dp
UserLin.4.X5	User linearisation table 4 'X' value v5	float32	2b49	11081	2dp
UserLin.4.X6	User linearisation table 4 'X' value 6	float32	2b4b	11083	2dp
UserLin.4.X7	User linearisation table 4 'X' value 7	float32	2b4d	11085	2dp
UserLin.4.X8	User linearisation table 4 'X' value 8	float32	2b4f	11087	2dp
UserLin.4.X9	User linearisation table 4 'X' value 9	float32	2b51	11089	2dp
UserLin.4.X10	User linearisation table 4 'X' value 10	float32	2b53	11091	2dp
UserLin.4.X11	User linearisation table 4 'X' value 11	float32	2b55	11093	2dp
UserLin.4.X12	User linearisation table 4 'X' value 12	float32	2b57	11095	2dp
UserLin.4.X13	User linearisation table 4 'X' value 13	float32	2b59	11097	2dp
UserLin.4.X14	User linearisation table 4 'X' value 14	float32	2b5b	11099	2dp
UserLin.4.X15	User linearisation table 4 'X' value 15	float32	2b5d	11101	2dp
UserLin.4.X16	User linearisation table 4 'X' value 16	float32	2b5f	11103	2dp
UserLin.4.X17	User linearisation table 4 'X' value 17	float32	2b61	11105	2dp
UserLin.4.X18	User linearisation table 4 'X' value 18	float32	2b63	11107	2dp
UserLin.4.X19	User linearisation table 4 'X' value 19	float32	2b65	11109	2dp
UserLin.4.X20	User linearisation table 4 'X' value 20	float32	2b67	11111	2dp
UserLin.4.X21	User linearisation table 4 'X' value 21	float32	2b69	11113	2dp
UserLin.4.X22	User linearisation table 4 'X' value 22	float32	2b6b	11115	2dp
UserLin.4.X23	User linearisation table 4 'X' value 23	float32	2b6d	11117	2dp
UserLin.4.X24	User linearisation table 4 'X' value 24	float32	2b6f	11119	2dp
UserLin.4.X25	User linearisation table 4 'X' value 25	float32	2b71	11121	2dp
UserLin.4.X26	User linearisation table 4 'X' value 26	float32	2b73	11123	2dp
UserLin.4.X27	User linearisation table 4 'X' value 27	float32	2b75	11125	2dp
UserLin.4.X28	User linearisation table 4 'X' value 28	float32	2b77	11127	2dp
UserLin.4.X29	User linearisation table 4 'X' value 29	float32	2b79	11129	2dp
UserLin.4.X30	User linearisation table 4 'X' value 30	float32	2b7b	11131	2dp
UserLin.4.X31	User linearisation table 4 'X' value 31	float32	2b7d	11133	2dp
UserLin.4.X32	User linearisation table 4 'X' value 32	float32	2b7f	11135	2dp
UserLin.4.Y1	User linearisation table 4 'Y' value 1	float32	2b42	11074	2dp
UserLin.4.Y2	User linearisation table 4 'Y' value 2	float32	2b44	11076	2dp
UserLin.4.Y3	User linearisation table 4 'Y' value 3	float32	2b46	11078	2dp
UserLin.4.Y4	User linearisation table 4 'Y' value 4	float32	2b48	11080	2dp
UserLin.4.Y5	User linearisation table 4 'Y' value 5	float32	2b4a	11082	2dp
UserLin.4.Y6	User linearisation table 4 'Y' value 6	float32	2b4c	11084	2dp
UserLin.4.Y7	User linearisation table 4 'Y' value 7	float32	2b4e	11086	2dp
UserLin.4.Y8	User linearisation table 4 'Y' value 8	float32	2b50	11088	2dp
UserLin.4.Y9	User linearisation table 4 'Y' value 9	float32	2b52	11090	2dp
UserLin.4.Y10	User linearisation table 4 'Y' value 10	float32	2b54	11092	2dp
UserLin.4.Y11	User linearisation table 4 'Y' value 11	float32	2b56	11094	2dp
UserLin.4.Y12	User linearisation table 4 'Y' value 12	float32	2b58	11096	2dp
UserLin.4.Y13	User linearisation table 4 'Y' value 13	float32	2b5a	11098	2dp
UserLin.4.Y14	User linearisation table 4 'Y' value 14	float32	2b5c	11100	2dp
UserLin.4.Y15	User linearisation table 4 'Y' value 15	float32	2b5e	11102	2dp
UserLin.4.Y16	User linearisation table 4 'Y' value 16	float32	2b60	11104	2dp
UserLin.4.Y17	User linearisation table 4 'Y' value 17	float32	2b62	11106	2dp
UserLin.4.Y18	User linearisation table 4 'Y' value 18	float32	2b64	11108	2dp
UserLin.4.Y19	User linearisation table 4 'Y' value 19	float32	2b66	11110	2dp
UserLin.4.Y20	User linearisation table 4 'Y' value 20	float32	2b68	11112	2dp
UserLin.4.Y21	User linearisation table 4 'Y' value 21	float32	2b6a	11114	2dp
UserLin.4.Y22	User linearisation table 4 'Y' value 22	float32	2b6c	11116	2dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
UserLin.4.Y23	User linearisation table 4 'Y' value 23	float32	2b6e	11118	2dp
UserLin.4.Y24	User linearisation table 4 'Y' value 24	float32	2b70	11120	2dp
UserLin.4.Y25	User linearisation table 4 'Y' value 25	float32	2b72	11122	2dp
UserLin.4.Y26	User linearisation table 4 'Y' value 26	float32	2b74	11124	2dp
UserLin.4.Y27	User linearisation table 4 'Y' value 27	float32	2b76	11126	2dp
UserLin.4.Y28	User linearisation table 4 'Y' value 28	float32	2b78	11128	2dp
UserLin.4.Y29	User linearisation table 4 'Y' value 29	float32	2b7a	11130	2dp
UserLin.4.Y30	User linearisation table 4 'Y' value 30	float32	2b7c	11132	2dp
UserLin.4.Y31	User linearisation table 4 'Y' value 31	float32	2b7e	11134	2dp
UserLin.4.Y32	User linearisation table 4 'Y' value 32	float32	2b80	11136	2dp
UsrVal.1.HighLimit	User Value High Limit	float32	2e8c	11916	Set by UsrVal.1.Resolution
UsrVal.1.LowLimit	User Value Low Limit	float32	2e8d	11917	Set by UsrVal.1.Resolution
UsrVal.1.Resolution	Result Resolution	uint8	2e90	11920	Not applicable
UsrVal.1.Status	User Value 1 Status (0 = Good (OK); 7 = Bad (Error))	bool	2e8f	11919	Not applicable
UsrVal.1.Units	Units of the value	string_t	68fc	26876	Not applicable
UsrVal.1.Val	The User Value	float32	2e8e	11918	Set by UsrVal.1.Resolution
UsrVal.2.HighLimit	User Value High Limit	float32	2e91	11921	Set by UsrVal.2.Resolution
UsrVal.2.LowLimit	User Value Low Limit	float32	2e92	11922	Set by UsrVal.2.Resolution
UsrVal.2.Resolution	Result Resolution	uint8	2e95	11925	Not applicable
UsrVal.2.Status	User Value 2 Status (0 = Good (OK); 7 = Bad (Error))	bool	2e94	11924	Not applicable
UsrVal.2.Units	Units of the value	string_t	6902	26882	Not applicable
UsrVal.2.Val	Thw User Value	float32	2e93	11923	Set by UsrVal.2.Resolution
UsrVal.3.HighLimit	User Value High Limit	float32	2e96	11926	Set by UsrVal.3.Resolution
UsrVal.3.LowLimit	User Value Low Limit	float32	2e97	11927	Set by UsrVal.3.Resolution
UsrVal.3.Resolution	Result Resolution	uint8	2e9a	11930	Not applicable
UsrVal.3.Status	User Value 3 Status (0 = Good (OK); 7 = Bad (Error))	bool	2e99	11929	Not applicable
UsrVal.3.Units	Units of the value	string_t	6908	26888	Not applicable
UsrVal.3.Val	The User Value	float32	2e98	11928	Set by UsrVal.3.Resolution
UsrVal.4.HighLimit	User Value High Limit	float32	2e9b	11931	Set by UsrVal.4.Resolution
UsrVal.4.LowLimit	User Value Low Limit	float32	2e9c	11932	Set by UsrVal.4.Resolution
UsrVal.4.Resolution	Result Resolution	uint8	2e9f	11935	Not applicable
UsrVal.4.Status	User Value 4 Status (0 = Good (OK); 7 = Bad (Error))	bool	2e9e	11934	Not applicable
UsrVal.4.Units	Units of the value	string_t	690e	26894	Not applicable
UsrVal.4.Val	The User Value	float32	2e9d	11933	Set by UsrVal.4.Resolution
UsrVal.5.HighLimit	User Value High Limit	float32	2ea0	11936	Set by UsrVal.5.Resolution
UsrVal.5.LowLimit	User Value Low Limit	float32	2ea1	11937	Set by UsrVal.5.Resolution
UsrVal.5.Resolution	Result Resolution	uint8	2ea4	11940	Not applicable
UsrVal.5.Status	User Value 5 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ea3	11939	Not applicable
UsrVal.5.Units	Units of the value	string_t	6914	26900	Not applicable
UsrVal.5.Val	The User Value	float32	2ea2	11938	Set by UsrVal.5.Resolution
UsrVal.6.HighLimit	User Value High Limit	float32	2ea5	11941	Set by UsrVal.6.Resolution
UsrVal.6.LowLimit	User Value Low Limit	float32	2ea6	11942	Set by UsrVal.6.Resolution
UsrVal.6.Resolution	Result Resolution	uint8	2ea9	11945	Not applicable
UsrVal.6.Status	User Value 6 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ea8	11944	Not applicable
UsrVal.6.Units	Units of the value	string_t	691a	26906	Not applicable
UsrVal.6.Val	The User Value	float32	2ea7	11943	Set by UsrVal.6.Resolution
UsrVal.7.HighLimit	User Value High Limit	float32	2eaa	11946	Set by UsrVal.7.Resolution
UsrVal.7.LowLimit	User Value Low Limit	float32	2eab	11947	Set by UsrVal.7.Resolution
UsrVal.7.Resolution	Result Resolution	uint8	2eae	11950	Not applicable
UsrVal.7.Status	User Value 7 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ead	11949	Not applicable
UsrVal.7.Units	Units of the value	string_t	6920	26912	Not applicable
UsrVal.7.Val	The User Value	float32	2eac	11948	Set by UsrVal.7.Resolution
UsrVal.8.HighLimit	User Value High Limit	float32	2eaf	11951	Set by UsrVal.8.Resolution
UsrVal.8.LowLimit	User Value Low Limit	float32	2eb0	11952	Set by UsrVal.8.Resolution
UsrVal.8.Resolution	Result Resolution	uint8	2eb3	11955	Not applicable
UsrVal.8.Status	User Value 8 Status (0 = Good (OK); 7 = Bad (Error))	bool	2eb2	11954	Not applicable
UsrVal.8.Units	Units of the value	string_t	6926	26918	Not applicable
UsrVal.8.Val	The User Value	float32	2eb1	11953	Set by UsrVal.8.Resolution
UsrVal.9.HighLimit	User Value High Limit	float32	2eb4	11956	Set by UsrVal.9.Resolution
UsrVal.9.LowLimit	User Value Low Limit	float32	2eb5	11957	Set by UsrVal.9.Resolution
UsrVal.9.Resolution	Result Resolution	uint8	2eb8	11960	Not applicable
UsrVal.9.Status	User Value 9 Status (0 = Good (OK); 7 = Bad (Error))	bool	2eb7	11959	Not applicable
UsrVal.9.Units	Units of the value	string_t	692c	26924	Not applicable
UsrVal.9.Val	The User Value	float32	2eb6	11958	Set by UsrVal.9.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
UsrVal.10.HighLimit	User Value High Limit	float32	2eb9	11961	Set by UsrVal.10.Resolution
UsrVal.10.LowLimit	User Value Low Limit	float32	2eba	11962	Set by UsrVal.10.Resolution
UsrVal.10.Resolution	Result Resolution	uint8	2ebd	11965	Not applicable
UsrVal.10.Status	User Value 10 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ebc	11964	Not applicable
UsrVal.10.Units	Units of the value	string_t	6932	26930	Not applicable
UsrVal.10.Val	The User Value	float32	2ebb	11963	Set by UsrVal.10.Resolution
UsrVal.11.HighLimit	User Value High Limit	float32	2ebe	11966	Set by UsrVal.11.Resolution
UsrVal.11.LowLimit	User Value Low Limit	float32	2ebf	11967	Set by UsrVal.11.Resolution
UsrVal.11.Resolution	Result Resolution	uint8	2ec2	11970	Not applicable
UsrVal.11.Status	User Value 11 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ec1	11969	Not applicable
UsrVal.11.Units	Units of the value	string_t	6938	26936	Not applicable
UsrVal.11.Val	The User Value	float32	2ec0	11968	Set by UsrVal.11.Resolution
UsrVal.12.HighLimit	User Value High Limit	float32	2ec3	11971	Set by UsrVal.12.Resolution
UsrVal.12.LowLimit	User Value Low Limit	float32	2ec4	11972	Set by UsrVal.12.Resolution
UsrVal.12.Resolution	Result Resolution	uint8	2ec7	11975	Not applicable
UsrVal.12.Status	User Value 12 Status (0 = Good (OK); 7 = Bad (Error))	bool	2ec6	11974	Not applicable
UsrVal.12.Units	Units of the value	string_t	693e	26942	Not applicable
UsrVal.12.Val	The User Value	float32	2ec5	11973	Set by UsrVal.12.Resolution
VirtualChannel.1.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01c0	448	Not applicable
VirtualChannel.1.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1c50	7248	Not applicable
VirtualChannel.1.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1c4b	7243	Not applicable
VirtualChannel.1.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1c48	7240	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1c4a	7242	Set by Network.Modbus.TimeFormat
VirtualChannel.1.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1c42	7234	Not applicable
VirtualChannel.1.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1c49	7241	Not applicable
VirtualChannel.1.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1c47	7239	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm1.Dwell	Alarm dwell time	time_t	1c45	7237	Set by Network.Modbus.TimeFormat
VirtualChannel.1.Alarm1.Hysteresis	Alarm hysteresis value	float32	1c44	7236	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1c4e	7246	Not applicable
VirtualChannel.1.Alarm1.Inhibit	1 = alarm inhibited	bool	1c51	7249	Not applicable
VirtualChannel.1.Alarm1.Latch	Alarm latch type (0 = None; 1 = Auto; 2 = Manual; 3 = Trigger	uint8	1c41	7233	Not applicable
VirtualChannel.1.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1c4f	7247	Not applicable
VirtualChannel.1.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1c46	7238	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm1.Status	Indication of the active and acknowledge status 0 = Unacknowledged 1 = None 2 = Active 3 = Inactive 4 = Acknowledged	uint8	0122	290	Not applicable
VirtualChannel.1.Alarm1.Threshold	Alarm trigger threshold	float32	1c43	7235	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm1.Type	Alarm type 0 = None 1 = Abs High 2 = Abs Low 3 = Dev high 4 = Dev Low 5 = Dev band 6 = ROC rising 7 = ROC falling 10 = Dig Off 11 = Dig High 12 = Dig Low	uint8	1c40	7232	Not applicable
VirtualChannel.1.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01c1	449	Not applicable
VirtualChannel.1.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1c70	7280	Not applicable
VirtualChannel.1.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1c6b	7275	Not applicable
VirtualChannel.1.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1c68	7272	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1c6a	7274	Set by Network.Modbus.TimeFormat
VirtualChannel.1.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1c62	7266	Not applicable
VirtualChannel.1.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time	uint8	1c69	7273	Not applicable
VirtualChannel.1.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1c67	7271	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm2.Dwell	Alarm dwell time	time_t	1c65	7269	Set by Network.Modbus.TimeFormat
VirtualChannel.1.Alarm2.Hysteresis	Alarm hysteresis value	float32	1c64	7268	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1c6e	7278	Not applicable
VirtualChannel.1.Alarm2.Inhibit	1 = alarm inhibited	bool	1c71	7281	Not applicable
VirtualChannel.1.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1c61	7265	Not applicable
VirtualChannel.1.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1c6f	7279	Not applicable
VirtualChannel.1.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1c66	7270	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0123	291	Not applicable
VirtualChannel.1.Alarm2.Threshold	Alarm trigger threshold	float32	1c63	7267	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1c60	7264	Not applicable
VirtualChannel.1.Main.Descriptor	Virtual Channel descriptor	string_t	4b00	19200	Not applicable
VirtualChannel.1.Main.Disable	1 = Virtual channel disabled	bool	1c23	7203	Not applicable
VirtualChannel.1.Main.HighCutOff	High cut off value for totalisers and counters	float32	1c05	7173	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.Input1	Input 1 value	float32	1c07	7175	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.Input2	Input 2 value	float32	1c08	7176	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.LowCutOff	Low cutoff value for totalisers and counters	float32	1c04	7172	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.ModbusInput	Modbus input value	float32	1c06	7174	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.Operation	Specifies the operation of the virtual channel 0 = Off 2 = Add 3 = Subtract 4 = Multiply 5 = Divide 6 = Group avg 7 = Group min 8 = Group max 9 = Modbus i/p 11 = Copy 20 = Grp min latch 21 = Grp max latch	uint8	1c01	7169	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
	34 = Chan max 35 = Chan min 36 = Chan avg 43 = Config rev 64 = Off 65 = On 80 = Off 81 = On				
VirtualChannel.1.Main.Period	The time period over which the calculation is made	int32	1c0a	7178	Not applicable
VirtualChannel.1.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1c0c	7180	Not applicable
VirtualChannel.1.Main.PresetValue	The preset value	float32	1c0d	7181	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.PV	The virtual channel output value	float32	0120	288	Set by VirtualChannel.1.Main.Resolution
VirtualChannel.1.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1c0b	7179	Not applicable
VirtualChannel.1.Main.Resolution	Number of decimal places (0 to 6)	uint8	1c02	7170	Not applicable
VirtualChannel.1.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1c11	7185	Not applicable
VirtualChannel.1.Main.Status	Virtual Channel output status 0 =Good 1 = Off 2 = Over range 3 = Under range 4 = HW error 5 = Ranging 6 = Overflow 7 = bad 8 = HW exceeded 9 = No data 12 = Comms channel error	uint8	0121	289	Not applicable
VirtualChannel.1.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1c09	7177	Set by Network.Modbus.TimeFormat
VirtualChannel.1.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1c0e	7182	Not applicable
VirtualChannel.1.Main.Type	Specifies the type of virtual channel 1 = Maths; 2 = Totaliser; 3 = Counter	uint8	1c00	7168	Not applicable
VirtualChannel.1.Main.Units	Units descriptor	string_t	4b15	19221	Not applicable
VirtualChannel.1.Main.UnitsScaler	Units scaler for totalisers	float32	1c03	7171	1dp
VirtualChannel.1.Trend.Colour	Configures the trend colour for this virtual channel 0 = Red 1 = Blue 2 = Green 3 = Honey 4 = Violet 5 = Russet 6 = Dark blue 7 = Jade 8 = Magenta 9 = Dusky rose 10 = Yellow 11 = Powder blue 12 = Dark red 13 = Avocado 14 = Indigo 15 = Dark brown 16 = Aegean 17 = Cyan 18 = Aubergine 19 = Dark orange 20 = Pale yellow 21 = Hyacinth 22 = Dark green 23 = Sugar pink 24 = Bluebell 25 = Orange 26 = Pink 27 = Buttersilk 28 = Terracotta 29 = Blue babe 30 = Lime 31 = Blue jive 32 = Cucumber 33 = Eurogreen 34 = Wheatgerm 35 = Sea Blue 36 = Ginger 37 = Aqua pool 38 = Pale red 39 = Pale blue 40 = Lilac 41 = Sky blue 42 = Wild moss 43 = Turquoise 44 = Pale green 45 = Coffee 49 = Dark Grey 53 = Light grey	uint8	1c20	7200	Not applicable
VirtualChannel.1.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1c22	7202	Same as VirtualChannel.1.Main.PV
VirtualChannel.1.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1c21	7201	Same as VirtualChannel.1.Main.PV
VirtualChannel.2.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01c2	450	Not applicable
VirtualChannel.2.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1cd0	7376	Not applicable
VirtualChannel.2.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1ccb	7371	Not applicable
VirtualChannel.2.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1cc8	7368	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1cca	7370	Set by Network.Modbus.TimeFormat
VirtualChannel.2.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1cc2	7362	Not applicable
VirtualChannel.2.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1cc9	7369	Not applicable
VirtualChannel.2.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1cc7	7367	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm1.Dwell	Alarm dwell time	time_t	1cc5	7365	Set by Network.Modbus.TimeFormat
VirtualChannel.2.Alarm1.Hysteresis	Alarm hysteresis value	float32	1cc4	7364	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1cce	7374	Not applicable
VirtualChannel.2.Alarm1.Inhibit	1 = alarm inhibited	bool	1cd1	7377	Not applicable
VirtualChannel.2.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1cc1	7361	Not applicable
VirtualChannel.2.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1ccf	7375	Not applicable
VirtualChannel.2.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1cc6	7366	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0126	294	Not applicable
VirtualChannel.2.Alarm1.Threshold	Alarm trigger threshold	float32	1cc3	7363	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1cc0	7360	Not applicable
VirtualChannel.2.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01c3	451	Not applicable
VirtualChannel.2.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1cf0	7408	Not applicable
VirtualChannel.2.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1ceb	7403	Not applicable
VirtualChannel.2.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1ce8	7400	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1cea	7402	Set by Network.Modbus.TimeFormat
VirtualChannel.2.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1ce2	7394	Not applicable
VirtualChannel.2.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1ce9	7401	Not applicable
VirtualChannel.2.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1ce7	7399	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm2.Dwell	Alarm dwell time	time_t	1ce5	7397	Set by Network.Modbus.TimeFormat
VirtualChannel.2.Alarm2.Hysteresis	Alarm hysteresis value	float32	1ce4	7396	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1cee	7406	Not applicable
VirtualChannel.2.Alarm2.Inhibit	1 = alarm inhibited	bool	1cf1	7409	Not applicable
VirtualChannel.2.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1ce1	7393	Not applicable
VirtualChannel.2.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1cef	7407	Not applicable
VirtualChannel.2.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1ce6	7398	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0127	295	Not applicable
VirtualChannel.2.Alarm2.Threshold	Alarm trigger threshold	float32	1ce3	7395	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1ce0	7392	Not applicable
VirtualChannel.2.Main.Descriptor	Virtual Channel descriptor	string_t	4b1b	19227	Not applicable
VirtualChannel.2.Main.Disable	1 = Virtual channel disabled	bool	1ca3	7331	Not applicable
VirtualChannel.2.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1c85	7301	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.Input1	Input 1 value	float32	1c87	7303	Set by VirtualChannel.2.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.2.Main.Input2	Input 2 value	float32	1c88	7304	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1c84	7300	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.ModbusInput	Modbus input value	float32	1c86	7302	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1c81	7297	Not applicable
VirtualChannel.2.Main.Period	The time period over which the calculation is made	int32	1c8a	7306	Not applicable
VirtualChannel.2.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1c8c	7308	Not applicable
VirtualChannel.2.Main.PresetValue	The Preset value	float32	1c8d	7309	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.PV	The virtual channel output value	float32	0124	292	Set by VirtualChannel.2.Main.Resolution
VirtualChannel.2.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1c8b	7307	Not applicable
VirtualChannel.2.Main.Resolution	Specifies the resolution/number of decimal places	uint8	1c82	7298	Not applicable
VirtualChannel.2.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1c91	7313	Not applicable
VirtualChannel.2.Main.Status	As VirtualChannel1.Main.Status	uint8	0125	293	Not applicable
VirtualChannel.2.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1c89	7305	Set by Network.Modbus.TimeFormat
VirtualChannel.2.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1c8e	7310	Not applicable
VirtualChannel.2.Main.Type	As VirtualChannel1.Main.Type	uint8	1c80	7296	Not applicable
VirtualChannel.2.Main.Units	Units descriptor	string_t	4b30	19248	Not applicable
VirtualChannel.2.Main.UnitsScaler	Units scaler for totalisers	float32	1c83	7299	1dp
VirtualChannel.2.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1ca0	7328	Not applicable
VirtualChannel.2.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1ca2	7330	Same as VirtualChannel.2.Main.PV
VirtualChannel.2.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1ca1	7329	Same as VirtualChannel.2.Main.PV
VirtualChannel.3.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01c4	452	Not applicable
VirtualChannel.3.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1d50	7504	Not applicable
VirtualChannel.3.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1d4b	7499	Not applicable
VirtualChannel.3.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1d48	7496	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1d4a	7498	Set by Network.Modbus.TimeFormat
VirtualChannel.3.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1d42	7490	Not applicable
VirtualChannel.3.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1d49	7497	Not applicable
VirtualChannel.3.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1d47	7495	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm1.Dwell	Alarm dwell time	time_t	1d45	7493	Set by Network.Modbus.TimeFormat
VirtualChannel.3.Alarm1.Hysteresis	Alarm hysteresis value	float32	1d44	7492	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1d4e	7502	Not applicable
VirtualChannel.3.Alarm1.Inhibit	1 = alarm inhibited	bool	1d51	7505	Not applicable
VirtualChannel.3.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1d41	7489	Not applicable
VirtualChannel.3.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1d4f	7503	Not applicable
VirtualChannel.3.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1d46	7494	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	012a	298	Not applicable
VirtualChannel.3.Alarm1.Threshold	Alarm trigger threshold	float32	1d43	7491	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1d40	7488	Not applicable
VirtualChannel.3.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01c5	453	Not applicable
VirtualChannel.3.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1d70	7536	Not applicable
VirtualChannel.3.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1d6b	7531	Not applicable
VirtualChannel.3.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1d68	7528	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1d6a	7530	Set by Network.Modbus.TimeFormat
VirtualChannel.3.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1d62	7522	Not applicable
VirtualChannel.3.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1d69	7529	Not applicable
VirtualChannel.3.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1d67	7527	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm2.Dwell	Alarm dwell time	time_t	1d65	7525	Set by Network.Modbus.TimeFormat
VirtualChannel.3.Alarm2.Hysteresis	Alarm hysteresis value	float32	1d64	7524	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1d6e	7534	Not applicable
VirtualChannel.3.Alarm2.Inhibit	1 = alarm inhibited	bool	1d71	7537	Not applicable
VirtualChannel.3.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1d61	7521	Not applicable
VirtualChannel.3.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1d6f	7535	Not applicable
VirtualChannel.3.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1d66	7526	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	012b	299	Not applicable
VirtualChannel.3.Alarm2.Threshold	Alarm trigger threshold	float32	1d63	7523	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1d60	7520	Not applicable
VirtualChannel.3.Main.Descriptor	Virtual Channel descriptor	string_t	4b36	19254	Not applicable
VirtualChannel.3.Main.Disable	1 = Virtual channel disabled	bool	1d23	7459	Not applicable
VirtualChannel.3.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1d05	7429	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.Input1	Input 1	float32	1d07	7431	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.Input2	Input 2	float32	1d08	7432	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1d04	7428	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.ModbusInput	Modbus input value	float32	1d06	7430	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1d01	7425	Not applicable
VirtualChannel.3.Main.Period	The time period over which the calculation is made	int32	1d0a	7434	Not applicable
VirtualChannel.3.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1d0c	7436	Not applicable
VirtualChannel.3.Main.PresetValue	The Preset value	float32	1d0d	7437	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.PV	The virtual channel output value	float32	0128	296	Set by VirtualChannel.3.Main.Resolution
VirtualChannel.3.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1d0b	7435	Not applicable
VirtualChannel.3.Main.Resolution	Number of decimal places (0 to 6)	uint8	1d02	7426	Not applicable
VirtualChannel.3.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1d11	7441	Not applicable
VirtualChannel.3.Main.Status	As VirtualChannel1.Main.Status	uint8	0129	297	Not applicable
VirtualChannel.3.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1d09	7433	Set by Network.Modbus.TimeFormat
VirtualChannel.3.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1d0e	7438	Not applicable
VirtualChannel.3.Main.Type	As VirtualChannel1.Main.Type	uint8	1d00	7424	Not applicable
VirtualChannel.3.Main.Units	Units descriptor	string_t	4b4b	19275	Not applicable
VirtualChannel.3.Main.UnitsScaler	Units scaler for totalisers	float32	1d03	7427	1dp
VirtualChannel.3.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1d20	7456	Not applicable
VirtualChannel.3.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1d22	7458	Same as VirtualChannel.3.Main.PV
VirtualChannel.3.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1d21	7457	Same as VirtualChannel.3.Main.PV

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.4.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01c6	454	Not applicable
VirtualChannel.4.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1dd0	7632	Not applicable
VirtualChannel.4.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1dcb	7627	Not applicable
VirtualChannel.4.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1dc8	7624	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1dca	7626	Set by Network.Modbus.TimeFormat
VirtualChannel.4.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1dc2	7618	Not applicable
VirtualChannel.4.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1dc9	7625	Not applicable
VirtualChannel.4.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1dc7	7623	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm1.Dwell	Alarm dwell time	time_t	1dc5	7621	Set by Network.Modbus.TimeFormat
VirtualChannel.4.Alarm1.Hysteresis	Alarm hysteresis value	float32	1dc4	7620	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1dce	7630	Not applicable
VirtualChannel.4.Alarm1.Inhibit	1 = alarm inhibited	bool	1dd1	7633	Not applicable
VirtualChannel.4.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1dc1	7617	Not applicable
VirtualChannel.4.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1dcf	7631	Not applicable
VirtualChannel.4.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1dc6	7622	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	012e	302	Not applicable
VirtualChannel.4.Alarm1.Threshold	Alarm trigger threshold	float32	1dc3	7619	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1dc0	7616	Not applicable
VirtualChannel.4.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01c7	455	Not applicable
VirtualChannel.4.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1df0	7664	Not applicable
VirtualChannel.4.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1deb	7659	Not applicable
VirtualChannel.4.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1de8	7656	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1dea	7658	Set by Network.Modbus.TimeFormat
VirtualChannel.4.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1de2	7650	Not applicable
VirtualChannel.4.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1de9	7657	Not applicable
VirtualChannel.4.Alarm2.Deviation	Deviation alarAlarm dwell timeAlarm dwell	time_t	1de5	7653	Set by Network.Modbus.TimeFormat
VirtualChannel.4.Alarm2.Hysteresis	Alarm hysteresis value	float32	1de4	7652	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1dee	7662	Not applicable
VirtualChannel.4.Alarm2.Inhibit	1 = alarm inhibited	bool	1df1	7665	Not applicable
VirtualChannel.4.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1de1	7649	Not applicable
VirtualChannel.4.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1def	7663	Not applicable
VirtualChannel.4.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1de6	7654	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	012f	303	Not applicable
VirtualChannel.4.Alarm2.Threshold	Alarm trigger threshold	float32	1de3	7651	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1de0	7648	Not applicable
VirtualChannel.4.Main.Descriptor	Virtual Channel descriptor	string_t	4b51	19281	Not applicable
VirtualChannel.4.Main.Disable	1 = Virtual channel disabled	bool	1da3	7587	Not applicable
VirtualChannel.4.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1d85	7557	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.Input1	Input 1 value	float32	1d87	7559	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.Input2	Input 2 value	float32	1d88	7560	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1d84	7556	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.ModbusInput	Modbus input value	float32	1d86	7558	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1d81	7553	Not applicable
VirtualChannel.4.Main.Period	Averaging period	int32	1d8a	7562	Not applicable
VirtualChannel.4.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1d8c	7564	Not applicable
VirtualChannel.4.Main.PresetValue	The Preset value	float32	1d8d	7565	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.PV	The virtual channel output value	float32	012c	300	Set by VirtualChannel.4.Main.Resolution
VirtualChannel.4.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1d8b	7563	Not applicable
VirtualChannel.4.Main.Resolution	Number of decimal places (0 to 6)	uint8	1d82	7554	Not applicable
VirtualChannel.4.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1d91	7569	Not applicable
VirtualChannel.4.Main.Status	As VirtualChannel1.Main.Status	uint8	012d	301	Not applicable
VirtualChannel.4.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1d89	7561	Set by Network.Modbus.TimeFormat
VirtualChannel.4.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1d8e	7566	Not applicable
VirtualChannel.4.Main.Type	As VirtualChannel1.Main.Type	uint8	1d80	7552	Not applicable
VirtualChannel.4.Main.Units	Units descriptor	string_t	4b66	19302	Not applicable
VirtualChannel.4.Main.UnitsScaler	Units scaler for totalisers	float32	1d83	7555	1dp
VirtualChannel.4.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1da0	7584	Not applicable
VirtualChannel.4.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1da2	7586	Same as VirtualChannel.4.Main.PV
VirtualChannel.4.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1da1	7585	Same as VirtualChannel.4.Main.PV
VirtualChannel.5.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01c8	456	Not applicable
VirtualChannel.5.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1e50	7760	Not applicable
VirtualChannel.5.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1e4b	7755	Not applicable
VirtualChannel.5.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1e48	7752	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1e4a	7754	Set by Network.Modbus.TimeFormat
VirtualChannel.5.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1e42	7746	Not applicable
VirtualChannel.5.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1e49	7753	Not applicable
VirtualChannel.5.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1e47	7751	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm1.Dwell	Alarm dwell time	time_t	1e45	7749	Set by Network.Modbus.TimeFormat
VirtualChannel.5.Alarm1.Hysteresis	Alarm hysteresis value	float32	1e44	7748	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1e4e	7758	Not applicable
VirtualChannel.5.Alarm1.Inhibit	1 = alarm inhibited	bool	1e51	7761	Not applicable
VirtualChannel.5.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1e41	7745	Not applicable
VirtualChannel.5.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1e4f	7759	Not applicable
VirtualChannel.5.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1e46	7750	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0132	306	Not applicable
VirtualChannel.5.Alarm1.Threshold	Alarm trigger threshold	float32	1e43	7747	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1e40	7744	Not applicable
VirtualChannel.5.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01c9	457	Not applicable
VirtualChannel.5.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1e70	7792	Not applicable
VirtualChannel.5.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1e6b	7787	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.5.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1e68	7784	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1e6a	7786	Set by Network.Modbus.TimeFormat
VirtualChannel.5.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1e62	7778	Not applicable
VirtualChannel.5.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1e69	7785	Not applicable
VirtualChannel.5.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1e67	7783	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm2.Dwell	Alarm dwell time	time_t	1e65	7781	Set by Network.Modbus.TimeFormat
VirtualChannel.5.Alarm2.Hysteresis	Alarm hysteresis value	float32	1e64	7780	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1e6e	7790	Not applicable
VirtualChannel.5.Alarm2.Inhibit	1 = alarm inhibited	bool	1e71	7793	Not applicable
VirtualChannel.5.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1e61	7777	Not applicable
VirtualChannel.5.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1e6f	7791	Not applicable
VirtualChannel.5.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1e66	7782	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0133	307	Not applicable
VirtualChannel.5.Alarm2.Threshold	Alarm trigger threshold	float32	1e63	7779	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1e60	7776	Not applicable
VirtualChannel.5.Main.Descriptor	Virtual Channel descriptor	string_t	4b6c	19308	Not applicable
VirtualChannel.5.Main.Disable	1 = Virtual channel disabled	bool	1e23	7715	Not applicable
VirtualChannel.5.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1e05	7685	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.Input1	Input 1 value	float32	1e07	7687	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.Input2	Input 2 value	float32	1e08	7688	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1e04	7684	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.ModbusInput	Modbus input value	float32	1e06	7686	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1e01	7681	Not applicable
VirtualChannel.5.Main.Period	The time period over which the calculation is made	int32	1e0a	7690	Not applicable
VirtualChannel.5.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1e0c	7692	Not applicable
VirtualChannel.5.Main.PresetValue	The Preset value	float32	1e0d	7693	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.PV	The virtual channel output value	float32	0130	304	Set by VirtualChannel.5.Main.Resolution
VirtualChannel.5.Main.Reset	nitiate reset. 0 = No; 1 = Yes	bool	1e0b	7691	Not applicable
VirtualChannel.5.Main.Resolution	Number of decimal places (0 to 6)	uint8	1e02	7682	Not applicable
VirtualChannel.5.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1e11	7697	Not applicable
VirtualChannel.5.Main.Status	As VirtualChannel1.Main.Status	uint8	0131	305	Not applicable
VirtualChannel.5.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1e09	7689	Set by Network.Modbus.TimeFormat
VirtualChannel.5.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1e0e	7694	Not applicable
VirtualChannel.5.Main.Type	As VirtualChannel1.Main.Type	uint8	1e00	7680	Not applicable
VirtualChannel.5.Main.Units	Units descriptor	string_t	4b81	19329	Not applicable
VirtualChannel.5.Main.UnitsScaler	Units scaler for totalisers	float32	1e03	7683	1dp
VirtualChannel.5.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1e20	7712	Not applicable
VirtualChannel.5.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1e22	7714	Same as VirtualChannel.5.Main.PV
VirtualChannel.5.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1e21	7713	Same as VirtualChannel.5.Main.PV
VirtualChannel.6.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01ca	458	Not applicable
VirtualChannel.6.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1ed0	7888	Not applicable
VirtualChannel.6.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1ecb	7883	Not applicable
VirtualChannel.6.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1ec8	7880	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1eca	7882	Set by Network.Modbus.TimeFormat
VirtualChannel.6.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1ec2	7874	Not applicable
VirtualChannel.6.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1ec9	7881	Not applicable
VirtualChannel.6.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1ec7	7879	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm1.Dwell	Alarm dwell time	time_t	1ec5	7877	Set by Network.Modbus.TimeFormat
VirtualChannel.6.Alarm1.Hysteresis	Alarm hysteresis value	float32	1ec4	7876	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1ece	7886	Not applicable
VirtualChannel.6.Alarm1.Inhibit	1 = alarm inhibited	bool	1ed1	7889	Not applicable
VirtualChannel.6.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1ec1	7873	Not applicable
VirtualChannel.6.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1ecf	7887	Not applicable
VirtualChannel.6.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1ec6	7878	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0136	310	Not applicable
VirtualChannel.6.Alarm1.Threshold	Alarm trigger threshold	float32	1ec3	7875	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1ec0	7872	Not applicable
VirtualChannel.6.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01cb	459	Not applicable
VirtualChannel.6.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1ef0	7920	Not applicable
VirtualChannel.6.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1eeb	7915	Not applicable
VirtualChannel.6.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1ee8	7912	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1eea	7914	Set by Network.Modbus.TimeFormat
VirtualChannel.6.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1ee2	7906	Not applicable
VirtualChannel.6.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1ee9	7913	Not applicable
VirtualChannel.6.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1ee7	7911	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm2.Dwell	Alarm dwell time	time_t	1ee5	7909	Set by Network.Modbus.TimeFormat
VirtualChannel.6.Alarm2.Hysteresis	Alarm hysteresis value	float32	1ee4	7908	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1eee	7918	Not applicable
VirtualChannel.6.Alarm2.Inhibit	1 = alarm inhibited	bool	1ef1	7921	Not applicable
VirtualChannel.6.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1ee1	7905	Not applicable
VirtualChannel.6.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1eef	7919	Not applicable
VirtualChannel.6.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1ee6	7910	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0137	311	Not applicable
VirtualChannel.6.Alarm2.Threshold	Alarm trigger threshold	float32	1ee3	7907	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1ee0	7904	Not applicable
VirtualChannel.6.Main.Descriptor	Virtual Channel descriptor	string_t	4b87	19335	Not applicable
VirtualChannel.6.Main.Disable	1 = Virtual channel disabled	bool	1ea3	7843	Not applicable
VirtualChannel.6.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1e85	7813	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.Input1	Input 1 value	float32	1e87	7815	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.Input2	Input 2 value	float32	1e88	7816	Set by VirtualChannel.6.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.6.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1e84	7812	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.ModbusInput	Modbus input value	float32	1e86	7814	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1e81	7809	Not applicable
VirtualChannel.6.Main.Period	The time period over which the calculation is made	int32	1e8a	7818	Not applicable
VirtualChannel.6.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1e8c	7820	Not applicable
VirtualChannel.6.Main.PresetValue	The Preset value	float32	1e8d	7821	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.PV	The virtual channel output value	float32	0134	308	Set by VirtualChannel.6.Main.Resolution
VirtualChannel.6.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1e8b	7819	Not applicable
VirtualChannel.6.Main.Resolution	Number of decimal places (0 to 6)	uint8	1e82	7810	Not applicable
VirtualChannel.6.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1e91	7825	Not applicable
VirtualChannel.6.Main.Status	As VirtualChannel1.Main.Status	uint8	0135	309	Not applicable
VirtualChannel.6.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1e89	7817	Set by Network.Modbus.TimeFormat
VirtualChannel.6.Main.Trigger	ncrement/decrement counter. 0 = No; 1 = Yes	bool	1e8e	7822	Not applicable
VirtualChannel.6.Main.Type	As VirtualChannel1.Main.Type	uint8	1e80	7808	Not applicable
VirtualChannel.6.Main.Units	Units descriptor	string_t	4b9c	19356	Not applicable
VirtualChannel.6.Main.UnitsScaler	Units scaler for totalisers	float32	1e83	7811	1dp
VirtualChannel.6.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1ea0	7840	Not applicable
VirtualChannel.6.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1ea2	7842	Same as VirtualChannel.6.Main.PV
VirtualChannel.6.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1ea1	7841	Same as VirtualChannel.6.Main.PV
VirtualChannel.7.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01cc	460	Not applicable
VirtualChannel.7.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1f50	8016	Not applicable
VirtualChannel.7.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1f4b	8011	Not applicable
VirtualChannel.7.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1f48	8008	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1f4a	8010	Set by Network.Modbus.TimeFormat
VirtualChannel.7.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1f42	8002	Not applicable
VirtualChannel.7.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1f49	8009	Not applicable
VirtualChannel.7.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1f47	8007	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm1.Dwell	Alarm dwell time	time_t	1f45	8005	Set by Network.Modbus.TimeFormat
VirtualChannel.7.Alarm1.Hysteresis	Alarm hysteresis value	float32	1f44	8004	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1f4e	8014	Not applicable
VirtualChannel.7.Alarm1.Inhibit	1 = alarm inhibited	bool	1f51	8017	Not applicable
VirtualChannel.7.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1f41	8001	Not applicable
VirtualChannel.7.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1f4f	8015	Not applicable
VirtualChannel.7.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1f46	8006	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	013a	314	Not applicable
VirtualChannel.7.Alarm1.Threshold	Alarm trigger threshold	float32	1f43	8003	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1f40	8000	Not applicable
VirtualChannel.7.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01cd	461	Not applicable
VirtualChannel.7.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1f70	8048	Not applicable
VirtualChannel.7.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1f6b	8043	Not applicable
VirtualChannel.7.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1f68	8040	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1f6a	8042	Set by Network.Modbus.TimeFormat
VirtualChannel.7.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1f62	8034	Not applicable
VirtualChannel.7.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1f69	8041	Not applicable
VirtualChannel.7.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1f67	8039	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm2.Dwell	Alarm dwell time	time_t	1f65	8037	Set by Network.Modbus.TimeFormat
VirtualChannel.7.Alarm2.Hysteresis	Alarm hysteresis value	float32	1f64	8036	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1f6e	8046	Not applicable
VirtualChannel.7.Alarm2.Inhibit	1 = alarm inhibited	bool	1f71	8049	Not applicable
VirtualChannel.7.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1f61	8033	Not applicable
VirtualChannel.7.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1f6f	8047	Not applicable
VirtualChannel.7.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1f66	8038	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm2.Status	As VirtualChanneAlarm trigger thresholdAlarm threshold	float32	1f63	8035	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1f60	8032	Not applicable
VirtualChannel.7.Main.Descriptor	Virtual Channel descriptor	string_t	4ba2	19362	Not applicable
VirtualChannel.7.Main.Disable	1 = Virtual channel disabled	bool	1f23	7971	Not applicable
VirtualChannel.7.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1f05	7941	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.Input1	Input 1 value	float32	1f07	7943	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.Input2	Input 2 value	float32	1f08	7944	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1f04	7940	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.ModbusInput	Modbus input value	float32	1f06	7942	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1f01	7937	Not applicable
VirtualChannel.7.Main.Period	Averaging period	int32	1f0a	7946	Not applicable
VirtualChannel.7.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1f0c	7948	Not applicable
VirtualChannel.7.Main.PresetValue	The Preset value	float32	1f0d	7949	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.PV	The virtual channel output value	float32	0138	312	Set by VirtualChannel.7.Main.Resolution
VirtualChannel.7.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1f0b	7947	Not applicable
VirtualChannel.7.Main.Resolution	Number of decimal places (0 to 6)	uint8	1f02	7938	Not applicable
VirtualChannel.7.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1f11	7953	Not applicable
VirtualChannel.7.Main.Status	As VirtualChannel1.Main.Status	uint8	0139	313	Not applicable
VirtualChannel.7.Main.TimeRemaining	Time remaining before calculation is made	time_t	1f09	7945	Set by Network.Modbus.TimeFormat
VirtualChannel.7.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1f0e	7950	Not applicable
VirtualChannel.7.Main.Type	As VirtualChannel1.Main.Type	uint8	1f00	7936	Not applicable
VirtualChannel.7.Main.Units	Units descriptor	string_t	4bb7	19383	Not applicable
VirtualChannel.7.Main.UnitsScaler	Units scaler for totalisers	float32	1f03	7939	1dp
VirtualChannel.7.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1f20	7968	Not applicable
VirtualChannel.7.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1f22	7970	Same as VirtualChannel.7.Main.PV
VirtualChannel.7.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1f21	7969	Same as VirtualChannel.7.Main.PV
VirtualChannel.8.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01ce	462	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.8.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	1fd0	8144	Not applicable
VirtualChannel.8.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	1fcb	8139	Not applicable
VirtualChannel.8.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	1fc8	8136	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	1fca	8138	Set by Network.Modbus.TimeFormat
VirtualChannel.8.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1fc2	8130	Not applicable
VirtualChannel.8.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1fc9	8137	Not applicable
VirtualChannel.8.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	1fc7	8135	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm1.Dwell	Alarm dwell time	time_t	1fc5	8133	Set by Network.Modbus.TimeFormat
VirtualChannel.8.Alarm1.Hysteresis	Alarm hysteresis value	float32	1fc4	8132	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1fce	8142	Not applicable
VirtualChannel.8.Alarm1.Inhibit	1 = alarm inhibited	bool	1fd1	8145	Not applicable
VirtualChannel.8.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1fc1	8129	Not applicable
VirtualChannel.8.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	1fcf	8143	Not applicable
VirtualChannel.8.Alarm1.Reference	Deviation alarm 'Reference' value	float32	1fc6	8134	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	013e	318	Not applicable
VirtualChannel.8.Alarm1.Threshold	Alarm trigger threshold	float32	1fc3	8131	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	1fc0	8128	Not applicable
VirtualChannel.8.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01cf	463	Not applicable
VirtualChannel.8.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	1ff0	8176	Not applicable
VirtualChannel.8.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	1feb	8171	Not applicable
VirtualChannel.8.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	1fe8	8168	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	1fea	8170	Set by Network.Modbus.TimeFormat
VirtualChannel.8.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	1fe2	8162	Not applicable
VirtualChannel.8.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	1fe9	8169	Not applicable
VirtualChannel.8.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	1fe7	8167	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm2.Dwell	Alarm dwell time	time_t	1fe5	8165	Set by Network.Modbus.TimeFormat
VirtualChannel.8.Alarm2.Hysteresis	Alarm hysteresis value	float32	1fe4	8164	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	1fee	8174	Not applicable
VirtualChannel.8.Alarm2.Inhibit	1 = alarm inhibited	bool	1ff1	8177	Not applicable
VirtualChannel.8.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	1fe1	8161	Not applicable
VirtualChannel.8.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	1fef	8175	Not applicable
VirtualChannel.8.Alarm2.Reference	Deviation alarm 'Reference' value	float32	1fe6	8166	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	013f	319	Not applicable
VirtualChannel.8.Alarm2.Threshold	Alarm trigger threshold	float32	1fe3	8163	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	1fe0	8160	Not applicable
VirtualChannel.8.Main.Descriptor	Virtual Channel descriptor	string_t	4bbd	19389	Not applicable
VirtualChannel.8.Main.Disable	1 = Virtual channel disabled	bool	1fa3	8099	Not applicable
VirtualChannel.8.Main.HighCutOff	The highest input value that will be totalised/counted	float32	1f85	8069	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.Input1	Input 1 value	float32	1f87	8071	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.Input2	Input 2 value	float32	1f88	8072	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	1f84	8068	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.ModbusInput	Modbus input value	float32	1f86	8070	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.Operation	As VirtualChannel1.Main.Operation	uint8	1f81	8065	Not applicable
VirtualChannel.8.Main.Period	The time period over which the calculation is made	int32	1f8a	8074	Not applicable
VirtualChannel.8.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	1f8c	8076	Not applicable
VirtualChannel.8.Main.PresetValue	The Preset value	float32	1f8d	8077	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.PV	The virtual channel output value	float32	013c	316	Set by VirtualChannel.8.Main.Resolution
VirtualChannel.8.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	1f8b	8075	Not applicable
VirtualChannel.8.Main.Resolution	Number of decimal places (0 to 6)	uint8	1f82	8066	Not applicable
VirtualChannel.8.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	1f91	8081	Not applicable
VirtualChannel.8.Main.Status	As VirtualChannel1.Main.Status	uint8	013d	317	Not applicable
VirtualChannel.8.Main.TimeRemaining	Time remaining before the calculation is made	time_t	1f89	8073	Set by Network.Modbus.TimeFormat
VirtualChannel.8.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	1f8e	8078	Not applicable
VirtualChannel.8.Main.Type	As VirtualChannel1.Main.Type	uint8	1f80	8064	Not applicable
VirtualChannel.8.Main.Units	Units descriptor	string_t	4bd2	19410	Not applicable
VirtualChannel.8.Main.UnitsScaler	Units scaler for totalisers	float32	1f83	8067	1dp
VirtualChannel.8.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	1fa0	8096	Not applicable
VirtualChannel.8.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	1fa2	8098	Same as VirtualChannel.8.Main.PV
VirtualChannel.8.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	1fa1	8097	Same as VirtualChannel.8.Main.PV
VirtualChannel.9.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01d0	464	Not applicable
VirtualChannel.9.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	2050	8272	Not applicable
VirtualChannel.9.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	204b	8267	Not applicable
VirtualChannel.9.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	2048	8264	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	204a	8266	Set by Network.Modbus.TimeFormat
VirtualChannel.9.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2042	8258	Not applicable
VirtualChannel.9.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2049	8265	Not applicable
VirtualChannel.9.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	2047	8263	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm1.Dwell	Alarm dwell time	time_t	2045	8261	Set by Network.Modbus.TimeFormat
VirtualChannel.9.Alarm1.Hysteresis	Alarm hysteresis value	float32	2044	8260	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	204e	8270	Not applicable
VirtualChannel.9.Alarm1.Inhibit	1 = alarm inhibited	bool	2051	8273	Not applicable
VirtualChannel.9.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2041	8257	Not applicable
VirtualChannel.9.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	204f	8271	Not applicable
VirtualChannel.9.Alarm1.Reference	Deviation alarm 'Reference' value	float32	2046	8262	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0142	322	Not applicable
VirtualChannel.9.Alarm1.Threshold	Alarm trigger threshold	float32	2043	8259	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	2040	8256	Not applicable
VirtualChannel.9.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01d1	465	Not applicable
VirtualChannel.9.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	2070	8304	Not applicable
VirtualChannel.9.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	206b	8299	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.9.Alarm2.Amount	Rate-of-change alarm 'Amount't	float32	2068	8296	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	206a	8298	Set by Network.Modbus.TimeFormat
VirtualChannel.9.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2062	8290	Not applicable
VirtualChannel.9.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2069	8297	Not applicable
VirtualChannel.9.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	2067	8295	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm2.Dwell	Alarm dwell time	time_t	2065	8293	Set by Network.Modbus.TimeFormat
VirtualChannel.9.Alarm2.Hysteresis	Alarm hysteresis value	float32	2064	8292	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	206e	8302	Not applicable
VirtualChannel.9.Alarm2.Inhibit	Inhibit	bool	2071	8305	Not applicable
VirtualChannel.9.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2061	8289	Not applicable
VirtualChannel.9.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	206f	8303	Not applicable
VirtualChannel.9.Alarm2.Reference	Deviation alarm 'Reference' value	float32	2066	8294	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0143	323	Not applicable
VirtualChannel.9.Alarm2.Threshold	Alarm trigger threshold	float32	2063	8291	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	2060	8288	Not applicable
VirtualChannel.9.Main.Descriptor	Virtual Channel descriptor	string_t	4bd8	19416	Not applicable
VirtualChannel.9.Main.Disable	1 = Virtual channel disabled	bool	2023	8227	Not applicable
VirtualChannel.9.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2005	8197	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.Input1	Input 1 value	float32	2007	8199	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.Input2	Input 2 value	float32	2008	8200	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2004	8196	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.ModbusInput	Modbus input value	float32	2006	8198	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2001	8193	Not applicable
VirtualChannel.9.Main.Period	The time period over which the calculation is made	int32	200a	8202	Not applicable
VirtualChannel.9.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	200c	8204	Not applicable
VirtualChannel.9.Main.PresetValue	The Preset value	float32	200d	8205	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.PV	The virtual channel output value	float32	0140	320	Set by VirtualChannel.9.Main.Resolution
VirtualChannel.9.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	200b	8203	Not applicable
VirtualChannel.9.Main.Resolution	Number of decimal places (0 to 6)	uint8	2002	8194	Not applicable
VirtualChannel.9.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2011	8209	Not applicable
VirtualChannel.9.Main.Status	As VirtualChannel1.Main.Status	uint8	0141	321	Not applicable
VirtualChannel.9.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2009	8201	Set by Network.Modbus.TimeFormat
VirtualChannel.9.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	200e	8206	Not applicable
VirtualChannel.9.Main.Type	As VirtualChannel1.Main.Type	uint8	2000	8192	Not applicable
VirtualChannel.9.Main.Units	Units descriptor	string_t	4bed	19437	Not applicable
VirtualChannel.9.Main.UnitsScaler	Units scaler for totalisers	float32	2003	8195	1dp
VirtualChannel.9.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2020	8224	Not applicable
VirtualChannel.9.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2022	8226	Same as VirtualChannel.9.Main.PV
VirtualChannel.9.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2021	8225	Same as VirtualChannel.9.Main.PV
VirtualChannel.10.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01d2	466	Not applicable
VirtualChannel.10.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	20d0	8400	Not applicable
VirtualChannel.10.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	20cb	8395	Not applicable
VirtualChannel.10.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	20c8	8392	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	20ca	8394	Set by Network.Modbus.TimeFormat
VirtualChannel.10.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	20c2	8386	Not applicable
VirtualChannel.10.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	20c9	8393	Not applicable
VirtualChannel.10.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	20c7	8391	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm1.Dwell	Alarm dwell time	time_t	20c5	8389	Set by Network.Modbus.TimeFormat
VirtualChannel.10.Alarm1.Hysteresis	Alarm hysteresis value	float32	20c4	8388	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	20ce	8398	Not applicable
VirtualChannel.10.Alarm1.Inhibit	1 = alarm inhibited	bool	20d1	8401	Not applicable
VirtualChannel.10.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	20c1	8385	Not applicable
VirtualChannel.10.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	20cf	8399	Not applicable
VirtualChannel.10.Alarm1.Reference	Deviation alarm 'Reference' value	float32	20c6	8390	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0146	326	Not applicable
VirtualChannel.10.Alarm1.Threshold	Alarm trigger threshold	float32	20c3	8387	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	20c0	8384	Not applicable
VirtualChannel.10.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01d3	467	Not applicable
VirtualChannel.10.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	20f0	8432	Not applicable
VirtualChannel.10.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	20eb	8427	Not applicable
VirtualChannel.10.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	20e8	8424	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	20ea	8426	Set by Network.Modbus.TimeFormat
VirtualChannel.10.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	20e2	8418	Not applicable
VirtualChannel.10.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	20e9	8425	Not applicable
VirtualChannel.10.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	20e7	8423	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm2.Dwell	Alarm dwell time	time_t	20e5	8421	Set by Network.Modbus.TimeFormat
VirtualChannel.10.Alarm2.Hysteresis	Alarm hysteresis value	float32	20e4	8420	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	20ee	8430	Not applicable
VirtualChannel.10.Alarm2.Inhibit	1 = alarm inhibited	bool	20f1	8433	Not applicable
VirtualChannel.10.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	20e1	8417	Not applicable
VirtualChannel.10.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	20ef	8431	Not applicable
VirtualChannel.10.Alarm2.Reference	Deviation alarm 'Reference' value	float32	20e6	8422	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0147	327	Not applicable
VirtualChannel.10.Alarm2.Threshold	Alarm trigger threshold	float32	20e3	8419	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	20e0	8416	Not applicable
VirtualChannel.10.Main.Descriptor	Virtual Channel descriptor	string_t	4bf3	19443	Not applicable
VirtualChannel.10.Main.Disable	1 = Virtual channel disabled	bool	20a3	8355	Not applicable
VirtualChannel.10.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2085	8325	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.Input1	Input 1 value	float32	2087	8327	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.Input2	Input 2 value	float32	2088	8328	Set by VirtualChannel.10.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.10.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2084	8324	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.ModbusInput	Modbus input value	float32	2086	8326	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2081	8321	Not applicable
VirtualChannel.10.Main.Period	Averaging period	int32	208a	8330	Not applicable
VirtualChannel.10.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	208c	8332	Not applicable
VirtualChannel.10.Main.PresetValue	The Preset value	float32	208d	8333	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.PV	The virtual channel output value	float32	0144	324	Set by VirtualChannel.10.Main.Resolution
VirtualChannel.10.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	208b	8331	Not applicable
VirtualChannel.10.Main.Resolution	Number of decimal places (0 to 6)	uint8	2082	8322	Not applicable
VirtualChannel.10.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2091	8337	Not applicable
VirtualChannel.10.Main.Status	As VirtualChannel1.Main.Status	uint8	0145	325	Not applicable
VirtualChannel.10.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2089	8329	Set by Network.Modbus.TimeFormat
VirtualChannel.10.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	208e	8334	Not applicable
VirtualChannel.10.Main.Type	As VirtualChannel1.Main.Type	uint8	2080	8320	Not applicable
VirtualChannel.10.Main.Units	Units descriptor	string_t	4c08	19464	Not applicable
VirtualChannel.10.Main.UnitsScaler	Units scaler for totalisers	float32	2083	8323	1dp
VirtualChannel.10.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	20a0	8352	Not applicable
VirtualChannel.10.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	20a2	8354	Same as VirtualChannel.10.Main.PV
VirtualChannel.10.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	20a1	8353	Same as VirtualChannel.10.Main.PV
VirtualChannel.11.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01d4	468	Not applicable
VirtualChannel.11.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	2150	8528	Not applicable
VirtualChannel.11.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	214b	8523	Not applicable
VirtualChannel.11.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	2148	8520	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	214a	8522	Set by Network.Modbus.TimeFormat
VirtualChannel.11.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2142	8514	Not applicable
VirtualChannel.11.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2149	8521	Not applicable
VirtualChannel.11.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	2147	8519	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm1.Dwell	Alarm dwell time	time_t	2145	8517	Set by Network.Modbus.TimeFormat
VirtualChannel.11.Alarm1.Hysteresis	Alarm hysteresis value	float32	2144	8516	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	214e	8526	Not applicable
VirtualChannel.11.Alarm1.Inhibit	1 = alarm inhibited	bool	2151	8529	Not applicable
VirtualChannel.11.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2141	8513	Not applicable
VirtualChannel.11.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	214f	8527	Not applicable
VirtualChannel.11.Alarm1.Reference	Deviation alarm 'Reference' value	float32	2146	8518	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	014a	330	Not applicable
VirtualChannel.11.Alarm1.Threshold	Alarm trigger threshold	float32	2143	8515	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	2140	8512	Not applicable
VirtualChannel.11.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01d5	469	Not applicable
VirtualChannel.11.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	2170	8560	Not applicable
VirtualChannel.11.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	216b	8555	Not applicable
VirtualChannel.11.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	2168	8552	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	216a	8554	Set by Network.Modbus.TimeFormat
VirtualChannel.11.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2162	8546	Not applicable
VirtualChannel.11.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2169	8553	Not applicable
VirtualChannel.11.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	2167	8551	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm2.Dwell	Alarm dwell time	time_t	2165	8549	Set by Network.Modbus.TimeFormat
VirtualChannel.11.Alarm2.Hysteresis	Alarm hysteresis value	float32	2164	8548	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	216e	8558	Not applicable
VirtualChannel.11.Alarm2.Inhibit	1 = alarm inhibited	bool	2171	8561	Not applicable
VirtualChannel.11.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2161	8545	Not applicable
VirtualChannel.11.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	216f	8559	Not applicable
VirtualChannel.11.Alarm2.Reference	Deviation alarm 'Reference' value	float32	2166	8550	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	014b	331	Not applicable
VirtualChannel.11.Alarm2.Threshold	Alarm trigger threshold	float32	2163	8547	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	2160	8544	Not applicable
VirtualChannel.11.Main.Descriptor	Virtual Channel descriptor	string_t	4c0e	19470	Not applicable
VirtualChannel.11.Main.Disable	1 = Virtual channel disabled	bool	2123	8483	Not applicable
VirtualChannel.11.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2105	8453	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.Input1	Input 1 value	float32	2107	8455	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.Input2	Input 2 value	float32	2108	8456	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2104	8452	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.ModbusInput	Modbus input value	float32	2106	8454	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2101	8449	Not applicable
VirtualChannel.11.Main.Period	The time period over which the calculation is made	int32	210a	8458	Not applicable
VirtualChannel.11.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	210c	8460	Not applicable
VirtualChannel.11.Main.PresetValue	The Preset value	float32	210d	8461	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.PV	The virtual channel output value	float32	0148	328	Set by VirtualChannel.11.Main.Resolution
VirtualChannel.11.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	210b	8459	Not applicable
VirtualChannel.11.Main.Resolution	Number of decimal places (0 to 6)	uint8	2102	8450	Not applicable
VirtualChannel.11.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2111	8465	Not applicable
VirtualChannel.11.Main.Status	As VirtualChannel1.Main.Status	uint8	0149	329	Not applicable
VirtualChannel.11.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2109	8457	Set by Network.Modbus.TimeFormat
VirtualChannel.11.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	210e	8462	Not applicable
VirtualChannel.11.Main.Type	As VirtualChannel1.Main.Type	uint8	2100	8448	Not applicable
VirtualChannel.11.Main.Units	Units descriptor	string_t	4c23	19491	Not applicable
VirtualChannel.11.Main.UnitsScaler	Units scaler for totalisers	float32	2103	8451	1dp
VirtualChannel.11.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2120	8480	Not applicable
VirtualChannel.11.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2122	8482	Same as VirtualChannel.11.Main.PV
VirtualChannel.11.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2121	8481	Same as VirtualChannel.11.Main.PV

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.12.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01d6	470	Not applicable
VirtualChannel.12.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	21d0	8656	Not applicable
VirtualChannel.12.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	21cb	8651	Not applicable
VirtualChannel.12.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	21c8	8648	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	21ca	8650	Set by Network.Modbus.TimeFormat
VirtualChannel.12.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	21c2	8642	Not applicable
VirtualChannel.12.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	21c9	8649	Not applicable
VirtualChannel.12.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	21c7	8647	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm1.Dwell	Alarm dwell time	time_t	21c5	8645	Set by Network.Modbus.TimeFormat
VirtualChannel.12.Alarm1.Hysteresis	Alarm hysteresis value	float32	21c4	8644	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	21ce	8654	Not applicable
VirtualChannel.12.Alarm1.Inhibit	1 = alarm inhibited	bool	21d1	8657	Not applicable
VirtualChannel.12.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	21c1	8641	Not applicable
VirtualChannel.12.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	21cf	8655	Not applicable
VirtualChannel.12.Alarm1.Reference	Deviation alarm 'Reference' value	float32	21c6	8646	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	014e	334	Not applicable
VirtualChannel.12.Alarm1.Threshold	Alarm trigger threshold	float32	21c3	8643	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	21c0	8640	Not applicable
VirtualChannel.12.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01d7	471	Not applicable
VirtualChannel.12.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	21f0	8688	Not applicable
VirtualChannel.12.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	21eb	8683	Not applicable
VirtualChannel.12.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	21e8	8680	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	21ea	8682	Set by Network.Modbus.TimeFormat
VirtualChannel.12.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	21e2	8674	Not applicable
VirtualChannel.12.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	21e9	8681	Not applicable
VirtualChannel.12.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	21e7	8679	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm2.Dwell	Alarm dwell time	time_t	21e5	8677	Set by Network.Modbus.TimeFormat
VirtualChannel.12.Alarm2.Hysteresis	Alarm hysteresis value	float32	21e4	8676	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	21ee	8686	Not applicable
VirtualChannel.12.Alarm2.Inhibit	1 = alarm inhibited	bool	21f1	8689	Not applicable
VirtualChannel.12.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	21e1	8673	Not applicable
VirtualChannel.12.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	21ef	8687	Not applicable
VirtualChannel.12.Alarm2.Reference	Deviation alarm 'Reference' value	float32	21e6	8678	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	014f	335	Not applicable
VirtualChannel.12.Alarm2.Threshold	Alarm trigger threshold	float32	21e3	8675	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	21e0	8672	Not applicable
VirtualChannel.12.Main.Descriptor	Virtual Channel descriptorl	string_t	4c29	19497	Not applicable
VirtualChannel.12.Main.Disable	1 = Virtual channel disabled	bool	21a3	8611	Not applicable
VirtualChannel.12.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2185	8581	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.Input1	Input 1 value	float32	2187	8583	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.Input2	Input 2 value	float32	2188	8584	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2184	8580	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.ModbusInput	Modbus input value	float32	2186	8582	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2181	8577	Not applicable
VirtualChannel.12.Main.Period	The time period over which the calculation is made	int32	218a	8586	Not applicable
VirtualChannel.12.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	218c	8588	Not applicable
VirtualChannel.12.Main.PresetValue	The Preset value	float32	218d	8589	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.PV	The virtual channel output value	float32	014c	332	Set by VirtualChannel.12.Main.Resolution
VirtualChannel.12.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	218b	8587	Not applicable
VirtualChannel.12.Main.Resolution	Number of decimal places (0 to 6)	uint8	2182	8578	Not applicable
VirtualChannel.12.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2191	8593	Not applicable
VirtualChannel.12.Main.Status	As VirtualChannel1.Main.Status	uint8	014d	333	Not applicable
VirtualChannel.12.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2189	8585	Set by Network.Modbus.TimeFormat
VirtualChannel.12.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	218e	8590	Not applicable
VirtualChannel.12.Main.Type	As VirtualChannel1.Main.Type	uint8	2180	8576	Not applicable
VirtualChannel.12.Main.Units	Units descriptor	string_t	4c3e	19518	Not applicable
VirtualChannel.12.Main.UnitsScaler	Units scaler for totalisers	float32	2183	8579	1dp
VirtualChannel.12.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	21a0	8608	Not applicable
VirtualChannel.12.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	21a2	8610	Same as VirtualChannel.12.Main.PV
VirtualChannel.12.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	21a1	8609	Same as VirtualChannel.12.Main.PV
VirtualChannel.13.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01d8	472	Not applicable
VirtualChannel.13.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	2250	8784	Not applicable
VirtualChannel.13.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	224b	8779	Not applicable
VirtualChannel.13.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	2248	8776	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	224a	8778	Set by Network.Modbus.TimeFormat
VirtualChannel.13.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2242	8770	Not applicable
VirtualChannel.13.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2249	8777	Not applicable
VirtualChannel.13.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	2247	8775	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm1.Dwell	Alarm dwell time	time_t	2245	8773	Set by Network.Modbus.TimeFormat
VirtualChannel.13.Alarm1.Hysteresis	Alarm hysteresis value	float32	2244	8772	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm1.Inhibit	1 = alarm inhibited	bool	2251	8785	Not applicable
VirtualChannel.13.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	224e	8782	Not applicable
VirtualChannel.13.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2241	8769	Not applicable
VirtualChannel.13.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	224f	8783	Not applicable
VirtualChannel.13.Alarm1.Reference	Deviation alarm 'Reference' value	float32	2246	8774	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0152	338	Not applicable
VirtualChannel.13.Alarm1.Threshold	Alarm trigger threshold	float32	2243	8771	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	2240	8768	Not applicable
VirtualChannel.13.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01d9	473	Not applicable
VirtualChannel.13.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	2270	8816	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.13.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	226b	8811	Not applicable
VirtualChannel.13.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	2268	8808	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	226a	8810	Set by Network.Modbus.TimeFormat
VirtualChannel.13.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2262	8802	Not applicable
VirtualChannel.13.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2269	8809	Not applicable
VirtualChannel.13.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	2267	8807	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm2.Dwell	Alarm dwell time	time_t	2265	8805	Set by Network.Modbus.TimeFormat
VirtualChannel.13.Alarm2.Hysteresis	Alarm hysteresis value	float32	2264	8804	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	226e	8814	Not applicable
VirtualChannel.13.Alarm2.Inhibit	1 = alarm inhibited	bool	2271	8817	Not applicable
VirtualChannel.13.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2261	8801	Not applicable
VirtualChannel.13.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	226f	8815	Not applicable
VirtualChannel.13.Alarm2.Reference	Deviation alarm 'Reference' value	float32	2266	8806	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0153	339	Not applicable
VirtualChannel.13.Alarm2.Threshold	Alarm trigger threshold	float32	2263	8803	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	2260	8800	Not applicable
VirtualChannel.13.Main.Descriptor	Virtual Channel descriptor	string_t	4c44	19524	Not applicable
VirtualChannel.13.Main.Disable	1 = Virtual channel disabled	bool	2223	8739	Not applicable
VirtualChannel.13.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2205	8709	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.Input1	Input 1 value	float32	2207	8711	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.Input2	Input 2 value	float32	2208	8712	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2204	8708	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.ModbusInput	Modbus input value	float32	2206	8710	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2201	8705	Not applicable
VirtualChannel.13.Main.Period	The time period over which the calculation is made	int32	220a	8714	Not applicable
VirtualChannel.13.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	220c	8716	Not applicable
VirtualChannel.13.Main.PresetValue	The Preset value	float32	220d	8717	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.PV	The virtual channel output value	float32	0150	336	Set by VirtualChannel.13.Main.Resolution
VirtualChannel.13.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	220b	8715	Not applicable
VirtualChannel.13.Main.Resolution	Number of decimal places (0 to 6)	uint8	2202	8706	Not applicable
VirtualChannel.13.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2211	8721	Not applicable
VirtualChannel.13.Main.Status	As VirtualChannel1.Main.Status	uint8	0151	337	Not applicable
VirtualChannel.13.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2209	8713	Set by Network.Modbus.TimeFormat
VirtualChannel.13.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	220e	8718	Not applicable
VirtualChannel.13.Main.Type	As VirtualChannel1.Main.Type	uint8	2200	8704	Not applicable
VirtualChannel.13.Main.Units	Units descriptor	string_t	4c59	19545	Not applicable
VirtualChannel.13.Main.UnitsScaler	Units scaler for totalisers	float32	2203	8707	1dp
VirtualChannel.13.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2220	8736	Not applicable
VirtualChannel.13.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2222	8738	Same as VirtualChannel.13.Main.PV
VirtualChannel.13.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2221	8737	Same as VirtualChannel.13.Main.PV
VirtualChannel.14.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01da	474	Not applicable
VirtualChannel.14.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	22d0	8912	Not applicable
VirtualChannel.14.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	22cb	8907	Not applicable
VirtualChannel.14.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	22c8	8904	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	22ca	8906	Set by Network.Modbus.TimeFormat
VirtualChannel.14.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	22c2	8898	Not applicable
VirtualChannel.14.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	22c9	8905	Not applicable
VirtualChannel.14.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	22c7	8903	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm1.Dwell	Alarm dwell time	time_t	22c5	8901	Set by Network.Modbus.TimeFormat
VirtualChannel.14.Alarm1.Hysteresis	Alarm hysteresis value	float32	22c4	8900	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	22ce	8910	Not applicable
VirtualChannel.14.Alarm1.Inhibit	1 = alarm inhibited	bool	22d1	8913	Not applicable
VirtualChannel.14.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	22c1	8897	Not applicable
VirtualChannel.14.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	22cf	8911	Not applicable
VirtualChannel.14.Alarm1.Reference	Deviation alarm 'Reference' value	float32	22c6	8902	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	0156	342	Not applicable
VirtualChannel.14.Alarm1.Threshold	Alarm trigger threshold	float32	22c3	8899	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	22c0	8896	Not applicable
VirtualChannel.14.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01db	475	Not applicable
VirtualChannel.14.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	22f0	8944	Not applicable
VirtualChannel.14.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	22eb	8939	Not applicable
VirtualChannel.14.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	22e8	8936	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	22ea	8938	Set by Network.Modbus.TimeFormat
VirtualChannel.14.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	22e2	8930	Not applicable
VirtualChannel.14.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	22e9	8937	Not applicable
VirtualChannel.14.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	22e7	8935	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm2.Dwell	Alarm dwell time	time_t	22e5	8933	Set by Network.Modbus.TimeFormat
VirtualChannel.14.Alarm2.Hysteresis	Alarm hysteresis value	float32	22e4	8932	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	22ee	8942	Not applicable
VirtualChannel.14.Alarm2.Inhibit	1 = alarm inhibited	bool	22f1	8945	Not applicable
VirtualChannel.14.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	22e1	8929	Not applicable
VirtualChannel.14.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	22ef	8943	Not applicable
VirtualChannel.14.Alarm2.Reference	Deviation alarm 'Reference' value	float32	22e6	8934	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	0157	343	Not applicable
VirtualChannel.14.Alarm2.Threshold	Alarm trigger threshold	float32	22e3	8931	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	22e0	8928	Not applicable
VirtualChannel.14.Main.Descriptor	Virtual Channel descriptor	string_t	4c5f	19551	Not applicable
VirtualChannel.14.Main.Disable	1 = Virtual channel disabled	bool	22a3	8867	Not applicable
VirtualChannel.14.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2285	8837	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.Input1	Input 1 value	float32	2287	8839	Set by VirtualChannel.14.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.14.Main.Input2	Input 2 value	float32	2288	8840	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2284	8836	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.ModbusInput	Modbus input value	float32	2286	8838	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.Operation	As VirtualChannel1.Main.Operation	uint8	2281	8833	Not applicable
VirtualChannel.14.Main.Period	The time period over which the calculation is made	int32	228a	8842	Not applicable
VirtualChannel.14.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	228c	8844	Not applicable
VirtualChannel.14.Main.PresetValue	The preset value	float32	228d	8845	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.PV	The virtual channel output value	float32	0154	340	Set by VirtualChannel.14.Main.Resolution
VirtualChannel.14.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	228b	8843	Not applicable
VirtualChannel.14.Main.Resolution	Number of decimal places (0 to 6)	uint8	2282	8834	Not applicable
VirtualChannel.14.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2291	8849	Not applicable
VirtualChannel.14.Main.Status	As VirtualChannel1.Main.Status	uint8	0155	341	Not applicable
VirtualChannel.14.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2289	8841	Set by Network.Modbus.TimeFormat
VirtualChannel.14.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	228e	8846	Not applicable
VirtualChannel.14.Main.Type	As VirtualChannel1.Main.Type	uint8	2280	8832	Not applicable
VirtualChannel.14.Main.Units	Units descriptor	string_t	4c75	19573	Not applicable
VirtualChannel.14.Main.UnitsScaler	Units scaler for totalisers	float32	2283	8835	1dp
VirtualChannel.14.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	22a0	8864	Not applicable
VirtualChannel.14.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	22a2	8866	Same as VirtualChannel.14.Main.PV
VirtualChannel.14.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	22a1	8865	Same as VirtualChannel.14.Main.PV
VirtualChannel.15.Alarm1.Acknowledge	1 = acknowledge alarm	bool	01de	478	Not applicable
VirtualChannel.15.Alarm1.Acknowledgement	1 = alarm acknowledged	bool	2350	9040	Not applicable
VirtualChannel.15.Alarm1.Active	1 = alarm source active, or safe but not ack'd	bool	234b	9035	Not applicable
VirtualChannel.15.Alarm1.Amount	Rate-of-change alarm 'Amount'	float32	2348	9032	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm1.AverageTime	Rate-of-change alarm 'Average time'	time_t	234a	9034	Set by Network.Modbus.TimeFormat
VirtualChannel.15.Alarm1.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2342	9026	Not applicable
VirtualChannel.15.Alarm1.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2349	9033	Not applicable
VirtualChannel.15.Alarm1.Deviation	Deviation alarm 'Deviation Value'	float32	2347	9031	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm1.Dwell	Alarm dwell time	time_t	2345	9029	Set by Network.Modbus.TimeFormat
VirtualChannel.15.Alarm1.Hysteresis	Alarm hysteresis value	float32	2344	9028	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm1.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	234e	9038	Not applicable
VirtualChannel.15.Alarm1.Inhibit	1 = Alarm inhibited	bool	2351	9041	Not applicable
VirtualChannel.15.Alarm1.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2341	9025	Not applicable
VirtualChannel.15.Alarm1.NotAcknowledged	1 = alarm has not been acknowledged	bool	234f	9039	Not applicable
VirtualChannel.15.Alarm1.Reference	Deviation alarm 'Reference' value	float32	2346	9030	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm1.Status	As VirtualChannel1.Alarm1.Status	uint8	015a	346	Not applicable
VirtualChannel.15.Alarm1.Threshold	Alarm trigger threshold	float32	2343	9027	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm1.Type	As VirtualChannel1.Alarm1.Type	uint8	2340	9024	Not applicable
VirtualChannel.15.Alarm2.Acknowledge	1 = acknowledge alarm	bool	01dd	477	Not applicable
VirtualChannel.15.Alarm2.Acknowledgement	1 = alarm acknowledged	bool	2370	9072	Not applicable
VirtualChannel.15.Alarm2.Active	1 = alarm source active, or safe but not ack'd	bool	236b	9067	Not applicable
VirtualChannel.15.Alarm2.Amount	Rate-of-change alarm 'Amount'	float32	2368	9064	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm2.AverageTime	Rate-of-change alarm 'Average time'	time_t	236a	9066	Set by Network.Modbus.TimeFormat
VirtualChannel.15.Alarm2.Block	0 = Blocking alarms off; 1 = Blocking alarms on	uint8	2362	9058	Not applicable
VirtualChannel.15.Alarm2.ChangeTime	Rate-of-change alarm 'Change Time'	uint8	2369	9065	Not applicable
VirtualChannel.15.Alarm2.Deviation	Deviation alarm 'Deviation Value'	float32	2367	9063	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm2.Dwell	Alarm dwell time	time_t	2365	9061	Set by Network.Modbus.TimeFormat
VirtualChannel.15.Alarm2.Hysteresis	Alarm hysteresis value	float32	2364	9060	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm2.Inactive	1 = alarm source safe and ack'd (if necessary)	bool	236e	9070	Not applicable
VirtualChannel.15.Alarm2.Inhibit	1 = alarm inhibited	bool	2371	9073	Not applicable
VirtualChannel.15.Alarm2.Latch	As VirtualChannel1.Alarm1.Latch	uint8	2361	9057	Not applicable
VirtualChannel.15.Alarm2.NotAcknowledged	1 = alarm has not been acknowledged	bool	236f	9071	Not applicable
VirtualChannel.15.Alarm2.Reference	Deviation alarm 'Reference' value	float32	2366	9062	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm2.Status	As VirtualChannel1.Alarm1.Status	uint8	015b	347	Not applicable
VirtualChannel.15.Alarm2.Threshold	Alarm trigger threshold	float32	2363	9059	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Alarm2.Type	As VirtualChannel1.Alarm1.Type	uint8	2360	9056	Not applicable
VirtualChannel.15.Main.Descriptor	Virtual Channel descriptor	string_t	4c7b	19579	Not applicable
VirtualChannel.15.Main.Disable	1 = Virtual channel disabled	bool	2323	8995	Not applicable
VirtualChannel.15.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2305	8965	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.Input1	Input 1 value	float32	2307	8967	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.Input2	Input 2 value	float32	2308	8968	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2304	8964	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.ModbusInput	Modbus input value	float32	2306	8966	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.Operation	Specifies the operation of the virtual channel	uint8	2301	8961	Not applicable
VirtualChannel.15.Main.Period	The time period over which the calculation is made	int32	230a	8970	Not applicable
VirtualChannel.15.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	230c	8972	Not applicable
VirtualChannel.15.Main.PresetValue	Specifies the preset value	float32	230d	8973	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.PV	The virtual channel output value	float32	0158	344	Set by VirtualChannel.15.Main.Resolution
VirtualChannel.15.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	230b	8971	Not applicable
VirtualChannel.15.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2302	8962	Not applicable
VirtualChannel.15.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2311	8977	Not applicable
VirtualChannel.15.Main.Status	As VirtualChannel1.Main.Status	uint8	0159	345	Not applicable
VirtualChannel.15.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2309	8969	Set by Network.Modbus.TimeFormat
VirtualChannel.15.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	230e	8974	Not applicable
VirtualChannel.15.Main.Type	As VirtualChannel1.Main.Type	uint8	2300	8960	Not applicable
VirtualChannel.15.Main.Units	Units descriptor	string_t	4c90	19600	Not applicable
VirtualChannel.15.Main.UnitsScaler	Units scaler for totalisers	float32	2303	8963	1dp
VirtualChannel.15.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2320	8992	Not applicable
VirtualChannel.15.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2322	8994	Same as VirtualChannel.15.Main.PV
VirtualChannel.15.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2321	8993	Same as VirtualChannel.15.Main.PV

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.16.Main.Descriptor	Virtual Channel descriptor	string_t	4c96	19606	Not applicable
VirtualChannel.16.Main.Disable	1 = Virtual channel disabled	bool	23a3	9123	Not applicable
VirtualChannel.16.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2385	9093	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.Input1	Input 1 value	float32	2387	9095	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.Input2	Input 2 value	float32	2388	9096	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2384	9092	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.ModbusInput	Modbus input value	float32	2386	9094	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.Operation	Specifies the operation of the virtual channel	uint8	2381	9089	Not applicable
VirtualChannel.16.Main.Period	The time period over which the calculation is made	int32	238a	9098	Not applicable
VirtualChannel.16.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	238c	9100	Not applicable
VirtualChannel.16.Main.PresetValue	Specifies the preset value	float32	238d	9101	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.PV	The virtual channel output value	float32	015c	348	Set by VirtualChannel.16.Main.Resolution
VirtualChannel.16.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	238b	9099	Not applicable
VirtualChannel.16.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2382	9090	Not applicable
VirtualChannel.16.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2391	9105	Not applicable
VirtualChannel.16.Main.Status	As VirtualChannel1.Main.Status	uint8	015d	349	Not applicable
VirtualChannel.16.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2389	9097	Set by Network.Modbus.TimeFormat
VirtualChannel.16.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	238e	9102	Not applicable
VirtualChannel.16.Main.Type	As VirtualChannel1.Main.Type	uint8	2380	9088	Not applicable
VirtualChannel.16.Main.Units	Units descriptor	string_t	4cab	19627	Not applicable
VirtualChannel.16.Main.UnitsScaler	Units scaler for totalisers	float32	2383	9091	1dp
VirtualChannel.16.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	23a0	9120	Not applicable
VirtualChannel.16.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	23a2	9122	Same as VirtualChannel.16.Main.PV
VirtualChannel.16.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	23a1	9121	Same as VirtualChannel.16.Main.PV
VirtualChannel.17.Main.Descriptor	Virtual Channel descriptor	string_t	4cb1	19633	Not applicable
VirtualChannel.17.Main.Disable	1 = Virtual channel disabled	bool	23e3	9187	Not applicable
VirtualChannel.17.Main.HighCutOff	The highest input value that will be totalised/counted	float32	23c5	9157	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.Input1	Input 1 value	float32	23c7	9159	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.Input2	Input 2 value	float32	23c8	9160	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	23c4	9156	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.ModbusInput	Modbus input value	float32	23c6	9158	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.Operation	Specifies the operation of the virtual channel	uint8	23c1	9153	Not applicable
VirtualChannel.17.Main.Period	The time period over which the calculation is made	int32	23ca	9162	Not applicable
VirtualChannel.17.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	23cc	9164	Not applicable
VirtualChannel.17.Main.PresetValue	Specifies the preset value	float32	23cd	9165	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.PV	The virtual channel output value	float32	015e	350	Set by VirtualChannel.17.Main.Resolution
VirtualChannel.17.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	23cb	9163	Not applicable
VirtualChannel.17.Main.Resolution	Specifies the resolution/number of decimal places	uint8	23c2	9154	Not applicable
VirtualChannel.17.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	23d1	9169	Not applicable
VirtualChannel.17.Main.Status	As VirtualChannel1.Main.Status	uint8	015f	351	Not applicable
VirtualChannel.17.Main.TimeRemaining	Time remaining before the calculation is made	time_t	23c9	9161	Set by Network.Modbus.TimeFormat
VirtualChannel.17.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	23ce	9166	Not applicable
VirtualChannel.17.Main.Type	As VirtualChannel1.Main.Type	uint8	23c0	9152	Not applicable
VirtualChannel.17.Main.Units	Units descriptor	string_t	4cc6	19654	Not applicable
VirtualChannel.17.Main.UnitsScaler	Units scaler for totalisers	float32	23c3	9155	1dp
VirtualChannel.17.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	23e0	9184	Not applicable
VirtualChannel.17.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	23e2	9186	Same as VirtualChannel.17.Main.PV
VirtualChannel.17.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	23e1	9185	Same as VirtualChannel.17.Main.PV
VirtualChannel.18.Main.Descriptor	Virtual Channel descriptor	string_t	4ccc	19660	Not applicable
VirtualChannel.18.Main.Disable	1 = Virtual channel disabled	bool	2523	9507	Not applicable
VirtualChannel.18.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2405	9221	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.Input1	Input 1 value	float32	2407	9223	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.Input2	Input 2 value	float32	2408	9224	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2404	9220	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.ModbusInput	Modbus input value	float32	2406	9222	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.Operation	Specifies the operation of the virtual channel	uint8	2401	9217	Not applicable
VirtualChannel.18.Main.Period	The time period over which the calculation is made	int32	240a	9226	Not applicable
VirtualChannel.18.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	240c	9228	Not applicable
VirtualChannel.18.Main.PresetValue	Specifies the preset value	float32	240d	9229	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.PV	The virtual channel output value	float32	0160	352	Set by VirtualChannel.18.Main.Resolution
VirtualChannel.18.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	240b	9227	Not applicable
VirtualChannel.18.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2402	9218	Not applicable
VirtualChannel.18.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2411	9233	Not applicable
VirtualChannel.18.Main.Status	As VirtualChannel1.Main.Status	uint8	0161	353	Not applicable
VirtualChannel.18.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2409	9225	Set by Network.Modbus.TimeFormat
VirtualChannel.18.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes)	bool	240e	9230	Not applicable
VirtualChannel.18.Main.Type	As VirtualChannel1.Main.Type	uint8	2400	9216	Not applicable
VirtualChannel.18.Main.Units	Units descriptor	string_t	4ce1	19681	Not applicable
VirtualChannel.18.Main.UnitsScaler	Units scaler for totalisers	float32	2403	9219	1dp
VirtualChannel.18.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2520	9504	Not applicable
VirtualChannel.18.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2522	9506	Same as VirtualChannel.18.Main.PV
VirtualChannel.18.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2521	9505	Same as VirtualChannel.18.Main.PV
VirtualChannel.19.Main.Descriptor	Virtual Channel descriptor	string_t	4ce7	19687	Not applicable
VirtualChannel.19.Main.Disable	1 = Virtual channel disabled	bool	2563	9571	Not applicable
VirtualChannel.19.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2445	9285	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.Input1	Input 1 value	float32	2447	9287	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.Input2	Input 2 value	float32	2448	9288	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2444	9284	Set by VirtualChannel.19.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.19.Main.ModbusInput	Modbus input value	float32	2446	9286	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.Operation	Specifies the operation of the virtual channel	uint8	2441	9281	Not applicable
VirtualChannel.19.Main.Period	The time period over which the calculation is made	int32	244a	9290	Not applicable
VirtualChannel.19.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	244c	9292	Not applicable
VirtualChannel.19.Main.PresetValue	Specifies the preset value	float32	244d	9293	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.PV	The virtual channel output value	float32	0162	354	Set by VirtualChannel.19.Main.Resolution
VirtualChannel.19.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	244b	9291	Not applicable
VirtualChannel.19.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2442	9282	Not applicable
VirtualChannel.19.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2451	9297	Not applicable
VirtualChannel.19.Main.Status	TAs VirtualChannel1.Main.Statusv	uint8	0163	355	Not applicable
VirtualChannel.19.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2449	9289	Set by Network.Modbus.TimeFormat
VirtualChannel.19.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	244e	9294	Not applicable
VirtualChannel.19.Main.Type	As VirtualChannel1.Main.Type	uint8	2440	9280	Not applicable
VirtualChannel.19.Main.Units	Units descriptor	string_t	4cfc	19708	Not applicable
VirtualChannel.19.Main.UnitsScaler	Units scaler for totalisers	float32	2443	9283	1dp
VirtualChannel.19.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2560	9568	Not applicable
VirtualChannel.19.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2562	9570	Same as VirtualChannel.19.Main.PV
VirtualChannel.19.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2561	9569	Same as VirtualChannel.19.Main.PV
VirtualChannel.20.Main.Descriptor	Virtual Channel descriptor	string_t	4d02	19714	Not applicable
VirtualChannel.20.Main.Disable	1 = Virtual channel disabled	bool	25a3	9635	Not applicable
VirtualChannel.20.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2485	9349	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.Input1	Input 1 value	float32	2487	9351	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.Input2	Input 2 value	float32	2488	9352	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2484	9348	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.ModbusInput	Modbus input value	float32	2486	9350	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.Operation	Specifies the operation of the virtual channel	uint8	2481	9345	Not applicable
VirtualChannel.20.Main.Period	The time period over which the calculation is made	int32	248a	9354	Not applicable
VirtualChannel.20.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	248c	9356	Not applicable
VirtualChannel.20.Main.PresetValue	Specifies the preset value	float32	248d	9357	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.PV	The virtual channel output value	float32	0164	356	Set by VirtualChannel.20.Main.Resolution
VirtualChannel.20.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	248b	9355	Not applicable
VirtualChannel.20.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2482	9346	Not applicable
VirtualChannel.20.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2491	9361	Not applicable
VirtualChannel.20.Main.Status	As VirtualChannel1.Main.Status	uint8	0165	357	Not applicable
VirtualChannel.20.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2489	9353	Set by Network.Modbus.TimeFormat
VirtualChannel.20.Main.Trigger	TIncrement/decrement counter. 0 = No; 1 = Yes	bool	248e	9358	Not applicable
VirtualChannel.20.Main.Type	As VirtualChannel1.Main.Type	uint8	2480	9344	Not applicable
VirtualChannel.20.Main.Units	Units descriptor	string_t	4d17	19735	Not applicable
VirtualChannel.20.Main.UnitsScaler	Units scaler for totalisers	float32	2483	9347	1dp
VirtualChannel.20.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	25a0	9632	Not applicable
VirtualChannel.20.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	25a2	9634	Same as VirtualChannel.20.Main.PV
VirtualChannel.20.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	25a1	9633	Same as VirtualChannel.20.Main.PV
VirtualChannel.21.Main.Descriptor	Virtual Channel descriptor	string_t	4d1d	19741	Not applicable
VirtualChannel.21.Main.Disable	1 = Virtual channel disabled	bool	25e3	9699	Not applicable
VirtualChannel.21.Main.HighCutOff	The highest input value that will be totalised/counted	float32	24c5	9413	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.Input1	Input 1 value	float32	24c7	9415	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.Input2	Input 2 value	float32	24c8	9416	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	24c4	9412	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.ModbusInput	Modbus input value	float32	24c6	9414	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.Operation	Specifies the operation of the virtual channel	uint8	24c1	9409	Not applicable
VirtualChannel.21.Main.Period	The time period over which the calculation is made	int32	24ca	9418	Not applicable
VirtualChannel.21.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	24cc	9420	Not applicable
VirtualChannel.21.Main.PresetValue	Specifies the preset value	float32	24cd	9421	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.PV	TThe virtual channel output value	float32	0166	358	Set by VirtualChannel.21.Main.Resolution
VirtualChannel.21.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	24cb	9419	Not applicable
VirtualChannel.21.Main.Resolution	Specifies the resolution/number of decimal places	uint8	24c2	9410	Not applicable
VirtualChannel.21.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	24d1	9425	Not applicable
VirtualChannel.21.Main.Status	As VirtualChannel1.Main.Status	uint8	0167	359	Not applicable
VirtualChannel.21.Main.TimeRemaining	Time remaining before the calculation is made	time_t	24c9	9417	Set by Network.Modbus.TimeFormat
VirtualChannel.21.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	24ce	9422	Not applicable
VirtualChannel.21.Main.Type	As VirtualChannel1.Main.Type	uint8	24c0	9408	Not applicable
VirtualChannel.21.Main.Units	Units descriptor	string_t	4d32	19762	Not applicable
VirtualChannel.21.Main.UnitsScaler	Units scaler for totalisers	float32	24c3	9411	1dp
VirtualChannel.21.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	25e0	9696	Not applicable
VirtualChannel.21.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	25e2	9698	Same as VirtualChannel.21.Main.PV
VirtualChannel.21.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	25e1	9697	Same as VirtualChannel.21.Main.PV
VirtualChannel.22.Main.Descriptor	Virtual Channel descriptor	string_t	4d38	19768	Not applicable
VirtualChannel.22.Main.Disable	1 = Virtual channel disabled	bool	2623	9763	Not applicable
VirtualChannel.22.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2505	9477	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.Input1	Input 1 value	float32	2507	9479	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.Input2	Input 2 value	float32	2508	9480	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2504	9476	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.ModbusInput	Modbus input value	float32	2506	9478	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.Operation	Specifies the operation of the virtual channel	uint8	2501	9473	Not applicable
VirtualChannel.22.Main.Period	The time period over which the calculation is made	int32	250a	9482	Not applicable
VirtualChannel.22.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	250c	9484	Not applicable
VirtualChannel.22.Main.PresetValue	Specifies the preset value	float32	250d	9485	Set by VirtualChannel.22.Main.Resolution
VirtualChannel.22.Main.PV	TThe virtual channel output value	float32	0168	360	Set by VirtualChannel.22.Main.Resolution

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.22.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	250b	9483	Not applicable
VirtualChannel.22.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2502	9474	Not applicable
VirtualChannel.22.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2511	9489	Not applicable
VirtualChannel.22.Main.Status	As VirtualChannel1.Main.Status	uint8	0169	361	Not applicable
VirtualChannel.22.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2509	9481	Set by Network.Modbus.TimeFormat
VirtualChannel.22.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	250e	9486	Not applicable
VirtualChannel.22.Main.Type	As VirtualChannel1.Main.Type	uint8	2500	9472	Not applicable
VirtualChannel.22.Main.Units	Units descriptor	string_t	4d4d	19789	Not applicable
VirtualChannel.22.Main.UnitsScaler	Units scaler for totalisers	float32	2503	9475	1dp
VirtualChannel.22.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2620	9760	Not applicable
VirtualChannel.22.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2622	9762	Same as VirtualChannel.22.Main.PV
VirtualChannel.22.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2621	9761	Same as VirtualChannel.22.Main.PV
VirtualChannel.23.Main.Descriptor	Virtual Channel descriptor	string_t	4d53	19795	Not applicable
VirtualChannel.23.Main.Disable	1 = Virtual channel disabled	bool	2663	9827	Not applicable
VirtualChannel.23.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2545	9541	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.Input1	Input 1 value	float32	2547	9543	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.Input2	Input 2 value	float32	2548	9544	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2544	9540	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.ModbusInput	Modbus input value	float32	2546	9542	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.Operation	Specifies the operation of the virtual channel	uint8	2541	9537	Not applicable
VirtualChannel.23.Main.Period	The time period over which the calculation is made	int32	254a	9546	Not applicable
VirtualChannel.23.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	254c	9548	Not applicable
VirtualChannel.23.Main.PresetValue	Specifies the preset value	float32	254d	9549	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.PV	The virtual channel output value	float32	016a	362	Set by VirtualChannel.23.Main.Resolution
VirtualChannel.23.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	254b	9547	Not applicable
VirtualChannel.23.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2542	9538	Not applicable
VirtualChannel.23.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2551	9553	Not applicable
VirtualChannel.23.Main.Status	As VirtualChannel1.Main.Status	uint8	016b	363	Not applicable
VirtualChannel.23.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2549	9545	Set by Network.Modbus.TimeFormat
VirtualChannel.23.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	254e	9550	Not applicable
VirtualChannel.23.Main.Type	As VirtualChannel1.Main.Type	uint8	2540	9536	Not applicable
VirtualChannel.23.Main.Units	Units descriptor	string_t	4d68	19816	Not applicable
VirtualChannel.23.Main.UnitsScaler	Units scaler for totalisers	float32	2543	9539	1dp
VirtualChannel.23.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2660	9824	Not applicable
VirtualChannel.23.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2662	9826	Same as VirtualChannel.23.Main.PV
VirtualChannel.23.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2661	9825	Same as VirtualChannel.23.Main.PV
VirtualChannel.24.Main.Descriptor	Virtual Channel descriptor	string_t	4d6e	19822	Not applicable
VirtualChannel.24.Main.Disable	1 = Virtual channel disabled	bool	26a3	9891	Not applicable
VirtualChannel.24.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2585	9605	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.Input1	Input 1 value	float32	2587	9607	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.Input2	Input 2 value	float32	2588	9608	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2584	9604	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.ModbusInput	Modbus input value	float32	2586	9606	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.Operation	Specifies the operation of the virtual channel	uint8	2581	9601	Not applicable
VirtualChannel.24.Main.Period	The time period over which the calculation is made	int32	258a	9610	Not applicable
VirtualChannel.24.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	258c	9612	Not applicable
VirtualChannel.24.Main.PresetValue	Specifies the preset value	float32	258d	9613	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.PV	The virtual channel output value	float32	016c	364	Set by VirtualChannel.24.Main.Resolution
VirtualChannel.24.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	258b	9611	Not applicable
VirtualChannel.24.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2582	9602	Not applicable
VirtualChannel.24.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2591	9617	Not applicable
VirtualChannel.24.Main.Status	As VirtualChannel1.Main.Status	uint8	016d	365	Not applicable
VirtualChannel.24.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2589	9609	Set by Network.Modbus.TimeFormat
VirtualChannel.24.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	258e	9614	Not applicable
VirtualChannel.24.Main.Type	As VirtualChannel1.Main.Type	uint8	2580	9600	Not applicable
VirtualChannel.24.Main.Units	Units descriptor	string_t	4d83	19843	Not applicable
VirtualChannel.24.Main.UnitsScaler	Units scaler for totalisers	float32	2583	9603	1dp
VirtualChannel.24.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	26a0	9888	Not applicable
VirtualChannel.24.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	26a2	9890	Same as VirtualChannel.24.Main.PV
VirtualChannel.24.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	26a1	9889	Same as VirtualChannel.24.Main.PV
VirtualChannel.25.Main.Descriptor	Virtual Channel descriptor	string_t	4d89	19849	Not applicable
VirtualChannel.25.Main.Disable	1 = Virtual channel disabled	bool	26e3	9955	Not applicable
VirtualChannel.25.Main.HighCutOff	The highest input value that will be totalised/counted	float32	25c5	9669	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.Input1	Input 1 value	float32	25c7	9671	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.Input2	Input 2 value	float32	25c8	9672	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	25c4	9668	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.ModbusInput	Modbus input value	float32	25c6	9670	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.Operation	Specifies the operation of the virtual channel	uint8	25c1	9665	Not applicable
VirtualChannel.25.Main.Period	The time period over which the calculation is made	int32	25ca	9674	Not applicable
VirtualChannel.25.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	25cc	9676	Not applicable
VirtualChannel.25.Main.PresetValue	Specifies the preset value	float32	25cd	9677	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.PV	The virtual channel output value	float32	016e	366	Set by VirtualChannel.25.Main.Resolution
VirtualChannel.25.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	25cb	9675	Not applicable
VirtualChannel.25.Main.Resolution	Specifies the resolution/number of decimal places	uint8	25c2	9666	Not applicable
VirtualChannel.25.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	25d1	9681	Not applicable
VirtualChannel.25.Main.Status	As VirtualChannel1.Main.Status	uint8	016f	367	Not applicable
VirtualChannel.25.Main.TimeRemaining	Time remaining before the calculation is made	time_t	25c9	9673	Set by Network.Modbus.TimeFormat
VirtualChannel.25.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	25ce	9678	Not applicable

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.25.Main.Type	As VirtualChannel1.Main.Type	uint8	25c0	9664	Not applicable
VirtualChannel.25.Main.Units	Units descriptor	string_t	4d9e	19870	Not applicable
VirtualChannel.25.Main.UnitsScaler	Units scaler for totalisers	float32	25c3	9667	1dp
VirtualChannel.25.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	26e0	9952	Not applicable
VirtualChannel.25.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	26e2	9954	Same as VirtualChannel.25.Main.PV
VirtualChannel.25.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	26e1	9953	Same as VirtualChannel.25.Main.PV
VirtualChannel.26.Main.Descriptor	Virtual Channel descriptor	string_t	4da4	19876	Not applicable
VirtualChannel.26.Main.Disable	1 = Virtual channel disabled	bool	2723	10019	Not applicable
VirtualChannel.26.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2605	9733	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.Input1	Input 1 value	float32	2607	9735	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.Input2	Input 2 value	float32	2608	9736	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2604	9732	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.ModbusInput	Modbus input value	float32	2606	9734	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.Operation	Specifies the operation of the virtual channel	uint8	2601	9729	Not applicable
VirtualChannel.26.Main.Period	The time period over which the calculation is made	int32	260a	9738	Not applicable
VirtualChannel.26.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	260c	9740	Not applicable
VirtualChannel.26.Main.PresetValue	Specifies the preset value	float32	260d	9741	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.PV	The virtual channel output value	float32	0170	368	Set by VirtualChannel.26.Main.Resolution
VirtualChannel.26.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	260b	9739	Not applicable
VirtualChannel.26.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2602	9730	Not applicable
VirtualChannel.26.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2611	9745	Not applicable
VirtualChannel.26.Main.Status	As VirtualChannel1.Main.Status	uint8	0171	369	Not applicable
VirtualChannel.26.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2609	9737	Set by Network.Modbus.TimeFormat
VirtualChannel.26.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	260e	9742	Not applicable
VirtualChannel.26.Main.Type	As VirtualChannel1.Main.Type	uint8	2600	9728	Not applicable
VirtualChannel.26.Main.Units	Units descriptor	string_t	4db9	19897	Not applicable
VirtualChannel.26.Main.UnitsScaler	Units scaler for totalisers	float32	2603	9731	1dp
VirtualChannel.26.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2720	10016	Not applicable
VirtualChannel.26.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2722	10018	Same as VirtualChannel.26.Main.PV
VirtualChannel.26.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2721	10017	Same as VirtualChannel.26.Main.PV
VirtualChannel.27.Main.Descriptor	Virtual Channel descriptor	string_t	4dbf	19903	Not applicable
VirtualChannel.27.Main.Disable	1 = Virtual channel disabled	bool	2763	10083	Not applicable
VirtualChannel.27.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2645	9797	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.Input1	Input 1 value	float32	2647	9799	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.Input2	Input 2 value	float32	2648	9800	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2644	9796	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.ModbusInput	Modbus input value	float32	2646	9798	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.Operation	Specifies the operation of the virtual channel	uint8	2641	9793	Not applicable
VirtualChannel.27.Main.Period	The time period over which the calculation is made	int32	264a	9802	Not applicable
VirtualChannel.27.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	264c	9804	Not applicable
VirtualChannel.27.Main.PresetValue	Specifies the preset value	float32	264d	9805	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.PV	The virtual channel output value	float32	0172	370	Set by VirtualChannel.27.Main.Resolution
VirtualChannel.27.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	264b	9803	Not applicable
VirtualChannel.27.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2642	9794	Not applicable
VirtualChannel.27.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2651	9809	Not applicable
VirtualChannel.27.Main.Status	As VirtualChannel1.Main.Status	uint8	0173	371	Not applicable
VirtualChannel.27.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2649	9801	Set by Network.Modbus.TimeFormat
VirtualChannel.27.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	264e	9806	Not applicable
VirtualChannel.27.Main.Type	As VirtualChannel1.Main.Type	uint8	2640	9792	Not applicable
VirtualChannel.27.Main.Units	Units descriptor	string_t	4dd4	19924	Not applicable
VirtualChannel.27.Main.UnitsScaler	Units scaler for totalisers	float32	2643	9795	1dp
VirtualChannel.27.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2760	10080	Not applicable
VirtualChannel.27.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2762	10082	Same as VirtualChannel.27.Main.PV
VirtualChannel.27.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2761	10081	Same as VirtualChannel.27.Main.PV
VirtualChannel.28.Main.Descriptor	Virtual Channel descriptor	string_t	4dda	19930	Not applicable
VirtualChannel.28.Main.Disable	1 = Virtual channel disabled	bool	27a3	10147	Not applicable
VirtualChannel.28.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2685	9861	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.Input1	Input 1 value	float32	2687	9863	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.Input2	Input 2 value	float32	2688	9864	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2684	9860	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.ModbusInput	Modbus input value	float32	2686	9862	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.Operation	Specifies the operation of the virtual channel	uint8	2681	9857	Not applicable
VirtualChannel.28.Main.Period	The time period over which the calculation is made	int32	268a	9866	Not applicable
VirtualChannel.28.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	268c	9868	Not applicable
VirtualChannel.28.Main.PresetValue	Specifies the preset value	float32	268d	9869	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.PV	The virtual channel output value	float32	0174	372	Set by VirtualChannel.28.Main.Resolution
VirtualChannel.28.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	268b	9867	Not applicable
VirtualChannel.28.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2682	9858	Not applicable
VirtualChannel.28.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2691	9873	Not applicable
VirtualChannel.28.Main.Status	As VirtualChannel1.Main.Status	uint8	0175	373	Not applicable
VirtualChannel.28.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2689	9865	Set by Network.Modbus.TimeFormat
VirtualChannel.28.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	268e	9870	Not applicable
VirtualChannel.28.Main.Type	As VirtualChannel1.Main.Type	uint8	2680	9856	Not applicable
VirtualChannel.28.Main.Units	Units descriptor	string_t	4def	19951	Not applicable
VirtualChannel.28.Main.UnitsScaler	Units scaler for totalisers	float32	2683	9859	1dp
VirtualChannel.28.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	27a0	10144	Not applicable
VirtualChannel.28.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	27a2	10146	Same as VirtualChannel.28.Main.PV
VirtualChannel.28.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	27a1	10145	Same as VirtualChannel.28.Main.PV

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
VirtualChannel.29.Main.Descriptor	Virtual Channel descriptor	string_t	4df5	19957	Not applicable
VirtualChannel.29.Main.Disable	1 = Virtual channel disabled	bool	27e3	10211	Not applicable
VirtualChannel.29.Main.HighCutOff	The highest input value that will be totalised/counted	float32	26c5	9925	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.Input1	Input 1 value	float32	26c7	9927	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.Input2	Input 2 value	float32	26c8	9928	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	26c4	9924	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.ModbusInput	Modbus input value	float32	26c6	9926	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.Operation	Specifies the operation of the virtual channel	uint8	26c1	9921	Not applicable
VirtualChannel.29.Main.Period	The time period over which the calculation is made	int32	26ca	9930	Not applicable
VirtualChannel.29.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	26cc	9932	Not applicable
VirtualChannel.29.Main.PresetValue	Specifies the preset value	float32	26cd	9933	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.PV	The virtual channel output value	float32	0176	374	Set by VirtualChannel.29.Main.Resolution
VirtualChannel.29.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	26cb	9931	Not applicable
VirtualChannel.29.Main.Resolution	Specifies the resolution/number of decimal places	uint8	26c2	9922	Not applicable
VirtualChannel.29.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	26d1	9937	Not applicable
VirtualChannel.29.Main.Status	As VirtualChannel1.Main.Status	uint8	0177	375	Not applicable
VirtualChannel.29.Main.TimeRemaining	Time remaining before the calculation is made	time_t	26c9	9929	Set by Network.Modbus.TimeFormat
VirtualChannel.29.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	26ce	9934	Not applicable
VirtualChannel.29.Main.Type	As VirtualChannel1.Main.Type	uint8	26c0	9920	Not applicable
VirtualChannel.29.Main.Units	Units descriptor	string_t	4e0a	19978	Not applicable
VirtualChannel.29.Main.UnitsScaler	Units scaler for totalisers	float32	26c3	9923	1dp
VirtualChannel.29.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	27e0	10208	Not applicable
VirtualChannel.29.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	27e2	10210	Same as VirtualChannel.29.Main.PV
VirtualChannel.29.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	27e1	10209	Same as VirtualChannel.29.Main.PV
VirtualChannel.30.Main.Descriptor	Virtual Channel descriptor	string_t	4e10	19984	Not applicable
VirtualChannel.30.Main.Disable	1 = Virtual channel disabled	bool	2823	10275	Not applicable
VirtualChannel.30.Main.HighCutOff	The highest input value that will be totalised/counted	float32	2705	9989	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.Input1	Input 1 value	float32	2707	9991	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.Input2	Input 2 value	float32	2708	9992	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.LowCutOff	The lowest input value that will be totalised/counted	float32	2704	9988	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.ModbusInput	Modbus input value	float32	2706	9990	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.Operation	Specifies the operation of the virtual channel	uint8	2701	9985	Not applicable
VirtualChannel.30.Main.Period	The time period over which the calculation is made	int32	270a	9994	Not applicable
VirtualChannel.30.Main.Preset	Initiate preset. 0 = No; 1 = Yes	bool	270c	9996	Not applicable
VirtualChannel.30.Main.PresetValue	Specifies the preset value	float32	270d	9997	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.PV	The virtual channel output value	float32	0178	376	Set by VirtualChannel.30.Main.Resolution
VirtualChannel.30.Main.Reset	Initiate reset. 0 = No; 1 = Yes	bool	270b	9995	Not applicable
VirtualChannel.30.Main.Resolution	Specifies the resolution/number of decimal places	uint8	2702	9986	Not applicable
VirtualChannel.30.Main.Rollover	A pulse signal to indicate PV (output) has just rolled over	bool	2711	10001	Not applicable
VirtualChannel.30.Main.Status	As VirtualChannel1.Main.Status	uint8	0179	377	Not applicable
VirtualChannel.30.Main.TimeRemaining	Time remaining before the calculation is made	time_t	2709	9993	Set by Network.Modbus.TimeFormat
VirtualChannel.30.Main.Trigger	Increment/decrement counter. 0 = No; 1 = Yes	bool	270e	9998	Not applicable
VirtualChannel.30.Main.Type	As VirtualChannel1.Main.Type	uint8	2700	9984	Not applicable
VirtualChannel.30.Main.Units	Units descriptor	string_t	4e25	20005	Not applicable
VirtualChannel.30.Main.UnitsScaler	Units scaler for totalisers	float32	2703	9987	1dp
VirtualChannel.30.Trend.Colour	As VirtualChannel1.Trend.Colour	uint8	2820	10272	Not applicable
VirtualChannel.30.Trend.SpanHigh	Specifies the highest PV (output value) to be displayed	float32	2822	10274	Same as VirtualChannel.30.Main.PV
VirtualChannel.30.Trend.SpanLow	Specifies the lowest PV (output value) to be displayed	float32	2821	10273	Same as VirtualChannel.30.Main.PV
Zirconia.aC_CO_O2	Carbon Activity Between CO and O2	float32	289e	10398	4dp
Zirconia.BalanceIntegral	Balance Integral	bool	289d	10397	Not applicable
Zirconia.CarbonPot	Calculated Carbon Potential	float32	2892	10386	Set by Zirconia.Resolution
Zirconia.Clean.AbortClean	1 = Abort cleaning process	bool	28b5	10421	Not applicable
Zirconia.Clean.CantClean	1 = can't clean	bool	28c3	10435	Not applicable
Zirconia.Clean.CleanAbort	1 = Cleaning cycle has been aborted	bool	28c4	10436	Not applicable
Zirconia.Clean.CleanEnable	1 = probe cleaning allowed	bool	28b2	10418	Not applicable
Zirconia.Clean.CleanFreq	Interval between probe cleaning cycles	time_t	28aa	10410	Set by Network.Modbus.TimeFormat
Zirconia.Clean.CleanMaxTemp	Maximum temperature for cleaning. If, during the cleaning cycle, the probe temperature exceeds this value, cleaning is aborted.	float32	28b4	10420	0dp
Zirconia.Clean.CleanMsgReset	1 = Clear cleaning related alarms	bool	28b3	10419	Not applicable
Zirconia.Clean.CleanProbe	1 = Initiate a probe cleaning cycle	bool	28b0	10416	Not applicable
Zirconia.Clean.CleanRecoveryTime	The time taken to recover from last clean. 0 = max. clean recovery time exceeded last time	time_t	28b6	10422	Set by Network.Modbus.TimeFormat
Zirconia.Clean.CleanTemp	1 = Clean cycle aborted because cleaning temperature was too high.	bool	28c5	10437	Not applicable
Zirconia.Clean.CleanTime	The time for which the probe is cleaned	time_t	28ab	10411	Set by Network.Modbus.TimeFormat
Zirconia.Clean.CleanValve	1 = Enable probe cleaning valve	bool	28af	10415	Not applicable
Zirconia.Clean.LastCleanMv	Probe output after last clean, in mV	float32	28b7	10423	0dp
Zirconia.Clean.MaxRcovTime	Max. recovery time after a purge	time_t	28ad	10413	Set by Network.Modbus.TimeFormat
Zirconia.Clean.MinRcovTime	Min. recovery time after a purge	time_t	28ac	10412	Set by Network.Modbus.TimeFormat
Zirconia.Clean.ProbeFault	1 = Probe failed to recover following the clean cycle	bool	28ae	10414	Not applicable
Zirconia.Clean.Time2Clean	Time to next cleaning cycle	time_t	28b1	10417	Set by Network.Modbus.TimeFormat
Zirconia.CleanFreq	Interval between cleaning cycles	time_t	2889	10377	Set by Network.Modbus.TimeFormat
Zirconia.CleanProbe	Initiates a demand cleaning cycle	bool	289a	10394	Not applicable
Zirconia.CleanState	Cleaning State (0 = Waiting, 1 = Cleaning, 2 = Recovering)	uint8	2899	10393	Not applicable
Zirconia.CleanTime	The time for which the probe is cleaned	time_t	288a	10378	Set by Network.Modbus.TimeFormat
Zirconia.CleanValve	1 = Enable probe cleaning valve	bool	2898	10392	Not applicable
Zirconia.DewPoint	Calculated Dewpoint	float32	2893	10387	Set by Zirconia.Resolution
Zirconia.GasRef	Reference value for hydrogen concentration	float32	2882	10370	1dp

5.3 PARAMETER LIST (Cont.)

Parameter path	Description	Type	Hex	Dec	Resolution
Zirconia.GasRefs.CO_Ideal	Gas ref value when Oxygen Type = Nernst	float32	28a9	10409	1dp
Zirconia.GasRefs.CO_InUse	The CO gas measurement value being used	float32	28a4	10404	1dp
Zirconia.GasRefs.CO_Local	Reference value for CO concentration	float32	28a1	10401	1dp
Zirconia.GasRefs.CO_Remote	CO concentration from remote source	float32	28a2	10402	1dp
Zirconia.GasRefs.CO_RemoteEn	1 = Allow remote gas measurement	bool	28a3	10403	Not applicable
Zirconia.GasRefs.H2_InUse	The hydrogen gas measurement value being used	float32	28a8	10408	1dp
Zirconia.GasRefs.H2_Local	Reference value for hydrogen concentration	float32	28a5	10405	1dp
Zirconia.GasRefs.H2_Remote	Hydrogen concentration from remote source	float32	28a6	10406	1dp
Zirconia.GasRefs.H2_RemoteEn	1 = Allow remote gas measurement	bool	28a7	10407	Not applicable
Zirconia.MaxRcovTime	Maximum recovery time after a purge	time_t	288c	10380	Set by Network.Modbus.TimeFormat
Zirconia.MinCalTemp	Min. temp at which the calculation is valid	float32	2886	10374	Same as Zirconia.TempInput
Zirconia.MinRcovTime	Minimum recovery time after a purge	time_t	288b	10379	Set by Network.Modbus.TimeFormat
Zirconia.NumResolution	Number of decimal places	uint8	2881	10369	Not applicable
Zirconia.Oxygen	Calculated Oxygen value	float32	2894	10388	Set by Zirconia.Resolution
Zirconia.OxygenExp	Exponent used by log oxygen calculations	int16	288d	10381	Not applicable
Zirconia.OxygenType	The oxygen equation being used.uint8 0 = Nernst 1=Nernst Bosch 2 = Nernst CP 3= Ferronova	28a0		10400	Not applicable
Zirconia.ProbeFault	Probe Clean Recovery Warning	bool	2896	10390	Not applicable
Zirconia.ProbeInput	Probe input in mV	float32	2890	10384	0dp
Zirconia.ProbeOffset	Probe offset in mV	float32	2891	10385	Set by Zirconia.Resolution
Zirconia.ProbeState	State of the probe measurement system 0 = Measuring 1 = Cleaning 2 = Clean Recovery 3 = Test impedance 4 = Impedance recovery 5 = Not ready	uint8	289f	10399	Not applicable
Zirconia.ProbeStatus	Status of Probe uint8 0 = OK 1 = mVSbr 2 = TempSbr 3 = MincalcT	289c		10396	Not applicable
Zirconia.ProbeType	Type of Probe 25 = MMI 26 = AACC 27 = Dray 28 = Accu 29 = SSI 30 = MacD 31 = Bosch 32 = Barber 33 = ferono 34 = PrbmV 35 = Eurotherm	uint8	2880	10368	Not applicable
Zirconia.ProcFactor	Process Factor (Value defined by probe manufacturer)	float32	2888	10376	1dp
Zirconia.PVFrozen	1 = PV frozen	bool	2897	10391	Not applicable
Zirconia.RemGasEn	1 = Enable use of remote gas reference	bool	2884	10372	Not applicable
Zirconia.RemGasRef	Remote Gas Reference Value	float32	2883	10371	1dp
Zirconia.SootAlm	1 = Soot alarm active	bool	2895	10389	Not applicable
Zirconia.TempInput	Probe temperature Input	float32	288e	10382	0dp
Zirconia.TempOffset	Temperature Offset	float32	288f	10383	Set by Zirconia.Resolution
Zirconia.Time2Clean	Time To Next Clean	time_t	289b	10395	Set by Network.Modbus.TimeFormat
Zirconia.Tolerance	Sooting Tolerance	float32	2887	10375	1dp
Zirconia.WrkGas	Working Reference Gas Value	float32	2885	10373	1dp

6 iTOOLS

iTools software running on a pc allows quick and easy access to the configuration of the unit. The parameters used are generally the same as those described in section 4 above, with the addition of various diagnostic parameters.

iTools also gives the user the ability to create software wiring between function blocks, such wiring being carried out using the Graphical wiring Editor feature.

A further feature - the display mode 'Promote List', is populated using iTools - see section 3.4.11 for details.

In addition to the guidance given here, there are two on-line Help systems available within iTools: Parameter help and iTools help. Parameter help is accessed by clicking on 'Help' in the toolbar (opens the complete parameter help system), by right-clicking on a parameter and selecting 'Parameter Help' from the resulting context menu, or by clicking on the Help menu and selecting 'Device Help'. iTools help is accessed by clicking on the Help menu, and selecting 'Contents'. iTools help is also available in manual format under part number HA028838, either as a physical manual or as a pdf file.

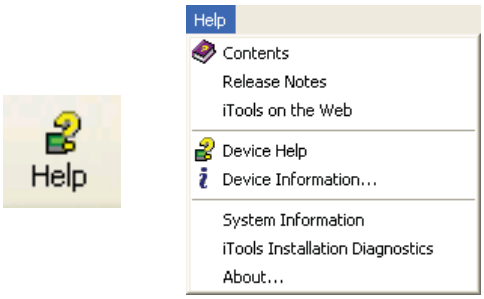


Figure 6 Help access

6.1 iTools CONNECTION

The following descriptions assume that iTools software has been correctly installed on the pc.

6.1.1 Ethernet (Modbus TCP) communications

Note: the following description is based on windows XP. Windows 'Vista' is similar.

It is first necessary to determine the IP address of the unit, as described under 'Network.Interface' in section 4.2.1.

Once the Ethernet link has been correctly installed, carry out the following actions at the pc:

1. Click on 'Start'
2. Click on 'Control Panel'. (If Control Panel opens in 'Category View' select 'Classic View' instead.)
3. Double-click on 'iTools'.
4. Click on the TCP/IP tab in the Registry settings configuration.
5. Click on 'Add...' The 'New TCP/IP Port' dialogue box opens.
6. Type-in a name for the port, then click 'Add...' again
7. Type the IP address of the unit in the 'Edit Host' box which appears. Click OK.
8. Check the details in the 'New TCP/IP Port' box, then click on 'OK'.
9. Click on 'OK' in the 'Registry settings' box to confirm the new port.

(Continued)

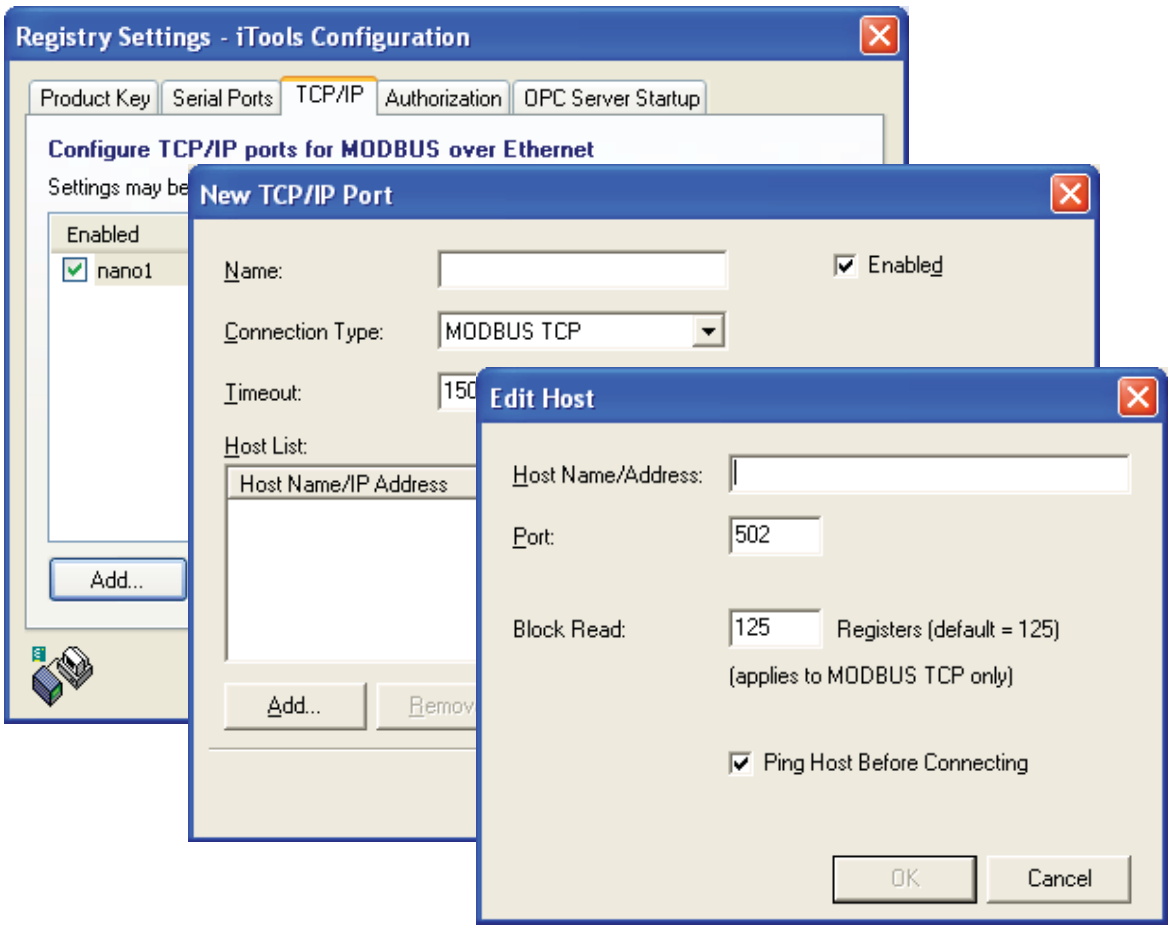


Figure 6.1.1a Adding a new Ethernet port

6.1.1 ETHERNET (TCP/IP) COMMUNICATIONS (Cont.)

To check that the pc can now communicate with the instrument, Click 'Start'. 'All Programs', 'Accessories', 'Command Prompt'

when the Command Prompt box appears, type in: Ping<Space>IP1.IP2.IP3.IP4<Enter> (where IP1 to IP4 are the IP address of the instrument).

If the Ethernet link to the instrument is operating correctly, the 'successful' reply arrives. Otherwise, the 'failed' reply arrives, in which case, the Ethernet link, IP address, and pc port details should be verified.

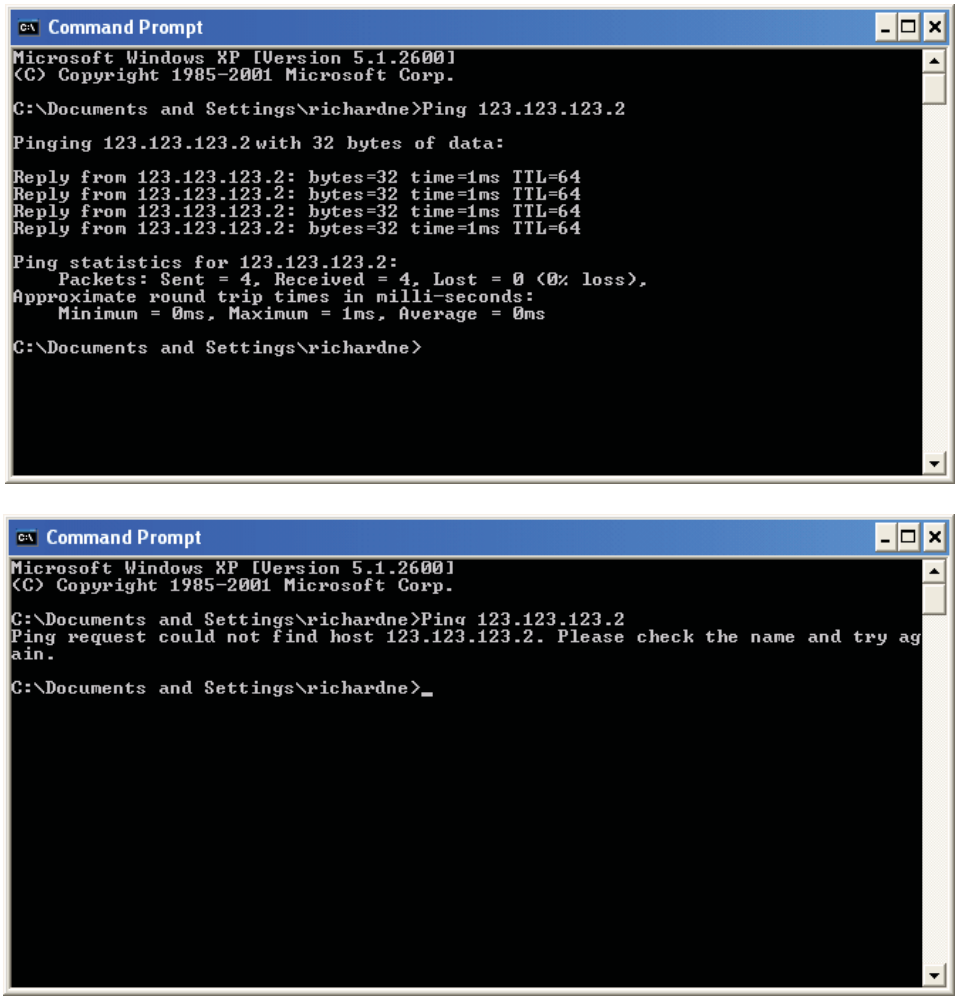


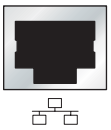
Figure 6.1.1b Command prompt 'Ping' screens (typical)

Once the Ethernet link to the instrument has been verified, iTools can be started (or shut down and restarted), and the Scan toolbar icon used, to 'find' the instrument. The scan can be stopped at any time by clicking on the Scan icon a second time.

See section 6.2 for more details of the scan procedure.

6.1.2 Direct Connection

This section describes how to connect a pc directly to the instrument.



PC Ethernet connector.

WIRING

Connection is made from the Ethernet connector at the rear of the Instrument to an Ethernet RJ45 connector, usually located at the rear of the pc. The cable can be either a 'cross-over' or 'straight through' type.

Once wired correctly, and powered up, it is necessary to enter a suitable IP address and subnet mask into the Comms configuration of the Driver Module. This information can be found as follows:

1. At the pc, click 'Start'. 'All Programs', 'Accessories', 'Command Prompt'
2. When the Command Prompt box appears, type IPConfig<Enter>

   The response is a display, such as that shown below, giving the IP address and Subnet mask of the pc. Choose an address in the range covered by these two values.

   A subnet mask element of 255 means that the equivalent element of the IP address must be used unchanged. A subnet mask element of 0 means that the equivalent element of the IP address may take any value between 1 and 255 (0 is not allowed). In the example below, the range of IP addresses which may be chosen for the Driver Module is 123.123.123.2 to 123.123.123.255. (123.123.123.0 is not allowed and 123.123.123.1 is the same as the pc's address, and may therefore not be used.)

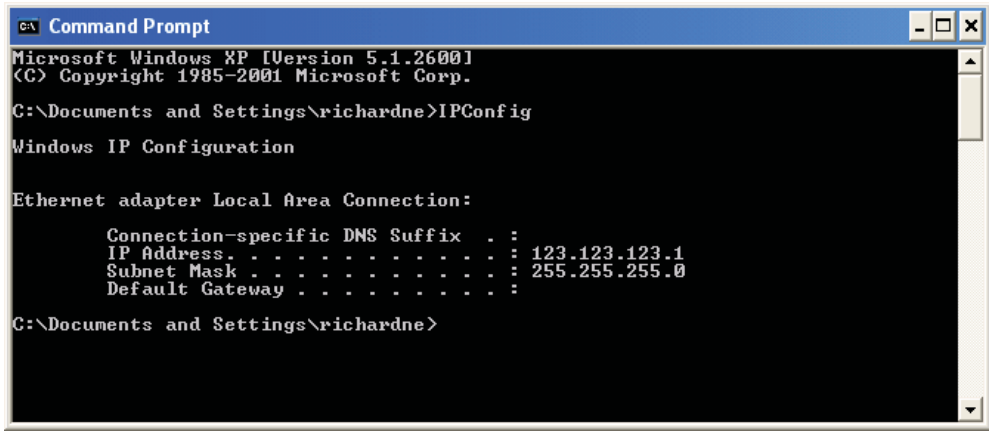


Figure 6.1.2b IP Config command

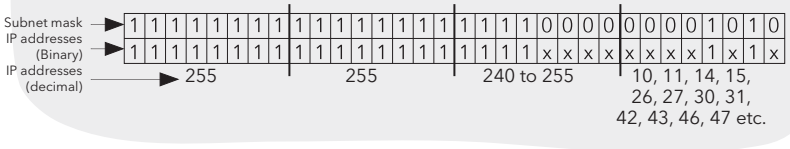
3. In Network.Interface configuration (section 4.2.1) enter the selected IP address and the subnet mask (as it appears in the command prompt window) in the relevant parts of the menu.
4. Check communications by 'pinging' as described in section 6.1.1, above.

Once the link to the instrument has been verified, iTools can be started (or shut down and re-started), and the Scan toolbar icon used, to 'find' the instrument. The scan can be stopped at any time by clicking on the Scan icon a second time.

See section 6.2 for more details of the scan procedure.

Subnet Masks and IP addresses.

Subnet Masks are most readily understood when looked at in binary format.
For example, a mask of 255.255.240.10 can be re-written as:
11111111.11111111.11110000.00001010. In such a case, IP addresses
11111111.11111111.1111xxxx.xxxx1x1x would be recognised (where x can be either a 0 or



6.2 SCANNING FOR INSTRUMENTS

Clicking on the 'Scan' toolbar icon causes a dialogue box (shown below) to appear. This allows the user to define a search range of addresses.

Notes:

1. The relevant instrument address is that entered in the Network.Modbus configuration item (section 4.2.4, and it can take any value between 1 and 254 inclusive, as long as it is unique to the comms link.
2. The default selection (Scan all device addresses...) will detect any instrument on the serial link, which has a valid address.

As the search progresses, any instruments detected by the scan appear as thumbnails (faceplates) in the 'Panel Views' area, normally located at the bottom of the iTools screen. (options/Panel Views position allows this area to be moved to the top of the window, or the Close icon can be used to close it. Once closed it can be re-opened by clicking on 'Panel Views' in the 'View' menu.)

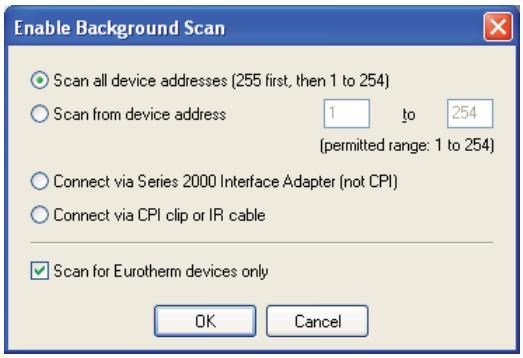


Figure 6.2a Scan range enable

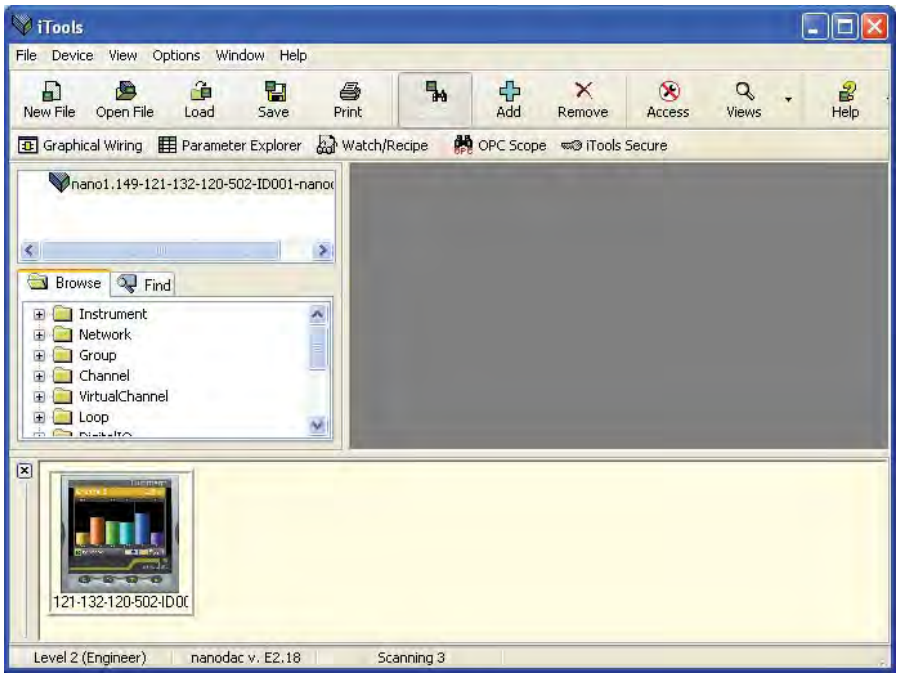


Figure 6.2b iTools initial window with one instrument detected

Once the instrument has been detected stop the scan. When the instrument has synchronised, click on the 'Access' button to enter configuration mode (a password might be required). Once the editing session is complete, click on the Access button again to quit configuration mode.

6.3 GRAPHICAL WIRING EDITOR Graphical Wiring

Clicking on the Graphical wiring Editor tool bar icon causes the Graphical wiring window for the current instrument configuration to open.

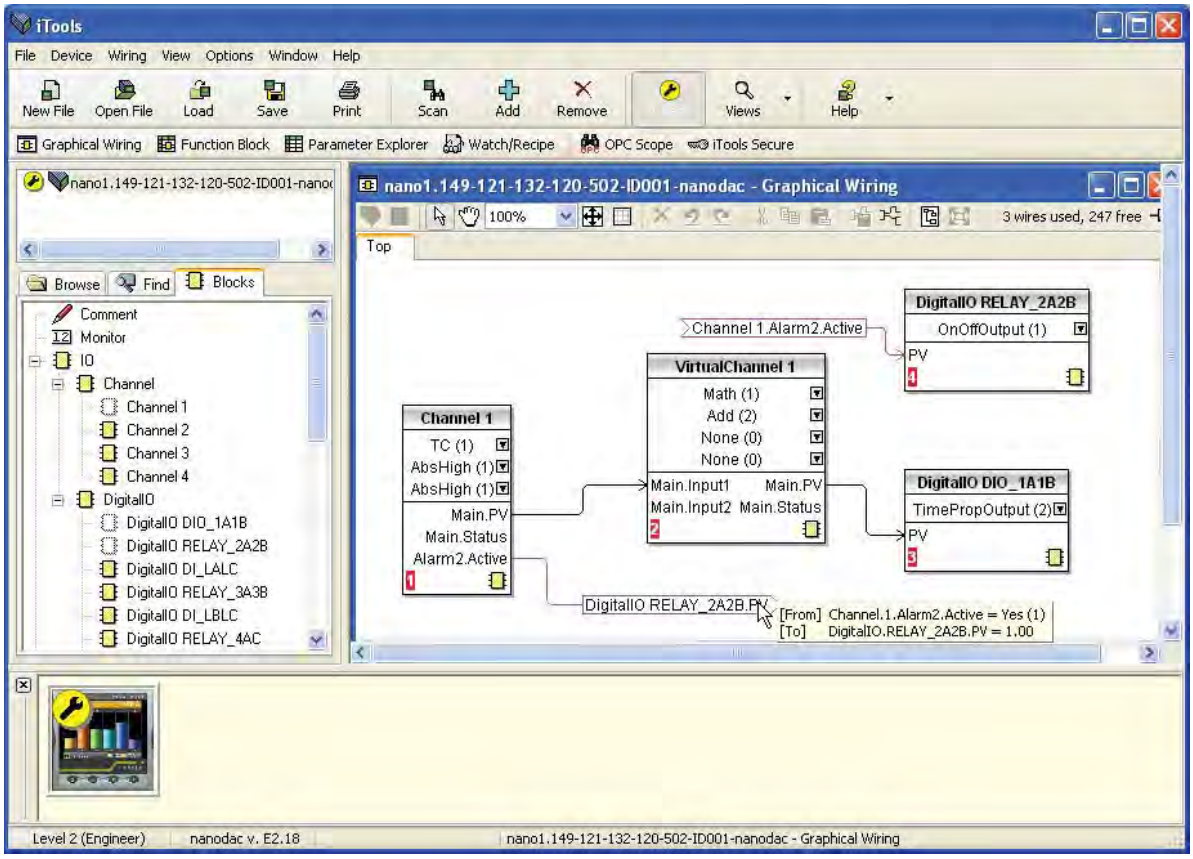


Figure 6.3 Graphical wiring Editor

The graphical wiring editor allows:

1. Function blocks, notes, comments etc. to be 'drag and dropped' into the wiring diagram from the tree list (left pane).
2. Parameters to be wired to one another by clicking on the output, the clicking on the required input.
3. Viewing and/or editing of parameter values by right-clicking on a function block and selecting 'Function Block View'.
4. The user to select parameter lists and to switch between parameter and wiring editors.
5. Completed wiring to be downloaded to the instrument (function blocks and wiring items with dashed outlines are new, or have been edited since the last download).

6.3.1 Tool bar

Download wiring to instrument

Mouse select. Select normal mouse operation. Mutually exclusive with 'Mouse Pan' below.

Mouse Pan. When active, this causes the mouse cursor to change to a hand-shaped icon. Allows the graphical wiring diagram to be click-dragged within the GWE window aperture.

100% Zoom. Allows the magnification factor of the wiring diagram to be selected

Pan tool. Whilst left clicked, the cursor appears as a rectangle showing which part of the wiring diagram is currently displayed. Click dragging allows the rectangle to be moved freely about the diagram. The size of the rectangle depends on the zoom setting.

Show/Hide grid. This toggles an alignment grid on and off.

Undo, redo.Allows the user to undo the last action, or, once an undo action has taken place, to undo the undo. Short cuts are <Ctrl>+<Z. for undo; <Ctrl>+<V, for undo

Cut, Copy, Paste. Normal Cut (copy and delete), Copy (copy without delete) and Paste (insert into) functions. Shortcuts are: <Ctrl> + <X> for 'Cut'; <Ctrl> + <C> for copy and <Ctrl> + <V> for Paste.

Copy diagram fragment; Paste diagram fragment. Allows a part of the wiring diagram to be selected, named and be saved to file. The fragment may then be pasted into any wiring diagram, including the source diagram

Create compound; Flatten compound. These two icons allow compounds to be created and 'un created' (flattened).

6.3.2 Wiring editor operating details

COMPONENT SELECTION

Single wires are shown with boxes at 'corners' when selected. When more than one wire is selected, as part of a group, the wire colour changes to magenta. All other items have a dashed line drawn round them when selected.

Clicking on a single item selects it. An Item can be added to the selection by holding down the control key (ctrl) whilst clicking on the item. (A selected item can be deselected in the same way.) If a block is selected, then all its associated wires are also selected.

Alternatively, the mouse can be click-dragged on the background to create a 'rubber band' round the relevant area; anything within this area being selected when the mouse is released.

<Ctrl>+<A> selects all items on the active diagram.

BLOCK EXECUTION ORDER

The order in which the blocks are executed by the instrument depends on the way in which they are wired. Each block displays its place in its sequence in a coloured block in the bottom left-hand corner (figure 6.3.2a).

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

FUNCTION BLOCKS

A Function Block is an algorithm which may be wired to and from other function blocks to make a control strategy. Each function block has inputs and outputs. Any parameter may be wired from, but only parameters that are alterable in Operator Mode may we wired to. A function block includes any parameters that are needed to configure or operate the algorithm. The inputs and outputs which are considered to be of most use are always shown. In most cases all of these need to be wired before the block can perform a useful task.

If a function block is not faded in the tree (left hand pane) it can be dragged onto the diagram. The block can be dragged around the diagram using the mouse.

A Channel block is shown below as an example. When block type information is alterable (as in this case) click on the box with the down arrow in it to display a dialogue box allowing the value to be edited.

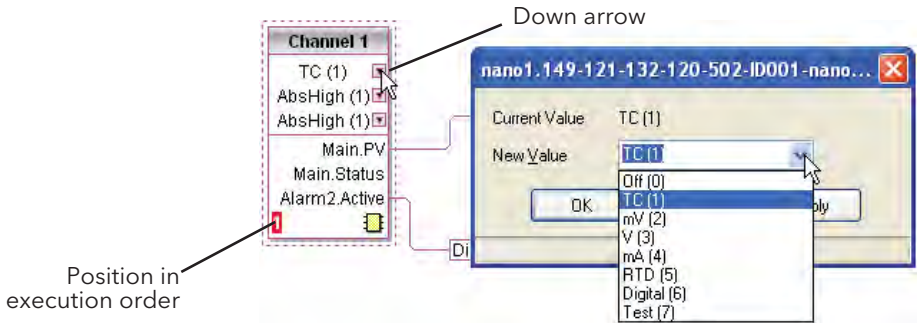


Figure 6.3.2a Function block example

If it is required to wire from a parameter, which is not shown as a recommended output, click on the 'Click to Select Output' icon in the bottom right hand corner to display a full list of parameters in the block (figure 6.3.2c, below). Click on one of these to start a wire.

FUNCTION BLOCK CONTEXT MENU

Right click in the function block to display the context menu.

Function block view — Displays a list of parameters associated with the function block. 'Hidden' parameters can be displayed by de-selecting 'Hide Parameters and Lists when not Relevant in the options menu 'Parameter availability setting...' item

Re-Route wires — Redraws all wiring associated with the function block.

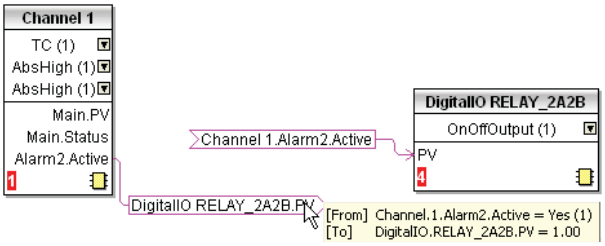
Re-route input wires — Redraws all input wiring associated with the function block

Re-route output wires — Redraws all output wiring associated with the function block.

Show wiring using tags

Wires are not drawn, but their start and end destinations are indicated by tags instead. Reduces wire clutter in diagrams where source and destination are widely separated.

Hovering the cursor over the tag shows both its source and destination parameters and their values



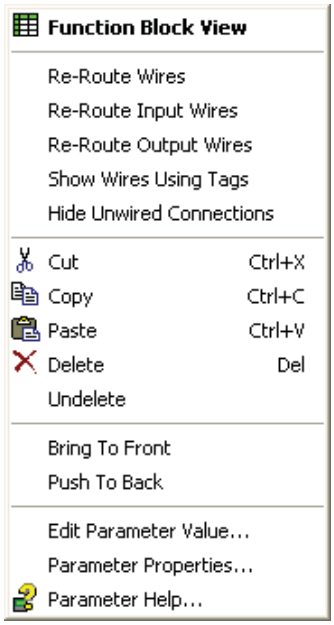


Figure 6.3.2b Function block context menu

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

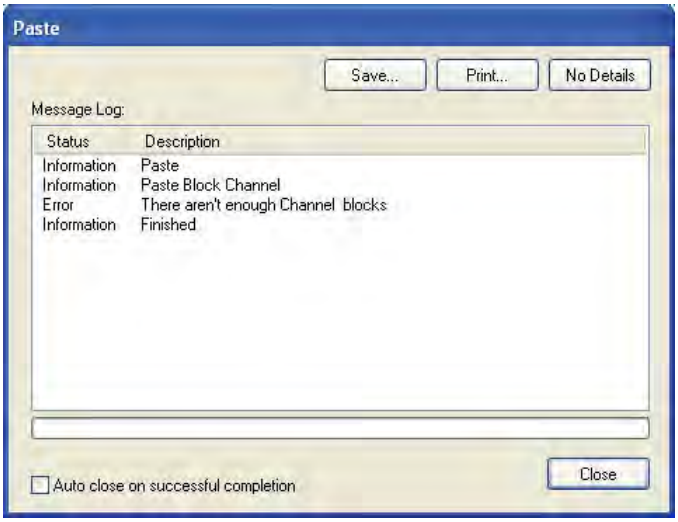
FUNCTION BLOCK CONTEXT MENU (Cont.)

Hide unwanted connections
: Causes the display to include only wired items.

Cut
: Allows one or more selected items to be moved to the Clipboard ready for pasting into another diagram or compound, or for use in a Watch window, or OPC scope. The original items are greyed out, and function blocks and wires are shown dashed until next download, after which they are removed from the diagram. Short cut = <Ctrl>+<X>. Cut operations carried out since the last download can be 'undone' by using the 'Undo' tool bar icon, by selecting 'Undelete' or by using the short cut <Ctrl>+<Z>.

Copy
: Allows one or more selected items to be copied to the Clipboard ready for pasting into another diagram or compound, or for use in a Watch window, or OPC scope. The original items remain in the current wiring diagram. Short cut = <Ctrl>+<C>. If items are pasted to the same diagram from which they were copied, the items will be replicated with different block instances. Should this result in more instances of a block than are available, an error display appears showing details of which items couldn't be copied.

Paste
: Copies items from the Clipboard to the current wiring diagram. Short cut = <Ctrl>+<V>. If items are pasted to the same diagram from which they were copied, the items will be replicated with different block instances. Should this result in more instances of a block than are available, a Paste error display appears showing details of those items which could not be copied.



Delete
: Marks all selected items for deletion. Such items are shown dashed until next download, after which they are removed from the diagram. Short cut = <Del>.

Undelete
: Reverses 'Delete' and 'Cut' operations carried out on selected item(s) since the last download.

Bring to Front
: Brings selected items to the front of the diagram.

Push to Back
: Sends the selected items to the back of the diagram.

Edit Parameter Value...
: This menu item is active if the cursor is hovering over an editable parameter. Selecting this menu item causes a pop-up window to appear, which allows the user to edit the parameter value.

Parameter Properties
: This menu item is active if the cursor is hovering over an editable parameter. Selecting this menu item causes a pop-up window to appear, which allows the user to view the parameter properties, and also, to view the parameter Help (by clicking on the 'Help' tab).

Parameter Help
: Produces Parameter Properties and Help information for the selected function block or parameter, depending on the hover position of the cursor, when the right-click occurs.

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

WIRES

To make a wire

1. Drag two (or more) blocks onto the diagram from the function block tree.
2. Start a wire by either clicking on a recommended output or clicking on the 'Click to Select output' icon at the bottom right corner of the block to bring up the connection dialogue, and clicking on the required parameter. Recommended connections are shown with a green plug symbol; other parameters which are available being shown in yellow. Clicking on the red button causes all parameters to be shown. To dismiss the connection dialogue either press the escape key on the keyboard, or click the cross at the bottom left of the dialogue box.
3. Once the wire has started a dashed wire is drawn from the output to the current mouse position. To complete the wire click on the required destination parameter.
4. Wires remain dashed until they are downloaded

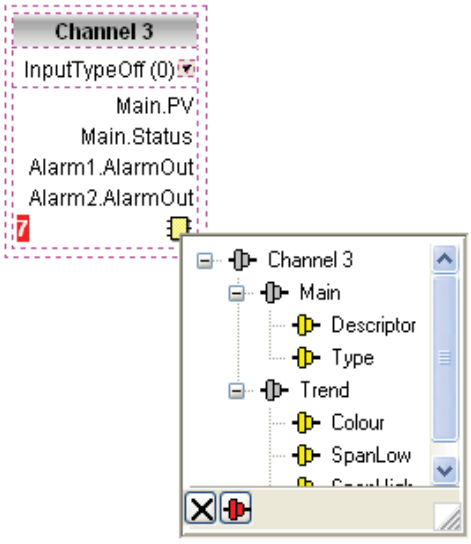


Figure 6.3.2c Output selection dialogue box.

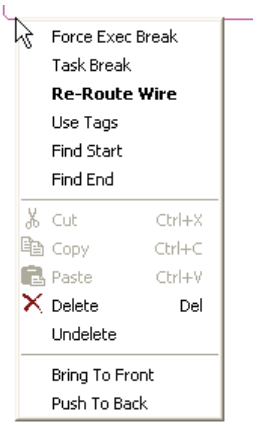
Routing wires

When a wire is placed it is auto-routed. The auto routing algorithm searches for a clear path between the two blocks. A wire can be auto-routed again using the context menus or by double clicking the wire. A wire segment can be edited manually by click-dragging. If the block to which it is connected is moved, the end of the wire moves with it, retaining as much of the path as possible.

If a wire is selected by clicking on it, it is drawn with small boxes on its corners.

Wire Context Menu

Right click on a wire to display the wire block context menu:



Force Exec Break	When wires form a loop, a break point must be introduced, where the value written to the block comes from a source which was last executed during the previous cycle. A break is automatically placed by iTools, and appears in red. Force Exec Break allows the user to define where a break must be placed. Surplus breaks appear in black.
Re-Route wire	Replaces the current wire route with a new route generated from scratch.
Use Tags	Toggles between wire and tag mode between parameters. Tag mode is useful for sources and destinations which are widely separated.
Find Start	Goes to the source of the wire.
Find End	Goes to the destination of the wire.
Cut, Copy, Paste	Not used in this context.
Delete	Marks the wire for deletion. The wire is redrawn as a dashed line (or dashed tags) until next download. Operation can be reversed until after next download.
Undelete	Reverses the effect of the Delete operation up until the next download, after which, Undelete is disabled.
Bring to Front	Brings the wire to the front of the diagram.
Push to Back	Sends the wire to the back of the diagram.

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

Wire Colours

Black	Normal functioning wire
Red	The wire is connected to a non-changeable parameter. Values are rejected by the destination block.
Magenta	A normal functioning wire is being hovered-over by the mouse cursor.
Purple	A red wire is being hovered-over by the mouse cursor.
Green	New Wire (dashed green wire changes to solid black after being downloaded.)

COMMENTS

Comments are added to a wiring diagram by click-dragging them from the Function Block tree onto the diagram. As soon as the mouse is released, a dialogue box opens to allow the comment text to be entered.

Carriage returns are used to control the width of the comment. Once text entry is complete, 'OK' causes the comment to appear on the diagram. There are no restrictions on the size of a comment. Comments are saved to the instrument along with the diagram layout information.

Comments can be linked to function blocks and wires by clicking on the chain icon at the bottom right-hand corner of the comment box and then clicking again on the required block or wire. A dashed line is drawn to the top of the block or to the selected wire segment (figure 6.3.2f).

Note: Once the comment has been linked, the Chain icon disappears. It re-appears when the mouse cursor is hovered over the bottom right-hand corner of the comment box.

Comment Context Menu

Edit	Opens the Comment dialogue box to allow the comment text to be edited.
Unlink	Deletes the current link from the comment.
Cut	Moves the comment to the Clipboard, ready to be pasted elsewhere. Short cut = <Ctrl>+<X>.
Copy	Copies the comment from the wiring diagram to the Clipboard, ready to be pasted elsewhere. Short cut = <Ctrl>+<C>.
Paste	Copies a comment from the Clipboard to the wiring diagram. Short cut = <Ctrl>+<V>.
Delete	Marks the comment for deletion at next download.
Undelete	Undoes the Delete command if download has not taken place since.

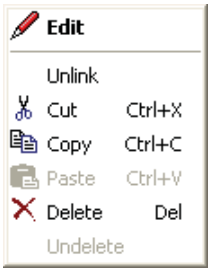


Figure 6.3.2e
Comment context menu

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

MONITORS

Monitor points are added to a wiring diagram by click-dragging them from the Function Block tree onto the diagram. A monitor shows the current value (updated at the iTools parameter list update rate) of the parameter to which it is linked. By default the name of the parameter is shown. To hide the parameter name either double click on the monitor box or 'Show Names' in the context (right-click) menu can be used to toggle the parameter name on and off.

Monitors are linked to function blocks and wires by clicking on the chain icon at the bottom right-hand corner of the box and then clicking again on the required parameter. A dashed line is drawn to the top of the block or the selected wire segment.

Note: Once the monitor has been linked, the Chain icon disappears. It re-appears when the mouse cursor is hovered over the bottom right-hand corner of the monitor box.

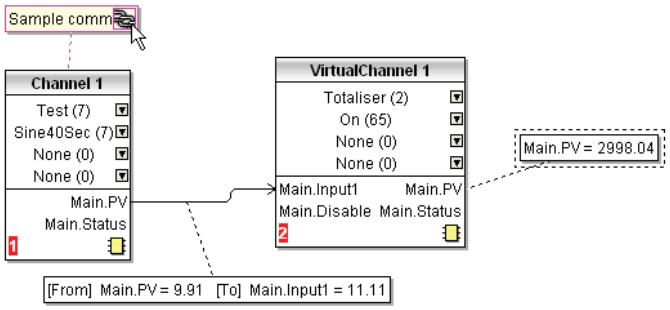


Figure 6.3.2f Comment and Monitor appearance

Monitor Context Menu

Show names	Toggles parameter names on and off in the monitor box.
Unlink	Deletes the current link from the monitor.
Cut	Moves the monitor to the Clipboard, ready to be pasted elsewhere. Short cut = <Ctrl>+<X>.
Copy	Copies the monitor from the wiring diagram to the Clipboard, ready to be pasted elsewhere. Short cut = <Ctrl>+<C>.
Paste	Copies a monitor from the Clipboard to the wiring diagram. Short cut = <Ctrl>+<V>.
Delete	Marks the monitor for deletion at next download.
Undelete	Undoes the Delete command if download has not taken place since.
Bring to Front	Moves the item to the 'top' layer of the diagram.
Push to Back	Moves the item to the 'bottom' layer of the diagram.
Parameter Help	Shows parameter help for the item.

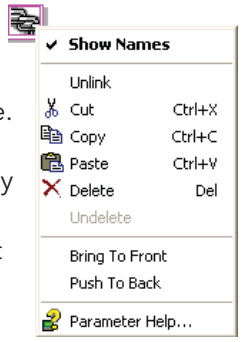


Figure 6.3.2g
Monitor context menu

DOWNLOADING

When the wiring editor is opened the current wiring and diagram layout is read from the instrument. No changes are made to the instrument function block execution or wiring until the download button is pressed. Any changes made using the operator interface after the editor is opened are lost on download.

When a block is dropped onto the diagram, instrument parameters are changed to make the parameters for that block available. If changes are made and the editor is closed without saving them there is a delay while the editor clears these parameters.

During download, the wiring is written to the instrument which then calculates the block execution order and starts executing the blocks. The diagram layout including comments and monitors is then written into instrument flash memory along with the current editor settings. When the editor is reopened, the diagram is shown positioned as it was when it was last downloaded.

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

COLOURS

Items on the diagram are coloured as follows:

Red	Items which totally or partially obscure other items and items which are totally or partially obscured by other items. Wires that are connected to unalterable or non-available parameters. Execution breaks.
Blue	Non-available parameters in function blocks.
Green	Items added to the diagram since last download are shown as green dashed lines.
Magenta	All selected items, or any item over which the cursor is hovering.
Purple	Red wires when being hovered over by the mouse cursor.
Black	All items added to the diagram before the last download. Redundant execution breaks. Monitor and comment text.

DIAGRAM CONTEXT MENU

Cut	Active only when the right click occurs within the bounding rectangle which appears when more than one item is selected. Moves the selection off the diagram to the Clipboard. Short cut = <Ctrl>+<X>.
Copy	As for 'Cut', but the selection is copied, leaving the original on the diagram. Short cut = <Ctrl>+<C>.
Paste	Copies the contents of the Clipboard to the diagram. Short cut = <Ctrl>+<V>.
Re-Route wires	Reroutes all selected wires. If no wires are selected, all wires are re-routed.
Align Tops	Aligns the tops of all blocks in the selected area.
Align Lefts	Aligns the left edges of all blocks in the selected area.
Space Evenly	Spaces selected items such that their top left corners are spaced evenly across the width of the diagram. Click on the item which is to be the left-most item, then <Ctrl>+<left click> the remaining items in the order in which they are to appear.
Delete	Marks the item for deletion at next download time. Can be 'Undeleted' up until download occurs.
Undelete	Reverses the action of 'Delete' on the selected item.
Select All	Selects all items on the current diagram.
Create Compound	Active only when the right click occurs, in the top level diagram, within the bounding rectangle which appears when more than one item is selected. Creates a new wiring diagram as described in 'Compound', below.
Rename	Allows a new name to entered for the current wiring diagram. This name appears in the relevant tab.
Copy Graphic	Copies the selected items (or the whole diagram if no items are selected) to the clipboard as a Windows metafile, suitable for pasting into a documentation application. Wiring entering/leaving the selection (if any) are drawn in tag mode.
Save Graphic...	As for 'Copy Graphic' above, but saves to a user-specified file location instead of the clipboard.
Copy Fragment To File...	Copies selected items to a user-named file in folder 'My iTools Wiring Fragments' located in 'My Documents'.
Paste Fragment From File	Allows the user to select a stored fragment for inclusion in the wiring diagram.
Centre	Places the display window at the centre of the selected items. If 'Select All' has previously been clicked-on, then the display widow is placed over the centre of the diagram.

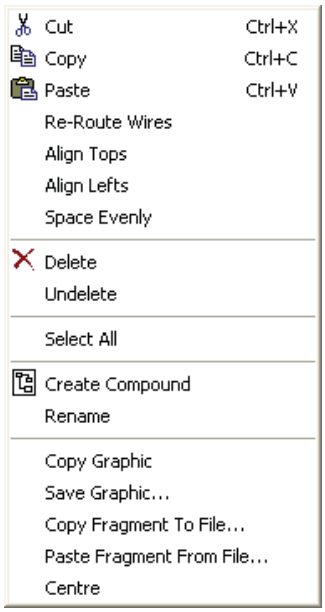


Figure 6.3.2h
Diagram context menu

6.3.2 WIRING EDITOR OPERATING DETAILS (Cont.)

COMPOUNDS

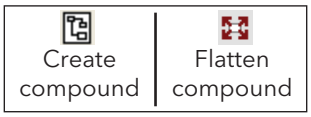
Compounds are used to simplify the top level wiring diagram, by allowing the placing of any number of function blocks within one 'box', the inputs and outputs of which operate in the same way as those of a normal function block.

Each time a compound is created, a new tab appears at the top of the wiring diagram. Initially compounds and their tabs are named 'Compound 1', 'Compound 2', etc. but they can be renamed by right clicking either on the compound in the top level diagram, or anywhere within an open Compound, selecting 'Rename' and typing in the required text string (16 characters max.).

Compounds cannot contain other compounds (i.e. they can be created only in the top level diagram).

Compound creation

1. Empty compounds are created within the top level diagram by clicking on the 'Create Compound' tool bar icon.
2. Compounds can also be created by highlighting one or more function blocks in the top level diagram and then clicking on the 'Create Compound' tool bar icon. The highlighted items are moved from the top level diagram into a new compound.



3. Compounds are 'uncreated' (flattened), by highlighting the relevant item in the top level menu and then clicking on the 'Flatten Compound' tool bar icon. All the items previously contained within the compound appear on the top level diagram.
4. Wiring between top level and compound parameters is carried out by clicking on the source parameter, then clicking on the compound (or the compound tab) and then clicking on the destination parameter. Wiring from a compound parameter to a top level parameter or from compound to compound is carried out in similar manner.
5. Unused function blocks can be moved into compounds by dragging from the tree view. Existing blocks can be dragged from the top level diagram, or from another compound, onto the tab associated with the destination compound. Blocks are moved out of compounds to the top level diagram or to another compound in a similar way. Function blocks can also be 'cut and pasted'.
6. Default compound names (e.g. 'Compound 2') are used only once, so that if, for example, Compounds 1 and 2 have been created, and Compound 2 is subsequently deleted, then the next compound to be created will be named 'Compound 3'.
7. Top level elements can be click-dragged into compounds.

TOOL TIPS

Hovering the cursor over the block displays 'tooltips' describing that part of the block beneath the cursor. For function block parameters the tooltip shows the parameter description, its OPC name, and, if downloaded, its value. Similar tooltips are shown when hovering over inputs, outputs and over many other items on the iTools screen.

A Function Block is enabled by dragging the block onto the diagram, wiring it, and finally downloading it to the instrument. Initially blocks and associated wires are drawn with dashed lines, and when in this state the parameter list for the block is enabled but the block is not executed by the instrument.

The block is added to the instrument function block execution list when the 'Download' icon is operated and the items are redrawn using solid lines.

If a block which has been downloaded is deleted, it is shown on the diagram in a ghosted form until the download button is pressed. (This is because it and any wires to/from it are still being executed in the instrument. On download it will be removed from the instrument execution list and the diagram.) A ghosted block can be 'undeleted' as described in 'Context menu', above.

When a dashed block is deleted it is removed immediately.

6.4 PARAMETER EXPLORER Parameter Explorer

This view can be displayed:

1. by clicking on the 'Parameter Explorer' toolbar icon,
2. by double clicking on the relevant block in the tree pane or in the graphical wiring editor
3. by selecting 'Function Block View' from the Function block context menu in the Graphical wiring Editor.
4. by selecting 'parameter Explorer from the 'View' menu
5. by using the short cut <Alt>+<Enter>

In each case the function block parameters appear in the iTools window in tabular form, such as the example in figure 6.4a, below.

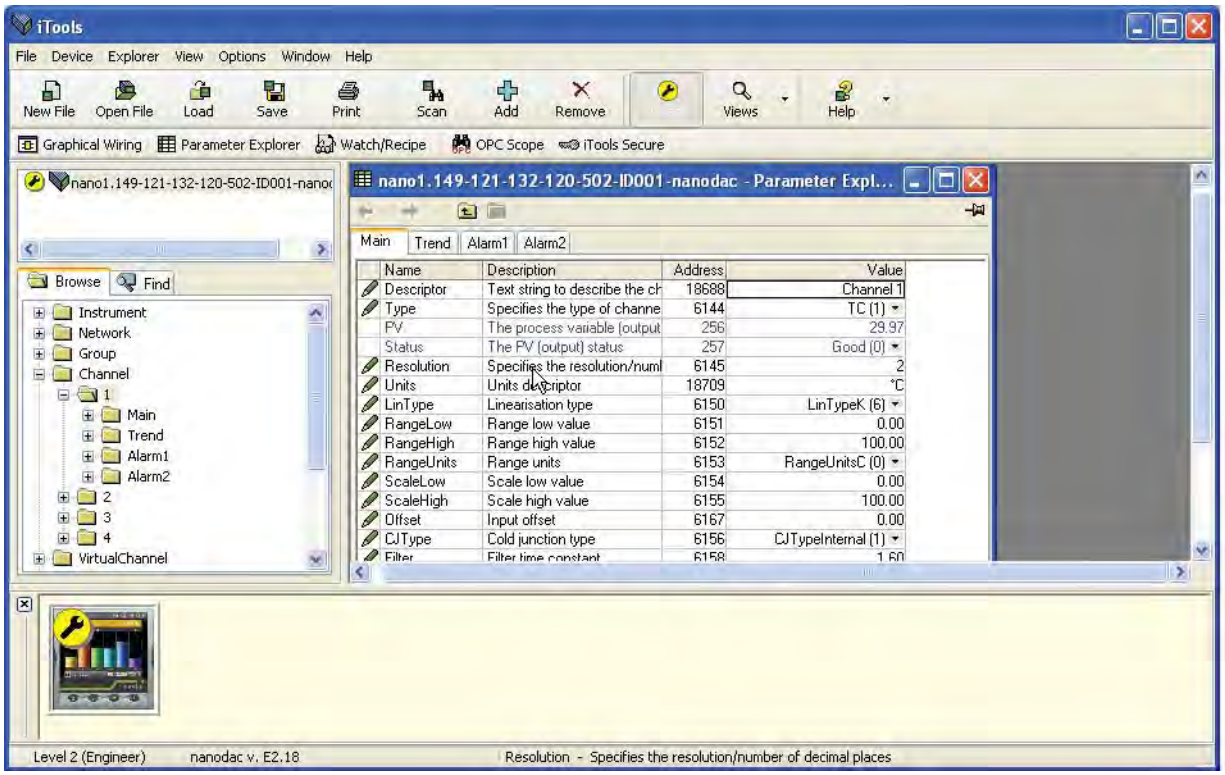


Figure 6.4a Parameter table example

The figure above shows the default table layout. Columns can be added/deleted from the view using the 'Columns' item of the Explorer or context menus (figure 6.4b).

6.4 PARAMETER EXPLORER (Cont.)

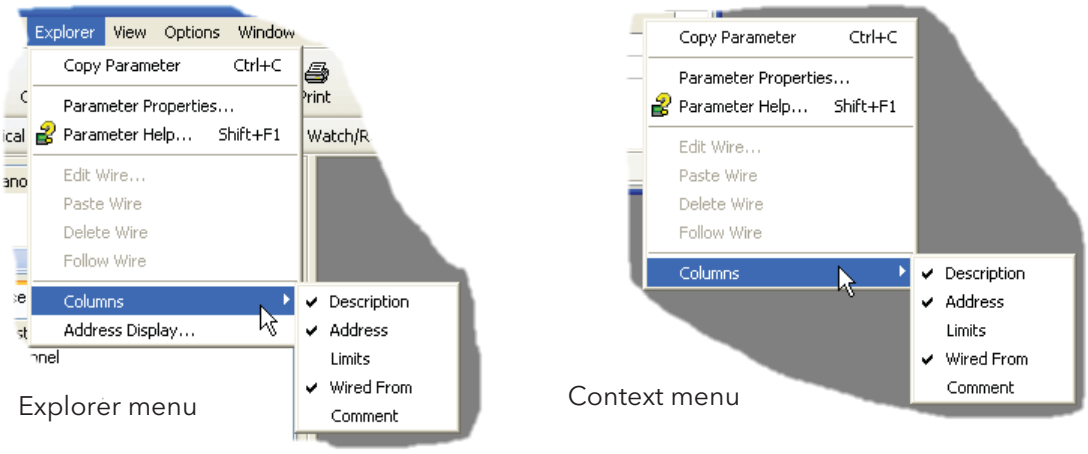


Figure 6.4b Column enable/disable

6.4.1 Parameter explorer detail

Figure 6.4.1a shows a typical parameter table. This particular parameter has a number of subfolders associated with it, and each of these is represented by a 'tab' across the top of the table.

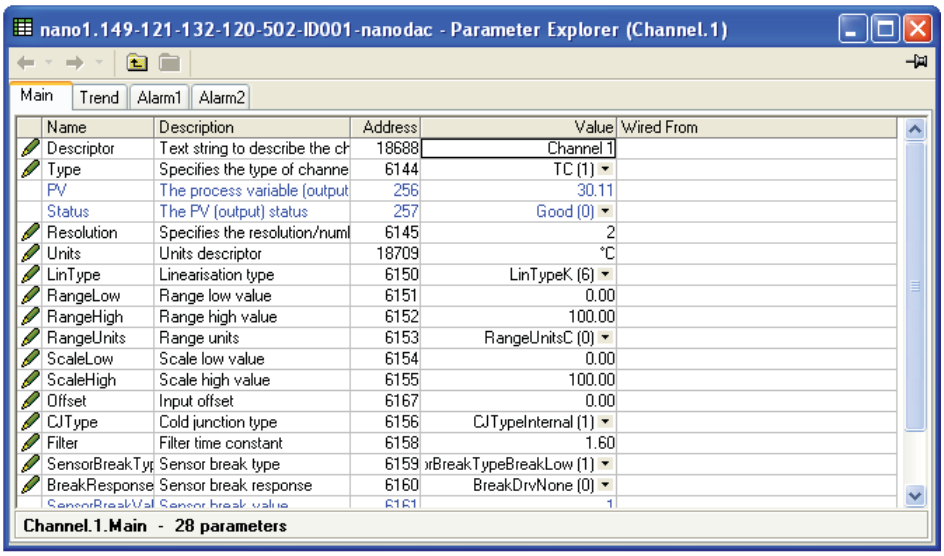


Figure 6.4.1a Typical parameter table

Notes:

1. Parameters in blue are non-editable (Read only). In the example above all the parameters are read only. Read/write parameters are in black and have a 'pencil' symbol in the 'read/Write access column at the left edge of the table. A number of such items are shown in figure 6.4.1a, above.
2. Columns. The default explorer window (figure 6.4a) contains the columns 'Name', 'Description', 'Address', 'Value', and 'Wired From'. As can be seen from figure 6.4b, the columns to be displayed can be selected, to a certain extent, using either the 'Explorer' menu or the context menu. 'Limits' have been enabled for the example above.
3. Hidden Parameters. By default, iTools hides parameters which are considered irrelevant in the current context. Such hidden parameters can be shown in the table using the 'Parameter availability' settings item of the options menu (figure 6.4.1b). Such items are displayed with a shaded background.
4. The full pathname for the displayed parameter list is shown at the bottom left hand corner of the window.

6.4.1 PARAMETER EXPLORER DETAIL (Cont.)

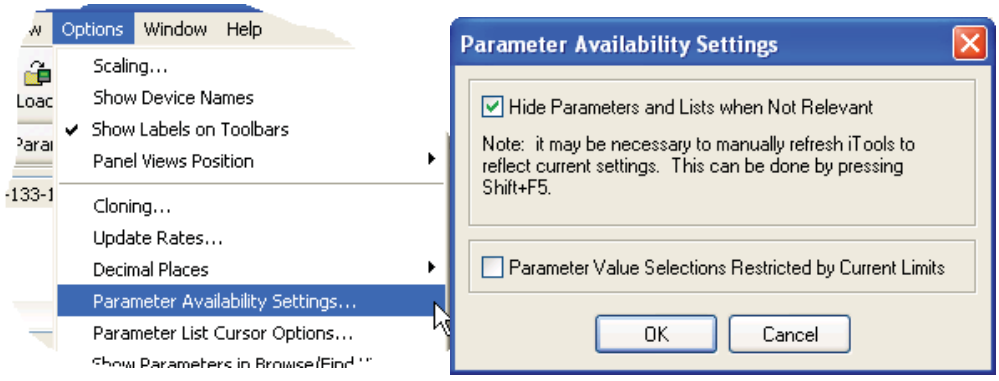


Figure 6.4.1b Show/Hide parameters

6.4.2 Explorer tools

A number of tool icons appear above the parameter list:

Back to: and Forward to:. The parameter explorer contains a history buffer of up to 10 lists that have been browsed in the current instance of the window. The 'Back to: (list name)' and 'Forward to: (list name)' icons allow easy retracing or repeating of the parameter list view sequence.
If the mouse cursor is hovered over the tool icon, the name of the parameter list which will appear if the icon is clicked-on appears. Clicking on the arrow head displays a pick list of up to 10 previously visited lists which the user can select. Short cut = <Ctrl>+<B> for 'Back to' or <Ctrl>+<F> for 'Forward to'.

Go Up a Level, Go Down a Level. For nested parameters, these buttons allow the user to navigate 'vertically' between levels. Short cut = <Ctrl>+<U> for 'Go Up a Level' or <Ctrl>+<D> for 'Go Down a Level'.

Push pin to give the window global scope. Clicking on this icon causes the current parameter list to be permanently displayed, even if another instrument becomes the 'current device'.

6.4.3 Context Menu

Copy Parameter Copies the clicked-on parameter to the clipboard

Parameter properties
Displays parameter properties for the clicked-on parameter

Parameter Help... Displays help information for the clicked-on parameter

Edit/Paste/Delete/Follow Wire
Not used in this application

Columns Allows the user to enable/disable a number of parameter table columns (figure 6.1.4b).

6.5 WATCH/RECIPE EDITOR Watch/Recipe

The watch/recipe editor is opened by clicking on the Watch/Recipe tool icon, by selecting 'Watch/Recipe' in the 'Views' menu or by using the short cut <Ctrl>+<A>. The window is in two parts: the left part containing the watch list; the right-hand part containing one or more data sets, initially empty and unnamed.

The Watch/Recipe window is used:

1. To monitor a list of parameters. This list can contain parameters from many different, and otherwise unrelated parameter lists within the same device. It cannot contain parameters from different devices.
2. To create 'data sets' of parameter values which can be selected and downloaded to the device in the sequence defined in the recipe. The same parameter may be used more than once in a recipe.

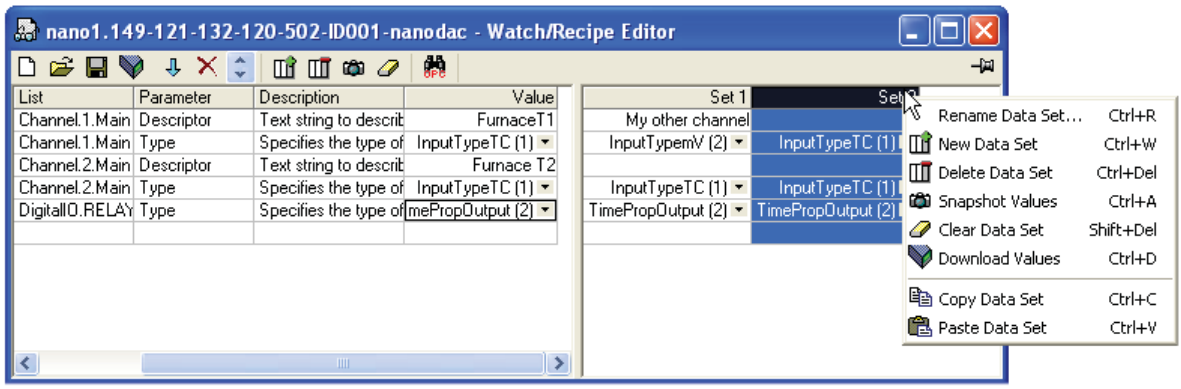


Figure 6.5 Watch/Recipe Editor window (with context menu)

6.5.1 Creating a Watch List

After opening the window, parameters can be added to it as described below. The values of the parameters update in real-time, allowing the user to monitor a number of values simultaneously.

ADDING PARAMETERS TO THE WATCH LIST

1. Parameters can be click-dragged into the watch list from another area of the iTools window (for example, the parameter explorer window, the graphical wiring editor, the browse tree). The parameter is placed either in an empty row at the bottom of the list, or if it is dragged on top of an already existing parameter, it is inserted above this parameter, with the remaining parameters being moved down one place.
2. Parameters can be dragged from one position in the list to another. In such a case, a copy of the parameter is produced, the source parameter remaining in its original position.
3. Parameters can be copied <Ctrl>+<C> and pasted <Ctrl>+<V> either within the list, or from a source external to it, for example the parameter browse window or the graphical wiring editor.
4. The 'Insert item...' tool button the 'Insert Parameter' item in the Recipe or context menu or the short cut <Insert> can be used to open a browse window from which a parameter is selected for insertion above the currently selected parameter.

DATA SET CREATION

Once all the required parameters have been added to the list, select the empty data set by clicking on the column header. Fill the data set with current values using one of the following methods:

1. Clicking on the 'Capture current values into a data set' tool icon (also known as the 'Snapshot Values' tool).
2. Selecting 'Snapshot Values' from the Recipe or Context (right-click) menu.
3. Using the short cut <Ctrl>+<A>.

6.5.1 CREATING A WATCH LIST (Cont.)

DATA SET CREATION (Cont.)

Individual data values can now be edited by typing directly into the grid cells. Data values can be left blank or cleared, in which case, no values will be written for those parameters at download. Data values are cleared by deleting all the characters in the cell then either moving to a different cell or typing <Enter>.

The set is called 'Set 1' by default, but it can be renamed by either by using the 'Rename data set...' item in the Recipe or context menus, or by using the short cut <Ctrl>+<R>.

New, empty data sets can be added using one of the following:

1. Clicking on the 'Create a new empty data set' toolbar icon.
2. Selecting 'New Data Set' in the Recipe or context menus
3. Using the short cut <Ctrl>+<W>

Once created, the data sets are edited as described above.

Finally, once all the required data sets have been created, edited and saved, they can be downloaded the instrument, one at a time, using the Download tool, the 'Download Values' item in the Recipe or context menus, or the short cut <Ctrl>+<D>.

6.5.2 Watch Recipe toolbar icons

Create a new watch/recipe list. Creates a new list by clearing out all parameters and data sets from an open window. If the current list has not been saved, confirmation is requested. Short cut <ctrl>+<N>

Open an existing watch/recipe file. If the current list or data set has not been saved, confirmation is requested. A file dialogue box then opens allowing the user to select a file to be opened. Short cut <ctrl>+<O>

Save the current watch/recipe list. Allows the current set to be saved to a user specified location. Short cut <ctrl>+<S>.

Download the selected data set to the device. Short cut <ctrl>+<D>

Insert item ahead of selected item. Short cut <Insert>.

Remove recipe parameter. Short cut <ctrl>+<Delete>.

Move selected item. Up arrow moves selected parameter up the list; down arrow move the selected parameter down the list.

Create a new empty data set. Short cut <ctrl>+<w>.

Delete an empty data set. Short cut <ctrl>+<Delete>

Capture current values into a data set. Fills the selected data set with values. Short cut <ctrl>+<A>.

Clear the selected data set. Removes values from the selected data set. Short cut <Shift>+<Delete>.

Open OPC Scope. Opens a separate utility that allows trending, data logging and Dynamic Data Exchange (DDE). OPC Scope is an OPC explorer program that can connect to any OPC server that is in the windows registry.
(OPC is an acronym for 'OLE for Process Control, where OLE stands for 'Object Linking and Embedding'.)

6.5.3 Watch/Recipe Context Menu

The Watch/Recipe Context menu items have the same functions as described above for toolbar items.

6.6 PROGRAMMER OPTION Programmer

Clicking on the Programmer tool bar icon opens the programmer configuration window, displaying the program currently loaded in the instrument, in Segment Parameter view. If no program is loaded, the programmer display opens with just one segment, defined as an 'End' Segment.

Figure 6.6 shows a simple program for example purposes. Parameters are defined in section 3.4.9 and section 4.8.

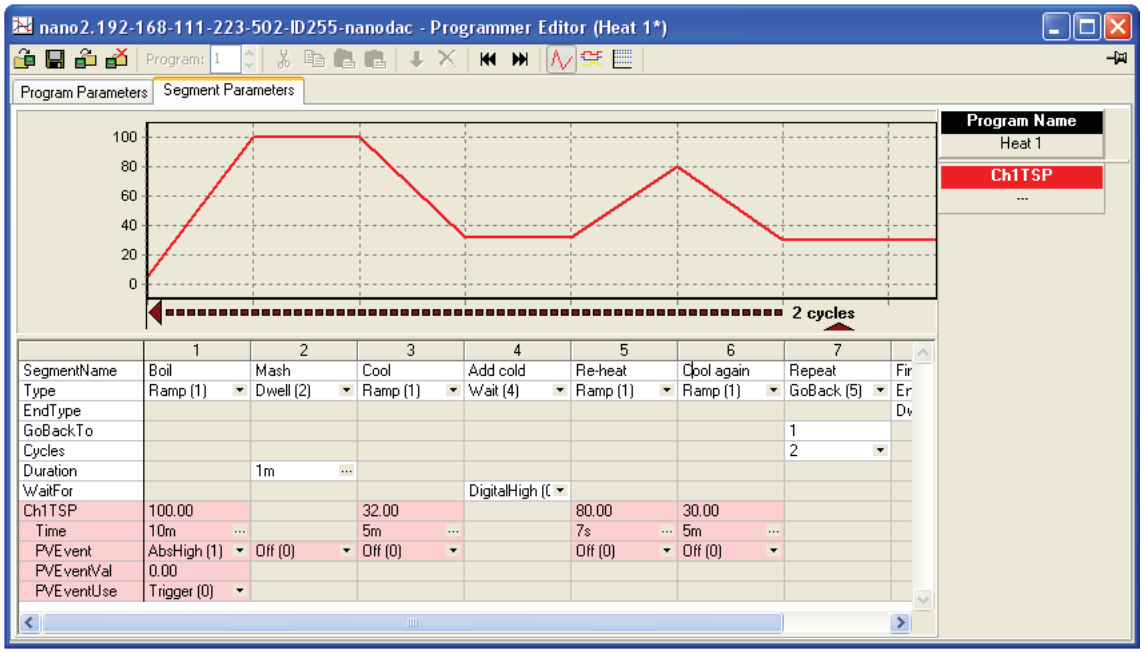


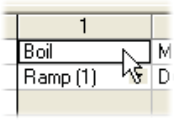
Figure 6.6 Programmer display

As can be seen from the example, the segments appear below a graphical representation of the program.

6.6.1 Segment parameter editing

SEGMENT NAME

To edit the segment name, click in the segment name field (as shown), and type in the required text, of up to 20 characters. Alternatively, double click on the existing name and edit it as desired.

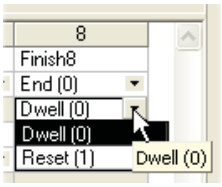


SEGMENT TYPE

Clicking on the down arrow symbol to the right of the existing segment type field, produces a pick list from which a segment type can be selected. The type of segment selected defines which configuration fields appear for that segment.

END TYPE

Allows the selection of 'Dwell' or 'Reset' as the action to be taken by the End segment.



6.6.1 SEGMENT EDITING (Cont.)

GO BACK TO

For GoBack segments only, this allows the user to enter a segment number for the program to return to.

CYCLES

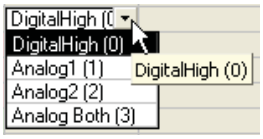
For GoBack segments only, this allows the number of times the program returns to the 'Go Back To' segment, before continuing.

DURATION

Sets the amount of time for which Dwell segments are to operate. Times are entered using a hours/minutes/seconds/milliseconds display which appears when the ellipsis button to the right of the duration field is clicked on.

WAIT FOR

Select an analogue or digital input as the wait criterion. For single channel programs only one analogue input is available; for two-channel programmers one digital and two analoge inputs are available, as shown.



CH1 (2) TSP

The channel 1 (2) target setpoint, editable by the user in a similar way as that used for segment name editing, described above. Ch2 TSP appears only for two channel programmers.

TIME

For programs where 'Ramp Style' = 'Time', this allows the user to enter time periods for ramp segments, in a similar way, as described for 'Duration', above. For two channel programmers, two times can be entered, and if the two times are different, the channel with the shorter time waits at its setpoint value until the other channel's time has elapsed.

RATE

For programs where 'Ramp Style' = 'Rate', this allows the user to eneter a rate value for Ramp segments. This value is entered in the same way as that used for segment name editing, described above. For two channel programmers, two rates can be entered.

OTHER PARAMETERS

Holdback, PV Event etc. parameters may or may not appear depending on the programmer features enabled, and they are all edited in the ways described above.

6.6.2 Digital Event display

Clicking on the 'Digital Events Output' tool bar icon produces a segment display, allowing the user to select the events on or off as required, for each segment. Figure 6.6.2 shows a programmer where the number of events is four.

The number of events which appear (maximum eight) is configured in the Programmer Setup menu as described in section 4.8.3

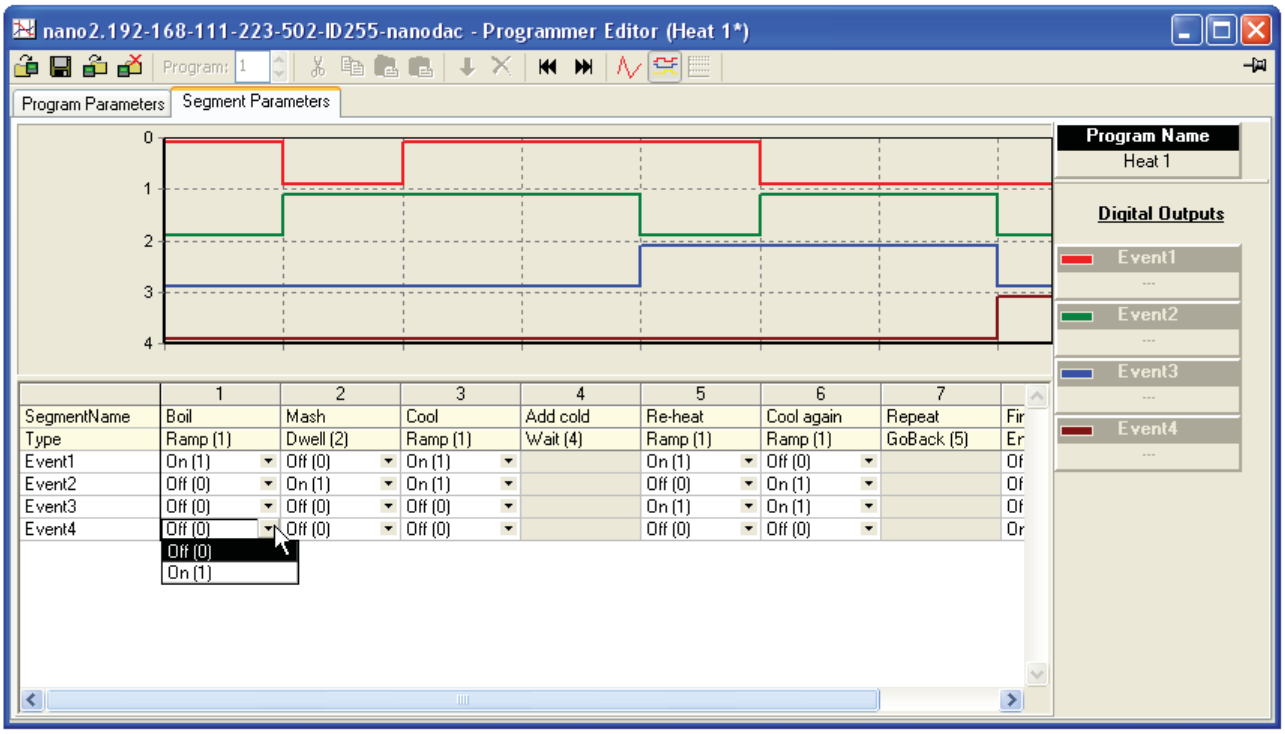


Figure 6.6.2 Event on/off configuration

6.6.3 Program parameters

The number of parameters which appear in this display depends on which program features are enabled. Figure 6.6.3 shows a basic set of parameters which allows the user to select Rate or Time as the Ramp style, and to select a value for Rate units.

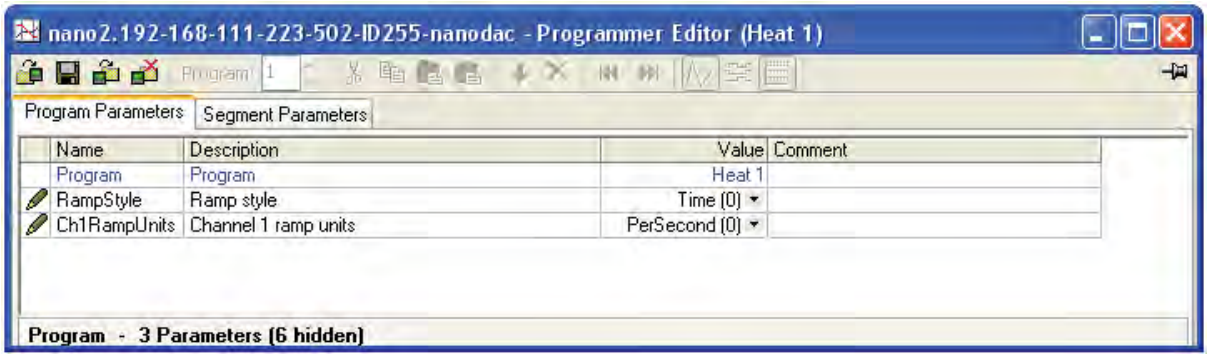


Figure 6.6.3 Program parameter display

6.6.4 Adding and deleting segments.

INSERT SEGMENT

As shown in figure 6.6.4, to insert a segment, click in the segment number field of the segment to the right of where the new segment is to be located. This causes the whole segment to highlight. Click on the blue down arrow tool icon to insert the new segment. The new segment name is the segment number, and the segment configuration is that of the segment to the right, unless that segment is a dwell or End segment, in which case the new segment is a ramp segment.

To insert more than one segment, operate the shift key whilst clicking on the range of contiguous segments to be copied.

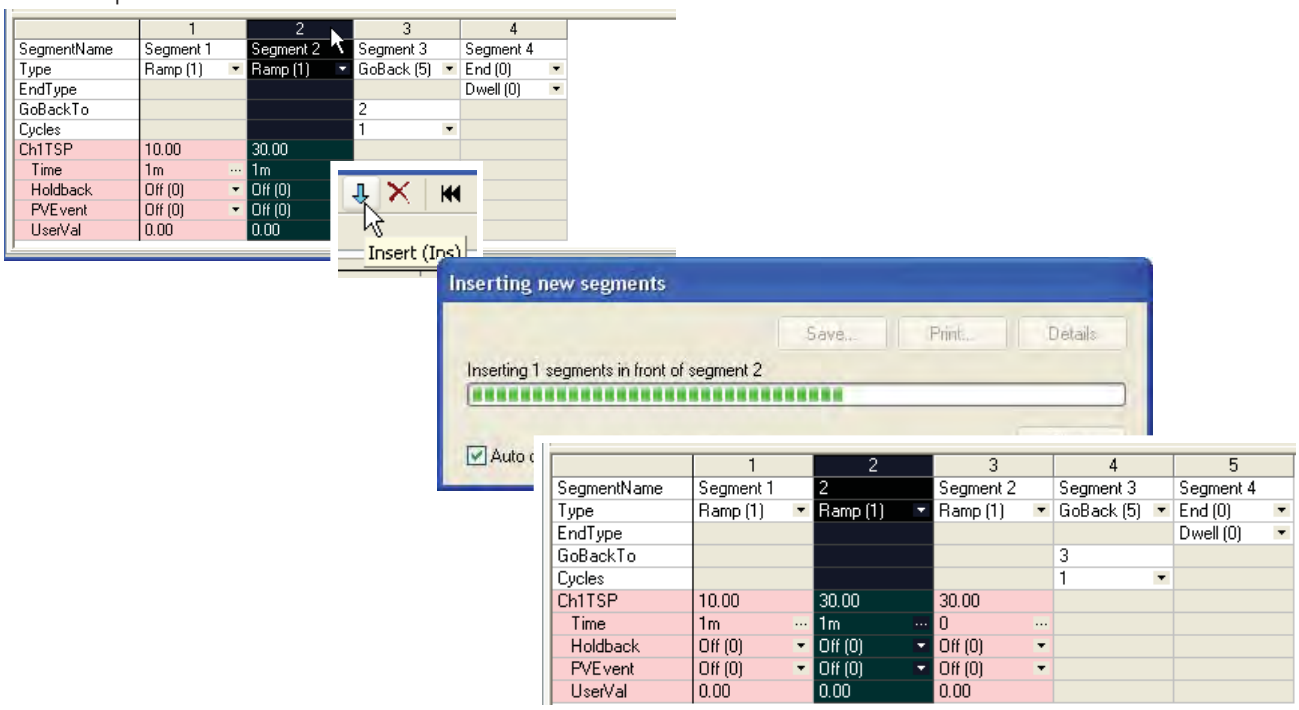


Figure 6.6.4 Insert a segment

Alternatively the mouse can be right-clicked anywhere in a segment, and the 'Insert segment' item selected, or one or more segment can be highlighted and the 'Insert' key on the pc keyboard used to initiate the process. See section 6.6.7 for more details of the right-click (context) menu.

CUTTING, COPYING AND PASTING SEGMENTS

The process of highlighting one or more segments causes the cut and copy toolbar icons to become active.

The cut tool removes the highlighted segments from the program and stores them on the pasteboard ready for re-use.

The copy tool copies the selected segment(s) to the paste board, leaving the original segment(s) in place.

Once one or more segments have been cut or copied, the 'Paste insert' and 'Paste over' icons become active allowing the user to paste the contents of the pasteboard in front of a selected segment (Paste insert), or to overwrite the existing highlighted segment(s) (Paste over). When using the Paste over tool, the number of segments being pasted over must match the number of segments on the paste board.

DELETING SEGMENTS

Once one or more segments have been highlighted, the highlighted segments can be removed using the Delete toolbar icon, by using the Delete Segment item in the right-click (context) menu, or by operating the pc keyboard 'Ctrl' and Delete' keys simultaneously.

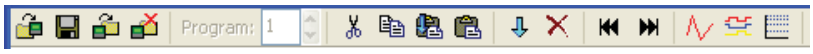
6.6.5 Loading and Saving programs

The four program operation keys at the top left of the programmer window allow the user to load a program from or save a program to either the currently connected instrument or to a pc.

The fourth icon allows the user to select a program to be deleted from the connected instrument.

See section 6.6.6 for more details.

6.6.6 Toolbar icons



The toolbar icons appearing at the top of the programmer window have the following properties:

- Load Program. Opens a browser window allowing the user to select a program on the pc, or a program stored in the connected instrument to load. Short cut: <Ctrl> + <L>.
- Save current program to file. Opens a browser window allowing the user to select a location on the pc in which to save the current program. This file is saved with a '.upiz' extension and can be saved to a USB memory stick for downloading to an instrument, or it can be transferred to the instrument via an ftp server. Short cut: <Ctrl> + <S>.
- Store current program on device. Allows the user to save the program to the program store on the instrument. Short cut: <Shift key> + <Ctrl> + <S>.
- Delete Programs from Device. Allows the user to delete programs from the program store on the connected instrument. Short cut: <Ctrl> + <F>.
- Cut. Removes the highlighted segment(s) from the program and places them on the pasteboard. Short cut: <Ctrl> + <X>.
- Copy. Copies the selected segment(s) to the pasteboard, leaving the original segments in place. Short cut: <Ctrl> + <C>.
- Paste insert. Inserts the segments on the pasteboard into a location to the left of the highlighted segment. Short cut: <Ctrl> + <V>.
- Paste over. Overwrites the highlighted segment(s) with the segment(s) on the pasteboard. The number of segments on the pasteboard must match the number of segments being overwritten. Short cut: <Shift key> + <Ctrl> + <V>.
- Insert. Inserts a new segment to the left of the highlighted segment. If more than one segment is highlighted, then the same number of segments are inserted as are highlighted. Copies the segment type of the segment to the right of the insertion point except if that segment is an 'End' or 'GoBack' segment, when newly inserted segments are of type 'Ramp'. Short cut: <Insert>.
- Delete. Deletes the highlighted segment(s). Short cut: <Ctrl> + <Delete>.
- Go to first. Moves the user to the first segment. Useful in very long programs. Short cut: <Ctrl> + <Left arrow>.
- Go to last. Moves the user to the end segment. Useful in very long programs. Short cut: <Ctrl> + <Right arrow>.
- Analog. Selects the analogue trace chart for display and segment configuration. Short cut: <Ctrl> + <G>.
- Digital Event Outputs. Selects the Event output chart for display and configuration.Short cut: <Ctrl> + <D>.
- Logarithmic. Switches the vertical scale to logarithmic. Short cut: <Ctrl> + <M> (figure 6.6.6)

6.6.6 TOOLBAR ICONS (Cont.)

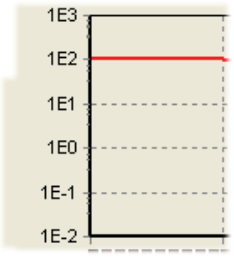
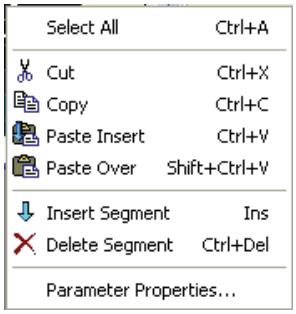


Figure 6.6.6 Logarithmic scale example

6.6.7 Context menus

SEGMENT CONTEXT MENU



Right-clicking when the mouse cursor is hovering over a segment in the analogue segment parameters view produces the segment context menu shown. The various items copy the relevant tool bar icons described above, with the following additions:

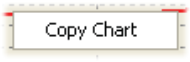
Select All	Selects all parameters
Parameter properties	Displays the properties window for the parameter right-clicked on, including a 'Help' tag for that parameter.

PROGRAM CONTEXT MENU

Right-clicking when the mouse cursor is hovering in the program parameters view produces the program context menu shown.

Parameter properties	Displays the properties window for the parameter right-clicked on, including a 'Help' tag for that parameter.
Columns	Allows the user to enable/disable columns in the program parameters display.

CHART CONTEXT MENU



Right-clicking when the mouse cursor is hovering over the analogue chart or the digital event chart produces the segment context menu shown. This allows the user to copy the chart to the pasteboard, from where it can be pasted into (for example) a standard word procesing document.

6.6.8 Programmer menu

Clicking on the 'Programmer' menu item near the top of the iTools window causes the Programmer menu (figure 6.6.8) to appear. The items contained within this menu are described in the 'Toolbar icons' and 'Context menu' sections (sections 6.6.6 and 6.6.7 respectively) above.

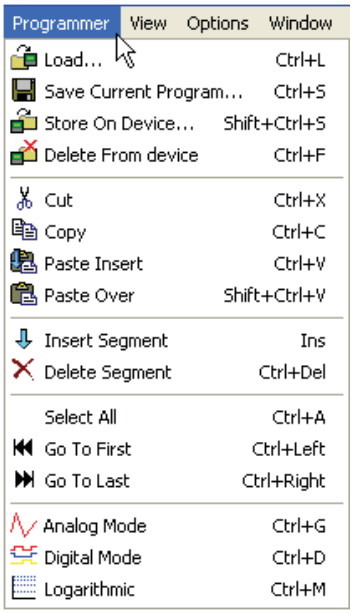


Figure 6.6.8 Programmer menu

6.6.9 Two channel programs

The display and editing of segment and program parameters for two-channel programmers is carried out in the same way as described above, for single channel programs. The major difference in apearance is that there are two sets of parameters for each segment, instead of one. The background colour for channel 1 parameters is pink; that for channel 2 parameters is green.

The number of channels and the program features enabled are set up at the instrument as desribed in section 3.4.9 and section 4.8.

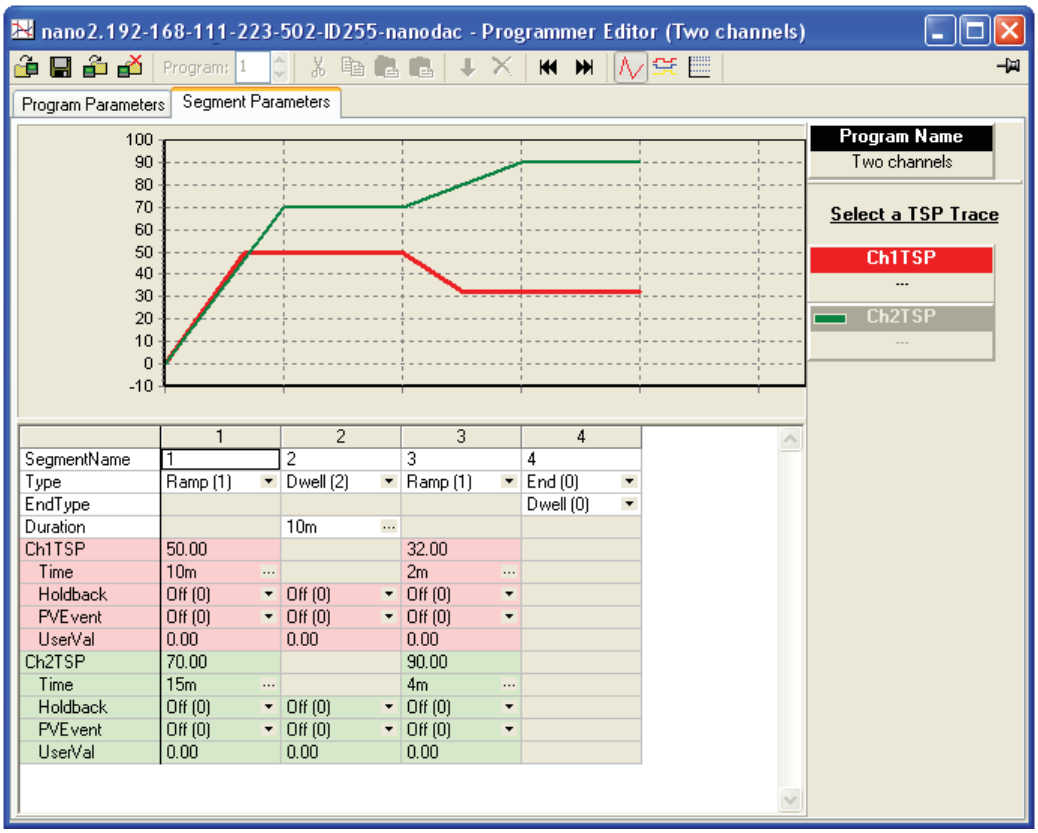


Figure 6.6.9 Two channel program display

7 USER WIRING

User wiring, created from the instrument front panel, allows parameters to be wired together so that, for example, a counter can be configured to be incremented when an alarm goes active. This can be used as an alternative to iTools.

This section is presented as two examples that show the general techniques used to create and delete wires from the instrument user interface.

Notes:

1. These examples refer to Channel Configuration and to Virtual Channel configuration, descriptions of which are to be found in sections 4.4 and 4.5 respectively.
2. The destination parameter field has a small green triangle at the top left corner to indicate that it has a wire routed to it. 3A/3B (Relay)

7.1 DRIVE RELAY EXAMPLE

To drive the relay whose terminal contacts are 3A/3B, whilst the temperature being measured by Channel 2 exceeds 30°C. For this example Channel 2 alarm 1 and a hysteresis of 4°C will be used.

1. In channel 2, Alarm 1 page (see note), set the following parameters:
   Type: Abs. High
   Threshold: 30
   Hysteresis: 4
   Latch: None
   Block: Off
   Dwell:00:00:00
   Acknowledge: No

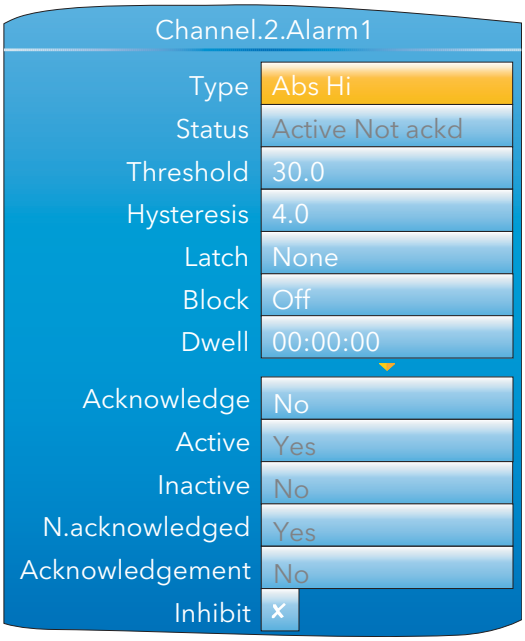


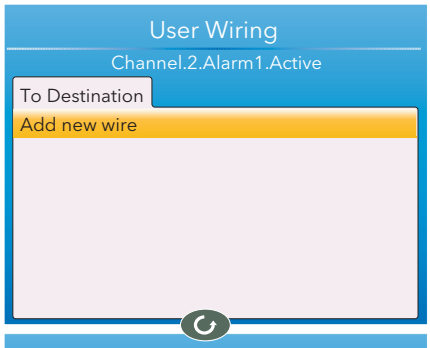
Figure 7.1a Channel 2, Alarm 1 set up

Note: the channel alarm areas of configuration become accessible only once the channel with which they are associated has been configured with a suitable 'Type' (section 4.4.1).

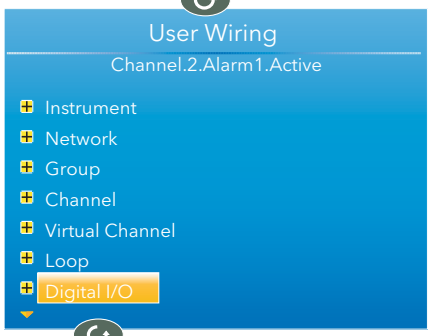
7.1 DRIVE RELAY EXAMPLE (Cont.)

2. Highlight the 'Active' field, and press and hold the scroll button for a few seconds, until the top level User Wiring page appears.
   The name of the selected parameter appears at the top of the page. Any already existing wires from this parameter would appear below the 'Add new wire' area.

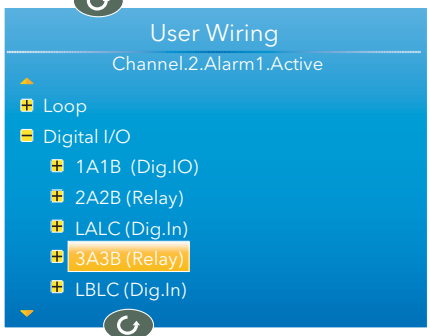
3. With 'Add new wire' highlighted operate the Scroll button.



4. Use the down arrow to highlight 'Digital I/O' and press the scroll button.

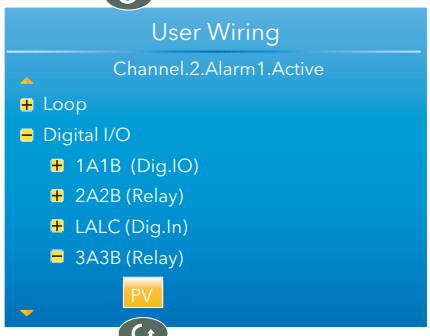


5. Use the down arrow to highlight '3A3B (Relay)' and press the scroll button.



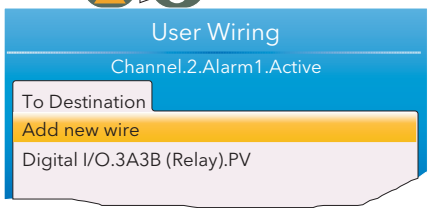
6. Use the down arrow to highlight 'PV' and press the scroll button.

   Note: If this parameter is already wired-to, the 'wired' symbol appears to the left of the parameter.



7. When the confirmation window appears, use the up or down arrow to highlight 'Ok', then operate the scroll button again.

8. The top level user wiring page reappears, showing the destination parameter.



7.1.1 Wire removal

At the top level user wiring page, use the up and down arrow buttons to highlight the wire to be deleted, and operate the scroll key. In the 'Delete Wire' confirmation window, highlight 'Ok' and operate the scroll key again. The wire is deleted without further confirmation.

7.2 COUNTER EXAMPLE

This example shows how to set up a counter to be incremented each time Channel 1 Alarm 1 becomes active, and reset each time channel 2, alarm 1 is acknowledged. For this example, Virtual Channel 3 will be configured as the counter, with a preset value of 0.

1. At Channel.1.Main, set:

   Type = test
   Test Signal = Sine 4 min.
   Scale Low = 0
   Scale High = 100

2. At Channel.1.Alarm1, set:

   Type = Abs Hi
   Threshold = 50
   Latch = None

3. At Channel.2.Main, set:

   Type = Test
   Test Signal = Sine 40 min.
   Scale Low = 0
   Scale High = 100

4. At Channel.2.Alarm 1, set:

   Type = Abs Hi
   Threshold = 90
   Latch = Manual

5. At Virtual Channel.3.Main, set:

   Type = Counter
   Operation = On
   Input = 1

All the other parameters can be left at their defaults.

6. Still at Virtual Channel 3 (Main), use the up/down arrow buttons to highlight 'Trigger'. Press and hold the scroll key. The top level User Wiring page appears, this time with a 'From Source' tab as well as the 'To Destination' tab of example 1. This is because this parameter is read/write, whereas Alarm Active is read only (i.e. its value may be read but not changed).
7. Use the up (or down) arrow button to select the 'From Source' tab.

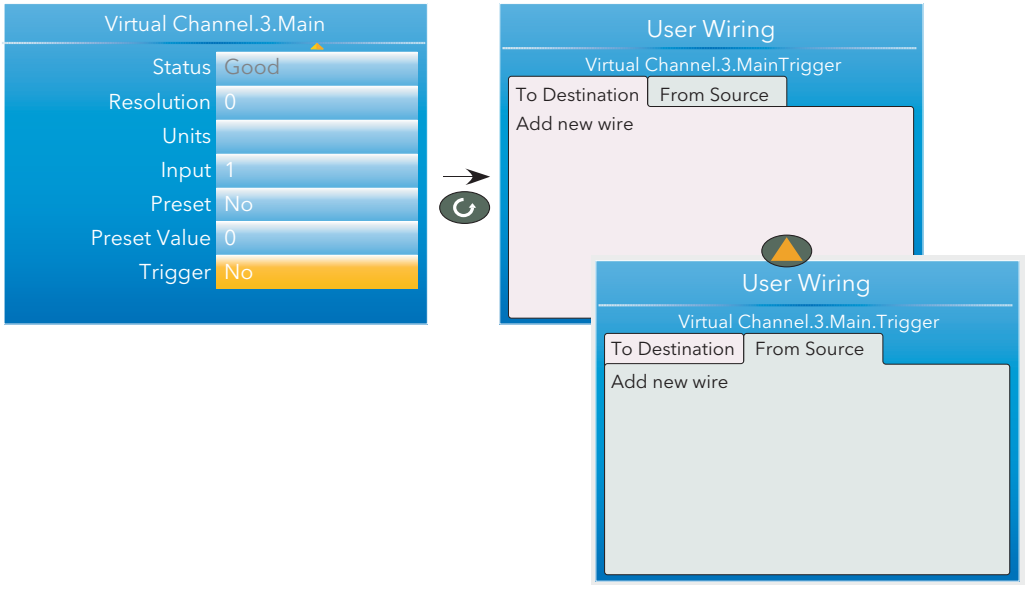


Figure 7.2a Wiring a counter: part 1

7.2 COUNTER EXAMPLE (Cont.)

8. Operate the Scroll key to highlight 'Add new wire', then again to display the top level parameter list.
9. Use the down arrow button to highlight 'Channel' and operate the scroll button.
10. Operate the scroll button to select '1'.
11. Highlight 'Alarm 1' and operate the scroll button.
12. Use the down arrow button to highlight 'Active'. Operate the Scroll button again, and create the new wire.
13. Use the Page button twice to return to the Virtual Channel 3 menu.

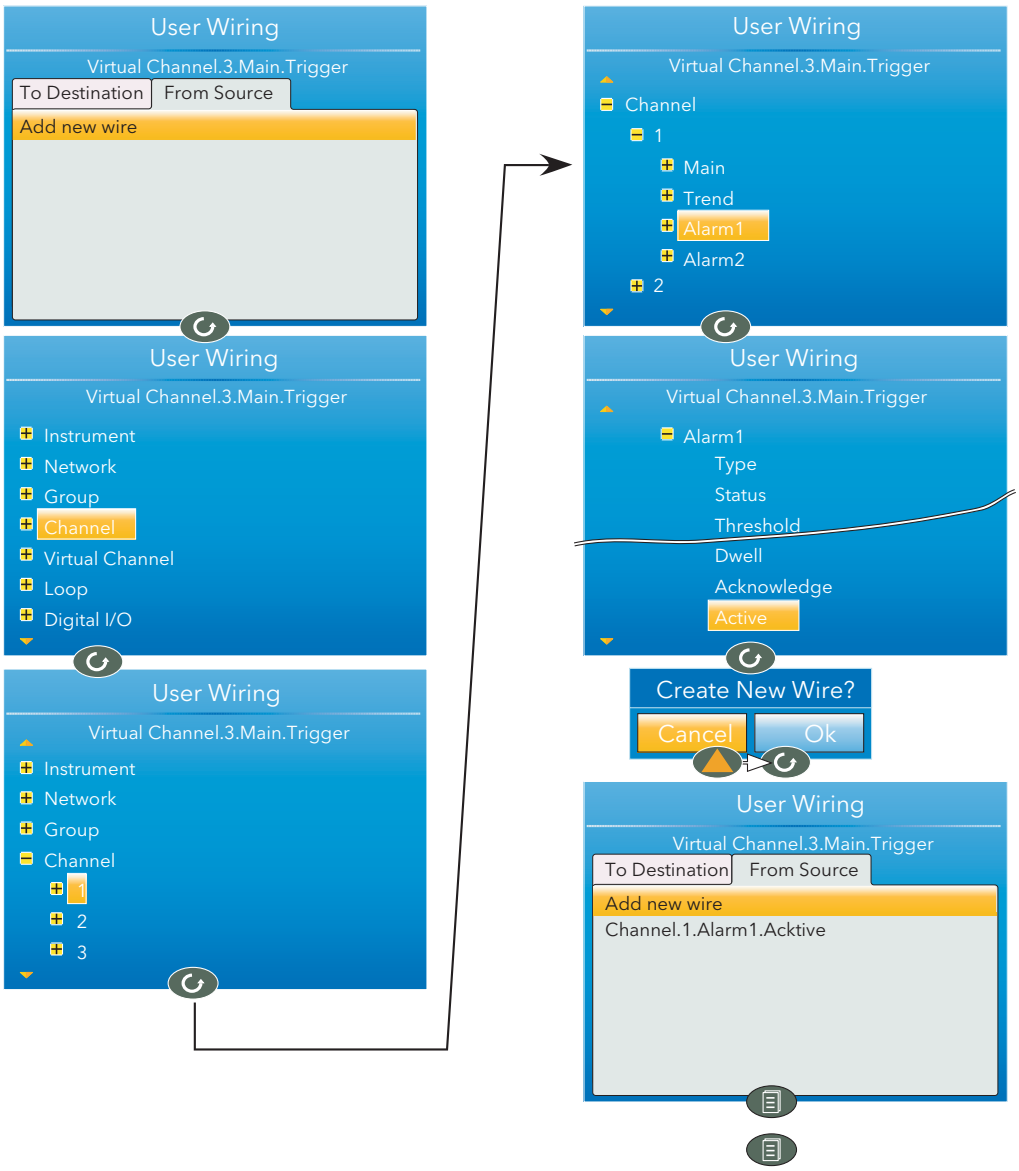


Figure 7.2b Wiring a counter: part 2

7.2 COUNTER EXAMPLE (Cont.)

14. At Virtual Channel.3.Main, use the down arrow to select 'Preset'. Press and hold the scroll key. The top level User Wiring page appears.
15. Use the up (or down) arrow button to select the 'From Source' tab, if not already selected.
16. Operate the Scroll key to highlight 'Add new wire', then again to display the top level parameter list.
17. Use the down arrow button to highlight 'Channel' and operate the scroll button.
18. Use the down arrow button to highlight '2' and operate the scroll button.
19. Highlight 'Alarm 1' and operate the scroll button.
20. Use the down arrow button to highlight 'Acknowledgement' (not 'Acknowledge'). Operate the Scroll button again, and create the new wire.

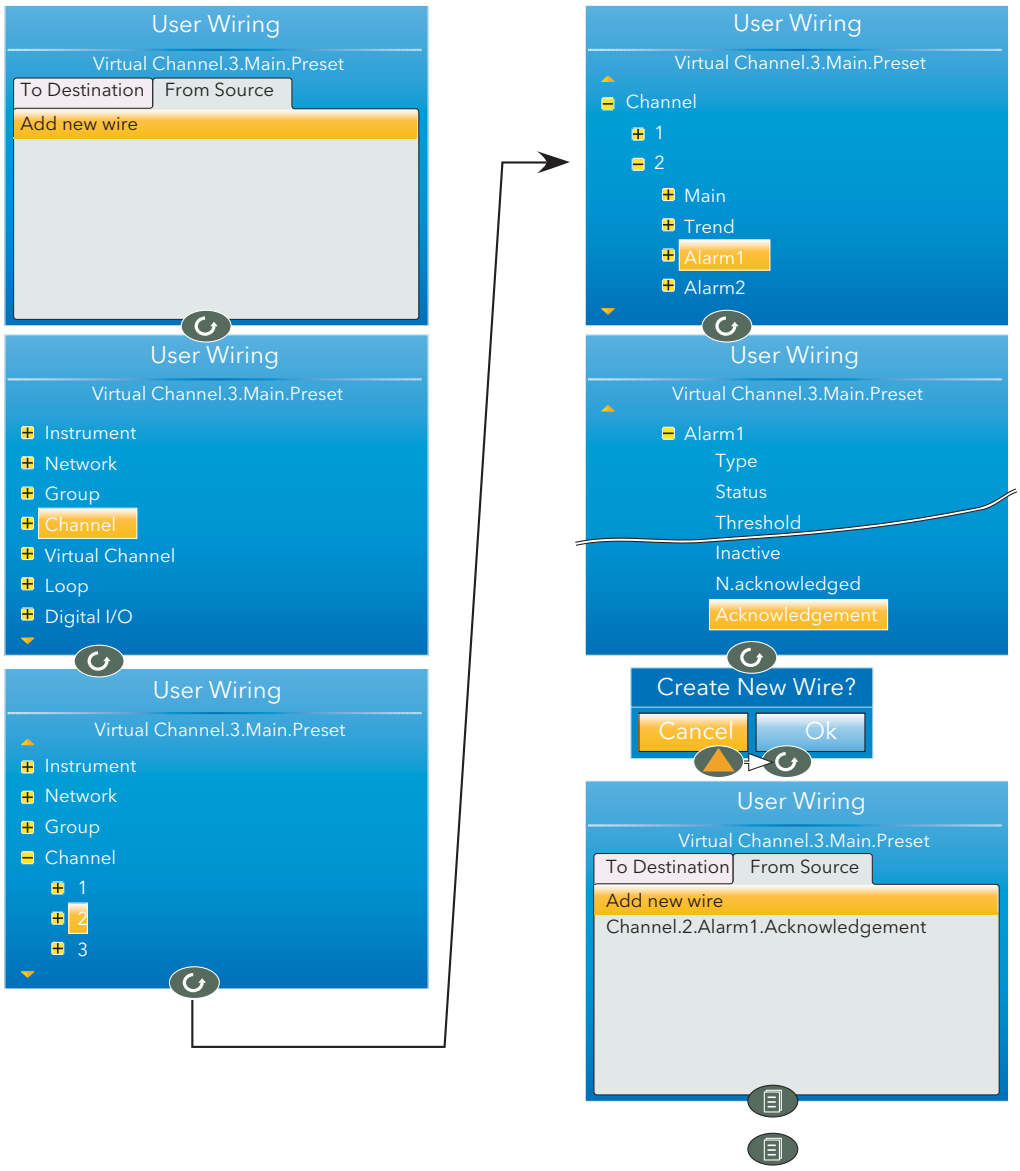


Figure 7.2c Wiring a counter: part 3

8 USB DEVICES

The devices listed below can be plugged into the USB connector at the back of the instrument, providing that the maximum current required is less than 100 mA.

1. Memory Stick
2 Bar code reader
3. Keyboard

Notes:
1. See 'USB device precautions' in the Safety Notes preamble section of the manual.
2. See Section A2 for the USB port specification
3. The use of USB hubs is not supported by this instrument.

8.1 MEMORY STICK

The use of the memory stick as an archiving device, or to facilitate software upgrades is well documented in the relevant sections of this manual.

8.2 BAR CODE READER

If 'USB Auto Scan is set to 'Yes' in Display Configuration (section 4.1.3) then, with the bar code reader plugged into the USB port, the scanned data input stream is packaged into a general message displayed on the trend page and included in the .uhh history file. The format of the message is: DD/MM/YY HH:MM:SS 123--13 (where 123--13 represents the ASCII data read from the bar code.

If 'USB auto Scan' is set to 'No, the ASCII data read from the bar code is displayed as a message ready for editing prior to being sent to the display etc. Figure 8.2 shows an example.

Note: the bar code reader must be configured to use a carriage return (decimal 13) terminating character.

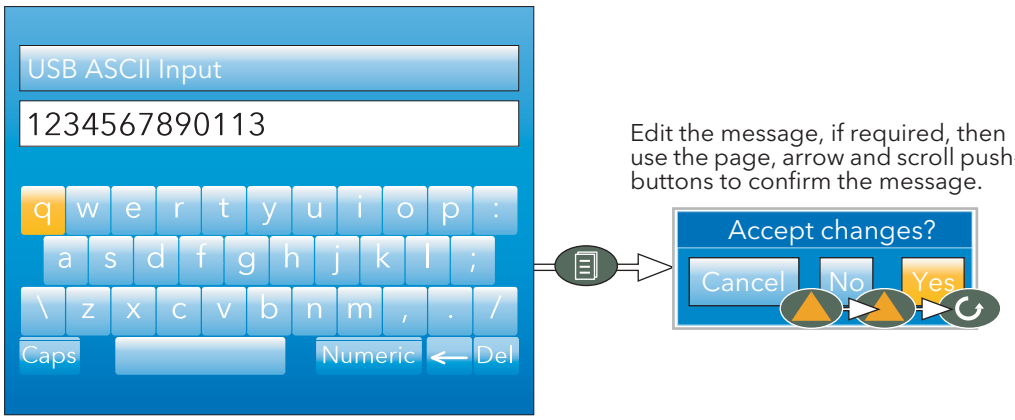


Figure 8.2 Bar Code reader display

8.3 USB KEYBOARD

A QWERTY keyboard may be plugged into the rear USB port to act in parallel with the virtual keyboard. The editing keys listed below are supported in addition to the standard alpha-numeric characters.

Left arrow	Moves the cursor left-wards through the text string (stops at the start of the string).
Right arrow	Moves the cursor right-wards through the text string (stops at the end of the string).
Backspace	Deletes the character immediately to the left of the cursor.
Delete	Removes the character immediately to the right of the cursor.
End	Moves the cursor to the end of the string
Home	Moves the cursor to the start of the string
Insert	Highlights the entire string, for overwriting
Esc	Exit without saving changes.

Appendix A: TECHNICAL SPECIFICATION

A1 INSTALLATION CATEGORY AND POLLUTION DEGREE

This product has been designed to conform to BS EN61010 installation category II and pollution degree 2, defined as follows:

Installation category II

The rated impulse voltage for equipment on nominal 230V mains is 2500V.

Pollution degree 2

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

A2 RECORDER SPECIFICATION

I/O types

Analogue i/p	Four (eight if dual input option fitted)
Digital i/p	Two
Digital (logic) o/p	See table A2 for options
Relay o/p	See table A2 for options
DC output	See table A2 for options

IO1	OP2	OP3	OP4	OP5	
L	R	R	R	R	← Default
L	R	D	R	R	
L	L	R	R	R	
R	D	D	R	R	← Options
D	D	D	R	R	

L = Logic output; R = Relay; D = DC output
OP4 and OP5 share Common terminals.

Table A2 Output options

Features	CSV archive format
	EtherNet/IP (Option)
	File transfer protocol (FTP)
	Messages
	Modbus Master (Option)
	Modbus TCP slave
	Set point programmer (option)
	uhh (history file) archiving
	USB port at rear of instrument
	User linearisation tables (four)
	Two control loops (optional)
	Advanced Loop (optional)
	Zirconia probe support (optional)
	15 Virtual channels (each configurable as maths, totaliser or counter).
	30 Virtual channels if Modbus Master or EtherNet/IPoptions fitted (no alarms on virtual channels 16 to 30)

Environmental performance

Ambient temperature range		
	Operating:	0 to 55°C
	Storage:	-20 to +70°C
Humidity range	Operating:	5% to 85% RH non condensing
	storage:	5% to 85% RH non condensing
Protection	Front panel (Standard):	IP65
	Front panel (Wash down):	IP66, NEMA4X (International)
	Behind panel:	IP10 (International)
Shock/Vibration		To BS EN61131-2 (5 to 150 Hz. at 1g; 1 octave per min.)
Altitude		<2000 metres
Atmosphere		Not suitable for use in explosive or corrosive atmospheres.
Electrical safety		BS EN61010-1 (Installation category II; Pollution degree 2)
Electromagnetic compatibility		
	Emissions (standard units):	BS EN61326 Class B - Light industrial.
	Emissions (Low voltage option):	BS EN61326 Class A - Heavy industrial
	Immunity	BS EN61326 Industrial

Other approvals and compliance details

General:	CE and cUL, EN61010
PV input	AMS2750D compliant
RoHS	EU; China
Packaging	BS EN61131-2 section 2.1.3.3.

Physical

Panel mounting	1/4 DIN
Weight	0.44kg (15.52 oz.)
Panel cutout dimension	92 mm x 92 mm (both -0.0 +0.8) or 3.62 in x 3.62 in (both -0.00 +0.03 in) (figure 2.1)
Depth behind panel	90 mm (3.54 in) (figure 2.1) excluding wiring.

Operator interface

Display	3.5" TFT colour display (320 pixels wide x 240 pixels high)
Controls	Four navigation pushbuttons below the display screen (Page, Scroll, Lower and Raise)

Power requirements

Supply voltage	Standard:	100 to 230Vac ± 15% at 48 to 62Hz.
	Low voltage option:	24Vac (+10% - 15%), at 48 to 62 Hz, or 24Vdc (+20% -15%)
Power dissipation		9 W
Fuse type		None
Interrupt protection	Standard:	Holdup >10ms at 85V RMS supply voltage.
	Low voltage option:	Holdup >10ms at 20.4V RMS supply voltage.

Battery backup

Stored data	Time, date.
Support time (for real-time clock)	Minimum of 1 year with unit unpowered.
Replacement period	Three years typical
Type	poly-carbonmonofluoride / lithium (BR2330) (PA260195)

Ethernet communications

Type:	10/100baseT Ethernet (IEEE802.3)
Protocols:	Modbus TCP/IP slave, FTP, DHCP
Cable type	Category 5
Maximum length	100metres (110 yards)
Termination	RJ45. Green LED illuminated = link connected; Amber LED flashing shows link activity.

A2 RECORDER SPECIFICATION (Cont.)

USB port

Number of ports	One at rear of instrument
Standard	USB1.1
Transmission speeds	1.5Mbits/sec (low speed device)
Maximum current	<100mA

Peripherals supported Memory stick (8GB max), Bar code reader, QWERTY keyboard

Update/Archive rates

Sample rate (input/output)	8Hz (4Hz for digital inputs) (4Hz for dual input channels)
Trend update	8 Hz max
Archive sample value	Latest value at archive time
Display value	Latest value at display update time.

A3 ANALOGUE INPUT SPECIFICATION

General

Number of anaologue inputs		Four
Input types	Standard:	dc Volts, dc mV, dc mA (external shunt required), thermocouple, RTD (2-wire and 3-wire), digital (contact closure).
	Optional:	dual mA, dual mV, dual thermocouple.
Input type mix		Freely configurable
Sample rate		8Hz (125ms)
Conversion method		16 bit delta sigma.
Input ranges		See below.
Mains rejection (48 to 62Hz)		
	Series mode:	>95dB
	Common mode:	>179dB
Common mode voltage		250Vac max.
Series mode voltage		280mV at lowest range; 5V peak-to-peak, at highest range.
Input impedance		See relevant Range specification, below.
Overvoltage protection	Continuous:	± 30V RMS
	Transient (<1ms):	±200V pk-pk between terminals.
Sensor break detection	Type	ac sensor break on each input giving quick response with no associated dc errors.
	Recognition time:	<3 secs.
	Minimum break resistance:	40mV, 80mV ranges: 5kΩ; other ranges: 12.5kΩ
Shunt (mA inputs only)	Values	1Ω to 1kΩ, mounted externally.
	additional error due to shunt:	0.1% input
Isolation	Channel to channel:	300V RMS or dc (double insulation)
	Channel to common electronics:	300V RMS or dc (double insulation)
	Channel to ground:	300V RMS or dc (double insulation)
Dielectric strength	Test:	BS EN61010, 1 minute type test
	Channel to channel:	2500 Vac
	Channel to ground:	1500 Vac

DC input ranges

Ranges		40mv, 80mV, 2V; 10V (-4.0 to +10V)
40mV Range	Range:	-40mV to + 40mV
	Resolution	1.9µV (unfiltered)
	Measurement noise:	1.0µV peak-to-peak with 1.6s input filter
	Linearity error:	0.003% (best fit straight line)
	Calibration error:	±4.6µV ±0.053% of measurement at 25°C ambient
	Temperature coefficient:	±0.2µV/°C ± 13ppm/°C of measurement from 25°C ambient
	Input leakage current:	±14nA
	Input resistance:	100MΩ
80mV Range	Range:	-80mV to + 80mV
	Resolution	3.2µV (unfiltered)
	Measurement noise:	3.3µV peak-to-peak with 1.6s input filter
	Linearity error:	0.003% (best fit straight line)
	Calibration error:	±7.5µV ±0.052% of measurement at 25°C ambient
	Temperature coefficient:	±0.2µV/°C ± 13ppm/°C of measurement from 25°C ambient
	Input leakage current:	±14nA
	Input resistance:	100MΩ
2V Range	Range:	±2V
	Resolution	82µV
	Measurement noise:	90µV peak-to-peak with 1.6s input filter
	Linearity error:	0.003% (best fit straight line)
	Calibration error:	±420µV ±0.044% of measurement at 25°C ambient
	Temperature coefficient:	±125µV/°C ± 13ppm/°C of measurement from 25°C ambient
	Input leakage current:	±14nA
	Input resistance:	100MΩ

A3 ANALOGUE INPUT SPECIFICATION (Cont.)

DC Input ranges (Cont.)

10V Range

Range:	-3V to +10V
Resolution	500µV
Measurement noise:	550µV peak-to-peak with 1.6s input filter
Linearity error:	0.007% (best fit straight line) for zero source resistance. Add 0.003% for each 10Ω source and lead resistance
Calibration error:	±1.5mV ±0.063% measurement at 25°C ambient
Temperature coefficient:	±66µV/°C ± 45ppm/°C of measurement from 25°C ambient
Input resistance:	62.5kΩ for input voltages > 5.6V. 667kΩ for input ranges < 5.6V.

Note: 10V range not available for dual input channels

Resistance input ranges

Temperature scale	ITS90
RTD Types, ranges and accuracies	See table
Maximum source current	200µA

Resistance input figures

Range:	0 to 400Ω (-200 to +850°C)
Resolution:	0.05°C
Measurement noise:	0.05°C peak-peak with 1.6s input filter
Linearity error:	0.0033% (best fit straight line)
Calibration error:	±0.31°C ±0.023% of measurement in °C at 25°C ambient
Temperature coefficient:	±0.01°C/°C ±25ppm/°C measurement in °C from 25°C ambient
Lead resistance	0 to 22Ω matched lead resistances
Bulb current:	200µA nominal

RTD type	Overall range °C	Standard	Max. linearisation error
Cu10	-20 to + 400	General electric Co.	0.02°C
Cu53	-70 to + 200	RC21-4-1966	<0.01°C
JPT100	-220 to + 630	JIS C1604:1989	0.01°C
Ni100	-60 to + 250	DIN43760:1987	0.01°C
Ni120	-50 to + 170	DIN43760:1987	0.01°C
Pt100	-200 to + 850	IEC751	0.01°C
Pt100A	-200 to + 600	Eurotherm Recorders SA	0.09°C

Table A3a RTD type details

Thermocouple data

Temperature scale		ITS90
CJC	Types:	Off, internal, external, remote.
	Remote CJC source	Any input channel
	Internal CJC error	<1 °C max, with instrument at 25 °C
	Internal CJC rejection ratio:	40:1 from 25°C
Upscale/downscale drive		High, low or none independently configurable for each channel's sensor break detection.
Types, ranges and accuracies		See table A3b

T/C type	Overall range (°C)	Standard	Max. linearisation error
B	0 to + 1820	IEC584.1	0 to 400°C = 1.7°C 400 to 1820°C = 0.03°C
C	0 to + 2300	Hoskins	0.12°C
D	0 to + 2495	Hoskins	0.08°C
E	-270 to + 1000	IEC584.1	0.03°C
G2	0 to + 2315	Hoskins	0.07°C
J	-210 to + 1200	IEC584.1	0.02°C
K	-270 to + 1372	IEC584.1	0.04°C
L	-200 to + 900	DIN43710:1985 (to IPTS68)	0.02°C
N	-270 to + 1300	IEC584.1	0.04°C
R	-50 to + 1768	IEC584.1	0.04°C
S	-50 to + 1768	IEC584.1	0.04°C
T	-270 to + 400	IEC584.1	0.02°C
U	-200 to + 600	DIN43710:1985	0.08°C
NiMo/NiCo	-50 to + 1410	ASTM E1751-95	0.06°C
Platinel	0 to + 1370	Engelhard	0.02°C
Mi/NiMo	0 to + 1406	Ipsen	0.14°C
Pt20%Rh/Pt40%/Rh	0 to + 1888	ASTM E1751-95	0.07°C

Table A3b Thermocouple types, ranges and accuracies

A4 RELAY AND LOGIC I/O SPECIFICATION

OP1, OP2, OP3 logic input, logic output and relay specification.

Active (current on) current sourcing logic output	
Voltage output across terminals	+11V min; +13V max.
Short circuit output current	6mA min. (steady state); 44mA max. (switch current)

Inactive (current off) current sourcing logic output (OP1 or OP2 only)	
Voltage output across terminals	0V (min.); 300mV (max)
Output source leakage current into short circuit	0µA (min.); 100µA max

Active (current on) contact closure sourcing logic input (OP1 only)		
Input current	Input at 12V:	0mA (min.); 44mA (max.)
	inout at 0V:	6mA min. (steady state); 44mA max. (switch current)
Open circuit input voltage		11V (min.); 13V (max.)
Open circuit (inactve) resistance		500Ω (min.); ∞ (max.)
Closed circuit (active) resistance		0Ω (min.); 150Ω (max.)

Relay contacts	
Contact switching power (resistive)	Max: 2A at 230V RMS ±15%; Min: 100mA @ 12V.
Maximum current through terminals	2A

A5 DIGITAL INPUTS

DigInA, DigInB, contact closure logic input

Contact closure	
Short circuit sensing current (source)	5.5mA (min.); 6.5mA (max.)
Open circuit (inactive) resistance	600 Ω (min.); ∞ (max.)
Closed circuit (active) resistance	0Ω (min.); 300Ω (max.)
Maximum frequency	8 Hz
Minimum pulse width	62.5 ms

A6 DC OUTPUTS

OP1, OP2, OP3 DC analogue outputs

Current outputs (OP1, OP2 and OP3)	
Output ranges	Configurable within 0 to 20mA
Load resistance	500Ω Max.
Calibration accuracy	<±100µA ±1% of reading

Voltage outputs (OP3 only)	
Output range	Configurable within 0 to 10V
Output impedance	500Ω Min.
Calibration accuracy	<±50mV ±1% of reading

General	
Isolation	300Vac double insulated from instrument and other I/O
Resolution	>11 bits
Thermal drift	<100ppm/°C

A7 BLOCKS SUPPORTED

A7.1 'TOOLKIT' BLOCKS

BCD input
Eight-input logic
Eight input multiplexer
Timers
Two-input logic
Two-input maths
User values

A7.2 APPLICATION BLOCKS

Humidity
Steriliser
Zirconia

Appendix B CONTROL LOOPS

Note: See section 4.6 for Loop configuration details

B.1 INTRODUCTION

With this recorder, two control loops are available, each loop containing two outputs (Channel 1 and Channel 2) which can be individually configured for PID, On/Off or valve position. For temperature control, channel 1 is normally configured for heating and channel 2 for cooling.

B1.1 EXAMPLE (HEAT ONLY)

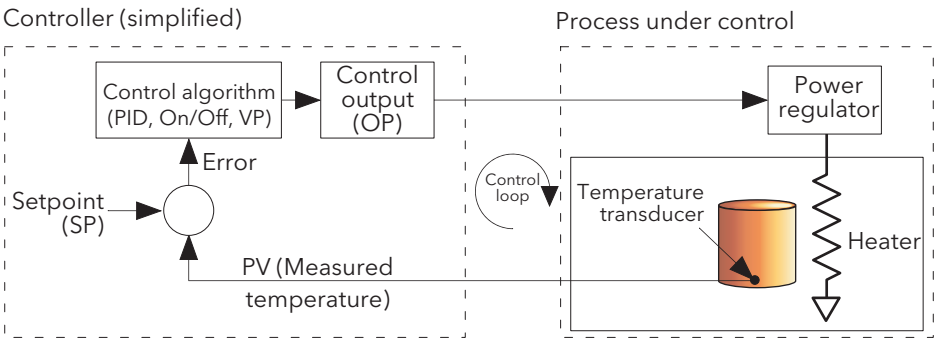


Figure B1.1 Control loop example

The measured temperature (process variable, or 'PV') is connected to the input of the controller, where it is compared with the 'Setpoint' (SP) (the target temperature). If there is a difference between the PV and the SP, the controller calculates and outputs a heating demand. This output is applied to the process heating device, which in turn causes a change in the PV in a direction intended to result in a zero error.

B2 CONTROL LOOP DEFINITIONS

B2.1 AUTO/MANUAL

In manual mode, if 'On/Off' control is configured, the output power may be edited by the user but the only power values allowed are: +100% (heat on; cool off) for positive user entries, 0% (heat off; cool off) for zero entry or -100%. (heat off; cool on) for negative entries.

In manual mode, for 'PID' control the output may be edited between +100% and (if 'cool' is configured), -100%. The actual output value is subject to limiting and output rate limit.

In manual mode, for valve position control, the up and down arrow buttons directly control (nudge) the raise and lower relay outputs respectively. It is also possible to control the valve by sending nudge commands over a serial link, or by software wiring from a suitable parameter. A single nudge command moves the valve by 1 minimum on time; longer nudge demands produce longer valve movements. See section B2.6.10 for more details.

If sensor break occurs while the controller is in automatic the controller outputs the sensor break output power. In such a case the user can switch to manual control and edit the output power. On returning to automatic control, the controller checks again for sensor break.

If autotune is enabled while in manual mode, the autotune remains in a reset state such that when the user puts the controller into automatic control the autotune starts.

B2.2 TYPES OF CONTROL LOOP

B2.2.1 On/Off control

This form of control turns heating power on when the process value is below the setpoint, and turns it off when it is above the setpoint (see also figure B2.6.9a). If cooling is configured, it has its own relay which operates in a similar way. In Direct Acting mode, the behaviour is inverted. On/off is suitable for controlling switching devices such as relays.

Because of the thermal inertia of the load, a certain amount of oscillation will take place, and this can affect the quality of the product. For this reason, On/Off control is not recommended for critical applications.

Depending on the nature of the process being controlled, some hysteresis may have to be included to prevent continuous operation or chatter in the controlling device.

B2.2.2 PID Control

Also known as 'three term control', this type of control continuously adjusts the output demand, according to a set of rules, in order to control the process as closely as possible to requirements. PID provides more stable control than On/Off control but is more complex to set up as the parameters must match the characteristics of the process under control.

The three major parameters are: Proportional band (PB), Integral time (Ti) and Derivative time (Td) and the output from the controller is the sum of these three terms. This output is a function of the size and duration of the error value and the rate-of-change of the process value.

It is possible to disable the integral and/or derivative terms and control on proportional only, on proportional plus integral (PI) or proportional plus derivative (PD).

PI control is often used when the PV is noisy and/or subject to rapid variations, where derivative action would cause the output power to fluctuate wildly.

PROPORTIONAL BAND

The proportional band (PB) delivers an output which is proportional to the size of the error signal. It is the range over which the output power is continuously adjustable in a linear fashion from 0% to 100% (for a heat only controller). Below the proportional band the output is full on (100%), above the proportional band the output is full off (0%) as shown in figure B2.2.2a.

The width of the proportional band determines the magnitude of the response to the error. If PB is too narrow (high gain) the system oscillates; if it is too wide (low gain) control is sluggish. The ideal situation is when the proportional band is as narrow as possible without causing oscillation.

Figure B2.2.2a also shows the effect of narrowing proportional band to the point of oscillation. A wide proportional band results in straight line control but with an appreciable initial error between setpoint and actual temperature. As the band is narrowed the temperature gets closer to setpoint until eventually, it becomes unstable.

The proportional band may be set in engineering units or as a percentage of the controller range.

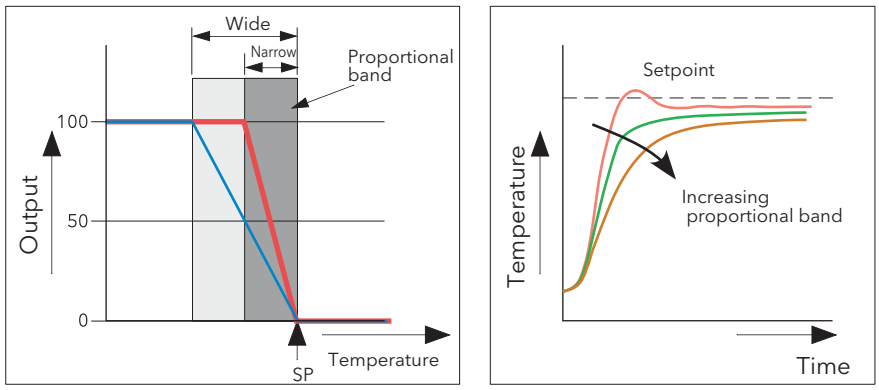


Figure B2.2.2a Proportional band action (reverse acting)

B2.2 TYPES OF CONTROL LOOP (Cont.)

INTEGRAL TERM

In a proportional only controller, as seen in the previous section, an error must exist between setpoint and PV in order for the controller to deliver power. Integral is used to achieve zero steady state control error.

The integral term slowly modifies the output level as a result of any error between setpoint and measured value. If the measured value is below setpoint the integral action gradually increases the output in an attempt to correct the error. If it is above setpoint integral action gradually decreases the output or increases the cooling power to correct the error.

Figure B2.2.2b shows proportional plus integral action.

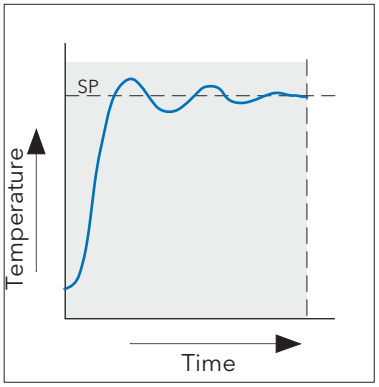


Figure B2.2.2b: Proportional + Integral Control

The integral term is set in seconds. The longer the integral time constant, the more slowly the output is modified and the more sluggish the response. Too small an integral time causes the process to overshoot, and perhaps to start oscillating. The integral action may be disabled by setting its value to Off.

DERIVATIVE TERM

Derivative (or rate) action provides a sudden change in output linked to the rate of change in error, whether this is caused by PV alone (derivative on PV) or by a change in the SP as well (derivative on error selection). If the measured value falls quickly, derivative provides a large change in output in an attempt to correct the perturbation before it goes too far. It is most beneficial in recovering from small perturbations.

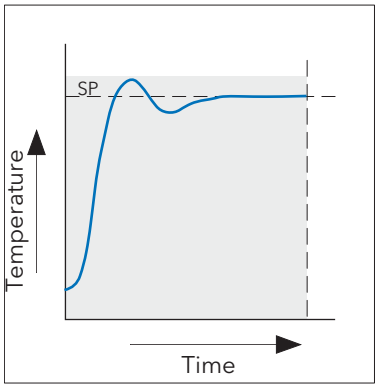


Figure B2.2.2c Proportional + Integral + Derivative Action

Derivative is used to improve the performance of the loop. There are, however, situations where derivative may be the cause of instability. For example, if the PV is noisy, then derivative can amplify that noise and cause excessive output changes, in these situations it is often better to disable the derivative and re-tune the loop.

B2.2 TYPES OF CONTROL LOOP (Cont.)

Derivative should not be used to curb overshoot in situations when the output is saturated at Op High or Op Low for extended periods, such as process start up, since to do so degrades the steady state performance of the system. Overshoot inhibition is best left to the approach control parameters, High and Low Cutback.

If Derivative is set to Off, no derivative action will be applied.

Derivative can be calculated on change of PV or change of Error. If configured on error, then changes in the setpoint will be transmitted to the output. For applications such as furnace temperature control, it is common practice to select Derivative on PV to prevent thermal shock caused by a sudden change of output as a result of a change in setpoint.

B2.2.3 Motorised valve control

Designed specifically for driving motorised valves this type of control can operate in 'Unbounded' mode (VPU) or 'Bounded' mode (VPB). Relay outputs are used to drive the valve motor.

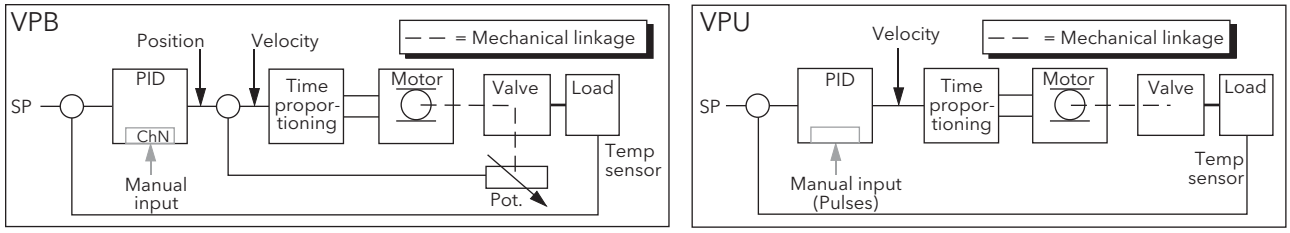


Figure B2.2.3 VPB and VPU comparison

Unbounded valve positioning (VPU) does not require a position feedback potentiometer in order to operate because it controls directly the direction and velocity of the movement of the valve in order to minimise the error between the setpoint (SP) and the process variable (PV). Control is performed by delivering a 'raise' or 'lower' pulse to control the velocity of the valve in response to the control demand signal.

Bounded VP (VPB) control uses PID (or any other combination of the three terms) to set a required valve position. A feedback potentiometer linked to the valve provides a signal giving actual valve position. This allows the control loop to calculate the difference between required and actual position dynamically, and adjust control output accordingly. Control is performed by delivering a 'raise' or 'lower' pulse to adjust the valve position.

MANUAL MODE

Bounded VP controls in manual mode because the inner positional loop is still running against the potentiometer feedback, so it is operating as a position loop.

In boundless mode the algorithm is a velocity mode positioner. When manual is selected then the up and down arrow produce +100% or –100% velocity respectively for the duration of the key press.

In boundless mode it is essential that the motor travel time is set accurately in order to allow the integral time to calculate correctly. Motor travel time is defined as (valve fully open – valve fully closed). This is not necessarily the time printed on the motor since, if mechanical stops have been set on the motor, the travel time of the valve may be different.

Every time the valve is driven to its end stops the algorithm is reset to 0% or 100% to compensate for any changes which may occur due to wear in linkages or other mechanical parts.

This technique makes boundless VP look like a positional loop in manual even though it is not. This enables combinations of heating and cooling e.g. PID heat, VPU cool with manual mode working as expected.

MOTORISED VALVE OUTPUT CONNECTIONS

The loop output which has been configured as valve position can be wired to the PV input of one of the pairs of relays 2A2B/3A3B or 4AC/5AC which has been configured as Type = 'Valve Raise'. Only one relay input needs to be wired as the other relay of the pair will be automatically set to 'Valve Lower'. For example, if Loop 1 Channel 1 output is wired to Relay 2A2B and the 'Type' is configured as 'Valve Raise' then the Type for Relay 3A3B will be 'Valve Lower'.

B2.3 LOOP PARAMETERS

B2.3.1 Relative cool gain (R2G)

This is the gain of channel 2 control output, relative to the channel 1 control output and is used to compensate for the different quantities of power available to heat and to cool a process. For example, water cooling applications might require a relative cool gain of 0.25 because cooling is 4 times greater than the heating process at the operating temperature.

By default, this parameter is set automatically when an Autotune is performed, but setting the Tune menu parameter 'AT.R2G' to 'No' causes the R2G value(s) entered in the PID menu to be used instead.

B2.3.2 High and Low cutback

Cutback high 'CBH' and Cutback low 'CBL' are values that modify the amount of overshoot, or undershoot, that occurs during large step changes in PV under start-up conditions, for example. They are independent of the PID terms which means that the PID terms can be set for optimal steady state response and the cutback parameters used to modify any overshoot which may be present.

Cutback involves moving the proportional band towards the cutback point nearest the measured value whenever the latter is outside the proportional band and the power is saturated (at 0 or 100% for a heat only controller). The proportional band moves downscale to the lower cutback point and waits for the measured value to enter it. It then escorts the measured value with full PID control to the setpoint. In some cases it can cause a 'dip' in the measured value as it approaches setpoint as shown in figure B2.3.2 but generally decreases the time to needed to bring the process into operation.

The action described above is reversed for falling temperature.

If cutback is set to Auto the cutback values are automatically configured to 3 × PB.

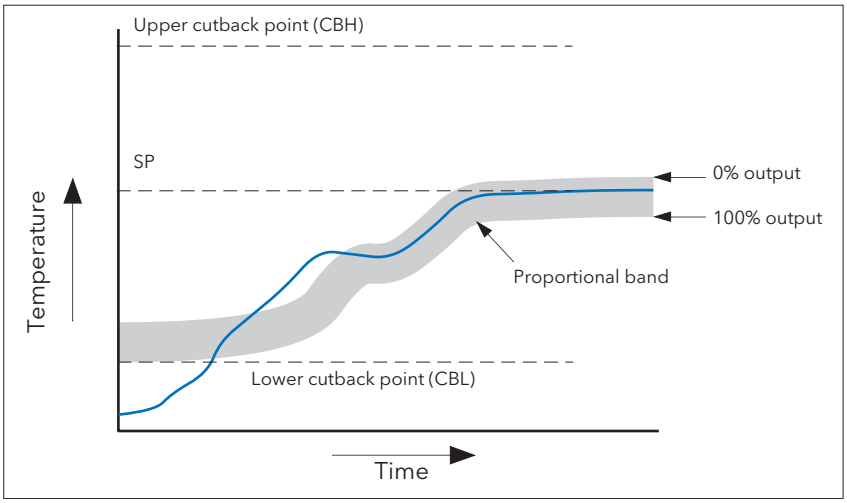


Figure B2.3.2 Cutback operation

Briefly, if PV < CBL then the output is set to its maximum.

If PV > CBH, then the output is set to its minimum

If PV lies within the range CBH-CBL, then PID calculations take control.

B2.3.3 Manual Reset

With PID control, the integral term automatically removes the steady state error from the setpoint. With PD control, the integral term is set to 'OFF', and the measured value will not settle precisely at the setpoint. The Manual Reset parameter (MR in the PID menu) represents the value of the power output that will be delivered when the error is zero. This value must be set manually in order to remove the steady state error.

B2.3 LOOP PARAMETERS (Cont.)

B2.3.4 Integral Hold

If 'Integral Hold' (Main menu) is set to 'Yes', the integral component of the PID calculation is frozen, that is, it holds its current value but does not integrate any disturbances in the plant. This is equivalent to switching into PD control with a manual reset value preconfigured.

Integral Hold may be used, in a situation where the loop is expected to open. For example, it may be necessary to turn heaters off for a short period or to switch into manual at low power. In this case it may be advantageous to wire Integral Hold to a digital input which activates when the heaters are turned off. When the heaters are switched on again, because the integral is at its previous value, overshoot is minimised.

B2.3.5 Integral De-bump

This feature is not accessible to the user. When changing from Manual to Auto control. the integral component is forced to: (out put value – proportional component – derivative component) (I = OP – P – D).

This ensures that no change occurs in output at the point of switch over, ('Bumpless Transfer**').** The output power then gradually changes in accordance with the demand from the PID algorithm.

If manual mode = 'Track', bumpless transfer also occurs when changing from Auto to Manual control. At the point of changeover the output power remains the same as the demand in the auto state. The value can then be altered by the operator. For other modes, the output steps to the 'Forced output' or 'Last MOP' value as appropriate. See 'Manual Mode in the Output menu for further details

B2.3.6 Loop Break

Loop Break attempts to detect loss of restoring action in the control loop by checking the control output, the process value and its rate of change. Since response times vary from process to process, the Loop Break Time (LBT) parameter (PID menu) allows a time to be set before a Loop Break Alarm (Loop Break - Diagnostics menu) becomes active. LBT is set automatically in Autotune.

The Loop Break Alarm parameter has no direct effect on control. In order to define behaviour under Loop Break conditions, the parameter must be wired, for example, to a relay, which can then activate an external indicator.

It is assumed that, so long as the requested output power is within the output power limits of a control loop, the loop is operating in linear control and is therefore not in a loop break condition. If, however, the output becomes saturated then the loop is operating outside its linear control region. If the output remains saturated at the same output power for a significant duration, then this might be symptomatic of a fault in the control loop. The source of the loop break is not important, but the loss of control could be catastrophic.

Since the worst case time constant for a given load is usually known, a worst case time can be calculated over which the load should have responded with a minimum movement in temperature. By performing this calculation the corresponding rate of approach towards setpoint can be used to determine if the loop can no longer control at the chosen setpoint. If the PV was drifting away from the setpoint or approaching the setpoint at a rate less than that calculated, the loop break condition would be met.

If an autotune is performed the loop break time is automatically set to Ti × 2 for a PI or PID loop, or to 12 × Td for a PD loop. For an On/Off controller loop break detection is based on loop range settings as 0.1 × Span where Span = Range High – Range Low. Therefore, if the output is at limit and the PV has not moved by 0.1Span in the loop break time a loop break will occur.

If the loop break time is 0 (off) the loop break time can be set manually. Then, if the output is in saturation and the PV has not moved by >0.5 × Pb in the loop break time, a loop break condition is considered to have occurred.

B2.3.7 Gain Scheduling

In some processes the tuned PID set may be different at low temperatures from that at high temperatures particularly in control systems where the response to the cooling power is significantly different from that of the heating power, or when changes in the process have occurred. Gain scheduling allows a number of PID sets to be stored and provides automatic transfer of control between one set of PID values and another. For this instrument, the maximum number of sets is three which means that two boundaries are provided to select when the next PID set is used. When a boundary is exceeded the next PID set is selected bumplessly. Hysteresis is used to stop scheduling oscillation at the boundaries.

Gain scheduling is basically a look up table which can be selected using different strategies or types. Auto tune tunes to the active scheduled PID set.

The following Gain Scheduled types are offered using the PID menu parameter 'Sched Type':

Set	Required set selected by the user. Alternatively soft wiring may be used to control the PID set selection
Setpoint	Transfer between sets is dependent on the setpoint value
PV	Transfer between sets is dependent on the process value
Error	Transfer between sets is dependent on the Error value
Output	Transfer between sets is dependent on the output demand value
Remote	A remote parameter may be wired into the scheduler. The PID set is then selected according to the value of this input.

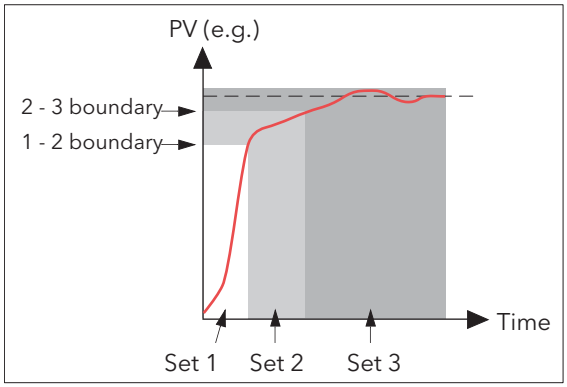


Figure B2.3.7 gain scheduling

B2.4 TUNING

B2.4.1 Introduction

The balancing of the P, I and D terms varies from process to process. In a plastics extruder, for example, there are different responses to a die, casting roll, drive loop, thickness control loop or pressure loop. In order to achieve the best performance from an extrusion line all loop tuning parameters must be set to their optimum values.

Tuning involves setting the following PID menu parameters:

Proportional Band (PB), Integral Time (Ti), Derivative Time (Td), Cutback High (CBH), Cutback Low (CBL), and Relative Cool Gain (R2G - applicable to heat/cool systems only).

The recorder/controller is shipped with these parameters set to default values. In many cases the default values give adequate, stable, straight-line control, but the response of the loop may not be ideal. Because process characteristics vary it is often necessary to adjust the control parameters to achieve best control. To determine the optimum values for any particular loop or process it is necessary to carry out a procedure called loop tuning. If significant changes are later made to the process which affect the way in which it responds it may be necessary to retune the loop.

Users have the choice of tuning the loop automatically or manually. Both procedures require the loop to oscillate and both are described in the following sections.

B2.4.2 Loop Response

Ignoring loop oscillation, there are three categories of loop performance *viz* Under damped, Critically damped and Over damped:

UNDER DAMPED

In this situation the parameters are set to prevent oscillation but lead to an overshoot of the Process Value (PV) followed by decaying oscillation until the PV finally settles at the Setpoint. This type of response can give a minimum time to Setpoint but overshoot may cause problems in certain situations and the loop may be sensitive to sudden changes in PV, resulting in further decaying oscillations before settling once again.

CRITICALLY DAMPED

This represents an ideal situation where noticeable overshoot to small step changes does not occur and the process responds to changes in a controlled, non oscillatory manner.

OVER DAMPED

In this situation the loop responds in a controlled but sluggish manner which results in a non-ideal and unnecessarily slow loop performance.

B2.4.3 Initial Settings

In addition to the tuning parameters listed above, there are a number of other parameters which can affect loop response. These parameters must be correctly configured before tuning is initiated. Parameters include, but are not limited to:-

SETPOINT

Before tuning, the loop conditions should be set as closely as practicable to the actual conditions which will be met in normal operation. For example, in a furnace or oven application a representative load should be included, an extruder should be running, etc.

OUTPUT HIGH, OUTPUT LOW

These Output menu heat and cool limits define the overall maximum and minimum power which may be delivered to the process by the control loop. For a heat only controller the default values are 0 and 100%. For a heat/cool controller the defaults are -100 and 100%. Although most processes are designed to work between these limits there may be instances where it is desirable to limit the power delivered to the process.

REM. OUTPUT LOW, REM. OUTPUT HIGH

If these Remote Output Limits parameters (Output menu) are used, they are effective only if they lie within the Heat/Cool Limits above.

CH2 DEADBAND

Heat/Cool Dead band If a second (cool) channel is configured, a parameter 'Ch2 Deadband' is also available in the Output menu which sets the distance between the heat and cool proportional bands. The default value is 0% which means that heating will cease to be available at the same time as cooling becomes available. The dead band may be set to ensure that there is no possibility of the heat and cool channels operating together, particularly when cycling output stages are installed.

MINIMUM ON TIME

If either or both of the output channels is fitted with a relay or logic output, the parameter 'Min On Time' appears in the output menu. This is the cycling time for a time proportioning output and should be set correctly before tuning is started.

FILTER

The 'Filter' parameter is found in the Channel 'Main' menu (section 4.4). It is used to remove noise from slowly changing signals so that the underlying trend can be seen more clearly.

B2.4.3 INITIAL SETTINGS (Cont.)

RATE

Sets the maximum PID rate-of-change. The output rate limit is active during tuning and can affect the tuning results. Rate is useful in preventing rapid changes in output from damaging the process or heater elements. The parameter 'Rate' is found in the 'Setpoint' menu.

CH1 TRAVEL TIME, CH2 TRAVEL TIME

Valve Travel Time. If the output is a motor valve positioner the 'Ch1 Travel Time' and Ch2 Travel Time' Output menu parameters must be set correctly. The valve travel time is the time taken for the valve to travel from 0% (closed) to 100% (open). This may be different from the motor travel time limits because the mechanical linkage between the motor and the valve, setting of limit switches etc. can modify behaviour. In a valve positioner application, the channel output is wired to the 'PV' input of relay 2A2B or 4AC. Configuring this relay as Type = Valve Raise causes the associated relay (3A3C or 5AC respectively) to be configured automatically as Type = Valve Lower, and the action of the relay pair is controlled by the single wire. In a heat/cool application, channel one is the heat valve and channel two is the cool valve.

B2.4.4 Other tuning considerations

If a process includes adjacent interactive zones, each zone should be tuned independently with the adjacent zones at operating temperature.

It is recommended that a tuning process be initiated when the PV and setpoint are far apart. This allows start up conditions to be measured and cutback values to be calculated more accurately. Cutback is not set for 'Tune at setpoint'.

In a programmer/controller tuning should only be attempted during dwell periods and not during ramp stages. If a programmer/controller is tuned automatically the controller should be placed in 'Hold' during each dwell period whilst autotune is active.

> Note: Tuning, carried out in dwell periods which are at different extremes of temperature may give different results owing to non linearity of heating (or cooling). This may provide a convenient way to establish values for Gain Scheduling.

If an auto tune is initiated there are two further parameters (High Output' and 'Low Output') which need to be set. These are found in the 'Tune' menu.

High Output	Sets a high output limit to be imposed during autotune. Must be ≤ Output High, set in the Output menu.
Low Output	Sets a low output limit to be imposed during autotune. Must be ≥ Output Low, set in the Output menu.

The above values must be set correctly, otherwise sufficient power to achieve SP might not be available during tuning, and the tune will eventually fail.

B2.4.5 Autotune

Autotune automatically sets the following PID menu parameters:

PB	Proportional band.
Ti	Integral time. If previously set to 'Off' Ti will remain off after an autotune.
Td	Derivative time. If previously set to 'Off' Td will remain off after an autotune.
CBH, CBL	Cutback high and low values. If either is set to 'Auto', it will remain so after auto tuning. In order that Autotune set the cutback values for the user, a value other than 'Auto' must be selected before Autotune is initiated. Autotune never returns cutback values less than 1.6 × PB
R2G	Calculated only if the unit is configured as Heat/Cool. Following an Autotune, R2G lies between 0.1 and 10. If the calculated value lies outside this range, a 'Tune Fail' alarm is set.
LBT	Loop break time. Following an autotune, LBT is set to 2 × Ti (if Ti was not previously set 'Off'), or to 12 × Td (if Ti was previously set to 'Off').

B2.4.5 AUTOTUNE (Cont.)

Autotune can be performed at any time, but normally it is performed only once, during the initial commissioning of the process. However, if the process under control subsequently becomes unsatisfactory (because its characteristics have changed), it may be necessary to tune again for the new conditions.

The auto tune algorithm reacts in different ways depending on the initial conditions of the plant. The explanations given later in this section are for the following example conditions:-

1. Initial PV is below the setpoint and, therefore, approaches the setpoint from below for a heat/cool control loop
2. As above, but for a heat only control loop
3. Initial PV is at the same value as the setpoint (tune at setpoint). That is, within 0.3% of the range of the controller if 'PB Units' (Setup menu) is set to 'Percent', or ±1 engineering unit (1 in 1000) if the 'PB Units' is set to 'Eng'. Range is defined as 'Range High' – 'Range Low' for process inputs or the thermocouple or RTD range defined in section A3 for temperature inputs. If the PV is just outside the range stated above the autotune will attempt a tune from above or below SP.

AUTOTUNE AND SENSOR BREAK

When the controller is autotuning and sensor break occurs, the autotune aborts and the controller outputs the sensor break output power 'Sbrk OP' set up in the Output menu. Autotune must be re-started when the sensor break condition is no longer present.

AUTOTUNE AND INHIBIT

If the controller is in autotune when 'Inhibit' is asserted, the tune goes to the Off state (Stage = Reset). On inhibit being released the controller will re-start autotune.

AUTOTUNE AND GAIN SCHEDULING

When gain scheduling is enabled and an autotune is performed, the calculated PID values are written into the PID set that is active, on completion of the tune. Therefore, the user may tune within the boundaries of a set and the values will be written into the appropriate PID set. However, if the boundaries are close (because the range of the loop is not large), then, at the completion of the tune, it cannot be guaranteed that the PID values will be written to the correct set particularly if the schedule type is PV or OP. In this situation the scheduler ('Sched Type') should be switched to 'Set' and the 'active set' chosen manually.

INITIAL CONDITIONS

Configure the parameters described in sections B2.4.3 and B2.4.4, above.

Notes:

1. The 'tighter' power limit applies. For example, if 'High Output' is set to 80% and 'Output High' is set to 70% then the output power will be limited to 70%
2. The PV must oscillate to some degree to allow the tuner to calculate the relevant values. The limits must be set so as to allow oscillation about the setpoint.

INITIATING THE AUTOTUNE

In the Loop Tune menu for the relevant loop, set 'TuneEn' to 'On'.

B2.4.5 AUTOTUNE (Cont.)

EXAMPLE 1: AUTOTUNE FROM BELOW SP (HEAT/COOL)

The point at which Automatic tuning is performed (Tune Control Point) lies just below the setpoint at which the process is normally expected to operate (Target Setpoint). This ensures that the process is not significantly overheated or overcooled. The Tune Control Point is calculated as follows:-

Tune Control Point = Initial PV + 0.75(Target Setpoint – Initial PV).

The Initial PV is the PV measured after a 1 minute settling period (point 'B' in the figure below).

Examples:

If Target Setpoint = 500°C and Initial PV = 20°C, then the Tune Control Point is 380°C.

If Target Setpoint = 500°C and Initial PV = 400°C, then the Tune Control Point is 475°C.

This is because the overshoot is likely to be less as the process temperature approaches the target setpoint.

Figure B2.4.5a shows the auto tune sequence.

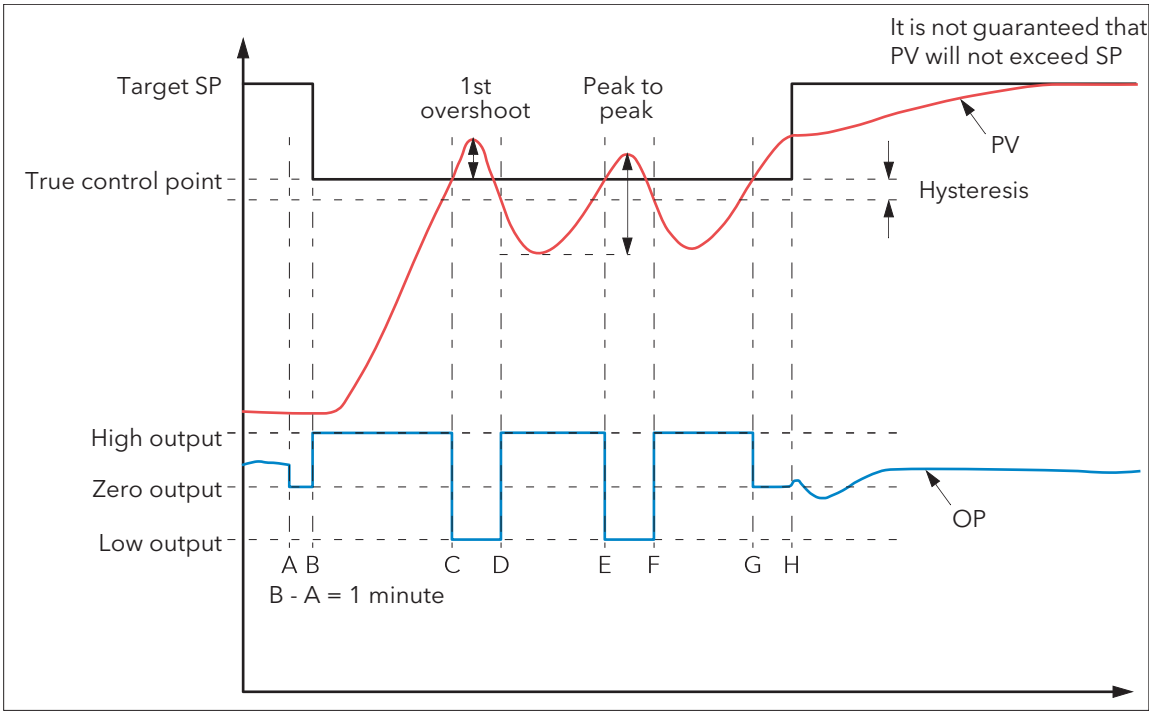


Figure B2.4.5a Autotune heat/cool process

KEY

A	Start of Autotune
A to B	Heating and Cooling off for one minute allows steady state conditions to be established.
B to D	First heat/cool cycle to establish first overshoot. Cutback low (CBL) value calculated from the overshoot magnitude (unless CBL set to 'Auto').
B to F	Two cycles of oscillation allow peak-to-peak value and oscillation period to be determined. PID terms are calculated.
F	Heating is switched on.
G	Heating (and cooling) are switched off allowing the plant to respond naturally. Measurements over the period F to G are used to calculate the Relative Cool Gain (R2G). Cutback High is calculated from the equation (CBH = CBL × R2G).
H	Autotune is turned off and the process is allowed to control at the target setpoint using the new control terms.

Note: Controlling from above SP is identical except that heating and cooling are reversed.

B2.4.5 AUTOTUNE (Cont.)

EXAMPLE 2: AUTOTUNE FROM BELOW SP (HEAT ONLY)

The sequence of operation for a heat only loop is the same as that described above for a heat/cool loop, except that the sequence ends at 'F' since there is no need to calculate 'R2G' (R2G is set to 1.0 for heat only processes). At 'F' autotune is turned off and the process is allowed to control using the new control terms.

For a tune from below setpoint 'CBL' is calculated on the basis of the size of the overshoot (assuming it was not set to Auto in the initial conditions). CBH is then set to the same value as CBL.

Note: Autotune can also occur when the initial PV is above SP. The sequence is the same as tuning from below setpoint except that the sequence starts with natural cooling applied at 'B' after the first one minute settling time. In this case CBH is calculated and CBL is then set to the same value as CBH.

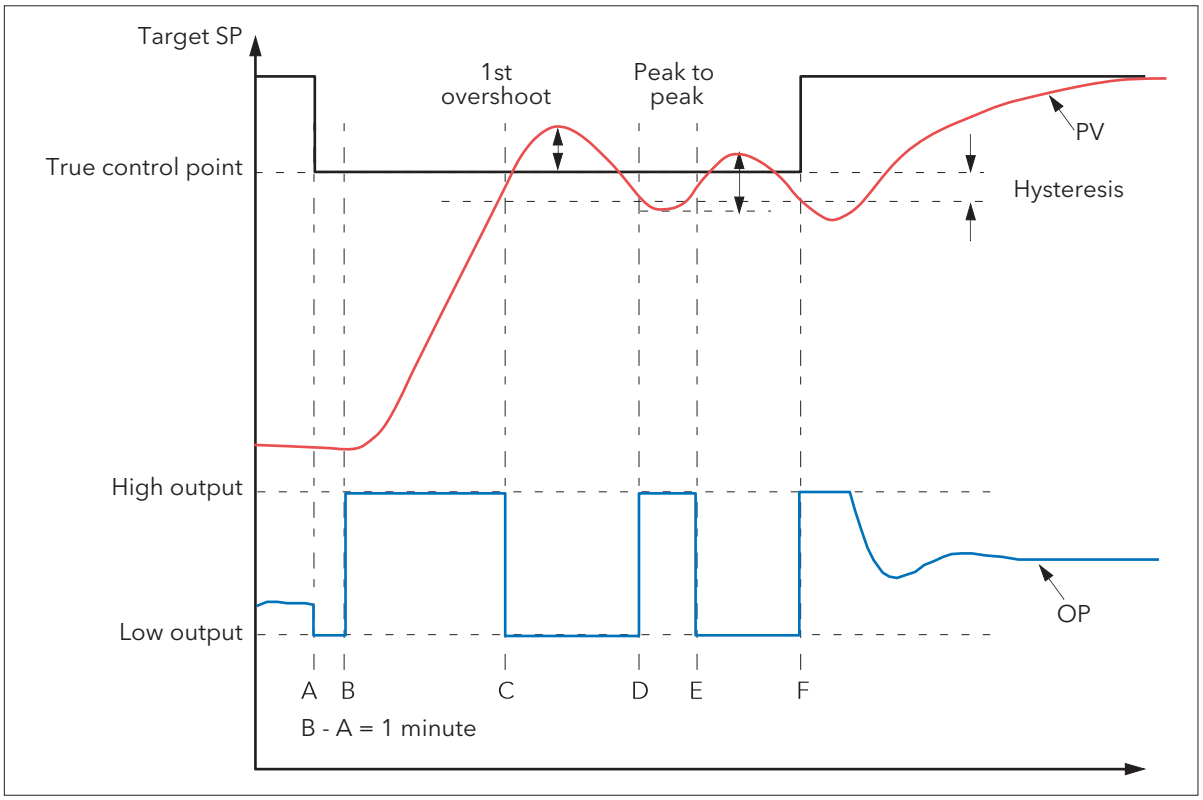


Figure B2.4.5b Autotune heat only process (from below SP)

A	Start of Autotune
A to B	Heating off for one minute to allow steady state conditions to be established.
B to D	First heat cycle to establish first overshoot. Cutback low (CBL) value calculated from the overshoot magnitude (unless CBL set to 'Auto').
D to F	Calculate PID terms.
F	Autotune is turned off and the process is allowed to control at the target setpoint using the new control terms.

B2.4.5 AUTOTUNE (Cont.)

EXAMPLE 3: AUTOTUNE AT SP (HEAT /COOL)

It is sometimes necessary to tune at the actual setpoint being used as shown below.

For a tune at setpoint, autotune does not calculate cutback since there was no initial start up response to the application of heating or cooling. Cutback values of less than 1.6 × PB will not be returned.

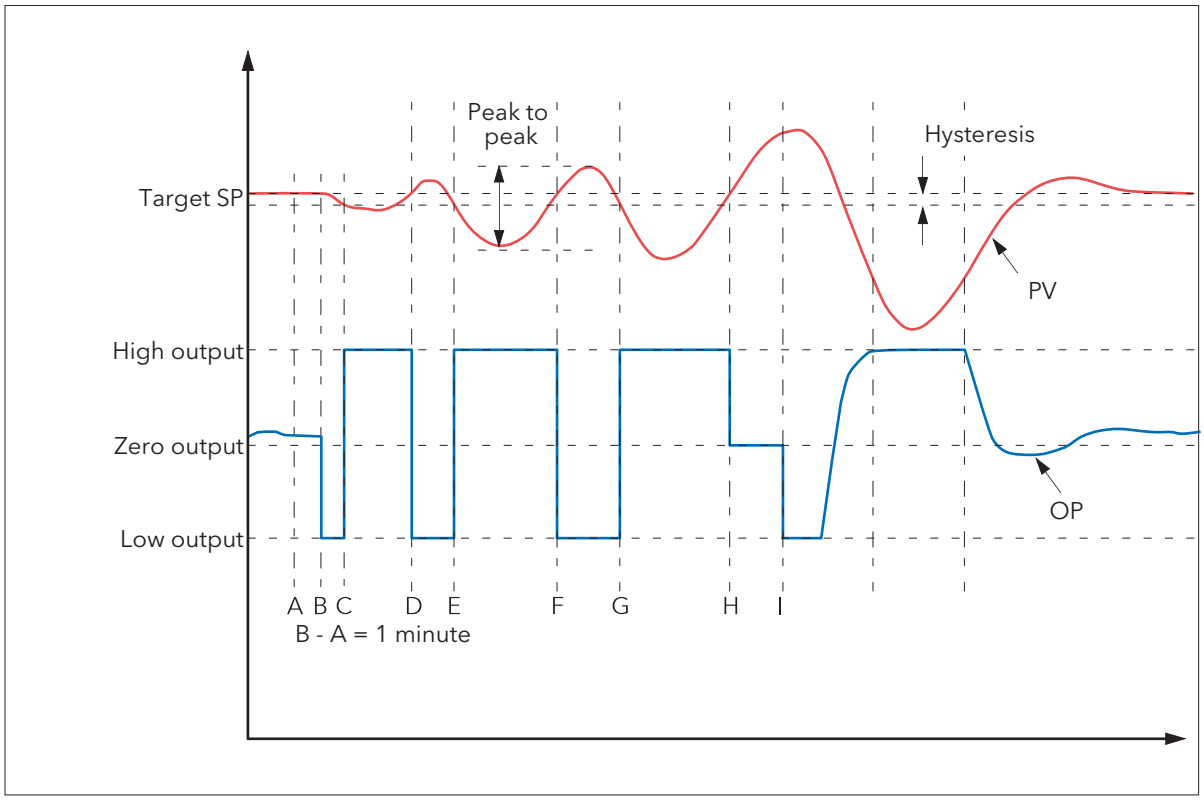


Figure B2.4.5c Autotune at setpoint

A	Start of Autotune. A test is done at the start of autotune to establish conditions for a tune at setpoint. Conditions are that SP must remain within 0.3% of the range of the controller if 'PB Units' (Setup menu) is set to 'Percent', or ±1 engineering unit (1 in 1000) if the 'PB Units' is set to 'Eng'. Range is defined as 'Range High' – 'Range Low' for process inputs or the thermocouple or RTD range defined in section A3 for temperature inputs.
A to B	The output is frozen at he current value for one minute, and the conditions are continuously monitored during this period. If the conditions specified above are met, then an autotune at setpoint is initiated at 'B'. If PV drifts outside the condition limits at any time during this period, tuning at SP is abandoned, and tuning resumes as a 'tune from above' or 'tune from below', depending on the direction of drift. Since the loop is already at setpoint, a Tune Control setpoint is not calculated; the loop is forced to oscillate about the Target SP.
C to G	The process is forced to oscillate by switching the output between the output limits. The oscillation period and the peak-to-peak response are determined, and the PID terms calculated.
G to H	An extra heating stage is initiated, then all heating and cooling are switched off at H, allowing the plant to respond naturally. The relative cool gain (R2G) is calculated.
I	Autotune is switched off and the process is allowed to control at the target setpoint using the newly calculated terms.

B2.4.5 AUTOTUNE (Cont.)

AT.R2G

Some load types and process conditions can cause autotune to set an incorrect value for R2G resulting in an instability in the system after an autotune has completed, In such circumstances, the value of R2G should be checked, and if it is low (approaching 0.1) a manual entry should be made as follows:

1. In the Tune menu, set the AT.R2G parameter to 'No'.
2. In the PID menu, enter the new R2G value (calculated as described below)
3. In the Tune menu, enter a value for Low Output, calculated from: Low Output = -High Output x R2G
4. In the Tune menu, set 'TuneEn' On.

R2G CALCULATION

1. In the Main menu, set the controller to Manual mode
2. Turn heating on (limited by the value of 'Output High' in the Output menu) and measure the heating rate ('H' °C/minute).
3. Allow the process to heat to, say, 10% above the setpoint value then turn the heating off and allow the temperature to settle.
4. Turn cooling power on (limited by the value of 'Output Low' in the Output menu) and measure the cooling rate ('C' °C/minute) whilst allowing the temperature to fall below the setpoint value.
5. Calculate the value of R2G from the equation R2G = (H/C) x (Output Low/output High)

Example:

For a measured heating rate (H) of 10°C per min and a measured cooling rate (C) of 25° per minute and with, Output High = 80% and Output Low = 40%, then R2G = (10/25) x (40/80) = 0.4 x 0.5 = 0.2.

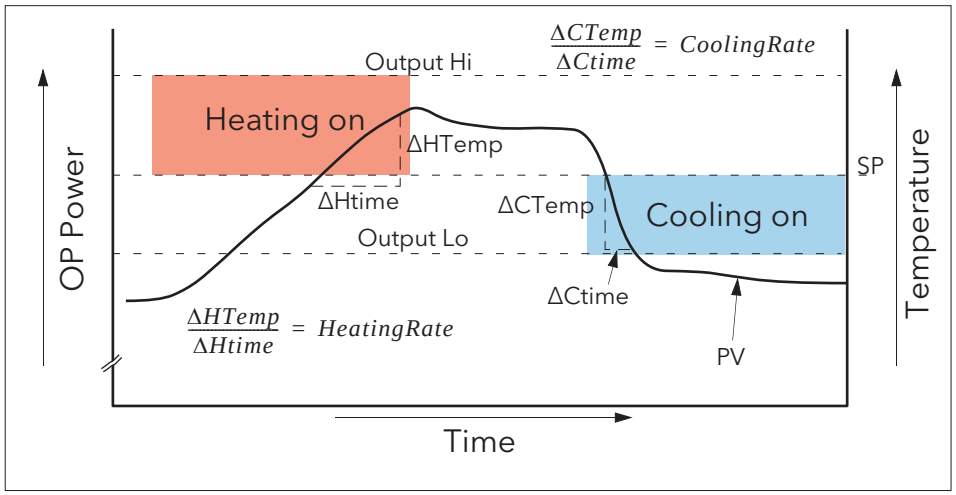


Figure 2.4.5d R2G calculation

Note: This is not a very accurate method as it does not take natural cooling into account. Its main advantage is that it is simple to achieve.

B2.4.5 AUTOTUNE (Cont.)

FAILURE MODES

The conditions for performing an autotune are monitored by the Tune menu parameter 'State'. If autotune is not successful error conditions are read by this parameter as follows:

Timeout	Set if any one stage is not completed within an hour. Possible causes are the loop being open circuit, or not responding to the controller demands. Some heavily lagged systems may produce a timeout if the cooling rate is very slow.
TI Limit	This is set if Autotune calculates a value for the integral term which is greater than the maximum allowable (99999 seconds). This indicates that the loop is not responding or that the tune is taking too long.
R2G Limit	Error occurs if the calculate value of R2G is outside the range 0.1 to 10.0. R2G limit can occur if the gain difference between heating and cooling is too large, or if the controller is configured for heat/cool, but the heating and/or cooling device is turned off or not working correctly.

B2.4.6 Manual tuning

If, for any reason, automatic tuning gives unsatisfactory results the controller can be tuned manually. There are a number of standard methods for manual tuning, the Zeigler-Nichols method being described here:

1. Adjust the setpoint to its normal running conditions (assumed to be above the PV so that 'heat only' is applied.
2. Set the integral and derivative times (Ti and Td) to 'Off'
3. Set High and Low cutback (CBH and CBL) to 'Auto'.
4. If the PV is stable (not necessarily at the setpoint), reduce the proportional band (PB) such that the PV just starts to oscillate, leaving time between adjustments to allow the loop to stabilise. Make a note of the PB at this point (PB′), and also note the oscillation period ('T').
   If the PV is already oscillating measure the oscillation period ('T') and then gradually increase PB to the point at which oscillation just ceases. Make a note of the PB (PB′) at this point.
5. If the controller is fitted with a cooling channel, enable this now.
6. Observe the oscillation waveform and adjust 'R2G' until a symmetrical wave form is observed (Figure B2.4.6).
7. Set PB, Ti and Td according to table B2.4.6.

Control type	PB	Ti	Td
Proportional only	2 × PB′	Off	Off
P + I	2.2 × PB′	0.8 × T	Off
P + I + D	1.7 × PB′	0.5 × T	0.12 × T

Table B2.4.6 Calculate parameter values

B2.4.6 MANUAL TUNING (Cont.)

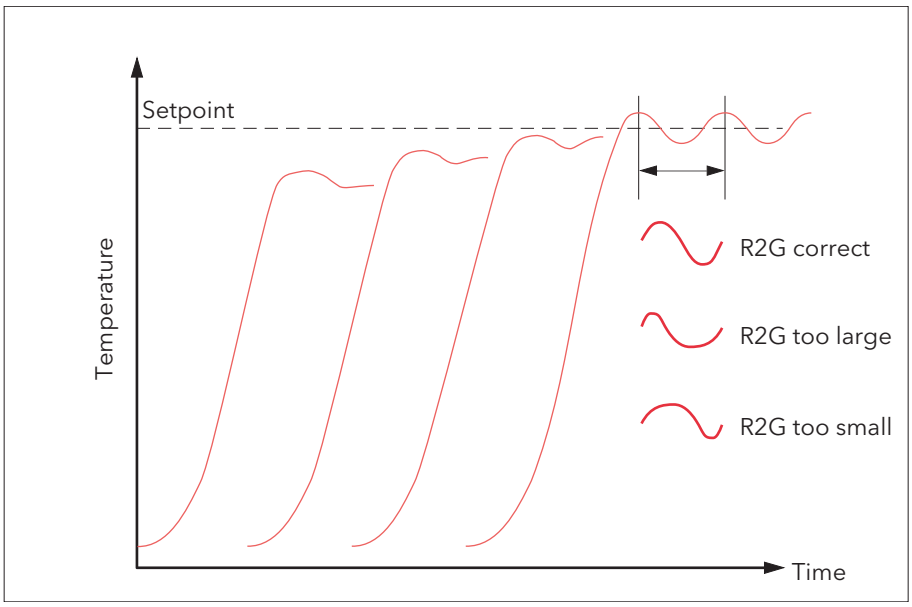


Figure 2.4.6a Relative Cool Gain

CUTBACK VALUES

The PID terms calculated from Table 2.4.6, above, should be entered before the cutback values are set.

The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in PV, then the cutback parameters should be set manually, as follows:

1. Initially set the cutback values to one proportional bandwidth converted into display units. This can be calculated by taking the value in percent that has been installed into the parameter 'PB' and entering it into the following formula:

   PB/100 × Span of controller = Cutback High and Cutback Low
   For example, if PB = 10% and the span of the controller is 0 to 1200°C, then
   Cutback High = Cutback Low = 10/100 × 1200 = 120

2. If overshoot is observed following the correct settings of the PID terms increase the value of 'CBL' by the value of the overshoot in display units. If undershoot is observed increase the value of the parameter 'CBH' by the value of the undershoot in display units.

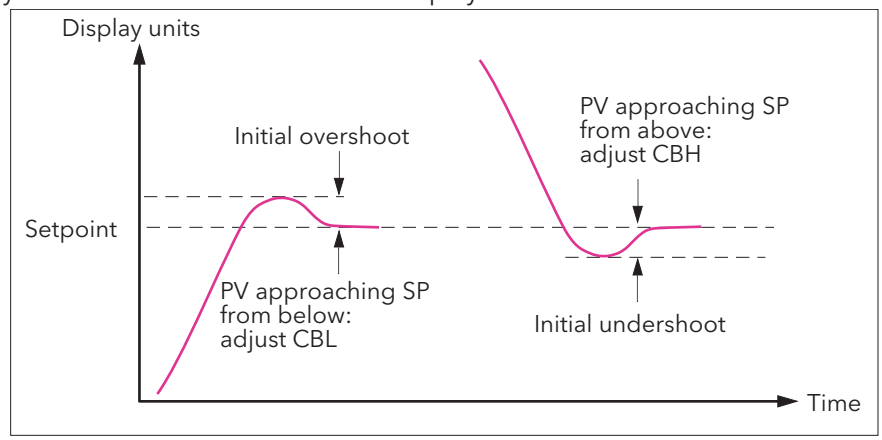


Figure 2.4.6b Manual Cutback setting

B2.5 SETPOINT

The controller setpoint is the Working Setpoint which can be derived from:-

1. SP1 or SP2, both of which are manually set by the user and can be switched into use by an external signal or via the user interface.
2. From an external (remote) analogue source
3. The output of a programmer function block.

B2.5.1 Setpoint function block

As well as providing a setpoint, the function block also provides:

1. The ability to limit the rate of change of the setpoint before it is applied to the control algorithm.
2. Upper and lower limits. These are defined as setpoint limits, 'SP High Limit' and 'SP Low Limit', for the local setpoints and instrument range high and low for other setpoint sources.

> Note: All setpoints are limited by 'Range High' and 'Range Low' so that if 'SP High Limit', for example, is set higher than 'Range High', then 'SP High Limit' is ignored and the setpoint is limited at the 'Range High' value.

User configurable methods for tracking are available, such that the transfers between setpoints and between operating modes do not cause 'bumps' in the setpoint.

Figure B2.5.1, below, shows the function block schematic.

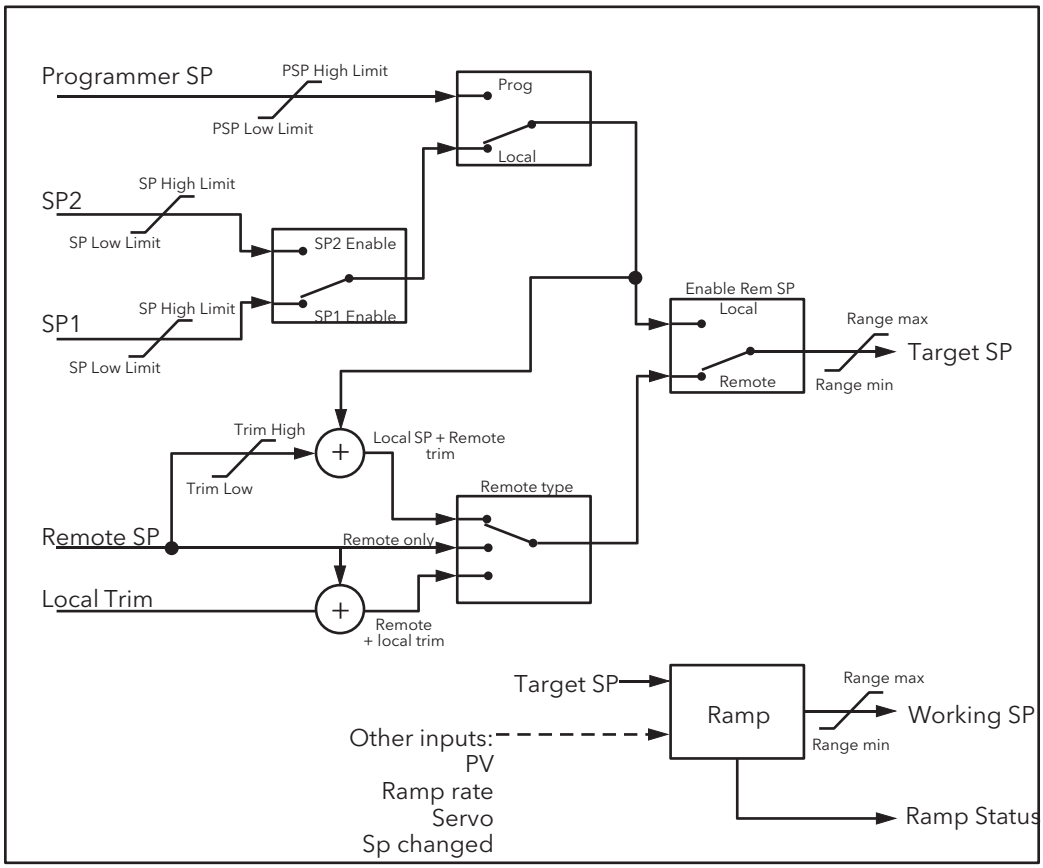


Figure 2.5.1 Setpoint Function block

B2.5.2 Setpoint Limits

The setpoint generator provides limits for each of the setpoint sources as well as an overall set of limits for the loop. These are summarised in figure 2.5.2, below.

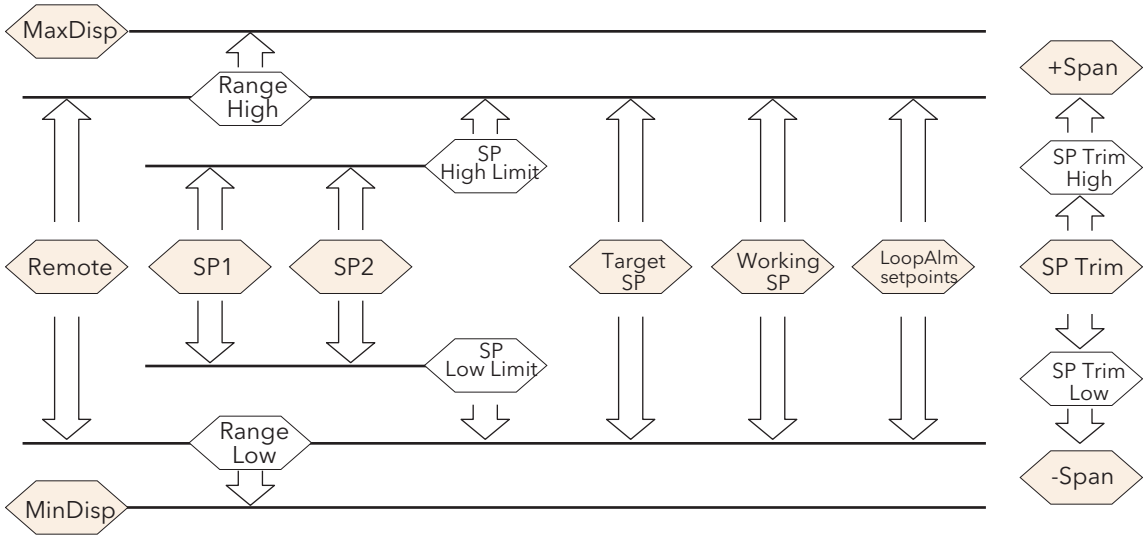


Figure 2.5.2 Setpoint Limits

'Range High' and 'Range Low' provide the range information for the control loop. They are used in control calculations to generate proportional bands. Span = Range High – Range Low.

B2.5.3 Setpoint Rate Limit

This symmetrical rate limiter allows the rate of change of setpoint to be controlled, preventing step changes in the setpoint. The limit is applied to the working setpoint which includes setpoint trim.

Rate limiting is enabled using the 'Rate' parameter. If this is set to '0' then any change made to the setpoint will be effective immediately. If it is set to any other value, then a change in the setpoint will be have rate limiting applied at the value set, in units per minute. Rate limit applies to SP1, SP2 and Remote SP.

When rate limit is active 'Rate Done' displays 'No'. When the setpoint has been reached the value changes to 'Yes'.

When 'Rate' is set to a value (other than 'Off') an additional parameter 'SP Rate Disable' is displayed which allows the setpoint rate limit to be turned off and on without the need to adjust the 'Rate' parameter between Off and a working value.

If the PV is in sensor break, the rate limit is suspended and the working setpoint takes the value of 0. On sensor break being released the working setpoint goes from 0 to the selected setpoint value at the rate limit.

B2.5.4 Setpoint Tracking

The setpoint used by the controller may be derived from a number of sources. For example:-

1. Local setpoints SP1 and SP2. These may be selected through the front panel using the parameter 'SP Select', through digital communications or by configuring a digital input which selects either SP1 or SP2. This might be used, for example, to switch between normal running conditions and standby conditions. If Rate Limit is switched off the new setpoint value is adopted immediately when the switch is changed.
2. A programmer generating a setpoint which varies over time. When the programmer is running, the 'Track SP' and 'Track PV' parameters update continuously so that the programmer can perform its own servo. This is sometimes referred to as 'Program Tracking'.
3. From a Remote analogue source. The source could be an external analogue input into an analogue input module wired to the 'Alt SP' parameter or a User Value wired to the 'Alt SP' parameter. The remote setpoint is used when the parameter 'Alt SP Enable' is set to 'Yes'.

Setpoint tracking (sometimes referred to as Remote Tracking) ensures that the Local setpoint adopts the Remote setpoint value when switching from Local to Remote to maintain bumpless transfer from Remote to Local. Bumpless transfer does not take place when changing from Local to Remote.

Note: If Rate Limit is applied, the setpoint will change at the set rate, when changing from Local to Remote.

B2.5.5 Manual Tracking

When the controller is operating in manual mode the currently selected SP (SP1 or SP2) tracks the PV. When the controller resumes automatic control there will be no step change in the resolved SP. Manual tracking does not apply to the remote setpoint or programmer setpoint.

B2.6 OUTPUT

B2.6.1 Introduction

The output function block selects the correct output sources to be used, determines whether to heat or cool and then applies limits. Power feed forward and non-linear cooling are also applied.

It is this block that manages the output in exception conditions such as start up and sensor break.

The outputs, 'Ch1 Output' and 'Ch2 Output', are normally wired to a digital I/O where they are converted into analogue or time proportioned signals for electrical heating, cooling or valve movement.

B2.6.2 Output Limits

Figure B2.6.2 shows where output limits are applied.

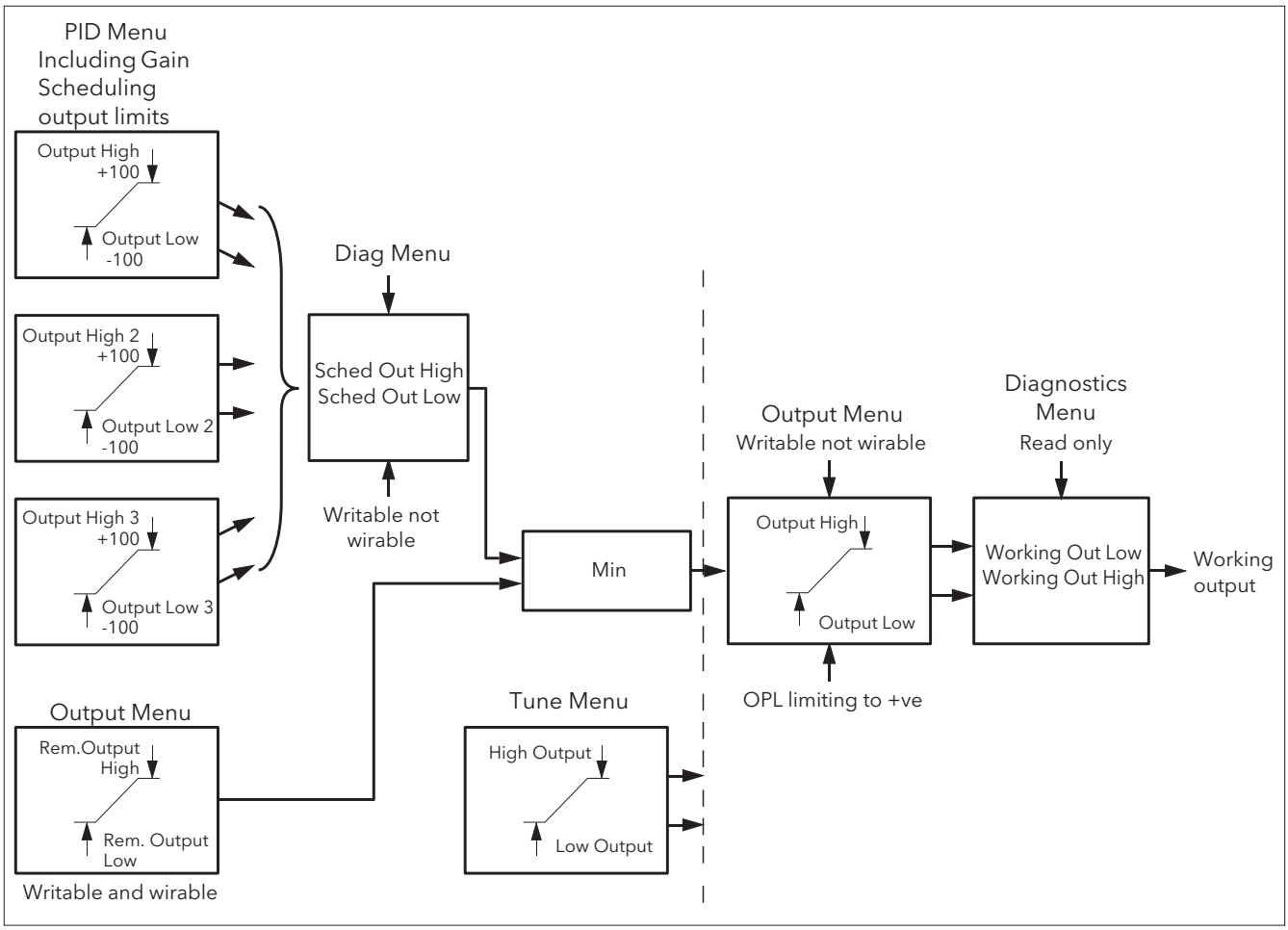


Figure B2.6.2 Output Limits

Notes:

1. Individual output limits may be set in the PID list for each set of PID parameters when gain scheduling is in use.
2. Limits may also be applied from an external source. These are 'Rem.Output High' and 'Rem. Output Low' found in the Output menu. These parameters are wireable; for example they may be wired to an analogue input module so that a limit may applied through some external strategy. If these parameters are not wired ±100% limit is applied every time the instrument is powered up.

(Continued)

B2.6.2 OUTPUT LIMITS (Cont.)

Notes (Continued)

3. The tightest limits (between Remote and PID) are connected to the output where an overall limit is applied using parameters 'Output High' and 'Output Low'.
4. 'Working Out High' and 'Working Out low' found in the Diagnostics list are read only parameters showing the overall working output limits.
5. The tune limits are a separate part of the algorithm and are applied to the output during the tuning process. The overall limits 'Output Hi' and 'Output Lo' always have priority.

B2.6.3 Output Rate Limit

The output rate limiter is a rate-of-change limiter, set in (%/sec) which prevents step changes in output power being demanded. Rate limiting is performed by determining the direction in which the output is changing, and then incrementing or decrementing the Working Output (Main menu) until it equals the required output (Target OP).

The amount to increment or decrement is calculated using the sampling rate of the algorithm (125ms) and the selected rate limit. If the change in output is less than the rate limit increment the change takes effect immediately.

The rate limit direction and increment is calculated on every execution of the rate limit. Therefore, if the rate limit is changed during execution, the new rate of change takes immediate effect. If the output is changed whilst rate limiting is taking place, the new value takes immediate effect on the direction of the rate limit and in determining whether the rate limit has completed.

The rate limiter is self-correcting such that if the increment is small it is accumulated until it takes effect.

The output rate limit is active when the loop is in both auto and manual modes, and during autotune.

B2.6.4 Sensor Break Mode

If a Sensor break is detected by the measurement system the loop reacts in one of two ways, according to the configuration of 'Sbrk Mode' ('Safe' or 'Hold'). On exit from sensor break the transfer is bumpless – the power output starts controlling again from the current operating setpoint and moves, under PID closed-loop control, from its pre-set value to the control value.

SAFE

If set to 'Safe', the output adopts a pre-set level (Sbrk OP). If rate limit is not configured, the output steps to the Sbrk OP value, otherwise it ramps to this value at the rate limit.

HOLD

If set to 'Hold' the output remains at its current value. If Output Rate Limit (Rate) has been configured a small step may be seen as the working output will limit to the value existing two iterations ago.

B2.6.5 Forced Output

This feature enables the user to specify what the output of the loop should do when moving from automatic control to manual control. The default is that the output power is maintained but it is then adjustable by the user.

If Manual Mode is set to 'Step', the user can set a manual output power value and on transition to manual the output will be forced to that value.

If Manual Mode is set to 'Track' the output steps to the forced manual output and then subsequent edits to the output power are tracked back into the manual output value.

If Manual Mode is set to 'Last Man. Out' then when moving from automatic to manual mode, the output adopts the last manual output value.

B2.6.6 Power Feed Forward

Power feed forward is used when driving an electrical heating element. It monitors the line voltage and compensates for fluctuations before they affect the process temperature. The use of this will give better steady state performance when the line voltage is not stable.

It is mainly used for digital type outputs which drive contactors or solid state relays. Because it only has value in this type of application it can be switched off using the parameter 'Pff En'. It should also be disabled for any non-electric heating process. It is not necessary when Eurotherm analogue thyristor control is used since compensation for power changes is included in the thyristor driver.

Consider a process running at 25% power, with zero error and then the line voltage falls by 20%. The heater power would drop by 36% because of the square law dependence of power on voltage. A drop in temperature would result. After a time, the thermocouple and controller would sense this fall and increase the ON-TIME of the contactor just enough to bring the temperature back to set point. Meanwhile the process would be running a bit cooler than optimum which may cause some imperfection in the product.

With power feed forward enabled the line voltage is monitored continuously and ON-TIME increased or decreased to compensate immediately. In this way the process need never suffer a temperature disturbance caused by a line voltage change.

'Power Feed forward' should not be confused with 'Feed forward' which is described in section B2.6.8.

B2.6.7 Cool Type

Cooling methods vary from application to application. For example, an extruder barrel may be cooled by forced air (from a fan), or by circulating water or oil around a jacket. The cooling effect will be different depending on the method. 'Cool Type' (appears only if the 'setup' parameter 'Ch2 Control' is set to 'PID') is used to accommodate different types of cooling methods as follows:

LINEAR

The cooling algorithm may be set to linear where the controller output changes linearly with the PID demand signal.

OIL COOLING

'Cool Type' = 'Oil'. As oil is, to all intents and purposes, non-evaporative, oil cooling is pulsed in a linear manner.

WATER COOLING

If the area being cooled is running well above 100°C, then the first few pulses of water flash into steam giving greatly increased cooling due to the latent heat of evaporation. When the area cools, less (or even no) evaporation takes place and the cooling is less effective.

Setting 'Cool Type' to 'Water' delivers much shortened pulses of water for the first few percent of the cooling range, when the water is likely to be flashing into steam. This compensates for the transition out of the initial strong evaporative cooling.

FAN COOLING

'Cool Type = 'Fan'. Fan cooling is much gentler than water cooling and not so immediate or decisive (because of the long heat transfer path through the process mechanics). With fan cooling, a cool gain setting of three upwards is typical. Delivery of pulses to the blower is non linear, this non-linearity being caused by a combination of forced air movement and fan efficiency as a function of air velocity (e. g. the efficiency of a fan when producing a low speed (laminar) air flow is different from its efficiency when producing a high-speed, turbulent flow.

B2.6.8 Feed forward

Feed forward is a method of adding an extra scalable component to the PID output, before any limiting. It can be used, for example, in the implementation of cascade loops and constant head control or it can be used to pre-load the control signal with a value close to that which is required to achieve the setpoint, thus improving system response. Feed forward (FF) is applied such that the PID output is limited by trim limits and acts as a trim on a FF value. The FF value is derived either from the PV or setpoint by scaling the PV or SP by the 'FF Gain' and 'FF Offset'. Alternatively, a remote value may be used for the FF value, but this is not subject to any scaling. The resultant FF value is added to the limited PID OP and becomes the PID output as far as the output algorithm is concerned. The feedback value then generated must then have the FF contribution removed before being used again by the PID algorithm. The diagram below shows how feed forward is implemented.

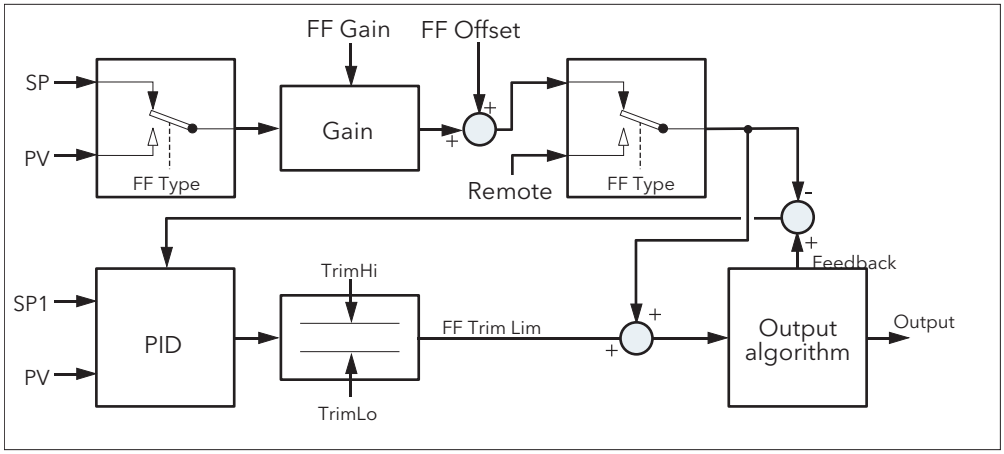


Figure B2.6.8 Implementation of Feed forward

B2.6.9 Effect of Control Action, Hysteresis and Deadband

CONTROL ACTION

For temperature control 'Control Act' should be set to 'Rev'. For a PID controller this means that the heater power decreases as the PV increases. For an on/off controller, output 1 (usually heat) will be on (100%) when PV is below the setpoint and output 2 (usually cool) will be on when PV is above the setpoint.

HYSTERESIS

Hysteresis applies to on/off control only and is set in the units of the PV. In heating applications the output will turn off when the PV is at setpoint. It will turn on again when the PV falls below SP by the hysteresis value. This shown in Figures B2.6.9a and B2.6.9b below for a heat and cool controller.

Hysteresis is intended to prevent the output from repeated switching on and off 'chattering' at the control setpoint. If the hysteresis is set to 0 then even the smallest change in the PV when at setpoint will cause the output to switch. Hysteresis should be set to a value which provides an acceptable life for the output contacts, but which does not cause unacceptable oscillations in the PV.

If this performance is unacceptable, it is recommended that PID control be used instead.

DEADBAND

Deadband 'Ch2 Deadband' can operate on both on/off control or PID control where it has the effect of extending the period when no heating or cooling is applied. In PID control the effect is modified by both the integral and derivative terms. Deadband might be used in PID control, for example, where actuators take time to complete their cycle thus ensuring that heating and cooling are not being applied at the same time. Deadband is likely to be used, therefore, in on/off control only. Figure B2.6.9b, below, adds a deadband of 20 to the first example in figure B2.6.9a.

B2.6.9 EFFECT OF CONTROL ACTION, HYSTERESIS AND DEADBAND (Cont.)

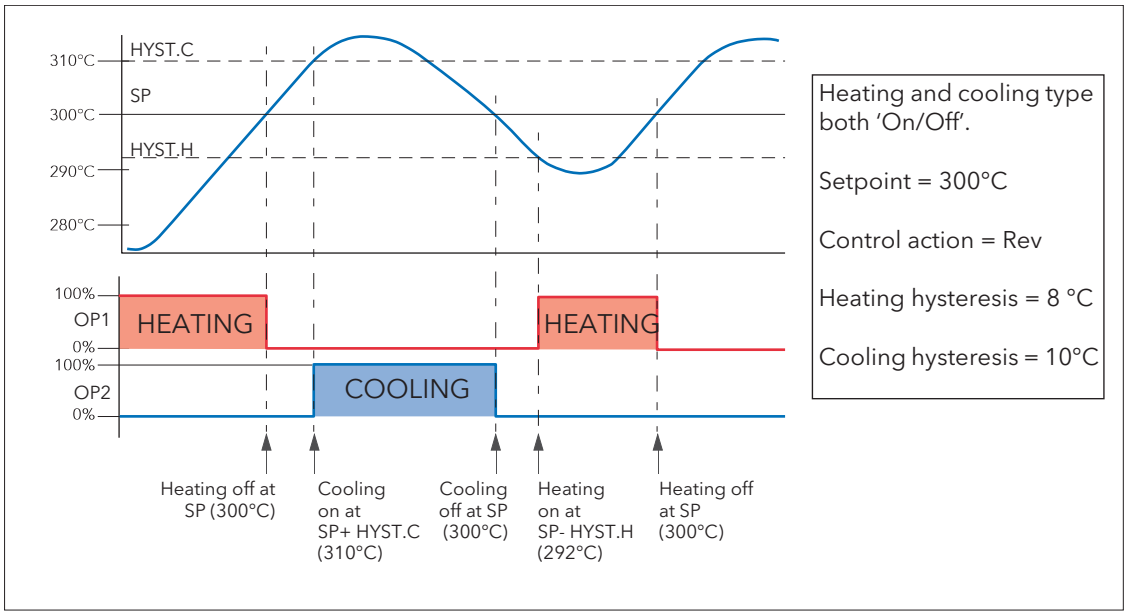


Figure B2.6.9a Deadband OFF

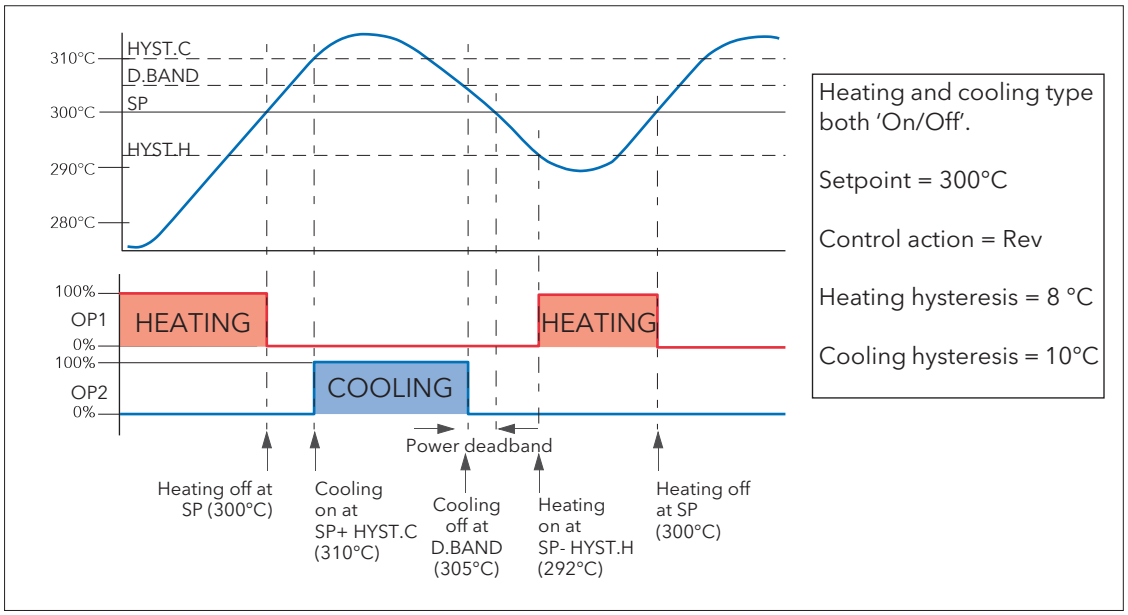


Figure B2.6.9b Deadband ON set at 50% of Cooling.

B2.6.10 Valve nudge

For systems configured as Unbounded Valve Positioning (VPU) - set up in Loop Setup configuration Ch1(2) control), it is possible to move the valve in small increments towards the open position (Nudge Raise) or towards the closed position (Nudge Lower). The trigger for such nudging can be a digital input (e.g. contact closure) 'wired' to the nudge raise or lower parameter, the up or down arrow keys or a command received over the serial link.

The nudge command causes the valve drive output to drive the valve for either the minimum on time, or for as long as the command is 'true', whichever is the longer (note 2). The default minimum on time is 125ms, but this can be edited in the configuration for the relevant output relay (section 4.11.2).

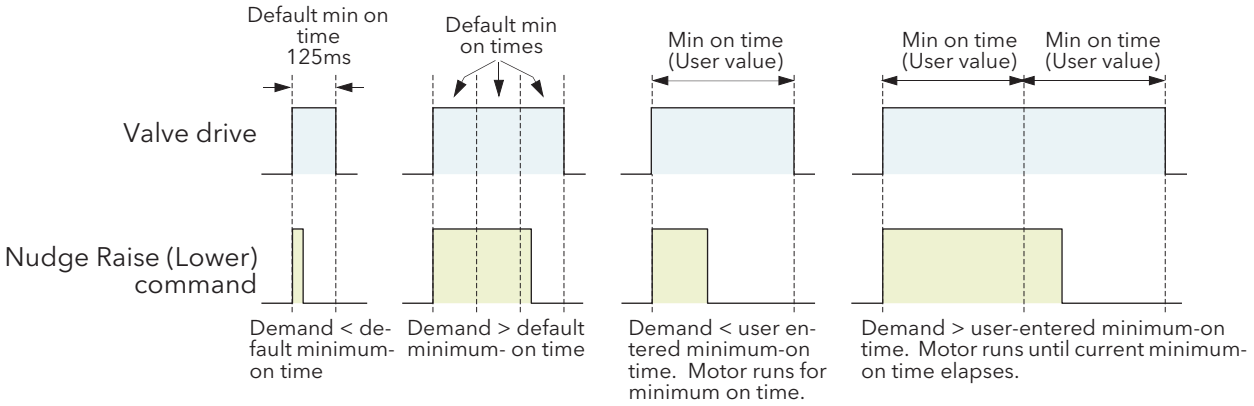


Figure B2.6.10 Valve nudge examples

Notes:

1. If Ch1 is set to VPU, Nudge operates the channel 1 valve, no matter what Ch2 is set to. If Ch1 is not set to VPU, and Ch2 is set to VPU then the nudge operates on channel 2 valve.
2. The minimum on time is continuously retriggered. This means that if a minimum on time of (say) 10 seconds has been configured, then the valve may continue to move for up to 10 seconds after the command has been removed. That is, it continues until the current minimum on time period has expired.

B2.6.11 Time Proportioning

PID controllers somtimes use Time Proportioning to control the average power to the load. This is done by repeatedly switching the output on for a period (T_{on}) and then off for a period (T_{off}). The total period (T_{on} + T_{off}) is called the 'cycle time'. During each cycle, the average power delivered to the load is:

$P_{Avg} = P_{Heater}$ x Duty cycle,

where 'P_{Heater}' is the actual transferred heater (or cooler) power and Duty cycle = $T_{on}/(T_{on} + T_{off})$, normally represented as a percentage value.

The PID controller calculates the Duty Cycle (the PID output control signal from 0 to 100%) and provides a Minimum on time between 100ms to 150 seconds.

Figure B2.6.11 shows how T_{on}, T_{off} and cycle time vary with demand %.

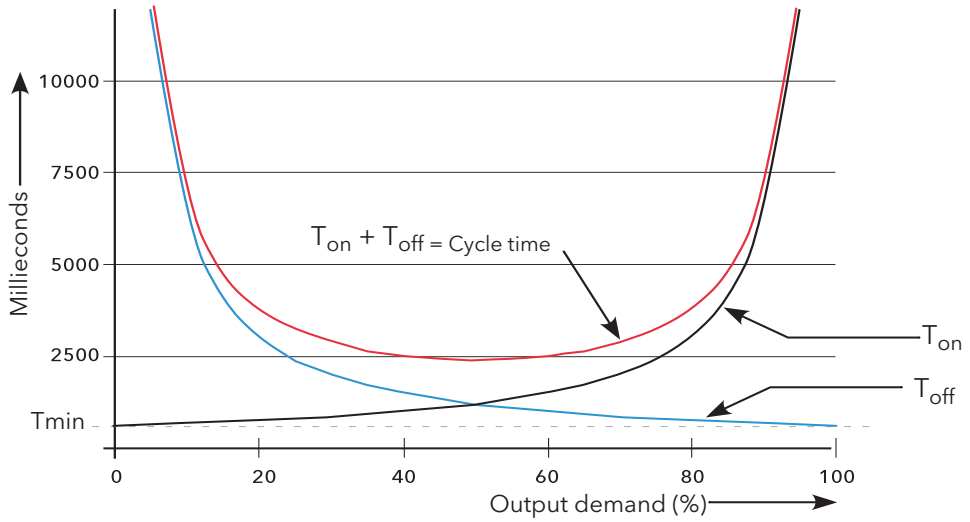


Figure B2.6.11 Time proportioning curves (Minimum on time = 625ms)

Note: For this instrument, only 'Min on time' is configurable

B2.7 DIAGNOSTICS

See section 4.6.7 for definitions of these parameters

Appendix C: REFERENCE

C1 BATTERY REPLACEMENT

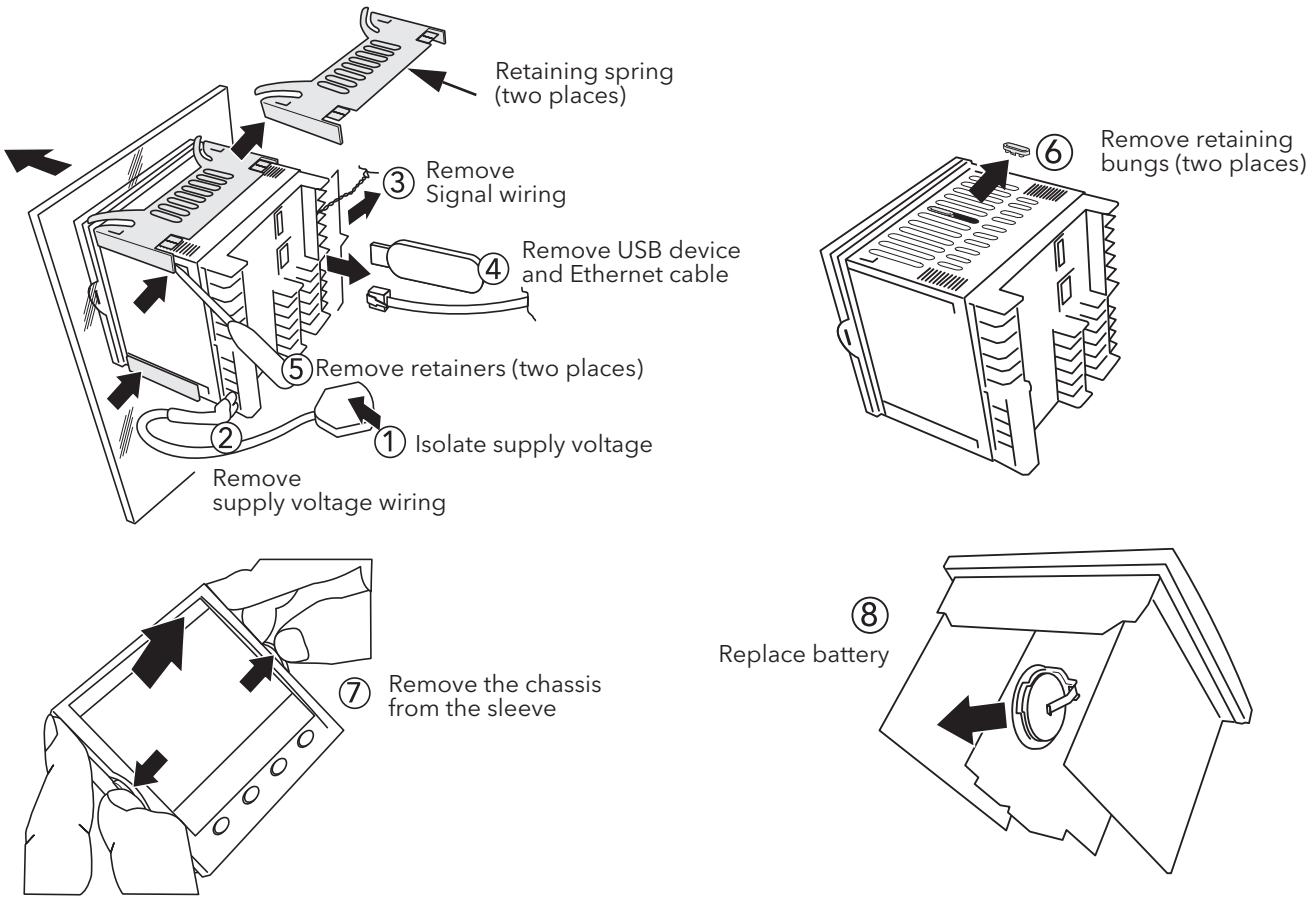
The battery can be replaced only after the unit has been withdrawn from the panel. It is therefore normally necessary to unwire the instrument before changing the battery.

WARNING

Before removing the supply voltage wiring, isolate the supply voltage and secure it against unintended operation.

Note: The new battery must be installed within 10 seconds of the exhausted battery's removal, or data will be lost.

1. Isolate the supply voltage and secure it against accidental operation.
2. Remove supply voltage wiring from the rear terminals.
3. Remove all signal wiring
4. Remove the Ethernet cable and USB device if fitted.
5. Remove the two securing springs, using a small screwdriver if necessary.
6. Prise the two chassis-retaining bungs, using a small screwdriver if necessary.
7. Ease the latching ears outwards, whilst pulling forwards on the bezel, until the chassis is free of the sleeve.
8. Replace the battery. Recycle the exhausted battery according to local procedures.
9. Reinsert the chassis into the sleeve, and secure it using the chassis-retaining bungs previously removed.
10. Reinstall the chassis into the panel and secure it using the retaining springs previously removed.
11. Reinstall all wiring, the Ethernet cable and USB device, if any.
12. Reset the date and time as described in section 4.1.1.



C2 SETTING UP AN FTP SERVER USING FILEZILLA

C2.1 DOWNLOADING

'FileZilla' is a free download from the internet (search for 'FileZilla server download').

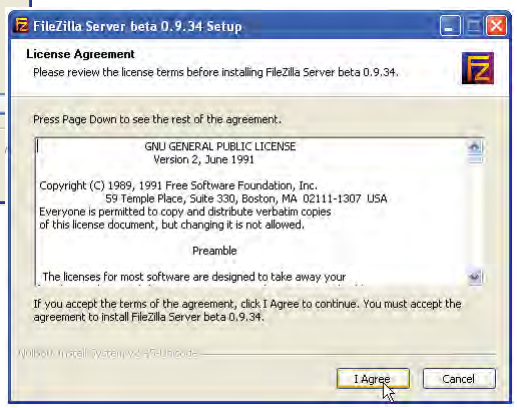
1. Download the latest version, following the instructions on the screen.

2. Answer 'No' to the question 'Do you want to view only the webpage content that was delivered securely'.

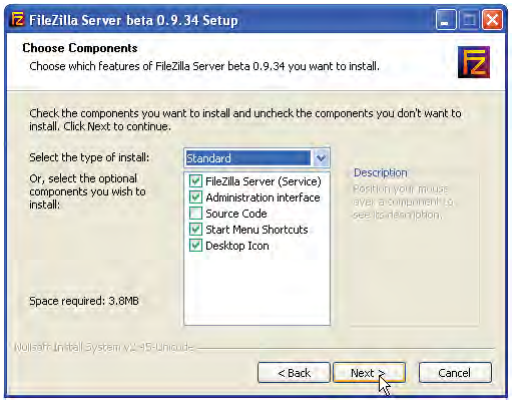
3. If necessary enable file download.

4. In the 'Do you want to run or save this file' Security Warning window- click on 'Run'

5. In the 'The Publisher could not be verified..., Security Warning window, click on 'Run'

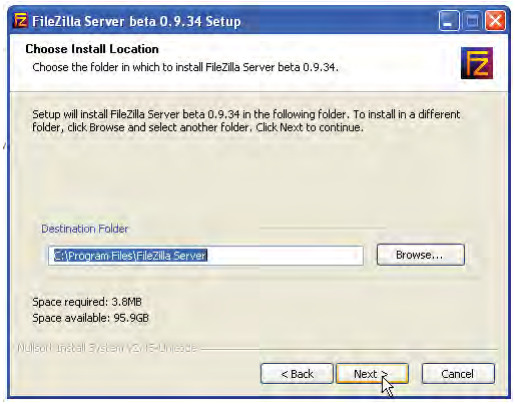


6. Agree or cancel the License agreement. If 'Agree', choose 'Standard' as the type of install.

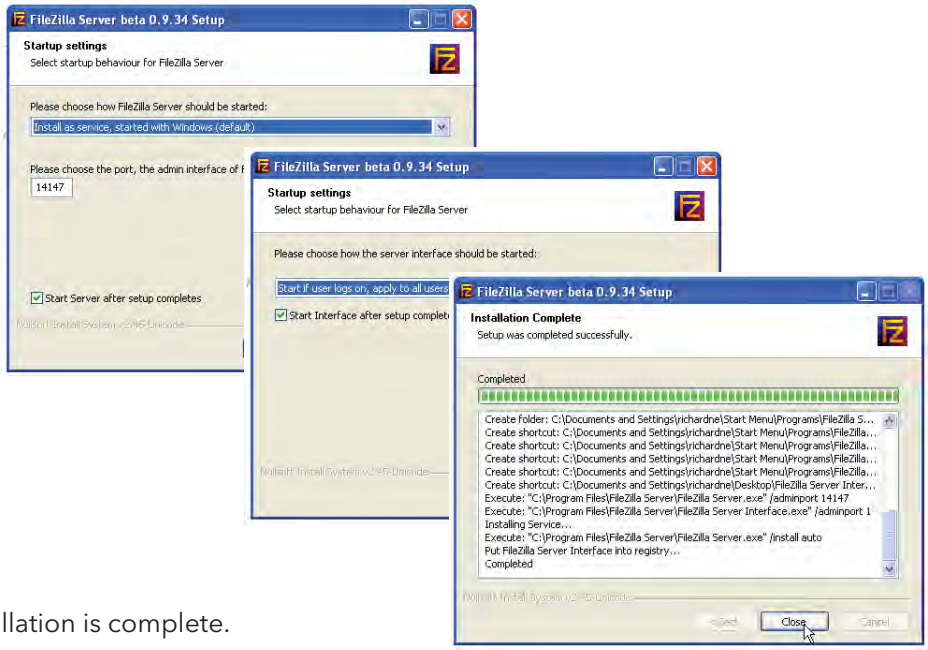


C2.1 DOWNLOADING (Cont.)

7. Choose the destination for the file



8. Select startup settings



9. Click on Close when Installation is complete.

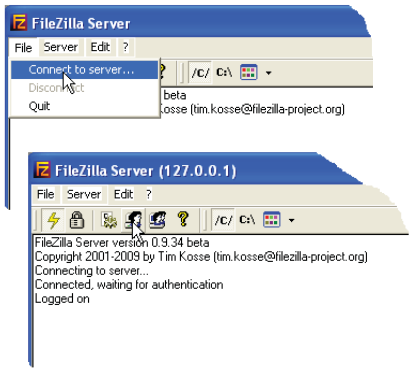
10. Click 'OK' in the 'Connect to Server' window.

C2.2 SERVER SETUP

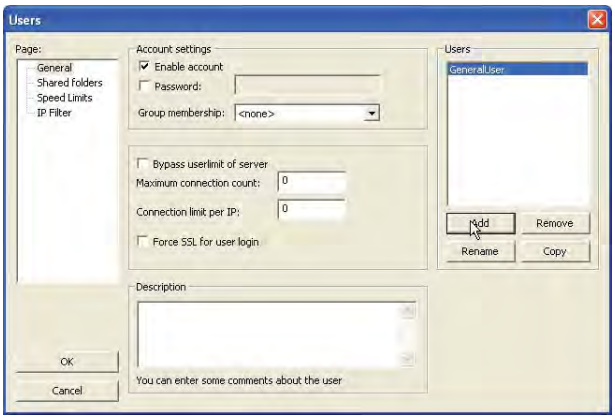
1. Create a new folder (directory) called, for this example, 'Archive' in a suitable location such as the C drive, or the desktop.

2. In the Filezilla server window, click on 'File' and select 'Connect to Server'.

   The 'Logged on' message appears



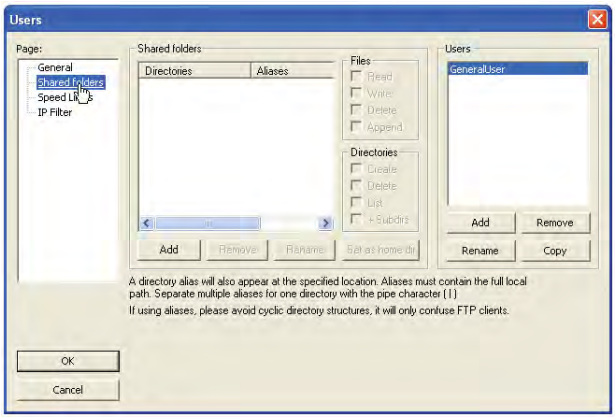
3 In the Edit menu, select 'Users' and in the 'General' page, click on 'Add' and enter a name for the user, then click 'OK'. For this example, 'GeneralUser' has been used, but it may be more advantageous to use 'Anonymous' because this is the default name in the recorder/controller. Click on 'OK'.



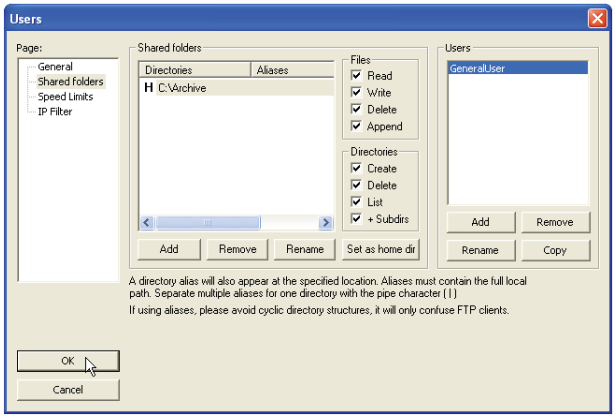
4 In the Edit menu, select 'Users' and in the 'Shared Folders' page, click on 'Add'

   A browse window opens allowing the user to select the new folder ('Archive') created in step 1, above.

   When OK has been clicked to confirm the selection, the new folder appears in the centre window (with an 'h' next to it to indicate that this is the home folder for this ftp user setup.



5. Click on the relevant folder to enable the tick boxes. Click on all the 'File' and 'Directory' enable tick boxes, then click OK

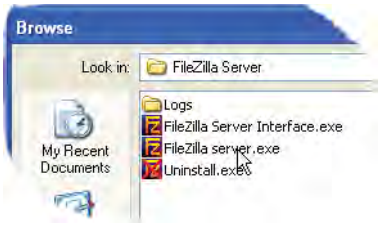


C2.3 PC SETUP

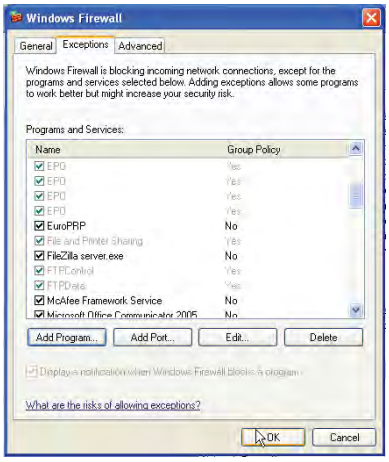
1. Operate the 'Start' button, and select 'Control Panel' from the window that appears. Double click on 'Windows Firewall'

2. Click on the 'Exceptions' tab in the window that appears, and check that both 'FTPControl' and 'FTPData' are enabled (ticked). If not, the user's IT department should be contacted for advice.

3. Click on 'Add Program...' and browse to the Filezilla destination defined in step 7 of the download section (C2.1). Select 'FileZilla server.exe' and click on 'Open'



'FileZilla server.exe' appears in the Exceptions list.



Click on 'OK'

C2.4 RECORDER/CONTROLLER SET UP

In Network Archiving (section 4.2.2):

1. Enter the IP address of the pc in which the FTP server has been enabled in the 'Primary Server' field.
2. Enter the Primary User name, as entered in step three of the Server setup procedure (section C2.2) above (GeneralUser in this example).
3. Enter the IP address of another suitable pc which has been configured as an ftp server in the 'Sec. Server' field, and enter the relevant 'Sec. User' name.
4. Configure the other unattended archive parameters as required (section 4.2.2).

Note: For the example above, 'Password' was not enabled in the User Accounts setup page (section C2.2), so for this example any Primary (Sec.) password entry is ignored. If a password had been entered in the User Accounts setup, then the Primary (Sec.) Password field would have to contain this password.

C2.5 ARCHIVE ACTIVITY

Once a demand or unattended archive is initiated, the FileZilla Server page shows the activity status as the archive progresses. Figure C2.5 shows a typical page. The top of the page shows the transaction details between the server and any clients to which it is connected. The bottom portion shows details of the files currently being transferred. These files are archived to the 'Archive' folder.

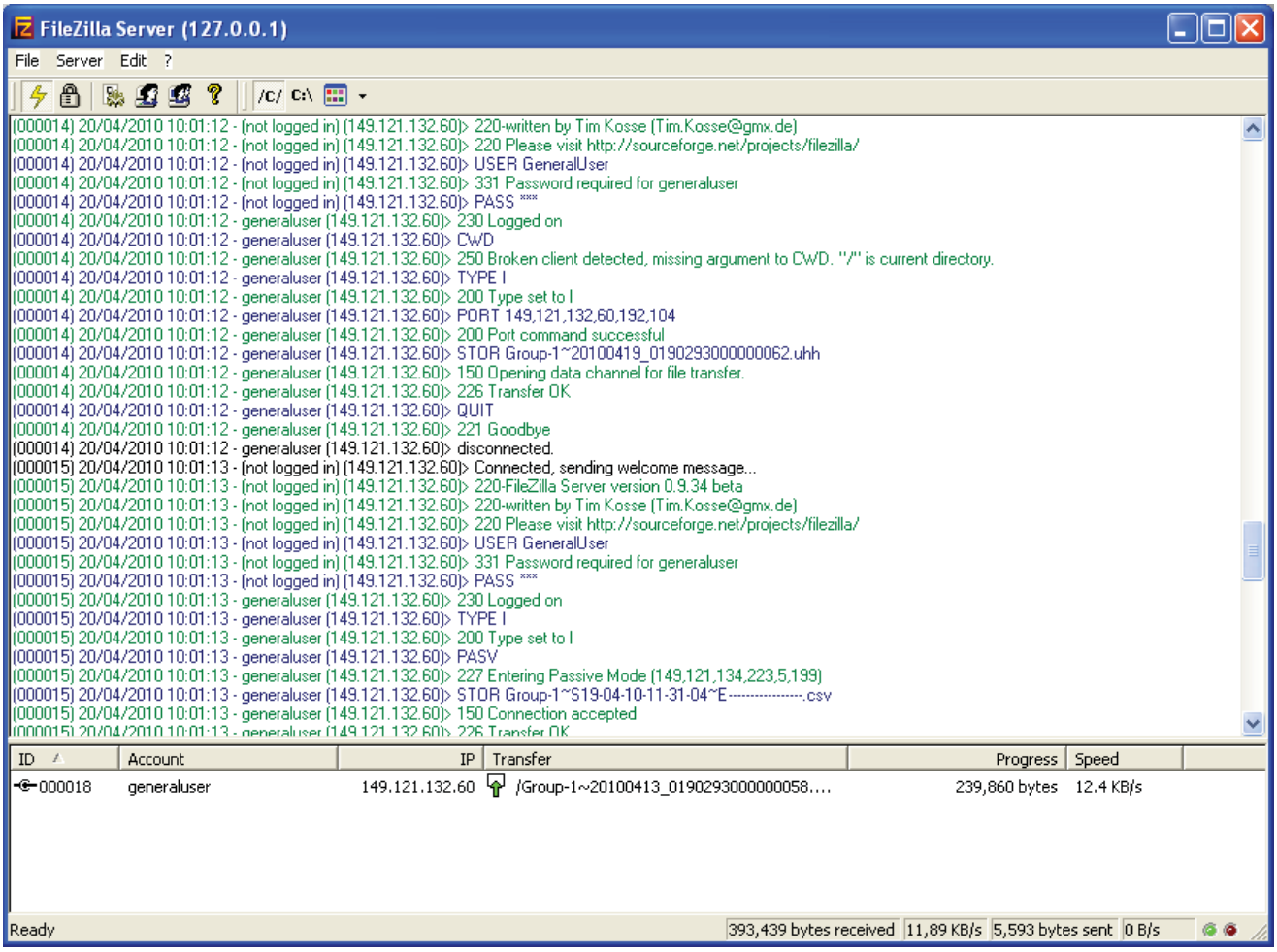


Figure C2.5 FileZilla Server archive activity page

C3 FUNCTION BLOCK DETAILS

C3.1 EIGHT INPUT OR BLOCK

An eight input logical OR block whose output is high (1, On) if any one or more inputs is high (1, On). If more than eight inputs are required, a second block is automatically introduced, as shown in figure C3.1a. The blocks in the figure are given the names 'A' and 'B', where 'A' and 'B' can be any of the 12 available instances.

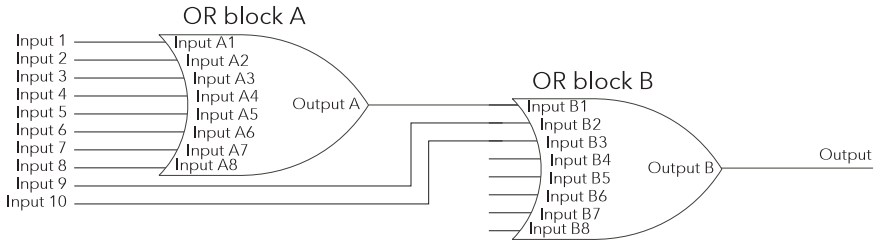


Figure C3.1a Eight input OR block

OR blocks are used automatically by the 'user wiring' when more than one source is wired to the same destination parameter. For example, it may be required that Relay (Digital I/O 2A2B) is to operate if channel 1 alarm 1 and/or channel 2 alarm 1 channels goes active. In such a case, the 'Active' parameter for the two channel alarms would be wired to the same relay's 'PV' parameter.

OR blocks are invisible to the user interface, but the iTools graphical wiring page for this configuration (figure C3.1b), shows that an OR block has been introduced to OR the two alarm outputs together.

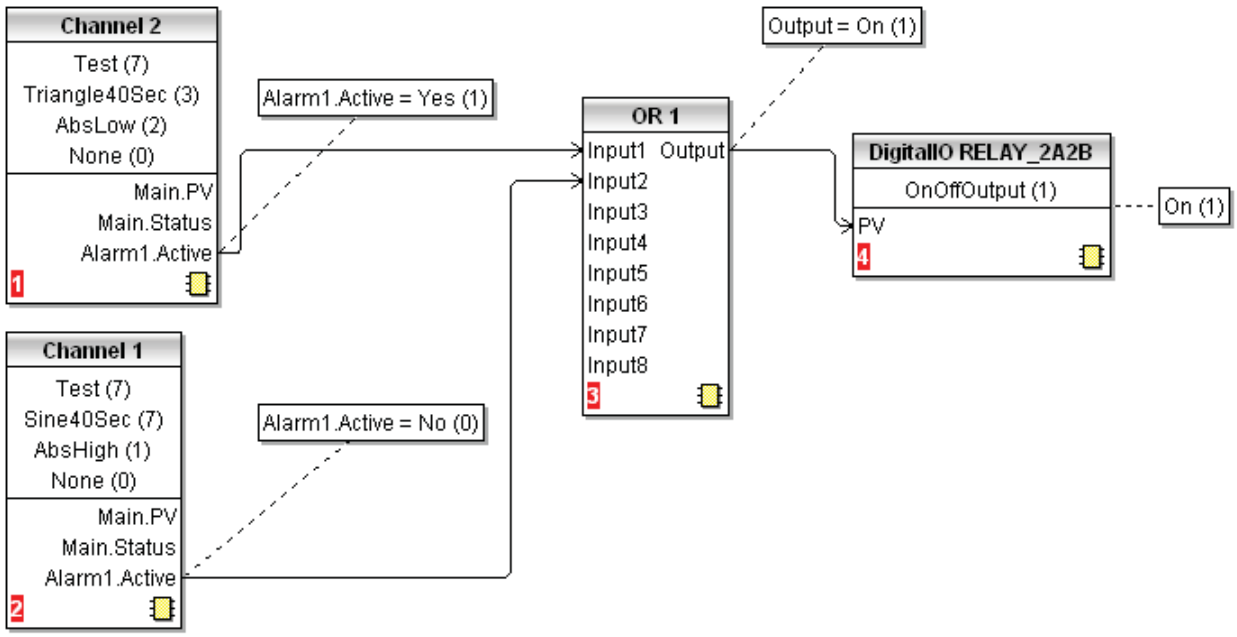


Figure C3.1b iTools representation of OR block usage

C4 TCP PORT NUMBERS

The following TCP ports are made use of by the instrument.

Port	Usage
20	File Transfer protocol (FTP) data
21	FTP control
502	Modbus TCP communications

C5 ISOLATION DIAGRAM

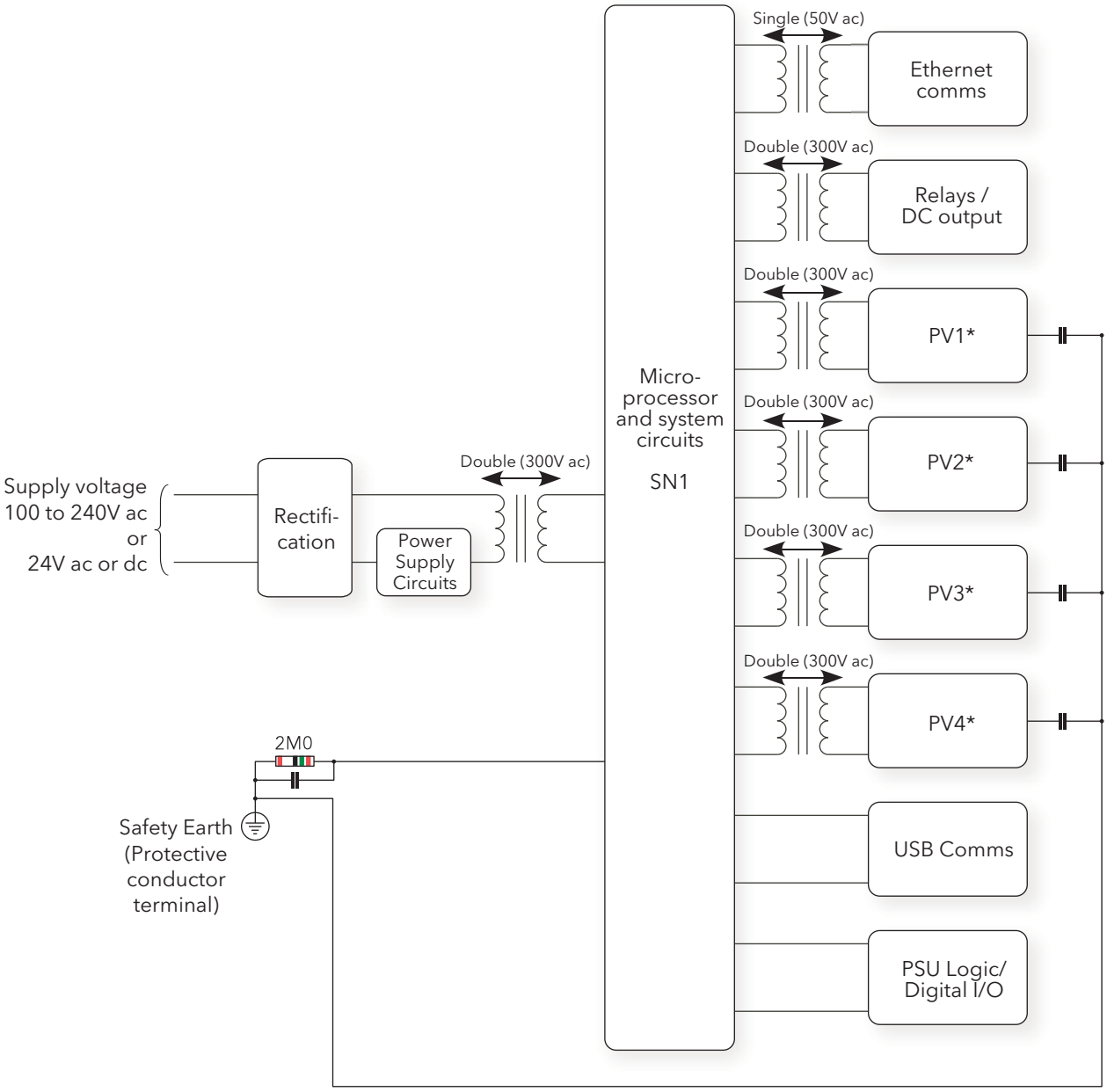


Figure C5 Isolation diagram

* Note: Each 'PV' is double isolated (300VRMS) from all other 'PV's.

Appendix D: CONFIGURATION MENU OVERVIEW

This appendix contains an overview of the configuration menus for the instrument, including all options as follows:

Instrument ------ Section D1
Network -------- Section D2
Group ---------- Section D3
Channel -------- Section D4
Virtual Channel --- Section D5
Loop ----------- Section D6
Advanced Loop -- Section D7
Progammer------ Section D8
Modbus Master--- Section D9
EtherNet/IP ------ Section D10
Digital I/O ------- Section D11
DC Output ------ Section D12
User Lin--------- Section D13
Custom Message - Section D14
Zirconia--------- Section D15
Steriliser -------- Section D16
Humidity -------- Section D17
BCD Input ------- Section D18
Logic (2 input)--- Section D19
Logic (8 input)--- Section D20
Multiplexer ------ Section D21
Math (2 Input) ---- Section D22
Timer ---------- Section D23
User Values------ Section D24
Real time Events -- Section D25

D1 INSTRUMENT CONFIGURATION MENUS

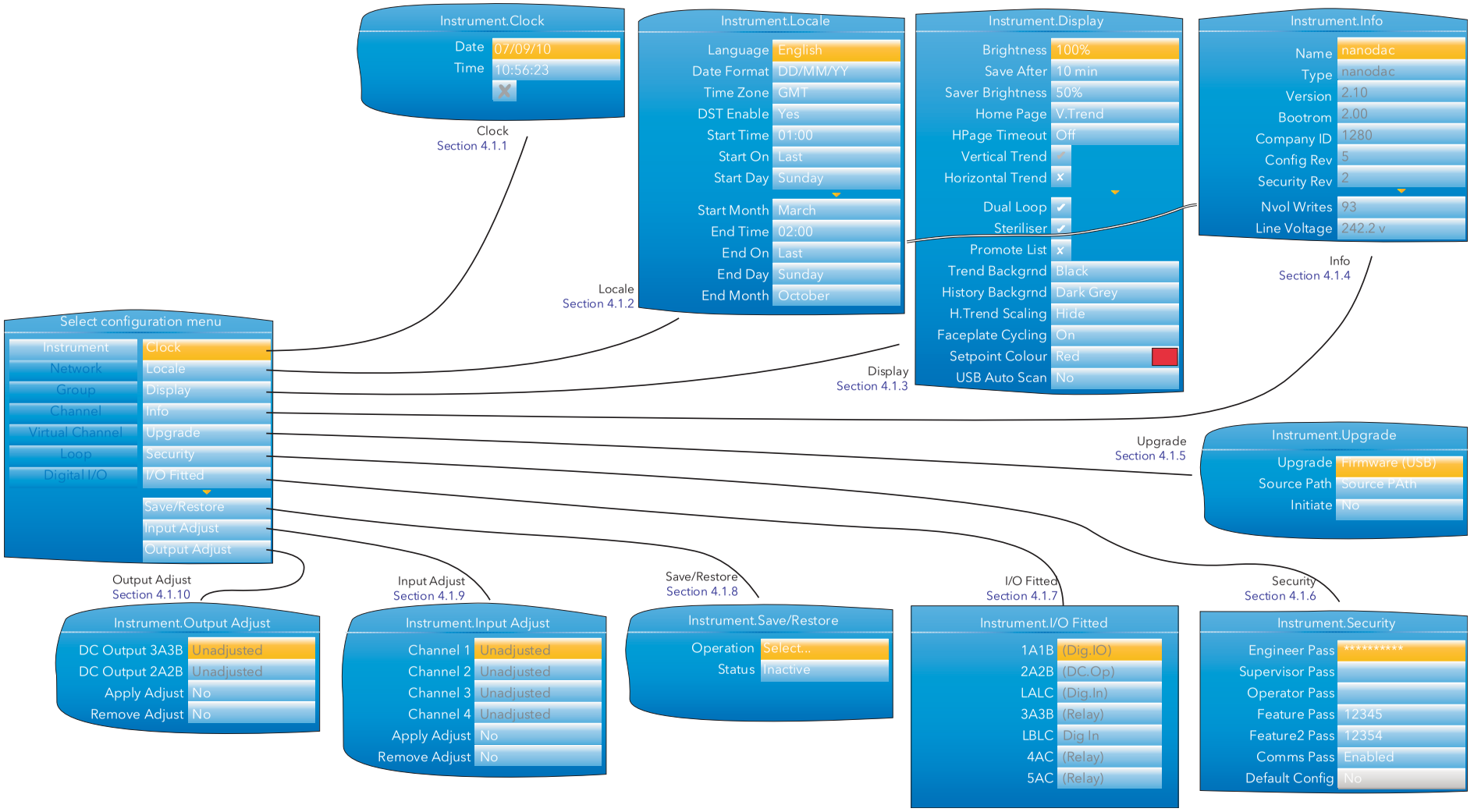


Figure D1 Instrument configuration menus

D2 NETWORK CONFIGURATION MENUS

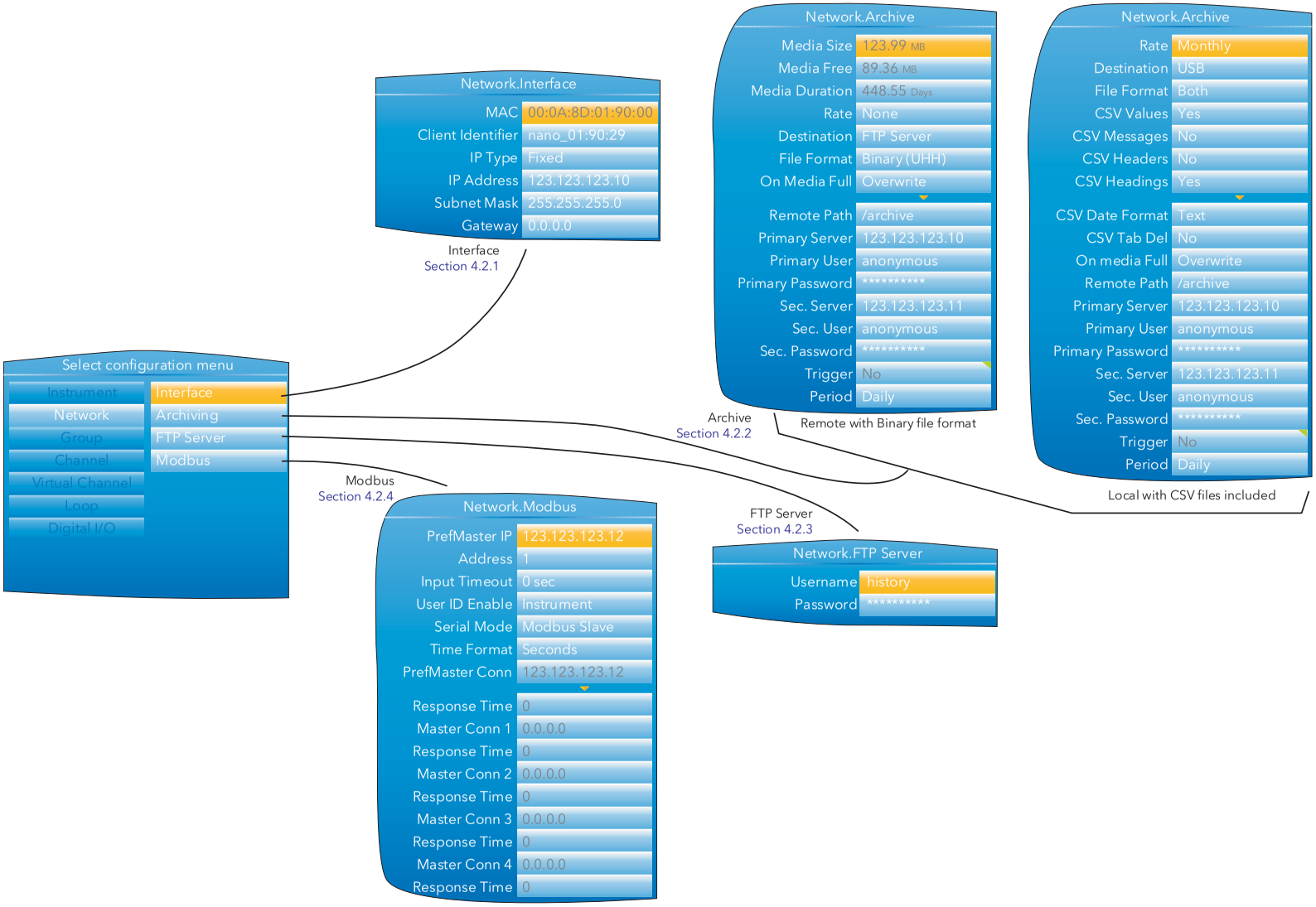


Figure D2 Network configuration menus

D3 GROUP CONFIGURATION MENU

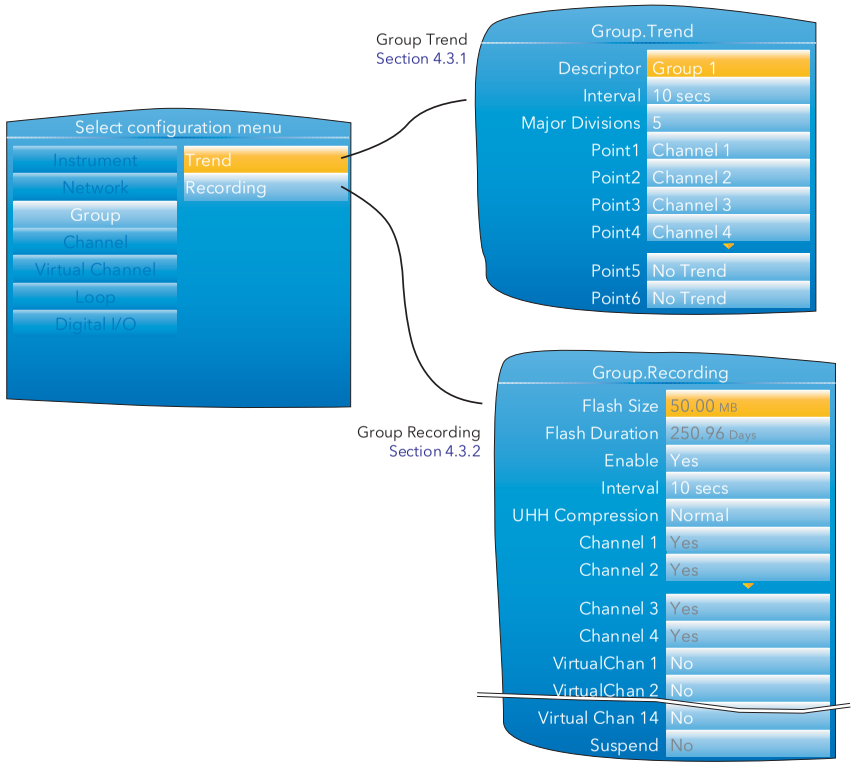


Figure D3 Group configuration menus

D4 CHANNEL CONFIGURATION MENU

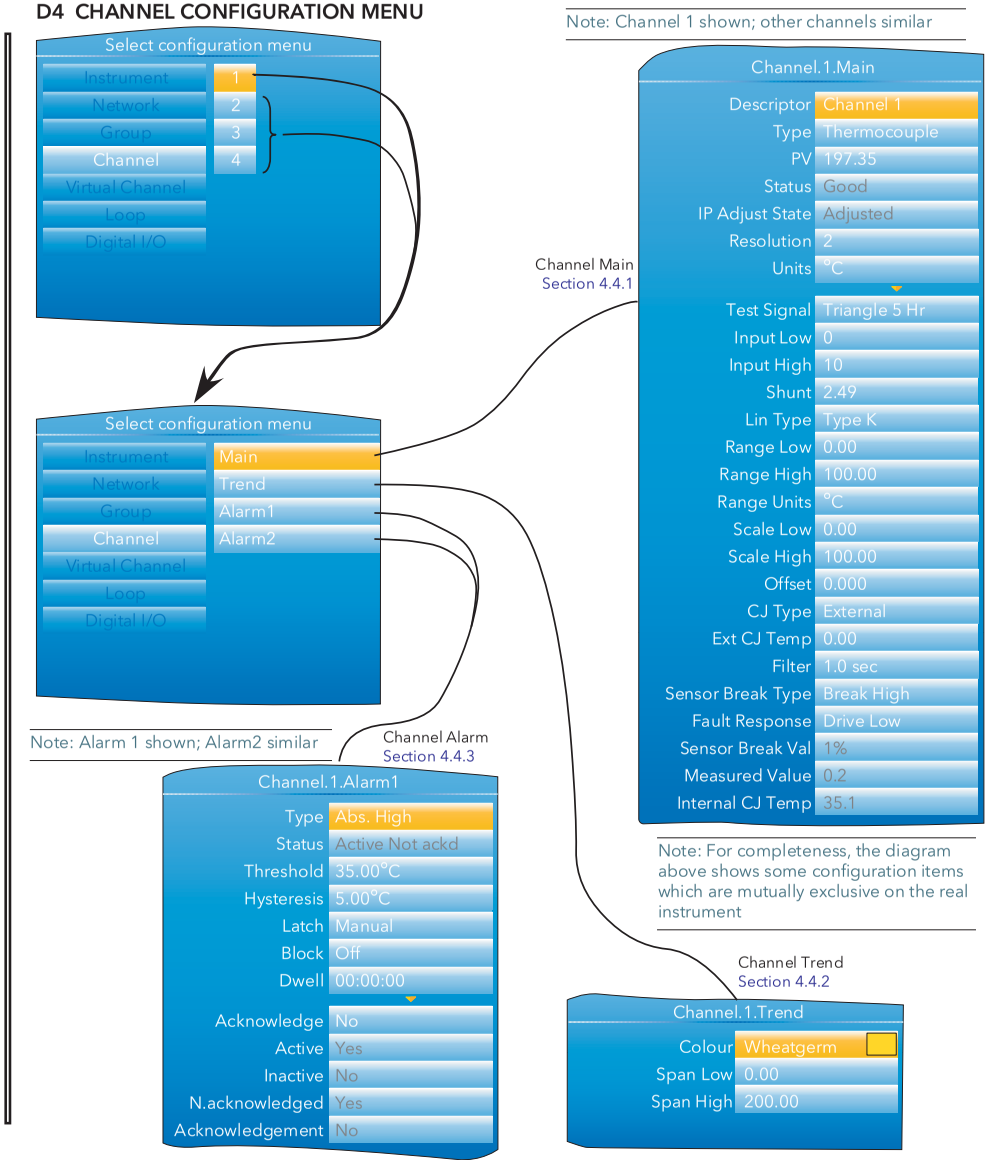
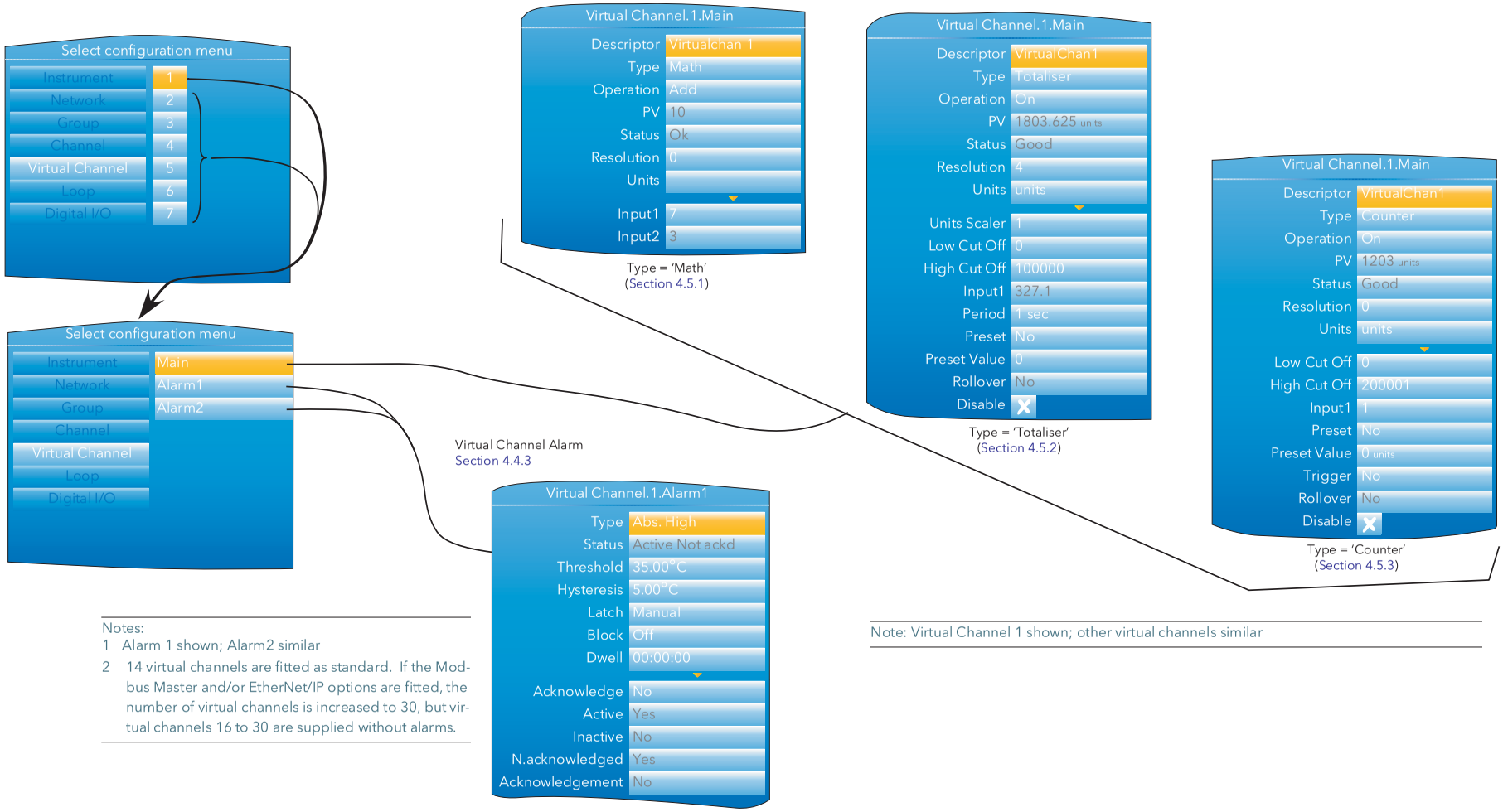


Figure D4 Channel configuration menus

D5 VIRTUAL CHANNEL CONFIGURATION MENU



Notes:
1 Alarm 1 shown; Alarm2 similar
2 14 virtual channels are fitted as standard. If the Modbus Master and/or EtherNet/IP options are fitted, the number of virtual channels is increased to 30, but virtual channels 16 to 30 are supplied without alarms.

Note: Virtual Channel 1 shown; other virtual channels similar

Figure D5 Virtual channel configuration menus

D6 LOOP CONFIGURATION MENUS

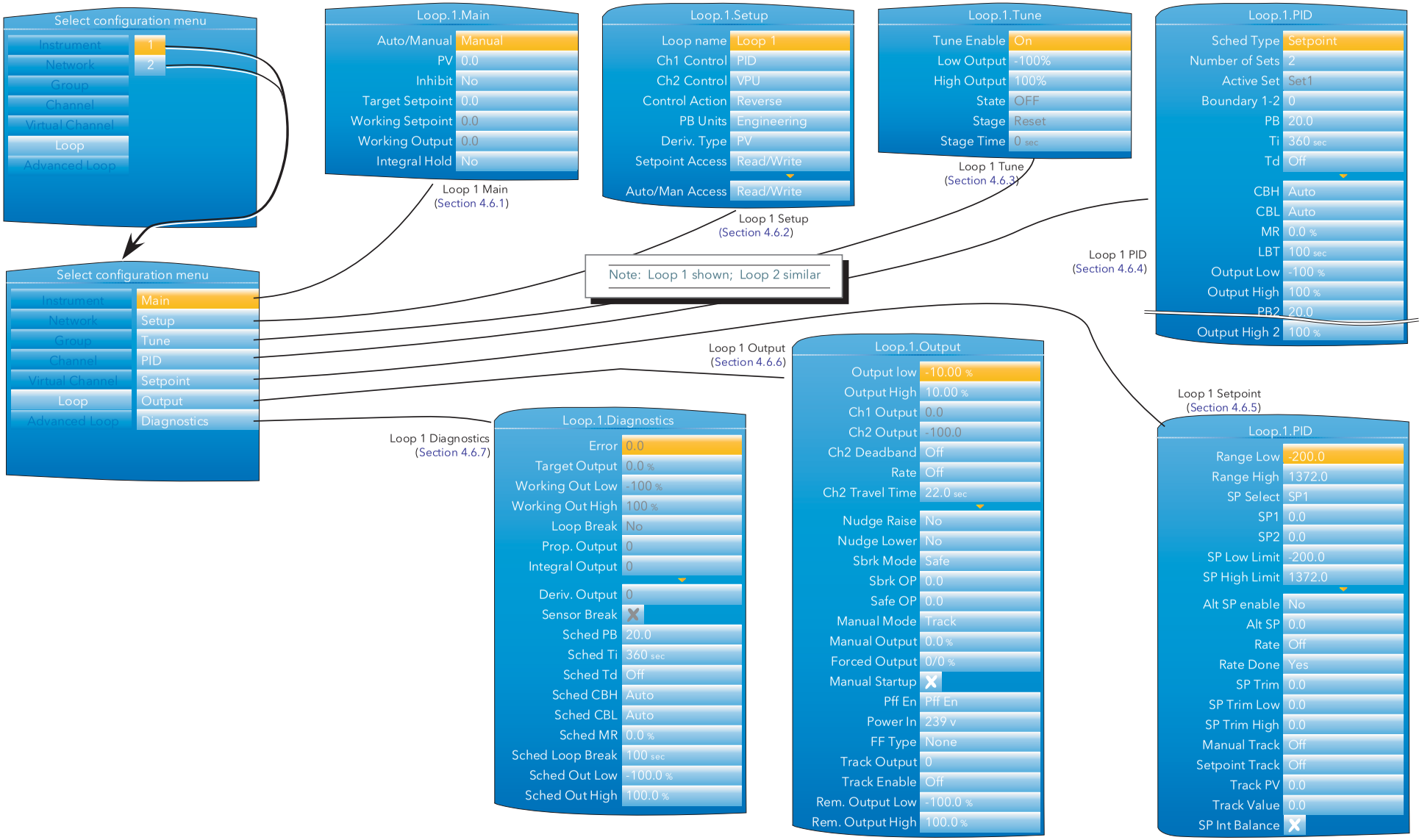


Figure D6 Loop Configuration menus

D7 ADVANCED LOOP CONFIGURATION MENUS

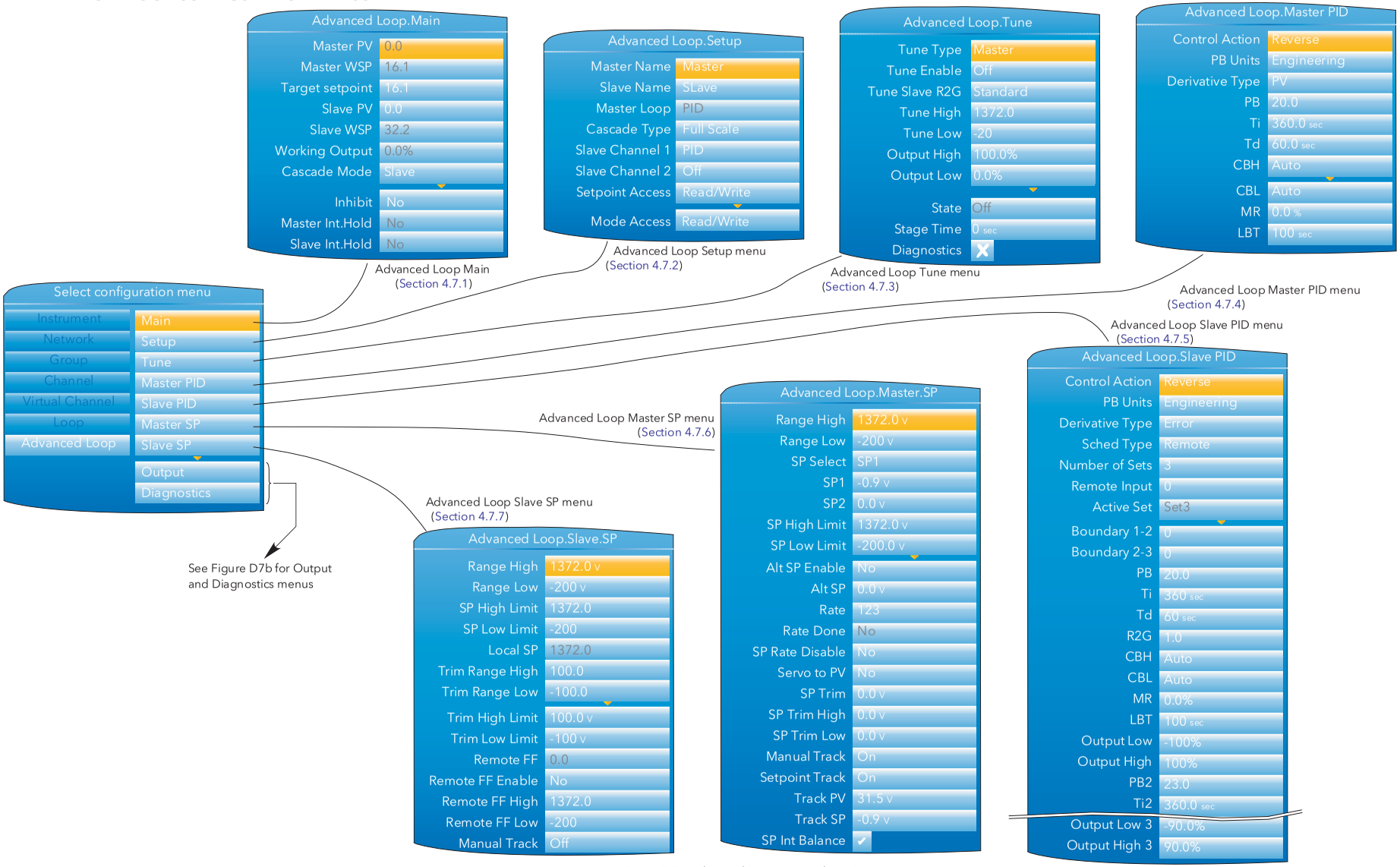


Figure D7a Advanced Loop menus sheet 1

D7 ADVANCED LOOP CONFIGURATION (Cont.)

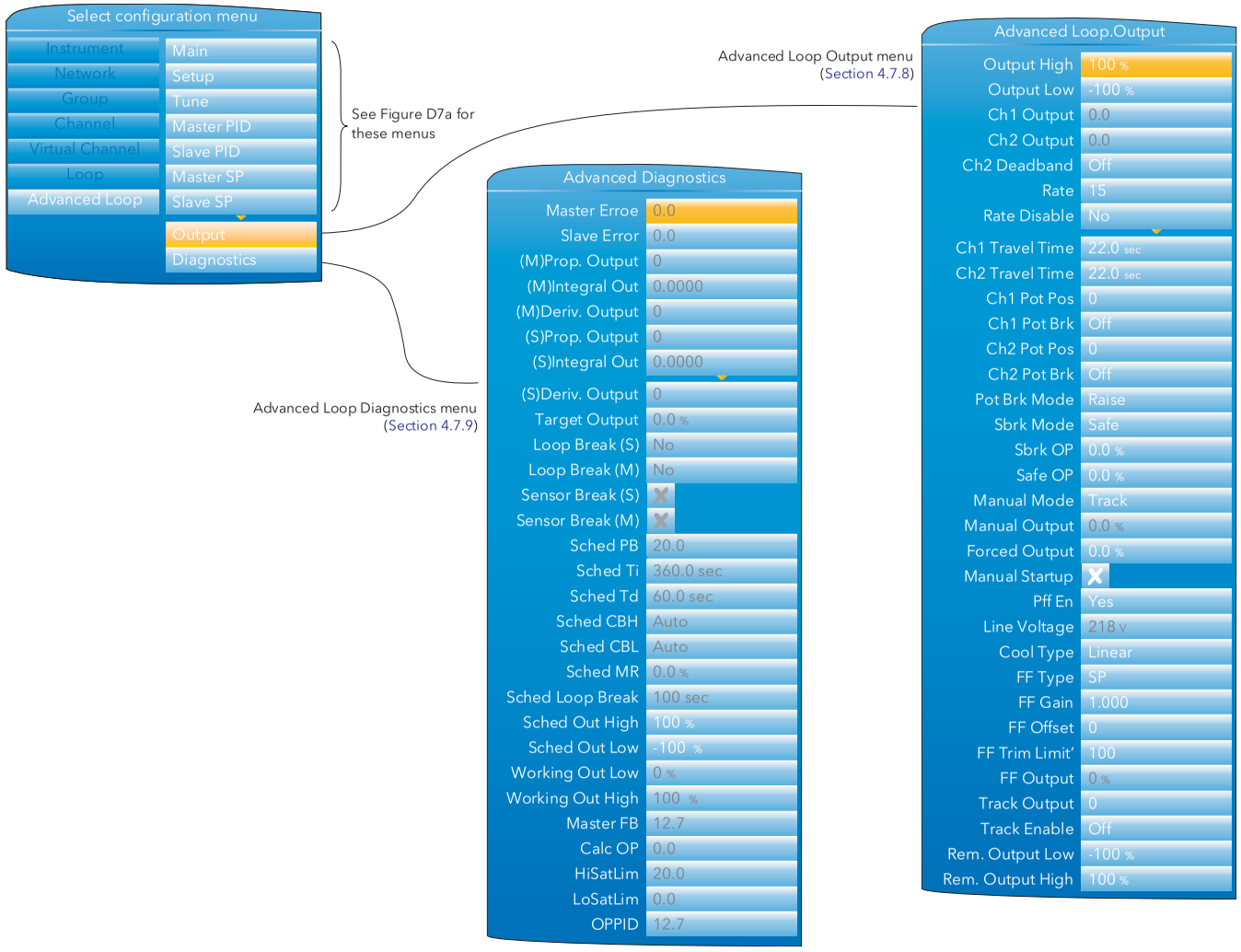


Figure D7b Advanced Loop menus sheet 2

D8 PROGRAMMER CONFIGURATION

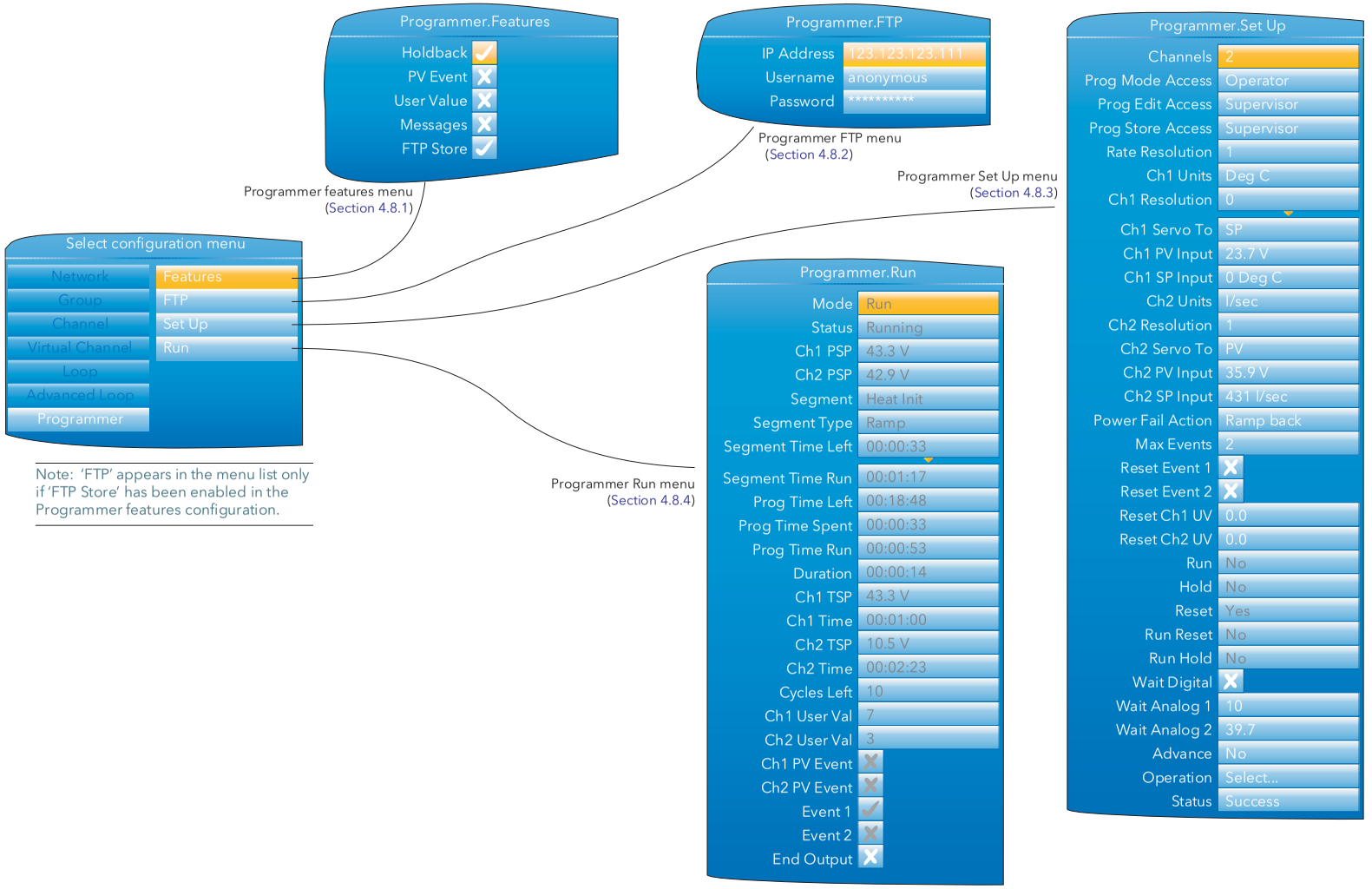


Figure D8 Programmer menus

D9 MODBUS MASTER CONFIGURATION

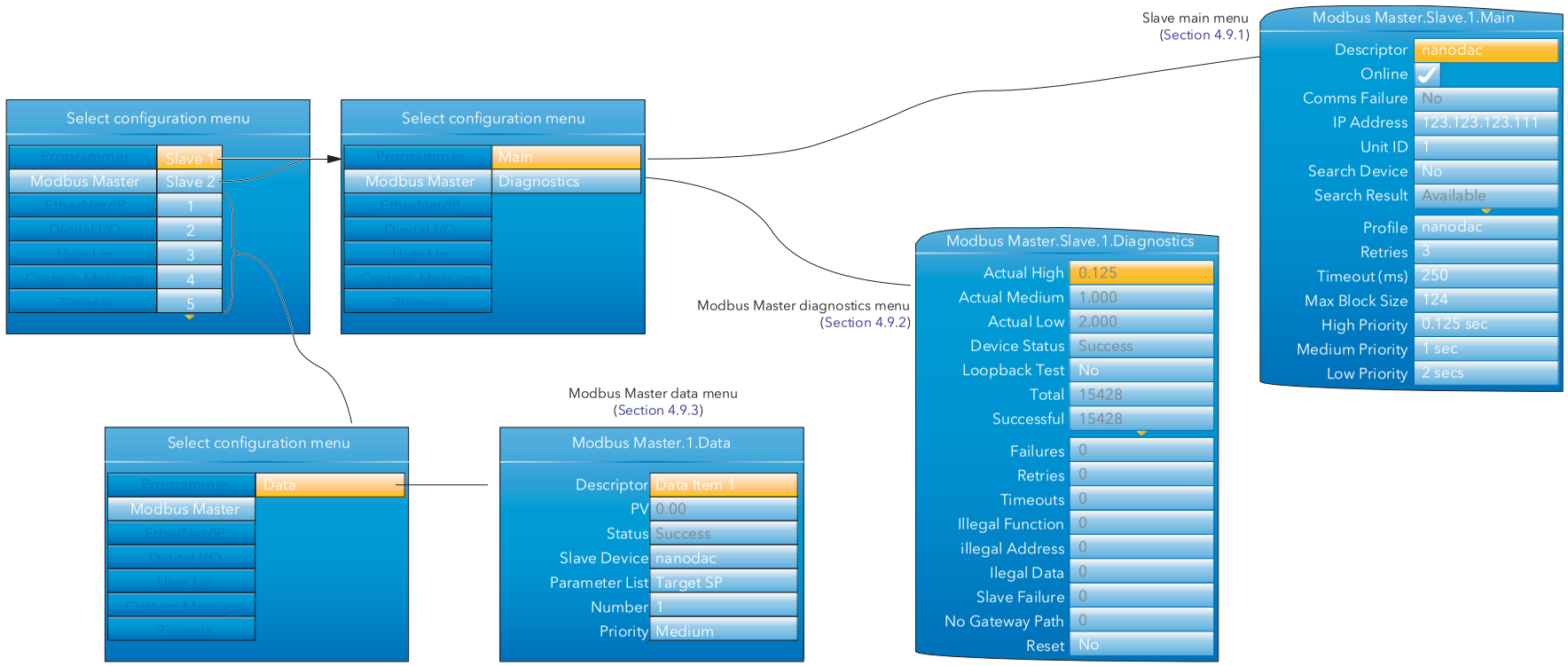


Figure D9 Modbus Master menus

D10 ETHERNET/IP CONFIGURATION

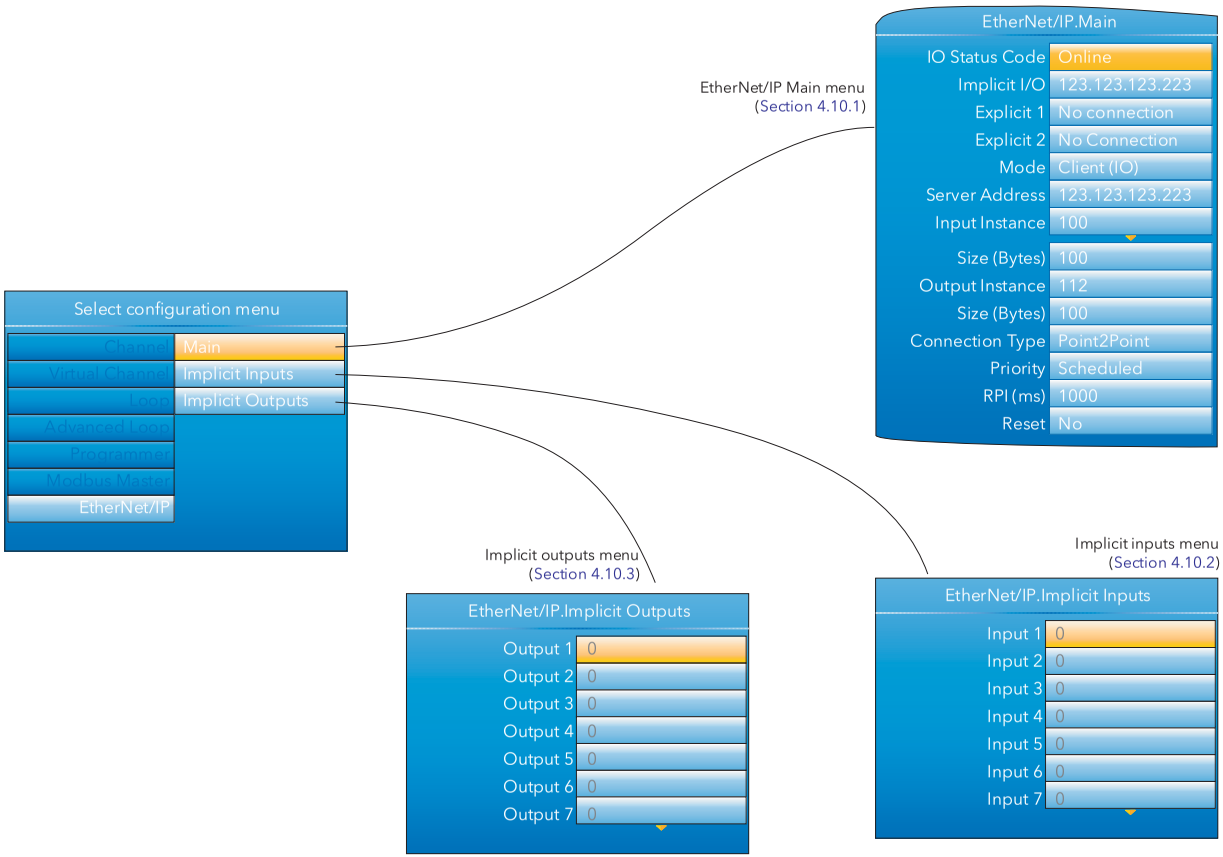


Figure D10 EtherNet/IP menus

D11 DIGITAL I/O CONFIGURATION MENUS

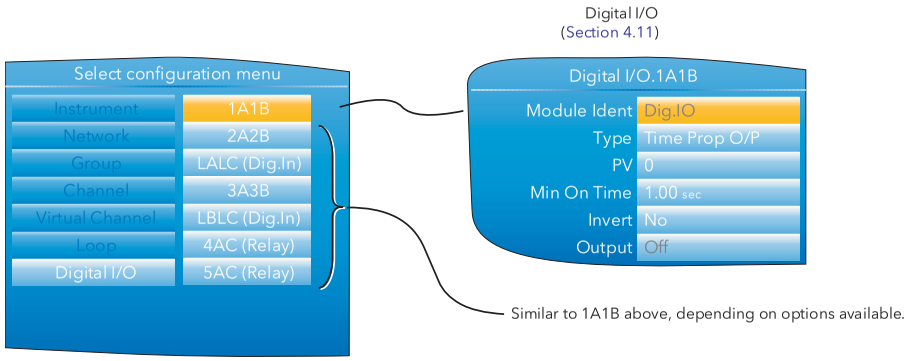


Figure D11 Digital I/O configuration menus

D12 DC OUTPUT CONFIGURATION MENUS

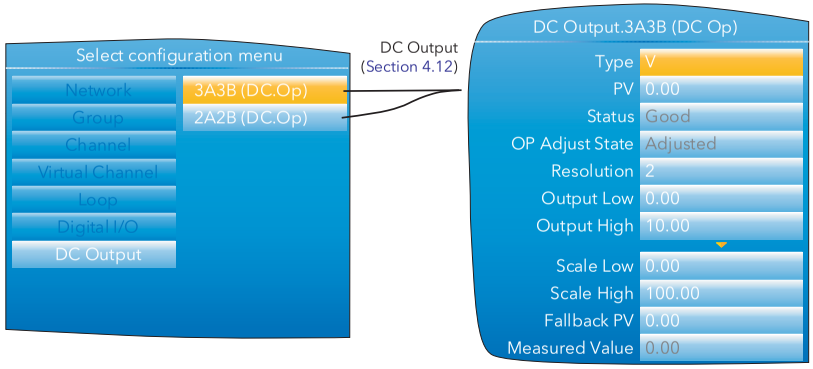


Figure D12 DC output configration menus

D13 USER LINEARISATION TABLE CONFIGURATION MENU

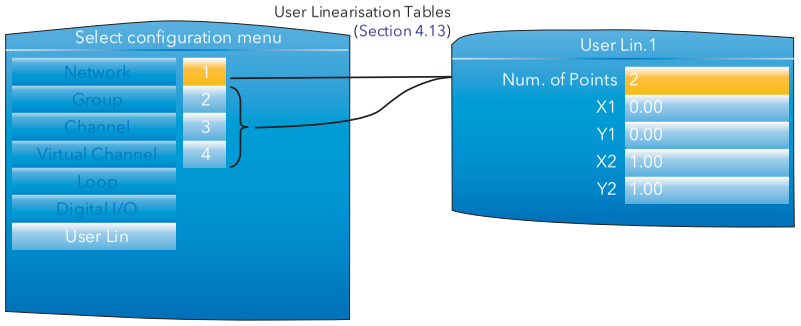


Figure D13 User Linearisation tble menus

D14 CUSTOM MESSAGES CONFIGURATION MENU

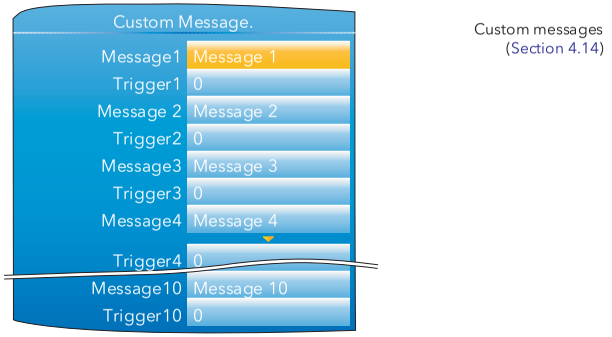


Figure D14 Custom messages configuration

D15 ZIRCONIA BLOCK CONFIGURATION

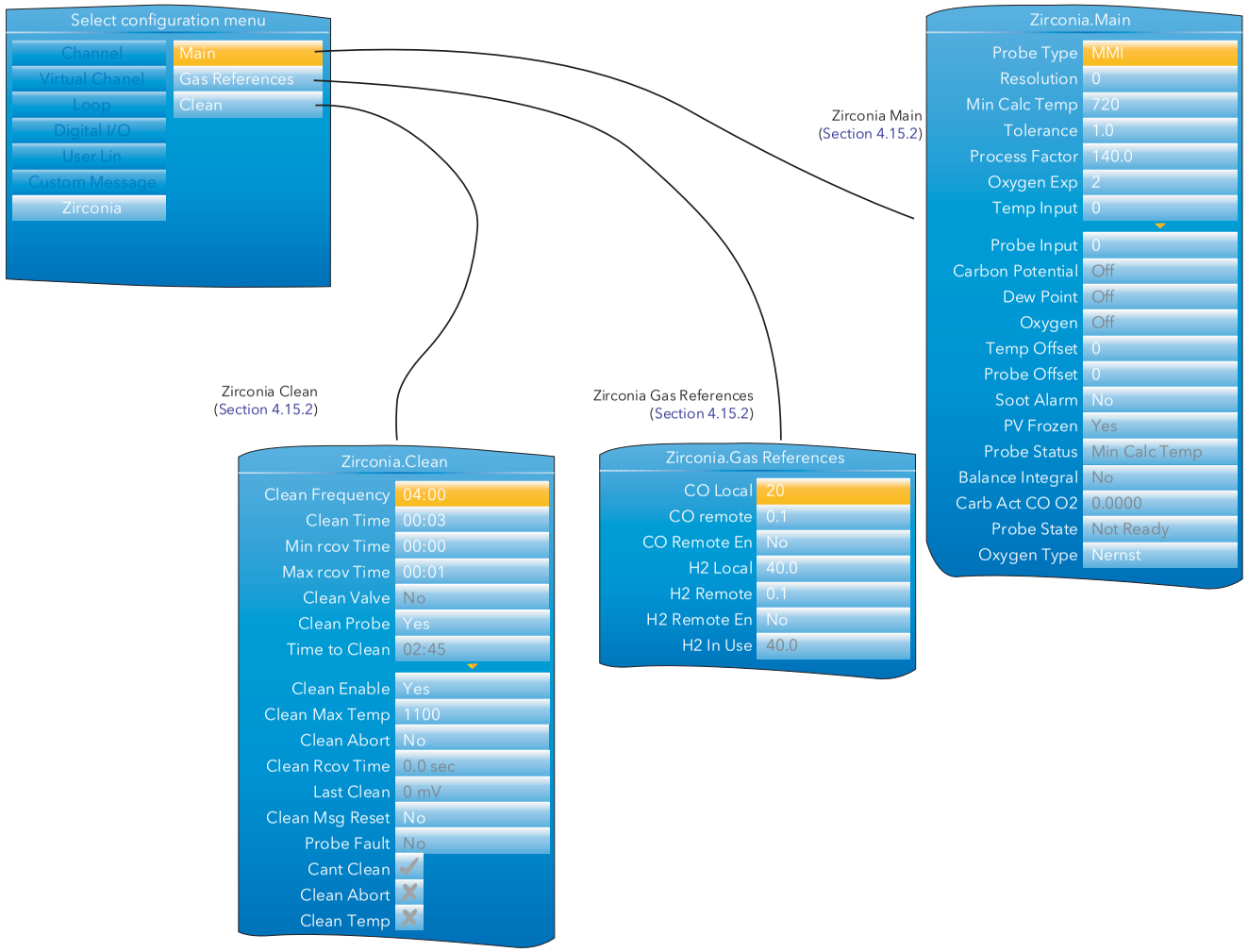


Figure D15 Zirconia block configuration menus

D16 STERILISER BLOCK CONFIGURATION MENU

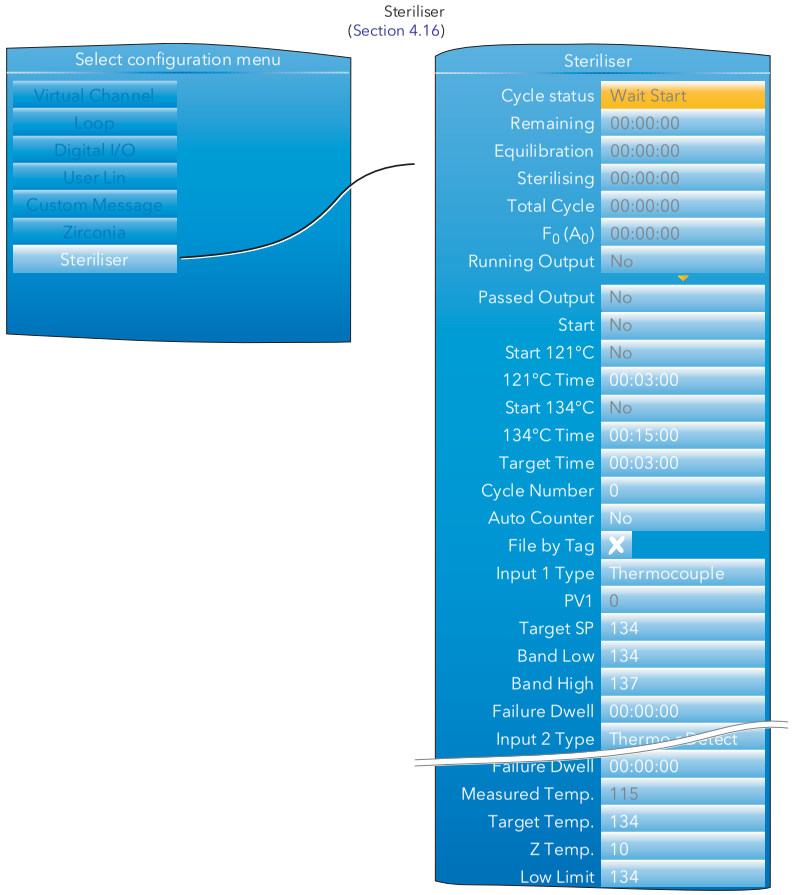


Figure D16 Steriliser menu

D17 HUMIDITY BLOCK CONFIGURATION MENU

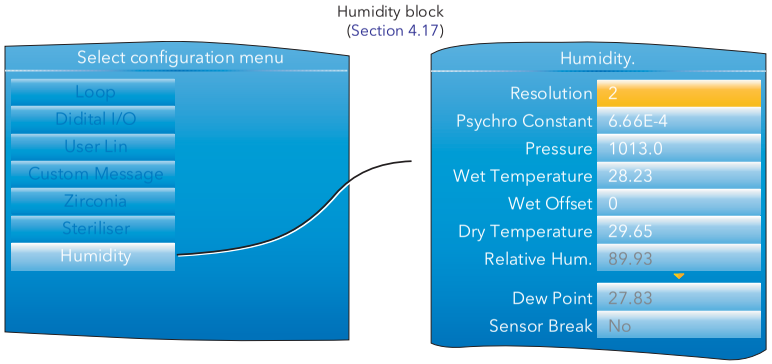


Figure D17 Humidity Block configuration menu

D18 BCD INPUT BLOCK CONFIGURATION MENU

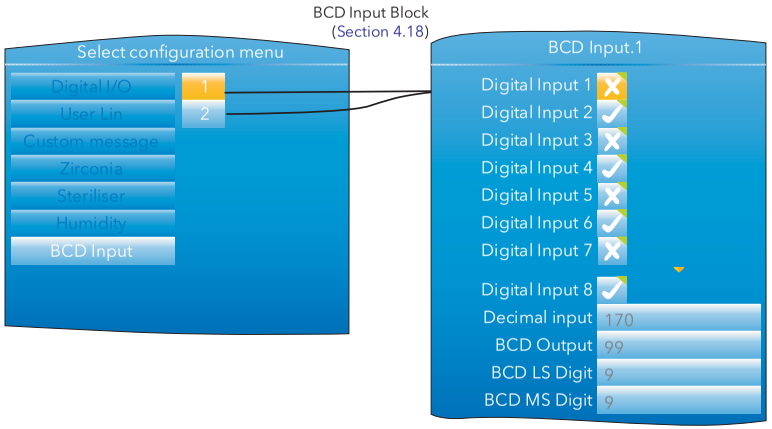


Figure D18 BCD input block menu

D19 LOGIC (2 INPUT) CONFIGURATION MENU

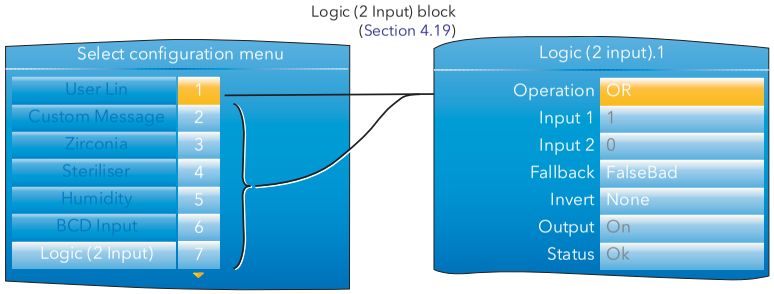


Figure D19 logic (2 input) configuration menu

D20 LOGIC (8 INPUT) CONFIGURATION MENU

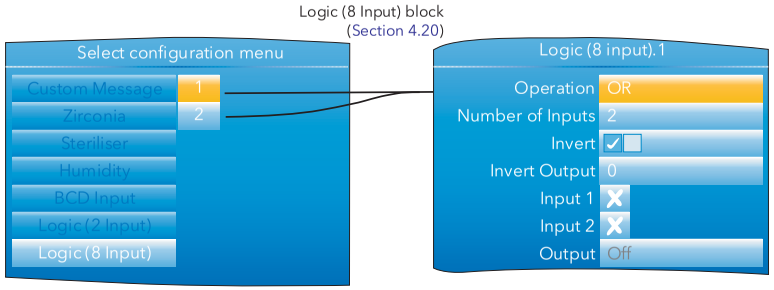


Figure D20 logic (8 input) configuration menu

D21 MULTIPLEXER BLOCK CONFIGURATION MENU

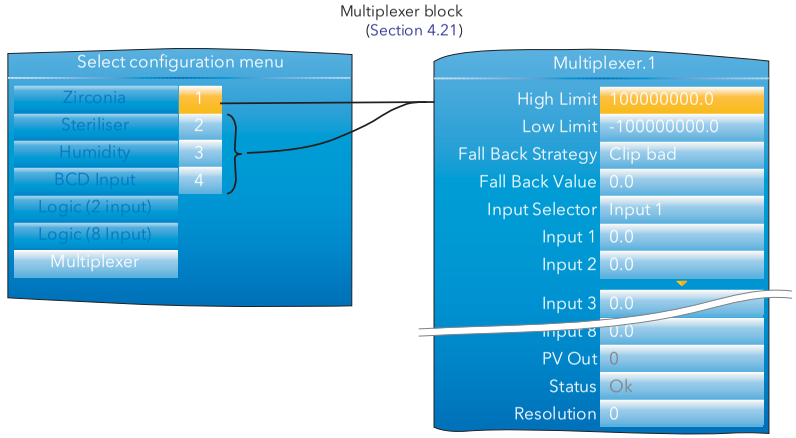


Figure D21 Logic (2 input) configuration menu

D22 MATH (2 INPUT) CONFIGURATION MENU

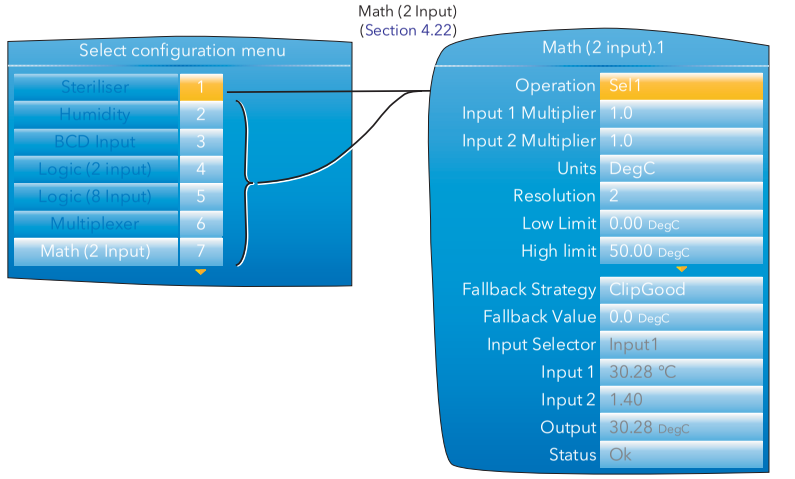


Figure D22 Math (2 Input) configuration menu

D23 TIMER CONFIGURATION MENU

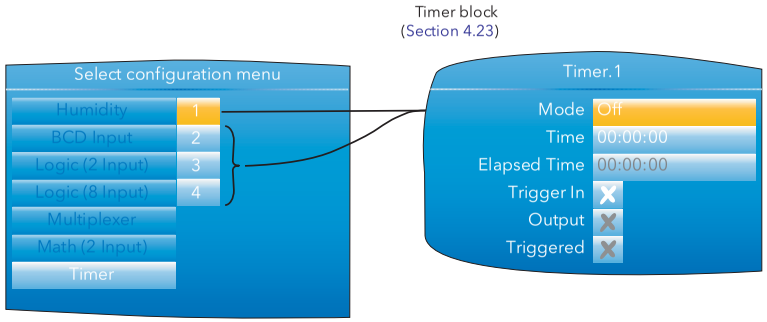


Figure D23 Timer configuration menu

D24 USER VALUES CONFIGURATION MENU

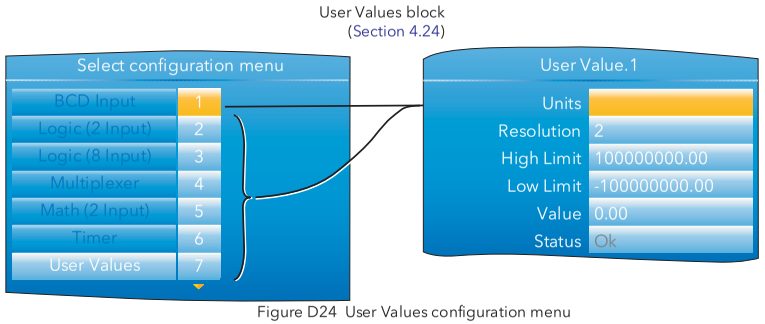


Figure D24 User Values configuration menu

D25 REAL TIME EVENTS CONFIGURATION MENU

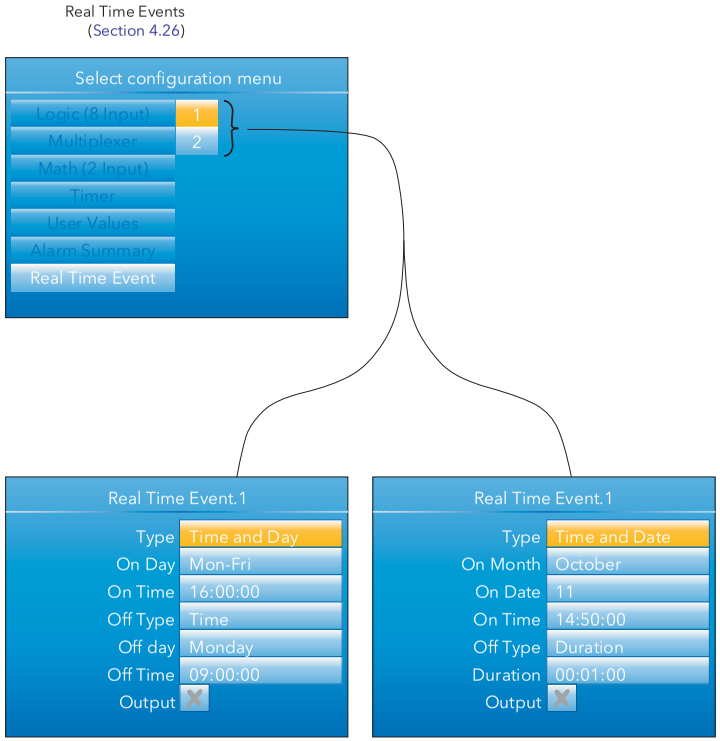


Figure D25 Real Time Event Configration

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Chapter 36 WATER FILTER

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36.1 **HAYWARD – SIMPLEX SB BASKET STRAINER SERIES**

36.2 **MUNICIPAL HOUSING MUNI-5-2FL-304 (2x)**

36.3 **MUNICIPAL HOUSING MUNI-8-2FL-304**

36.4 **HURRICANE CARTIDGE FIL-074-0020-08268 HC/170-20**

36.5 **HURRICANE CARTIDGE FIL-074-0046-08577 HC/170-5**

36.6 **HURRICANE CARTIDGE FIL-074-0046-08576 HC/170-LT2**

SHOP DRAWING FOR APPROVAL

Date : 14/06/2016

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F: 206-338-2249

Project : 2016-061 **Igloolik Truck Fill - YGT12**
Process

	Owner Tag Number	Section	DESCRIPTION	Model	Status	Initial Date of submital
1	F-1 to F-3	23 44 00	Municipal Filter	Harmsco	Initial	14/06/2016
2	-	23 44 00	Cartridge for the Filters	Harmsco	Initial	14/06/2016

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

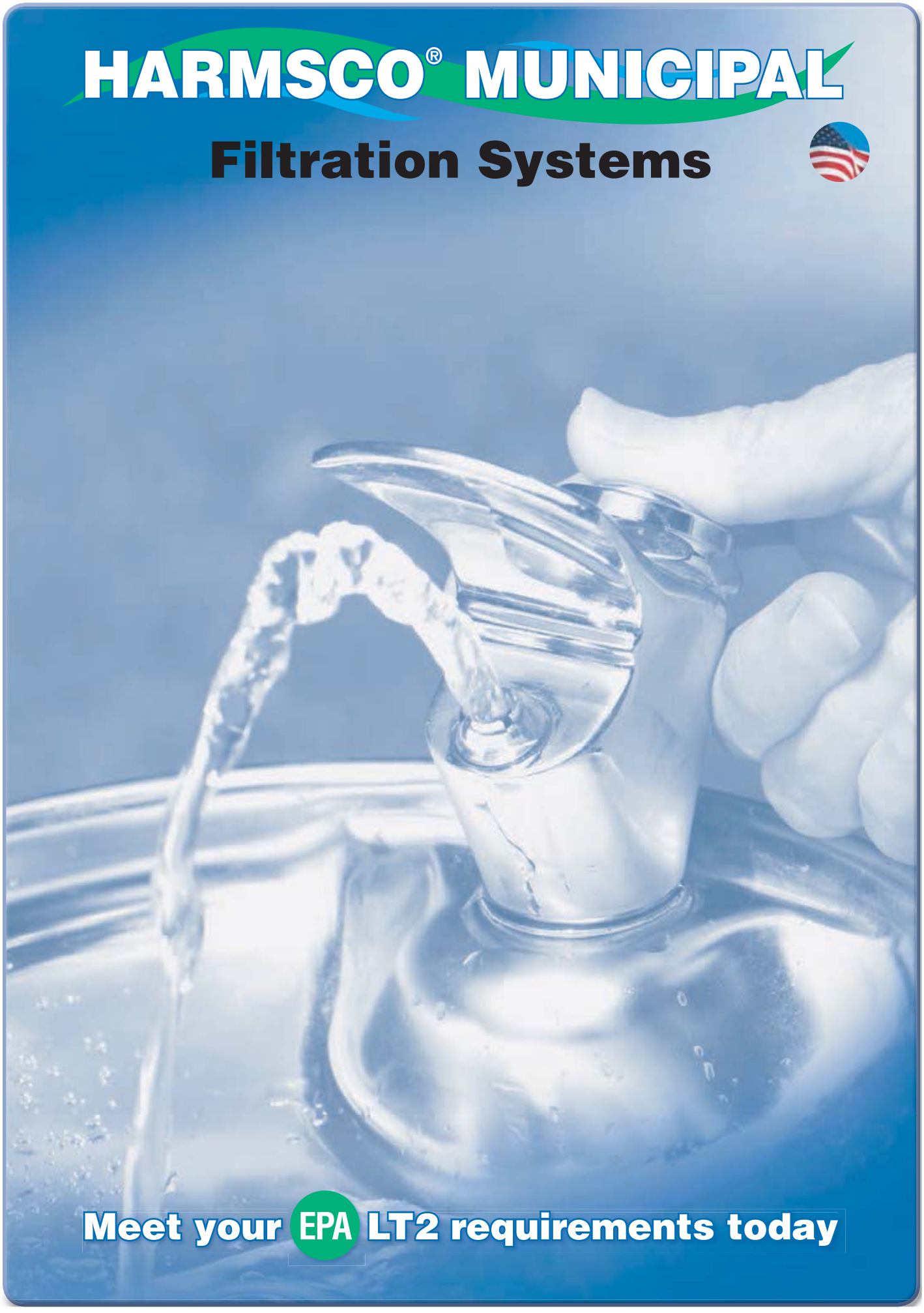
Reviewed pages 1 to 41

Reviewed By: M.M.
Reviewed [X]
Reviewed as noted [ ]
Date: 15 June 2016
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

HARMSCO® MUNICIPAL

Filtration Systems



Meet your EPA LT2 requirements today

Harmsco's Cost-effective Solutions for LT2 Compliance

FACTS

What is Long Term 2 Enhanced Surface Water Treatment Rule (LT2 Rule)?

The EPA has developed the LT2 ESWTR (LT2 Rule) to improve your drinking water quality and provide additional protection from disease-causing microorganisms and contaminants.

Why is the EPA concerned about *Cryptosporidium*?

Cryptosporidium is a significant concern in drinking water because it contaminates most drinking water sources, it is resistant to chlorine and other disinfectants, and has caused waterborne disease outbreaks. Consuming water with ***Cryptosporidium*** can cause gastrointestinal illness which may be severe and sometimes fatal for people with weakened immune systems including infants and the elderly. The EPA estimates that full compliance with LT2 ESWTR will reduce the incidence of cryptosporidiosis by 89,000 to 1,459,000 cases per year, with an associated reduction of 20 to 314 premature deaths.

Who does this rule apply to?

The LT2 ESWTR applies to all public water systems that use surface water, or ground water under the direct influence of surface water. This includes about 14,000 systems serving approximately 180 million people.

LT2 ESWTR Toolbox Manual (April, 2010)

COMPLIANCE

- All components used in drinking water treatment process should be evaluated for contaminant leaching and Certified under **ANSI/NSF Standard 61**.
- The **filter housing and cartridge** must be challenge tested per **LT2 ESWTR Toolbox Guidance Manual** with specific instructions regarding:
  - Full scale filter testing, challenge particulate, test solution concentration, challenge test duration, water quality of test solution, maximum design flow rate, challenge particulate seeding method and concentration, sampling procedures and calculation of log removal.
- Testing is product specific, not site specific, meaning it does not have to be tested at every water system seeking removal credit. Instead, a manufacturer or independent third party would challenge test each of its products in order to obtain a 2.0- or 2.5-log Cryptosporidium removal rating:
  - Up to 2.0-log removal for individual cartridge filters showing a minimum of 3.0-log removal in challenge testing.
  - Up to 2.5-log removal for cartridge filters in series showing a minimum of 3.0-log removal in challenge testing.
- A minimum of two (2) bag or cartridge filter housings should be provided to ensure continuous water treatment in the event of failure in the filter operation and to allow for filter maintenance and replacement.

For more information, please visit: http://water.epa.gov/lawsregs/rulesregs/sdwa/lt2/basicinformation.cfm

Harmsco® LT2 Cartridges for Cyst-free Drinking Water

Harmsco® LT2 cartridges and housings exceed the three-log (99.9%) removal requirement described in LT2 ESWTR Toolbox Guidance Manual 8.4.1. for cyst-sized particles. For this reason, Harmsco® LT2 filter cartridge elements are ideal to control cryptosporidium, giardia cysts and other harmful microorganisms to help ensure safe drinking water.

Independent Lab Validated

To verify the performance of the Harmsco® LT2 cartridge and NSF filter housing, Pace/IBR, highly respected independent testing facilities, were selected to conduct challenge tests as outlined in the LT2 ESWTR Toolbox Guidance Manual 8.4.1. This defines the maximum challenge particulate based on detection limit and acceptable cryptosporidium surrogate…2 microns in these tests. The "terminal" pressure drop was determined by Harmsco® to be 30 psi. The Harmsco® LT2 cartridges were tested via single pass protocol per the EPA at 3 separate points: 1.) after initial flushing (clean cartridge), 2.) at 50% of terminal pressure drop (15 psid) and 3.) after terminal pressure loss has been reached (30 psid).

Results of Challenge Test Conducted by IBR

Cartridge Tested	Filter Housing	Tested Flow Rate	Sample Point	Minimum Log Removal
HC/170-LT2	MUNI-1-2FL-304	100 GPM	Initial Efficiency	3.6
			50% Terminal Pressure Drop: 15 psi	3.8
			100% Terminal Pressure Drop: 30 psi	3.7

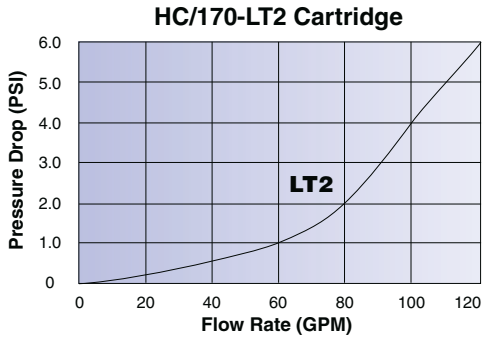
Features & Benefits

- NSF-61 Listed cartridge filter system removes cyst-sized particles providing safe drinking water
- Pleated microfiber media provides exceptional surface area for longer filter life and increased particle removal
- Patented Dual Durometer end caps ensure positive end cap sealing
- End caps, center tubes and media are thermally bonded as one integral component for added strength while providing superior sealing
- 125 sq. ft. media (surface area) in a single cartridge design
- FDA Listed Materials: Manufactured from materials which are listed for food contact applications in Title 21 of the U.S. Code of Federal Regulations

LT2 Cartridge
Length and O.D.

Low Pressure Drop

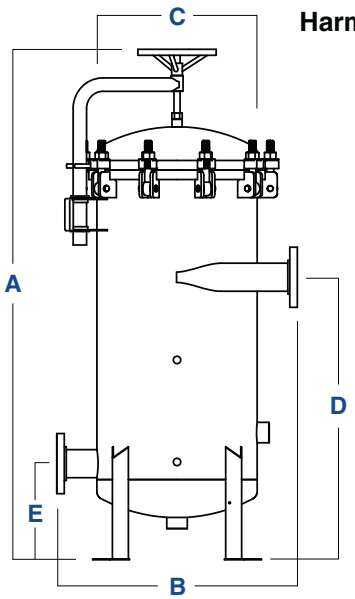
Initial pressure drop using HC/170-LT2 cartridges is exceptionally low due to our pleated design and increased surface area. Pressure drop data is shown below, calculated for new cartridges in clear water.



Specifications

- **Filter Media:** FDA borosilicate microglass with acrylic binder
- **Support Media:** spun-bonded polyester laminated on both upstream and downstream sides
- **Center Tubes:** rigid PVC with perforations
- **End Caps:** plastisol (pliable PVC)
- **Heat-seal Bags:** standard on HC/170-LT2 cartridge
- **Flow Rate:** 100 GPM (recommended) per HC/170-LT2 cartridge; > 3.6 Log removal
- **Temperature:** 140˚F (60˚C) max*
  * Temperature limits vary and depend on pressure and time under load.
- **Maximum Change Out:** 30 PSI (2.07 Bar) ΔP
- **Surface Area:** 125 sq. ft. (HC/170-LT2)
- **Dimensions:** 7-3/4" O.D.; 4" I.D.; 30-3/4" L.
- **pH:** 3 to 11

HARMSCO® MUNICIPAL Filtration Systems



Harmsco HURRICANE® Animation:
www.harmsco.com/z/100

Certified: NSF/ANSI Standard 61
Drinking Water System Components - Health Effects

Certified to ANSI-NSF 61

MUNI-1-2FL-304

MUNI-3-3FL-304

MUNI-5-4FL-304

MUNI-8-6FL-304

Filter Model	A Filter Height	B Width	C Diameter	D Inlet	E Outlet	Pipe Size I/O NPS	Drain Size NPT	Floor Space	Service Height	Shipping Wt. (lbs.)
MUNI-1-2FL-304	48”	15-1/2”	11”	23-5/8”	9-3/4”	2” Flange	3/4”	1.6 ft²	77”	150
MUNI-3-3FL-304	64”	30”	20”	35-1/4”	12”	3” Flange	1-1/2”	4.5 ft²	98-1/2”	420
MUNI-5-4FL-304	74”	37-1/2”	30”	38”	14-1/8”	4” Flange	1-1/2”	8.5 ft²	98-1/2”	1,100
MUNI-8-6FL-304	84”	45-1/4”	35-3/8”	44-1/4”	20-1/2”	6” Flange	1-1/2”	14 ft²	104-1/2”	1,600

2
1

Design Recommendations

Pre-filtration is always recommended due to potential changes in environmental conditions. Turbidity must not exceed 1-NTU prior to final filtration stage (HC/170-LT2 cartridge). For more information please contact Harmsco Filtration Products.

Pre-Filtration

Filter Model	NO. of Cartridges	Pleated Media Area (sq.ft.)	Max Flow Rate (GPM)	Max Flow Rate (LPM)	Max Flow Rate (M³/HR)
MUNI-1-2FL-304	1	170	150	568	34
MUNI-3-3FL-304	3	510	450	1,703	102
MUNI-5-4FL-304	5	850	750	2,839	170
MUNI-8-6FL-304	8	1,360	1,200	4,542	272

Final Stage

Filter Model	NO. of Cartridges	Pleated Media Area (sq.ft.)	Max Flow Rate (GPM)	Max Flow Rate (LPM)	Max Flow Rate (M³/HR)
MUNI-1-2FL-304	1	125	100	378	23
MUNI-3-3FL-304	3	375	300	1,135	68
MUNI-5-4FL-304	5	625	500	1,892	113
MUNI-8-6FL-304	8	1000	800	3,028	181

Filter Specifications

- 304L or 316L stainless steel, electropolished
- Built to ASME design standards (not code stamped)
- Standpipe - 304L or 316L stainless steel
- Inlet/Outlet - flanged connections
- NSF 61 Listed Ball Valves (2) - 316 stainless steel
- O-ring housing seal, swing bolt closure
- NSF 61 Listed Pressure Gauges (2) - 316 stainless steel
- Pressure - 150 psi (10 bar) max.
- Temperature* - up to 140˚F (60˚C) with standard cartridges

* Temperature ratings based on pressure and time under load.

Note: This publication is to be used as a guide. The data within has been obtained from many sources and is considered to be accurate. Harmsco does not assume liability for the accuracy and/or completeness of this data. Changes to the data can be made without notification. Temperature, Pressure, Flow Rates, Differential Pressures, Chemical Combinations and other unknown factors can affect performance in unknown ways. **Limited Warranty:** Harmsco warrants their products to be free of material and workmanship defects. Determination of suitability of Harmsco products for uses and applications contemplated by Buyer shall be the sole responsibility of Buyer. The end user/installer/buyer shall be liable for the product's performance and suitability regarding their specific intended applications. End users should perform their own tests to determine suitability for each application.

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HARMSCO® MUNICIPAL LT2

3.6 Log Removal

Pleated Microglass Cartridges

Meets Long Term 2 (LT2) Requirements for Ground Water Under Direct Influence of Surface Water (GWUDI)

Certified: NSF/ANSI Standard 61
Drinking Water System Components - Health Effects

High flow capability
Low initial pressure drop
Lower overall operating cost
Increased contaminant removal
Longer filter runs for fewer change-outs

Features

- NSF-61 Listed filter media removes cyst-sized particles for safe, cyst-free drinking water
- Pleated microfiber media provides more surface area for longer filter life and increased particle removal
- Patented Dual Durometer end caps ensure positive end cap sealing
- End caps, center tubes and media are thermally bonded as one integral component for added strength and to provide superior end sealing
- 38 - 125 sq. ft. media (surface area) in a single cartridge design
- FDA Listed Materials: Manufactured from materials which are listed for food contact applications in Title 21 of the U.S. Code of Federal Regulations

Applications

Pleated Microglass Cartridges

- Surface Water Treatment Rule (SWTR) LT2
- Ground Water Under Direct Influence (GWUDI)
- Municipal Drinking Water
- Reverse Osmosis Pre-filtration
- Food & Beverage Filtration
- Desalination Pre-filtration
- Commercial/Residential Drinking Water
- Marine/Aquatic Filtration

Specifications

- Filter Media: FDA borosilicate microglass with acrylic binder
- Support Media: spun-bonded polyester laminated on both upstream and downstream sides
- Center Tubes: rigid PVC with perforations
- End Caps: Dual Durometer plastisol (pliable PVC) ensures a positive sealing surface
- Shrink Wrap: standard on all LT2 cartridges
- Flow Rate: 30 to 100 GPM (recommended) per Harmsco® LT2 cartridge; > 3.6 Log removal
- Temperature: 140˚F (60˚C) max*
  * Temperature limits vary and depend on pressure and time under load.
- Change Out: 25 - 30 PSI (1.72 - 2.07 Bar) ΔP
- Surface Area: 38 to 125 sq. ft.
- pH: 3 to 11

INDEPENDENT LAB VALIDATED

To verify the performance of the Harmsco LT2 cartridge and NSF filter housing, IBR, a highly respected independent testing facility, was selected to conduct a challenge test outlined in the LT2 ESWTR Toolbox Guidance Manual 8.4.1. This defines the maximum challenge particulate based on detection limit and acceptable cryptosporidium surrogate…2 microns in this test. The "terminal" pressure drop was determined by Harmsco to be 30 psi. The Harmsco LT2 cartridge was tested in a single-pass challenge test at 3 points…after initial flushing, at 15 psi differential, and again at 30 psi differential.

Results of Challenge Test
Using 2-micron surrogate beads.

Sample Point	Log Removal
Initial Efficiency	3.6
50% Terminal Pressure Drop: 15 psi	3.8
100% Terminal Pressure Drop: 30 psi	3.7

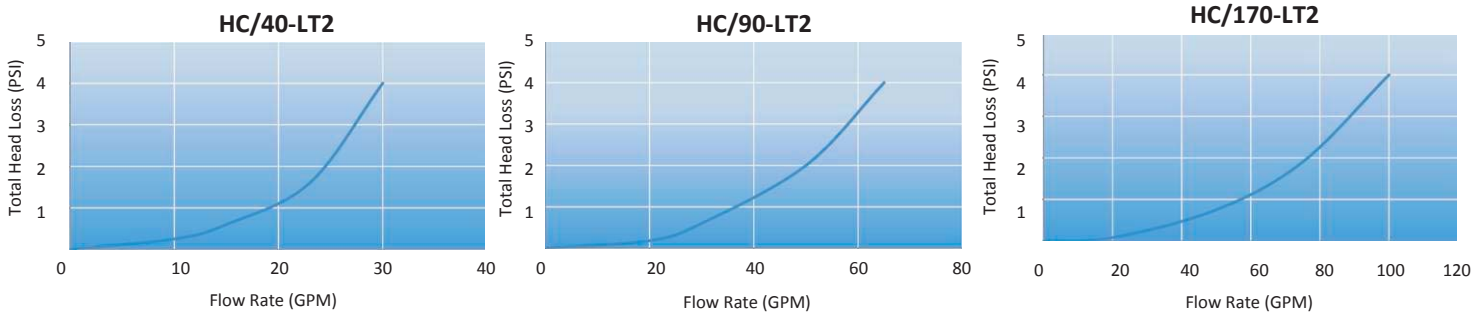
Cartridge Selection/Sizing Guide

Product Code	Pleated Media Area (sq. ft.)	Length (in.)	O.D. (in.)	I.D. (in.)	Recommended Flow Rate (gpm) for >3.6 log removal
LT2 Pleated Microglass Cartridges - Packed one cartridge per case.					
HC/40-LT2	38	9-5/8	7-3/4	4	30
HC/90-LT2	81.25	19-1/2	7-3/4	4	65
HC/170-LT2	125	30-3/4	7-3/4	4	100

Meets the Challenge Test Method defined in the LT2 ESWTR Tool Box Guidance Manual 8.4.1

Low Pressure Drop

Initial pressure drop using HC/170-LT2 cartridges is exceptionally low due to our pleated design and increased surface area. Pressure drop data is shown below, calculated for new cartridges in clear water.



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Made in USA
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HARMSCO®

Premium Hurricane® Polyester Cartridges

Maximum Surface Area

Designed for Hurricane® and WaterBetter® Filter Housings

High Flow Performance

Lower Operation Cost with Hurricane® Cartridges

- **High flow capability**
- **Lower overall operating cost**
- **Reduced waste disposal**
- **Longer filter runs for fewer change-outs**
- **Increased contaminant removal**
- **Operator friendly**

NSF Certified to ANSI-NSF 61

Premium Hurricane® Polyester Cartridges

Features

- Fewer cartridges for fewer change-outs and lower maintenance cost
- Pleated Polyester-Plus™ filter media provides higher flow rates and lower initial pressure drop
- Pleated surface area provides higher loading capacity for longer filter life and increased particle removal
- End cap, center tube and media are thermally bonded as one integral component for added strength
- Offered in three sizes (40, 90 and 170) and eight micron ratings (0.35, 1, 5, 10, 20, 50, 100 and 150) to meet all your high flow requirements

Applications

- Reverse Osmosis Pre-filtration
- Municipal Drinking Water Filtration
- Commercial/Residential Drinking Water Filtration
- Desalination Pre-filtration
- Industrial Water Filtration
- Cooling Tower Filtration
- Chill Water Loop Filtration
- Food & Beverage Filtration
- Marine/Aquatic Filtration
- Industrial Coolant Filtration

Premium Hurricane® Polyester Cartridges

Specifications

- **Micron Ratings:** Nominal micron ratings of 0.35, 1, 5, 10, 20, 50, 100, 150
- **Filter Media:** nominal pleated Polyester-Plus™
- **End Caps:** Pliable PVC with sealing surface built-in
- **Center Tubes:** ABS or PVC
- **Temperature:** 140˚F (60˚C) temperature limit*

* Temperature limits vary and depend on pressure and time under load.

Cleanable/Reusable in most filtration applications and micron ratings.

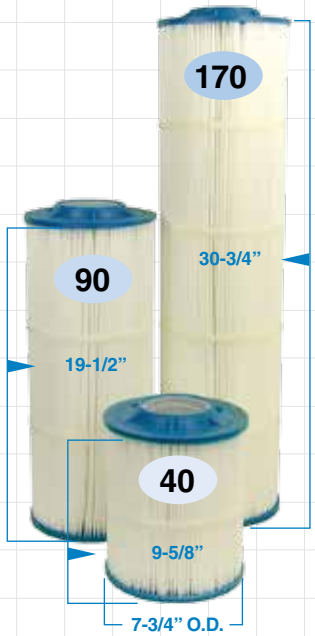
NSF Certified to ANSI-NSF 61

Cartridge Selection/Sizing Guide

7-3/4" O.D. For Harmsco® Hurricane® and WaterBetter® Single-cartridge Filter Housings

Cartridge Length	Product Code	Nominal Micron Rating	Media (sq ft)	Recommended Flow Rate* (GPM)	Max Flow Rate* (GPM)	Max Flow Rate* (LPM)	Max Flow Rate* (M^3/HR)	No./ Carton	Carton Size
	Premium Hurricane® Polyester Cartridges - rated up to 140˚F (60˚C).								
9-5/8"	HC/40-0.35	0.35	40	35	50	189	12	1	9x9x11
	HC/40-1	1	40	35	50	189	12	1	9x9x11
	HC/40-5	5	40	35	50	189	12	1	9x9x11
	HC/40-10	10	40	35	50	189	12	1	9x9x11
	HC/40-20	20	40	35	50	189	12	1	9x9x11
	HC/40-50	50	40	35	50	189	12	1	9x9x11
	HC/40-100	100	40	35	50	189	12	1	9x9x11
	HC/40-150	150	40	35	50	189	12	1	9x9x11
19-1/2"	HC/90-0.35	0.35	90	70	100	378	24	1	9x9x21
	HC/90-1	1	90	70	100	378	24	1	9x9x21
	HC/90-5	5	90	70	100	378	24	1	9x9x21
	HC/90-10	10	90	70	100	378	24	1	9x9x21
	HC/90-20	20	90	70	100	378	24	1	9x9x21
	HC/90-50	50	90	70	100	378	24	1	9x9x21
	HC/90-100	100	90	70	100	378	24	1	9x9x21
	HC/90-150	150	90	70	100	378	24	1	9x9x21
30-3/4"	HC/170-0.35	0.35	170	105	150	568	36	1	9x9x32
	HC/170-1	1	170	105	150	568	36	1	9x9x32
	HC/170-5	5	170	105	150	568	36	1	9x9x32
	HC/170-10	10	170	105	150	568	36	1	9x9x32
	HC/170-20	20	170	105	150	568	36	1	9x9x32
	HC/170-50	50	170	105	150	568	36	1	9x9x32
	HC/170-100	100	170	105	150	568	36	1	9x9x32
	HC/170-150	150	170	105	150	568	36	1	9x9x32

*Harmsco® recommends operation at 70% of maximum flow rate for optimum performance.

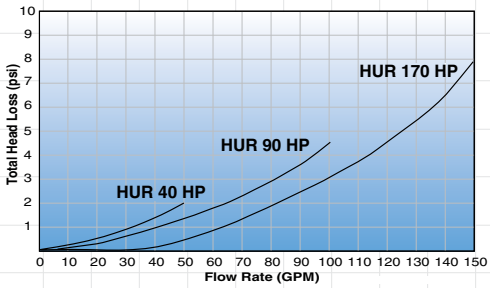


Premium Hurricane® Polyester Cartridges

Length and O.D.

Pressure Drop

Pressure drop shown at right is for filter housing and 20 micron filter cartridge in clean water.



Note: This publication is to be used as a guide. The data within has been obtained from many sources and is considered to be accurate. Harmsco does not assume liability for the accuracy and/or completeness of this data. Changes to the data can be made without notification. Temperature, Pressure, Flow Rates, Differential Pressures, Chemical Combinations and other unknown factors can affect performance in unknown ways. **Limited Warranty:** Harmsco warrants their products to be free of material and workmanship defects. Determination of suitability of Harmsco products for uses and applications contemplated by Buyer shall be the sole responsibility of Buyer. The end user/installer/buyer shall be liable for the product's performance and suitability regarding their specific intended applications. End users should perform their own tests to determine suitability for each application.

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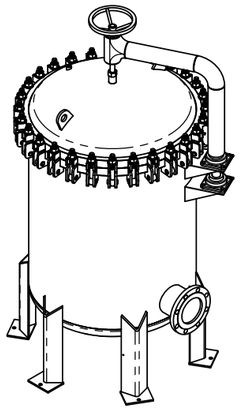
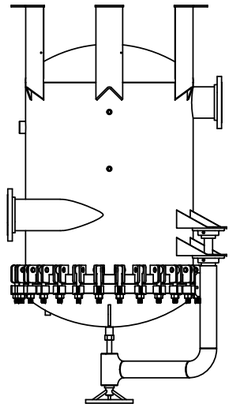
E FILE: Harmsco MUNI-8-6FL-304, 6 view DXF

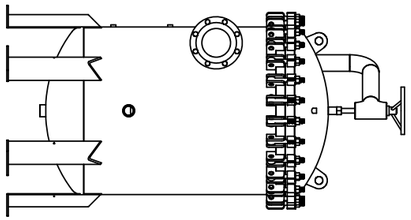
DRAWING SIZE: B

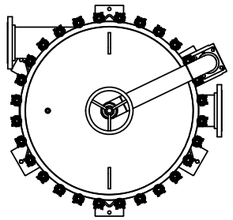
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED

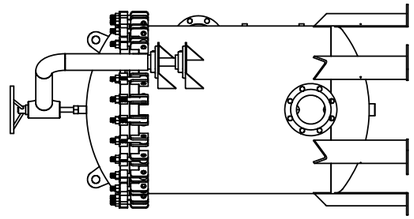


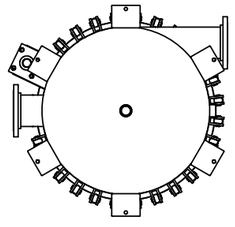


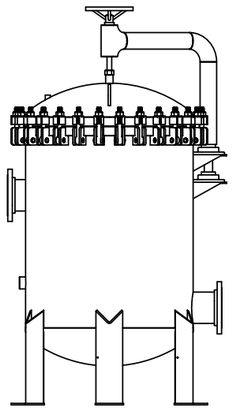
FOR CAD SCALING PURPOSES;
OD OF TANK IS 35.400 INCHES











APPROVALS		DATE
DRAWN	RS	8-1-14
APPROVED		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:

FRACTIONS	DECIMALS	ANGLES
+/- 1/32	+/- .010	+/- 30'

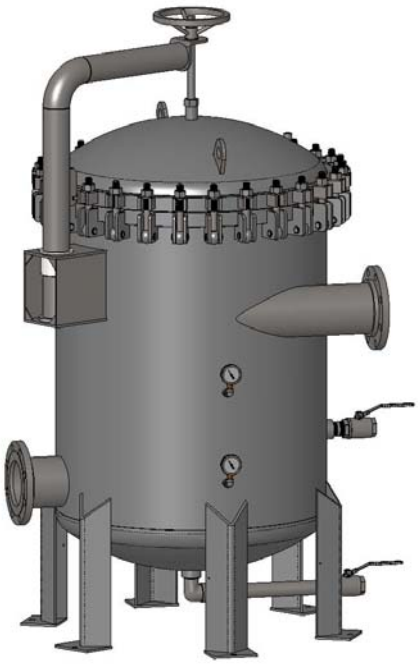
DRAWN ON CAD DO NOT SCALE

HARMSCO INC.

P.O. BOX 14066 N. PALM BEACH, FL

SCALE	PART NAME	PART NO.
"1:32"	6 view DXF of MUNI-8-6FL-304	MUNI-8-6FL-304

PRODUCT SPECIFICATION
Harmsco® Model #: MUNI-8-6FL-304



Description: Tangential Entry, Up-Flow Cartridge Filter Housing with; Swing Bolt Closure, Davit Cover Lift, and Flanged Connections.

Details:

1. Stainless steel construction, wetted metallic components are 304/304L SS.
2. Electro-polish finish.
3. Swing bolt style housing closure. Swing bolts are SS alloy per ASTM A-193 B7.
4. NSF Certified using Genuine Harmsco® Hurricane® replacement filter cartridges.*
5. Tangential inlet and the integral inner-can, create a centrifugal flow that induces pre-filtration by heavy particulate separation.
6. Patented "Up-Flow" design that;
   a. Self purges housing of air.
   b. Eliminates by-pass contamination during servicing.
   c. Improves efficiency by creating an even flow distribution across filtering media.
7. Strong, durable, built to ASME Design Standards.
8. Utilizes eight (8) Genuine Harmsco® Hurricane® HC/170 series filter cartridges. *
9. Inlet & Outlet are NPS 6 Flanges ANSI/ASME B16.5 Class 150
10. Drains (Qty 2) are 1-1/2" Female NPT (FPT) Couplings, Class 1000
11. Ball Valves (Qty 2) 1-1/2" NSF 61 316SS included.
12. Vent is 1/2" Female NPT (FPT) Coupling, Class 1000
13. Gauge Ports (Qty 2) are 1/2" Female NPT (FPT) Couplings, Class 1000
14. Pressure Gauges (Qty 2, w/fittings) NSF 61 316SS included.
15. Closure Gasket is EPDM 70 Durometer O-ring.
16. Pressure Rating - 150 P.S.I.G.
17. Temperature Rating – Up to 140°F
    Note: Higher temperatures are possible, check cartridge specifications. **
18. Flow Rate – 800 GPM Max. with HC/170-LT2 cartridges.
    *(1200 gpm max for **pre-filtration only** utilizing Harmsco Premium Series cartridges 5u and above)*
    See Pressure Drop vs. Flow Rate Curve, page 2.
19. One person can perform maintenance.

Requirements:

Floor Load:	Dry weight = 1,640 lbs. Volume = 232 US gallons x 8.337 lbs./US gallon (water) = 1,935 lbs. Total weight = 1,640 + 1,935 = 3,575 lbs. (housing + water) Floor contact area = 1.164 ft². Floor Load = 3,575 lbs. divided by 1.164 ft² = **3,100 pounds per square foot** (approx.) Note: Piping shall conform to all applicable codes and be independently supported. If floor strength is suspect, use appropriate measures to adequately distribute load.
Floor Space:	**14 ft²** (does not include Cover/Davit swing position), See Installation Diagram, page 3.
Service Height:	104-1/2", See Installation Diagram, page 3.
Bonding:	Housing shall be bonded in accordance with all applicable codes. A grounding lug is provided.

Recommended Spare Parts:
Closure Gasket O-ring: PN 368-E
Set of 8 Harmsco® Hurricane® HC/170 replacement cartridges

* The use of any filter cartridges other than Genuine Harmsco® Hurricane® filter cartridges in this filter housing voids certifications by NSF International.
** Contact a Harmsco® sales representative for Harmsco® Hurricane® HC/170 filter cartridge specifications.

This product is manufactured under one or more of the following patents: U.S. NO. 4,187,179; 3,720,322; CANADA NO. 977,693; GT. BRIT. NO. 1,372,014; W. GERMANY NO. 2,261,817; FRANCE NO. 7,246,864; EUROPEAN NO. 0,191,844, Other patents pending.
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File Name:
SPECIFICATION MUNI-8-6FL-304 (pg. 1 of 3)

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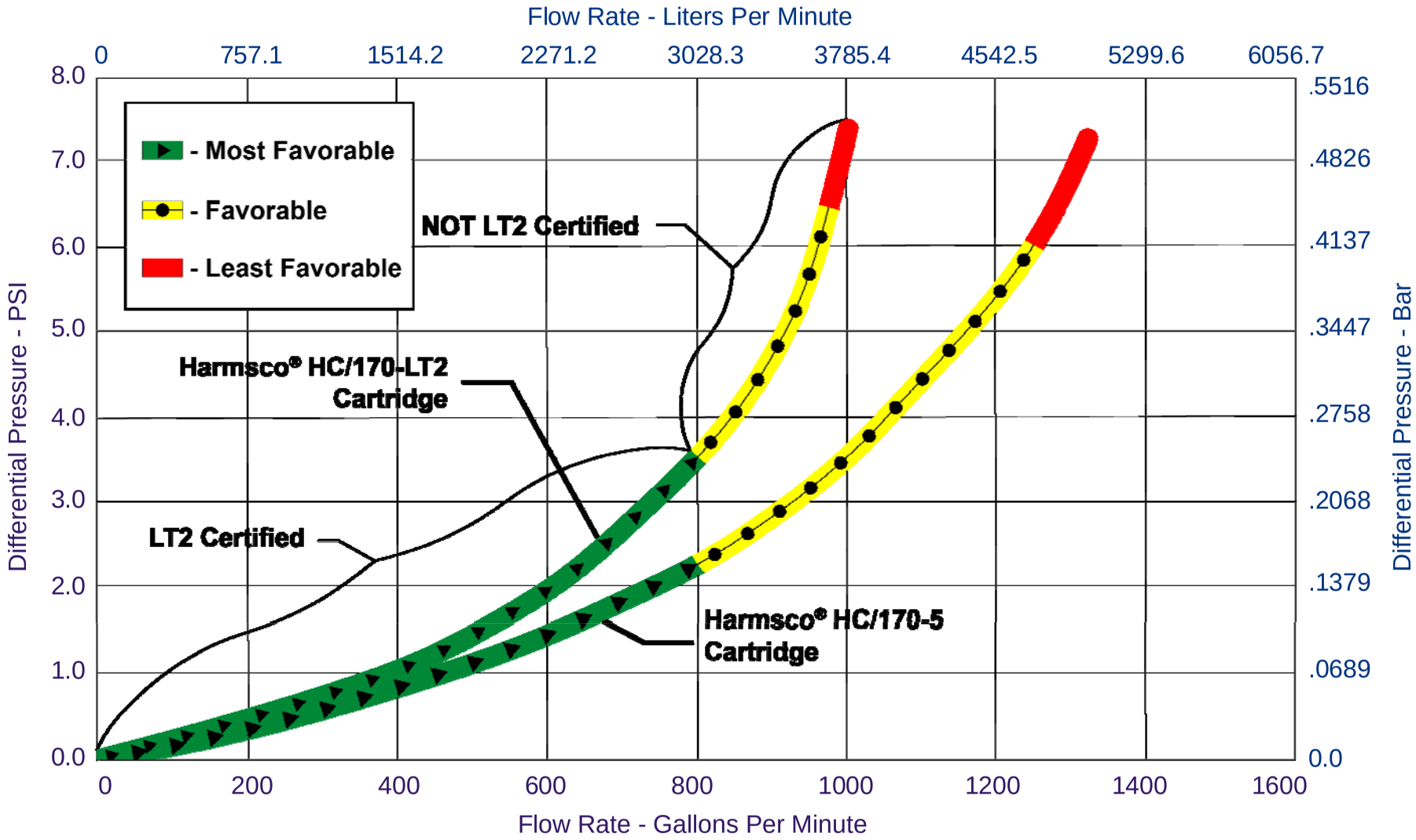
Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-8-6FL-304



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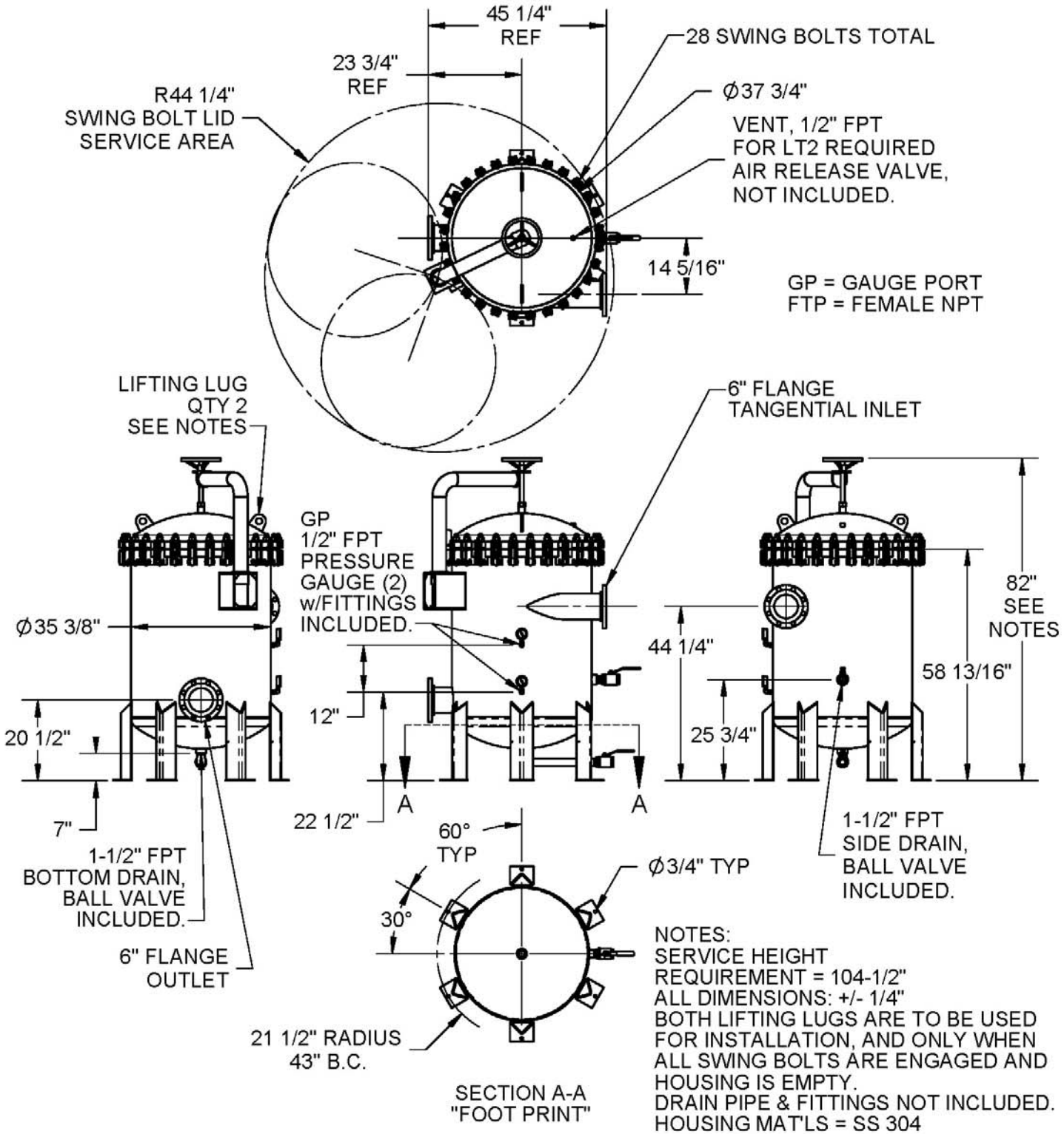
Harmsco® Filtration Products
Installation Diagram
MUNI-8-6FL-304 Swing Bolt Housing



NOTES:
SERVICE HEIGHT REQUIREMENT = 104-1/2"
ALL DIMENSIONS: +/- 1/4"
BOTH LIFTING LUGS ARE TO BE USED FOR INSTALLATION, AND ONLY WHEN ALL SWING BOLTS ARE ENGAGED AND HOUSING IS EMPTY.
DRAIN PIPE & FITTINGS NOT INCLUDED.
HOUSING MAT'LS = SS 304

MODEL #: MUNI-8-6FL-304

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SPECIFICATION MUNI-8-6FL-304 (pg. 3 of 3)

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E FILE: Harmsco MUNI-5-4FL-304, 6 view DXF

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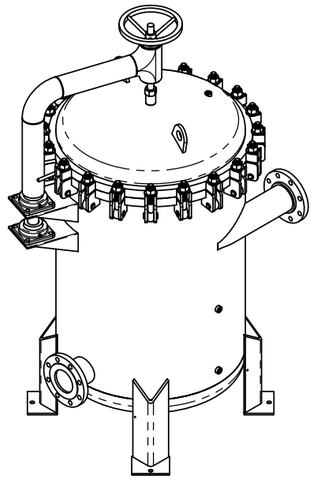
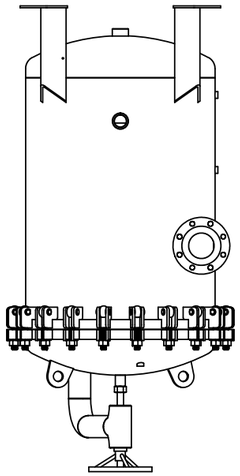
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED





FOR SCALING PUPOSES,
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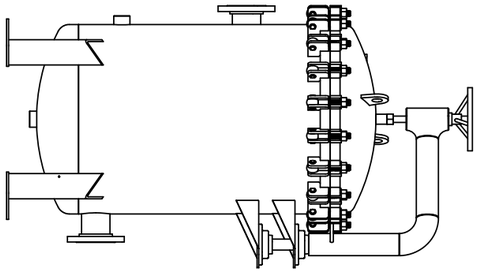

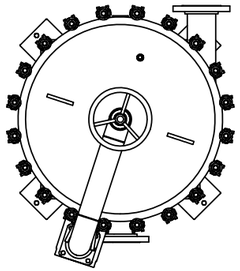

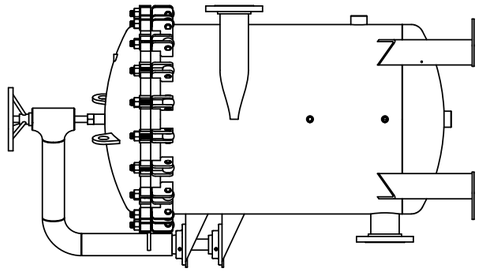

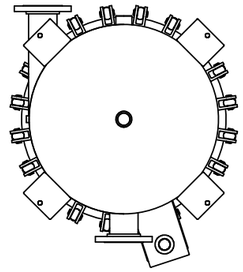

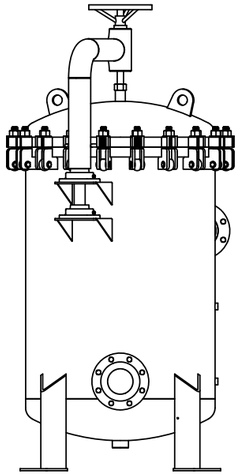

APPROVALS		DATE
DRAWN	RS	8-1-14
APPROVED		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:

FRACTIONS	DECIMALS	ANGLES
+/- 1/32	+/- .010	+/- 30'

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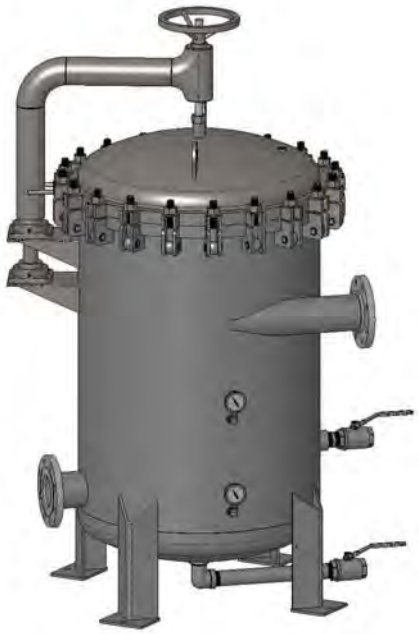
HARMSCO INC.

P.O. BOX 14066 N. PALM BEACH, FL

SCALE	PART NAME	PART NO.
"1:24"	6 view DXF of MUNI-5-4FL-304	MUNI-5-4FL-304

PRODUCT SPECIFICATION
Harmsco® Model #: MUNI-5-4FL-304



Description: Tangential Entry, Up-Flow Cartridge Filter Housing with; Swing Bolt Closure, Davit Cover Lift, and Flanged Connections.

Details:

1. Stainless steel construction, wetted metallic components are 304/304L ASTM A-240.
2. Electro-polish finish.
3. Swing bolt style housing closure. Swing bolts are SS alloy per ASTM A-193 B7.
4. NSF Certified using Genuine Harmsco® Hurricane® replacement filter cartridges.*
5. Tangential inlet and the integral inner-can, create a centrifugal flow that induces pre-filtration by heavy particulate separation.
6. Patented "Up-Flow" design that;
   a. Self purges housing of air.
   b. Eliminates by-pass contamination during servicing.
   c. Improves efficiency by creating an even flow distribution across filtering media.
7. Strong, durable, built to ASME Design Standards.
8. Utilizes five (5) Genuine Harmsco® Hurricane® HC/170 series filter cartridges. *
9. Inlet & Outlet are NPS 4 Flanges ANSI/ASME B16.5 Class 150
10. Drains (Qty 2) are 1-1/2" Female NPT (FPT) Couplings, Class 1000
11. Ball Valves (Qty 2) 1-1/2" NSF 61 316SS included.
12. Vent is 1/2" Female NPT (FPT) Coupling, Class 1000
13. Gauge Ports (Qty 2) are 1/2" Female NPT (FPT) Couplings, Class 1000
14. Pressure Gauges (Qty 2, w/fittings) NSF 61 316SS included.
15. Closure Gasket is EPDM 70 Durometer O-ring.
16. Pressure Rating - 150 P.S.I.G.
17. Temperature Rating – Up to 140°F
    Note: Higher temperatures are possible, check cartridge specifications. **
18. Flow Rate – 500 GPM Max. with HC/170-LT2 cartridges.
    *(750 gpm max for **pre-filtration only** utilizing Harmsco Premium Series cartridges 5u and above)*
    See Pressure Drop vs. Flow Rate Curve, page 2.
19. One person can perform maintenance.

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016
Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]
Out for approval
SIFEC NORTH INC.

Requirements:

Floor Load:	Dry weight = 1,130 lbs. Volume = 142 US gallons x 8.337 lbs./US gallon (water) = 1,184 lbs. Total weight = 1,130 + 1,184 = 2,314 lbs. (housing + water) Floor contact area = .776 ft² Floor Load = 2,314 lbs. divided by .776 ft² = **3,000 pounds per square foot** (approx.) Note: Piping shall conform to all applicable codes and be independently supported. If floor strength is suspect, use appropriate measures to adequately distribute load.
Floor Space:	**8.5 ft²** (does not include Cover/Davit swing position), See Installation Diagram, page 3.
Service Height:	98-1/2", See Installation Diagram, page 3.
Bonding:	Housing shall be bonded in accordance with all applicable codes. A grounding lug is provided.

Recommended Spare Parts:
Closure Gasket O-ring: PN 365-E
Set of 5 Harmsco® Hurricane® HC/170 replacement cartridges

* The use of any filter cartridges other than Genuine Harmsco® Hurricane® filter cartridges in this filter housing voids certifications by NSF International.
** Contact a Harmsco® sales representative for Harmsco® Hurricane® HC/170 filter cartridge specifications.

This product is manufactured under one or more of the following patents: U.S. NO. 4,187,179; 3,720,322; CANADA NO. 977,693; GT. BRIT. NO. 1,372,014; W. GERMANY NO. 2,261,817; FRANCE NO. 7,246,864; EUROPEAN NO. 0,191,844, Other patents pending.

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Revised: 7-25-14
File Name:
SPECIFICATION MUNI-5-4FL-304 (pg. 1 of 3)

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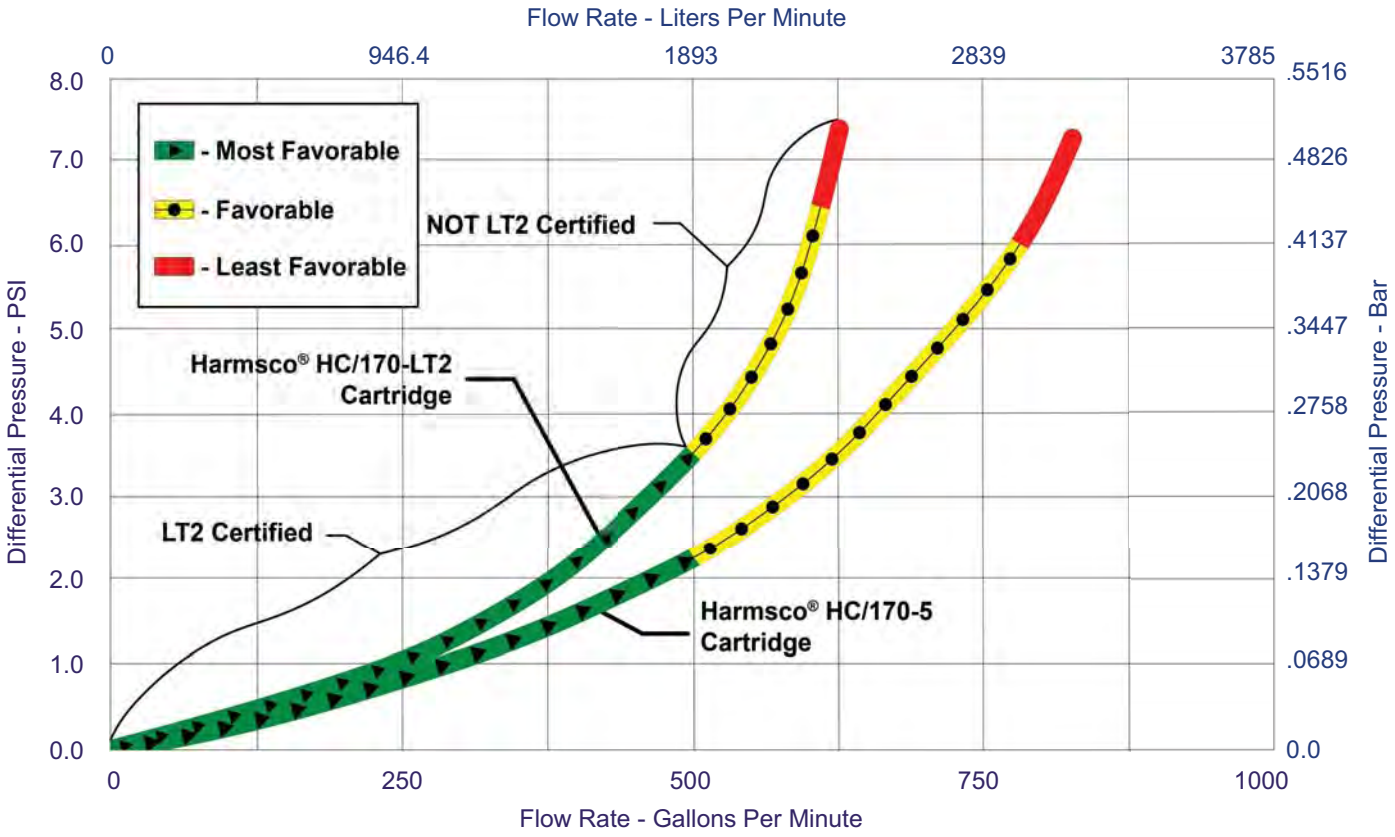
Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-5-4FL-304



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Harmsco® Filtration Products
Installation Diagram
MUNI-5-4FL-304 Swing Bolt Housing

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 14 Juin, 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

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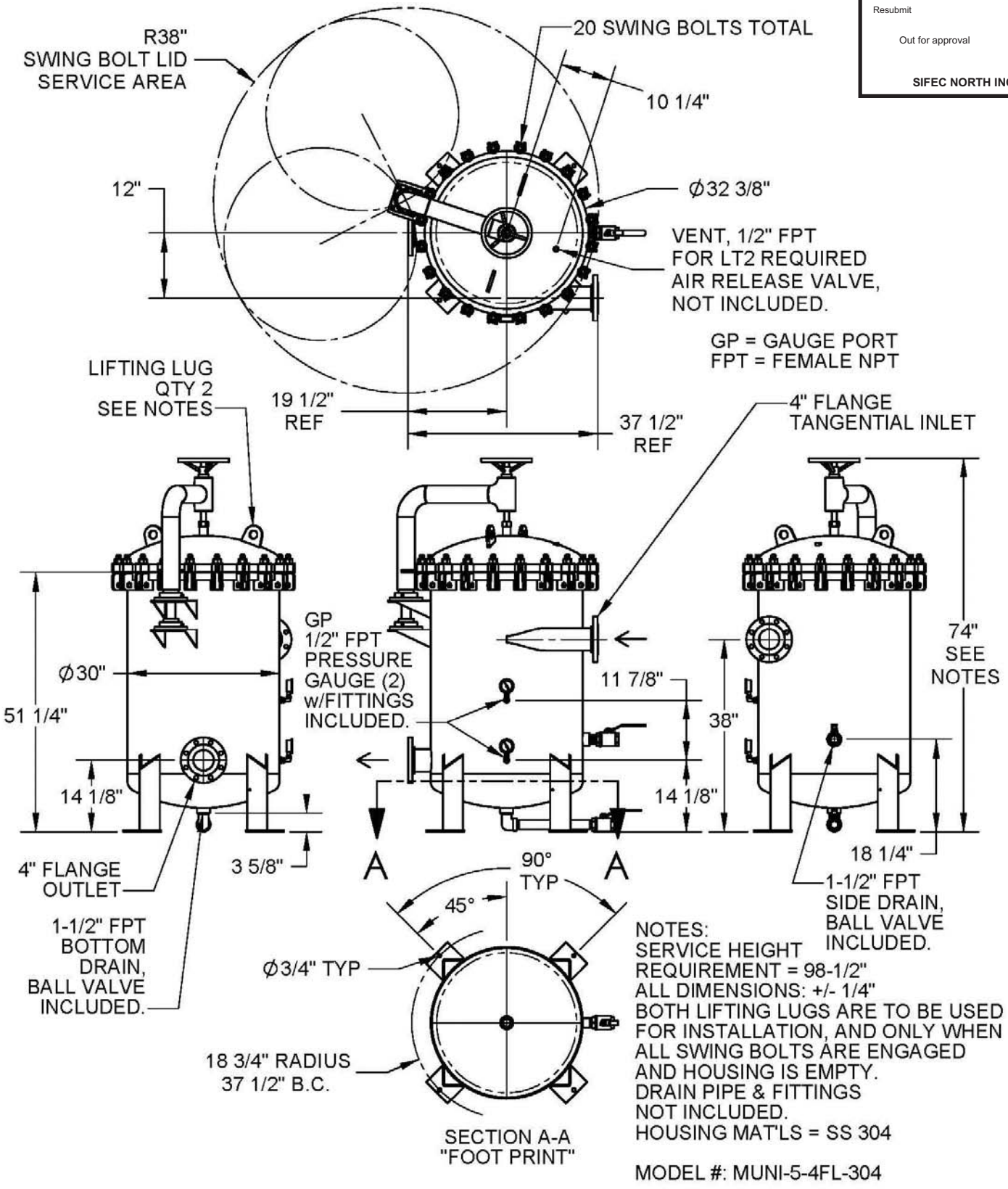

NOTES:
SERVICE HEIGHT REQUIREMENT = 98-1/2"
ALL DIMENSIONS: +/- 1/4"
BOTH LIFTING LUGS ARE TO BE USED FOR INSTALLATION, AND ONLY WHEN ALL SWING BOLTS ARE ENGAGED AND HOUSING IS EMPTY.
DRAIN PIPE & FITTINGS NOT INCLUDED.
HOUSING MAT'LS = SS 304

MODEL #: MUNI-5-4FL-304

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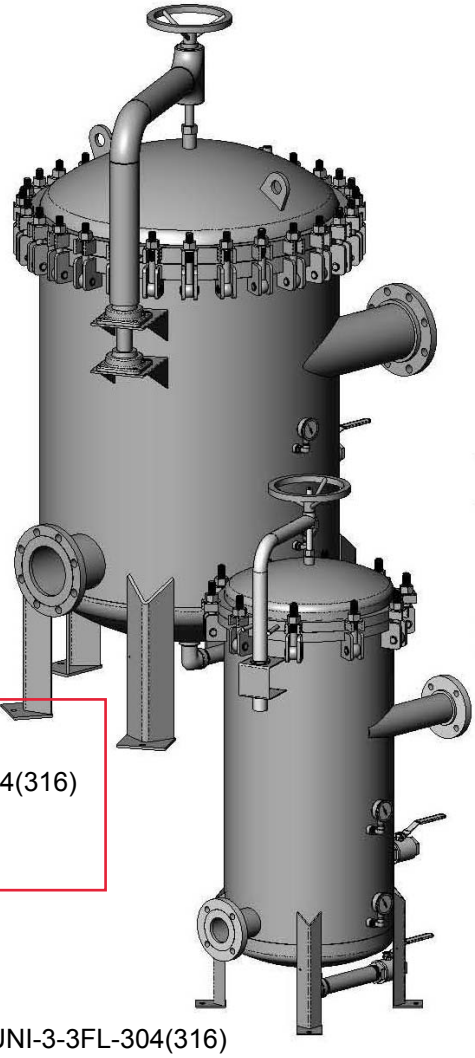
HARMSCO® MUNICIPAL

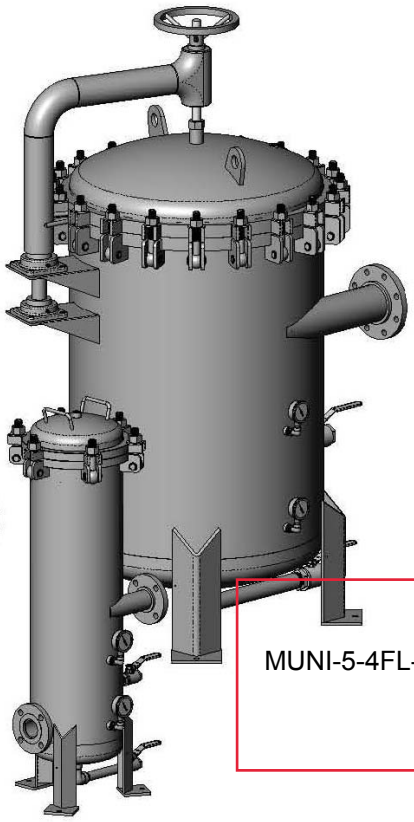
Filtration Systems

Models: MUNI-1-2FL-304(316), MUNI-3-3FL-304(316)
MUNI-5-4FL-304(316), & MUNI-8-6FL-304(316)

INSTALLATION AND OPERATION MANUAL



MUNI-8-6FL-304(316)



MUNI-5-4FL-304(316)

MUNI-3-3FL-304(316)

MUNI-1-2FL-304(316)

NSF®

Certified to NSF/ANSI STD 61

Harmsco® Filtration Products

With Patented Up-Flow and Tangential/Rotational Flow Filtration Technology

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1243-MUNI, MANUAL - MUNI FL SWINGBOLTS
Revised - 11/17

HARMSCO® Municipal Filtration Systems

INTRODUCTION

The Harmsco® Municipal Filtration System is a water filtration device that utilizes the Harmsco® Hurricane® HC/170 size filter cartridge.

The Hurricane® HC/170 cartridges are available in many micron ratings, styles and materials of construction. To meet the EPA LT2 requirement Part Number HC/170-LT2 cartridge is required. Consult the Harmsco® Product Catalog (www.harmsco.com) or a Sales Representative for more details.

All of the Harmsco® Municipal Fitration System housings are NSF Certified per Standard 61 when used with Genuine Harmsco® Hurricane® HC/170 cartridges.

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Safety Precautions:

Before using and installing this product or its components please read this entire manual. Failure to do so could result in serious personal injury or damage to the equipment and assembled components.

This product and all of its components MUST NOT be installed or used in any manner other than that which is specified in this manual.

! WARNINGS !

1. **Seek qualified assistance for installation. Piping shall conform to all applicable State and Local codes and be independently supported.**
2. **Do not install the unit where a temperature of 32° F or lower can occur. Damage caused by freezing shall void all warranties.**
3. **The unit shall be properly bonded in accordance with all applicable State and Local codes. A grounding lug is provided.**
4. **Always isolate unit and relieve pressure before servicing.**
5. **Utilize only Genuine Harmsco® Hurricane® HC/170 filter cartridges. The use of any filter cartridges other than Genuine Harmsco® Hurricane® filter cartridges will void certifications by NSF International.**
6. **Unit is to be bolted to floor/support, see step 9 of Installation/Set-Up**
7. **Do not allow fluid to flow in reverse direction (Backflow) through the unit when filling or draining. This will cause damage to filter cartridges.**

This product is manufactured under one or more of the following patents: U.S. NO. 8,696,906; 7,138,054; 4,187,179; 3,720,322; CANADA NO. 977,693; GT. BRIT. NO. 1,372,014; W. GERMANY NO. 2,261,817; FRANCE NO. 7,246,864; EUROPEAN NO. 0,191,844. Other patents pending.

Notice: The information contained in this publication is considered accurate and is intended to be used as a guide. This information is subject to change without notification. Contact Harmsco® Filtration Products for the latest and most up to date specifications. Harmsco® Filtration Products does not assume any liability for the accuracy and completeness of the data in this publication.

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REQUIREMENTS

- Only qualified personnel are to perform the installation.
- Install shut off valves on both the inlet and the outlet to isolate unit while servicing.
- Unit is to be bolted to floor/support, see step 9 of Installation/Set-Up.
- Installation requires appropriately sized Waste Drain be available for disposal of flushing discharge. Disposal of flushing waste water shall conform to state and local codes.

RECOMMENDATIONS

- Attach drains with supplied ball valves.
- An appropriate Torque Wrench with a 1-7/16” deep well socket should be onsite to properly torque the Swing Bolt Closure hex nuts when servicing Filter Housings.
- Install supplied pressure gauges and fittings into the gauge ports provided.
- Install appropriate Air Relief valve into the Vent Port provided in Lid.
- Close any sampling port valves prior to servicing Filter Housing. NTU meters will read entrained air bubbles. Closing these ports will keep air and any other servicing debris out of the sampling piping. Do not open these sampling ports until flushing of the housing has been completed.
- Lubricate Swing Bolt Assemblies (all models) & Davit Assemblies using Food Grade grease with PTFE and NSF rated H1 only.
- Cleanable Pre-filter Cartridges should be cleaned when differential pressure is at 20 psi.
- Replace cartridge(s) when certain conditions exist.
  For example:
  1. Differential pressure is greater than 30 psi.
  2. Quality of water is unacceptable.
  3. Flow rate has diminished.
  4. Every 6 months

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RECOMMENDATIONS cont.

- **Spare Parts:**
  1. Sufficient supply of replacement cartridges.
  2. Housing O-ring Seal:

Model #	Part #		
	EPDM (std)	BunaN	Viton
MUNI-1-2FL-304(316)-HP	361-E	361-B	361-V
MUNI-3-3FL-304(316)-HP	363-E	363-B	363-V
MUNI-5-4FL-304(316)-HP	365-E	365-B	365-V
MUNI-8-6FL-304(316)-HP	368-E	368-B	368-V

  3. Additional: Cartridge Lifting Handle/Plug, Part #362-L(-316)

- Do Not leave stagnant liquid in the filter housing.

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INSTALLATION/SET-UP

The following instructions & diagrams show the Harmsco® Municipal Filtration System housing with typical plumbing hook-up requirements. All steps of the installation are to be performed by qualified personnel.

1. Always adhere to state and local plumbing codes and requirements for design of installation.
2. For models MUNI-3-3FL-304(316), MUNI-5-4FL-304(316) & MUNI-8-6FL-304(316), make sure sufficient space is available to rotate lid away from housing allowing access to all cartridges.
3. Install incoming water supply with shut off valve to flange marked "Inlet".
4. Install return line with shut off valve to flange marked “Outlet”.
5. Install supplied ball valves in drain lines into the FPT couplings located at the bottom center and side of housing.
6. Install supplied pressure gauges and fittings into the gauge ports.
7. Install air relief valve into the vent port in lid.
8. Bond the filter housing utilizing the grounding lug on the leg.
   - must be performed by a qualified electrician.
9. Bolt down housing to floor/support with appropriate hardware per the application and seismic zone, through the holes at the base of the legs - see SECTION A-A “FOOTPRINT” of the Installation Diagrams. Models MUNI-5-4FL-304(316) & MUNI-8-6FL-304(316) have two lifting lugs welded onto the lid for positioning of the housing. Swing bolts must be engaged and the housing must be empty prior to using the lifting lugs.
10. Refer to Specifications, Installation Block Diagram & Installation Diagrams for more details.

Notes:

- Shut-off valves shall be installed on inlet and outlet for servicing unit.
- To protect against electrolysis, all filters shall be bonded.
  Failure to properly bond the filter will void all warranties.
- NSF STD 61 listed drain valves and pressure gauges are provided.
  In heavy solids applications, the side drain may be used to purge sediments while filter is in operation.
- Use gaskets, sealants and/or expansion/vibration coupling materials appropriate for the application.
- When filling the unit, adequately flush unit through Outlet Flushing Port or Bottom Drain Port to waste drain to remove air (champagne-like bubbles) from filtration media prior to use. The hundreds of square feet of filtration media hold a lot of air that produces fine bubbles resulting in a foam appearance. The preferred method is to use the Outlet Flushing Port with water flowing at housings rated flow. This will evacuate more entrained air from the Filter Cartridge(s) and Housing.
- For cartridge replacement, see pgs. 13 - 19.

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HARMSCO® Municipal Filtration Systems

SPECIFICATIONS

	MUNI-1-2FL-304 MUNI-1-2FL-316	MUNI-3-3FL-304 MUNI-3-3FL-316	MUNI-5-4FL-304 MUNI-5-4FL-316	MUNI-8-6FL-304 MUNI-8-6FL-316
Cartridge Quantity[1]	1	3	5	8
Max. Flow Rate, gal/min[2]	100	300	500	800
Pressure Rating, P.S.I.G. Max.	150	150	150	150
Height, inches	48"	63-1/2"	74"	84"
Service Height, inches	77"	98-1/2"	98-1/2"	104-1/2"
Housing Diameter	11"	20"	30"	35-3/8"
Inlet/Outlet[3]	2" Flange	3" Flange	4" Flange	6" Flange
Height of Inlet, inches	23-5/8"	35-1/4"	38"	44-1/4"
Height of Outlet, inches	9-3/4"	12"	14-1/8"	20-1/2"
Drain (Qty 2, Female)	3/4" NPT	1-1/2" NPT	1-1/2" NPT	1-1/2" NPT
Weight, Dry	150 lbs.	435 lbs.	1,130 lbs.	1,640 lbs.
Weight, Wet	284 lbs.	944 lbs.	2,314 lbs.	3,575 lbs.
Floor Contact Area	.188 ft²	.292 ft²	.776 ft²	1.164 ft²
Floor Load (approx.)[3,4]	1,515 lbs/ft²	3,250 lbs/ft²	3,000 lbs/ft²	3,100 lbs/ft²
Floor Space[5]	1.6 ft²	4.5 ft²	8.5 ft²	14.0 ft²

Bonding: Housing shall be bonded in accordance with all applicable codes. A grounding lug is provided on the leg.

Housing Material: Stainless Steel Construction.
Wetted metalic components are: 304/304L ASTM A-240 for 304 units
316/316L ASTM A-240 for 316 units

Finish: Electro-polish

O-ring Material: EPDM is standard. Buna-N & Viton are available

Temperature Rating: Up to 140°F, Note: Higher temperatures are possible, check cartridge specifications and contact a Harmsco® sales engineer.

Notes:

1. Utilizes Genuine Harmsco® Hurricane® HC/170 cartridges.
   - The use of cartridges other than Genuine Harmsco® Hurricane® HC/170 filter cartridges will void certifications by NSF International.
2. HC/170-LT2 Cartridge Flow Rate
   - Higher flow rates can be realized for pre-filtration applications. Contact your Harmsco Municipal Customer Service Representative for further information.
3. Piping shall conform to all applicable codes and be independently supported.
4. If floor strength is suspect, use appropriate measures to adequately distribute load.
5. Does not include Cover/Davit swing position for models MUNI-3-3FL-304(316), MUNI-5-4FL-304(316) & MUNI-8-6FL-304(316). See Installation Diagrams, pages 9-11.

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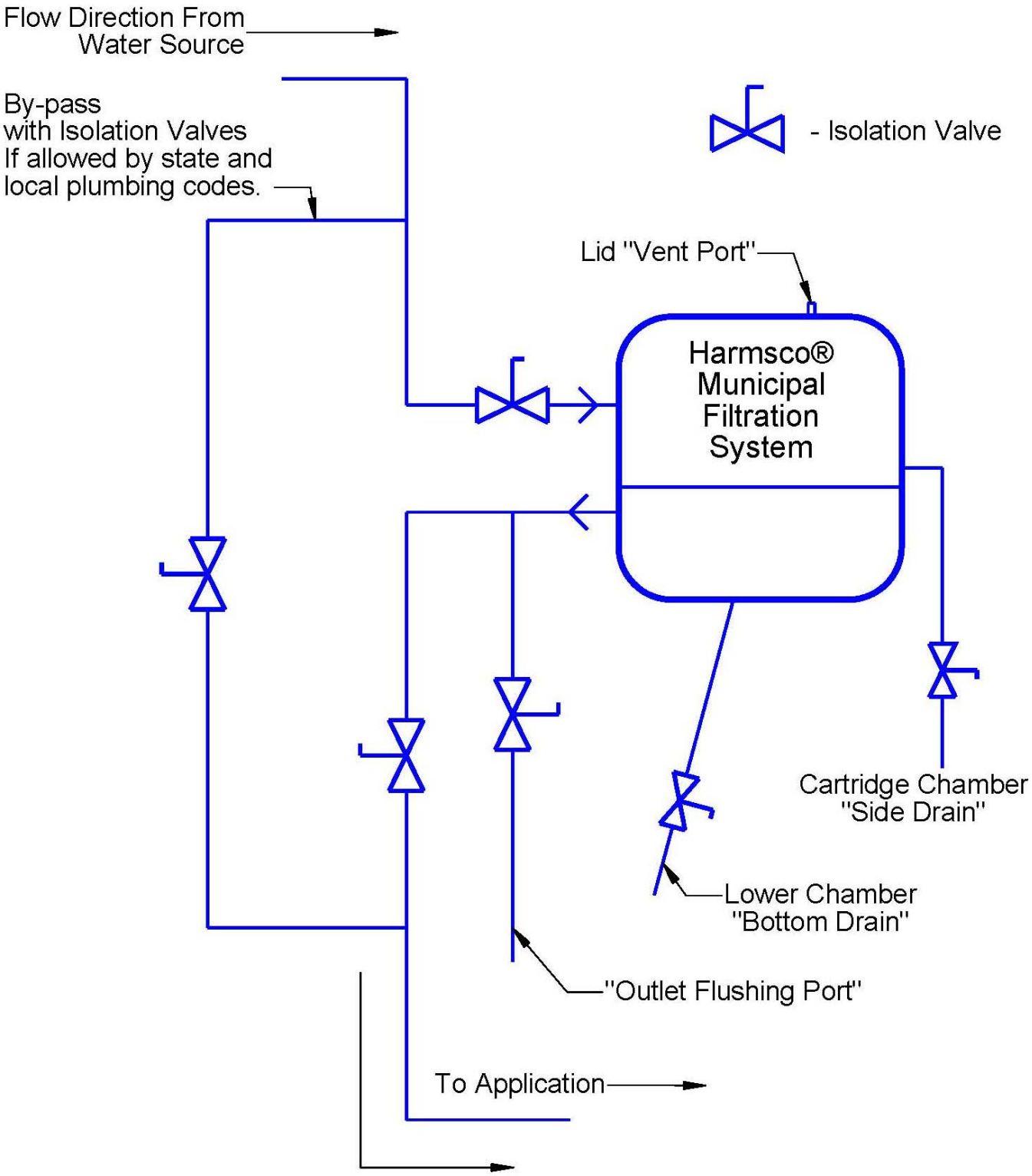
Installation Block Diagram



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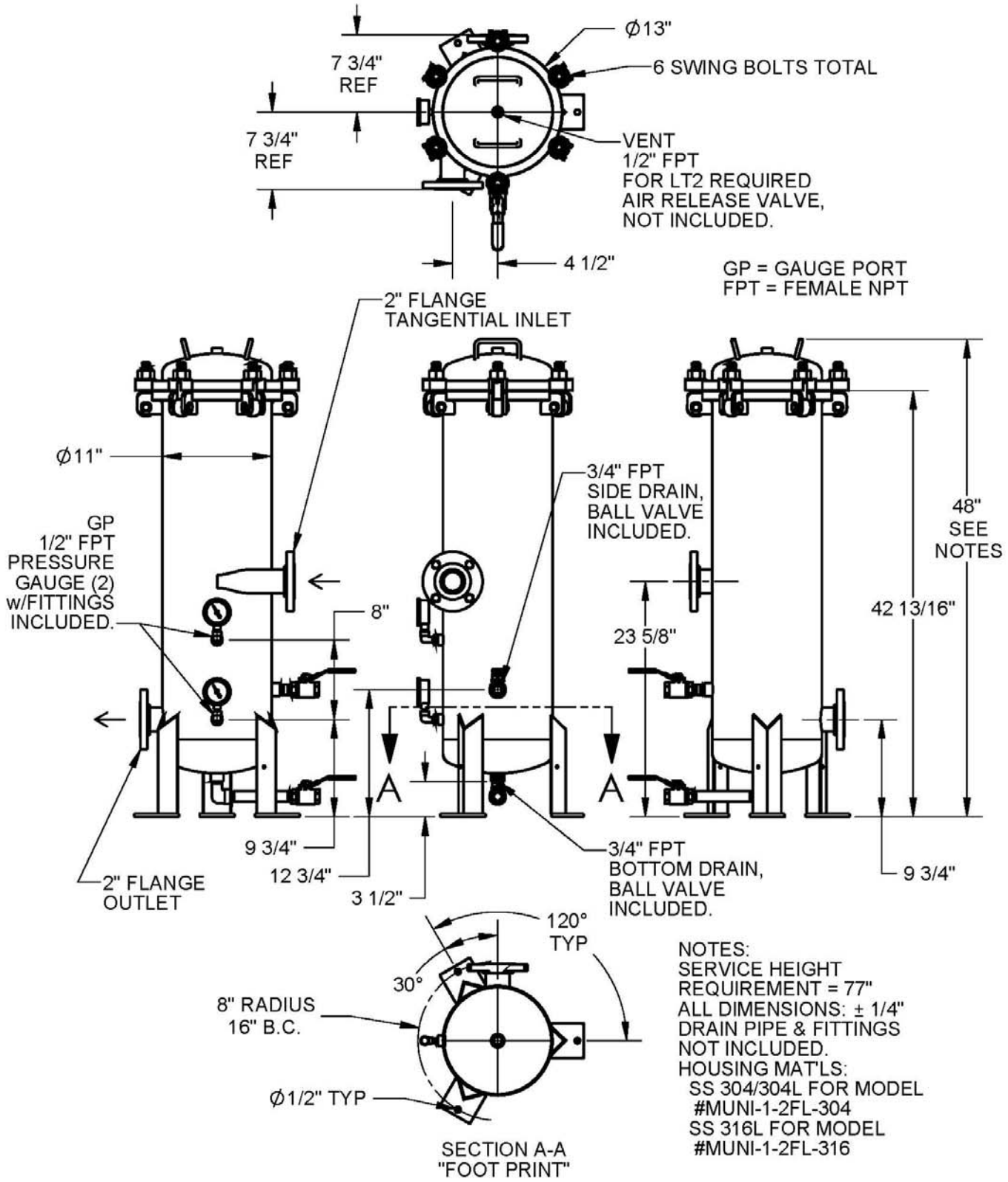
Installation Diagram
Models MUNI-1-2FL-304 & MUNI-1-2FL-316



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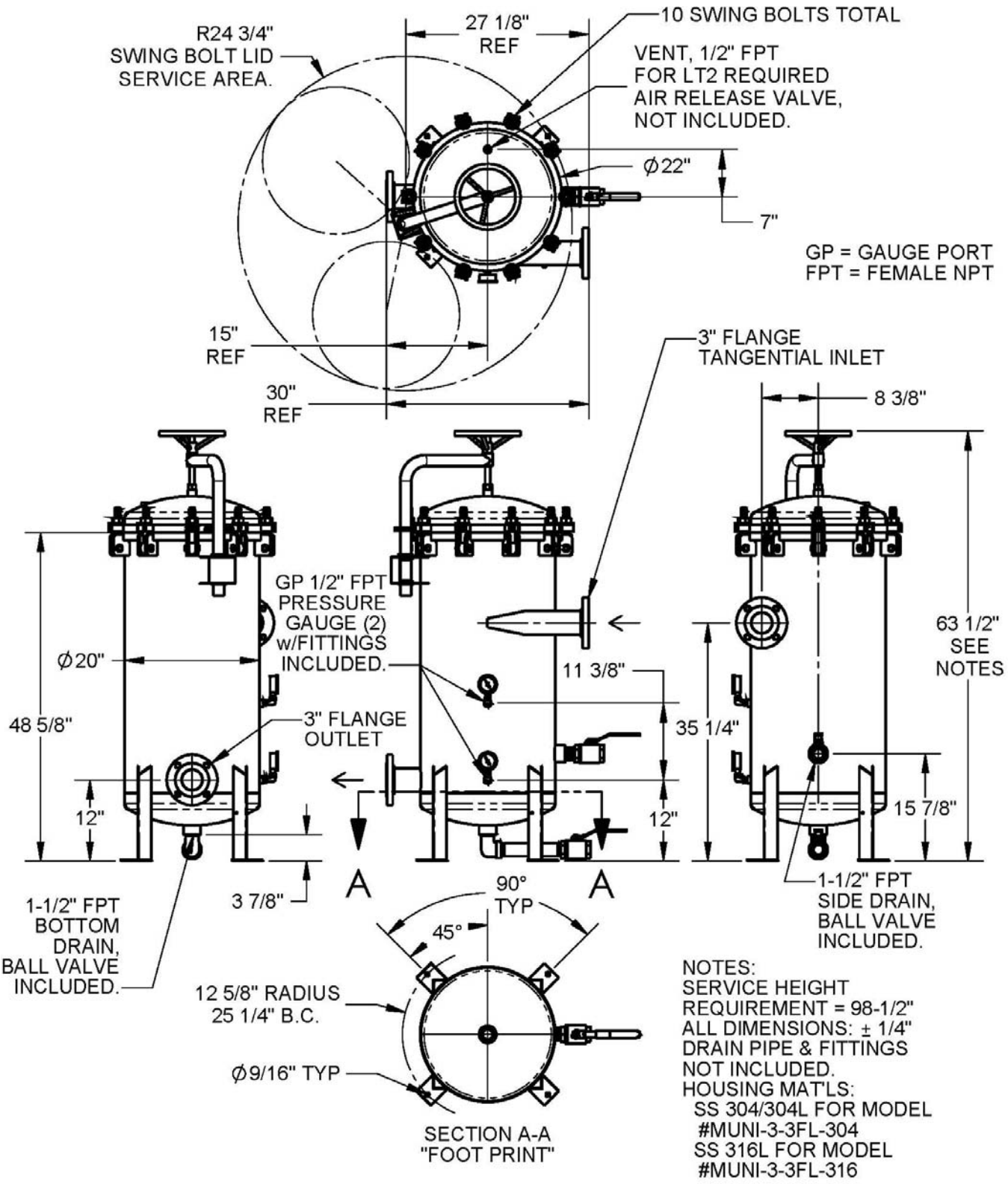
Installation Diagram
Models MUNI-3-3FL-304 & MUNI-3-3FL-316



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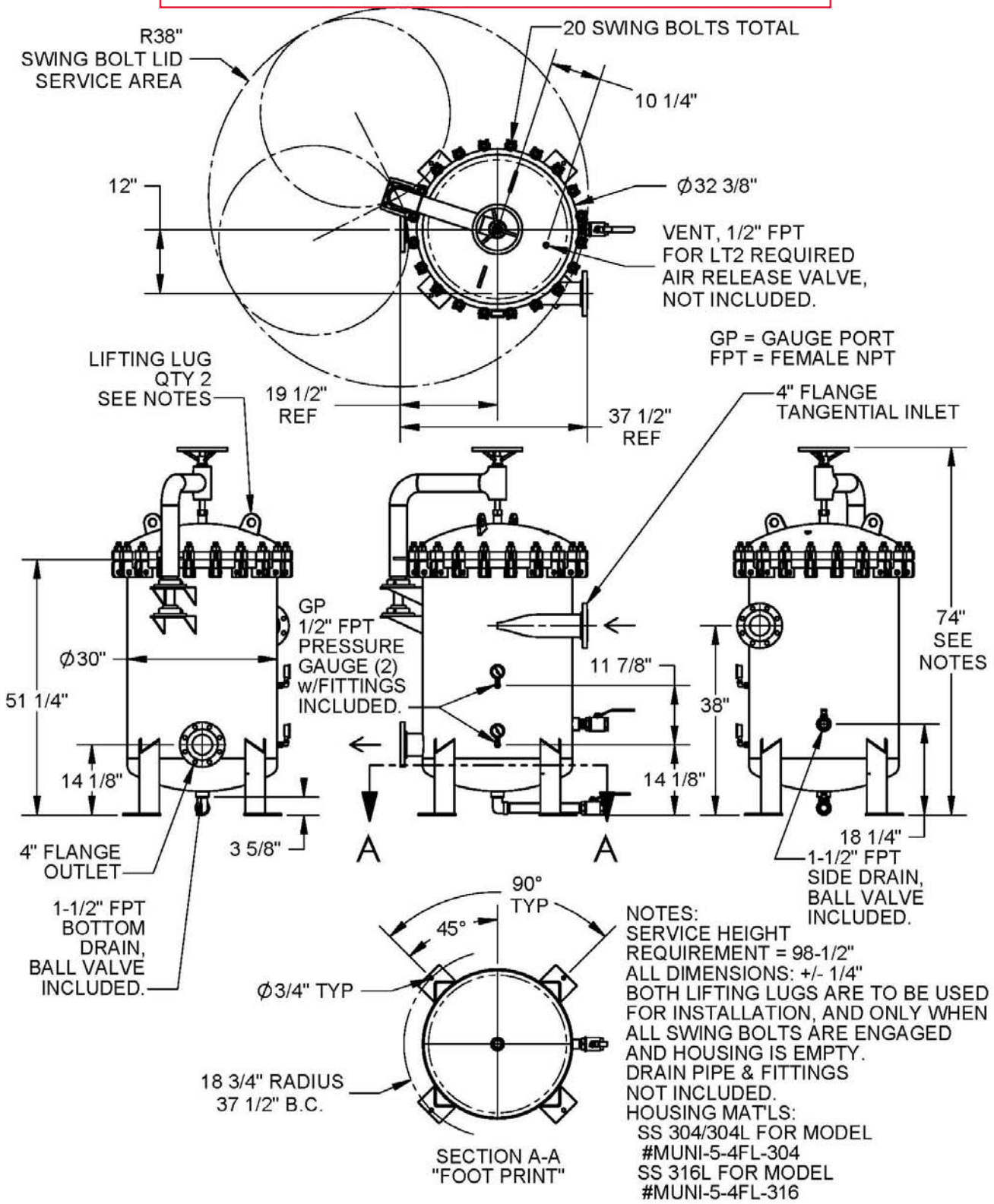
Installation Diagram
Models MUNI-5-4FL-304 & MUNI-5-4FL-316



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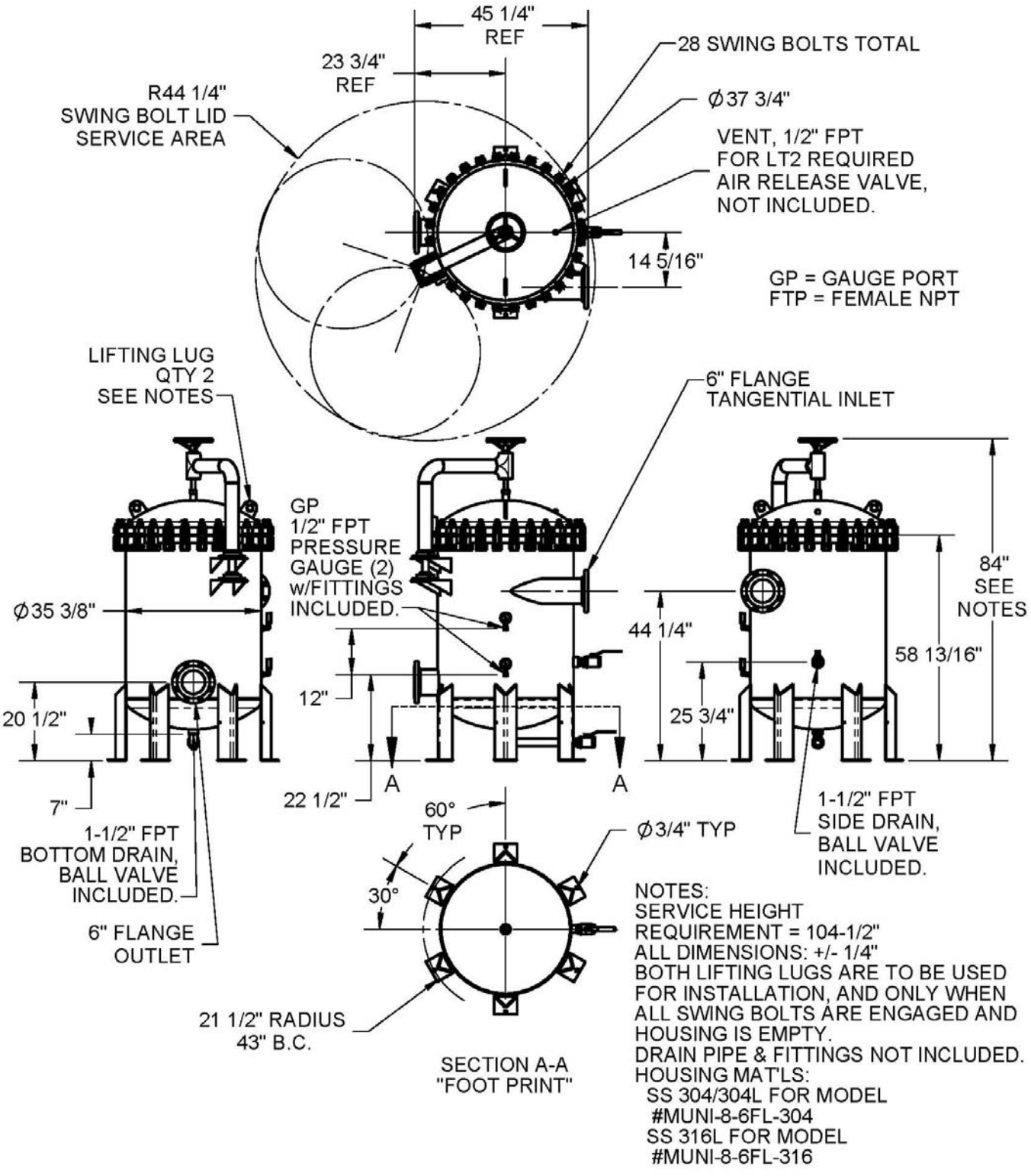
Installation Diagram
Models MUNI-8-6FL-304 & MUNI-8-6FL-316



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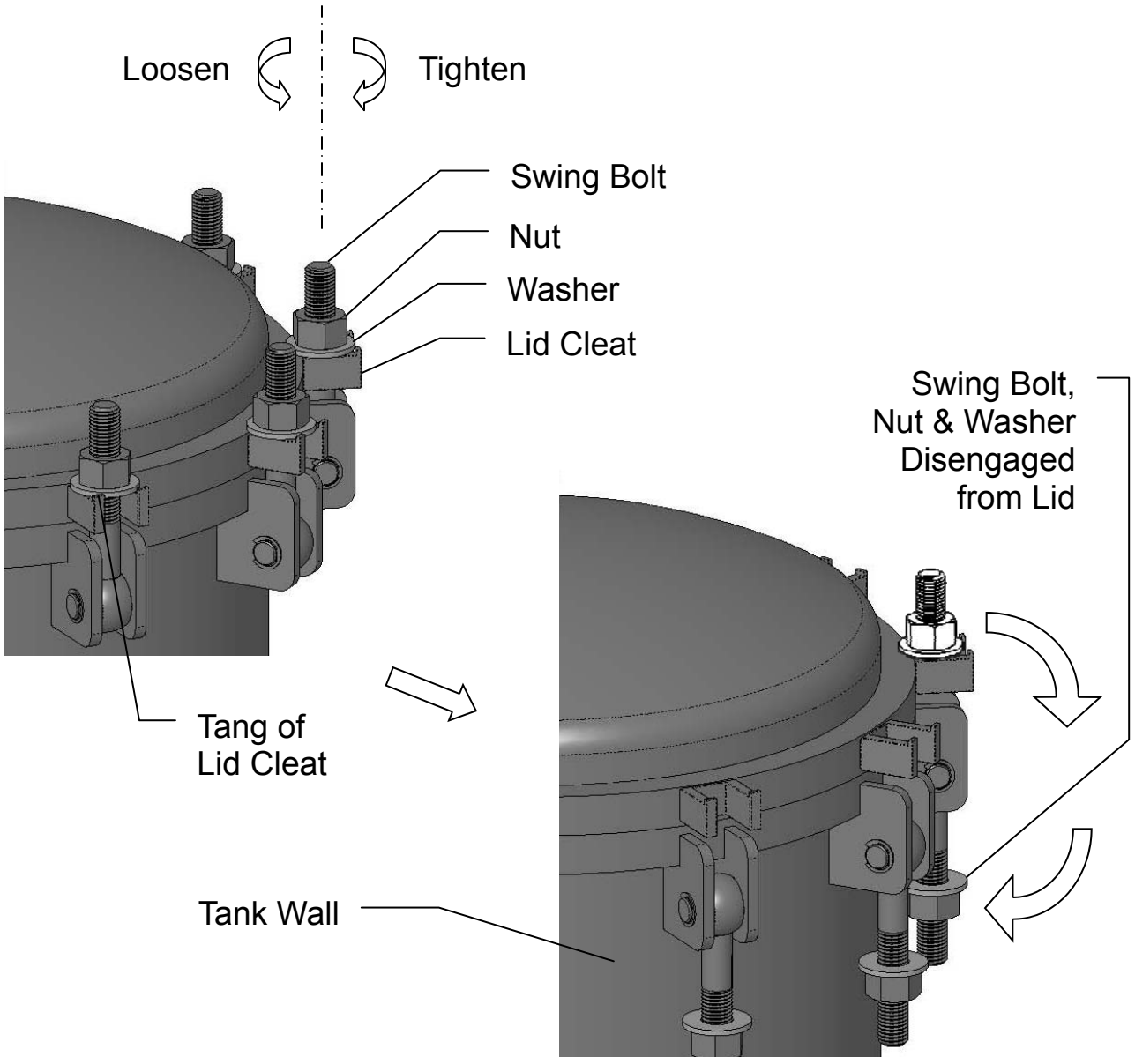
CARTRIDGE REPLACEMENT

1. Isolate unit from all water sources (close I/O lines and any sampling ports) and relieve pressure to housing by first opening the “Bottom Drain” to prevent reverse flow. Do not allow backflow.
   See Installation Diagrams.
2. Open Side Drain and let housing drain completely.
3. Loosen all Nuts of Swing Bolts by 1/2 turn increments counter-clockwise to gradually step down load applied to swing bolts. Repeat process as needed.
4. Fully loosen Nuts but do not remove from Swing Bolt. Lift Washer above Tangs in Lid Cleats and allow Swing Bolt to rotate downward along the side of the housing’s Tank Wall.



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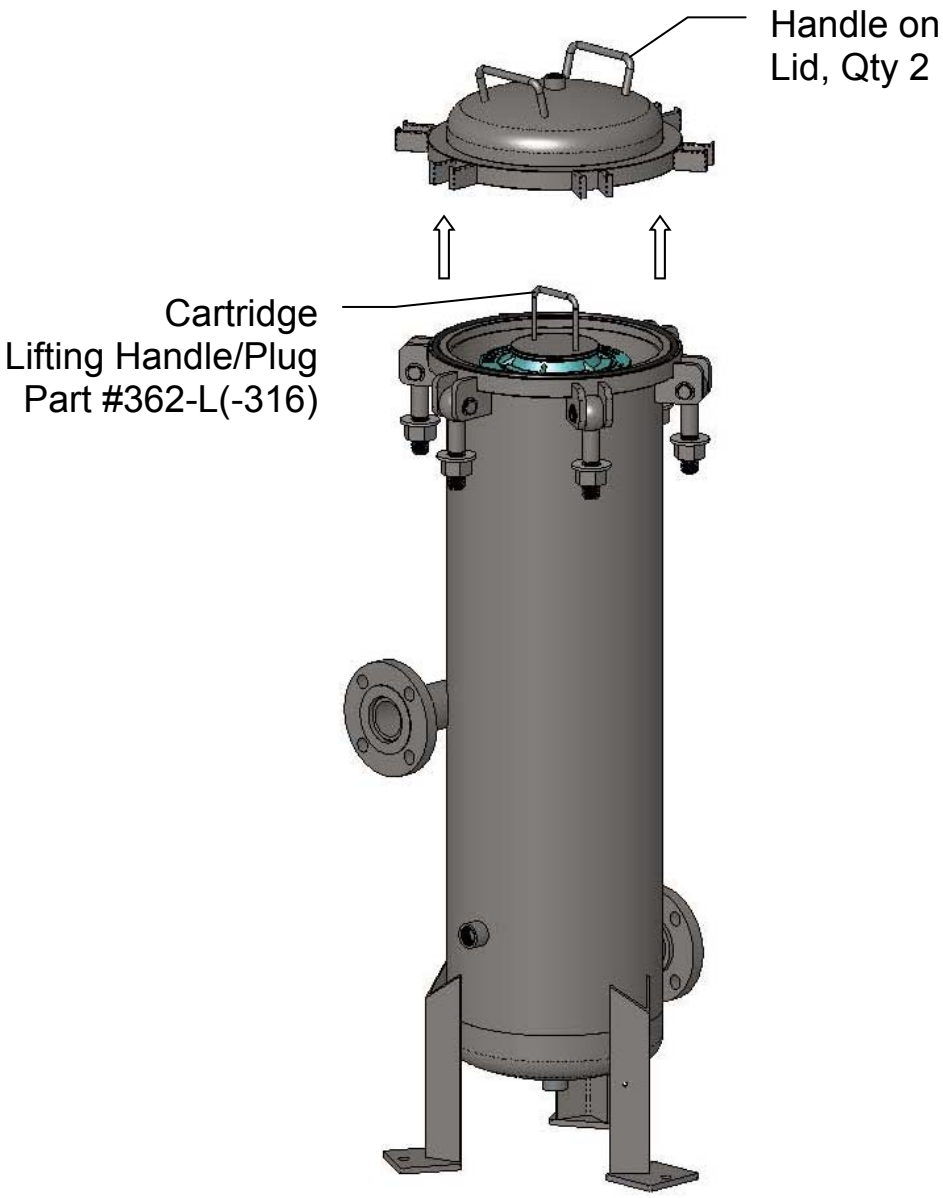
CARTRIDGE REPLACEMENT cont.

5. When all of the Swing Bolt hardware is disengaged, the Lid can be removed.

5 a. For Model MUNI-1-2FL-304(316) the Handles on the Lid are used to raise and remove the Lid.
Note: The Lid must be raised sufficiently to clear the Cartridge Lifting Handle/ Plug prior to removal.



Model MUNI-1-2FL-304(316)

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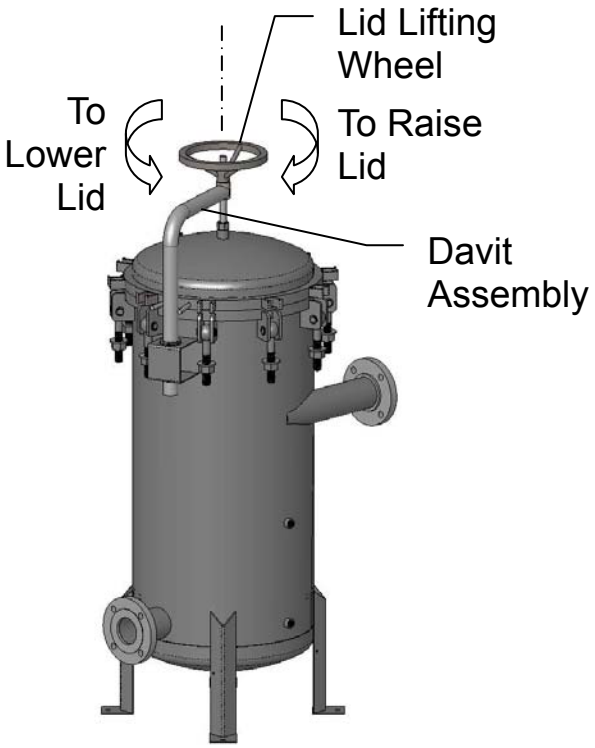
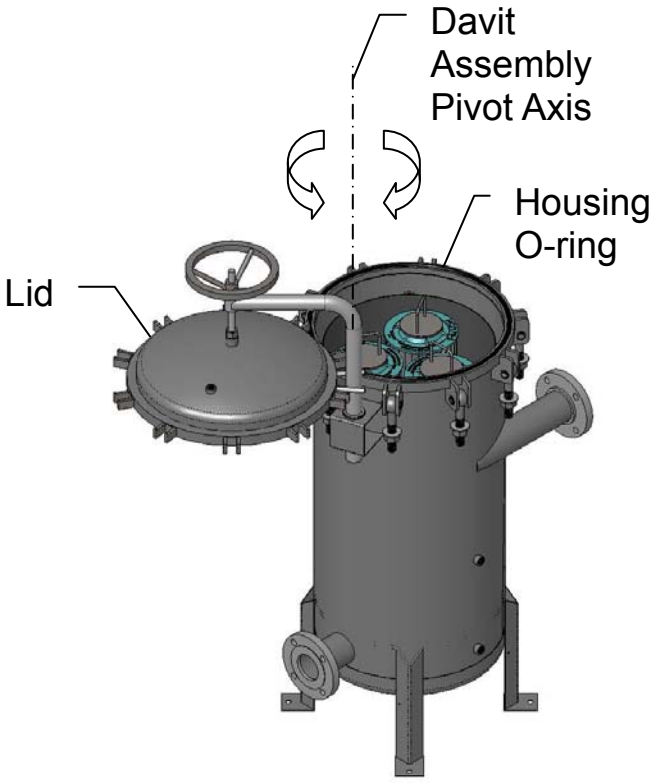
CARTRIDGE REPLACEMENT cont.

5 b. Models MUNI-3-3FL-304(316), MUNI-5-4FL-304(316) & MUNI-8-6FL-304(316) all have a Davit Assembly and Lid Lifting Wheel to raise and lower the Lid. To raise Lid, turn Lid Lifting Wheel clockwise. To lower Lid, turn Wheel counter-clockwise.
Note: Housing O-ring may stick to Lid.
Raise Lid approximately 1" to clear housing. Swing Lid and Davit Assembly until cartridge compartment is fully exposed. Secure Lid in open position and apply "Warning" measures in accordance with safety regulations.

Caution: The Lid is to be secured while in the "open" position for servicing.



Lid Closed
Model MUNI-3-3F-304(316)



Lid Open
Model MUNI-3-3FL-304(316)

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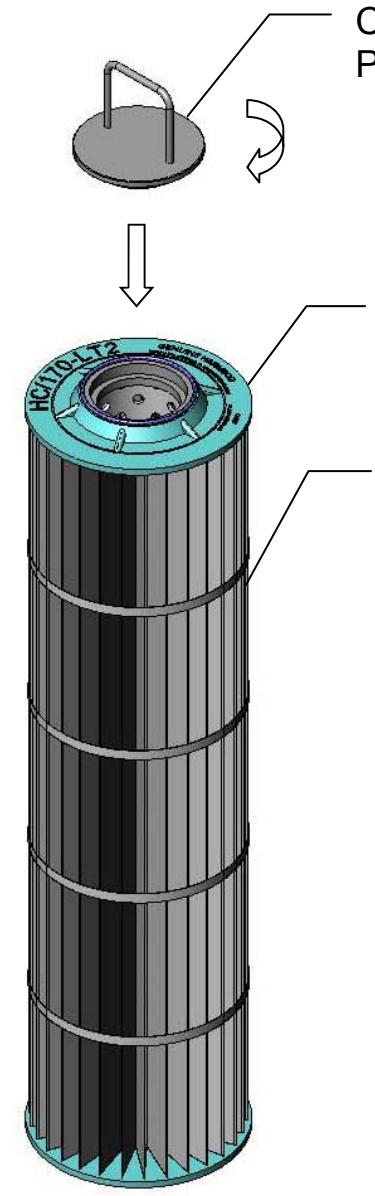
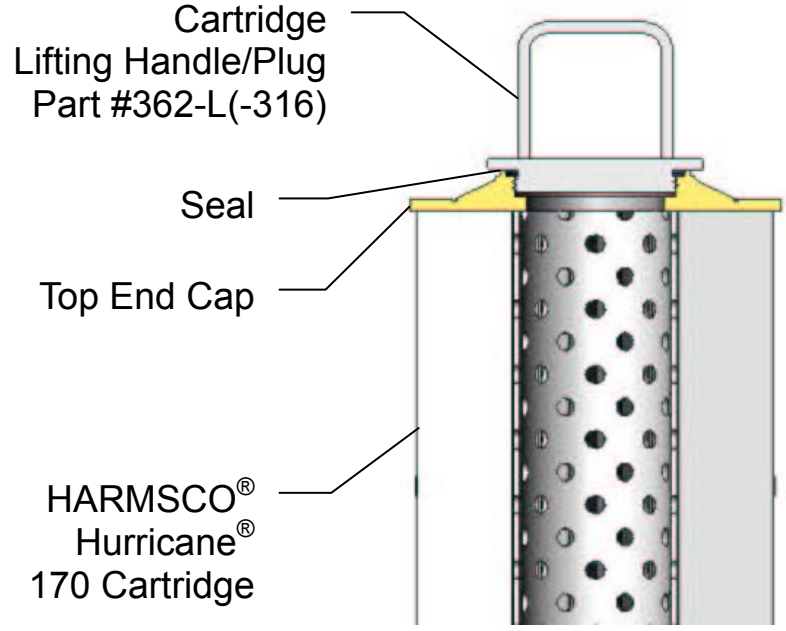
CARTRIDGE REPLACEMENT cont.

6. Install Cartridge Lifting Handle/Plug(s), part #362-L(-316), to Cartridge(s). Tighten securely to seal with Top End Cap to prevent by-passing of the Cartridge.
   The Cartridge Lifting Handle/Plug(s) remain with the cartridge(s) inside the vessel during operation.
   Note: Inside of vessel may be cleaned prior to installing new cartridges.



Exploded View



Partial Sectional View

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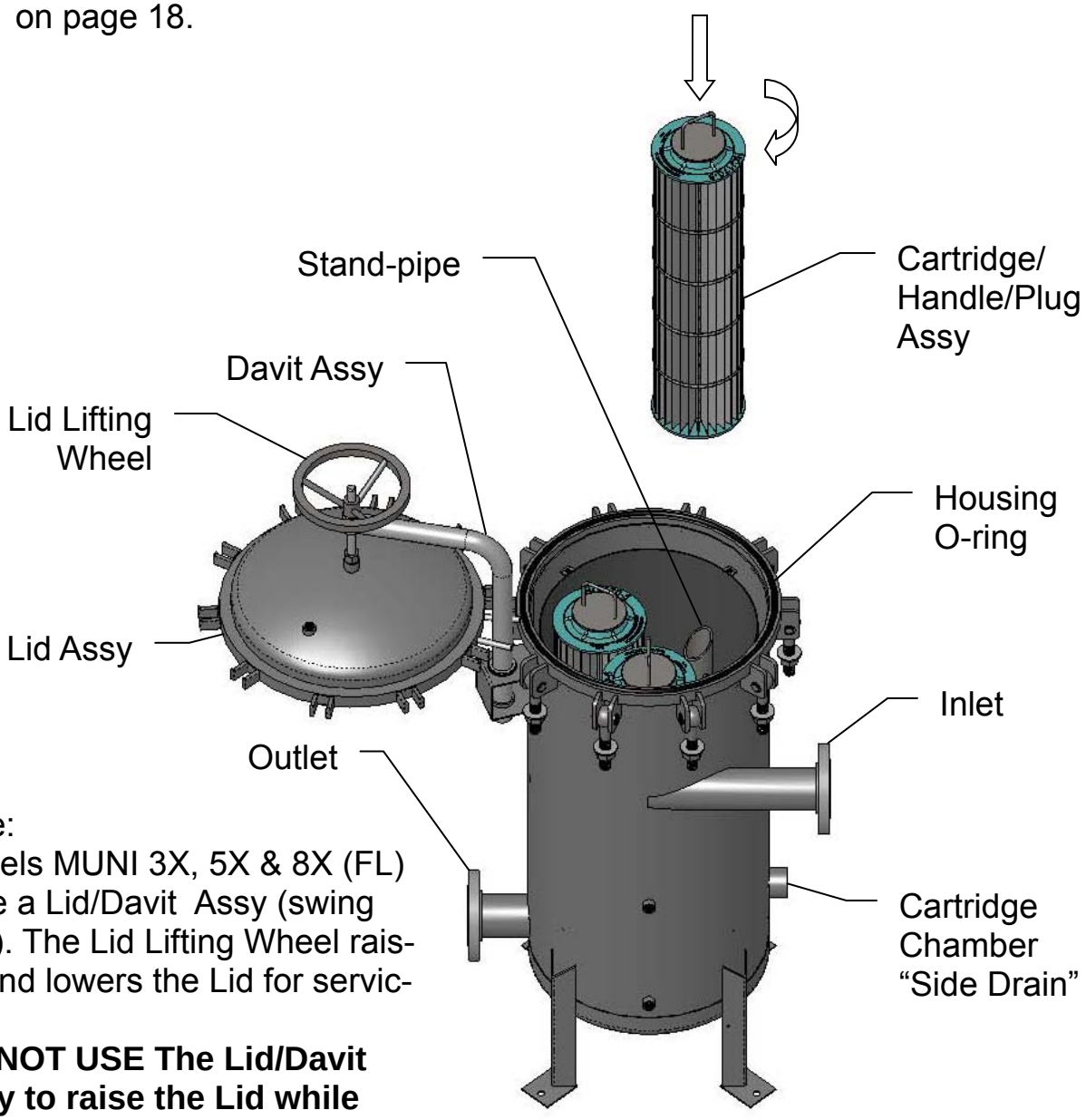
CARTRIDGE REPLACEMENT cont.

7. With swing bolts disengaged and lid removed, install Cartridge/Handle/Plug assembly(s) onto Stand-pipe(s). Position Cartridge/Handle/Plug assembly(s) downward until Cartridge's Bottom End Cap contacts the housing's Tube Sheet. The Cartridge's Bottom End Cap will seal with the Stand-pipe Coupling to prevent by-passing. A clockwise rotating motion will help to position the Cartridge while engaging the Stand-pipe Coupling. Confirm all Cartridge/Handle/Plug assembly(s) are fully installed with all Cartridge Bottom End Caps contacting the housing's Tube Sheet, see illustrations on page 18.



Note:
Models MUNI 3X, 5X & 8X (FL) have a Lid/Davit Assy (swing arm). The Lid Lifting Wheel raises and lowers the Lid for servicing.
DO NOT USE The Lid/Davit Assy to raise the Lid while swing bolts are engaged.

Model MUNI-3-3FL-304(316)

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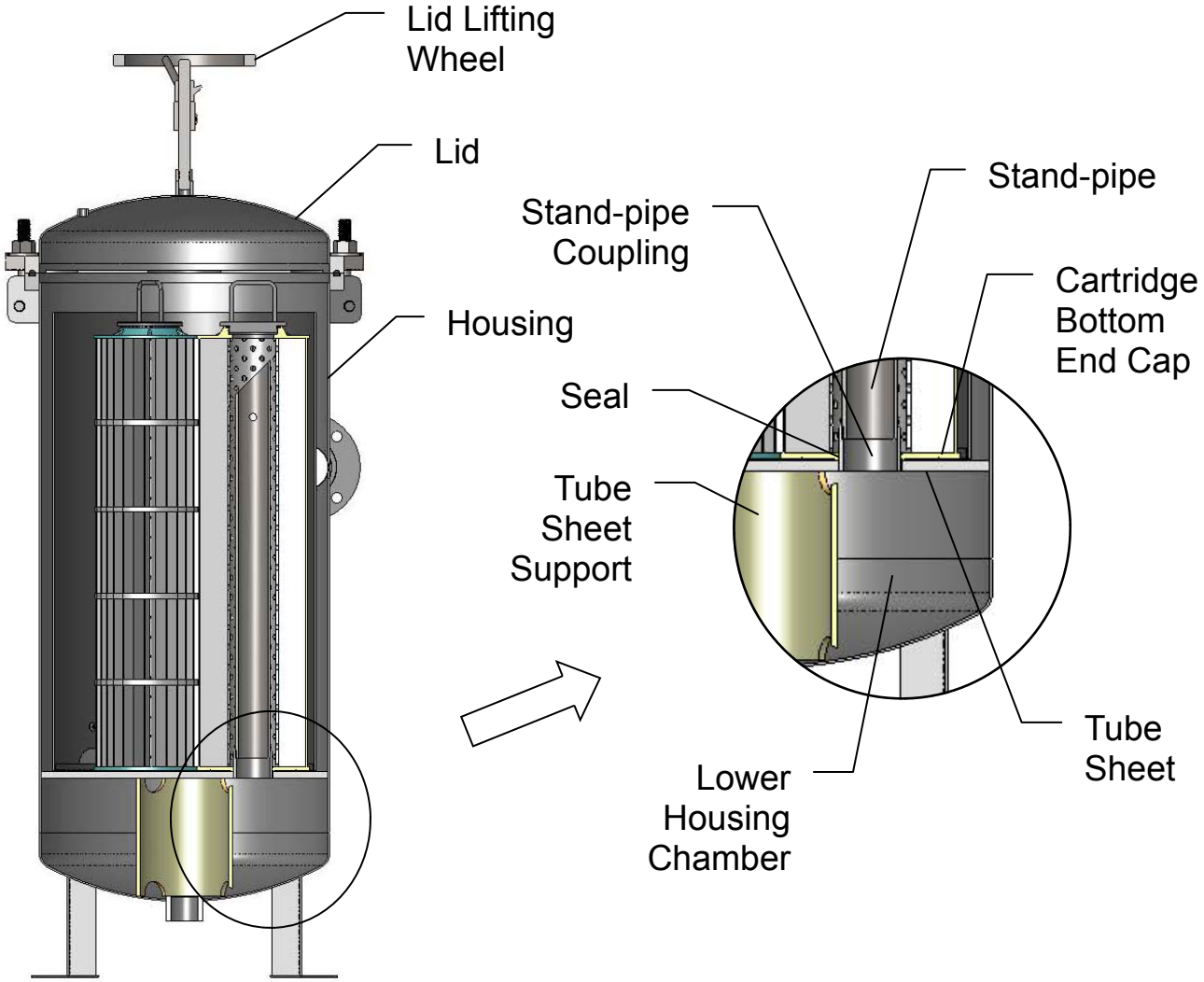
CARTRIDGE REPLACEMENT cont.



Section View
Model MUNI-3-3FL-304(316)

8. Inspect Housing O-ring and make sure that it is free from cracks and debris.
9. Clean Housing and Lid O-ring mating surfaces.
10. Place Housing O-ring into channel of Housing.
11. Return Lid to closure position and maintain alignment of Lid on Housing. Lower lid onto Housing O-ring. Make sure O-ring stays in the channel of the Housing. Do not allow tilting or cocking of Lid on the O-ring.

Note: The Lid/Davit Assembly is NOT to be carrying any load from the Lid at this time.

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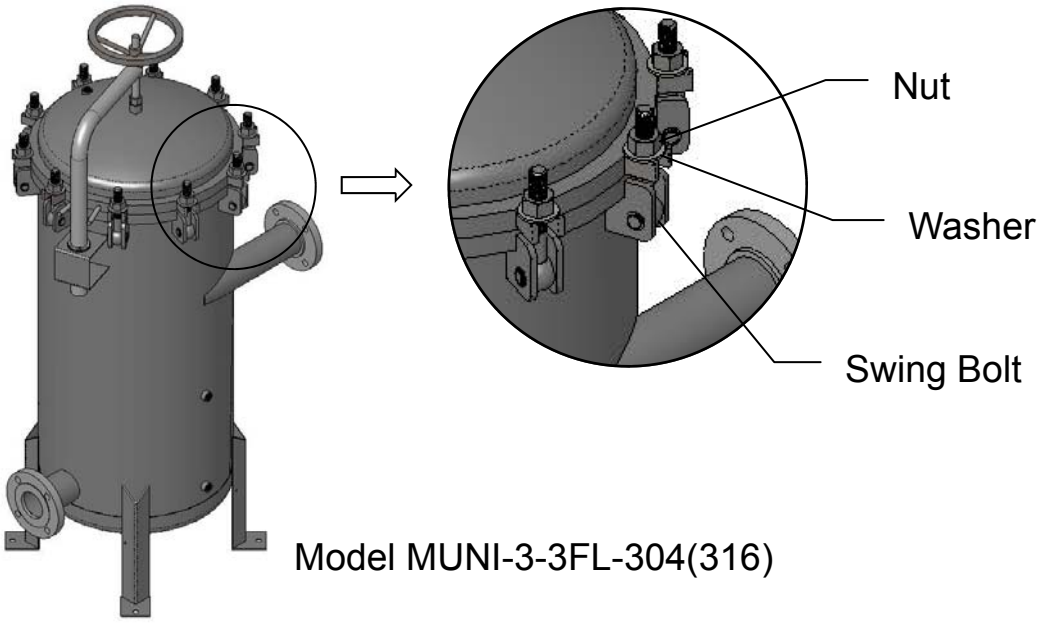
CARTRIDGE REPLACEMENT cont.

12. Return all Swing Bolts, Nuts, & Washers to their closure position.
13. Tighten all Nuts in a “star/criss-cross” pattern several times until all Nuts are torqued to 10 ft-lbs. Make sure Lid position and alignment to Housing is maintained.



Model MUNI-3-3FL-304(316)

All Nuts are to be equally torqued to **10 ft-lbs**. prior to start-up.

14. Start the flow of water through the Filtration Housing by opening the Inlet Valve first. Do not allow reverse flow (backflow) through the cartridge Filters. Once the air has been evacuated from the Filter Housing inspect the Swing Bolt Closure for any leaks. If a leak is found Isolate and Remove Pressure in Housing, then repeat steps 1 through 5 and 8 through 16. If no leaks are observed proceed through steps 15 and 16.
15. Flush Filter unit by opening the Outlet Flushing Port valve to adequately flush Housing and Cartridges of air (champagne-like bubbles). If an Outlet Flushing Port valve has not been provided, the required flushing must be done through the Bottom Drain valve. After adequately flushing the Filter Housing, close whichever valve was used.
16. Now open the Outlet Valve placing the Filter Housing back online. After 10 minutes check for any loose nuts on the closure and re-torque if required, see step 13, and only when housing is un-pressurized.

The Harmsco® Municipal Filtration System is now operational.

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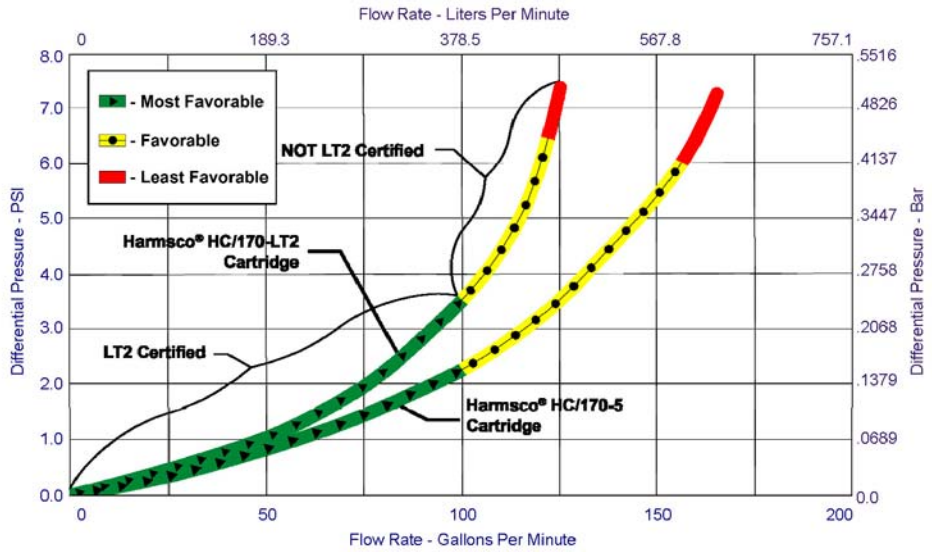
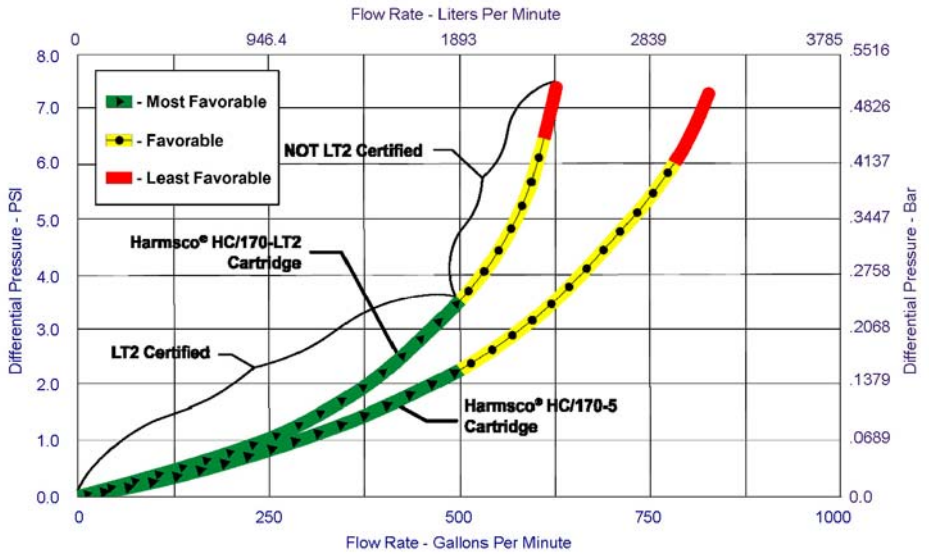
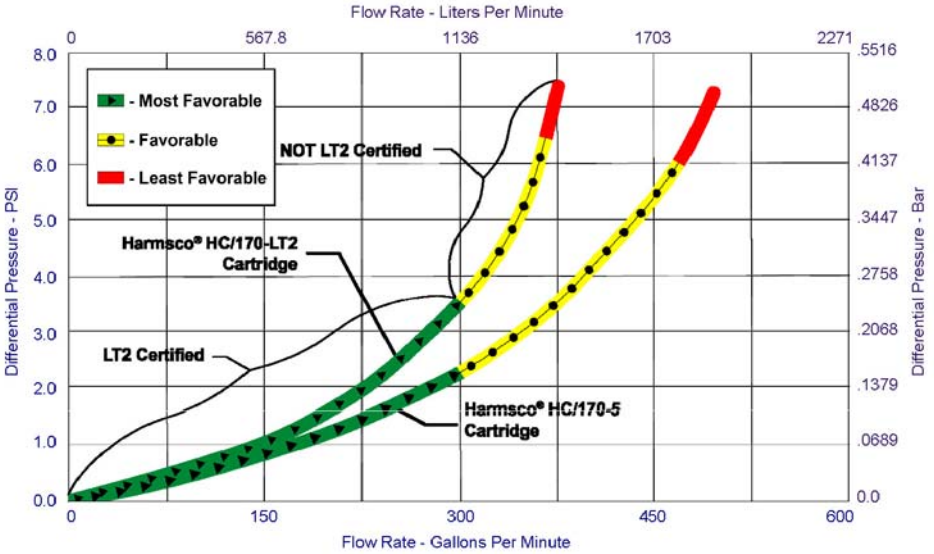
Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-1-2FL-304(316)



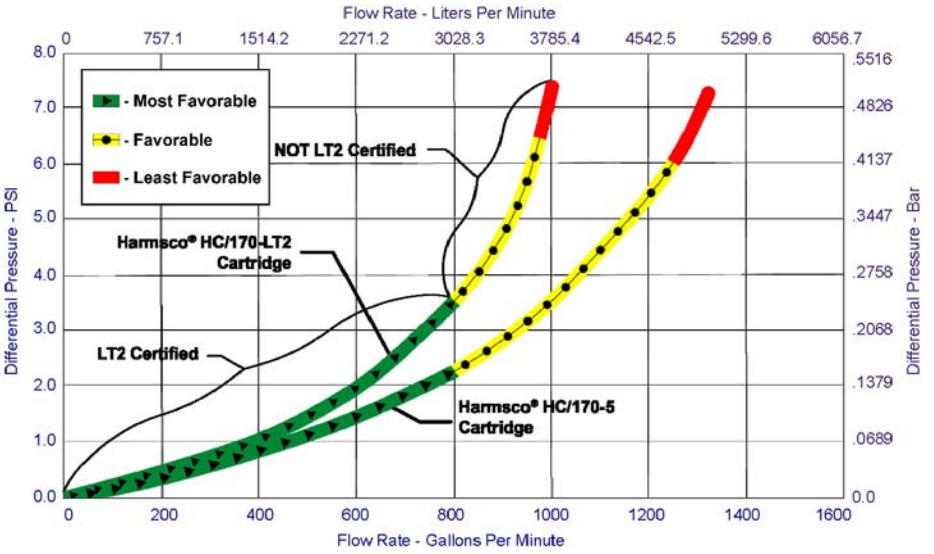
Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-5-4FL-304(316)



Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-3-3FL-304(316)



Pressure Drop vs. Flow Rate Curves
Harmsco® MUNI-8-6FL-304(316)



Harmsco® Filtration Products Limited Warranty

1. Harmsco® warrants its line of Water Filters to be free of defects in material and workmanship for a period of one year from the date of installation.
2. This warranty does not cover any equipment purchased for use in applications in which the product is not suited. It is the responsibility of the buyer to determine if a product is suitable for a particular application.

3. **THIS WARRANTY EXCLUDES THE FOLLOWING:**
   A. Any fresh water unit installed for salt water use.
   B. Damage caused by improper installation, operation or care.
   C. Chemical attack.
   D. Modification or alteration by other than Harmsco® employees.
   E. Rubber type parts and normal wear items, i.e. “O” rings, rim gaskets.
   F. Any costs of labor or expenses expended in the removal and/or installation of a unit, or any surrounding device.
   G. Damage caused by galvanic or electrolytic attack.
   H. Altering or removing the Harmsco® information label.
   I. Any unit not grounded.
4. Service under this warranty is to be provided by the dealer who sold the unit to the user. If the dealer is unable to provide warranty service, contact:

Harmsco Filtration Products
7169 49th Terrace North, Riviera Beach, Florida, 33407, U.S.A.
Phone: (561) 848-9628 • Fax: (561) 845-2474

A Returned Goods Authorization (RGA) number must be received from the above office and placed on all shipments to and correspondence with Harmsco® Filtration Products. Please be prepared with the following information: 1. Model number and serial number. 2. Date of installation. 3. Name of installer. 4. Nature of problem. 5. Your address and telephone number.

****NOTICE****

Some of the information contained in this publication has been obtained from outside sources and is considered accurate. Temperature ratings, flow rates and chemical resistance can be affected by a number of unknown factors. For this reason, we do not assume any liability for the accuracy or completeness of the data in this publication. End users should perform their own tests to determine suitability for each application.

Available from:

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MADE IN U.S.A.

Harmsco® Filtration Products

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Chapter 37 GENERATOR GROUP

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2997 RUE WATT
STE-FOY, P.Q., G1X 3W1
Email:
GSTOnge@generatricedrummond.com
Tel:(418) 780-3535
Fax:(418) 780-3435

37.1 **GENERATOR GROUP**

37.2 **TRANSFER SWITCH**

SHOP DRAWING FOR APPROVAL

Date : 17/06/2016

To:
Arktis Solutions
Chiarelli Engineering Management Ltd.
M.M. Mallet
P.O. Box 242
Gjoa Haven, NU, K0B 1J0
T: 867-446-0036
F: 866-475-1147

From :
Kudlik Construction Ltd.
C/O Jean-Sébastien Demers ing.
P.O. 727, 1519 Federal Road
Iqaluit, X0A 0H0
Tel.: 867-979-1166
F: 867-979-1169

SIFEC NORTH inc.
Electro Mechanical Contractor
P.O. Box 556
Rankin Inlet, NU, X0C 0G0
T: 866-437-4001
F: 206-338-2249

Project : 2016-061 **Igloolik Water Supply Upgrade - YGT12**

	Owner Tag Number	Section	DESCRIPTION	MODEL	Status	Initial Date of submital
1	N/A	26 36 23	Generator and transfer switch		Initial	17/06/2016

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016

Reviewed [X]
Reviewed as noted [ ]
Resubmit [ ]

Out for approval

SIFEC NORTH INC.

SHOP DRAWING

This review is solely for the verification of general design quality and does not alleviate the responsibility of the contractor for insuring that all specification, space and installation requirements are met.

Reviewed pages 1 to 52

Reviewed By: N.K.
Reviewed [X]
Reviewed as noted [ ]
Date: June 21, 2016
Resubmit [ ]

CHIARELLI ENGINEERING LTD.

GÉNÉRATRICE DRUMMOND
WAJAX POWER SYSTEMS

GENERATOR SET
SHOP DRAWINGS

PROJECT
IGLOOLIK WATER SUPPLY SYSTEM

REF: GDM-1915

CUSTOMER : Kudlik Construction LTD
1519 Federal Road PO Box 727
Iqaluit, NY
X0A 0H0

ENGINEER : CEML
203-100, Craig Henry Dr.
Nepean, ON
K2G 5W3

PREPARED BY : GÉNÉRATRICE DRUMMOND
243, RUE DES ARTISANS
ST-GERMAIN DE GRANTHAM, QUÉBEC
J0C 1K0

DATE : June, 15 2016

SHOP DRAWING
Reviewed by: Samuel Charbonneau
Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

SALES REPRESENTATIVE : Yvan Brouillette
TECHNICAL SUPPORT : Michelle Roy
SALES COORDINATOR : Éméline Gagnon

Phone : 819-472-4076 · Montreal : 514-875-0554 · Toll free : 1-800-567-3835
Fax : 819-395-5517 · www.generatricedrummond.com

ISO CERTIFIED ORGANIZATION 9001 2008

TABLE OF CONTENTS

Generator set	**SECTION 1**
Accessories	**SECTION 2**
Automatic Transfer Switch	**SECTION 3**
Customer Interconnection	**SECTION 4**
Warranties, Certifications & Procedures	**SECTION 5**

SECTION 1

Generator set

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

DIESEL GENERATOR SET
MTU 4R0120 DS80

80 kWe / 60 Hz / Standby
208 - 600V

Reference MTU 4R0120 DS80 (72 kWe) for Prime Rating Technical Data

SYSTEM RATINGS

Standby

Voltage (L-L)	240V	240V	208V	240V	380V	480V	600V
Phase	1	1	3	3	3	3	3
PF	1	1	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60	60
kW	80	80	80	80	80	80	80
kVA	80	80	100	100	100	100	100
Amps	333	333	278	241	151	120	96
skVA@30% Voltage Dip	145	311	216	216	165	288	236
Generator Model*	363CSL1607	363CSL1617	362CSL1604	362CSL1604	362CSL1606	362CSL1604	362PSL1635
Temp Rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	12 LEAD ZIG-ZAG	4 LEAD	12 LEAD LOW WYE	12 LEAD HI DELTA	12 LEAD HI WYE	12 LEAD HI WYE	4 LEAD WYE

CERTIFICATIONS AND STANDARDS

// **Emissions –** EPA Tier 3 Certified

// **Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004**

// **UL 2200 / CSA – Optional**
- UL 2200 Listed
- CSA Certified
- CE Marking Provided

// **Performance Assurance Certification (PAC)**
- Generator Set Tested to ISO 8528-5 for Transient Response
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

// **Power Rating**
- Accepts Rated Load in One Step Per NFPA 110

STANDARD FEATURES*

// MTU Onsite Energy is a single source supplier
// Global Product Support
// 2 Year Standard Warranty
// OM924LA Diesel Engine
- 4.8 Liter Displacement
- 4-Cycle
// Engine-generator resilient mounted
// Complete Range of Accessories
// Generator
- Brushless, Rotating Field Generator
- 2/3 Pitch Windings
- 300% Short Circuit Capability with Optional PMG
// Digital Control Panel(s)
- UL Recognized, CSA Certified, NFPA 110
- Complete System Metering
- LCD Display
// Cooling System
- Integral Set-Mounted
- Engine Driven Fan

STANDARD EQUIPMENT*

// Engine

Air Cleaners
Oil Pump
Oil Drain Extension & S/O Valve
Full Flow Oil Filter
Fuel Filter with Water Separator
Jacket Water Pump
Thermostat
Blower Fan & Fan Drive
Radiator - Unit Mounted
Electric Starting Motor - 12V
Governor – Electronic Isochronous
Base - Formed Steel
SAE Flywheel & Bell Housing
Charging Alternator - 12V
Battery Box & Cables
Flexible Fuel Connectors
Flexible Exhaust Connection
EPA Certified Engine

// Generator

NEMA MG1, IEEE and ANSI standards compliance for temperature rise and motor starting
Self-Ventilated and Drip-Proof
Superior Voltage Waveform
Solid State, Volts-per-Hertz Regulator
±1% Voltage Regulation No Load to Full Load
Brushless Alternator with Brushless Pilot Exciter
4 Pole, Rotating Field
130 °C Maximum Standby Temperature Rise
1 Bearing, Sealed
Flexible Coupling
Full Amortisseur Windings
125% Rotor Balancing
3-Phase Voltage Sensing
100% of Rated Load - One Step
5% Maximum Total Harmonic Distortion

// Digital Control Panel(s)

Digital Metering
Engine Parameters
Generator Protection Functions
Engine Protection
SAE J1939 Engine ECU Communications
Windows®-Based Software
Multilingual Capability
Remote Communications to RDP-110 Remote Annunciator
Programmable Input and Output Contacts
UL Recognized, CSA Certified, CE Approved
Event Recording
IP 54 Front Panel Rating with Integrated Gasket
NFPA 110 Compatible

* Represents standard product only. Consult Factory/MTU Onsite Energy Distributor for additional configurations.

APPLICATION DATA

// Engine

Manufacturer	Mercedes-Benz
Model	OM924LA
Type	4-Cycle
Arrangement	4-Inline
Displacement: L (in^3)	4.8 (293)
Bore: cm (in)	10.6 (4.17)
Stroke: cm (in)	13.6 (5.35)
Compression Ratio	17.5:1
Rated RPM	1,800
Engine Governor	MR2 / ADM3
Maximum Power: kWm (bhp)	147 (197)
Speed Regulation	±0.25%
Air Cleaner	Dry

// Liquid Capacity (Lubrication)

Total Oil System: L (gal)	15.8 (4.2)
Engine Jacket Water Capacity: L (gal)	7 (1.8)
System Coolant Capacity: L (gal)	20.8 (5.5)

// Electrical

Electric Volts DC	12
Cold Cranking Amps Under -17.8 °C (0 °F)	950

// Fuel System

Fuel Supply Connection Size	-6 JIC
Fuel Supply Hose Size	3/8“ ID
Fuel Return Connection Size	-6 JIC
Fuel Return Hose Size	3/8“ ID
Maximum Fuel Lift: m (ft)	2.7 (9)
Recommended Fuel	Diesel #2
Total Fuel Flow: L/hr (gal/hr)	328.2 (86.7)

// Fuel Consumption *

At 100% of Power Rating: L/hr (gal/hr)	19.3 (5.1)
At 75% of Power Rating: L/hr (gal/hr)	14 (3.7)
At 50% of Power Rating: L/hr (gal/hr)	9.8 (2.6)

* Based on 362CSL1604 480 Volt generator set

// Cooling - Radiator System

Ambient Capacity of Radiator: °C (°F)	50 (122)
Maximum Allowable Static Pressure on Rad. Exhaust: kPa (in. H_20)	0.12 (0.5)
Water Pump Capacity: L/min (gpm)	143 (37)
Heat Rejection to Coolant: kW (BTUM)	37.5 (2,133)
Heat Rejection to Air to Air: kW (BTUM)	23.6 (1,342)
Heat Radiated to Ambient: kW (BTUM)	24.8 (1,410)
Fan Power: kW (hp)	3.3 (4.4)

// Air Requirements

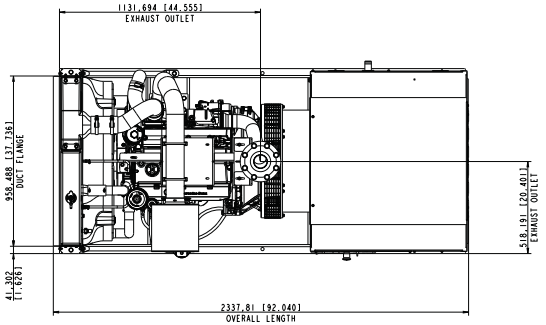
Aspirating: *m^3/min (SCFM)	8.6 (304)
Air Flow Required for Rad. Cooled Unit: *m^3/min (SCFM)	209 (7,381)
Remote Cooled Applications; Air Flow Required for Dissipation of Radiated Gen-set Heat for a Max of 25 °F Rise: *m^3/min (SCFM)	90.7 (3,203)

* Air density = 1.184 kg/m^3 (0.0739 lbm/ft^3)

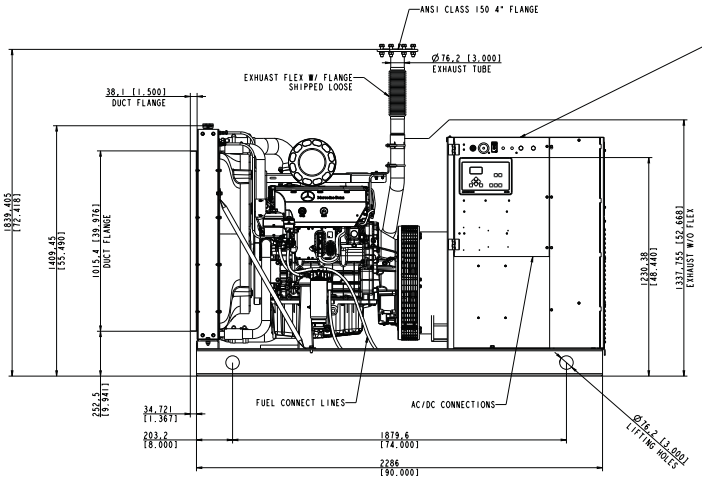
// Exhaust System

Gas Temp. (Stack): °C (°F)	354 (669)
Gas Volume at Stack Temp: m^3/min (CFM)	21.6 (763)
Maximum Allowable Back Pressure: kPa (in. H_20)	6.5 (26)

		Stand-By	Prime
60 Hz Models (kWe)	DG04RM120A1N	80	72
	DG04RM120A2N	100	90
	DG04RM120A3N	125	111
50 Hz Models (kVA)	DG04RM120A1L	89	80
	DG04RM120A2L	111	100
	DG04RM120A3L	139	125

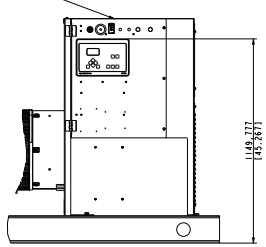


TOP VIEW



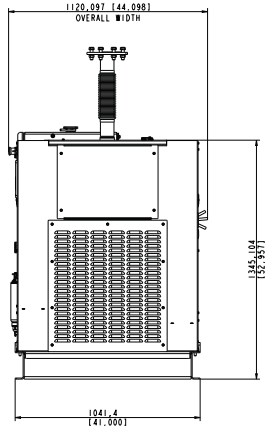
LEFT VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATIONS:
1. 430 GEN, ALL BREAKER SIZES
2. 360 GEN, P-FRAME BREAKER



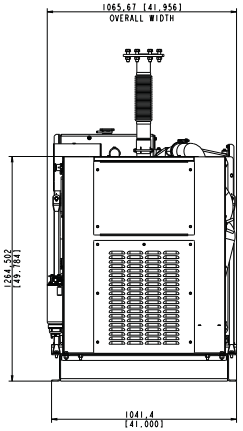
LEFT VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATION:
1. 360 GEN, H, J OR L-FRAME BREAKERS



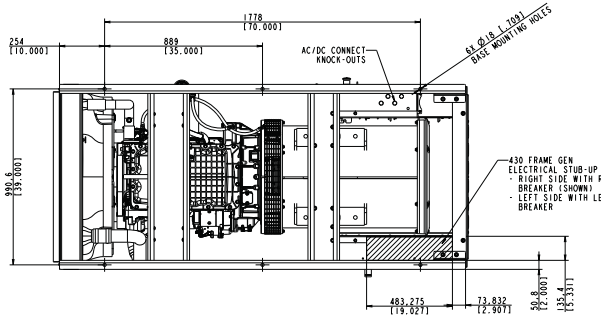
BACK VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATIONS:
1. 430 GEN, ALL BREAKER SIZES
2. 360 GEN, P-FRAME BREAKER

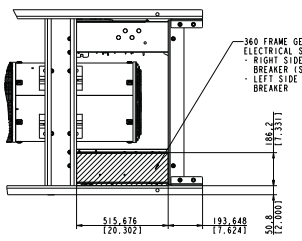


BACK VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATION:
1. 360 GEN, H, J & L-FRAME BREAKERS



BOTTOM VIEW



BOTTOM VIEW

STANDARD SCOPE OF SUPPLY

WITH NON-HOUSED/NON-TANKED BASE

GENSET DIMENSIONAL

| | | |

		Stand-By	Prime
60 Hz Models (kWe)	DG04RM120A1N	80	72
	DG04RM120A2N	100	90
	DG04RM120A3N	125	111
50 Hz Models (kVA)	DG04RM120A1L	89	80
	DG04RM120A2L	111	100
	DG04RM120A3L	139	125

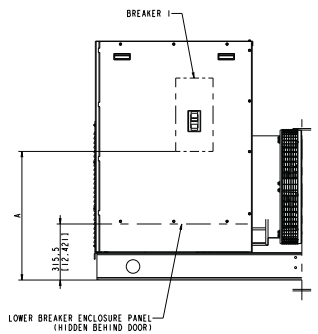
SINGLE BREAKER

BREAKER 1: UP TO 1200 AMP

MAXIMUM TOP ENTRY CONDUIT FITTING ACCOMMODATIONS:
QTY 2, 3.00" FITTINGS

MAXIMUM BOTTOM ENTRY CONDUIT FITTING ACCOMMODATIONS:
QTY 4, 3.50" FITTINGS, OR
QTY 3, 4.00" FITTINGS

RIGHT SIDE BREAKER SHOWN.
LEFT SIDE BREAKER OPTIONAL.



RIGHT VIEW

MARATHON GENERATOR	SQUARE-D BREAKER	
GENERATOR FRAME SIZE	BREAKER FRAME SIZE	DIMENSION "A"
360-FRAME	H-FRAME	768.64 [30.261]
	J-FRAME	754.41 [29.701]
	L-FRAME	673.88 [26.531]
	M/P-FRAME	724.03 [28.511]
430-FRAME	H-FRAME	849.24 [33.431]
	J-FRAME	835.02 [32.871]
	L-FRAME	760.48 [29.941]
	M/P-FRAME	724.03 [28.511]

BREAKER OPTIONS

Maßstab / Scale	Masse/Mass [g]	Format/Size
1:10	2650.795	A0

Werkstoff / Material

Bezeichnung / Title
ABMASSZEICHNUNG
OPU BASE
DIMENSIONAL DRAWING
CM924 GENSET

Zeichnungs-Nr./Drawing No.
XZG2100100021

Blatt/Sheet Nr. 3

Prüf	Datum/Date	Name
Check	09.04.2015	Ibsat
Standard	09.04.2015	Anderson
Norm	09.04.2015	Carsten
Ref.	2009	Carsten

Oberflächenangaben nach/Surface Specification per/ISO1302

Allgemeine Fertigungsvorschriften nach/Production Specification per/DIN 7151

Härtung, Modifizierung/Semi-finished Product, Pattern, Die

Ersatz für / Replaces

Ersetzt durch / Superseded by

Maßstab/Scale 1:10

Masse/Mass [g] 2650.795

Format/Size A0

Werkstoff/Material

Bezeichnung/Title
ABMASSZEICHNUNG
OPU BASE
DIMENSIONAL DRAWING
CM924 GENSET

Zeichnungs-Nr./Drawing No.
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Gezeichnet/Drawn	09.04.2015	Ibsat
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Aufgefährte Normen/Relevant Standards

Zeichnungsnummer/Drawing No.

Änderung/Revision

Änderungs-Nr./Revision Notice No.

Datum/Date

Name

Gepr./Check.

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DIGITAL GENERATOR SET CONTROLLER
MGC-1500 Series Data Sheet

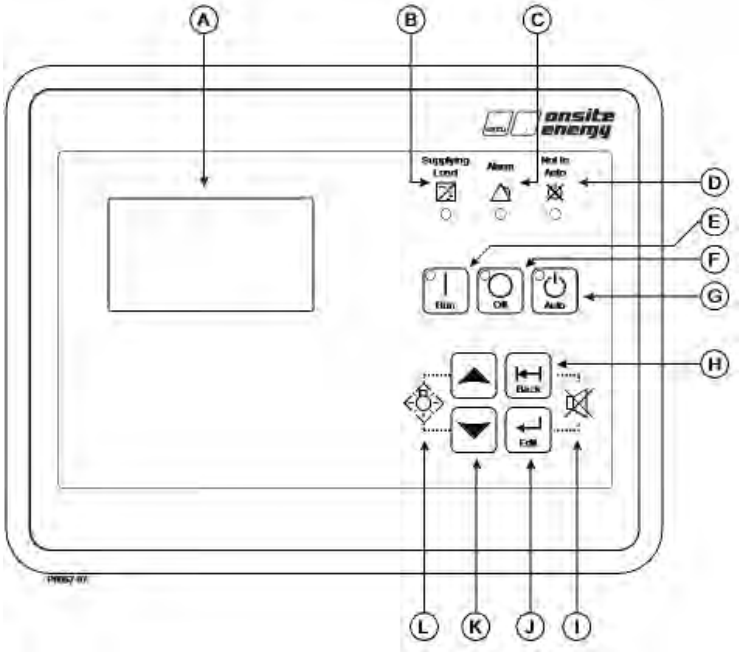
MTU Onsite Energy's Generator Set Controllers (MGC Series) are rugged, reliable, and easy-to-use digital generator set control systems. The MGC-1500 Series is perfectly focused, combining rugged construction and microprocessor technology to offer a product that will hold up to almost any environment and is flexible enough to meet your application's needs.

PRODUCT HIGHLIGHTS

- Three-phase generator metering
- Engine metering
- Generator set control
- Engine protection
- Generator protection
- BESTCOMS*Plus*®
  - Windows®-based software for optional remote operation (Software can be downloaded at www.mtuonsiteenergy.com)
  - Programming and setup software
  - Intuitive and powerful
  - Remote control and monitoring
  - Programmable logic
  - USB communications
- Suitable for rental generator sets with high/low sensing, single or three phase override, wye/delta/grounded delta configurable, and alternate frequency override (50/60 Hz)
- SAE J1939 Engine Control Unit (ECU) communications (optional)
- Resistive sender inputs for oil pressure and coolant temperature
- Multilingual capability
- Remote annunciation with RDP-110
- Event recording (up to 30 events in non-volatile memory)
- Extremely rugged, fully potted design
- Seven programmable contact inputs with Input 1 programmed to recognize an emergency stop
- Start, run, and prestart relays with four programmable outputs
- UL recognized, CSA certified, CE approved
- IP56 rating per IEC 60529
- NFPA-110 compatible
- Microprocessor based
- Complete system metering
- Expandable to meet customer needs

DIGITAL GENERATOR SET CONTROLLER
MGC-1500 Series Data Sheet

DIAGRAM



Front Panel Descriptions

- Liquid Crystal Display (A)
- Supplying Load Indicator (B)
- Alarm Indicator (C)
- Not in Auto Indicator (D)
- Run Pushbutton and Mode Indicator (E)
- Off Pushbutton and Mode Indicator (F)
- Auto Pushbutton and Mode Indicator (G)
- Back Pushbutton (H)
- Alarm Silence Pushbutton Combination (I)
- Edit Pushbutton (J)
- Arrow Pushbuttons (K)
- Lamp Test Pushbutton Combination (L)

FUNCTIONS

Generator Set Protection

Generator ANSI Codes

- Overvoltage (59)
- Overfrequency (81O)
- Voltage Phase Imbalance (47)
- Undervoltage (27)
- Underfrequency (81U)
- Overcurrent (50)

All generator set protection features are programmable as alarms, pre-alarms, status, or not used.

Alarms (Shutdowns)

- Automatic Restart Failure
- High Coolant Temperature
- Low Coolant Temperature
- Overspeed
- Overcrank
- Fuel Leak/Fuel Sender Failure
- Engine Sender
- Emergency Stop
- Battery Charger Failure
- Critical Low Fuel Level (optional)

FUNCTIONS, Generator Set Protection, continued:

Pre-Alarms (Warnings)

- Low Oil Pressure
- Low Coolant Temperature
- Weak Battery Voltage
- Engine Sender Unit Failure
- Maintenance Interval Timer
- Low Fuel Level
- High Fuel Level (optional)
- High Coolant Temperature
- Battery Overvoltage
- Battery Charger Fail
- Engine kW Overload (three levels)
- Low Coolant Level
- Fuel Leak Detect

All alarms and pre-alarms can be enabled or disabled via the BESTCOMS*Plus*® PC software or the front panel. Additional custom alarms and pre-alarms are available upon request.

Generator Set Metering

- Generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor. The view can be programmed to display up to 20 parameters using the scrolling and time delay feature.

- Engine parameters include oil pressure, coolant temperature, RPM, battery voltage, fuel level, engine runtime, and various SAE J1939 supported parameters.

Engine Control

- Cranking Control: Cycle or Continuous (Quantity and Duration fully programmable)
- Engine Cooldown: Smart Cooldown function saves time and fuel
- Successful Start Counter: Counts and records successful engine starts
- Timers:
  - Engine Cooldown Timer
  - Engine Maintenance Timer
  - Pre-Alarm Time Delays for Weak/Low Battery Voltage
  - Alarm Time Delay for Overspeed
  - Alarm Time Delay for Sender Failure
  - Arming Time Delays after Crank Disconnect:
    - Low Oil Pressure
    - High Coolant Temperature
  - Pre-Crank Delay
  - Continuous or Cycle Cranking Time Delay
  - Programmable Logic Timers

Event Recording

The MGC-1500 Series has an event recorder that provides a record of alarms, pre-alarms, engine starts, engine runtime loaded, engine runtime unloaded, last run date, and many other events that are all date and time stamped to help the user determine the cause and effect of issues related to the generator set. Contains up to 30 event records each retaining numerous occurrences in memory. Time, date, and engine hour detail are available for the most current 30 occurrences within each event record.

FUNCTIONS, continued:

Transfer Switch Control (Mains Failure) (optional)

The MGC-1500 Series has the ability to detect a mains failure via a single- or three-phase bus input. A mains failure is established when any one of the following conditions are met:

- Any phase of bus voltage falls below the dead bus threshold
- Any phase of bus voltage is unstable due to overvoltage or undervoltage
- Any phase of bus voltage is unstable due to overfrequency or underfrequency

When conditions are met, the MGC-1500 Series will start the generator set and, when ready, will send generator and mains breaker commands to apply power to the load from the generator set. The MGC-1500 Series implements open or closed breaker transitions to and from the mains. When the mains returns and is considered stable, the MGC-1500 Series will transfer the load back to the mains and stop the engine.

USB Port

The USB communication port can be used with BESTCOMS*Plus*® software to quickly configure a MGC-1500 Series with the desired settings or retrieve metering values and event log records.

Programmable Logic

The MGC-1500 Series offers a very powerful, yet easy-to-use, programmable logic scheme, BESTlogic™*Plus*, for custom programming of the various inputs, outputs, alarms, and pre-alarms. It allows these elements to be integrated into a complete logic scheme so that the user can meet even the most complex specification. The Programmable logic control includes the selection of logic gates and timers with drag-and-drop technology to make it fast and simple.

Remote Display Panel Annunciation (optional)

The MGC-1500 Series can communicate to a remote display panel, Model RDP-110. This requires only two wires to annunciate many of the alarms and pre-alarms required by NFPA-110 Level I and II. External power is required.

SAE J1939 Communications (optional)

SAE J1939 CANBus communications allows the MGC-1500 Series to communicate with the ECU to gather critical engine information like oil pressure, engine coolant temperature, RPM, battery voltage, and much more. By utilizing the ECU, the addition of analog engine senders is no longer required. This can save substantial money for the installer. It also eliminates any errors or discrepancies between the ECU data and the data displayed on the MGC-1500 Series that may be present due to analog sender inaccuracies or incompatibility. An additional benefit is access to the ECU's diagnostic troubleshooting codes (DTCs). The DTCs provide information about the engine's operating conditions and communicate these via SAE J1939 to the MGC-1500 Series, eliminating the need for hand-held service tools to diagnose simple engine issues.

SPECIFICATIONS

Operating Power

- Nominal: 12 or 24 VDC
- Range: 6 to 32 VDC
- Power Consumption:
  - Sleep Mode: 4.5 W
  - Normal Operational Mode: 6.5 W - Run mode, LCD heater off, three relays energized
  - Maximum Operational Mode: 14 W - Run mode, LCD heater on, seven relays energized
  - Battery Ride-Through: Withstands cranking ride-through down to 0 V for 50 ms (typical)

SPECIFICATIONS, continued:

Current Sensing (5 Amp CT Inputs)

- Continuous Rating: 0.1 to 5.0 Aac
- One Second Rating: 25 Aac
- Burden: 1 VA

Voltage Sensing

- Range: 12 to 576 V rms, line-to-line
- Frequency Range: 10 to 72 Hz
- Burden: 1 VA
- One Second Rating: 720 V rms

Contact Sensing/Input Contacts

- Contact sensing inputs include one emergency stop input and seven programmable inputs. The emergency stop input accepts normally closed, dry contacts. The remote emergency stop is limited to 75 ft. standard. Extended runs are available with an optional relay. All programmable inputs accept normally open, dry contacts. The factory may utilize up to three of these inputs.

Engine System Inputs

- Fuel Level Sensing Resistance Range: 5 to 250 Ω nominal
- Coolant Temperature Sensing Resistance Range: 5 to 2,750 Ω nominal
- Oil Pressure Sensing Resistance Range: 5 to 250 Ω nominal
- Engine Speed Sensing:
  - Magnetic Pickup or CANBus
    - Magnetic Pickup Voltage Range: 3 to 35 V peak (6 to 70 V peak to peak)
    - Magnetic Pickup Frequency Range: 32 to 10,000 Hz

Output Contacts

- (7) Total Outputs: (3) 5 A @ 28 VDC and (4) 2 A @ 28 VDC

- The factory utilizes the following on each generator set which can be reprogrammed as needed:
  - (3) 5 A @ 28 VDC for Pre-start, Start, and Run
  - (4) 2 A @ 28 VDC for general purpose

Metering

- Generator Voltage (rms)
  - Metering Range: 12 to 576 VAC (direct measurement), up to 9,999 VAC (with appropriate voltage transformer)
  - Accuracy: ±1% of programmed rated voltage or ±2 VAC (subject to accuracy of voltage transformer when used)
- Generator Current (rms)
  - Generator current is measured at the secondary windings of 5 A CTs.
  - Metering Range: 0 to 5,000 Aac
  - CT Primary Range: 1-5,000 Aac, in primary increments of 1 Aac
  - Accuracy: ±3% of programmed rated current or ±3 Aac (subject to accuracy of CTs)

SPECIFICATIONS, Metering, continued:

- Generator Frequency
  - Metering Range: 10 to 72 Hz
  - Accuracy: ±0.25% or 0.05 Hz
- Apparent Power
  - Indicates total kVA and individual line kVA (four-wire, line-to-neutral or three-wire, line-to-line).
  - Accuracy: ±5% of the full-scale indication or ±4 kVA
- Power Factor
  - Metering Range: 0.2 leading to 0.2 lagging
  - Accuracy: ±0.02
- Real Power
  - Indicates total kW and individual line kW (four-wire, line-to-neutral or three-wire, line-to-line)
  - Accuracy: ±5% of the full-scale indication or ±4 kW
- Oil Pressure
  - Metering Range: 0 to 150 psi or 0 to 1,034 kPa
  - Accuracy: ±3% of actual indication or ±2 psi or ±12 kPa (subject to accuracy of sender)
- Coolant Temperature
  - Metering Range: 0 °C to 204 °C (32 °F to 410 °F)
  - Accuracy: ±3% or actual indication or ±2° (subject to accuracy of sender)Fuel Level
  - Metering Range: 0 to 100%
  - Accuracy: ±3% (subject to accuracy of sender)
- Battery Voltage
  - Metering Range: 6 to 32 VDC
  - Accuracy: ±3% of actual indication or ±0.2 VDC
- Engine RPM
  - Metering Range: 0 to 4,500 rpm
  - Accuracy: ±2% of actual indication or ±2 rpm
- Engine Run Time
  - Engine run time is retained in non-volatile memory.
  - Metering Range: 0 to 99,999 h; Update Interval: 6 min
  - Accuracy: ±1% of actual indication or ±12 min
- Maintenance Timer
  - Maintenance timer indicates the time remaining until generator set service is due. Value is retained in non-volatile memory.
  - Metering Range: 0 to 5,000 h; Update Interval: 6 min
  - Accuracy: ±1% or actual indication or ±12 min

Generator Protection Functions

- Overvoltage (59) and Undervoltage (27)
  - Pickup Range: 70 to 576 VAC
  - Activation Delay Range: 0 to 30 s
- Overfrequency (81O) and Underfrequency (81U)
  - Pickup Range: 45 to 66 Hz
  - Pickup Increment: 0.1 Hz
  - Activation Delay Range: 0 to 30 s

SPECIFICATIONS, Generator Protection Functions, continued:

- Phase Imbalance (47)
  - Pickup Range: 5 to 100 VAC
  - Pickup Increment: 1 VAC
  - Activation Delay Range: 0 to 30 s
  - Activation Delay Increment: 0.1 s
- Overcurrent (51)
  - Pickup Range: 0.18 to 1.18 Aac (1 A current sensing)
  - Time Dial Range: 0 to 7,200 s (fixed time curve)

Environmental

- Temperature
  - Operating: -40 °C to 70 °C (-40 °F to 158 °F)
  - Storage: -40 °C to 85 °C (-40 °F to 185 °F)
- Humidity: IEC 68-2-38
- Salt Fog: ASTM B 17-73, IEC 68-2-11 (tested while operational)
- Ingress Protection: IEC IP54 for front panel
- Shock: 15 G in three perpendicular planes
- Vibration: 5 to 29 to 5 Hz at 1.5 G peak for 5 min
  29 to 52 to 29 Hz at 0.036" DECS-A for 2.5 min
  52 to 500 to 52 Hz at 5 G peak for 7.5 min
  - Swept over the above ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep.

Agency Approvals

- UL/CSA Approvals: "cURus" approved to UL 6200 and CSA C22.2 No.14
- NFPA Compliance: Complies with NFPA Standard 110, Standard for Emergency and Standby Power
- CE Marked: Complies with applicable EC Directives

ADDITIONAL SPECIFICATIONS

Battery Backup for Real Time Clock

The MGC-1500 Series provides a real-time clock with capacitor backup that is capable of operating the clock for up to 24 hours after power is removed from the controller. As the capacitor nears depletion, an internal backup battery takes over and maintains timekeeping. The battery will maintain the clock for approximately 10 years, depending on conditions. The battery is not replaceable. The clock is used by the events recorder function to timestamp events, and the exercise timer is used to start and stop the generator set when the exercise feature is utilized.

Breaker Management

The MGC-1500 Series is capable of controlling the generator breaker and the mains breaker. The status of the breakers is determined by using BESTlogic™*Plus* programmable logic to set up the GENBRK and MAINSBRK logic blocks. These logic blocks have outputs that can be configured to energize an output contact and control a breaker, as well as inputs for breaker control and status. The MGC-1500 Series will attempt to close a breaker only after verifying that it can be closed. If the breaker cannot be closed, the close request will be ignored. Only one breaker can be closed at a time. Synchronization is required before closing the breaker to a live bus. Closure to a dead bus can be performed after meeting dead bus threshold and timing requirements set by the user.

MAGNAPLUS®

MARATHON ELECTRIC
SYNCHRONOUS AC GENERATOR
TYPICAL SUBMITTAL DATA

Basic Model 362CSL1604 **Date: 4-27-05**

Kilowatt ratings at	**1800** RPM	**60** Hertz					**12** Leads		
kW (kVA)	**3** Phase	**0.8** Power Factor					**Dripproof or Open** Enclosure		
	Class B	**Class F**					**→ Class H**		
Voltage*	**80° C ① Continuous**	**90° C ① Lloyds**	**95° C ① ABS**	**105° C † British Standard**	**105° C ① Continuous**	**130° C ① Standby**	**125° C † British Standard**	**125° C ① Continuous**	**150° C ① Standby**
240/480	**75 (94)**	**77 (96)**	**77 (96)**	**84 (105)**	**84 (105)**	**90 (113)**	**90 (113)**	**90 (113)**	**95 (119)**
230/460	**71 (89)**	**73 (91)**	**73 (91)**	**80 (100)**	**80 (100)**	**86 (107)**	**86 (107)**	**86 (107)**	**90 (113)**
220/440	**68 (85)**	**70 (88)**	**70 (88)**	**76 (95)**	**76 (95)**	**84 (105)**	**84 (105)**	**84 (105)**	**89 (112)**
→ 208/416	**65 (81)**	**67 (84)**	**67 (84)**	**72 (90)**	**72 (90)**	**80 (100)**	**80 (100)**	**80 (100)**	**85 (106)**
190/380	**60 (75)**	**60 (75)**	**60 (75)**	**65 (81)**	**65 (81)**	**72 (90)**	**72 (90)**	**72 (90)**	**77 (96)**

① *Rise by resistance method, Mil-Std-705, Method 680.1b.* † *Rating per BS 5000.*

Submittal Data: 480 Volts, 100 kVA, 1800 RPM, 60 Hz, 3 Phase

Mil-Std-705B		
Method	**Description**	**Value**
301.1b	Insulation Resistance	> 1.5 Meg
302.1a	High Potential Test	
	Main Stator	2000 Volts
	Main Rotor	1500 Volts
	Exciter Stator	1500 Volts
	Exciter Rotor	1500 Volts
401.1a	Stator Resistance, Line to Line	
	High Wye Connection	0.138 Ohms
	Rotor Resistance	1.05 Ohms
	Exciter Stator	23.5 Ohms
	Exciter Rotor	0.12 Ohms
410.1a	No Load Exciter Field Amps	
	at 480 Volts Line to Line	0.52 A DC
420.1a	Short Circuit Ratio	0.634
421.1a	Xd Synchronous Reactance	1.864 pu
422.1a	X2 Negative Sequence	
	Reactance	0.148 pu
423.1a	X0 Zero Sequence Reactance	0.038 pu
425.1a	X'd Transient Reactance	0.127 pu
426.1a	X"d Subtransient Reactance	0.098 pu
427.1a	T'd Transient Short Circuit	
	Time Constant	0.05 sec.
428.1a	T"d Subtransient Short Circuit	
	Time Constant	0.007 sec.
430.1a	T'do Transient Open Circuit	
	Time Constant	0.8 sec.
432.1a	Ta Short Circuit Time	
	Constant of Armature Winding	0.01 sec.

Mil-Std-705B		
Method	**Description**	**Value**
505.3b	Overspeed	2250 RPM
507.1c	Phase Sequence CCW-ODE	ABC
601.4a	L-L Harmonic Maximum - Total	3.5%
	(Distortion Factor)	
601.4a	L-L Harmonic Maximum - Single	2.5%
601.1c	Deviation Factor	7.0%
---	TIF (1960 Weightings)	<50
	Additional Prototype Mil-Std Methods are Available on Request.	
--	Generator Frame	360
--	Type	Ext. Voltage Regulated, Brushless
--	Insulation	Class H
--	Coupling - Single Bearing	Flexible
--	Amortisseur Windings	Full
--	Cooling Air Volume	700 CFM
--	Exciter	Rotating
--	Voltage Regulator	SE350
--	Voltage Regulation	1%

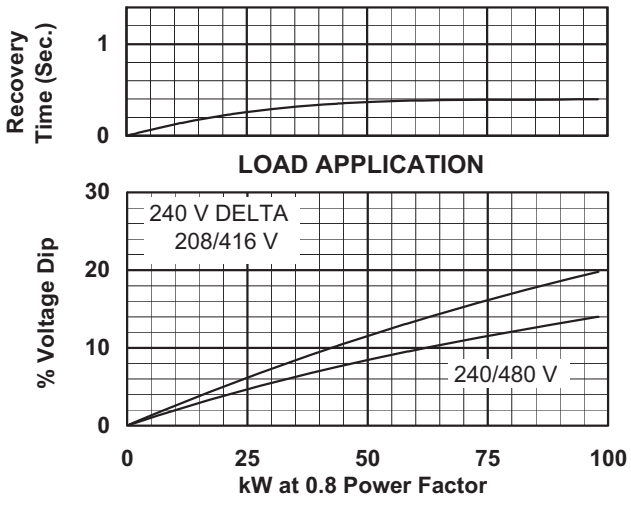
* Voltage refers to wye (star) connection, unless otherwise specified.

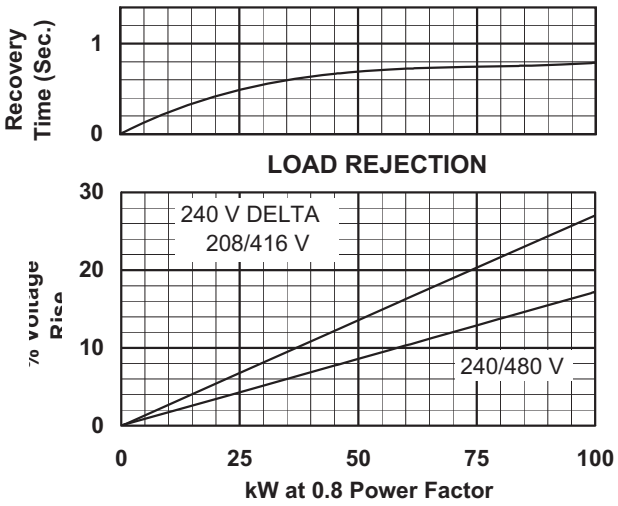
MAGNAPLUS®

MARATHON ELECTRIC
SYNCHRONOUS AC GENERATOR
TYPICAL DYNAMIC CHARACTERISTICS

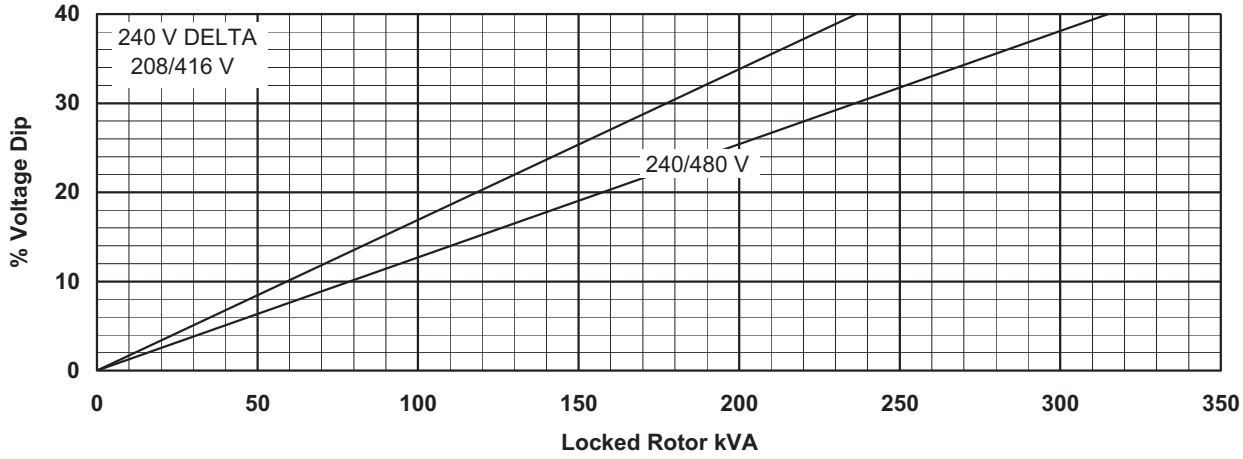
Basic Model 362CSL1604 **Date: 6-1-00**

60 HERTZ

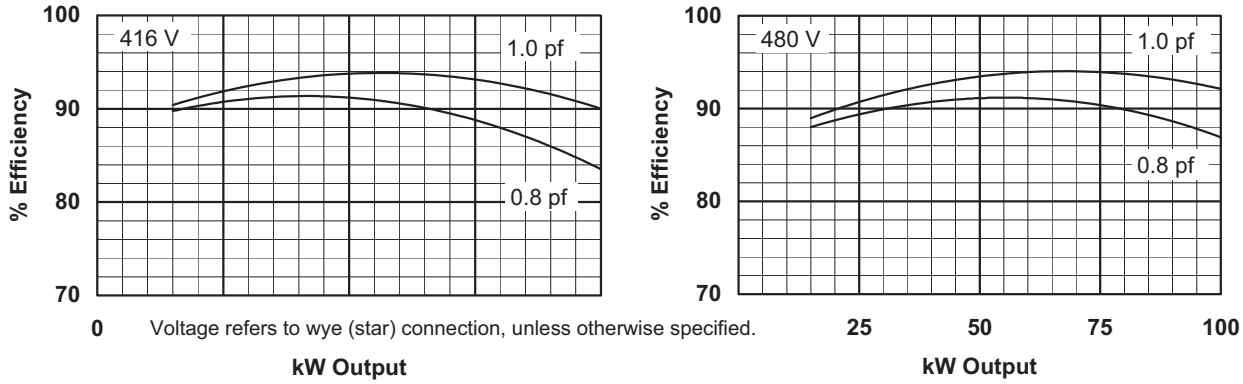




TYPICAL MOTOR STARTING CHARACTERISTICS



TYPICAL GENERATOR EFFICIENCY



Voltage refers to wye (star) connection, unless otherwise specified.

SECTION 2

Accessories

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

List of material

GÉNÉRATRICE DRUMMOND

Project no 2016-05-0758A

File 1915GDM

Project IGLOOLIK WATER SUPPLY SYSTEM

Group DS80D6S, 362CSL1604, 80kW/100kVA, A, 120/208V

Part no	Description	Quantity
	ATS	
ATH3KDA30300BSC	Automatic Transfer Switch, CH , 300A, 120/208V, 3Ph, 3P TS-	1.00
	Cooling system	
	Block Heater Kim Hotstart 1500W/120V	1.00
	Electrical system	
DD31P925	Battery EAST PENN 925CCA 12V (EPM)	1.00
79100	Battery Charger Guest compact 12 Vcc, 6 A	1.00
MGC-1520	Controler MTU MGC-1520	1.00
JDL36250	Breaker Square D 3 poles, 600V,250A (3/0-350MCM) (85686)	1.00
CRM012DC4LSS42H	Relays 12Vdc ABB 4P2D	2.00
	Exhaust system	
JIS-04	Silencer industrial grade	1.00
	Exhaust flex	1.00
	Fuel system	
B200-F	Fuse Valve ½" 165F ULC	1.00
	Miscellaneous	
MANUEL ATS	Owner's Manual - Automatic Transfer Switch	1.00
MANUEL GENE	Owner's Manual - Genset Group	1.00
	USB Key GD	2.00
GARANTIE ATS	Warranty 1 year - Automatic Transfer Switch	1.00
GARANTIE GENE	Warranty 2 years (3000 hours) - Genset Group	1.00
	Factory test	
	Standard Test	1.00

GENUINE DETROIT DIESEL MAINTENANCE FREE STARTING BATTERIES

Reliable starting power for any commercial service vehicle. Heavy-duty construction reduces damaging effect of vibration for long service life.

Genuine Detroit Diesel Maintenance-Free Starting Batteries assure quick, reliable starting power for any commercial service vehicle. Anchorlocked elements, radial grids and tight-pack, heavy-duty construction significantly reduce the damaging effects of vibration, resulting in maximum power-per-pound and long service life.

Genuine Detroit Diesel Starting Batteries are completely maintenance-free and never need watering, dramatically reducing maintenance costs. And the popular Group 31 size fits most types of commercial equipment for easy replacement. All our batteries pass more than 250 quality checks during manufacture, ensuring superior performance and long life. And Genuine Detroit Diesel Batteries are made in the U.S.A., your assurance of quality!

PERFORMANCE LEVEL								DIMENSIONS INCHES/(mm)		
BCI Group Size	Detroit Diesel Part Number	Footnotes	Cranking Amps @ 32°F	Cold Cranking Amps @ 0°F	Reserve Capacity Mins @ 80°F	Volts	Approx. Wt. Lbs. Wet	L	W	H
MAINTENANCE-FREE STARTING SERVICE										
31	EPM/DD931MF	JLMX	810	650	145	12	51	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD931PMF	JLMS	810	650	145	12	51	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1031MF	JLMX	910	760	170	12	54 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1031PMF	JLMS	910	760	170	12	54 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD31P925	JLMX	1110	925	170	12	56 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1131PMF	JLMS	1110	925	170	12	56 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1131XMF	JLMX	1190	1000	185	12	58	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1131XPMF	JLMS	1190	1000	185	12	58	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1231MF	JLMX~	1260	1125	195	12	61	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD1231PMF	JLMS~	1260	1125	195	12	61	13 (330)	6 3/4 (171)	9 1/2 (241)
FLOODED HEAVY-DUTY MAINTENANCE-FREE DUAL PURPOSE CYCLING/STARTING SERVICE										
31	EPM/DDDP31CS	JLMS§	875	700	180	12	57	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DDDP31PCS	JLMS§	875	700	180	12	57	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD7T31	JLMS§	940	730	190	12	62 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
31	EPM/DD7T31P	JLMS§	940	730	190	12	62 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)
ABSORBED GLASS MAT MAINTENANCE-FREE DUAL PURPOSE CYCLING/STARTING SERVICE										
31	EPM/DD8A31	HX1	**1000	**800	190	12	69	13 (330)	6 3/4 (171)	9 3/8 (238)
31	EPM/DD9A31	HX1	**1150	**925	190	12	68 1/2	13 (330)	6 3/4 (171)	9 1/2 (241)

H – Includes handles
J – Includes lifting ledges
L – Anchor lock elements
M – Flush manifold vented cover
N – Flush manifold vented cover when shipped wet, standard cover when shipped dry or FP
S – SAE "Automotive Type" post
X – 3/8" x 16 stainless steel stud posts

1 – "Non-Spillable" by DOT (Department of Transportation) definition
~ – Deduct 4% from CCA & CA rating to allow for special electrolyte additive
§ – Deduct 15% from CCA and CA rating shown to allow for double insulation (glass mat)
** – Pre-production estimate

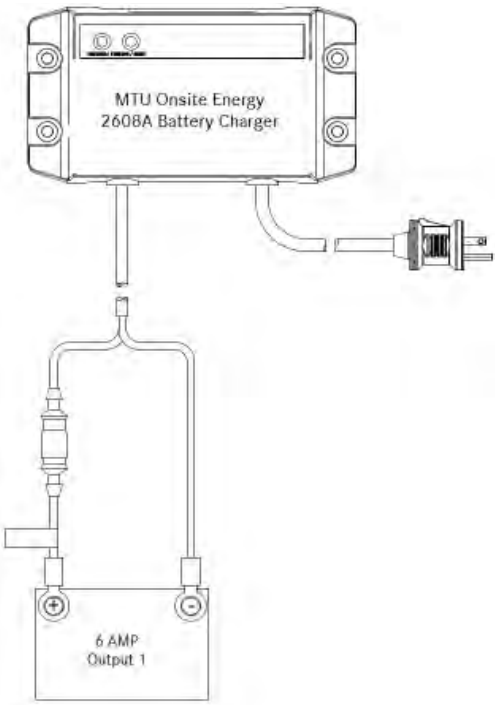
California Proposition 65 Warning:
Batteries, battery posts, terminals and related accessories contain lead and lead compounds and other chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.
Wash Hands after handling!

BATTERY CHARGER
2608A Data Sheet

FEATURES
- Watertight, shock and corrosion resistant
- Short circuit and thermal protection
- LED status indicator
- Reverse polarity protection

DESCRIPTION
The 2608A battery charger is designed to recharge batteries as well as extend the battery's life in applications where it is stored for long periods of time. This charger is "3-stage" electronic, completely automatic, and lightweight. Unlike automotive trickle chargers, the 2608A will not overcharge batteries. The visible red and green LED lights on the charger faceplate allow for easy operation.

SPECIFICATIONS
- MTU Onsite Energy Part #: SUA79100
- Output Volts: 12 Volts
- Output Amps: 6 Amps
- Load Banks: 1 Bank
- DC Cable Length: 1219.2 mm (48 in)
- Dimensions (L x W x H): 88.9 mm (3.5 in) x 162.56 mm (6.4 in) x 57.15 mm (2.25 in)
- Input Volts: 115 VAC - 50/60 Hz
- Input Amps Max: 2 Amps



2608A Battery Charger Schematic

© MTU Onsite Energy. Subject to alteration due to technological advances. 2014-08

Product Data Sheet

JDL36250

Molded Case Circuit Breaker , 600VAC/250VDC, 250A

Technical Characteristics

Approvals	UL Listed - CSA Certified - IEC Rated
Circuit Breaker Type	Standard
Catalog Reference Number	0611CT0401
For Use With	Industrial Enclosures and Switchboards
Ampere Rating	250A
General Application	Provides overload and short circuit protection
AC Magnetic Trip Setting	1250A - 2500A Adjustable Trip
Frame Type	J-Frame
HACR Rated	Yes
Marketing Trade Name	Powerpact
Voltage Rating	600VAC/250VDC
Mounting Type	Unit Mount
Number of Poles	3-Pole
Weight	5 Pounds
Short Circuit Current Rating	25kA@240VAC - 18kA@480VAC - 14kA@600VAC
Terminal Type	Line: Lug - Load: Lug
Type	JD
Wire Size	#3/0-350 AWG/kcmil(Al/Cu)
Height	7.52 Inches
Width	4.12 Inches
Depth	5.00 Inches

Shipping and Ordering

Category	01110 -
Discount Schedule	DE2
Article Number	785901839941
Package Quantity	1
Weight	4.79 lbs.
Availability Code	Non-Stock Item: This item is not normally stocked in our distribution facility.
Returnability	Y

As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this document.

Generated: 06/01/2009 12:26:22

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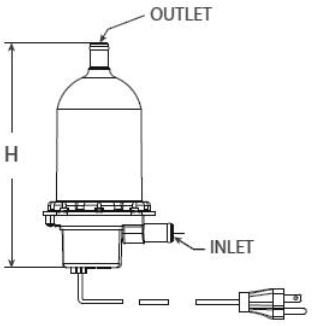
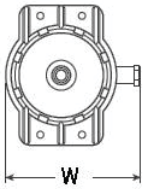
WATER HEATER
TPS Series Data Sheet

The TPS engine preheater is designed to preheat diesel and gas engines in generator set applications. Simple to install and very lightweight, the TPS engine preheater features a built-in thermostat and heats engines up to 12 liter displacement. Thermosiphon circulation of the coolant delivers heat throughout the entire engine.





CERTIFICATIONS AND STANDARDS

- C-UL-US Listed
- CSA Certified

SPECIFICATIONS

Height:	200 mm (7.9 in)
Width:	117 mm (4.6 in)
Weight:	771 g (1.7 lb)
Heating Fluid:	Engine coolant (50% glycol/50% water)
Power:	0.5, 1, 1.5, 1.8 and 2 kW
Rated Voltage:	1 Phase – 120 and 240 VAC
Tank Material:	Polyphenylene Sulfide (PPS)
Heating Element:	Incoloy 800
Enclosure:	IP41
Fluid Capacity:	416 cm^3 (0.11 gal)
Max Pressure:	6.2 bar (90 psi)
Inlet / Outlet:	15.9 mm (0.625 in)
Thermostat Range:	
On	38 °C (100 °F)
Off	49 °C (120 °F)

Model Number	MTU Onsite Energy Part Number	Watts	Volts	Phase	Hz	Amps
TPS101GT10-000	SUA52746	1,000	120	1	60	8.4
→ TPS151GT10-000	SUA52748	1,500	120	1	60	12.5
TPS181GT10-000	SUA52750	1,800	120	1	60	15

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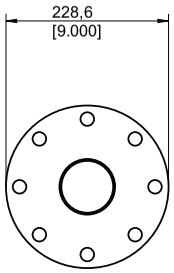

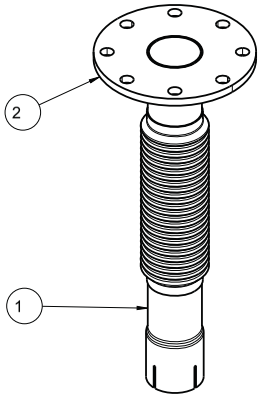

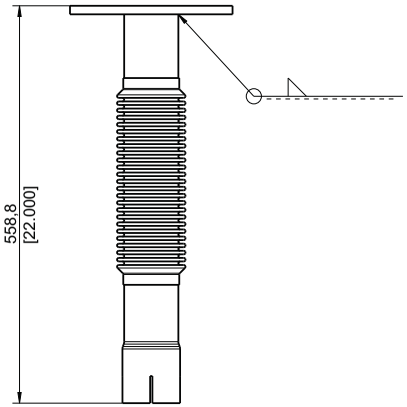

Rz 100

MTN5168

Beschichtung nach MTV5010; Aluminiumlack,
Farbton ca. RAL9006 weissaluminium

Coating acc. to MTV5010; Aluminium paint,
color approx. RAL9006 aluminium-white

Es gilt zusaetzlich die 3D-Geometrie
The 3D geometry is also applicable

Schweissverfahren WIG/MAG
Welding method

Bewertungsgruppe C
nach ISO 5817
Evaluation group
as per ISO 5817

Zusatzwerkstoff W3Si1/G3Si1
nach MMN 402
Filler material
as per MMN 402

Nahtdicke bei a = 2 mm
Kehlnaehten
Seam thickness for
fillet welds

NOTES:
1) FINISH: ALUMINIZED
2) DIMENSIONS: MM[IN]

Pos.	Benennung/Title	Material-Nr./Material No. Halbzeug,Modell usw. Semi-finished product,Pattern...	Norm Standard	Abmessung/Dimensions Behandlungszustand Treatment condition	Werkstoff/Material Oberflächenschutz Surface protection	Kl/Kl. Sr/Fo.	Masse Mass kg
1	4" FLANGE	SUA107547-02			S235JR	2	3.199
1	FLEX TUBE	SUA107547-01			S235JR	1	4.551

Ausfuehrung u.Lieferung Tech. Characteristics	Oberflaechenangaben nach MTN5033 Surface Specification per MTN5033	Massstab Scale 1:5	Masse/Mass kg 7.75
Oberflaechenschutz Surface Protection			Format/Size A2
Verwendbar fuer Typ Applicable to Model	Allgemeine Fertigungs-vorschriften nach MMN 332 Production Specification per MMN 332	Werkstoff Material	
Projekt-/Auftrags-Nr. Project/Order No.		Halbzeug,Modell,Gesenk Semifinished Product, Pattern,Die	
Referenz-Nr./Reference No.		Benennung/Title ROHR TUBE	

	Pro/E	Datum/Date	Name
Bearb. Drawn		06.06.2014	Kost
Gepr. Checked		06.06.2014	Anderson
Norm. Stndr.		06.06.2014	Carsten
Abt. Dept.	EDMM		Carsten

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onsite energy

Zeichnungs-Nr./Drawing No. SUA107547

Blatt Sheet 1v.4

Aufgeführte Normen Relevant Standards	Passmass Fit	Abmass in Deviation Lim	Buchst. Rev.Ltr.	kommt vor Frequency	Aenderung/Revision	Aenderungs-Nr. Revision Notice No.	Datum Date	Name	Gepr. Check.
MMN402	0	0 0							
MTN5168	0	0 0							
MTV5010	0	0 0							
ISO5817	0	0 0					06.06.2014	kost	

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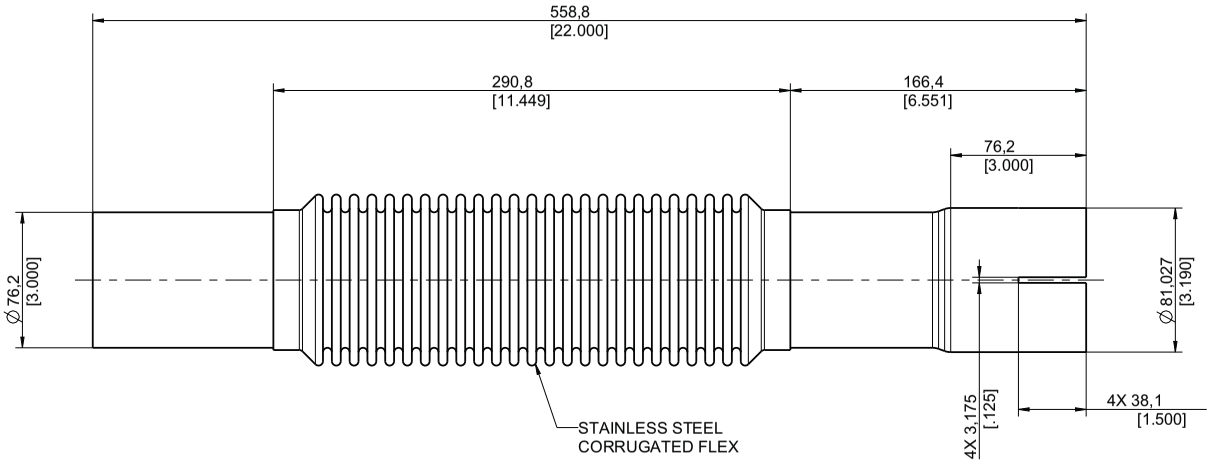
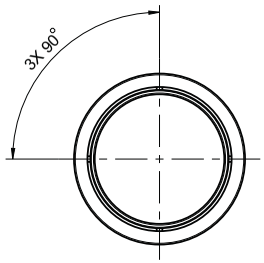
lfd.Nr./Ser.No. 1

SCALE 1:5





NOTES:
1) MATERIAL, TUBE: 3.00 OD X .065; 16 GA. STEEL TUBING
MATERIAL, FLEX: STAINLESS STEEL CORRUGATED
2) FINISH: ALUMINIZED
3) DIMENSIONS: MM[IN]

Aufgeführte Normen Relevant Standards	Passmass Fit	Abmass in Deviation Lim	Buchst. Rev.Ltr.	kommt vor Frequency	Aenderung/Revision	Aenderungs-Nr. Revision Notice No.	Datum Date	Name	Gepr. Check.
	0	0							
	0	0							
	0	0							
	0	0							
	0	0							
	0	0					06.06.2014	kost	

Ausfuehrung u.Lieferung Tech. Characteristics	Oberflaechenangaben nach MTN5033 Surface Specification per MTN5033	Massstab Scale 1:2	Masse/Mass kg 7.75	Format/Size A2
Oberflaechenschutz Surface Protection		Werkstoff Material		
Verwendbar fuer Typ Applicable to Model	Allgemeine Fertigungsvorschriften nach MMN 332 Production Specification per MMN 332	Halbzeug,Modell,Gesenk Semifinished Product, Pattern,Die		
Projekt-/Auftrags-Nr. Project/Order No.		Benennung/Title		
Referenz-Nr./Reference No.		ROHR		
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		Zeichnungs-Nr./Drawing No. SUA107547		Blatt Sheet 2v.4

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REVISION HISTORY				
No.	DATE	BY	ZONE	COMMENTS
C	5/19/00	BAW	*	OUTLINE UPDATED

400094 | C

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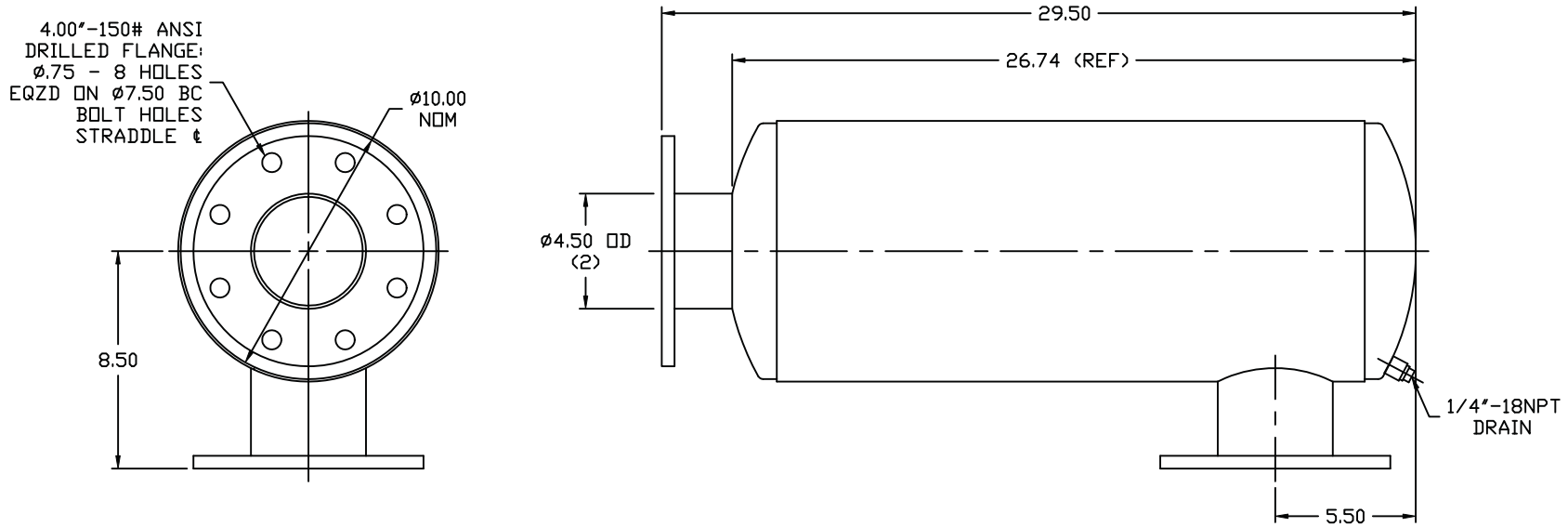


GAS FLOW

EM PRODUCTS™

PHILLIPS & TEMRO *industries*
A Thyssen Budd Automotive Company

THIRD ANGLE PROJECTION	DRAWN BY INS	DATE 5/1/87	DESCRIPTION: JIS-04: S/E 4.00" FLG CONN *
	APPR. BY *	DATE *	
DIMENSIONS ARE IN: X IN , MM , INDMO	DRAWING ORIGIN PRIOR LAKE		REF: *
UNLESS SPECIFIED DIMENSION TOLERANCES ARE: ANGLES ∠± 2° / INCHES .00 ± .13, .000 ± * / MILLIMETERS 00. ± *, 0.0 ± *			MATERIAL: CARBON STEEL

CUSTOMER *	WORK ORDER *	FINISH HIGH TEMP. BLACK	WEIGHT *

SCALE:	DWT.	FAB.	DRAWING No.	REV.
1:4	B	B	400094	C

SHEET 1 OF 1

SECTION 3

Automatic Transfer Switch(es)

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

Cutler-Hammer

ATC-300
Automatic Transfer Switch Controller

Technical Data

New Information

ATH3KDA30300BSC

Introduction

The Cutler-Hammer® ATC-300 Automatic Transfer Switch Controller from Eaton's Electrical business is a comprehensive, multi-function, microprocessor-based automatic transfer switch controller. It is a compact, self-contained, panel-mounted controller that is designed to accurately monitor power sources and provide the necessary intelligence to reliably operate a transfer switch through a series of programmed sensing and timing functions. The ATC-300 provides an unmatched degree of programming flexibility to address the needs of any system.

Primary Functions

As standard, the ATC-300 Automatic Transfer Controller will:

- Monitor normal and emergency source voltages and frequencies.
- Provide transfer and re-transfer control signals.
- Provide engine/generator starting and shutdown signals.
- Permit customer programming of operational set points.
- Display real-time and historical information.
- Permit system testing.
- Store customer and factory established parameters in nonvolatile memory.
- Provide faceplate source status indication.
- Provides an LCD-based display for programming and status readouts.

Operational Simplicity

From installation to programming to usage, the ATC-300 Controller was designed with operational simplicity in mind. Only one style needs to be considered regardless of input/output requirements or system voltages and frequencies. The intuitive front panel interface simplifies routine operation, programming, and data presentation and set point adjustment. An LCD-based display is backlit for enhanced visibility. The front panel membrane pushbuttons with positive-feedback move the ATC-300 Controller display from function-to-function or step-to-step within a function. The ATC-300 Controller provides the functionality of multiple devices combined in one package and mounts in less than 5.75 inches (146.1 mm) x 7.75 inches (196.8 mm) of panel space.

Industrial Design Highlights

- True rms voltage sensing of normal and emergency sources.
- Frequency sensing of normal and emergency sources.
- Voltage unbalance and phase rotation sensing.
- Programmable set points stored in nonvolatile memory.
- PowerNet™ communications capable.
- System monitoring with historical data storage and display.
- Gold-plated engine start contact.
- Digital set points for accurate and consistent performance.
- Automatic plant exerciser.
- UV-resistant faceplate with Mimic Diagram and LED status indicators.
- LCD-based, backlit, two-line display.
- Suitable for application over a wide range of environmental conditions.
- Self-diagnostic and system diagnostic functions with LED indication.
- Help function for detailed description of displayed message.
- System Test pushbutton.
- Positive feedback membrane pushbuttons for application in harsh environments.
- Password protected access to programming mode.
- Pretransfer contacts.
- Bypass Time Delay pushbutton.
- Control input for remote testing or peak shaving applications.
- Five different control input functions for maximum operational flexibility.
- In-phase and Time Delay Neutral transfer modes for systems with inductive loads.

Standards

The Cutler-Hammer ATC-300 Automatic Transfer Switch Controller meets or exceeds all industry standards for endurance, reliability and performance. It is designed to meet the needs of markets worldwide.

The ATC-300 Automatic Transfer Switch Controller is designed and built as standard in accordance with the following standards where applicable.

Table 1. Standards

UL® 1008	UL Standard for Safety for Transfer Switch Equipment
UL 991	Tests for Safety-Related Controls Employing Solid-State Devices
CSA® 22.2 No.178	Canadian Standards Association
IEC 61000-4-2, 61000-4-3, 61000-4-4 61000-4-5 61000-4-6 61000-4-11	International Electrotechnical Commission EMC Standards
FCC Part 15, Class A	Federal Communication Commission RF Emissions
CISPR 11	International Electrotechnical Commission Standard for RF Emissions
UBC®, BOCA® Seismic Zone 4	California Building Code
CE	European Standards Conformance

ATC-300 Automatic Transfer Switch Controller Product Overview

ATC-300 Automatic Transfer Switch Controller

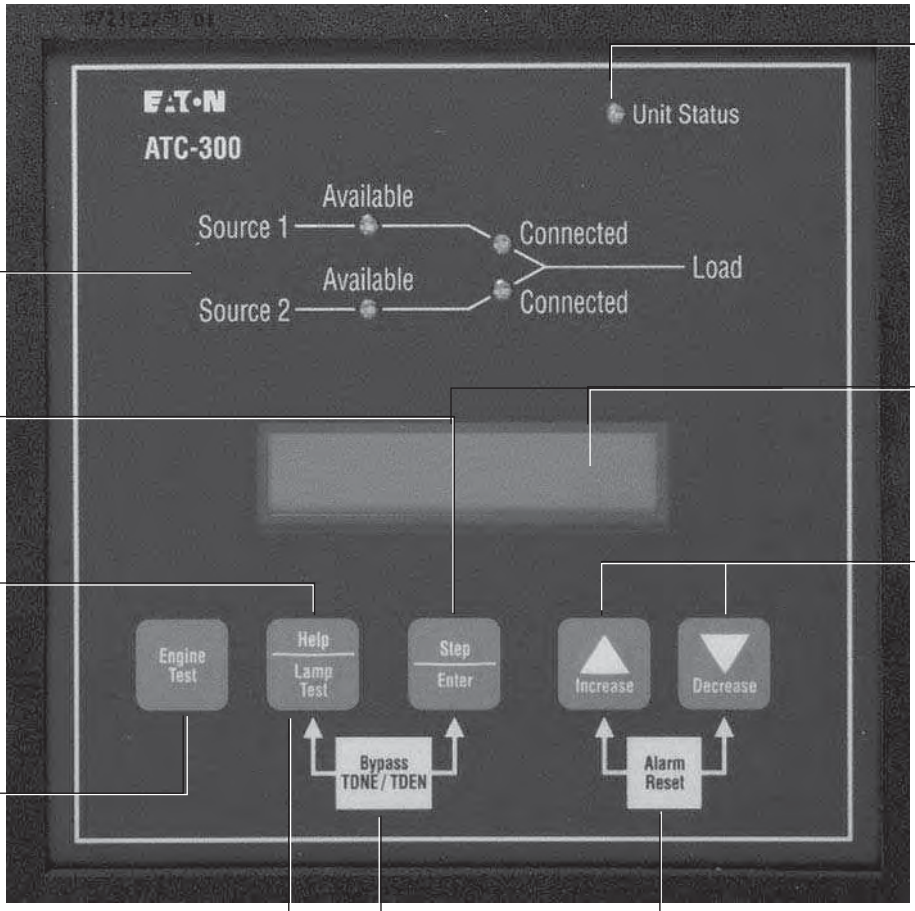
Table 2. Product Overview

Specifications	Value
Voltage	
Voltage Measurements of: Voltage Measurement Range Voltage Measurement Accuracy	Source 1 and 2: VAB, VBC and VCA 0 – 790 Vac rms ±1% of Full Scale
Frequency	
Frequency Measurements of: Frequency Measurement Range Frequency Measurement Accuracy	Source 1 and 2 40 – 70 Hz ±0.3 Hz
Control Power	
Input Range	65 Vac – 145 Vac rms, 50/60 Hz
System Inputs	
Source 1 Closed Source 2 Closed Lockout	Yes Yes Yes
Go to Source 2 Monitor Mode	Yes Yes
Output Contacts	
Form “A” for Generator Start Form “A” for Control	(1) 5 A, 250 Vac/30 Vdc (2) 10 A, 250 Vac/30 Vdc
Form “C” for Alarm Form “C” for Pre-Transfer	(1) 10 A, 250 Vac/30 Vdc (1) 10 A, 250 Vac/30 Vdc
Front Panel	
LED Indication	Unit Status. Source 1 and 2: Available and Connected (5 Total)
Main Display	LCD-Based Display
Parameters Displayed	Voltage, Frequency, Status, History, Time, Date, Set Points, Help Information
Stored Historical Data Includes:	Engine Run Time, Source 1 Available Time, Source 2 Available Time, Source 1 Connect Time, Source 2 Connect Time, Load Energized Time, Number of Transfers; Date, Time and Reason for Last 16 Transfers; Monitor Mode Event, Fail-Safe Event, Aborted Test

Table 2. Product Overview (Continued)

Specifications	Value
Front Panel	
Display Language Enclosure Compatibility	English, French NEMA® 1, 12 and 3R, UV-Resistant Faceplate
Operating Environmental Range	Operation -20°C – +70°C, Storage -30°C – +85°C, Humidity 0% – 95% Relative (Non-condensing)
Applicable Standards	UL 1008, UL 991, FCC Part 15, CISPR 11, IEC 1000-2,3,4,5, CSA, UBC and BOCA for Seismic Zone 4
Programming Access	Password
Front Panel Input Pushbuttons	Engine Test, Step, Help, Lamp Test, Increase, Decrease, Alarm Reset, Bypass Time Delays, Enter
Programming Selections	
Time Delay Normal to Emergency Time Delay Emergency to Normal Time Delay Engine Cooldown	0 – 1800 Seconds 0 – 1800 Seconds 0 – 1800 Seconds
Time Delay Engine Start Time Delay Neutral Time Delay Emergency Fail	0 – 120 Seconds 0 – 120 Seconds 0 – 6 Seconds
In-Phase In-Phase Frequency Difference Synchronization Time Allowance	Enabled or Disabled 0 – 3 Hz 1 – 60 Minutes
Pre-Transfer Signal Plant Exerciser	1 – 120 Seconds (Form “C” Contact) Selectable: Disabled, Daily or 7, 14, 28-Day Intervals, 0 – 600 Minutes, Load or No Load
System Sensing Voltage Unbalance Phase Reversal	3-Phase or Single-Phase 5% – 20% ABC – CBA
Test Pushbutton Mode	Disabled, Load, No Load
Undervoltage Dropout Range Undervoltage Pickup Range Overvoltage Dropout Range Overvoltage Pickup Range	50% – 97% of Nominal Dropout +2% – 99% of Nominal 105% – 120% of Nominal 103% of Nominal to Dropout -2%
Underfrequency Dropout Range Underfrequency Pickup Range	90% – 97% of Nominal Dropout +1 Hz – 99% of Nominal
Overfrequency Dropout Range Overfrequency Pickup Range	103% – 110% of Nominal 101% of Nominal to Dropout -1 Hz

ATC-300 Automatic Transfer Switch Controller Front Panel Display and Operator Functions



Unit Status
The Unit Status LED is a blinking indicator for self and system diagnostics.

Mimic Diagram
Source 1 and Source 2 color-coded LEDs provide Available and Connected status indication.

LCD-Based Display
The LCD-based display is a backlit, 2-line, 16-character display. Displayed information includes:

- Source voltages and frequency
- Time/date stamp
- Historical data
- Programming and set point information
- Password entry

Step/Enter
Pressing the Step/Enter pushbutton advances the information through the programming or display cycle.

Help
Pressing the Help pushbutton in any function mode will bring up display messages, explanations and prompts to assist the operator.

Increase and Decrease
Pressing the Increase or Decrease pushbuttons effect the value of the function presently active on the LCD-based display.

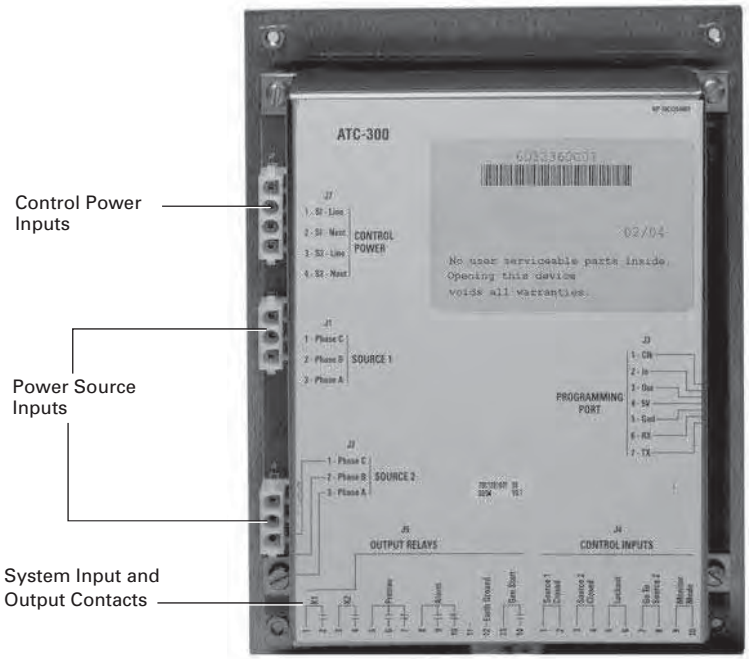
Engine Test
Pressing the Engine Test pushbutton twice initiates engine test cycle.

Alarm Reset
Pressing the Increase and Decrease pushbuttons simultaneously restores automatic operation in the event of an alarm condition).

Lamp Test
Pressing the Lamp Test pushbutton lights all LEDs and then displays ATC-300 controller information.

Bypass TDNE/TDEN
Pressing Step and Help/Lamp Test pushbuttons simultaneously reduces programmed time delays to zero to simplify test procedures.

ATC-300 Automatic Transfer Switch Controller



Rear View of ATC-300 Automatic Transfer Switch Controller

Output Contacts: The output contacts are dry relay contacts. The GEN START contact is rated 5 amperes at 250 Vac/ 30 Vdc. All other contacts are rated 10 amperes at 250 Vac/30 Vdc.

- K1, K2: These Form "A" output contacts are utilized to control single power switching mechanisms. They operate in conjunction with the SOURCE 1 and 2 CLOSED inputs.
- ALARM: Form "C" contact. This relay is energized during any of the following alarm conditions: failure of the power switching device to open or close, motor operator failure, unsuccessful in-phase transition, lockout condition, failed engine test, failed plant exerciser operation.
- PRE-TRAN: This relay operates on a timed basis (adjustable 0 – 120 seconds) prior to any transfer operation. Timing begins after TDNE or TDEN times out.
- GEN START: This is a latching relay utilized to initiate startup and shutdown cycles of the engine/ generator set.

Control Power Inputs (Source 1 and Source 2): The Control Power Input range is 65 Vac – 145 Vac, 50/60 Hz.

System Inputs: System Inputs are "wetted" contacts. Some system inputs are optional and must be enabled via factory control.

- SOURCE 1 CLOSED: This input is connected to the Source 1 power switching device position indication contact.
- SOURCE 2 CLOSED: This input is connected to the Source 2 power switching device position indication contact.
- LOCKOUT: This input is connected to an alarm contact. During an alarm condition, automatic operation is inhibited.
- GO TO SOURCE 2: This input provides the means to remotely initiate a startup and transfer cycle or retransfer and shutdown cycle.
- MONITOR MODE: This input allows the controller to be placed in a "non-automatic mode" while continuing to monitor source voltages and frequencies.
- EARTH GROUND: Provides a connection point for the common system ground.

Power Source Inputs (SOURCE 1 and SOURCE 2): The Power Source Inputs are the connection points for the power sources that are to be monitored. Three-phase systems are connected to Phase A, B and C. Single-phase systems are connected to points Phase A and Phase B.

Standard and Optional Features

All ATC-300 standard and optional features are listed in **Table 3**. All standard features are included and provided on all ATC-300 units.

Optional features must be specified with order entry and factory programmed. Only features that are originally ordered and factory programmed will appear on the LCD-based display. The ATC-300 Upgrade Module may be ordered to add optional features in the field.

Table 3. ATC-300 Automatic Transfer Controller — Standard and Optional Features

ATC-300 Features	Cutler-Hammer Feature Number	Field Programmable Set Point Range
Standard		
Time Delay Source 1 to Source 2 (TDNE) Time Delay Engine Start (TDES) Time Delay Source 2 to Source 1(TDEN) Time Delay Engine Cooldown (TDEC)	1 2 3 4	0 – 1800 Seconds 0 – 120 Seconds 0 – 1800 Seconds 0 – 1800 Seconds
Source 2 Single-Phase Undervoltage and Underfrequency Sensing	5B	UV Dropout: 50% – 97% of Nominal UV Pickup: (Dropout +2%) – 99% of Nominal UF Dropout: 90% – 97% of Nominal UF Pickup: (Dropout +1 Hz) – 99% of Nominal
Source 2 (Emergency) 3-Phase Undervoltage and Underfrequency Sensing	5J	UV Dropout: 50% – 97% of Nominal UV Pickup: (Dropout +2%) – 99% of Nominal UF Dropout: 90% – 97% of Nominal UF Pickup: (Dropout +1 Hz) – 99% of Nominal
Test Pushbutton Time Delay Emergency Fail (TDEF) Bypass TDEN Time Delay Bypass TDNE Time Delay	6B 7 8C 8D	No Load, Load or Disabled 0 – 6 Seconds Pushbutton Pushbutton
Source 1 Connected LED Indication Source 2 Connected LED Indication	12C 12D	N/A N/A
Source 1 Available LED Indication Source 2 Available LED Indication	12G 12H	N/A N/A
Plant Exerciser (Fail-Safe) with Selectable: (Daily, 7, 14 or 28-Day Cycle), (Load or No Load), (Day, Hour, Minute for Test Event) (0 – 600 Minutes Test Length)	23K	(Daily, 7, 14 or 28-Day Cycle), (No Load or Load) (Day, Hour, Minute) (0 – 600 Minutes Test Length)
Source 1 (All Phase) Undervoltage Sensing	26A	UV Dropout: 50% – 97% of Nominal UV Pickup: (Dropout +2%) – 99% of Nominal
Automatic Operation	29A	N/A
Seismic Zone 4 Qualification	42	N/A
Nominal Frequency Nominal Voltage	N/A N/A	50 or 60 Hz 120 – 600 Vac
System Phases Engine Test Run Duration for Engine Test Pushbutton and Plant Exerciser Duration	N/A N/A	1 or 3 0 – 600 Minutes
Optional		
Source 2 Single-Phase Overvoltage and Overfrequency Sensing	5C	OV Dropout: 105% – 120% of Nominal OV Pickup: 103% of Nominal to (Dropout -2%) OF Dropout: 103% – 110% of Nominal OF Pickup: 101% of Nominal to (Dropout -1 Hz)
Source 2 Single-Phase Undervoltage	5D	UV Dropout: 50% – 97% of Nominal UV Pickup: (Dropout +2%) – 99% of Nominal
Source 2 Single-Phase Overvoltage	5E	OV Dropout: 105% – 120% of Nominal OV Pickup: 103% of Nominal to (Dropout -2%)
Source 2 3-Phase Undervoltage	5F	UV Dropout: 50% – 97% of Nominal UV Pickup: (Dropout +2% – 99% of Nominal)
Source 2 3-Phase Overvoltage	5G	OV Dropout: 105% – 120% of Nominal OV Pickup: 103% of Nominal to (Dropout -2%)
Source 2 Phase Reversal	5H	0 = Disabled, 1 = ABC, 2 = CBA
Source 2 3-Phase Overvoltage and Overfrequency Sensing	5K	OV Dropout: 105% – 120% of Nominal OV Pickup: 103% of Nominal to (Dropout -2%) OF Dropout: 103% – 110% of Nominal OF Pickup: 101% of Nominal to (Dropout -1 Hz)
Source 2 3-Phase Voltage Unbalance	5L	(0 = Disabled, 1 = Active), (Dropout = 5% – 20%) (Pickup = 3% – (Dropout -2%)
Source 1 Overvoltage Sensing	26C	OV Dropout: 105% – 120% of Nominal OV Pickup: 103% of Nominal to (Dropout -2%)
Go to Source 2	26D	N/A
Source 1 Underfrequency Sensing	26E	UF Dropout: 90% – 97% of Nominal UF Pickup: (Dropout +1 Hz) – 99% of Nominal
Source 1 Overfrequency Sensing	26F	OF Dropout: 103% – 110% of Nominal OF Pickup: 101% of Nominal to (Dropout -1 Hz)
Source 1 Phase Reversal	26H	0 = Disabled, 1 = ABC, 2 = CBA
Source 1 3-Phase Voltage Unbalance	26L	(0 = Disabled, 1 = Active), (Dropout = 5% – 20%) (Pickup = 3% – (Dropout -2%)
Time Delay Neutral (TDN)	32A	0 – 120 Seconds
In-Phase Transition with Selectable (Enable or Disable), (Frequency Difference 0 – 3 Hz), (Synchronization Time 1 – 60 Minutes) and Default to Time Delay Neutral	32E	(Enable or Disable) (Frequency Difference 0 – 3 Hz) (Synchronization Time 1 – 60 Minutes)
Pretransfer Contacts (1NO/1NC)	35A	N/A

ATC-300 Upgrade Module

If an optional feature needs to be added after a transfer switch is in the field, contact the factory for availability of field upgrades with the ATC-300 Upgrade Module. This module can download new programs into the Automatic Transfer Controller (ATC-300) via connection to the communication module connector on the rear of the Automatic Transfer Controller device.

Dimensions in Inches (mm)

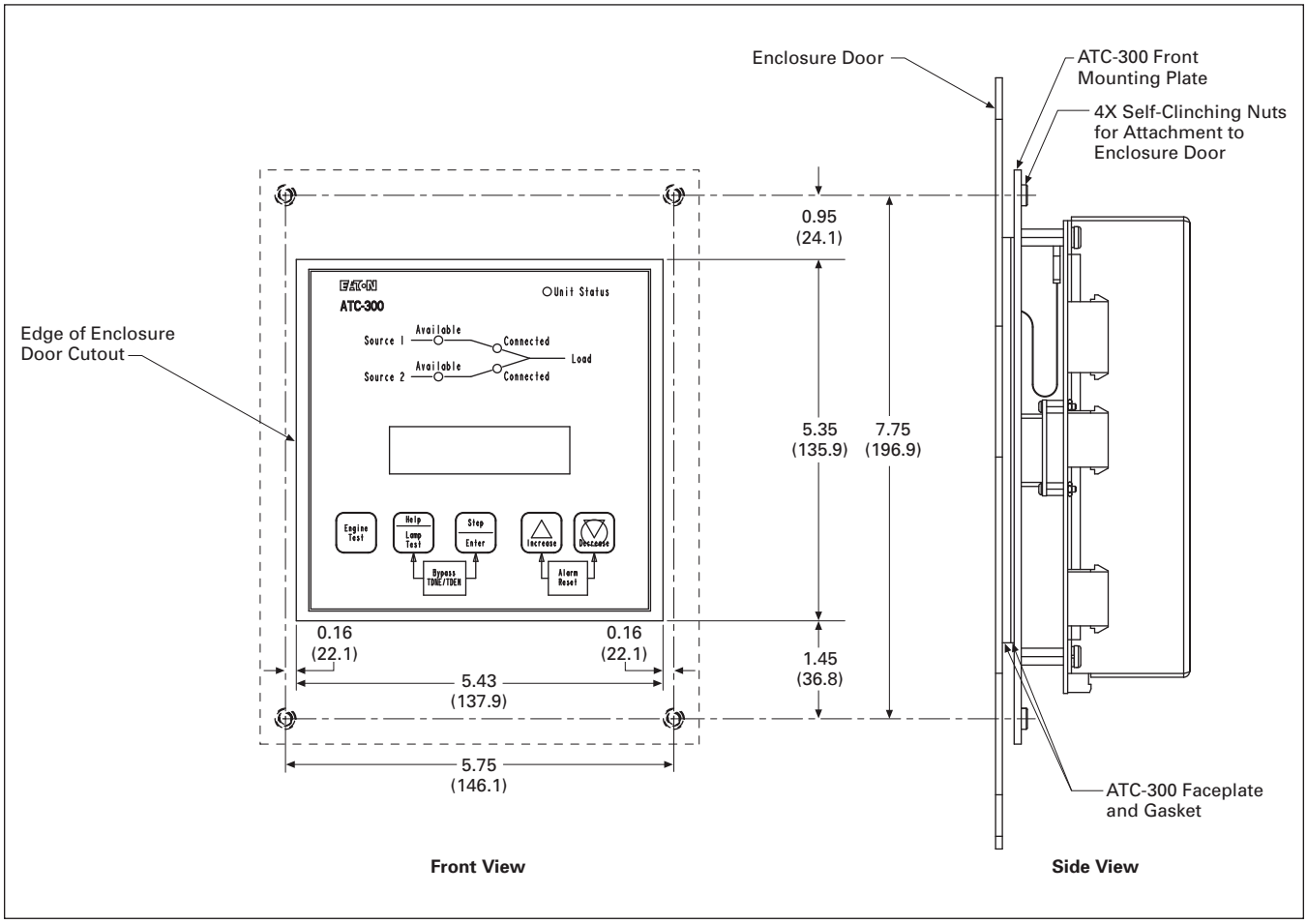


Figure 1. Automatic Transfer Controller (ATC-300)

UL is a federally registered trademark of Underwriters Laboratories Inc. CSA is a registered trademark of the Canadian Standards Association. UBC is a trademark of the International Conference of Building Officials (ICBO). BOCA is a registered trademark of Building Officials and Code Administrators International, Inc. Cutler-Hammer is a federally registered trademark of Eaton Corporation. NEMA is the registered trademark and service mark of the National Electrical Manufacturers Association.

Dimensions are approximate and should not be used for construction purposes (1 inch = 25.4 mm).

Commutateurs de transfert à disjoncteur

Type de commutateur - Fonctionnement automatique, manuel et électrique
30 A à 1000 A

Commutateur de transfert automatique ATHM

Description du produit

Une gamme économique de commutateurs de transfert avec automate informatisé offrant des caractéristiques de base pour les utilisations d'alimentation de base de systèmes de 30 à 1000 A jusqu'à 600 V, à 2, 3 ou 4 pôles.

Caractéristiques électriques

- 40, 100, 150, 200, 225, 260, 400, 600, 800 et 1000 ampères
- 2, 3 ou 4 pôles
- Jusqu'à 600 V c.a., 50/60 Hz.
- NEMA® 1, 3R, ouvert, 12, 4, 4x
- Approuvé UL 1008
- Homologué CSA® C22.2 n° 178

Caractéristiques standard (ATC300)

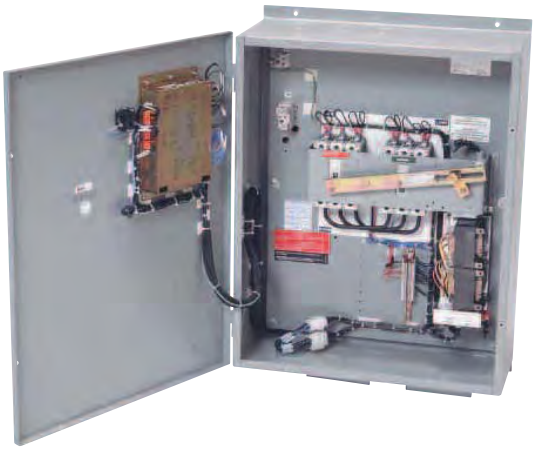
- Positions des contacts de commutateur
  - Source 1 Position 1NO et 1NF
  - Source 2 Position 1NO et 1NF
- Commande programmable à microprocesseur
- Surveillance du système d'alimentation normale et d'urgence
- Simulation des sources d'énergie à sécurité intégrée (programmable)
- Valeurs de tenue, de pouvoir de coupure et de fermeture élevées
- Transfert manuel sous charge
- Contacts de démarrage du moteur
- Délai temporisé entre le mode normal et le mode d'urgence
- Délai temporisé de démarrage du moteur
- Délai temporisé urgence à normal
- Délai temporisé de refroidissement du moteur
- Indicateurs DEL – position du commutateur
- Indicateurs DEL – source disponible
- Détection de sous-tension/sous-fréquence de la source d'urgence
- Détection de sous-tension de la source normale
- Délai temporisé de charge neutre
- Passer au contact d'urgence (protection de zone)
- Contacts de signal de prétransfert
- Délais temporisés de dérivation à bouton-poussoir

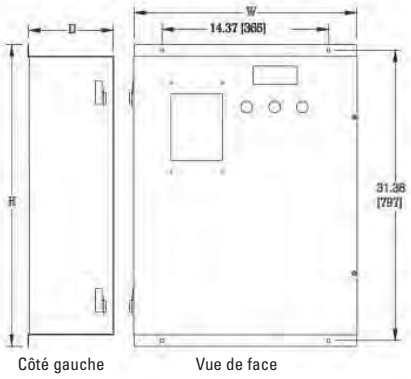
Caractéristiques en option

- Suppresseur de surtension disponible pour commande/alimentation, circuit de démarrage de moteur, connexions de téléphone et de câble
- Chaufferette avec thermostat
- Ampèremètre - du côté de la charge
- Surveillance de la qualité du courant
- Couvercle de commande en acier inoxydable

Caractéristiques en option (ATC 600)

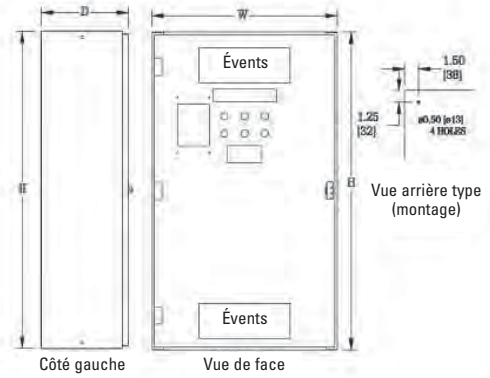
- Communication à distance
- Délestage de la charge d'urgence
- Fonctionnement automatique ou non automatique sélectionnable





Côté gauche Vue de face

Figure A



Vue arrière type (montage)

Côté gauche Vue de face

Figure B

DIMENSIONS DU BOÎTIER DE COMMUTATEUR DE TRANSFERT

Dimension du châssis	Nominale	Figure	Hauteur	Largeur	Profondeur
F	30A - 150A, 600V 30A - 200A, 240V	A	32,63 po (829)	24 po (610)	9 po (229)
→ K, L, M	225A - 600A	B	55 po (1397)	32 po (813)	15 po (381)
N	800A - 1200A	B	65 po (1651)	38 po (965)	16 po (406)

AT H 3 KD A 3 0300 B S C

Type
- **AT** = Automatique
- **MT** = Non automatique Manuel
- **NT** = Non automatique - Électrique

Automate programmable
- **3** = ATC-300
- **I** = ATC-600
- **X** = Sans logique

Montage
- **A** = Source1 (MCS), Source 2 (MCS)
- **B** = Source1 (MCCB), Source 2 (MCCB)
- **C** = Source1 (MCCB), Source 2 (MCS)
- **D** = Source1 (MCS), Source 2 (MCCB)

Nombre de pôles
- **2** = 2 pôles
- **3** = 3 pôles
- **4** = 4 pôles

Ampères
- **0030** = 30 A
- **0070** = 70 A
- **0100** = 100 A
- **0150** = 150 A
- **0200** = 200 A
- **0300** = 300 A
- **0400** = 400 A
- **0600** = 600 A
- **0800** = 800 A
- **1000** = 1000 A

Tension
- **A** = 120 V, 60 Hz
- **B** = 208 V, 60 Hz
- **E** = 600 V, 60 Hz
- **G** = 220 V, 50 Hz
- **H** = 380 V, 50 Hz
- **K** = 600 V, 50 Hz
- **M** = 230 V, 50 Hz
- **N** = 401 V, 50 Hz
- **O** = 415 V, 50 Hz
- **W** = 240 V, 60 Hz
- **X** = 480 V, 60 Hz
- **Z** = 365 V, 50 Hz

Boîtier
- **S** = NEMA 1
- **R** = NEMA 3R
- **J** = NEMA 12
- **L** = NEMA 4
- **D** = NEMA 4X
- **K** = Ouvert
- **P** = À l'épreuve des gicleurs

Orientation
- **H** = Horizontal

Bâti du commutateur

Type	240 V c.a.	480 V c.a.	600 V c.a.
FD = Bâti F	30-225A*	30-150A	30-150A
→ **KD** = Bâti K	400A	200-300A	200-300A
LD = Bâti L	600A	400A	400A
MD = Bâti M	800A	600A**	600A**
NB = Bâti N	800-1000A	800-1000A	800-1000A

Homologations
- **U** = Classifié UL
- → **C** = Certifié CSA

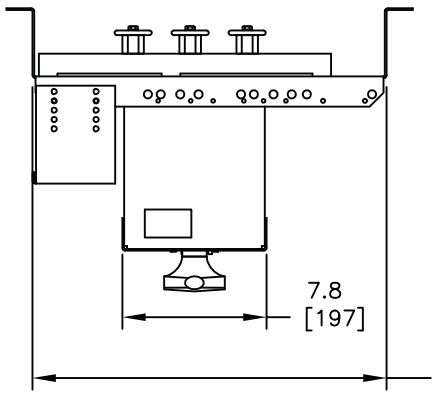
Remarques : * Applications monophasées 225 A seulement
** 4 pôles, 600 V c.a., 600 A et bâti N

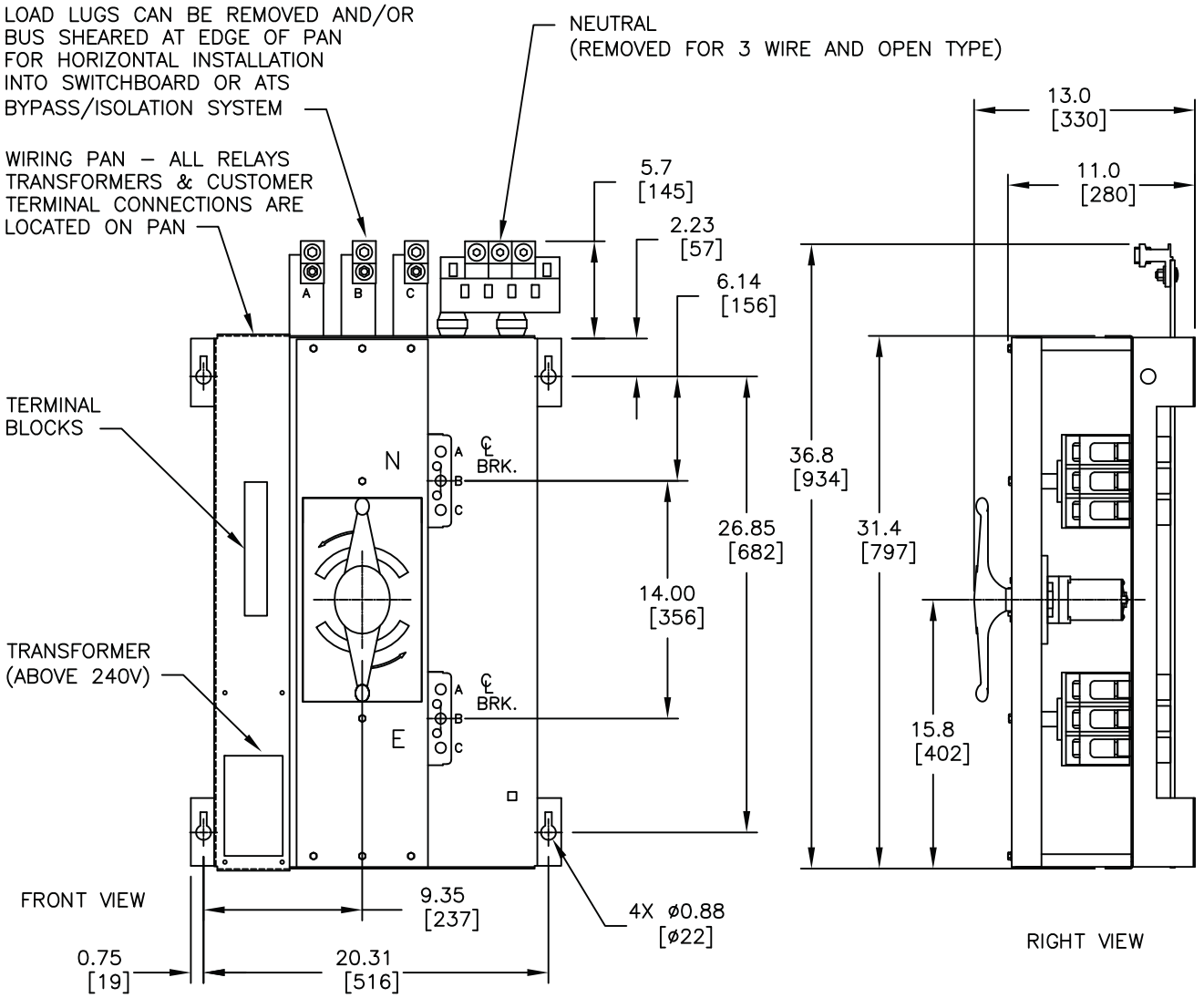
Système de numérotation du catalogue de commutateurs de transfert automatique à disjoncteur

REVISION	
2	ADDED 150A RATING GG 5/9/06

01

DIMENSIONS FOR OPEN–TYPE APPLICATION





WIRE SIZE FOR STANDARD TERMINALS PER PHASE

AMP. RATING	SWITCHING DEVICE	LINE	LOAD	NEUTRAL
150, 200, 225, 250	K	(1) #3–350 MCM AL/CU	(1) 3/0–750 MCM AL/CU OR (2) 3/0–250MCM	(3) 3/0–750 MCM AL/CU OR (6) 3/0–250MCM
300,350 400 (240V MAX.) 400 (TYPE B)	K	(1) 2/0–500 MCM AL/CU OR (2) 2/0–250MCM	(1) 3/0–750 MCM AL/CU OR (2) 3/0–250MCM	(3) 3/0–750 MCM AL/CU OR (6) 3/0–250MCM

Issued For Approval

The Information on this document Is Intended to convey and document that the contract specification has been accurately interpreted and may not be accurate for construction purposes.

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DFTR	DATE
RGC	15 MARCH 2006
APPD	DATE
RSA	20 APRIL 2006
S.O.	

EATON | Cutler-Hammer MILTON, ON

TITLE: WALL MOUNT AUTOMATIC TRANSFER SWITCH K–FRAME (150A – 400A)

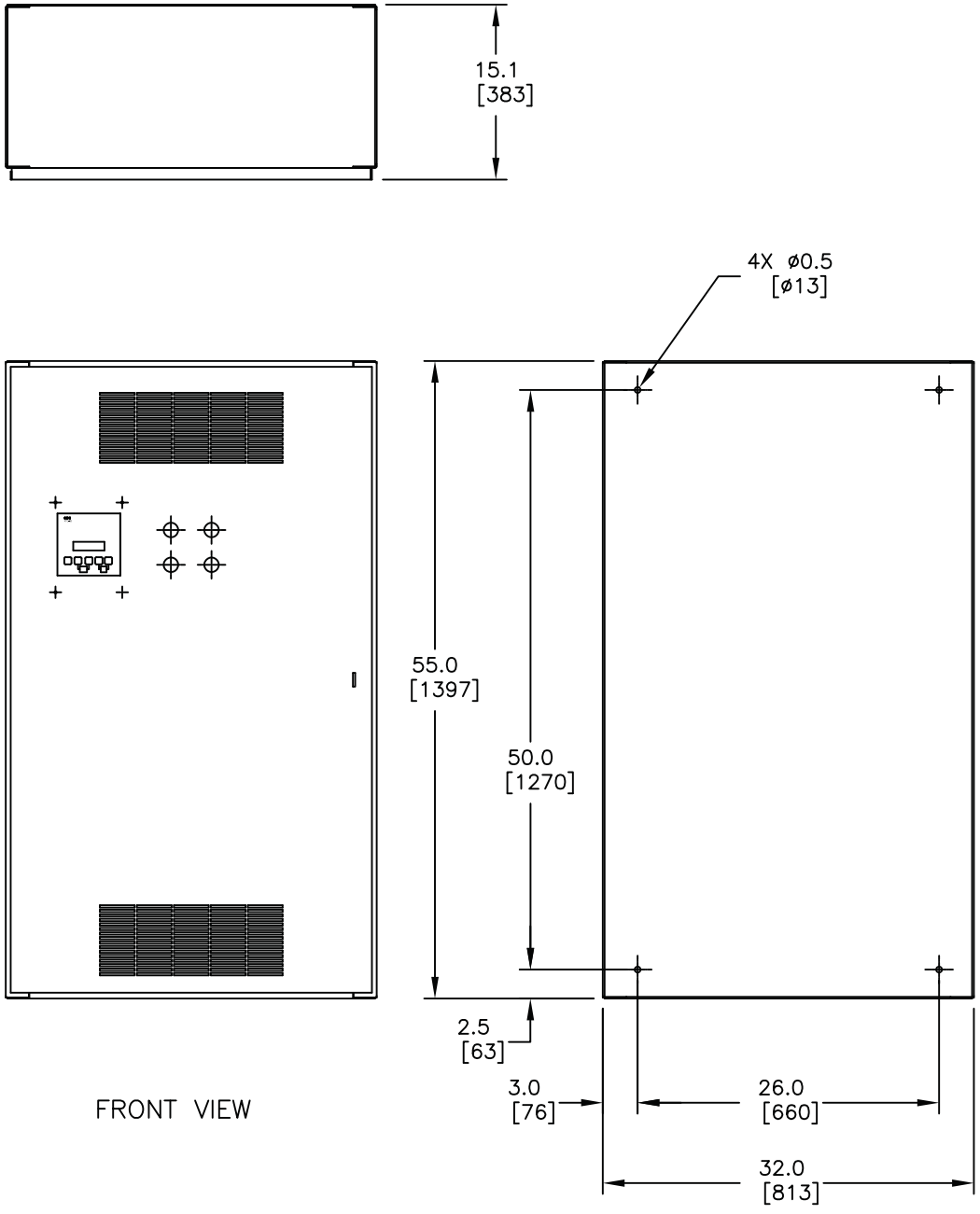
TYPE: ATH_K, NTHXK, MTHXK

CE23115_SH1.DWG

FEDERAL ID NO.	PRODUCT CODE	REVISION	DWG SIZE	G.O.	DWG	SHEET
80429	PG 230	2	A		CE23115	1 OF 2

REVISION
01

ENCLOSURE DIMENSIONS



FRONT VIEW

REAR MOUNTING HOLES

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DFTR	DATE
RGC	15 MARCH 2006
APPD	DATE
RSA	20 APRIL 2006
S.O.	

EATON | Cutler-Hammer MILTON, ON

TITLE: WALL MOUNT AUTOMATIC TRANSFER SWITCH K-FRAME ENCLOSURE

TYPE: ATH_K, NTHXK, MTHXK

CE23115_SH2.DWG

FEDERAL ID NO.	PRODUCT CODE	REVISION	DWG SIZE	G.O.	DWG	SHEET
80429	PG 230	1	A		CE23115	2 OF 2

The information on this document is created by Eaton Corporation. It is disclosed in confidence and it is only to be used for the purpose in which it is supplied.	PREPARED BY: PHILIPPEMONTPETIT	DATE: 04/21/11	Eaton Corporation		
	APPROVED BY	DATE	JOB NAME: ATH3FDA30150ESC DESIGNATION		
	VERSION: 7.5		TYPE	DRAWING TYPE: Customer Appr.	
	NEG-ALT NUMBER: SO750421C104-0000	REVISION	DWG SIZE: A	G.O.	ITEM / SHEET: 3 OF 3

Cutler- Hammer "Contactor Type" Transfer Switches (Wallmount and Bypass Transfer Switches) "Specific Breaker" Withstand / Closing Ratings

When protected by a specific upstream circuit breaker as shown, the transfer switch is rated for use on a circuit capable of delivering not more than the RMS Symmetrical amps at the voltage shown below.

Voltage	Transfer Switch Ampere Rating	Number of Poles Switched	Maximum fault level available at upstream device (kA symmetrical)						
			Upstream Specific*						
			10kA	22kA	30kA	35kA	42kA	50kA	65kA
120/240 and 240, 208Y/120	30-100A	2,3,4	Specific*	Specific*	Specific*	---	---	---	---
	125 - 200	2,3,4	Specific*	Specific*	Specific*	---	---	---	---
	300-400	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	---
	600	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*
	800 - 1200	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*
480Y/277 and 480	30-100A	2,3,4	Specific*	Specific*	Specific*	---	---	---	---
	125 - 200	2,3,4	Specific*	Specific*	Specific*	---	---	---	---
	300-400	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	---
	600	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*
	800 - 1200	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*
600Y/347 and 600	30-100A	2,3,4	Specific*	Specific*	---	---	---	---	---
	125 - 200	2,3,4	Specific*	Specific*	---	---	---	---	---
	300-400	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	---	---
	600	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*
	800 - 1200	2,3,4	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*	Specific*

* Contact Cutler Hammer

04/05/09

Cutler-Hammer "Breaker Type" Transfer Switch Withstand / Closing Ratings

When protected by any manufacturers' breaker or Cutler-Hammer circuit breaker upstream as shown, the transfer switch is rated for use on a circuit capable of delivering not more than the RMS Symmetrical amps at the voltage shown below.

Voltage	Transfer Switch Ampere Rating	Number of Poles Switched	Maximum fault level available at upstream device (kA symmetrical)						
			Upstream any manufacturers' breaker or Cutler-Hammer circuit breaker type						
			25kA	35kA	42kA	50kA	65kA	100kA	200kA
120/240 and 240, 208Y/120	30 - 200	2,3,4	Any*	Any*	Any*	Any*	Any*	Any*	FDC,JDC,KDC
	225	2	Any*	Any*	Any*	Any*	Any*	Any*	FDC,JDC,KDC
	300	2,3,4	Any*	Any*	Any*	Any*	Any*	Any*	KDC
	400	2,3,4	Any*	Any*	Any*	Any*	Any*	Any*	KDC
	600	2,3,4	Any*	Any*	Any*	Any*	Any*	Any*	LDC
	800 - 1000	2,3,4	Any*	Any*	Any*	Any*	Any*	Any*	---
480Y/277 and 480	30 - 150	2,3,4	Any*	Any*	Any*	Any*	Any*	(FDB/FD)+LFD FDC,JDC,KDC	150kA FCL***,LCL***
	200 - 300	2,3,4	Any*	Any*	Any*	Any*	Any*	KDC,NB-TP**	LCL***
	400	2,3,4	Any*	Any*	Any*	Any*	Any*	---	---
	600	2,3	Any*	Any*	Any*	Any*	Any*	NB-TP	---
	800	2,3	Any*	Any*	Any*	Any*	---	NB-TP	---
	600 - 1000	4	Any*	Any*	Any*	Any*	---	---	---
	1000	2,3	Any*	Any*	Any*	Any*	---	---	---
600Y/347 and 600	30 - 150	2,3,4	Any*	Any*	(FD/FDB)+LFD KDC	(FD/FDB)+LFD KDC	(FD/FDB)+LFD KDC	(FD/FDB)+LFD LCL	---
	200 - 300	2,3,4	Any*	Any*	Any*	KDC	KDC	LCL	---
	400	2,3,4	Any*	Any*	Any*	KDC	KDC	---	---
	600	2,3	Any*	Any*	Any*	LDC	---	---	---
	600	4	Any*	---	---	---	---	---	---
	800 - 1000	2,3,4	Any*	---	---	---	---	---	---

*Any manufacturers' breaker ** with P12 limiter *** 150kA maximum

Cutler-Hammer "Breaker Type" Transfer Switch Withstand / Closing Ratings

When protected by an upstream fuse type shown, the transfer switch is rated for use on a circuit capable of delivering not more than the RMS Symmetrical amps at the voltage shown below.

Voltage	Transfer Switch Ampere Rating	Number of Poles Switched	Maximum fault level available at upstream device (kA symmetrical)		
			Upstream Fuse Type		Max Fuse Amperes
			100kA	200kA	
120/240 and 240, 208Y/120	30 - 225	2,3,4	---	J, T	200A
			J, T	---	400A
	300	2,3,4	R	J, T	400A
			J, T	---	600A
	400	2,3,4	J, T	R	600A
			L	---	1200A
	600	2,3,4	L	---	800A
			---	L	1600A
	800 - 1000	2,3,4	---	L	1600A
480Y/277, 480, 600Y/347 and 600	30 - 150	2,3,4	---	J, T	200A
			J, T	---	400A
	200 - 300	2,3,4	R	J, T	400A
			J, T	---	600A
	400	2,3,4	J, T	R	600A
			L	---	1200A
	600	2,3	L	---	800A
			---	L	1600A
	600	4	---	L	1600A
	800 - 1000	2,3,4	---	L	1600A

SECTION 4

Customer Interconnection

SHOP DRAWING

Reviewed by: Samuel Charbonneau

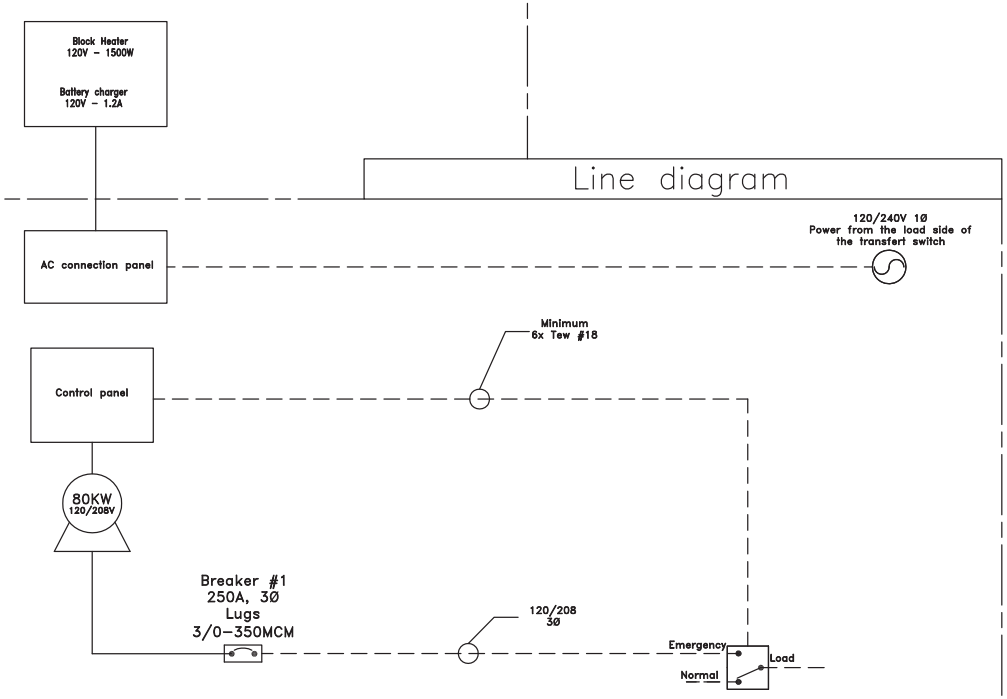
Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

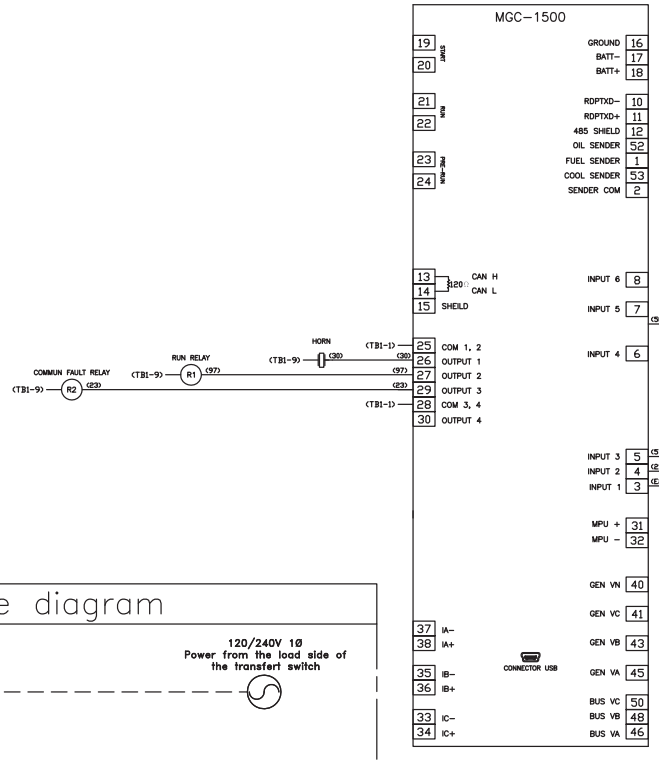
Out for approval

SIFEC NORTH INC.

AC Distribution



Line diagram



Customer connection

Legend:

- — — — Customer connection
- ——— Factory wired

LES TOLÉRANCES SONT: TOLERANCES ARE: X.XXX ± – X.XX ± – FRACTIONS ± – ANGLES ± –	MATÉRIEL MATERIAL	–
PROJECTION NORD-AMÉRICAINE THIRD ANGLE PROJECTION	FINI FINISH	–
APPROBATION / APPROVALS	DATE	POIDS WEIGHT –
DESSINÉ DRAWN EC	17/06/16	PROJET PROJECT GDM-1915
APPROUVÉ APPROVED		NO. PIÈCE PART NO. –
CHEMIN D'ACCÈS FILE PATH N:\Drummondville\Projets\GDM\1915 GDM IGLOOLIK WATER SUPPLY\Ingénierie\Electrique		

WAJAX POWER SYSTEMS
243, rue des Artisans
St-Germain-de-Grantham
(Québec) J0C 1K0
Tél: 1.800.567.3835
Fax: 819.395.5517

TITRE / TITLE: Customer connection

ÉCHELLE / SCALE: – | NO. DESSIN / DRAWING NO.: Customer connection | PAGE 1/1

SECTION 5

Warranties, Certifications & Procedures

SHOP DRAWING

Reviewed by: Samuel Charbonneau

Date: 17 juin 2016

Reviewed	X
Reviewed as noted	
Resubmit	

Out for approval

SIFEC NORTH INC.

MTU ONSITE ENERGY– STANDBY LIMITED WARRANTY
TWO (2) YEARS / 3,000 HOUR BASIC

LIMITED WARRANTY: Your MTU Onsite Energy product has been manufactured and inspected with care by experienced craftspeople. If you are the original consumer, MTU Onsite Energy warrants, for the limited warranty period indicated below, each product to be free from defects in materials and workmanship, and will perform under normal use and service from valid startup performed by MTU Onsite Energy. This Limited Warranty shall apply only when the product has been property installed, serviced, and operated in accordance with the applicable MTU Onsite Energy instruction manuals. If this Limited Warranty applies, the liability of MTU Onsite Energy shall be limited to the replacement, repair, or appropriate adjustment of the product, at MTU Onsite Energy's option. This Limited Warranty does not apply to malfunctions caused by normal wear and tear, or by damage, unreasonable use, misuse, repair, or service by unauthorized persons.

LIMITED WARRANTY PERIOD: Engine Generator Set: Parts and labor for 24 (twenty-four) months will begin with the first commissioning of the product(s). In all cases, the warranty period will expire not later than 36 (thirty-six) months from the date of shipment ex-works MTU Onsite Energy or after 3,000 operation hours, whichever occurs first. Accessories: Parts and labor for one (1) year from date of shipment. For a description of accessories and items excluded from this Limited Warranty, review the listings on the reverse side of this document.

LIMITED WARRANTY CONDITIONS: Before there is any protection under this Limited Warranty, the distributor must: (1) complete the MTU Onsite Energy Warranty, Start-Up Validation and Pre - Inspection form and return it to MTU Onsite Energy within 60 days of the start-up date, and (2) complete the engine registration form and return it to the manufacturer as stated in the instructions with engine registration form (when applicable). In addition, this Limited Warranty is not valid or enforceable unless: (1) all supporting maintenance records is to be kept on file with the end user and made available upon request from factory, (2) the generator set is routinely exercised in accordance with operating instructions, and (3) the installation meets the general guidelines, standards, and recommendations as laid out in the Installation Guide provided with the product and all local standards and codes applicable in the location of installation.

Engine generator sets that are stored by Owner / Buyer longer than 180 days from date of shipment are subject to special requirements. Contact MTU Onsite Energy's Service Center for instructions.

TO OBTAIN WARRANTY SERVICE: Warranty service may only be performed by MTU Onsite Energy authorized service providers. **Service provided by unauthorized persons will void this Limited Warranty. Non-MTU Onsite Energy replacement part(s) will void this Limited Warranty.**
Contact your nearest MTU Onsite Energy Service Representative to obtain warranty service. For assistance in locating your nearest authorized service representative, see contact information at the bottom of this page.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED. NO WARRANTIES SHALL BE IMPLIED OR OTHERWISE CREATED UNDER THE UNIFORM COMMERCIAL CODE, INCLUDING BUT NOT LIMITED TO A WARRANTY OF MERCHANTABILITY OR A WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

MTU ONSITE ENERGY SHALL NOT BE LIABLE FOR ANY CLAIM GREATER IN AMOUNT THAN THE PURCHASE PRICE OF THE PRODUCT AT ISSUE, AND IN NO EVENT SHALL MTU ONSITE ENERGY BE LIABLE FOR ANY SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES. STATE LAWS REGARDING THE RIGHTS OF CONSUMERS MAY VARY FROM STATE TO STATE.

1. The following items are not considered nor will they be covered under this Limited Warranty. If there are questions as to coverage under this Limited Warranty, it is advisable to contact the factory in advance of filing a claim.
   a. Battery or batteries of any type or kind. The battery manufacturer's warranty, if any, is the only warranty that applies to batteries. Any warranty claim should be handled with the manufacturer according to its policies.
   b. Adjustments to fuel systems or governor system at time of start-up or any time after. A warranty claim for such adjustments is acceptable only when a defective part has been replaced, returned to the factory, and approved as defective.
   c. Normal maintenance costs, including but not limited to adjustments, loose and/or leaking fittings or clamps, and tune-ups performed during start-up or anytime thereafter.
   d. Due to shipping, manufacturer is not responsible for loose connections. All connections must be checked at time of start-up.
   e. Non-MTU Onsite Energy replacement part(s) will void this Limited Warranty.

Europe / Middle East / Africa / Latin America / MTU Onsite Energy / 88040 Friedrichshafen / Germany / Phone + 49 7541 90 7060 / Fax +49 7541 90 7084 / powergenregion1@mtu-online.com // **Asia / Australia / Pacific /** MTU Onsite Energy / 1, Benoi Place / Singapore 629923 / Republic of Singapore / Phone + 65 6861 5922 / Fax + 65 6861 3615 / powergenregion2@mtu-online.com // **USA / Canada / Mexico /** MTU Onsite Energy Corporation/ 100 Power Drive / Mankato, Minnesota 56002 / USA / Phone + 1 507 625 7973 / Fax + 1 507 625 2968 / powergenregion3@mtu-online.com // **Worldwide for HotModule /** MTU Onsite Energy GmbH/ 81663 Munich / Germany / Phone + 49 89 203042 800 / Fax +49 89 203042 900 / hotmodule@mtu-online.com //www.mtu-online.com

OE-001ENU-1002

MTU ONSITE ENERGY– STANDBY LIMITED WARRANTY
TWO (2) YEARS / 3,000 HOUR BASIC

f. Products that are modified in any form without the written consent of MTU Onsite Energy will void this Limited Warranty.
g. Shipping damage of any type.
h. Any installation errors or damage of the equipment when shipped as ordered.
i. Any overtime travel or labor to make repairs under warranty.
j. Any special access fees required to gain access to MTU Onsite Energy equipment, including but not limited to any training or safety policy requirements to gain access.
k. Additional costs associated with inaccessible installations, including but not limited to removal and reinstallation of the generator set.
l. Rental equipment used during warranty work including but not limited to generators, rigging equipment such as a crane or boom truck, load banks and special test equipment above factory requirements.
m. Excess mileage charges. Any authorized service provider may perform warranty service anywhere, but will only be paid for mileage expenses from the nearest service center and limited to 400 miles / 644 Kilometers roundtrip.
n. Any equipment not factory approved and engineered for use on MTU Onsite Energy products. This includes but is not limited to aftermarket items such as special fuel systems, enclosures, exhaust systems, or switch gear that had been sought out and quoted by a third party to be included in billing of the MTU Onsite Energy equipment.
o. Misuse or abuse during installation and thereafter.
p. Normal wear and tear, maintenance, and consumable items that are not required as part of a warranty repair.
Consumable items include but are not limited to belts, hoses, coolant, oil, filters, and fuses.
q. Acts of nature or acts of God such as lightning, wind, flood, tornado, hurricane or earthquake.
r. Any damage due to situations beyond the control of the manufacturing of the product or workmanship of the product.
s. Installation or operation outside the guidelines as stated in the Installation Guide and Owner's Manual.
t. Diesel engine "Wet Stacking" due to lightly loaded diesel engines.
u. Misapplication of the equipment such as usage outside the original design parameters as stated on the nameplate of the equipment.
v. Travel expense on portable equipment.
w. Trailer lights, wiring, and brakes.
x. More than one trip to the job site because a service vehicle was not stocked with normal service parts.
y. Lodging expense of person(s) performing service, unless approved in advance by factory.
z. Engine fluids.
aa. Units purchased at the Standby Power rating that are being used in a prime power application.
bb. Any repair labor time that is determined to be excessive, e.g., two or more people performing a one-person job.
cc. Any expenses associated with investigating performance complaints in which no defect is found.
dd. Any associated costs for replacing components that are found not to be defective.
ee. Any adjustments covered in the start-up and inspection forms that are to be completed during start-up.

2. The accessories that are limited to one (1) year parts and labor from date of shipment include but are not limited to:
   a. Cords, receptacles, and cord reels
   b. Gas flex pipes
   c. Housing lights, space heaters, and associated equipment

Rev. 20100420

TOGNUM GROUP COMPANIES

Europe / Middle East / Africa / Latin America / MTU Onsite Energy / 88040 Friedrichshafen / Germany / Phone + 49 7541 90 7060 / Fax +49 7541 90 7084 / powergenregion1@mtu-online.com // **Asia / Australia / Pacific /** MTU Onsite Energy / 1, Benoi Place / Singapore 629923 / Republic of Singapore / Phone + 65 6861 5922 / Fax + 65 6861 3615 / powergenregion2@mtu-online.com // **USA / Canada / Mexico /** MTU Onsite Energy Corporation/ 100 Power Drive / Mankato, Minnesota 56002 / USA / Phone + 1 507 625 7973 / Fax + 1 507 625 2968 / powergenregion3@mtu-online.com // **Worldwide for HotModule /** MTU Onsite Energy GmbH/ 81663 Munich / Germany / Phone + 49 89 203042 800 / Fax +49 89 203042 900 / hotmodule@mtu-online.com //www.mtu-online.com

OE-001ENU-1002

Selling Policy, Distribution and Control Products, and Service Solutions General Terms and Conditions of Sale

Terms and Conditions of Sale
The Terms and Conditions of Sale set forth herein, and any supplements which may be attached hereto, constitute the full and final expression of the contract for the sale of products or services (hereinafter referred to as Product(s) or Services by Eaton Industries (Canada) Company (hereinafter referred to as Seller) to the Buyer, and supersedes all prior quotations, purchase orders, correspondence or communications whether written or oral between the Seller and the Buyer. Notwithstanding any contrary language in the Buyer's purchase order, correspondence or other form of acknowledgment, Buyer shall be bound by these Terms and Conditions of Sale when it sends a purchase order or otherwise indicates acceptance of this contract, or when it accepts delivery from Seller of the Products or Services. THE CONTRACT FOR SALE OF THE PRODUCTS OR SERVICES IS EXPRESSLY LIMITED TO THE TERMS AND CONDITIONS OF SALE STATED HEREIN. ANY ADDITIONAL OR DIFFERENT TERMS PROPOSED BY BUYER ARE REJECTED UNLESS EXPRESSLY AGREED TO IN WRITING BY SELLER. No contract shall exist except as herein provided.

Complete Agreement
No amendment or modification hereto nor any statement, representation or warranty not contained herein shall be binding on the Seller unless made in writing by an authorized representative of the Seller. Prior dealings, usage of the trade or a course of performance shall not be relevant to determine the meaning of this contract even though the accepting or acquiescing party had knowledge of the nature of the performance and opportunity for objection.

Quotations
Written quotations are valid for 30 days from its date unless otherwise stated in the quotation or terminated sooner by notice.

Verbal quotations, unless accepted, expire the same day they are made.

A complete signed order must be received by Seller within 20 calendar days of notification of award; otherwise the price and shipment will be subject to re-negotiation.

Termination and Cancellation
Any order may be terminated by the Buyer only by written notice and upon payment of reasonable termination charges, including all costs plus profit.

Seller shall have the right to cancel any order at any time by written notice if Buyer breaches any of the terms hereof, becomes the subject of any proceeding under provincial or federal law for the relief of debtors, or otherwise becomes insolvent or bankrupt, generally does not pay its debts as they become due or makes an assignment for the benefit of creditors.

Prices
All prices are subject to change without notice. In the event of a price change, the effective date of the change will be the date of the new price or discount sheet, letter or telegram. All quotations made or orders accepted after the effective date will be on the new basis. For existing orders, the price of the unshipped portion of post price increase dated orders will be the price in effect at time of order entry. We reserve the right to limit order quantities and requested ship dates pre price increase.

Price Policy – Products and Services
When prices are quoted as firm for quoted shipment, they are firm provided the following conditions are met:

1. The order is released with complete engineering details.
2. Shipment of Products is made, and Services purchased are provided within the quoted lead-time.
3. When drawings for approval are required for any Products, the drawings applicable to those Products must be returned within 30 calendar days from the date of the original mailing of the drawings by Seller (60 days where a Contractor is involved). The return drawings must be released for manufacture and shipment and must be marked "APPROVED" or "APPROVED AS NOTED". Drawing re-submittals, which are required for any other reason than to correct Seller errors, will not extend the 30-day period.

If the Buyer initiates or in any way causes delays in shipment, provision of Services or return of approval drawings beyond the periods stated above, the price of the Products or Services will be increased 1% per month or fraction thereof up to a maximum of 18 months from the date of the Buyer's order. For delays resulting in shipment or provision of Services beyond 18 months from the date of the Buyer's order, the price must be renegotiated.

Minimum Billing
Shelf goods individual purchase orders less than $100.00 will be billed $100.00.

Rush Shipments
Fee applies to shelf product orders where the customer requests "guaranteed" same day rush treatment of available product.

Taxes
The price does not include any taxes. Buyer shall be responsible for the payment of all taxes applicable to, or arising from the transaction, the Products, its sale, value, or use, or any Services performed in connection therewith regardless of the person or entity actually taxed.

TERMS OF PAYMENT
Product
At option of Seller one of the following will be quoted:

Terms of Payment - Net 25th Prox.
Terms of payment are Net 25th of the month following shipment.

Cash Discount
A cash discount can be applied to orders for predefined Products designated by Seller from time to time, whether shipped to a Distributor or drop shipped. The discount will be earned on orders for such Products when payment is received on or before the 10th day of the month following shipment by Seller **and where the account is not in arrears.**

Terms of Payment - Net 30
Terms of payment are net within 30 days from the date of invoice.

Progress Billings: we reserve the right to require progress payment terms on orders over $500,000 Canadian.

Services
Terms of payment are net within 30 days from date of invoice for orders amounting to less that $50,000.00.

Terms of payment for orders exceeding $50,000.00 shall be made according to the following:
1. Twenty percent (20%) of order value with the purchase order payable 30 days from date of invoice.
2. Eighty percent (80%) of order value in equal monthly payments over the performance period payable 30 days from date of invoice.

Except for work performed (i) under a firm fixed price basis or (ii) pursuant to terms of a previously priced existing contract between Seller and Buyer, invoices for work performed by Seller shall have added and noted on each invoice a charge of 3% (over and above the price of the work) which is related to Seller compliance with present and proposed environmental, health, and safety regulations associated with prescribed requirements covering hazardous materials management and employee training, communications, personal protective equipment, documentation and record keeping associated therewith.

Adequate Assurances
If, in the judgment of Seller, the financial condition of the Buyer, at any time during the period of the contract, does not justify the terms of payment specified, Seller may require full or partial payment in advance.

Delayed Payment
If payments are not made in accordance with these terms, a service charge will, without prejudice to the right of Seller to immediate payment, be added in an amount equal to the lower of 1.5% per month or fraction thereof or the highest legal rate on the unpaid balance. In addition, any special remuneration will be forfeited until payment is made.

FREIGHT
Freight policy will be listed on the Product discount sheets, or at option of Seller one of the following will be quoted:

F.O.B. - P/S - Frt./Ppd. and Allowed
Product is sold F.O.B. point of shipment, freight prepaid and included to the Buyer for purchase orders valued at $1,000.00 or more, pre-tax. Freight is charged at 5% of invoice value or $25.00 whichever is greater, for orders less than $1,000.00. The 5% fee will be waived on 'collect', premium freight (charged) minimum billing or 'rush fee' applied shipments.

Seller reserves the right to charge freight on small project 'staged' shipments post the initial shipment, when the staged shipments are at customer request.

F.O.B. - P/S - Frt./Charged
Product is sold F.O.B. point of shipment and freight charged to the Buyer.

F.O.B. Destination - Frt./Ppd. and Allowed
At Buyer's option, Seller will deliver the Products F.O.B. destination freight prepaid and 2% will be added to the net price. The term "freight prepaid" means that freight charges will be prepaid to the accessible common carrier delivery point nearest the destination for shipments within Canada unless noted differently on the Product discount sheets. For any other destination contact Seller's representative.

Shipment and Routing
Seller shall select the point of origin of shipment, the method of transportation, the type of carrier equipment, and the routing of the shipment.

If the Buyer specifies a special mode of transportation, type of carrier equipment, routing, or delivery requirement, Buyer shall pay all special freight and handling charges.

When freight is included in the price, no allowance will be made in lieu of transportation if the Buyer accepts shipment at factory, warehouse, or freight station or otherwise supplies its own transportation.

Risk of Loss
Risk of loss or damage to the Products shall pass to Buyer at the F.O.B. point. The Buyer is responsible to procure adequate insurance for loss or damage during shipment.

Concealed Damage & Short Shipments
Except in the event of F.O.B. destination shipments, Seller will not participate in any settlement of claims for concealed damage.

When shipment has been made on an F.O.B. destination basis, the Buyer must unpack immediately and, if damage is discovered must:

1. Not move the Products from the point of examination.
2. Retain shipping container and packing material.
3. Notify the carrier in writing of any apparent damage.
4. Notify Seller representative within 72 hours of delivery.
5. Send Seller a copy of the carrie inspection report.
6. Shortages in quantity must be reported in writing to Seller within 72 hours from receipt.

Witnessed Tests/Customer Inspection
Standard factory tests may be witnessed by the Buyer at Seller's factory for an additional charge calculated at the rate of $2,500 per day (not to exceed eight (8) hours) per Product type. Buyer may final inspect Products at Seller's factory for $700 per day per Product type.

Witness tests will add one (1) week to the scheduled shipping date. Seller will notify Buyer fourteen (14) calendar days prior to schedule witness testing or inspection. In the event Buyer is unable to attend, the Parties shall mutually agree on a rescheduled date. However, Seller reserves the right to deem the witness tests waived with the right to ship and invoice the Products.

Held Orders
For any order held, delayed or rescheduled at the request of the Buyer, Seller may, at its sole option (1) require payment to be based on any reasonable basis, including but not limited to the contract price, and any additional expenses, or cost resulting from such a delay; (2) store Products at the sole cost and risk of loss to the Buyer; and/or (3) charge to the Buyer those prices under the applicable price policy. Payment for such price, expenses and costs, in any such event, shall be due by Buyer within thirty (30) days from date of Seller's invoice. Any order so held delayed or rescheduled beyond three (3) months will be treated as a Buy termination.

Drawing Approval
Seller will design the Products in line with, in Seller's judgment, good commercial practice. If at drawing approval Buyer makes changes outside of the design as covered in their specifications, Seller will then be paid reasonable charges and allowed a commensurate delay in shipping date based on the changes made.

Drawing Re-Submittal
When Seller agrees to do so in its quotation, Seller shall provide Buyer with the first set of factory customer approval drawing(s) at Seller's expense. The customer approval drawing(s) will be delivered at the quoted delivery date. If Buyer requests drawing changes or additions after the initial factory customer approval drawing(s) have been submitted by Seller, the Seller, at its option, may assess Buyer drawing charges. Factory customer approval drawing changes required due to misinterpretation by Seller will be at Seller's expense. Approval drawings generated by Bid-Manager are excluded from this provision.

WARRANTY
Warranty For Products
Seller warrants that the Products manufactured by it will conform to Seller's applicable specifications and be free from failure due to defects in workmanship and material for one (1) year from the date of installation of the Product or eighteen (18) months from the date of shipment of the Product, whichever occurs first.

In the event any Product fails to comply with the foregoing warranty Seller will, at its option, either (a) repair or replace the defective Product, or defective part or component thereof, F.O.B. Seller's facility freight prepaid, or (b) credit Buyer for the purchase price of the Product. All warranty claims shall be made in writing. Seller requires all non-conforming Products be returned at Seller's expense for evaluation unless specifically stated otherwise in writing by Seller.

This warranty does not cover failure or damage due to storage, installation, operation or maintenance not in conformance with Seller's recommendations and industry standard practice or due to accident, misuse, abuse or negligence. This warranty does not cover reimbursement for labour, gaining access, removal, installation, temporary power or any other expenses, which may be incurred in connection with repair or replacement.

This warranty does not apply to equipment not manufactured by Seller. Seller limits itself to extending the same warranty it receives from the supplier.

Extended Warranty for Products
If requested by the Buyer and specifically accepted in writing by Seller, the foregoing standard warranty for Products will be extended from the date of shipment for the period and price indicated below:

24 months – 2% of Contract Price
30 months – 3% of Contract Price
36 months – 4% of Contract Price

Special Warranty (In and Out) for Products
If requested by the Buyer and specifically accepted in writing by Seller, Seller will, during the warranty period for Products, at an additional cost of 2% of the contract price, be responsible for the direct cost of:

1. Removing the Product from the installed location.
2. Transportation to the repair facility and return to the site.
3. Reinstallation on site.

The total liability of Seller for this Special Warranty for Products is limited to 50% of the contract price of the particular Product being repaired and excludes expenses for removing adjacent apparatus, walls, piping, structures, temporary service, etc.

Warranty For Services
Seller warrants that the Services performed by it hereunder will be performed in accordance with generally accepted professional standards.

The Services, which do not so conform, shall be corrected by Seller upon notification in writing by the Buyer within one (1) year after completion of the Services.

Unless otherwise agreed to in writing by Seller, Seller assumes no responsibility with respect to the suitability of the Buyer's, or its customers, equipment or with respect to any latent defects in the same. This warranty does not cover damage to Buyer's, or its customers, equipment, components or parts resulting in whole or in part from improper maintenance or operation or from their deteriorated condition. Buyer will, at its cost, provide Seller with unobstructed access to the defective Services, as well as adequate free working space in the immediate vicinity of the defective Services and such facilities and systems, including, without limitation, docks, cranes and utility disconnects and connects, as may be necessary in order that Seller may perform its warranty obligations. The conducting of any tests shall be mutually agreed upon and Seller shall be notified of, and may be present at, all tests that may be made.

Warranty for Power Systems Studies
Seller warrants that any power systems studies performed by it will conform to generally accepted professional standards. Any portion of the study, which does not so conform shall be corrected by Seller upon notification in writing by the Buyer within six (6) months after completion of the study. All warranty work shall be performed in a single shift straight time basis Monday through Friday. In the event that the study requires correction of warranty items on an overtime schedule, the premium portion of such overtime shall be for the Buyer's account.

Limitation on Warranties for Products, Services and Power Systems Studies
THE FOREGOING WARRANTIES ARE EXCLUSIVE EXCEPT FOR WARRANTIES OF TITLE. SELLER DISCLAIMS ALL OTHER WARRANTIES INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

CORRECTION OF NON-CONFORMITIES IN THE MANNER AND FOR THE PERIOD OF TIME PROVIDED ABOVE SHALL CONSTITUTE SELLER'S SOLE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR FAILURE OF SELLER TO MEET ITS WARRANTY OBLIGATIONS, WHETHER CLAIMS OF THE BUYER ARE BASED IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY), EXTRA-CONTRACTUALLY, OR OTHERWISE.

Asbestos
Provincial Law requires that building or facility owners identify the presence, location and quantity of asbestos containing material (hereinafter "ACM") at work sites. Seller is not licensed to abate ACM. Accordingly, for any contract which includes the provision of Services, prior to (i) commencement of work at any site under a specific Purchase Order, (ii) a change in the work scope of any Purchase Order, the Buyer will certify that the work area associated with the Seller's scope of work includes the handling of Class II ACM, including but not limited to generator wedges and high temperature gaskets which include asbestos materials. The Buyer shall, at its expense, conduct abatement should the removal, handling, modification or reinstallation, or some or all of them, of said Class II ACM be likely to generate airborne asbestos fibers; and should such abatement affect the cost of or time of performance of the work then Seller shall be entitled to an equitable adjustment in the schedule, price and other pertinent affected provisions of the contract.

Compliance with Nuclear Regulation
Seller's Products are sold as commercial grade Products not intended for application in facilities or activities licensed by the Atomic Energy Control Board of Canada for atomic purposes. Further certification will be required for use of the Products in any safety-related application in any nuclear facility licensed by the AECB.

Returning Products
Authorization and shipping instructions for the return of any Products must be obtained from Seller before returning the Products. Re-stocking charge applies to excess and Customer error returns.

When return is occasioned due to Seller error, full credit including all transportation charges will be allowed.

Product Notices
Buyer shall provide the user (including its employees) of the Products with all Seller supplied Product notices, warnings, instructions, recommendations, and similar materials.

Force Majeure
Seller shall not be liable for failure to perform or delay in performance due to fire, flood, strike or other labor difficulty, act of God, act of any governmental authority or of the Buyer, acts of terrorism, riot, embargo, fuel or energy shortage, car shortage, wrecks or delays in transportation, or due to any other cause beyond Seller's reasonable control. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be extended by a period of time reasonably necessary to overcome the effect of such delay.

Liquidated Damages
Contracts which include liquidated damage clauses for failure to meet shipping or job completion promises are not acceptable or binding on Seller, unless such clauses are specifically accepted in writing by an authorized representative of the Seller at its headquarters office.

Patent Infringement
Seller will defend or, at its option, settle any suit or proceeding brought against Buyer, or Buyer's customers, to the extent it is based upon a claim that any Product or part thereof, manufactured by Seller or its subsidiaries and furnished hereunder infringes any Canadian or United States patent, other than a claim of infringement based upon use of a Product or part thereof in a process, provided Seller is notified in reasonable time and given authority, information and assistance (at Seller's expense) for the defense of same. Seller shall pay all legal and court costs and expenses and court-assessed damages awarded therein against Buyer and resulting from or incident to such suit or proceeding. In addition to the foregoing, if at any time Seller determines there is a substantial question of infringement of any Canadian or United States patent, and the use of such Product is or may be enjoined, Seller may, at its option and expense, either (a) procure for Buyer the right to continue using and selling the Product; (b) replace the Product with non-infringing apparatus; (c) modify the Product so it becomes non-infringing; or (d) as a last resort, remove the Product and refund the purchase price, equitably adjusted for use and obsolescence. In no case does Seller agree to pay any recovery based upon its Buyer's savings or profit through use of Seller's Products whether the use be special or ordinary. The foregoing states the entire liability of Seller for patent infringement.

The preceding paragraph does not apply to any claim of infringement based upon: (a) any modification made to a Product other than by Seller; (b) any design and/or

specifications of Buyer to which a Product was manufactured; or (c) the use or combination of Product with other products where the Product does not itself infringe. As to the above-identified claim situations where the preceding paragraph does not apply Buyer shall defend and hold Seller harmless in the same manner and to the extent as Seller's obligation described in the preceding paragraph. Buyer shall be responsible for obtaining (at Buyer's expense) all license rights required for Seller to be able to use software products in the possession of Buyer where such use is required in order to perform any Service for Buyer.

With respect to a Product or part thereof not manufactured by Seller or its subsidiaries, Seller will attempt to obtain for Buyer, from the supplier(s), the patent indemnification protection normally provided by the supplier(s) to customers.

Compliance with OSHA
Seller offers no warranty and makes no representation that its Products comply with the provisions or standards of the Occupational Safety and Health Act of 1998, or any regulation issued there under. In no event shall Seller be liable for any loss, damage, fines, penalty or expenses arising under said Act.

Limitation of Liability
THE REMEDIES OF THE BUYER SET FORTH IN THIS CONTRACT ARE EXCLUSIVE AND ARE ITS SOLE REMEDIES FOR ANY FAILURE OF SELLER TO COMPLY WITH ITS OBLIGATIONS HEREUNDER.

NOTWITHSTANDING ANY PROVISION IN THIS CONTRACT TO THE CONTRARY, IN NO EVENT SHALL SELLER BE LIABLE IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) EXTRA-CONTRACTUALLY, OR OTHERWISE FOR DAMAGE TO PROPERTY OR EQUIPMENT OTHER THAN PRODUCTS SOLD HEREUNDER, LOSS OF PROFITS OR REVENUE, LOSS OF USE OF PRODUCTS, COST OF CAPITAL, CLAIMS OF CUSTOMERS OF THE BUYER OR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, REGARDLESS OF WHETHER SUCH POTENTIAL DAMAGES ARE FORESEEABLE OR IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

THE TOTAL CUMULATIVE LIABILITY OF SELLER ARISING FROM OR RELATED TO THIS CONTRACT WHETHER THE CLAIMS ARE BASED IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) EXTRA-CONTRACTUALLY OR OTHERWISE, SHALL NOT EXCEED THE PRICE OF THE PRODUCT OR SERVICES ON WHICH SUCH LIABILITY IS BASED.

Governing Law
This contract shall be governed, interpreted and construed by and in accordance with the laws of the Province of Ontario.

Election of Language
It is the express wish of the parties that this document and all documents related to it be drawn up in English. Les parties aux présentes ont expressément exigé que ce document soit rédigé en langue anglaise ainsi que tous document y afférent.

Eaton Industries (Canada) Company
P.O. Box 5040, Station "A"
5050 Mainway
Burlington, Ontario L7R 3Y8

Printed in Canada
Rev **# 10F**, December 1, 2012

Certificate of Registration

nqa global assurance

This is to certify that the Quality Management System of:

Génératrice Drummond

243 Avenue des artisans
St-Germain (Québec)
J0C 1K0 Canada

applicable to:

Selling, installation, renting and servicing of generator sets and their related systems. Selling of parts for the same activities.

has been assessed and approved by
National Quality Assurance against the provisions of:

ISO 9001: 2008

Certificate Number :	12318
Code EAC :	29
First Issued :	July 7, 2010
Valid Until :	July 1, 2016
Reissued :	July 1, 2013

For and on behalf of NQA
NQA, USA,
4 Post Office Square,
Acton, MA 01720

ANAB ACCREDITED

This approval is subject to the company maintaining its system to the required standard, which will be monitored by NQA, USA, Acton, MA 01720, an accredited organization under the ANSI-ASQ National Accreditation Board.

WAJAX POWER SYSTEMS

LIST OF WORK TO BE

1- *Wiring of the:
- block heater
- transfer switch engine start contact
- battery charger by load side of the transfer switch
- power cables
- fuel lines (if required)
- transfer switch position contacts (if required)

*see «Connections diagram» drawing for more details

2- Finish the ventilation system;

3- Fill tank(s);

4- Check phase sequence;

5- Make sure the exhaust system outlet is protected against birds, snow and rain;

6- Check presence of normal power at the transfer switch;

7- Keep one (1) meter clearance on back and both side of the generator.

Operation and Maintenance Manual

Diesel engine-generator sets
with Mercedes-Benz (0120) OM924LA and OM926LA engines
Application group 3B, 3D
60 Hz, 50 Hz
Built in North America

131658944E

Order No.	131658944
Serial No.	95130600197

System designation		Engine model	Power node	kW/cyl	Application group
Product name	Model number				
MTU 4R0120 DS80	DG04RM120A1N	OM924LA	72 kW	22	Prime Power (3B)
MTU 4R0120 DS80	DG04RM120A1N	OM924LA	80 kW	25	Emergency Standby (3D)
MTU 4R0120 DS100	DG04RM120A2N	OM924LA	90 kW	27	Prime Power (3B)
MTU 4R0120 DS100	DG04RM120A2N	OM924LA	100 kW	31	Emergency Standby (3D)
MTU 4R0120 DS125	DG04RM120A3N	OM924LA	111 kW	31	Prime Power (3B)
MTU 4R0120 DS125	DG04RM120A3N	OM924LA	125 kW	36	Emergency Standby (3D)
MTU 6R0120 DS150	DG06RM120A1N	OM926LA	135 kW	28	Prime Power (3B)
MTU 6R0120 DS150	DG06RM120A1N	OM926LA	150 kW	31	Emergency Standby (3D)
MTU 6R0120 DS180	DG06RM120A2N	OM926LA	163 kW	33	Prime Power (3B)
MTU 6R0120 DS180	DG06RM120A2N	OM926LA	180 kW	37	Emergency Standby (3D)
MTU 6R0120 DS200	DG06RM120A3N	OM926LA	180 kW	36	Prime Power (3B)
MTU 6R0120 DS200	DG06RM120A3N	OM926LA	200 kW	41	Emergency Standby (3D)
MTU 4R0120 DS89	DG04RM120A1L	OM924LA	80 kVA	19	Prime Power (3B)
MTU 4R0120 DS89	DG04RM120A1L	OM924LA	89 kVA	21	Emergency Standby (3D)
MTU 4R0120 DS111	DG04RM120A2L	OM924LA	100 kVA	24	Prime Power (3B)
MTU 4R0120 DS111	DG04RM120A2L	OM924LA	111 kVA	27	Emergency Standby (3D)
MTU 4R0120 DS139	DG04RM120A3L	OM924LA	125 kVA	29	Prime Power (3B)
MTU 4R0120 DS139	DG04RM120A3L	OM924LA	139 kVA	31	Emergency Standby (3D)
MTU 6R0120 DS167	DG06RM120A1L	OM926LA	150 kVA	26	Prime Power (3B)
MTU 6R0120 DS167	DG06RM120A1L	OM926LA	167 kVA	29	Emergency Standby (3D)
MTU 6R0120 DS200	DG06RM120A2L	OM926LA	180 kVA	31	Prime Power (3B)
MTU 6R0120 DS200	DG06RM120A2L	OM926LA	200 kVA	32	Emergency Standby (3D)
MTU 6R0120 DS222	DG06RM120A3L	OM926LA	200 kVA	32	Prime Power (3B)
MTU 6R0120 DS222	DG06RM120A3L	OM926LA	222 kVA	36	Emergency Standby (3D)

Table 1: Applicability

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

Preface

This Operation & Maintenance Manual provides general instructions for operating your MTU Onsite Energy engine-generator set properly. Every person who works on or with the engine-generator set must be completely familiar with the contents of this manual and carefully follow the instructions contained herein.

Each operation and maintenance task may require some modification of the suggested guidelines in this manual. These modifications must be consistent with locally applicable standards and follow safety guidelines and measures.

Following this guide will result in an efficient and reliable installation.

Carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety section at the beginning of this manual.

For information about where to find additional supporting resources, see the table.(→ Page 46)

All instructions and diagrams have been checked for accuracy and simplicity of application, however, the skills of the operator are most important. MTU Onsite Energy does not guarantee the result of any operation contained in this manual nor can MTU Onsite Energy assume responsibility for any injury or damage to property. Persons engaging in operating do so entirely at their own risk.

In this publication, the manufacturer of the engine-generator set is known as MTU Onsite Energy.

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1 Safety

1.1 MTU System Safety Section

System Safety Considerations

MTU systems or systems utilizing MTU equipment are integrated in a specific application to provide a capability to satisfy a stated need or objective.

In many cases, the system includes components from multiple product manufacturers, facility design considerations and the use of outside contractors. Complete safety information for the system can include multiple sources in addition to information provided by MTU. It is recommended you obtain and review the latest product application manuals from each manufacturer before design, installation or commissioning. It is the responsibility of the installation contractor and owner of the system installation site to ensure all local laws, ordinances and regulations are followed.

Given variations in system requirements, facility design and equipment, incompatibilities may result in potential hazards. If a system design, procedure or process that is not specifically recommended by MTU is used, you must satisfy yourself that it is safe for your application and facility.

System Installation and Commissioning

The safety guidelines and recommendations for the installation and commissioning of the MTU system are described in this manual and the Installation and Commissioning Validation Forms [for your application]. These materials contain specifications and procedures that must be considered by qualified technicians, project planners and outside contractors when installing and commissioning an MTU system and supporting equipment. Categories include:

- Transport, handling and lifting
- System identification
- System room, enclosure and open unit requirements
- Air inlet system
- Cooling system
- Mounting and foundation
- Fuel system
- Lube oil system
- Exhaust system
- Starting and battery charging system
- Electronic controls
- Electrical connections

TIM-ID: 0000035185 - 003

1.2 Use of MTU Technical Documentation

Access to MTU technical documentation is restricted, due to the highly technical nature of the information. Maintenance and workshop documentation is structured based on Qualification Levels (QLs). Personnel are to be qualified at the appropriate level to carry out specific tasks. The QLs are matched to MTU training courses and a demonstrated proficiency related to various tool kits.

QL1 - Operational monitoring and maintenance tasks that can be done during breaks in operation, and do not require disassembly of the system, engine or any components.

QL2 - Maintenance procedures requiring the exchange of assemblies.

QL3 - Maintenance procedures requiring overhaul of assemblies.

Do not use MTU Technical Documentation or attempt to perform the activities described in this manual if you have not been properly qualified by an MTU-authorized distributor for this QL level.

The information, specifications and illustrations in this manual are based upon information available at the time it was written. The information, specifications and illustrations can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before you start any work on the system, engine or any components.

If you did not receive this manual through MTU, stop all work and contact MTU to make sure you have the appropriate training and qualifications to follow the procedures within.

Keep this Manual near Engine for Personnel [QL1]

This publication must be provided to all MTU-certified personnel involved in any work being done on the engine and a copy must be located in the vicinity of the engine, accessible at all times.

General Responsibilities of Owners and Operators and MTU Technicians [QL1]

Owner and operator responsibilities

In preparation for service of an engine, owners and operators must:

- Keep unauthorized personnel clear of engine service areas.
- Provide a clear path for transport of the engine.
- Provide a service area for the engine.
- Provide proper equipment to transport the engine.
- Provide that lifting and handling of heavy objects are performed or supervised by personal knowledgeable with lifting procedures.
- Provide certified forklift and crane operators.
- Provide proper tools for working on an engine that are properly maintained and calibrated.
- Provide necessary add-on heat generating devices, such as a fuel heater.
- Make sure that servicing of batteries is performed or supervised by personnel knowledgeable with batteries and required battery service procedures.

TIM-ID: 0000035182 - 006

1.3 MTU Engine Safety Section

Preparing to Service Engine

Shut off equipment

You could be seriously injured or killed when working on running equipment. A release or spill of coolant, oil, fuel or hydraulic fluid while the engine is running can cause a fire or explosion. Do not fill coolant or fuel tanks while the engine is running. To reduce the risk of exposure to compressed air, fluids or moving parts, never carry out maintenance and repair work with the engine running and:

- Make sure that nobody is standing in the path of moving parts before barring over or starting the engine.
- Use care when working around moving belts and rotating parts.
- Remove safety guards only to complete service procedures that can only be completed with the guard removed and replace safety guards as soon as possible once the service is completed. Do not crank or start the engine with the safety guards removed unless specifically required in the procedure.

The engine may need to be running for some types of diagnostic activities.

Let engine and exhaust cool down

All exhaust components are hot when the engine is running and remain hot for an extended period after the engine is shut off. Other components and fluids are hot when the engine is running and remain hot for an extended period after the engine is shut off. Allow all components and fluids to cool before working on or near the unit, or use proper precautions to reduce the risk of being burned.

Engine placement [QL3]

When placing an engine in an area to be serviced, remember the following to reduce your risk of injury or death:

- Place the engine on a firm, flat and stable surface capable of supporting the units weight. Unless authorized by an MTU dealer or distributor, never set an engine down on the oil pan.
- Before servicing anything raised by hydraulics, make sure that it is mechanically supported by stands, blocks or a mechanical lock. Never rely on a hydraulic circuit alone when working underneath raised equipment.

Safe Engine Servicing

Following safe work practices can help reduce the risk of serious injury or death to yourself or bystanders when servicing an engine.

Use proper emergency shutdown procedures

If you have an emergency shutdown situation, use the hot shutdown procedure. You may damage the engine. Each emergency situation is unique. Follow the restart procedures in the manual.

Use lockout and tagout procedures

To reduce the risk of severe injury or death from electric shock or unintentional startup, disconnect all electrical power sources and batteries. Additionally, lockout and tagout the equipment before removing protective shields for service or maintenance. Do not remove a lockout tag unless proper authorization is obtained.

Provide proper ventilation

Do not operate this engine in an area where combustible chemicals or vapors may be present. Combustible vapors near the air intake system could be ingested into the engine, causing the engine to suddenly accelerate and overspeed or explode. This condition could cause an unexpected increase in engine rpm or fire. When changing the engine oil or working on the fuel system, make sure that the service area is properly ventilated.

Avoid carbon monoxide poisoning

All engine exhaust contains carbon monoxide, a deadly gas. Breathing carbon monoxide can cause headaches, dizziness, nausea, confusion and eventually death.

TIM-ID: 0000033371 - 005

Carbon monoxide is a colorless, odorless, tasteless gas that may be present even if you do not see or smell any engine exhaust. Deadly levels of carbon monoxide can collect rapidly and you can be quickly overcome and unable to save yourself. Also, deadly levels of carbon monoxide can linger for hours or days in enclosed or poorly ventilated areas. If you experience any symptoms of carbon monoxide poisoning, leave the area immediately, get fresh air and seek medical treatment.

To prevent serious injury or death from carbon monoxide:

- Never run engine in poorly ventilated or partially enclosed areas such as barns, garages, basements, carports, under dwellings, or in pits.
- Never run engine outdoors where engine exhaust can be drawn into a building through openings such as windows and doors.
- Make sure that the exhaust pipework is free of leaks and that the gases are discharged into the atmosphere.

Compressed gases and liquids hazards

Remember that you may be exposed to a variety of systems containing gases or fluids under pressure while working on an engine. Equipment does not necessarily have to be running to produce high fluid pressure-residual pressures in stationary circuits can represent a serious safety hazard.

Fluids in both liquid and gaseous states can be dangerous when proper safety precautions are not observed. Pressurized systems may cause fires, flying debris, or burns, and escaping fluid under high pressure, even a pin-hole sized leak, can penetrate body tissue, causing serious injury or death.

Electrical hazards

Hazardous voltages are present within this system. Contact with electrical components can result in electric shock. Disconnect all electrical power, and lockout and tagout the equipment before removing protective shields for service or maintenance.

Battery hazards

Refer to battery manufacturers warnings and instructions when interacting with batteries to reduce the risk of injury or death from electric shock, battery fire or explosion. Remember to:

- Use care when disconnecting battery cables. Always remove the negative side of the battery first.
- Charge batteries in a well-ventilated area and do not smoke in battery charging areas.

Using jumper cables

When starting the engine with an auxiliary or external power source, ground leads must be connected last and removed first. Improper jumper cable connections can cause an explosion that can result in injury. Connect the ground lead from the power source to the ground lead of the engine or to the ground terminal of the starter to avoid sparks in the vicinity of the battery.

Post-Service, Preparing to put Engine back in Service and to Start Engine

Complete all procedures when preparing to put an engine back into service to reduce the risk of serious injury or death to you and bystanders. Keep in mind the following steps to avoid incomplete procedures:

- Make sure all safety guards are in place and secured.
- Check that all protective devices have been reinstalled and all tools removed from the engine.
- Connect and secure all cables that may have become loose.
- Remove all loose components from the engine vicinity.
- Check battery polarity before connecting the cables to the battery.
- Ground the engine in accordance with the requirements in applicable national, state or local codes.
- Clear the area of bystanders before starting the engine.
- Start the engine from the operator station. Never short across the starting motor terminals or the batteries. This could bypass the engine neutral start system or damage the electrical system.
- Complete a successful commissioning inspection.

TIM-ID: 0000033371 - 005

1.4 MTU General Shop Safety Section

Personal Protective Equipment

Remember, there are many hazards that you may encounter in the workplace, such as falling objects, flying debris, loud noises, chemical exposure and sharp edges. To reduce your risk of injury when servicing the engine, always consider your activity and remember to wear appropriate protective gear:

- Feet – approved safety shoes (not bare feet, sandals or sneakers)
- Face – approved face shield
- Eyes – protective glasses or goggles
- Ears – hearing protection
- Lungs – respiratory protection
- Head – safety helmet, tied back hair
- Hand – gloves (for example, sleeved heat protective gloves)
- Body – protective clothing – apron, cotton work clothing (no rings, watches, jewelry or loose clothing)

Use of Compressed Air

Follow general shop safety procedures when utilizing compressed air and follow these common rules to reduce your risk of injury:

- Always use a pressure reducing valve and a safety valve and do not exceed 376 kPa (40 psi) air pressure. Make sure that the connected devices and equipment are appropriate for this pressure.
- Make sure that the hose coupling and connections are securely attached together.
- Make sure that the snout of the air nozzle has a protective disc (for example, rubber disc) to prevent airborne particles from being deflected.
- Always shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tools are exchanged.
- Never use compressed air to force flammable liquids out of containers.
- Never force compressed air into thin-walled containers (for example, containers made of tin, plastic or glass) for drying purposes or to check for leaks as the container may shatter.
- Do not direct a compressed-air jet at someone and never use compressed air to clean contaminated clothing while it is worn.

Safe Use of Tools and Equipment

Make sure you understand how to use the tools before performing any service work. Always use tools that are in good conditions and follow manufacturers instructions. Improper use of tools or use of tools in poor condition can increase your risk of injury.

Working from Heights

When working from heights on the engine, always use proper procedures for working at height and follow equipment manufacturers instructions. To reduce your risk of injuries from falls while working on MTU engines, remember to:

- Use suitable ladders and work platforms.
- Make sure components are placed on stable surfaces.
- Never use pressurized lines for climbing or support.

Welding

When welding, always use proper welding techniques and follow the manufacturers instructions and warning. To reduce your risk of injuries from welding, also keep in mind:

- If components (for example, exhaust manifold) are to be welded, they must be removed from the engine.
- Do not use the assembly or system as ground terminal.
- It is not necessary to remove the connector and the connections when carrying out welding operations on the manufacturers electronics if the master switch for power supply is switched from "ON" to "OFF" and the wire is disconnected from the negative and positive poles on the battery.

TIM-ID: 0000035184 - 006

Safe Work Space

As with other industrial work, it is important to maintain an area surrounding the engine that is dry, well lit, ventilated and free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist. Make sure a First Aid Kit is available.

Fluids and lubricants must be kept in suitable, properly designated containers. Never put maintenance fluids into glass containers – glass containers can break.

Cleanup

After completion of maintenance and repair work, make sure that no loose objects are in or on the assembly or system. Try to organize parts in bins and on benches when you are disassembling components.

To reduce the risk of injury from slipping and falling, clean up spilled liquids with suitable cleaning agents or as defined by the manufacturers specifications. Clean up oil spills quickly. You can do this by applying absorbent grit: this not only absorbs oil but makes it less likely that a person may slip and fall on an oil slick.

Proper Disposal

Always dispose of all lubricants (motor oil, coolant, gear box oils, and so on.) and filters according to federal or local regulations. Used oil disposed of in nature or waterways contaminates drinking water and kills wildlife.

Fire Prevention

Ignition sources

As in other industrial contexts, there are various potential sources of fire or explosion hazards when working on an engine. To reduce the risk of injury from fire or explosion, be aware of potential ignition sources. Some examples of ignition sources include:

- Electrical sparks or arcs
- Cutting, welding or grinding sparks
- Open flame
- Hot surfaces
- Incandescent lights
- Smoking

Flammable materials and vapors

Avoid exposing potential ignition sources to flammable materials and vapors. Some examples of flammable materials and vapors include:

- Paint
- Batteries or battery charging areas
- Oxygen and acetylene fuel cylinders
- Diesel fuel
- Fuel gases or vapors
- Engine oil
- Grease
- Textiles soaked in fuels and lubricants
- Most lubricants
- Some coolant mixtures
- Oil and fluid leaks

Clean up spills immediately. Substances spilled onto hot surfaces or electrical components can cause a fire.

To help reduce the severity of a fire, remember to keep appropriate fire extinguishers on hand. Know how to use them according to manufacturers instructions and inspect them regularly.

TIM-ID: 0000035184 - 006

Noise

Recall that there is a risk of hearing damage, including permanent hearing loss, from exposure to high noise levels (above 85dB). Although this can be the result of a single exposure to a high level of noise, it often results from years of exposure to excessive and repetitive noise levels. Noise can also lead to an increased risk of accident if instructions or sounds indicating danger cannot be heard.

To reduce the risk of injury from hazardous noise levels, remember to wear hearing protection or protective devices for ears when the engine is in operation.

Chemical Safety

When working with fluids, lubricants and other chemical substances, remember to follow the instructions that are provided by other manufacturers or chemical producers and to review/have available material Safety Data Sheets for the products that you are using or coming into contact with.

To reduce the risk of injury from chemical contact, be cautious when handling acids, alkaline solutions, coolant, fuel, paint and preservatives. Follow the chemical manufacturers usage, handling, storage and disposal instructions. To reduce the risk of injury from chemicals, remember the following precautions:

- Make sure that the work area is well-ventilated and wear proper protective equipment (for example, gloves, respiratory protection, goggles) as necessary.
- Protect skin from contact with battery acid or alkaline electrolytes or caustic byproducts.
- Avoid contact with skin.
- Do not fill coolant or fuel tanks while the engine is running.

Dispose of used fluids, lubricants, materials and filters in accordance with local regulations. Used oil may contain combustion residues hazardous to health.

General precautions for chemical contact

If chemicals contact the skin with, wash skin immediately with water for at least 15 minutes.

Precautions for contact with battery acid or electrolyte

If you come in contact with battery acid, flush your skin with water, apply baking soda to help neutralize the acid and get medical attention immediately. Immediately seek medical attention after contact with electrolyte or byproduct.

Liquid nitrogen precautions

Liquid nitrogen is a clear, colorless liquid that is exceptionally cold, approximately -200 °C (-328 °F). Generally it is stored in containers at high pressure, and can cause rapid freezing on contact with living tissue, which may lead to frostbite. To reduce the risk of injury and damage to equipment when using liquid nitrogen, remember the following precautions:

- Store liquid nitrogen only in small quantities in regulation containers without fixed covers, and make sure that all liquid nitrogen containers are handled properly.
- Use proper protective clothing, eye and hand protection, and a face shield.
- Make sure that the work area is well-ventilated. High concentrations of liquid nitrogen fumes may lead to suffocation.

Coolant precautions

Coolant is toxic and carries the risk of poisoning. Remember the following precautions, which can reduce your risk of severe illness or death, when working with coolants:

- Use proper hand protection when handling coolant.
- After coming into contact with any antifreeze or coolant solution, wash the affected skin areas.
- If coolant is accidentally ingested, contact a Poison Control Center immediately
- Keep coolant out of reach of children and animals.

Fluoroelastomer (for example, Viton®) precautions

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Fluoroelastomer parts, such as O-rings and seals, are safe to handle under normal environmental conditions. However, they may present a potential hazard if raised to a temperature above 316 °C (600 °F). At this temperature, fluoroelastomers decompose (indicated by charring or the appearance of a black, sticky mass) and produce hydrofluoric acid. This acid is corrosive and may cause severe burns to bare skin if touched; however, the symptoms may not appear for several hours. To reduce your risk of injury or death, remember the following precautions when working with degraded fluoroelastomer parts:

- Wear eye protection (for example, goggles or face shield) and neoprene or PVC gloves.
- Discard protective clothing after handling degraded fluoroelastomer parts.

Viton® is a registered trademark of Dupont Performance Elastomers L.L.C.

TIM-ID: 0000035184 - 006

1.5 General Service Safety

Contact Authorized Service for Additional Help

If you have any questions about a procedure or safety message related to servicing this engine, contact an authorized service outlet for assistance. Repair or engine overhaul must be carried out in an MTU authorized workshop.

Trained and Authorized Personnel only

Maintenance and repair work is to be carried out by trained and authorized personnel only. Do not allow unauthorized personnel on or near the engine when the engine is serviced. Work on or around this engine must be performed by people who have the necessary training, skills and tools to do the work. Improper maintenance or repair work can cause severe injury or death for yourself or bystanders.

Using this Manual

Read and understand this safety section before working on this product. This section contains general safety messages. Additional safety messages are included in the specific task procedures.

Signal Words Used in this Manual

Failure to follow the signal words and safety alert symbols contained in this manual can result in serious injury or death. Important safety information is distinguished in this manual by the following notations:

DANGER	In the event of immediate danger. **Consequences: Death or serious injury** • Remedial action
WARNING	In the event of potentially dangerous situations. **Consequences: Death or serious injury** • Remedial action
CAUTION	In the event of hazardous situations. **Consequences: Minor or moderate injuries** • Remedial action
NOTICE	In the event of a situation involving potentially adverse effects on the product. **Consequences: Material damage!** • Remedial action. • Additional product information.

Consider the Safety of Procedures You Choose

The manufacturer cannot anticipate every possible circumstance that might involve a potential hazard. If a tool, procedure, work method or operating technique that is not specifically recommended by the manufacturer is used, you must consider possible hazards and satisfy yourself that it is safe for you and for others. Ensure the product will not be damaged or made unsafe by the transport, installation, commissioning, operation, lubrication, maintenance, repair or storage procedures that you choose.

TIM-ID: 0000033337 - 006

Use Genuine Parts and do not make Unauthorized Modifications

Unauthorized modifications, third-party add-on devices and replacement parts may compromise the integrity of the equipment, and may present a safety risk. Only genuine MTU parts are allowed to be used to replace components or assemblies. Failure to heed this warning can lead to product damage, serious injury or death and may cause non-compliance with environmental regulations.

Follow Applicable Standards and Regulations

MTU recommends owners, operators and certified technicians become familiar with applicable national safety standards. To reduce the risk of severe injury or death, follow all codes, standards, regulations and laws pertaining to the products installation and application.

Maintain Product Labels

Safety labels should be legible and not covered. If any safety labels are damaged, missing or illegible, contact an MTU-authorized distributor or dealer to obtain replacement labels.

TIM-ID: 0000033337 - 006

1.6 Engine-Generator Set – Lockout/Tagout and Unlocking Procedures

1.6.1 Lockout/tagout procedure

Preconditions

☑ Engine is not running and controls are in "OFF" position.

☑ Engine starting circuit is disabled.

DANGER	Not completely de-energized systems can contain parts under high voltage. Live components and connections. **Risk of burns or death from electric shock!** • Disconnect all electrical power. • Lockout and tagout the equipment before removing protective shields for service or maintenance.
DANGER	Manipulation of interlocks on parts under high voltage. Live components and connections. **Risk of burns or death from electric shock!** • Do not tamper with any interlocks in the system.
DANGER	High voltage. Live components and connections. **Risk of burns or death from electric shock!** • Disable the engine start contact leads from the engine-generator set control panel. • Do not disconnect the engine start contact leads from the transfer switch enclosure.
DANGER	Circuit breakers are live components. **Risk of burns or death from electric shock!** • Ensure all circuit breakers are placed in the "OPEN" position prior to and while servicing the engine-generator set.
DANGER	Battery charger is a live component. **Risk of burns or death from electric shock!** • Wait at least 30 seconds after removing power source from the battery charger prior to servicing the engine-generator set.
WARNING	Rotating and moving parts and high level of engine noise in the event of unexpected engine-generator set start during service. **Risk of crushing, danger of parts of the body being caught or pulled in!** **Risk of damage to hearing!** • Ensure the engine-generator set has been stopped. • Ensure the control panel is in "OFF" position to disable starting during service. • Disconnect the battery charger prior to service.
WARNING	Hot components/surfaces. **Risk of burns!** • Allow the engine to cool down to below 50 °C before beginning work. • Wear suitable protective equipment/thermal gloves. • Avoid unprotected contact with hot surfaces.

TIM-ID: 0000000257 - 016

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries are live parts.
Risk of electric shock!
- Take care when disconnecting battery cables.
- Remove the negative side of the battery first.

NOTICE

Surge when using insufficient fuses.
Damage to engine-generator set!
- Make notes from where each fuse is removed, and keep these notes until reinstallation.
- Ensure to install the correct fuses in each slot of the control panel and the battery charger.

Note: The instructions in this section are general and cannot reflect all possible control and electrical configurations (control panel, circuit breaker, etc.).

General recommendations

- MTU Onsite Energy strongly recommends documenting the particular starting procedure applicable to your system during commissioning.
- All commissioning personnel should attend the commissioning training for operators offered at the authorized training center for their specific region.

Facility battery charger

1. Remove AC power source from battery charger.
2. Remove the battery charger fuses.
3. Open the circuit breaker supplying AC power to the battery charger.

Battery

1. Disconnect the negative lead from battery terminal.
2. Tag "DO NOT OPERATE" or similar warning label, and secure lock.

Automatic transfer switch (if fitted)

1. Open the engine-generator set control panel door.
2. Remove the panel fuses.
3. Remove the generator start contact leads supplied from remote start.
4. Install protective cover to exposed lead ends.
5. Secure loose leads away from circuit boards and other electronic devices.
6. Close the engine-generator set control panel door.
7. Add lock and tag to panel door to indicate Lockout/Tagout condition.

TIM-ID: 0000000257 - 016

Engine-generator set controls

1. Push the EMERGENCY STOP button to lockout the engine-generator set.

Note: This causes the alarm to sound. There is another button which functions to silence the alarm. Depending on your panel configuration, this button is called ALARM SILENCE, ACK, etc.

2. Press this button to silence the alarm.
3. Add lock and tag to panel door to indicate Lockout/Tagout condition, if not in place.

Main circuit breaker(s)

1. Move circuit breaker handle into the "OPEN" position.
2. Tag "DO NOT OPERATE" or similar warning label.
3. For multiple breakers, repeat the two previous steps.

TIM-ID: 0000000257 - 016

2 Transport

2.1 Transport

Lifting instructions

DANGER

Suspended load.
Danger to life!
- Use appropriate lifting devices and appliances.
- Never stand beneath a suspended load.

Note the following:
- The engine-generator set may only be lifted with empty fuel tank.
- If the fuel tank extends beyond the base of the engine-generator set, it must be lifted separately.
- The engine-generator set may only be lifted at the points intended for this purpose (see decals).
- Pay attention to the center of gravity of the engine-generator set.
- Use appropriate handling equipment and lifting gear only.
- Remove any loose parts on the engine-generator set.
- Lift the engine-generator set slowly. The hoisting cables or chains must not touch the engine-generator set.

Transport locking devices

Always fit transport locking devices (if available) on the resilient engine and generator mounts before transportation.

Remove all transport locking devices before startup.

Transport

The engine-generator set may be transported in its intended installation position only.

Secure the engine-generator set such that it cannot conceivably tip over during transport. Eliminate any possibility of slipping and toppling when negotiating inclines and ramps.

TIM-ID: 0000064125 - 001

3 Product Information

3.1 Spec Sheet MTU 4R0120 DS80 (80 kW Standby) 25
3.2 Parts List - Shop Order 95130600197 29

DIESEL GENERATOR SET
MTU 4R0120 DS80

80 kWe / 60 Hz / Standby
208 - 600V

Reference MTU 4R0120 DS80 (72 kWe) for Prime Rating Technical Data

SYSTEM RATINGS

Standby

Voltage (L-L)	240V	240V	208V	240V	380V	480V	600V
Phase	1	1	3	3	3	3	3
PF	1	1	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60	60
kW	80	80	80	80	80	80	80
kVA	80	80	100	100	100	100	100
Amps	333	333	278	241	151	120	96
skVA@30% Voltage Dip	145	311	216	216	165	288	236
Generator Model	363CSL1607	363CSL1617	362CSL1604	362CSL1604	362CSL1606	362CSL1604	362PSL1635
Temp Rise	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C	130 °C/40 °C
Connection	12 LEAD DOUBLE DELTA	4 LEAD	12 LEAD WYE	12 LEAD DELTA	12 LEAD WYE	12 LEAD WYE	4 LEAD WYE

CERTIFICATIONS AND STANDARDS

// **Emissions –** EPA Tier 3 Certified

// **Generator set is designed and manufactured in facilities certified to standards ISO 9001:2008 and ISO 14001:2004**

// **Seismic Certification – Optional**
- IBC Certification
- OSHPD Pre-Approval

// **Power Rating**
- Accepts Rated Load in One Step Per NFPA 110

// **UL 2200 / CSA – Optional**
- UL 2200 Listed
- CSA Certified
- CE Marking Provided

// **Performance Assurance Certification (PAC)**
- Generator Set Tested to ISO 8528-5 for Transient Response
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

TIM-ID: 0000098745 - 004

STANDARD FEATURES*

// MTU Onsite Energy is a single source supplier
// Global Product Support
// 2 Year Standard Warranty
// OM924LA Diesel Engine
- 4.8 Liter Displacement
- 4-Cycle
// Engine-generator resilient mounted
// Complete Range of Accessories
// Generator
- Brushless, Rotating Field Generator
- 2/3 Pitch Windings
- 300% Short Circuit Capability with Optional Permanent Magnet Generator (PMG)
// Digital Control Panel(s)
- UL Recognized, CSA Certified, NFPA 110
- Complete System Metering
- LCD Display
// Cooling System
- Integral Set-Mounted
- Engine-Driven Fan

STANDARD EQUIPMENT*

// Engine

Air Cleaners
Oil Pump
Oil Drain Extension and S/O Valve
Full Flow Oil Filter
Fuel Filter with Water Separator
Jacket Water Pump
Thermostat
Blower Fan and Fan Drive
Radiator - Unit Mounted
Electric Starting Motor - 12V
Governor – Electronic Isochronous
Base - Formed Steel
SAE Flywheel and Bell Housing
Charging Alternator - 12V
Battery Box and Cables
Flexible Fuel Connectors
Flexible Exhaust Connection
EPA Certified Engine

// Generator

NEMA MG1, IEEE and ANSI standards compliance for temperature rise and motor starting
Self-Ventilated and Drip-Proof
Superior Voltage Waveform
Solid State, Volts-per-Hertz Regulator
±1% Voltage Regulation No Load to Full Load
Brushless Alternator with Brushless Pilot Exciter
4 Pole, Rotating Field
130 °C Max. Standby Temperature Rise
1 Bearing, Sealed
Flexible Coupling
Full Amortisseur Windings
125% Rotor Balancing
3-Phase Voltage Sensing
100% of Rated Load - One Step
5% Max. Total Harmonic Distortion

// Digital Control Panel(s)

Digital Metering
Engine Parameters
Generator Protection Functions
Engine Protection
SAE J1939 Engine ECU Communications
Windows®-Based Software
Multilingual Capability
Remote Communications to RDP-110 Remote Annunciator
Programmable Input and Output Contacts
UL Recognized, CSA Certified, CE Approved
Event Recording
IP 54 Front Panel Rating with Integrated Gasket
NFPA 110 Compatible

TIM-ID: 0000098745 - 004

* Represents standard product only. Consult Factory/MTU Onsite Energy Distributor for additional configurations.

APPLICATION DATA

// Engine

Manufacturer	Mercedes-Benz
Model	OM924LA
Type	4-Cycle
Arrangement	4-Inline
Displacement: L (in³)	4.8 (293)
Bore: cm (in)	10.6 (4.17)
Stroke: cm (in)	13.6 (5.35)
Compression Ratio	17.5:1
Rated RPM	1,800
Engine Governor	MR2 / ADM3
Max. Power: kWm (bhp)	147 (197)
Speed Regulation	±0.25%
Air Cleaner	Dry

// Liquid Capacity (Lubrication)

Total Oil System: L (gal)	15.8 (4.2)
Engine Jacket Water Capacity: L (gal)	7 (1.8)
System Coolant Capacity: L (gal)	20.8 (5.5)

// Electrical

Electric Volts DC	12
Cold Cranking Amps Under -17.8 °C (0 °F)	950

// Fuel System

Fuel Supply Connection Size	-6 JIC
Fuel Supply Hose Size	3/8" ID
Fuel Return Connection Size	-6 JIC
Fuel Return Hose Size	3/8" ID
Max. Fuel Lift: m (ft)	2.7 (9)
Recommended Fuel	Diesel #2
Total Fuel Flow: L/hr (gal/hr)	328.2 (86.7)

// Fuel Consumption *

At 100% of Power Rating: L/hr (gal/hr)	19.3 (5.1)
At 75% of Power Rating: L/hr (gal/hr)	14 (3.7)
At 50% of Power Rating: L/hr (gal/hr)	9.8 (2.6)

* Based on 362CSL1604 480 Volt generator set

// Cooling - Radiator System

Ambient Capacity of Radiator: °C (°F)	50 (122)
Max. Restriction of Cooling Air: Intake and Discharge Side of Rad.: kPa (in. H_2O)	0.12 (0.5)
Water Pump Capacity: L/min (gpm)	143 (37)
Heat Rejection to Coolant: kW (BTUM)	37.5 (2,133)
Heat Rejection to Air to Air: kW (BTUM)	23.6 (1,342)
Heat Radiated to Ambient: kW (BTUM)	24.8 (1,410)
Fan Power: kW (hp)	3.3 (4.4)

// Air Requirements

Aspirating: *m³/min (SCFM)	8.6 (304)
Air Flow Required for Rad. Cooled Unit: *m³/min (SCFM)	209 (7,381)
Remote Cooled Applications; Air Flow Required for Dissipation of Radiated Generator Set Heat for a Max. of 25 °F Rise: *m³/min (SCFM)	90.7 (3,203)

* Air density = 1.184 kg/m³ (0.0739 lbm/ft³)

// Exhaust System

Gas Temp. (Stack): °C (°F)	354 (669)
Gas Volume at Stack Temp: m³/min (CFM)	21.6 (763)
Max. Allowable Back Pressure: kPa (in. H_2O)	6.5 (26)

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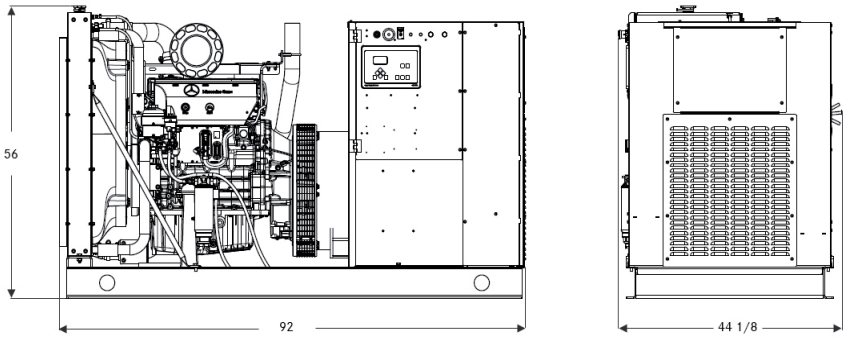
WEIGHTS AND DIMENSIONS



Drawing above for illustration purposes only, based on standard open power 480 volt generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (L x W x H)	Weight (less tank)
Open Power Unit (OPU)	2,336 x 1,121 x 1,422 mm (92 x 44.13 x 56 in)	1,769 kg (3,900 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific generator set.

SOUND DATA

Unit Type	Standby Full Load
Level 0: Open Power Unit dB(A)	83

Sound data is provided at 7 m (23 ft). Generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

EMISSIONS DATA

NO_x + NMHC	CO	PM
3.61	1.42	0.08

All units are in g/hp-hr and shown at 100% load (not comparable to EPA weighted cycle values).
Emission levels of the engine may vary with ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data was obtained in compliance with US EPA regulations. The weighted cycle value (not shown) from each engine is guaranteed to be within the US EPA Standards.

RATING DEFINITIONS AND CONDITIONS

// Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 3046-1, BS 5514, and AS 2789. Average load factor: ≤ 85%.

// Deration Factor:
Altitude: Consult your local MTU Onsite Energy Power Generation Distributor for altitude derations.
Temperature: Consult your local MTU Onsite Energy Power Generation Distributor for temperature derations.

C/F = Consult Factory/MTU Onsite Energy Distributor
N/A = Not Available

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MTU Onsite Energy
A Rolls-Royce Power Systems Brand

www.mtuonsiteenergy.com

3.2 Parts List - Shop Order 95130600197

ORDER SUMMARY

BASIC INFORMATION			
SALES ORDER #: (1 per Sales Order)	131658944		
MATERIAL/SLU #: (1 per Sales Order)	DG04RM120A1N	**MODEL #:** (1 per Sales Order)	MTU 4R0120 DS80
APPLICATION:	☒ Standby ☐ Prime	**kW:** (1 per Sales Order)	80
DOC TYPE / QTY	With Unit: _____ HARDCOPY 1 CD 1 USB Separate: _____ HARDCOPY _____ CD _____ USB		

UNIT SPECIFIC INFORMATION		
PROD ORDER #: (1 or more per Sales Order)	**SERIAL #:** (1 per Production Order)	**FINISH DATE:** (1 per Production Order / Serial Number)
1. 403007419	1. 95130600197	1. 08/01/2016

Configuration Summary

```
MTU 4R0120 DS80
DG04RM120A1N


Customer:           WAJAX Systemes du Puissance-Power

Project:            307210367
MTU Order:          1316589
                    20.07.2016

II.                 Selection Criteria for the Scope of Supply

Criteria
                    Selection           for Product No.
Frequency           60 Hz               1,
Voltage for starters                    208 V               1,
```

TIM-ID: 0000107732 - 001

Phase	3 Phase	1,		
Unit Specification	CSA	1,		
IBC Certification	Without IBC	1,		
OSHPD Certification	Without OSHPD	1,		
Engine Model	4R 4.8L OM924LA	1,		
Exhaust Emissions (EPA)		EPA "Nonroad" T. 3 Stationary (40 CFR 60)		
	1,			
Radiator Design Temperature		50°C	1,	
Temp Rise	130°	1,		
Power Output	80 kW	1,		
Generator Frame and Wire Qty		362/1604 (12 Wire)	1,	
Generator Wire Configuration		Wye	1,	
OPU/HSD	Level 0 - Open Power Unit		1,	
Fuel Tank	Without Tank	1,		
Control Panel	With Control Panel	1,		
Circuit Breaker Options		Single Circuit Breaker		1,
Breaker Wire Color Scheme		CEC Breaker Wire Color Scheme		1,
Paralleling	No Paralleling Operation		1,	
Acceptance testing	Factory acceptance	1,		
Country of Operation		USA/Canada	1,	
Emission cert. authority		18 US EPA Agency	1,	

Electrical: XZG2100100045

Dimensional: XZG2100100021

III. Scope of Supply

		valid for engine No.	
1	SYSTEM CONFIGURATION		1,
1.1	System Description	1,	
	Model: DG04RM120A1N		
	1,		
1.2	Cooling Package	1,	
	50 Deg C Cooling System		
•	Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump		
	1,		
1.3	Circuit Breaker	1,	

Circuit Breaker: Option 1

*For technical data refer to the circuit breaker enclosure data sheets located on the business portal.
1,

Circuit Breaker: Position 1

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*For technical data refer to the circuit breaker enclosure data sheets located on the business portal.

1,
Single Circuit Breaker
1,
Circuit Breaker Position 1:
1,
250 Amp 3 Pole 80% CB SQ-D JDL36250
1,
Circuit Breaker #1 Accessories:
1,
Canadian Electrical Code (CEC) breaker wire scheme
- Phase 1 (A) is Red label "CEC L1"
- Phase 2 (B) is Black label "CEC L2"
- Phase 3 (C) is Blue label "CEC L3"
- Neutral is White label "CEC NEU"

1,
LI Trip Breaker:

- LI breakers provide protection from long time overload and instantaneous short circuit events. Specific overload current values and time delays vary with breaker type and trip unit.

1,
1.4 Starting Aids 1,
Battery Rack Only
- Shipped with Battery Rack only (no battery included) 1,

Battery Charger: Guest 12-6A
1,
Battery Charger Mounted & AC/DC Wired
1,
With Coolant Preheating
1,
Block Heater
- -20 Deg F (120V 1PH 1500W)
- Model: TPS151GT10-005 1,

Block Heater Mounted & AC Wired
1,
1.5 Genset Enclosure 1,
OPU
- Engine Generator Set mounted on base with no enclosure 1,

1.6 Vibration Isolation 1,
Pad Isolators (Std)
- ¼ inch thick elastomeric pad in square shape placed under the base frame at each of the pre-drilled isolator mounting holes

1,
2 ENGINE CONFIGURATION 1,

TIM-ID: 0000107732 - 001

2.1 Engine System 1,
4R 4.8L OM924LA Charged Air Cooling
1,
Note Emission Compliance
- Please note that the engines and systems (only) comply with the country or region specific emission requirements and have appropriate emission certification(s) which are explicitly stated in respective RRPS/MTU defined technical specifications. Any Export / Import / Operation of the engine in countries or regions with different applicable emission law requirements is therefore at your own responsibility
1,
2.2 Exhaust System 1,
Shipped Loose Exhaust Silencer
• Muffler Model Number - JIS-04 1,
2.3 FUEL SYSTEM 1,
2.4 Air Intake System 1,
Air Filter (Standard)
1,
3 GENERATOR CONFIGURATION 1,
3.1 Generator Specification 1,
Generator Model Number: 362/1604
1,
3.2 Generator accessories 1,
MVC63-4 Regulator
1,
4 CONTROL PANEL CONFIGURATION 1,
4.1 Control panel 1,

Control Panel: Option 1

*For technical data refer to the circuit breaker enclosure data sheets located on the business portal.

1,

Control Panel: LH Mounted

*For technical data refer to the circuit breaker enclosure data sheets located on the business portal.

1,
MGC-1520
• MTU Onsite Energy's Generator Set Controllers are rugged, reliable, and easy-to-use digital generator set control systems. The MGC-1500 Series is perfectly focused, combining rugged construction and microprocessor technology to offer a product that will hold up to almost any environment and is flexible enough to meet your application's needs.

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```
                    1,
                    No Parallel Operation
                    1,
5                   SERVICES AND AFTER SALES SUPPLY         1,
5.1                 Warranty            1,
                    2 Year/3000 Hour Basic Standby Limited Warranty (Standard)
                    1,
6                   MISCELLANEOUS       1,
6.2                 Documentation       1,
                    English
                    1,
                    1 CD Format
                    1,
                    1 Flash Drive
                    1,
                    French
                    1,
                    Spanish
                    1,
6.3                 Additional Options  1,
7                   FUNCTIONAL TESTING  1,
7.1                 Acceptance Testing  1,
                    Standard Commercial Test
                    1,
8                   SHIPPING CONDITIONS 1,
8.1                 Shipment            1,
                    Ship Unit Wet - Fluids Installed
                    1,
```

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Raw Material Components

Material	Material Description	Requirement quantity	Base Unit of Measure
XSG21200.00007	RADIATOR FOR GENSET	1	PC
XD0341100001	RADIATOR FOR GENSET	1	PC
XG2162500001	FAN COUPLING	1	PC
SUA103046	SENSOR LOW WATER LEVEL "ROCHESTER GAUGE"	1	PC
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	4	PC
SUA95905	CAP SCREW M12-1.75 X 35MM 8.8 DIN 933 FU	2	PC
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	2	PC
SUA106934	TUBE JW UPPER - 150-225KW OM926	1	PC
SUA100444	HOSE 2"ID X 4"L 4PLY SILICONE POLYESTER	4	PC
SUA43329	CLAMP HOSE 1 9/16" - 2 1/2" OD HEX HEAD	8	PC
SUA106935	TUBE JW LOWER - 150-225KW OM926	1	PC
XG2106100037	STEEL TUBE	1	PC
XG2120200003	HOSE	1	PC
SUA97555	CLAMP HOSE CONSTANT TENSION BREEZE CT-35	4	PC
XG2120200002	HOSE	1	PC
XG2141100013	STEEL TUBE	1	PC
SUA71154	HOSE 3 1/2"ID X 6"L SILICONE CUT FROM 71	2	PC
SUA97556	CLAMP HOSE CONSTANT TENSION BREEZE CT-40	4	PC
SUA47505	FITTING HOSE 1/4-18 MALE PIPE TO 3/8" ID	1	PC
SUA43350	CLAMP HOSE SIZE 1	4	PC
SUA43314	HOSE 3/8" ID 50 PSI (FUEL) (UL) GATES 42	2	FT
SUA47506	FITTING HOSE 3/8-18 MALE PIPE TO 3/8" ID	1	PC
XG2122700004	FAN	1	PC
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	8	PC
SUA89200	WASHER M8 DIN 127 ZINC PLATED SPLIT LOCK	4	PC
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	6	PC
SUA43314	HOSE 3/8" ID 50 PSI (FUEL) (UL) GATES 42	2	FT
XG2120500002	BANJO UNION FOR GENSET	1	PC
XG2162500002	DUCT	1	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	8	PC
SUA57040	PETCOCK 1/4" NPT MCMASTER-CARR 4921K16	1	PC
SUA107086	BRACKET LOWER CAC - 150-225KW OM926	1	PC
SUA44319	CLAMP MUFFLER 2 3/4"	1	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA102088	8X1.25X40MM HEX HEAD 10.9 ZINC	4	PC
SUA72679	CLAMP SUPPORT PLASTIC COATED	3	PC
SUA71172	HOSE 9/32" OVERFLOW HOSE	5	FT
SUA102014	6 WORM DRIVE CLAMP 7/16 TO 25/32	1	PC
XSG21000.00021	ARRANGEMENT DRAWING FOR GENSET	1	PC
XZG2100100045	ARRANGEMENT DRAWING FOR GENSET	1	PC
XSG21300.00046	COMPONENTS FOR GENSET	1	PC
XG2141100011	BRACE	2	PC
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	2	PC
SUA49473	CAP SCREW M12-1.75 X 30MM 8.8 DIN 933 FU	2	PC
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	2	PC
SUA89102	LOCK NUT M10-1.5 DIN 985 NYLON INSERT ZI	2	PC
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	4	PC
XSG21300.00092	FLUIDS + LUBRICANTS	1	PC
SUA100490	COOLANT	17	GAL
XSG21300.00124	ADHESIVE LABEL FOR GENSET	1	PC
SUA88485	DECAL "MTU/ONSITE" (SMALL)	4	PC
XSG30500.00056	SWITCH	1	PC
SUA95536	MACHINE SCREW, M5-0.8 X 25MM, DIN 7985 P	3	PC
SUA97910	BLOCK NEUTRAL KIT 250-400A TNIA400UR GE	1	PC
XZG3150000010	BLOCK WITH SWITCH	1	PC
XSG21300.00064	BATTERY TRAY FOR GENSET	1	PC
SUA97234	CABLE BATTERY 2/0 AWG X 24"L W/ AUX. WIR	1	PC
SUA76018	CABLE BATTERY 2/0 AWG X 24"L W/ AUX WIRE	1	PC
SUA96114	NUT FLANGE M10-1.5 DIN6923	4	PC
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	4	PC
SUA88935	HEX FULL NUT M10-1.5 DIN 934 Z CL8 COARS	4	PC
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	4	PC
SUA94350	BOLT BATTERY HOLD DOWN, 10MM ROD	2	PC
SUA107520	BRACKET BATTERY HOLD DOWN BAR TEXTURED B	1	PC
SUA107521	BATTERY RACK TEXTURED BLACK	1	PC
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	2	PC
XSG30340.00085	BATTERY CHARGER	1	PC
SUA79100	12V 6A 120VAC 2-STAGE (GUEST) ONSITE ENE	1	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	4	PC

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ORDER SUMMARY

Material	Material Description	Requirement quantity	Base Unit of Measure
XZG3136000002	BATTERY CHARGER	1	PC
XSG21300.00030	HEATER FOR GENSET	1	PC
SUA106825	ADAPTER FLANGE TO 1/2" NPT - OM900	1	PC
XG2130100036	THREADED FITTING	3	PC
SUA47425	ELBOW PIPE SCHED 40 BLK	1	PC
SUA52057	BALL 1/2" NPT BRASS USE AS STANDARD	2	PC
SUA57057	FITTING HOSE 5/8 HOSE BARB TO 1/2" NPT	2	PC
SUA52748	HEATER TANK 1500W 120V 1PH KIM HOTSTART	1	PC
SUA43320	CLAMP HOSE HEX HEAD WOR	4	PC
SUA80452	HOSE 5/8" ID 2 PLY GREEN STRIPE (300' SP	1.6	FT
SUA80452	HOSE 5/8" ID 2 PLY GREEN STRIPE (300' SP	3.4	FT
SUA95568	CAP SCREW M6-1.0 X 20MM 8.8 DIN 933 FULL	4	PC
SUA101348	NUT FLANGE LOCK HEX NYLON-INSERT M6-1.0	4	PC
XG2120200004	GASKET	1	PC
SUA95313	WASHER, FLAT HARDENED, M8 X 8.4MM ID X 1	4	PC
SUA88932	HEX CAP SCREW M8-1.25 X 25MM 8.8 DIN 933	3	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	1	PC
SUA43344	CLAMP SUPPORT 1" PLASTIC COATED	1	PC
XSG21230.00003	BASE FOR GENSET	1	PC
XG2123300006	BASE	1	PC
SUA102667	BRACKET FRONT ENGINE FEET OM926	2	PC
SUA88919	HEX CAP SCREW M12-1.75 X 60MM 8.8 DIN 93	2	PC
SUA88918	HEX CAP SCREW M12-1.75 X 45MM 8.8 DIN 93	2	PC
SUA47719	WASHER FLAT1/2" ZINC PLATED USS	4	PC
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	4	PC
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	26	PC
SUA95905	CAP SCREW M12-1.75 X 35MM 8.8 DIN 933 FU	22	PC
XG2123300007	BRACKET	1	PC
SUA107504	BRACKET GENERATOR RISER 430FR TO 360FR -	1	PC
SUA77045	MOUNT VIBE RUBBER CONE K-61 50 DUROMETER	4	PC
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	4	PC
XG2101500003	COLLARED BUSHING	2	PC
XSG30300.00015	ASSEMBLY KIT	1	PC
SUA63015	MOUNT VIBE PAD 3 X 8 X 1/4 SP NEOPRENE	6	PC
XSG21180.00001	OIL DRAIN VALVE FOR GENSET	1	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA106440	QUICK RELEASE OIL DRAIN VALVE WITH 90 DE	1	PC
XSG21180.00002	OIL DRAIN LINE FOR GENSET	1	PC
SUA43316	HOSE 4PLY 250 PSI GATES 4219G	4	FT
XSG21300.00001	COUPLING FOR GENSET	1	PC
SUA88914	HEX CAP SCREW M10-1.5 X 30MM 8.8 DIN 933	12	PC
SUA95543	WASHER, FLAT HARDENED, M10 X 10.5MM ID X	20	PC
SUA89157	SOCKET HEAD CAP SCREW M10-1.5 X 30MM CL	8	PC
XSG21300.00073	WIRING HARNESS FOR GENSET	1	PC
XD0342400005	WIRING HARNESS FOR GENSET	1	PC
XSG21300.00075	WIRING HARNESS FOR GENSET	1	PC
SUA107208	HARNESS ENGINE ALTERNATOR OM924	1	PC
XSG21240.00004	ENGINE FOR GENSET	1	PC
SUA107006	ENGINE MERCEDES-BENZ OM924 1800RPM SAE 2	1	PC
XG2100400003	ADHESIVE LABEL	1	PC
XSG21140.00014	EXHAUST PIPE FOR GENSET	1	PC
XG2141700002	BRACKET	1	PC
SUA107107	TUBE EXHAUST TURBO - OM924	1	PC
SUA44320	CLAMP MUFFLER	1	PC
SUA94725	WASHER FLAT HARDENED M8 X 16MM	4	PC
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	2	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	2	PC
XSG21140.00015	EXHAUST PIPE FOR GENSET	1	PC
SUA107547	FLEX EXHAUST SS OAL 22" - 3" SLEEVE TO 5	1	PC
SUA44320	CLAMP MUFFLER	1	PC
SUA86745	GASKET 4" PIPE FLANGE 150 ASA FLANGE RI	1	PC
SUA94436	WASHER, FLAT HARDENED, M16 X 17MM ID X 3	16	PC
SUA88803	CAP SCREW M16-2.0 X 60MM 10.9 DIN 933 FU	8	PC
SUA89075	NUT M16-2.0 DIN 934 Z CL8 COARSE THREAD	8	PC
XSG21140.00017	EXHAUST SILENCER FOR GENSET	1	PC
SUA61016	MUFFLER 4" INDUSTRIAL SI F=5.5 MIN	1	PC
XSG21070.00001	FUEL SYSTEM FOR GENSET	1	PC
XG2108300001	BRACKET	1	PC
SUA107555	FUEL FILTER	1	PC
SUA78974	CLAMP SUPPORT PLASTIC COATED (SP	1	PC
SUA94725	WASHER FLAT HARDENED M8 X 16MM	6	PC

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ORDER SUMMARY

Material	Material Description	Requirement quantity	Base Unit of Measure
SUA88931	HEX CAP SCREW M8-1.25 X 20MM 8.8 DIN 933	2	PC
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	2	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	3	PC
SUA105984	FITTING 6 FEMALE JIC SWIVEL TO 3/8" ID	1	PC
SUA43314	HOSE 3/8" ID 50 PSI (FUEL) (UL) GATES 42	1.04	FT
SUA107533	ADAPTER M16X1.5 MALE X 6 MALE 37DEG FLA	1	PC
SUA73698	CLAMP HOSE 2 EAR UL SP FOR 5/8" FUEL HO	2	PC
SUA94725	WASHER FLAT HARDENED M8 X 16MM	2	PC
SUA88931	HEX CAP SCREW M8-1.25 X 20MM 8.8 DIN 933	1	PC
XSG21070.00003	FUEL SYSTEM FOR GENSET	1	PC
SUA105984	FITTING 6 FEMALE JIC SWIVEL TO 3/8" ID	2	PC
SUA43314	HOSE 3/8" ID 50 PSI (FUEL) (UL) GATES 42	2.05	FT
SUA43314	HOSE 3/8" ID 50 PSI (FUEL) (UL) GATES 42	3.83	FT
SUA92507	PLUG PLASTIC 9/16-18 MALE PD-60	2	PC
XG21K4700006	BANJO UNION	1	PC
XG21K4700007	WASHER	2	PC
XG21K4700005	BANJO SCREW	1	PC
SUA73698	CLAMP HOSE 2 EAR UL SP FOR 5/8" FUEL HO	4	PC
XSG21180.00005	ENGINE OIL	1	PC
SUA101639	15W-40 DIESEL ENGINE	1	GAL
XSG21180.00006	ENGINE OIL	1	PC
SUA89619	OIL FOR WEIGHT CALCULATION ONLY	12	PC
XSG21120.00003	AIR FILTRATION SYST FOR GENSET	1	PC
SUA107094	ELBOW HOSE RUBBER REDUCING 90 DEG 4.00"-	1	PC
XG2112300001	AIR INTAKE PIPE	1	PC
SUA44323	CLAMP MUFFLER 4"	2	PC
XG2112100001	AIR FILTER	1	PC
SUA43339	CLAMP HOSE 3" TO 5 1/2" OD HEX HEAD WORM	1	PC
SUA43335	CLAMP HOSE 2 1/8" TO 4" OD HEX HEAD WORM	1	PC
SUA106994	BRACKET MOUNTING MUFFLER REAR - OM924 OM	1	PC
SUA106993	BRACKET MOUNTING MUFFLER TOP - OM924	1	PC
SUA107002	SPACER MOUNTING MUFFLER - OM924 OM926	1	PC
SUA106995	BRACKET MOUNTING MUFFLER FRONT - OM924 O	2	PC
SUA107671	BOLT FLANGE M10-1.5 X 25MM CLASS 10.9 DI	4	PC
SUA95544	WASHER, FLAT HARDENED, M12 X 13MM ID X 2	2	PC

TIM-ID: 0000107732 - 001

Material	Material Description	Requirement quantity	Base Unit of Measure
SUA95531	CAP SCREW, HEX, M12-1.75 X 65MM 8.8 DIN	1	PC
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	1	PC
SUA94725	WASHER FLAT HARDENED M8 X 16MM	8	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	4	PC
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	4	PC
SUA43339	CLAMP HOSE 3" TO 5 1/2" OD HEX HEAD WORM	1	PC
XSG21340.00045	GENERATOR	1	PC
SUA107475	GENERATOR 362/1604 SAE 2 FLYWHEEL 11 1/2	1	PC
XSG31500.00012	CABLING	1	PC
SUAMF140017	SUB ASSEMBLY	1	PC
XSG21500.00032	OUTLET HOUSING FOR GENSET	1	PC
SUA107377	OUTLET BOX 360 FRAME, RH PRIMARY BREAKER	1	PC
SUA107453	PANEL VENT 360 GEN - OM924	1	PC
SUA107451	PANEL BREAKER LOWER 360 FRAME	1	PC
SUA107452	PANEL OUTLET BOX TOP 360 FRAME	1	PC
SUA96031	BOLT ON (BLIND) POWDER BLACK STAINLESS P	2	PC
SUA82554	FOAM INSULATION 3/4" WIDE X 1/16" THICK	5.525	FT
SUA88879	WASHER FLAT 1/2" GRADE 9 SAE YELLOW ZINC	4	PC
SUA47728	LOCK WASHER ZINC PLATED MEDIUM SPLI	4	PC
SUA88918	HEX CAP SCREW M12-1.75 X 45MM 8.8 DIN 93	4	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	8	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	10	PC
SUA96086	WASHER FLAT NYLON 1/4 X 1/16 THICK	6	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	9	PC
SUA96086	WASHER FLAT NYLON 1/4 X 1/16 THICK	9	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	7	PC
SUA96086	WASHER FLAT NYLON 1/4 X 1/16 THICK	7	PC
XSG21500.00034	OUTLET HOUSING FOR GENSET	1	PC
SUA107818	PANEL BREAKER J-H-FRAME 360 GEN - OM924	1	PC
SUA107257	HANDLE SNAP-IN POCKET PULL, .070-.085 PA	2	PC
SUA34137	TRIM VINYL PROTECTIVE	2	FT
XSG21500.00014	OUTLET HOUSING FOR GENSET	1	PC
SUA107260	BRACKET H-J-FRAME BREAKER STAND-OFF 430	1	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	4	PC
XSG21500.00023	CONTROL PANEL FOR GENSET	1	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA107230	PANEL DOOR CONTROL MGC-1500 - OM924 OM92	1	PC
SUA74221	CLAMP SUPPORT 1 1/4" ID PLASTIC COATED	3	PC
SUA80505	CLAMP SUPPORT PLASTIC COATED W/	2	PC
SUA72679	CLAMP SUPPORT PLASTIC COATED	1	PC
SUA90393	WASHER FLAT .25 .281ID X .875OD X .090 T	3	PC
SUA101348	NUT FLANGE LOCK HEX NYLON-INSERT M6-1.0	6	PC
XSG21500.00031	CONTROL PANEL FOR GENSET	1	PC
XG2168500006	CONTROL PANEL	1	PC
SUA96086	WASHER FLAT NYLON 1/4 X 1/16 THICK	4	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	4	PC
XSG31300.00125	WIRING HARNESS	1	PC
SUAMF140008	HARNESS VOLTAGE REGULATOR SE350/KAVC63-	1	PC
XSG21500.00051	VOLTAGE REGULATOR	1	PC
SUA77199	REGULATOR VOLTAGE MAVC63-4D UL (SE350)	1	PC
SUA70782	LABEL VOLTAGE REGULATOR ADJUST BLACK ON	1	PC
SUA95527	K-LOCK NUT, M4-0.7 KEP ZINC PLATED	2	PC
XG21K5300005	PANEL	1	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	6	PC
XSG21500.00055	GENSET COMPONENTS	1	PC
XG2142400001	GENSET COMPONENTS	1	PC
SUA88879	WASHER FLAT 1/2" GRADE 9 SAE YELLOW ZINC	1	PC
SUA89004	LOCK WASHER ZINC PLATED SPLI	1	PC
SUA88918	HEX CAP SCREW M12-1.75 X 45MM 8.8 DIN 93	1	PC
SUA49430	STUD GROUND LUG CSA TD COMPRESSION --SP-	1	PC
SUA88865	BOLT FLANGE 3/8-16 X 3/4" CASE HARDENED	1	PC
XSG21500.00059	CONTROL PANEL	1	PC
SUA105389	MGC-1520 (MICROPROCESSOR DGC-2020ES LEVE	1	PC
XSG21300.00070	WIRING HARNESS FOR GENSET	1	PC
XD0430900002	WIRING HARNESS	1	PC
XSG30500.00069	CONNECTION	1	PC
SUA100595	BLOCK TERMINAL 4-QUATTRO PE 3031461	1	PC
SUA39156	COVER DUPLEX RECEPTACLE STANDARD	1	PC
SUA90460	TERMINAL BLOCK MARKER BLANK	5	PC
SUA95537	MACHINE SCREW, M4-0.7 X 12MM, DIN 7985 P	2	PC
SUA95852	HARNESS WIRING DUPLEX RECEPTACLE SPECIAL	1	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA96594	TERMINAL BLOCK DOUBLE DOUBLE 30A MAX ST	4	PC
SUAMF96981	RECEPTACLE DUPLEX 120V 20A NEMA 5-20R 2P	1	PC
SUA93505	TERMINAL BLOCK, END BLOCK	2	PC
SUA96738	TERMINAL BLOCK END CAP QUATTRO (USED WIT	1	PC
XSG21500.00056	MOUNTING BRACKET	1	PC
SUA106651	BRACKET ADM3 MOUNTING - OM900	1	PC
SUA105204	MOUNT VIBE 5/8" NEOPRENE WITH M6-1.0 FEM	4	PC
SUA95542	WASHER, FLAT HARDENED, M6 X 6.4MM ID X 1	4	PC
SUA95540	LOCK NUT, M6-1.0 DIN 985, NYLON INSERT Z	4	PC
SUA95534	FLAT WASHER, M5, DIN 125 TYPE A ZINC	4	PC
SUA88924	HEX CAP SCREW M5-0.8 X 12MM 8.8 DIN 933	4	PC
SUA95528	K-LOCK NUT, M5-0.8 KEP ZINC PLATED	4	PC
XSG21500.00062	ELECTRICAL EQUIPMENT	1	PC
SUA102705	ALARM BUZZER 12-24VDC STD PANEL ALARM SO	1	PC
SUA77880	SWITCH TOGGLE SPST 10AMP OFF-(ON) (SPRIN	1	PC
XG2130100005	LABEL FOR CONTROL PANEL	1	PC
SUA74221	CLAMP SUPPORT 1 1/4" ID PLASTIC COATED	2	PC
SUA90393	WASHER FLAT .25 .281ID X .875OD X .090 T	2	PC
SUA101348	NUT FLANGE LOCK HEX NYLON-INSERT M6-1.0	2	PC
SUA105964	PLUG DOME 1/2" DIAMETER HOLE CONVEX MATT	2	PC
SUA86539	COVER TERMINAL BLOCK D-STS 4 (USE WITH P	1	PC
SUA86540	TERMINAL BLOCK D-STS 4 (USE WITH PN 8653	3	PC
SUA93505	TERMINAL BLOCK, END BLOCK	2	PC
SUA95528	K-LOCK NUT, M5-0.8 KEP ZINC PLATED	6	PC
SUA90460	TERMINAL BLOCK MARKER BLANK	3	PC
SUAMF95279	RAIL MOUNTING DIN 35MM X 7.5MM X 7-1/8"	1	PC
SUA106794	GROUND LUG MECHANICAL - ALUM SINGLE COND	1	PC
SUA95905	CAP SCREW M12-1.75 X 35MM 8.8 DIN 933 FU	2	PC
SUA96710	LOCK NUT M12-1.75 DIN 985 ZINC PLATED NY	2	PC
SUA97421	WASHER FLAT M12 X 13MM ID X 24MM OD ZINC	4	PC
SUA34137	TRIM VINYL PROTECTIVE	0.9	FT
XG2150700002	WIRING HARNESS	1	PC
SUA105604	RIVET 3/16" DIA 0.188 - 0.250 GRIP RANG	11	PC
SUA102765	LABEL EQUIPMENT GROUNDING TERMINAL	1	PC
SUA86666	SWITCH E-STOP MAINTAINED YELLOW ISO LEGE	1	PC

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ORDER SUMMARY

Material	Material Description	Requirement quantity	Base Unit of Measure
XG3130900013	ADHESIVE LABEL	1	PC
XSG31300.00054	ADHESIVE LABEL FOR GENSET	1	PC
SUA39008	LABEL CAUTION FOR STANDBY SERVICE CSA EN	1	PC
XSG31300.00056	ADHESIVE LABEL FOR GENSET	1	PC
SUA44540	PLATE "CAUTION" (UL) "FOR USE IN WEATHER	1	PC
XSG31300.00048	ADHESIVE LABEL FOR GENSET	1	PC
SUA92623	LABEL CAUTION RISK OF ELECTRIC SHOCK REC	1	PC
XSG31300.00030	ADHESIVE LABEL FOR GENSET	1	PC
SUA92608	LABEL CONTROL PANEL MODEL 1.75L X 4.25W	1	PC
XSG31300.00042	ADHESIVE LABEL FOR GENSET	1	PC
SUA79477	LABEL HEATER 120VAC CHARGER 120VAC WHITE	1	PC
XSG31300.00028	ADHESIVE LABEL FOR GENSET	1	PC
SUA100530	ADHESIVE LABEL	1	PC
XSG30000.00002	ADHESIVE LABEL	1	PC
SUA105981	LABEL LIFTING INSTRUCTION LIFTING HOLES	1	PC
XSG31300.00031	ADHESIVE LABEL FOR GENSET	1	PC
SUA77906	LABEL NOTICE NOT RESPONSIBLE FOR LOOSE C	1	PC
XSG31300.00033	ADHESIVE LABEL FOR GENSET	1	PC
SUA105201	LABEL STRANDED WIRE ONLY	1	PC
XSG31300.00027	TAG FOR GENSET	1	PC
SUA72045	TAG CAUTION EXHAUST SYSTEM HAS BEEN SEAL	1	PC
XSG31300.00046	TAG FOR GENSET	1	PC
SUA96612	TAG-CONNECT BATTERIES BEFORE ENERGIZIING	1	PC
XSG31300.00040	TAG FOR GENSET	1	PC
SUA100426	TAG TAG NFPA 37 EXHAUST	1	PC
XSG31300.00050	ADHESIVE LABEL FOR GENSET	1	PC
SUA39003	PLATE "PAC" W/ ADHESIVE BACKING BLK PRIN	1	PC
SUA39015	PLATE "WARNING" (UL) (UNIT MAY	1	PC
SUA39016	PLATE "DANGER" (UL)	1	PC
SUA47938	PLATE "ISOLATED NEUTRAL N0T BONDED.."	1	PC
SUA71558	PLATE - GROUND (UL)	1	PC
SUA72036	TAG FUEL RETURN DO NOT BEND FLEX WHEN IN	1	PC
SUA72037	TAG PRIME FUEL SYSTEM + BLEED LINE BEFOR	1	PC
SUA72038	TAG FUEL INLET - DO NOT BEND FLEX WHEN I	1	PC
SUA72039	TAG N0TICE: COOLING SYSTEM HAS BEEN FILL	1	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA72044	TAG CAUTION CHECK OIL LEVEL BEFORE START	1	PC
SUA72047	TAG DO NOT REMOVE TAG UNTIL WARRANTY REG	1	PC
SUA72709	LABEL "CAUTION" FOR LOW WATER LEVEL SHUT	1	PC
SUA73369	PLATE "NOTICE" DISCONNECT BATTERY CABLES	1	PC
SUA73791	PLATE "CAUTION" RISK OF ELECTRICAL SHOCK	1	PC
SUA73799	PLATE "NOTICE" SERVICE ACCESS DO N0T BLO	1	PC
SUA73800	PLATE "NOTICE" AC+DC CIRCUITS MUST BE RU	1	PC
SUA75985	TAG WARNING!!! BATTERY MUST BE FULLY CHA	1	PC
SUA76197	PLATE "WARNING" 2" X 3" (UL) "UNIT STAR	2	PC
SUA77823	DECAL "MADE IN THE USA"	1	PC
SUA83389	TAG "IMPORTANT" REFER TO INSTALLTION GUI	1	PC
XG3000400004	LABEL	1	PC
XSG21300.00099	CARRIER BAG	1	PC
SUA101374	BAG	1	PC
XSG21300.00098	GUARD FOR GENSET	1	PC
SUA107661	BRACKET GUARD BELT RIGHT - OM924 OM926	1	PC
SUA107659	GUARD BELT RIGHT - OM924 OM926	1	PC
SUA107660	GUARD BELT LEFT - OM924 OM926	1	PC
SUA93424	FLANGE BOLT PLATED	4	PC
SUA96084	FLANGE BOLT M8-1.25 X16MM 8.8 DIN6921 ZI	2	PC
XSG21300.00107	BRACKET	1	PC
XG2100400001	BRACKET	1	PC
SUA101370	UL2200 "CAUTION HOT SURFACES DO NOT TOUC	1	PC
SUA101398	1/8" DIA 0.039"- 0.187"" GRIP RANGE ALU	2	PC
SUA94725	WASHER FLAT HARDENED M8 X 16MM	4	PC
SUA88933	HEX CAP SCREW M8-1.25 X 30MM 8.8 DIN 933	2	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	2	PC
XSG21500.00083	CURRENT TRANSFORMER	1	PC
SUA41708	TRANSFORMER CURRENT 400:5 600V 10.0VA SE	3	PC
XSG21500.00070	FUSE HOLDER	1	PC
XG21K5300003	PANEL	1	PC
SUA96031	BOLT ON (BLIND) POWDER BLACK STAINLESS P	1	PC
XG21K5300004	ADAPTER PLATE	1	PC
SUA42820	BLOCK FUSE	1	PC
SUA42828	FUSE	3	PC

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Material	Material Description	Requirement quantity	Base Unit of Measure
SUA95527	K-LOCK NUT, M4-0.7 KEP ZINC PLATED	2	PC
SUA88992	LOCK NUT M8-1.25 DIN 985 ZINC PLATED NYL	4	PC
SUA95538	FLANGE BOLT, M6-1.0 X 16MM, DIN 6921 CLA	2	PC
XG2130100014	ADHESIVE LABEL	1	PC
XSG32300.00281	WORK SCHEDULE	1	EA
TXT00016703	DUMMY FOR IPAS PM GASSYSTEM DEVELOPMENT	1	PC
XS575500.00568	CIRCUIT BREAKER	1	PC
SUA47123	WIRE 1 AWG 150 DEG C BLACK TYPE EPDM LEA	18	FT
SUA74263	CONNECTOR WIRE RING LUG 1/2" 0N-INSULATE	4	PC
SUA98209	BREAKER 250A 600V 3P SQUARE-D J-FRAME 80	1	PC
SUA105543	SCREW SOCKET HEAD CAP M5-.8 X 70MM CL 12	2	PC
XSG21300.00113	ADHESIVE LABELS	1	PC
SUA106111	LABEL SERVICE EQUIPMENT UL	1	PC
SUA102766	LABEL SERVICE DISCONNECT	1	PC
XSG21000.00001	DIMENSIONAL DRAWING FOR BASE FRAME	1	PC
XZG2100100021	DIMENSIONAL DRAWING	1	PC
XS00D000.06593	USB-STICK FOR DOCUMENTATION	1	PC
USB00001/00E	USB-STICK ENGLISH	1	PC
XS00D000.06590	CD-ROM GENSET FOR DOCUMENTATION	1	PC
CDZ01753/00E	CD-ROM GENSET ENGLISH	1	PC
XSG25300.00294	WIRE FOR GENSET	1	PC
SUA121110	HARNESS EXCITER WIRE EXTENSION VERIZON	1	PC

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4 Product Summary

4.1 Chapter overview

This chapter provides general information about the engine-generator set and its component parts, including a functional description, technical data, and details of benefits. A listing of where to find additional resources for support is also provided here.

Engine-generator sets can be delivered with a range of standard and optional components.

Note: This publication describes all available engine-generator set components. Disregard any components which are not included in the scope of delivery of your particular engine-generator set.

Consult your local MTU Onsite Energy distributor or dealer should you require more detailed information about a specific component.

TIM-ID: 0000064667 - 001

4.2 Additional Resources for Support

Additional resources providing information about your specific engine-generator set are available. The following documents can be accessed as needed.

Document	Description	Location
Bill of Materials	Complete listing of all components selected for your specific engine-generator set	Provided by your MTU Onsite Energy dealer or distributor
Spec Sheet	Additional data pertaining to individual engine-generator set models	Visit www.mtuonsiteenergy.com or contact your MTU Onsite Energy dealer or distributor.
Template Drawings	Dimensional and electrical template drawings of individual engine-generator set models	Visit www.mtuonsiteenergy.com or contact your MTU Onsite Energy dealer or distributor.
Spare Parts Catalog	Complete listing of parts and part numbers for your specific unit	Provided by your MTU Onsite Energy dealer or distributor
Warranty	Warranty agreement purchased with your specific unit	Provided by your MTU Onsite Energy dealer or distributor
Specifications for Operating Fluids	Overview of requirements for operating fluids and specific product recommendations that are approved for use with your engine-generator set	Refer to Mercedes-Benz Specifications for Operating Fluids at https://bevo.mercedes-benz.com.
Maintenance Schedule	Overview of maintenance work for your engine-generator set, including a list of tasks to be performed with applicable time intervals	Provided by your MTU Onsite Energy dealer or distributor

For questions about supplementary documents, contact your MTU Onsite Energy dealer or distributor.

TIM-ID: 0000064637 - 001

4.3 Engine-Generator Set

4.3.1 Engine-generator set – General information

The engine-generator set consists mainly of a diesel engine and a generator mounted on a common base frame. Upon demand, the engine starts and drives the generator to produce electrical power.

Engine-generator sets are available in two application groups: prime power and standby power.

Application group 3B – Prime power

Prime power is continuous electric power generation for long periods of time. Engine-generator sets for prime power are used in the following conditions:

- When no utility service is available, for example in remote or developing areas
- When existing utility service is very expensive or not reliable

Continuous operation	Application group 3B
Operating mode	Continuous operation, variable
Rating definition	10% overload capacity (ICXN)
Load factor	< 75%
Operating hours	Unrestricted

Application group 3D – Standby power

Standby power systems are a type of system used to provide backup resources in a crisis or when regular systems (for example, a power grid) fail. They find uses in a wide variety of settings:

- Residential homes
- Hospitals
- Airports
- Scientific laboratories
- Data centers

Standby operation	Application group 3D
Operating mode	Short-time operation, variable
Rating definition	ISO fuel stop power (IFN)
Load factor	< 85%
Operating hours	Maximum 500 hours per year

Model designation of engine-generator sets

Key to the engine-generator set model designation – Example: MTU 4R0120 DS80	
MTU	Equipment Brand Identifier: MTU – MTU Onsite Energy
4	Number of engine cylinders
R	Cylinder arrangement: • R – Inline • V – V-block
0120	Engine series or nominal displacement per cylinder (liters x 100): • Example: 1.2 liters per cylinder displacement x 100 = 120 • Leading zero added when calculation results in three digits
D	Engine type: • D – Diesel • G – Gas

TIM-ID: 0000055270 - 001

Key to the engine-generator set model designation – Example: MTU 4R0120 DS80	
S	Project type: Standard product
80	Nominal power node (based on standby application) kW for 60 Hz (kVA for 50 Hz)

Benefits

- Wide range of standardized engine-generator sets to meet customer requirements regarding power, emission, and other characteristics
- Opportunity to choose from different component designs and to select options
- Latest diesel engine technology
- State-of-the-art main components for high efficiency and long service life

TIM-ID: 0000055270 - 001

4.3.2 Engine-generator set – Standard scope of delivery

The illustrations show an engine-generator set with a Mercedes-Benz OM924LA engine. The illustrations are also valid for engine-generator sets featuring a Mercedes-Benz OM926LA engine. Visual appearance and configuration may vary depending on the unit.

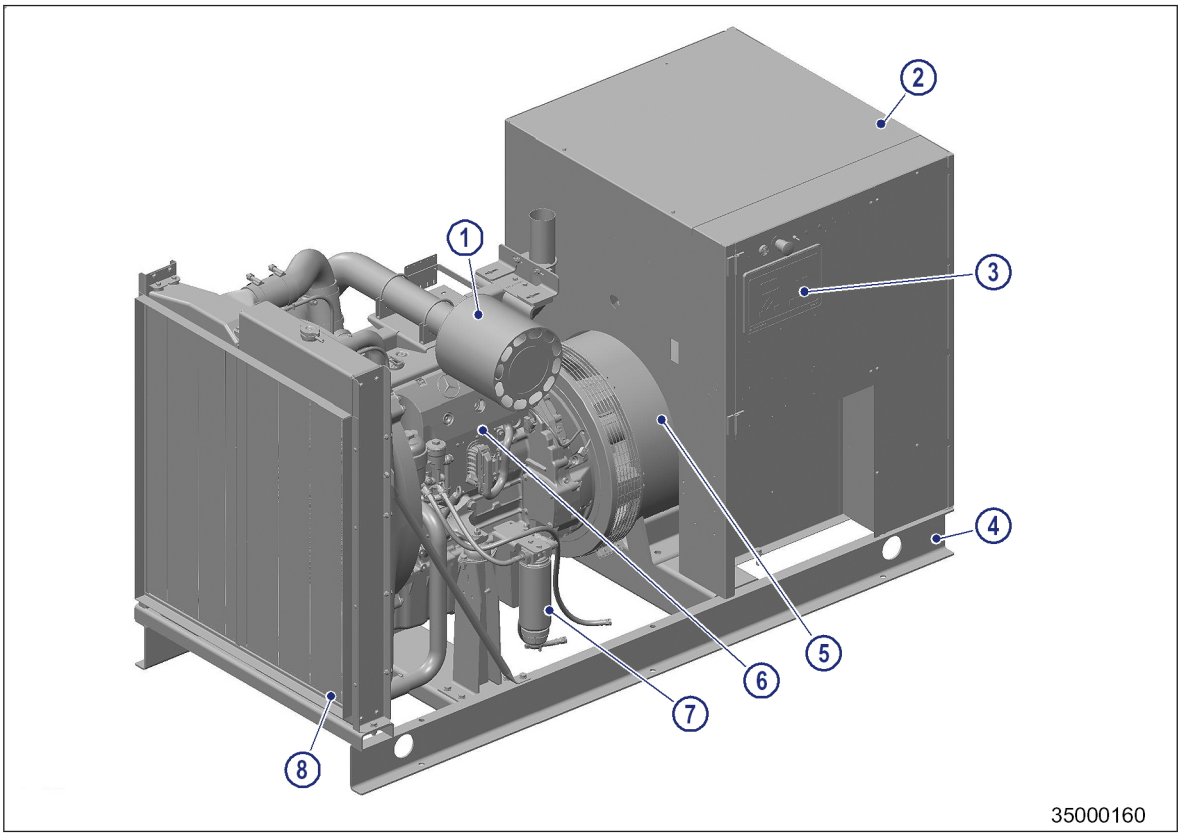

Figure 1: Engine-generator set with Mercedes-Benz OM924LA engine – Engine side

1 Air filter
2 Outlet box
3 Control panel
4 Base frame
5 Generator
6 Engine
7 Fuel prefilter with water separator
8 Unit-mounted radiator

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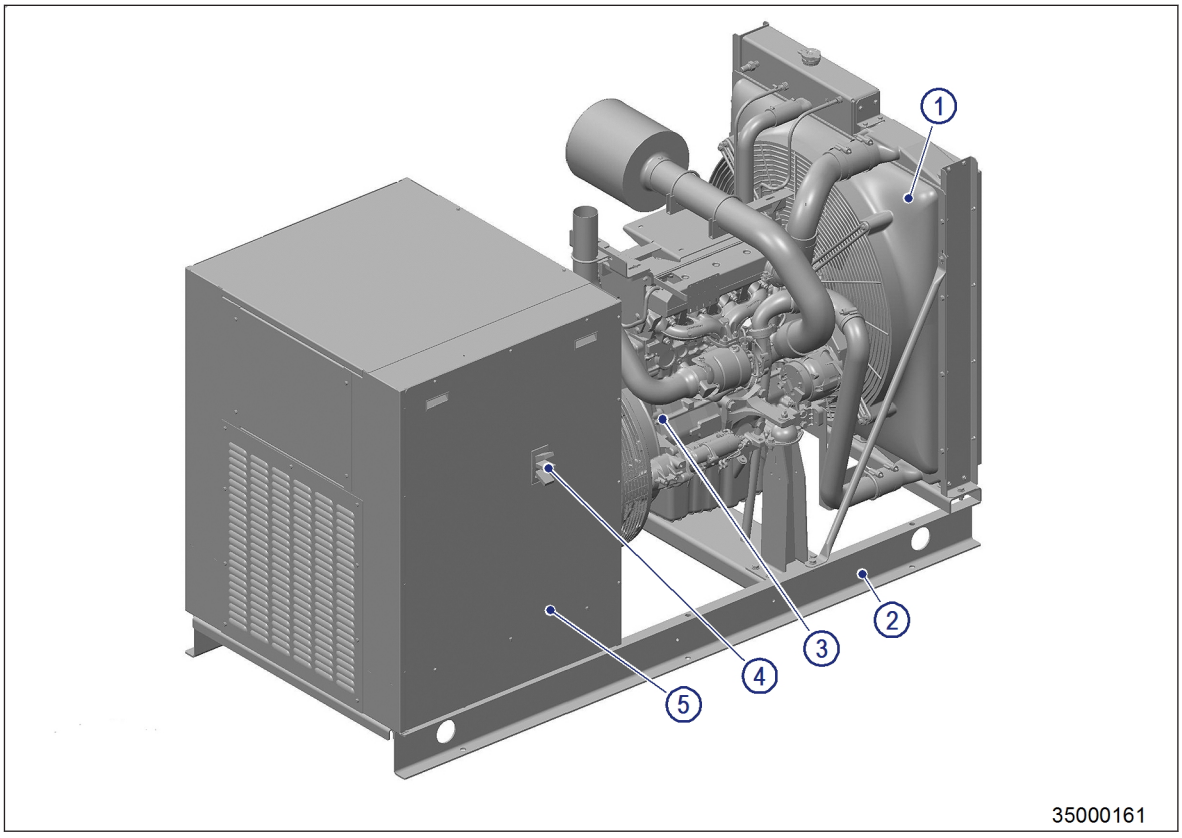

Figure 2: Engine-generator set with Mercedes-Benz OM924LA engine – Generator side

1 Unit-mounted radiator
2 Base frame
3 Engine
4 Circuit breaker
5 Outlet box

Standard scope of delivery

- Mercedes-Benz OM924LA engine, Mercedes-Benz OM926LA engine:
  - Rated speed 1,800 rpm (60 Hz), 1,500 rpm (50 Hz)
  - Electronic engine management system
  - 12 VDC Electric starter
- Generator:
  - Three measuring current transformers
  - Digital voltage regulator
- Control cabinet without control function
- Connections for fuel supply and return to the fuel tank
- Air filter
- Safety guards for all rotating parts
- Base frame with resilient mounts
- Radiator 50 °C
- Fuel prefilter with water separator

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Available options

- Sub base fuel tank
- Enclosure
- Jacket water heater -28.89 °C (-20 °F)
- Exhaust system – Open Power Unit (OPU)
  - Silencer (Industrial)
  - Silencer (Critical)
  - Silencer (Hospital)
- Charging/starting
  - Battery, rack, box, and cables
  - Battery charger
    - Guest 6 Amp
    - MicroGenius 6 Amp
    - MicroGenius 10 Amp
    - NRG 10 Amp
- Generator accessories:
  - Anti-condensation heater
  - Enhanced model of voltage regulator
- Generator temperature rise (60 Hz)
  - 80 °C (176 °F)
  - 105 °C (221 °F)
  - 130 °C (266 °F)
  - 150 °C (302 °F)
- Generator temperature rise (50 Hz)
  - 80 °C (176 °F)
  - 105 °C (221 °F)
  - 125 °C (257 °F)
  - 150 °C (302 °F)
- Single phase voltages (60 Hz)
  - 240 V, 4 wire
  - 240 V, 12 wire
- Three phase voltages (60 Hz)
  - 208 V
  - 240 V
  - 380 V
  - 480 V
  - 600 V
- Single phase voltages (50 Hz)
  - 220 V, 4 wire
  - 220 V, 12 wire
- Three phase voltages (50 Hz)
  - 220 V
  - 380 V
  - 400 V
  - 415 V
- Controller
  - MGC Series Digital Generator Set Controller
    - MGC-1500 Series
    - MGC-2000 Series
    - MGC-3000 Series
  - Contact Expansion Module (CEM)
  - Analog Expansion Module (AEM)
  - Remote annunciator
  - Safety override switch
  - Analog meter package
- Circuit breakers
  - 80% rated
  - 100% rated

TIM-ID: 0000061850 - 001

  - Electric trip
  - Up to two breakers
- Vibration isolation
  - Spring vibration isolation
  - Seismic spring isolation
- Literature
  - Quality/test documents
  - Prototype test report, test sheet

Technical data

- Application groups: 3D, standby power operation, fuel stop power, and 3B, prime power operation
- Mercedes-Benz OM924LA/OM926LA engine with:
  - 1,800 rpm (60 Hz), 1,500 rpm (50 Hz)
  - Charge-air cooling
- For engine-generator set dimensions, refer to the drawings.

For further technical data, refer to the Spec Sheet.

For an explanation of the model number classification, refer to the key code description(→ Page 49).

TIM-ID: 0000061850 - 001

4.4 Engine

4.4.1 Mercedes-Benz OM924LA/OM926LA Engines

Mercedes-Benz OM924LA/OM926LA engines with air-to-air charge-air cooling

These engines are compact, powerful, reliable, maintenance-friendly, and economical.

Their injection system unites optimum fuel utilization with compliance to the requirements of all relevant environmental protection regulations.

For more information about the engine, refer to the Mercedes-Benz engine manual (→ Page 277).

Technical data

- Four-stroke diesel engine with two intake valves and one exhaust valve per cylinder, direct injection
- Four or six cylinders, in-line arrangement
- Displacement:
  - Per cylinder = 1.2 liters (73 in^3)
  - Total for four cylinders = 4.8 liters (293 in^3)
  - Total for six cylinders = 7.2 liters (493 in^3)
- Counterclockwise rotation
- High-pressure fuel-injection system with centrally positioned injection nozzles
- Electronically controlled fuel injection
- Exhaust turbocharger and air-to-air charge-air cooling
- Engine cooling system with coolant circulation pump and thermostat
- Piston cooling
- Electric starter
- Resilient engine mounting
- Efficient internal oil cooler

Engine model designation

Key to the engine model designation	
OM	Oil engine (diesel)
9XX	Engine type
L	Intercooler
A	Exhaust gas turbocharger

Benefits

- Long service life
- High running capacity
- Low fuel consumption
- Engines meet all relevant exhaust emission standards

TIM-ID: 0000054005 - 001

4.5 Generator

4.5.1 Generator – General information

The electrical generator converts mechanical energy produced by the engine to electrical energy using electromagnetic induction.

Generators can differ from type to type in their appearance but not in their main functions. The figure (→ Figure 3) shows a typical generator with its components.

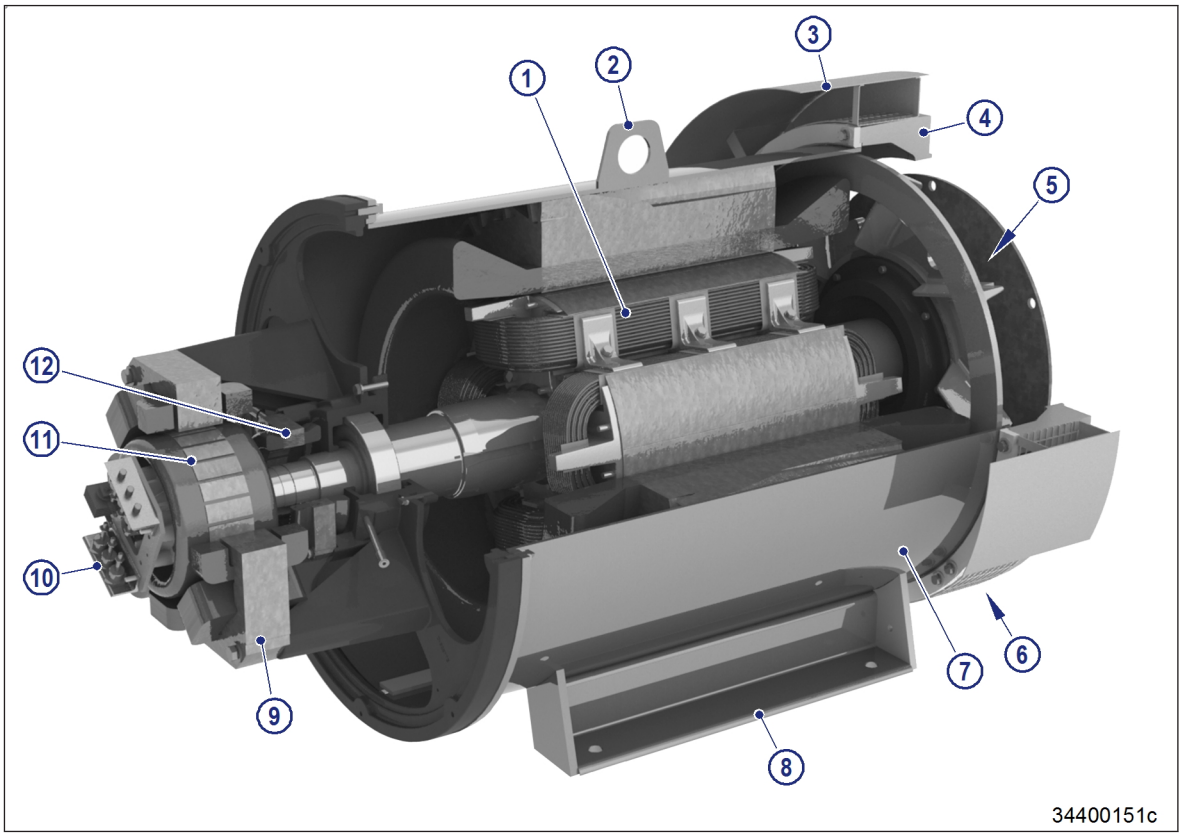


Figure 3: Generator interior view

1 Main rotor assembly
2 Generator lifting point
3 Drip cover
4 SAE adapter
5 Fan
6 Screen (air outlet)
7 Main body with main stator assembly
8 Mounting bracket
9 Exciter stator
10 Exciter rectifier assembly
11 Exciter rotor assembly
12 PMG rotor and stator

Note: Do not use the lifting points (2) to lift the entire engine-generator set.

Note: The PMG (12) may be optional, depending on the generator type.

Benefits

- Exclusive uni-rotor construction
- Superior class H insulation
- Long-life bearing
- Easy access and serviceability
- Extended life applications
- Robust voltage regulation in the presence of harmonic distortion caused by non-linear loads
- Low reactance design to minimize the harmonic voltage distortion caused by non-linear loads
- On-top-mounted outlet box to provide ample space for easy connection

TIM-ID: 0000057993 - 001

Function

The figure (→ Figure 3) shows the two main parts of a generator: the rotor (1) and the stator (in 7) which are integrated in the generator main body (7). An outlet box allows good load access from all sides.

This system supplies a minimum short circuit support current of 300% of rating for 60 Hz operation (250% for 50 Hz operation) for 10 seconds when the optional PMG is selected.

Controlling

The generator output voltage is controlled by a voltage regulator. For further information, see the description of the voltage regulator (→ Page 57).

Cooling

Generators are forced air-cooled. Air enters the lower part of the outlet box at the louvered cover. It passes through the stator and rotor coils and is exhausted as hot air at the adapter ring screened openings (6). The cast uni-directional aluminum alloy ventilation fan (5), driven by the main rotor (1), provides even air flow to maximize cooling of the generator.

Outlet box

The outlet box includes various equipment, such as a voltage regulator, CTs, and fuses. Load connections pass through cable grommets into the circuit breaker enclosure.

The figure (→ Figure 4) shows the interior of the outlet box, which can be equipped in slightly different variants.

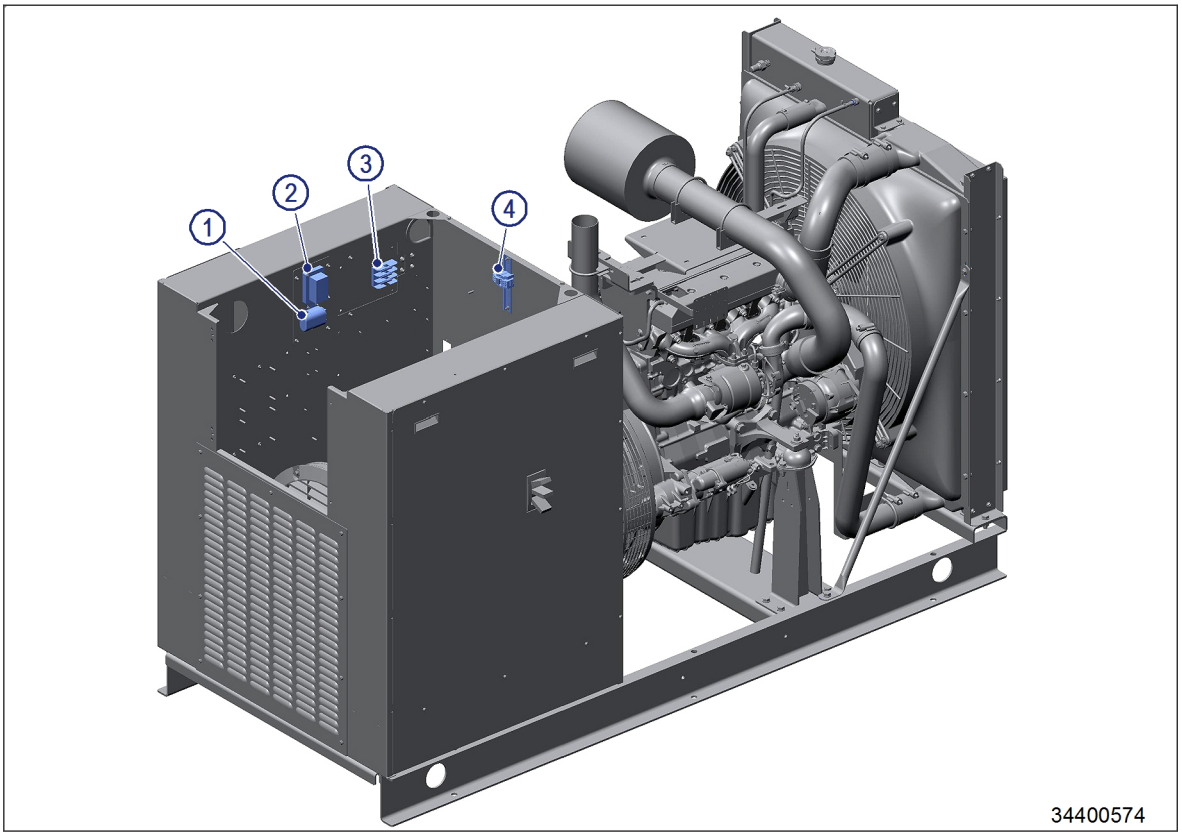


Figure 4: Generator outlet box

1 Capacitor (optional)
2 Voltage regulator (analog shown, digital optional)
3 Fuses
4 Terminal block

The mounted outlet box is shown without the cover to locate the equipment.

TIM-ID: 0000057993 - 001

The hinged control panel enables access to the voltage regulator. The adjusting points for the analog voltage regulator or the digital voltage regulator panel (if applicable) are handled from behind the control panel. The analog voltage regulator is a standard feature. The digital voltage regulator and the capacitor (1) are optional features. For further information, see the description of the voltage regulator (→ Page 57).

The current transformers (not shown in figure) are located on the cables that are connected to the studs on the link board. Fuses (3) are also located inside the outlet box.

Diodes perform the function of an "electrical check valve". They conduct in one direction only and are used to rectify AC current into DC current. Three forward polarity diodes and three reverse polarity diodes are used. The surge suppressor is polarized. Diodes and surge suppressor are located on the exciter rectifier assembly.

Technical data

- Single bearing generator of type:
  - MagnaPlus 360 frame
  - MagnaPlus 430 frame
- 1,800 rpm (60 Hz), 1,500 rpm (50 Hz)
- Voltage range: up to 600 V; 3-phase
- Windings with brushless exciter
- Meets NEMA MG 1 Part 32, BS 5000 and IEC 60034-1 requirements; CE marking provided
- UL recognized component and CSA certified; conforms to UL 1004-1 and CSA C22.2 No. 100

Identification number

Each model of a generator is characterized by an identification number composed of several sections. The identification number is defined by the technical specification of the model and located on the nameplate of the generator.

Exemplary composition of the identification number

433	Frame number
P	Construction: MagnaPlus
S	Bearing: Single (1 bearing)
L	Voltage: Up to 480 V
6216	Model in Series

Key to codes in generator identification numbers

Codes for Construction:	P – MagnaPlus (430 frame)
Codes for Bearing:	S – Single (1 bearing)
Codes for Voltage:	L – Up to 480 V S – 600 V
Codes for Model in Series:	Diverse types and codes

TIM-ID: 0000057993 - 001

4.5.2 Analog voltage regulator

The analog voltage regulator adjusts the generator output voltage by regulating the current into the exciter field. It is mounted behind the control panel inside the outlet box.

The figure (→ Figure 5) shows the location of the analog voltage regulator and its setting controls.

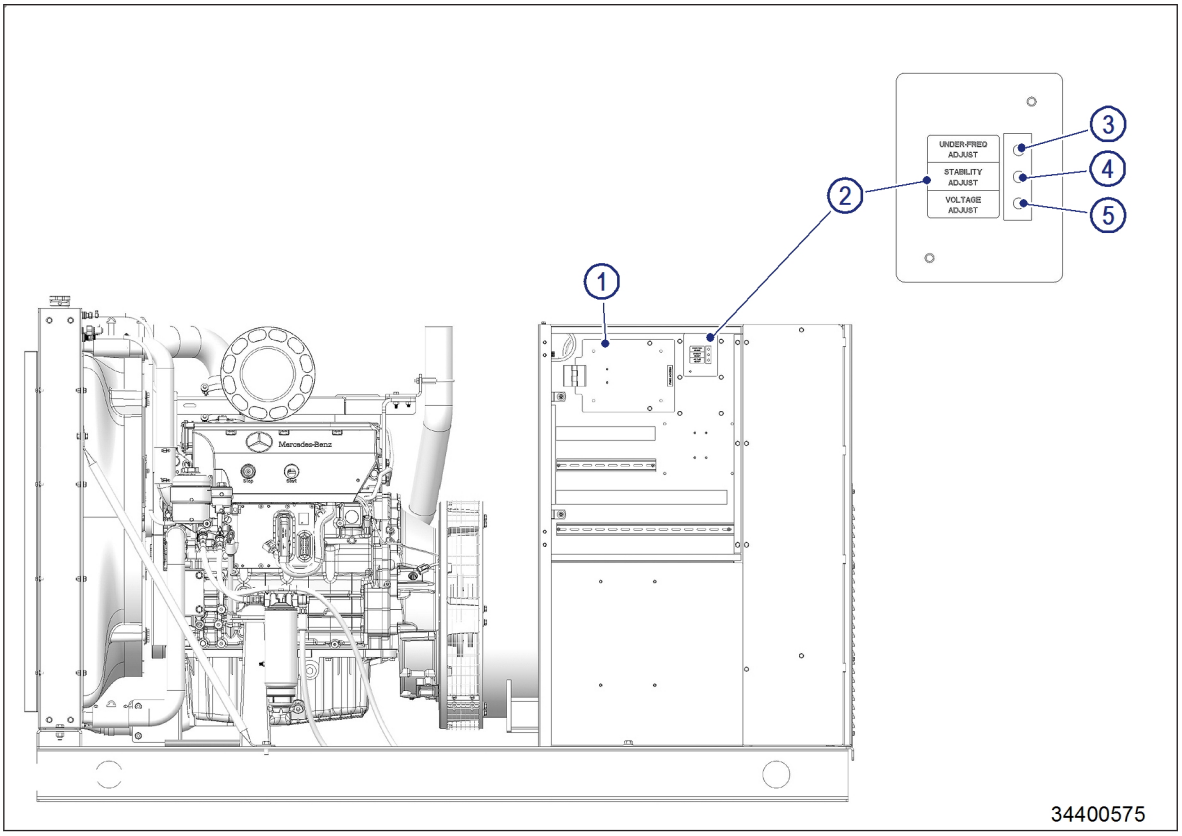


Figure 5: Analog voltage regulator (controls door removed for visibility)

1 Fuse access panel
2 Analog voltage regulator
3 Access point for underfrequency adjust
4 Access point for stability adjust
5 Access point for voltage adjust

Technical data

- Voltage regulation: 1% from no load to full load (with 5% frequency variation)
- Regulator drift: < 1% per 40 °C (72 °F) ambient temperature change
- Sensing and power input: 190 to 240 VAC
- 50 Hz or 60 Hz operation
- Overexcitation and underspeed protection
- Static-type using non-aging silicon controlled rectifiers
- Electromagnetic interference suppression to commercial standards with internal EMI filter
- Encapsulated design for humidity and abrasion protection

Function

In the standard configuration (shunt excited), the voltage regulator receives both its input power and voltage sensing from the generator's output terminals.

TIM-ID: 0000057994 - 001

At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter field resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

The requested frequency (50 Hz or 60 Hz) is set by means of a moveable jumper.

Voltage adjust

The screwdriver adjustable potentiometer labeled "VOLT" adjusts the generator output voltage.

- Adjustment clockwise increases the generator output voltage.
- Adjustment counterclockwise decreases the generator output voltage.

When using a remote voltage adjust rheostat, and if the jumper wire across terminals 6 and 7 is removed and a 2,000 Ω 0.5 W (minimum) rheostat is installed, a ±10% voltage variation from the nominal can be reached. By using a 1,000 Ω 0.5 W rheostat, a ±5% voltage variation is possible.

Stability adjust

The screwdriver adjustable potentiometer labeled "STAB" adjusts the system stability.

- Adjustment clockwise increases the stability and, therefore, increases the response time of the generator.
- Adjustment counterclockwise decreases the stability and, therefore, decreases the response time of the generator.

System stability is the ability of the generator to respond to load transients. Decreasing the stability makes the generator less sluggish and faster to respond to load transients. If the stability of the regulator is decreased too much, the generator will tend to hunt under steady state conditions.

V/Hz roll-off frequency selection

The roll-off point is the frequency where the generator voltage starts to decrease. This reduces the kilowatt load to the engine, which allows the engine to recover in speed under any load transient condition.

The screwdriver adjustable potentiometer labeled "U/F" sets the roll-off frequency from 54 to 61 Hz in the 60 Hz setting (45 to 51 Hz in the 50 Hz setting).

The analog voltage regulator has the roll-off point preset to:

- 58 Hz in the 60 Hz mode
- 48 Hz in the 50 Hz mode

To change the roll-off point:

1. Set the engine speed to the desired rated speed (50 Hz or 60 Hz).
2. Set the voltage to the desired setting at rated speed.
3. Set the engine speed to the desired roll-off point.
4. Adjust the potentiometer counterclockwise until the voltage starts to drop off.
5. Adjust the potentiometer clockwise until the voltage returns to rated voltage.
6. Reset engine speed to rated speed.

TIM-ID: 0000057994 - 001

4.5.3 Digital voltage regulator DVR2000E+

The digital voltage regulator is an encapsulated, microprocessor-based control device that regulates the output voltage of a brushless, AC generator by controlling the current into the generator exciter field. It is powered by a permanent magnet generator (PMG) and designed for behind-the-panel mounting.

All regulator adjustments are located on the front panel for easy use. The display annunciates regulator status and system conditions. Push buttons allow adjustment of the various regulator functions. Normally, the display is covered with a protection plate. The rear panel is accessible through a removable regulator panel located behind the hinged control panel in the outlet box.

The figure (→ Figure 6) shows the front panel and the rear panel of the digital voltage regulator.

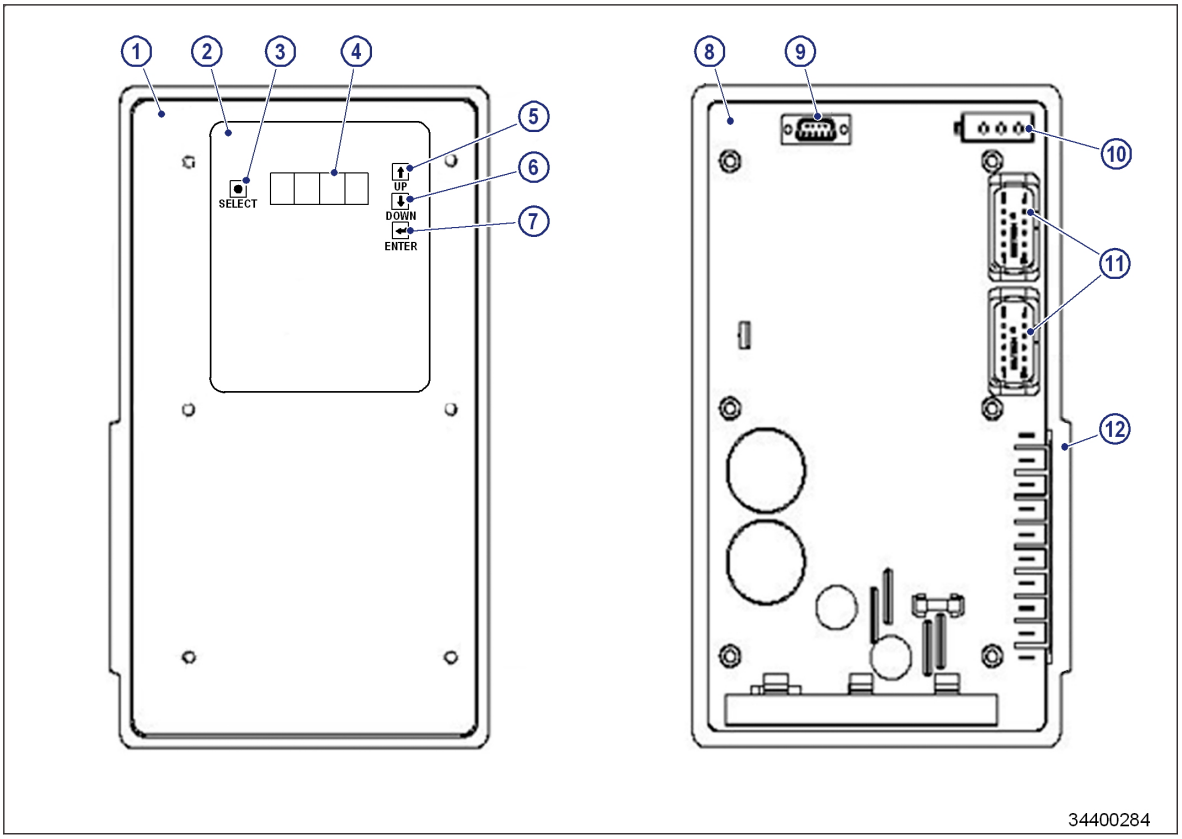


Figure 6: Digital voltage regulator panels

1 Front panel
2 Operating interface
3 SELECT button
4 Display
5 UP button
6 DOWN button
7 ENTER button
8 Rear panel
9 Serial port
10 CAN J1939 port
11 J1 and J2 connection points
12 Quick disconnect terminals

TIM-ID: 0000057995 - 001

Features

Operating features

- Voltage regulation to 0.25%
- Three regulation modes:
  - Single phase automatic voltage regulation (AVR1)
  - Three-phase automatic voltage regulation (AVR3)
  - Field current regulation (FCR)
- 50 or 60 Hz operation
- Preset stability settings
- Adjustable soft start in AVR1 or AVR3 regulation modes
- Underfrequency (volts/hertz) regulation
- Three-phase or single phase generator voltage (RMS) sensing
- Three-phase or single phase generator current (RMS) sensing
- True three-phase power metering
- Field current sensing
- Field voltage monitoring
- Contact inputs for system interface capability
- Contact output for fault indication
- Generator paralleling with reactive droop compensation and reactive differential compensation
- Front-panel human-machine interface (HMI) for status and configuration
- Modbus protocol via RS232 for external communication
- DVR2000E+ Windows ®-based software for configuration and monitoring
- Controller Area Network (CAN) interface with CAN 2.0B J1939 protocol for metering and control
- “Power on” LED indicator
- Configurable auxiliary input for metering and control
- CAN capability

Protection features

- Shutdown:
  - Field overexcitation shutdown
  - Generator overvoltage shutdown
  - Generator undervoltage shutdown
  - Generator voltage imbalance shutdown
  - Loss of generator sensing shutdown
  - Field current limiting shutdown
  - Regulator overtemperature shutdown
  - Instantaneous field overcurrent shutdown
- Alarm:
  - Generator underfrequency alarm
  - Generator reverse power flow alarm
  - Loss of CAN communication alarm

Front panel – Display and operation

The front panel of the digital voltage regulator consists of four push buttons and a 4-digit-display. The display gives out status conditions and failure messages. The push buttons were used to select adjustments during generator installation or service.

TIM-ID: 0000057995 - 001

The display works in three modes:

- STATUS mode
  The display shows the non-editable operating state of the digital voltage regulator.
  The display flashes while in STATUS mode.
- EDIT mode
  The display shows a multi-layer menu for reading and editing operating parameters of the digital voltage regulator.
  The display is steady-on while in EDIT mode.
- SLEEP mode
  The display is turned-off after a period of button-press inactivity.

Adjustments are chosen by means of the push buttons.

Panel push buttons

No. *	Button	Result
3	SELECT	Selects a function for adjustment. Successive pressing scrolls through the menu. Serves also as an escape key in EDIT mode.
5	UP	Increases the setting level of the function being adjusted in steps from the current value to a defined maximum.
6	DOWN	Decreases the setting level of the function being adjusted in steps from the current value to a defined minimum.
7	ENTER	Stores the current value of the parameter being adjusted and returns the user to the main menu list.
* Numbers correspond to (→ Figure 6).		

If regulator power is interrupted before the automatic save feature is commanded, that level of adjustment will be lost.

If no button is pressed for one minute, the regulator saves the settings and exits the adjustment mode.

Notes:

- To change settings, appropriate training by the user is required to avoid malfunctions!
- The engine-generator set must be running before conducting adjustments or settings must be adjusted while engine-generator set is operational.

Rear panel – Communication ports and terminals

Communication ports and terminals on the rear panel consists of four types of connectors:

- Ten quarter-inch, quick-connect terminals for generator connections
- Two 12-pin Deutsch (DTC style) connectors for current transformer (CTs) and system interface connections
- One 3-pin Amp/Tyco Mini Mate-N-Lok receptacle for CAN bus interface
- One 9-pin DB-9 type connector for serial communication between the digital voltage regulator and a Windows ® compatible PC (programming setup)

TIM-ID: 0000057995 - 001

Operating modes

The digital voltage regulator provides three modes of operation selectable through Windows ® or Palm OS ® communication software. Standard features are:

- Automatic voltage regulation mode – Single phase (AVR1)
  In AVR mode, the digital voltage regulator regulates the RMS generator output voltage. This is accomplished by sensing generator output voltage and adjusting DC output excitation current to maintain voltage at the regulation setpoint.
- Automatic voltage regulation mode – Three-phase (AVR3)
  In AVR mode, the digital voltage regulator regulates the RMS generator output voltage. This is accomplished by sensing generator output voltage and adjusting DC output excitation current to maintain voltage at the regulation setpoint.
- Manual mode (FCR)
  In manual mode, also known as field current regulation (FCR) mode, the digital voltage regulator maintains DC excitation current at a set level.

Digital voltage regulator communications software

DVR2000E+ is a Windows ®-based digital voltage regulator communication software package which is supplied with the digital voltage regulator.

The software provides a communication link between the digital voltage regulator and the user. The software enables the user to enter all digital voltage regulator settings and read all system metering values through an easy to use graphical interface.

For a detailed description of the DVR2000E+ software, contact your MTU Onsite Energy distributor or dealer.

Registered trademarks

Windows is a registered trademark of Microsoft Corporation.

Palm OS is a registered trademark of Palm, Inc.

TIM-ID: 0000057995 - 001

4.6 Engine-Generator Set MGC-1500 Series Control Panel

4.6.1 Control panel enclosure with MGC-1500 Series - General information

The control panel is the local control console and emergency control station for the engine-generator set. Its control and display elements provide status and alarm information and allow quick start/stop/emergency stop operations. The screen display is controlled by a key pad beneath the display panel. Command input for engine-generator set operation and alarm handling is provided by additional control keys on the display panel.

The control panel communication software allows units to be easily customized for each application.

Digital Generator Set Controller MGC-1500 Series

The MGC-1500 Series installed in MTU Onsite Energy engine-generator sets is a highly advanced, integrated engine-generator set control system. The MGC-1500 Series is perfectly focused, combining rugged construction and microprocessor technology to offer a product that holds up to almost any environment. The MGC-1500 is flexible enough to meet the needs of your application. This device provides engine-generator set control, metering, protection, and programmable logic in a simple, easy-to-use, reliable, and cost effective package.

A control panel with MGC-1500 Series is installed on engine-generator sets with management and monitoring in:

- Engine-generator set without mains, with standard generator protection
- Engine-generator set with third-party ATS, with enhanced generator protection

(→ Figure 7) shows the control panel enclosure with MGC-1500 Series.

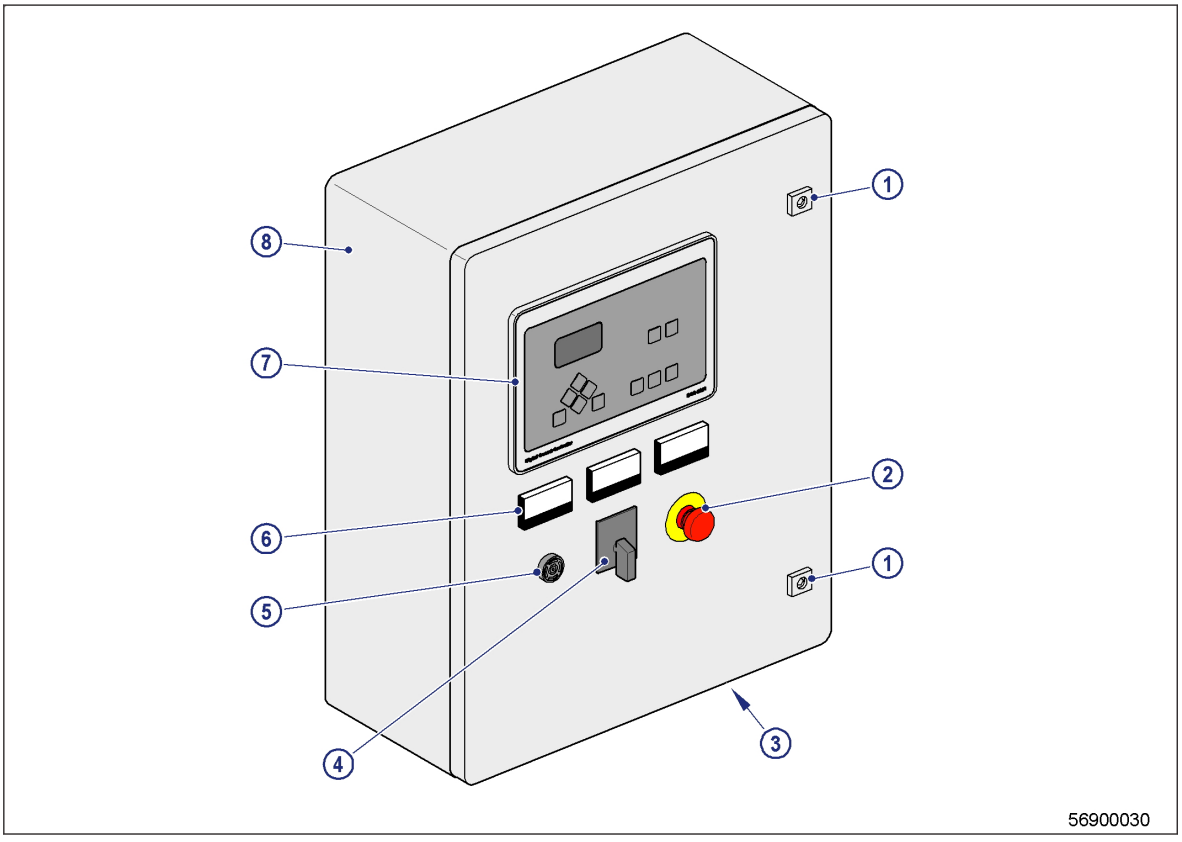


Figure 7: Control panel enclosure with MGC-1500 Series and meters – Exterior

1 Latch
2 Emergency stop button
3 Cable entries point
4 Phase selector switch (optional)
5 Audible alarm
6 Meters (optional)
7 Microprocessor MGC-1500 Series display (optional)
8 Control panel enclosure

TIM-ID: 0000054660 - 002

NOTE: (→ Figure 7) is a generic representation of the controller. The appearance of the front panel and enclosure varies depending on the controller type and engine-generator set. The location of enclosure buttons, switches, and other options may change but their functionality remains consistent.

The meters (6) show the present voltage and current per phase and the frequency. The phase selector switch (4) is used with the analog meters and has a position for each of the three phases. Turning the switch determines the phase. The values according to this phase are shown on the meters.

Features

- Engine metering and protection
- Emergency stop
- Current sensing (5 A CT inputs)
- System protection and supervision:
  - Under/Overvoltage
  - Under/Overfrequency
  - Overcurrent
  - Voltage phase imbalance
  - Loss of mains protection
  - Engine kW overload (three levels)
  - Bus under/overvoltage
  - Bus under/overfrequency
- 7 contact outputs:
  - Factory utilized: three 5 A at 28 VDC for Pre-start, Start, and Run and four 2 A at 28 VDC for general purpose
- 16 inputs
- Battery backup for Real Time Clock (RTC)
- LCD heater
- SAE J1939 CAN bus engine ECU communications
- Rugged, fully potted design
- Wide ambient temperature range
- UL/CSA approvals: cURus approved to UL 6200 and CSA C22.2 No. 14
- HALT (Highly Accelerated Life Tests) tested
- IP54 front panel rating with integrated gasket
- NFPA 110 level compliant
- Windows ®-based control panel communication software
  - Programming and setup software – intuitive and powerful
  - Programmable logic
  - USB communications
- Multilingual capability (English, Spanish, Chinese)
- Event recording

Accessories

- Contact expansion module for additional contact inputs and outputs

Contact expansion module (not available with all controllers)

The contact expansion module is programmed to display operating conditions (potential-free contacts):

TIM-ID: 0000054660 - 002

- Global (Pre-alarm)
- Global (Alarm)
- Not in AUTO
- Low fuel level (Pre-alarm)
- Fuel leak
- Low coolant level (Alarm)
- Low oil pressure (Pre-alarm)
- Low oil pressure (Alarm)
- High engine temperature (Pre-alarm)
- High engine temperature (Alarm)
- Low engine temperature (Pre-alarm)
- Engine running
- Overcrank (Alarm)
- Overspeed (Alarm)
- Battery overvoltage (Pre-alarm)
- Low battery voltage (Pre-alarm)
- Emergency system supplying load

The communications to the MGC-1500 Series takes place via CAN bus.

Functions

Engine-generator set protection

- Generator protection
  - Undervoltage
  - Overvoltage
  - Underfrequency
  - Overfrequency
  - Overcurrent
  - Phase imbalance
- Engine-generator set alarms, protected by MGC-1500 Series
  - Low oil pressure
  - Engine sender
  - Overcrank
  - Overspeed
  - Low coolant level
  - High coolant temperature
  - Fuel leak/fuel sender failure
  - Emergency stop
- Engine-generator set pre-alarms, protected by MGC-1500 Series
  - Low oil pressure
  - High coolant temperature
  - Low coolant temperature
  - Battery overvoltage
  - Battery charger failure
  - Weak battery voltage
  - Engine sender unit failure
  - Engine kW overload low (three levels)
  - Maintenance interval timer
  - Fuel leaks detect
  - Low fuel level
  - Low coolant level
  - High fuel level (optional)

TIM-ID: 0000054660 - 002

Engine-generator set metering

- Generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor (PF).
- Engine parameters include oil pressure, coolant temperature, RPM, battery voltage, fuel level, engine run-time, and various CAN bus supported parameters.

Engine control

- Cranking control: cycle or continuous (quantity and duration fully programmable)
- Engines cool-down: smart cool-down function saves time and fuel
- Successful starts counter: counts and records successful engine starts
- Timers:
  - Engine cool-down timer
  - Pre-alarm time delays for weak/low battery voltage
  - Alarm time delay for overspeed
  - Alarm time delay for sender failure
  - Continuous or cycle cranking time delay
  - Arming time delays after crank disconnect for:
    Low oil pressure
    High coolant temperature
  - Engine maintenance timer
  - Pre-crank delay
  - Programmable logic timer

Event recording

The MGC-1500 Series has an event recorder. The event recorder provides a record of alarms, pre-alarms, engine starts, engine runtime loaded, engine runtime unloaded, last run date, and many other events. These events are all date and time stamped to help the user determine the cause and effect of issues related to the engine-generator set. It contains 30 event records each retaining numerous occurrences in memory. Time, date and engine hour detail is available for the most current 30 occurrences within each event record.

Technical data

Operating power	Values
Nominal	12 or 24 V DC
Range	6 to 32 V DC
Power consumption in sleep mode	5 W with all relays non-energized
Power consumption in typical operation mode	6.5 W in RUN mode, with LCD heater off and three relays energized
Battery ride through	Withstands cranking ride-through down to 0 V for 50 ms (typical)

Environmental condition	Values	
Temperature	Operating:	-40 to 70 °C (-40 to 158 °F)
	Storage:	-40 to 85 °C (-40 to 185 °F)
Humidity	IEC 68-2-38	
Salt Fog	ASTM B 17-73 IEC 68-2-11 (tested while operational)	
Ingress Protection	IEC IP54 for front panel	
Shock	15 G in three perpendicular planes	

TIM-ID: 0000054660 - 002

Environmental condition	Values	
Vibration	5 to 29 to 5 Hz:	1.5 G peak for 5 min.
	29 to 52 to 29 Hz:	0.036" double amplitude for 2.5 min.
	52 to 500 to 52 Hz:	5 G peak for 7.5 min.
	Swept over these ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep	

Display operations

The front panel display is used to make settings changes and to display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions.

For further information to the main display operations, refer to (→ Page 68).

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

Registered trademark

Windows is a registered trademark of Microsoft Corporation.

TIM-ID: 0000054660 - 002

4.6.2 Control panel MGC-1500 Series – Display operations

Front panel display

The front panel display is used to change settings and display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions. The figure (→ Figure 8)shows the display of the MGC-1500 Series in detail.

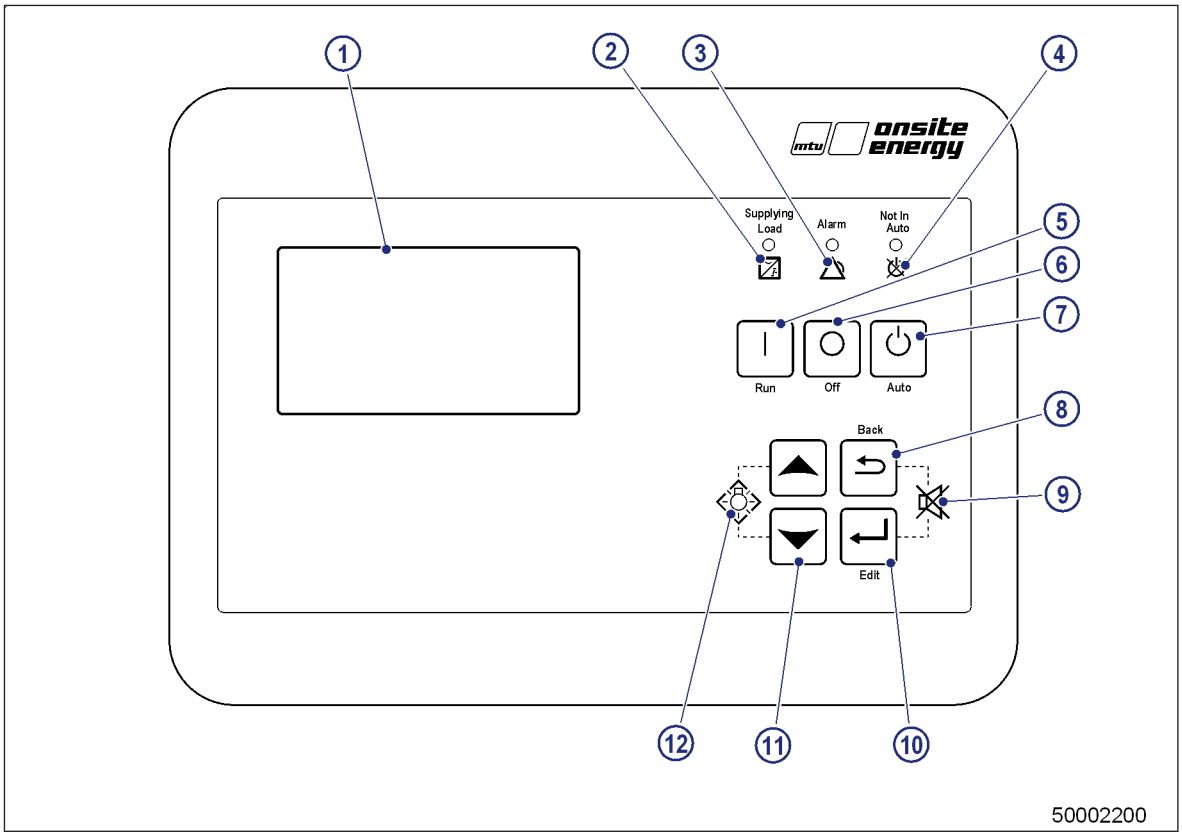


Figure 8: Control panel with MGC-1500 Series – Controls and indicators

1 Liquid Crystal Display (LCD)
2 Supplying load indicator
3 Alarm indicator
4 "Not in auto" indicator
5 RUN pushbutton and mode indicator
6 OFF pushbutton and mode indicator
7 AUTO pushbutton and mode indicator
8 Back pushbutton
9 Alarm silence pushbutton combination
10 EDIT pushbutton
11 Arrow pushbuttons
12 LAMP TEST pushbutton combination

Panel LED indicators

No.*	LED	Indication
2	Supplying Load	Green – Indicates the system is supplying current to a connected load.
3	Alarm	Red – Indicates an alarm situation by continuous illumination. Indicates a pre-alarm by flashing.
4	Not in Auto	Red – Indicates unit is not in the AUTO mode.
5	Run	Green – Indicates the MGC is in the RUN mode.
* Numbers correspond to (→ Figure 8).		

TIM-ID: 0000055005 - 002

No.*	LED	Indication
6	Off	Red – Indicates the MGC is in the OFF mode.
7	Auto	Green – Indicates the unit is in the AUTO mode of operation.
* Numbers correspond to (→ Figure 8).		

Panel pushbuttons

No.*	Pushbutton	Result
5	RUN	Places the MGC-1500 Series in RUN mode. The green LED lights when RUN mode is active.
6	OFF	Places the MGC-1500 Series in OFF mode. The red LED lights when OFF mode is active.
7	AUTO	Places the MGC-1500 Series in AUTO mode. The green LED lights when AUTO mode is active.
8	BACK	Cancels an editing session and discards any settings changed. When pressed, this pushbutton also resets the Breaker Management Pre-alarms.
9	ALARM SILENCE	Stops the currently occurring audible alarm.
10	EDIT	Starts an editing session and enables changes to MGC-1500 Series settings. At the conclusion of an editing session, the EDIT pushbutton is pressed again to save the setting chances.
11	(arrows)	Navigates through the front panel display menus and modifies settings. The left- and right-arrow pushbuttons are used to navigate through the menu levels. • The right-arrow pushbutton is pressed to move downward through the menu levels. • The left-arrow pushbutton is pressed to move upward. Within a level, the up- and down-arrow pushbuttons are used to move among items within the menu level. • Pressing the down-arrow pushbutton moves to items lower in the list. • Pressing the up-arrow pushbutton moves to items higher in the list. During an editing session, the up- and down-arrow pushbuttons are used to raise and lower the value of the selected setting.
12	LAMP TEST	Tests the MGC-1500 Series indicators by exercising all LCD pixels and lighting all LEDs.
* Numbers correspond to (→ Figure 8).		

Login/logout and permissions

Note: To change settings, appropriate user training is required to avoid malfunctions.

TIM-ID: 0000055005 - 002

1. To log in, navigate to the SETTINGS → ENTER PASSWORD screen and press the EDIT pushbutton.
2. Enter the password.
   - Use the up- and down-arrow pushbuttons to scroll through the characters.
   - Use the edit pushbutton to accept a character and move to the next space.
3. Press the EDIT pushbutton to log in.
   The LOGOUT selection now appears in the list of SETTINGS.
4. ... select your further operations ...
5. To log out, navigate to SETTINGS → LOGOUT and press the EDIT pushbutton.
   The LOGOUT selection is removed from the list of SETTINGS.

Summary screen

Note: To change settings, appropriate user training is required to avoid malfunctions.

The summary screen can be set to standard or scrolling.

Set the summary screen

1. Press the right arrow to select a standard or scrolling summary.
2. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
3. Press the EDIT pushbutton. Enter user ID and password as needed.
4. Edit the SUMMARY VIEW.
   The SCROLL DELAY setting is also found on the screen.

When set to standard, the following values are displayed:

VOLT*	AMP*	PH*	Hz	OIL	FUEL	TEMP	BATT

* Information for each phase is obtained by pressing the up- and down-arrow pushbuttons on the front panel.

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values scroll at a delay time specified by the user.

Select the scrolling values

1. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
2. Edit the CONFIGURABLE METERING.

The following values may be selected by the user to be placed in the scrolling summary:

NONE*	BATT V	GEN VAB	GEN VAN	KW A	KVA A	GEN Hz	GEN IA
BLANK**	RPM	GEN VBC	GEN VBN	KW B	KVA B	GEN PF	GEN IB
OIL P	RPM SRC	GEN VCA	GEN VCN	KW C	KVA C	BUS Hz	GEN IC
TEMP	FUEL	RUN HRS	KWH	KW TOT	KVA TOT	BUS V	

* Removes a line from the scrolling list.
** Shows nothing on this line.

Remote access

If communications access is active through the modem or USB, the front panel displays "REMOTE COMMS, FRONT PANEL IS READ ONLY" and the summary screen. This informs that the front panel can only be used for viewing metering data and settings information. Remote access must be ended before modifying settings through the front panel.

TIM-ID: 0000055005 - 002

Sleep mode

The sleep mode serves as a power-saving feature. A number of conditions must be met for the MGC-1500 Series to be in sleep mode. These conditions include being in OFF mode or AUTO mode not running. Also, if a pushbutton is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The MGC-1500 Series resumes normal display operation when any front panel pushbutton is pressed or the engine-generator set is started remotely via the ATS input.

The MGC-1500 Series will not go to sleep while in an alarm state. If needed, the sleep mode can be permanently disabled via the control panel communication software or the front panel menu.

As a default, the sleep mode is disabled at the factory, however, it can be reinitiated.

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

TIM-ID: 0000055005 - 002

4.6.3 Remote annunciator for MGC Series

The remote annunciator is used with the MGC Series (→ Page 63) to provide electrical signaling for the engine-generator set. The MGC Series detects alarm, pre-alarm, and operating conditions and communicates via Modbus communications with RS-485 to the remote annunciator.

The figure(→ Figure 9) shows the remote annunciator front panel.

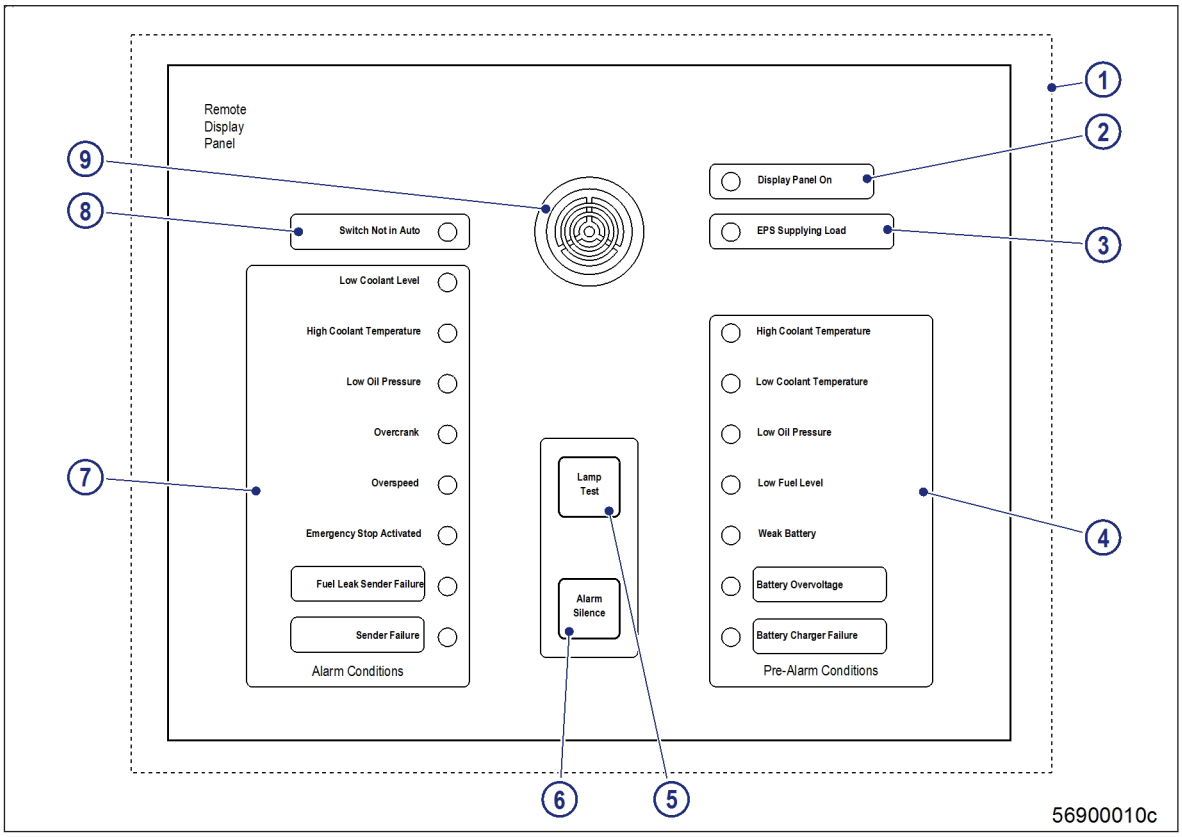


Figure 9: Remote annunciator for MGC Series – Front panel

1 Front panel *
2 LED "Power on"
3 LED "Supplying load"
4 LEDs for pre-alarms
5 LAMP TEST pushbutton
6 ALARM SILENCE pushbutton
7 LEDs for alarms
8 LED "Not in AUTO"
9 Audible alarm

* The dashed line indicates the outside edges when flush mounted. Otherwise, the full line denotes the edges.

Functions

The remote annunciator has 18 LEDs. These LEDs indicate alarms (7), pre-alarms (4), and operating conditions (2, 3, 8) of the engine-generator set as detected by the MGC Series.

If an alarm or pre-alarm is indicated, an audible alarm (9) sounds.

Panel LED indicators

No.*	LED	Indication
2	Display Panel On	Green – Indicates that power is applied to the remote annunciator.
3	EPS Supplying Load	Green – Indicates that the system is supplying more than two percent of rated current to a connected load.
Numbers correspond to the figure (→ Figure 9).		

TIM-ID: 0000055008 - 002

No.*	LED	Indication
4	Pre-alarm Conditions	Yellow – Indicates: • High coolant temperature • Low coolant Temperature • Low oil pressure • Low fuel level • Weak battery • Battery overvoltage • Battery charger failure
7	Alarm Conditions	Red – Indicates: • Low coolant level • High coolant temperature • Low oil pressure • Overcrank • Overspeed • Emergency stop activated • Fuel leak/Fuel sender failure • Sender failure
8	Switch Not in Auto	Red – Indicates that the unit is not in AUTO mode.
Numbers correspond to the figure (→ Figure 9).		

Panel pushbuttons

No.*	Pushbutton	Result
5	LAMP TEST	Tests the indicators by lighting all LEDs and exercises the audible alarm.
6	ALARM SILENCE	Stops the currently occurring audible alarm.
Numbers correspond to the figure (→ Figure 9).		

Benefits

- Monitoring main operating conditions and (pre-)alarms from a distance, for example from an office
- RS-485 communications
- Conduit box is included for easy installation
- Independent of environmental needs for operating the engine-generator set, the remote annunciator itself is designed for use in harsh environments

Technical data

- Power input from the starter batteries at 24 VDC or with an AC source at 120 VAC
- Port RS-485 interface
- Distance between annunciator and MGC Series: up to 1,200 m (4,000 ft)
- Meets the requirements of NFPA-110
- UL recognized, File E97035, and CSA certified, File LR23-23131
- Two mounting configurations: surface and flush mount

Environmental condition	Values
Operating temperature	-40 to 70 °C (-40 to 158 °F)
Storage temperature	-40 to 85 °C (-40 to 185 °F)
Salt Fog	Qualified to ASTM 117B-1989
Shock	15 G
Vibration	Withstands 2 G in each of three mutually perpendicular planes*
Sound	Alarm horn rated at 80 dB [from a distance of 60 cm (2 ft)]

TIM-ID: 0000055008 - 002

* Swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance

TIM-ID: 0000055008 - 002

4.7 Engine-Generator Set MGC-2000 Series Control Panel

4.7.1 Control panel enclosure with MGC-2000 Series - General information

The control panel is the local control console and emergency control station for the engine-generator set. Its control and display elements provide status and alarm information and allow quick start/stop/emergency stop operations. The screen display is controlled by a key pad beneath the display panel. Command input for engine-generator set operation and alarm handling is provided by additional control keys on the display panel.

The control panel communication software allows units to be easily customized for each application.

Digital Generator Set Controller MGC-2000 Series

The MGC-2000 Series installed in MTU Onsite Energy engine-generator sets is a highly advanced, integrated engine-generator set control system. The MGC-2000 Series is perfectly focused, combining rugged construction and microprocessor technology to offer a product that holds up to almost any environment. The MGC-2000 is flexible enough to meet the needs of your application. This device provides engine-generator set control, metering, protection, and programmable logic in a simple, easy-to-use, reliable, and cost effective package.

A control panel with MGC-2000 Series installed on engine-generator sets with management and monitoring in:

- Engine-generator set without mains, with standard generator protection
- Engine-generator set without mains, with enhanced generator protection
- Engine-generator set with third-party ATS, with enhanced generator protection

(→ Figure 10) shows the control panel enclosure with MGC-2000 Series.

TIM-ID: 0000055364 - 002

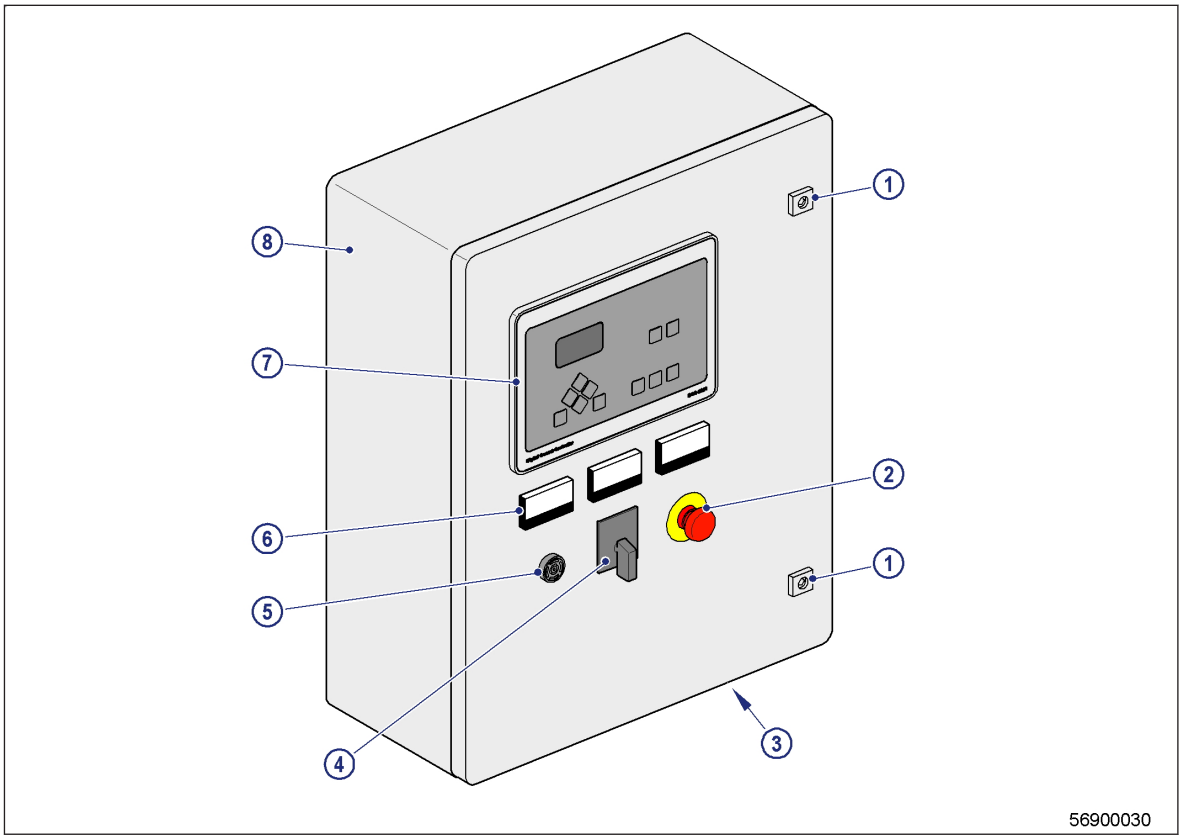


Figure 10: Control panel enclosure with MGC-2000 Series and meters – Exterior

1 Latch
2 Emergency stop button
3 Cable entries point
4 Phase selector switch (optional)
5 Audible alarm
6 Meters (optional)
7 Microprocessor MGC-2000 Series display (optional)
8 Control panel enclosure

NOTE: (→ Figure 10) is a generic representation of the controller. The appearance of the front panel and enclosure varies depending on the controller type and engine-generator set. The location of enclosure buttons, switches, and other options may change but their functionality remains consistent.

The meters (6) show the present voltage and current per phase and the frequency. The phase selector switch (4) is used with the analog meters and has a position for each of the three phases. Turning the switch determines the phase. The values according to this phase are shown on the meters.

TIM-ID: 0000055364 - 002

Features

- Engine metering and protection
- Emergency stop
- Current sensing (5 A CT inputs)
- System protection and supervision:
  - Under/Overvoltage
  - Under/Overfrequency
  - Overcurrent
  - Phase imbalance
  - Loss of mains protection
  - Loss of excitation
  - Reverse power
  - Engine kW overload
  - Bus under/overvoltage
  - Bus under/overfrequency
- 15 contact outputs:
  - Factory utilized: three 30 A DC and twelve 2 A DC rated contacts
  - User-defined: ten 2 A DC rated contacts
- 16 inputs
- Battery backup for Real Time Clock (RTC)
- LCD heater
- Modbus communications (via RS-485 communications port and Modbus RTU protocol)
- SAE J1939 CAN bus engine ECU communications
- Rugged, fully potted design
- Wide ambient temperature range
- UL/CSA approvals: cURus approved to UL 6200 and CSA C22.2 No. 14
- HALT (Highly Accelerated Life Tests) tested
- IP54 front panel rating with integrated gasket
- NFPA 110 level compatible
- Windows ®-based control panel communication software
  - Programming and setup software – intuitive and powerful
  - Programmable logic
  - USB communications
- Multilingual capability (English, Spanish, Chinese)
- Event recording

Accessories

- Analog expansion module for winding and bearing RTD (generator accessories)
- Contact expansion module for potential-free contacts

Analog expansion module

The analog expansion module is a remote auxiliary device that provides additional MGC-2000 Series analog inputs and outputs. Its features include:

- Eight RTD inputs (six for winding, one for bearing); for monitoring engine-generator set temperature (protect against high temperature conditions)
- Communications to the MGC-2000 Series via CAN bus

Contact expansion module

The contact expansion module is programmed to display operating conditions (potential-free contacts):

TIM-ID: 0000055364 - 002

- Global (Pre-alarm)
- Global (Alarm)
- Not in AUTO
- Low fuel level (Pre-alarm)
- Fuel leak
- Low coolant level (Alarm)
- Low oil pressure (Pre-alarm)
- Low oil pressure (Alarm)
- High engine temperature (Pre-alarm)
- High engine temperature (Alarm)
- Low engine temperature (Pre-alarm)
- Engine running
- Overcrank (Alarm)
- Overspeed (Alarm)
- Battery overvoltage (Pre-alarm)
- Low battery voltage (Pre-alarm)
- Emergency system supplying load

The communications to the MGC-2000 Series takes place via CAN bus.

TIM-ID: 0000055364 - 002

Functions

Engine-generator set protection

- Generator protection
  - Undervoltage
  - Overvoltage
  - Underfrequency
  - Overfrequency
  - Reverse power
  - Loss of excitation
  - Overcurrent
  - Phase imbalance (only available on MGC-2020 and MGC-2050)
  - Rate of change of frequency (only available on MGC-2020 and MGC-2050)
  - Vector shift (only available on MGC-2020 and MGC-2050)
- Engine-generator set alarms, protected by MGC-2000 Series
  - Low oil pressure
  - Engine sender unit failure
  - Overcrank
  - Overspeed
  - Low coolant level
  - High coolant temperature
  - Fuel leak/fuel sender failure
  - Emergency stop
- Engine-generator set pre-alarms, protected by MGC-2000 Series
  - Low oil pressure
  - High coolant temperature
  - Low coolant temperature
  - Battery overvoltage
  - Low battery voltage
  - Weak battery
  - Engine kW overload low
  - Maintenance interval timer
  - Low fuel level
  - High fuel level
  - AEM comms failure
  - Breaker open failure
  - CEM comms failure
  - Reverse rotation
  - Low coolant level
  - Active DTC
  - Breaker close failure
  - ECU comms failure
  - Checksum failure

Engine-generator set metering

- Generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor (PF).
- Engine parameters include oil pressure, coolant temperature, RPM, battery voltage, fuel level, engine run-time, ECU-specific parameters, and runtime statistics.

TIM-ID: 0000055364 - 002

Engine control

- Cranking control: cycle or continuous (quantity and duration fully programmable)
- Engines cool-down: smart cool-down function saves fuel and engine life
- Successful starts counter: counts and records successful engine starts
- Timers:
  - Engine cool-down timer
  - Pre-alarm time delays for weak/low battery voltage
  - Alarm time delay for overspeed
  - Alarm time delay for sender failure
  - Continuous or cycle cranking time delay
  - Arming time delays after crank disconnect for:
    Low oil pressure
    High coolant temperature
  - Engine maintenance timer
  - Pre-crank delay
  - Programmable logic timers

Event recording

The MGC-2000 Series has an event recorder. The event recorder provides a record of alarms, pre-alarms, engine starts, engine runtime loaded, engine runtime unloaded, last run date, and many other events. These events are all date and time-stamped to help the user determine the cause and effect of issues related to the engine-generator set. It contains 30 event records each retaining up to 99 occurrences in memory. Time, date and engine hour detail is available for the most current 30 occurrences within each event record.

Technical data

Operating power	Values
Nominal	12 or 24 V DC
Range	6 to 32 V DC
Power consumption in sleep mode	5 W with all relays non-energized
Power consumption in typical operation mode	7.9 W in RUN mode, with LCD heater off and six relays energized
Battery ride through	Withstands cranking ride-through down to 0 V for 50 ms (starting at 10 VDC)

Environmental condition	Values	
Temperature	Operating:	-40 to 70 °C (-40 to 158 °F)
	Storage:	-40 to 85 °C (-40 to 185 °F)
Humidity	IEC 68-2-38	
Salt Fog	ASTM B 17-73, IEC 68-2-11 (tested while operational)	
Ingress Protection	IEC IP54 for front panel	
Shock	15 G in three perpendicular planes	
Vibration	5 to 29 to 5 Hz:	1.5 G peak for 5 min.
	29 to 52 to 29 Hz:	0.036" double amplitude for 2.5 min.
	52 to 500 to 52 Hz:	5 G peak for 7.5 min.
	Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep	

TIM-ID: 0000055364 - 002

Display operations

The front panel display is used to make settings changes and to display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions.

For further information to the main display operations, refer to (→ Page 68).

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

Registered trademark

Windows is a registered trademark of Microsoft Corporation.

TIM-ID: 0000055364 - 002

4.7.2 Control panel MGC-2000 Series – Display operations

Front panel display

The front panel display is used to make settings changes and display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions. The figure (→ Figure 11)shows the display of the MGC-2000 Series in detail.

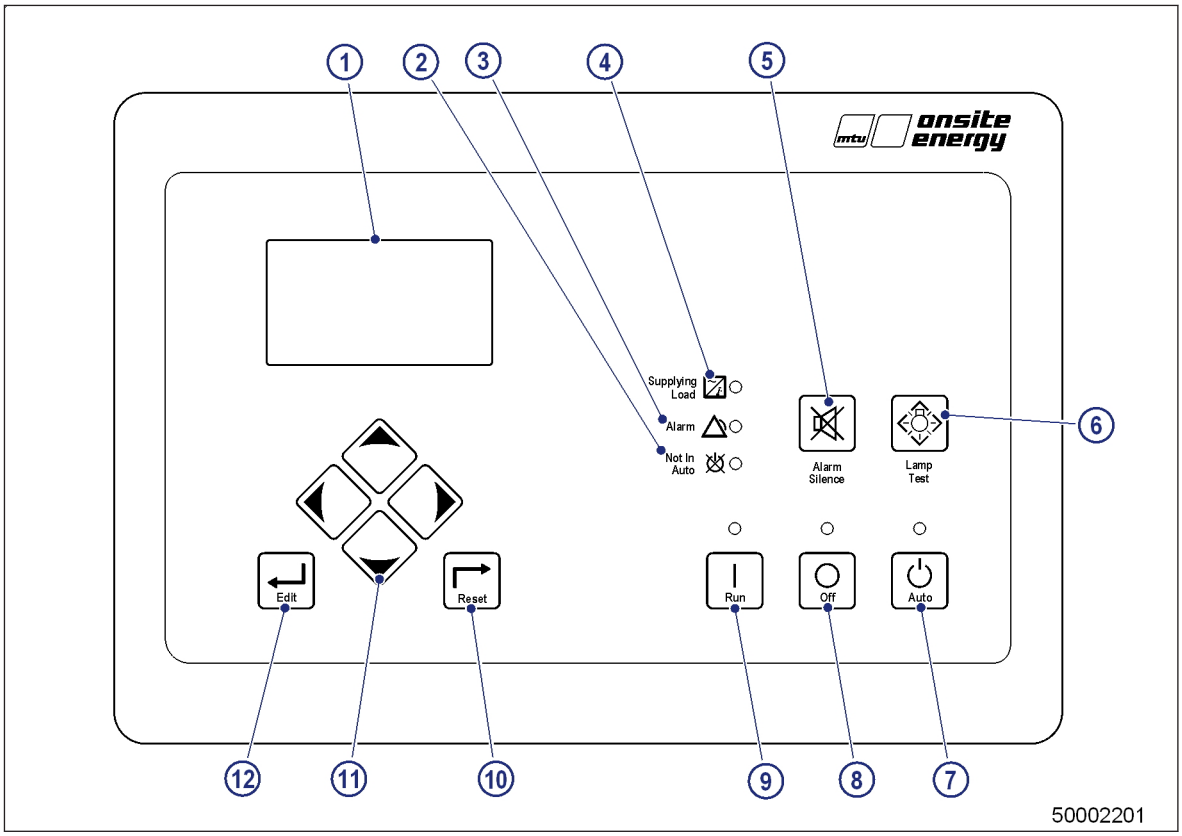


Figure 11: Control panel with MGC-2000 Series – Controls and indicators

1 Liquid Crystal Display (LCD)
2 "Not in auto" indicator
3 Alarm indicator
4 Supplying load indicator
5 Alarm Silence pushbutton
6 LAMP TEST pushbutton
7 AUTO pushbutton and mode indicator
8 OFF pushbutton and mode indicator
9 RUN pushbutton and mode indicator
10 RESET pushbutton
11 Arrow pushbuttons
12 EDIT pushbutton

Panel LED indicators

No.*	LED	Indication
2	Not in auto	Red – Indicates unit is not in the AUTO mode.
3	Alarm	Red – Indicates an alarm situation by continuous illumination. Indicates a pre-alarm by flashing.
4	Supplying Load	Green – Indicates the system is supplying current to a connected load.
7	Auto	Green – Indicates the unit is in the AUTO mode of operation.
8	Off	Red – Indicates the MGC is in the OFF mode.
9	Run	Green – Indicates the MGC is in the RUN mode.
* Numbers correspond to (→ Figure 11).		

TIM-ID: 0000055544 - 002

Panel pushbuttons

No.*	Pushbutton	Result
5	ALARM SILENCE	Stops the currently occurring audible alarm.
6	LAMP TEST	Tests the MGC-2000 Series indicators by exercising all LCD pixels and lighting all LEDs.
7	AUTO	Places the MGC-2000 Series in AUTO mode. The green LED lights when AUTO mode is active.
8	OFF	Places the MGC-2000 Series in OFF mode. The red LED lights when OFF mode is active.
9	RUN	Places the MGC-2000 Series in RUN mode. The green LED lights when RUN mode is active.
10	RESET	Cancels an editing session and discards any settings changed. When pressed, this pushbutton also resets the Breaker Management Pre-alarms.
11	(arrows)	Navigates through the front panel display menus and modifies settings. The left- and right-arrow pushbuttons are used to navigate through the menu levels. • The right-arrow pushbutton is pressed to move downward through the menu levels. • The left-arrow pushbutton is pressed to move upward. Within a level, the up-and down-arrow buttons are used to move among items within the menu level. • Pressing the down-arrow pushbutton moves to items lower in the list. • Pressing the up-arrow pushbutton moves to items higher in the list. During an editing session, the up- and down-arrow pushbuttons are used to raise and lower the value of the selected setting.
12	EDIT	Starts an editing session and enables changes to MGC-2000 Series settings. At the conclusion of an editing session, the EDIT pushbutton is pressed again to save the setting chances.
* Numbers correspond to (→ Figure 11).		

Login/logout and permissions

Note: To change settings, appropriate user training is required to avoid malfunctions.

1. To log in, navigate to the SETTINGS → ENTER PASSWORD screen and press the EDIT pushbutton.
2. Enter the password.
   - Use the up- and down-arrow pushbuttons to scroll through the characters.
   - Use the left- and right-arrow pushbuttons to enter more characters.
3. Press the EDIT pushbutton to log in.
   The LOGOUT selection now appears in the list of SETTINGS.
4. ... select your further operations ...
5. To log out, navigate to SETTINGS → LOGOUT and press the EDIT pushbutton.
   The LOGOUT selection is removed from the list of SETTINGS.

Summary screen

Note: To change settings, appropriate user training is required to avoid malfunctions.

TIM-ID: 0000055544 - 002

The summary screen can be set to standard or scrolling.

Set the summary screen

1. Press the right arrow to select a standard or scrolling summary.
2. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
3. Press the EDIT pushbutton. Enter user ID and password as needed.
4. Edit the SUMMARY VIEW.
   The SCROLL DELAY setting is also found on the screen.

When set to standard, the following values are displayed:

VOLT*	AMP*	PH*	Hz	OIL	FUEL	TEMP	BATT

* Information for each phase is obtained by pressing the up- and down-arrow pushbuttons on the front panel.

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values scroll at a delay time specified by the user.

Select the scrolling values

1. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
2. Edit the CONFIGURABLE METERING.

The following values may be selected by the user to be placed in the scrolling summary:

NONE*	BATT V	GEN VAB	GEN VAN	KW A	KVA A	GEN Hz	GEN IA
BLANK**	RPM	GEN VBC	GEN VBN	KW B	KVA B	GEN PF	GEN IB
OIL P	RPM SRC	GEN VCA	GEN VCN	KW C	KVA C	BUS Hz	GEN IC
TEMP	FUEL	RUN HRS	KWH	KW TOT	KVA TOT	BUS V	FUEL DELV P
kvar A	kvar B	kvar C	kvar TOTAL	INJ RAIL PRS	TOTAL FUEL USED	FUEL TEMP	ENG OIL TEMP
ENG INTCLR TEMP	COOLANT PRESS	FUEL RATE	BOOST PRESS	INTAKE MNFLD TMP			

* Removes a line from the scrolling list.
** Shows nothing on this line.

Remote access

If communications access is active through the modem or USB, the front panel displays "REMOTE COMMS, FRONT PANEL IS READ ONLY" and the summary screen. This informs that the front panel can only be used for viewing metering data and settings information. Remote access must be ended before modifying settings through the front panel.

Sleep mode

The sleep mode serves as a power-saving feature. A number of conditions must be met for the MGC-2000 Series to be in sleep mode. These conditions include being in OFF mode or AUTO mode not running. Also, if a pushbutton is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The MGC-2000 Series resumes normal display operation when any front panel pushbutton is pressed or the engine-generator set is started remotely via the ATS input.

The MGC-2000 Series will not go to sleep while in an alarm state. If needed, the sleep mode can be permanently disabled via the control panel communication software or the front panel menu.

As a default, the sleep mode is disabled at the factory, however, it can be reinitiated.

TIM-ID: 0000055544 - 002

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

TIM-ID: 0000055544 - 002

4.7.3 Remote annunciator for MGC Series

The remote annunciator is used with the MGC Series (→ Page 63) to provide electrical signaling for the engine-generator set. The MGC Series detects alarm, pre-alarm, and operating conditions and communicates via Modbus communications with RS-485 to the remote annunciator.

The figure(→ Figure 12) shows the remote annunciator front panel.

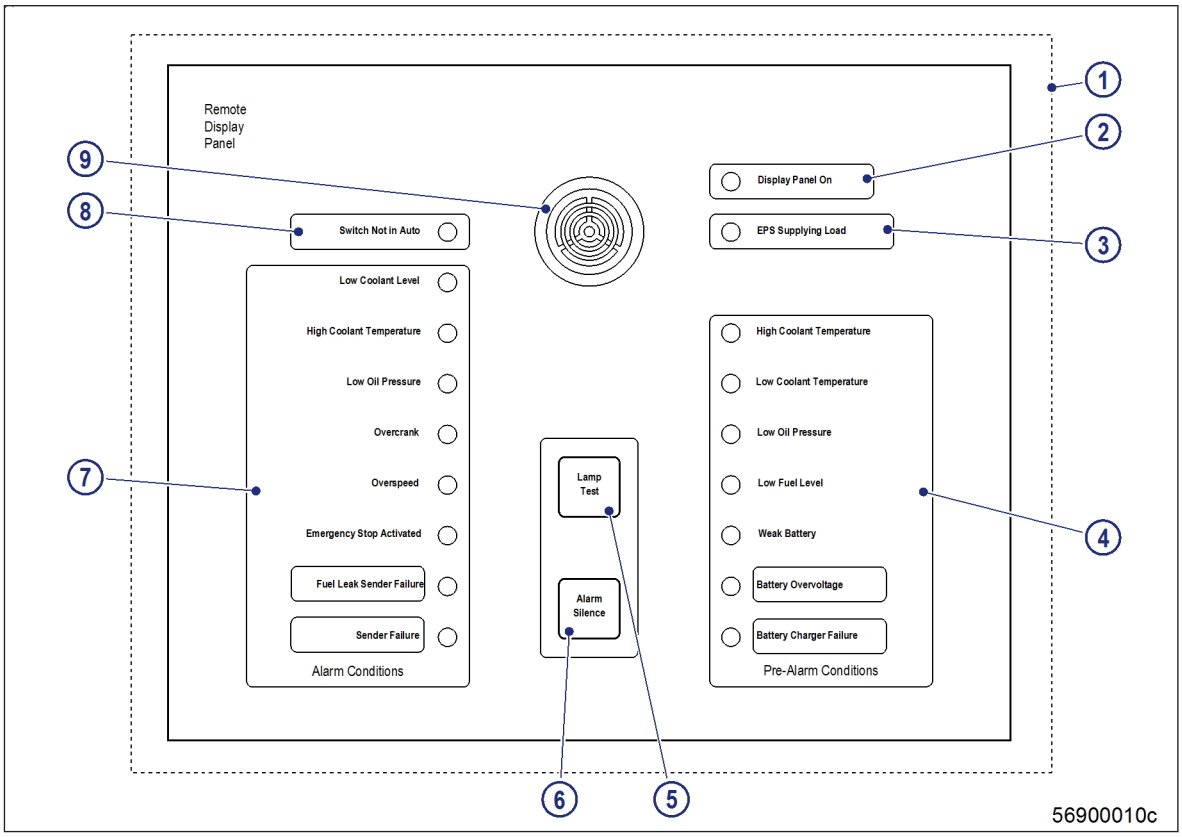


Figure 12: Remote annunciator for MGC Series – Front panel

1 Front panel *
2 LED "Power on"
3 LED "Supplying load"
4 LEDs for pre-alarms
5 LAMP TEST pushbutton
6 ALARM SILENCE pushbutton
7 LEDs for alarms
8 LED "Not in AUTO"
9 Audible alarm

* The dashed line indicates the outside edges when flush mounted. Otherwise, the full line denotes the edges.

Functions

The remote annunciator has 18 LEDs. These LEDs indicate alarms (7), pre-alarms (4), and operating conditions (2, 3, 8) of the engine-generator set as detected by the MGC Series.

If an alarm or pre-alarm is indicated, an audible alarm (9) sounds.

Panel LED indicators

No.*	LED	Indication
2	Display Panel On	Green – Indicates that power is applied to the remote annunciator.
3	EPS Supplying Load	Green – Indicates that the system is supplying more than two percent of rated current to a connected load.
Numbers correspond to the figure (→ Figure 12).		

TIM-ID: 0000055008 - 002

No.*	LED	Indication
4	Pre-alarm Conditions	Yellow – Indicates: • High coolant temperature • Low coolant Temperature • Low oil pressure • Low fuel level • Weak battery • Battery overvoltage • Battery charger failure
7	Alarm Conditions	Red – Indicates: • Low coolant level • High coolant temperature • Low oil pressure • Overcrank • Overspeed • Emergency stop activated • Fuel leak/Fuel sender failure • Sender failure
8	Switch Not in Auto	Red – Indicates that the unit is not in AUTO mode.
Numbers correspond to the figure (→ Figure 12).		

Panel pushbuttons

No.*	Pushbutton	Result
5	LAMP TEST	Tests the indicators by lighting all LEDs and exercises the audible alarm.
6	ALARM SILENCE	Stops the currently occurring audible alarm.
Numbers correspond to the figure (→ Figure 12).		

Benefits

- Monitoring main operating conditions and (pre-)alarms from a distance, for example from an office
- RS-485 communications
- Conduit box is included for easy installation
- Independent of environmental needs for operating the engine-generator set, the remote annunciator itself is designed for use in harsh environments

Technical data

- Power input from the starter batteries at 24 VDC or with an AC source at 120 VAC
- Port RS-485 interface
- Distance between annunciator and MGC Series: up to 1,200 m (4,000 ft)
- Meets the requirements of NFPA-110
- UL recognized, File E97035, and CSA certified, File LR23-23131
- Two mounting configurations: surface and flush mount

Environmental condition	Values
Operating temperature	-40 to 70 °C (-40 to 158 °F)
Storage temperature	-40 to 85 °C (-40 to 185 °F)
Salt Fog	Qualified to ASTM 117B-1989
Shock	15 G
Vibration	Withstands 2 G in each of three mutually perpendicular planes*
Sound	Alarm horn rated at 80 dB [from a distance of 60 cm (2 ft)]

TIM-ID: 0000055008 - 002

* Swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance

TIM-ID: 0000055008 - 002

4.8 Engine-Generator Set MGC-3000 Series Control Panel

4.8.1 Control panel enclosure with MGC-3000 Series - General information

The control panel is the local control console and emergency control station for the engine-generator set. Its control and display elements provide status and alarm information and allow quick start/stop/emergency stop operations. The screen display is controlled by a key pad beneath the display panel. Command input for engine-generator set operation and alarm handling is provided by additional control keys on the display panel.

The control panel communication software allows units to be easily customized for each application.

Digital Generator Set Controller MGC-3000 Series

The MGC-3000 Series installed in MTU Onsite Energy engine-generator sets is a highly advanced, integrated engine-generator set control system. The MGC-3000 Series is perfectly focused, combining rugged construction and microprocessor technology to offer a product that holds up to almost any environment. The MGC-3000 is flexible enough to meet the needs of your application. This device provides engine-generator set control, metering, protection, and programmable logic in a simple, easy-to-use, reliable, and cost-effective package.

A control panel with MGC-3000 Series is installed on engine-generator sets with management and monitoring in:

- Engine-generator set without mains, with standard generator protection
- Engine-generator set without mains, with enhanced generator protection
- Engine-generator set with third-party ATS, with enhanced generator protection
- Engine-generator set with electrical interlock circuit breakers, with enhanced generator protection
- Engine-generator set in parallel operation (island mode), with enhanced generator protection and automatic synchronizer

(→ Figure 13) shows the control panel enclosure with MGC-3000 Series.

TIM-ID: 0000055546 - 002

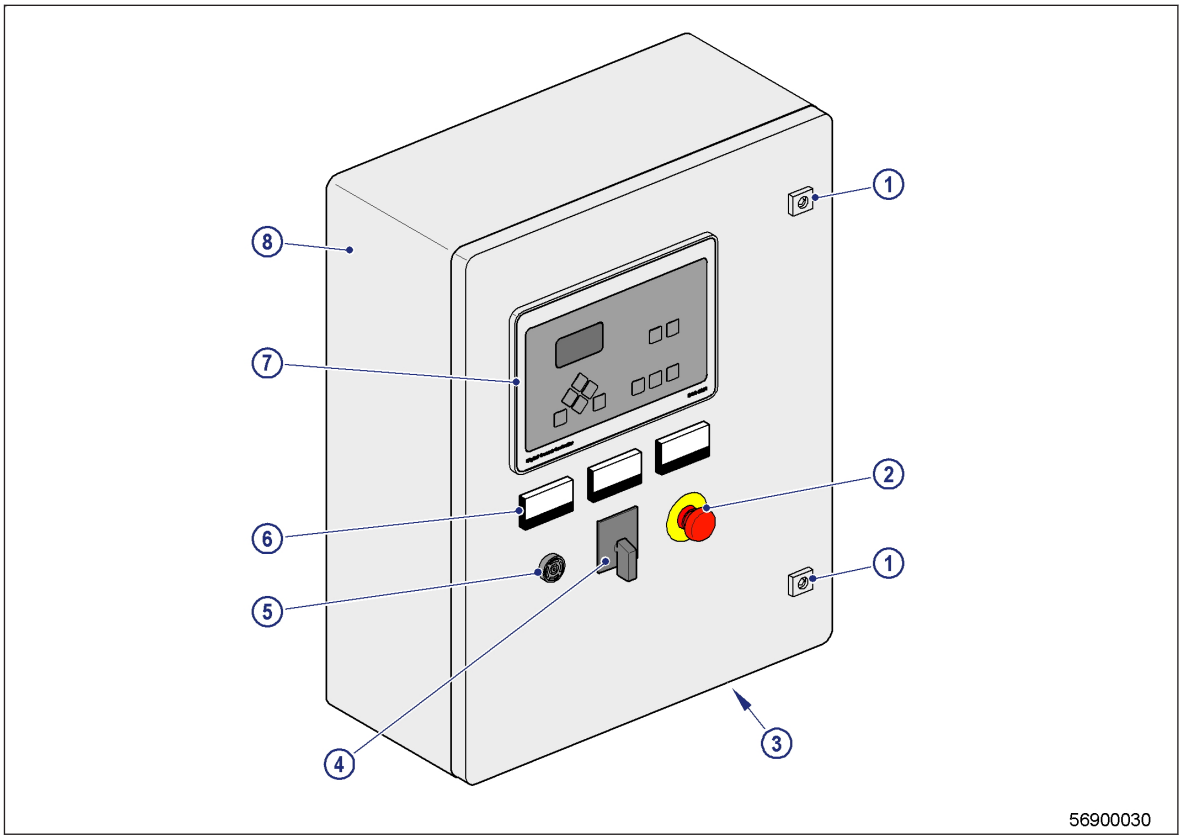


Figure 13: Control panel enclosure with MGC-3000 Series and meters – Exterior

1 Latch
2 Emergency stop button
3 Cable entries point
4 Phase selector switch (optional)
5 Audible alarm
6 Meters (optional)
7 Microprocessor MGC-3000 Series display (optional)
8 Control panel enclosure

NOTE: (→ Figure 13) is a generic representation of the controller. The appearance of the front panel and enclosure varies depending on the controller type and engine-generator set. The location of enclosure buttons, switches, and other options may change, but their functionality remains consistent.

The meters (6) show the present voltage and current per phase and the frequency. The phase selector switch (4) is used with the analog meters and has a position for each of the three phases. Turning the switch determines the phase. The values according to this phase are shown on the meters.

TIM-ID: 0000055546 - 002

Features

- Engine metering and protection
- Emergency stop
- Current sensing (5 A CT inputs)
- System protection and supervision:
  - Under/Overvoltage
  - Under/Overfrequency
  - Overcurrent
  - Phase imbalance
  - Loss of mains protection (optional)
  - Loss of excitation
  - Reverse power
  - Engine kW overload (three levels)
  - Bus under/overvoltage
  - Bus under/overfrequency
- 17 contact outputs:
  - Factory utilized: three 30 A DC and twelve 2 A DC rated contacts
  - User-defined: ten 2 A DC rated contacts
- 16 inputs
- Battery backup for Real Time Clock (RTC)
- LCD heater
- Modbus communications (via RS-485 communications port and Modbus RTU protocol)
- SAE J1939 CAN bus engine ECU communications
- Rugged, fully encapsulated design
- Wide ambient temperature range
- UL/CSA approvals: cURus approved to UL 6200 and CSA C22.2 No. 14
- HALT (Highly Accelerated Life Tests) tested
- NFPA 110 level compatible
- Windows ®-based control panel communication software
  - Programming and setup software – intuitive and powerful
  - Programmable logic
  - USB communications
- Multilingual capability (English, Spanish, Chinese)
- Event recording

Accessories

- Analog expansion module for winding and bearing RTD (generator accessories)
- Contact expansion module for potential-free contacts
- Automatic synchronizer for engine-generator set in parallel operations

Analog expansion module

The analog expansion module is a remote auxiliary device that provides additional MGC-3000 Series analog inputs and outputs. Its features include:

- Eight RTD inputs (six for winding, one for bearing); for monitoring engine-generator set temperature (protect against high temperature conditions)
- Communications to the MGC-3000 Series via CAN bus

Contact expansion module

The contact expansion module is programmed to display operating conditions (potential-free contacts):

TIM-ID: 0000055546 - 002

- Global (Pre-alarm)
- Global (Alarm)
- Not in AUTO
- Low fuel level (Pre-alarm)
- Fuel leak
- Low coolant level (Alarm)
- Low oil pressure (Pre-alarm)
- Low oil pressure (Alarm)
- High engine temperature (Pre-alarm)
- High engine temperature (Alarm)
- Low engine temperature (Pre-alarm)
- Engine running
- Overcrank (Alarm)
- Overspeed (Alarm)
- Battery overvoltage (Pre-alarm)
- Low battery voltage (Pre-alarm)
- Emergency system supplying load

The communications to the MGC-3000 Series takes place via CAN bus.

Automatic synchronizer

When the MGC-3000 Series is configured with this option, it can be selected between two types of auto-synchronizers: phase lock or anticipatory style.

In both methods, the MGC-3000 Series adjusts generator frequency and voltage to match that of the bus (mains) via analog outputs. Then, the MGC-3000 connects the generator to the bus by closing the connecting breaker.

TIM-ID: 0000055546 - 002

Functions

Engine-generator set protection

- Generator protection
  - Undervoltage
  - Overvoltage
  - Underfrequency
  - Overfrequency
  - Reverse power
  - Loss of excitation
  - Overcurrent
  - Phase voltage imbalance
  - Rate of change of frequency
  - Vector shift
- Engine-generator set alarms
  - Low oil pressure
  - Engine sender unit failure
  - Battery charger failure
  - Overspeed
  - Low coolant level
  - High coolant temperature
  - Low fuel level
  - Fuel leak/fuel sender failure
  - Emergency stop
- Engine-generator set pre-alarms
  - Low oil pressure
  - High coolant temperature
  - Low coolant temperature
  - Battery overvoltage
  - Battery charger failure
  - Weak battery
  - Engine sender unit failure
  - Engine kW overload (three levels)
  - Maintenance interval timer
  - Fuel leaks detect
  - Low fuel level
  - High fuel level (optional)
  - Low coolant level
  - AEM 1 through AEM 4 comms failure
  - Breaker open failure
  - CEM 1 and CEM2 comms failure
  - Generator reverse rotation
  - ID missing
  - Intergenset communication failure
  - Rated data and per unit values
  - Active Diagnostic Trouble Codes (DTC)
  - Breaker close failure
  - Bus 1 and Bus 2 reverse rotation
  - Ethernet 1 and Ethernet 2 link lost
  - Low battery voltage
  - High battery voltage
  - ID repeat
  - Synchronizer failure

TIM-ID: 0000055546 - 002

Engine-generator set metering

- Generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor (PF).
- Engine parameters include oil pressure, coolant temperature, battery voltage, fuel level, speed, engine runtime, ECU-specific parameters, and runtime statistics.

Engine control

- Cranking control: cycle or continuous (quantity and duration fully programmable)
- Engines cool-down: smart cool-down function saves fuel and engine life
- Successful starts counter: counts and records successful engine starts
- Timers:
  - Engine cool-down timer
  - Pre-alarm time delays for weak/low battery voltage
  - Alarm time delay for overspeed
  - Alarm time delay for sender failure
  - Continuous or cycle cranking time delay
  - Pre-crank delay
  - Programmable logic timers
  - Arming time delays after crank disconnect for:
    Low oil pressure
    High coolant temperature

Event recording

The MGC-3000 Series has an event recorder. The event recorder provides a record of alarms, pre-alarms, engine starts, engine runtime loaded, engine runtime unloaded, last run date, and many other events. These events are all date and time stamped to help the user determine the cause and effect of issues related to the engine-generator set. It contains 30 event records each retaining up to 99 occurrences in memory. Time, date and engine hour detail is available for the most current 30 occurrences within each event record.

Technical data

Operating power	Values
Nominal	12 or 24 V DC
Range	6 to 32 V DC
Power consumption in sleep mode	12.7 W - LCD heater off, all relays deenergized, and all analog outputs disabled
Power consumption in typical operation mode	18.1 W in RUN mode, with LCD heater off, start and run relays energized, analog outputs enabled, and six relays energized
Battery ride through	Withstands cranking ride-through down to 0 V for 50 ms (typical)

Environmental condition	Values	
Temperature	Operating:	-40 to 70 °C (-40 to 58 °F)
	Storage:	-40 to 85 °C (-40 to 185 °F)
Humidity	IEC 68-2-38	
Salt Fog	IEC 60068	
Ingress Protection	IEC IP56 for front panel	
Shock	15 G in three perpendicular planes	

TIM-ID: 0000055546 - 002

Environmental condition	Values	
Vibration	5 to 29 to 5 Hz:	1.5 G peak for 5 min.
	29 to 52 to 29 Hz:	0.036" double amplitude for 2.5 min.
	52 to 500 to 52 Hz:	5 G peak for 7.5 min.
	Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep	

Display operations

The front panel display is used to make settings changes and to display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions.

For further information to the main display operations, refer to (→ Page 68).

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

Registered trademark

Windows is a registered trademark of Microsoft Corporation.

TIM-ID: 0000055546 - 002

4.8.2 Control panel MGC-3000 series – Display operations

Front panel display

The front panel display is used to make settings changes and display metering values.

The wide temperature-range LCD with backlighting can be viewed under a wide range of ambient light and temperature conditions. The figure (→ Figure 14) shows the display of the MGC-3000 Series in detail.

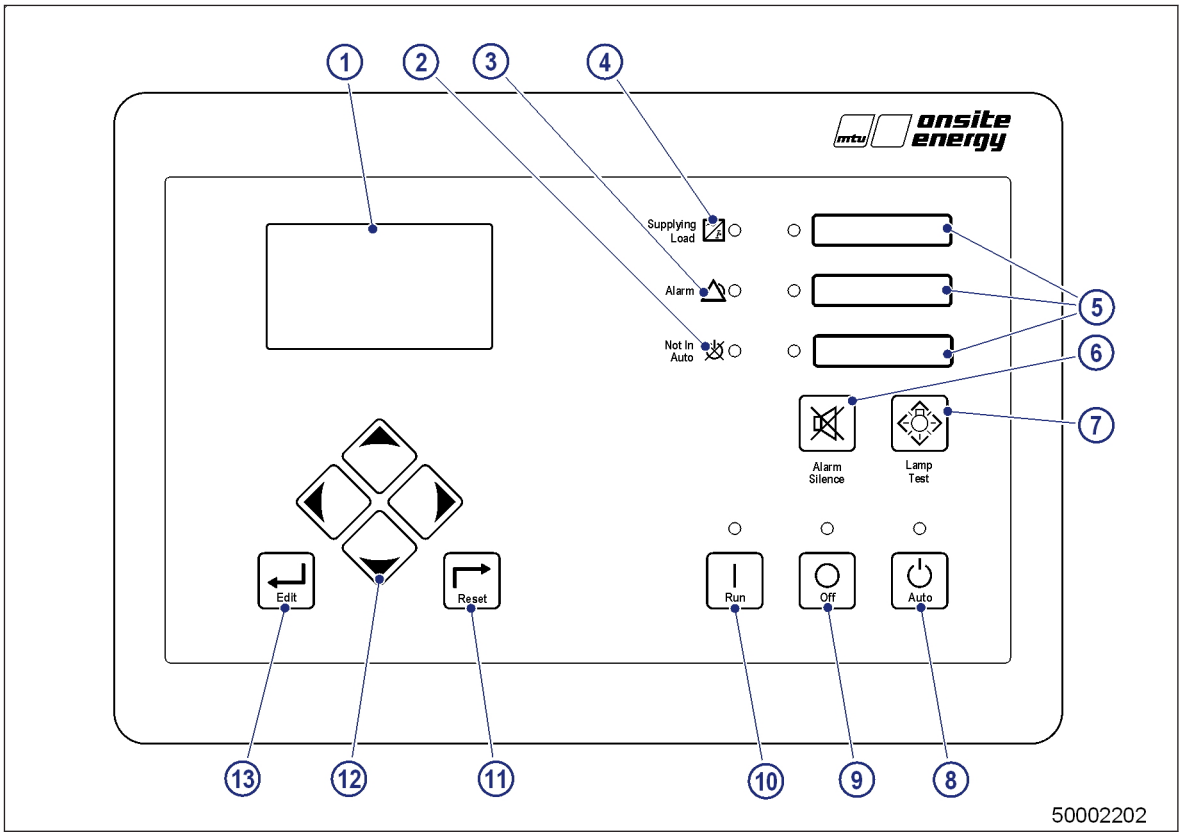


Figure 14: Control panel with MGC-3000 Series – Controls and indicators

1 Liquid Crystal Display (LCD)
2 "Not in auto" indicator
3 Alarm indicator
4 Supplying load indicator
5 Programmable indicators
6 Alarm silence pushbutton
7 LAMP TEST pushbutton
8 AUTO pushbutton and mode indicator
9 OFF pushbutton and mode indicator
10 RUN pushbutton and mode indicator
11 RESET pushbutton
12 Arrow pushbuttons
13 EDIT pushbutton

Panel LED indicators

No.*	LED	Indication
2	Not in Auto	Red – Indicates unit is not in the AUTO mode.
3	Alarm	Red – Indicates an alarm situation by continuous illumination. Indicates a pre-alarm by flashing.
4	Supplying Load	Green – Indicates the system is supplying current to a connected load.
8	Auto	Green – Indicates the unit is in the AUTO mode of operation.
* Numbers correspond to (→ Figure 14).		

TIM-ID: 0000055549 - 002

No.*	LED	Indication
9	Off	Red – Indicates the MGC is in the OFF mode.
10	Run	Green – Indicates the MGC is in the RUN mode.
* Numbers correspond to (→ Figure 14).		

Panel pushbuttons

No.*	Pushbutton	Result
6	ALARM SILENCE	Stops the currently occurring audible alarm.
7	LAMP TEST	Tests the MGC-3000 Series indicators by exercising all LCD pixels and lighting all LEDs.
8	AUTO	Places the MGC-3000 Series in AUTO mode. The green LED lights when AUTO mode is active.
9	OFF	Places the MGC-3000 Series in OFF mode. The red LED lights when OFF mode is active.
10	RUN	Places the MGC-3000 Series in RUN mode. The green LED lights when RUN mode is active.
11	RESET	Cancels an editing session and discards any settings changed. When pressed, this pushbutton also resets the Breaker Management Pre-alarms.
12	(arrows)	Navigates through the front panel display menus and modifies settings. The left- and right-arrow pushbuttons are used to navigate through the menu levels. • The right-arrow pushbutton is pressed to move downward through the menu levels. • The left-arrow pushbutton is pressed to move upward. Within a level, the up- and down-arrow pushbuttons are used to move among items within the menu level. • Pressing the down-arrow pushbutton moves to items lower in the list. • Pressing the up-arrow pushbutton moves to items higher in the list. During an editing session, the up- and down-arrow pushbuttons are used to raise and lower the value of the selected setting.
13	EDIT	Starts an editing session and enables changes to MGC-3000 Series settings. At the conclusion of an editing session, the EDIT pushbutton is pressed again to save the setting chances.
* Numbers correspond to (→ Figure 14).		

Login/logout and permissions

Note: To change settings, appropriate user training is required to avoid malfunctions.

TIM-ID: 0000055549 - 002

1. To log in, navigate to the SETTINGS → ENTER PASSWORD screen and press the EDIT pushbutton.
2. Enter the password.
   - Use the up- and down-arrow pushbuttons to scroll through the characters.
   - Use the left- and right-arrow pushbuttons to enter more characters.
3. Press the EDIT pushbutton to log in.
   The LOGOUT selection now appears in the list of SETTINGS.
4. ... select your further operations ...
5. To log out, press the RESET pushbutton while viewing any screen other than the overview screen.

Summary screen

Note: To change settings, appropriate user training is required to avoid malfunctions.

The summary screen can be set to standard or scrolling.

Set the summary screen

1. Press the right arrow pushbutton to select a standard or scrolling summary.
2. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
3. Press the EDIT pushbutton. Enter user ID and password as needed.
4. Edit the SUMMARY VIEW.
   The SCROLL DELAY setting is also found on the screen.

When set to standard, the following values are displayed:

VOLT*	AMP*	PH*	Hz	OIL	FUEL/DEF	TEMP	BATT

* Information for each phase is obtained by pressing the up- and down-arrow pushbuttons on the front panel.

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values scroll at a delay time specified by the user.

Select the scrolling values

1. Navigate to the SETTINGS → GENERAL SETTINGS → FRONT PANEL HMI screen.
2. Edit the CONFIGURABLE METERING.

The following values may be selected by the user to be placed in the scrolling summary:

NONE*	BATT V	GEN VAB	GEN VAN	KW A	KVA A	GEN Hz	GEN IA
BLANK**	RPM	GEN VBC	GEN VBN	KW B	KVA B	GEN PF	GEN IB
OIL P	RPM SRC	GEN VCA	GEN VCN	KW C	KVA C	BUS Hz	GEN IC
TEMP	FUEL	RUN HRS	KWH	KW TOT	KVA TOT	BUS V	

* Removes a line from the scrolling list.
** Shows nothing on this line.

Remote access

If communications access is active through the modem or USB, the front panel displays "REMOTE COMMS, FRONT PANEL IS READ ONLY" and the summary screen. This informs that the front panel can only be used for viewing metering data and settings information. Remote access must be ended before modifying settings through the front panel.

Sleep mode

The sleep mode serves as a power-saving feature. A number of conditions must be met for the MGC-3000 Series to be in sleep mode. These conditions include being in OFF mode or AUTO mode not running. Also, if a pushbutton is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The MGC-3000 Series resumes normal display operation when any front panel pushbutton is pressed or the engine-generator set is started remotely via the ATS input.

TIM-ID: 0000055549 - 002

The MGC-3000 Series will not go to sleep while in an alarm state. If needed, the sleep mode can be permanently disabled via the control panel communication software or the front panel menu.

As a default, the sleep mode is disabled at the factory, however, it can be reinitiated.

Control panel communication software

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

TIM-ID: 0000055549 - 002

4.8.3 Remote annunciator for MGC Series

The remote annunciator is used with the MGC Series (→ Page 63) to provide electrical signaling for the engine-generator set. The MGC Series detects alarm, pre-alarm, and operating conditions and communicates via Modbus communications with RS-485 to the remote annunciator.

The figure(→ Figure 15) shows the remote annunciator front panel.

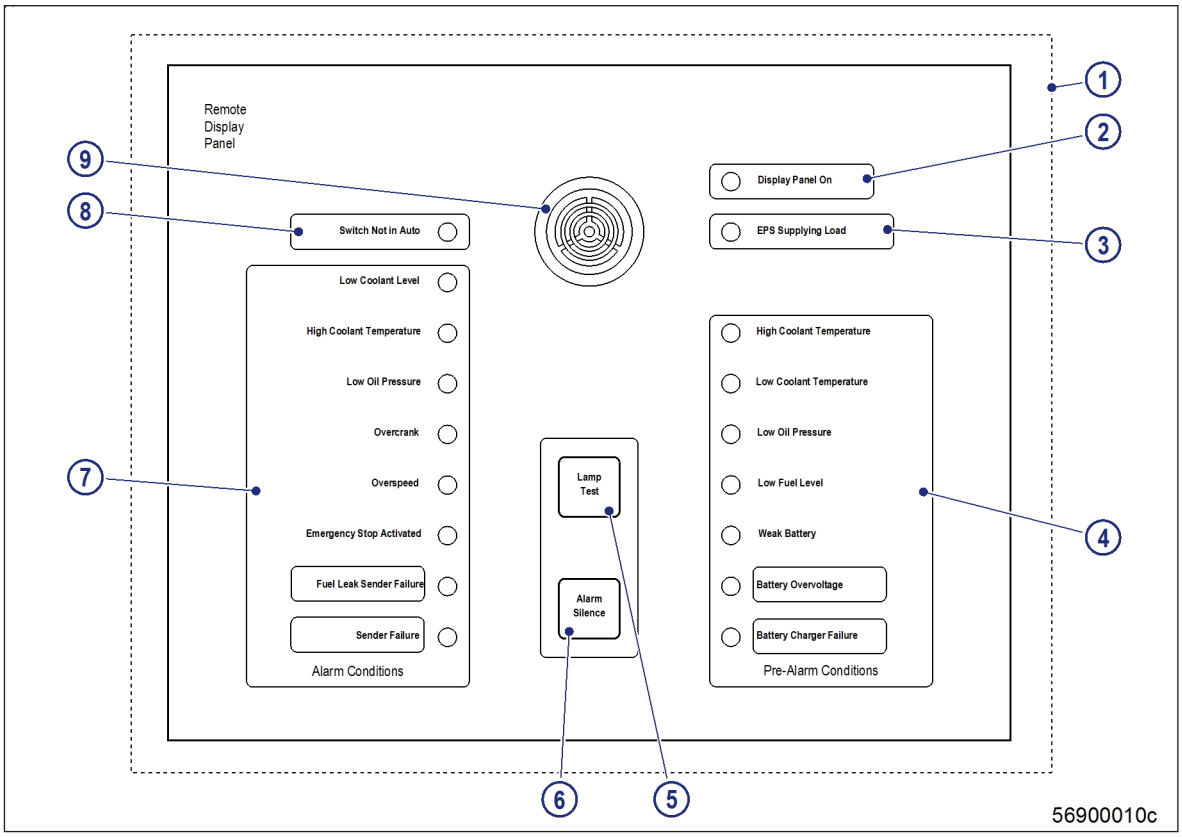


Figure 15: Remote annunciator for MGC Series – Front panel

1 Front panel *
2 LED "Power on"
3 LED "Supplying load"
4 LEDs for pre-alarms
5 LAMP TEST pushbutton
6 ALARM SILENCE pushbutton
7 LEDs for alarms
8 LED "Not in AUTO"
9 Audible alarm

* The dashed line indicates the outside edges when flush mounted. Otherwise, the full line denotes the edges.

Functions

The remote annunciator has 18 LEDs. These LEDs indicate alarms (7), pre-alarms (4), and operating conditions (2, 3, 8) of the engine-generator set as detected by the MGC Series.

If an alarm or pre-alarm is indicated, an audible alarm (9) sounds.

Panel LED indicators

No.*	LED	Indication
2	Display Panel On	Green – Indicates that power is applied to the remote annunciator.
3	EPS Supplying Load	Green – Indicates that the system is supplying more than two percent of rated current to a connected load.
Numbers correspond to the figure (→ Figure 15).		

TIM-ID: 0000055008 - 002

No.*	LED	Indication
4	Pre-alarm Conditions	Yellow – Indicates: • High coolant temperature • Low coolant Temperature • Low oil pressure • Low fuel level • Weak battery • Battery overvoltage • Battery charger failure
7	Alarm Conditions	Red – Indicates: • Low coolant level • High coolant temperature • Low oil pressure • Overcrank • Overspeed • Emergency stop activated • Fuel leak/Fuel sender failure • Sender failure
8	Switch Not in Auto	Red – Indicates that the unit is not in AUTO mode.
Numbers correspond to the figure (→ Figure 15).		

Panel pushbuttons

No.*	Pushbutton	Result
5	LAMP TEST	Tests the indicators by lighting all LEDs and exercises the audible alarm.
6	ALARM SILENCE	Stops the currently occurring audible alarm.
Numbers correspond to the figure (→ Figure 15).		

Benefits

- Monitoring main operating conditions and (pre-)alarms from a distance, for example from an office
- RS-485 communications
- Conduit box is included for easy installation
- Independent of environmental needs for operating the engine-generator set, the remote annunciator itself is designed for use in harsh environments

Technical data

- Power input from the starter batteries at 24 VDC or with an AC source at 120 VAC
- Port RS-485 interface
- Distance between annunciator and MGC Series: up to 1,200 m (4,000 ft)
- Meets the requirements of NFPA-110
- UL recognized, File E97035, and CSA certified, File LR23-23131
- Two mounting configurations: surface and flush mount

Environmental condition	Values
Operating temperature	-40 to 70 °C (-40 to 158 °F)
Storage temperature	-40 to 85 °C (-40 to 185 °F)
Salt Fog	Qualified to ASTM 117B-1989
Shock	15 G
Vibration	Withstands 2 G in each of three mutually perpendicular planes*
Sound	Alarm horn rated at 80 dB [from a distance of 60 cm (2 ft)]

TIM-ID: 0000055008 - 002

* Swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance

TIM-ID: 0000055008 - 002

4.9 Charge-Air System and Exhaust System

4.9.1 Air system - Overview

The air system provides the engine with filtered, cooled air for the combustion process.

The figure(→ Figure 16) shows the air system of an engine-generator set with a Mercedes-Benz OM924LA engine. It is also valid for an engine-generator set with a Mercedes-Benz OM926LA engine.

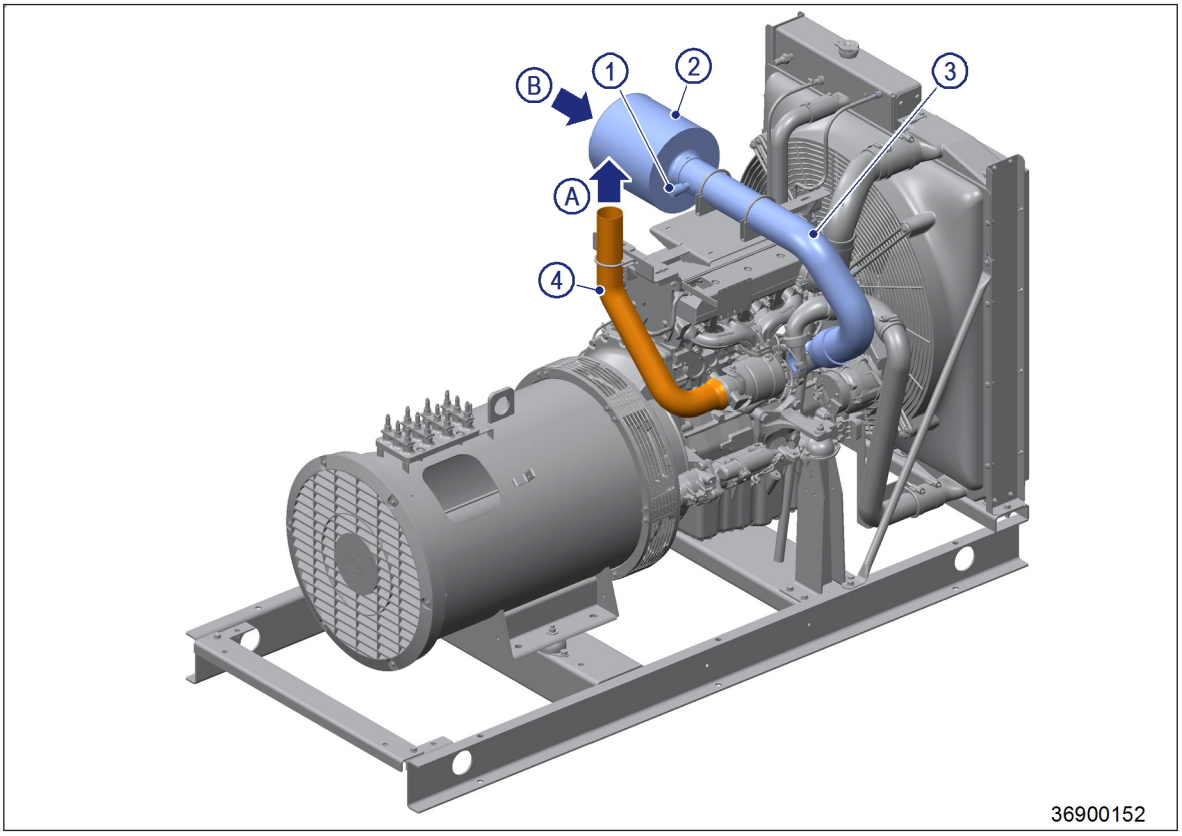


Figure 16: Air system

1 Air filter service indicator
2 Air intake filter
3 Air intake tube
4 Air exhaust tube
a Exhaust gas
b Air intake

Technical data

- Air-to-air charge-air cooling
- Unit-mounted radiator with intercooler core
- Single-stage air filter

Benefits

- Optimum load application characteristics
- Low fuel consumption

Function

The turbine wheel and the compressor wheel of the turbocharger are positioned on one shaft. The compressor wheel in the compressor housing draws air over an intake pipe (3) from the air filter (2) and compresses it. The compressed air flows from the compressor housing outlet through the charge-air pipe to the unit-mounted radiator.

TIM-ID: 0000057947 - 001

The radiator(→ Page 112) cools the charge-air in load operation, allowing optimum operational behavior of the engine to be achieved. The cooled charge-air flows through the charge-air pipe from the radiator via the charge-air intake neck to the inlet ducts of the cylinder head. It is consumed there during the combustion process.

TIM-ID: 0000057947 - 001

4.9.2 Air filter

The dry-type air filter cleans the incoming air used for combustion to prevent internal damage to major components.

The air filter features a single-stage, easy-to-service filter.

The figure (→ Figure 17)shows a standard air filter, with the air inlet on one end and the outlet on the other end.

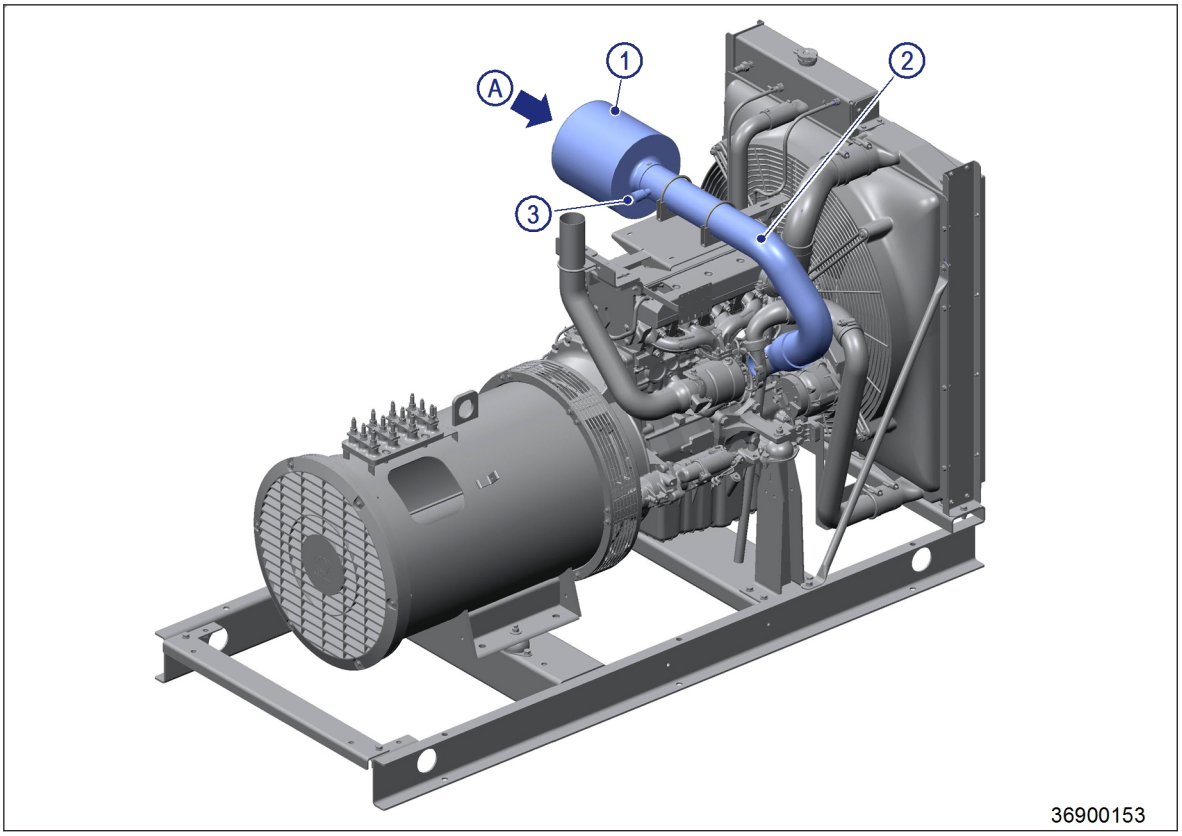


Figure 17: Air filter

1 Air intake filter
2 Air intake tube
3 Air filter service indicator
A Air

Technical data

- Single-stage engine air filter operating in light to medium dust conditions
- Airflow throughput: 162 to 524 CFM (4.5 to 15 m^3/min) at 1.2 to 8 in H_2O (3 to 20 mbar)
- Non-metallic, non-corrosive, tough materials
- Air filter housing and filter media are constructed as one unit
- Direct installation
- Horizontal installation

Benefits

- PermaPleat® embossing process forms dividers between pleats, preventing bunching and ensuring uniform air flow
- Compact design, vibration-resistant
- Improved reliability and durability with reduced weight and cost
- Mounted filter service indicator
- Flexible, easy installation
- Easy and fast service
- Completely disposable

TIM-ID: 0000057948 - 001

Function

Through the inlet, air is inducted into the air filter housing (1). The air flows through the filter media from outside to inside and then flows to the engine via the intake tube (2). Dust particles suspended in the air are retained by the filter media.

Replaced air filters can be disposed of in normal trash.

Filter service indicator

The engine-generator set shown is equipped with an optional filter service indicator (3) on the intake tube.

The filter service indicator signals when the filter should be replaced. This restriction measurement tool provides a dependable assessment of filter service life that is not possible by visual inspection alone. Although a filter may look "dirty," in most cases it can be used for several more hours. Attaching a filter service indicator to an air filter in the ducting ensures the longest possible filter life and provides the best engine protection.

TIM-ID: 0000057948 - 001

4.9.3 Exhaust system – Overview

The figure (→ Figure 18)shows the exhaust system of an engine-generator set with a Mercedes-Benz OM924LA engine. It is also valid for an engine-generator set with a Mercedes-Benz OM926LA engine.

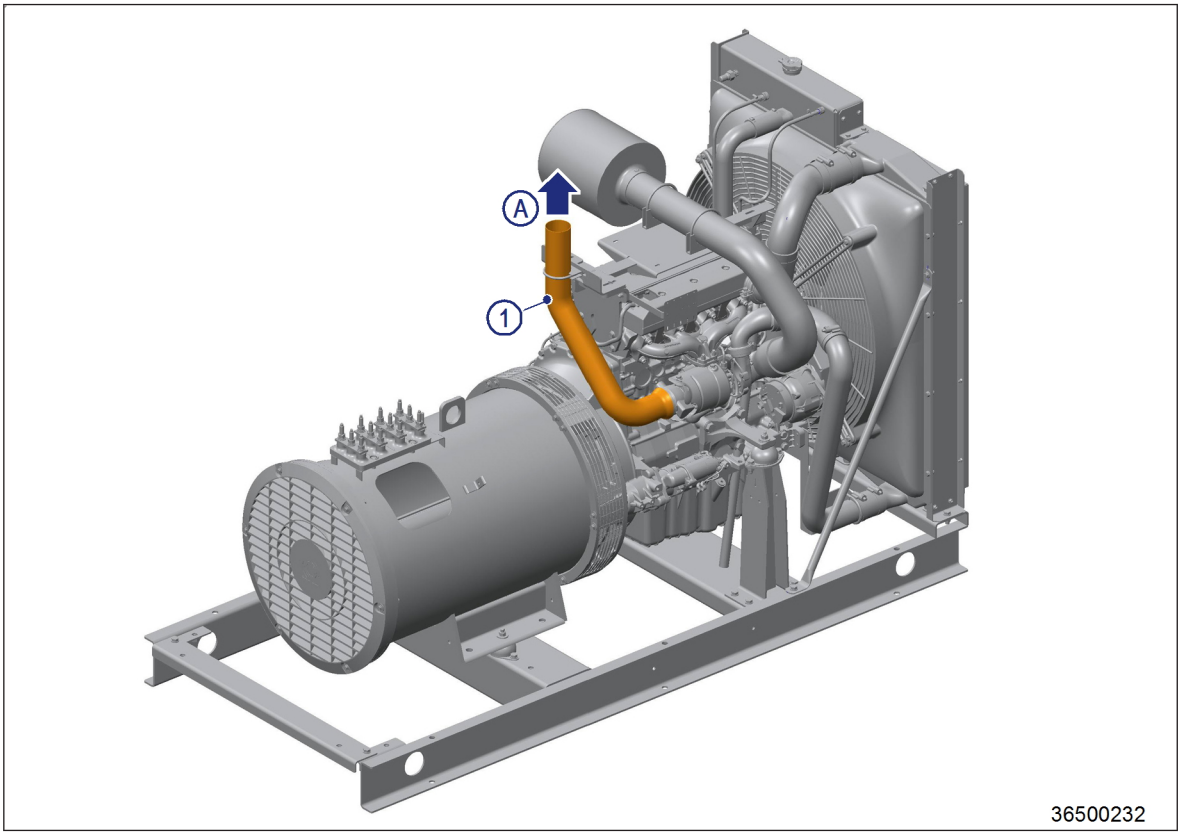


Figure 18: Exhaust system

1 Air exhaust tube A Exhaust gas

Technical data

- Single-stage exhaust with turbocharger

Benefits

- Low exhaust emissions
- Straightforward connection to external exhaust gas system
- High torque at low speeds
- Optimum load application characteristics
- Low fuel consumption

Function

The exhaust gases flow from the combustion chambers via exhaust manifolds to the exhaust turbocharger.

The exhaust gas rushing into the turbine housing drives the turbine wheel of the rotor assembly of the exhaust turbocharger, which consists of the turbine wheel and the compressor wheel mounted on one common shaft. In doing so, the exhaust flow provides the mechanical power to compress the combustion air. The exhaust gas (A) is routed from the turbocharger outlet via the exhaust pipework (1) to the atmosphere.

TIM-ID: 0000057949 - 001

4.9.4 Exhaust silencer

The function of an exhaust silencer is to reduce the diesel engine exhaust gas noise level. The figure(→ Figure 19) shows a typical exhaust silencer.

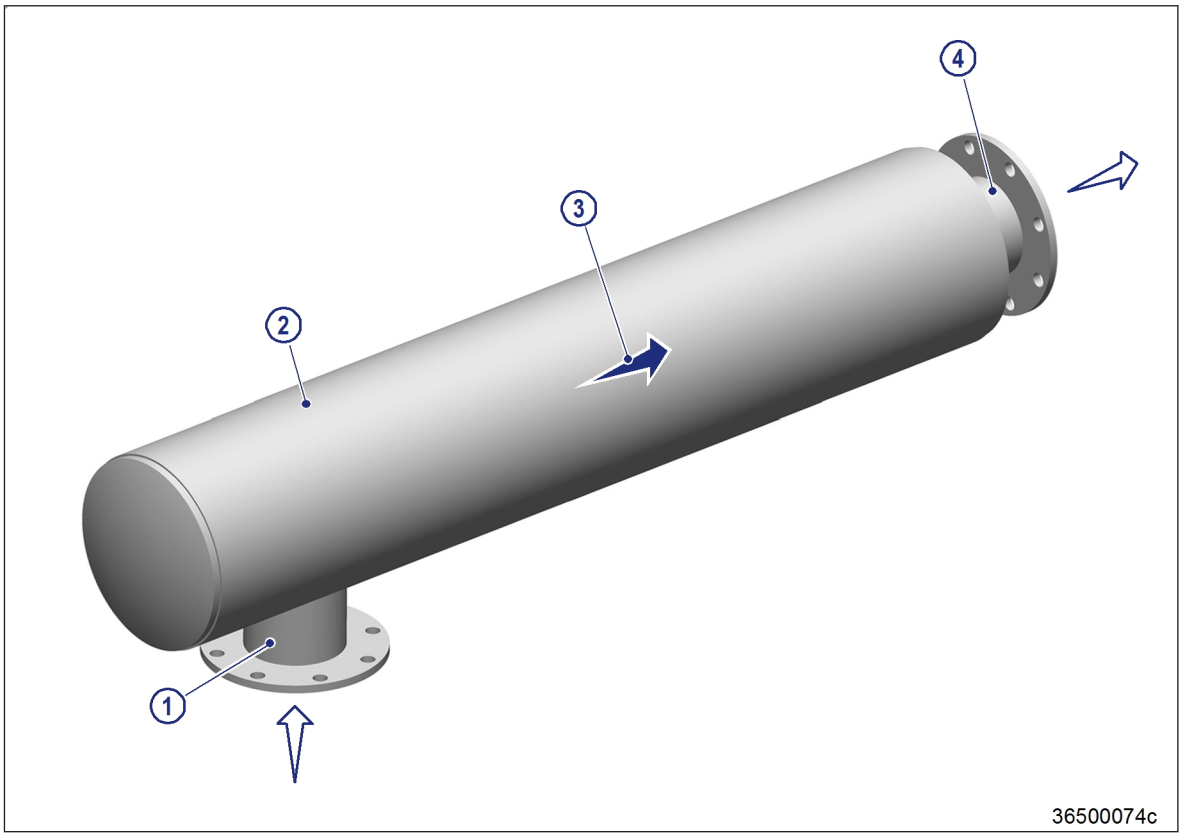


Figure 19: Exhaust Silencer

1 Inlet with flange
2 Enclosure
3 Flow direction
4 Outlet with flange

Technical data

- Material: Aluminized carbon steel construction, welded
- Vertical inlet and axial outlet direction
- Noise reduction: 35 to 40 dB(A)
- Exhaust gas volume: 0.3 to 0.7 m^3/s
- Maximum exhaust flow velocity: 30 m/sec
- Vertical installation
- Welded flanges with gaskets
- Counterflanges for connection provided
- Painted with high temperature resistant color

Benefit

- Low exhaust gas noise emissions

Function

The silencer is mounted in the exhaust pipework of the engine.

The exhaust gas is routed from the turbocharger outlet via the exhaust pipework flows through the intake (1) into the silencer (2). The reduction of convection heat is ensured by internal insulation of the silencers.

TIM-ID: 0000057950 - 001

To muffle the noise, diverse techniques are applied for different purposes:

- 10 dB(A): pure absorptive system made of specially designed rock wool
- 30 dB(A): combination of simple reactive chamber and absorptive system
- 40 dB(A): combination of double interconnected reactive chambers and absorptive system

The muffled exhaust gas leaves the silencers through the outlet (4) and is piped to the atmosphere.

TIM-ID: 0000057950 - 001

4.10 Cooling System

4.10.1 Cooling system – Overview

The cooling system on an engine-generator set with an air-to-air charge-air cooled engine consists of:
- Cooling circuit for engine coolant (radiator jacket water circuit)
- Cooling circuit for charge-air (radiator intercooler circuit)
- Generator cooling

The cooling circuits on the engine work by means of an external tube and fin type unit-mounted radiator(→ Page 112). The generator ventilation does not need an additional device.

Technical data

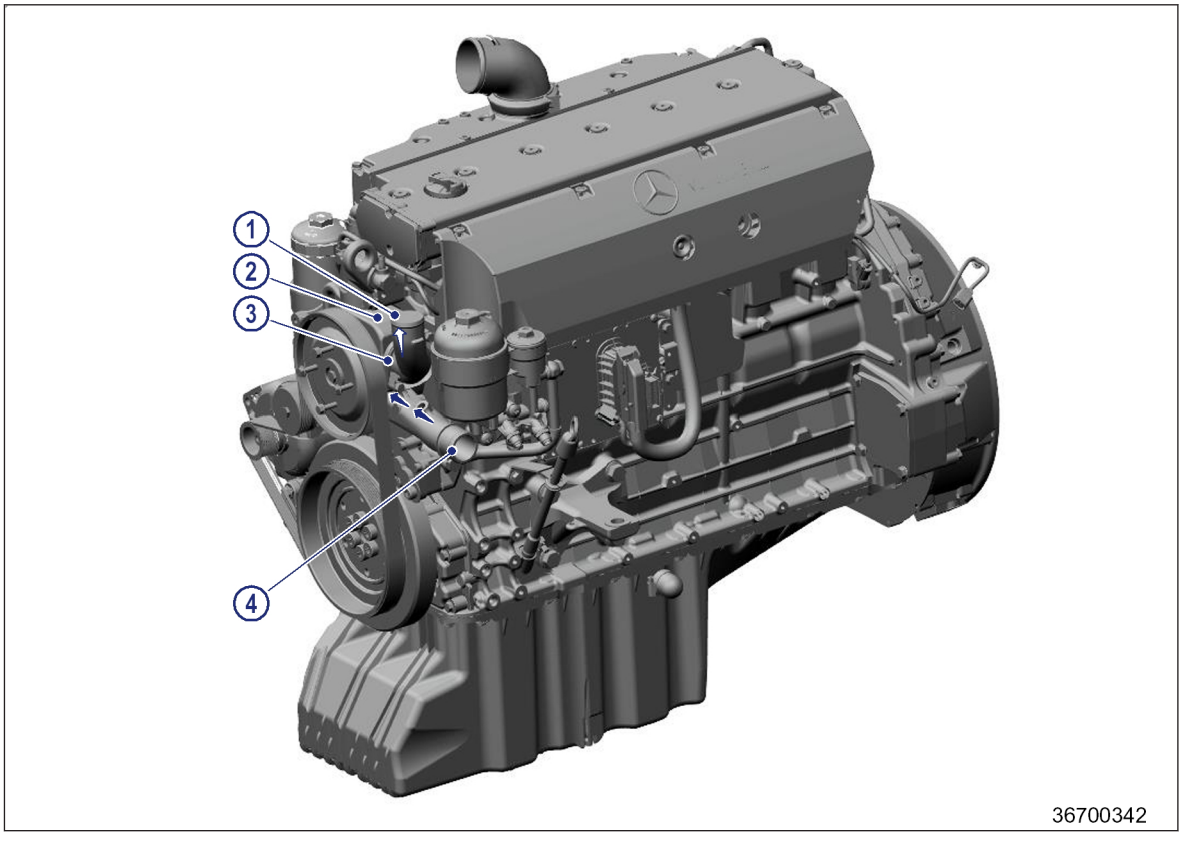
- Single-circuit cooling system with air-to-air charge-air cooling
- Complete system solution with unit-mounted radiator, including fan drive, fan, and piping
- Thermostat-controlled jacket water circuit

Benefits

- All-in-one solution
- Cooling package designed to perform in very high ambient conditions (122 °F)

Cooling circuit for engine coolant – Jacket water circuit

The figure(→ Figure 20) shows the engine coolant flow (engine side) of an engine-generator set with a Mercedes-Benz OM924LA engine. The figure is also valid for an engine-generator set with a Mercedes-Benz OM926LA engine.



TIM-ID: 0000057996 - 001

Figure 20: Engine coolant circuit

1 Outlet to radiator coolant pipe
2 Coolant pump
3 Thermostat
4 Inlet from radiator coolant pipe

The engine coolant circuit is a high-temperature circuit (HT).

The engine coolant is cooled in the jacket water core of the unit-mounted radiator(→ Page 112).

The coolant pump (2) is assembled on the engine. It pumps the cooled coolant from the jacket water core of the radiator via the coolant pipe to the inlet (4) through the engine. There, one part of the coolant is routed through the oil cooler, and a second part bypasses the oil cooler. The coolant flows into the coolant duct of the crankcase. In the crankcase, the coolant flows to the cylinders in the cylinder head, around the cylinder liners from bottom to top, and overflows into the cylinder head. There, it flows through the coolant spaces and coolant ducts of the cylinder head and arrives at the thermostat (3).

The thermostat (3) leads the engine coolant directly to the engine coolant pump (2) when the engine is cold.

Bypassing the radiator allows the engine, lube oil, and engine coolant to reach operating temperature quickly.

The thermostat (3) diverts the engine coolant via the outlet (1) and the coolant pipe to the radiator when the engine is under load (warm engine). Recooled engine coolant coming from the radiator (jacket water core) then returns to the engine coolant pump (2).

Drain plugs are provided at the lowest points of the engine coolant circuit.

Coolant preheating

Coolant preheating is provided by an optional coolant preheating unit [jacket water heater(→ Page 114)].

Cooling circuit for charge-air – Intercooler circuit

Fresh, compressed, heated air (coming via air filters and turbocharger) flows through the intake charge-air pipes of the unit-mounted radiator (→ Page 112) to the intercooler core. There, the charge-air is air-cooled by means of fan circulation during load operation.

The cooled charge-air flows through the outlet charge-air pipes of the radiator to the engine, where it is consumed during fuel combustion.

For a figure of the charge-air flow, refer to (→ Page 103).

Generator cooling

Generators are air-cooled. The air enters the lower part of the outlet box through the louvered cover (air gaps).

The shape of the outlet box properly directs outside ventilating air through the generator. The generator "hot air" passes through the stator and rotor coils and out the adapter ring screened openings.

The cast unidirectional aluminum alloy ventilation fan (driven by the main rotor) provides even air flow to maximize cooling of the generator.

For a figure of the generator parts, refer to (→ Page 54).

TIM-ID: 0000057996 - 001

4.10.2 Unit-mounted radiator

The unit-mounted radiator is a combined cooler for the engine coolant (in the jacket water circuit) and the charge-air coolant (in the intercooler circuit).

The figure shows a typical unit-mounted radiator.

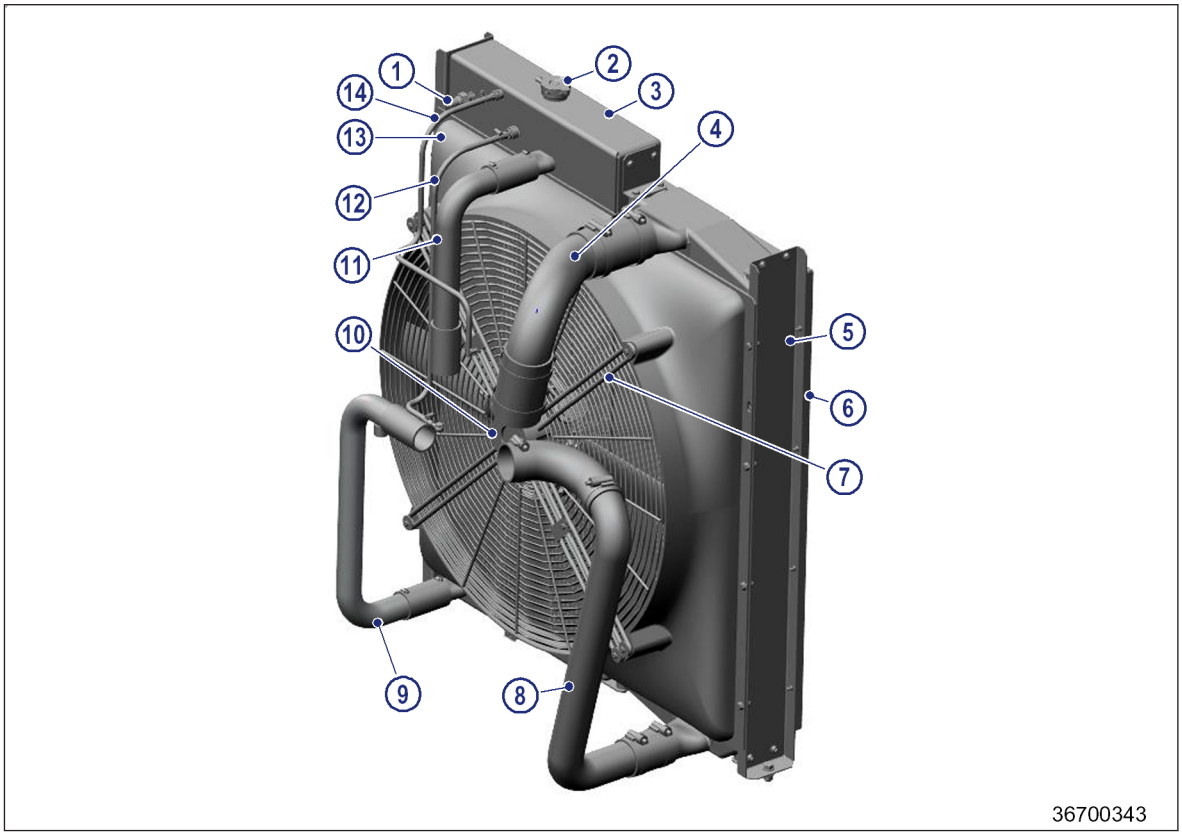


Figure 21: Unit-mounted radiator

1 Level sensor connection (jacket water circuit)
2 Pressure cap (jacket water circuit)
3 Expansion tank (jacket water circuit)
4 Charge-air pipe from radiator to engine (intercooler circuit)
5 Core (intercooler circuit)
6 Core face guard
7 Complete fan guard
8 Charge-air pipe from engine to radiator (intercooler circuit)
9 Coolant pipe from radiator to engine (jacket water circuit)
10 Fan
11 Coolant pipe from engine to radiator (jacket water circuit)
12 Expansion hose (jacket water circuit)
13 Core (jacket water circuit)
14 Connection vent line (jacket water circuit)

Technical data

- Single-circuit cooling system with air-to-air charge-air cooling
- Complete system solution with unit-mounted radiator, including fan drive, fan, and piping

Benefits

- Thermostat control ensures that optimum coolant and engine temperatures are reached quickly
- Charge-air cooling during load operation

Function

Jacket water circuit

The engine coolant is cooled in the jacket water core (13) of the radiator by means of fan (10) circulation.

TIM-ID: 0000057997 - 001

From the jacket water core (13), the coolant is pumped via the coolant pipe (9) to the engine and cools the cylinders during work. Depending on coolant temperature after passing the cylinders, an engine-mounted thermostat routes a part of the coolant via the coolant pipe (11) back to the jacket water core (13) where the coolant is recooled.

The coolant expansion tank (3) is installed at the highest point of the cooling system, usually on the radiator. It allows compensation of coolant quantity and pressure variations. As the coolant expands with increasing temperature, its pressure in the closed system increases also. The coolant expansion tank is equipped with pressure overflow devices, vent line connections (14), and level sensor connection (1).

Intercooler circuit

Fresh, compressed, heated air (coming via air filters and turbocharger) flows through the intake charge-air pipes (8) to the intercooler core (5). There, the charge-air is cooled by means of fan (10) circulation during load operation.

The cooled charge-air flows through outlet charge-air pipe (4) to the engine where it is consumed during fuel combustion.

TIM-ID: 0000057997 - 001

4.10.3 Jacket water heater

The jacket water heater is a convection coolant heating system designed to efficiently maintain an engine at optimum starting temperatures. Maintaining jacket water temperatures ensures easy starting, reduces harmful emissions at start-up, and allows engines to go to full power without unnecessary idling.

The figure (→ Figure 22)shows a standard convection jacket water heating system.

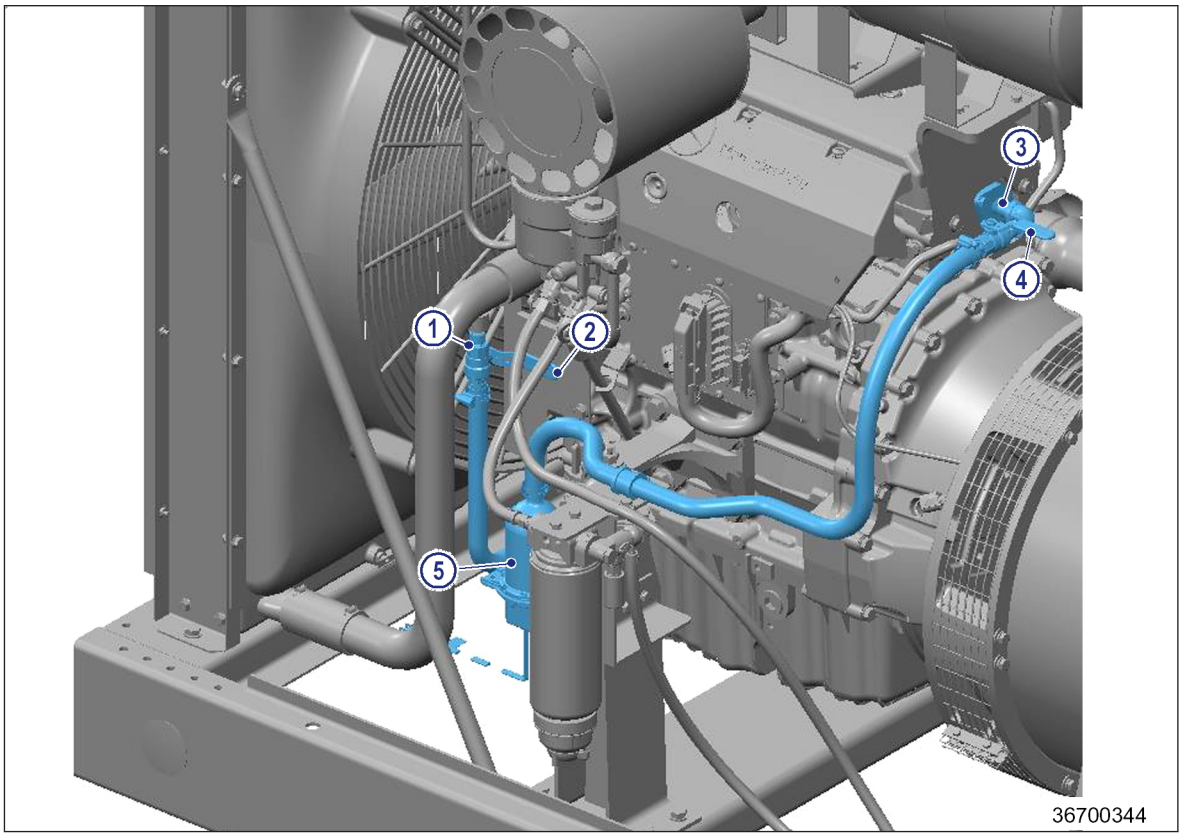


Figure 22: Preheater installation location

1 Coolant return from engine
2 Shut-off valve
3 Coolant supply to engine
4 Shut-off valve
5 Preheater

Technical data

- Single-phase system:
  - 120/240 V, 60 Hz model
- c-UL-us Listed; conforms to UL 499 and CSA C22.2 No. 191
- CE marking provided
- Available for engines ranging in size from 2.5 to 12 liters (153 to 732 in^3)
- Power of 0.4 to 2 kW
- Adjustable thermostat from 32 to 54 °C (90 to 130 °F)

Benefits

- Reduced outlet temperature extends hose life and reduces heater maintenance
- Reduced electrical consumption on engine startup
- Includes all required controls for automatic operation
- Compact design requires minimal material, space, and time for mounting
- Simple to install
- High-impact plastic tank heater offers exceptional tensile strength and resists corrosion

TIM-ID: 0000057998 - 001

Function

The jacket water heater is powered by an external power supply. It works during the out-of-operation time of the engine-generator set. It turns on and off depending on the temperature measured with the sensor on the thermostat.

Upon energizing the system, engine coolant circulates from the engine through the heating tank and back to the engine. An adjustable thermostat cycles the heating element on and off based on coolant temperature.

The coolant flows through the return line from the engine (1) to the jacket water heater (5). The circulating heating system consists of a coolant heating tank, with a low-watt density heating element inside, an adjustable thermostat, an electrical box, electrical connections, and mounting elements. The coolant leaves the jacket water heater through the fill line to the engine (3).

If the heating system is configured with user supplied, non-restrictive shut-off valves (isolation valves) in the coolant lines between jacket water heater and engine (2,4), maintenance on the heating system is allowed without draining the complete engine coolant.

TIM-ID: 0000057998 - 001

4.11 Fuel System

4.11.1 Fuel system – Overview

The fuel system provides the engine with fuel. The fuel source is a fuel tank which can be located below or beside the engine-generator set or outside the engine-generator set room. The fuel tank is connected to the fuel delivery pump via fuel hoses.

The fuel system electronics are controlled by the engine electronics and guarantee an optimal fuel supply for each application.

Technical data

Low pressure (LP) fuel system:

- Fuel delivery pump
- Fuel hand pump
- Fuel filter
- Fuel prefilter
- Fuel prefilter with water separator

High pressure (HP) fuel system:

- HP unit pumps
- Single-wall HP fuel lines
- Injection nozzles
- Pressure retaining valve

Fuel return system:

- Return line from the injection nozzles
- Return line from the unit pumps

Fuel control system:

- Control by electronic engine management system
- Electronically controllable (variable) injection start and injection end

Benefits

- Low exhaust emissions and low fuel consumption over the entire power range
- Excellent acceleration and load acceptance performance
- Injection time and amount of injected fuel electronically controlled
- Exemplary smooth running and high-speed stability
- No power loss at high fuel temperatures

Function

The fuel delivery pump draws fuel via the fuel prefilter with water separator from the fuel tank and delivers it through the hand pump, fuel prefilter, and fuel filter to the HP unit pumps. The HP unit pumps increase fuel pressure and deliver fuel via the fuel lines to the injection nozzles. Fuel injected by the nozzles is distributed evenly in the combustion chamber. Surplus fuel is led from the nozzles via return lines back to the fuel tank. The hand pump supports the manual filling and venting of the fuel system. The start of injection and the injection quantity are electronically controlled by the engine governor.

TIM-ID: 0000062124 - 001

4.11.2 Fuel prefilter with water separator

The fuel prefilter with water separator is installed in the intake line of the fuel delivery pump. It removes solid and liquid contaminants found in the fuel.

The figure (→ Figure 23) shows a fuel prefilter with water separator.

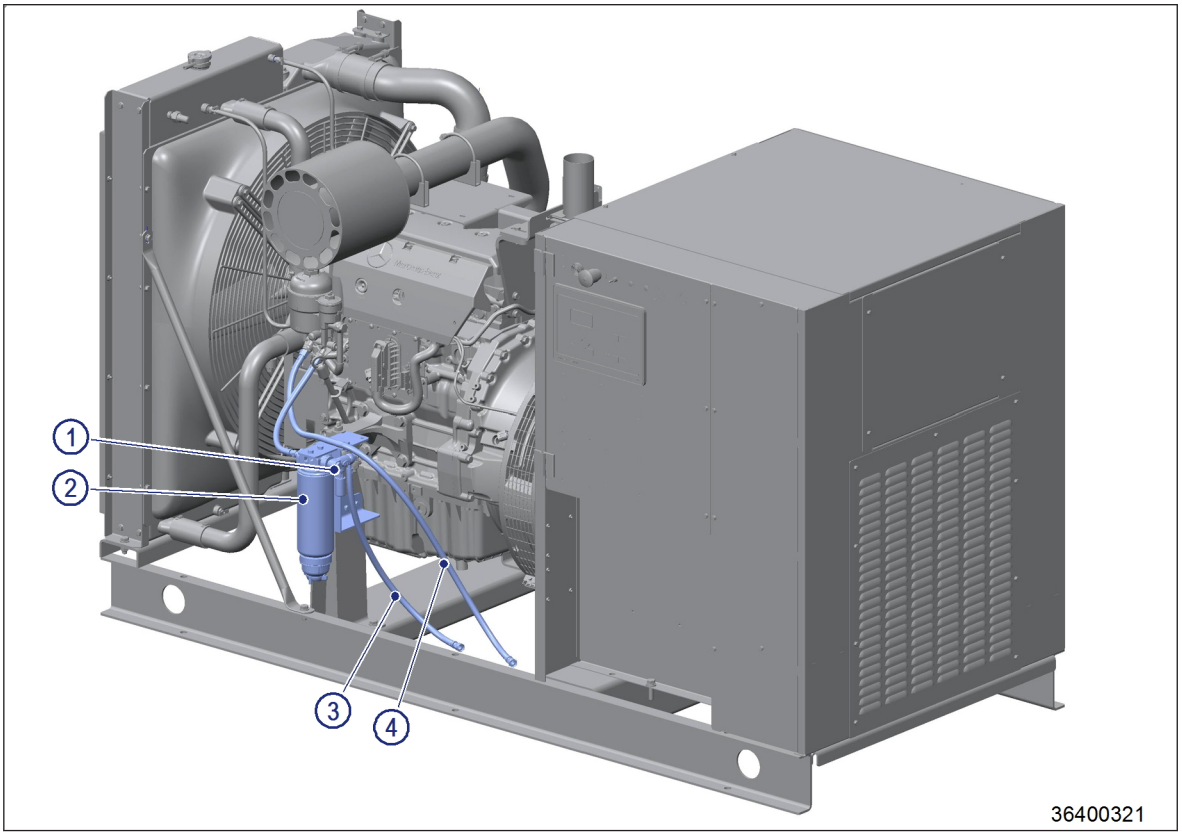


Figure 23: Fuel prefilter with water separator

1 Fuel primer pump
2 Fuel prefilter with water separator
3 Fuel supply to engine
4 Fuel return

Technical data

- Water separator and fuel filter for standard diesel fuel
- 3-stage filtration (multi-stage centrifugal system)

Benefits

- Most compact design
- High efficiency
- Low flow restriction
- Long life filter element
- Easy installation and simple maintenance

Function

The fuel prefilter with water separator (2) consists of one filter housing. The fuel passes through an inlet connection, flows through the filter housing, centrifugal filter, and bowl to the filter element. There, the fuel flows from outside to inside and is filtered in three stages.

TIM-ID: 0000063246 - 001

Filter stages	Meaning
1st stage	Separation: Using the fuel flow, the turbine separates large solids and free water through enhanced centrifugal force.
2nd stage	Coalescing: Smaller water droplets and solids coalesce on the conical baffle and fall to the collection bowl.
3rd stage	Filtration: Engines benefit from near 100% water separation and fuel filtration with water-repelling media. The replaceable filter elements are available in 10 micron ratings.

The cleaned fuel then passes through the outlet connection.

By venting the filter and draining the contaminants and water from the bowl at the drain valve, the filter element is flushed in the opposite flow direction and cleaned again.

TIM-ID: 0000063246 - 001

4.11.3 Sub-base tank

The sub-base tank is located beneath the base and stores the fuel that is delivered to the engine.

The double wall secondary containment fuel tank contains fuel leakage from the inner tank. Thus, it is an extra protection against fuel leakage to the surrounding environment. The secondary containment fuel tank is also sealed to prevent the entrance of rain and debris.

The figure (→ Figure 24) shows a typical sub-base tank. The location of each of these fittings may vary from system to system, but a typical sub-base tank always includes these items.

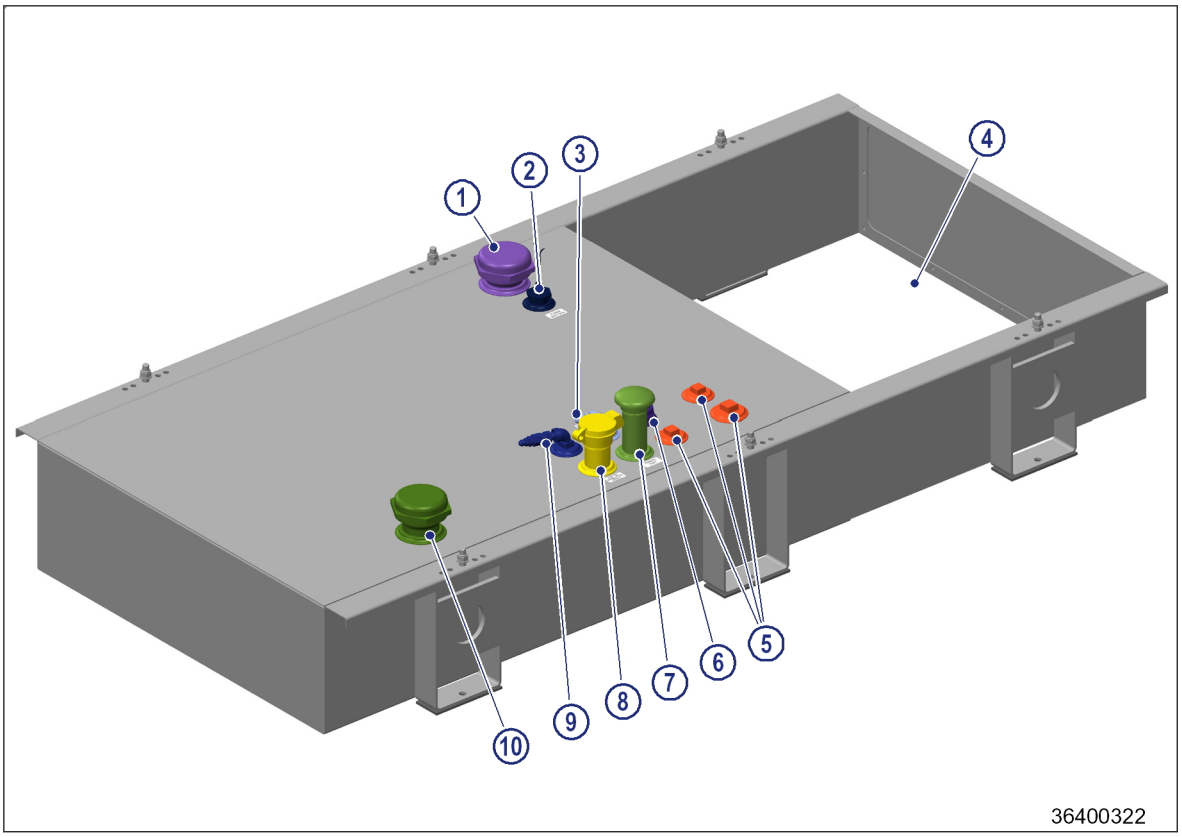


Figure 24: Sub-base tank

1 Emergency vent (secondary containment)
2 Leak detection switch
3 Fuel return to tank
4 Stub-up area
5 Extra fittings
6 Fuel gauge
7 Normal vent
8 Fuel fill
9 Fuel supply to engine
10 Emergency vent (primary containment)

Technical data

- Different sizes of sub-base tanks available with fuel capacities of 12, 24, 48, or 72 hours
- Steel construction
- Double wall with rupture basin
- Secondary containment system
- Normal and emergency ventilation for primary and secondary containment
- (National Pipe Thread) NPT fittings

Benefits

- Retains hazardous materials inside the container
- Switch indicates internal tank issues or leakages
- Leakages from inner tank are caught in the rupture basin

TIM-ID: 0000063247 - 001

Function

The sub-base tank delivers fuel to the diesel engine. Fuel is inserted into the tank via the fuel fill (8) and is stored there until consumption by the engine via the fuel supply (9). Excess fuel not used by the engine is returned to the tank via the fuel return (3). Any resulting gases produced during fuel containment are exhausted through the normal vent (7) and the emergency vents (1 and 10) as needed.

Optionally, the sub-base tank can be equipped with a spill fill box. The spill fix box is a container that holds approximately 19 liters (5 gallons) and is used to collect fuel from overfill and drips during tank filling. With a lockable fill cap inside and a drain port in the bottom, it is mounted on the fuel fill (8).

TIM-ID: 0000063247 - 001

4.12 Electrical System

4.12.1 Starter battery

A starter battery is necessary to start the engine-generator set.

The figure (→ Figure 25) shows the installation location of the starter battery.

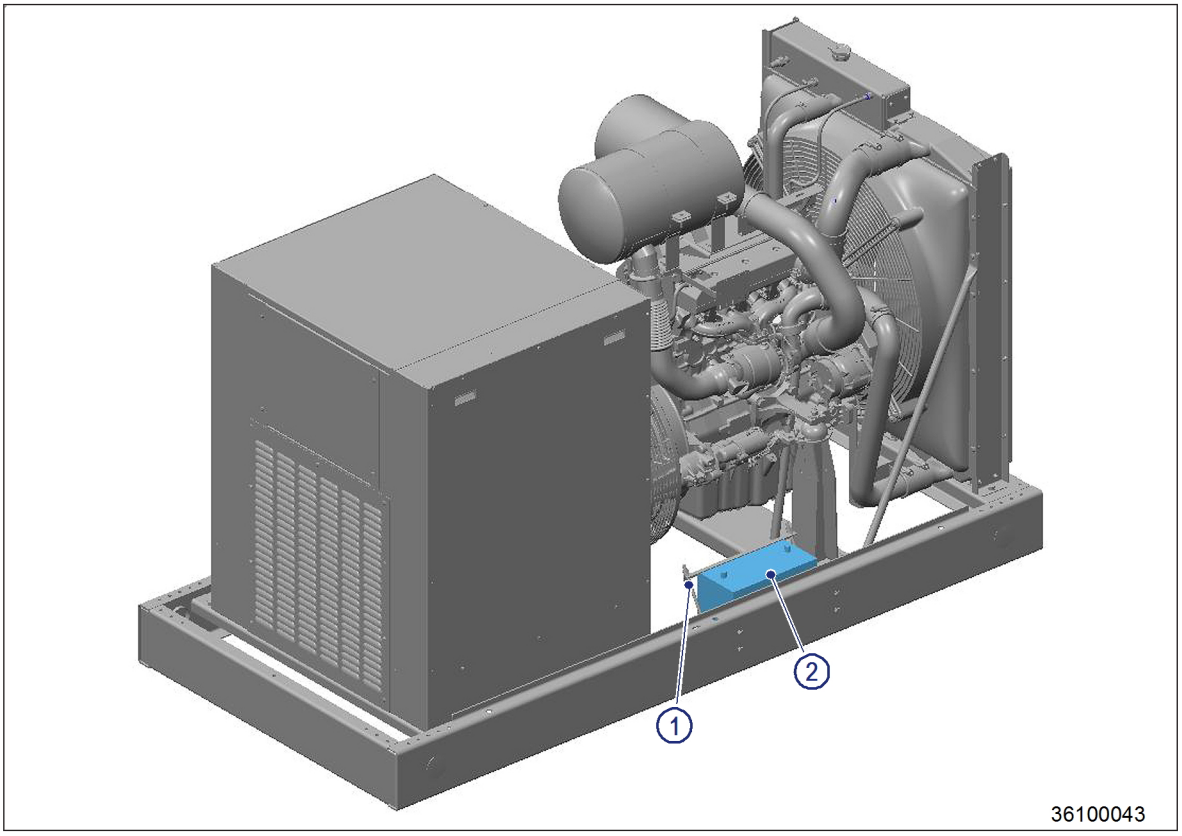


Figure 25: Starter battery installation location

1 Retainer 2 Starter battery

Technical data

NOTE: Technical data is based on one 12 V battery group number 31, lead-acid.

- Cold cranking amperes at -18 °C (0 °F): 950 A
- Cranking amperes at 0 °C (32 °F): 1,140 A
- Reserve capacity minutes at 25 A: 170 minutes
- Very low self-discharge rate

Benefits

- Immediate start of the engine-generator set due to high-quality battery
- Large tolerance for low ambient temperatures
- Automatic recharge by the engine-driven charging system
- Best battery performance and longest battery life with optional battery charger control system
- Easy installation and maintenance
- Rechargeable

Function

The battery (2) is connected to the starter. If the start of the engine-generator set is requested, the control panel tells the starter to operate. The starter itself engages the battery for DC electricity to supply power to start the engine-generator set.

TIM-ID: 0000062112 - 001

After the engine is running, the power supply by the battery stops. The lost capacity (discharge amount) is filled by an automatic recharge by the engine-driven alternator during engine operation.

Starting Lighting Ignition (SLI) batteries have a relatively low degree of discharge on each use. Once the engine is started, the battery is recharged by the engine-driven generator.

TIM-ID: 0000062112 - 001

4.12.2 Battery charger

A battery charger monitors and charges the batteries and displays the battery status. Precise charging and temperature compensation assure the correct battery charge under all conditions.

The figure shows a typical battery charger with details of the diagnostic display.

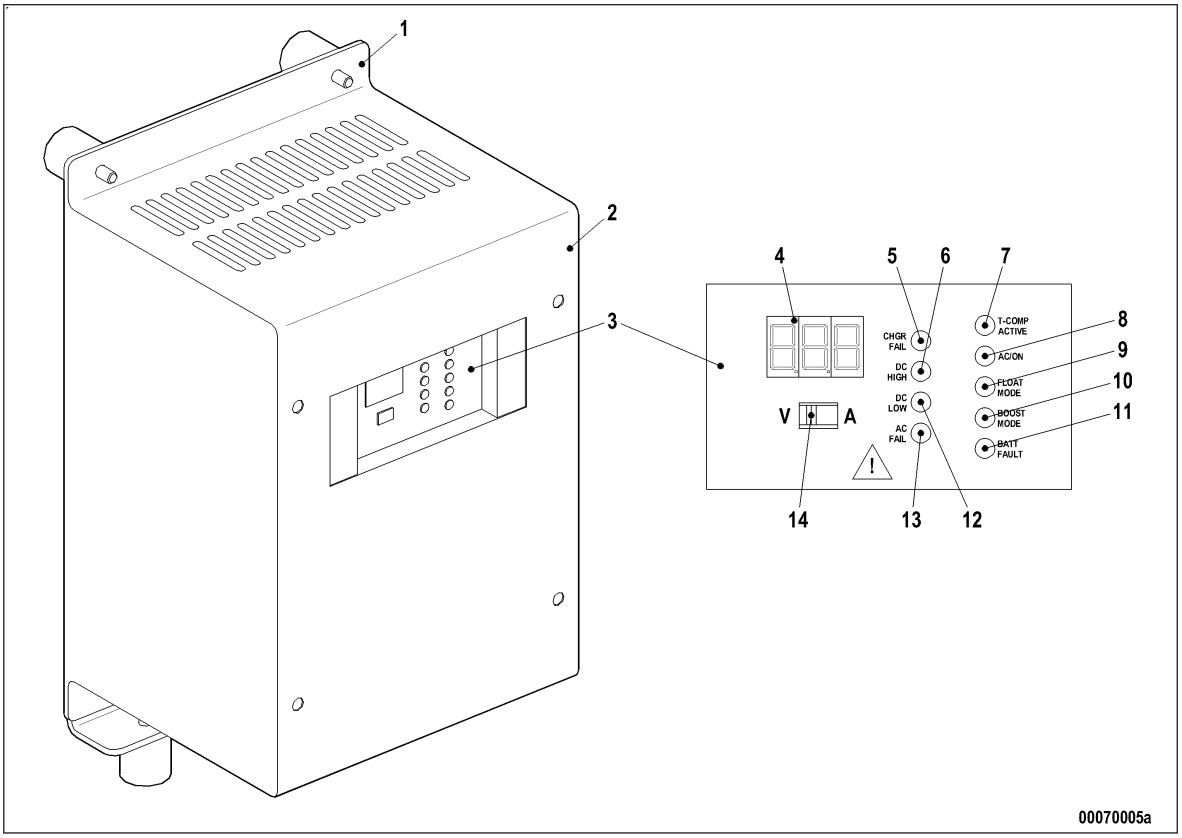


Figure 26: Battery charger

1 Mounting bracket
2 Battery charger box
3 Diagnostic display
4 DC Volt/Ampere meter display
5 RED for internal charge failure
6 RED for excessive battery voltage
7 GREEN for temperature-corrected charge voltage
8 GREEN for normal AC input
9 GREEN for normal voltage (float charge)
10 YELLOW for boost voltage (fast charge)
11 RED for open, wrong voltage, or reversed battery
12 RED for low battery voltage
13 RED for low or missing AC input
14 Meter mode selector

Technical data

- c-UL-us listed to UL 1236
- CSA standard 22.2 no. 107.2
- CE marked (50/60 Hz units) to EN 60335
- Single phase input: 110/120, 208/240 VAC
- DC output: 24 V nominal
- Operating temperature: -20 to 60 °C (-40 to 140 °F); meets full specification from -20 to 45 °C (-4 to 113 °F)
- Humidity 5 to 95%, non-condensing
- Vibration resistance to UL 991, Class B
- Lightning transient immunity to ANSI/IEEE C62.41 Cat. Band EN 50082-2 heavy industrial
- EN 61000-6-2 Seismic Certification IBC 2000, 2003, 2006, 2009

TIM-ID: 0000000150 - 010

Benefits

- Easy field adjustments for any battery
- Complete system status and diagnostics
- Enabled or disabled automatic fast charging
- Enabled or disabled automatic temperature compensation, or installation of optional remote temperature sensor
- Dead battery charge feature
- Worldwide operating voltage and frequency ranges
- Float and boost voltage electronically controlled with a fast charge program

Function

Float and boost voltage are selectable at install per specific battery vendor recommendations. Remote temperature compensation is responsible for accurate float and boost voltage control and to match the negative temperature coefficient of the battery. The output voltage increases slightly as the temperature decreases and vice versa.

The output voltage is clamped at 0 and 40 °C (32 and 104 °F) to protect against high or low output voltage. The battery charger can operate in automatic 4-rate fast charge program, so float and boost voltage are electronically controlled.

Display and alarm system

The display and alarm system gives the complete system status and diagnostics available. Optional alarm system "C" exceeds NFPA-110 requirements. The digital meter works accurately to +2% voltage and +5% amperes.

The battery charger issues a battery fault alarm if one of the following errors occur:
- Battery disconnected
- Polarity reversed
- Mismatched charger/battery voltage
- Open charger to battery connection
- Open battery cell
- Excessive internal resistance

Charger protection

The charger is protected from the following faults and installation errors:
- Reverse battery connection
- Powering up into a shorted battery
- Powering up with the wrong voltage setting (24 V charger with 12 V battery)
- Powering up into an open battery (battery not connected)
- Internal power component failures
- Overheating (over temperature output power reduction)
- Protected against power line transients and surges

TIM-ID: 0000000150 - 010

4.12.3 Circuit breakers

Circuit breakers are electrical switches designed to protect electrical systems from damage caused by overloads, short circuits, and ground faults. All circuit breakers open (break) and close a circuit by nonautomatic means and open (break) the circuit automatically on a predetermined overcurrent. Electronic trip case circuit breakers use an electronic trip system to signal the circuit breaker to open automatically.

The figure (→ Figure 27) shows a P-frame circuit breaker. Visual appearance and configuration may vary depending on the unit.

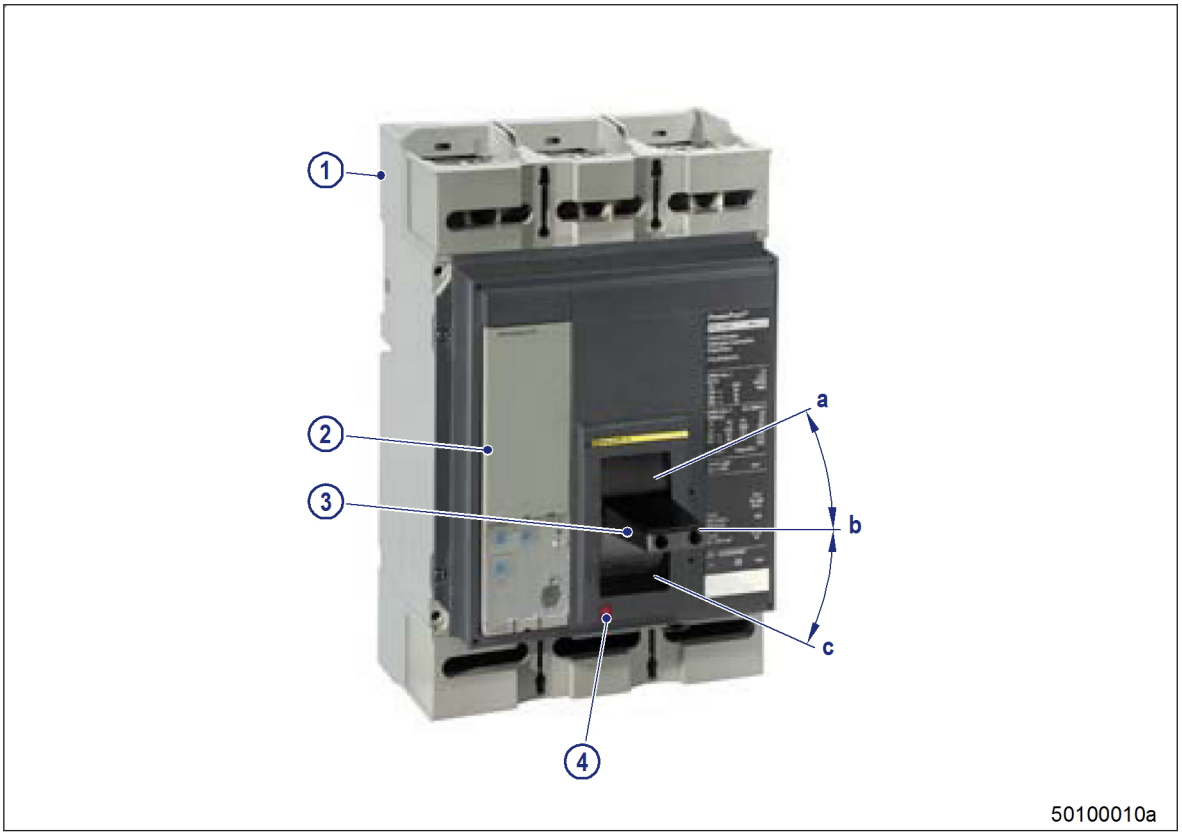


Figure 27: Circuit breaker P-frame

1 Case and mounting support
2 Trip unit
3 Handle
4 Release key
a I (ON) position
b Tripped position
c O (OFF) position

Technical data

- Brand: Square-D, 80% and 100% rated; 600 V, electronic trip circuit breakers
- Breaker models from 20 to 2,000 A with diverse frames and trip units
- Manually operated circuit breakers
- 3-pole
- Trip units:
  - Basic magnetic trip elements
  - Built-in electronic trip units
  - Micrologic trip units
- Molded case made of a glass-reinforced insulating material (thermal set composite resin) provides high dielectric strength
- UL Listed and CSA Certified; conforms to UL 489 and CSA C22.2 No. 5
- Meets IEC 60947-2 requirements; CE marking provided
- True RMS sensing devices

There are many different circuit breaker models available. For detailed information about circuit breakers for your system, contact your local MTU Onsite Energy distributor or dealer.

TIM-ID: 0000064774 - 001

Benefits

- Flexible connection capabilities
- High interrupting ratings and field-installable accessories in a small package

Function

Manually operated circuit breakers

Manually operated circuit breakers have a single operating handle (3) that acts directly through the operating mechanism against the contact blades. Multi-pole circuit breakers have a common trip bar for positive action of all poles on manual and automatic operation. These circuit breakers have a trip-free mechanism that allows them to trip even though the operating handle may be restricted (by a handle operating mechanism or padlock attachment) in the I (ON) position.

If not restricted, the operating handle moves to a position between I (ON) and O (OFF) when the circuit breaker is tripped (see handle positions a, b, and c in the figure).

The face of the manually operated circuit breakers is marked with standard ON/OFF and international I/O markings to indicate handle position. In addition, the I (ON) portion of the circuit breaker handle is color coded green.

Push-to-trip button

The push-to-trip button located on the face of each manually operated circuit breaker is a standard feature. It provides the ability to manually trip the circuit breaker without risking exposure to live parts. During normal ON-OFF operation, the handle opens and closes the circuit breaker contact, but does not exercise the tripping mechanism. The push-to-trip button can be used to exercise the circuit breaker mechanism and to check the auxiliary and alarm switch circuits.

Trip system

Trip units are designed to protect power circuits and loads.

The trip system causes the circuit breaker to open automatically under overload, short-circuit, or equipment ground-fault conditions. Electronic trip circuit breakers give the customer more versatility to achieve coordination with features such as adjustable instantaneous pickup and high withstand ratings.

The trip system consists of a set of current transformers (CTs or sensors) to sense current, a trip unit to evaluate the current, and a tripping solenoid (tripping coil) to trip the circuit breaker. The tripping coil is a flux transfer solenoid that requires no external power source. All protective functions are completely fault powered.

Magnetic trip element (available with H and J frames)

Magnetic trip elements provide short circuit protection. The circuit breakers use a magnetic actuator to trip the circuit. The current flow through the electrical device passes through an electromagnetic actuator. When the current flow reaches a preset level (determined by the current rating of the circuit breaker), the magnetic field in the electromagnet is strong enough to trip the breaker and allow the contacts to open. The current flow stops. This type of breaker generally has to be manually reset.

ET electronic trip system (available with H, J, L, and P frames)

The built-in electronic trip unit provides better accuracy than standard thermal-magnetic trip units. It is handled via calculations instead of bending metal, cannot be field replaced, and does not allow adjustment of the trip point setting.

Electronic trip circuit breakers provide:

- Overload and short-circuit protection
- Means to manually disconnect power to the circuit
- Enhanced coordination by their adjustability
- High interrupting ratings and withstand ratings

TIM-ID: 0000064774 - 001

Micrologic electronic trip system (available with H, J, L, and P frames)

Different models are available. The figure (→ Figure 28) shows a 6.0P model as an example.

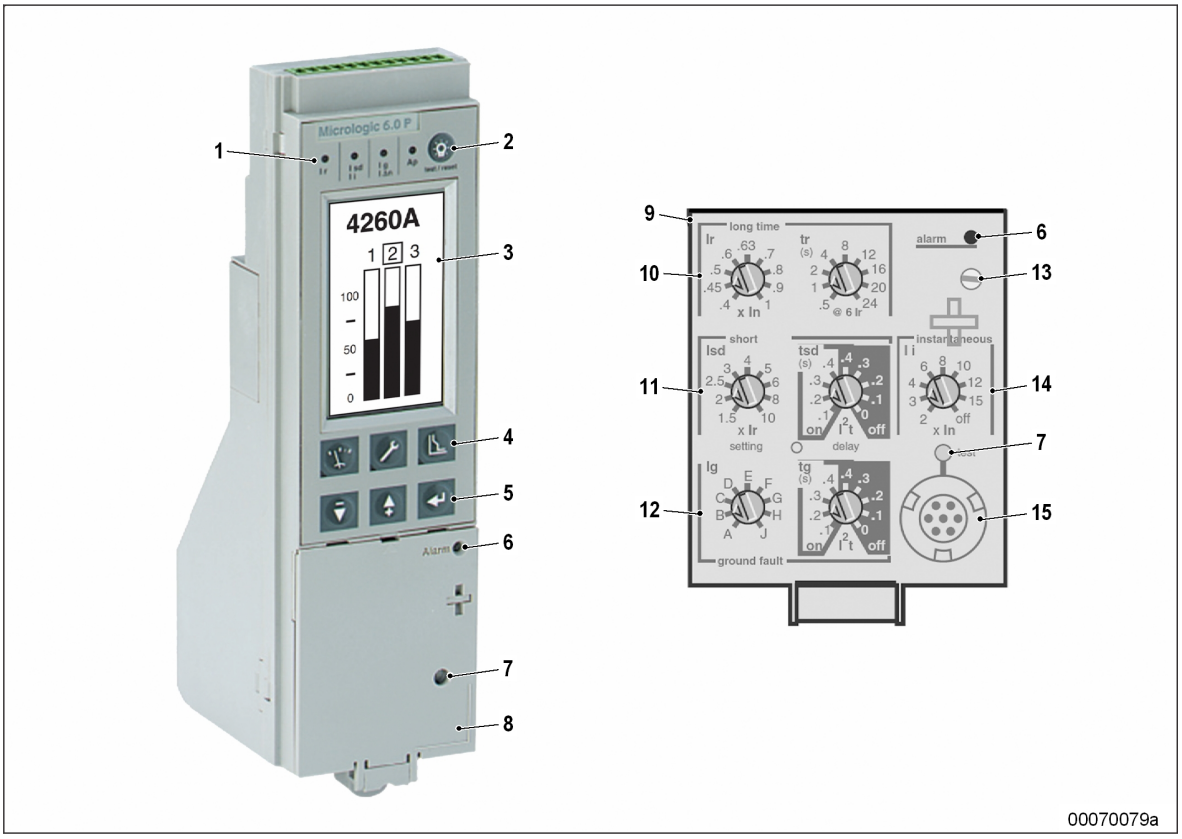


Figure 28: Circuit breakers – Trip unit Micrologic 6.0P

1 Indications of tripping cause (LED)
2 Test lamp (LED) and reset
3 Graphics display
4 Menu access buttons
5 Navigation/value set and confirm buttons
6 Alarm indicator "Overload" (LED)
7 Electronic push-to-trip button
8 Cover for adjustment dials
9 Adjustment dials
10 Long-time current setting and tripping delay
11 Short-time pickup and tripping delay
12 Ground-fault pickup and tripping delay
13 Long-time rating plug screw
14 Instantaneous pickup
15 Test connector

Features found in Micrologic electronic trip circuit breakers, such as adjustable rating plugs, adjustable long-time pickups, and 100% ratings also provide capacity for future growth.

The integral equipment ground fault sensing capabilities available with Micrologic trip systems mean that there are fewer parts and pieces to purchase, mount, and wire. These capabilities include integral ground-fault protection for equipment (which causes the circuit breaker to trip when a ground fault is detected) as well as integral ground-fault alarm (which does not trip the circuit breaker, but sends an alarm when a ground fault is detected).

Adjustable rotary switches on the trip unit allow the user to set the proper overcurrent or equipment ground-fault current protection required in the electrical system. If current exceeds a set value for longer than its set time delay, the trip system opens the circuit breaker. Alarms may be programmed for remote indications. Measurements of current, voltage, frequency, power, and power quality optimize continuity of service and energy management.

Different models are available with progressively increasing levels of functionality, from basic overcurrent protection to advanced protection, communications, and power metering/monitoring.

The table shows a choice of available Micrologic trip units and its characteristics:

TIM-ID: 0000064774 - 001

Features of Micrologic trip unit	3.0	5.0	5.0P	6.0P
Overload and short-circuit protection	✔	✔	✔	✔
Thermal imaging (active thermal imaging before and after tripping)	✔	✔	✔	✔
Means to manually disconnect power to the circuit	✔	✔	✔	✔
LED for long-time pickup	✔	✔	✔	✔
LED for trip indication	–	–	✔	✔
Support of an optional communication network with four wire Modbus, RTU, RS485; including event recording	–	–	✔	✔
Short time protection	–	✔	✔	✔
Long time and instantaneous protection	✔	✔	✔	✔
Ground fault protection for equipment: • Residual ground fault protection • Source ground-return ground fault protection • Modified differential ground fault protection	–	–	–	✔
Neutral protection	–	–	✔	✔
Enhanced coordination for adjustability, fine-tuning of settings	–	–	✔	✔
Ammeter for metering the true RMS value of currents	–	–	✔	✔
Phase loading bar graph	–	–	✔	✔
Power metering and monitoring • calculates in real time all electrical values: V, A, W, VAR, VA, Wh, VARh, VAh, Hz, power factor, and crest factor • calculates demand current and demand power over an adjustable time period	–	–	✔	✔
Zone-selective interlocking (ZSI) which can reduce damage in the event of a fault	–	–	✔	✔
Protective relaying functions	–	–	✔	✔
Contact wear indication	–	–	✔	✔
Trip and alarm histories of the last ten trips and ten alarms; recorded in two separate history files; can be displayed on the screen	–	–	✔	✔

TIM-ID: 0000064774 - 001

4.13 Base and Mounting System

4.13.1 Base and mounting system

The base frame provides support for all components of the engine-generator set.

The figure (→ Figure 29)shows a typical open power unit (OPU) base frame with mounts. Depending on the size of engine, generator, and radiator, the base frame can differ in its dimensions and number and location of cross members and resilient mounts. A base frame for a housed power unit (HPU) differs in its appearance but not in its function.

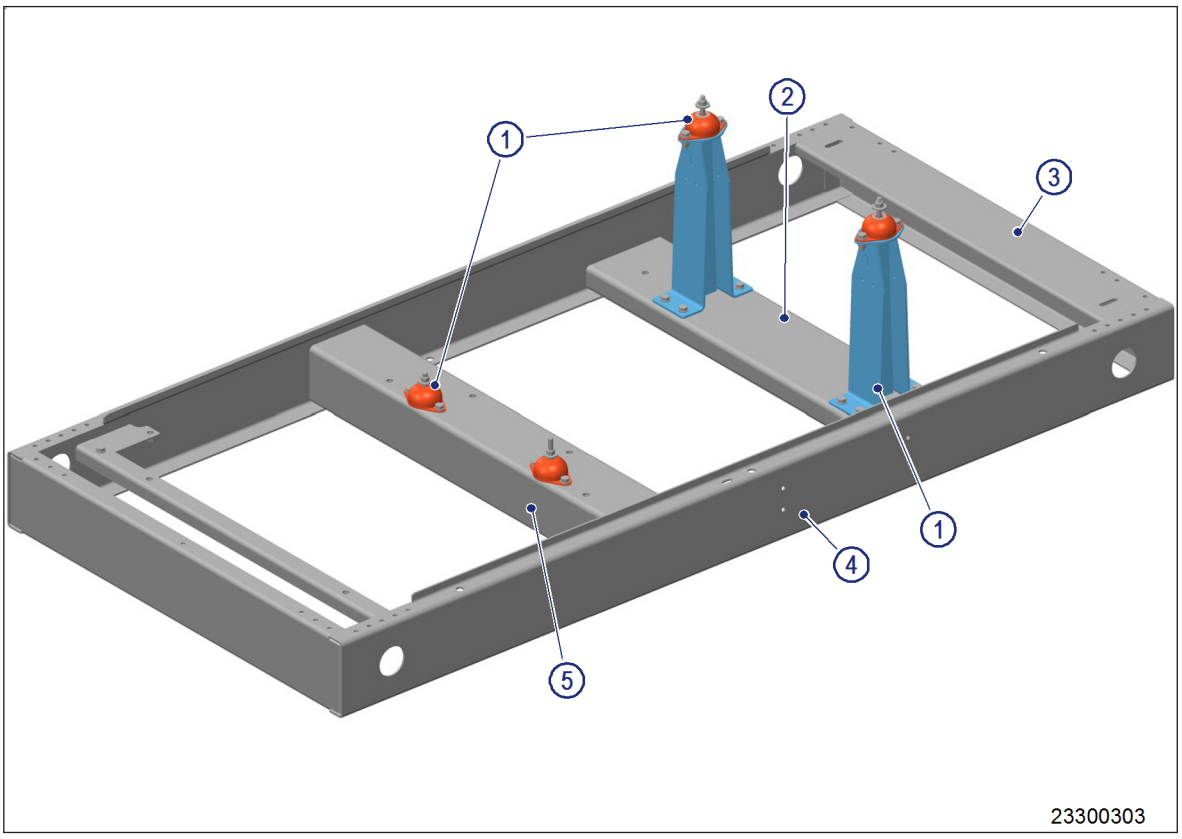


Figure 29: Base frame with mounts

1 Resilient mounts – engine and generator
2 Engine cross member
3 Radiator cross member
4 Side channel – left and right
5 Generator cross member

The base frame is a steel structure and consists of two side channels (4) and several cross members (2, 3, 5). The cross member for the generator (5) is fitted with resilient mounting elements (1). The cross member for the diesel engine (2) is fitted with engine mounts and resilient mounting elements (1). The unit-mounted radiator is mounted directly on the radiator cross member (3).

Technical data

- Welded steel structure
- Resilient mounting elements for diesel engine and generator

Benefits

- One common base to facilitate engine-generator set transportation
- Easy access to all major components
- Optimization of vibrational characteristics

TIM-ID: 0000062110 - 001

4.14 Enclosure

4.14.1 Enclosure

The engine-generator set enclosure consists mainly of a steel or aluminum housing that provides protection from the elements and/or sound attenuation.

The figures (→ Figure 30) (→ Figure 31)show in overview the components of an engine-generator set enclosure.

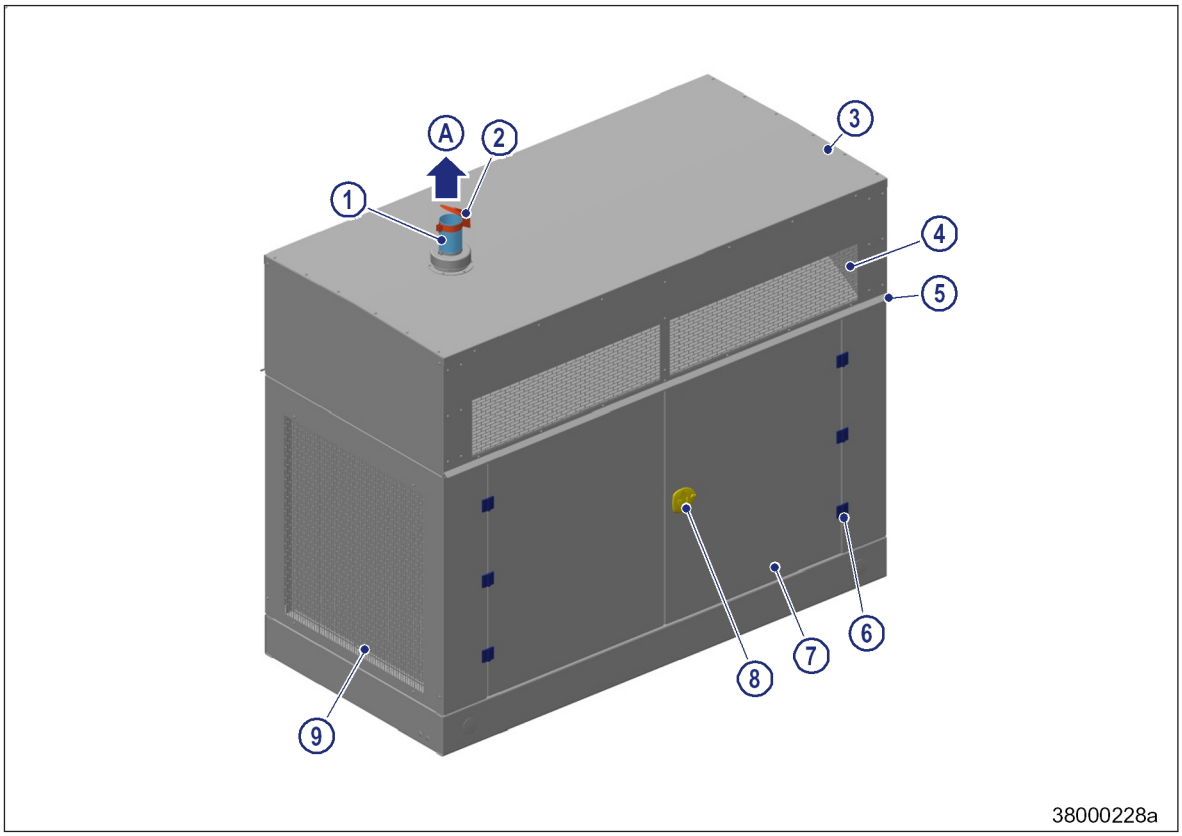


Figure 30: Enclosure

1 Exhaust pipe
2 Flapper rain cap
3 Pitched enclosure roof
4 Air intake
5 Drip rail
6 Aluminum hinge
7 Rubber sealed door
8 Lockable door handle
9 Air outlet grid
A Exhaust gas

TIM-ID: 0000062111 - 001

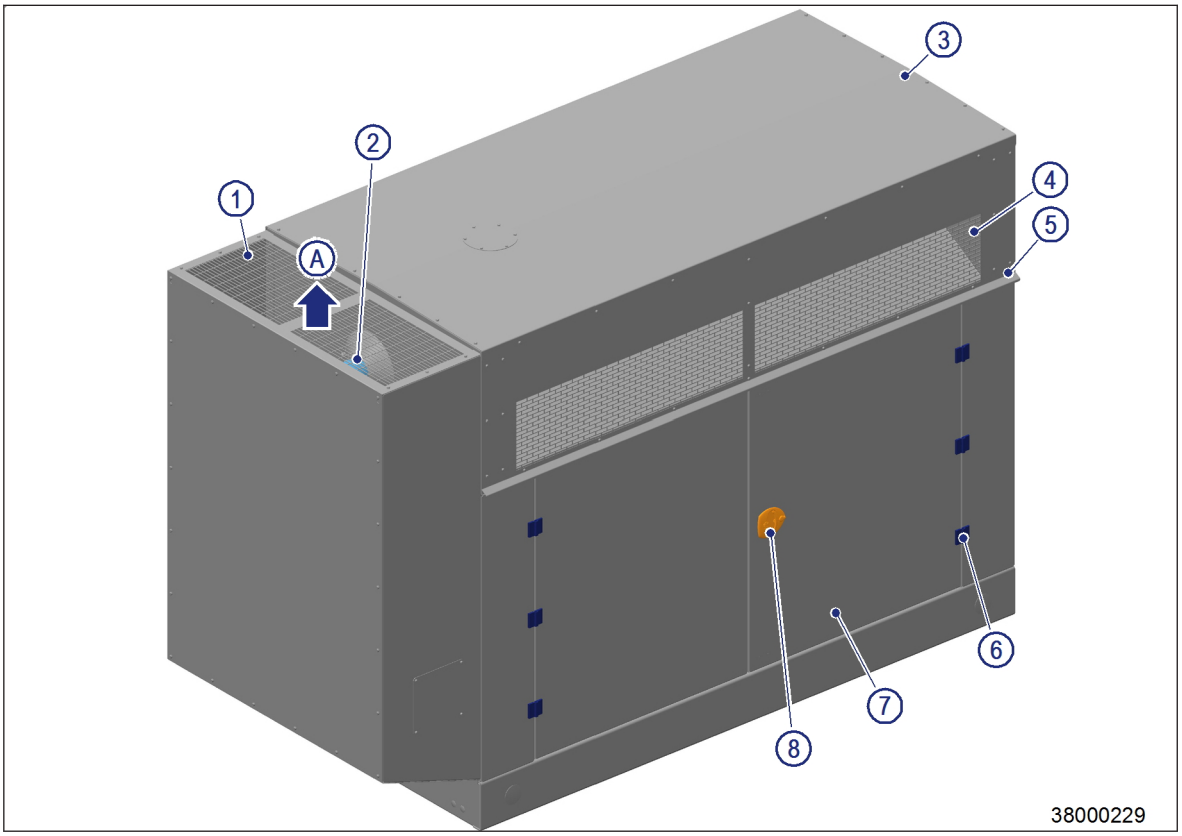


Figure 31: Enclosure with scoop

1 Air outlet grid
2 Exhaust pipe
3 Pitched enclosure roof
4 Air intake baffles
5 Drip rail
6 Aluminum hinge
7 Rubber sealed door
8 Lockable door handle
A Exhaust gas

Standard features

- Modular construction
- Bolted panels
- Fixed air intake baffles
- Punched air outlet grid
- Radiator ducted to enclosure air outlet
- Pitched enclosure roof
- Heavy-gauge steel construction
- Powder-baked primer
- Aluminum hinges and latches
- Recessed and lockable door handles
- Rubber sealed doors

Available options

- Aluminum
- LED light package
- Exhaust scoop
- Sub-base and cross member for engine-generator set
- Door restraints

Technical data

- Steel construction
- Aluminum construction (optional)

TIM-ID: 0000062111 - 001

Enclosure level identification	
Level 1:	Skid-mounted weather-protective enclosure constructed of heavy gauge steel or aluminum with fixed stormproof panels designed for 190 mph wind load rating. Enclosure consists of a bolted and welded construction with unit-mounted internal muffler. Hinged, lockable double-door access on both sides of the enclosure.
Level 2:	Level 1 enclosure with UL 94 HF-1 compliant, 1.5" thick sound attenuated foam insulation installed inside enclosure walls.
Level 3:	Level 2 enclosure with air exhaust scoop. UL 94 HF-1 compliant, 1.5" thick sound attenuated foam insulation installed in scoop.

Table 2: Enclosure levels

Benefits

- Modular construction allows design flexibility to meet different field conditions.
- Bolted panels may be easily removed for service, field replacement, and even modifications.
- Steel construction provides a durable, resilient structure.
- The pitched roof prevents water accumulation.
- Powder coating provides a durable weather-resistant finish, assuring years of corrosion-free service.
- Aluminum hinges and latches are corrosion-resistant and endure through harsh weather conditions.
- Lockable door handles provide security by preventing unauthorized access.
- Door gaskets prevent water and moisture from entering the enclosure and simultaneously minimize noise.
- Optional aluminum construction provides a superior corrosion resistance in salt spray or alkaline environment.

Function

Air enters through the air intake baffles (4) and flows to the engine for both intake and cooling. Air exits from the air outlet grid (1) and exhausts gas (A

) through the exhaust pipe (2). The pitched enclosure roof (3), the flapper rain caps (if applicable), drip rails (5), and sealed doors (7) keep water and other elements from entering the enclosure. The doors on both sides allow access to each component of the engine-generator set. To protect the engine-generator set from unauthorized access, the doors can be locked.

TIM-ID: 0000062111 - 001

5 Engine Generator Set Basic Operations

5.1 Lockout/tagout procedure

Preconditions

☑ Engine is not running and controls are in "OFF" position.

☑ Engine starting circuit is disabled.

DANGER

Not completely de-energized systems can contain parts under high voltage. Live components and connections.
Risk of burns or death from electric shock!
- Disconnect all electrical power.
- Lockout and tagout the equipment before removing protective shields for service or maintenance.

DANGER

Manipulation of interlocks on parts under high voltage. Live components and connections.
Risk of burns or death from electric shock!
- Do not tamper with any interlocks in the system.

DANGER

High voltage. Live components and connections.
Risk of burns or death from electric shock!
- Disable the engine start contact leads from the engine-generator set control panel.
- Do not disconnect the engine start contact leads from the transfer switch enclosure.

DANGER

Circuit breakers are live components.
Risk of burns or death from electric shock!
- Ensure all circuit breakers are placed in the "OPEN" position prior to and while servicing the engine-generator set.

DANGER

Battery charger is a live component.
Risk of burns or death from electric shock!
- Wait at least 30 seconds after removing power source from the battery charger prior to servicing the engine-generator set.

WARNING

Rotating and moving parts and high level of engine noise in the event of unexpected engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped.
- Ensure the control panel is in "OFF" position to disable starting during service.
- Disconnect the battery charger prior to service.

WARNING

Hot components/surfaces.
Risk of burns!
- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

TIM-ID: 0000000257 - 016

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries are live parts.
Risk of electric shock!
- Take care when disconnecting battery cables.
- Remove the negative side of the battery first.

NOTICE

Surge when using insufficient fuses.
Damage to engine-generator set!
- Make notes from where each fuse is removed, and keep these notes until reinstallation.
- Ensure to install the correct fuses in each slot of the control panel and the battery charger.

Note: The instructions in this section are general and cannot reflect all possible control and electrical configurations (control panel, circuit breaker, etc.).

General recommendations

- MTU Onsite Energy strongly recommends documenting the particular starting procedure applicable to your system during commissioning.
- All commissioning personnel should attend the commissioning training for operators offered at the authorized training center for their specific region.

Facility battery charger

1. Remove AC power source from battery charger.
2. Remove the battery charger fuses.
3. Open the circuit breaker supplying AC power to the battery charger.

Battery

1. Disconnect the negative lead from battery terminal.
2. Tag "DO NOT OPERATE" or similar warning label, and secure lock.

Automatic transfer switch (if fitted)

1. Open the engine-generator set control panel door.
2. Remove the panel fuses.
3. Remove the generator start contact leads supplied from remote start.
4. Install protective cover to exposed lead ends.
5. Secure loose leads away from circuit boards and other electronic devices.
6. Close the engine-generator set control panel door.
7. Add lock and tag to panel door to indicate Lockout/Tagout condition.

TIM-ID: 0000000257 - 016

Engine-generator set controls

1. Push the EMERGENCY STOP button to lockout the engine-generator set.

Note: This causes the alarm to sound. There is another button which functions to silence the alarm. Depending on your panel configuration, this button is called ALARM SILENCE, ACK, etc.

2. Press this button to silence the alarm.
3. Add lock and tag to panel door to indicate Lockout/Tagout condition, if not in place.

Main circuit breaker(s)

1. Move circuit breaker handle into the "OPEN" position.
2. Tag "DO NOT OPERATE" or similar warning label.
3. For multiple breakers, repeat the two previous steps.

TIM-ID: 0000000257 - 016

5.2 Unlocking procedure

Preconditions

☑ Engine is not running and controls are in "OFF" position.

☑ Engine starting circuit is disabled.

DANGER

High voltage. Live components and connections.
Risk of burns or death from electric shock!
- Disable the engine start contact leads from the engine-generator set control panel.
- Do not disconnect the engine start contact leads from the transfer switch enclosure.

DANGER

Circuit breakers are live components.
Risk of burns or death from electric shock!
- Ensure all circuit breakers are placed in the "OPEN" position prior to and while servicing the engine-generator set.

DANGER

Battery charger is a live component.
Risk of burns or death from electric shock!
- Wait at least 30 seconds after removing power source from the battery charger prior to servicing the engine-generator set.

WARNING

Rotating and moving parts and high level of engine noise in the event of unexpected engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped.
- Ensure the control panel is in "OFF" position to disable starting during service.
- Disconnect the battery charger prior to service.

WARNING

Rotating and moving parts and high level of engine noise in the event of unexpected engine-generator set start after service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the control panel is in "OFF" position prior to reconnecting the negative terminal of the battery.

WARNING

Batteries are live parts.
Risk of electric shock!
- Take care when disconnecting battery cables.
- Remove the negative side of the battery first.

NOTICE

Surge when using insufficient fuses.
Damage to engine-generator set!
- Make notes from where each fuse is removed, and keep these notes until reinstallation.
- Ensure to install the correct fuses in each slot of the control panel and the battery charger.

Note: The instructions in this section are general and cannot reflect all possible control and electrical configurations (control panel, circuit breaker, and so on).

TIM-ID: 0000000270 - 014

General recommendations

- MTU Onsite Energy strongly recommends to document the particular starting procedure applicable to your system during commissioning.
- All commissioning personnel should attend the commissioning training for operators offered at the authorized training center for their specific region.

Automatic transfer switch (if fitted)

1. Remove lockout tag and lock.
2. Open the engine-generator set control panel door.
3. Remove protective cover to exposed lead ends.
4. Reinstall the generator start contact leads supplied from remote start.
5. Reinstall the panel fuses.
6. Close the engine-generator set control panel door.

Engine-generator set controls

1. Twist and pull the EMERGENCY STOP button to reset.
2. Remove lock and tag.
3. Set the control panel to the requested operating mode.

Battery

1. Remove lock and lockout warning label.
2. Remove lead cap from negative lead.
3. Connect negative lead to negative battery terminal.

Result: This starts the panel boot process which causes the alarm to sound.

Note: There is a button which functions to silence the alarm. Depending on your panel configuration, this button will be called ALARM SILENCE, ACK, and so on.

4. Press this button to silence the alarm.

Facility battery charger

1. Close the circuit breaker supplying AC power to the battery charger.
2. Reinstall the battery charger fuses.
3. Reinstall AC power source from the battery charger.

Main circuit breaker(s)

1. Remove tag "DO NOT OPERATE" or similar warning label, and secure lock.
2. Set the circuit breaker(s) according to the applicable configuration. Note the "General recommendations" above.

Final step

▶ Test the engine-generator set through normal exercise procedure (→ Page 224).

TIM-ID: 0000000270 - 014

5.3 Putting the engine-generator set into operation after extended out-of-service-period

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

☑ Ensure that the Mercedes-Benz OM924-926LA engine manual is available.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000064937 - 001

Additional tasks to be carried out before operation after extended out-of-service-period (> 3 months)

Item	Task
Engine	Refer to recommissioning instructions in the Mercedes-Benz OM924-926LA engine manual(→ Page 531)
Cooling system	If engine is out of service for more than one year, change engine coolant (→ Page 531) (→ Page 533).

Checks to be carried out before operation

Item	Task
Engine-generator set location	Ensure that the location is clean of all debris and flammable or combustible material.
Engine-generator set	Check for dirt, leaks, and loose or contaminated wire connections. Carry out visual inspection for loose / missing fasteners and leaks. Clean, repair, and tighten, if necessary. Ensure that inlets and outlets, screens, and protection guards are clean and free of obstructions. Ensure that all needed fuel and cooling line valves are open, and drain valves are closed.
Engine	Check drive belt (→ Page 277). Check engine wiring (→ Page 277) . Check engine governor plug-in connection (→ Page 277).
Fuel system	Check fuel level in tank. If equipped with day tank, check for proper annunciator and alarm operation. Check tank fuel line connection, tank gauges, and alarms. Check tank for signs of rust. Check fuel lines for leaks, chafing, or dry rotting. Drain fuel prefilter with water separator (→ Page 220). Check fuel filter housing for leaks. Vent fuel system (→ Page 277).
Air system	Check air filters (signal ring position of service indicator)(→ Page 223). Check air filter assembly for dirt and debris. Check intake manifold for cracks and missing hardware.
Exhaust system	Check for leaks and missing hardware. If equipped with heat shields, check for missing / damaged heat shields.
Exhaust silencer, if fitted	Check flex pipe for crack and signs of leakage. Check for corrosion and leaks. Check rain cap for damage and proper fit.
Lube oil system	Check oil level (→ Page 429). Check for oil leaks.
Cooling system	Check engine coolant level (→ Page 529). Take coolant sample and analyze (pH value, antifreeze concentration, corrosion inhibitor concentration). Check coolant lines and connections for traces of coolant leaks. Check radiator expansion tank and pressure cap. Check radiator inlet / outlet lines and hoses. Check radiator cooling fins for debris, leaks, and corrosion. Ensure that no more than 20% of radiator cooling fins are blocked or clogged. Check preheater (jacket water heater) for leaks.
Starter batteries	Check and clean battery terminals and post. Check battery electrolyte level. Check batteries state of charge (perform load test) and charge, if necessary.

TIM-ID: 0000064937 - 001

Item	Task
Battery charger	Check shore power / incoming voltage to battery charger. Check annunciation terminal wires. Check charge flow rate, charging amps, and battery voltage.
Customer control system	Carry out a lamp test or similar test for general functionality, refer to the customer control system documentation. Test switches for operation. Check wiring for chafing and frayed wires inside panel. Check vibration dampers for cracks and dry rotting. Ensure that control panel is clean from debris. Verify that there are no fault messages.
Engine-generator set control panel	Press LAMP TEST push button to carry out a lamp test. Test switches for operation. Check wiring for chafing and frayed wires inside panel. Check vibration dampers for cracks and dry rotting. Ensure that control cabinet is clean from debris.
Remote annunciator, if fitted	Test alarm lights. Check wiring to annunciator. Check shore power wiring to annunciator.
Circuit breaker(s), if fitted	Check proper operation of breaker(s) and trip mechanism. Check lug terminals and load cables.
Generator anti-condensation heaters, if fitted	Ensure that engine-generator sets operating in a high humidity region are equipped with anti-condensation heaters (600 VAC and above - standard). Ensure that wiring on heaters is not chafed or frayed and that the voltage supplied to the heaters is correct. If the engine-generator set has been out of service for an extended time, allow heaters to operate 24 to 48 hours before operating the engine-generator set.
Rotating rectifier / main rotor assembly	Check diodes to ensure they are secure. Check that rotating exciter wiring and shaft wiring are not chafed or frayed. Check stator windings and field wires F1/F2. Check main stator and rotor winding insulation coating. Check generator housing for debris and clean as needed. Check generator terminals, e.g. T0, T1, T2, and T3.
Phase bar / isolators (if fitted)	Check bars and isolator terminal connections. Check isolators for loose fitting and cracks.
Voltage regulator	Check sensing leads and field leads for frayed or loose connection. Check wiring for PMG for loose or frayed connection (→ Page 243). Check vibration damper.
Automatic transfer switch, if fitted	Check utility / emergency load connection cable. Check transfer switch control wiring. Check controller lights for proper annunciation. If transfer switch is outdoor type: Ensure that heat strips are working correctly and check wiring. Ensure that transfer switch cabinet is clean of debris.
Engine governor, if fitted	Verify that there are no fault messages.

Putting the engine-generator set into operation

Item	Task
Engine-generator set	Perform unlocking procedure (→ Page 136).
Engine-generator set location	Start ventilation fan or open the doors / windows if engine-generator set is located in a closed space. Ensure room ventilation functions properly.

TIM-ID: 0000064937 - 001

Item	Task
Cooling system	Preheat coolant with preheater (jacket water heater). Ensure proper coolant operating temperature.
Customer control system	Select operating mode, e.g. automatic, manual mode, refer to the customer control system documentation.
Engine-generator set control panel	Select operating mode: • Press AUTO push button to select automatic operation (AUTO mode). • For manual operation, no further activity is required.

TIM-ID: 0000064937 - 001

5.4 Automatic start and stop

Preconditions

☑ Engine-generator set is in AUTO mode.

☑ A remote control is enabled.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

Automatic start

1. The engine-generator set is in standby (AUTO mode) and starts on request only (remote control).
2. If an electrically operated (motorized) circuit breaker is fitted, the digital generator set control panel delivers a pulse or a continuous signal to close the circuit breaker automatically under certain conditions. These conditions include the generator being stable, and no fault conditions are active (failed or a global alarm).

Note: Manual operation is only required if a manually operated circuit breaker is fitted.

3. If a manually operated circuit breaker is fitted, switch on the circuit breaker manually using the appropriate push button under certain conditions. These conditions include the generator being stable, and no fault conditions are active (failed or a global alarm).

Result: The circuit breaker is in ON position (closed). From this point on, the engine-generator set supplies power to the load until automatic stop is executed or a failure occurs.

Note:
- The generator circuit breaker (GCB) is used only for protection and is not used for control.
- For any information about the third-party ATS, refer to the manufacturer's documentation.

Automatic start with electrically operated (motorized) GCB

1. Ensure that the GCB is in OFF position (open).
2. The engine-generator set is in standby (AUTO mode). The ATS starts the engine-generator set automatically if one of the programmed events occur:
   - A power outage occurs.
   - A test run is started.
3. The digital generator set control panel delivers a pulse or a continuous signal to close the GCB automatically under certain conditions. These conditions include the generator being stable, and no fault conditions are active (failed or a global alarm).

Result: The GCB is in ON position (closed). From this point on, the engine-generator set supplies power to the load until automatic stop is executed or an engine failure occurs.

Automatic start with manually operated GCB or without GCB

1. Ensure that the manually operated GCB is in ON position (closed).
2. The engine-generator set is in standby (AUTO mode). The ATS starts the engine-generator set automatically if one of the programmed events occur:
   - The normal voltage does not meet specified requirements.
   - A test run is started.

Result: After the generator became stable, the ATS control system switches over the transfer switch. The engine-generator set supplies power to the load until automatic stop is executed or an engine failure occurs.

TIM-ID: 0000056800 - 001

Automatic stop

1. If the engine-generator set started via remote control, it will automatically stop after the remote control contact is open.
   a) If the engine has run with load, it should cool down before shutdown: The engine runs unloaded until the cool-down timer has expired.
   b) If during this time the remote control contact is reclosed, the circuit breaker closes and the cool down timer is reset.
2. If an electrically operated (motorized) circuit breaker is fitted, it switches open automatically.
3. If a manually operated circuit breaker is fitted, switch off the circuit breaker manually using the appropriate push button on the circuit breaker.

Result: The circuit breaker is in OFF position (open). After stopping, the engine-generator set is in standby (AUTO mode) again.

Automatic stop with ATS

▶ If an ATS started the engine-generator set, the engine-generator set will automatically stop after the normal voltage or power source returns. Also, the engine-generator set will automatically stop after a test run ends and time delays has been satisfied.

Result:
- If fitted: The electrically operated (motorized) GCB is in OFF position (open).
- After retransfer to the normal power source, a time delay begins to keep the engine running for a cool-down period. After the cool-down period, the ATS signals the engine-generator set to shut down. All circuits are reset for any future normal power source failure.
- After stopping, the engine-generator set is in standby (AUTO mode) again.

TIM-ID: 0000056800 - 001

5.5 Manual start

Preconditions

☑ Engine-generator set is ready for operation.

☑ Load leads are properly connected to the network.

☑ Load to transfer is available.

☑ Circuit breaker is in OFF position (open).

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Note: The start procedure is to be controlled by an external controller (customer control system). Observe strictly the instructions of the customer control system documentation.

Start

▶ For the start procedure, refer to the customer control system documentation.

Note: The generator circuit breaker (GCB) is used only for protection, and is not used for control.

Starting the engine-generator set manually

1. Switch the generator circuit breaker (GCB) to OFF position.
2. Press the RUN push button to activate the system and start the engine.

Result:
- After a few seconds, the engine starts. The starter motor disengages when the engine reaches a sufficient speed.
- After another few seconds, the engine-generator set will reach the rated speed.

3. When the generator becomes stable and no fault conditions are active (failed or a global alarm), switch on the GCB by pressing the appropriate push button.

Result:
- The generator circuit breaker is in ON position (closed).

4. If using a third-party ATS, execute the appropriate steps to transfer the load from the main to the generator. Refer to the manufacturer's documentation of the ATS for further information.

Result:
- The switch transfers the load from the main (normal) to the generator (emergency).

5. The engine-generator set supplies power to the load until manual stop is executed or an engine failure occurs.

TIM-ID: 0000056801 - 001

5.6 Manual stop

Preconditions

☑ Engine-generator set is operating and supplies power to the load.

☑ Engine-generator set is not in AUTO mode.

☑ Engine-generator set circuit breaker is in ON position.

☑ Automatic transfer switch has switch to the emergency (generator side).

WARNING

Rotating and moving parts during operation.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Ensure that all protective guards and covers are installed.
- Take care when working around moving belts and rotating parts near or on an operating engine-generator set.
- Do not tamper with moving or rotating parts.
- Wear close-fitting clothes and hairnet.
- Remove watches, rings and other metal objects.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

NOTICE

Stopping the engine when it is running at full load subjects it to extreme thermal and mechanical stresses.
Overheating of and, therefore, damage to components is possible!
- Before shutting down the engine, allow it to idle until the engine temperatures decrease and constant levels are indicated.

Stopping the engine-generator set manually

1. If an ATS is controlling the generator, retransfer the load from the generator to the main, and execute the appropriate steps on the ATS. Refer to the manufacturer's documentation of the ATS for further information.

Result: The switch transfers the load from the generator (emergency) to the mains (normal).

2. Press the OFF push button on the digital generator set control panel.

Result: The engine stops.

3. If an electrically operated (motorized) circuit breaker is fitted, it switches off automatically.
4. If a manually operated circuit breaker is fitted, switch off the circuit breaker manually by pressing the appropriate push button.

Result: The circuit breaker is in OFF position. The engine-generator set is in OFF mode.

TIM-ID: 0000056832 - 001

5.7 Emergency stop

Preconditions

☑ Engine-generator set is running in AUTO or RUN mode.

NOTICE

An emergency stop causes extreme stress to the engine.
Risk of overheating, damage to engine-generator set!
- Stop the engine according to the instructions in this manual.
- Initiate emergency stop only in emergency situations.

Note: The emergency stop procedure is to be controlled by an external controller (customer control system). Observe strictly the instructions of the customer control system documentation.

Emergency stop with third-party controller

▶ For the emergency stop procedure, refer to the customer control system documentation.

Emergency stop

▶ Press EMERGENCY STOP button.
Result: The engine is stopped and the alarm sounds.

After emergency stop

1. Reset the EMERGENCY STOP push button.

Result: Audible signalization stops.

2. Press ALARM SILENCE push button.

Result: Engine-generator set is in OFF mode and cannot switch on again automatically.

3. Press OFF push button.

Result: The signalization stops. The control panel is reset.

4. Execute troubleshooting.

Result: Faults which were reasons for the emergency stop must be resolved. If faults cannot be resolved, contact MTU Onsite Energy authorized Service outlet for assistance.

5. After faults are resolved, press AUTO or RUN push button, depending on desired operating mode.

Result: The engine-generator set is in standby (AUTO mode) or starts to run immediately (RUN mode).

TIM-ID: 0000056802 - 001

5.8 Exercising checks

Preconditions

☑ Engine-generator set is running and engine has reached operating temperature.

☑ Engine runs under load and at nominal speed.

DANGER

High voltage. Live components and connections.
Risk of burns or death from electric shock!
- Use extreme care when performing operational checks.

WARNING

Rotating and moving parts during operation.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Ensure that all protective guards and covers are installed.
- Take care when working around moving belts and rotating parts near or on an operating engine-generator set.
- Do not tamper with moving or rotating parts.
- Wear close-fitting clothes and hairnet.
- Remove watches, rings and other metal objects.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Note: The procedure for operational checks depends on the requirements of the particular installation and application of the engine-generator set.

Operational checks during engine-generator set operation

Item	Task
Engine-generator set	Check for abnormal running noises and vibration.
Engine-generator set control panel	Check whether the displayed operating parameters are within the limit: • For engine: oil pressure, coolant temperature, RPM, battery voltage, fuel / coolant levels, engine run time, speed • For generator: AC output voltage, current, frequency, real power (W), apparent power (VA), power factor
Air filter	Check signal ring position of service indicator (→ Page 223).
Exhaust pipework	Check exhaust color (→ Page 150).
Lube oil system	Check for oil leaks.

TIM-ID: 0000064938 - 001

Item	Task
Fuel system	Check fuel level in tank. If equipped with day tank, check for proper annunciator and alarm operation. Check pump operation. Check tank fuel line connection, tank gauges, and alarms. Check fuel lines for leaks, chafing or dry rotting.
Cooling system	Check coolant lines and connections for traces of coolant leaks. If equipped with preheater/jacket water heater, check preheater hose (→ Page 246).

TIM-ID: 0000064938 - 001

5.9 Putting the engine-generator set out of operation

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

☑ Ensure that the Mercedes-Benz OM924-926LA engine manual is available

After stopping the engine-generator set

Item	Task
Engine-generator set	Perform lockout/tagout procedure. (→ Page 18)
Cooling system	Drain engine coolant(→ Page 507) if any of the following conditions apply: • Freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive. • The engine room is not heated. • The coolant is not maintained at a suitable temperature. • The antifreeze concentration is insufficient for the engine-room temperature. • Antifreeze concentration is 50% and engine-room temperature is below -40 °C (-40 °F).
Air intake and exhaust system	Seal air and exhaust sides if the engine-generator set is to remain out of service for more than one week.
Engine-generator set	Decommission(→ Page 277) if the engine-generator set is to remain out of service for more than one month.

TIM-ID: 0000064939 - 001

6 Troubleshooting

6.1 Troubleshooting by symptoms

Engine-generator set does not start automatically / ATS will not transfer to Emergency

Component	Probable Cause	Task
ATS	Internal fault	If applicable, check ATS wiring and run ATS functional test. Refer to manufacturer documentation of the ATS.
	Timing cycle is not complete	Check "transfer to emergency" timer setting. Refer to manufacturer documentation of the ATS.
Engine	Engine start wires not correctly terminated	Contact Service.
Engine-generator set	Power supply harness unplugged	Plug in power supply harness.
	Limit switch harness unplugged	Plug in limit switch harness.
	In OFF mode	• Investigate why mode switch was set to OFF. • Switch to AUTO mode.
Engine-generator set control system	Alarm status	• If applicable, check alarm status on the customer control panel and correct fault conditions. Refer to manufacturer documentation of the customer control system. • If applicable, check alarm status on the controller and correct fault conditions. (→ Page 156)

Engine-generator set does not stop automatically / ATS will not transfer to Normal

Component	Probable Cause	Task
ATS	Internal fault	If applicable, check ATS wiring and run ATS functional test, refer to manufacturer documentation of the ATS.
	"Retransfer to normal" timing cycle not complete	Check "retransfer to normal" timer setting, refer to the manufacturer documentation of the ATS.
Engine	Engine start wires not correctly terminated	Contact Service.
Engine-generator set	In RUN mode	Investigate why mode switch was set to RUN. Switch to OFF to stop manually, unless there is a reason for not doing so.
	Normal voltage or frequency not within parameters	Check utility and utility breakers.
	Power supply harness unplugged	Plug in power supply harness.
	Limit switch harness unplugged	Plug in limit switch harness.

TIM-ID: 0000065485 - 001

Component	Probable Cause	Task
Engine-generator set control system	Internal fault	Check control system.
	Cool-down cycle	Check control system.

Engine does not turn when starter is actuated

Component	Probable Cause	Task
Starter battery	Low or damaged	Charge or replace.
	Cable connections damaged, loose, or corroded	Check cable connections for secure seating. Repair and clean, if necessary.
Engine starter	Engine wiring to starter loose	Check cable connections for secure seating.
	Starter damaged	Contact Service.
Engine wiring	Loose or damaged	Contact Service.
Engine-generator set control system	Secure seating of assemblies or connectors not provided	Check visually. Tighten, if necessary.
	Alarm status	• If applicable, check alarm status on the customer control panel and correct fault conditions. Refer to manufacturer documentation of the customer control system. • If applicable, check alarm status on the controller and correct fault conditions. (→ Page 156)
	Blown fuse	Replace blown fuse.
Engine governor	Plug-in connections are loose	Check plug-in connections. (→ Page 277)
	Damaged	Contact Service.
Engine	Running gear blocked (engine cannot be barred manually)	Contact Service.

Engine turns but does not fire

Component	Probable Cause	Task
Starter battery	Low voltage	Charge or replace.
Engine starter	Damaged	Contact Service.
Engine wiring	Loose or damaged	Contact Service.
Fuel system	Low fuel	Fill fuel tank.
	Not vented	Vent fuel system. See page 82 in Mercedes-Benz OM 904-926 LA Engine Manual.(→ Page 277)
	Fuel filter clogged	Replace filter in fuel prefilter with water separator.(→ Page 227) Clean filter element of fuel prefilter. (→ Page 467) Replace fuel filter.(→ Page 475)
Engine governor	Damaged	Contact Service.

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Engine fires unevenly

Component	Probable Cause	Task
Fuel injection equipment	Injector damaged	Contact Service.
Engine wiring	Loose or damaged	Contact Service.
Fuel system	Low fuel	Fill fuel tank.
	Not vented	Vent fuel system. See page 82 in Mercedes-Benz OM 904-926 LA Engine Manual. (→ Page 277)
	Fuel filter clogged	Replace filter in fuel prefilter with water separator.(→ Page 227) Clean filter element of fuel prefilter. (→ Page 467) Replace fuel filter.(→ Page 475)
Engine governor	Damaged	Contact Service.

Engine does not reach nominal speed

Component	Probable Cause	Task
Fuel supply	Fuel prefilter with water separator clogged	Replace filter element.(→ Page 227)
	Fuel filter clogged	Replace filter in fuel prefilter with water separator.(→ Page 227) Clean filter element of fuel prefilter. (→ Page 467) Replace fuel filter.(→ Page 475)
	Low fuel	Fill fuel tank.
Air supply	Air filter clogged	Check signal ring position of service indicator. (→ Page 223)
Fuel injection equipment	Injector damaged	Contact Service.
Engine wiring	Loose or damaged	Contact Service.
Engine	Overloaded	Reduce load. Contact Service.

Engine speed not steady

Component	Probable Cause	Task
Generator	Load fluctuation / imbalanced load	Rebalance system loads.
	Voltage regulator improperly calibrated or damaged	Contact Service.
Fuel injection equipment	Injector damaged	Contact Service.
Speed sensor	Damaged	Contact Service.

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Component	Probable Cause	Task
Fuel system	Not vented	Vent fuel system. See page 82 in Mercedes-Benz OM 904-926 LA Engine Manual. (→ Page 277)
	Incorrect fuel	Verify correct fuel and change, if necessary. Refer to Mercedes-Benz Specifications for Operating Fluids at https://bevo.mercedes-benz.com.
	Fuel filter clogged	Replace filter in fuel prefilter with water separator.(→ Page 227) Clean filter element of fuel prefilter. (→ Page 467) Replace fuel filter.(→ Page 475)
Engine governor	Damaged	Contact Service.

Charge-air temperature too high

Component	Probable Cause	Task
Engine room	Air intake temperature too high	Check fans, air supply, ventilation ducts, and louvers.
	Air intake and outlet louvers not open	Open louvers.

Charge-air pressure too low

Component	Probable Cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator.(→ Page 223)
Exhaust turbocharger	Damaged	Contact Service.

Exhaust gas black

Component	Probable Cause	Task
Air supply	Air filter clogged	Check signal ring position of service indicator. (→ Page 223)
Fuel injection equipment	Injector damaged	Contact Service.
Fuel system	Low fuel	Fill fuel tank.
	Not vented	Vent fuel system. See page 82 in Mercedes-Benz OM 904-926 LA Engine Manual.(→ Page 277)
	Fuel filter clogged	Replace filter in fuel prefilter with water separator.(→ Page 227) Clean filter element of fuel prefilter. (→ Page 467) Replace fuel filter.(→ Page 475)
	Incorrect fuel	Verify correct fuel and change, if necessary. Refer to Mercedes-Benz Specifications for Operating Fluids at https://bevo.mercedes-benz.com.
Engine	Overloaded	Reduce load. Contact Service.

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Exhaust gas blue

Component	Probable Cause	Task
Engine oil	Too much oil in engine	Drain engine oil. (→ Page 429)
Exhaust turbocharger, cylinder head, piston rings, cylinder liner	Damaged	Contact Service.

Exhaust gas white

Component	Probable Cause	Task
Engine	Not at operating temperature	Run engine for 10 to 15 minutes with at least 30% load to reach operating temperature.
Fuel system	Water in fuel	Drain fuel prefilter with water separator. (→ Page 220)

No AC output voltage

Component	Probable Cause	Task
Engine-generator set control system	Voltmeter damaged	Verify output with another meter. Check meter fuses and meter. Replace meter fuses/meter, if necessary.
	Blown fuses	Check fuses and replace blown fuses.
	Secure seating of assemblies or connectors not provided	Check visually. Tighten, if necessary.
Generator	Regulator fuse blown or defective	Check fuses and replace. If voltage build-up causes fuse to blow, contact Service.
	Wiring loose or damaged	Check. (→ Page 241)
	Diodes damaged	Check rotating rectifier for damaged diodes. Contact Service.
	Regulator damaged	Contact Service.

Leakage

Component	Probable Cause	Task
Coolant system	Hoses, piping, or seals damaged Fittings damaged or loose	Identify damaged component and replace. Tighten fittings.
Fuel system	Hoses, piping, or seals damaged Fittings damaged or loose	Identify damaged component and replace. Tighten fittings.
Oil system	Hoses, piping, or seals damaged Fittings damaged or loose	Identify damaged component and replace. Tighten fittings.

Noise

Component	Probable Cause	Task
Engine-generator set	Varies	Contact Service.

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Vibration

Component	Probable Cause	Task
Engine-generator set	Varies	Contact Service.

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6.2 Fault Codes and Events on MGC Series Panels

6.2.1 Recording of fault codes on MGC Series digital control panels

The MGC Series digital control panels (referred to as the controller) monitor signals, detect status, and receive reports from all over the engine-generator set.

There are two types of messages:
- Messages created by the controller (controller events)
- Messages created in the engine governor originally and sent to the controller (engine fault codes)

MGC Series events

System events to be recorded are alarms, pre-alarms (warnings), and status messages. Depending on defined thresholds (limits), an event is classified as alarm or pre-alarm.

A pre-alarm may not require any action if the settings return to normal ranges.

Event log

An event log retains history of system events in nonvolatile memory.

30 event records are retained and each record contains a time stamp of the first and last event occurrence. The record also contains the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99.

If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest "last" event occurrence is removed from the log. The new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events is retained in the controller.

Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus, the time, date, and engine hours details for up to 900 specific event occurrences are retained in the event log.

How to access the event log

The event log can be accessed in two ways:

- Use the control panel communication software to view and/or download the event log: Use the Metering Explorer, and select "Event log" to get a list of all recently occurred events.
- Navigate in the front panel display to Metering → Alarms-Status → Event Log.
  1. Use the up/down arrow buttons to highlight an event.
  2. Press the right-arrow button to view the summary of that event record.
     The summary contains the description of the event, date, time, and engine hours of the first occurrence of the event, along with date, time, and engine hours of the most recent occurrence of the event.
  3. Press the down-arrow button until DETAILS is highlighted and then press the right-arrow button to view details of specific event occurrences.
  4. The occurrence number can be changed by pressing the Edit button, up/down arrow buttons to select the number, and pressing the Edit button again to exit.

List of events in alphabetical order

The event list shows possible events in alphabetical order. (→ Page 158)

In the list, each event description is built of the following parts:

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- Short display text
- Long display text
- Event type and fault result
- Appearance in the event log
- Cause
- Corrective action

Note: The letter "x" in some texts is a placeholder for a number between 1 and a maximum value. The section "Cause" of each concerned event description contains that maximum value, e.g. "8" in the term "x = 1 to 8".

Engine fault codes

The controller displays the active engine fault codes issued by the engine governor. Each fault code appears on the controller display with fault number and short fault text.

If the controller does not have descriptive information about a fault code that was received from the engine governor, the fault text displays "NO TEXT AVAILABLE."

How to access the fault codes list

Engine fault codes can be accessed in two ways:

- Use the control panel communication software to view and/or download the J1939 fault codes list: Use the Metering Explorer to expand the "J1939" tree.
- Navigate in the front panel display to Metering → Alarms-Status → J1939 Fault Codes

List of J1939 engine fault codes in numerical order

The J1939 fault codes list shows possible fault codes in numerical order. (→ Page 255)

Each item in the list is built of the following parts:

- Fault code
- Fault location
- Fault description
- Remedial action
- Pin

Detailed information

For a detailed description of the communication software, contact your local MTU Onsite Energy distributor or dealer.

For a detailed description of the controller display operations, refer to (→ Page 68).

General note

In the description of fault codes and messages, the terms "sender" and "sensor" are used as synonyms.

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6.2.2 List of fault codes on MGC Series digital control panels in alphabetical order

27-1 UNDVOLT TRP

27-1 Undervoltage trip

Pre-Alarm

Appearance in event log: 27-1 UNDVOLT TRP P

Cause	Corrective action
Generator voltage is lower than the 27-1 Undervoltage limit in at least one phase, and 27-1 Undervoltage element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause low voltage conditions.

27-1 UNDVOLT TRP

27-1 Undervoltage trip

Alarm – causes machine shutdown

Appearance in event log: 27-1 UNDVOLT TRP A

Cause	Corrective action
Generator voltage is lower than the 27-1 Undervoltage limit in at least one phase, and 27-1 Undervoltage element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause low voltage conditions.

27-2 UNDVOLT TRP

27-2 Undervoltage trip

Pre-Alarm

Appearance in event log: 27-2 UNDVOLT TRP P

Cause	Corrective action
Generator voltage is lower than the 27-2 Undervoltage limit in at least one phase, and 27-2 Undervoltage element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause low voltage conditions.

27-2 UNDVOLT TRP

27-2 Undervoltage trip

Alarm – causes machine shutdown

Appearance in event log: 27-2 UNDVOLT TRP A

Cause	Corrective action
Generator voltage is lower than the 27-2 Undervoltage limit in at least one phase, and 27-2 Undervoltage element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause low voltage conditions.

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32 RVS PWR TRP

32 Reverse power protection trip

Pre-Alarm

Appearance in event log: 32 RVS PWR TRP P

Cause	Corrective action
Generator is absorbing power at a level higher than the 32 Reverse power protection limit, and 32 Reverse power protection element has been configured as pre-alarm.	1. Check the polarity of all potential transformers and current transformers used on the machine. 2. Check load sharing circuitry and components, and verify all machines in a load share system correctly receive generator breaker status. 3. If the machine is paralleled to the utility, make sure the Parallel to Mains Logic element is driven correctly.

32 RVS PWR TRP

32 Reverse power protection trip

Alarm – causes machine shutdown

Appearance in event log: 32 RVS PWR TRP A

Cause	Corrective action
Generator is absorbing power at a level higher than the 32 Reverse power protection limit, and 32 Reverse power protection element has been configured as alarm.	1. Check the polarity of all potential transformers and current transformers used on the machine. 2. Check load sharing circuitry and components, and verify all machines in a load share system correctly receive generator breaker status. 3. If the machine is paralleled to the utility, make sure the Parallel to Mains Logic element is driven correctly.

40 EXC LOSS TRP

40 Loss of excitation (reverse VAr) protection trip

Pre-Alarm

Appearance in event log: 40 EXC LOSS TRP P

Cause	Corrective action
Generator is absorbing power at a level higher than the 40 Loss of excitation protection limit, and 40 Loss of excitation protection element has been configured as pre-alarm.	1. Check the system wiring and the system voltage regulator. 2. Verify the voltage regulator is in droop or cross-current mode for VAr sharing on island systems. 3. Verify all the contact inputs to the voltage regulator are correctly received. 4. Check the voltage regulator settings and programming.

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40 EXC LOSS TRP

40 Loss of excitation (reverse VAr) protection trip

Alarm – causes machine shutdown

Appearance in event log: 40 EXC LOSS TRP A

Cause	Corrective action
Generator is absorbing power at a level higher than the 40 Loss of excitation protection limit, and 40 Loss of excitation protection element has been configured as alarm.	1. Check the system wiring and the system voltage regulator. 2. Verify the voltage regulator is in droop or crosscurrent mode for VAr sharing on island systems. 3. Verify all the contact inputs to the voltage regulator are correctly received. 4. Check the voltage regulator settings and programming.

47 PHS IMBAL TRP

47 Phase imbalance protection trip

Pre-Alarm

Appearance in event log: 47 PHS IMBAL TRP P

Cause	Corrective action
Generator in generator line to line voltages between phases is greater than the 47 Phase imbalance protection limit, and 47 Phase imbalance protection element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check load for the cause of phase imbalance. Loss of one leg of the wiring from machine to load could cause this situation.

47 PHS IMBAL TRP

47 Phase imbalance protection trip

Alarm – causes machine shutdown

Appearance in event log: 47 PHS IMBAL TRP A

Cause	Corrective action
Generator in generator line to line voltages between phases is greater than the 47 Phase imbalance protection limit, and 47 Phase imbalance protection element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check load for the cause of phase imbalance. Loss of one leg of the wiring from machine to load could cause this situation.

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51-1 OVRCURR TRP

51-1 Overcurrent protection trip

Pre-Alarm

Appearance in event log: 51-1 OVRCURR TRP P

Cause	Corrective action
Generator current is higher than the 51-1 overcurrent limit in at least one phase, and 51-1 overcurrent element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check load sharing devices in multiple generator applications. 4. Check load for source of overcurrent condition.

51-1 OVRCURR TRP

51-1 Overcurrent protection trip

Alarm – causes machine shutdown

Appearance in event log: 51-1 OVRCURR TRP A

Cause	Corrective action
Generator current is higher than the 51-1 Overcurrent limit in at least one phase, and 51-1 Overcurrent element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check load sharing devices in multiple generator applications. 4. Check load for source of overcurrent condition.

51-2 OVRCURR TRP

51-2 Overcurrent protection trip

Pre-Alarm

Appearance in event log: 51-2 OVRCURR TRP P

Cause	Corrective action
Generator current is higher than the 51-2 Overcurrent limit in at least one phase, and 51-2 Overcurrent element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check load sharing devices in multiple generator applications. 4. Check load for source of overcurrent condition.

51-2 OVRCURR TRP

51-2 Overcurrent protection trip

Alarm – causes machine shutdown

Appearance in event log: 51-2 OVRCURR TRP A

Cause	Corrective action
Generator current is higher than the 51-2 Overcurrent limit in at least one phase, and 51-2 Overcurrent element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check load sharing devices in multiple generator applications. 4. Check load for source of overcurrent condition.

TIM-ID: 0000065425 - 001

59-1 OVRVOLT TRP

59-1 Overvoltage trip

Pre-Alarm

Appearance in event log: 59-1 OVERVOLT TRP P

Cause	Corrective action
Generator voltage is higher than the 59-1 Overvoltage limit in at least one phase, and 59-1 Overvoltage element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause high voltage conditions.

59-1 OVRVOLT TRP

59-1 Overvoltage trip

Alarm – causes machine shutdown

Appearance in event log: 59-1 OVERVOLT TRP A

Cause	Corrective action
Generator voltage is higher than the 59-1 Overvoltage limit in at least one phase, and 59-1 Overvoltage element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause high voltage conditions.

59-2 OVRVOLT TRP

59-2 Overvoltage trip

Pre-Alarm

Appearance in event log: 59-2 OVERVOLT TRP P

Cause	Corrective action
Generator voltage is higher than the 59-2 Overvoltage limit in at least one phase, and 59-2 Overvoltage element has been configured as pre-alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause high voltage conditions.

59-2 OVRVOLT TRP

59-2 Overvoltage trip

Alarm – causes machine shutdown

Appearance in event log: 59-2 OVERVOLT TRP A

Cause	Corrective action
Generator voltage is higher than the 59-2 Overvoltage limit in at least one phase, and 59-2 Overvoltage element has been configured as alarm.	1. Check generator wiring (→ Page 241). 2. Check machine configuration (refer to spec sheet). 3. Check generator voltage regulator. 4. Check load for faults that could cause high voltage conditions.

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78 VECTOR SHIFT TRIP

78 Vector shift protection trip

Pre-Alarm

Appearance in event log: 78 VECTOR SHIFT TRIP P

Cause	Corrective action
A phase shift in the generator voltage is detected (this often occurs when the grid is lost), and 78 Vector shift element has been configured as alarm.	1. Check vector shift setting. 2. Check mains voltage. 3. Check engine governor.

78 VECTOR SHIFT TRIP

78 Vector shift protection trip

Alarm – causes machine shutdown

Appearance in event log: 78 VECTOR SHIFT TRIP A

Cause	Corrective action
A phase shift in the generator voltage is detected (this often occurs when the grid is lost), and 78 Vector shift element has been configured as pre-alarm.	1. Check vector shift setting. 2. Check mains voltage. 3. Check engine governor.

81 ROC DF/DT TRIP

81 Rate of change of frequency protection trip

Pre-Alarm

Appearance in event log: 81ROC DF/DT TRIP P

Cause	Corrective action
A sudden change of load occurs, the pickup setting is reached and the activation delay has expired, and 81 ROC DF/DT has been configured as pre-alarm.	1. Check ROCOF setting. 2. Check engine governor.

81 ROC DF/DT TRIP

81 Rate of change of frequency protection trip

Alarm – causes machine shutdown

Appearance in event log: 81 ROC DF/DT TRIP P A

Cause	Corrective action
A sudden change of load occurs, the pickup setting is reached and the activation delay has expired, and 81 ROC DF/DT has been configured as alarm.	1. Check ROCOF setting. 2. Check engine governor.

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81O OVRFREQ TRP

81-O Overfrequency trip

Pre-Alarm

Appearance in event log: 81O OVRFREQ TRP P

Cause	Corrective action
Generator frequency is higher than the 81-O Overfrequency limit, and 81-O Overfrequency element has been configured as pre-alarm.	1. Check the rated frequency setting. 2. Check speed bias into the engine governor. 3. Check engine governor. 4. Check any load sharing devices in multiple generator applications.

81O OVRFREQ TRP

81-O Overfrequency trip

Alarm – causes machine shutdown

Appearance in event log: 81O OVRFREQ TRP A

Cause	Corrective action
Generator frequency is higher than the 81-O Overfrequency limit, and 81-O Overfrequency element has been configured as alarm.	1. Check the rated frequency setting. 2. Check speed bias into the engine governor. 3. Check engine governor. 4. Check any load sharing devices in multiple generator applications.

81U UNDFREQ TRP

81-U Underfrequency trip

Pre-Alarm

Appearance in event log: 81U UNDFREQ TRP P

Cause	Corrective action
Generator frequency is lower than the 81-U Underfrequency limit, and 81-U Underfrequency element has been configured as pre-alarm	1. Check the rated frequency setting. 2. Check speed bias into the engine governor. 3. Check engine governor. 4. Check any load sharing devices in multiple generator applications.

81U UNDFREQ TRP

81-U Underfrequency trip

Alarm – causes machine shutdown

Appearance in event log: 81U UNDFREQ TRP A

Cause	Corrective action
Generator frequency is lower than the 81-U Underfrequency limit, and 81-U Underfrequency element has been configured as alarm.	1. Check the rated frequency setting. 2. Check speed bias into the engine governor. 3. Check engine governor. 4. Check any load sharing devices in multiple generator applications.

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AEM COMM FAIL

Analog Expansion Module communications failure

Pre-Alarm

Appearance in event log: AEM COMM FAIL P

Cause	Corrective action
Analog Expansion Module (AEM) communications failure	1. Check that the AEM is powered when communication is expected. 2. Check CAN bus wiring from AEM to the controller-2020. 3. Check that a 120 Ω termination resistors (one on each end if the main wire, two total) are in place.

AEM OUTx OUT RNG

Analog Expansion Module output x is out of range

Status

Programmable string; default appearance in event log: AEM OUTx OUT RNG

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Analog Expansion Module (AEM) output x (x = 1 to 4) is out of range.	1. Check the parameter which drives the analog output, and verify that the parameter is within its valid range. 2. Check that the range used in mapping the parameter range to the analog output range is correct.

AEM OUTx OUT RNG

Analog Expansion Module output x is out of range

Pre-Alarm

Programmable string; default appearance in event log: AEM OUTx OUT RNG P

Cause	Corrective action
Analog Expansion Module (AEM) output x (x = 1 to 4) is out of range.	1. Check the parameter which drives the analog output, and verify that the parameter is within its valid range. 2. Check that the range used in mapping the parameter range to the analog output range is correct.

AEM OUTx OUT RNG

Analog Expansion Module output x is out of range

Alarm – causes machine shutdown

Programmable string; default appearance in event log: AEM OUTx OUT RNG A

Cause	Corrective action
Analog Expansion Module (AEM) output x (x = 1 to 4) is out of range.	1. Check the parameter which drives the analog output, and verify that the parameter is within its valid range. 2. Check that the range used in mapping the parameter range to the analog output range is correct.

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ALG IN x O1

Analog input x over limit 1

Status

Programmable string; default appearance in event log: ALG IN x_O1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for analog input x (x = 1 to 8) is over limit 1.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

ALG IN x O1

Analog input x over limit 1

Pre-Alarm

Programmable string; default appearance in event log: ALG IN x_O1 P

Cause	Corrective action
Analog input x (x = 1 to 8) over limit 1 has been programmed as a pre-alarm, and limit 1 has been exceeded.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

ALG IN x O1

Analog input x over limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: ALG IN x_O1 A

Cause	Corrective action
Analog input x (x = 1 to 8) over limit 1 has been programmed as an alarm, and limit 1 has been exceeded.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

ALG IN x O2

Analog input x over limit 2

Status

Programmable string; default appearance in event log: ALG IN x_O2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for analog input x (x = 1 to 8) is over limit 2.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

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ALG IN x O2

Analog input x over limit 2

Pre-Alarm

Programmable string; default appearance in event log: ALG IN x_O2 P

Cause	Corrective action
Analog input x (x = 1 to 8) over limit 2 has been programmed as a pre-alarm, and limit 2 has been exceeded.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

ALG IN x O2

Analog input x over limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: ALG IN x_O2 A

Cause	Corrective action
Analog input x (x = 1 to 8) over limit 2 has been programmed as an alarm, and limit 2 has been exceeded.	1. Check the external device which drives the analog input and caused the limit to be exceeded. 2. Take any necessary action.

ALG IN x OOR

Analog input x out of range

Status

Programmable string; default appearance in event log: ALG IN x_OOR

Cause	Corrective action
Status indication on the front panel, and control panel communication software for analog input x (x = 1 to 8) is out of range.	1. Check the external device which drives the analog input and went outside the valid range. 2. Take any necessary action. 3. Verify the range programmed for the external device is correct for the application.

ALG IN x OOR

Analog input x out of range

Pre-Alarm

Programmable string; default appearance in event log: ALG IN x_OOR P

Cause	Corrective action
Analog input x (x = 1 to 8) out of range has been programmed as a pre-alarm, and the input is outside the valid range.	1. Check the external device which drives the analog input and went outside the valid range. 2. Take any necessary action. 3. Verify the range programmed for the external device is correct for the application.

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ALG IN x OOR

Analog input x out of range

Alarm – causes machine shutdown

Programmable string; default appearance in event log: ALG IN x_OOR A

Cause	Corrective action
Analog input x (x = 1 to 8) out of range has been programmed as an alarm, and the input is less than the limit.	1. Check the external device which drives the analog input and went outside the valid range. 2. Take any necessary action. 3. Verify the range programmed for the external device is correct for the application.

ALG IN x U1

Analog input x under limit 1

Status

Programmable string; default appearance in event log: ALG IN x_U1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for analog input x (x = 1 to 8) is under limit 1.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

ALG IN x U1

Analog input x under limit 1

Pre-Alarm

Programmable string; default appearance in event log: ALG IN x_U1 P

Cause	Corrective action
Analog input x (x = 1 to 8) under limit 1 has been programmed as a pre-alarm, and the input is less than limit 1.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

ALG IN x U1

Analog input x under limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: ALG IN x_U1 A

Cause	Corrective action
Analog input x (x = 1 to 8) under limit 1 has been programmed as an alarm, and the input is less than limit 1.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

ALG IN x U2

Analog input x under limit 2

Status

Programmable string; default appearance in event log: ALG IN x_U2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for analog input x (x = 1 to 8) is under limit 2.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

ALG IN x U2

Analog input x under limit 2

Pre-Alarm

Programmable string; default appearance in event log: ALG IN x_U2 P

Cause	Corrective action
Analog input x (x = 1 to 8) under limit 2 has been programmed as a pre-alarm, and the input is less than limit 2.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

ALG IN x U2

Analog input x under limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: ALG IN x_U2 A

Cause	Corrective action
Analog input x (x = 1 to 8) under limit 2 has been programmed as an alarm, and the input is less than limit 2.	1. Check the external device which drives the analog input and went below the underlimit setting. 2. Take any necessary action.

ATS INPUT CLOSED

ATS input closed

Status

Appearance in event log: ATS INPUT CLOSED

Cause	Corrective action
The contact used for the Automatic Transfer Switch (ATS) input has closed.	▶ (none)

TIM-ID: 0000065425 - 001

AUTO RESTART

Automatic restart in progress

Status

Appearance in event log: AUTO RESTART

Cause	Corrective action
Automatic restart in progress	▶ (none)

AUTO RESTART FAIL

Automatic restart failure

Alarm – causes machine shutdown

Appearance in event log: AUTO RESTART FAIL A

Cause	Corrective action
The automatic restart feature is enabled. The controller cleared the generator faults and tried to restart the programmed number of times, but could not restart. Most likely there are other alarms active at the same time.	1. Check the alarm list and the event log to find what alarms are preventing the unit from restarting. 2. Correct the conditions indicated by those alarms.

BATT CHRG FAIL

Battery charger failure

Pre-Alarm

Appearance in event log: BATT CHRG FAIL P

Cause	Corrective action
The contact input to which the battery charger failure programmable function has been assigned has been turned on, and battery charger failure has been configured as pre-alarm.	▶ Check the battery charger and battery charger fail detection devices and wiring.

BATT CHRG FAIL

Battery charger failure

Alarm – causes machine shutdown

Appearance in event log: BATT CHRG FAIL A

Cause	Corrective action
The contact input to which the battery charger failure programmable function has been assigned has been turned on, and battery charger failure has been configured as alarm.	▶ Check the battery charger and battery charger fail detection devices and wiring.

TIM-ID: 0000065425 - 001

BATT OVERVOLT

Battery overvoltage

Pre-Alarm

Appearance in event log: BATT OVERVOLT P

Cause	Corrective action
The battery voltage is above the limit set for the battery overvoltage pre-alarm.	1. Check the battery charging circuit and correct any conditions which could cause overcharging. 2. Check the battery voltage level setting for rated battery voltage in the controller. Ensure it matches a range appropriate for the nominal battery voltage.

BATTLE OVERRIDE

Battle override

Pre-Alarm

Appearance in event log: BATTLE OVERRIDE P

Cause	Corrective action
Battle override (shutdown override) – all engine and generator protection is bypassed.	▶ Remove the battle override to resume normal operation of engine and generator protection.

CEM COMM FAIL

Contact Expansion Module (CEM) communications failure

Pre-Alarm

Appearance in event log: CEM COMM FAIL P

Cause	Corrective action
Contact Expansion Module (CEM) communications failure	1. Check that the CEM is powered when communication is expected. 2. Check CAN bus wiring from CEM to controller. 3. Check that a 120 Ω termination resistors (one on each end if the main wire, two total) are in place.

CEM HW MISMATCH

CEM hardware mismatch

Pre-Alarm

Appearance in event log: CEM HW MISMATCH P

Cause	Corrective action
The number of outputs on the Contact Expansion Module (CEM) communicating with the controller does not match the number of CEM outputs programmed as a setting in the controller.	1. Check the number of outputs on the CEM. 2. Correct the setting for the number of CEM outputs.

TIM-ID: 0000065425 - 001

CHECKSUM FAIL

Checksum failure

Pre-Alarm

Appearance in event log: CHECKSUM FAIL P

Cause	Corrective action
The controller has detected a checksum error in internal memory. This can happen after flashing new firmware and/or language files into a controller, for example.	1. Push the RESET button on the front panel, or power cycle the controller. 2. If the pre-alarm occurs each time the controller is powered up, contact Service.

CONF PROT x

Configurable protection element x

Status

Programmable string; default appearance in event log: CONF PROT x

Cause	Corrective action
Status indication on the front panel, and control panel communication software for configurable protection element x (x = 1 to 8) is out of programmed range.	1. Check the parameter which caused the limit to be exceeded. 2. Take any necessary action.

CONF PROT x

Configurable protection element x

Pre-Alarm

Programmable string; default appearance in event log: CONF PROT x P

Cause	Corrective action
Configurable Protection element x (x = 1 to 8) has been programmed as a pre-alarm, and the programmed range has been exceeded.	1. Check the parameter which caused the limit to be exceeded. 2. Take any necessary action.

CONF PROT x

Configurable protection element x

Alarm – causes machine shutdown

Programmable string; default appearance in event log: CONF PROT x A

Cause	Corrective action
Configurable Protection element x (x = 1 to 8) has been programmed as a pre-alarm, and the programmed range has been exceeded.	1. Check the parameter which caused the limit to be exceeded. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

CONFIG ELEMENT x

Configurable element x

Pre-Alarm

Programmable string; default appearance in event log: CONF ELEMENT x P

Cause	Corrective action
Configurable element x (x = 1 to 8) has been programmed as a pre-alarm, and the input to the element in the PLC logic is true.	1. Check the logic in the PLC logic which is driving the input of the configurable element. 2. Take any necessary corrective action.

CONFIG ELEMENT x

Configurable element x

Alarm – causes machine shutdown

Programmable string; default appearance in event log: CONF ELEMENT x A

Cause	Corrective action
Configurable element x (x = 1 to 8) has been programmed as an alarm, and the input to the element in the PLC logic is true.	1. Check the logic in the PLC logic which is driving the input of the configurable element. 2. Take any necessary corrective action.

COOL LVL SNDR FL

Coolant level sender fail

Alarm – causes machine shutdown

Appearance in event log: COOL LVL SNDR FL A

Cause	Corrective action
The coolant level sender has failed.	▶ Check coolant level sender and replace, if necessary.

COOL SNDR FAIL

Coolant temperature sender fail

Status

Appearance in event log: COOL SNDR FAIL

Cause	Corrective action
The input from the sender is outside the valid range for the device.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

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COOL SNDR FAIL

Coolant temperature sender fail

Pre-Alarm

Appearance in event log: COOL SNDR FAIL P

Cause	Corrective action
The input from the sender is outside the valid range for the device, and the coolant temperature sender fail is configured as pre-alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

COOL SNDR FAIL

Coolant temperature sender fail

Alarm – causes machine shutdown

Appearance in event log: COOL SNDR FAIL A

Cause	Corrective action
The input from the sender is outside the valid range for the device, and the coolant temperature sender fail is configured as alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

DEMAND START

Demand Start request

Status

Appearance in event log: DEMAND START

Cause	Corrective action
An automatic machine start due to system demand has occurred.	▶ (none)

DEMAND STOP

Demand Stop request

Status

Appearance in event log: DEMAND STOP

Cause	Corrective action
An automatic machine stop due to system demand has occurred.	▶ (none)

TIM-ID: 0000065425 - 001

MGC HEARTBEAT FAIL

MGC heartbeat failure

Pre-Alarm

Appearance in event log: MGC HEARTBEAT FAIL P

Cause	Corrective action
An I/O module has lost the heartbeat from the controller.	1. Verify all CAN bus communications cables are in place, properly wired, and properly terminated. 2. Check that the I/O modules that are present in the system are enabled in the controller Settings. 3. Check the I/O modules to be sure they are powered up and functioning.

DIAG TRBL CODE

Diagnostic trouble codes

Pre-Alarm

Appearance in event log: DIAG TRBL CODE P

Cause	Corrective action
Diagnostic trouble codes have been received from the engine governor.	1. Check the meaning of the reported diagnostic codes in the engine documentation, or contact Service. 2. Remedy the issues reported by the diagnostic codes.

DIAL OUT FAILED

Modem dial out Failure

Status

Appearance in event log: DIAL OUT FAILED

Cause	Corrective action
Modem dial out has failed.	1. Check phone lines and phone connection. 2. Verify dial out phone numbers are correct. 3. Check that the pager ID is correct.

DIAL OUT SUCCESS

Modem dial out success

Status

Appearance in event log: DIAL OUT SUCCESS

Cause	Corrective action
Modem dial out has successfully accomplished.	1. Check phone lines and phone connection. 2. Verify dial out phone numbers are correct. 3. Check that the pager ID is correct.

TIM-ID: 0000065425 - 001

ECU SHUTDOWN

Shutdown by ECU

Alarm – causes machine shutdown, but presumably, it has shut down due to an unknown cause before this is announced

Appearance in event log: ECU SHUTDOWN A

Cause	Corrective action
The engine stopped, but the controller did not knowingly cause the stop. The assumed source of the stop is the engine governor, so, an engine governor shutdown alarm is announced.	▶ Check the engine governor for data indicating the cause of the shutdown.

EMERGENCY STOP

Emergency stop

Alarm – causes machine shutdown

Appearance in event log: EMERGENCY STOP A

Cause	Corrective action
The emergency stop input has opened.	1. Release the EMERGENCY STOP button. 2. If the alarm will not clear when the OFF button is pressed, check the wiring of the emergency stop circuit and verify that when the switch is not pushed or closed, there is a short circuit between terminals 46 and 47. There should be an open circuit between terminals 46 and 47 when the EMERGENCY STOP switch is pushed or is open.

ENG KW OVRLD-1

Engine kW overload 1

Pre-Alarm

Appearance in event log: ENG KW OVRLD-1 P

Cause	Corrective action
The kW output of the generator is above the limit for the kW overload 1 protection element.	1. Check generator wiring, machine configuration, load sharing devices in multiple generator applications and the load. 2. Shed some load, if necessary.

ENG KW OVRLD-2

Engine kW overload 2

Pre-Alarm

Appearance in event log: ENG KW OVRLD-2 P

Cause	Corrective action
The kW output of the generator is above the limit for the kW overload 2 protection element.	1. Check generator wiring, machine configuration, load sharing devices in multiple generator applications and the load. 2. Shed some load, if necessary.

TIM-ID: 0000065425 - 001

ENG KW OVRLD-3

Engine kW overload 3

Pre-Alarm

Appearance in event log: ENG KW OVRLD-3 P

Cause	Corrective action
The kW output of the generator is above the limit for the kW overload 3 protection element.	1. Check generator wiring, machine configuration, load sharing devices in multiple generator applications and the load. 2. Shed some load, if necessary.

ENGINE RUNNING

Engine running

Status

Appearance in event log: ENGINE RUNNING

Cause	Corrective action
The engine governor has determined the engine is running and sends the status to the controller.	▶ (none)

FUEL LEAK 1

Fuel leak 1

Pre-Alarm

Appearance in event log: FUEL LEAK 1

Cause	Corrective action
The engine governor has sent a FUEL LEAK 1 indication to the controller.	1. Check the fuel tanks and fuel lines for leakage. 2. Check the fuel leak detect sensor, and verify if fuel is actually present on the sensor.

FUEL LEAK 2

Fuel leak 2

Pre-Alarm

Appearance in event log: FUEL LEAK 2

Cause	Corrective action
The engine governor has sent a FUEL LEAK 2 indication to the controller.	1. Check the fuel tanks and fuel lines for leakage. 2. Check the fuel leak detect sensor, and verify if fuel is actually present on the sensor.

TIM-ID: 0000065425 - 001

FUEL LEAK DETECT

Fuel leak detect

Pre-Alarm

Appearance in event log: FUEL LEAK DETECT P

Cause	Corrective action
The contact input to which the fuel leak detect programmable function has been assigned has been turned on, and fuel leak detect has been configured as a pre-alarm.	1. Check the fuel tanks and fuel lines for leakage. 2. Check the fuel leak detect sensor, and verify if fuel is actually present on the sensor.

FUEL LEAK DETECT

Fuel leak detect

Alarm – causes machine shutdown

Appearance in event log: FUEL LEAK DETECT A

Cause	Corrective action
The contact input to which the fuel leak detect programmable function has been assigned has been turned on, and fuel leak detect has been configured as alarm.	1. Check the fuel tanks and fuel lines for leakage. 2. Check the fuel leak detect sensor, and verify if fuel is actually present on the sensor.

FUEL LEVL SENDR

Fuel level sender fail

Pre-Alarm

Appearance in event log: FUEL LEVL SENDR P

Cause	Corrective action
The input from the sender is outside the valid range for the device, and the fuel level sender fail is configured as pre-alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

FUEL LEVL SENDR

Fuel level sender fail

Alarm – causes machine shutdown

Appearance in event log: FUEL LEVL SENDR A

Cause	Corrective action
The input from the sender is outside the valid range for the device and the fuel level sender fail is configured as alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

TIM-ID: 0000065425 - 001

FUEL LEVL SENDR FAIL

Fuel level sender fail

Status

Appearance in event log: FUEL LEVL SENDR

Cause	Corrective action
The input from the sender is outside the valid range for the device.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

GEN TEST LOADED

Generator exerciser test with load

Status

Appearance in event log: GEN TEST LOADED

Cause	Corrective action
The generator exerciser has started a test run session with the breaker closed.	▶ (none)

GEN TEST UNLOADED

Generator exerciser test without load

Status

Appearance in event log: GEN TEST UNLOADED

Cause	Corrective action
The generator exerciser has started a test run session with the breaker open.	▶ (none)

GLBL SNDR FAIL

Global sender fail

Alarm – causes machine shutdown

Appearance in event log: GLBL SNDR FAIL A

Cause	Corrective action
A sender has failed, and the sender fail detection for the failed sender is configured as alarm.	1. Consult the alarms status to determine which sender has failed. 2. Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

TIM-ID: 0000065425 - 001

GN BKR CL FL

Generator breaker close failure

Pre-Alarm

Appearance in event log: GN BKR CL FL P

Cause	Corrective action
The controller has issued a breaker close output, but the breaker status has not reported the breaker closed within the time allowed by the Breaker Close Wait time.	1. This is a latched pre-alarm and can be cleared only by pushing the RESET button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. 4. Verify the breaker is receiving open and close commands from the controller. 5. If pulsed breaker commands are employed, make sure the pulse is long enough for the breaker to change states. Consider lengthening the Breaker Close Wait time.

GN BKR OP FL

Generator breaker open failure

Pre-Alarm

Appearance in event log: GN BKR OP FL P

Cause	Corrective action
The controller has issued a breaker open output, but the breaker status has not reported the breaker open within the time allowed by the Breaker Close Wait time.	1. This is a latched pre-alarm and can be cleared only by pushing the RESET button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. 4. Verify the breaker is receiving open and close commands from the controller. 5. If pulsed breaker commands are employed, make sure the pulse is long enough for the breaker to change states. Consider lengthening the Breaker Close Wait time.

GN BKR SYN FL

Generator breaker synchronization failure

Pre-Alarm

Appearance in event log: GN BKR SYN FL P

Cause	Corrective action
The Synchronizer Fail Activation Delay timer expired while the generator was trying to synchronizer and close the generator breaker.	1. This is a latched pre-alarm and can be cleared only by pushing the RESET button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. 4. Consider lengthening the Synchronizer Fail Activation Delay. 5. Check speed controller tuning, re-tune to make it more aggressive, if possible.

TIM-ID: 0000065425 - 001

HI COOLANT TMP

High coolant temperature

Pre-Alarm

Appearance in event log: HI COOLANT TMP P

Cause	Corrective action
The engine coolant temperature is above the limit set for the high coolant temperature pre-alarm.	1. Check engine thermostat. 2. Check engine coolant level. 3. Check that coolant pump is operating properly. 4. Check radiator and coolant passages for obstructions.

HI COOLANT TMP

High coolant temperature

Alarm – causes machine shutdown

Appearance in event log: HI COOLANT TMP A

Cause	Corrective action
The engine coolant temperature is above the limit set for the High coolant temperature alarm.	1. Check engine thermostat. 2. Check engine coolant level. 3. Check that coolant pump is operating properly. 4. Check radiator and coolant passages for obstructions.

HIGH FUEL LEVEL

High fuel level

Pre-Alarm

Appearance in event log: HIGH FUEL LEVEL P

Cause	Corrective action
The fuel level reading is above the level specified in the High fuel level pre-alarm element.	1. Avoid overfilling tank. 2. If an automatic fuel pump is used to fill the tank, check the fuel pump and associated wiring and verify pump shuts off when it should.

ID MISSING

LSM-2020 ID missing

Pre-Alarm

Appearance in event log: ID MISSING P

Cause	Corrective action
The controller is not detecting one or more machines that have been specified to be present on the inter-genset communications network.	1. Verify other generators are on line. 2. Check network cabling and components for network issues. 3. Verify that all devices on the network are industrially rated designed to comply with IEC 61000-4 series of specifications. 4. As a last resort, power cycle the LSM, and the network devices to see if communications is restored. 5. Check the I/O modules to be sure they are powered up and functioning. 6. Check the settings for the expected generator sequencing IDs and check it against the sequencing IDs of the actual machines.

TIM-ID: 0000065425 - 001

ID REPEAT

LSM-2020 ID repeated

Pre-Alarm

Appearance in event log: ID REPEAT P

Cause	Corrective action
The controller detects more than on machine with the same sequencing ID.	1. Verify other generators are on line. 2. Check the sequencing ID in each unit, and verify all are unique. This is necessary for network integrity even if sequencing is not enabled. 3. Check network cabling and components for network issues. 4. Verify that all devices on the network are industrially rated designed to comply with IEC 61000-4 series of specifications.

INPUT x

Contact input x (programmable)

Pre-Alarm

Programmable string; default appearance in event log: INPUT x P

Cause	Corrective action
Contact input x (x = 1 to 40) has been programmed as a pre-alarm, and the input has been triggered.	1. Check the external device which triggered the input. 2. Take any necessary action.

INPUT x

Contact input x (programmable)

Alarm – causes machine shutdown

Programmable string; default appearance in event log: INPUT x A

Cause	Corrective action
Contact input x (x = 1 to 40) has been programmed as an alarm, and the input has been triggered.	1. Check the external device which triggered the input. 2. Take any necessary action.

LOGIC OUTPUT

Logic output pre-alarm

Pre-Alarm

Appearance in event log: LOGIC OUTPUT P

Cause	Corrective action
The PLC logic in the controller is setting the logic pre-alarm PLC logic element to true.	1. Check the logic in the controller that drives the logic pre-alarm PLC logic element. 2. Correct the conditions that caused the logic pre-alarm PLC logic element to be triggered.

TIM-ID: 0000065425 - 001

LOGIC OUTPUT

Logic output alarm

Alarm – causes machine shutdown

Appearance in event log: LOGIC OUTPUT A

Cause	Corrective action
The PLC logic in the controller is setting the logic alarm PLC logic element to true.	1. Check the logic in the controller that drives the logic alarm PLC logic element. 2. Correct the conditions that caused the logic alarm PLC logic element to be triggered.

LOSS OF VOLT

Voltage sensing failure

Status

Appearance in event log: LOSS OF VOLT

Cause	Corrective action
The generator is not sensing voltage on at least one phase where voltage should be present.	1. Check machine wiring and potential transformer wired. 2. Check the load for conditions which would cause a low voltage reading on one or more phases.

LOSS OF VOLT

Voltage sensing failure

Pre-Alarm

Appearance in event log: LOSS OF VOLT P

Cause	Corrective action
The generator is not sensing voltage on at least one phase where voltage should be present and the voltage sensing failure element is configured as pre-alarm.	1. Check machine wiring and potential transformer wired. 2. Check the load for conditions which would cause a low voltage reading on one or more phases.

LOSS OF VOLT

Voltage sensing failure

Alarm – causes machine shutdown

Appearance in event log: LOSS OF VOLT A

Cause	Corrective action
The generator is not sensing voltage on at least one phase where voltage should be present and the voltage sensing failure element is configured as alarm.	1. Check machine wiring and potential transformer wired. 2. Check the load for conditions which would cause a low voltage reading on one or more phases.

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LOSS REM COMS

Loss of module communication fail

Pre-Alarm

Appearance in event log: LOSS REM COMS P

Cause	Corrective action
Loss of remote module communications string used in event log and/or alarm and pre-alarm annunciation (not used at this time).	▶ (none)

LOST ECU COMM

Loss of ECU communications

Pre-Alarm

Appearance in event log: LOST ECU COMM P

Cause	Corrective action
Communications with the engine governor is lost when it is pulsed or while communicating when the engine is not running or starting.	1. Check that the engine governor is powered when communications is expected. 2. Check CAN bus wiring from engine governor to controller. 3. Check that a 120 Ω termination resistors (one on each end if the main wire, two total) are in place.

LOST ECU COMM

Loss of ECU communications

Alarm – causes machine shutdown

Appearance in event log: LOST ECU COMM A

Cause	Corrective action
Communications with the engine governor is lost when the engine is running or trying to start.	1. Check that the engine governor is powered when communications is expected. 2. Check CAN bus wiring from engine governor to controller. 3. Check that a 120 Ω termination resistors (one on each end if the main wire, two total) are in place.

LOW BATT VOLT

Low battery voltage

Pre-Alarm

Appearance in event log: LOW BATT VOLT P

Cause	Corrective action
The battery voltage is below the limit set for the low battery voltage pre-alarm.	1. Check the battery voltage level, the battery charging circuits, and connections from the battery to the engine. 2. Charge battery, if necessary.

TIM-ID: 0000065425 - 001

LOW COOL LEVEL

Low coolant level

Pre-Alarm

Appearance in event log: LOW COOL LEVEL P

Cause	Corrective action
The engine coolant level is below the limit set for the low coolant level pre-alarm.	1. Check engine coolant level and add some, if necessary. 2. Check and correct any coolant leaks if the level is low.

LOW COOL LEVEL

Low coolant level

Alarm – causes machine shutdown

Appearance in event log: LOW COOL LEVEL A

Cause	Corrective action
The engine coolant level is below the limit set for the low coolant level alarm.	1. Check engine coolant level and add some, if necessary. 2. Check and correct any coolant leaks if the level is low.

LOW COOL TMP

Low coolant temperature

Pre-Alarm

Appearance in event log: LOW COOL TMP P

Cause	Corrective action
The engine coolant temperature is below the limit set for the low coolant temperature pre-alarm.	▶ Check engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.

LOW COOL TMP

Low coolant temperature

Alarm – causes machine shutdown

Appearance in event log: LOW COOL TMP A

Cause	Corrective action
The engine coolant temperature is below the limit set for the low coolant temperature alarm.	▶ Check engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.

TIM-ID: 0000065425 - 001

LOW FUEL LEVEL

Low fuel level

Pre-Alarm

Appearance in event log: LOW FUEL LEVEL P

Cause	Corrective action
The fuel level is below the level set in the low fuel level pre-alarm element.	1. Add fuel. 2. If an automatic fuel pump is employed to fill the tank, verify pump turns on when it should.

LOW FUEL LEVEL

Low fuel level

Alarm – causes machine shutdown

Appearance in event log: LOW FUEL LEVEL A

Cause	Corrective action
The fuel level is below the level set in the low fuel level alarm element.	1. Add fuel. 2. If an automatic fuel pump is employed to fill the tank, verify pump turns on when it should.

LOW OIL PRES

Low oil pressure

Pre-Alarm

Appearance in event log: LOW OIL PRES P

Cause	Corrective action
The engine oil pressure is below the limit set for the low oil pressure pre-alarm.	1. Check the engine oil level and add oil, if necessary. 2. Check oil pump. 3. Check for obstructions in the oil lubrication passages.

LOW OIL PRES

Low oil pressure

Alarm – causes machine shutdown

Appearance in event log: LOW OIL PRES A

Cause	Corrective action
The engine oil pressure is below the limit set for the low oil pressure alarm.	1. Check the engine oil level and add oil, if necessary. 2. Check oil pump. 3. Check for obstructions in the oil lubrication passages.

TIM-ID: 0000065425 - 001

LSM AVR OUT LMT

Load Share Module AVR output limit

Pre-Alarm

Appearance in event log: LSM AVR OUT LMT P

Cause	Corrective action
The Analog Voltage Regulator (AVR) bias signal has hit the low or high limit of its range. Usually this indicates some sort of wiring error or settings error which causes the bias output to be incompatible with the bias range on the AVR.	1. Check wiring and external devices to make sure the bias output and load share lines are not driven by an external device. 2. Verify the selected range for the bias output is compatible with the AVR bias input range. 3. Perform tests in the troubleshooting section of the manual to verify that changing bias output voltage or current values will change the generator's output voltage in the desired manner.

LSM COMMS FAIL

Load Share Module communications failure

Pre-Alarm

Appearance in event log: LSM COMMS FAIL P

Cause	Corrective action
The controller is not receiving a heartbeat from the Load Share Module (LSM).	1. Verify all CAN bus communications cables are in place, properly wired, and properly terminated. 2. Check that the I/O modules that are present in the system are enabled in the controller settings. 3. Check the I/O modules to be sure they are powered up and functioning.

LSM GOV OUT LMT

Load Share Module GOV output limit

Pre-Alarm

Appearance in event log: LSM GOV OUT LMT P

Cause	Corrective action
The Load Share Module (LSM) governor bias signal has hit the low or high limit of its range. Usually this indicates some sort of wiring error or settings error which causes the bias output to be incompatible with the bias range on the governor.	1. Check wiring and external devices to make sure the bias output and load share lines are not driven by an external device. 2. Verify the selected range for the bias output is compatible with the governor bias input range. 3. Perform tests in the troubleshooting section of the manual to verify that changing bias output voltage or current values will change the generator's RPM in the desired manner.

TIM-ID: 0000065425 - 001

LSM HEARTBEAT FAIL

Load Share Module heartbeat failed

Pre-Alarm

Appearance in event log: LSM HEARTBEAT FAIL P

Cause	Corrective action
The controller is not receiving a heartbeat from the Load Share Module (LSM).	1. Verify all CAN bus communications cables are in place, properly wired, and properly terminated. 2. Check that the I/O modules that are present in the system are enabled in the controller settings. 3. Check the I/O modules to be sure they are powered up and functioning.

LSM INTERGEN COM FAIL

Load Share Module intergen communications failure

Pre-Alarm

Appearance in event log: LSM INTERGEN COM FAIL P

Cause	Corrective action
The controller lost communications with the other generators on the Inter-Genset communications network. Typically, this indicates some sort of network issue is blocking communications between the generators.	1. Verify other generators are on line. 2. Check network cabling and components for network issues. 3. Verify that all devices on the network are industrially rated and designed to comply with IEC 61000-4 series of specifications. 4. As a last resort, power cycle the Load Share Module (LSM) and the network devices to see if communications is restored.

MAINT INTERVAL

Maintenance interval

Pre-Alarm

Appearance in event log: MAINT INTERVAL P

Cause	Corrective action
The maintenance interval has expired indicating it is time to service the unit.	1. Service the machine. 2. Reset the pre-alarm on the front panel under SETTINGS → SYSTEM SETTINGS → MAINT RESET by setting MAINT RESET to YES. It will reset the pre-alarm and change its value back to NO.

MF TRANSFER

Mains fail transfer complete

Status

Appearance in event log: MF TRANSFER

Cause	Corrective action
A transfer of the load from the utility to the generator after a mains failure has been successfully completed.	▶ (none)

TIM-ID: 0000065425 - 001

MF TRANSFER FAIL

Mains fail transfer fail

Status

Appearance in event log: MF TRANSFER FAIL P

Cause	Corrective action
A transfer of the load from the mains to the generator has not been accomplished in the time allowed by the Mains Fail Max Transfer time setting.	1. Check that bus sensing indicates a failed or dead bus status when the bus is not stable. 2. Verify that the breaker status for the generator breaker and mains breaker are received by the controller. 3. Check the time required for a transfer to occur and that enough time is allowed by the Mains Fail Max Transfer time setting.

MN BKR CL FL

Main breaker close failure

Pre-Alarm

Appearance in event log: MN BKR CL FL P

Cause	Corrective action
The controller has issued a mains breaker close output, but the breaker status has not reported the breaker closed within the time allowed by the Breaker Close Wait time.	1. This is a latched pre-alarm and can be cleared only by pushing the reset button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. 4. Verify the breaker is receiving open and close commands from the controller. 5. If pulsed breaker commands are employed, make sure the pulse is long enough for the breaker to change states. Consider lengthening the Breaker Close Wait time.

MN BKR OP FL

Main breaker open failure

Pre-Alarm

Appearance in event log: MN BKR OP FL P

Cause	Corrective action
The controller has issued a breaker open output, but the breaker status has not reported the breaker open within the time allowed by the Breaker Close Wait time.	1. This is a latched pre-alarm and can be cleared only by pushing the reset button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. 4. Verify the breaker is receiving open and close commands from the controller. 5. If pulsed breaker commands are employed, make sure the pulse is long enough for the breaker to change states. Consider lengthening the Breaker Close Wait time.

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MN BKR SYN FL

Main breaker synchronization failure

Pre-Alarm

Appearance in event log: MN BKR SYN FL P

Cause	Corrective action
The Synchronizer Fail Activation Delay timer expired while the generator was trying to synchronizer and close the mains breaker.	1. This is a latched pre-alarm and can be cleared only by pushing the reset button on the front of the controller or putting the machine into OFF mode. 2. Check the wiring from the controller to the breaker. 3. Verify the controller is receiving correct open-closed status from the breaker. Consider lengthening the Synchronizer Fail Activation Delay. 4. Check speed controller tuning and re-tune to make it more aggressive if possible.

MPU FAIL

Magnetic Pickup failure

Pre-Alarm

Appearance in event log: MPU FAIL P

Cause	Corrective action
The Magnetic Pickup (MPU) that senses flywheel teeth for speed sensing is not being monitored by the controller and the speed source is set for MPU or GEN (generator frequency). Loss of MPU causes a pre-alarm, and the controller uses generator frequency as the speed source to continue running.	1. Check the MPU sensor, and verify that it is creating pulses. 2. Check the wiring from the MPU sensor to the controller, and correct any issues.

MPU FAIL

Magnetic Pickup failure

Alarm – causes machine shutdown

Appearance in event log: MPU FAIL A

Cause	Corrective action
The Magnetic Pickup (MPU) that senses flywheel teeth for speed sensing is not being monitored by the controller, and the speed source is set for MPU. Loss of MPU causes an alarm.	1. Check the MPU sensor, and verify that is creating pulses. 2. Check the wiring from the MPU sensor to the controller, and correct any issues.

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MULTIPLE AEM

Multiple Analog Expansion Modules detected

Pre-Alarm

Appearance in event log: MULTIPLE AEM P

Cause	Corrective action
More than one Analog Expansion Module (AEM) has been detected on the CAN bus I/O network.	1. Remove all but one AEM if more than one is present. 2. Check CAN bus connections, terminations, etc. and verify good CAN bus communications are occurring.

MULTIPLE CEM

Multiple Contact Expansion Modules detected

Pre-Alarm

Appearance in event log: MULTIPLE CEM P

Cause	Corrective action
More than one Contact Expansion Modules (CEM) has been detected on the CAN bus I/O network.	1. Remove all but one CEM if more than one is present. 2. Check CAN bus connections, terminations, etc., and verify good CAN bus communications are occurring.

MULTIPLE LSM

Multiple Load Share Modules detected

Pre-Alarm

Appearance in event log: MULTIPLE LSM P

Cause	Corrective action
More than one Load Share Modules (LSM) has been detected on the CAN bus I/O network.	1. Remove all but one LSM if more than one is present. 2. Check CAN bus connections, terminations, etc., and verify good CAN bus communications are occurring.

NORM SHUTDOWN

Normal shutdown

Status

Appearance in event log: Normal Shutdown

Cause	Corrective action
The engine has shut down since all sources of run request have been removed.	▶ (none)

TIM-ID: 0000065425 - 001

OIL SNDR FAIL

Oil pressure sender fail

Status

Appearance in event log: OIL SNDR FAIL

Cause	Corrective action
The input from the sender is outside the valid range for the device.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

OIL SNDR FAIL

Oil pressure sender fail

Pre-Alarm

Appearance in event log: OIL SNDR FAIL P

Cause	Corrective action
The input from the sender is outside the valid range for the device, and the Oil Pressure sender fail is configured as pre-alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

OIL SNDR FAIL

Oil pressure sender fail

Alarm – causes machine shutdown

Appearance in event log: OIL SNDR FAIL A

Cause	Corrective action
The input from the sender is outside the valid range for the device, and the Oil Pressure sender fail is configured as alarm.	▶ Check the sender, the sender wiring, and the sender common wiring from the engine block to the controller.

OVERCRANK

Overcrank

Alarm – causes machine shutdown

Appearance in event log: OVERCRANK A

Cause	Corrective action
The engine has exceeded the allowed cranking time or number of crank cycles, and engine still has not started.	1. Check that the engine is receiving fuel and that the starter is rotating the engine adequately for engine cranking. 2. Investigate and correct issues that could prevent the engine from starting.

TIM-ID: 0000065425 - 001

OVERSPEED

Overspeed

Alarm – causes machine shutdown

Appearance in event log: OVERSPEED A

Cause	Corrective action
The engine RPM has exceeded the overspeed alarm limit.	1. Check the rated RPM setting, the speed bias into the engine governor, and the engine governor. 2. Check any load sharing devices in multiple generator applications.

PROT SHUTDOWN

Protective shutdown

Status

Appearance in event log: Protective Shutdown

Cause	Corrective action
The engine has shut down to a protective shut down.	1. Determine the source of the shut down. 2. Take action to correct the cause of the shutdown.

RTD IN x O1

Resistive Temperature Device input x over limit 1

Status

Programmable string; default appearance in event log: RTD IN x_O1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Resistive Temperature Device (RTD) input x (x = 1 to 8) is over limit 1.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

RTD IN x O1

Resistive Temperature Device input x over limit 1

Pre-Alarm

Programmable string; default appearance in event log: RTD IN x_O1 P

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) over limit 1 has been programmed as a pre-alarm, and limit 1 has been exceeded.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

RTD IN x O1

Resistive Temperature Device input x over limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: RTD IN x_O1 A

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) over limit 1 has been programmed as an alarm, and limit 1 has been exceeded.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

RTD IN x O2

Resistive Temperature Device input x over limit 2

Status

Programmable string; default appearance in event log: RTD IN x_O2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Resistive Temperature Device (RTD) input x (x = 1 to 8) is over limit 2.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

RTD IN x O2

Resistive Temperature Device input x over limit 2

Pre-Alarm

Programmable string; default appearance in event log: RTD IN x_O2 P

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) over limit 2 has been programmed as a pre-alarm, and limit 2 has been exceeded.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

RTD IN x O2

Resistive Temperature Device input x over limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: RTD IN x_O2 A

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) over limit 2 has been programmed as an alarm, and limit 2 has been exceeded.	1. Check the external device which drives the RTD input and caused the limit to be exceeded. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

RTD IN x OOR

Resistive Temperature Device input x out of range

Status

Programmable string; default appearance in event log: RTD IN x_OOR

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Resistive Temperature Device (RTD) input x (x = 1 to 8) is out of range.	1. Check the external device which drives the RTD input and went outside the valid range. 2. Take any necessary action.

RTD IN x OOR

Resistive Temperature Device input x out of range

Pre-Alarm

Programmable string; default appearance in event log: RTD IN x_OOR P

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) out of range has been programmed as a pre-alarm, and the input is outside the valid range.	1. Check the external device which drives the RTD input and went outside the valid range. 2. Take any necessary action.

RTD IN x OOR

Resistive Temperature Device input x out of range

Alarm – causes machine shutdown

Programmable string; default appearance in event log: RTD IN x_OOR A

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) out of range has been programmed as an alarm, and the input is less than the limit.	1. Check the external device which drives the RTD input and went outside the valid range. 2. Take any necessary action.

RTD IN x U1

Resistive Temperature Device input x under limit 1

Status

Programmable string; default appearance in event log: RTD IN x_U1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Resistive Temperature Device (RTD) input x (x = 1 to 8) is under limit 1.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

RTD IN x U1

Resistive Temperature Device input x under limit 1

Pre-Alarm

Programmable string; default appearance in event log: RTD IN x_U1 P

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) under limit 1 has been programmed as a pre-alarm, and the input is less than limit 1.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

RTD IN x U1

Resistive Temperature Device input x under limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: RTD IN x_U1 A

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) under limit 1 has been programmed as an alarm, and the input is less than limit 1.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

RTD IN x U2

Resistive Temperature Device input x under limit 2

Status

Programmable string; default appearance in event log: RTD IN x_U2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for Resistive Temperature Device (RTD) input x (x = 1 to 8) is under limit 2.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

RTD IN x U2

Resistive Temperature Device input x under limit 2

Pre-Alarm

Programmable string; default appearance in event log: RTD IN x_U2 P

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) under limit 2 has been programmed as a pre-alarm, and the input is less than limit 2.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

RTD IN x U2

Resistive Temperature Device input x under limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: RTD IN x_U2 A

Cause	Corrective action
Resistive Temperature Device (RTD) input x (x = 1 to 8) under limit 2 has been programmed as an alarm, and the input is less than limit 2.	1. Check the external device which drives the RTD input and went below the underlimit setting. 2. Take any necessary action.

SCREEN ERROR

Screen error

Status

Appearance in event log: SCREEN ERROR

Cause	Corrective action
The processor tried to display something on the front panel but data missing or corrupt data prevented it. This message will not affect the operation of the unit, but it may affect viewing of some of the front panel screens.	1. Power cycle the controller. 2. If the error still occurs, re-program the controller Firmware and Language Module.

SPD SNDR FAIL

Speed sender failed

Status

Appearance in event log: SPD SNDR FAIL

Cause	Corrective action
The engine is running, the speed source is set to use MPU or GEN (generator frequency) as the speed source, and no input is detected from the Magnetic Pickup Unit (MPU).	1. Check the MPU speed source, if an MPU is a speed source. 2. Check the wiring from the MPU to the controller.

TIM-ID: 0000065425 - 001

SPD SNDR FAIL

Speed sender failed

Alarm – causes machine shutdown

Appearance in event log: SPD SNDR FAIL A

Cause	Corrective action
The engine is running or trying to start, and no engine speed source is detected. Speed source selections are MPU, GEN (generator frequency), or MPU-GEN in which case MPU is used if it is detected. Otherwise, it will revert to generator frequency as the speed source and report an MPU FAIL pre-alarm.	1. Check the Magnetic Pickup Unit (MPU) speed source if an MPU is a speed source. 2. Check that generator frequency is being monitored by the controller if generator frequency is a valid speed source.

SS OVERRIDE ON

Shutdown override active

Pre-Alarm

Appearance in event log: SS OVERRIDE ON P

Cause	Corrective action
The engine governor has determined the Safety System Shutdown Override is in effect and sent the pre-alarm to the controller.	▶ Remove the Safety System Shutdown Override to clear the pre-alarm.

THRM CPL x O1

Thermocouple input x over limit 1

Status

Programmable string; default appearance in event log: THRM CPL x_O1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for thermocouple input x (x = 1 to 2) is over limit 1.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

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THRM CPL x O1

Thermocouple input x over limit 1

Pre-Alarm

Programmable string; default appearance in event log: THRM CPL x_O1 P

Cause	Corrective action
Thermocouple input x (x = 1 to 2) over limit 1 has been programmed as a pre-alarm, and limit 1 has been exceeded.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

THRM CPL x O1

Thermocouple input x over limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: THRM CPL x_O1 A

Cause	Corrective action
Thermocouple input x (x = 1 to 2) over limit 1 has been programmed as an alarm, and limit 1 has been exceeded.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

THRM CPL x O2

Thermocouple input x over limit 2

Status

Programmable string; default appearance in event log: THRM CPL x_O2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for thermocouple input x (x = 1 to 2) is over limit 2.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

THRM CPL x O2

Thermocouple input x over limit 2

Pre-Alarm

Programmable string; default appearance in event log: THRM CPL x_O2 P

Cause	Corrective action
Thermocouple input x (x = 1 to 2) over limit 2 has been programmed as a pre-alarm, and limit 2 has been exceeded.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

TIM-ID: 0000065425 - 001

THRM CPL x O2

Thermocouple input x over limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: THRM CPL x_O2 A

Cause	Corrective action
Thermocouple input x (x = 1 to 2) over limit 2 has been programmed as an alarm, and limit 2 has been exceeded.	1. Check the external device which drives the thermocouple input and caused the limit to be exceeded. 2. Take any necessary action.

THRM CPL x OOR

Thermocouple input x out of range

Status

Programmable string; default appearance in event log: THRM CPL x_OOR

Cause	Corrective action
Status indication on the front panel, and control panel communication software for thermocouple input x (x = 1 to 2) is out of range.	1. Check the external device which drives the thermocouple input and went outside the valid range. 2. Take any necessary action.

THRM CPL x OOR

Thermocouple input x out of range

Pre-Alarm

Programmable string; default appearance in event log: THRM CPL x_OOR P

Cause	Corrective action
Thermocouple input x (x = 1 to 2) out of range has been programmed as a pre-alarm, and the input is outside the valid range.	1. Check the external device which drives the thermocouple input and went outside the valid range. 2. Take any necessary action.

THRM CPL x OOR

Thermocouple input x out of range

Alarm – causes machine shutdown

Programmable string; default appearance in event log: THRM CPL x_OOR A

Cause	Corrective action
Thermocouple input x (x = 1 to 2) out of range has been programmed as an alarm, and the input is less than the limit.	1. Check the external device which drives the thermocouple input and went outside the valid range. 2. Take any necessary action.

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THRM CPL x U1

Thermocouple input x under limit 1

Status

Programmable string; default appearance in event log: THRM CPL x_U1

Cause	Corrective action
Status indication on the front panel, and control panel communication software for thermocouple input x (x = 1 to 2) is under limit 1.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

THRM CPL x U1

Thermocouple input x under limit 1

Pre-Alarm

Programmable string; default appearance in event log: THRM CPL x_U1 P

Cause	Corrective action
Thermocouple input x (x = 1 to 2) under limit 1 has been programmed as a pre-alarm, and the input is less than limit 1.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

THRM CPL x U1

Thermocouple input x under limit 1

Alarm – causes machine shutdown

Programmable string; default appearance in event log: THRM CPL x_U1 A

Cause	Corrective action
Thermocouple input x (x = 1 to 2) under limit 1 has been programmed as an alarm, and the input is less than limit 1.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

THRM CPL x U2

Thermocouple input x under limit 2

Status

Programmable string; default appearance in event log: THRM CPL x_U2

Cause	Corrective action
Status indication on the front panel, and control panel communication software for thermocouple input x (x = 1 to 2) is under limit 2.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

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THRM CPL x U2

Thermocouple input x under limit 2

Pre-Alarm

Programmable string; default appearance in event log: THRM CPL x_U2 P

Cause	Corrective action
Thermocouple input x (x = 1 to 2) under limit 2 has been programmed as a pre-alarm, and the input is less than limit 2.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

THRM CPL x U2

Thermocouple input x under limit 2

Alarm – causes machine shutdown

Programmable string; default appearance in event log: THRM CPL x_U2 A

Cause	Corrective action
Thermocouple input x (x = 1 to 2) under limit 2 has been programmed as an alarm, and the input is less than limit 2.	1. Check the external device which drives the thermocouple input and went below the underlimit setting. 2. Take any necessary action.

WEAK BATTERY

Weak battery voltage

Pre-Alarm

Appearance in event log: WEAK BATTERY P

Cause	Corrective action
The battery voltage measured while the engine is cranking is below the limit set for the weak battery voltage pre-alarm.	1. Check the battery voltage level, the battery charging circuits, and connections from the battery to the engine. 2. Charge battery, if necessary. (The pre-alarm will not clear until a crank cycle occurs where the battery voltage is above the limit set for the weak battery voltage pre-alarm.)

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6.2.3 ADM3 Fault Codes for Mercedes-Benz Engines

A list of fault codes on the ADM3 for Mercedes-Benz engines can be accessed here: (→ Page 255).

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7 Ground Fault Protection - Field Testing

7.1 Field Testing of Residual Equipment Ground Fault Protection Systems 207

7.1 Field Testing of Residual Equipment Ground Fault Protection Systems

FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

SCOPE 1

DEFINITION(S) 1

SYSTEM OPERATION 3

SYSTEM TESTING 4

SCOPE

The purpose of this document is to provide instructions for testing a residual Equipment Ground Fault Protection (EGFP) system utilizing an MGC-3000 Series controller and a shunt trip-equipped disconnect device or circuit breaker (if tripping is required).

NFPA 70, National Electric Code (NEC) 215.10 specifies that each feeder disconnect rated 1,000 amperes or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground fault protection of equipment in accordance with the provisions of NEC 230.95. NEC 230.95(C) specifies performance testing of the ground fault protection system when first installed onsite.

In certain installations, such as emergency systems (NEC Article 700) and legally required standby systems (NEC Article 701), indication of ground fault conditions is required.

To maintain UL2200 Listing of the engine generator assembly provided with equipment ground fault protection, use current transformer catalog number 115-601MR manufactured by Instrument Transformers Inc. in accordance with these instructions.

DEFINITION(S)

Residual Equipment Ground Fault Protection System

A residual or ground-strap form equipment ground fault protection system that typically utilizes a current transformer, protective relay, and a shunt trip-equipped disconnect device (if tripping is required). The system is configured with a main bonding jumper that connects the equipment ground bus to the generator neutral which passes through the center of the ground current transformer. The current transformer is connected to a protective relay that will sense ground fault currents and either indicate the condition or trip the main disconnect device by means of a shunt trip device. According to the placement of the main bonding jumper in Figure 1, the majority of the ground fault current will flow through the main bonding jumper and will be detected by the protective relay through means of the current transformer.

Ground Current Transformer

An instrument transformer used for measuring alternating electric currents. Specifically in EGFP systems, the current transformer detects any abnormal, damaging currents that may flow in the equipment ground back to the generator source when a phase-to-ground fault occurs.

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FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

MGC-3000 Series Controller
A microprocessor-based generator set controller with comprehensive control, metering, and protection capabilities. The MGC-3000 Series controller is responsible for starting and stopping the generator set, monitoring power quality and performance, and protecting equipment in the event of faults. In an EGFP system, the MGC-3000 Series controller serves as a protective relay, detecting ground faults by means of the current transformer, annunciating the fault condition, and tripping the disconnect device by means of a shunt trip device (if tripping is required). The MGC-3000 Series controller ground fault protection circuit complies with the applicable requirements of UL1053, as required by UL6200, and is also listed under MTU Onsite Energy's file AU3559.

Disconnect Device
A disconnect device (usually a circuit breaker) is the means by which the conductors of a circuit can be disconnected from its source of supply. This is controlled by the protective relay and protects equipment from damaging line-to-ground faults by simultaneously opening all ungrounded conductors of the faulted circuit.

Shunt Trip
A device commonly found on circuit breakers that allows a remote device, such as a protective relay, to trip the circuit breaker open mechanism, thereby disconnecting the power source and the load.

Ground Fault Indication (GFI)
Ground faults are indicated but the disconnect device remains closed.

Ground Fault Indication and Trip (GFIT)
Ground faults are indicated and the disconnect device is tripped open.

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FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

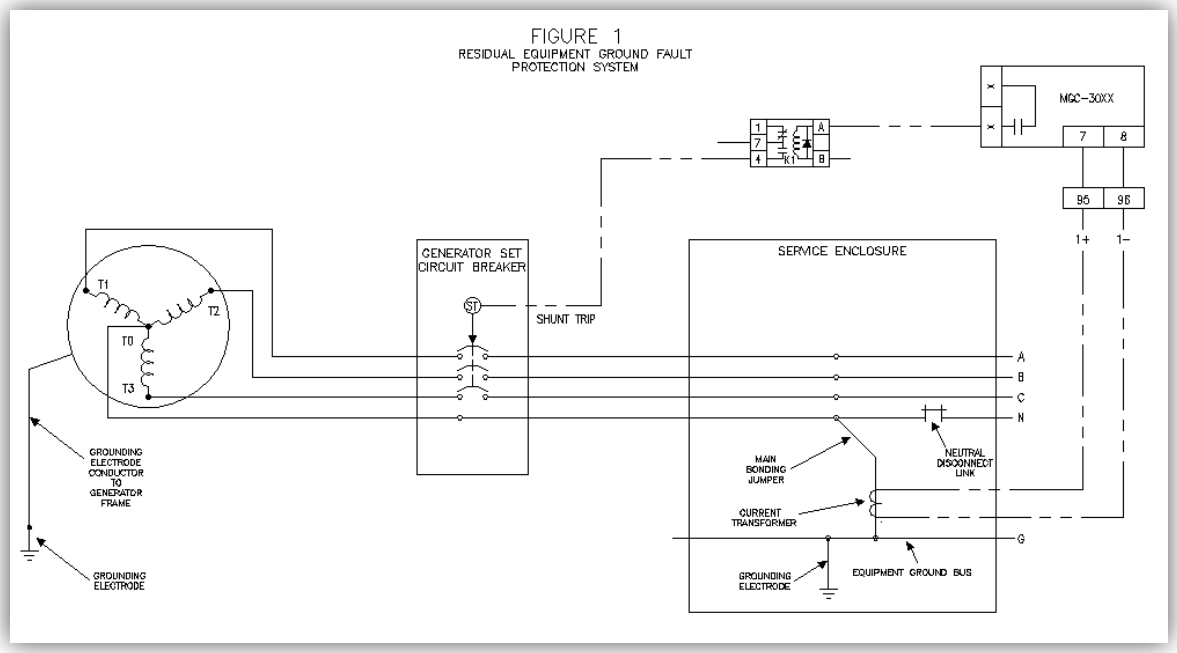

Figure 1: Residual Equipment Ground Fault Protection System

SYSTEM OPERATION

During normal operating conditions, there should be little to no ground return current flowing from the equipment ground bus, through the main bonding jumper, and back to the generator set neutral. The generator set circuit breaker will be closed, and actual ground return current should be below the trip/indication threshold in the MGC-3000 Series controller. Therefore, the controller will not activate the shunt trip.

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FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

SYSTEM TESTING

⚠ DANGER

ELECTRICAL SHOCK, EXPLOSION AND ARC FLASH HAZARD

- This equipment must be installed and serviced only by qualified electrical personnel.
- Do NOT attempt to test this equipment while it is energized. Death or severe personal injury could result.
- Turn off all power sources and use properly rated devices to confirm that power is off before testing.
- Replace all devices, doors, and covers before re-energizing equipment.

Preparation and Verification

1. Disconnect all sources supplying this equipment with power using approved lock-out, tag-out procedures.
2. Confirm that power is off using properly rated devices before testing.
3. Verify that all ground bus bar splices and straps are solidly connected at the generator set and in the service enclosure.
4. Verify that the main bonding jumper is installed between the generator set neutral bus and the equipment grounding bus in the service enclosure.
5. Verify that the ground current transformer is installed on the main bonding jumper with line side facing the equipment grounding bus.
6. Verify that there are no ground to neutral bonds on the line side of the main bonding jumper in the service enclosure (towards generator set).
7. Temporarily remove the neutral disconnect link in the service enclosure to isolate the load side of the neutral from the generator set source and the equipment grounding bus.
8. Measure and record the neutral-to-ground resistance to ensure that there are no connections on the load side of the EGFP system. The resistance should be greater than 1 mega ohm. Accidental or intentional grounding of the neutral anywhere else on the load side of the main bonding jumper will desensitize the EGFP system or render it ineffective.
9. Reinstall the neutral disconnect link.

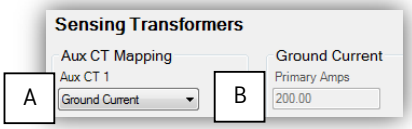
TIM-ID: 0000097094 - 001

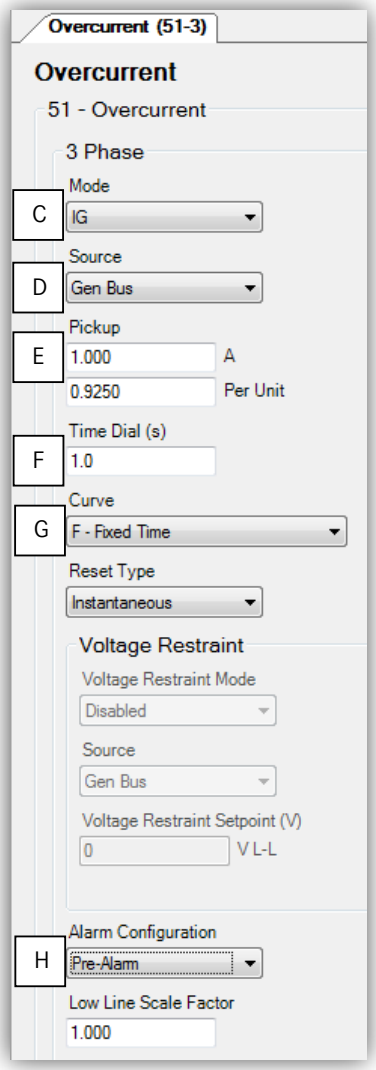
FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

Settings and Programming

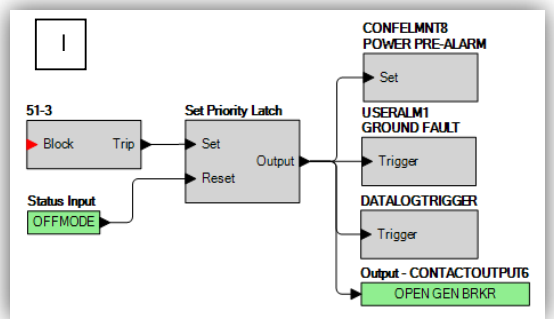
1. Verify the following settings and logic in the MGC-3000 Series controller:
   - A. Aux CT 1set to “Ground Current”
   - B. Ground Current “Primary Amps” based on current transformer used in application
   - C. Overcurrent Mode set to “IG”
   - D. Overcurrent Source set to “Gen Bus”
   - E. Overcurrent Pickup set to “1.000” A (reduced for testing)
   - F. Overcurrent Time Dial set to “1.0” (s)
   - G. Overcurrent Curve set to “F – Fixed Time”
   - H. Overcurrent Alarm Configuration based on application:
     - i. Ground Fault Indication (GFI) → Pre-alarm
     - ii. Ground Fault Trip (GFIT) → Alarm
   - I. Verify logic is appropriate for application (i.e. breaker tripping, indication, data logging trigger, etc…)





Ground fault protection pickup and time delay settings must be determined through means of a coordination study of other protection devices and equipment in the power system on a per-application basis. The fixed time, definite time, and all inverse time curves have been investigated for ground fault protection. Do not use negative-sequence (46) or user programmable (P) curves.

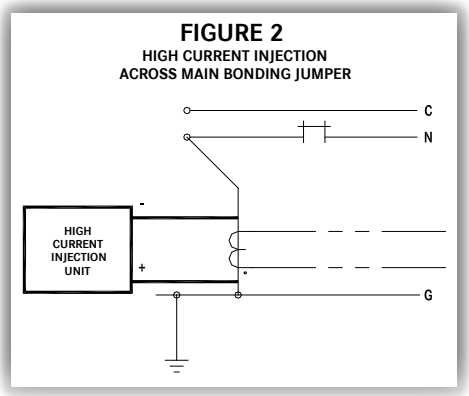
NEC 230.95(C) stipulates that the maximum setting of the EGFP system may not exceed 1200 amperes and a maximum time delay of 1 second for fault currents equal to or greater than 3000 amperes.

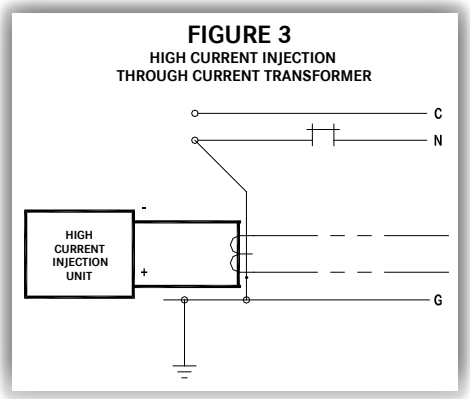


TIM-ID: 0000097094 - 001

Testing

1. Close the generator set circuit breaker.
2. Connect a high current injection unit by either method:
    a. Across the main bonding jumper; or
    b. By running a conductor through the ground current transformer.





3. Place the MGC-3000 series controller in 'Auto' mode.
4. Inject current in excess of the pickup threshold set in the MGC-3000 Series controller.
5. The MGC-3000 Series controller should:
    a. Provide ground fault indication condition by text, audible alarm, and indicator light; or
    b. Provide ground fault indication condition by text, audible alarm, and indicator light and trip the circuit breaker by means of the shunt trip device [if trip is required and tripping devices are present].
6. Reset the MGC-3000 Series controller.
7. Disconnect the high current injection unit.
8. Record the testing results in the EGFP System Test Record Table.

TIM-ID: 0000097094 - 001

FIELD TESTING OF RESIDUAL EQUIPMENT GROUND FAULT PROTECTION SYSTEMS

Utilizing MGC-3000 Series Controllers and Shunt Trip-Equipped Circuit Breakers

EGFP System Test Record Table			
Location			
Technician			
Tested EGFP Settings			
Ground Current Transformer Ratio		Overcurrent Time Dial	
Overcurrent Mode		Overcurrent Curve	
Overcurrent Source		Alarm Configuration	
Overcurrent Pickup			
Test Results			
Notes			
Coordinated EGFP Settings			
Ground Current Transformer Ratio		Overcurrent Time Dial	
Overcurrent Mode		Overcurrent Curve	
Overcurrent Source		Alarm Configuration	
Overcurrent Pickup			
Notes			
Signature		Date	

A copy of this table shall be retained by parties responsible for the building's electrical installation and shall be available to the authority having jurisdiction.

TIM-ID: 0000097094 - 001

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8 Maintenance

8.1 Preface

The maintenance schedule is applicable to products certified in accordance with U.S. emissions regulations and operated in the area of applicability of these regulations.

Information about the latest maintenance schedule is available at: http://www.mtu-online.com.

The following instructions must be observed for these products:

The maintenance schedule is an integral part of the emissions certification. Nonobservance of the maintenance instructions can result in violation of the statutory emission specifications. Modification or removal of mechanical or electronic components or the installation of additional components as well as the execution of calibration processes that might affect the emission characteristics of the product are prohibited by emission regulations. Emission-relevant components may only be maintained, exchanged or repaired if the components used for this purpose are approved by MTU or equivalent components. Emission-relevant components are for instance control units, data records, sensors, injectors, exhaust flaps ands all components of exhaust aftertreatment systems.

The maintenance system for MTU products is based on a preventive maintenance concept. Preventive maintenance facilitates advance operational planning and ensures a high level of equipment availability.The maintenance intervals and the scope of required maintenance activities are the result of operational experience and therefore represent recommendations. Severe operating and ambient conditions may require additional maintenance work and/or modification of the maintenance intervals.

Maintenance activities are specified with intervals based on hours in operation and time limits. Whichever value is reached first shall apply.

The individual maintenance intervals are classified in accordance with the qualification levels QL1 to QL4.

QL1: Operational monitoring and maintenance work which does not require disassembly of the product.
QL2: Exchange of components and parts (corrective only, not part of the maintenance schedule).
QL3: Maintenance work which requires partial disassembly of the product.
QL4: Maintenance work which requires complete disassembly of the product.

Additional notes on maintenance and preservation:

For change intervals for fluids and lubricants as well as for preservation specifications, refer to the relevant instructions of the component manufacturers and the MTU Fluids and Lubricants Specifications. The latest version for drive systems is available online at: http://www.mtu-online.com, and for power generation systems at: http://www.mtuonsiteenergy.com.

Components which are not listed in this maintenance schedule must be serviced in accordance with Manufacturer's Instructions.

TIM-ID: 0000046248 - 005

8.2 Maintenance schedule matrix

0 to 500 Operating hours

Task	Limit	Operating hours [h]	
		Daily	500
Engine-generator set monitoring			
W0109	-	X	
W0115	-	X	
W0110	-	X	
W0112	-	X	
W0134	1 m		
W6506	6 m		X
W1675	2 a		X
Engine			
W6536	-		
Generator			
W6535	1 m		X
X6065	1 a		X
W8654	1 a		X
W6534	1 a		X
X7900	1 a		X
Preheater / Jacket water heater			
W6521	1 a		X
Engine-generator set control panel			
W6511	6 m		X
X3041	10 a		
Radiator			
W1510	6 m		X
W8655	1 a		
w = weeks m = months a = years			

TIM-ID: 0000064808 - 001

8.3 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Note: For engine maintenance information, refer to the Mercedes-Benz OM924-926LA engine documentation contained within this manual. To ensure you have the most current version of the engine manual, contact the engine manufacturer or your MTU Onsite Energy distributor or dealer.

Task	Option	Maintenance Task	Reference
W0109		Check engine oil level.	(→ Page 219)
W0115		Drain off water and contamination from fuel prefilter with water separator.	(→ Page 220)
W0110		Check general condition of engine-generator set and inspect for leaks.	(→ Page 221)
W0112		Inspect service indicator of air filter.	(→ Page 223)
W0134		Test run at not below 1/3 load and at least until steady-state temperature is reached (monthly).	(→ Page 224)
W6506		Test status lights and gauges.	(→ Page 225)
W1675		Fit new fuel prefilter or new fuel prefilter insert.	(→ Page 227)
W6536		Check air flow into and out of unit, remove debris from ventialtion system.	(→ Page 240)
X6065		Check generator wiring visually for damage.	(→ Page 241)
W8654		Check antifriction bearings, replace if necessary.	(→ Page 242)
W6534		Check and adjust voltage regulator if needed.	(→ Page 243)
X7900		Check circuit breaker condition visually and carry out function tests.	(→ Page 245)
W6521		Test preheating functionality.	(→ Page 246)
W6511		Test controller displays for functionality.	(→ Page 247)
X3041		Replace backup battery in controller.	(→ Page 248)
W1510		Check cooler / radiator elements externally for contamination and leaks.	(→ Page 249)
W8655		Cooler / radiator core face cleaning.	(→ Page 250)

TIM-ID: 0000065770 - 001

9 Task Description

9.1 Chapter overview

This chapter provides instructions on performing the necessary maintenance work on the engine-generator set.

Note: This publication describes all available engine-generator set components. Disregard any components which are not included in the scope of delivery of your particular engine-generator set. For engine maintenance tasks, refer to the Engine Manual OM924-926 LA. (→ Page 277)

Before starting work

- Ensure that the prerequisites listed in the descriptions have been fulfilled.
- Ensure that all necessary special tools, consumables, and spare parts are available.
- Ensure that fluids and lubricants used for work have been approved for the engine-generator set.

Spare part designations and the quantities required are listed in the task descriptions. Spare part order numbers are listed in the Spare Parts Catalog.

Contact Service if a maintenance task cannot be successfully completed.

TIM-ID: 0000061864 - 001

9.2 Engine-Generator Set

9.2.1 Check engine oil level

The engine oil level must be checked daily. See the Mercedes-Benz OM924-926LA Operating Instructions, page 40. (→ Page 277)

TIM-ID: 0000065670 - 001

9.2.2 Fuel prefilter - Draining

Preconditions

☑ Engine is stopped and starting disabled.

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel prefilter – Draining

1. Provide a suitable container to collect the water.
2. Open drain valve (2).
3. Drain water and contaminants from the filter bowl (1) until pure fuel emerges.
4. Close drain screw.

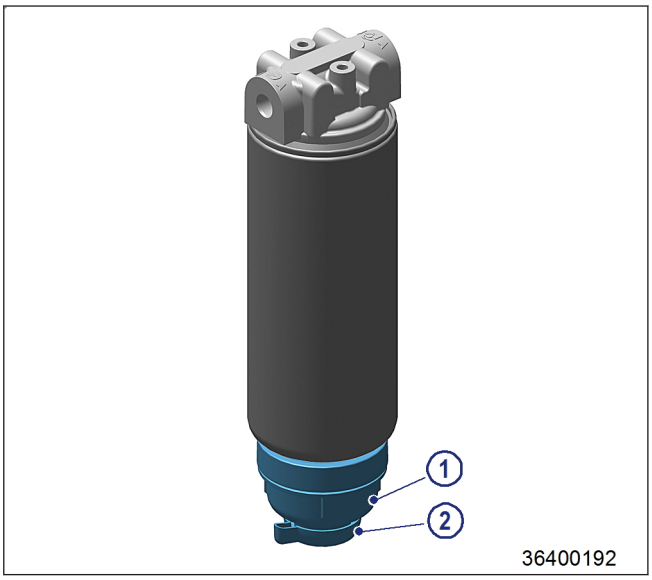

Figure 32: Fuel prefilter – Draining

TIM-ID: 0000057747 - 001

9.2.3 Engine-generator set - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000060384 - 001

Maintenance checks to be carried out on engine-generator set

Item	Findings	Action
Check the engine-generator set location.	Debris or flammable/combustible material found.	Clear away debris and clean area as needed.
Inspect engine-generator set.	Dirt or contamination found. Loose/missing wires or fasteners found. Leaks or evidence of leakage found.	Clean as needed. Tighten or replace as needed. Repair or replace as needed.
Check inlets, outlets, screens, and protection guards.	Obstructions or debris found.	Clear and clean as needed.

TIM-ID: 0000060384 - 001

9.2.4 Service indicator – Signal ring position check

Preconditions

☑ Engine is stopped and starting disabled.

Checking signal ring position

1. If the signal ring is completely visible in the observation window (2), replace air filter.
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.

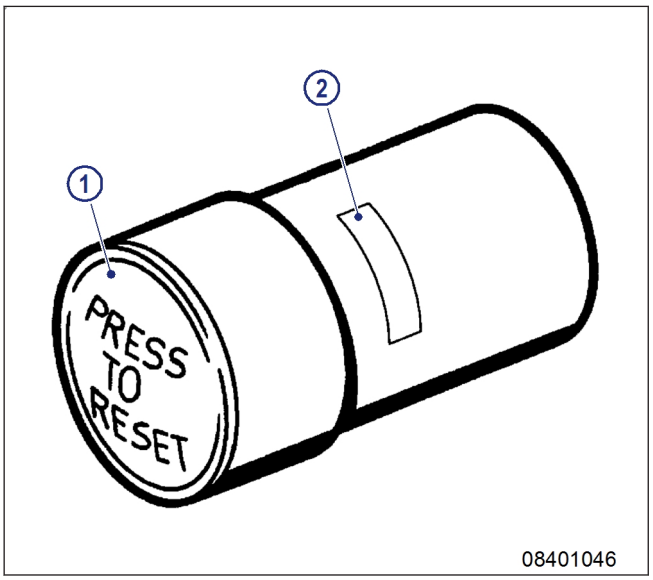

Figure 33: Service indicator

TIM-ID: 0000005483 - 003

9.2.5 Engine-generator set – Test run

Preconditions

☑ Engine-generator set is stopped.

☑ Engine-generator set is ready for operation and is in AUTO mode.

WARNING

Live parts, rotating and moving parts and a high level of engine noise.
Risk of electric shock, crushing, parts of the body being caught or pulled in or damage to hearing!
- Before starting, ensure that no other persons are in or near the danger zone.
- Carry out safety precautions to prevent persons entering the danger zone.
- Ensure that all protective guards and covers are installed, if the engine has been started in order to perform maintenance tasks
- Always start the engine according to the procedure described in the Operation and Maintenance Manual.

WARNING

Rotating and moving parts during operation.
Risk of crushing, danger of parts of the body being caught or pulled in!
- Ensure that all protective guards and covers are installed.
- Take care when working around moving belts and rotating parts near or on an operating engine-generator set.
- Do not tamper with moving or rotating parts.
- Wear close-fitting clothes and hairnet.
- Remove watches, rings and other metal objects.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

High level of engine noise when the engine is running.
Risk of damage to hearing!
- Wear ear protectors.

Test run

1. Start the engine-generator set using manual start procedure (→ Page 144). If the engine-generator set doesn't start, refer to troubleshooting (→ Page 150).
2. Carry out test run at a minimum of 30 % load and at least until steady-state temperature is reached (approximately for 10 to 15 minutes).
3. Carry out exercising checks (→ Page 147).
4. Stop the engine-generator set (→ Page 145).

TIM-ID: 0000001021 - 011

9.2.6 Engine-generator set – Test status lights and gauges

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000060420 - 001

Test status lights and gauges

Item	Findings	Action
Carry out lamp test on engine-generator set control panel.	Improper function.	Contact Service.
Test switches on engine-generator set control panel.	Improper function.	Contact Service.
Check for fault messages on engine-generator set control panel.	Fault messages found.	Contact Service.
Test alarm lights on remote annunciator, if fitted.	Improper function.	Contact Service.
Test controller lights and display on automatic transfer switch, if fitted.	Improper annunciation	Contact Service.

TIM-ID: 0000060420 - 001

9.2.7 Fuel prefilter – Replacement

Preconditions

☑ Engine is stopped and starting disabled.

☑ System is not under pressure.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	1

WARNING

Fuels are combustible.
Risk of fire and explosion!
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Tank is pressurized.
Risk of eye injuries resulting from fluid escaping under high pressure!
- Open tank slowly.
- Wear goggles or safety mask.

NOTICE

Contamination of components.
Damage to component!
- Observe manufacturer's instructions.
- Check components for special cleanliness.

Replacing fuel prefilter

1. Remove easy-change filter (2) with filter wrench.
2. Clean sealing surface on filter head (1).
3. Lightly lubricate seal on the easy-change filter (2).
4. Screw on easy-change filter (2) by hand until the seal makes contact with the filter head and tighten manually.

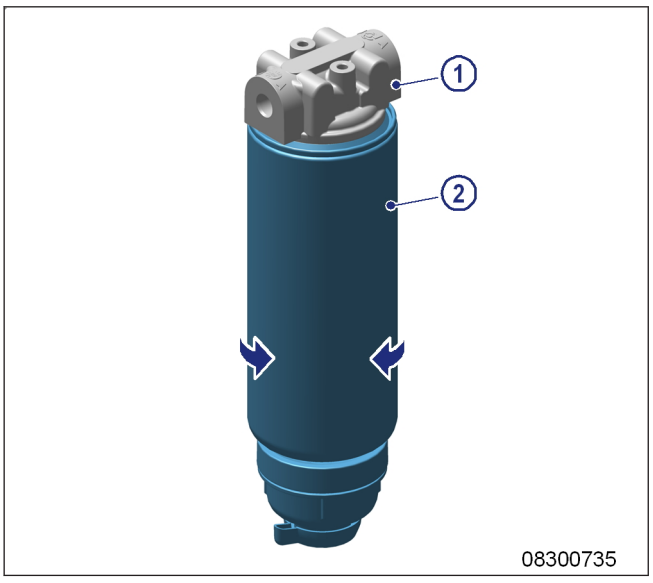

Figure 34: Replacing fuel prefilter

TIM-ID: 0000036955 - 003

9.3 Engine

9.3.1 Engine Maintenance for Mercedes-Benz OM924LA/OM926LA Engines

For engine maintenance information, refer to the Mercedes-Benz OM924LA/OM926LA engine documentation contained within this manual. To ensure you have the most current version of the engine manual, contact the engine manufacturer or MTU Onsite Energy(→ Page 381).

TIM-ID: 0000065669 - 001

9.3.2 Fuel system - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000060428 - 001

Checks to be carried out on the fuel system

Item	Findings	Action
Inspect fuel tank if supplied.	Signs of rust found.	Repair or replace as needed.
Inspect fuel lines.	Leaks, chafing, or dry rot found.	Repair or replace as needed.
Check fuel prefilter with water separator.	Fluid in collection bowl found.	Drain (→ Page 220).
Inspect fuel filter housing.	Signs of leakage found.	Replace.
Check to ensure that fuel system is vented.	Fuel system is not vented.	Contact Service.

TIM-ID: 0000060428 - 001

9.3.3 Taking fuel samples

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

Note:
- Fluid analysis is most effective when samples are representative of the typical environmental conditions under which they operate. Dirt, system debris, water, and light fuels tend to separate from lubricants and coolants when system temperatures cool. Samples must be taken while the systems are operating under normal conditions or immediately after shutdown while they are still at operating temperature.

TIM-ID: 0000062623 - 001

- Samples must also be taken at regularly scheduled intervals and from the same sampling point each time. Although an equipment manufacturer's recommendations provide a good starting point for developing preventive maintenance practices, sampling intervals can vary. A major consideration for determining sampling frequency is how critical a piece of equipment is to production. Environmental factors are also important, such as hot, dirty operating conditions, short trips with heavy loads, and excessive idle times.
- For any engine or component failure that will generate a warranty claim, MTU Onsite Energy requires that samples of the appropriate fluids (such as oil, coolant, and/or fuel) are retained for analysis until the warranty claim is closed, unless otherwise instructed.

Collecting Fuel Samples

Use only new, clean, dry, and tightly sealable sample vessels. Do not use beverage bottles.
Fuel test kits can also be ordered from MTU Onsite Energy.The following kits are available:

- Basic Test (Part # F-PDFM1) This kit is used for checking the contamination level of diesel fuel. The test checks for metals, water, bacteria, and particle contaminates.
- Advanced Test (Part # F-PDFM2) This kit includes Basic Test plus analysis to determine contamination levels, possible filter plugging characteristics, and ignition performance in an engine.
- Advanced Test Plus (Part # F-PDFM3) This kit includes Advanced Test and lubricity analysis. Maintaining correct lubricity level is beneficial for ensuring long-term performance of engine fuel system components.

1. Clean the sampling point as well as possible with a clean, lint-free cloth before collecting the sample.
2. Discard the first liter of fuel collected. This prevents contaminants at the sampling point from reaching the sample vessel.
3. Collect the sample directly into the sample vessel. **Note**: Sample volumes depend on scope of examination. For standard analysis, 2000 ml must be provided.
4. Seal the sample immediately after collection.
5. Label the sample with the following information:
   - Fuel type
   - Engine
   - Sampling point
   - Date
   - Notes
6. Send the sample to one of the addresses below for analysis.

USA: Polaris Laboratories 7451 Winton Drive Indianapolis, IN 46268 Phone: 877.808.3750
Polaris Laboratories 10910 W. Sam Houston Parkway N., Suite 700 Houston, TX 77064-6314 Phone: 877.808.3750
Polaris Laboratories 3060 W. California Avenue, Suite B Salt Lake City, UT 84104 Phone: 877.808.3750
CANADA: Polaris Laboratories 5140 75th Street Edmonton, Alberta Canada T6E 6W2 Phone: 877.808.3750

Table 3: Delivery addresses for fuel samples

TIM-ID: 0000062623 - 001

9.3.4 Removing and installing air filter

Preconditions

☑ Engine-generator set is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

Note: Filter may differ in appearance from image shown, but the procedure is the same.

Removing and installing air filter

1. Undo clamp (2).
2. Remove air filter (1) and clamp (2) from connecting flange of intake (3).
3. Clean the connecting flange of the intake (3) and check for obstruction.
4. Secure new air filter (1) on intake (3) with clamp (2).
5. Tighten clamp (2).

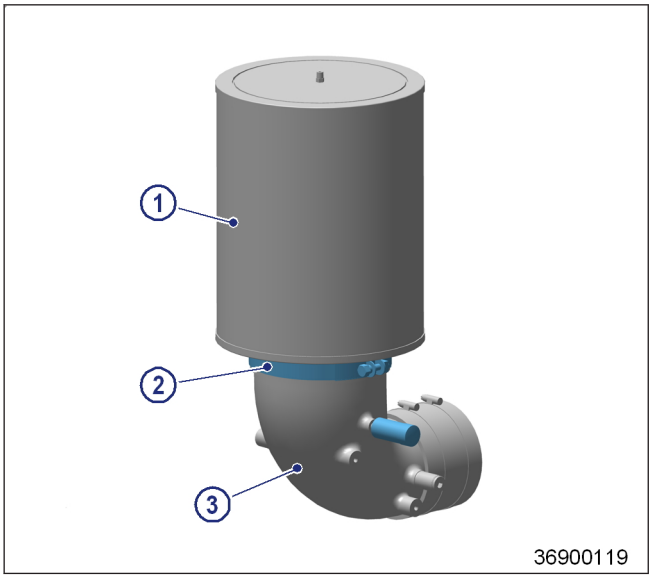

Figure 35: Air filter with intake

Final steps

▶ Press reset button (1) to return the signal ring in observation window (2) to its initial position.

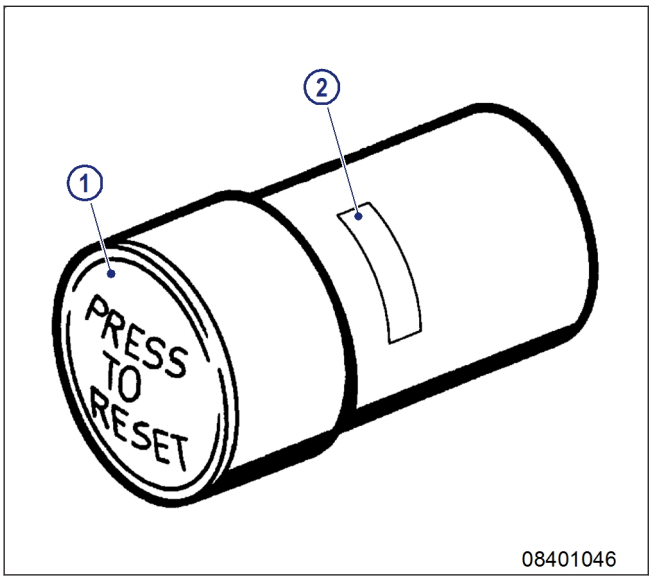

Figure 36: Filter restriction indicator

TIM-ID: 0000060424 - 001

9.3.5 Exhaust system - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000060429 - 001

WARNING

Hot components/surfaces.
Risk of burns!
- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

Checks to be carried out on the exhaust system

Item	Findings	Action
Inspect exhaust system.	Leaks are found or hardware is missing.	Repair or replace as needed.
Inpsect heat shields if applicable.	Heat shields are missing or damaged.	Contact Service.
Inspect flex pipe on exhaust silencer.	Cracks, corrosion, or signs of leakage are found.	Contact Service.
Check rain cap.	Rain cap is damaged or fits improperly.	Contact Service.

TIM-ID: 0000060429 - 001

9.3.6 Engine battery - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000061526 - 001

Checks to be carried out on the battery

Item	Findings	Action
Check battery terminals and posts.	Dirt or debris found.	Clean terminals and posts.
Check battery electrolyte level.	Low fluid level found.	Add distilled water.
Perform load test to check level of charge in battery.	Low battery charge found.	Charge battery.

TIM-ID: 0000061526 - 001

9.3.7 Battery charger - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000061527 - 001

Checks to be carried out on the battery charger

Item	Findings	Action
Check shore power / incoming voltage to battery charger.	Readings found are not within 10% of nameplate rating.	Contact Service.
Check annunciation terminal wires, if applicable.	Damaged wires or broken connections.	Contact Service.
Check battery voltage.	Readings found are not between 12 and 14 volts.	Contact Service.

TIM-ID: 0000061527 - 001

9.4 Generator

9.4.1 Generator – Check

Preconditions

☑ Engine-generator set is stopped and starting disabled.

☑ Circuits are disconnected.

☑ Lockout/tagout procedure is completed.

☑ Auxiliary equipment (if supplied, e.g. battery charger, water heater) is de-energized.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

Hot components/surfaces.
Risk of burns!
- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

Preparatory step

▶ Remove the cover of the outlet box.

Checking the generator

Item	Findings	Action
Inspect generator for external contamination.	Dirt or debris found.	Remove any dirt or debris with vacuum cleaner or brush.
Inspect all parts for wear and damage.	Wear or damage visible.	Contact Service.
Check that heat strips (if fitted) are operational.	Heat strips are not warm.	Contact Service.
Inspect air intake and outlet openings.	Dirt or blockages visible.	Remove any dirt with vacuum cleaner or brush. Remove foreign material to keep the openings unobstructed.

TIM-ID: 0000000179 - 008

Final step

▶ Install the cover of the outlet box.

9.4.2 Generator – Wiring check

Preconditions

☑ Engine-generator set is stopped and starting disabled.

☑ Circuits are disconnected.

☑ Lockout/tagout procedure is completed.

☑ Auxiliary equipment (if supplied, such as battery charger, water heater) is de-energized.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

Preparatory step

▶ Remove the cover of the outlet box.

Checking the generator wiring

Item	Findings	Action
Check all electrical connections.	Connections loose. Contacts corroded.	Tighten connections. Contact Service.
Check wiring for damage to the insulation.	Insulation damaged or oil-soaked.	Contact Service.
Inspect varnish coatings on the windings.	Coating deteriorated.	Contact Service.

Final step

▶ Install the cover of the outlet box.

TIM-ID: 0000064624 - 001

9.4.3 Generator - Check antifriction bearing

Preconditions

☑ Engine-generator set is stopped and starting disabled.

☑ Circuits are disconnected.

☑ Lockout/tagout procedure is completed.

☑ Auxiliary equipment (if supplied, for example, battery charger, water heater) is de-energized.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

Note: The generator is equipped with double-shielded ball bearings lubricated for the life of the bearing. Recommended practice is to replace bearing(s) during major overhaul of the engine.

Checks to be carried out on the generator bearings

Item	Findings	Action
Check anti-friction bearings for smooth and quiet operation.	Grinding, noisy, or rough operation observed.	Replace bearing.

TIM-ID: 0000061524 - 001

9.4.4 Voltage regulator - Check

Preconditions

☑ Engine-generator set is locked out.

☑ Engine-generator set is not in AUTO mode.

☑ Generator is not connected to network.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

WARNING

Rotating and moving parts and high level of engine noise in the event of accidental engine-generator set start during service.
Risk of crushing, danger of parts of the body being caught or pulled in!
Risk of damage to hearing!
- Ensure the engine-generator set has been stopped and starting is disabled during service.

WARNING

An engine-generator set in AUTO mode can start at any moment: Rotating and moving parts and high level of engine noise.
Risk of crushing, danger of parts of the body being caught or pulled in if started!
Risk of damage to hearing if started!
- Always remain clear of the engine-generator set when in AUTO mode.
- Keep ear protection on hand during the stay in the engine-generator set room.
- Disconnect/disable the starting system while servicing the engine-generator set.

WARNING

Exhaust gas is harmful to health.
Risk of poisoning!
- Repair leaking exhaust pipes prior to starting and operating the engine.
- Do not modify or tamper with the exhaust or emission control system.
- Always start and operate the engine in a well-ventilated area.
- If operating the engine in an enclosed area, properly vent the exhaust to the atmosphere.

WARNING

Batteries contain very caustic acid.
Risk of serious injury from chemical burn!
- Wear protective clothing, gloves and goggles/safety mask.
- If contact with battery acid occurs, flush skin with water, apply baking soda or lime to neutralize the acid, flush eyes with water and get medical attention immediately.

WARNING

Batteries develop explosive gases during charging.
Risk of serious injury from explosion and burning!
- Work in a well-ventilated area.
- Avoid open flames, electrical sparks and ignition sources near the battery.
- Do not smoke.
- Ensure only the negative lead is removed from the battery.
- Ensure correct polarity of battery connections.

TIM-ID: 0000060430 - 001

Preparatory step

▶ Remove the cover of the outlet box.

Checks to be carried out on the voltage regulator

Item	Findings	Action
Check sensing leads and field leads.	Frayed wires or loose connections found.	Contact Service.
Check PMG wiring if applicable.	Frayed wires or loose connections found.	Contact Service.

Final step

▶ Install the cover of the outlet box.

TIM-ID: 0000060430 - 001

9.4.5 Power circuit breaker – Functional check

Preconditions

☑ Engine-generator set at standstill.

☑ All sources de-energized.

☑ Control panel must be switched OFF.

☑ Battery charger isolated from power supply.

☑ Battery disconnected.

☑ Engine Control Unit deactivated (plug disconnected).

☑ Lockout/tagout procedure completed.

☑ Mains power switched off.

☑ Power circuit breaker open.

DANGER

High voltage. Live components and connections.
Risk of death or serious injury from electric shock!
- Disconnect the engine-generator set from all power sources (mains, batteries, other external power supplies) before starting to work.

DANGER

Circuit breakers are live components.
Risk of burns or death from electric shock!
- Ensure all circuit breakers are placed in the "OPEN" position prior to and while servicing the engine-generator set.

NOTICE

Oil contaminants in shop or onboard air causes circuitry damage.
Damage to engine-generator set!
- Use only clean, dry compressed air to clean excess dirt.

Cleaning power circuit breaker

▶ Clean the outer surfaces of the power circuit breaker with dry compressed air.

Checking mechanical operation of power circuit breaker

1. Actuate the ON and OFF switches on the power circuit breaker manually and by remote tripping (if applicable).
2. Check tripping by tripping unit.
3. Check all indicators and function.
4. Check number of switching operations at the operation counter.

Checking main connections

1. Check insulation for cracking.
2. Tighten screws and nuts.
3. Check connections for signs of overheating or oxidation.

TIM-ID: 0000048471 - 002

9.5 Jacket Water Heater

9.5.1 Jacket water heater - Hoses check

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

☑ All power sources for the heater are disconnected.

WARNING

Hot components/surfaces.
Risk of burns!
- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Visual inspection of hoses

1. Verify that the heater is operable (hose from jacket water heater to the engine is warmer than others).
2. Inspect heater and hoses for leaks. Contact Service if leaks found.
3. Check for hard, brittle hoses. Contact Service if such hoses found.

TIM-ID: 0000000191 - 007

9.6 Engine-Generator Set Control Panel

9.6.1 Engine-generator set controller – Check

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

☑ Operating voltage is not present.

Checking electrical connections

1. Unlock and open the door of the control cabinet.
2. Visually inspect the interior as follows:

Item	Findings	Action
Check all parts for wear and damage.	Wear or damage found, for example, corrosion and scorch or burn marks.	Contact Service.
Check wiring.	Connections loose.	Tighten connections.
Check screw and clip mountings.	Connections loose.	Tighten connections.
Check fuses.	Blown fuse.	Replace fuse.

3. Close the door of the control cabinet and lock it.

TIM-ID: 0000060425 - 001

9.6.2 Control panel MGC Series – Backup battery replacement

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

☑ Operating voltage is not present.

Replacing the backup battery

Note: Battery location differs between various control panels.

1. Unlock and open the front door of the control panel. The backup battery is located on the rear side of the display (1).
2. Remove the backup battery (3) with flat nose pliers, or use a screwdriver to pry it out of the socket (2).

Note: The replacement battery must be the same size as the old battery.

3. Insert the new battery with correct polarity.
4. Close the front door of the control panel, and lock it.
5. Return the control panel to service.

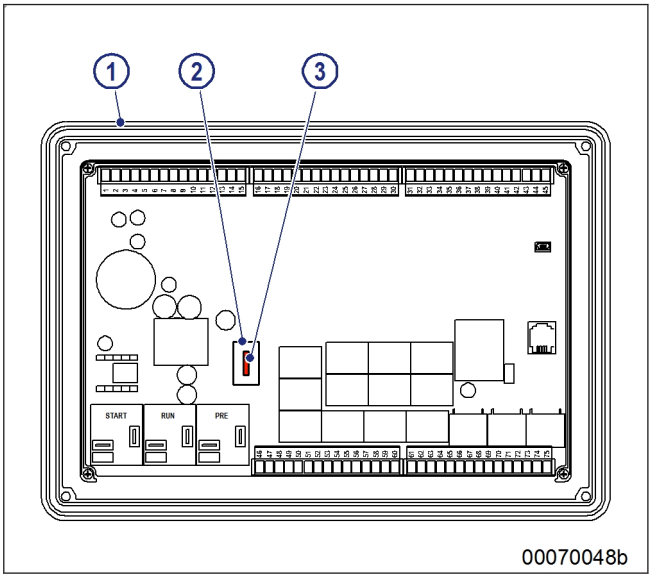

Figure 37: Backup battery location in control panel

TIM-ID: 0000057861 - 001

9.7 Radiator

9.7.1 Radiator - Check the core for leaks and contamination

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

☑ For remote radiator: All power sources for the radiator are disconnected.

DANGER

Not completely de-energized systems can contain parts under high voltage. Live components and connections.
Risk of burns or death from electric shock!
- Disconnect all electrical power.
- Lockout and tagout the equipment before removing protective shields for service or maintenance.

WARNING

Coolant is hot and under pressure.
Risk of injury and scalding!
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking radiator core for leaks and contamination

Item	Findings	Action
Check the core for coolant leaks.	Leaks	Contact Service.
Check the front core face (on fan side) for contamination.	Dust, or foreign matters	Clean the clogged core (→ Page 250). Contact Service if any major cleaning is required.
Check all other components externally for dirt.	Dust and/or debris	Vacuum or brush off.

TIM-ID: 0000000193 - 010

9.7.2 Radiator - Core face cleaning

Preconditions

☑ Engine-generator set is stopped and starting is disabled.

DANGER

Not completely de-energized systems can contain parts under high voltage. Live components and connections.
Risk of burns or death from electric shock!
- Disconnect all electrical power.
- Lockout and tagout the equipment before removing protective shields for service or maintenance.

WARNING

Compressed air gun ejects a jet of pressurized air.
Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!
- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

WARNING

Chemical substances in cleaners.
Risk of irritation and chemical burns!
- Always obey manufacturer's instructions for use.

NOTICE

Cleaning agents should not be left to take effect for too long.
Damage to components is possible!
- Observe manufacturer's instructions.

NOTICE

Inappropriate cleaning tool.
Risk of damage to component!
- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

Cleaning with industrial vacuum cleaner

Note: An industrial vacuum cleaner may only be used from the fan side of the radiator.

1. Remove complete fan guard to access to the fan side.
2. Vacuum away the dirt.
3. Remount the complete fan guard.

TIM-ID: 0000000192 - 013

Cleaning with air gun and, if required, with industrial pressure washer

1. From the rear core face (1), blow out the fins with a jet of compressed air working in the opposite direction of the cooling air flow.

Note: The air gun nozzle (2) must maintain the air jet only in a right angle (90°) to the core face (1). Non-compliance results in damage to the fins and loss of cooling.

2. Remove and dispose of any debris blown from the core before engine-generator set start-up.
3. If cooling elements are still badly soiled, clean the core face with an industrial pressure washer from the rear core (1). A hot-water washer should preferably be used. A suitable proprietary degreasing agent (as recommended by the manufacturer of the pressure washer) should be added to the water, but this must not contain ammonia as it will corrode the core.

Note: Ensure the following targets. Non-compliance results in damage to the fins and loss of cooling.

- Apply the water jet in the opposite direction to the cooling air flow.
- Keep the nozzle (2) of the water jet at a right angle (90°) to the core face (1).
- The distance (d) between the core face and the nozzle must not be less than 450 mm (18 inches) for pressures up to 206 bar (3,000 PSI). For pressures above this limit, the distance must be increased accordingly.
- The diameter (Ø) of the water jet must not be less than 200 mm (8 inches).

4. Dry the core and the surrounding area thoroughly before engine-generator set start-up.

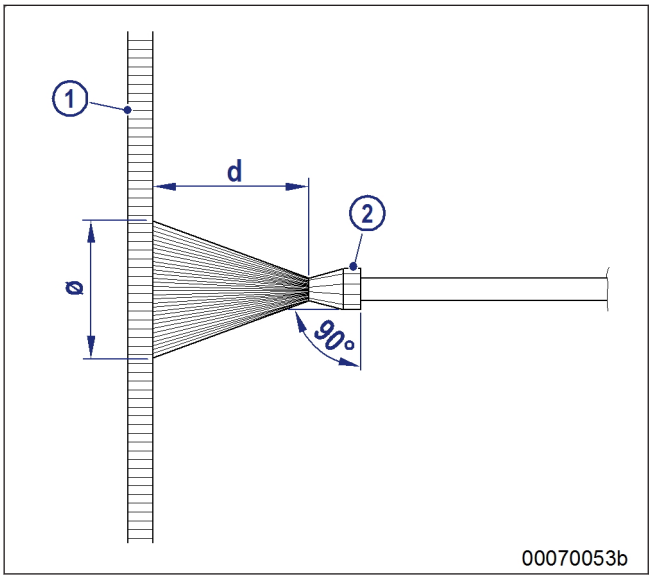

Figure 38: Radiator cleaning specifications

TIM-ID: 0000000192 - 013

10 Engine

10.1 ADM3 Fault Codes 255
10.2 Engine Manual OM 904-926 LA 277
10.3 Maintenance Booklet OM 904-926 LA 381
10.4 OM900 Engine oil and filter change 429
10.5 OM900 Inspect poly v-belt for wear and damage 441
10.6 OM900 Remove and install poly v-belt 455
10.7 OM900 Clean filter element of fuel prefilter 467
10.8 OM900 Replace fuel filter 475
10.9 OM900 Set valve clearance 485
10.10 OM900 Engine cooling system check fluid level 507
10.11 Engine Coolant - Level check 529
10.12 Engine Coolant - Draining 531
10.13 Engine Coolant - Filling 533

9. Fault codes

9.1. Fault codes diagnosis version 210

The background colour is used to indicate the newly supported or changed fault codes since diagnosis version 207.
The background colour is used to indicate the newly supported or changed fault codes since diagnosis version 210.
The background colour is used to indicate the newly supported or changed fault codes since diagnosis version 211.
The background colour indicates PLD/MR2 fault codes which are received from the PLD/MR2 control unit and are broadcasted by the ADM over J1939.

ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
51 / 0	-	12419	Engine Throttle Position	Above Measuring Range		LSCAN-MR
51 / 1	-	12420	Engine Throttle Position	Below Measuring Range		LSCAN-MR
51 / 2	-	12424	Engine Throttle Position	Measuring Range Not Plausible		LSCAN-MR
51 / 2	-	14217	Engine Throttle Position	Performance		LSCAN-MR
51 / 3	-	14205	Engine Throttle Position Sensor	Circuit High		LSCAN-MR
51 / 4	-	14206	Engine Throttle Position Sensor	Circuit Low		LSCAN-MR
51 / 7	-	12431	Engine Throttle Position	Defective		LSCAN-MR
51 / 13	-	14218	Engine Throttle Position	Position Not Learned		LSCAN-MR
69 / 9	17309	-	Two Speed Axle Switch	Abnormal Update Rate		CAN-J1939
69 / 19	17319	-	Two Speed Axle Switch	Received Network Data in Error		CAN-J1939
70 / 9	17409	-	Parking Brake Switch	Abnormal Update Rate		CAN-J1939
70 / 19	17419	-	Parking Brake Switch	Received Network Data in Error		CAN-J1939
84 / 3	10103	-	Vehicle Speed (C3 or J1939)	Open Circuit	- Check wiring	15/03
84 / 9	10109	-	Vehicle Speed (C3 or J1939)	Abnormal Update Rate		CAN-J1939
84 / 14	10114	-	Vehicle Speed (C3 or J1939)	Signal Not Plausible	- Check wiring	15/03
84 / 19	10119	-	Vehicle Speed (C3 or J1939)	Received Network Data in Error		CAN-J1939
91 / 0	10200	-	Accelerator Pedal (AFPS or J1939)	Not Adjusted	- Restart accelerator pedal adjustment routine - Check wiring - Limit value idle operation position: 5,0 V - Limit value kickdown position: 4,9 V	21/11
91 / 3	10203	-	Accelerator Pedal (AFPS or J1939)	Voltage too High	- Pedal unit exchange, if defective - check wiring - Limit value idle operation position: 5,0 V - Limit value kickdown position: 4,9 V	21/11

TIM-ID: 0000101050 - 001

ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
91 / 4	10204	-	Accelerator Pedal (AFPS or J1939)	Voltage too Low	- Pedal unit exchange, if defective - Check wiring - Limit value idle operation position: 5,0 V - Limit value kickdown position: 4,9 V	21/11
91 / 9	10209	-	Accelerator Pedal (AFPS or J1939)	Abnormal Update Rate		CAN-J1939
91 / 19	10219	-	Accelerator Pedal (AFPS or J1939)	Received Network Data in Error		CAN-J1939
94 / 0	-	11715	Fuel Pressure	Circuit High Input		LSCAN-MR
94 / 1	-	11716	Fuel Pressure	Circuit Low Input		LSCAN-MR
94 / 2	-	11717	Fuel Pressure	Range/Performance		LSCAN-MR
94 / 3	-	13015	Fuel Pressure	Open Circuit		LSCAN-MR
94 / 4	-	13016	Fuel Pressure	Shorted To Ground		LSCAN-MR
94 / 14	-	11917	Fuel Pressure	Pressure Too High/Too Low		LSCAN-MR
96 / 9	17509	-	Fuel Level	Abnormal Update Rate		CAN-J1939
96 / 19	17519	-	Fuel Level	Received Network Data in Error		CAN-J1939
98 / 0	10400	-	Oil Level (from PLD/MR2)	Oil Level too High	- Oil discharge with to strong overstocking. - Remark: This problem can occur also if in PLD/MR2 the false type of oil pan were programmed.	PLD/MR2
98 / 1	10401	-	Oil Level (from PLD/MR2)	Low Oil Level	- Refill oil	PLD/MR2
98 / 2	-	12026	Oil Level (from PLD/MR2)	Oil Level too High or too Low		LSCAN-MR
98 / 2	-	12403	Oil Level (from PLD/MR2)	Oil Level Not Plausible		LSCAN-MR
98 / 2	-	12517	Oil Level (from PLD/MR2)	Data Erratic, Not Plausible		LSCAN-MR
98 / 3	-	12516	Oil Level (from PLD/MR2)	Voltage Below		LSCAN-MR
98 / 4	-	12515	Oil Level (from PLD/MR2)	Voltage Above		LSCAN-MR
98 / 5	-	12509	Oil Level (from PLD/MR2)	Open Circuit		LSCAN-MR
98 / 14	10414	-	Oil Level (from PLD/MR2)	Oil Level too Low	- Refill oil - Remark: This problem can occur also if in PLD/MR2 the false type of oil pan were programmed.	PLD/MR2
100 / 1	10501	-	Oil Pressure (from PLD/MR2)	Low Oil Pressure	- Check oil pump and oil circuit	PLD/MR2
100 / 1	-	12021	Oil Pressure (from PLD/MR2)	Oil Pressure too Low		LSCAN-MR
100 / 2	-	11617	Oil Pressure (from PLD/MR2)	Range/Performance		LSCAN-MR
100 / 3	-	11615	Oil Pressure (from PLD/MR2)	High Voltage		LSCAN-MR
100 / 4	-	11616	Oil Pressure (from PLD/MR2)	Low Voltage		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
100 / 14	10514	-	Oil Pressure (from PLD/MR2)	Oil Pressure too Low	- Check oil pump and oil circuit.	PLD/MR2
100 / 14	-	12020	Oil Pressure (from PLD/MR2)	Oil Pressure too Low		LSCAN-MR
102 / 0	-	11820	Turbo Charger/ Supercharger	Overboost Condition		LSCAN-MR
102 / 1	-	11818	Turbo Charger/ Supercharger	Boost System Performance		LSCAN-MR
102 / 2	-	11417	Turbo Charger/ Supercharger	Boost Sensor “A” Circuit Range/Performance		LSCAN-MR
102 / 3	-	11415	Turbo Charger/ Supercharger	Boost Sensor “A” Circuit High		LSCAN-MR
102 / 4	-	11416	Turbo Charger/ Supercharger	Boost Sensor “A” Circuit Low		LSCAN-MR
102 / 7	-	11876	Turbo Charger/ Supercharger	Boost System Performance		LSCAN-MR
102 / 7	-	11878	Turbo Charger/ Supercharger	Bypass Valve – Mechanical		LSCAN-MR
102 / 13	-	11873	Turbo Charger/ Supercharger	Underboost, Control at Limit		LSCAN-MR
102 / 13	-	11874	Turbo Charger/ Supercharger	Underboost, Control Deviation too High		LSCAN-MR
102 / 13	-	11875	Turbo Charger/ Supercharger	Boost System Performance		LSCAN-MR
103 / 3	-	12616	Turbo Charger Speed Sensor	Circuit Low		LSCAN-MR
103 / 4	-	12615	Turbo Charger Speed Sensor	Circuit High		LSCAN-MR
103 / 7	-	12612	Turbo Charger Speed Sensor	Signal Timeout, no revolution on charger 1		LSCAN-MR
105 / 0	-	11822	Intake Air Temperature	Temperature Too high		LSCAN-MR
105 / 3	-	11215	Intake Air Temperature Sensor 1	Circuit High		LSCAN-MR
105 / 4	-	11216	Intake Air Temperature Sensor 1	Circuit Low		LSCAN-MR
107 / 0	10800	-	Air Filter Sensor (LF_SE)	Differential Pressure too High	- Check wiring.	15/08
107 / 3	10803	-	Air Filter Sensor (LF_SE)	Open Circuit	- Check wiring.	15/08
107 / 4	10804	-	Air Filter Sensor (LF_SE)	Short Circuit to Ground	- Check wiring.	15/08
110 / 0	-	12122	Coolant Temperature (from PLD/MR2)	High Coolant Temperature	- Cooling-water level and cooling circuit check.	LSCAN-MR
110 / 3	-	11515	Coolant Temperature (from PLD/MR2)	Sensor 1 Circuit High		LSCAN-MR
110 / 4	-	11516	Coolant Temperature (from PLD/MR2)	Sensor 1 Circuit Low		LSCAN-MR
110 / 14	10914	-	Coolant Temperature (from PLD/MR2)	Coolant Temperature too High	- Cooling-water level and cooling circuit check.	PLD/MR2
111 / 1	11001	-	Coolant Level Sensor (KW_SE)	Low Coolant Level	- Refill coolant - Check wiring	15/07
111 / 3	11003	-	Coolant Level Sensor (KW_SE)	Open Circuit	- Check wiring - Voltage must be larger than 2,0 V.	15/07
111 / 4	11004	-	Coolant Level Sensor (KW_SE)	Short Circuit to Ground	- Check wiring.	15/07
111 / 14	11014	-	Coolant Level Sensor (KW_SE)	Coolant Level too Low	- Refill coolant - Check wiring	15/07

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
158 / 0	11100	-	Battery Voltage Switched (Terminal 15)	Over Voltage	- Check battery voltage - Check parameter 2/08 (24V/12V selection)	21/02
158 / 1	11101	-	Battery Voltage Switched (Terminal 15)	Under Voltage	- Check battery voltage - Check parameter 2/08 (24V/12V selection)	21/02
158 / 2	-	12219	Battery Voltage Switched (Terminal 15)	Inconsistent		LSCAN-MR
158 / 14	-	12319	Battery Voltage Switched (Terminal 15)	Starter Switch Inconsistent		LSCAN-MR
161 / 9	17609	-	Transmission Input Shaft Speed	Abnormal Update Rate		CAN-J1939
161 / 19	17619	-	Transmission Input Shaft Speed	Received Network Data in Error		CAN-J1939
168 / 3	-	17542	System Voltage	Voltage High		LSCAN-MR
168 / 4	-	17543	System Voltage	Voltage Low		LSCAN-MR
171 / 2	-	13617	Ambient Air Temperature	Sensor Circuit Range/Performance		LSCAN-MR
171 / 3	16603	-	Ambient Air Temperature	Voltage too High	- Check wiring - Input Pin depending on configuration of parameter 13/39	21/11, 18/18, 15/08
171 / 4	16604	-	Ambient Air Temperature	Voltage too Low	- Check wiring - Input Pin depending on configuration of parameter 13/39	21/11, 18/18, 15/08
171 / 9	16609	-	Ambient Air Temperature	Abnormal Update Rate		CAN-J1939
171 / 9	-	13604	Ambient Air Temperature	Lost Message		LSCAN-MR
171 / 19	16619	-	Ambient Air Temperature	Received Network Data in Error		CAN-J1939
173 / 0	-	12406	Engine Exhaust Gas Temperature	Above Nominal Value		LSCAN-MR
173 / 15	-	12429	Engine Exhaust Gas Temperature	Too High		LSCAN-MR
174 / 3	-	11115	Fuel Temperature Sensor “A”	Circuit High Input		LSCAN-MR
174 / 4	-	11116	Fuel Temperature Sensor “A”	Circuit Low Input		LSCAN-MR
175 / 3	-	11015	Engine Oil Temperature Sensor	Circuit High		LSCAN-MR
175 / 4	-	11016	Engine Oil Temperature Sensor	Ciruit Low		LSCAN-MR
190 / 0	-	10530	Engine Speed	Engine Overspeed Condition		LSCAN-MR
191 / 9	17709	-	Transmission Output Shaft Speed	Abnormal Update Rate		CAN-J1939
191 / 19	17719	-	Transmission Output Shaft Speed	Received Network Data in Error		CAN-J1939
354 / 3	-	13415	Ambient Air Combi Sensor, Part Humidity	Circuit High		LSCAN-MR
354 / 4	-	13416	Ambient Air Combi Sensor, Part Humidity	Circuit Low		LSCAN-MR
523 / 9	17809	-	Transmission Current Gear	Abnormal Update Rate		CAN-J1939
523 / 19	17819	-	Transmission Current Gear	Received Network Data in Error		CAN-J1939

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
524 / 9	17909	-	Transmission Selected Gear	Abnormal Update Rate		CAN-J1939
524 / 19	17919	-	Transmission Selected Gear	Received Network Data in Error		CAN-J1939
558 / 1	11701	-	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Signals Equal but Should Not	- Check wiring	21/12 and 21/13
558 / 5	11705	-	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Switches Open Circuit	- Check wiring - Pedal unit exchange, if defective	21/12 and 21/13
558 / 9	11709	-	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Abnormal Update Rate		CAN-J1939
558 / 12	11712	-	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Switches Closed	- check wiring - Pedal unit exchange, if defective	21/12 and 21/13
558 / 19	11719	-	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Received Network Data in Error		CAN-J1939
559 / 9	18009	-	Accelerator Pedal Kickdown Switch	Abnormal Update Rate		CAN-J1939
559 / 19	18019	-	Accelerator Pedal Kickdown Switch	Received Network Data in Error		CAN-J1939
573 / 9	18109	-	Transmission Torque Converter Lockup Engaged	Abnormal Update Rate		CAN-J1939
573 / 19	18119	-	Transmission Torque Converter Lockup Engaged	Received Network Data in Error		CAN-J1939
574 / 9	18209	-	Transmission Shift In Process	Abnormal Update Rate		CAN-J1939
574 / 19	18219	-	Transmission Shift In Process	Received Network Data in Error		CAN-J1939
596 / 9	18309	-	Cruise Control Enable Switch	Abnormal Update Rate		CAN-J1939
596 / 19	18319	-	Cruise Control Enable Switch	Received Network Data in Error		CAN-J1939
597 / 9	18409	-	Brake Switch	Abnormal Update Rate		CAN-J1939
597 / 19	18419	-	Brake Switch	Received Network Data in Error		CAN-J1939
598 / 9	18509	-	Clutch Switch	Abnormal Update Rate		CAN-J1939
598 / 19	18519	-	Clutch Switch	Received Network Data in Error		CAN-J1939
599 / 9	11809	-	Cruise Control Switch CC- (Set + Coast)	Abnormal Update Rate (Set Switch)		CAN-J1939
599 / 12	11812	-	Cruise Control Switch CC- (Set + Coast)	Both Switches CC- and CC+ Closed	- Check wiring - Check cruise control switch	18/04 and 18/05
599 / 14	11814	-	Cruise Control Switch CC- (Set + Coast)	Plausibility Check Failed (Check Stalk Switch Wiring)	- Check wiring of stalk switch - Check parameter 13/37	18/04 and 12/07
599 / 19	11819	-	Cruise Control Switch CC- (Set + Coast)	Received Network Data in Error		CAN-J1939
600 / 9	18609	-	Cruise Control Coast (Decelerate) Switch	Abnormal Update Rate		CAN-J1939
600 / 19	18619	-	Cruise Control Coast (Decelerate) Switch	Received Network Data in Error		CAN-J1939
601 / 9	11909	-	Cruise Control Switch CC+ (Res + Acc)	Abnormal Update Rate (Resume Switch)		CAN-J1939

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
601 / 12	11912	-	Cruise Control Switch CC+ (Res + Acc)	Both Switches CC+ and CC- Closed	- Check wiring - Check cruise control switch	18/04 and 18/05
601 / 14	11914	-	Cruise Control Switch CC+ (Res + Acc)	Plausibility Check Failed (Check Stalk Switch Wiring)	- Check wiring of stalk switch - Check parameter 13/37	18/05 and 12/07
601 / 19	11919	-	Cruise Control Switch CC+ (Res + Acc)	Received Network Data in Error		CAN-J1939
602 / 9	18709	-	CCVS1 Cruise Control Accelerate Switch	Abnormal Update Rate or Signal Not Available		CAN-J1939
602 / 19	18719	-	CCVS1 Cruise Control Accelerate Switch	Received Network Data in Error		CAN-J1939
609 / 0	-	19960	Anti Theft Device	Immobilizer Number of Keys Limited to 8		LSCAN-MR
609 / 2	12002		PLD/MR2 Error	Unknown Cause	- Check PLD/MR2 Error Codes	PLD/MR2
609 / 2	-	19963	Anti Theft Device	Immobilizer TPC Signal Error CAN		LSCAN-MR
609 / 2	-	19965	Anti Theft Device	Incorrect Immobilizer Key		LSCAN-MR
609 / 9	-	19964	Anti Theft Device	Immobilizer TPC Signal Error Starter Line		LSCAN-MR
609 / 11	-	14056	PLD/MR2	Data Map Manipulated, Control Module Performance		LSCAN-MR
609 / 11	-	14058	PLD/MR2	Data Map Manipulated, Control Module Programming Error		LSCAN-MR
609 / 11	-	19962	Anti Theft Device	Immobilizer Automatically Activated		LSCAN-MR
609 / 12	-	11315	PLD/MR2 Barometric Pressure Circuit	Open Circuit		LSCAN-MR
609 / 12	-	11316	PLD/MR2 Barometric Pressure Circuit	Shorted to Ground		LSCAN-MR
609 / 12	-	12401	PLD/MR2	Auxiliary Voltage 8,5V Defective		LSCAN-MR
609 / 12	-	12402	PLD/MR2	Common Internal Error		LSCAN-MR
609 / 12	-	14024	PLD/MR2	Limp Home Controller / Controller #2 Defective		LSCAN-MR
609 / 12	-	14034	PLD/MR2	High Side Driver PVB1 Defective		LSCAN-MR
609 / 12	-	14035	PLD/MR2	High Side Driver PVB2 Defective		LSCAN-MR
609 / 12	-	14036	PLD/MR2	High Side Driver PV5 Defective		LSCAN-MR
609 / 12	-	14038	PLD/MR2	Starter Driver Defective (Redundant)		LSCAN-MR
609 / 12	-	14039	PLD/MR2	Starter Driver Defective (Main)		LSCAN-MR
609 / 12	-	14040	PLD/MR2	Diagnosis Starter Error		LSCAN-MR
609 / 12	-	14041	PLD/MR2	Diagnosis Starter Error		LSCAN-MR
609 / 12	-	14054	PLD/MR2	Low Speed CAN Data Error		LSCAN-MR
609 / 12	-	14262	PLD/MR2	Wrong Boot Block		LSCAN-MR
609 / 12	-	14296	PLD/MR2 Bootloader	Application Software Defective		LSCAN-MR
609 / 12	-	14297	PLD/MR2 Bootloader	Flash Memory Defective		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
609 / 12	-	14298	PLD/MR2 Bootloader	Flash Not Erasable		LSCAN-MR
609 / 12	-	14299	PLD/MR2 Bootloader	No Application Software In Flash		LSCAN-MR
609 / 12	-	18039	PLD/MR2 Starter Relay Circuit	Shorted (Main or Redundant)		LSCAN-MR
609 / 13	-	12400	PLD/MR2	No. Of Cylinders Not Corresponding To Engine Type		LSCAN-MR
609 / 14	-	14037	PLD/MR2 Program	Wrong No. of Cylinders		LSCAN-MR
609 / 14	-	14047	PLD/MR2 Program	Set of Maps Error		LSCAN-MR
609 / 14	-	14048	PLD/MR2 Program	Wrong No. of Cylinders		LSCAN-MR
609 / 14	-	14049	PLD/MR2 Program	PWM Calibration		LSCAN-MR
609 / 14	-	14050	PLD/MR2 Program	Wrong Hardware		LSCAN-MR
609 / 14	-	14051	PLD/MR2 Program	EEPROM Checksum 1		LSCAN-MR
609 / 14	-	14052	PLD/MR2 Program	EEPROM Checksum 2		LSCAN-MR
609 / 14	-	14053	PLD/MR2 Program	EEPROM Checksum 3		LSCAN-MR
609 / 14	-	14269	Euromot3b / Tier4i Engine Control Module	Chassis Control Module Mismatch	New Since Version 10.00	LSCAN-MR
609 / 14	-	19961	Anti Theft Device	Immobilizer Response Counter Flow		LSCAN-MR
611 / 4	-	16506	Oil Separator	Circuit Low		LSCAN-MR
611 / 12	-	16564	Oil Separator	Circuit High		LSCAN-MR
620 / 3	12103	-	Supply Analog Accelerator Pedal (AFP+)	Voltage too High	- Supply voltage > 5,2 V.	21/09
620 / 4	12104	-	Supply Analog Accelerator Pedal (AFP+)	Voltage too Low	- Supply voltage < 4,8 V.	21/09
625 / 2	12202	-	CAN Link ADM3 – PLD/MR2	No Communication with PLD/MR2	- Check wiring (engine CAN) - Check configuration: PLD/MR2 parameter (../..) and ADM3 parameter 01/01 to be set to equal functionality (One wire capability)	-
625 / 2	-	10102	CAN Link ADM3 – PLD/MR2	Invalid Data Received	- Check wiring (engine CAN)	LSCAN-MR
625 / 2	-	10104	CAN Link ADM3 – PLD/MR2	No Communication	- Check wiring (engine CAN)	LSCAN-MR
625 / 14	-	10100	CAN Link ADM3 – PLD/MR2	CAN B Bus (+) Circuit	- Check wiring (engine CAN)	LSCAN-MR
625 / 14	-	10101	CAN Link ADM3 – PLD/MR2	CAN B Bus (-) Circuit	- Check wiring (engine CAN)	LSCAN-MR
625 / 14	-	10149	PLD/MR2	Control Module Vehicle Options Error		LSCAN-MR
630 / 2	-	14092	Control Module	Module Performance		LSCAN-MR
630 / 9	-	14149	Control Module	Vehicle Options Error	- Check Engine Brake Parameters	LSCAN-MR
632 / 5	-	12430	Fuel Shutoff Valve "A" Control	Circuit Open		LSCAN-MR
636 / 1	-	10310	Crankshaft Position Sensor “A”	Circuit Range/Perforamnce		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
636 / 3	-	10309	Crankshaft Position Sensor “A”	Open Circuit		LSCAN-MR
636 / 4	-	10308	Crankshaft Position Sensor “A”	Low Input		LSCAN-MR
636 / 7	-	10311	Crankshaft Position	Camshaft Position Correlation (Bank 1 Sensor)		LSCAN-MR
636 / 8	-	10312	Crankshaft Position Sensor “A” Circuit	Time Out		LSCAN-MR
636 / 14	-	10313	Crankshaft Position Sensor “A”	Polarity Error		LSCAN-MR
639 / 2	14902	-	SAE J1939 Interface	At Least One J1939 Message is Missing	- Check wiring - Check other Control Units on J1939	CAN-J1939
651 / 5	-	15027	Injector Cylinder 1	Open Ciruit		LSCAN-MR
651 / 6	-	15028	Injector Cylinder 1	Shorted Circuit		LSCAN-MR
651 / 7	-	15026	Injector Cylinder 1	Injection Timing, No Plunger		LSCAN-MR
651 / 12	-	19044	Injector Cylinder 1	Idle Control At Limit		LSCAN-MR
651 / 14	-	19045	Injector Cylinder 1	Cylinder Correction At Limit		LSCAN-MR
652 / 5	-	15127	Injector Cylinder 2	Open Circuit		LSCAN-MR
652 / 6	-	15128	Injector Cylinder 2	Shorted Circuit		LSCAN-MR
652 / 7	-	15126	Injector Cylinder 2	Injection Timing, No Plunger		LSCAN-MR
652 / 12	-	19144	Injector Cylinder 2	Idle Control At Limit		LSCAN-MR
652 / 14	-	19145	Injector Cylinder 2	Cylinder Correction At Limit		LSCAN-MR
653 / 5	-	15227	Injector Cylinder 3	Open Circuit		LSCAN-MR
653 / 6	-	15228	Injector Cylinder 3	Shorted Circuit		LSCAN-MR
653 / 7	-	15226	Injector Cylinder 3	Injection Timing, No Plunger		LSCAN-MR
653 / 12	-	19244	Injector Cylinder 3	Idle Control At Limit		LSCAN-MR
653 / 14	-	19245	Injector Cylinder 3	Cylinder Correction At Limit		LSCAN-MR
654 / 5	-	15327	Injector Cylinder 4	Open Circuit		LSCAN-MR
654 / 6	-	15328	Injector Cylinder 4	Shorted Circuit		LSCAN-MR
654 / 7	-	15326	Injector Cylinder 4	Injection Timing, No Plunger		LSCAN-MR
654 / 12	-	19344	Injector Cylinder 4	Idle Control At Limit		LSCAN-MR
654 / 14	-	19345	Injector Cylinder 4	Cylinder Correction At Limit		LSCAN-MR
655 / 5	-	15427	Injector Cylinder 5	Open Circuit		LSCAN-MR
655 / 6	-	15428	Injector Cylinder 5	Shorted Circuit		LSCAN-MR
655 / 7	-	15426	Injector Cylinder 5	Injection Timing, No Plunger		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
655 / 12	-	19444	Injector Cylinder 5	Idle Control At Limit		LSCAN-MR
655 / 14	-	19445	Injector Cylinder 5	Cylinder Correction At Limit		LSCAN-MR
656 / 5	-	15527	Injector Cylinder 6	Open Circuit		LSCAN-MR
656 / 6	-	15528	Injector Cylinder 6	Shorted Circuit		LSCAN-MR
656 / 7	-	15526	Injector Cylinder 6	Injection Timing, No Plunger		LSCAN-MR
656 / 12	-	19544	Injector Cylinder 6	Idle Control At Limit		LSCAN-MR
656 / 14	-	19545	Injector Cylinder 6	Cylinder Correction At Limit		LSCAN-MR
657 / 5	-	15627	Injector Cylinder 7	Open Circuit		LSCAN-MR
657 / 6	-	15628	Injector Cylinder 7	Shorted Circuit		LSCAN-MR
657 / 7	-	15626	Injector Cylinder 7	Injection Timing, No Plunger		LSCAN-MR
657 / 12	-	19644	Injector Cylinder 7	Idle Control At Limit		LSCAN-MR
657 / 14	-	19645	Injector Cylinder 7	Cylinder Correction At Limit		LSCAN-MR
658 / 5	-	15727	Injector Cylinder 8	Open Circuit		LSCAN-MR
658 / 6	-	15728	Injector Cylinder 8	Shorted Circuit		LSCAN-MR
658 / 7	-	15726	Injector Cylinder 8	Injection Timing, No Plunger		LSCAN-MR
658 / 12	-	19744	Injector Cylinder 8	Idle Control At Limit		LSCAN-MR
658 / 14	-	19745	Injector Cylinder 8	Cylinder Correction At Limit		LSCAN-MR
677 / 3	-	18005	Output Relay 1 (PLD/MR2)	Starter Relay Shorted To High		LSCAN-MR
677 / 3	13303	-	Output Relay 1 (REL 1)	Open Circuit	- Check wiring - Check relay 1	15/12
677 / 4	13304	-	Output Relay 1 (REL 1)	Short Circuit to Ground	- Check wiring - Check relay 1	15/12
677 / 5	-	18009	Output Relay 1 (PLD/MR2)	Starter Relay Open Circuit		LSCAN-MR
677 / 6	-	18008	Output Relay 1 (PLD/MR2)	Starter Relay Shorted To Ground		LSCAN-MR
677 / 7	-	18086	Output Relay 1 (PLD/MR2)	Starter Stick, Does not Engage		LSCAN-MR
677 / 14	-	18033	Output Relay 1 (PLD/MR2)	Starter Relay Stick		LSCAN-MR
697 / 3	-	17007	Proportional Valve 1	Circuit High		LSCAN-MR
697 / 3	-	17705	Proportional Valve Bank 1	Shorted To Battery Voltage Bank 1		LSCAN-MR
697 / 4	-	17708	Proportional Valve Bank 1	Shorted To Ground Bank 1		LSCAN-MR
697 / 5	-	12425	Proportional Valve Bank 1	Open Circuit		LSCAN-MR
697 / 5	-	17009	Proportional Valve 1	Open Circuit		LSCAN-MR
697 / 6	-	17006	Proportional Valve 1	Shorted To Ground		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
698 / 3	-	17305	Proportional Valve 2	Shorted To Battery Voltage		LSCAN-MR
698 / 3	-	17307	Proportional Valve 2	Shorted To Battery Voltage		LSCAN-MR
698 / 5	-	12426	Proportional Valve Bank 2	Open Circuit		LSCAN-MR
698 / 5	-	17309	Proportional Valve 2	Open Circuit		LSCAN-MR
698 / 5	-	17317	Proportional Valve 2	Open Circuit		LSCAN-MR
698 / 6	-	17306	Proportional Valve 2	Shorted To Ground		LSCAN-MR
699 / 3	-	17107	Proportional Valve 3	Shorted To Battery Voltage		LSCAN-MR
699 / 5	-	17109	Proportional Valve 3	Open Circuit		LSCAN-MR
699 / 6	-	17106	Proportional Valve 3	Shorted To Ground		LSCAN-MR
700 / 3	-	17207	Proportional Valve 4	Shorted To Battery Voltage		LSCAN-MR
700 / 5	-	17209	Proportional Valve 4	Open Circuit		LSCAN-MR
700 / 6	-	17206	Proportional Valve 4	Shorted To Ground		LSCAN-MR
705 / 3	-	12411	Proportional Valve 5	CNG Lock Valve Shorted To Battery Voltage		LSCAN-MR
705 / 3	-	17405	Proportional Valve 5	Shorted To Battery Voltage		LSCAN-MR
705 / 3	-	17805	Proportional Valve Bank 2	Shorted To Battery Voltage		LSCAN-MR
705 / 4	-	12412	Proportional Valve 5	CNG Lock Valve Shorted To Ground		LSCAN-MR
705 / 4	-	17408	Proportional Valve 5	Shorted To Ground		LSCAN-MR
705 / 4	-	17808	Proportional Valve Bank 2	Shorted To Ground		LSCAN-MR
706 / 3	-	17609	Proportional Valve 6	Open Circuit		LSCAN-MR
706 / 5	-	17607	Proportional Valve 6	Shorted To Battery Voltage		LSCAN-MR
706 / 6	-	17606	Proportional Valve 6	Shorted To Ground		LSCAN-MR
723 / 3	-	10409	Camshaft Position Sensor “A” (Bank 1 or Single Sensor)	Open Circuit		LSCAN-MR
723 / 4	-	10408	Camshaft Position Sensor “A” (Bank 1 or Single Sensor)	Shorted To Ground		LSCAN-MR
723 / 8	-	10412	Camshaft Position Sensor “A” (Bank 1 or Single Sensor)	Time Out		LSCAN-MR
723 / 14	-	10413	Camshaft Position Sensor “A” (Bank 1 or Single Sensor)	Polarity Error, Pins Swapped		LSCAN-MR
729 / 3	14003	-	Intake Air Heater (MBR_KD)	Open Circuit	- Check wiring - Check solenoid valve	15/10
729 / 4	14004	-	Intake Air Heater (MBR_KD)	Short Circuit to Ground	- Check wiring - Check solenoid valve	15/10
729 / 5	-	16409	Intake Air Heater (PLD/MR2)	Circuit Open		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
729 / 12	-	16432	Intake Air Heater (PLD/MR2)	Circuit Universal Troubles		LSCAN-MR
730 / 0	13900	-	Output Relay 2 (REL 2)	Grid Heater: No Increasing Boost Temperature After Activation	- Check wiring - Check relay 2 - Check grid heater	15/09
730 / 1	13901	-	Output Relay 2 (REL 2)	Relay Permanently Closed (Grid Heater)	- Check wiring - Check relay 2	15/09
730 / 2	13902	-	Output Relay 2 (REL 2)	Relay Permanently Open (Grid Heater)	- Check wiring - Check relay 2	15/09
730 / 3	13903	-	Output Relay 2 (REL 2)	Voltage too High when Activated	- Check wiring	15/09
730 / 4	13904	-	Output Relay 2 (REL 2)	Voltage too Low when Activated	- Check wiring - Check relay 2	15/09
870 / 3	-	14223	SCR Diffusor Heating	Circuit High		LSCAN-MR
870 / 3	-	14270	Heater Regeneration System	Circuit High		LSCAN-MR
870 / 4	-	14222	SCR Diffusor Heating	Circuit Low		LSCAN-MR
870 / 4	-	14269	Heater Regeneration System	Circuit Low		LSCAN-MR
870 / 5	-	14221	SCR Diffusor Heating	Circuit Open		LSCAN-MR
904 / 9	18809	-	Front Axle Speed	Abnormal Update Rate		CAN-J1939
904 / 19	18819	-	Front Axle Speed	Received Network Data in Error		CAN-J1939
925 / 3	-	17905	SCR Module Proportional Valve Bank	Circuit High		LSCAN-MR
925 / 4	-	17908	SCR Module Proportional Valve Bank	Circuit Low		LSCAN-MR
973 / 9	18909	-	Engine Retarder Selection	Abnormal Update Rate		CAN-J1939
973 / 19	18919	-	Engine Retarder Selection	Received Network Data in Error		CAN-J1939
974 / 2	14202	-	Remote Throttle Pedal (HFG)	Supply Voltage Out of Range (Pin HFG+)	- Limit values for the supply voltage of the HFG: Minimum value: 4,8 V and maximum value: 5,2 V.	18/17
974 / 3	14203	-	Remote Throttle Pedal (HFG)	Voltage too High	- Check wiring - Check remote pedal	18/18
974 / 4	14204	-	Remote Throttle Pedal (HFG)	Voltage too Low	- Check wiring - Check remote pedal	18/18
986 / 1	-	10631	Fan Speed	Speed Too Low		LSCAN-MR
986 / 9	-	10612	Fan Speed	Time Out		LSCAN-MR
986 / 9	-	17112	Fan Speed	Time Out		LSCAN-MR
1004 / 3	14403	-	Output Relay 4 (REL 4)	Open Circuit	- Check wiring - Check relay 4	18/01
1004 / 4	14404	-	Output Relay 4 (REL 4)	Short Circuit to Ground	- Check wiring - Check relay	18/01
1005 / 3	14503	-	Output PWM Pedal Supply or Transmission (FP+)	Open Circuit	- Check wiring.	15/05
1005 / 4	14504	-	Output PWM Pedal Supply or Transmission (FP+)	Short Circuit to Ground	- Check wiring.	15/05

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
1015 / 1	15001	-	PWM Accelerator Pedal (PWM FFG)	No Supply Voltage at Pin FP+	- Check wiring	15/05
1015 / 3	15003	-	PWM Accelerator Pedal (PWM FFG)	No Signal at Path 2 (GAS2)	- Check wiring - Pins 21/13, 15/05 , 21/14.	
1015 / 4	15004	-	PWM Accelerator Pedal (PWM FFG)	No Signal at Path 1 (GAS1)	- Check wiring - Pins 21/12, 15/05 , 21/14	
1015 / 5	15005	-	PWM Accelerator Pedal (PWM FFG)	Not Adjusted	- Restart accelerator pedal adjustment routine	-
1015 / 6	15006	-	PWM Accelerator Pedal (PWM FFG)	Idle Position Out of Adjusted Range	- Restart accelerator pedal adjustment routine	-
1015 / 7	15007	-	PWM Accelerator Pedal (PWM FFG)	Out of Adjusted Range	- Restart accelerator pedal adjustment routine	-
1072 / 3	10003	-	Decompression Brake Valve (MBR_KD)	Open Circuit	- Check wiring - Check solenoid valve	15/10
1072 / 4	10004	-	Decompression Brake Valve (MBR_KD)	Short Circuit to Ground	- Check wiring - Check solenoid valve	15/10
1074 / 3	14603	-	Exhaust Brake Valve (MBR_BK)	Open Circuit	- Check wiring - Check exhaust brake valve	15/06
1074 / 3	-	14256	Exhaust Brake Valve (PLD/MR2)	Circuit High		LSCAN-MR
1074 / 4	14604	-	Exhaust Brake Valve (MBR_BK)	Short Circuit to Ground	- Check wiring - Check exhaust brake valve	15/06
1074 / 4	-	14255	Exhaust Brake Valve (PLD/MR2)	Circuit Low		LSCAN-MR
1074 / 5	-	14257	Exhaust Brake Valve (PLD/MR2)	Circuit Open		LSCAN-MR
1074 / 12	-	14254	Exhaust Brake Valve (PLD/MR2)	Performance		LSCAN-MR
1127 / 1	-	14259	Intake Throttle Turbocharger	Underboost		LSCAN-MR
1132 / 3	-	13115	Intake Air Temperature Sensor 2	Circuit High		LSCAN-MR
1132 / 4	-	13116	Intake Air Temperature Sensor 2	Circuit Low		LSCAN-MR
1136 / 0	-	14273	Engine ECU Temperature	Temperature too High		LSCAN-MR
1136 / 1	-	14274	Engine ECU Temperature	Temperature too Low		LSCAN-MR
1184 / 0	-	14422	Engine Turbocharger 1 Turbine Outlet Tempeature	Temperature Too High		LSCAN-MR
1184 / 2	-	14263	Engine Turbocharger 1 Turbine Outlet Tempeature	Not Plausible		LSCAN-MR
1184 / 3	-	14415	Engine Turbocharger 1 Turbine Outlet Tempeature	Circuit High		LSCAN-MR
1184 / 4	-	14416	Engine Turbocharger 1 Turbine Outlet Tempeature	Circuit Low		LSCAN-MR
1213 / 12	-	16327	Malfunction Indicator Lamp (MIL)	Control Circuit		LSCAN-MR
1227 / 7	-	14261	Constant Throttle System	System Performance		LSCAN-MR
1231 / 9	-	10204	High Speed CAN Communication Bus	Lost Communication		LSCAN-MR
1237 / 9	19509	-	Engine Shutdown Override	Abnormal Update Rate		CAN-J1939

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
1237 / 19	19519	-	Engine Shutdown Override	Received Network Data in Error		CAN-J1939
1268 / 3	-	12432	Engine Ignition Coil #1	Circuit High		LSCAN-MR
1268 / 4	-	12433	Engine Ignition Coil #1	Circuit Low		LSCAN-MR
1268 / 5	-	12434	Engine Ignition Coil #1	Open Circuit		LSCAN-MR
1269 / 3	-	12435	Engine Ignition Coil #2	Circuit High		LSCAN-MR
1269 / 4	-	12436	Engine Ignition Coil #2	Circuit Low		LSCAN-MR
1269 / 5	-	12437	Engine Ignition Coil #2	Open Circuit		LSCAN-MR
1270 / 3	-	12438	Engine Ignition Coil #3	Circuit High		LSCAN-MR
1270 / 4	-	12439	Engine Ignition Coil #3	Circuit Low		LSCAN-MR
1270 / 5	-	12440	Engine Ignition Coil #3	Open Circuit		LSCAN-MR
1271 / 3	-	12441	Engine Ignition Coil #4	Circuit High		LSCAN-MR
1271 / 4	-	12442	Engine Ignition Coil #4	Circuit Low		LSCAN-MR
1271 / 5	-	12443	Engine Ignition Coil #4	Open Circuit		LSCAN-MR
1272 / 3	-	12444	Engine Ignition Coil #5	Circuit High		LSCAN-MR
1272 / 4	-	12445	Engine Ignition Coil #5	Circuit Low		LSCAN-MR
1272 / 5	-	12446	Engine Ignition Coil #5	Open Circuit		LSCAN-MR
1273 / 3	-	12447	Engine Ignition Coil #6	Circuit High		LSCAN-MR
1273 / 4	-	12448	Engine Ignition Coil #6	Circuit Low		LSCAN-MR
1273 / 5	-	12449	Engine Ignition Coil #6	Open Circuit		LSCAN-MR
1387 / 2	-	18417	Reductant Pressure Sensor	Circuit Range/Performance		LSCAN-MR
1387 / 3	-	18415	Reductant Pressure Sensor	Circuit High		LSCAN-MR
1387 / 4	-	18416	Reductant Pressure Sensor	Circuit Low		LSCAN-MR
1390 / 0	-	12409	Engine Fuel Valve 1 Inlet Absolute Pressure	Above Measuring Range		LSCAN-MR
1390 / 1	-	12410	Engine Fuel Valve 1 Inlet Absolute Pressure	Below Measuring Range		LSCAN-MR
1390 / 17	-	12408	Engine Fuel Valve 1 Inlet Absolute Pressure	Too Low		LSCAN-MR
1623 / 9	19009	-	Tachograph Output Shaft Speed	Abnormal Update Rate		CAN-J1939
1623 / 19	19019	-	Tachograph Output Shaft Speed	Received Network Data in Error		CAN-J1939
1624 / 9	19109	-	Tachograph Vehicle Speed	Abnormal Update Rate		CAN-J1939
1624 / 19	19119	-	Tachograph Vehicle Speed	Received Network Data in Error		CAN-J1939
1633 / 9	19209	-	Cruise Control Pause Switch	Abnormal Update Rate		CAN-J1939

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
1633 / 14	19214	-	Cruise Control Pause Switch	Plausibility Check Failed (Check Stalk Switch Wiring)	- Check wiring of stalk switch - Check parameter 13/37	18/06 and 12/07
1633 / 19	19219	-	Cruise Control Pause Switch	Received Network Data in Error		CAN-J1939
1636 / 3	-	13515	Ambient Air Combi Sensor, Part Temperature	Circuit High		LSCAN-MR
1636 / 4	-	13516	Ambient Air Combi Sensor, Part Temperature	Circuit Low		LSCAN-MR
1695 / 0	-	12413	Engine Exhaust Gas Oxygen Sensor (Lambda Sensor) Fueling Correction	Control Deviation Too High		LSCAN-MR
1695 / 2	-	12450	Engine Exhaust Gas Oxygen Sensor (Lambda Sensor) Fueling Correction	Drift Not Plausible		LSCAN-MR
1716 / 9	19309	-	Retarder Selection, non-engine	Abnormal Update Rate		CAN-J1939
1716 / 19	19319	-	Retarder Selection, non-engine	Received Network Data in Error		CAN-J1939
1761 / 1	-	16029	Reductant Level	Level Low		LSCAN-MR
1761 / 18	-	14270	Tier4i Reductant Level Sensor	Level Too Low		LSCAN-MR
1761 / 3	-	16015	Reductant Level Sensor	Circuit High		LSCAN-MR
1761 / 4	-	16016	Reductant Level Sensor	Circuit Low		LSCAN-MR
1908 / 3	-	18107	SCR Air Pressure Shut-Off Valve Solenoid	Circuit High		LSCAN-MR
1908 / 4	-	18106	SCR Air Pressure Shut-Off Valve Solenoid	Circuit Low		LSCAN-MR
1908 / 5	-	18109	SCR Air Pressure Shut-Off Valve Solenoid	Circuit Open		LSCAN-MR
2436 / 9	-	12712	Generator Speed Sensing	Signal-Timeout		LSCAN-MR
2791 / 0	-	13215	Exhaust Gas Recirculation	Temperature Sensor Circuit High		LSCAN-MR
2791 / 1	-	13216	Exhaust Gas Recirculation	Temperature Sensor Circuit Low		LSCAN-MR
2791 / 2	-	16679	Exhaust Gas Recirculation	System Performance, Temperature Diagnosis		LSCAN-MR
2791 / 7	-	16678	Exhaust Gas Recirculation	System Performance, Universal Control Error		LSCAN-MR
2791 / 12	-	13332	Exhaust Gas Recirculation	Temperature Too High/Too Low		LSCAN-MR
2797 / 3	-	14805	Engine Injector Group 1	Circuit High		LSCAN-MR
2797 / 4	-	14806	Engine Injector Group 1	Circuit Low		LSCAN-MR
2797 / 5	-	12427	Engine Injector Group 1	Open Circuit		LSCAN-MR
2797 / 9	-	19846	Engine Injector Group 1, Cylinder Contribution/Balance	Timeout		LSCAN-MR
2798 / 3	-	14905	Engine Injector Group 2	Circuit High		LSCAN-MR
2798 / 4	-	14906	Engine Injector Group 2	Circuit Low		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
2798 / 5	-	12428	Engine Injector Group 2	Open Circuit		LSCAN-MR
3031 / 3	-	16115	Reductant Tank Temperature Sensor	Circuit High		LSCAN-MR
3031 / 4	-	16116	Reductant Tank Temperature Sensor	Circuit Low		LSCAN-MR
3031 / 7	-	16169	Reductant Tank Temperature Sensor	Circuit		LSCAN-MR
3050 / 7	-	14247	NOx Emission SCR Catalyst	SCR Catalyst Error		LSCAN-MR
3050 / 13	-	16949	SCR System Calibration	Calibration Error		LSCAN-MR
3217 / 0	-	12414	Aftertreatment 1 Intake %O2 (Lambda Sensor)	Above Measuring Range		LSCAN-MR
3217 / 1	-	12415	Aftertreatment 1 Intake %O2 (Lambda Sensor)	Below Measuring Range		LSCAN-MR
3217 / 2	-	12451	Aftertreatment 1 Intake %O2 (Lambda Sensor)	Not Plausible		LSCAN-MR
3219 / 1	-	12823	NOx Sensor	Operation Temperature Not Reached		LSCAN-MR
3220 / 9	-	12804	NOx Concentration	Lost Message		LSCAN-MR
3222 / 0	-	12416	Aftertreatment 1 Intake Gas Sensor (Lambda Sensor) Heater Preliminary FMI	Above Measuring Range		LSCAN-MR
3222 / 1	-	12417	Aftertreatment 1 Intake Gas Sensor (Lambda Sensor) Heater Preliminary FMI	Below Measuring Range		LSCAN-MR
3222 / 2	-	12418	Aftertreatment 1 Intake Gas Sensor (Lambda Sensor) Heater Preliminary FMI	Measuring Range Not Plausible		LSCAN-MR
3224 / 3	-	12815	NOx Sensor	Circuit High (Bank 1)		LSCAN-MR
3224 / 4	-	12816	NOx Sensor	Circuit Low (Bank 1)		LSCAN-MR
3224 / 16	-	14234	NOx Emission	Level 2 Exceeded		LSCAN-MR
3226 / 15	-	14246	NOx Emission	Increased Raw Emission		LSCAN-MR
3234 / 2	-	14237	NOx Sensor (Bank 1)	Circuit Range/Performance		LSCAN-MR
3234 / 12	-	14245	NOx Emission NOx Sensor	Sensor Error		LSCAN-MR
3234 / 13	-	14244	NOx Sensor	Sensor Readiness Error		LSCAN-MR
3242 / 3	-	14207	Diesel Oxidation Catalyst Inlet Temperature Sensor	Circuit High		LSCAN-MR
3242 / 4	-	14208	Diesel Oxidation Catalyst Inlet Temperature Sensor	Circuit Low		LSCAN-MR
3246 / 1	-	14238	Diesel Particulate Filter Operation Temperature	Temperature Not Reached		LSCAN-MR
3250 / 3	-	14209	Diesel Oxidation Catalyst Outlet Temperature Sensor	Circuit High		LSCAN-MR
3250 / 4	-	14210	Diesel Oxidation Catalyst Outlet Temperature Sensor	Circuit Low		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
3251 / 0	-	14215	Diesel Particulate Filter Differential Pressure	Pressure Too High		LSCAN-MR
3251 / 1	-	14216	Diesel Particulate Filter Differential Pressure	Pressure Too Low		LSCAN-MR
3251 / 7	-	14231	Diesel Particulate Filter	Component Not Present		LSCAN-MR
3251 / 15	-	14258	Diesel Particulate Filter Regeneration	Regeneration Insuffcient		LSCAN-MR
3361 / 3	-	18207	Prop. Valve 7, Reductant Injector (Bank 1 Unit 1)	Circuit High		LSCAN-MR
3361 / 3	-	18907	Reductant Injector (Bank 1 Unit 1)	Circuit High		LSCAN-MR
3361 / 4	-	18206	Prop. Valve 7, Reductant Injector (Bank 1 Unit 1)	Circuit Low		LSCAN-MR
3361 / 4	-	18208	Prop. Valve 7, Reductant Injector (Bank 1 Unit 1)	Circuit Low		LSCAN-MR
3361 / 4	-	18906	Reductant Injector (Bank 1 Unit 1)	Circuit Low		LSCAN-MR
3361 / 5	-	18209	Prop. Valve 7, Reductant Injector (Bank 1 Unit 1)	Circuit / Open		LSCAN-MR
3361 / 5	-	18909	Reductant Injector (Bank 1 Unit 1)	Circuit / Open		LSCAN-MR
3363 / 3	-	14266	Reductant Tank Heating Solenoid Valve	Circuit High		LSCAN-MR
3363 / 3	-	15907	Prop. Valve 8, Reductant Tank Heating Solenoid Valve	Circuit High		LSCAN-MR
3363 / 4	-	14265	Reductant Tank Heating Solenoid Valve	Circuit Low		LSCAN-MR
3363 / 4	-	15906	Prop. Valve 8, Reductant Tank Heating Solenoid Valve	Circuit Low		LSCAN-MR
3363 / 5	-	14267	Reductant Tank Heating Solenoid Valve	Circuit Open		LSCAN-MR
3363 / 5	-	15909	Prop. Valve 8, Reductant Tank Heating Solenoid Valve	Circuit Open		LSCAN-MR
3363 / 7	-	14268	Reductant Tank Heating Solenoid Valve	Circuit, Component Defective		LSCAN-MR
3363 / 7	-	15969	Prop. Valve 8, Reductant Tank Heating Solenoid Valve	Circuit, Component Defective		LSCAN-MR
3363 / 14	-	14276	Euromot3b / Tier4i Engine Cold Operation	Invalid Engine Cold Operation		LSCAN-MR
3464 / 2	-	14224	Intake Throttle Highside Transistor	Control Module Performance		LSCAN-MR
3464 / 3	-	14200	Intake Throttle Direction Signal	Circuit High		LSCAN-MR
3464 / 4	-	14201	Intake Throttle Direction Signal	Circuit Low		LSCAN-MR
3464 / 6	-	12407	Intake Throttle Direction Signal	Command Current Too High		LSCAN-MR
3465 / 3	-	14204	Intake Throttle	Circuit Open		LSCAN-MR
3465 / 4	-	14202	Intake Throttle	Circuit Low		LSCAN-MR
3465 / 5	-	14203	Intake Throttle	Circuit High		LSCAN-MR
3485 / 2	-	18517	Reductant Injection Air Pressure Sensor	Circuit Range/Performance		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
3485 / 3	-	18515	Reductant Injection Air Pressure Sensor	Circuit High		LSCAN-MR
3485 / 4	-	18516	Reductant Injection Air Pressure Sensor	Circuit Low		LSCAN-MR
3509 / 2	-	14239	5V Output Reference Voltage 1	Voltage Too High/Too Low		LSCAN-MR
3510 / 2	-	14240	5V Output Reference Voltage 2	Voltage Too High/Too Low		LSCAN-MR
3511 / 5	-	14241	Sensor Reference Voltage “A”	Circuit Open		LSCAN-MR
3512 / 5	-	14242	Sensor Reference Voltage “B”	Circuit Open		LSCAN-MR
3513 / 5	-	14243	Sensor Reference Voltage “C”	Circuit Open		LSCAN-MR
3516 / 1	-	14236	NOx Emission Reducant Dosing	Unsufficient Reductant Dosing		LSCAN-MR
3516 / 14	-	14249	NOx Emission Reductant Dosing	Reductant Quality/Unsufficient Reductant Dosing/SCR Catalyst Error		LSCAN-MR
3516 / 18	-	14248	NOx Emission Reductant Dosing	Reductant Quality/Unsufficient Reductant Dosing		LSCAN-MR
3520 / 18	-	14235	NOx Emission Reductant	Reductant Quality		LSCAN-MR
3597 / 2	-	14227	Proportional Valve Bank 1	Control Module Performance		LSCAN-MR
3597 / 3	-	14225	Proportional Valve Bank 1	Circuit High		LSCAN-MR
3597 / 4	-	14226	Proportional Valve Bank 1	Circuit Low		LSCAN-MR
3605 / 3	-	14252	Coolant Pump Control	Circuit High		LSCAN-MR
3605 / 4	-	14250	Coolant Pump Control	Circuit Low		LSCAN-MR
3605 / 5	-	14251	Coolant Pump Control	Circuit Open		LSCAN-MR
3609 / 2	-	14232	Diesel Particulate Filter Inlet Pressure Sensor	Circuit Range/Performance		LSCAN-MR
3609 / 3	-	14211	Diesel Particulate Filter Inlet Pressure Sensor	Circuit High		LSCAN-MR
3609 / 4	-	14212	Diesel Particulate Filter Inlet Pressure Sensor	Circuit Low		LSCAN-MR
3610 / 2	-	14233	Diesel Particulate Filter Outlet Pressure Sensor	Circuit Range/Performance		LSCAN-MR
3610 / 3	-	14213	Diesel Particulate Filter Outlet Pressure Sensor	Circuit High		LSCAN-MR
3610 / 4	-	14214	Diesel Particulate Filter Outlet Pressure Sensor	Circuit Low		LSCAN-MR
3673 / 0	-	12421	Engine Throttle Position 2	Above Measuring Range		LSCAN-MR
3673 / 1	-	12422	Engine Throttle Position 2	Below Measuring Range		LSCAN-MR
3673 / 2	-	12423	Engine Throttle Position 2	Measuring Range Not Plausible		LSCAN-MR
3826 / 0	-	18790	Average Reductant Consumption	Consumption Too High		LSCAN-MR
3826 / 1	-	18791	Average Reductant Consumption	Consumption Too Low		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
3828 / 0	-	18690	Current Reductant Consumption	Consumption Too High		LSCAN-MR
3828 / 1	-	18691	Current Reductant Consumption	Consumption Too Low		LSCAN-MR
4213 / 7	-	14275	Diagnostic Function Engine Cranking	Engine Cranking Without Fuel Injection		LSCAN-MR
4332 / 12	-	16293	Aftertreatment 1 SCR System State	Control Module Performance		LSCAN-MR
4334 / 1	-	16770	Reductant Pressure System	Pressure Decrease Too Low (Shut Off Sequence)		LSCAN-MR
4334 / 7	-	14219	SCR Dosing Unit	Air Route Plugged		LSCAN-MR
4334 / 12	-	14220	SCR Dosing Unit	Pressure Route Plugged		LSCAN-MR
4334 / 18	-	16721	Reductant Pressure System	Reductant Pressure Too Low		LSCAN-MR
4335 / 0	-	16820	SCR Air Pressure System	Pressure Too High		LSCAN-MR
4335 / 1	-	16821	SCR Air Pressure System	Pressure Too Low		LSCAN-MR
4335 / 7	-	16883	SCR Air Pressure System	Missing Air Supply		LSCAN-MR
4335 / 14	-	14264	SCR Air Pressure System	Draining Pressure Pipe Not Performed		LSCAN-MR
4336 / 3	-	13707	SCR Air Pressure Control Valve Solenoid	Circuit Low		LSCAN-MR
4336 / 4	-	13706	SCR Air Pressure Control Valve Solenoid	Circuit High		LSCAN-MR
4336 / 5	-	13709	SCR Air Pressure Control Valve Solenoid	Circuit Open		LSCAN-MR
4337 / 3	-	18315	Reductant Temperature Sensor	Circuit High Input		LSCAN-MR
4337 / 4	-	18316	Reductant Temperature Sensor	Circuit Low Input		LSCAN-MR
4354 / 3	-	15807	SCR Reductant Pipe Heating	Circuit High		LSCAN-MR
4354 / 4	-	15806	SCR Reductant Pipe Heating	Circuit Low		LSCAN-MR
4354 / 5	-	15809	SCR Reductant Pipe Heating	Circuit Open		LSCAN-MR
4354 / 7	-	15869	SCR Reductant Pipe Heating	Circuit		LSCAN-MR
4360 / 0	-	10797	SCR Catalyst Temperature Before Catalyst	Temperature Too High		LSCAN-MR
4360 / 2	-	13817	Catalyst Temperature Sensors	Range/Performance		LSCAN-MR
4360 / 15	-	10788	SCR Catalyst Temperature	Level 1 Exceeded		LSCAN-MR
4360 / 16	-	10789	SCR Catalyst Temperature	Level 2 Exceeded		LSCAN-MR
4363 / 0	-	10722	SCR Catalyst Temperature Behind Catalyst	Temperature Too High		LSCAN-MR
4364 / 15	-	12971	NOx Emission	Level 1 Exceeded		LSCAN-MR
4364 / 16	-	12972	NOx Emission	Level 2 Exceeded		LSCAN-MR
4375 / 0	-	16777	Reductant Pressure System Pump	Current Too High		LSCAN-MR

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ADM3 fault code (J1939) SPN / FMI	ADM3 fault code (K-line)	MR2 fault code (K-line)	Fault location	Fault description	Remedial action	Pin
4375 / 3	-	13907	Reductant Supply Control	Curcuit High		LSCAN-MR
4375 / 4	-	13906	Reductant Supply Control	Curcuit Low		LSCAN-MR
4375 / 5	-	13909	Reductant Supply Control	Curcuit Open		LSCAN-MR
4794 / 14	-	10782	Aftertreatment 1 SCR Catalyst System	Component Not Present		LSCAN-MR
4809 / 3	-	10815	Catalyst Temperature Sensor (Bank 1 Sensor 1)	Circuit High Input		LSCAN-MR
4809 / 3	-	12404	Catalyst Temperature Sensor (Bank 1 Sensor 1)	Circuit High Input		LSCAN-MR
4809 / 4	-	10816	Catalyst Temperature Sensor (Bank 1 Sensor 1)	Circuit Low Input		LSCAN-MR
4809 / 4	-	12405	Catalyst Temperature Sensor (Bank 1 Sensor 1)	Circuit Low Input		LSCAN-MR
4810 / 3	-	10915	Catalyst Temperature Sensor (Bank 1 Sensor 2)	Circuit High		LSCAN-MR
4810 / 4	-	10916	Catalyst Temperature Sensor (Bank 1 Sensor 2)	Circuit Low		LSCAN-MR
520192 / 9	19409	-	Engine Start Stop Signals	Abnormal Update Rate		CAN-J1939
520192 / 19	19419	-	Engine Start Stop Signals	Received Network Data in Error		CAN-J1939
520230 / 0	-	18820	SCR Pressure Accumulator Bubble Pressure	Pressure Too High		LSCAN-MR
520230 / 2	-	14253	SCR Pressure Accumulator Bubble Pressure	Pressure Outside Range		LSCAN-MR
520258 / 7	-	14228	SCRT System Component	Component Not Present		LSCAN-MR
520259 / 2	-	14229	SCRT Temperature Sensors Pair A	Circuit Range/Performance		LSCAN-MR
520260 / 2	-	14230	SCRT Temperature Sensors Pair B	Circuit Range/Performance		LSCAN-MR
520262 / 14	-	16994	SCR System EGA	Disabled Mannheim-Function		LSCAN-MR
520262 / 14	-	16995	SCR System EGA	Disabled Wörth-Function		LSCAN-MR
520263 / 9	-	14272	Automatic Compression Detection Function	Timeout		LSCAN-MR
520263 / 14	-	14271	Automatic Compression Detection Function	Cancelling		LSCAN-MR

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9.2. Fault codes listed by K-line code

ADM3 fault code (K-line)	ADM3 fault code (J1939) SPN / FMI	Fault location	Fault description
10003	1072 / 3	Decompression Brake Valve (MBR_KD)	Open Circuit
10004	1072 / 4	Decompression Brake Valve (MBR_KD)	Short Circuit to Ground
10103	84 / 3	Vehicle Speed (C3 or J1939)	Open Circuit
10109	84 / 9	Vehicle Speed (C3 or J1939)	Abnormal Update Rate
10114	84 / 14	Vehicle Speed (C3 or J1939)	Signal Not Plausible
10119	84 / 19	Vehicle Speed (C3 or J1939)	Received Network Data in Error
10200	91 / 0	Accelerator Pedal (AFPS or J1939)	Not Adjusted
10203	91 / 3	Accelerator Pedal (AFPS or J1939)	Voltage too High
10204	91 / 4	Accelerator Pedal (AFPS or J1939)	Voltage too Low
10209	91 / 9	Accelerator Pedal (AFPS or J1939)	Abnormal Update Rate
10219	91 / 19	Accelerator Pedal (AFPS or J1939)	Received Network Data in Error
10400	98 / 0	Oil Level (from PLD/MR2)	Oil Level too High
10401	98 / 1	Oil Level (from PLD/MR2)	Low Oil Level
10414	98 / 14	Oil Level (from PLD/MR2)	Oil Level too Low
10501	100 / 1	Oil Pressure (from PLD/MR2)	Low Oil Pressure
10514	100 / 14	Oil Pressure (from PLD/MR2)	Oil Pressure too Low
10800	107 / 0	Air Filter Sensor (LF_SE)	Differential Pressure too High
10803	107 / 3	Air Filter Sensor (LF_SE)	Open Circuit
10804	107 / 4	Air Filter Sensor (LF_SE)	Short Circuit to Ground
10914	110 / 14	Coolant Temperature (from PLD/MR2)	Coolant Temperature too High
11001	111 / 1	Coolant Level Sensor (KW_SE)	Low Coolant Level
11003	111 / 3	Coolant Level Sensor (KW_SE)	Open Circuit
11004	111 / 4	Coolant Level Sensor (KW_SE)	Short Circuit to Ground
11014	111 / 14	Coolant Level Sensor (KW_SE)	Coolant Level too Low
11100	158 / 0	Battery Voltage Switched (Terminal 15)	Over Voltage
11101	158 / 1	Battery Voltage Switched (Terminal 15)	Under Voltage
11701	558 / 1	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Signals Equal but Should not
11705	558 / 5	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Switches Open Circuit
11709	558 / 9	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Abnormal Update Rate
11712	558 / 12	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Both Switches Closed
11719	558 / 19	Accelerator Pedal Idle Switch (GAS1 + GAS2 or J1939)	Received Network Data in Error
11809	599 / 9	Cruise Control Switch CC- (Set + Coast)	Abnormal Update Rate (Set Switch)
11812	599 / 12	Cruise Control Switch CC- (Set + Coast)	Both Switches CC- and CC+ Closed
11814	599 / 14	Cruise Control Switch CC- (Set + Coast)	Plausibility Check Failed (Check Stalk Switch Wiring)
11819	599 / 19	Cruise Control Switch CC- (Set + Coast)	Received Network Data in Error
11909	601 / 9	Cruise Control Switch CC+ (Res + Acc)	Abnormal Update Rate (Resume Switch)
11912	601 / 12	Cruise Control Switch CC+ (Res + Acc)	Both Switches CC+ and CC- closed
11914	601 / 14	Cruise Control Switch CC+ (Res + Acc)	Plausibility Check Failed (Check Stalk Switch Wiring)
11919	601 / 19	Cruise Control Switch CC+ (Res + Acc)	Received Network Data in Error
12002	609 / 2	PLD/MR2 Error	Unknown Cause
12103	620 / 3	Supply Analog Accelerator Pedal (AFP+)	Voltage too High
12104	620 / 4	Supply Analog Accelerator Pedal (AFP+)	Voltage too Low
12202	625 / 2	CAN Link ADM3 – PLD/MR2	No Communication with PLD/MR2
13303	677 / 3	Output Relay 1 (REL 1)	Open Circuit
13304	677 / 4	Output Relay 1 (REL 1)	Short Circuit to Ground

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ADM3 fault code (K-line)	ADM3 fault code (J1939) SPN / FMI	Fault location	Fault description
13900	730 / 0	Output Relay 2 (REL 2)	Grid Heater: No Increasing Boost Temperature After Activation
13901	730 / 1	Output Relay 2 (REL 2)	Relay Permanently Closed (Grid Heater)
13902	730 / 2	Output Relay 2 (REL 2)	Relay Permanently Open (Grid Heater)
13903	730 / 3	Output Relay 2 (REL 2)	Voltage too High when Activated
13904	730 / 4	Output Relay 2 (REL 2)	Voltage too Low when Activated
14003	729 / 3	Intake Air Heater (MBR_KD)	Open Circuit
14004	729 / 4	Intake Air Heater (MBR_KD)	Short Circuit to Ground
14202	974 / 2	Remote Throttle Pedal (HFG)	Supply Voltage Out of Range (Pin HFG+)
14203	974 / 3	Remote Throttle Pedal (HFG)	Voltage too High
14204	974 / 4	Remote Throttle Pedal (HFG)	Voltage too Low
14403	1004 / 3	Output Relay 4 (REL 4)	Open circuit
14404	1004 / 4	Output Relay 4 (REL 4)	Short Circuit to Ground
14503	1005 / 3	Output PWM Pedal Supply or Transmission (FP+)	Open Circuit
14504	1005 / 4	Output PWM Pedal Supply or Transmission (FP+)	Short Circuit to Ground
14603	1074 / 3	Exhaust Brake Valve (MBR_BK)	Open Circuit
14604	1074 / 4	Exhaust Brake Valve (MBR_BK)	Short Circuit to Ground
14902	639 / 2	SAE J1939 Interface	At Least One J1939 Message is Missing
15001	1015 / 1	PWM Accelerator Pedal (PWM FFG)	No Supply Voltage at Pin FP+
15003	1015 / 3	PWM Accelerator Pedal (PWM FFG)	No Signal at Path 1 (GAS1)
15004	1015 / 4	PWM Accelerator Pedal (PWM FFG)	No Signal at Path 2 (GAS2)
15005	1015 / 5	PWM Accelerator Pedal (PWM FFG)	Not Adjusted
15006	1015 / 6	PWM Accelerator Pedal (PWM FFG)	Idle Position Out of Adjusted Range
15007	1015 / 7	PWM Accelerator Pedal (PWM FFG)	Out of Adjusted Range
16603	171 / 3	Ambient Air Temperature	Voltage too High
16604	171 / 4	Ambient Air Temperature	Voltage too Low
16609	171 / 9	Ambient Air Temperature	Abnormal Update Rate
16619	171 / 19	Ambient Air Temperature	Received Network Data in Error
17309	69 / 9	Two Speed Axle Switch	Abnormal Update Rate
17319	69 / 19	Two Speed Axle Switch	Received Network Data in Error
17409	70 / 9	Parking Brake Switch	Abnormal Update Rate
17419	70 / 19	Parking Brake Switch	Received Network Data in Error
17509	96 / 9	Fuel Level	Abnormal Update Rate
17519	96 / 19	Fuel Level	Received Network Data in Error
17609	161 / 9	Transmission Input Shaft Speed	Abnormal Update Rate
17619	161 / 19	Transmission Input Shaft Speed	Received Network Data in Error
17709	191 / 9	Transmission Output Shaft Speed	Abnormal Update Rate
17719	191 / 19	Transmission Output Shaft Speed	Received Network Data in Error
17809	523 / 9	Transmission Current Gear	Abnormal Update Rate
17819	523 / 19	Transmission Current Gear	Received Network Data in Error
17909	524 / 9	Transmission Selected Gear	Abnormal Update Rate
17919	524 / 19	Transmission Selected Gear	Received Network Data in Error
18009	559 / 9	Accelerator Pedal Kickdown Switch	Abnormal Update Rate
18019	559 / 19	Accelerator Pedal Kickdown Switch	Received Network Data in Error
18109	573 / 9	Transmission Torque Converter Lockup Engaged	Abnormal Update Rate
18119	573 / 19	Transmission Torque Converter Lockup Engaged	Received Network Data in Error
18209	574 / 9	Transmission Shift in Process	Abnormal Update Rate
18219	574 / 19	Transmission Shift in Process	Received Network Data in Error
18309	596 / 9	Cruise Control Enable Switch	Abnormal Update Rate
18319	596 / 19	Cruise Control Enable Switch	Received Network Data in Error

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ADM3 fault code (K-line)	ADM3 fault code (J1939) SPN / FMI	Fault location	Fault description
18409	597 / 9	Brake Switch	Abnormal Update Rate
18419	597 / 19	Brake Switch	Received Network Data in Error
18509	598 / 9	Clutch Switch	Abnormal Update Rate
18519	598 / 19	Clutch Switch	Received Network Data in Error
18609	600 / 9	Cruise Control Coast (Decelerate) Switch	Abnormal Update Rate
18619	600 / 19	Cruise Control Coast (Decelerate) Switch	Received Network Data in Error
18709	602 / 9	Cruise Control Accelerate Switch	Abnormal Update Rate
18719	602 / 19	Cruise Control Accelerate Switch	Received Network Data in Error
18809	904 / 9	Front Axle Speed	Abnormal Update Rate
18819	904 / 19	Front Axle Speed	Received Network Data in Error
18909	973 / 9	Engine Retarder Selection	Abnormal Update Rate
18919	973 / 19	Engine Retarder Selection	Received Network Data in Error
19009	1623 / 9	Tachograph Output Shaft Speed	Abnormal Update Rate
19019	1623 / 19	Tachograph Output Shaft Speed	Received Network Data in Error
19109	1624 / 9	Tachograph Vehicle Speed	Abnormal Update Rate
19119	1624 / 19	Tachograph Vehicle Speed	Received Network Data in Error
19209	1633 / 9	Cruise Control Pause Switch	Abnormal Update Rate
19214	1633 / 14	Cruise Control Pause Switch	Plausibility Check Failed (Check Stalk Switch Wiring)
19219	1633 / 19	Cruise Control Pause Switch	Received Network Data in Error
19309	1716 / 9	Retarder Selection, non-engine	Abnormal Update Rate
19319	1716 / 19	Retarder Selection, non-engine	Received Network Data in Error
19409	520192 / 9	Engine Start Stop Signals	Abnormal Update Rate
19419	520192 / 19	Engine Start Stop Signals	Received Network Data in Error
19509	1237 / 9	Engine Shutdown Override	Abnormal Update Rate
19519	1237 / 19	Engine Shutdown Override	Received Network Data in Error

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OM 904-926 LA BlueTec®, OM 904-926 LA

Operating Instructions

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Mercedes-Benz

Symbols

⚠ WARNING

Warning notes make you aware of dangers which could pose a threat to your health or life, or to the health and life of others.

Environmental note

Environmental notes provide you with information on environmentally aware actions or disposal.

❗ Notes on material damage alert you to dangers that could lead to damage to your vehicle.

ⓘ These symbols indicate useful instructions or further information that could be helpful to you.

▶ This symbol designates an instruction you must follow.

▶ Several consecutive symbols indicate an instruction with several steps.

(▷ page) This symbol tells you where you can find further information on a topic.

▷ ▷ This symbol indicates a warning or an instruction that is continued on the next page.

`Display` This text indicates an indicator in the display.

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Welcome

Familiarise yourself with your engine system and read the operating instructions before you use the engine system. This will help you to avoid endangering yourself or others.

The standard equipment and product description of your engine system may vary, depending on individual specifications. This is described on the data card.

The engine systems are constantly updated to be state of the art.

Mercedes-Benz reserves the right to make changes to the following:

- design
- equipment
- technical features

Descriptions may therefore differ in individual cases from your engine system.

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Engine system

The OM 904-926 LA BlueTec® series of engines only function as intended when used in conjunction with the corresponding exhaust gas aftertreatment unit. Therefore, in these Operating Instructions, the term "engine system" refers to the engine and the exhaust gas aftertreatment unit.

Protection of the environment

Environmental note

Daimler AG has a declared policy of comprehensive environmental protection.

The objectives are to use the natural resources which form the basis of our existence on this planet sparingly and in a manner which takes the requirements of both nature and humanity into account.

You too can help to protect the environment by operating your vehicle in an environmentally responsible manner.

Information and notes on driving in an environmentally responsible and fuel-saving manner can be found in the "Operating notes" section (▷ page 57).

Assembly equipment

These Operating Instructions describe all models and all standard and optional equipment available for your engine system at the time of publication of the Operating Instructions. Country-specific deviations are possible. Note that your engine system may not be fitted with all features described. This also applies to safety-relevant systems and functions. Therefore, the equipment on your engine system may differ from certain descriptions and illustrations.

All of the components in your engine system are listed in the data card of your engine system. Data card (▷ page 94).

Please contact a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre if you have any questions about equipment or operation (see addresses in the publication details on the rear inside cover).

- Mercedes-Benz recommends, for on-highway applications, that you use a Mercedes-Benz Service Centre.
- MTU recommends, for off-highway applications, an MTU partner or MTU-authorised Mercedes-Benz partner.

Genuine Mercedes-Benz parts

Environmental note

Daimler AG also supplies reconditioned assemblies and parts which are of the same quality as new parts. For these, the same warranty applies as for new parts.

If you use parts which have not been approved by Mercedes-Benz, the operational safety of the engine system may be jeopardised. This could lead to malfunctions in safety-relevant systems. Use only genuine Mercedes-Benz parts or parts of equal quality. Only use parts that have been approved for your engine type.

Mercedes-Benz checks genuine Mercedes-Benz parts for:

- reliability
- safety
- suitability

Despite ongoing market research, Mercedes-Benz is unable to assess other parts. Mercedes-Benz therefore accepts no responsibility for the use of such parts in Mercedes-Benz vehicles, even if they have been officially approved or independently approved by a testing centre.

In Germany, certain parts are only officially approved for installation or modification if they comply with legal requirements. This also applies to some other countries. All genuine Mercedes-Benz parts meet the approval

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requirements. The use of non-approved parts may invalidate the vehicle's general operating permit.

This is the case if:

- they result in a change to the vehicle type from that for which the vehicle's general operating permit was granted
- they pose a possible risk for road users
- they adversely affect the emission or noise levels

You can find more information on recommended conversion parts and accessories, as well as permitted technical modifications at a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10).

Always state the engine number when ordering genuine Mercedes-Benz parts. You can find the engine number on the identification plate of your engine. You can also find the numbers on the data card (▷ page 94).

Modifying the engine output

! Increased power could:

- change emission levels
- cause malfunctions
- lead to consequential damage

The operating safety of the engine cannot be guaranteed in all situations.

Any tampering with the engine management system in order to increase the engine power output will lead to a loss of warranty entitlements.

Safety/emergency running program

The engine is equipped with an electronic engine management system that monitors the engine and has a self-diagnostic system.

If the electronic control system detects a malfunction, one of the following measures is automatically implemented after an appraisal of the malfunction:

- faults during operation are indicated by the corresponding warning lamp (▷ page 48).
- in conjunction with the electronic engine management system, fault codes with additional information can be shown on a display.
- the system switches to a suitable backup function for the continued, albeit restricted, operation of the engine. This includes torque and engine speed limitation, for example, as well as road speed limitation or constant emergency running speed.

Correct use

The engine system may only be installed as contractually specified.

The manufacturer of the end product is responsible for the correct installation of the engine and the exhaust gas aftertreatment system in the overall system.

The engine and the exhaust gas aftertreatment system may not be modified. If the engine is modified, Mercedes-Benz and MTU do not accept responsibility for any damage arising as a result.

Correct use of the engine system also requires adherence to the instructions in these Operating Instructions. This also requires compliance with the maintenance intervals and the professional execution of maintenance work. Please observe the Workshop Information System (WIS) (▷ page 10).

Implied warranty

A well-developed network of Mercedes-Benz, MTU and MTU-authorised Mercedes-Benz Service Centres is available to carry out maintenance work.

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These Mercedes-Benz and MTU or MTU-authorised Mercedes-Benz Service Centres:

- have special equipment and tools as well as specialists who receive continuous training
- guarantee that your engine system is repaired and maintained thoroughly and expertly
- carry out all repairs related to implied warranty
- carry out all maintenance work expertly
- confirm in the Maintenance Booklet that the maintenance work has been carried out at the required time
- handle implied warranty claims that are admissible according to the sales contract

Please observe the instructions and recommendations as well as the maintenance services in the Maintenance Booklet. Please observe these instructions even if you let a third party use and care for your vehicle. This is the only way to ensure that you do not lose your entitlements.

If the prescribed maintenance work is not carried out, claims can only be decided after the manufacturer has inspected the claim.

During the implied warranty period, have the prescribed maintenance service for your engine system carried out as follows:

- regularly
- punctually
- at a qualified specialist workshop which has the necessary specialist knowledge and tools to carry out the work required

  Mercedes-Benz recommends that you use a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre. In particular, work relevant to safety or on safety-related systems must be carried out by a qualified specialist workshop.

If there are legal requirements on emission control, please note that:

- maintenance on the engines must be carried out according to specific regulations and using special measuring devices
- it is prohibited to modify or tamper with components relevant to emissions

All Mercedes-Benz and MTU or MTU-authorised Mercedes-Benz Service Centres are familiar with the relevant regulations.

Maintenance work does not include repair work. Issue a separate order for repair work.

You can obtain further information on the maintenance of your engine system from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre.

Stored data

Several of the electronic components in your engine system contain data memories.

These data memories temporarily or permanently store technical information about:

- the engine system state
- events
- malfunctions

In general, this technical information documents the state of a component, a module, a system or the surroundings.

This includes, for example:

- operating conditions of system components, e.g. fluid levels
- the vehicle's status messages and those of its individual components, e.g. speed, deceleration in movement, accelerator position
- malfunctions and defects in important system components
- the vehicle's reactions and operating statuses in special driving situations
- ambient conditions, e.g. outside temperature

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This data is exclusively technical in nature and can be used to:

- assist in the detection and rectification of faults and defects
- analyse vehicle functions, e.g. after an accident

The data cannot be used to trace the vehicle's movements.

When you use one of the available services, technical information may be read from the event data memory and fault data memory.

Services include, for example:

- repair services
- service processes
- implied warranty and guarantee cases
- quality assurance

The information is read out by employees of the service network (including manufacturers) using special diagnostic testers. Further information is available there if required.

After a fault has been rectified, the information is deleted from the fault memory or is continually overwritten.

Qualified specialist workshop

A qualified specialist workshop has the necessary specialist knowledge, tools and qualifications to carry out the work required on the engine to a professional standard. This is particularly applicable to work relevant to safety.

Observe the notes in the Maintenance Booklet.

Always have the following maintenance work carried out at a qualified specialist workshop:

- work relevant to safety
- service and maintenance work
- repair work
- modifications as well as installations and conversions
- work on electronic components
- Mercedes-Benz recommends, for on-highway applications, that you use a Mercedes-Benz Service Centre.
- MTU recommends, for off-highway applications, an MTU partner or MTU-authorised Mercedes-Benz partner.

Further applicable documents

These Operating Instructions describe all models, as well as all standard and optional equipment of your engine system which are part of the scope of delivery of Daimler AG. The installation of the engine system into the vehicle/device may require additional operating instructions adapted to the vehicle/device and the appropriate use thereof. These additional operating instructions will be provided by the vehicle/device manufacturer. The additional operating instructions will describe, in particular, the functions specific to the installation and operation, the use of such functions as well as warning and control mechanisms.

To use the engine correctly, you also require the Maintenance Booklet.

For US-certified off-highway engines you also require the "Emission Warranty" supplement.

Please also observe the information contained in the vehicle or the equipment operating instructions (manufacturer of the end product). Always keep these documents together with the engine, vehicle or equipment. These documents should be passed on to the new owner if you sell the engine, vehicle or equipment.

When carrying out maintenance work, you require access to the Workshop Information System (WIS) via the Internet. This access is subject to a fee.

Current information on the system and prices can be found at this web address: http://service-parts.mercedes-benz.com. Click on "EPC, WIS/ASRA" in the "Service and parts information" tab and then on "WIS".

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You can log in by clicking on "Register" on the right-hand side.

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General information

The engine is a four-stroke, water-cooled diesel engine with direct injection.

The cylinders are arranged in a row. Each cylinder has two inlet valves and one outlet valve.

Each cylinder has its own fuel injection pump (unit pump) with a short high-pressure fuel injection line to the multi-hole nozzle at the centre of the combustion chamber. The unit pumps sit directly in the crankcase and are driven by the camshaft.

The engine is equipped with exhaust gas turbocharger and intercooler as standard. The engine may include an engine brake (airbrake and constantly open throttle) as optional equipment.

It is a low-emission engine. Start of injection, injection duration and injection quantity are controlled entirely electronically.

BlueTEC® exhaust gas aftertreatment

The engines meet the requirements of the relevant emissions level and are correspondingly certified. Compliance with emissions laws and regulations is a condition of the operating permit for the vehicle/equipment.

The BlueTEC® exhaust gas aftertreatment unit is characterised by the following technologies:

- selective catalytic reduction (SCR) with ammonia slip catalytic converter
- the diesel oxidation catalytic converter (DOC)

Engines with BlueTEC® exhaust gas aftertreatment must be operated with AdBlue® or DEF in order to meet the emissions laws and regulations. The operating permit is invalidated if the vehicle/equipment is operated without AdBlue®/DEF. Failure to use AdBlue® or DEF during operation may be a statutory or regulatory offence in certain countries. Special concessions granted either at the time of purchase or to reduce operating costs of the vehicle/equipment, e.g. reduced taxes or tolls, may also be rendered retroactively invalid. This may be the case in the country of registration. Or also in another country where you operate the vehicle/equipment.

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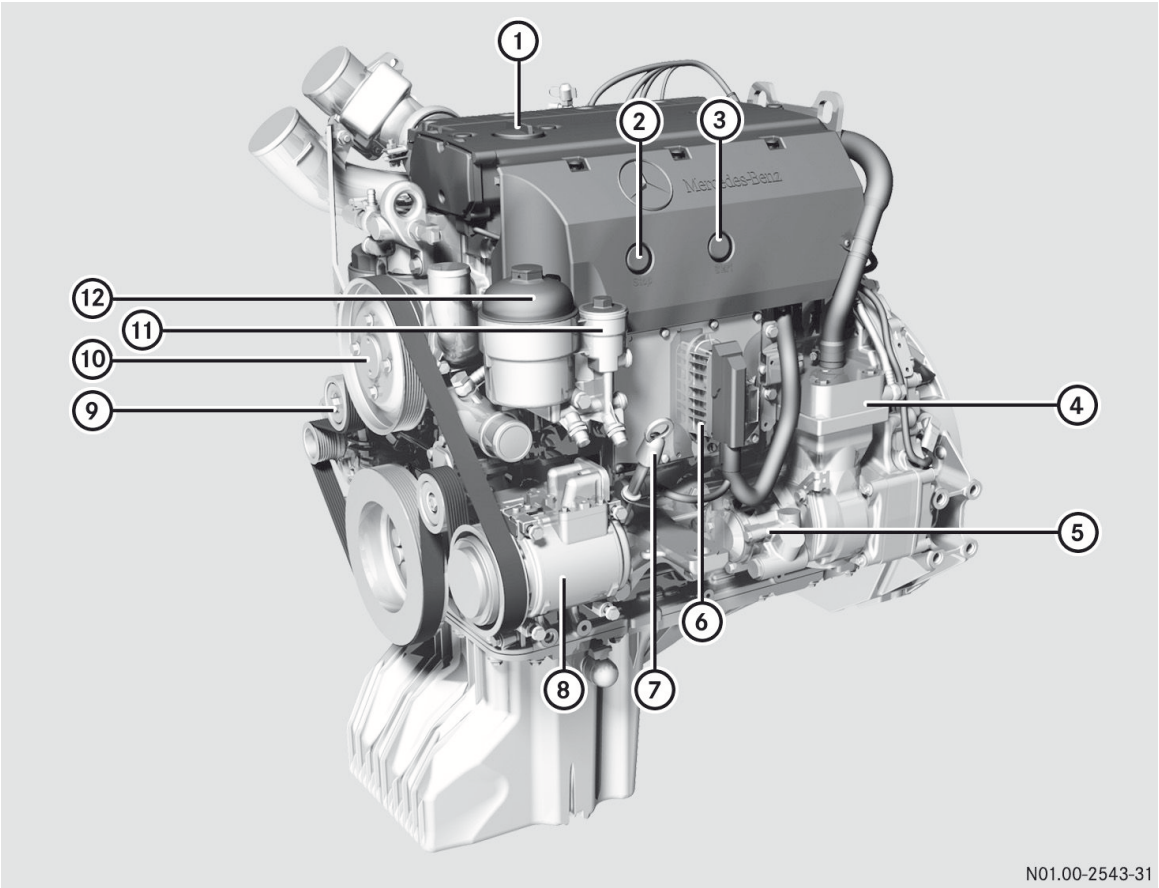
Engine overview



Engine overview: OM 904 LA

① Engine oil filler neck
② Stop button
③ Start button
④ Air compressor
⑤ Power-steering pump
⑥ Engine control unit (MR)
⑦ Dipstick
⑧ Refrigerant compressor
⑨ Poly V-belt tensioning device
⑩ Coolant pump
⑪ Fuel prefilter
⑫ Fuel filter

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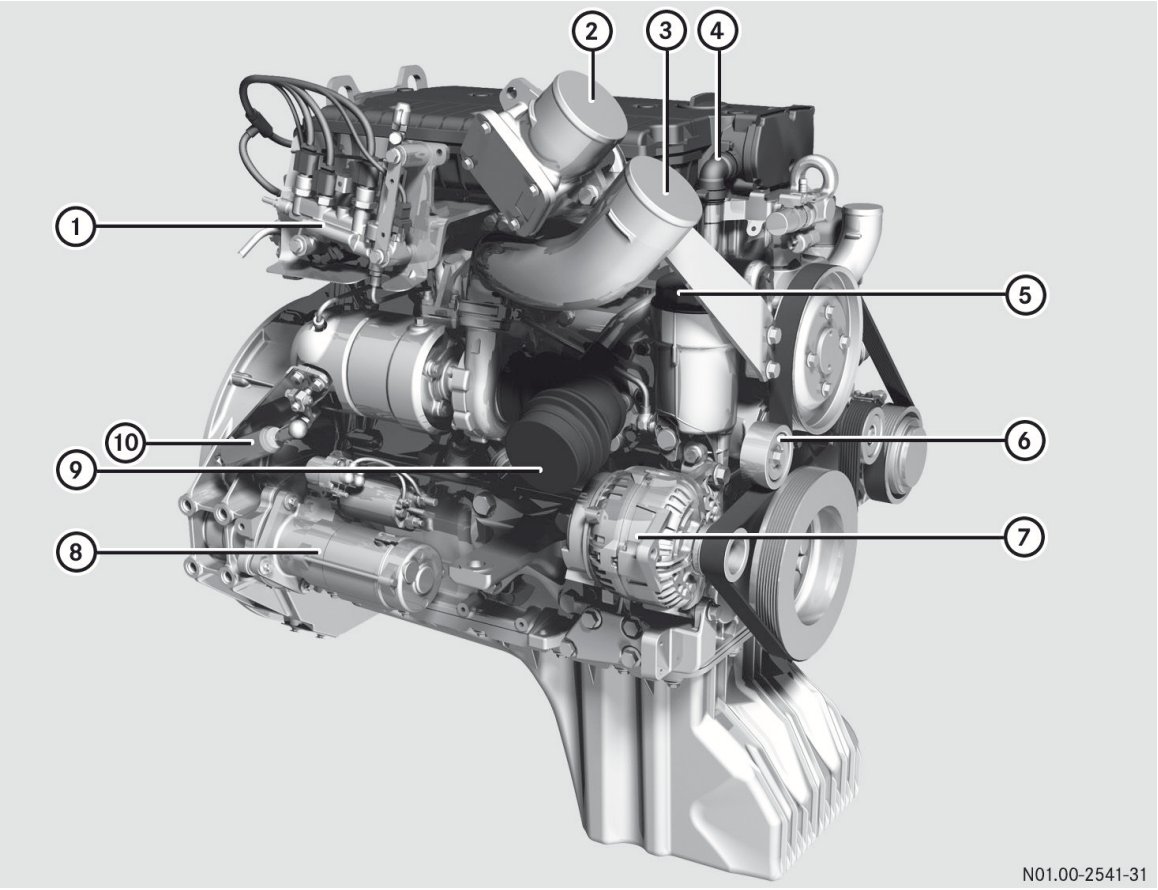

Engine overview: OM 904 LA

① AdBlue®/DEF metering unit
② Charge-air pipe from the charge-air cooler
③ Charge-air pipe to the charge-air cooler
④ Engine ventilation hose
⑤ Oil filter
⑥ Poly V-belt tensioning device
⑦ Alternator
⑧ Starter motor
⑨ Intake air inlet
⑩ Engine brake

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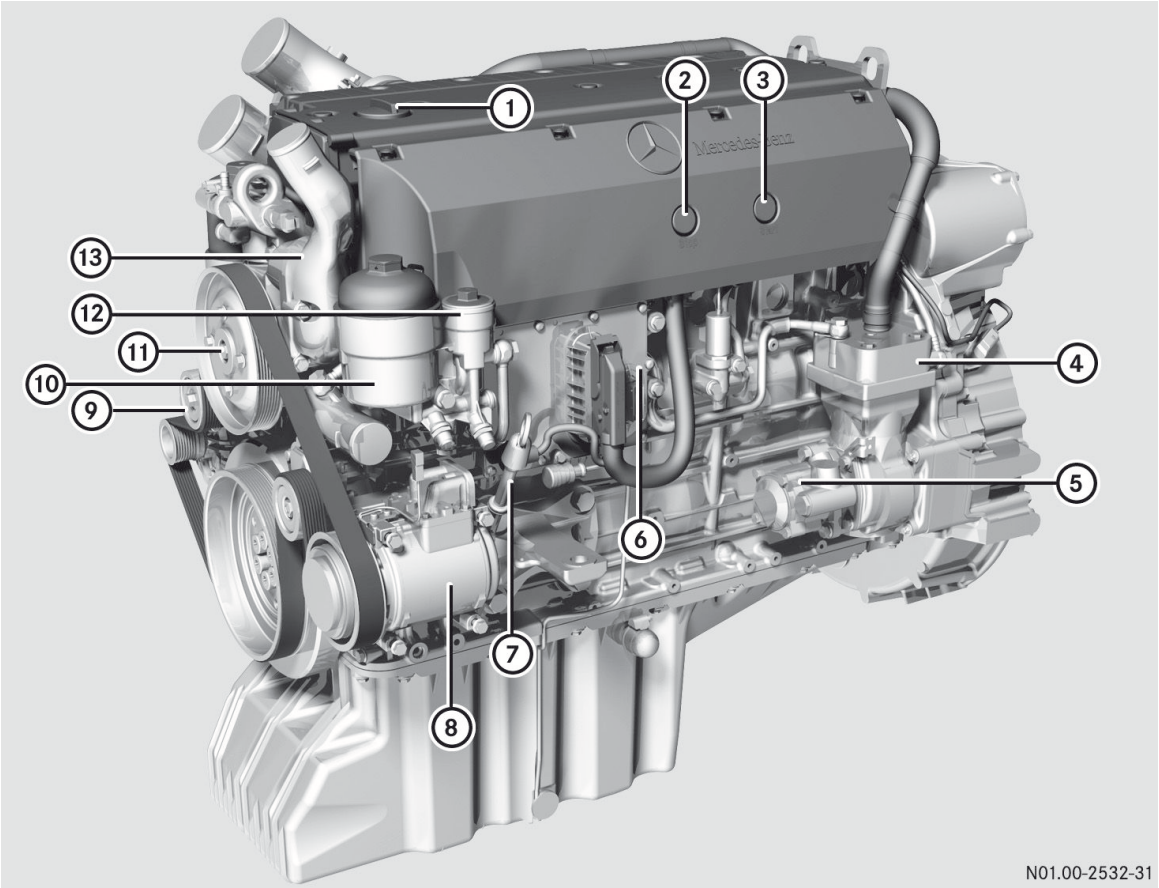

Engine overview: OM 906 LA

① Engine oil filler neck
② Stop button
③ Start button
④ Air compressor
⑤ Power-steering pump
⑥ Engine control unit (MR)
⑦ Dipstick
⑧ Refrigerant compressor
⑨ Poly V-belt tensioning device
⑩ Fuel filter
⑪ Coolant pump
⑫ Fuel prefilter
⑬ Coolant outlet to the radiator

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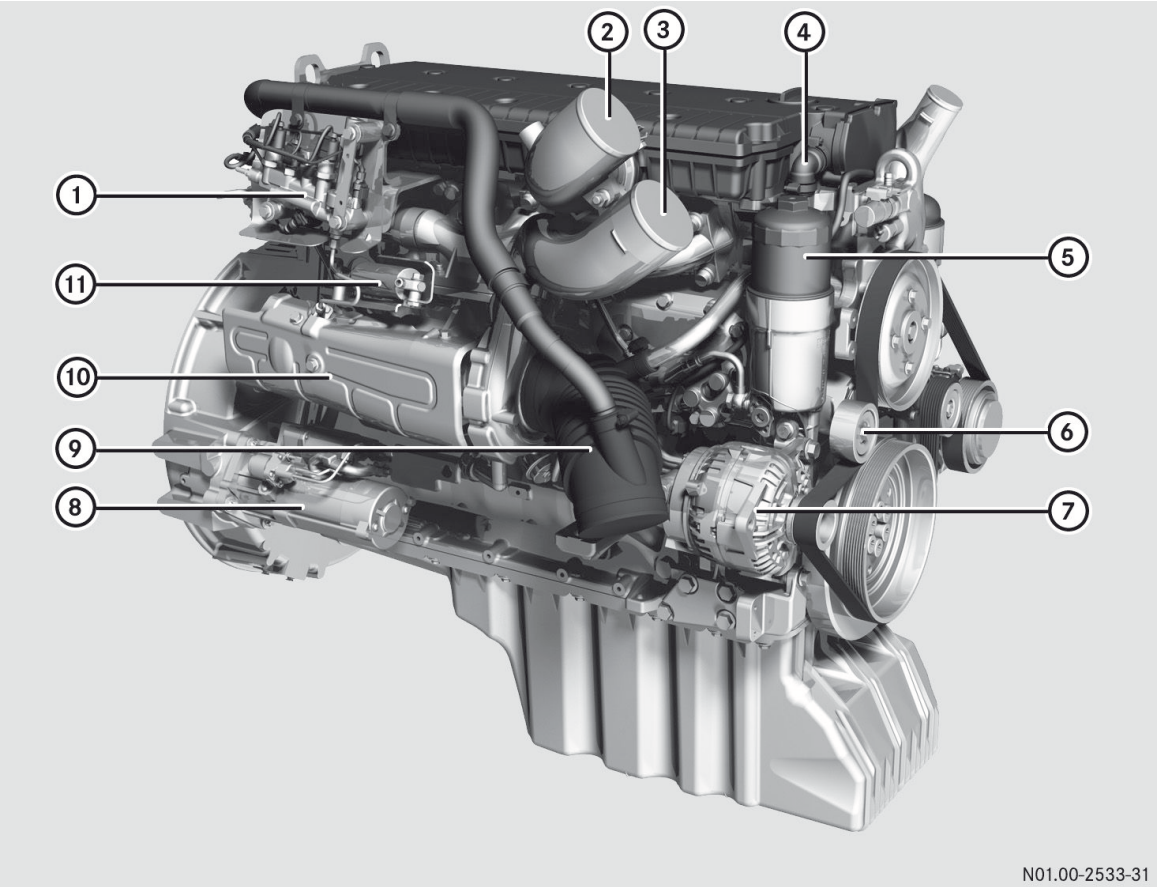
18 Engine overview



Engine overview: OM 906 LA

① AdBlue®/DEF metering unit
② Charge-air pipe from the charge-air cooler
③ Charge-air pipe to the charge-air cooler
④ Engine ventilation hose
⑤ Oil filter
⑥ Poly V-belt tensioning device
⑦ Alternator
⑧ Starter motor
⑨ Intake air inlet
⑩ Exhaust gas turbocharger
⑪ Engine brake

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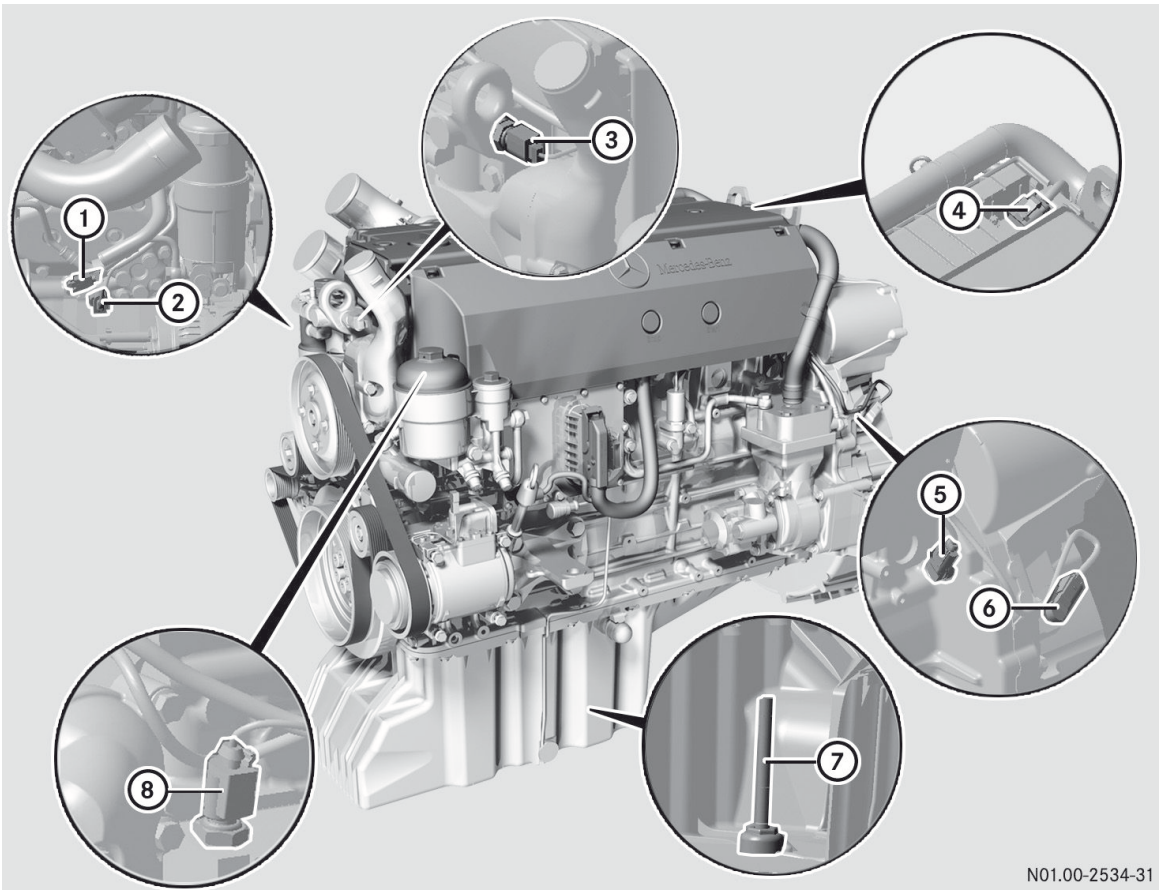
Sensors overview

Sensors, general



Example: OM 926 LA

① Oil temperature
② Oil pressure
③ Coolant temperature
④ Charge-air temperature/charge-air pressure
⑤ Camshaft position sensor (on camshaft gear)
⑥ Crankshaft position sensor (on flywheel)
⑦ Oil level
⑧ Fuel temperature

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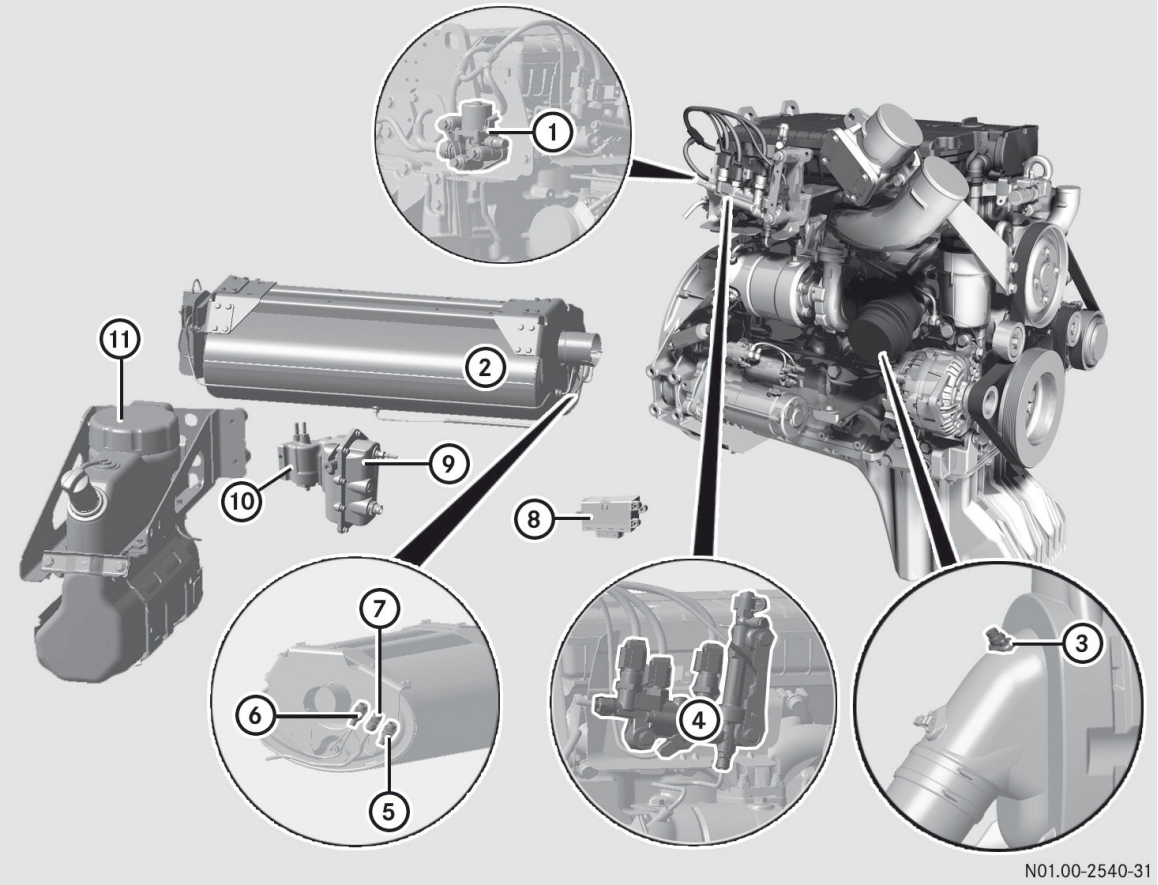
AdBlue®/DEF components



BlueTec® sensors, overview: OM 924 LA

① Valve preheating, AdBlue®/DEF system
② Exhaust aftertreatment unit
③ Temperature and humidity sensor (air filter, clean air side)
④ Metering unit
⑤ Temperature sensor downstream of catalytic converter
⑥ NOx sensor
⑦ Temperature sensor upstream of catalytic converter
⑧ Exhaust gas aftertreatment control unit
⑨ Supply unit
⑩ AdBlue®/DEF filter
⑪ AdBlue®/DEF tank

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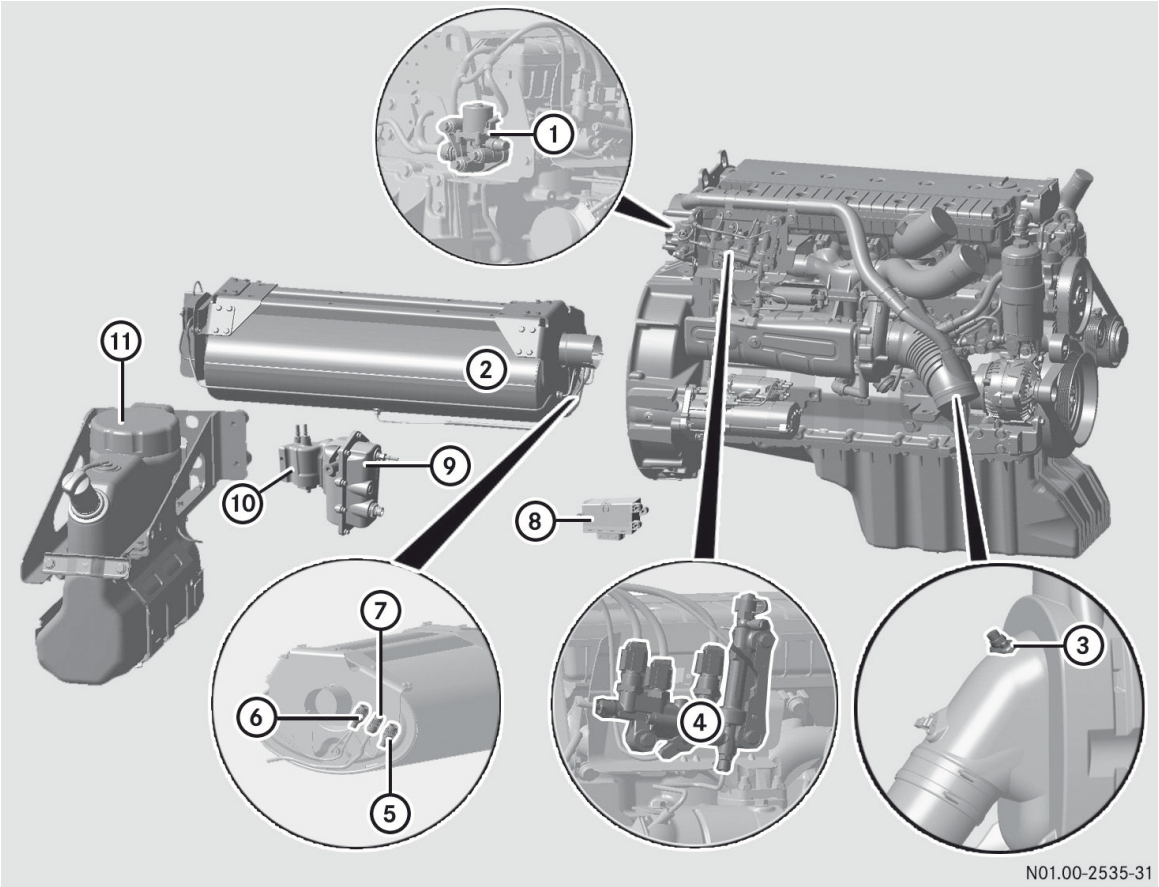

BlueTec® sensors, overview: OM 926 LA

① Valve preheating, AdBlue®/DEF system
② Exhaust aftertreatment unit
③ Temperature and humidity sensor (air filter, clean air side)
④ Metering unit
⑤ Temperature sensor downstream of catalytic converter
⑥ NOx sensor
⑦ Temperature sensor upstream of catalytic converter
⑧ Exhaust gas aftertreatment control unit
⑨ Supply unit
⑩ AdBlue®/DEF filter
⑪ AdBlue®/DEF tank

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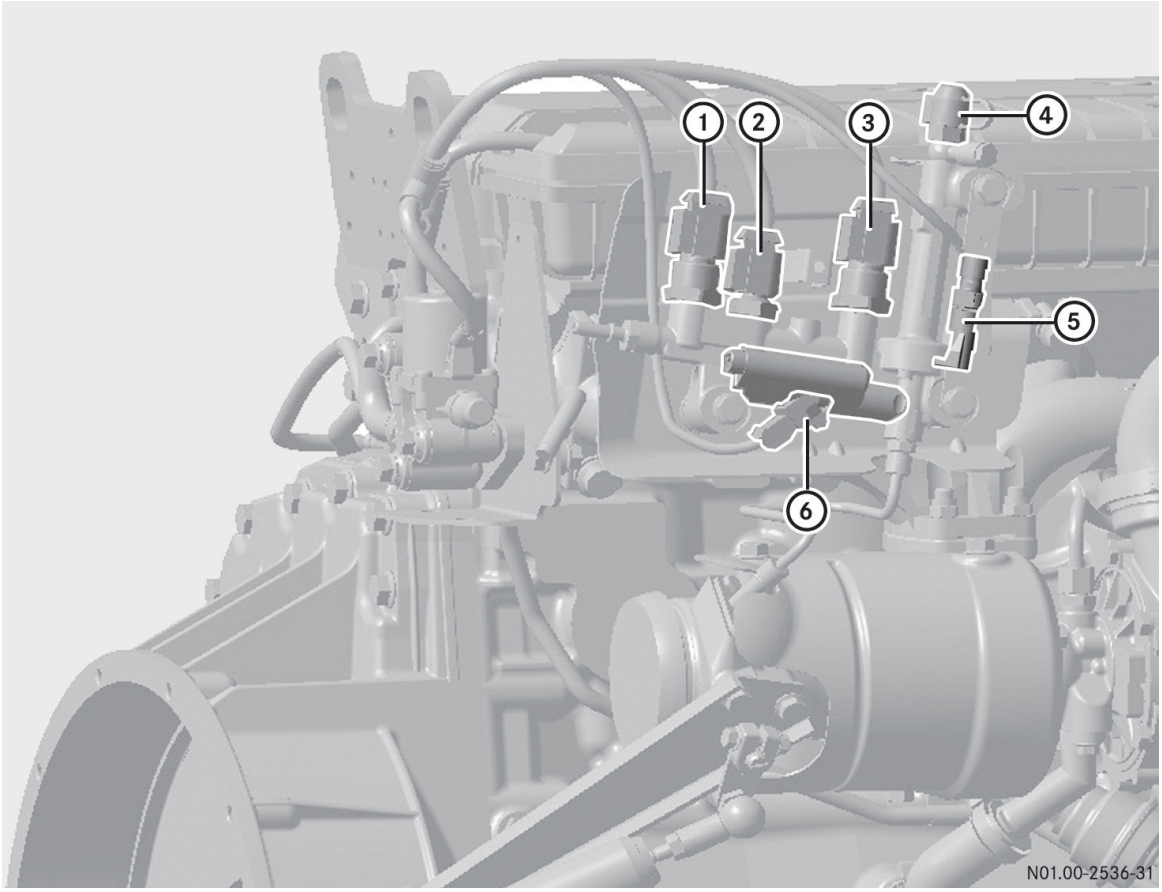

Example: BlueTec® sensors and test connection on the metering unit

① AdBlue®/DEF pressure sensor
② AdBlue®/DEF temperature sensor
③ Pressure sensor for compressed air
④ Metering unit test connection
⑤ Metering unit heater
⑥ Metering valve

Electronic engine management

The engine system is equipped with an electronic engine management system which comprises the following control units:

- engine control unit (MR)
- drive control unit (ADM)
- exhaust gas aftertreatment control unit (only for engines with BlueTec® exhaust gas aftertreatment)

The electronic engine management system monitors:

- the engine
- the exhaust gas aftertreatment in the case of BlueTec®
- and, as well as the connection to the vehicle or the device, it also monitors itself.

Depending on the malfunctions or failures which occur, warning and information displays are activated (▷ page 26). The malfunction is stored in the fault memory and if necessary a safety and emergency mode is automatically selected (▷ page 44). If the electronic engine management control

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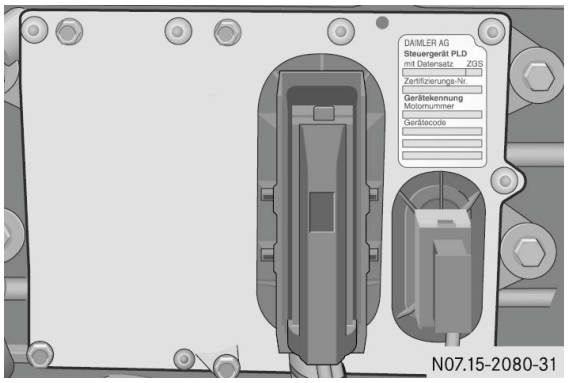
detects a fault, the fault code is stored in the control units. It can then be read by a qualified specialist workshop (▷ page 10) using a diagnostic tester.

Engine management control unit (MR) (engine-mounted)

The engine management control unit (MR) is on the side of the engine.



Example: OM 926 LA engine management control unit (MR)

The engine management control unit (MR) processes values from the drive control unit (ADM). These are, for example, the position of the accelerator pedal sensor, the engine brake or engine start/stop, etc.

These values are analysed together with data from the engine sensors. They are compared with the charts or characteristic curves stored in the engine management control unit (MR).

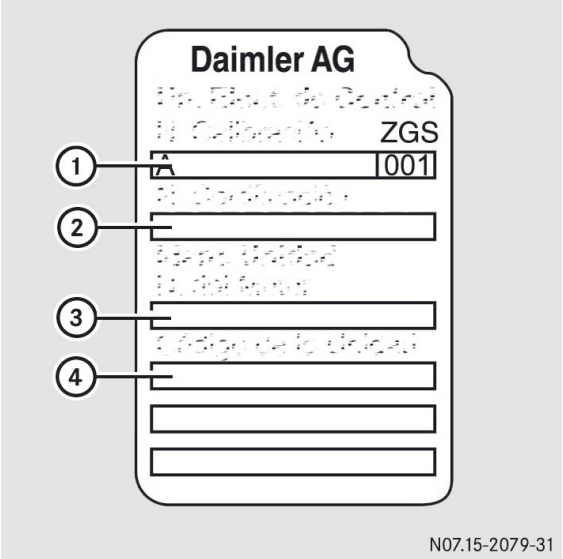
Data from the sensors derives from information such as:

- charge-air pressure and charge-air temperature
- coolant temperature
- fuel temperature
- oil pressure

Start of injection, injection duration and injection quantity are calculated on this basis and the unit pumps are controlled via the solenoid valve accordingly.

If BlueTec® exhaust gas aftertreatment is available, the associated sensors are also analysed and the AdBlue®/DEF dosage is controlled.

ⓘ To obtain a replacement engine management control unit (MR), you will require all the data on the control unit type plate.



Control unit type plate

① Data record
② Certification no.
③ Engine number
④ Equipment code

Drive control unit (ADM)

The drive control unit (ADM) is installed in a protected location in the vehicle/device by the vehicle/device manufacturer. It acts as an interface between the electric and electronic components on the vehicle/device side and the engine management control module (MR) on the engine side.

The engine can be adapted to the various operation-specific requirements using the drive control unit (ADM).

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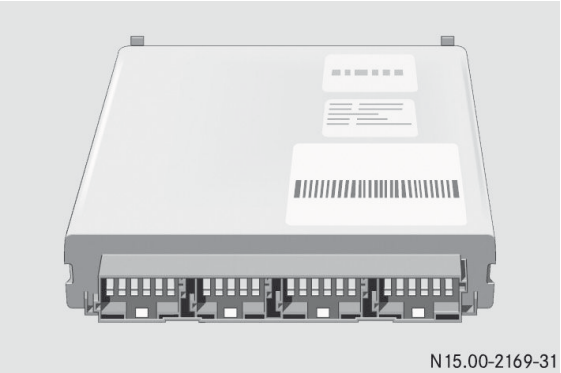


Example: drive control unit (ADM)

The drive control unit (ADM) has many functions:

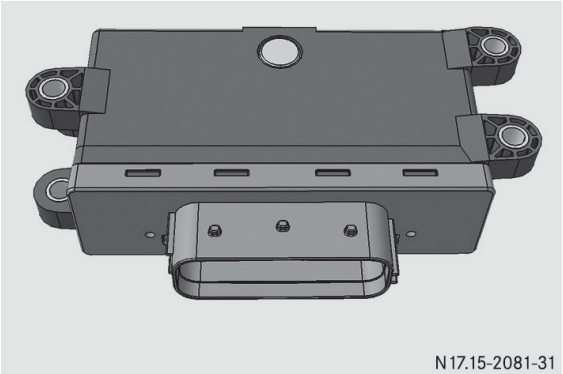
- Calculation of torque demand

  The drive control unit (ADM) registers the driver's requirements. For example, the position of the accelerator is detected by the drive control unit (ADM). A torque requirement is calculated from that and sent to the engine management control module (MR) via the CAN connection.

  In doing so, information and limitations from optionally connected control units such as the gearbox control, retarder control, ABS and ASR are taken into account.
- Output of displays and indicator signals which are displayed in the instrument cluster.
- Monitoring of coolant level, charge current and air filter, for example
- Legal speed limitation
- Evaluation of start request

  The engine starting process is initiated once a corresponding start request is present (ignition lock or external engine start/engine stop button).

Exhaust gas aftertreatment control unit (on the frame)



Exhaust gas aftertreatment control unit

The exhaust gas aftertreatment control unit reads signals and transmits them via the CAN line to the engine management (MR) control unit.

The following signals are read:

- temperature sensor upstream of the SCR catalytic converter
- temperature sensor downstream of the SCR catalytic converter
- NOx sensor downstream of the SCR catalytic converter
- pressure and temperature sensor for the fluid level and temperature in the AdBlue®/DEF tank
- sensor for humidity and intake air temperature

If the electronic engine management control detects a fault, the fault code is stored in the control units.

BlueTec® exhaust gas aftertreatment

The exhaust gas aftertreatment system is activated immediately after the engine is started and remains activated during engine operation. It ensures that the pollutant emissions in the exhaust gas are reduced to the limits stipulated in the emissions standard.

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Exhaust gas treatment is carried out by:

- selective catalytic reduction (SCR) with ammonia slip catalytic converter
- the diesel oxidation catalytic converter (DOC)

In order to ensure correct operation of the BlueTec® exhaust gas aftertreatment system, only operate the engine, vehicle or device with AdBlue®/DEF reducing agent. AdBlue®/DEF is not refilled as part of the maintenance work. You should therefore top up the AdBlue®/DEF tank regularly.

BlueTec® technology is one part of the engine homologation that requires certification. Operating the engine, vehicle or device without AdBlue®/DEF or with another medium that has not been approved by Daimler invalidates the engine's operating permit or certification.

Continuous brake

If increased braking power is required, the engine can be equipped with a brake valve downstream from the exhaust gas turbocharger in conjunction with constant throttle valves. The brake valve uses exhaust back pressure to increase braking power. The constant throttle valves bring about a reduction of the compression pressure in the power stroke (third stroke), whilst the compression (second stroke) is not significantly affected. The constant throttle valve is an additional valve in the cylinder head. When open, the constant throttle valve establishes a connection between the combustion chamber and exhaust port.

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Warning and indicator lamps

Important safety notes

Important safety notes

If you ignore warning and indicator lamps, you will not be able to recognise failures and malfunctions in components or systems. The driving and braking characteristics may change and the road and operating safety of your vehicle or equipment may be restricted. Have the affected system checked and repaired at a qualified specialist workshop. Always observe the warning and indicator lamps and follow the corresponding corrective actions (▷ page 48).

Overview

The indicator and warning lamp display is designed for the specific vehicle or equipment. Please also observe the information in the additional operating instructions. These will be provided by the vehicle/device manufacturer. The symbols listed below are examples only and their appearance may differ in the vehicle or on the equipment. In the event of a fault or warning, a warning lamp or indicator lamp lights up automatically. Depending on the priority of the fault or warning, the warning and indicator lamps light up in different combinations. The following warning and indicator lamps may be available on the instrument panel:

On-highway version without BlueTec®[1]

The following warning and indicator lamps may be available on the instrument panel:

Indicator lamp	Description
red[2]	Engine stop
	Engine system malfunction
	Charge current
(optional)	Cold-start aid
(optional)	Oil pressure too low (engine)
(optional)	Oil level too low (engine)
(optional)	Coolant level too low
(optional)	Coolant temperature too high

1 On-highway: vehicles with operating permit

2 In addition, an acoustic warning signal may sound.

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Indicator lamp	Description
(optional)	Continuous brake active
(optional)	Cruise control
LIM (optional)	Speed limiter
(optional)	Power take-off engaged

On-highway version[1] with BlueTec®

The following warning and indicator lamps may be available on the instrument panel:

Indicator lamp	Description
red[2]	Engine stop
	Engine system malfunction
	Engine diagnostics MIL
LIMIT (lit constantly)	Torque operating restriction
	Charge current
(optional)	Cold-start aid
(optional)	AdBlue®/DEF reserve level
(optional)	Oil pressure too low (engine)
(optional)	Oil level too low (engine)
(optional)	Coolant level too low
(optional)	Coolant temperature too high

1 On-highway: vehicles with operating permit

2 In addition, an acoustic warning signal may sound.

TIM-ID: 0000094786 - 003

Indicator lamp	Description
(optional)	Continuous brake active
(optional)	Cruise control
LIM (optional)	Speed limiter
(optional)	Power take-off engaged

Off-highway version[3] without BlueTec®

The following warning and indicator lamps may be available on the instrument panel:

Indicator lamp	Description
red[2]	Engine stop
	Engine system malfunction
	Charge current
(optional)	Cold-start aid
(optional)	Oil pressure too low (engine)
(optional)	Oil level too low (engine)
(optional)	Coolant level too low
(optional)	Coolant temperature too high
(optional)	Continuous brake active
(optional)	Cruise control

3 Off-highway: devices/vehicles

2 In addition, an acoustic warning signal may sound.

TIM-ID: 0000094786 - 003

Indicator lamp	Description
LIM (optional)	Speed limiter
(optional)	Power take-off engaged

Off-highway version[3] with BlueTec®

The following warning and indicator lamps may be available on the instrument panel:

Indicator lamp	Description
red[2]	Engine stop
	Engine system malfunction
	Emissions-relevant malfunction of the exhaust gas aftertreatment system or AdBlue®/DEF supply
LIMIT (lit constantly)	Torque operating restriction
LIMIT (flashing)	Torque and engine speed operating restriction
	Charge current
(optional)	Cold-start aid
(optional)	AdBlue®/DEF reserve level
(optional)	Oil pressure too low (engine)
(optional)	Oil level too low (engine)
(optional)	Coolant level too low
(optional)	Coolant temperature too high
(optional)	Continuous brake active

3 Off-highway: devices/vehicles

2 In addition, an acoustic warning signal may sound.

TIM-ID: 0000094786 - 003

Indicator lamp	Description
(optional)	Cruise control
LIM (optional)	Speed limiter
(optional)	Power take-off engaged

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Operating safety

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

The operating safety of an engine system depends on its professional installation in the overall system (e.g. the vehicle or working machinery). As the operator of the engine, you also affect its safe operation.

Through compliance with the prescribed maintenance intervals, you fulfil part of the requirements for safe operation of the engine.

However, safe operation of the engine also depends upon its proper use and care. This includes, for example, regularly checking the oil level.

Safety precautions

Damage to the engine can also lead to personal injury. In order to avoid engine damage, the following safety precautions must be adhered to.

- Only start the engine when the batteries are firmly attached.
- Do not disconnect the batteries when the engine is running.
- Do not use a rapid charger to start the engine.
- Only perform the jump-starting procedure with separate batteries.
- Note, the battery terminals must be disconnected when rapid charging the batteries.
- Observe the operating instructions of the rapid battery charger.
- Please note that the "+" and "-" terminals on the batteries must be disconnected when carrying out electric welding work.
- The control unit connectors may only be connected/disconnected when the electrical system is switched off.
- Incorrect control unit-power supply polarity (e.g. by connecting up the batteries incorrectly) can cause irreparable damage to the control units.
- Tighten diesel injection system connections to the prescribed tightening torque.
- If temperatures above 80 °C are to be expected (e.g. in a drying oven), the control unit on the engine must be removed.
- Only use the appropriate testing probes when taking measurements from electrical connectors (e.g. a Mercedes-Benz connection set). Telephones and two-way radio devices that are not connected to an external aerial can cause malfunctions in the electronics and thus endanger the operating safety of the engine.

Warning stickers

If you remove any warning stickers, you or others could fail to recognise certain dangers.

Various warning stickers are attached to the engine system. Their purpose is to make you and others aware of various risks.

Notes on electronic systems

Important safety notes

⚠ WARNING

Modifications to electronic components, their software as well as wiring could affect their function and/or the operation of other networked components. This could in particular also be the case for systems relevant to safety. They might not function properly anymore and/or jeopardise the operational

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safety of the vehicle. There is an increased risk of an accident and injury.

Do not attempt to modify the wiring as well as electronic components or their software. Always have work on electrical and electronic components carried out at a qualified specialist workshop.

The general operating permit for your vehicle/equipment could be rendered invalid if you carry out modifications to electronic components, their software or their wiring.

Electromagnetic compatibility

The electromagnetic compatibility of the engine system's components has been checked and certified according to the currently valid version of Directive ECE-R 10.

Diagnostics connection

The diagnostics connection is used for connecting diagnostic equipment at a qualified specialist workshop.

⚠ WARNING

If you connect equipment to a diagnostics connection in the vehicle, it can affect the operation of the vehicle systems. This may affect the operating safety of the vehicle. There is a risk of an accident.

Do not connect any equipment to a diagnostics connection in the vehicle.

If the engine is switched off and devices connected to the diagnostics connection are being used, the starter battery can become discharged.

Staff qualifications

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

The engine should only be operated, maintained and repaired by trained personnel who have been briefed and authorised by the operator. The prescribed minimum legal age for personnel carrying out maintenance and repair work must be observed.

Organisational measures

The operator must determine the responsibilities for operation, maintenance and repairs. Give the Operating Instructions and the Maintenance Booklet to the personnel that are charged with operating or carrying out work on the engine.

Instruct personnel on how to operate the engine using the Operating Instructions. When doing so, put special emphasis on safety-relevant information. This is particularly important for personnel that only work occasionally on the engine.

Always keep the Operating Instructions and the Maintenance Booklet readily accessible, in the area of engine operation.

In addition to the Operating Instructions, other general, country-specific, legal and other binding regulations on accident prevention and environmental protection must be adhered to.

Please also observe the information in the additional operating instructions. These will be provided by the device/vehicle manufacturer.

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Transport

⚠ WARNING

If you do not lift the engine as described, the lugs intended for the purpose may be torn out or snap. This may be the case especially if the maximum permissible lug load is exceeded. The engine could then drop uncontrolled, causing serious or even fatal injury.

Always make sure that:

- the engine is only lifted at the intended lifting points/lifting lugs.
- the engine is only lifted and transported in the fitting position.
- ropes/chains are always routed vertically.
- only parts which are typically in the original scope of delivery are attached to the engine.

⚠ WARNING

If you lift the engine at unsuitable points and/or using unsuitable lifting gear, it may:

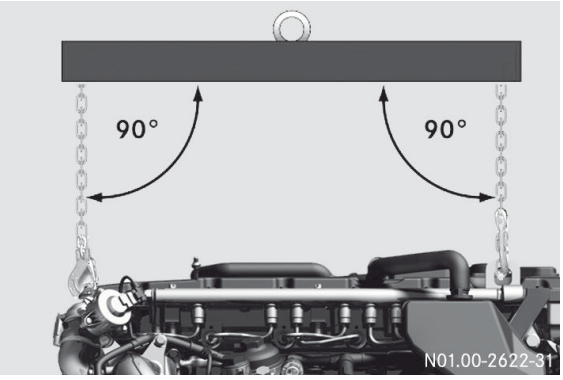
- work loose and fall off
- swing uncontrollably as a result of a change in the centre of gravity.

There is a risk of injury.

Lift the engine only at the lifting points provided using suitable lifting gear. Make sure that there is nobody in the danger zone when raising and lowering the engine.

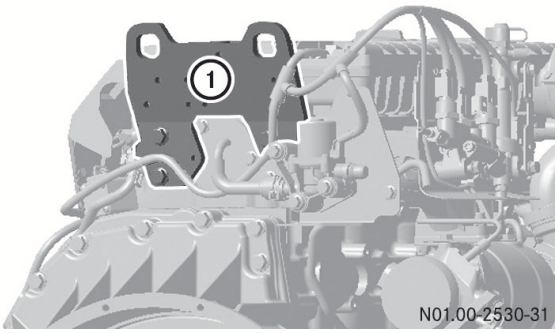
! The engines are by default delivered filled with oil. If the engine is transported at an angle or on its side, oil could leak out. Only transport the engine in the installation position.

! Do not stand on the engine or the exhaust gas aftertreatment unit. They may otherwise be damaged.

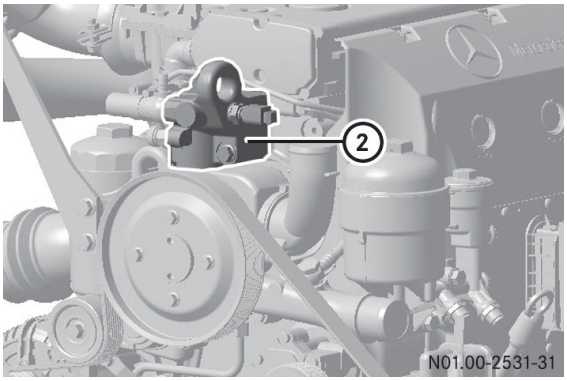


Example: using a cross member

The engine may only be lifted using a cross member with the chain/rope at 90° relative to the horizontal engine.



① Example: flywheel-side lifting point



② Example: belt-side lifting point

Installation

The engine system may only be installed as contractually specified.

Observe the sections "Correct use" (▷ page 8) and "Modifying the engine output" (▷ page 8).

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Daimler AG provides the vehicle manufacturer with comprehensive material, e.g. the installation guideline, for initial installation. The vehicle manufacturer must take this into account. If the engine is fitted after repair work, for example, the information in the Workshop Information System (WIS) must be observed (▷ page 10).

Observe the sections "Qualified specialist workshop" (▷ page 10) and "Further applicable documents" (▷ page 10).

Please consult a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre if you have any questions.

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Preparation for operation

Engine with initial operation oil from the factory

The engine is filled at the factory with an initial operation oil.

These high-quality engine oils are beneficial to the running-in process. They also allow you to make the first oil change in accordance with the applicable oil change intervals. This eliminates the need for special break-in oils and the additional oil change otherwise required.

Checking the engine oil level

The engine is equipped with an electronic oil level detection system.

If the engine is also equipped with a dipstick, this is subsidiary to the electronic oil level measurement system. It is merely used for a general check to determine if there is oil in the engine.

Electronic oil level measurement – system description

The engine oil level sensor is installed in the oil pan for oil level measurement. The electrical signals are detected in the engine control (MR) control unit and transmitted to the adaptation module (ADM) via the engine CAN.

Output can be displayed on a matrix display when the engine is not running.

The engine oil level is not displayed while the engine is running.

Checking the oil level electronically

Check the engine oil level on a regular basis, e.g. every week or each time you refuel.

The current oil level in the engine is only displayed once the engine is switched off and with the ignition switched on. An accurate display of the engine oil level is therefore only possible with the engine switched off and the ignition switched on.

- ▶ Park the vehicle/device on a level surface.
- ▶ Engage the parking brake.
- ▶ Switch off the engine.
- ▶ Wait approximately five to ten minutes. If you call up the oil level in the engine too early or while the engine is running, it is not available.

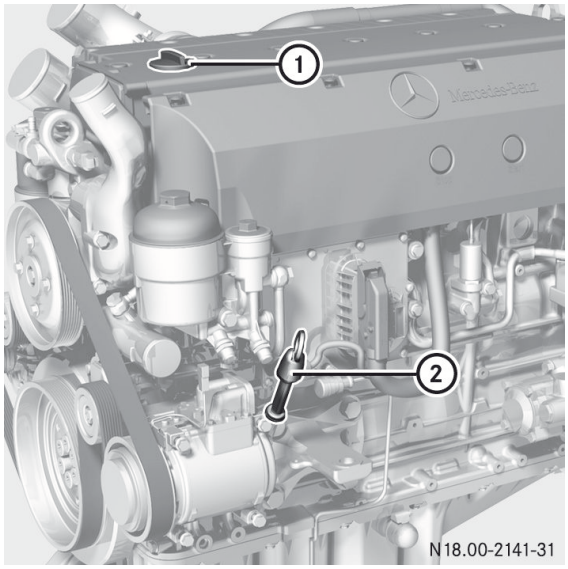
Only use engine oil which has been approved for the engine and which meets the specified SAE classification (▷ page 65).

Checking the oil level with the dipstick

❗ Do not add too much oil. If you add too much oil, the engine or the exhaust aftertreatment unit could be damaged. Drain or siphon off any excess oil.

Check the engine oil level on a regular basis, e.g. every week or each time you refuel.

- ▶ Park the vehicle/device on a level surface.
- ▶ Engage the parking brake.
- ▶ Switch off the engine.
- ▶ Wait approximately five to ten minutes.



Example: OM 926 LA

- ▶ Check the engine oil level with dipstick ②. The oil level should be between the upper and lower marks on dipstick ②.
- ▶ If necessary, use filler neck ① to top up the oil.

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Only use engine oil which has been approved for the engine and which meets the specified SAE classification (▷ page 65).

Checking the coolant level

- ▶ Check the coolant level as stated in the vehicle's/device's operating instructions.
- ▶ Fill the cooling system if necessary. Only use coolant that has been approved for the engine (▷ page 68).

Checking the fuel level

For checking the fuel level on the fuel gauge, see the vehicle's operating instructions. Refuel if necessary (▷ page 68).

Checking the AdBlue®/DEF supply

For checking the AdBlue®/DEF supply on the AdBlue®/DEF gauge, see the vehicle's operating instructions. Refuel if necessary (▷ page 59).

Starting and stopping the engine

Starting the engine

⚠ WARNING

Combustion engines emit poisonous exhaust gases such as carbon monoxide. Inhaling these exhaust gases leads to poisoning. There is a risk of fatal injury. Therefore never leave the engine running in enclosed spaces without sufficient ventilation.

! If the oil pressure in the engine is too low, a warning light lights up on the instrument panel. The warning buzzer also sounds.

The operating safety of the engine is jeopardised. Switch off the engine immediately.

! Do not pull away as soon as the engine starts. Let the engine run in neutral for a short time after starting, until there is sufficient engine oil pressure. Do not drive at high engine speeds when the engine is cold.

This will prevent excessive wear and possible engine failure.

Warm up the engine quickly by driving at moderate engine speeds. Depending on the outside temperature, the engine will reach its operating temperature after approximately 10 to 20 minutes (▷ page 98).

You can utilise the full engine power output once the engine has reached its normal operating temperature.

The display format for indicator and warning lights is vehicle-specific/device-specific. Please also observe the information in the additional operating instructions. These will be provided by the vehicle/device manufacturer.

- ▶ Start the engine using the key in the ignition lock or the external engine start/engine stop button on the engine. Do not depress the accelerator or clutch pedal while doing so.

For additional safety, the electronic engine management system is equipped with a function that only allows the engine to be started when the transmission is in neutral (vehicle-specific/device-specific).

Starting the engine with the key

! After starting the engine, let it run at engine idling speed until the oil pressure is displayed. If no oil pressure is displayed after approximately 10 seconds, switch off the engine. Determine the cause. The operating safety of the engine is jeopardised.

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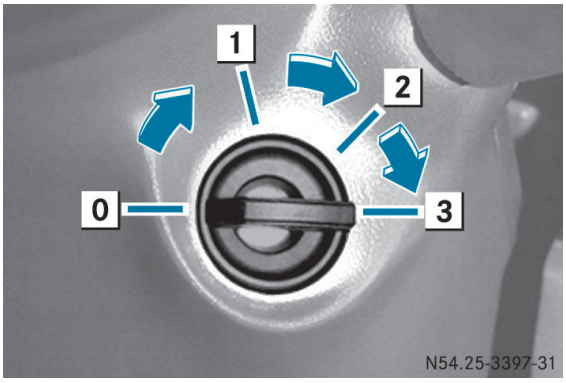

Example: ignition lock

0 To insert/remove the vehicle key
1 Steering wheel unlocked/radio position
2 Drive position (ignition)
3 Start position

- ▶ Secure the vehicle/equipment against rolling away.
- ▶ Deactivate power take-off.
- ▶ Shift the transmission to neutral or engage neutral on the equipment.
- ▶ **To start the engine:** turn the key in the ignition lock to drive position 2.
- ▶ Vehicles/equipment with a hot-water auxiliary heater: preheat the engine at outside temperatures below −20 °C before starting.
- ▶ Vehicles/equipment with cold-start aid: wait until the indicator lamp in the instrument cluster goes out.
- ▶ Turn the key to start position 3 in the ignition lock. Do not depress the accelerator pedal whilst doing so. For equipment, keep the idling function active.
- ▶ When the engine has started, release the key.
  The idling speed is controlled automatically.

ⓘ The engine idling speed is raised at very low outside temperatures.

- ▶ **If the engine does not start immediately:** interrupt the starting procedure after no more than 30 seconds.
- ▶ Turn the key in the ignition lock back to the stop at key position 0.
- ▶ Repeat the starting procedure after a waiting period of approximately 1 minute.
- ▶ If the engine fails to start: rectify the cause of the poor starting characteristics (▷ page 85).
- ▶ Observe the oil pressure gauge immediately after having started the engine.

Starting the engine with the external engine start/engine stop button

- ▶ **To start the engine with the external engine start/engine stop button:** (▷ page 80).

Stopping the engine

⚠ WARNING

When switching off the equipment or parking the vehicle, make sure that the exhaust system does not come into contact with combustible objects, e.g. dry leaves, grass or other highly flammable materials.

⚠ WARNING

If you switch off the ignition while the vehicle is in motion, safety-relevant functions are restricted or not available. This can affect the power steering function and the brake boosting effect, for example. You will then require considerably more force to steer and brake. There is a risk of an accident.

Do not switch off the ignition while the vehicle is in motion.

❗ Stop the engine immediately, paying attention to the road and traffic conditions if:

- the oil pressure falls or fluctuates significantly.
- the power output or engine speed decreases and the position of the position sensor (accelerator) remains constant.
- heavy smoke is emitted from the exhaust.

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- the coolant or engine oil temperature rises steeply.
- abnormal noises suddenly come from the engine or exhaust gas turbocharger.

▶ Park the vehicle/equipment.

▶ Secure the vehicle/equipment against rolling away.

▶ Shift the transmission into neutral/decouple the drive system.

Let the engine idle for approximately two minutes before switching off the engine if:

- the coolant temperature is very high (over 90 ℃).
- the engine has been operated at full output.

▶ **To switch off the engine:** turn the vehicle key in the ignition lock back to the stop at position 0.

ⓘ When you switch off the engine, BlueTec® exhaust gas aftertreatment automatically flushes the exhaust system with fresh air. Residues of AdBlue®/DEF on the metering unit or the injection nozzle might otherwise impair the function of BlueTec® exhaust gas aftertreatment. Depending on the engine's previous operating load, BlueTec® exhaust gas aftertreatment may flush the exhaust system several times.

When BlueTec® exhaust gas aftertreatment flushes the exhaust system, an air valve is activated. You may then hear a hissing sound. This hissing sound does not indicate a leak in the compressed-air system.

Switching off the engine with the external engine start/engine stop button

▶ **Switch off the engine with the external engine start/engine stop button:** (▷ page 80).

Switching the continuous brake on and off

⚠ WARNING

If you activate the continuous brake or shift to a lower gear on a slippery road surface in order to increase the engine's braking effect, the drive wheels may lose traction. There is an increased risk of skidding and an accident.

Do not activate the continuous brake and do not shift to a lower gear in order to increase the engine's braking effect on a slippery road surface.

! If the continuous brake is deactivated and the indicator lamp in the instrument cluster does not go out, have the continuous brake checked at a qualified specialist workshop.

The engine brake and retarder are used as a continuous brake.

You can utilise the engine's braking effect, particularly on long downhill gradients if you:

- activate the continuous brake
- shift to a lower gear in good time

Slowly depress the brake pedal if the engine's braking effect is insufficient when driving downhill.

Vehicles without a retarder are equipped with only two brake stages.

Operation of the continuous brake (see the vehicle/device operating instructions).

The indicator lamp in the instrument cluster is lit when the continuous brake is active.

When ABS (Anti-lock Braking System) intervenes, the continuous brake is switched off. The indicator lamp in the instrument cluster remains on.

Engine brake

The effectiveness of the engine brake depends on the engine speed. A high engine

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speed results in more effective engine braking.

Observe the effective engine braking range marked on the rev counter (▷ page 46).

The maximum permissible engine speed is restricted if necessary, depending on the vehicle/device application.

Observe the vehicle/device Operating Instructions.

At very low outside temperatures, the engine brake has limited or no effect after the engine has been started.

Operation of the engine brake (see the vehicle/device Operating Instructions).

Retarder

Operation of the retarder; see the vehicle/device Operating Instructions.

Idling speed

After the engine has been started, idling speed is regulated automatically. The engine idling speed may differ in certain operating conditions depending on the engine or on vehicles with power take-off.

The engine idling speed is raised at very low outside temperatures.

You can set the speed to the working speed via the electronic engine management system. This makes it possible to drive auxiliary equipment such as pumps at their working speed. For setting the working speed, see the vehicle's operating instructions.

Operational monitoring

Charge current

The charge current indicator lamp must go out after the engine has started.

If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. Searching for and eliminating the cause of the malfunction (▷ page 85).

Electronic engine management

The indicator and warning lamps must go out after the engine has started.

If an indicator lamp or warning lamp does not go out, or if it lights up while the engine is running, there is a malfunction in the electronic engine management system.

Searching for and eliminating the cause of the malfunction (▷ page 85).

Each malfunction is stored in the system with its own fault code. Temporary faults are also stored.

Fault codes can be read by a qualified specialist workshop using a diagnostic tester (▷ page 8).

Oil pressure

If the indicator lamp does not go out or if it lights up when the engine is running, switch off the engine. Searching for and eliminating the cause of the malfunction (▷ page 85).

Operating restrictions for on-highway applications with BlueTec®

The electronic engine management system monitors:

- emissions-relevant malfunctions in the exhaust gas aftertreatment
- malfunctions in the electronic monitoring of the exhaust gas aftertreatment system
- consumption, level and quality of the AdBlue®/DEF reducing agent
- the efficiency of the catalytic converter in accordance with the permitted thresholds for nitric oxide emissions (NOx)

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Operating restrictions may occur in the form of torque reduction, thus also limiting output and speed.

The degree of torque reduction depends on the vehicle category:

- vehicles above 7.5 t: torque reduction by approximately 40%
- vehicles below 7.5 t: torque reduction by approximately 25%

Operating restrictions for off-highway engines with BlueTec®

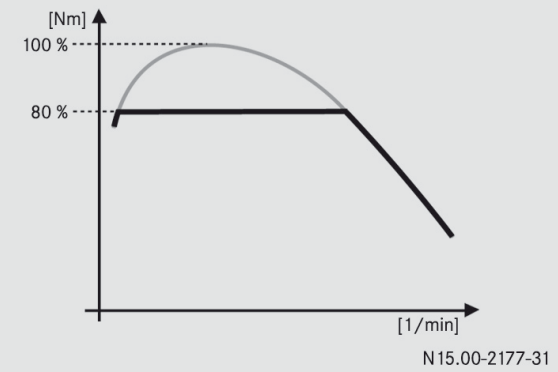
The electronic engine management system monitors:

- emissions-relevant malfunctions in the exhaust gas aftertreatment
- malfunctions in the electronic monitoring of the exhaust gas aftertreatment system
- consumption, level and quality of the AdBlue®/DEF reducing agent
- the efficiency of the catalytic converter in accordance with the permitted thresholds for nitric oxide emissions (NOx)

Operating restrictions in the form of torque reduction and thus output and speed limitation may occur.

Minor operating restriction

The available torque is reduced to roughly 80% of the maximum torque.



Reduction in output during minor operating restriction

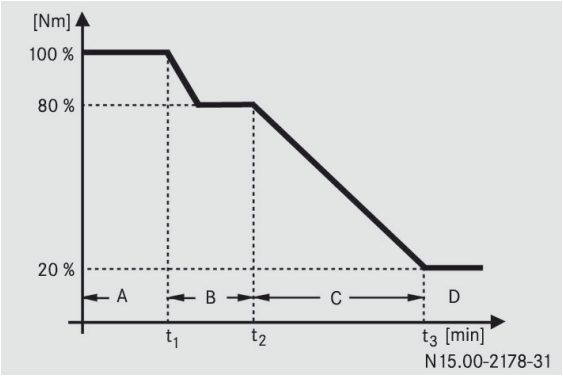
Major operating restriction

The transition between a minor and a major operating restriction is achieved by a gradual reduction in engine speed and torque.

- The engine torque is linearly reduced to 20% of the nominal value.
- At the same time, the engine speed is slowly reduced to 1000 rpm.

Types of operating restriction

AdBlue®/DEF level low



Insufficient AdBlue®/DEF remaining; warning and length of operating restriction period (example display)

A Acknowledged fault

B Minor operating restriction

C Speed/torque reduction

D Major operating restriction

Operation

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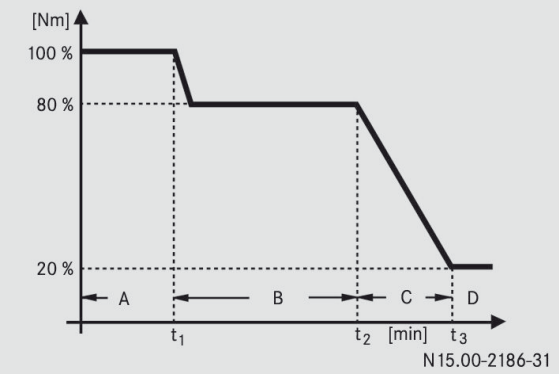
AdBlue®/DEF quality not OK/fault in the monitoring system



Poor AdBlue®/DEF quality and misuse; warning and length of operating restriction period (example display)

A Acknowledged fault

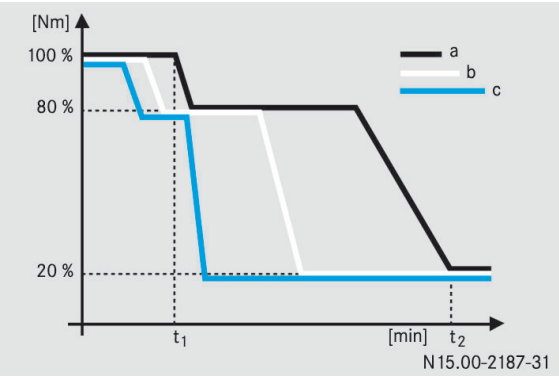
B Minor operating restriction

C Speed/torque reduction

D Major operating restriction

Repeated violations

In the event of repeated violations, the periods for the operating restriction system are shortened. When a fault is eliminated (for example the NOx sensor is replaced or reconnected), the operating restrictions are reset. Normal operation can be resumed.



Recurring fault (example display)

a Regular operating restriction

b Operating restriction after first recurrence of fault

c Operating restriction after second recurrence of fault

Emergency switch for overriding operating restrictions

If an emissions-relevant malfunction in the exhaust gas aftertreatment or the AdBlue®/DEF supply is detected, this can cause an operating restriction (limitation of engine torque and engine speed).

In case of emergency a push-button switch can be operated to override the operating restriction. This means that full engine power is available for a maximum of 30 minutes. This emergency function by operating the switch can be activated a maximum of three times.

When the final operating restriction (idling speed and 20% of torque) has been reached, the push-button switch is deactivated.

Deleting the fault memory

A fault stored in the fault memory because of the operating restriction system cannot be deleted with a conventional reading device. Faults can only be deleted using the Daimler/MTU maintenance system.

Displays

Rev counter

! If you exceed the maximum permissible engine speed, the warning tone sounds.

You should not drive and change gear by the sound of the engine, but according to the engine speed shown in the rev counter.

Avoid driving in the red overrevving range. This could lead to engine damage.

The engine speed display is the responsibility of the vehicle manufacturer and is not necessarily supplied by Mercedes-Benz. Daimler AG recommends that the vehicle manufacturer uses a rev counter divided by:

- operational efficiency
- engine braking range
- engine overrevving range

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General notes on the rev counter:

- Keep an eye on the rev counter while driving and stay within the economical operating range.

  In some situations it may make sense to operate the engine outside the economical engine speed range, e.g. on uphill gradients or when overtaking.
- If you run the engine within the economical engine speed range, you achieve low fuel consumption and reduced wear.
- In engine braking mode, drive in the middle engine speed range. The highest engine braking effect will be achieved just before the red overrevving range.
- When driving downhill, make sure that the engine speed does not enter the overrevving range (marked red).
- Idling speed is set automatically depending on the coolant temperature.
- When the vehicle is stationary, the engine is running and the transmission is in neutral, the engine increases throttle only slowly.

AdBlue®/DEF level

The AdBlue®/DEF gauge is the responsibility of the vehicle manufacturer. It is not necessarily supplied by Mercedes-Benz. Daimler AG recommends that the vehicle manufacturer uses an AdBlue®/DEF gauge and an AdBlue®/DEF indicator lamp for the AdBlue®/DEF reserve level .

The AdBlue®/DEF reducing agent is required for reduction of engine emissions.

The MOT approval/operating permit is invalidated if the vehicle/equipment is operated without AdBlue®/DEF. The legal consequence of this is that the vehicle/equipment may no longer be operated on public roads.

If the AdBlue®/DEF level has sunk to approximately 10%, a warning lamp for the AdBlue®/DEF reserve level lights up on the instrument panel. Top up the AdBlue®/DEF tank in good time (▷ page 59).

If the display is ignored and the AdBlue®/DEF level drops further, engine torque and engine speed may be reduced (▷ page 44).

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Warning and indicator lamps

Warning and indicator lamps – causes/consequences and solutions

Warning and indicator lamps for on-highway applications

Problem	Possible causes/consequences and ▶ Solutions
The indicator lamp flashes red.	A serious fault in the engine system has been detected. ▶ Immediately stop the vehicle/device while paying attention to the traffic conditions and contact a qualified specialist workshop.
The indicator lamp lights up.	Impermissible operating conditions have been detected in the engine system. One of the following systems is malfunctioning: • Engine • Engine cooling • Engine management • Diesel injection system ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause. ▶ Have the systems checked at a qualified specialist workshop.
The indicator lamp lights up.	A malfunction has been detected in the electric power supply. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go out or if it lights up when the engine is running, search for the cause of the malfunction and have it repaired at a qualified specialist workshop.
The indicator lamp lights up.	After you have switched the ignition lock to the drive position, the indicator lamp indicates the status of the cold-start aid (▷ page 60). ▶ If there are no malfunctions, the indicator lamp goes out after the cold start aid has been switched off.
The indicator lamp lights up.	A malfunction was detected in the supply of engine lubricating oil. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check the engine oil level (▷ page 40). ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The indicator lamp lights up.	A malfunction was detected in the supply of engine lubricating oil. The engine oil level is too low. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check the engine oil level (▷ page 40). ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.
The indicator lamp lights up.	A malfunction in the coolant circuit has been detected. The coolant level is too low. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check coolant level. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.
The indicator lamp lights up.	A malfunction in the coolant circuit has been detected. The coolant temperature is too high. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check coolant level. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop. If you do not observe the instructions, engine performance and torque may be limited.
The indicator lamp lights up.	The indicator lamp shows the status of the continuous brake. ▶ The indicator lamp lights up after activation of the continuous brake. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions. ▶ If the indicator lamp does not go out after deactivation or if it lights up permanently, there is a malfunction. ▶ Have the malfunction rectified immediately at a specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The [cruise control] indicator lamp lights up.	The indicator lamp shows the status of the cruise control function. ▶ The indicator lamp lights up after activation of cruise control. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.
The [LIM] indicator lamp lights up.	The indicator lamp shows the status of the variable speed limiter. ▶ The indicator lamp lights up after a speed limit was activated by the speed limiter. ▶ The active speed limit is shown in the vehicle/equipment display. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.
The [LIM] indicator lamp flashes.	The indicator lamp shows that the speed set by the speed limiter has been exceeded. ▶ The maximum speed (speed limit) set by the speed limiter is being exceeded by more than 3 km/h. If necessary, reduce speed by adaptive braking. ▶ The speed limit set by the speed limiter was temporarily deactivated by kickdown and may be exceeded. By briefly switching to idle throttle position, the set speed limit is reactivated. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.
The [power take-off] indicator lamp lights up.	The indicator lamp shows the status of the power take-off. ▶ The indicator lamp lights up after engaging power take-off. ▶ If there are no malfunctions, the indicator lamp goes out after the power take-off is switched off. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.

Additional tips for vehicles/devices with BlueTec®/DEF

Problem	Possible causes/consequences and ▶ Solutions
The [AdBlue] indicator lamp lights up.	The AdBlue®/DEF reserve level has been reached. ▶ Top up the AdBlue®/DEF tank.
The [engine] indicator lamp flashes when the ignition is ON.	After you have switched the ignition lock into the drive position, the indicator lamp indicates the status of the European On-Board Diagnosis (OBD) by means of a sequence of flashes . ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started.

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Problem	Possible causes/consequences and ▶ Solutions
The [engine] indicator lamp lights up.	An emissions-relevant fault has been detected. ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause. ▶ Have the exhaust gas aftertreatment system checked at a qualified specialist workshop. The operating permit is invalidated if you continue to use the vehicle. If there are no malfunctions, the indicator lamp only goes out after further test routines. The system check may involve several engine starts, several hours or several journeys without a malfunction.
The [LIMIT] indicator lamp lights up.	An emissions-relevant fault has been detected. ▶ An operating restriction is active. The engine torque is temporarily limited. ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause.

When the AdBlue®/DEF tank is filled or the fault is rectified, full engine power will be available again. If the system check does not detect any other faults, the indicator lamps go out after the system's status indicator. The system check may involve several engine starts, several hours or several journeys without a malfunction.

Warning and indicator lamps for off-highway engines

Problem	Possible causes/consequences and ▶ Solutions
The [engine] indicator lamp flashes red.	A serious fault in the engine system has been detected. ▶ Immediately stop the vehicle/device while paying attention to the traffic conditions and contact a qualified specialist workshop.
The [CHECK] indicator lamp lights up.	Impermissible operating conditions have been detected in the engine system. One of the following systems is malfunctioning: • Engine • Engine cooling • Engine management • Diesel injection system ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause. ▶ Have the systems checked at a qualified specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The indicator lamp lights up.	A malfunction has been detected in the electric power supply. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go out or if it lights up when the engine is running, search for the cause of the malfunction and have it repaired at a qualified specialist workshop.
The indicator lamp lights up.	After you have switched the ignition lock to the drive position, the indicator lamp indicates the status of the cold-start aid (▷ page 60). ▶ If there are no malfunctions, the indicator lamp goes out after the cold start aid has been switched off.
The indicator lamp lights up.	A malfunction was detected in the supply of engine lubricating oil. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check the engine oil level (▷ page 40). ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.
The indicator lamp lights up.	A malfunction was detected in the supply of engine lubricating oil. The engine oil level is too low. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check the engine oil level (▷ page 40). ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.
The indicator lamp lights up.	A malfunction in the coolant circuit has been detected. The coolant level is too low. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check coolant level. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The indicator lamp lights up.	A malfunction in the coolant circuit has been detected. The coolant temperature is too high. ▶ If there are no malfunctions, the indicator lamp goes out after the engine is started. ▶ If the indicator lamp does not go off or lights up when the engine is running, switch off the engine. ▶ Check coolant level. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop. If you do not observe the instructions, engine performance and torque may be limited.
The indicator lamp lights up.	The indicator lamp shows the status of the continuous brake. ▶ The indicator lamp lights up after activation of the continuous brake. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions. ▶ If the indicator lamp does not go out after deactivation or if it lights up permanently, there is a malfunction. ▶ Have the malfunction rectified immediately at a specialist workshop.
The indicator lamp lights up.	The indicator lamp shows the status of the cruise control function. ▶ The indicator lamp lights up after activation of cruise control. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.
The LIM indicator lamp lights up.	The indicator lamp shows the status of the variable speed limiter. ▶ The indicator lamp lights up after a speed limit was activated by the speed limiter. ▶ The active speed limit is shown in the vehicle/equipment display. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.

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Problem	Possible causes/consequences and ▶ Solutions
The LIM indicator lamp flashes.	The indicator lamp shows that the speed set by the speed limiter has been exceeded. ▶ The maximum speed (speed limit) set by the speed limiter is being exceeded by more than 3 km/h. If necessary, reduce speed by adaptive braking. ▶ The speed limit set by the speed limiter was temporarily deactivated by kickdown and may be exceeded. By briefly switching to idle throttle position, the set speed limit is reactivated. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.
The indicator lamp lights up.	The indicator lamp shows the status of the power take-off. ▶ The indicator lamp lights up after engaging power take-off. ▶ If there are no malfunctions, the indicator lamp goes out after the power take-off is switched off. ▶ Observe the information contained in the equipment's/vehicle's Operating Instructions.

More tips for vehicles/equipment with BlueTec®

Problem	Possible causes/consequences and ▶ Solutions
The indicator lamp lights up.	The AdBlue®/DEF reserve level has been reached. ▶ Top up the AdBlue®/DEF tank.
The LIMIT indicator lamp lights up.	An emissions-relevant fault has been detected. ▶ An operating restriction is active. The engine torque is temporarily limited. ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause.
The LIMIT indicator lamp flashes.	An emissions-relevant fault has been detected. ▶ An operating restriction is active. The engine torque is temporarily limited. ▶ If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause.

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Problem	Possible causes/consequences and ▶ Solutions
The [⚠] indicator lamp lights up.	An emissions-relevant malfunction in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply has been detected. ▶ Top up the AdBlue®/DEF tank immediately. ▶ If this does not help: have the exhaust gas aftertreatment system checked at a qualified specialist workshop. Have the malfunction rectified immediately. If you do not, engine output may be reduced and engine speed may be limited. If there are no malfunctions, the indicator lamp only goes out after further test routines. The system check may involve several engine starts, several hours or several journeys without a malfunction. If further indicator lamps are displayed, take the combination of lamps (see below) into account when evaluating the cause.
The [⚠] indicator lamp flashes, the [LIMIT] indicator lamp lights up.	You have not rectified an emissions-relevant malfunction that has been detected in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply. Reduced engine output is active. The engine torque is temporarily limited to a maximum of 80% across the entire engine speed range. The effect of the limitation is linear. If you do not observe the instructions, engine torque may be further limited to a maximum of 50%. ▶ Adapt your driving/operating style. ▶ Top up the AdBlue®/DEF tank immediately. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop. If you do not observe the instructions, engine performance and also engine speed may be limited.
The [⚠] and [LIMIT] indicator lamps are flashing.	You have not rectified an emissions-relevant malfunction that has been detected in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply. The reduction in engine output and limitation of the engine torque are activated. The engine torque is limited to a maximum of 20% across the whole engine speed range. The engine speed is limited to a maximum of 1000 rpm. ▶ Adapt your driving/operating style. ▶ Top up the AdBlue®/DEF tank immediately. ▶ If this does not help, have the malfunction rectified at a qualified specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The [⚠] and [CHECK] indicator lamps are lit.	An emissions-relevant malfunction in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply has been detected. ▶ Have the exhaust gas aftertreatment system checked at a qualified specialist workshop. Have the malfunction rectified immediately. If you do not, engine output may be reduced and engine speed may be limited. If there are no malfunctions, the indicator lamp only goes out after further test routines. The system check may involve several engine starts, several hours or several journeys without a malfunction.
The [⚠] indicator lamp flashes, the [CHECK] and [LIMIT] indicator lamps light up.	You have not rectified an emissions-relevant malfunction that has been detected in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply. The reduction in engine output and limitation of the engine torque are activated. The engine torque is temporarily limited to a maximum of 80% across the entire engine speed range. The effect of the limitation is linear. If you do not observe the instructions, engine torque may be further limited to a maximum of 50%. ▶ Adapt your driving/operating style. ▶ Have the malfunction rectified immediately at a specialist workshop. If you do not observe the instructions, engine performance and also engine speed may be limited.
The [⚠] and [LIMIT] indicator lamps flash, the [CHECK] indicator lamp lights up.	You have not rectified an emissions-relevant malfunction that has been detected in the exhaust gas aftertreatment system or in the AdBlue®/DEF supply. The reduction in engine output and limitation of the engine torque are activated. The engine torque is limited to a maximum of 20% across the whole engine speed range. The engine speed is limited to a maximum of 1000 rpm. ▶ Adapt your driving/operating style. ▶ Have the malfunction rectified immediately at a specialist workshop.

In the event of an emergency, operating restrictions (limitation of the engine torque and engine speed) can be temporarily overridden with the emergency switch (▷ page 46). When the AdBlue®/DEF tank is filled or the fault is rectified, full engine power will be available again. If the system check does not detect any other faults, the indicator lamps go out after the system's status indicator. The system check may involve several engine starts, several hours or several journeys without a malfunction.

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Operating instructions

Running-in

Vehicles/devices

Observe the vehicle/device manufacturer's running-in notes.

The running-in period of the engine has a significant effect on the vehicle, especially with regard to:

- service life
- operating safety
- economy

Observe the following notes during the running-in period up to 2,000 km (30 operating hours):

- avoid subjecting the engine to full load.
- run in the engine with care, using differing speeds and engine revs.
- avoid high engine speeds.
- do not drive at more than ¾ of the maximum road speed for each gear.
- change gear in good time.
- do not shift down to brake the vehicle.
- for vehicles with automatic transmission, do not depress the accelerator pedal beyond the point of resistance (kickdown).

After 2,000 km (30 operating hours), you can gradually bring the vehicle up to full road speed and increase engine speeds.

Fuel consumption

General notes

Fuel consumption depends on:

- the type of fuel used (diesel fuel, fatty acid methyl ester FAME fuel)
- the machine version/vehicle version
- the operating mode
- the operating conditions
- the attached equipment (e.g. hydraulic pumps, mowers, etc.)
- maintenance
- driving resistance
- your driving style

For these reasons, exact details about any single engine's fuel consumption cannot be provided.

Machine version/vehicle version

The following components affect fuel consumption:

- tyres (e.g. tyre pressure, tyre condition)
- body type
- drive train (e.g. transmission ratio)
- additional equipment (e.g. automatic climate control, auxiliary heating)

Maintenance

Fuel consumption and assembly wear depend on how often maintenance is carried out. Regular maintenance increases safety and lowers fuel consumption. Keep to the maintenance intervals. Always have maintenance work carried out at a qualified specialist workshop.

Fuel type

The fuel grade also affects fuel consumption. Use of lower fuel grades and/or non-approved fuel additives will increase fuel consumption. When refuelling, ensure that you are filling the appropriate fuel grade (▷ page 68).

AdBlue®/DEF consumption

AdBlue®/DEF consumption is between 3 and 6% of the fuel consumption, depending on engine use.

Engine oil consumption

After running-in the engine, oil consumption may reach 0.5% of the vehicle's fuel consumption.

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More arduous operating conditions and increased distance covered could result in engines exceeding this oil consumption value.

Warning buzzer

If the warning buzzer sounds and the symbol on the instrument panel is displayed, the engine's operating safety is jeopardised. Do not pull away, or stop the vehicle as soon as possible, paying attention to road and traffic conditions. You could otherwise damage the engine. The warning buzzer sounds depending on the vehicle if:

- you exceed the maximum permissible engine speed.
- the engine speed or vehicle speed is too high when changing gears.
- the coolant level is too low or the maximum permissible coolant temperature (about 100 °C) is exceeded. The operating safety of the engine is jeopardised.
- an emissions-relevant fault is detected or there is an operating restriction due to an emissions-relevant malfunction.

Refuelling

Fuels

Important safety notes

⚠ WARNING

Fuels are poisonous and hazardous to health. There is a danger of injury.

Do not swallow fuel or let it come into contact with skin, eyes or clothing. Do not inhale fuel vapours. Keep fuels out of the reach of children.

If you or others come into contact with fuel, observe the following:

- Wash the fuel off any affected areas of skin with water and soap immediately.
- If you get fuel in your eyes, rinse them thoroughly with clean water immediately. Seek immediate medical attention.
- If fuel is swallowed, seek immediate medical attention. Do not induce vomiting.
- Change any clothing that has come into contact with fuel immediately.

⚠ WARNING

Fuel is highly flammable. Improper handing of fuel creates a risk of fire and explosion.

Avoid fire, naked flames, smoking and creating sparks under all circumstances. Switch off the ignition and auxiliary heating before carrying out work to the fuel system. Always wear protective gloves.

⚠ WARNING

If you mix diesel fuel with petrol, the flash point of this fuel mixture is lower than that of pure diesel fuel. When the engine is running, components in the exhaust system may overheat unnoticed. There is a risk of fire.

Never refuel with petrol. Never add petrol to diesel fuel.

! Do not use petrol to refuel vehicles with a diesel engine. Even small amounts of petrol result in damage to the fuel system and engine.

! Do not switch on the ignition if you accidentally refuel with the wrong fuel. Otherwise, the fuel will enter the fuel lines. Notify a qualified specialist workshop and have the fuel tank and fuel lines drained completely.

! Do not add any special fuel additives to the diesel fuel.

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Special fuel additives can lead to:

- malfunctions
- damage to the catalytic converter
- engine damage

! AdBlue®/DEF is not a fuel additive and must not be added to the diesel tank. If AdBlue®/DEF gets into the diesel tank, this could lead to engine damage.

! A higher fuel sulphur content accelerates the ageing process of the engine oil and can damage the engine and exhaust system.

Environmental note

If fuels are handled improperly, they pose a danger to persons and the environment. Do not allow fuels to run into the sewage system, the surface waters, the ground water or into the ground.

Only refuel using approved fuels which are commercially available. Please note the approved fuel grade in the "Service products" section (▷ page 68). Using fuels which have not been approved causes irreversible damage to the engine and the exhaust gas aftertreatment system, as well as also significantly reducing the expected service life.

Before filling the tank

! If you are using drums or canisters to refuel the vehicle, you should filter the fuel before adding it.

This will prevent malfunctions in the fuel system due to contaminated fuel.

▶ Switch off the engine.

▶ Secure the vehicle/equipment against rolling away.

▶ Switch off the auxiliary heating.

▶ Observe the fuel grade (▷ page 68).

Regularly check the fuel prefilter with heated water separator for condensation.

AdBlue®/DEF

Important safety notes

! Do not allow diesel fuel to run into the AdBlue®/DEF tank. You could otherwise damage the exhaust gas aftertreatment system.

! Only use AdBlue®/DEF in accordance with DIN 70070/ISO 22241. Do not use any additives.

If AdBlue®/DEF comes into contact with painted or aluminium surfaces when filling the tank, rinse the affected area immediately with plenty of water.

! Do not mix additives to AdBlue®/DEF. Do not dilute AdBlue®/DEF with tap water. This could destroy the exhaust gas aftertreatment system.

! Always close the AdBlue®/DEF tank properly. Otherwise impurities may get into the exhaust gas aftertreatment system and damage it.

! Make sure that you do not overfill the AdBlue®/DEF tank. Otherwise, the AdBlue®/DEF tank could be damaged at very low temperatures.

Environmental note

Dispose of AdBlue®/DEF in an environmentally responsible manner.

When opening the AdBlue®/DEF tank, small amounts of ammonia vapours could escape.

Ammonia vapours have a pungent smell and are particularly irritating to:

- skin
- mucous membranes
- eyes

The vapours may cause a burning sensation in the eyes, nose and throat as well as irritation of the throat and watering eyes.

Avoid inhaling ammonia vapours. Only fill the AdBlue®/DEF tank in well-ventilated areas.

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AdBlue®/DEF should not come into contact with skin, eyes or clothing, and should not be swallowed. Keep AdBlue®/DEF out of the reach of children.

If you come into contact with AdBlue®/DEF, observe the following:

- immediately wash AdBlue®/DEF from your skin with water and soap.
- if AdBlue®/DEF comes into contact with your eyes, rinse your eyes with clean water immediately. Seek medical attention immediately.
- if you have swallowed AdBlue®/DEF, immediately rinse your mouth with water and drink plenty of water. Seek medical attention immediately.
- change clothing that has come into contact with AdBlue®/DEF immediately.

AdBlue®/DEF is not refilled as part of the maintenance work. Top up the tank regularly during vehicle operation or at the latest when the first event message is displayed on the electronic engine management system.

You will find further information on AdBlue®/DEF in the "Service products" section (▷ page 71).

Before filling the tank

▶ Switch off the engine.

▶ Secure the vehicle/equipment against rolling away.

Always fill the tank with at least 5 litres, as smaller amounts could cause malfunctions.

Winter operation

Notes for winter operation

! At very low outside temperatures, make sure that the engine oil added is of an appropriate SAE classification. Using engine oils that are not suitable for very low outside temperatures may result in engine damage.

Before the start of the cold season, make sure that:

- the coolant contains sufficient antifreeze (▷ page 68)
- the fuel used is suitable for winter use (▷ page 68)
- the SAE class of the engine oil used is in accordance with outside temperatures (▷ page 65).

Jump-starting

⚠ WARNING

The use of liquid or gaseous starting aids can cause explosions. This may result in severe injuries.

Do not use liquid or gaseous starting aids such as ether or Startpilot to start the engine.

Batteries

Always aim to achieve the full charge status. You can do this by means of careful maintenance and low electrical consumption. The cold start capacity is reduced when it is very cold. For example, at -10 °C it is only around 60% of the normal capacity.

Diesel fuels

Notes on diesel fuel at low temperatures (▷ page 70).

Cold-start aid

The cold-start aid makes it easier to start the engine at low outside temperatures (below–15 °C). It is activated when the outside temperature falls below –4 °C.

Environmental note

At outside temperatures below approximately -4 °C, the cold-start aid minimises pollutant emissions (after the engine is started). In addition, it reduces the load on the starter motor and batteries and enables the engine to be started more rapidly. For this reason, only

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start the engine once the [indicator lamp] indicator lamp in the status area of the on-board computer has gone out.

▶ **To activate the cold-start aid:** turn the vehicle key to the drive position in the ignition lock.
The [indicator lamp] indicator lamp lights up in the instrument panel.

▶ After the [indicator lamp] indicator lamp goes out, start the engine within 30 seconds.

The cold-start aid is automatically deactivated if:

- the engine is not started within 30 seconds of the [indicator lamp] indicator lamp going out.
- the engine is started when the [indicator lamp] indicator lamp is lit.
- the coolant temperature reaches around 0 °C while the engine is running.

At a coolant temperature above approximately -4 °C, the [indicator lamp] indicator lamp goes out after approximately 2 seconds (function check). At a coolant temperature below approximately -4 °C, the [indicator lamp] indicator lamp goes out after approximately 20 seconds.

Have the cold-start aid checked and repaired only at a qualified specialist workshop. Mercedes-Benz recommends that you use a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10). Work relevant to safety or on safety-related systems must be carried out at a qualified specialist workshop.

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General notes

⚠ WARNING

Before carrying out maintenance or repair work, you must read the relevant sections of the technical documentation relating to maintenance and repair measures, e.g. the Operating Instructions and workshop information.

In particular, first familiarise yourself with the legal regulations, e.g. work safety and accident prevention regulations.

You could otherwise fail to recognise dangers and injure yourself or others.

Always have maintenance work carried out at a qualified specialist workshop.

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

⚠ WARNING

Limbs could be crushed or trapped if the engine is started unintentionally during service or maintenance work. There is a risk of injury.

Always secure the engine against unintentional starting before carrying out maintenance or repair work.

⚠ WARNING

Cloths or other flammable materials left in the engine compartment can ignite if they come into contact with the exhaust system or parts of the engine that heat up. There is a risk of fire. After carrying out maintenance work, make sure that no extraneous flammable material is left in the engine compartment or on the exhaust system.

Environmental note

If circumstances require you to do some maintenance work yourself, you must observe the environmental protection requirements. When disposing of service products, e.g. engine oil, you must comply with the legal requirements. This also concerns all parts, e.g. filters, that have been in contact with service products.

Dispose of empty containers, cleaning cloths and care products in an environmentally responsible manner.

Observe the instructions for care products.

Do not let the engine run longer than necessary when stationary.

Like all technical equipment, the engine system requires care and maintenance.

The scope and frequency of maintenance work depends mainly on:

- the widely varying operating conditions.
- the service products used.

ⓘ All maintenance intervals and work refer to genuine Mercedes-Benz parts. They also refer to accessory parts and service products that have been expressly approved by Mercedes-Benz for the engine.

Inspection and maintenance work requires special skills that cannot be acquired by reading these Operating Instructions. Always have this work and maintenance work carried out by a qualified specialist workshop.

Have any work that is carried out confirmed with an entry in the Maintenance Booklet. This proof of regular maintenance is always required for any warranty claims.

Instructions and important information on carrying out maintenance work can be found in the Workshop Information System (WIS) on the Internet. Make sure that you have access to this information when carrying out maintenance work. Information on WIS (▷ page 10).

Please also observe the maintenance instructions for special accessories.

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When working on the vehicle, comply with all safety regulations, such as operating instructions, regulations concerning hazardous materials, environmental protection measures, work safety and accident prevention regulations.

Service products

Important safety notes

⚠ WARNING

Service product can be poisonous and hazardous to health. There is a risk of injury.

Observe the instructions on the respective original container when using, storing and disposing off service products. Always store service products in the sealed original container. Always keep service products out of the reach of children.

! Special additives (except approved fuel additives) are neither required nor approved for use with approved service products. Additives may cause damage to major assemblies. Therefore, do not mix any additives with service products. You are responsible for the results of using fuel additives.

Environmental note

Dispose of service products in an environmentally-responsible manner.

Service products are:

- fuels (e.g. diesel)
- lubricants (e.g. engine oil, transmission oil, grease)
- coolant, antifreeze
- AdBlue®/DEF, reducing agent in the exhaust gas aftertreatment system

Approved service products fulfil the highest quality standards and are documented in the Mercedes-Benz Specifications for Service Products. For this reason, only use approved service products for your vehicle. Information about approved service products is available from any Mercedes-Benz Service Centre (▷ page 10).

You can recognise service products approved by Mercedes-Benz by the following inscription on the container:

- MB-Freigabe (e.g. MB-Freigabe 228.51)

  or
- MB-Approval (z. B. MB-Approval 228.51)

Other labels and recommendations relating to the quality or indicating that the product meets a certain specification are not necessarily approved by Mercedes-Benz. Further information is available from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10).

ⓘ Information about service products which have been tested by Mercedes-Benz and approved for your engine system can be found in the Mercedes-Benz Specifications for Service products on the Internet at: **http://bevo.mercedes-benz.com/**.

ⓘ The specification and availability of lubricants may vary. Individual lubricants may no longer be available, especially for older engines. Information is available from any Mercedes-Benz, MTU or MTU-authorised Service Centre (▷ page 10).

Engine oils

Notes on engine oils

! Engine oils other than those of the quality specified in this Operator's Manual are not permitted.

Only use engine oils that comply with the Mercedes-Benz Specifications for Service Products.

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The following engine oils are approved:

- Sheet No. 228.5 / 228.3 / 228.1 standard quality multi-grade engine oils
- Sheet No. 228.51 / 228.31 low-ash multi-grade engine oils
- Sheet No. 228.0 / 228.2 standard quality single-grade engine oils (exceptional circumstances)

Mercedes-Benz particularly recommends engine oils that comply with Sheet no. 228.5 of the Mercedes-Benz Specifications for Service Products.

These engine oils are of a high standard of quality and have a beneficial effect on:

- length of oil change intervals
- engine wear
- fuel consumption
- exhaust emissions

The maximum interval for oil change is only achieved with engine oils of a particularly high quality grade.

Check the vehicle assemblies for leaks regularly. If fluid loss is identified, e.g. by oil drops on the parking area, have the cause of the fluid loss rectified at a qualified specialist workshop.

Scope of application

For engines with BlueTec® exhaust gas aftertreatment and operation with diesel fuel, only use multi-grade engine oils compliant with Sheet Nos. 228.5, 228.51, 228.3 and 228.31 or, in exceptional cases, single-grade engine oils compliant with Sheet No. 228.2.

For engines without BlueTec® exhaust gas aftertreatment, multi-grade oils compliant with Sheet No. 228.1 and, in exceptional cases, single-grade oils compliant with Sheet No. 228.0 / 228.2 can also be used.

For operation with FAME fatty acid methyl ester fuel (bio-diesel fuel), use only engine oils compliant with Sheet Nos. 228.5, 228.51, 228.3 and 228.31 (▷ page 70).

This is also required for a mixture of conventional diesel fuels and FAME fatty acid methyl ester fuels (bio-diesel fuel).

Multi-grade engine oils compliant with Sheet Nos. 228.5, 228.51, 228.3, 228.31 and 228.1 can be used all year round. Depending on the fuel quality (fuel sulphur content or FAME fatty acid methyl ester fuel), the oil change intervals may be shortened. For details, see the Maintenance Booklet.

Single-grade engine oils only cover an SAE (viscosity) classification for certain temperature ranges. Change the engine oil to an SAE class suitable for the time of year and the respective outside temperatures.

The use of low-ash engine oils is permitted but only necessary on engines with a diesel particle filter. The use of low-ash engine oils compliant with Sheet No. 228.51 and 228.31 is however only approved in conjunction with low-sulphur diesel fuel (less than 50 ppm, 0.005% by weight) (▷ page 69).

Oil change

! If you mix engine oils with differing oil grades, the change interval for the engine oil is reduced in comparison to mixtures of engine oil of identical grade.

Therefore, only mix engine oils of differing grade in exceptional circumstances. To prevent damage to the engine, the maintenance intervals must be adjusted accordingly.

! If the SAE class (viscosity) of the engine oil used is not suitable for continually low outside temperatures below -20 ℃, this could cause engine damage.

The specified temperatures of the SAE class always refer to freshly added oil. Engine oil ages during driving due to soot and fuel residue. This impairs the characteristics of the engine oil, particularly at low outside temperatures.

If the outside temperature is under -20 ℃, Mercedes-Benz strongly recommends

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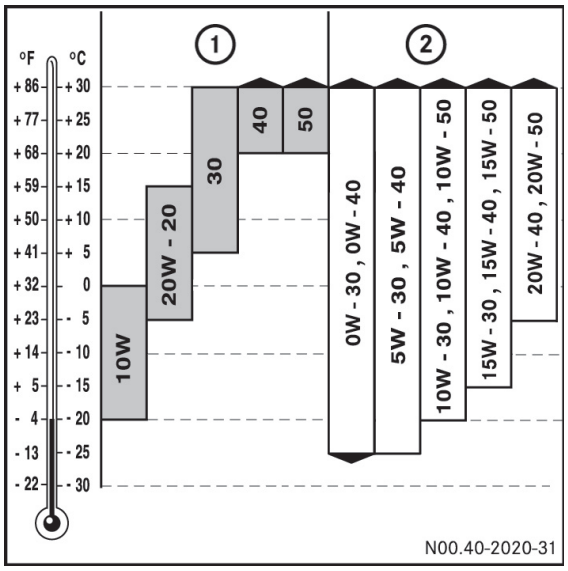
using engine oils of SAE class 5W-30 or 0W-30.

Use only all-season oils.

! If you do not use oil for all-year-round operation in your engine, change the engine oil right at the beginning of the cold season. Use only an approved engine oil in the specified SAE classification.



Engine oil SAE classes (viscosity)

① Single-grade engine oils

② Multi-grade engine oils

Oil change intervals are dependent on the following:

- the operating conditions of the vehicle
- the grade of the engine oil used
- the fuel grade (sulphur content)
- the fuel type, e.g. FAME fatty acid methyl ester fuel

For more details, see the Maintenance Booklet.

The maximum oil change interval can only be achieved by using engine oils of particularly high quality in accordance with Sheet No. 228.51 and 228.5 of the Mercedes-Benz Specifications for Service Products. The classification of oil change intervals is specified in the Maintenance Booklet.

Environmental note

If you operate your vehicle using FAME fatty acid methyl ester fuel (bio-diesel), special precautions must be taken and national specifications complied with when disposing of engine oils. Information is available from any Mercedes-Benz or MTU Service Centre.

Adding/topping up the engine oil

! There is a risk of damage to the catalytic converter or to the engine if too much oil is added. Have excess oil drained off.

When topping up, Mercedes-Benz recommends that you only use engine oil of the same grade and SAE class as the oil filled at the last oil change.

Check the oil level before topping up the engine oil (▷ page 40).

Miscibility of engine oils

The benefits of high-quality engine oils are diminished if you mix them.

Engine oils are differentiated according to:

- engine oil brand
- quality grade (Sheet No.)
- SAE viscosity class

If, in exceptional circumstances, the type of engine oil currently used in the engine is not available, another mineral or synthetic engine oil may be used. Make sure it is approved for Mercedes-Benz.

Please observe the following: if you top up with an engine oil of a lower quality, the maintenance interval corresponding to the lower quality (Sheet No.) must be used. The maintenance interval is reduced. If you top up with an engine oil of a higher quality, the maintenance interval is not altered.

Observe the notes in the Maintenance Booklet.

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Coolant

⚠ WARNING

The engine cooling system is under pressure, particularly if the engine is warm. You could be scalded by hot coolant spraying out when opening the cap. There is a danger of injury.

Allow the engine to cool before opening the cap. Wear gloves and protective eyewear when opening. Slowly turn the cap half a turn to allow pressure to escape.

⚠ WARNING

If antifreeze comes into contact with hot components in the engine compartment, it may ignite. There is a risk of fire and injury.

Let the engine cool down before you top up the antifreeze. Make sure that antifreeze is not spilled next to the filler neck. Thoroughly clean the antifreeze from components before starting the engine.

A coolant that ensures anti-corrosion/antifreeze protection and other important protective effects is filled at the factory.

The coolant is a mixture of water and corrosion inhibitor/antifreeze.

The corrosion inhibitor/antifreeze in the coolant has the following properties:

- heat transfer
- anti-corrosion protection
- cavitation protection (protection against pitting)
- antifreeze protection
- raising the boiling point

Leave the coolant in the engine cooling system all year round – even in countries with high outside temperatures.

Check the corrosion inhibitor/antifreeze concentration in the coolant every six months.

Renew the coolant at the interval specified in the Maintenance Booklet.

Only use approved corrosion inhibitor/antifreeze agents. Please note the Mercedes-Benz Specifications for Service Products (▷ page 65). This prevents damage to the engine cooling system and engine.

When renewing the coolant, ensure that it contains 50% corrosion inhibitor/antifreeze by volume. This corresponds to antifreeze protection down to -37 ℃.

Do not exceed 55% by volume (antifreeze down to approximately -45 ℃). The heat dissipation and antifreeze may otherwise be negatively affected.

If there is a loss of coolant, do not top it up by using only water, but also add an approved corrosion inhibitor/antifreeze agent.

The water in the coolant must meet certain requirements, which are often fulfilled by the use of drinking water. The water must be treated if its quality does not meet the required standards.

Please note the Mercedes-Benz Specifications for Service Products, Sheet No. 310.1.

Mixtures with other corrosion inhibitors/antifreeze agents are not permitted.

Diesel fuels

Important safety notes

⚠ WARNING

Fuel is highly flammable. Improper handing of fuel creates a risk of fire and explosion.

Avoid fire, naked flames, smoking and creating sparks under all circumstances. Switch off the engine and, if applicable, the auxiliary heating before refuelling.

⚠ WARNING

Fuels are poisonous and hazardous to health. There is a danger of injury.

Do not swallow fuel or let it come into contact with skin, eyes or clothing. Do not inhale fuel vapours. Keep fuels out of the reach of children.

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If you or others come into contact with fuel, observe the following:

- Wash the fuel off any affected areas of skin with water and soap immediately.
- If you get fuel in your eyes, rinse them thoroughly with clean water immediately. Seek immediate medical attention.
- If fuel is swallowed, seek immediate medical attention. Do not induce vomiting.
- Change any clothing that has come into contact with fuel immediately.

! If you are using drums or canisters to refuel the engine/vehicle/equipment, you should filter the fuel before filling.

This prevents malfunctions in the fuel system caused by contaminated fuel.

The following fuel types are not permitted:

- marine diesel fuel
- aviation turbine fuel
- heating oils

Fuel grade

i Certain countries have diesel fuel with varying sulphur content. Diesel fuel with low sulphur content is sold in certain countries under the name "Euro diesel".

Fuel sulphur content

! A higher fuel sulphur content accelerates the ageing process of the engine oil and can damage the engine and exhaust system.

! **Vehicles with BlueTec® exhaust gas aftertreatment:**

Only standardised fuels with a maximum sulphur content of 0.05% (500 ppm) by weight are permissible. However, Mercedes-Benz only recommends fuel that complies with the European standard EN 590 as of 2005, et seq. (max. 0.005% (50 ppm) sulphur by weight). The use of fuels with a sulphur content higher than 0.005% (50 ppm) by weight reduces the life expectancy of the engine and exhaust system.

! **Vehicles without BlueTec® exhaust gas aftertreatment:**

Only commercially available fuels which comply with the European standard EN 590 or comparable national fuel standards are permitted. Mercedes-Benz recommends fuels with a low sulphur content. The use of fuels with a high sulphur content reduces the lifespan of the engine and the exhaust system. For operation with a high sulphur content > 0.05% by weight (500 ppm), the maintenance intervals for the engine oil and filter must be reduced.

For details, see the Maintenance Booklet.

i Even if the maintenance intervals are reduced, operation with fuel with a higher sulphur content will lead to increased engine wear, especially on the fuel injectors.

Information about current country-specific fuel sulphur contents can be obtained from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10).

You can find a table of fuel sulphur contents in specific countries in the Mercedes-Benz Specifications for Service Products, Sheet 136.2 at http://bevo.mercedes-benz.com.

The maintenance intervals for engine oil and filter replacement must be adapted depending on the fuel grade used. The higher the sulphur content in diesel fuel, the shorter the maintenance intervals for engine oil and filter replacement. Observe the notes in the Maintenance Booklet.

Water content

If the engine is operated with increased amounts of dirt and water, an additional fuel prefilter with a water separator must be fitted on the chassis.

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Diesel fuels at low temperatures

⚠ WARNING

If you heat fuel system components, e.g. with a hot-air gun or naked flame, these components could be damaged. This can cause fuel to escape and ignite. Depending on the type of damage, fuel may also not escape until the engine is running. There is a risk of fire and explosion.

Never heat fuel system components. Contact a qualified specialist workshop to rectify the malfunction.

At low outside temperatures, paraffin separation may cause the flow properties of the diesel fuel to be insufficient.

To prevent operating problems, diesel fuel with improved flow properties is available in the winter months.

Winter diesel fuels are reliable down to outside temperatures of −22 °C in Germany and other Central European countries. You can normally use winter diesel fuel without problems at the outside temperatures expected in the country where it is on sale.

Fuel additives

! When necessary, use only approved fuel additives.

There is otherwise a risk of impaired engine performance or engine and catalytic converter damage. The use of appropriate fuel additives is your responsibility.

! Do not add any petrol or kerosene to diesel fuel to improve its flow characteristics. Petrol or kerosene impairs the lubricity of the diesel fuel. This can cause damage to the injection system, for example.

For lower temperatures, the engine can be equipped with a fuel preheating system. This improves the flow characteristics of the diesel fuel according to the output of the installed heater.

Fuel additives used to improve flow characteristics are flow improvers.

Do not add flow improvers to winter diesel fuel guaranteed to operate down to −22 °C. The cold flow properties of the fuel may deteriorate as a consequence of the flow improver.

Fatty acid methyl ester (FAME) fuel (bio-diesel)

General notes

Operate your engine using pure FAME fatty acid methyl ester fuel in compliance with DIN EN 14214. You can also operate your engine using a mixture of conventional diesel fuel and FAME fatty acid methyl ester fuel. This also applies to engines with exhaust gas aftertreatment.

Observe the specifications in accordance with Sheet no. 135.0 of the Mercedes-Benz Specifications for Service Products for operation with FAME fatty acid methyl ester fuel.

Operating the vehicle with FAME fatty acid methyl ester fuel results in:

- higher fuel consumption
- reduced engine power output
- increased white smoke after a cold start
- reduced maintenance intervals

Low outside temperatures

FAME fatty acid methyl ester fuel compliant with DIN EN 14214 can be used reliably at outside temperatures down to −20 °C.

If you add a flow improver to the FAME fatty acid methyl ester fuel, the fuel's resistance to low temperatures does not change.

For lower temperatures, the engine can be equipped with a fuel preheating system. This improves the flow characteristics of the FAME fatty acid methyl ester fuel according to the heat output installed.

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AdBlue®/DEF

Important safety notes

⚠ WARNING

AdBlue®/DEF must not come into contact with skin, eyes or clothing.

- If AdBlue®/DEF comes into contact with your eyes or skin, rinse affected areas with clean water immediately.
- If AdBlue®/DEF is swallowed, immediately rinse your mouth out with a lot of clean water and drink plenty of water.
- Change clothing that is soiled with AdBlue®/DEF immediately.
- If allergic reactions occur, consult a doctor immediately.

Keep AdBlue®/DEF out of the reach of children.

! Only use AdBlue®/DEF in accordance with DIN 70070/ISO 22241. Do not use any additives.

If AdBlue®/DEF comes into contact with painted or aluminium surfaces when filling the tank, rinse the affected area immediately with plenty of water.

The terms "Urea" and "DEF" (Diesel Exhaust Fluid) are also used for "AdBlue®".

If the AdBlue®/DEF tank is full of AdBlue®/DEF, pressure compensation may occur when the tank lid is unscrewed. AdBlue®/DEF may spill out. Therefore, open the AdBlue®/DEF tank lid carefully. If AdBlue®/DEF spills out, immediately wash the affected area with plenty of water.

When opening the AdBlue®/DEF tank, small amounts of ammonia vapours could escape.

Ammonia vapours have a pungent smell and are particularly irritating to:

- skin
- mucous membranes
- eyes

The vapours may cause a burning sensation in the eyes, nose and throat as well as irritation of the throat and watering eyes.

Avoid inhaling ammonia vapours. Only fill the AdBlue®/DEF tank in well-ventilated areas.

AdBlue®/DEF should not come into contact with skin, eyes or clothing, and should not be swallowed. Keep AdBlue® out of the reach of children.

If you come into contact with AdBlue®/DEF, observe the following:

- immediately wash AdBlue®/DEF from your skin with water and soap.
- if AdBlue®/DEF comes into contact with your eyes, rinse your eyes with clean water immediately. Seek medical attention immediately.
- if you have swallowed AdBlue®/DEF, immediately rinse your mouth with water and drink plenty of water. Seek medical attention immediately.
- change clothing that has come into contact with AdBlue®/DEF immediately.

High outside temperatures

⚠ WARNING

If the AdBlue®/DEF tank cap is opened at high temperatures, ammonia vapours may escape.

Ammonia vapours have a pungent odour and particularly irritate:

- skin
- mucous membranes
- eyes

The vapours may cause a burning sensation in the eyes, nose and throat as well as irritation of the throat and watering eyes.

Avoid inhaling ammonia vapours.

The chemical composition of AdBlue®/DEF can break down if it heats up to 50 °C over a long period (e.g. as a result of direct sunlight on the tank). This creates ammonia vapour.

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Low outside temperatures

AdBlue®/DEF freezes at a temperature of approximately −11 °C .

Depending on equipment and country, the AdBlue®/DEF supply system of the vehicle may be heated; see the vehicle's Operating Instructions. Winter operation is thus guaranteed at temperatures below −11 °C .

Additives, tap water

! Do not mix additives to AdBlue®/DEF. Do not dilute AdBlue®/DEF with tap water. This could destroy the exhaust gas aftertreatment system.

Storage

! Containers made of the following materials are not suitable for the storage of AdBlue®/DEF:

- aluminium
- copper
- copper alloys
- unalloyed steel
- galvanised steel

If AdBlue® is stored in these types of container, constituents of these metals may dissolve and damage the exhaust gas aftertreatment beyond repair.

Only use containers made of the following materials to store AdBlue®:

- Cr-Ni steel in accordance with DIN EN 10 088-1/2/3
- Mo-Cr-Ni steel in accordance with DIN EN 10 088-1/2/3
- Polypropylene
- Polyethylene

Disposal

Environmental note

Dispose of AdBlue®/DEF in an environmentally responsible manner.

Observe laws and regulations on the disposal of AdBlue®/DEF in the country concerned.

Purity

! Impurities in AdBlue®/DEF, e.g. due to other service products, cleaning products or dust, may lead to:

- increased emission values
- damage to the catalytic converter
- engine damage
- malfunctions in the exhaust gas aftertreatment system.

Ensure that AdBlue®/DEF is always pure to avoid malfunctions in the exhaust gas aftertreatment system.

If AdBlue®/DEF is pumped from the tank, e.g. during repairs, do not use this fluid to refill the tank. Otherwise the purity of the fluid would no longer be guaranteed.

Cleaning and care

Notes on care

Regular care helps to maintain the value of the engine.

Mercedes-Benz recommends that you only use care products that have been approved for Mercedes-Benz. You can obtain these care products from any MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10).

High-pressure cleaning

Environmental note

Only wash your vehicle at a wash bay designed for this purpose. Dispose of empty containers and used cleaning products in an environmentally responsible manner.

! The exhaust gas aftertreatment system may only be cleaned when it is cool. The sensors can otherwise be damaged.

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! When cleaning, never point the water jet at the exhaust pipe. The system may otherwise be damaged.

! When using a high-pressure cleaner, keep a minimum distance between the high-pressure nozzle and the engine parts. Otherwise, parts of the engine may be damaged.

Observe the following minimum distances:

- about 70 cm with round-spray jets
- about 30 cm with 25° flat-spray jets
- about 30 cm with concentrated-power jets

! Keep the water jet moving constantly while cleaning. In this way, you will avoid causing damage.

Do not point the water jet at:

- electrical components
- plug connectors
- seals
- hoses

Cleaning the engine

! Observe the following notes when cleaning the engine. This avoids malfunctions and damage to the engine.

- When using high-pressure or steam cleaners, do not point the spray directly at electrical components and electric cables.
- Make sure that no water enters the air intake and ventilation openings.
- Treat the engine with preservative agents after it has been cleaned. When doing so, protect the belt drive system from the preservative agent.
- Only use wax-based protective agents for engines that comply with Sheet No. 385.4 of the Mercedes-Benz Specifications for Service Products.

In addition, observe the notes in the "High-pressure cleaning" section (▷ page 72).

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General notes

Decommissioned engines are engines that are not operated for over a month.

Special measures are required to decommission the engine/vehicle.

Information about batteries: if the engine/vehicle is to be out of use for longer than three weeks, disconnect the negative terminal on the battery. This prevents the batteries from being discharged by no-load current consumers.

If the engine/vehicle is to be out of use for a longer period, remove the batteries and store them in a dry and well-ventilated area.

Recharge batteries every 3 months at the latest.

Ensure that there is adequate ventilation when recharging. Check the battery fluid levels before and after charging and if necessary correct them. For further information (▷ page 60).

Decommissioning for up to 6 months

When decommissioning an engine/vehicle, keep it in a covered, dry and well-ventilated area. The room temperature should not fall below -10 °C.

Measures prior to decommissioning:

- Clean the engine/vehicle thoroughly.
- Remove any patches of corrosion from the engine.
- Change the engine oil and oil filter if the last oil change was carried out more than 20,000 km (or around 300 operating hours) ago.

  Also change the engine oil and filter if the oil is more than 12 months old.
- Check and adjust the level of coolant or renew coolant.
- Check and adjust the concentration of anti-corrosion/antifreeze additives in the coolant.
- Top up the AdBlue®/DEF tank until it is full, to prevent AdBlue®/DEF from crystallising.
- Drain the water separator for the fuel system.

Engine/vehicle/equipment run on FAME (Fatty Acid Methyl Ester) bio-diesel fuel

Before decommissioning, operate the engine with at least two fuel tanks of diesel fuel. Decommissioning with FAME fatty acid methyl ester (bio-diesel fuel) is not permitted.

Measures prior to recommissioning:

- Fit and connect the battery.
- Check that the electrical system is functioning correctly.
- Check cables, hoses and lines for tears and leaks.
- Check the engine oil level.
- Check the oil level in the steering and hydrostatic fan drive.
- Check the coolant level and correct it, if necessary.
- Check AdBlue®/DEF level.
- Check the fuel level.
- Start the engine and leave it running at medium engine speeds until it is at operating temperature (coolant temperature). While doing so, observe the indicators for oil pressure, coolant temperature and oil temperature.
- Vehicles with auxiliary heating: activate the auxiliary heating and check operation.
- Check operation of the steering and brakes.
- Check whether maintenance is due and if necessary carry it out.

Decommissioning for up to 12 months

Carry out all measures in "Decommissioning for up to 6 months". In addition, the engine must be started at least every three months. Warm up the engine at medium engine

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speeds and allow it to run for approximately 30 minutes at operating temperature.

Before recommissioning, carry out the prescribed maintenance work, see the Maintenance Booklet.

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Important safety notes

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

⚠ WARNING

There are moving components in the engine compartment. Certain components may continue to move or suddenly move again even after the ignition has been switched off, e.g. the radiator fan. There is a risk of injury.

If you have to carry out work in the engine compartment:

- switch off the ignition
- never touch the dangerous areas surrounding moving components, e.g. the rotation area of the fan
- remove jewellery and watches
- keep items of clothing and hair, for example, away from moving parts.

⚠ WARNING

Certain engine components can become very hot. There is a risk of injury when carrying out work at the engine.

Where possible, allow the engine to cool down and only touch the components described below.

When working on the vehicle, comply with all safety regulations, such as operating instructions, regulations concerning hazardous materials, environmental protection measures, work safety and accident prevention regulations.

Be aware of the road and traffic situation when working on public roads and secure your position accordingly.

Apart from careful operation and maintenance of the engine it is also important that malfunctions be rectified in good time.

You can rectify certain malfunctions yourself, (▷ page 85).

Have malfunctions that you cannot eliminate yourself rectified at a qualified specialist workshop.

External engine start/engine stop button

Switch off the engine with the external engine start/engine stop button:

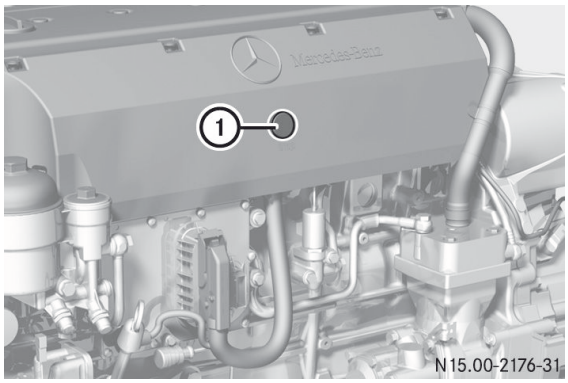
The safety functions of the electronic engine management system only allow the engine to be started when the transmission is in neutral or equipment is not being driven (disengaged).

Observe the information contained in the equipment's/vehicle's Operating Instructions.

Before starting the engine

- ▶ Switch the ignition lock to the drive position.
- ▶ Shift into neutral.
- ▶ Secure the vehicle against rolling away.
- ▶ Deactivate power take-off.

Engine with one button



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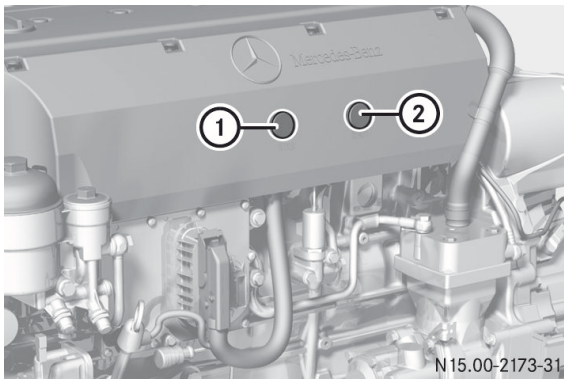
- ▶ **To start the engine:** press Start/Stop button ①.
  The engine starts and runs at engine idling speed.
- ▶ **To start the engine and increase the engine speed:** press and hold Start/Stop button ①.
  The engine starts and runs at engine idling speed. After about three seconds, the engine speed increases.
- ▶ Hold down Start/Stop button ① until the desired engine speed is reached.
  After releasing Start/Stop button ①, the engine continues to run at the currently set speed. The engine speed can be increased up to the limiting speed.
- ▶ **To stop the engine:** press Start/Stop button ① again.
  The engine switches off.

Engine with two buttons



- ▶ **To start the engine:** press start button ②.
  The engine starts and runs at engine idling speed.
- ▶ **To increase the engine speed:** while the engine is running, press start button ② again and hold it down until the desired engine speed is reached.
  After releasing start button ②, the engine continues to run at the currently set speed. The engine speed can be increased up to the limiting speed.
- ▶ **To stop the engine:** while the engine is running, press stop button ①.
  The engine switches off.
- ▶ **To turn the engine over without starting it:** press and hold start button ② and stop button ① at the same time.
  The engine turns over without starting.
- ▶ Release start button ② and stop button ①.
  The engine remains at a standstill.

Bleeding and draining the fuel system

When the engine is started, the battery must have sufficient charge to bleed the fuel system.

Bleeding with a heated fuel prefilter with a water separator fitted on the chassis:

- ▶ Bleed the fuel prefilter with water separator on the chassis before bleeding the fuel circuit on the engine side (▷ page 82).

Bleeding the fuel system without a fuel prefilter on the chassis frame

! Do not bleed the fuel system by operating the starter motor for an extended period of time. You could otherwise damage the starter motor.

- ▶ Turn the key to the start position in the ignition lock and hold it. Do not depress the accelerator pedal whilst doing so.

i Stop the starting procedure after approximately 30 seconds.

- ▶ Repeat the starting procedure after a waiting period of approximately 1 minute.

The fuel system is bled automatically.

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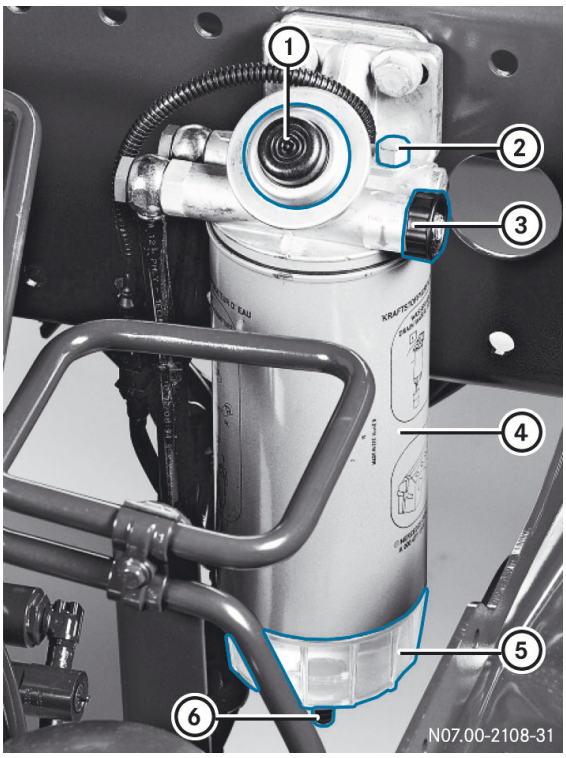
Bleeding the fuel system with a fuel prefilter on the chassis frame

Fuel prefilter overview



Example: fuel prefilter

① Manual fuel pump
② Vent valve
③ Shutoff valve
④ Filter housing
⑤ Water separator with inspection window
⑥ Water release valve

If water has collected in inspection window ⑤, drain the fuel prefilter before bleeding.

Draining the fuel prefilter

Environmental note

Dispose of the water-fuel mixture in an environmentally responsible manner.

Drain the fuel prefilter regularly.

- ▶ Place a collector under water release valve ⑥.
- ▶ On vehicles with fuel prefilter at tank level: close shutoff valve ③.
- ▶ Open water release valve ⑥.
- ▶ Press manual fuel pump ① and collect the fuel/water mixture.
- ▶ Close water release valve ⑥.
- ▶ On vehicles with fuel prefilter at tank level: open shutoff valve ③.
- ▶ Start the engine and allow it to run for about one minute.
  The fuel system is bled automatically.
- ▶ Check the fuel system for leaks.

Bleeding the fuel prefilter with the manual fuel pump

The fuel prefilter must only be bled when:

- the fuel tank is empty or
- the fuel filter has been replaced.

- ▶ Unscrew the fuel tank filler cap.
- ▶ Place the collector underneath the fuel prefilter.
- ▶ Open shutoff valve ③ fully.
- ▶ Open bleed nipple ②.
- ▶ Press manual fuel pump ① repeatedly until the escaping fuel is free of bubbles ②. Do not continue to pump.
- ▶ Close bleed nipple ②.
- ▶ Close the fuel tank filler cap.
- ▶ Start the engine.

The fuel system is bled automatically.

! Do not continue to press the fuel hand pump after the engine has started. This could otherwise damage the hand pump.

Electrical fuses

Important safety notes

⚠ WARNING

If you manipulate, bridge or replace a faulty fuse with a fuse of a higher amperage, the electric cables could be overloaded. This may result in a fire. There is a risk of an accident and injury.

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Always replace faulty fuses with specified new fuses of the correct amperage.

The individual electrical circuits are protected by safety fuses or automatic circuit-breakers.

Blown fuses or defective automatic circuit-breakers must be replaced by equivalent fuses with the fuse ratings recommended in the fuse allocation chart. Fuses with the same fuse rating are the same colour.

Further information is available from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre (▷ page 10).

The vehicle-specific fuse allocation chart is provided by the vehicle manufacturer.

If the newly inserted fuse also blows, have the cause traced and rectified at a qualified specialist workshop, e.g. a Mercedes-Benz Service Centre.

▶ If a circuit fails, switch off the consumer equipment and switch the ignition lock to position **0**.

Checking and replacing a safety fuse

▶ Pull the fuse out of the module using the pliers and carry out a visual inspection.
▶ If the fuse wire has melted, replace the blown fuse with a spare fuse.
▶ Switch on consumers and check that they function correctly.

If the safety fuse burns out again, have the electrical system checked at a qualified specialist workshop.

Jump-starting

Important safety notes

⚠ WARNING

Comply with safety precautions and take protective measures when handling batteries.

Risk of explosion

Fire, naked flames and smoking are prohibited when handling the battery. Avoid creating sparks.

Battery acid is caustic. Avoid contact with the skin, eyes or clothing.

Wear suitable protective clothing, in particular gloves, an apron and a face mask.

Immediately rinse acid splashes off with clean water. Consult a doctor if necessary.

Wear eye protection.

Keep children away.

Observe this Owner's Manual.

! Observe the following notes. You could otherwise damage the battery or electronic components in the vehicle:

- do not use a battery quick-charge unit for jump-starting.
- if you use a mobile battery charger (battery device with mains power stage), remove the mains plug before jump-starting.
- only have jump-starting provided by vehicles with a 24 V system.
- use jump leads which are protected against polarity reversal and with a wire

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cross section of approximately 35–50 mm² and insulated terminal clamps.

- if the outside temperature drops below -10 °C, a discharged battery could freeze. Do not start the engine under these circumstances. Let the battery thaw out first.

! Do not connect the negative terminal clamp of the jump lead to the chassis frame. Otherwise, engine or transmission components can be damaged.

! When you remove the jump leads, let the engine of the vehicle being jump-started idle. This avoids damage being caused to the vehicle electronics.

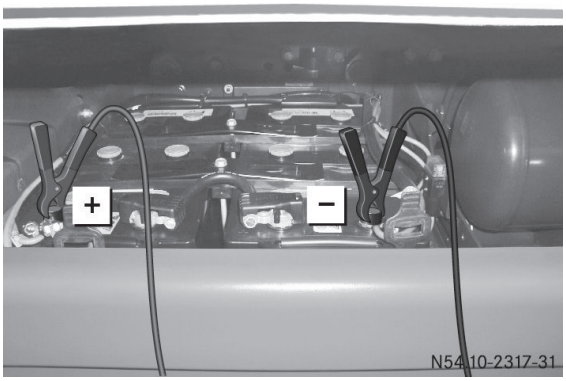
General notes

Observe the instructions relevant to safety and protective measures when handling the battery.

After jump-starting, have the batteries checked at a qualified specialist workshop.

- ▶ Make sure that the vehicles are not touching.
- ▶ Engage the parking brake.
- ▶ Switch off all electrical consumers.
- ▶ Turn the key to position **0** in the ignition lock.

Vehicles without a jump-starting connection point



Connecting the jump lead

- ▶ Remove the battery compartment cover.
- ▶ First, connect the positive terminal clamp of the jump lead to the positive terminal of the other vehicle's battery and then to the + positive terminal of the starter battery.
- ▶ First, connect the negative terminal clamp of the jump lead to the negative terminal of the other vehicle's battery and then to the – negative terminal of the starter battery.
- ▶ Assisting vehicle: run the engine at a high speed.
- ▶ Start the engine and allow it to idle.

Disconnecting the jump lead

- ▶ First, disconnect the negative terminal clamps of the jump lead from the negative terminals.
- ▶ Remove the positive terminal clamps of the jump lead from the positive terminals.

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Troubleshooting

Engine problems

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

Apart from careful operation and maintenance of the engine it is also important that malfunctions be rectified in good time. You can rectify certain faults yourself.

Have malfunctions that you cannot eliminate yourself rectified at a qualified specialist workshop (▷ page 10).

Problem	Possible causes/consequences and ▶ Solutions
The drive pinion does not turn or turns too slowly.	The battery is not sufficiently charged. ▶ Charge the battery.
	The connecting cable to the starter motor is loose. ▶ Tighten the cable on the terminal. If necessary, solder on a new terminal.
	The earth connection to the battery is loose. ▶ Tighten the cable on the terminal. If necessary, solder on a new terminal.
	The starter motor solenoid switch is faulty or the starter motor is faulty. ▶ Have it checked at a qualified specialist workshop.
The engine does not start or stalls again immediately.	The fuel tank is empty. ▶ Refill the fuel tank (▷ page 58).
	The fuel filter is blocked. ▶ Replace the fuel filter element.
	The fuel prefilter contains water. ▶ Drain the fuel prefilter.
	The fuel prefilter is blocked. ▶ Replace the fuel filter element.

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Problem	Possible causes/consequences and ▶ Solutions
	Leaks or insufficient pressure in the low-pressure fuel circuit ▶ Check for leaks (visual check), replace the seals if necessary. ▶ Have the fuel pressure tested at a qualified specialist workshop. Replace the seals.
The engine does not start correctly.	There is a malfunction in the engine control unit. ▶ Read out the MR (engine control) unit; have it checked at a qualified specialist workshop.
	There are leaks or there is insufficient pressure in the low-pressure fuel circuit. ▶ Carry out a check for leaks (visual check). ▶ Have the pressure tested at a qualified specialist workshop.
The engine stops inadvertently.	The MR (engine control) unit is faulty (total failure). ▶ Consult a qualified specialist workshop.
	The power supply to the MR and ADM control units is interrupted or there is a short circuit in the wiring. ▶ Have the power supply checked at a qualified specialist workshop.
	There are leaks or there is insufficient pressure in the low-pressure fuel circuit or the fuel pump drive is faulty. ▶ Check for leaks (visual check). ▶ Have the fuel pressure tested at a qualified specialist workshop.
The engine is in emergency running mode.	There is an interruption in the data flow of the MR and ADM control units. ▶ Read out the control unit's fault memory. ▶ Have it checked at a qualified specialist workshop.
The engine surges, vibrates or runs irregularly.	There is a malfunction in the fuel system. ▶ Carry out a check for leaks (visual check). ▶ Read out the control unit's fault memory. ▶ Have it checked at a qualified specialist workshop.
The engine's output is poor (lack of power).	The air filter is dirty or blocked. ▶ Replace the air filter element.
	The charge-air temperature is too high; the charge-air cooler or coolant radiator is dirty on the exterior. ▶ Clean the exterior of the charge-air cooler and coolant radiator.

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Problem	Possible causes/consequences and ▶ Solutions
	The coolant temperature is too high. ▶ Check the temperature sensor; replace if necessary. Check the fan speed. ▶ Check the thermostat and replace as necessary. Consult a qualified specialist workshop.
	Malfunction in the fuel system (blocked, leaking). ▶ Visual inspection for leaks. ▶ Consult a qualified specialist workshop.
	Poor fuel grade ▶ Use the specified type of fuel and fuel grade (▷ page 68).
	The charge-air system is leaking; the hose clip on the charge-air hose is loose or damaged. ▶ Check the charge-air system for leaks. ▶ Check the charge-air pressure sensor and, if necessary, replace. ▶ Consult a qualified specialist workshop.
	An operating restriction is activated due to an emissions-relevant malfunction. ▶ Observe the notes on warning and indicator lamps (▷ page 26).
There is an interruption in the tractive power.	There is an increased voltage drop to the MR and ADM control unit (loose contact). ▶ Check the battery terminals and the connectors on the MR and ADM control unit for secure seating and corrosion.
The engine braking effect is poor.	The cause must be established in a qualified specialist workshop. ▶ Consult a qualified specialist workshop.
Fuel consumption is too high.	The cause must be established in a qualified specialist workshop. ▶ Consult a qualified specialist workshop.
The engine cuts off too early (maximum engine speed cannot be reached).	The engine management (MR) control unit is faulty or parameterised incorrectly. ▶ Consult a qualified specialist workshop.
The engine gets too hot (according to the coolant temperature gauge).	There is not enough coolant in the coolant circuit. ▶ Add coolant and bleed the system.
	The coolant temperature sensor or display is faulty. ▶ Replace the sensor or display.

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Problem	Possible causes/consequences and ▶ Solutions
	The poly-V-belt is damaged. ▶ Replace the poly-V-belt.
	The fan does not switch on correctly. ▶ Consult a qualified specialist workshop.
	The coolant radiator is dirty on the inside; the coolant radiator is very dirty on the outside. ▶ Clean the coolant radiator.
	The thermostat is faulty. ▶ Check and replace as necessary. ▶ Consult a qualified specialist workshop.
Indicator lamps do not light up at IGNITION ON.	The lamps are faulty or the electrical cables are interrupted. ▶ Consult a qualified specialist workshop.
The charge current indicator lamp lights up when the engine is running.	The poly-V-belt is slipping. ▶ Check the belt tensioner function. ▶ Check that the poly-V-belt contact surfaces are not torn, damaged, oily or glazed. Replace the poly-V-belt if necessary.
	The poly-V-belt is torn. ▶ Replace the poly-V-belt.
	The alternator or sensor is faulty. ▶ Check the alternator or sensor. ▶ Consult a qualified specialist workshop.
The engine emits black smoke.	The air filter is heavily contaminated. ▶ Replace the air filter element.
	The engine brake is faulty. ▶ Consult a qualified specialist workshop.
	The exhaust gas turbocharger is faulty. ▶ Carry out a visual inspection. ▶ Consult a qualified specialist workshop.
	Misfiring; the fuel injector is faulty. ▶ Consult a qualified specialist workshop.

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Problem	Possible causes/consequences and ▶ Solutions
The exhaust fumes are blue.	The oil level in the engine is too high; the crankcase ventilation system is faulty; engine oil has entered the combustion chamber. ▶ Adjust the oil level correctly. ▶ Have the crankcase ventilation system checked at a qualified specialist workshop.
The exhaust fumes are white.	Coolant is entering the combustion chamber. ▶ Have a pressure loss test carried out at a qualified specialist workshop.
The engine is "knocking".	The engine is misfiring. ▶ Consult a qualified specialist workshop.
The engine is "knocking".	There is bearing damage. ▶ Consult a qualified specialist workshop.
There are abnormal sounds.	The air intake pipe and exhaust gas pipe are leaking, causing a whistling noise. ▶ Rectify the cause of the leak and, if necessary, replace gaskets.
	The turbine or compressor wheel is scraping the housing; there are foreign objects in the compressor or turbine housing; bearings have seized on the rotating parts. ▶ Have the exhaust gas turbocharger checked at a qualified specialist workshop.
	The valve clearance is excessive. ▶ Check and adjust the valve clearance.
	The poly-V-belt is slipping. ▶ Check that the poly-V-belt contact surfaces are not torn, damaged, oily or glazed. Replace the poly-V-belt if necessary.
Indicator lamp for charge current lights up.	The poly-V-belt is slipping. ▶ Check that the poly-V-belt contact surfaces are not torn, damaged, oily or glazed. Replace the poly-V-belt if necessary.

Replacing the poly-V-belt

If the poly-V-belt is torn or shows damage patterns , it must be replaced.

⚠ WARNING

The tensioning device is spring-tensioned. When it is loosened or tightened, there is a risk of injury from crushing or entrapment in pretensioned parts.

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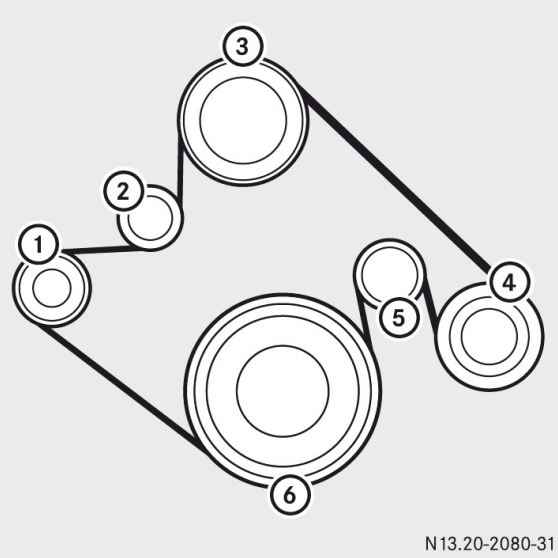
▷▷

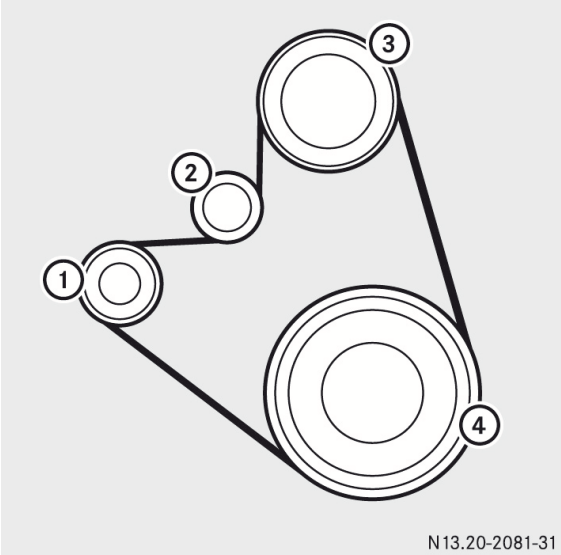
- Always carry out work on the tensioning device with extreme care.
- Make sure that the tool is handled correctly.

Belt profile



Poly-V-belt routing (engine with refrigerant compressor)

① Alternator
② Tensioning pulley
③ Coolant pump
④ Refrigerant compressor
⑤ Guide pulley
⑥ Crankshaft

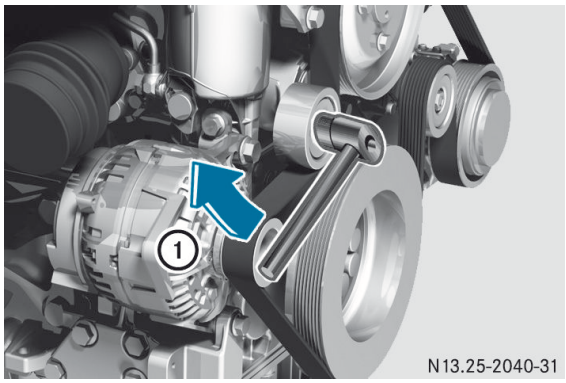


Poly-V-belt routing (engine without refrigerant compressor)

① Alternator
② Tensioning pulley
③ Coolant pump
④ Crankshaft

Routing

Fitting/removing poly-V-belts



① Example: releasing the poly-V-belt

▶ Insert the 15 mm socket, with the handle and extension attached, into the tensioner.
▶ Swing the tensioning pulley up and remove the poly-V-belt.
▶ Swing back the tensioner.
▶ Check that both the tensioner and the belt pulley are in fault-free condition. Check for such defects as worn bearings in the tensioner, tensioning pulley and guide pulleys

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and for wear of the tooth profile on the belt pulleys.

- ▶ Replace faulty parts.
- ▶ Route the new poly-V-belt over all belt pulleys except the tensioning pulley (observe the poly-V-belt routing shown in the illustration).
- ▶ Swing the tensioning pulley up using the lever, lay the poly-V-belt over the tensioning pulley and allow the tensioning pulley to swing back.
- ▶ Remove the spanner and check for correct seating of the poly-V-belt on the belt pulleys.

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Engine data plate 94
Information on the engine data plate 94
Engine model designation 94
Data card 94
Engine data 95

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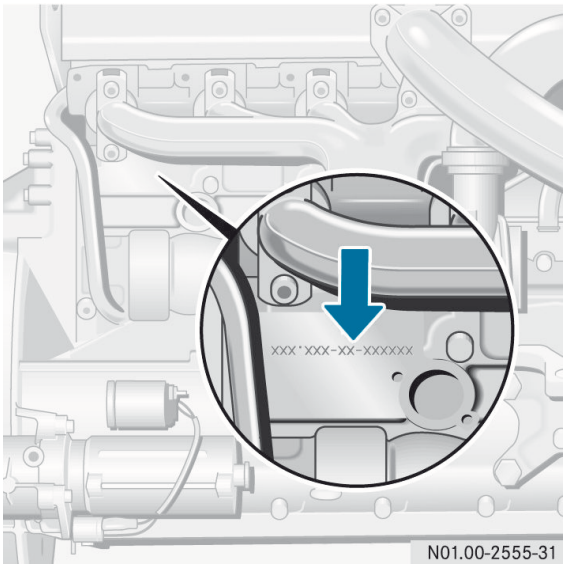
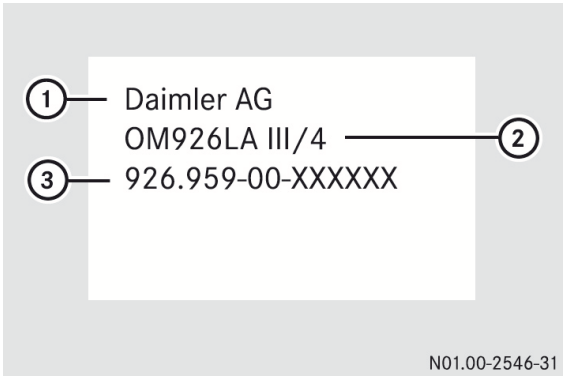
Engine data plate

The engine data plate is located on the right-hand side of the engine below the exhaust manifold. The engine data plate data is stamped into the crankcase.



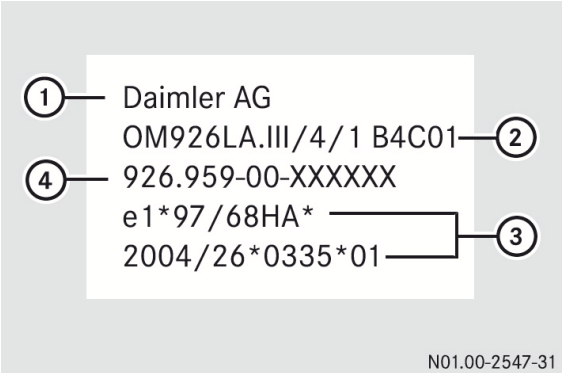
Information on the engine data plate

The following data is contained on the engine data plate in the form of numbers stamped directly onto the crankcase:



Example: engine data plate for road vehicles (on-highway engine)

① Manufacturer's name
② Engine model designation
③ Engine number



Example: engine data plate for non-road vehicles (off-highway engine)

① Manufacturer's name
② Engine model designation
③ Type approval number
④ Engine number

Engine model designation

Example: engine model designation

OM	9XX	L	E	
OM				Oil engine (diesel)
	9XX			Engine type
		L		Intercooler
			E	Exhaust gas turbocharger

Data card

The engine data card forms an integral part of the documents belonging to the engine and should always be kept together with the Maintenance Booklet. It contains details about the design of the engine, including special features.

The engine data card must be presented or the complete engine number must be specified for the procurement of genuine Mercedes-Benz parts.

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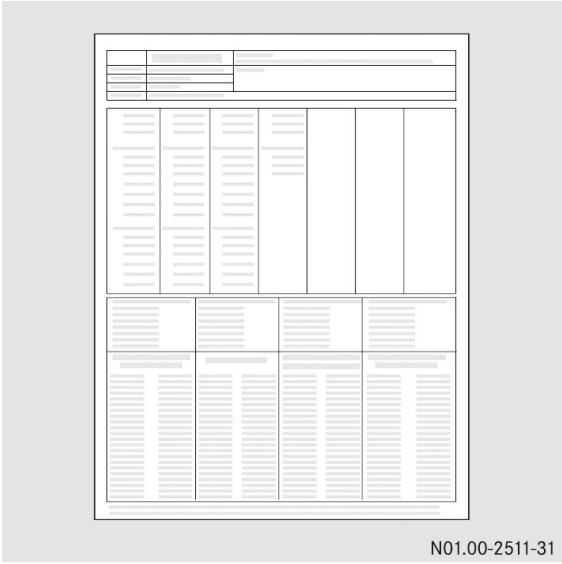

N01.00-2511-31

Engine data card

The engine data card describes the scope of delivery from the Mercedes-Benz factory.

Conversion parts on the engine system which change the scope of the engine delivered by Mercedes-Benz should be reported to Mercedes-Benz. Once the documentation (VeDoc) has been updated, an updated data card is supplied. This helps to prevent incorrect ordering of replacement parts.

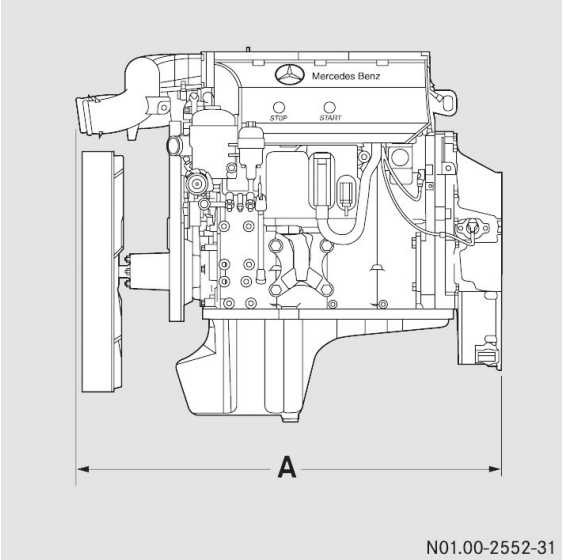
In order to prevent incorrect ordering of replacement parts, the Mercedes-Benz replacement parts service must also be informed.

Engine data

Dimensions and weights

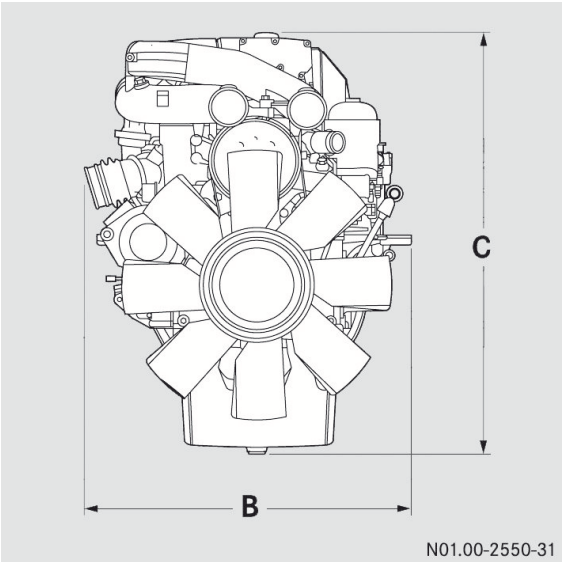
All data refers to the standard version of the respective engine type. Deviations may occur, depending on the engine equipment and installation situation in the vehicle/device.

Dimensions



N01.00-2552-31

Example: engine length



N01.00-2550-31

Example: engine width and height

	OM 904 LA OM 924 LA	OM 906 LA OM 926 LA
A = engine length	830 mm	1078 mm
B = engine width	645 mm	645 mm
C = engine height	925 mm	940 mm

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Weights

	OM 904 LA OM 924 LA	OM 906 LA OM 926 LA
Dry engine maximum	405 kg	540 kg
Wet engine maximum	425 kg	575 kg

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General data

All data refers to the standard version of the respective engine type. Data for other versions is available on request.

Engine	Engine type	OM 904 LA OM 924 LA	OM 906 LA OM 926 LA
	Assembly model series	904.9 924.9	906.9 926.9
	Type	Turbocharged in-line engine with intercooler	
	Combustion principle	4-stroke direct injection diesel	
	Number of cylinders	4	6
	Bore	102 mm 106 mm	102 mm 106 mm
	Stroke	130 mm 136 mm	130 mm 136 mm
	Engine capacity	4250 cm^3 4800 cm^3	6370 cm^3 7200 cm^3
	Type of cooling system	Forced circulation cooling	
	Engine, direction of rotation	Anti-clockwise (when looking at the flywheel)	
Valve clearance	Intake valve	0.40 mm	0.40 mm
	Exhaust valve	0.60 mm	0.60 mm
Starter motor	Starter	Electric	Electric
	Voltage	24 V	24 V
	Output	4.0 kW	4.0 kW
Battery	Voltage	12 V/24 V	12 V/24 V
	Cold-discharge test current	Maximum 450 A	Maximum 450 A
	Cold start ability (battery charge level 75 %) (▷ page 60)	OM 904 LA, E5: -10 °C	OM 906 LA, E5: -10 °C
		OM 924 LA, 3B: -18 °C	OM 926 LA, 3B: -18 °C
		OM 924 LA, E5: -15 °C	OM 926 LA, E5: -15 °C

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Alternator	Voltage	28 V	28 V
	Amperage	80 A	80 A

Operating data

Engine type		OM 904 LA/OM 924 LA	OM 906 LA/OM 926 LA
Rated engine speed		2200 rpm	2200 rpm
Effective engine speed range		2500 rpm	2500 rpm
Idling speed		Approximately 600 rpm	Approximately 600 rpm
Engine brake permissible up to		2700 rpm	2700 rpm
Engine speed limiter (emergency running mode)		1300 rpm	1300 rpm
Oil pressure	At idling speed	Minimum 0.5 bar	Minimum 0.5 bar
	At nominal engine speed	Minimum 2.5 bar	Minimum 2.5 bar
Coolant temperature	Normal operation	Approximately 80-95 °C	Approximately 80-95 °C
	Maximum permissible coolant temperature	100 °C	100 °C

Capacities and service products

		Capacity approximately	Service product (Sheet No.[4])
Engine with oil filter (with standard truck oil pan)	OM 904 LA/OM924 LA	13 l - 16 l	For all engines: Engine oil (Sheet No. 228.2/.3/.31/.5/.51) For engines without BlueTec®, also: Engine oil (Sheet No. 228.0, 228.1)
	OM 906 LA/OM 926 LA	24 l - 29 l	

4 Mercedes-Benz Specifications for Service Products

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			Capacity approximately	Service product (Sheet No.[4])
Fuel system	Diesel fuel tank[5]		-	Diesel fuels in accordance with EN 590 or ASTM D975 (Sheet No. 131.0)
	Vehicle operation with fatty acid methyl ester		-	Fatty acid methyl ester fuel in accordance with DIN EN 14214 (Sheet No. 135.0)
Exhaust gas aftertreatment system	AdBlue®/DEF tank[5]		-	AdBlue®/DEF in accordance with ISO 22241 (Sheet No. 352.1)
	AdBlue®/DEF filter sealing rings		-	MB silicon grease
Cooling system	Amount of coolant in the engine	OM 904/924 LA OM 906/926 LA	7 l 10 l	Antifreeze/corrosion inhibitor (Sheet No. 325.0/2/3/5) and water quality (Sheet No. 310.1) or premixed coolant (Sheet No. 326.0/2/3/5).
	Corrosion inhibitor/antifreeze agent volume down to –37 °C		Approx. 50% by volume	
	Corrosion inhibitor/antifreeze volume down to –45 °C		Approx. 55% by volume	
	Coolant additive (coolant without antifreeze protection)		-	Coolant additive and water quality (Sheet No. 310.1, 312.0)
Engine compartment	Protective wax		-	Wax preservative (Sheet No. 385.4)
Engine brake	Heat-resistant lubricant		-	Heat-resistant lubricant (part number A000 989 76 51)

4 Mercedes-Benz Specifications for Service Products

5 Installation on the vehicle side; designed by the vehicle manufacturer.

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Tightening torques

All threads on mechanical components and the corresponding contact surfaces must be clean, smooth and coated with engine oil. Other lubricants lead to substantially different tightening torques.

Engine	Cylinder head cover	Light alloy (with oil filler cap)	25 Nm
		Plastic (without oil filler cap)	20 Nm
	Valve clearance setting	Counternut on the rocker arm adjustment screw	50 Nm
	Inspection hole cap on the timing case		25 Nm
	Flywheel housing rotation device		25 Nm
	Charge-air distributor at cylinder head		30 Nm
Fuel system	Cap on the fuel filter housing		25 Nm
Oil circuit	Drain plug on the oil pan	M 20 x 1.5	70 Nm
		M 26 x 1.5	90 Nm
	Oil filter cap on the oil filter housing		40 Nm
Cooling system	Coolant drain screw	On the crankcase	60 Nm
		On the radiator	2 Nm
Exhaust gas aftertreatment	Filter bowl on the AdBlue®/DEF pump module		32 Nm

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Imprint

Internet

Further information about MTU, Mercedes-Benz and Daimler AG can be found on the Internet at:

www.mtu-online.com

www.mercedes-benz.com

www.daimler.com

Documentation team

Should you have any questions or suggestions regarding this manual, you can reach the technical documentation team at the following address:

Daimler AG, HPC: CAC, Customer Service, 70546 Stuttgart, Germany

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Equipment manufacturer

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Mercedesstraße 137
70327 Stuttgart
Germany

TIM-ID: 0000094786 - 003

As at 02.09.2014

Order no. 6462 9851 02 Part no. 926 584 29 81 Edition 01-15

TIM-ID: 0000094786 - 003

OM 904-926 LA BlueTec® / OM 904-926 LA
OM 906 hLA BlueTec® / OM 906 hLA

Wartungsheft | Maintenance Booklet | Carnet de maintenance | Cuaderno de mantenimiento | Libretto di manutenzione | Сервисная книжка

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Vehicle/equipment/assembly data/symbols

Vehicle/equipment data

Manufacturer	▶
Vehicle/equipment identification number	▶
Type	▶
Date of first registration/initial operation	▶
Licence plate	▶
Licence plate	▶
Licence plate	▶

Assembly data

Major assembly ID number (AGS ID)	▶
Engine number	▶
Exhaust gas aftertreatment system ID number (AGN ID)	▶

Symbols

⚠ Warning

Environmental note

General information

Introduction

This Maintenance Booklet should serve as a guideline for the maintenance of your engine system.

The prescribed tasks must be carried out regularly and in good time to ensure the operating safety of your engine and exhaust gas aftertreatment system.

Work relevant to safety or on safety-related systems must be carried out at a qualified specialist workshop.

Mercedes-Benz is constantly updating its engines to the state of the art. Please be aware that these changes could also affect the scope of maintenance work.

Qualified specialist workshop

A qualified specialist workshop has the necessary specialist knowledge, tools and qualifications to carry out the work required on the engine to a professional standard. This is particularly applicable to work relevant to safety.

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Observe the notes in the Maintenance Booklet.

Always have the following maintenance work carried out at a qualified specialist workshop:

- work relevant to safety
- service and maintenance work
- repair work
- modifications as well as installations and conversions
- work on electronic components
- Mercedes-Benz recommends, for on-highway applications, that you use a Mercedes-Benz Service Centre.
- MTU recommends, for off-highway applications, an MTU partner or MTU-authorised Mercedes-Benz partner.

Implied warranty

A well-developed network of Mercedes-Benz, MTU and MTU-authorised Mercedes-Benz Service Centres is available to carry out maintenance work.

These Mercedes-Benz and MTU or MTU-authorised Mercedes-Benz Service Centres:

- have special equipment and tools as well as specialists who receive continuous training
- guarantee that your engine system is repaired and maintained thoroughly and expertly
- carry out all repairs related to implied warranty
- carry out all maintenance work expertly
- confirm in the Maintenance Booklet that the maintenance work has been carried out at the required time
- handle implied warranty claims that are admissible according to the sales contract

Please observe the instructions and recommendations as well as the maintenance services in the Maintenance Booklet. Please observe these instructions even if you let a third party use and care for your vehicle. This is the only way to ensure that you do not lose your entitlements.

If the prescribed maintenance work is not carried out, claims can only be decided after the manufacturer has inspected the claim.

During the implied warranty period, have the prescribed maintenance service for your engine system carried out as follows:

- regularly
- punctually
- at a qualified specialist workshop which has the necessary specialist knowledge and tools to carry out the work required

  Mercedes-Benz recommends that you use a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre. In particular, work relevant to safety or on safety-related systems must be carried out by a qualified specialist workshop.

If there are legal requirements on emission control, please note that:

- maintenance on the engines must be carried out according to specific regulations and using special measuring devices
- it is prohibited to modify or tamper with components relevant to emissions

All Mercedes-Benz and MTU or MTU-authorised Mercedes-Benz Service Centres are familiar with the relevant regulations.

Maintenance work does not include repair work. Issue a separate order for repair work.

You can obtain further information on the maintenance of your engine system from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre.

Important safety notes

⚠ WARNING

Before carrying out maintenance or repair work, you must read the relevant sections of the technical documentation relating to maintenance and repair measures, e.g. the Operating Instructions and workshop information.

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In particular, first familiarise yourself with the legal regulations, e.g. work safety and accident prevention regulations.

You could otherwise fail to recognise dangers and injure yourself or others.

Always have maintenance work carried out at a qualified specialist workshop.

⚠ WARNING

If you do not have the prescribed service/maintenance work or necessary repairs carried out, this could result in malfunctions or system failures. There is a risk of an accident.

Always have the prescribed service/maintenance work as well as necessary repairs carried out at a qualified specialist workshop.

⚠ WARNING

Limbs could be crushed or trapped if the engine is started unintentionally during service or maintenance work. There is a risk of injury.

Always secure the engine against unintentional starting before carrying out maintenance or repair work.

⚠ WARNING

Cloths or other flammable materials left in the engine compartment can ignite if they come into contact with the exhaust system or parts of the engine that heat up. There is a risk of fire. After carrying out maintenance work, make sure that no extraneous flammable material is left in the engine compartment or on the exhaust system.

When carrying out maintenance work, you require access to the Workshop Information System (WIS) via the Internet. This access is subject to a fee.

Current information on the system and prices can be found at this web address: http://service-parts.mercedes-benz.com. Click on "EPC, WIS/ASRA" in the "Service and parts information" tab and then on "WIS".

You can log in by clicking on "Register" on the right-hand side.

Service products

⚠ WARNING

Service product can be poisonous and hazardous to health. There is a risk of injury.

Observe the instructions on the respective original container when using, storing and disposing off service products. Always store service products in the sealed original container. Always keep service products out of the reach of children.

Environmental note

Dispose of service products in an environmentally-responsible manner.

Service products include:

- fuels (e.g. diesel)
- lubricants (e.g. engine oil, transmission oil, hydraulic fluid, greases)
- antifreeze protection, coolant
- AdBlue®/DEF (reducing agent of the exhaust gas aftertreatment system)[3]

The approved service products are summarised in the Mercedes-Benz Specifications for Service Products. Information about these specifications can be obtained from any Mercedes-Benz or MTU Service Centre or at http://bevo.mercedes-benz.com.

For filling capacities, see the "Technical data" section of the Operating Instructions.

Changing the engine oil and replacing the filter

The interval for changing the engine oil and replacing the filter depends on the following:

- engine oil grade
- fuel type: diesel/fatty acid methyl ester FAME (bio-diesel) and sulphur content

[3] As alternatives to "AdBlue®", the terms "Urea" and "DEF" (Diesel Exhaust Fluid) are also used.

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- engine load (observe maintenance category)
- time: at least every **2 years** for diesel fuel operation

  at least **once a year** if operated using acid methyl ester FAME (bio-diesel)

Engine oil

Select the SAE class (viscosity) of the engine oil to suit the average outside temperatures for the time of year.

Only use engine oils that comply with the Mercedes-Benz Specifications for Service Products.

The following engine oils are approved:

- For engines with BlueTec® exhaust gas aftertreatment and which are operated with diesel fuel, only use multi-grade oils compliant with Sheet No. 228.3/.31/.5/.51 or, in exceptional cases, single-grade oils compliant with Sheet No. 228.2.
- For engines without BlueTec® exhaust gas aftertreatment, multi-grade oils compliant with Sheet No. 228.1 and, in exceptional cases, single-grade oils compliant with Sheet No. 228.0/.2 can also be used.
- For operation with FAME fatty acid methyl ester fuel (bio-diesel fuel), only use engine oil compliant with Sheet No. 228.3/.31/.5/.51.

  This is also required for a mixture of conventional diesel fuels and FAME fatty acid methyl ester fuels (bio-diesel fuel).

Depending on the fuel quality (sulphur content or FAME fatty acid methyl ester fuel), the oil change intervals may be shortened.

Multi-grade oils which comply with Sheet No. 228.1/.3/.31/.5/.51 can be used all year round. Single-grade oils which comply with Sheet No. 228.0/.2 are only designed for one SAE viscosity class for specific temperature ranges. Change the engine oil to an SAE class suitable for the time of year and the respective outside temperatures.

Using engine oils that have not been approved could restrict your warranty entitlements.

Information is available from any Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre.

The maximum oil change interval can only be achieved by using engine oils of particularly high quality in accordance with Sheet No. 228.5/.51 of the Mercedes-Benz Specifications for Service Products. If you use a lower grade engine oil (e.g. in accordance with Sheet No. 228.31) when the engine oil is changed or topped up, the maximum oil change interval is reduced. Then use the maintenance interval according to the lower oil quality.

Fuels

Fuel sulphur content

! A higher fuel sulphur content accelerates the ageing process of the engine oil and can damage the engine and exhaust system.

! Vehicles with BlueTec® exhaust gas aftertreatment:

Only standardised fuels with a maximum sulphur content of 0.05% (500 ppm) by weight are permissible. However, Mercedes-Benz only recommends fuel that complies with the European standard EN 590 as of 2005, et seq. (max. 0.005% (50 ppm) sulphur by weight). The use of fuels with a sulphur content higher than 0.005% (50 ppm) by weight reduces the life expectancy of the engine and exhaust system.

! Vehicles without BlueTec® exhaust gas aftertreatment:

Only commercially available fuels which comply with the European standard EN 590 or comparable national fuel standards are permitted. Mercedes-Benz recommends fuels with a low sulphur content. The use of fuels with a high sulphur content reduces the lifespan of the engine and the exhaust

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system. For operation with a high sulphur content > 0.05% by weight (500 ppm), the maintenance intervals for the engine oil and filter must be reduced.

ⓘ Even if the maintenance intervals are reduced, operation with a higher sulphur content will lead to increased engine wear, especially on the fuel injectors.

Sulphur content in diesel fuel	Interval for changing engine oil and filter
up to 0.05 % by weight (500 ppm)	100%
from 0.05% by weight (500 ppm) to 0.1% by weight (1000 ppm)	50%
over 0.1 % by weight (1000 ppm)	25 %

You can find a table of fuel sulphur contents in specific countries in the Mercedes-Benz Specifications for Service Products, Sheet No. 136.1/.2 at http://bevo.mercedes-benz.com.

! When necessary, use only approved fuel additives.

There is otherwise a risk of impaired engine performance or engine and catalytic converter damage. The use of appropriate fuel additives is your responsibility.

Operation with FAME fuels (bio-diesel)

The fuel must comply with DIN EN 14214. Operating with a fuel of lower quality can lead to damage and malfunctions.

The intervals for renewing engine oil and filter changes are significantly shorter. An engine oil and filter change must be carried out at least once a year. When the oil and the oil filter are changed, the fuel filter must also be replaced.

Before operation on FAME fuels, the replacement intervals must be individually determined. For this, consultation with a Mercedes-Benz or MTU Service Centre is necessary.

Only use engine oils which have been approved for operation with fatty acid methyl ester FAME (bio-diesel) (▷ page 53).

AdBlue®/DEF

Only use AdBlue®/DEF in accordance with DIN 70070/ISO 22241.

Coolant

⚠ WARNING

The engine cooling system is under pressure, particularly if the engine is warm. You could be scalded by hot coolant spraying out when opening the cap. There is a danger of injury.

Allow the engine to cool before opening the cap. Wear gloves and protective eyewear when opening. Slowly turn the cap half a turn to allow pressure to escape.

⚠ WARNING

If antifreeze comes into contact with hot components in the engine compartment, it may ignite. There is a risk of fire and injury.

Let the engine cool down before you top up the antifreeze. Make sure that antifreeze is not spilled next to the filler neck. Thoroughly clean the antifreeze from components before starting the engine.

A coolant that ensures anti-corrosion/antifreeze protection and other important protective effects is filled at the factory.

The coolant is a mixture of water and corrosion inhibitor/antifreeze.

The corrosion inhibitor/antifreeze in the coolant has the following properties:

- heat transfer
- anti-corrosion protection

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- cavitation protection (protection against pitting)
- antifreeze protection
- raising the boiling point

Leave the coolant in the engine cooling system all year round – even in countries with high outside temperatures.

Check the corrosion inhibitor/antifreeze concentration in the coolant every six months.

Renew the coolant every 3 years.

Only use antifreeze and corrosion inhibitor which has been approved according to Sheet No. 325.0/2/3/5 and water quality according to Sheet No. 310.1 or premixed coolant according to Sheet No. 326.0/2/3/5. In this way, you will avoid damaging the engine cooling system and the engine itself.

When renewing the coolant, ensure that it contains 50% corrosion inhibitor/antifreeze by volume. This corresponds to antifreeze protection down to -37 °C.

Do not exceed 55% by volume (antifreeze down to approximately -45 °C). The heat dissipation and antifreeze may otherwise be negatively affected.

If there is a loss of coolant, do not top it up by using only water, but also add an approved corrosion inhibitor/antifreeze agent.

The water in the coolant must meet certain requirements, which are often fulfilled by the use of drinking water. The water must be treated if its quality does not meet the required standards.

Please note the Mercedes-Benz Specifications for Service Products, Sheet No. 310.1.

Mixtures with other corrosion inhibitors/antifreeze agents are not permitted.

Maintenance work

Engine usage

The scope and frequency of maintenance work depends mainly on the different vehicle applications and operating conditions. The maintenance intervals are also dependent upon the grade of the engine oil and fuel used as well as the sulphur content of the fuel. Depending on the load, the assemblies are divided into three maintenance categories with varying maintenance intervals.

If in doubt, especially in the case of unusual operating conditions, contact a Mercedes-Benz, MTU or MTU-authorised Mercedes-Benz Service Centre.

Maintenance categories

Maintenance category A

Intermittent use with light load. Average speed of above 50 km/h.

Distance-based maintenance

Usage examples:

- Vehicles:

  Tourist coaches/intercity buses (European road conditions), commercial long-distance vehicles

Maintenance category B

Intermittent use predominantly at medium engine speeds and load range.

Distance-based maintenance

Usage examples:

- Tourist coaches/intercity buses (non-European road conditions)
- City buses (gentle topography)
- Short-radius distribution vehicles
- Trucks used as construction site vehicles (for road use)

When using the engines in vehicles (e.g. city buses) with a fuel consumption of more than 7 l/h in urban traffic or speeds less than 15 km/h, maintenance category C should generally be used.

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Maintenance by operating hours

Usage examples:

- Vehicles:

  Airport shuttle buses, hybrid vehicles, refuse collection vehicles
- Agricultural machinery:

  Agricultural tractors, vineyard tractors, grape pickers, car loaders, mixing and grinding machines, bark peeling machines, logging tractors
- Materials handling equipment and lifting gear:

  Industrial tractors, fork-lift trucks, charging trolleys, aircraft towing vehicles, container loaders, container handling gantries, harbour cranes, mobile cranes – vehicle engine and special purpose body engine
- Construction machinery:

  Wheel loaders, road graders, face shovel excavators, bucket excavators, road rollers, vibratory rollers, cement mixer vehicles – vehicle engine and special purpose body engine, cement mixer vehicle – special purpose body engine, concrete pumps, road pavers, soil compactors, track tamping machines
- Working machinery:

  Road sweepers – vehicle engine and special purpose body engine, snow cats, high-pressure flushing pumps, fire engine pumps, grain blowers, refuse compressors, snow blowers – vehicle engine and special purpose body engine

Maintenance category C

Operation mainly:

- in the high engine speed and load range
- with frequent idling
- extreme short-term operation
- frequent cold starts
- difficult topography

Fuel consumption greater than 7 l/h or an average speed of less than 15 km/h. This corresponds to total fuel consumption of 50 l/100 km, for example, for a city bus with an average speed of 15 km/h.

Distance-based maintenance

Usage examples:

- Vehicles:

  Heavy trucks, city buses, fire engines, trucks used as construction-site vehicles (for operation on construction sites), cement mixer vehicles (vehicle engine and special purpose body engine), cement pump vehicles (vehicle engine and special purpose body engine), sightseeing buses.

Maintenance by operating hours

Usage examples:

- Agricultural machinery:

  Combine harvesters, corn threshers, field choppers, sugar cane harvesters, beet lifters, potato lifters
- Construction machinery:

  Bulldozers, trench diggers, dumpers, road milling machines
- Working machinery:

  Drills, compressor assemblies, crushers, snow cutters – engine of special-purpose body, stone crushers, road sweepers – engine of special-purpose body
- Generators:

  Emergency power operation, continuous operation

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Maintenance intervals

Engine with BlueTec®

The maximum engine oil retention time in the engine must be observed (▷ page 53).

The following tables are valid for the following emission levels:

- Euro 4/5
- EUROMOT 3B
- Tier 4i

Engine use according to the specifications in the maintenance category overview.

Maintenance according to distance covered (km)

Oil grade according to Sheet Number	Maintenance category A	Maintenance category B	Maintenance category C
228.5/51	100000 km	50000 km	25000 km
228.2[4]/3/31	50000 km	30000 km	15000 km

Maintenance according to operating hours (h)

Oil grade according to Sheet Number	Maintenance category A	Maintenance category B	Maintenance category C
228.5/51	1400 h	900 h	500 h
228.2[24681012]/3/31	1100 h	700 h	400 h

Engine without BlueTec®

When using fuel with a higher sulphur content, the maintenance intervals must be reduced (▷ page 54).

The following tables are valid for the following emission levels:

- Euro 3
- EUROMOT 2/3A
- Tier 2/3

Engine use according to the specifications in the maintenance category overview.

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4 Only use single-grade oil in exceptional circumstances.
2 Einbereichsöl nur in Ausnahmefällen verwenden
6 N'utilisez une huile monograde que dans des cas exceptionnels.
8 Utilice aceites de motor monogrado solo en casos excepcionales
10 Utilizzare oli unigrado solo in casi eccezionali
12 Используйте сезонное моторное масло только в исключительных случаях.

Maintenance according to distance covered (km)

Oil grade according to Sheet Number	Maintenance category A	Maintenance category B	Maintenance category C
228.5/51	100000 km	50000 km	25000 km
228.2[24681012]/3/31	50000 km	30000 km	15000 km
228.0[24681012]/1	30000 km	20000 km	12000 km

Maintenance according to operating hours (h)

Oil grade according to Sheet Number	Maintenance category A	Maintenance category B	Maintenance category C
228.5/51	1400 h	900 h	500 h
228.2[24681012]/3/31	1100 h	700 h	400 h
228.0[24681012]/1	800 h	500 h	300 h

Maintenance

Maintenance

Maintenance due dates

Abbre-viation	Maintenance due date
M	Engine maintenance (depending on the distance/operating hours according to maintenance category, at least every 2 years)
J3	Time-based maintenance - Maintenance work should be carried out every 3 years
V2	Adjust the valve clearance (every 1st, 3rd, 5th, 7th etc. engine maintenance)
X	Vehicle scope - Maintenance due date is set by the vehicle manufacturer
Z	Additional scope for engine maintenance
Z2	Additional work (every 2nd, 4th, 6th, 8th etc. engine maintenance)
Z3	Additional work (every 3rd, 6th, 9th etc. engine maintenance)

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12 Используйте сезонное моторное масло только в исключительных случаях.

Maintenance	J3	M	V2	X	Z	Z2	Z3
Engine maintenance							
Oil and filter change		•					
Check the poly-V-belt for wear and damage		•					
Fuel prefilter: clean the filter element		•					
Fuel filter: replace filter element.		•					
Fuel prefilter with water separator: replace fuel filter element (fixed to the chassis)		•					
Additional engine maintenance work							
Check and adjust the valve clearance of the engine.			•				
Engine brake: check condition and setting.							•
Indicator lamps and warning systems: function check					•		
Check all equipment for leaks and condition. In the event of fluid loss, find the cause and remedy it.					•		
Check the air intake duct between the air filter, charge-air cooler and the engine for leaks and condition. In the event of leaks, find and rectify the cause. Vehicle scope: task descriptions are provided by the vehicle manufacturer.					•		
Cooling and heating system: check radiator, cables and hoses for leaks and condition. In the event of fluid loss or damage, find and rectify the cause. Vehicle scope: task descriptions are provided by the vehicle manufacturer.					•		
Check the exhaust system for leaks and condition. In the event of damage or leaks, find and rectify the cause. Vehicle scope: task descriptions are provided by the vehicle manufacturer.					•		
Check all reservoirs, units, covers, bellows and protective caps for leaks and condition. In the event of damage or fluid loss, find and rectify the cause. Vehicle scope: task descriptions are provided by the vehicle manufacturer.					•		
Check all lines, hoses and electrical cables for areas of abrasion and correct routing.					•		
Engine cooling system: check and adjust corrosion/antifreeze protection. Vehicle scope: task descriptions are provided by the vehicle manufacturer.					•		

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	J3	M	V2	X	Z	Z2	Z3
Charging the AdBlue® pressure reservoir					•		
Replace AdBlue® filter						•	
Time-based maintenance							
Renew coolant. Vehicle scope: task descriptions are provided by the vehicle manufacturer. Observe the coolant mixture ratio (interval between changes depends on the Sheet No. of the corrosion inhibitor/antifreeze in the Mercedes-Benz Specifications.	•						
Compressed-air dryer: replace granulate cartridge. Vehicle scope: task descriptions are provided by the vehicle manufacturer.				•			
Replace the air filter element. Vehicle scope: task descriptions are provided by the vehicle manufacturer.				•			

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English

Confirmations

Maintenance service/additional maintenance work

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

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Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

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Date	
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Maintenance/time-based maintenance/additional maintenance work

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Maintenance/time-based maintenance/additional maintenance work

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Operating hours (h)	
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Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

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Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

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Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

English

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

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- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

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- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

English

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

English

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

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- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

English

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

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- ☐ Air filter element
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- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
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- ☐ Air filter element
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- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
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Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

English

Date	
Odometer reading	
Operating hours (h)	
Job no.	

Maintenance/time-based maintenance/additional maintenance work

☐ M ☐ J3 ☐ V2 ☐ X

☐ Z ☐ Z2 ☐ Z3

Oil change

Engine

Viscosity	
Sheet No.	

Maintenance carried out in accordance with Daimler AG specifications:

Yes/No	

Replaced/renewed:

- ☐ Air filter element
- ☐ Fuel filter element
- ☐ Fuel prefilter with water separator: fuel filter element
- ☐ Compressed-air dryer: granulate cartridge(s)
- ☐ Coolant
- ☐ AdBlue®/DEF filter

Signature/stamp of the Mercedes-Benz or MTU Service Centre

TIM-ID: 0000096123 - 001

Imprint

Internet

Further information about MTU, Mercedes-Benz and Daimler AG can be found on the Internet at:

www.mtu-online.com

www.mercedes-benz.com

www.daimler.com

Documentation team

Should you have any questions or suggestions regarding this manual, you can reach the technical documentation team at the following address:

Daimler AG, HPC: CAC, Customer Service, 70546 Stuttgart, Germany

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Equipment manufacturer

Daimler AG

Mercedesstraße 137

70327 Stuttgart

Germany

TIM-ID: 0000096123 - 001

Engine-Oil and filter change

TIM-ID: 0000099517 - 001

Dokumenttitel Engine oil and filter change

Dokumentnummer ap1800g0101dd

TIM-ID: 0000099517 - 001

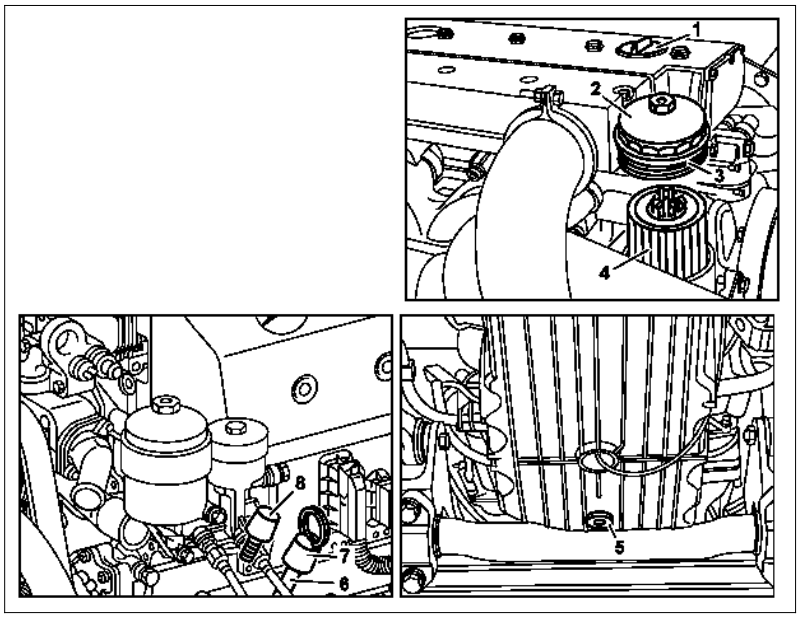
AP18.00-G-0101DD	Engine oil and filter change	11.6.15

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Modification notes

24.11.14	Contents completely revised.		

1 Cap
2 Threaded cap
3 Sealing ring
4 Oil filter element
5 Drain screw
6 Guide tube
7 Oil dipstick
8 Plug



G18.00-3172-06

⚠ **Danger !**	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
i	Notes on engine oil		AH18.00-N-0101-01B
	Lowering		
1	Replace oil filter element (4)	Nm Oil filter cover to oil filter housing	AP18.20-G-0100-04DD *BA18.20-N-1003-01L
2	Detach end cover (1)		
3	Pull oil dipstick (7) or stop plug (8) out of guide tube (6)	If the oil is extracted using the oil suction unit.	
4.1	Extract oil through guide tube (6)	If the oil is extracted using the oil suction unit. i Extract the oil only when the engine is at normal operating temperature. Engine oil suction unit - mobile gotis://S_18.1_02.0	
4.2	Remove drain screw (5) and drain oil	If the oil is drained from the oil pan. i Drain the oil only when the engine is at normal operating temperature. Used oil collector - mobile gotis://S_18.1_05.0	
5.1	Insert oil dipstick (7) or stop plug (8) into guide tube (6)	If the oil was extracted using the oil suction unit.	
5.2	Screw in drain screw (5) securely with a new sealing ring	If the oil was drained from the oil pan. Nm Oil drain screw to oil pan	*BA01.45-N-1002-01K

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Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.90/93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in mc

TIM-ID: 0000099517 - 001

	Filling		
6	Pour in engine oil	Refer to the owner's manual for the specified filling capacity as well as the quality of the engine oil.	
7	Attach end cover (1)		
	Check		
8	Start engine and observe oil pressure indicator with the engine running at idle speed	Do not rev up the engine while there is no oil pressure. The engine can otherwise be damaged. An oil pressure must be indicated after about 10 seconds. Engine oil pressure	*BE18.00-N-1001-01I
9	Switch off engine and check and correct oil level after a waiting time of approx. 5 min	See information provided by vehicle manufacturer or engine supplier.	
10	Check threaded cap (2) and, if necessary, drain screw (5) of oil pan for leaks	Visual inspection.	

Check values of engine oil pressure

Number	Designation			ENGINE 900.9, 902.9, 904.9, 906.9	ENGINE 924.9, 926.9
BE18.00-N-1001-01I	Engine oil pressure	idle speed	bar	≥0,5	≥0,5
		maximum speed	bar	≥2,5	≥2,5

Nm **Oil pan**

Number	Designation			ENGINE 900.9, 902.9, 904.9, 906.9, 924.9	ENGINE 926.9
BA01.45-N-1002-01K	Oil drain screw to oil pan	M20×1.5	Nm	65	65
		M26×1.5	Nm	85	–

Nm **Oil filter**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9	ENGINE 924.9, 926.9
BA18.20-N-1003-01L	Oil filter cover to oil filter housing	Nm	25	25

TIM-ID: 0000099517 - 001

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099517 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099517 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

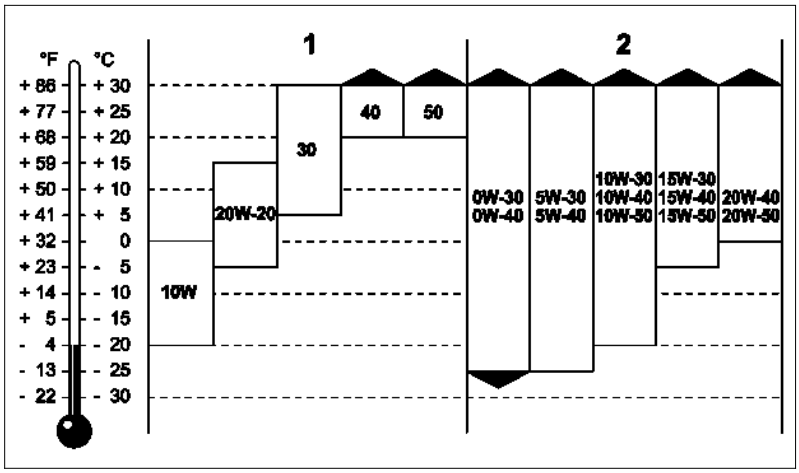
Dokumenttitel	Notes on engine oil
Dokumentnummer	ah1800n010101b

TIM-ID: 0000099517 - 001

AH18.00-N-0101-01B	Notes on engine oil		i

ENGINE 457.9 in MODEL 374, 375, 695, 940, 942, 943, 944, 949, 958
ENGINE 541.9 in MODEL 930, 932, 933, 934, 950, 952, 953, 954
ENGINE 542.9 in MODEL 930, 932, 934, 950, 952, 954
ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 925.9, 926.9

SAE viscosity class
The SAE viscosity class must be selected in accordance with the average air temperature for the specific season.
Strict application of SAE viscosity classes based on ambient air temperatures would require more frequent-oil changes. The temperature ranges for the SAE viscosity classes should therefore be regarded as a guide and the particular temperature may be higher or lower than that stated.



P00.40-2029-05

Specified engine oil quality
Certified engine oils are ones that have been named and approved in the valid version of the MB-Specifications for Operating Fluids.

Oil types for the different engine oil qualities are listed under the respective sheet number.

Vehicles without maintenance system
Refer to the maintenance booklet valid for the vehicle for the engine oil and oil filter change interval.
The intervals listed in the maintenance booklet depend on:
- Engine oil quality (sheet no. of the MB-Specifications for Operating Fluids)
- Fuel type (diesel or FAME)
- Sulfur content of fuel
- Vehicle usage

Vehicles with maintenance system
The point in time for an engine oil and oil filter change is calculated by the maintenance system and shown on the multifunction display. To this end, the following details must be entered into the maintenance system:
- Engine oil quality (sheet no. of the MB-Specifications for Operating Fluids)
- Used SAE viscosity class
- Fuel type (diesel or FAME)
- Sulfur content of fuel

TIM-ID: 0000099517 - 001

Dokumenttitel Replace oil filter element

Dokumentnummer ap1820g010004dd

TIM-ID: 0000099517 - 001

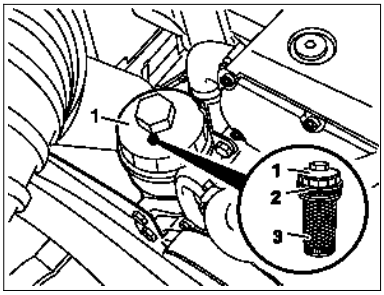
AP18.20-G-0100-04DD	Replace oil filter element		

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Nm **Oil filter**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9	ENGINE 924.9, 926.9
BA18.20-N-1003-01L	Oil filter cover to oil filter housing	Nm	25	25

1 Threaded cap
2 Sealing ring
3 Oil filter element



N18.20-0252-01

1 Unscrew threaded cap (1) of oil filter using socket wrench bit and allow oil to flow out of filter housing.

2 Remove threaded cap (1) with oil filter element (3) and unclip oil filter element (3) by pressing at side.

i Ensure that no foreign matter gets into the oil filter housing. Never wipe out the oil filter housing.

3 Replace sealing ring (2).

i Grease sealing ring (2) slightly.

4 Clip new oil filter element (3) into the threaded cap (1).

5 Screw on threaded cap (1) with oil filter element (3) and tighten Nm.

TIM-ID: 0000099517 - 001

© Daimler AG, 10.08.15, G/08/15, ap18.20-g-0100-04dd, Replace oil filter element

Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.90/93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in mc

Inspect poly-V-belt for wear and damage

TIM-ID: 0000099519 - 001

Dokumenttitel Inspect poly-V-belt for wear and damage

Dokumentnummer ap1322g1351dd

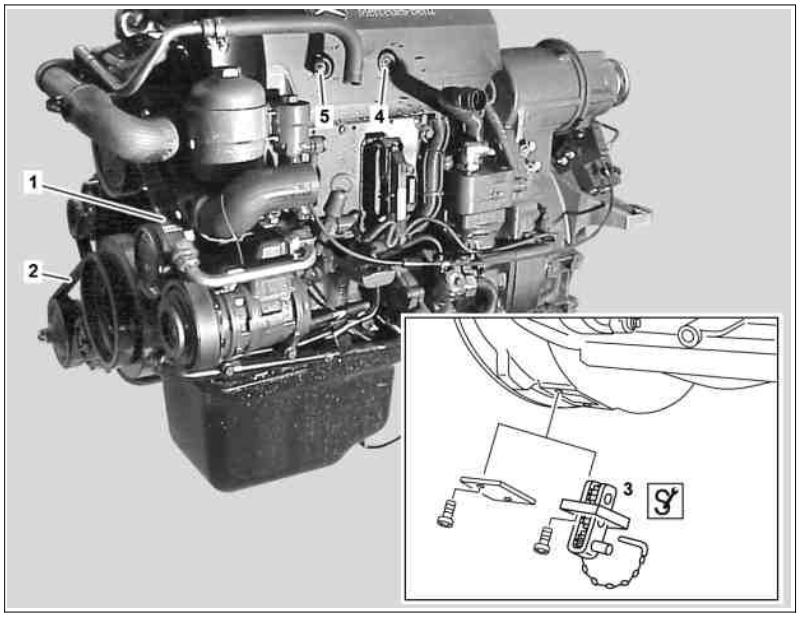
TIM-ID: 0000099519 - 001

AP13.22-G-1351DD	Inspect poly-V-belt for wear and damage	8.5.15

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Shown on engine 904

1 Poly-V-belt
2 Poly-V-belt
3 Turning device
4 Engine start button
5 Engine stop button



G13.22-3113-06

⚠ **Danger !**	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
	Check		
1 AR	Attach cranking device (3) to engine	Only when for test purposes the engine is cranked using the turning device (3). When the cranking device (3) is installed, the engine start button (4) must not be pressed. Otherwise the flywheel or the cranking device (3) may be damaged. Nm Bolt, turning device to timing case Turning device	AR03.30-G-1600-03DD *BA01.60-N-1003-01I *904589046300
2.1 AR	Crank engine using cranking device (3) while checking entire length of poly-V belts (1, 2) in sections for signs of wear and damage	Only when cranking the engine using the cranking device (3). Damage profiles for a poly-V belt If wear or damage is present: ↓ Replace the affected poly-V belts (1, 2).	AP13.22-D-1351-01A AR13.22-G-1202DD
2.2 AR	Crank engine gradually using engine start button (4) and engine stop button (5) while checking entire length of poly-V belts (1, 2) in sections for signs of wear and damage	Only when cranking engine with starter. Damage profiles for a poly-V belt If wear or damage is present: ↓ Replace the affected poly-V belts (1, 2).	AP13.22-D-1351-01A AR13.22-G-1202DD

© Daimler AG, 10.08.15, G/08/15, ap13.22-g-1351dd, Inspect poly-V-belt for wear and damage

Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.90/93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in mc

TIM-ID: 0000099519 - 001

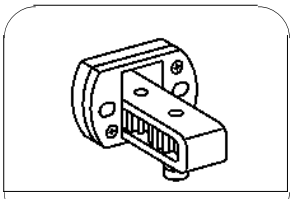
3 AR	Remove cranking device (3) from engine	Only when for test purposes the engine was cranked using the turning device (3). Nm Inspection hole cap to timing case Turning device	 AR03.30-G-1600-03DD *BA01.60-N-1002-01I *904589046300

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1002-01I	Inspection hole cap to timing case	Nm	25

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1003-01I	Bolt, turning device to timing case	Nm	25



904 589 04 63 00

Turning device

TIM-ID: 0000099519 - 001

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099519 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099519 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

Dokumenttitel	Attach/detach cranking/blocking device for engine
Dokumentnummer	ar0330g160003dd

TIM-ID: 0000099519 - 001

AR03.30-G-1600-03DD	Attach/detach cranking/blocking device for engine		

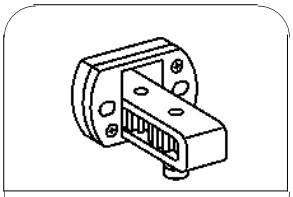
Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1002-01I	Inspection hole cap to timing case	Nm	25

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1003-01I	Bolt, turning device to timing case	Nm	25



904 589 04 63 00

Turning device

Installing

1 Remove cap (1) at flywheel housing.

2 Attach turning device (2) with screw/bolts (4) to the flywheel housing Nm.

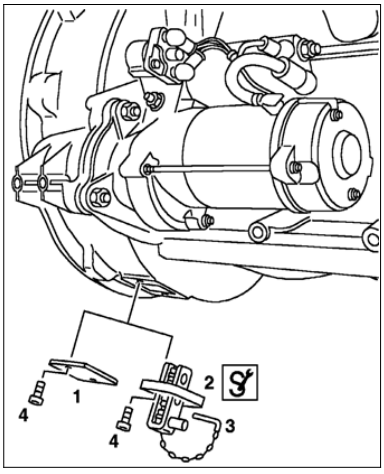
The cranking device (2) must be removed before starting the engine. The flywheel or the cranking device (2) will be damaged otherwise.

The cranking device (2) can be blocked by inserting the pin (3).

Remove

3 Remove turning device (2) from the flywheel housing.

4 Attach cap (1) with screw/bolts (4) on flywheel housing Nm.



W03.30-0001-02

TIM-ID: 0000099519 - 001

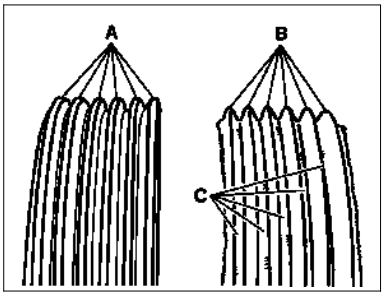
© Daimler AG, 10.08.15, G/08/15, ar03.30-g-1600-03dd, Attach/detach cranking/blocking device for engine

Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.90/93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in mo

Dokumenttitel	Damage patterns for poly V-belt
Dokumentnummer	ap1322d135101a

TIM-ID: 0000099519 - 001

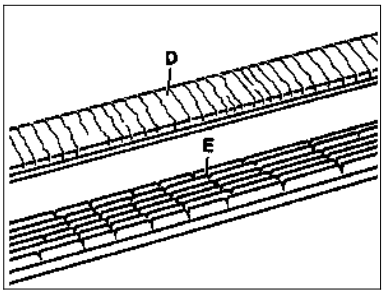
AP13.22-D-1351-01A	Damage patterns for poly V-belt		



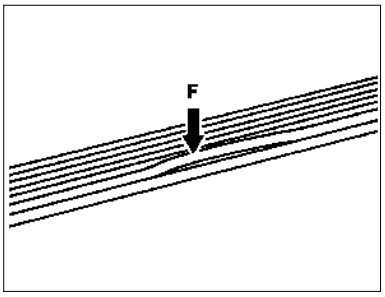
N13.22-2068-01

Wear to flank - ribs wedge-shaped (B) and cord visible in base of rib (C),
condition of ribs when new is trapezoidal in shape (A)

Splits across the back (D)
Splits across several ribs (E)



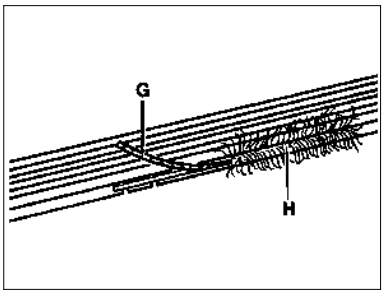
N13.22-2066-01



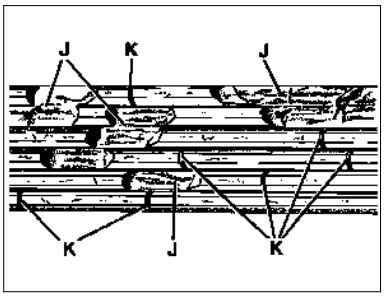
N13.22-2071-01

Rib detached from base of belt (F)

Strand torn out at the side (G), fraying (H) of outer strands



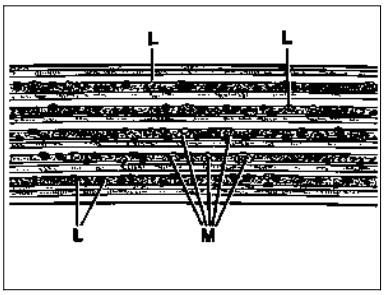
N13.22-2067-01



N13.22-2069-01

Sections of ribs broken out (J)
Splits across ribs (K),

Rubber lumps in base of rib (L)
Dirt or grit embedded (M)



N13.22-2070-01

TIM-ID: 0000099519 - 001

© Daimler AG, 10.08.15, G/08/15, ap13.22-d-1351-01a, Damage patterns for poly V-belt
ENGINE all

Dokumenttitel	Routing diagram for poly-V belt
Dokumentnummer	ar1322g390202dd

TIM-ID: 0000099519 - 001

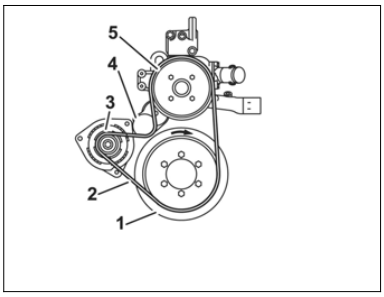
AR13.22-G-3902-02DD	Routing diagram for poly-V belt		

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Modification notes

24.11.14	Contents completely revised.		

1 *Belt pulley or vibration damper*
2 *Poly-V belt*
3 *Alternator belt pulley (if installed)*
4 *Tensioning device*
5 *Coolant pump belt pulley*
Pfeil *Direction of engine rotation*



W13.22-1029-01

TIM-ID: 0000099519 - 001

Remove/install poly-V-belt

TIM-ID: 0000099520 - 001

Dokumenttitel Remove/install poly-V belt

Dokumentnummer ar1322g1202dd

TIM-ID: 0000099520 - 001

AR13.22-G-1202DD	Remove/install poly-V belt	28.5.15

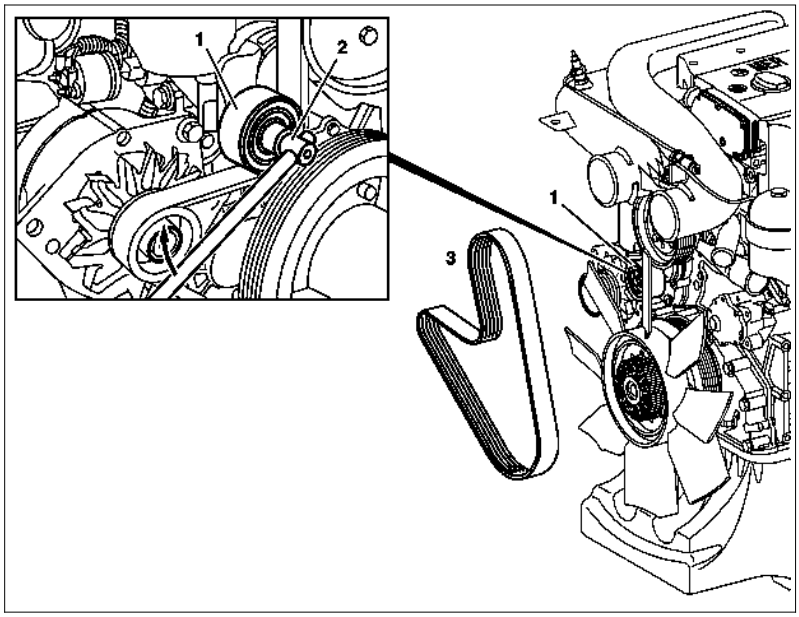
Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Modification notes

24.11.14	Contents completely revised.		
24.11.14	Contents completely revised.		AR13.22-G-3902-02DD

Shown on ENGINE 904.9

1 Tensioner pulley
2 Breaker bar and socket
3 Poly-V belt



W13.22-0004-06

	Remove		
1	Swivel and hold tensioner pulley (1) with breaker bar and socket (2) upwards (direction of arrow)	Only swivel clamping device against the spring tension of the tensioner pulley (1). The screw/bolt can loosen otherwise.	
2	Remove poly-V belt (3) from tensioner pulley (1)		
3	Swivel the tensioning device back and remove the poly-V belt (3)	Do not kink poly-V belt (3). Otherwise it may be damaged.	
	Check		
4	Check condition of poly-V belt (3)	If necessary: ↓ Replace poly-V belts (3). Damage profiles	 AP13.22-D-1351-01A
5	Check vibration damper, belt pulley of alternator and coolant pump and tensioning device with tensioner pulley (1)	If necessary: ↓ Replace damaged or worn parts. Belt pulley/vibration damper Poly-V belt tensioning device	 AR03.30-G-1600DD AR13.25-G-3200DD

TIM-ID: 0000099520 - 001

		Coolant pump	AR20.10-G-1271DD
	Install		
6	Fit poly-V belt (3) onto the belt pulley and the vibration damper	Routing diagram Do not fit the poly-V belt (3) onto the tensioner pulley (1) at this stage. Observe the routing diagram.	AR13.22-G-3902-02DD
7	Swivel and hold tensioner pulley (1) with breaker bar and socket (2) upwards (direction of arrow)	Only swivel clamping device against the spring tension of the tensioner pulley (1). The screw/bolt can loosen otherwise.	
8	Fit poly-V belt (3) onto tensioner pulley of tensioning device (1) and swivel tensioning device back, remove breaker bar and socket (2)		
	Check		
9	Check for correct seating of poly-V belt (3).	If necessary: ↓ Align poly-V belt (3).	

TIM-ID: 0000099520 - 001

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099520 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

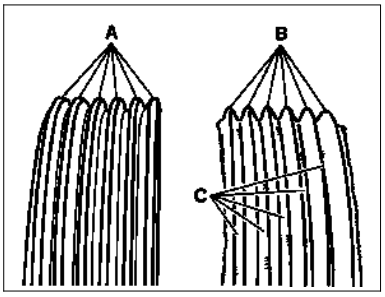
TIM-ID: 0000099520 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

Dokumenttitel	Damage patterns for poly V-belt
Dokumentnummer	ap1322d135101a

TIM-ID: 0000099520 - 001

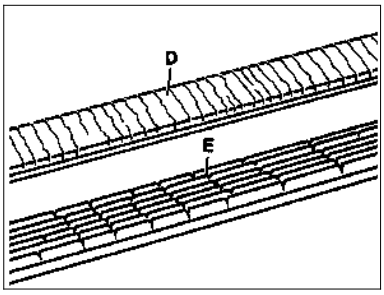
AP13.22-D-1351-01A	Damage patterns for poly V-belt		



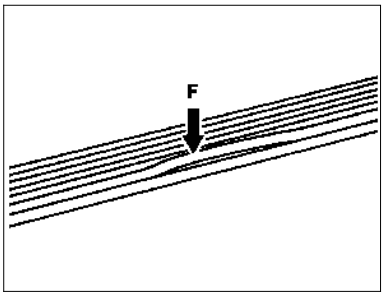
N13.22-2068-01

Wear to flank - ribs wedge-shaped (B) and cord visible in base of rib (C),
condition of ribs when new is trapezoidal in shape (A)

Splits across the back (D)
Splits across several ribs (E)



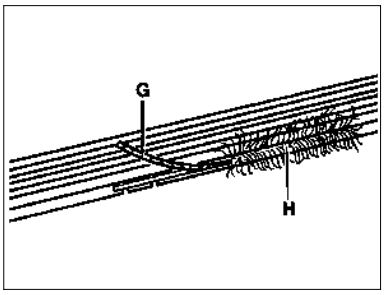
N13.22-2066-01



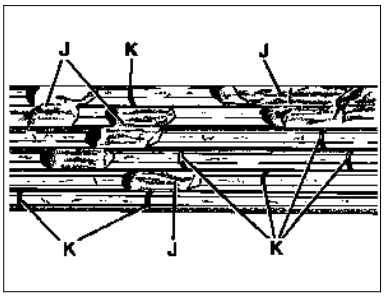
N13.22-2071-01

Rib detached from base of belt (F)

Strand torn out at the side (G), fraying (H) of outer strands



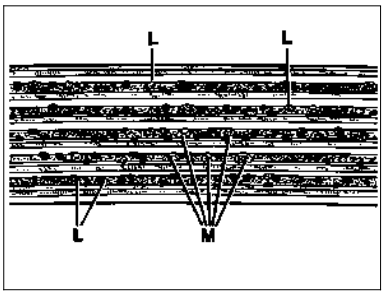
N13.22-2067-01



N13.22-2069-01

Sections of ribs broken out (J)
Splits across ribs (K),

Rubber lumps in base of rib (L)
Dirt or grit embedded (M)



N13.22-2070-01

TIM-ID: 0000099520 - 001

© Daimler AG, 10.08.15, G/08/15, ap13.22-d-1351-01a, Damage patterns for poly V-belt
ENGINE all

Dokumenttitel	Routing diagram for poly-V belt
Dokumentnummer	ar1322g390202dd

TIM-ID: 0000099520 - 001

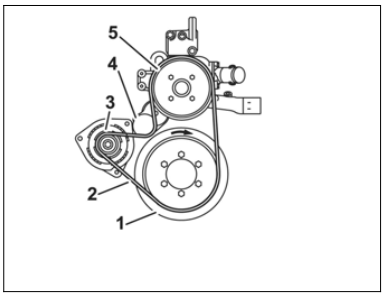
AR13.22-G-3902-02DD	Routing diagram for poly-V belt		

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Modification notes

24.11.14	Contents completely revised.		

1 *Belt pulley or vibration damper*
2 *Poly-V belt*
3 *Alternator belt pulley (if installed)*
4 *Tensioning device*
5 *Coolant pump belt pulley*
Pfeil *Direction of engine rotation*



W13.22-1029-01

TIM-ID: 0000099520 - 001

Clean filter element of fuel prefilter

TIM-ID: 0000099521 - 001

Dokumenttitel Clean filter element of fuel prefilter

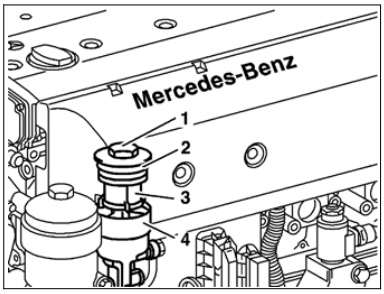
Dokumentnummer ap4720g0730dd

TIM-ID: 0000099521 - 001

AP47.20-G-0730DD	Clean filter element of fuel prefilter	11.5.15

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

1 Cap
2 Sealing ring
3 Filter element
4 Filter housing



G47.20-3114-01

⚠ **Danger !**	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
⚠ **Danger !**	**Risk of explosion** caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.	No fires, sparks, open flames or smoking. Pour fuels into suitable and appropriately marked containers only. Wear protective clothing when handling fuel.	AS47.00-Z-0001-01A
	Clean		
1	Open lid on fuel tank	i In order to reduce the overpressure in the fuel system.	
2	Clean exterior of filter housing (4)		
3	Unscrew screw cap (1) and pull out of filter housing (4) together with filter element (3)	i Ensure that no foreign bodies enter the filter housing (4). Do not wipe the filter housing (4) under any circumstances.	
4	Clean screw cap (1) and filter element (3)	With severely clogged or damaged filter element (3): ↓ Replace filter element (3).	
5	Replace seal (2)		
6	Apply a thin coating of grease to sealing ring (2)		
7	Screw on screw cap (1) with filter element (3) and tighten	Nm Cover to fuel prefilter housing	*BA47.20-N-1003-02I
8	Start the engine and bleed the fuel system	i Run engine for approx. 1 minute. The fuel system is bled automatically.	
9	Check leaktightness of filter housing (4) when the engine is running	i Visual inspection.	
10	Turn off engine		

Nm **Fuel filter**

Number	Designation		Engine 900.9 in model 000.001 Engine 902.9 in model 000.001 Engine 904.9 in model 000.001 Engine 906.903/91/92/93/94/95/96/97/98/99 in model 000.001	Engine 924.9 in model 000.001 Engine 926.9 in model 000.001
BA47.20-N-1003-02I	Cover to fuel prefilter housing	Nm	25	25

TIM-ID: 0000099521 - 001

© Daimler AG, 10.08.15, G/08/15, ap47.20-g-0730dd, Clean filter element of fuel prefilter

Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in model 000.

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099521 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099521 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work
MODEL ALL

Dokumenttitel	Risk of explosion caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.
Dokumentnummer	as4700z000101a

TIM-ID: 0000099521 - 001

AS47.00-Z-0001-01A	**Risk of explosion** caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.	No fires, sparks, open flames or smoking. Pour fuels into suitable and appropriately marked containers only. Wear protective clothing when handling fuel.	⚠ **Danger !**

ENGINE ALL
ENGINE ALL
except natural gas engine

Potential risks
Risk of explosion, poisoning and injury
Fuels are highly inflammable and toxic if taken. Fuel may cause damage to skin. For example, skin is degreased when it comes into contact with gasoline fuel. Fuel vapors are explosive, invisible and spread out across the floor. They are poisonous when inhaled and have an anesthetizing effect in high concentrations.
Safety precautions/instructions
- Pay attention to national safety precautions and regulations.
- No fires, sparks, open flames or smoking.
- Ensure the work place is adequately ventilated.
- Never drain or pour in fuels over maintenance pits.
- Store drained fuel in suitable and sealed containers.
- Immediately clean up any fuel which has leaked.

Performing work on a vehicle with open flame
(e.g. welding or similar)
- Remove the relevant parts of the fuel system before performing this type of work and seal open fuel lines with stop plugs.

First-aid measures
- Clean skin coated with fuel using water and soap.
- Change clothing coated with fuel as quickly as possible.
- If fuel gets into the eyes, rinse eyes with water immediately and consult a physician if necessary.

TIM-ID: 0000099521 - 001

© Daimler AG, 10.08.15, G/08/15, as47.00-z-0001-01a, Risk of explosion caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to ENGINE ALL ENGINE ALL except natural gas engine

Replace fuel filter

TIM-ID: 0000099522 - 001

Dokumenttitel Replace fuel filter

Dokumentnummer ap4720g0780dd

TIM-ID: 0000099522 - 001

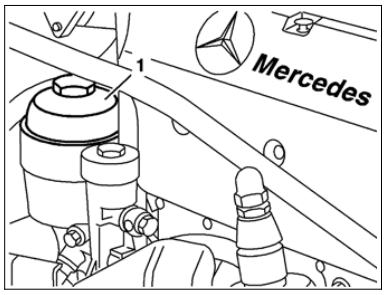
AP47.20-G-0780DD	Replace fuel filter	11.5.15

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

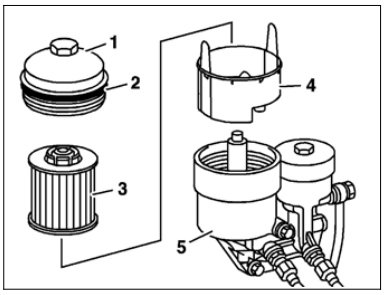
Modification notes

24.11.14	Contents completely revised.		

1 Threaded cap
2 Sealing ring
3 Filter element
4 Dirt collecting tank
5 Fuel filter housing



N07.57-0226-01



N07.57-0225-01

⚠ **Danger !**	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
⚠ **Danger !**	**Risk of explosion** caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.	No fires, sparks, open flames or smoking. Pour fuels into suitable and appropriately marked containers only. Wear protective clothing when handling fuel.	AS47.00-Z-0001-01A
	Remove		
1	Open lid on fuel tank	ℹ In order to reduce the overpressure in the fuel system.	
2	Remove threaded cap (1) from fuel filter housing (5)	ℹ Remove the screw cap (1) with the filter element (3) only after the fuel has drained out of the fuel filter housing (5).	
3	Remove threaded cap (1) with filter element (3) and unclip filter element (3) by pressing at side	ℹ Ensure that no foreign bodies get into the fuel filter housing (5) Under no circumstances rinse out the fuel filter housing (5).	
4	Pull out the dirt collecting tank (4) at the fishplate from the fuel filter housing (5)	Do not empty the dirt collecting tank (4) into the fuel filter housing (5), never wipe out the fuel filter housing (5) and make sure that the deposited dirt does not enter the fuel filter housing (5). The fuel system can otherwise be damaged.	
5	Clean threaded cap (1) and dirt collecting tank (4)		
	Install		
6	Replace seal (2)		
7	Apply a thin coating of grease to sealing ring (2)		
8	Insert new filter element (3) into the screw cap (1)		
9	Insert the dirt collecting tank (4) into the fuel filter housing (5)	ℹ Install components in correct positions.	
10	Screw on screw cap (1) with filter element (3) and tighten	Nm Cover on fuel filter housing	*BA47.20-N-1001-02I
11	Close cap on fuel tank		
12	Start the engine and bleed the fuel system	ℹ Run the engine for approx. 1 minute. The fuel system is ventilated automatically.	

TIM-ID: 0000099522 - 001

13	Check the fuel filter housing (5) for leaks when the engine is running		
14	Turn off engine		

Nm **Fuel filter**

Number	Designation		Engine 900.9 in model 000.001 Engine 902.9 in model 000.001 Engine 904.9 in model 000.001 Engine 906.903/91/92/93/94/95/96/97/98/99 in model 000.001	Engine 924.9 in model 000.001 Engine 926.9 in model 000.001
BA47.20-N-1001-02I	Cover on fuel filter housing	Nm	25	25

TIM-ID: 0000099522 - 001

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099522 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099522 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

Dokumenttitel	Risk of explosion caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.
Dokumentnummer	as4700z000101a

TIM-ID: 0000099522 - 001

AS47.00-Z-0001-01A	**Risk of explosion** caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to eyes and skin caused by contactwith fuel.	No fires, sparks, open flames or smoking. Pour fuels into suitable and appropriately marked containers only. Wear protective clothing when handling fuel.	⚠ **Danger !**

ENGINE ALL
ENGINE ALL
except natural gas engine

Potential risks
Risk of explosion, poisoning and injury
Fuels are highly inflammable and toxic if taken. Fuel may cause damage to skin. For example, skin is degreased when it comes into contact with gasoline fuel. Fuel vapors are explosive, invisible and spread out across the floor. They are poisonous when inhaled and have an anesthetizing effect in high concentrations.
Safety precautions/instructions
- Pay attention to national safety precautions and regulations.
- No fires, sparks, open flames or smoking.
- Ensure the work place is adequately ventilated.
- Never drain or pour in fuels over maintenance pits.
- Store drained fuel in suitable and sealed containers.
- Immediately clean up any fuel which has leaked.

Performing work on a vehicle with open flame
(e.g. welding or similar)
- Remove the relevant parts of the fuel system before performing this type of work and seal open fuel lines with stop plugs.

First-aid measures
- Clean skin coated with fuel using water and soap.
- Change clothing coated with fuel as quickly as possible.
- If fuel gets into the eyes, rinse eyes with water immediately and consult a physician if necessary.

TIM-ID: 0000099522 - 001

© Daimler AG, 10.08.15, G/08/15, as47.00-z-0001-01a, Risk of explosion caused by fuel igniting, risk of poisoning caused by inhaling and swallowing fuel as well as risk of injury to ENGINE ALL ENGINE ALL except natural gas engine

Set valve clearance

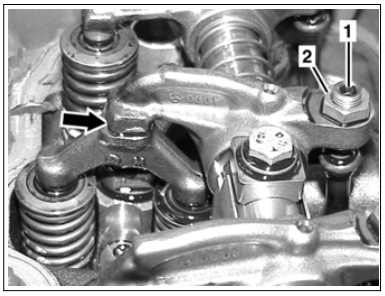
TIM-ID: 0000099523 - 001

Dokumenttitel	Set valve clearance
Dokumentnummer	ap0530g0560dd

TIM-ID: 0000099523 - 001

AP05.30-G-0560DD	Set valve clearance	18.1.11

ENGINE 900.91 /92, 902.91 /93, 904.94 /95 /96 /97, 906.90 /93 /94 /95 /96 /98 /99, 924.91 /93, 926.91 /92 /93 /95 /97 in MODEL 000.001



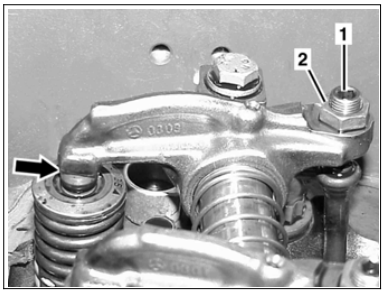
G05.30-3102-01

Inlet valve

1 Adjustment screw
2 Jam nut

Exhaust valve

1 Adjustment screw
2 Jam nut



G05.30-3103-01

	Remove/install		
1	Remove cylinder head cover Remove/install cylinder head cover	 Except engine 906.90 with code (MS8) Natural gas engine, Engine 906.90 with code (MS8) Natural gas engine	 AR01.20-G-5014DD AR01.20-G-5014DE
2 i i	Select adjustment method for valve clearance General information on adjustment of valve clearance General information on adjustment of valve clearance	Setting according to injection order: ↓ Engine 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 926.9 Method 1 Setting at two crankshaft positions: ↓ Engine 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 926.9 Method 2	 AH05.30-N-1000-01C AH05.30-N-1000-01D
3	Attach turning device for engine Attach/detach cranking/blocking device for engine	 Nm 	 AR03.30-G-1600-03DD *BA01.60-N-1003-01I *904589046300
4	Move engine into the crankshaft position of the selected setting method		
	Checking		
5	Inspect valve clearance (arrow) and adjust	i Check or adjust valve clearance when engine is cold only, at the earliest 30 min. following adjustment of the engine, to ensure uniform warming up. The same also applies for short-term operation. i The inspection tolerance of the valve clearance applies only to the inspection, not to the setting. Nm	AP05.30-G-0560-01DD *BE05.30-N-1012-01K *BE05.30-N-1013-01K *BA05.00-N-1002-01H
6	Detach turning device for engine Attach/detach cranking/blocking device for engine	 Nm 	 AR03.30-G-1600-03DD *BA01.60-N-1002-01I *904589046300
7	Install cylinder head cover Remove/install cylinder head cover	 Except engine 906.90 with code (MS8) Natural gas engine, Engine 906.90 with code (MS8) Natural gas engine	 AR01.20-G-5014DD AR01.20-G-5014DE
⚠ **Danger!** 8	**Risk of accident** caused by vehicle starting off by itself when engine is running. **Risk of injury** caused by contusions and burns during starting procedure or when working near the engine as it is running Start engine and inspect cylinder head cover for leaks	Secure vehicle to prevent it from moving by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A

TIM-ID: 0000099523 - 001

Check values for valves

Number	Designation			Engine 900.9 except 900.910, Engine 902.9 except 902.910/919, Engine 924.9, 926.9	Engine 900.910, Engine 902.910/919	Engine 906.901/902
BE05.30-N-1012-01K	Valve clearance	Inlet	mm	0.40	0.40	0.40
		Outlet	mm	0.60	0.60	0.60
BE05.30-N-1013-01K	Test tolerance for valve clearance	Inlet	mm	-0.05/+0.05	-0.05/+0.05	-0.05/+0.05
		Outlet	mm	-0.10/+0.10	-0.10/+0.10	-0.10/+0.10

Check values for valves

Number	Designation			Engine 904.9 up to end no. 039739, Engine 906.9 up to end no. 041955 except 906.901/902	Engine 904.9 up to end no. 039740, Engine 906.9 up to end no. 041956 except 906.901/902
BE05.30-N-1012-01K	Valve clearance	Inlet	mm	0.40	0.40
		Outlet	mm	0.60	0.60
BE05.30-N-1013-01K	Test tolerance for valve clearance	Inlet	mm	-0.05/+0.05	-0.05/+0.05
		Outlet	mm	-0.10/+0.10	-0.10/+0.10

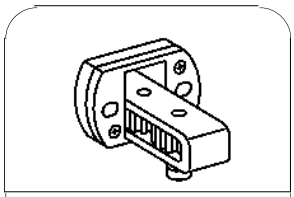
Nm Timing case

Number	Designation		Engine 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1002-01I	Inspection hole closure cover to timing case	Nm	25
BA01.60-N-1003-01I	Bolt, turning device to timing case	Nm	25

Nm Engine timing - general

TIM-ID: 0000099523 - 001

Number	Designation	Engines 900.9, 902.9	Engine 904.9, 906.9	Engines 924.9, 926.9
BA05.00-N-1002-01H	Jam nut on rocker arm adjustment screw Nm	25	25	25



904 589 04 63 00

Cranking device

TIM-ID: 0000099523 - 001

Dokumenttitel Remove/install cylinder head cover

Dokumentnummer ar0120g5014dd

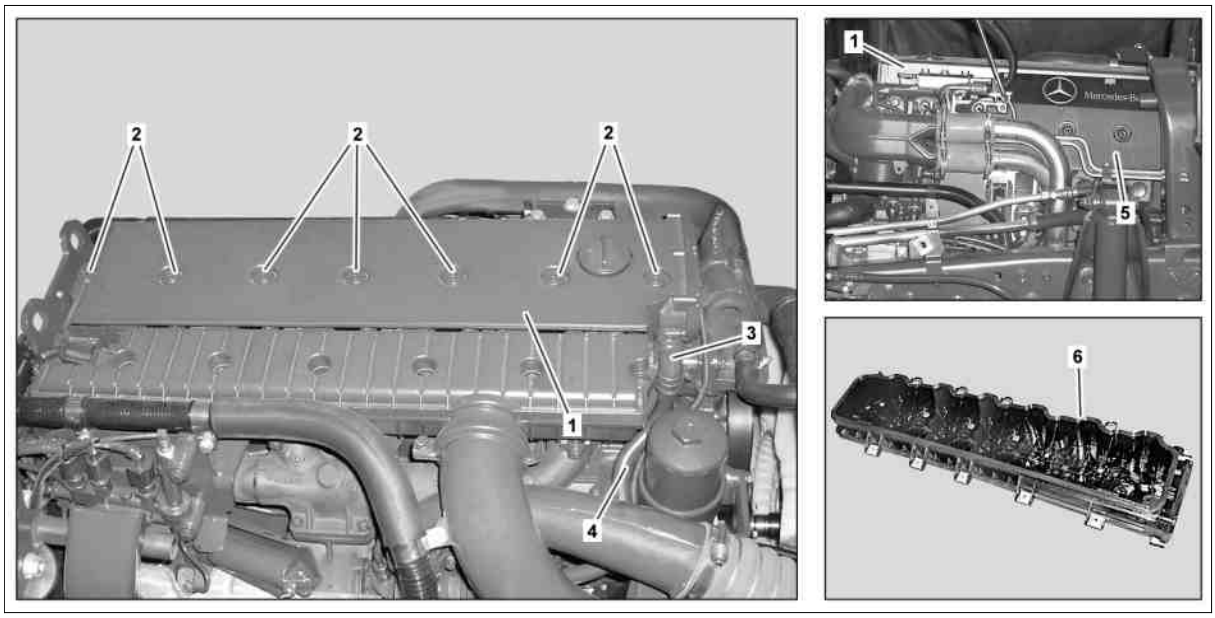
TIM-ID: 0000099523 - 001

AR01.20-G-5014DD	Remove/install cylinder head cover	12.5.15

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Modification notes

6.11.14	Contents completely revised.		



G01.20-3119-09

1 Cylinder head cover
2 Screw/bolts
3 Vent hose
4 Vent line
5 Engine cover
6 Seal

⚠ **Danger !**	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
	Remove/install		
1	Remove engine cover (5)	**Installation:** Only re-install the engine cover (5) after the leak test.	
2	Remove vent hose (3) on vent line (4)		
3	Check bleed hose (3) for damage	If damage is present: ↓ Replace vent hose (3).	
4	Remove cylinder head cover (1)	**Installation:** Clean the sealing surfaces of cylinder head cover (1) and the cylinder head. Replace sealing washers on screw/bolts (2) and seal (6). Nm Screw/bolt, cylinder head cover to cylinder head	*BA01.20-N-1001-01J
5	Install in the reverse order		

TIM-ID: 0000099923 - 001

6	Start engine and perform an engine test run	i Allow engine to run at a higher rotational speed.	
7	Stop engine and check in the area of cylinder head cover (1) for leaktightness		

Nm **Crankcase ventilation, cylinder head cover**

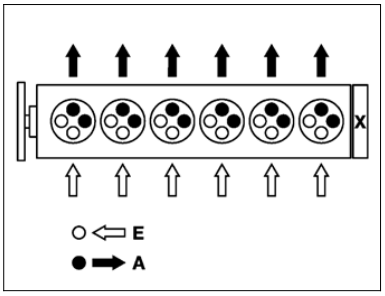
Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9	ENGINE 924.9, 926.9
BA01.20-N-1001-01J	Screw/bolt, cylinder head cover to cylinder head	Nm	30	30

TIM-ID: 0000099523 - 001

Dokumenttitel	General information on adjusting valve clearance
Dokumentnummer	ah0530n100001c

TIM-ID: 0000099523 - 001

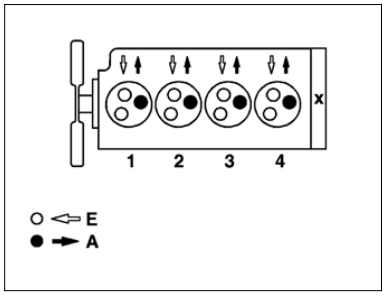
AH05.30-N-1000-01C	General information on adjusting valve clearance	Engine 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 925.9, 926.9 Method 1	i



A01.00-0001-01

Engine 457.9, 458.9

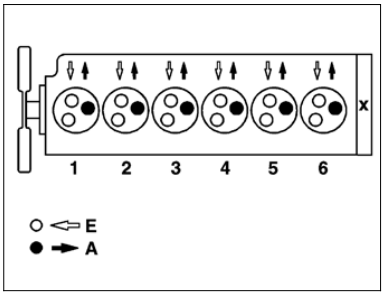
A *Outlet valve*
E *Inlet valve*
X *Flywheel side*



N01.00-0347-01

Engine 900.9, 904.9, 924.9

A *Outlet valve*
E *Inlet valve*
X *Flywheel side*



N01.00-0348-01

Engines 902.9, 906.9, 925.9, 926.9

A *Outlet valve*
E *Inlet valve*
X *Flywheel side*

Method 1:

Set inlet and exhaust valves for each cylinder, according to firing order.

The cylinder to be set must be at ignition TDC, the synchronized cylinder at overlap TDC.

Engine	Crankshaft position	Cylinder/injection order
4-cylinder	Ignition TDC	1 3 4 2
	Overlap TDC	4 2 1 3
6-cylinder	Ignition TDC	1 5 3 6 2 4
	Overlap TDC	6 2 4 1 5 3

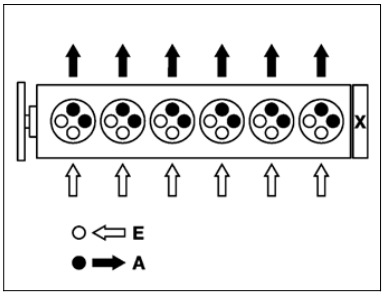
TIM-ID: 0000099523 - 001

© Daimler AG, 10.08.15, G/08/15, ah05.30-n-1000-01c, General information on adjusting valve clearance
ENGINE 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 925.9, 926.9 Methode 1

Dokumenttitel	General information on adjusting valve clearance
Dokumentnummer	ah0530n100001d

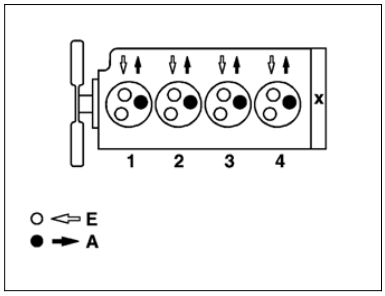
TIM-ID: 0000099523 - 001

AH05.30-N-1000-01D	General information on adjusting valve clearance	Engine 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 925.9, 926.9 Method 2	i



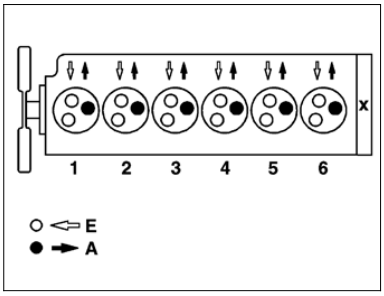
A01.00-0001-01

Engine 457.9, 458.9
A Outlet valve
E Inlet valve
X Flywheel side



N01.00-0347-01

Engine 900.9, 904.9, 924.9
A Outlet valve
E Inlet valve
X Flywheel side



N01.00-0348-01

Engines 902.9, 906.9, 925.9, 926.9
A Outlet valve
E Inlet valve
X Flywheel side

Method 2:
Set inlet and exhaust valves at two crankshaft positions, as shown in the table.

4-cylinder
Position cylinder 4 in the valve overlap TDC (cylinder 1 in ignition TDC), then position cylinder 1 in valve overlap TDC (cylinder 4 in ignition TDC).

6-cylinder
Position cylinder 6 in the valve overlap TDC (cylinder 1 in ignition TDC), then position cylinder 1 in valve overlap TDC (cylinder 6 in ignition TDC).

Engine	Crankshaft position	Cylinder/valves to be set					
		1	2	3	4	5	6
4-cylinder	Cylinder 4 valve overlap TDC	E/A	R	A	-		
	Cylinder 1 valve overlap TDC	-	A	R	E/A		
6-cylinder	Cylinder 6 valve overlap TDC	E/A	R	A	R	A	-
	Cylinder 1 valve overlap TDC	-	A	R	A	R	E/A

TIM-ID: 0000099523 - 001

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ENGINE 457.9, 458.9, 900.9, 902.9, 904.9, 906.9, 924.9, 925.9, 926.9 Methode 2

Dokumenttitel Attach/detach cranking/blocking device for engine

Dokumentnummer ar0330g160003dd

TIM-ID: 0000099923 - 001

AR03.30-G-1600-03DD	Attach/detach cranking/blocking device for engine		

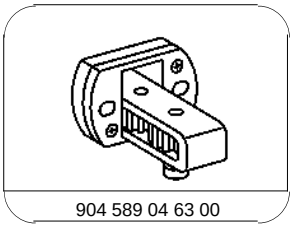
Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1002-01I	Inspection hole cap to timing case	Nm	25

Nm **Timing case**

Number	Designation		ENGINE 900.9, 902.9, 904.9, 906.9, 924.9, 926.9
BA01.60-N-1003-01I	Bolt, turning device to timing case	Nm	25



904 589 04 63 00

Turning device

Installing

1 Remove cap (1) at flywheel housing.

2 Attach turning device (2) with screw/bolts (4) to the flywheel housing Nm.

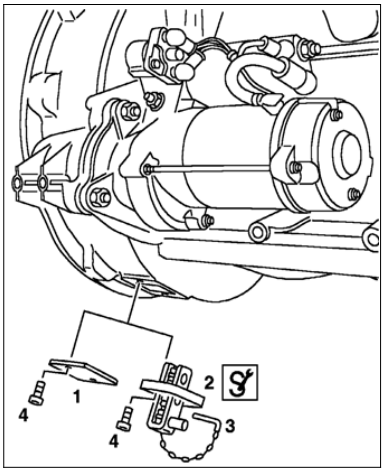
The cranking device (2) must be removed before starting the engine. The flywheel or the cranking device (2) will be damaged otherwise.

The cranking device (2) can be blocked by inserting the pin (3).

Remove

3 Remove turning device (2) from the flywheel housing.

4 Attach cap (1) with screw/bolts (4) on flywheel housing Nm.



W03.30-0001-02

TIM-ID: 0000099523 - 001

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Engine 900.91/92 in model 000.001 Engine 902.91/93 in model 000.001 Engine 904.94/95/96/97 in model 000.001 Engine 906.90/93/94/95/96/98/99 in model 000.001 Engine 924.91/93/94 in mo

Dokumenttitel	Check and adjust valve clearance
Dokumentnummer	ap0530g056001dd

TIM-ID: 0000099523 - 001

AP05.30-G-0560-01DD	Check and adjust valve clearance		

Engine 900.91/92 in model 000.001
Engine 902.91/93 in model 000.001
Engine 904.94/95/96/97 in model 000.001
Engine 906.90/93/94/95/96/98/99 in model 000.001
Engine 924.91/93/94 in model 000.001
Engine 926.91/92/93/95/97/98 in model 000.001

Check values for valves

Number	Designation			ENGINE 900.9 (except 900.910), ENGINE 902.9 (except 902.910/919), ENGINE 924.9, 926.9	ENGINE 900.910 ENGINE 902.910/919
BE05.30-N-1012-01K	Valve clearance	Inlet	mm	0,40	0,40
		Outlet	mm	0,60	0,60

Check values for valves

Number	Designation			ENGINE 906.901/902	ENGINE 904.9## ## up to 039739, ENGINE 906.9## (except 906.901/902) ## up to 041955
BE05.30-N-1012-01K	Valve clearance	Inlet	mm	0,40	0,40
		Outlet	mm	0,60	0,60

Check values for valves

Number	Designation			ENGINE 904.9## ## as of 039740, ENGINE 906.9## (except 906.901/902) ## as of 041956
BE05.30-N-1012-01K	Valve clearance	Inlet	mm	0,40
		Outlet	mm	0,60

Check values for valves

Number	Designation			ENGINE 900.9 (except 900.910), ENGINE 902.9 (except 902.910/919), ENGINE 924.9, 926.9	ENGINE 900.910 ENGINE 902.910/919
BE05.30-N-1013-01K	Test tolerance for valve clearance	Inlet	mm	–0,05/+0,05	–0,05/+0,05
		Outlet	mm	–0,10/+0,10	–0,10/+0,10

TIM-ID: 0000099523 - 001

Check values for valves

Number	Designation			ENGINE 906.901/902	ENGINE 904.9## ## up to 039739, ENGINE 906.9## (except 906.901/902) ## up to 041955
BE05.30-N-1013-01K	Test tolerance for valve clearance	Inlet	mm	–0,05/+0,05	–0,05/+0,05
		Outlet	mm	–0,10/+0,10	–0,10/+0,10

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Check values for valves

Number	Designation			ENGINE 904.9## ## as of 039740, ENGINE 906.9## (except 906.901/902) ## as of 041956
BE05.30-N-1013-01K	Test tolerance for valve clearance	Inlet	mm	–0,05/+0,05
		Outlet	mm	–0,10/+0,10

Nm **Engine timing - general**

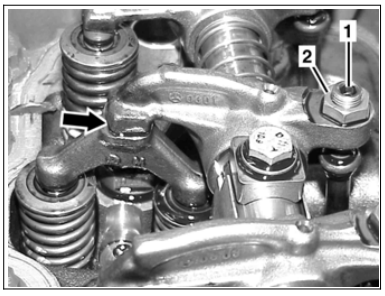
Number	Designation		Engine 900.9, 902.9 in model 000.001	Engine 904.9, 906.9 in model 000.001
BA05.00-N-1002-01H	Jam nut on rocker arm adjustment screw	Nm	25	25

Nm **Engine timing - general**

Number	Designation		Engine 924.9, 926.9 in model 000.001
BA05.00-N-1002-01H	Jam nut on rocker arm adjustment screw	Nm	25

000 589 10 99 00

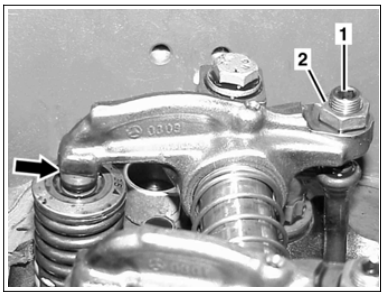
Tool kit



G05.30-3102-01

Inlet valve
1 Adjustment screw
2 Jam nut

Outlet valve
1 Adjustment screw
2 Jam nut



G05.30-3103-01

1 Use feeler gauge to check valve clearance (arrow) between rocker arm and valve bridge (intake valves)or valve stem (exhaust valves).

i The valve clearance (arrow) must be adjusted if it is outside the test tolerance.

i Use the "14 mm" open end wrench bit from the tool kit.

4 Check the valve clearance (arrow) again.

TIM-ID: 0000099923 - 001

© Daimler AG, 10.08.15, G/08/15, ap05.30-g-0560-01dd, Check and adjust valve clearance

If the valve clearance (arrow) is outside the tolerance:

2 Loosen jam nut (2) and set valve clearance (arrow) on adjustment screw (1).

Correct valve clearance (arrow).

i The valve clearance (arrow) is correctly set, if it is possible to pull the feeler gauge through with a slight resistance.

3 Counterhold adjustment screw (1) and tighten jam nut (2) Nm.

TIM-ID: 0000099523 - 001

Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099523 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099523 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

Engine cooling system-check fluid level, adjust to correct level. Inspect anticorrosion/antifreeze protection, adjust to correct concentration

TIM-ID: 0000099524 - 001

Dokumenttitel	Engine cooling system - check fluid level, adjust to correct level. Inspect anticorrosion/antifreeze protection, adjust to correct concentration
Dokumentnummer	ap2000g2010mt

TIM-ID: 0000099524 - 001

AP20.00-G-2010MT	Engine cooling system - check fluid level, adjust to correct level. Inspect anticorrosion/antifreeze protection, adjust to correct concentration	30.3.09

MODEL 000.001 with ENGINE 444.9, 447.9, 457.9, 458.9, 541.9, 542.9, 900.9, 902.9, 904.9, 906.9, 907.9, 909.9, 924.9, 926.9, 941.9, 942.9

	Check		
⚠ **Danger!**	**Risk of injury** to skin and eyes caused by scalding from contact with hot coolant spray. **Risk of poisoning** caused by swallowing coolant.	Do not open cooling system unless coolant temperature is below 90°C. Open cap slowly and release the pressure. Do not pour coolant into beverage containers. Wear protective gloves, protective clothing and safety glasses.	AS20.00-Z-0001-01A
1	Open filler neck for coolant	ℹ See Operator's Manual	
2	Check anticorrosion agent and antifreeze concentration, correct if necessary	ℹ See Operator's Manual ℹ If there is insufficient anticorrosion agent and antifreeze in the coolant, the concentration of anticorrosion agent and antifreeze must be corrected: ↓ Correct the corrosion protection or antifreeze protection	AP20.00-G-2010-01MT
BB	Coolant specifications	Sheet 310.1	BB00.40-P-0310-01A
BB	Anticorrosion/antifreeze agents (Sheet 325.2)	Sheet 325.2 Antifreeze tester gotis://D_13/20_03.0	BB00.40-P-0325-02A
3	Check coolant level, correct if necessary	ℹ See Operator's Manual ℹ The coolant temperature must be below 50 °C. The specified composition of the coolant must be guaranteed.	
	Notes on coolant	All engines	AH20.00-N-2080-01A
4	Close filler neck for coolant	ℹ See Operator's Manual	

TIM-ID: 0000099524 - 001

© Daimler AG, 10.08.15, G/08/15, ap20.00-g-2010mt, Engine cooling system - check fluid level, adjust to correct level. Inspect anticorrosion/antifreeze protection, adjust to correct . Seite 1 von 1
MODEL 000.001 with ENGINE 444.9, 447.9, 457.9, 458.9, 541.9, 542.9, 900.9, 902.9, 904.9, 906.9, 907.9, 909.9, 924.9, 926.9, 941.9, 942.9

Dokumenttitel	Notes on coolant
Dokumentnummer	ah2000n208001a

TIM-ID: 0000099524 - 001

AH20.00-N-2080-01A	Notes on coolant		

ENGINE 100, 102, 103, 104, 110, 111, 112, 113, 114, 115, 116, 117, 119, 120, 121, 123, 127, 129, 130, 133, 137, 152, 155, 156, 157, 159, 166, 177, 178, 180, 266, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 285, 601, 602, 603, 604, 605, 606, 607, 611, 612, 613, 615, 616, 617, 621, 626, 628, 629, 640, 642, 646, 647, 648, 651, 668, 780 (except 780.991)

ENGINE ALL

Coolant composition

Car and commercial vehicle engines (normal case):

50% water and 50% anticorrosion or antifreeze.

For different coolant composition for CV engines, refer to **MB Specifications for Operating Fluids**.

Coolant composition OM 607 or M 200 in model 415

Hot countries:

60% water and 40% anticorrosion or antifreeze.

Cold countries:

50% water and 50% anticorrosion or antifreeze.

In the model series 415 the anticorrosion/antifreeze "Arteco ETX 9536 B" (yellow fluorescent) is used at the factory. With this anticorrosion/antifreeze, the antifreeze protection configured at the factory will change in comparison to previous Mercedes-Benz van model series. The antifreeze protection is set between -25 °C and -37 °C ex factory and does not need to be adjusted. This results in a different coolant composition. Observe **MB-Specifications for Operating Fluids**.

Tasks of anticorrosion/antifreeze agent

- Corrosion and cavitation protection for all components in the engine cooling system
- Antifreeze
- Increasing the boiling point so that coolant does not evaporate so rapidly. Avoiding ejection of coolant at high coolant temperatures.

Antifreeze

50% anticorrosion or antifreeze by volume provides antifreeze protection for up to approx. **-37 °C**. A higher concentration is only necessary if the ambient temperatures are even lower. 55% anticorrosion or antifreeze agent by volume provides antifreeze protection for up to approx. **-45 °C**.

For model series 415 with OM 607 or M 200, the factory-adjusted anticorrosion or antifreeze agent by volume is 40_% (hot countries) or 50_% (cold countries). This provides up to **-25 °C** or up to **-37 °C**.

A concentration of more than 55% anticorrosion/antifreeze agent by volume should not be used as the maximum antifreeze protection is already reached at this concentration.

An even higher concentration reduces the anti-freeze protection and impairs heat dissipation. Reduced heat dissipation can result in damage to components of the engine cooling system and to the engine.

Water

Use water which is clean and not too hard. Drinking water often satisfies the requirements, but not always. The amount of dissolved substances in the water may be of significance for the occurrence of corrosion. If doubt exists, analyze the water.

For fresh water specifications refer to **MB Specifications for Operating Fluids**.

Operational monitoring of coolant

Inspect the coolant for resistance to low temperatures before the start of the cold season.

In countries with high ambient temperatures, check concentration of anticorrosion/antifreeze agent once a year.

The corrosion protection in the coolant is depleted during operation. Old coolant, in which the corrosion protection is mainly depleted, is extremely corrosive.

Period of use

The maximum permissible period of use of the coolant is given in the maintenance booklet, the applicable "Service/Maintenance Sheet" or the **MB-Specifications for Operating Fluids**.

For the period of use for a deviating coolant composition for CV engines, refer to **MB Specifications for Operating Fluids**.

Before pouring in fresh coolant, flush the used coolant out of the engine cooling system.

In case of severe soiling or oil streaks, clean engine cooling system.

Otherwise engine cooling system components may be damaged.

If the drained coolant is used again, it is essential that the coolant is filtered before being filled into the engine cooling system.

Dust particles must not enter into the engine cooling system. Otherwise engine cooling system components may be damaged.

Disposing of coolants

Observe the legal provisions and local waste water regulations. The following brochure is available about disposing of waste products in auto repair trade for the location Federal Republic of Germany:

"Environmental protection manual for motor vehicle repair operations"

Publisher: German Association of the Automotive Industry e. V. (VDA)

60325 Frankfurt am Main, Westendstraße 61

TIM-ID: 0000099524 - 001

Dokumenttitel	Risk of injury to skin and eyes suffering scalding from contact with hot coolantspray. Risk of poisoning from swallowing coolant.
Dokumentnummer	as2000z000101a

TIM-ID: 0000099524 - 001

AS20.00-Z-0001-01A	**Risk of injury** to skin and eyes suffering scalding from contact with hot coolantspray. **Risk of poisoning** from swallowing coolant.	Do not open cooling system unless coolant temperature is below 90 °C. Open cap slowly and release the pressure. Do not pour coolant into beverage containers. Wear protective gloves, protective clothing and safety glasses.	⚠ **Danger !**

ENGINE ALL

Potential risks

Risk of injury

When the engine is warm, the cooling system is pressurized. If the cooling system is opened suddenly, there is a **risk of scalding** from hot coolant which splashes out.

Risk of poisoning

If coolant is swallowed, this can result in symptoms of poisoning such as headaches, dizziness, stomach ache, respiratory paralysis, unconsciousness, vomiting and cramps.

Safety precautions/instructions

- Allow cooling system to cool down to a coolant temperature of less than 90 °C.
- Open coolant cap slowly; in the case of a conventional coolant cap, turn it as far as the first detent and in the case of a screwed coolant cap, turn approx. $^1/_2$ turn and release the pressure.
- Wear protective gloves, protective clothing and safety glasses.
- Do not pour coolant into beverage containers.

First aid measures

- Rinse affected skin with large quantities of cold water and cover with sterile dressing.
- Drink plenty of water with medicinal charcoal additive.
- If the person has suffered severe burns or has swallowed coolant, contact a physician.

TIM-ID: 0000099524 - 001

© Daimler AG, 10.08.15, G/08/15, as20.00-z-0001-01a, Risk of injury to skin and eyes suffering scalding from contact with hot coolantspray. Risk of poisoning from swallowing cool

Dokumenttitel Correcting anticorrosion/antifreeze concentration

Dokumentnummer ap2000g201001mt

TIM-ID: 0000099524 - 001

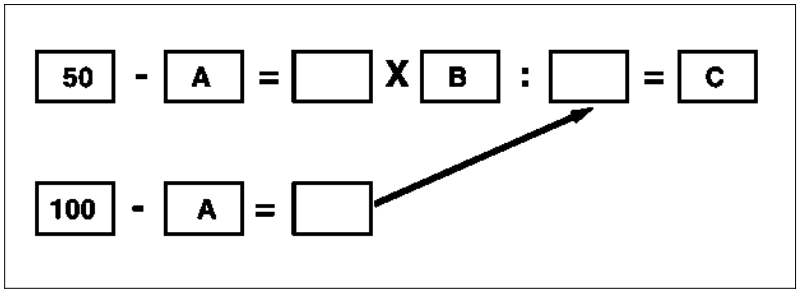
AP20.00-G-2010-01MT	Correcting anticorrosion/antifreeze concentration		
⚠ **Danger!**	**Risk of accident** caused by vehicle starting off by itself when engine is running. **Risk of injury** caused by contusions and burns during starting procedure or when working near the engine as it is running	Secure vehicle to prevent it from moving by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	AS00.00-Z-0005-01A
⚠ **Danger!**	**Risk of injury** to skin and eyes caused by scalding from contact with hot coolant spray. **Risk of poisoning** caused by swallowing coolant.	Do not open cooling system unless coolant temperature is below 90°C. Open cap slowly and release the pressure. Do not pour coolant into beverage containers. Wear protective gloves, protective clothing and safety glasses.	AS20.00-Z-0001-01A

Comparison table (specifications "approx.")
Antifreeze protection in [°C] and anticorrosion agent and antifreeze concentration in [vol %]

°C	vol %	°C	vol %	°C	vol %
–10	20	–20	32	–30	42
–15	26	–25	37	–33	45
–18	30	–27	40	–37	50

Calculation table of refill quantity of anticorrosion agent and antifreeze

A *Determined anticorrosion agent and antifreeze concentration (in % by volume)*
B *Total coolant filling capacity (in liters)*
C *Replenishment quantity of anticorrosion agent and antifreeze (in liters)*



N20.00-0377-04

1 Enter determined anticorrosion agent and antifreeze concentration (A) in the calculation table.

2 Obtain the total coolant filling quantity (B) from the manufacturer's operator's manual and enter in the calculation table.

3 Calculate refill quantity of anticorrosion agent and antifreeze (C).

4 Remove drain screw on radiator and drain as much coolant as is to be poured in again as refill quantity of anticorrosion agent and antifreeze (C).
ⓘ Installation location of drain screw: See operator's manual.

5 Screw drain screw into the radiator again.

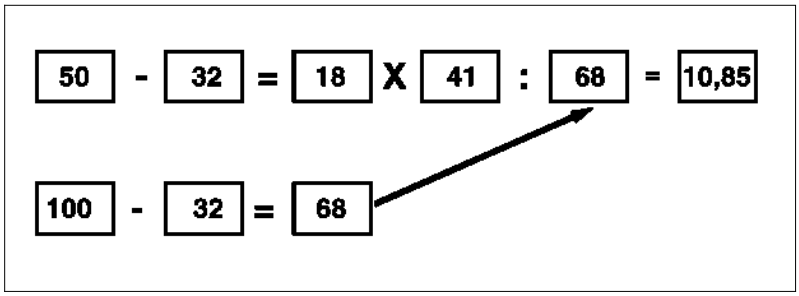
6 Pour the calculated refill quantity of anticorrosion agent and antifreeze (C) into the cooling system.

7 Start engine and run for about one minute at varying revs.

8 Switch off engine.

Example

- Determined anticorrosion agent and antifreeze concentration (A): 32 % by volume (corresponds to antifreeze protection down to –20 °C)
- Complete coolant filling capacity (B): 41 liters
- Refill quantity of anticorrosion agent and antifreeze (C): 10.85 liters



N20.00-0376-04

TIM-ID: 0000099524 - 001

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MODEL 000.001 with ENGINE 444.9, 447.9, 457.9, 458.9, 470.9, 471.9, 541.9, 542.9, 900.9, 902.9, 904.9, 906.9, 907.9, 909.9, 924.9, 926.9, 941.9, 942.9

Dokumenttitel	Risk of injury to skin and eyes suffering scalding from contact with hot coolantspray. Risk of poisoning from swallowing coolant.
Dokumentnummer	as2000z000101a

TIM-ID: 0000099524 - 001

AS20.00-Z-0001-01A	**Risk of injury** to skin and eyes suffering scalding from contact with hot coolantspray. **Risk of poisoning** from swallowing coolant.	Do not open cooling system unless coolant temperature is below 90 °C. Open cap slowly and release the pressure. Do not pour coolant into beverage containers. Wear protective gloves, protective clothing and safety glasses.	⚠ **Danger !**

ENGINE ALL

Potential risks

Risk of injury

When the engine is warm, the cooling system is pressurized. If the cooling system is opened suddenly, there is a **risk of scalding** from hot coolant which splashes out.

Risk of poisoning

If coolant is swallowed, this can result in symptoms of poisoning such as headaches, dizziness, stomach ache, respiratory paralysis, unconsciousness, vomiting and cramps.

Safety precautions/instructions

- Allow cooling system to cool down to a coolant temperature of less than 90 °C.
- Open coolant cap slowly; in the case of a conventional coolant cap, turn it as far as the first detent and in the case of a screwed coolant cap, turn approx. $^1/_2$ turn and release the pressure.
- Wear protective gloves, protective clothing and safety glasses.
- Do not pour coolant into beverage containers.

First aid measures

- Rinse affected skin with large quantities of cold water and cover with sterile dressing.
- Drink plenty of water with medicinal charcoal additive.
- If the person has suffered severe burns or has swallowed coolant, contact a physician.

TIM-ID: 0000099524 - 001

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Dokumenttitel	Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from working on the engine while it is being started or when it is running.
Dokumentnummer	as0000z000501a

TIM-ID: 0000099524 - 001

AS00.00-Z-0005-01A	**Risk of accident** from vehicle starting off by itself when engine running. **Risk of injury** (bruises and burns) resulting from working on the engine while it is being started or when it is running.	Secure vehicle to prevent it from starting off by itself. Wear closed and snug-fitting work clothes. Do not touch hot or rotating parts.	⚠ **Danger !**

MODEL ALL

Potential risks

Risk of accident

Caused by the vehicle driving off by itself while being started (e.g. during compression test) **due to engaged gear** or with the engine running and vehicles with automatic transmission **due to selector lever position "P" or "N"** not being engaged (except for vehicles that do not have selector lever position "P").

Risk of injury

Severe injuries can occur near a running engine caused by its rotating parts.

Because the engine heats up when operating, serious burns can be caused by touching unshielded parts.

Safety instructions/precautions

- In general, only work on a running engine when it is absolutely necessary.
- **Apply parking brake** before starting the engine.
- The vehicle is to be secured against moving forwards or backwards.
- The person performing tests on vehicles with engines running must sit in the driver seat to be able to prevent the vehicle from moving.
- It is not permitted for persons to be in the hazard area in front of and behind the vehicle while performing tests.
- **Shift the gearshift lever to neutral** on vehicles with manual transmission.
- On vehicles with automatic transmission, move **selector lever into position "P" or "N"** (exception for vehicles that do not have selector lever position "P").
- On vehicles that do not have selector lever position "P", the **selector lever** is to be **secured against unauthorized access** .
- Wear closed and snug-fitting work clothes.
- Remove all jewelry such as chains, rings, etc.
- Wear suitable head wear to cover long hair.
- Before commencing any work on the running engine, familiarize yourself with the location of potentially hot parts.
- When carrying out work when starting the engine or when engine is running **do not touch any hot and rotating parts.**

First aid measures in the event of burns

- Do not rub the skin areas affected; rinse with plenty of cold water and cover skin with sterile dressings.
- Consult a physician immediately.

TIM-ID: 0000099524 - 001

© Daimler AG, 10.08.15, G/08/15, as00.00-z-0005-01a, Risk of accident from vehicle starting off by itself when engine running. Risk of injury (bruises and burns) resulting from work

Dokumenttitel	Coolant specifications
Dokumentnummer	bb0040p031001a

TIM-ID: 0000099524 - 001

MODEL ALL

Note: These regulations apply to the Mercedes-Benz, Maybach, smart and Setra brands.

1. Terms used

Antifreeze with corrosion inhibitor, KFM:
Component of the coolant for combustion engines as corrosion and antifreeze protection, for lowering the freezing point as well as raising the boiling point.

Coolant, KM:
Mixture of antifreeze with corrosion inhibitor and water for cooling engines. Normally coolants consists of antifreeze with corrosion inhibitor and water. The coolants must exhibit the following properties:
- Guarantee of heat transfer
- Long-term corrosion and cavitation protection for all components in cooling system
- Guarantee of antifreeze protection
- Increase of boiling point
- Resistance to microorganisms
- Effective foaming suppression

Coolant additives:
Anticorrosion agent that can be used for special applications mixed with water. The mixture has no antifreeze protection!

MB approval:
Marking of the coolants or antifreezes with corrosion inhibitor that are tested by Daimler AG and approved for the corresponding use, see table 1 and 2. On the containers with tested brand-name products, you will find **MB approval 325.0** , for example, as a note.

2. Overview

Tables 1 and 2 give an overview for the application of the tested antifreezes with corrosion inhibitor and the maximum change intervals. Pay attention to the MB approval before using a coolant. With the correct use of tested coolant qualities with MB approval, you ensure the full protection of the cooling system. The vehicles with combustion engine are defined in the assignment across the engine model series. Table 1 therefore applies for all vehicles with an OM642 engine, for example.

Table 1: For passenger cars and vehicles with passenger car combustion engines

Sheet No.	Major assembly model series			Change interval years/km
	M1xx/M2xx	OM6xx		
325.0 and 326.0	●	●	For all vehicles with a manufacture date up to and including April 2014	15/250.000 i Whichever occurs first must be observed; exception: in the vehicle's maintenance manual, shorter change intervals are stipulated.
325.6 and 326.6	●	●	Usable for all vehicles	15/250.000 i Whichever occurs first must be observed; exception: in the vehicle's maintenance manual, shorter change intervals are stipulated.

Table 2: For vehicles with commercial vehicle engines

Sheet No.	Major assembly model series							Change interval in years
	OM300	OM400	OM904 up to 926	OM934, 936	OM457, 460	OM500	OM470 up to 473	
311.0	●	●						0.5
312.0	●	●	●		●	●		1
325.0 or 326.0	●	●	●		●	●		3
325.2 or 326.2	●	●	●		●	●		3
325.3 or 326.3	●	●	●		●	●		5
325.5 or 326.5			●	●	●	●	●	3

Coolants or antifreezes with corrosion inhibitor that are listed on different sheet numbers in tables 1 and 2 must not be mixed, as a considerably reduced corrosion protection may damage the cooling system. In general, mixtures of different antifreezes with corrosion inhibitor offer a lesser performance than the specially adapted active components of a formulation.
The sheet numbers: 325.x show the antifreezes with corrosion inhibitor and the corresponding sheet number 326.x shows the finally mixed coolant. The antifreezes with corrosion inhibitor must be mixed with water before use.

Vehicles with a fuel cell require a special coolant for cooling the fuel cell. Coolants for fuel cell vehicles must only be refilled in an F-Cell support point.

3. Coolant

The coolants and antifreezes with corrosion inhibitor are based on ethylene glycol as the antifreeze component but differ with regard to the remaining ingredients, e.g. for corrosion protection, table 3.

TIM-ID: 0000099524 - 001

Table 3: Specifications for Operating Fluids sheet number and coolant type				
Coolantsheet no.	**Anticorrosion/ antifreezesheet no.**	**Inhibitors**		**Free of**
		inorganic	**organic**	
326.0	325.0	Si, B	X	amine, phosphate
326.2	325.2	Si, B	X	amine, phosphate
326.3	325.3		X	nitrite, amine, phosphate, borat, silicon
326.5	325.5	SI	X	nitrite, amine, phosphate, borat, 2-ethylhexanoic acid
326.6	325.6	SI	X	nitrite, amine, phosphate, borat, 2-ethylhexanoic acid

The coolant must remain in the cooling system year round to protect against corrosion under all operating conditions. Corrosion may lead to poor heat output and engine overheating!

3.1. Mixing ratio

Generally a coolant must be used with approx. 50 % by volume of antifreeze with corrosion inhibitor and 50 % by volume of water. The water quality must satisfy the requirements in the following chapter. The antifreeze protection of this mixture is sufficient up to approx. -37 °C. Even with extremely low ambient temperatures, not more than 55 % by volume of antifreeze with corrosion inhibitor should be used. With 55 % antifreeze with corrosion inhibitor, the maximum antifreeze protection, approx. -45 °C, of a water-based ethylene glycol solution is reached; a higher KFM portion lowers the antifreeze protection and the heat dissipation in the engine worsens.

Table 4: Target concentration of antifreeze with corrosion inhibitor and water		
Sheet No.	**Mixing ratio**	
	KFM vol %	**Water % by vol.**
325.0	50	50
325.2	50	50
325.3	50	50
325.5	50	50
325.6	50	50
311.0	1	99
312.0	10	90

The boiling point of the coolant increases with the portion of the antifreeze with corrosion inhibitor. In the vehicle, the coolant is additionally protected against boiling by the pressure in the cooling system. By raising the pressure, the boiling temperature of the coolant is increased further.

Only approved products offer reliable protection of the cooling system. In special cases (commercial-vehicle engines, no antifreeze specification) coolant additives can be used that are primarily corrosion protection additives.

4. Water quality

Clean and the softest possible water should be used for processing the coolant. Drinking water often satisfies the requirements. Information concerning the water quality of drinking water is available from the local water-plant authorities or the official water utilities on request.

If there is no available information regarding the water quality or if no suitable water is available, then distilled or deionized water should be used to prepare the coolant. Sea water, brackish water, brine and industrial waters are not suitable. Salts may promote corrosion or form disruptive deposits.

The analysis values of the water for mixing coolants must be within the limits of table 5.

Table 5: Water quality			
Water quality		**min**	**max.**
Earth alkali ions	mmol/l		2.7
Hardness	°dH		15
Chloride	mg/l		80
Chloride + sulfate	mg/l		160
pH-value	-	6.5	8.0

1° dH = 1.783 mmol/l alkaline earth ions = 7.147 mg/l Ca^{2+} or 4.336 mg/l Mg^{2+}

With the use of premixed coolant, compliance with the concentration (50/50) must also be observed in addition to the MB approval.

TIM-ID: 0000099524 - 001

4.1. Coolant additives for commercial vehicle engines without antifreeze specification

In climate zones free of frost year round, no antifreeze protection is required as the cooling systems are adapted to coolant according to sheet 325.x and 326.x. However in justified exceptional cases an aqueous solution with corrosion protection should be used. The use of anticorrosion agents in water is limited to the engines named in table 2. The use of anticorrosion oil emulsion according to sheet 311.0 is limited thermally. The emulsion must therefore not be used in efficient modern engines.

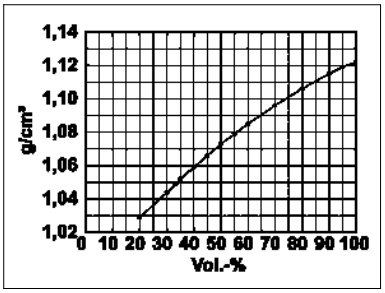
Mixtures of different products as stated in sheet 311.0 and 312.0 are not permitted.

When producing the anticorrosion oil emulsion in accordance with sheet 311.0, the following must be noted: When carrying out a new filling (initial filling or filling after a cleansing operation), an emulsion of 1.0 - 1.5 % by volume must be used. When refilling, an emulsion of 0.5 - 1.0 % by volume should be used. Concentrations that are too high (>1.5 % by volume) do not improve the corrosion protection, but rather exert a negative influence on seals and hoses.

5. Monitoring coolant operation

During operation the corrosion inhibitors of the coolant are consumed and the mixing ratio may be changed due to the evaporation of water. It is therefore very important to regularly monitor the coolant if the engine is to run trouble free.

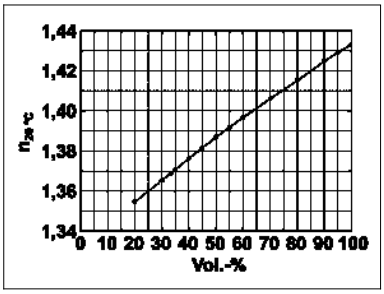
The inspection of the mixing ratio should be conducted with suitable apparatus. To do so, the density can be used to determine this in accordance with picture 1 or the refractive index in accordance with picture 2. The specifications on the mixing ratio may vary slightly for individual coolants from the values in pictures 1 and 2.



P00.40-2032-01

Bild 1: Density of KFM/water mixtures

Bild 2: Refractive index of KFM/water mixtures



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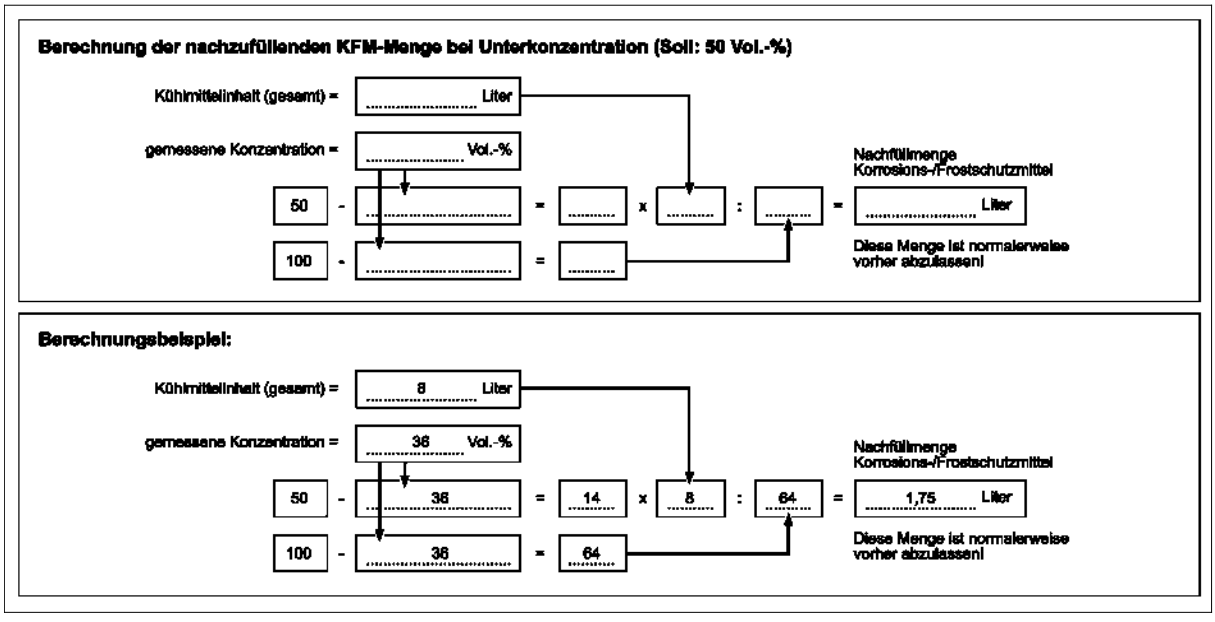
Should the coolant contain only 40 % by volume or greater than 55 % by volume of antifreeze with corrosion inhibitor, the mixing ratio must be corrected immediately. To calculate the refill quantity, the following calculation aid can be used:



P00.40-2038-09

Refrigerant protection/concentration table (approx.)												
°C	–10	–14	–15	–18	–20	–23	–25	–27	–30	–33	–35	–40
vol %	20	25	26	30	32	35	37	40	42	45	47	50

6. Disposal of coolants

TIM-ID: 0000099524 - 001

The coolants are biologically-degradable material. The statutory regulations or waste water ordinances in each individual country must be observed when disposing of used coolant. It is recommended to have the possibilities available for disposing of materials explained by the local responsible water authorities.

TIM-ID: 0000099524 - 001

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MODEL ALL

Dokumenttitel	Anticorrosion/antifreeze agents (Sheet 325.2)
Dokumentnummer	bb0040p032502a

TIM-ID: 0000099524 - 001

BB00.40-P-0325-02A	Anticorrosion/antifreeze agents (Sheet 325.2)	Commercial vehicles and industrial engines: usable in all engines **Except** model series OM 600, M 100 and M200	

MODEL ALL

Product name	**Customer, town/country**
Anticongelante Lubral HD M5.2	Lubricantes de América, S.A. de C.V., Santa Catarina/Mexico

TIM-ID: 0000099524 - 001

OM900 Series (0120)
Engine coolant – Level check

Preconditions:

- ✓ Engine is stopped and starting is disabled.
- ✓ Mercedes-Benz Specifications for Operating Fluids are accessible at https://bevo.mercedes-benz.com.

WARNING	
	Coolant is hot and under pressure. **Risk of injury and scalding!** • Let the engine cool down. • Wear protective clothing, gloves, safety mask, and goggles.

Preparatory steps:

1. Turn radiator cap counterclockwise to first stop and allow pressure to escape (see Figure 1).
2. Continue to turn radiator cap counterclockwise and remove.

□

Engine coolant – Level check

1. Check coolant level. Coolant must be visible at the lower edge of the filler neck on the radiator (Figure 1).
2. Top up with treated coolant as needed. Refer to Mercedes-Benz Specifications for Operating Fluids at https://bevo.mercedes-benz.com.
3. Check radiator cap (visual inspection) and clean, if necessary.
4. Position radiator cap on filler neck and turn clockwise to close.

□

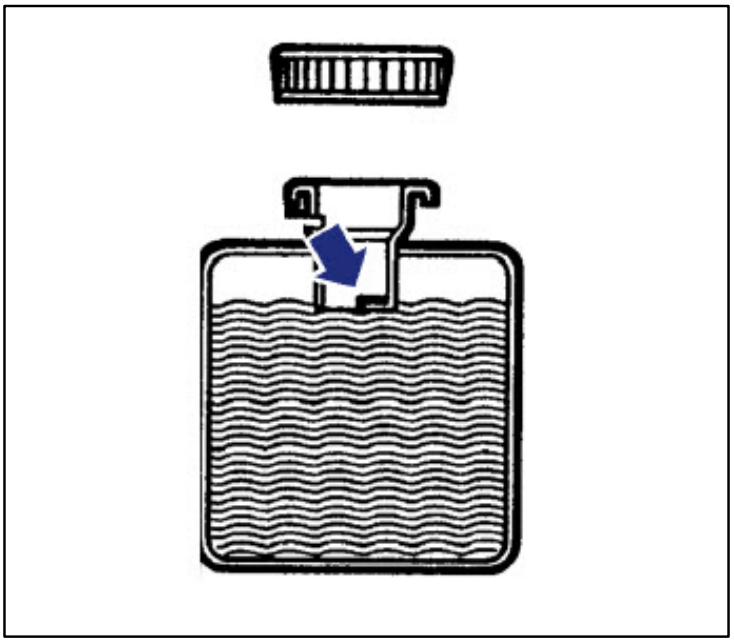

Figure 1: Engine coolant – Level check

TIM-ID: 0000103741 - 001

OM900 Series (0120)
Engine coolant – Level check

Checking engine coolant level by means of level sensor

1. Switch on engine control system and check readings on display.
2. Check coolant level and top up with coolant as necessary. Refer to Mercedes-Benz Specifications for Operating Fluids at https://bevo.mercedes-benz.com.
   □

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OM900 Series (0120)
Engine coolant – Draining

Preconditions:

✓ Engine is stopped and starting is disabled.

WARNING	
	Coolant is hot and under pressure. **Risk of injury and scalding!** • Let the engine cool down. • Wear protective clothing, gloves, safety mask, and goggles.

Preparatory steps:

1. Provide an appropriate container to drain the coolant into.
2. Switch off preheater, if installed.

Engine coolant – Draining

1. Turn radiator cap on filler neck counterclockwise to first stop and allow pressure to escape.
2. Continue to turn radiator cap counterclockwise and remove.
3. Attach drain hose onto coolant drain plug on the crankcase (see Figure 1).
4. Place a suitably-sized container underneath the drain hose to catch the coolant.
5. Release drain plug and collect coolant.
6. Clear blocked drainage openings of deposits.
7. Tighten coolant drain plug on engine with a new seal.

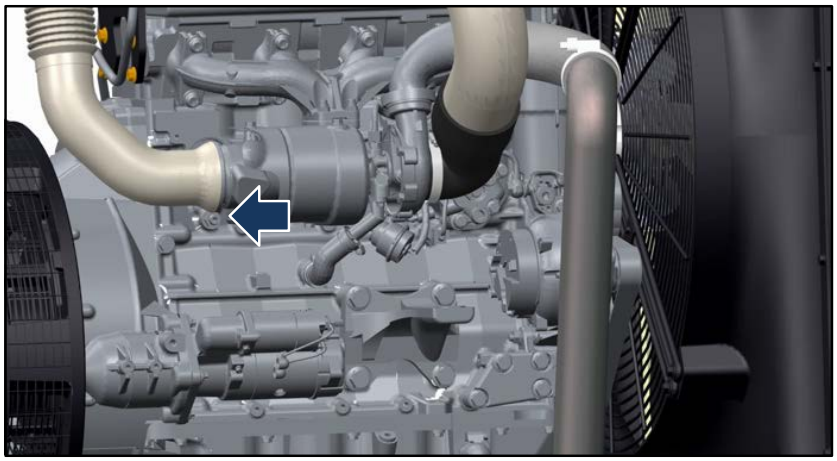

Figure 1: Engine coolant – Draining

TIM-ID: 0000103742 - 001

8. Place a suitably-sized container underneath the radiator to catch the coolant.
9. Turn radiator drain valve counterclockwise to drain coolant from radiator (see Figure 2).
10. Turn radiator drain valve clockwise to tighten.
11. Position radiator cap on filler neck and turn clockwise to close.
12. If performing coolant change, proceed to instructions for *Engine coolant – Filling*.

Figure 2: Engine coolant – Draining

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OM900 Series (0120)
Engine coolant – Filling

Preconditions:

- ✓ Engine is stopped and starting is disabled.
- ✓ Mercedes-Benz Specifications for Operating Fluids are accessible at https://bevo.mercedes-benz.com

WARNING	
	Coolant is hot and under pressure. **Risk of injury and scalding!** • Let the engine cool down. • Wear protective clothing, gloves, safety mask, and goggles.

WARNING	
	High level of noise when the engine is running. **Risk of damage to hearing!** • Wear ear protection.

NOTICE	
	Cold coolant in hot engine can cause thermal stress. **Possible formation of cracks in the engine!** • Fill / top up coolant only into cold engine.

Preparatory steps:

1. Turn radiator cap counterclockwise to first stop and allow pressure to escape (see Figure 1).
2. Continue to turn radiator cap counterclockwise and remove.

□

TIM-ID: 0000103743 - 001

Engine coolant – Filling

1. Fill coolant through filler neck on radiator (see Figure 1) until coolant level reaches lower edge of filler neck.
2. Check proper condition of radiator cap and clean sealing faces, if required.
3. Position radiator cap on filler neck and turn clockwise to close.

Figure 1: Engine coolant – Filling

Final steps:

1. Start the engine and operate it at idle speed for five minutes.
2. Check coolant level (see *Engine coolant – Level check*) and top up with coolant, if required.

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11 Fluids and Lubricants Specifications

11.1 Fluids and Lubricants for Mercedes-Benz Engines

Fluids and lubricants specifications for Mercedes-Benz engines can be accessed at the following location: https://bevo.mercedes-benz.com.

This site provides an overview of requirements for operating fluids and specific product recommendations that are approved for use with your engine-generator set. Because further developments to operating fluids and lubricants are constantly being made, this website is continually updated. For this reason, only the online version of the Mercedes-Benz Specifications for Operating Fluids found here is valid.

For questions about fluids and lubricants specifications, contact your MTU Onsite Energy distributor or dealer.

TIM-ID: 0000064636 - 001

12 Appendix A

12.1 Abbreviations

Abbreviation	Meaning	Explanation
A/AC	Air-to-Air Charge Cooling	Type of diesel engine cooling configuration
AC	Alternating Current	The movement or flow of electric charge that periodically reverses direction
ADEC	Advanced Diesel Engine Control	Engine governor
AEM	Analog Expansion Module	Option for Digital Genset Controller
AGA	American Gas Association	
AL	Alarm	Alarm (general)
ANSI	American National Standards Institute	
ASTM	American Society for Testing and Materials	
ATS	Automatic Transfer Switch	
AVR	Automatic Voltage Regulation	
AWG	American Wire Gauge	Unit of the cross-sectional size of a wire
BDC	Bottom Dead Center	
BCI	Battery Council International	
BHP	Brake Horse Power	
BMEP	Brake Mean Effective Pressure	
BTU	British Thermal Unit	
CA	Cranking Amperes	Unit of current provided by an battery at 0 °C (32 °F)
CAD	Computer-Aided Design	
CAN	Controller Area Network	Data bus system, bus standard
CCA	Cold Cranking Amperes	Unit of current provided by an battery at -18 °C (0 °F)
CCB	CAN Connection Board	Plug-in board for CAN bus communication
CE	Conformité Européenne	Mandatory conformity mark on many products placed on the single market in the European Economic Area
CEM	Contact Expansion Module	Option for Digital Genset Controller
CFH	Cubic Feet per Hour	Unit for volumetric flow rate
CFM	Cubic Feet per Minute	Unit for volumetric flow rate
COM	Communication equipment	Hardware interface (serial port)
CSA	Canadian Standards Association	Not-for-profit association for safety and performance standards, including those for electrical/electronic/industrial equipment, boilers and pressure vessels, environmental protection, and more
CT	Current Transformer	
dB(A)	A-weighted decibel	One-tenth of a bel; unit for noise level
DC	Direct Current	
DGC	Digital Genset Controller	

TIM-ID: 0000000159 - 012

Abbreviation	Meaning	Explanation
DIN	Deutsches Institut für Normung e. V.	German Standardization Organization, at the same time identifier of German standards ("Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DN	Diameter Nominal	A designated or theoretical diameter that may vary from the actual size, usually within an allowable tolerance band
DVR	Digital Voltage Regulator	
ECM	Electronic Control Module	
ECMS	Engine Side Control Management System	
ECU	Engine Control Unit	
EPA	Environmental Protection Agency	U.S. regulatory agency for implementation of federal laws for environment protection; establishes standards that will help meet those laws.
FCR	Field Current Regulation	
GPM	Gallons Per Minute	Unit for volumetric flow rate
HALT	Highly Accelerated Life Tests	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	
HMI	Human Machine Interface	Alarm: Measured value exceeds 2nd maximum limit
HP	High Pressure	
HP	Horse Power	
HT	High Temperature	
IEC	International Electrotechnical Committee	International standards organization for all electrical, electronic and related technologies
IEEE	Institute of Electrical and Electronic Engineers	International organization for the advancement of technology related to electricity
IP	Ingress Protection	Classification for environmental protection for electrical/electronic devices
ISO	International Organization for Standardization	International organization for publishing worldwide proprietary industrial and commercial standards
ITS	Integral Test System	
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
LCD	Liquid Crystal Display	
LED	Light Emitting Diode	
L.L.C.	Limited Liability Company	
LO	LOW	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
LP	Low Pressure	
LSM	Load Sharing Module	Option for Digital Genset Controller
LT	Low Temperature	
MAU	Medium Attachment Unit	Interface
MCS	Monitoring and Control System	

TIM-ID: 0000000159 - 012

Abbreviation	Meaning	Explanation
MIL-STD	Mlitary Standard	
NEC	National Electrical Code	U.S. association for standards
NEMA	National Electrical Manufacturer's Association	U.S. association for standards for electrical products
NFPA	National Fire Protection Association	U.S. association for standards
NPT	National Pipe Thread	U.S. standard for tapered threads
QL	Qualification Level	
OEM	Original Equipment Manufacturer	A company that uses a component made by a second company in its own product, or sells the product of the second company under its own brand.
OPU	Open Power Unit	An engine-generator set with no enclosure
OSHA	Occupational Safety and Health Administration	A US federal agency
PAC	Performance Assurance Certificate	MTU Onsite Energy statement of assurance
PAN	Panel	
PF	Power Factor	
PH	Phase	
PM	Permanent Magnet	
PMG	Permanent Magnetic Generator	
PSI	Pounds per Square Inch	
PTO	Power Take-Off	
PVC	Polyvinyl Chloride	
RCM	Reserve Capacity Minutes	Unit for battery discharge
RDP	Remote Desktop Protocol	
RFOB	Rear Face of Block	
RMS	Root Mean Square	Mathematics: Effective value
RPM	Revolutions Per Minute	Unit of frequency (1 RPM = 1/60 Hz); number of rotations completed in one minute around a fixed shaft
RTC	Real Time Clock	
RTD	Resistive Temperature Device	
RTU	Remote Terminal Unit	Interface for Modbus
SAE	Society of Automotive Engineers	U.S. standardization organization
SAM	Service and Application Module	Diagnostic interface
SCA	Supplemental Coolant Additive	
SCCC	Seperate Charge Cooling Circuit	
SD	Sensor Defect	Alarm: Sensor failure
SLI	Starting, Lighting, Ignition	Type of starter battery
SS	Safety System	
TA-Luft	Technische Anleitung zur Reinhaltung der Luft	German technical regulation for protection of the air (emission limits for stationary engines in Germany)
TB	Terminal Block	
TB	–	Synonym for: water-to-air charge-air cooling

TIM-ID: 0000000159 - 012

Abbre-viation	Meaning	Explanation
TCP	Transmission Control Protocol	Interface for Modbus
TD	–	Synonym for: air-to-air charge-air cooling
TDC	Top Dead Center	
TEN	Technical Evolution Network	Technical sales documentation
TS	Transfer Switch	
TVU	Technische Verkaufs Unterlagen	German terminology for Technical Sales Documentation; a Business Portal-based MTU computer database which provides engine technical information for application and sales engineering purposes
UDP	User Datagram Protocol	Network protocol for Ethernet communication
UL	Underwriters Laboratories	Global not-for-profit organization for product safety testing and certification
UPS	Un-interrupted Power Source	
VAR	Volt-Amperes Reactive	Reactive power control
VAwS	Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen	German degree on the protection against water hazard substances
VDE	Verband Deutscher Elektrotechniker	German organization for electrical engineers
ZSI	Zone-Selective Interlocking	

TIM-ID: 0000000159 - 012

12.2 Conversion tables

Length

Unit A	multiplied by factor	= Unit B
in	25.4	= mm
ft	0.3048	= m
yd	0.9144	= m
stat. mile	1.609	= km
Nm	1.852	= km
yd	3	= ft
yd	36	= in

Unit B	multiplied by factor	= Unit A
mm	0.03937	= in
m	3.281	= ft
km	0.6215	= stat. mile

Area

Unit A	multiplied by factor	= Unit B
in^2	645.16	= mm^2
ft^2	0.0929	= m^2
yd^2	0.8361	= m^2
stat. $mile^2$	2.59	= km^2

Unit B	multiplied by factor	Unit A
mm^2	0.00155	= in^2
m^2	10.764	= ft^2
m^2	1.1960	= yd^2
km^2	0.3861	= stat. $mile^2$

Volume

Unit A	multiplied by factor	= Unit B
in^3	16387	= mm^3
ft^3	0.02832	= m^3
yd^3	0.7646	= m^3
gallon (U.S.)	3.785	= dm^3
gallon (UK)	4.546	= dm^3

Unit B	multiplied by factor	= Unit A
cm^3	0.06102	= in^3
m^3	35.31	= ft^3
dm^3	0.2642	= gallon (U.S.)
dm^3	0.22	= gallon (UK)

TIM-ID: 0000002173 - 016

Volumetric flow

Unit A	multiplied by factor	= Unit B
gal/min (GPM, U.S.)	3.79	= l/min
gal/min (GPM, U.S.)	0.134	= ft^3/min (cfm)
ft^3/min (cfm)	1.70	= m^3/h

Unit B	multiplied by factor	= Unit A
l/min	0.264	= gal/min (U.S.)
ft^3/min (cfm)	7.48	= gal/min (U.S.)
m^3/h	0.589	= ft^3/min (cfm)

Velocity

Unit A	multiplied by factor	= Unit B
ft/s	0.3048	= m/s
stat. mile/h (mph)	1.609	= km/h
knot (UK)	1.852	= km/h

Unit B	multiplied by factor	= Unit B
m/s	3.281	= ft/s
km/h	0.6214	= stat. mile/h (mph)
km/h	0.54	= knot (UK)

Mass

Unit A	multiplied by factor	= Unit B
lb	0.4536	= kg
oz	28.35	= g
ton (imp.)	1.016	= t

Unit B	multiplied by factor	= Unit A
g	0.03527	= oz
kg	2.205	= lb
t	0.9842	= ton (imp.)

Force

Unit A	multiplied by factor	= Unit B
lbf	0.4536	= kp
lbf	4.4482	= N
kp	9.80665	= N

Unit B	multiplied by factor	= Unit A
kp	2.205	= lbf
N	0.10197	= kp
N	0.2248	= lbf

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Density

Unit A	multiplied by factor	= Unit B
slug/ft^3	515.4	= kg/m^3

Unit B	multiplied by factor	= Unit A
kg/m^3	0.00194	= slug/ft^3

Torque

Unit A	multiplied by factor	= Unit B
lbf ft	1.3558	= Nm

Unit B	multiplied by factor	= Unit A
Nm	0.7376	= lbf ft

Pressure

Unit A	multiplied by factor	= Unit B
lbf/in^2 (psi)	703.1	= kp/m^2 (mmH_2O)
lbf/in^2 (psi)	0.06895	= bar
lbf/ft^2 (psf)	47.88	= Pa
inHg	0.03386	= bar
inHg	345.3	= kp/m^2 (mmH_2O)

Unit B	multiplied by factor	= Unit A
atm	760	= mmHg
atm	1.0133	= bar
atm	10332	= kp/m^2 (mmH_2O)
atm	1.0332	= kp/cm^2 (at)
atm	14.696	= lbf/in^2 (psi)
bar	14.504	= lbf/in^2 (psi)
Pa	0.0209	= lbf/ft^2 (psf)

2nd moment of mass

Unit A	multiplied by factor	= Unit B
slug ft^2	1.3558	= kg m^2

Unit B	multiplied by factor	= Unit A
kg m^2	0.7376	= slug ft^2

Energy

Unit A	multiplied by factor	= Unit B
lbf ft	1.356	= J
kcal	4186.8	= J
BTU	1055	= J
CHU	1899	= J

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Unit B	multiplied by factor	= Unit A
J	0.7376	= lbf ft
J	0.0002388	= kcal
J	0.0009478	= BTU
J	0.00052656	= CHU

Power

Unit A	multiplied by factor	= Unit B
PS	0.7355	= kW
HP	0.7457	= kW
BTU/s	1.054	= kW
kcal/h	1.163	= W
HP	550	= lbf ft/s

Unit B	multiplied by factor	= Unit A
kW	1.36	= PS
kW	1.341	= HP
kW	0.9487	= BTU/s
W	0.8598	= kcal/h
lbf ft/s	0.0018	= HP

Temperature

	Celsius	Kelvin
x °C	-	= x + 273.15 K
x K	= x − 273.15 °C	-
x °F	= 5/9(x − 32) °C	= 5/9(x − 32) + 273.15 K
x °R	= 5/4x °C	= (5/4x) + 273.15 K

	Fahrenheit	Réaumur
x °C	= 9/5x + 32 °F	= (4/5x) °R
x K	= 9/5(x − 273.15) + 32 °F	= 4/5(x − 273.15) °R
x °F	-	= 4/9(x − 32) °R
x °R	= (9/4x) + 32 °F	-

Fuel consumption

Unit A	multiplied by factor	= Unit B
mile/gal (US)	0.4251	= km/l
gal/mile (US)	2.3527	= l/km

Unit B	multiplied by factor	= Unit A
km/l	2.3527	= mile/gal (US)
l/km	0.4251	= gal/mile (US)

TIM-ID: 0000002173 - 016

12.3 Glossary

Aeration	Ventilation (progressive or otherwise) of air or combustion gases in the engine coolant
After boil	Boiling of the coolant after engine shutdown due to residual heat in the engine
After boil volume	Quantity of coolant discharged from the pressure relief overflow tube following engine shutdown
Air bind	A condition where a pocket of air has been trapped in the water pump causing it to lose its prime and ability to pump coolant
Air cleaner	A device to filter combustion air at the entrance to the combustion air circuit
Air handling	The cooling system's ability to purge air when injected at a given rate determined by the engine manufacturer and meeting specified criteria
Air re-circulation	A condition either occurring around the tips of the fan blades or where discharged air from a radiator core is returned to the front of the core; Either condition hinders cooling capability.
Alternator	A device for converting mechanical energy into alternating current electrical energy; In this documentation, the term "generator" (AC or synchronous generator) is used instead.
Altitude	The vertical relative to sea level at which the generating system is operating
Altitude rating	The maximum power recommended by the manufacturer for satisfactory operating at a given altitude
Ambient temperature	The air temperature of the surroundings in which the generating system or other applicable electrical equipment operates; The ambient temperature for optimum rating of components of the system may vary from device to device.
Ammeter	An instrument for measuring the magnitude of an electric current
Amperage	The strength of an electric current measured in Amperes
Analog control panel	A control panel that represents data by measurement of a continuous physical variable, as voltage or pressure
Annunciator	A signaling apparatus, generally used in conjunction with a buzzer, that displays a visual indication when energized by electric current; typically mounted on the unit
Annunciator panel	Groupings of annunciator lights
Antimony	A blue-white metalloid used in electrical batteries to increase the hardness of lead
Aspiration	A drawing of something in, out, up or through by or as if by suction
Audible alarm	Horn, siren, bell or buzzer which is used to attract the attention of the operator when a fault occurs in the electric power generating system
Automatic transfer switch	A switch designed to sense the loss of one power source and automatically transfer the load to another source of power
Auxiliary contact	Contacts, in a switching device, in addition to the main circuit contacts, which function with the movement of the latter
Base frame	The bottom support of an engine-generator set
Battery	A device that transforms chemical energy into electric energy in a cell with positive and negative electrodes in an electrolyte; Technically two or more cells connected in series, but in common usage often applied to single cells
Battery (lead-acid)	A battery that uses lead as a negative electrode, lead dioxide as a positive electrode and sulfuric acid as an electrolyte; nominal voltage 1.2 V per cell
Battery (nickel cadmium)	A battery that uses nickel oxide for a positive electrode and cadmium for a negative electrode with an alkaline electrolyte; nominal voltage 1.2 V per cell
Battery charger	Equipment used to restore the charge in storage batteries

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Battery rack	A framework of bars designed to support a battery
Battery warmer	Heater used in cold climates to maintain battery electrolyte temperature
Battery warmer plate	Heater mounted under the battery; Ensures battery will hold a charge in sub-zero conditions
Bell alarm	Audible alarm that electronically sounds from an input signal on a circuit breaker
Bio diesel	A type of diesel fuel derived from biological sources (such as vegetable oils), as opposed to petroleum
Bleed line	Line strategically placed on the cooling system to vent air/gases from the system both during fill and engine running mode; also known as deaeration or vent line.
Block heater	Coolant heating device which may be mounted in the engine block and immersed in engine coolant, (immersion type heater) or mounted externally and connected to the engine's coolant passages by means of piping or hoses (tank type heater)
Blocked open	Thermostats mechanically blocked open to required position; Used for cooling tests only.
Blower fan	A fan that pushes the air through the radiator core.
Bore (engine)	A measurement of the diameter of the holes bored into the engine block for use as cylinders
Bottom tank	Refers to the down stream radiator tank temperature that is usually the lowest temperature
Break horsepower	The power available at the flywheel, or other output member(s) for doing useful work
Brake mean effective pressure	The average (mean) pressure which, if imposed on the pistons uniformly from the top to the bottom of each power stroke, would produce the measured (brake) power output
Bus	A conductor, or group of conductors, that serve as a common connection for two or more circuits
Business portal	A web-based sales and technical information portal that is accessible to authorized MTU Onsite Energy personnel, distributors and dealers
Bypass switch	A specific device or combination of devices designed to bypass a control device
Bypass-isolation switch	A manually operated device used in conjunction with a transfer switch to provide a means of directly connecting load conductors to a power source and isolating the transfer switch to permit maintenance and testing of the transfer switch with no interruption to the load
Catalytic converter	A device used to reduce the toxicity of emissions from an internal combustion engine
Cavitation	A localized event where a vapor pressure/temperature phenomenon of the cooling liquid allows partial vaporization of the coolant; These cavities of vapor are carried downstream to a region of higher pressure, causing them to collapse. Cavitation reduces coolant flow and increases pump wear.
Cetane number	A relative measure of the time delay between the beginning of fuel injection and the start of combustion
Circuit	The portion of a circuit breaker mechanism that opens the circuit under sustained overload but does not protect against short-circuit currents
Circuit breaker	A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specific time and automatically breaking currents under specified abnormal circuit conditions, such as those of short circuit
Circuit breaker, magnetic trip	The portion of a circuit breaker mechanism that opens the circuit under specified abnormal current

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Circuit breaker, thermal trip	The portion of a circuit breaker mechanism that opens the circuit under sustained overload but does not protect against short-circuit currents
Circuit breaker, thermal/magnetic trip	Thermal/magnetic trips employ a thermal bi-metallic element having an inverse time/current characteristic for protection against sustained overloads. In addition, the breaker contains an instantaneous magnetic trip element for short-circuit protection.
Cold cranking amperes	A standard rating for lead-acid batteries; established by the BCI; The cold cranking ampere rating is the current, in amperes, that a battery will deliver for 30 seconds, at -18 °C (0 °F), before the battery terminal voltage drops to 1.2 V per cell (7.2 V for a 12 V system and 14.4 V for a 24 V system). Lead-acid batteries are generally specified in terms of cold cranking amperes and reserve capacity (see Reserve capacity minutes).
Commercial power	A term applied to power furnished by an electric power utility
Compression ratio	The ratio of a cylinder volume enclosed by the piston at its outermost position to the volume enclosed by it at its innermost position
Connector	A coupling device employed to connect conductors of one circuit element with those of another circuit element
Continuous power	Power recommended by the manufacturer for satisfactory operation under the manufacturer's specified continuous duty conditions (defined as operating with a constant, non-varying load)
Control panel	A flat, often vertical, area where control or monitoring instruments are displayed
Controller	A device used to operate an electronic device
Coolant	A liquid medium used to transport heat from one area to another.
Coolant flow rate	The rate of coolant flow through the cooling system and/or radiator.
Coolant level	The amount of coolant to completely fill the cooling system to its designed capacity (volume) cold full level
Coolant recovery	An add-on coolant reserve tank that is used when radiator top tank and/or bottle remote deaeration tank cannot be sized large enough to meet cooling system drawdown requirements; Also known as an overflow bottle.
Cooling	The transfer of thermal energy via thermal radiation, heat conduction or convection
Cooling potential	The temperature difference between air entering the radiator core and the average temperature of the coolant in the radiator core
Cooling capability	The ambient in which a cooling system can perform without exceeding maximum engine coolant out temperature approved by the engine manufacturer
Cooling system	A group of inter-related components used in the transfer of heat
Cooling system air	The pressure drop across the radiator core and other up and down stream restriction components that offer resistance to the airflow
Crankcase oil heater	120 V probes that are inserted in the oil in the oil pan, designed to heat motor oil when the oil is idle
Cranking	The act of turning an engine crankshaft over through the use of a DC starter
Cranking amperes	A standard rating for lead-acid batteries; established by the BCI; (also referred to as marine cranking amperes); The cranking ampere rating is the current, in amperes, that a battery will deliver for 30 seconds, at 0 °C (32 °F), before the battery terminal voltage drops to 1.2 V per cell (7.2 V for a 12 V system and 14.4 V for a 24 V system).
Critical silencer	An exhaust silencer that is applied in sensitive noise control areas
Current	The rate of flow of electricity; The unit of current is Ampere (A).
Cycle	Any set of operations that are repeated regularly in the same sequence
Cylinder arrangement	The pattern an engine's cylinder are arranged in

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Darcy-Weisbach	In fluid dynamics, the Darcy-Weisbach equation is a phenomenological equation, which relates pressure loss due to friction along a given length of pipe to the average velocity of the fluid flow. The equation is named after Henry Darcy and Julius Weisbach. In fluid dynamics, the equivalent length is the associated length of straight pipe of the same diameter as an accessory (for example elbow), which will incur the same pressure loss.
Day tank	A small fuel tank usually adjacent or in close proximity to the engine driven fuel pump which stores a ready fuel supply near the engine; Also called a transfer tank.
Deaeration	The cooling systems ability to purge trapped gases from the cooling system after an initial fill
Deaeration capability	The running time required to expel all the trapped gases from the cooling system after an initial fill
Deaeration tank	A tank used to separate air/gases from the circulating coolant and return unaerated coolant to the system; Also used for filling, expansion of the coolant, reserve capacity, etc. Sometimes called a surge tank or top tank.
Deaeration volume	The volume of space designed into the deaeration tank and located above the expansion volume for collecting the trapped gases as they are expelled into the tank
Decibel (dB)	One-tenth of a bel; The number of decibels denoting the ratio of the two amounts of power being ten times the logarithm to the base 10 of this ratio. A unit of measure of noise level in which the faintest sound we can hear, called the threshold of hearing, is 0 dB, and the loudest sound the human ear can tolerate, called the threshold of pain, is 140 dB.
Delay transition	A timed load disconnect during transfer between power sources, primarily to allow for the decay of motor residual voltage
DiaSys	DiaSys (Diagnostic System) is a diagnostic tool consisting of a software CD, dongle and RS232 cable. This tool is used for the following to transfer data to and from the engine controller, monitor all sensors installed on the engine and record snapshots of engine operation.
Diesel fuel	Fuel used in a diesel engine; Usually refers to diesel fuel processed from petroleum (petro diesel), but may also refer to bio diesel or any number of other alternative diesel fuel.
Diode	A device that allows current to pass in one direction only; It may be used as a rectifying element.
Displacement	The swept volume of an engine cylinder, referring to the volume displaced by the cyclic travel of the piston
Dongle	A hardware key required to communicate with ADEC via DiaSys
D-rate	A change in the kW rating usually occurs when fuels are switched (usually applied when LP is substituted for natural gas)
Drawdown	The quantity of coolant that can be removed from a full cooling system before aeration occurs
Drawing	A visual representation of a unit or component of which it is made; Usually created using a CAD program.
Driving end	The driving end of the engine is the end that has the flywheel installed.
Dual fuel	The ability to use two different types of fuels in the same unit
Duct flange	Radiator mounted shroud of metal, used to fill the air gap from the radiator to the duct work or louver. It prevents re-circulation and overheating
Duration	An amount of time or a particular time interval
Electric starting system	Utilizes a series of wound DC electric motor to crank the engine for starting; The DC power is usually supplied by a battery pack.

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Electronic control unit (ECU)	The most important component of ADEC/MDEC, as it controls the engine operation and acts as an interface with the other subsystems and devices
Elevation	The height to which something is elevated or to which it rises
Emergency-stop button	Typically located on the panel and possibly in several other areas of the machine; It provides a rapid means to disconnect the energy source of the device to protect workers.
Enclosure	A structure that can be added to enclose an engine-generator set to protect against the environment and reduce sound
Engine	A machine for converting thermal energy into mechanical energy or power to produce force and motion
Engine coolant out	Usually the hottest coolant and measured at the thermostat housing; Also called radiator inlet or top tank temperature.
Engine gauges	Gauges mounted on the engines typically used to measure oil pressure and engine temperature
Engine-generator set	A power generation system comprised of a combustion engine driving an electrical generator
Engine safety controls	Devices that protect against catastrophic damage by shutting the engine down in the event of abnormal operating conditions
Excitation	The DC power supplied to the field coils of a synchronous generator, producing the magnetic flux required for inducing voltages in the opposing member
Exciter	A device for supplying excitation to the generator field; It may be rotating DC, AC with rectifiers, or a static device converting AC to DC.
Exerciser	A timer is mounted in the control panel that will trigger a run command to exercise the unit. This preventative maintenance practice ensures the engine-generator set will function properly when it is actually needed.
Exhaust emissions	The constituents of the waste gas that leaves the prime mover through its exhaust system
Exhaust louver	A slanted opening on the end of an enclosed engine-generator set for the expulsion of exhaust and ventilation
Exhaust manifold	Generally simple cast iron units which collect engine exhaust from multiple cylinders and deliver it to the exhaust pipe
Expansion volume	The volume of space designed into the deaeration tank to permit the coolant to expand as it is heated without being lost to the environment
Failure light	Light that indicates an engine-generator set malfunction
Fan airflow	The rate of airflow a fan can deliver at a given speed and static pressure
Field	A region of magnetic lines of flux; The field may be produced by electrical current or permanent magnet.
Field coil	A suitably insulated electric winding to be mounted on a field pole
Field pole	The part of a magnetic structure of an electric machine on which the field coils are located
Fill line	A line used to route coolant from the deaeration tank to the inlet of the water pump; It is also called a shunt or make up line.
Fill rate	The coolant flow rate at which an empty cooling system can be completely filled without overflowing
Filter	In engine systems, a device having a porous medium, whose primary function is the separation and retention of particular contaminants from a fluid; In electrical systems, a device used to reduce unwanted alternating currents
Flange	An external or internal rib or rim (lip) used for strengthening

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Flexible exhaust connection	A flexible section in the exhaust system used to reduce stresses which can result from relative motion between the engine and fixed exhaust piping, or from thermal expansion and contraction
Flux	Magnetic lines of force
Flywheel	A heavy disk or wheel rotating on a shaft so that its momentum gives almost uniform rational speed to the shaft and to all connected machinery
Foam insulation	Foam mounted on the inside of an enclosure, used to decrease the decibel level of an engine-generator set
Free end	The free end is the non-drive end of the engine. For example, if a cooling system fan drive is required for an application it would be mounted on this end of the engine.
Frequency	The number of complete cycles of an alternating voltage or current per unit of time, expressed in Hertz (Hz), cycles per second
Frequency meter	An instrument that indicates frequency of the generator output in Hertz
Fuel	An energy source for engine-generator sets; typically diesel, natural gas, or liquid propane
Fuel cell	A device that produces a continuous electric current directly from the oxidation of a fuel, as that of hydrogen and oxygen
Fuel solenoid	Electric valve used on fuel lines to prevent accidental ignition of fuel in the line
Fuel tank	A safe container for a flammable liquid or fuel gas and typically part of an engine system in which the fuel is stored and propelled (fuel pump) or released (pressurized gas) into an internal combustion engine or fuel cell
Fuel tank cooler	Cooler that maintains fuel temperature in a tank at an optimal level
Fuel tank heater	Heater that maintains fuel temperature in a tank at an optimal level
Fuel water separator	Component that removes water from fuel; This raises the quality of the fuel used in the engine-generator set.
Fuse	An overcurrent protective device which consists of a conductor that melts and opens the circuit when current exceeds rated values for a predetermined time
Gas temperature	Temperature of exhaust gases coming out of the muffler
Gas volume	The amount (volume) of exhaust gas coming out of the muffler
Gaseous	Existing in the state of gas; not solid or liquid
Generator	A machine for converting mechanical energy into electrical energy; The energy may be direct current (DC) or alternating current (AC).
Generator drive engine	An engine specifically developed to drive and engine generator
Generator set	See Engine-generator set.
Genset	See Engine-generator set.
Governor	A device that regulates prime mover speed by adjusting the fuel input to maintain constant speed
Ground fault protection	A function that trips (opens) a circuit breaker or sounds an alarm in the event that there is an electrical fault between one or more of the phase conductors and ground (earth); This ground fault protection function may be incorporated into a circuit breaker.
Harmonics	Voltage or current components which operate at integral multiples of the fundamental frequency of a power system (50 or 60 Hz); Harmonic currents have the effect of distorting the shape of the voltage wave form from that of a pure sine wave.
Heat dissipation	The amount of heat engine (BTU) that a heat transfer component can dissipate to the environment at specified conditions

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Heat exchanger cooling	Engine coolant heat dissipated to water through a liquid to liquid heat exchanger
Heat rejection to ambient	Engine and generator heat radiated to ambient (surrounding engine-generator set)
Heat rejection to coolant	Engine heat dissipated to engine coolant
Hertz (Hz)	A unit of frequency equal to one cycle per second; Engine-generator sets in North America operate at 60 Hz, while most of Europe operates at 50 Hz.
Horse power (HP)	A measure of engine power output, equivalent to 550 ft-lbs/second. (1 HP = 0.986 BHP = 0.7457 kW)
Hydrometer	An instrument used to measure the specific gravity (or relative density) of liquids; that is, the ratio of the density of the liquid to the density of water
Installation	To place, position, or fit into a position and then to connect, change, or modify in such a manner as to bring (the equipment) into service
Intake louver	A slanted opening on the end of an enclosed engine-generator set for the intake of air and ventilation
Interlock	A device to help prevent a machine from harming an operator or damaging itself when tripped
Kilovolt-Amperes (kVA)	An electrical unit, equal to 1000 Volt-Amperes
Kilowatts (kW)	A unit of power equal to 1000 Watts (1 kW = 1.360 HP = 1.341 BHP)
Liquid crystal display	An electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector
Limited warranty	A guarantee: a written assurance by MTU Onsite Energy that our product or service will be provided and will meet certain specifications. Warranties are typically limited by time since the purchase of the warranty and hours of product use.
Liquid capacity	The total capacity of the different liquids needed for operation of the engine-generator set
Liquid petroleum gas (LP)	A mixture of hydrocarbon gases used as a fuel
Liquid withdrawal	Used to describe fuel systems where the fuel is drawn from the liquid section of the storage tank
Load	The power consumed by a circuit
Load factor	The ratio of the average load imposed on the prime mover to the prime mover's load rating
Lubrication	Lubrication is the process or technique employed to reduce wear of one or both surfaces in close proximity, and moving relative to each another, by interposing a substance called lubricant between the surfaces to carry or to help carry the load (pressure generated) between the opposing surfaces.
Maintenance	Fixing any sort of mechanical or electrical device should it become out of order or broken (repair) as well as performing the routine actions which keep the device in working order (maintenance) or prevent trouble from arising (preventive maintenance)
Mankato	Minnesota city (approximately 80 miles southwest of Minneapolis) where MTU Onsite Energy Corporation is headquartered
Maximum power	The largest amount of kW an engine-generator set can output

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MTU Onsite Energy	An umbrella brand created by the Tognum Group in September 2008, consisting of decentralized power generation operations; The product range includes standardized and customized diesel engine-generator sets for emergency stand-by, base and peak load applications as well as compact cogeneration modules powered by gas engines, fuel cells or gas turbines for the generation of both heat and power.
MTU Onsite Energy, Gen I Training	A three day training course offered by MTU Onsite Energy Corporation tailored to new and experienced technicians, sales staff, spec writers and engineering support; This class covers installation, troubleshooting, general maintenance and start-ups.
MTU Onsite Energy, Gen II Training	A four day training course offered by MTU Onsite Energy Corporation designed for experienced technicians and engineering support; This class covers in-depth troubleshooting, control panels and start-ups. GEN II attendees are required to have completed GEN I and pass the GEN II class with an 85 % or higher score. Training offered byMTU Onsite Energy Corporation for salespeople.
Muffler	Any of various devices of deadening sound, as the sound of escaping gases of an internal-combustion engine
Natural gas	A combustible mixture of gaseous hydrocarbons that accumulates in porous sedimentary rocks, esp. those yielding petroleum, consisting of usually over 80 % methane together with minor amounts of ethane, propane, butane, nitrogen and sometimes helium; It is used as a fuel to make synthesis gas.
NEMA 1 enclosure	An enclosure designation for indoor use only – where dirt, dust and water are not a consideration; Personnel protection is the primary purpose of this type of enclosure.
Neutral	The common point of a Y-connected AC generator, a conductor connected to that point or to the mid-winding point of a single-phase AC generator
Nominal value	An accepted condition which is a goal or an approximation as opposed to the real value
OEM manuals	Manuals (written instructions) created by an OEM
Oil pump	A gear pump driven by the camshaft or crankshaft; The oil pump usually sucks the oil out of the engine's oil pan through a wire mesh strainer and pumps the oil through an oil filter before it goes to the bearings.
Oil sampling kit	A parts package used to determine the quality of engine oil
Operating instructions	Directions included with an engine-generator set that provide information on how to operate the unit
Overcooling	A condition where the coolant temperature will not approach the start to open temperature value of the thermostat under normal engine operation
Overheating	An operating condition where coolant temperature exceeds design intent; This may be caused by a deficiency in the cooling system of by abnormal operating conditions.
Overload power	Overload power is that load in excess of rated load which the engine-generator set is capable of delivering for a specified period of time. It should be recognized that the voltage, frequency and operating temperature may differ from normal rated values.
Parallel connection	An electrical connection in which the input terminal of one element is connected to the input terminal of another element and the output terminals are similarly connected together, thereby providing two paths for current flow
Parallel operation	Two or more generators, or other power sources, of the same phase, voltage and frequency characteristics supplying the same load
Paralleling	The procedure used to connect two or more generators to a common load
Peak shaving	Process by which utility customer minimizes utility charges by either generating power and eliminating excessive demand charges or by shedding load

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Permanent magnet	A ferromagnetic body that maintains a magnetic field without the aid of external electric current; The most practical material types are alnico, ceramic and rare earth.
Permanent magnet generator	A generator that has a permanent magnet field, usually rotating; The generator is usually synchronous.
Phase	The winding of a generator that determines the number of complete voltage and/or current sine waves generated per 360 electrical degrees, as in three-phase
Pole, magnetic	A part of a magnetic structure; There being two such parts, called a north pole and a south pole. Since neither pole can exist without the corresponding opposite, they always are present in pairs. Hence, a generator always has an even number of poles.
Power	The rate of performing work or of expending energy; Typically, mechanical power is expressed in terms of horse power and electrical power in terms of kilowatts. 1 kW equals 1.34 HP.
Power factor (PF)	(also cos θ); In AC circuits, the inductances and capacitances may cause the point at which the voltage wave passes through zero to differ from he point at which the current wave passes through zero. When the current wave precedes the voltage wave, a leading power factor results, as in the case of a capacitive load or over-excited synchronous motors. When the voltage wave precedes the current wave, a lagging power factor results. The power factor expresses the extent to which voltage zero differs from the current zero. Considering one full cycle to be 360 electrical degrees, the difference between the zero points can be expressed as an angle, θ. Power factor is calculated as the cosine of θ between zero points and expressed as a decimal fraction (0.8) or as a percentage (80 %). It can also be shown to be the ratio of apparent power (kW or VA), divided by the real power (kVA or W).
Power factor meter	An instrument that measures the power factor of the system
Pre-alarm	Warning prior to actually actuating the automatic engine safeties to indicate impending shutdown
Prime power	An application where the engine-generator set(s) must supply power on a continuous basis and for long periods of time between shutdowns; No utility service is present in typical prime power applications.
Radiator	A type of heat exchangers designed to transfer thermal energy from one medium to another for the purpose of cooling and heating
Radiator fan	Fan on end of the radiator used to push air through the radiator for engine cooling
Radiator shutters	A device placed either in front of or behind the radiator to block air flow when not required
Rain cap	A device mounted on the exhaust system with the purpose to preventing rain from entering the system
Rated power	The net electric output a generator can provide continuously when functioning is designed
Reactive load sharing	The process of regulating excitation which causes the reactive load to be shared proportionally between engine-generator sets
Reactive power control	This value is the calculated product of the metered generator voltage (VAVG), metered generator current (IB) square root of 3 and the sine of the metered phase angle.
Real load sharing	The process of governing which causes the real load (in Watts) to be shared proportionally between engine-generator sets
Regulator	Any of various controls or devices for regulating or controlling fluid flow, pressure, temperature, etc.

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Relay	An electrical switch that opens and closes under the control of another electrical circuit
Remote annunciator	A signaling apparatus not mounted on the engine-generator set, generally used in conjunction with a buzzer, that displays a visual indication when energized by electric current
Remote radiator	Radiator and fan that is mounted at some distance from the engine; The fan is generally not directly driven by the engine.
Reserve capacity minutes	A standard rating for lead-acid batteries; established by the BCI; (also referred to as reserve capacity); Battery's ability to sustain a minimum stated electrical load; It is defined as the time, in minutes, that a lead-acid battery will continuously deliver 25 A at 27 °C (80 °F) before its voltage drops below 10.5 V.
Reserve volume	A volume designed into the deaeration tank to provide a surplus of coolant to offset losses that might occur
Resistance	The non-reactive opposition which a device or material offers to the flow of direct or alternating current
Resistive temperature device	A solid state temperature sensor
Rotor	The rotating element of a motor or generator
Running time meter	Meter that keeps track of the total amount of time an engine-generator set has operated
Selector switch	A switch that is used to select among alternatives
Shunt trip	A feature added to a circuit breaker or fusible switch to permit the remote opening of the breaker or switch by an electrical signal
Shutdown	To stop operation
Silencer	See Muffler.
Software	A collection of computer programs, procedures and documentation that perform some tasks on a computer system
Sound	Can be considered both in terms of the sound pressure waves traveling in air (pressures superimposed on the atmospheric pressure) and the corresponding aural sensation; Sound can be "structure-borne", that is, transmitted through any solid elastic medium, but is audible only at points where the solid medium "radiates" the pressure waves into the air.
Sound attenuation	Reduction of sound level
Space heater	Integral heater used to prevent condensation in electrical equipment
Spec sheet	Term referring to MTU Onsite Energy's Engine Data Spec Sheets; These spec sheets provide specific technical information on different engine-generator sets (arranged by kW). They can be found online or in engineering guidebooks.
Stabilization	A condition where under a controlled operating environment, the coolant, oil, air and exhaust temperatures will not change regardless of the length of time the unit is run.
Standby power supply	The power supply that is selected to furnish electric energy when the normal power supply is not available
Standpipe	Deaeration tube located in the integral radiator deaeration tank to vent the radiator core of gases. Also called “J” tube.
Start-up request form	Form that is submitted by the end user of the engine-generator set to the distributor to initiate the units start up
Start-up validation and inspection form	Form that is completed by a qualified MTU Onsite Energy technician at the time of a unit start up

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Starter	An electric motor that initiates rotational motion in an internal combustion engine before it can power itself
Static	Inactive: not in physical motion
Static head	A term used in fluid mechanics to represent the internal energy of a fluid due to the pressure exerted on its container
Stroke	A single action of certain engines; Can also refer to the distance the piston travels.
Suction fan	A fan that pulls air through the core
Surge tank	See Deaeration tank.
Synchronous generator	A synchronous alternating-current machine that transforms mechanical power into electrical power; Note: • A synchronous machine is one in which the speed of normal operation is exactly proportional to the frequency of the system to which it is connected. • Unless otherwise stated, it is generally understood that a synchronous generator (or motor) has field poles excited with direct current or permanent magnets.
TB engine	Engine with water-to-air charge-air cooling circuit
TD engine	Engine with air-to-air charge-air cooling circuit
Temperature rise	The temperature increase over ambient due to load
Temperature stability	The ability of the cooling system to maintain coolant temperature at light loads or drift and/or engine speed or long vehicle drift (coasting); It is an important system characteristic for good heater operation during cold ambient conditions.
Thermo-regulating valve	Heat actuated valve that limits amount of city or raw cooling water into the system to conserve water and regulate cooling
Thermostat	A device that is heat actuated to maintain the circulating water temperature at a pre-determined level
Thermostatic valve	A pressure-balancing shower mixing valve with automatic temperature control; When temperature or pressure fluctuations occur at the water inlets, a thermal actuator adjusts the hot and cold ratio to maintain the original temperature setting.
Tier level	EPA emission standards and diesel fuel rules for non-road diesel engines in the United States
Top tank	See Deaeration tank.
Torque	Force required to move a shaft around its axis; It is measured in pounds-feet.
Tractor-driven generator	An electric generator so constructed that its rotor is driven by a power take-off on a farm tractor; Typically referred to as a PTO generator.
Trailer	An unpowered vehicle pulled by a powered vehicle
Transient curve	The measurement characteristics of a generator's electrical output when placed under changing loads
Transient response	The amount of time required for a generator to return to steady-state electrical output after applying or removing a load
Transient tolerances	A window of accepted deviation between theoretical and actual transient curves
Troubleshooting	The identification and resolution of problems, especially problems of a technical nature
UL 2200	A UL safety standard for stationary engine generator assemblies
Unidirectional current	A current which flows in one direction only; Is also called direct current (DC).
Unit mounted radiator	A radiator mounted on the engine-generator set
Valve	A device that regulates the flow of fluid (gases, fluidized solids, slurries, or liquids) by opening, closing, or partially obstructing various passageways
Ventilation	The circulation air

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Vibration isolator	A resilient support that tends to isolate the engine-generator set from steady state excitation
Voltage	The difference of electrical potential between any two conductors; The unit of voltage is Volt (V).
Voltage dip	The reduction in voltage resulting from a sudden application of load, usually expressed as a percentage
Voltage range	The span of voltage through which the engine-generator set is capable of being connected
Voltage regulation	The voltage regulation of an engine-generator set is the difference between steady state no load and steady state full load output voltage expressed as a percentage of the full load voltage.
Voltage regulator	A device which automatically controls the voltage output of a generator at its specific value
Voltage transient	The maximum change in voltage when a specified load is suddenly applied or removed
Warning	A signal of danger
Water heater	Also tank heater; An appliance for heating water above its ambient temperature
Water pump	The pump, driven by the engine crankshaft, that circulates coolant through the engine block, cylinder head and radiator
Water pump inlet	The pressure (suction) at the inlet to the water pump when the pressure cap is removed, which represents up-stream restriction
Weatherproof	Capable of resisting damage caused by the weather
Wet stack	A field term used to describe the condition when unburned hydrocarbons in the exhaust gases condense in the exhaust system; This is a result of under utilized power (typically < 30 % load) on a diesel engine. Unchecked, this condition can lead to degradation of performance and compromise the integrity of the diesel engine.
Winding	An assembly of coils that acts to produce a magnetic flux field or to link a flux field
Wiring harness	A pre-assembled group of wires arranged to facilitate interconnection of electrical circuits

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13 Appendix B

13.1 Index

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14 Preparation and Startup Information

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14.1 Form A - Engine Generator Set Request for Start-Up OE-G-GEN-A-001

MTU ONSITE ENERGY
Form A - Engine Generator Set Request for Start-Up

Requested Date: _____

☐ First Visit ☐ Follow-Up Visit

Instructions
This form must be completed and signed by the customer/client to ensure proper installation of the generator set prior to scheduling a start-up date and to request start-up service from an authorized MTU Onsite Energy distributor or regional service center.

Applicant Contact Details

Company: _____

Name: _____

Telephone: _____

Email: _____

Project Details

Project Name: _____

Project Number: _____

Site Address: _____

_____

Engine Generator Set Nameplate

Model Number: _____

Serial Number: _____

Rating: _____

Hz: _____ kW: _____

kVA: _____ Volts: _____

Phase: _____ Amps: _____

Engine

Model Number: _____

Serial Number: _____

Power: _____ RPM: _____

Fuel Type
☐ Diesel ☐ NG ☐ LP Vapor ☐ Liquid LP ☐ Other

ATS (☐ Yes ☐ No)

Manufacturer: _____

Model Number: _____

Serial Number: _____

Voltage: _____ Current: _____

Poles: _____

Utility Service

Volts: _____ Phase: _____

Phase Rotation: _____

Load Bank (☐ Yes ☐ No)

Capacity: _____

Pre-Start-Up Validation Checklist

	Yes	No	N/A
Unit set in final location	☐	☐	☐
Radiator ducted to air discharge louvers	☐	☐	☐
Intake and discharge air louvers installed and wired	☐	☐	☐
Unit filled with oil to proper level	☐	☐	☐
Unit filled with coolant to proper level	☐	☐	☐
Battery filled and fully charged	☐	☐	☐
Battery charger mounted with AC and DC wiring	☐	☐	☐
Block heater wired to correct AC power supply	☐	☐	☐
Switch gear/transfer switch connections made	☐	☐	☐
All other AC and DC electrical connections made	☐	☐	☐
Fuel inlet and return lines run between the unit and fuel storage system	☐	☐	☐
Fuel storage system filled with sufficient quantity for commissioning	☐	☐	☐
Exhaust system properly installed and supported	☐	☐	☐
Radiator and engine generator set room is free of debris	☐	☐	☐
Permission for use of site load or request load bank	☐	☐	☐
Other: _____	☐	☐	☐

NOTE: If the tasks on this checklist are not adequately completed upon arrival of the authorized MTU Onsite Energy technician or for reasons beyond MTU Onsite Energy's control, an additional start-up charge may be incurred. Please resubmit this form when items are addressed.

Additional Comments/Notes:

_____

_____

_____

_____

Completed by (signature): _____

Print Name: _____

Company: _____

Date: _____

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14.2 Form B - Engine Generator Set Installation and Commissioning OE-G-GEN-A-002

MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Instructions
This report must be completed and signed by an MTU Onsite Energy certified commissioning technician in order to accomplish all requirements of the MTU Onsite Energy Limited Warranty. This report includes the physical installation checkups and commissioning procedures for all control versions as well as open and enclosed generator sets.

After completion, a signed copy must be provided to each of the following:

1. Distributor/Dealer
2. Owner
3. MTU Onsite Energy Regional Warranty Department

Applicant Contact Details

Distributor/Company: _____

Name: _____

Telephone: _____

Email: _____

Project Details

Project Name: _____

Project Number: _____

Site Address: _____

_____

Start-Up and Commissioning Start Date: _____

Start-Up and Commissioning Completion Date: _____

Engine Generator Set Nameplate

Model Number: _____

Serial Number: _____

Rating: _____

Hz: _____ kW: _____

kVA: _____ Volts: _____

Phase: _____ Amps: _____

Engine

Model Number: _____

Serial Number: _____

Power: _____ RPM: _____

Fuel Type:

☐ Diesel ☐ NG ☐ LP Vapor ☐ Liquid LP ☐ Other

Generator

Manufacturer: _____

Model Number: _____

Serial Number: _____

AVR Type: _____

kVA: _____ Hz: _____

Voltage: _____ Current: _____

Phase Rotation: _____

Breaker (MTU Delivery ☐ Yes ☐ No)

Manufacturer: _____

Model Number: _____

Serial Number: _____

Voltage: _____ Current: _____

Poles: _____

ATS (☐ Yes ☐ No)

Manufacturer: _____

Model Number: _____

Serial Number: _____

Voltage: _____ Current: _____

Poles: _____

Controller

Manufacturer: _____

Model Number: _____

Serial Number: _____

Firmware Version: _____

General

Application: ☐ 3A Continuous ☐ 3B Prime ☐ 3D Standby ☐ 3F DCCP ☐ _____

Load test type on site: ☐ Building load ☐ Load bank ☐ Grid parallel ☐ None

Load test not possible because:

_____

_____

Engine Generator Set Application

☐ Installed in building

☐ Containerized

☐ Enclosed

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Prestart Safety Checks/Environmental Check

	Yes	No	N/A
Commissioning performed by an MTU Onsite Energy certified commissioning technician	☐	☐	☐
Personal protection equipment is available and functional	☐	☐	☐
Access only for authorized personnel	☐	☐	☐
Emergency escape routes are unobstructed (no loose materials, parts, or tools) and labeled	☐	☐	☐
Danger spots are indicated (e.g. trip hazards, beams, pipes)	☐	☐	☐
Control panel/engine area is unobstructed	☐	☐	☐
All warning plates and instruction labels are properly in place	☐	☐	☐
Genset room is free of debris, dirt, dust, loose materials, parts, and tools	☐	☐	☐
Air ducts are free and clean	☐	☐	☐
Engine generator set is leveled; mounting bolts secure	☐	☐	☐
Shipping blocks are removed	☐	☐	☐
For two-bearing generators, check for proper alignment	☐	☐	☐
Heat protection covers are installed	☐	☐	☐

Engine Generator Set Room (Equipment)

	Yes	No	N/A
Battery powered emergency light is installed	☐	☐	☐
Fire extinguishers are in place	☐	☐	☐
First aid kit is in place	☐	☐	☐
Oil resistant floor coating	☐	☐	☐
Spill containment system in place	☐	☐	☐

Fire extinguishing system

☐ Water ☐ CO_2 ☐ Chemical ☐ None

Engine Room Requirements (Open Power Units)

	Yes	No	N/A
Engine room is located as close as practical to the main consumer	☐	☐	☐
Space for maintenance is left around the engine generator set	☐	☐	☐
Battery powered back-up lights available	☐	☐	☐

Engine Generator Set Room Ventilation

	Yes	No	N/A
Intake and exhaust opening properly sized and louvers installed	☐	☐	☐
Flexible duct section installed	☐	☐	☐
Radiator duct properly sized to louver	☐	☐	☐
Proper air flow direction past alternator and then the engine	☐	☐	☐
Engine room inlet air filter in place	☐	☐	☐
Weather/animal guard is fitted to intake and outlet	☐	☐	☐

Self-Contained Engine Generator Set Ventilation

	Yes	No	N/A
Engine generator set intake positioned away from obstruction to airflow	☐	☐	☐
Radiator discharge positioned away from prevailing winds	☐	☐	☐
Sufficient clearance around self-contained engine generator set for airflow	☐	☐	☐

Air Inlet and Outlet

	Yes	No	N/A
Air ducts are clean and clear	☐	☐	☐
Ducts are installed properly	☐	☐	☐
Weather protection guards are installed	☐	☐	☐
Silencers are installed properly	☐	☐	☐
Louvers open and close automatically	☐	☐	☐
Manual operation of louvers is possible	☐	☐	☐
Structure air flows are correct (no thermal short circuit)	☐	☐	☐
Unrestricted airflow over the engine	☐	☐	☐

Cooling System

	Yes	No	N/A
Cooling system is free of leakages	☐	☐	☐
Pipelines and connections undamaged	☐	☐	☐
Radiator fan(s) are clear and clean	☐	☐	☐
Venting pipes have gradient toward expansion tank	☐	☐	☐
Overflow is free and spillage is avoided	☐	☐	☐
System is filled to proper level	☐	☐	☐
Filling cap is freely accessible	☐	☐	☐
Coolant-preheater is functional	☐	☐	☐
Coolant type and concentration as specified in MTU manual: _____	☐	☐	☐

Frame-Mounted Radiator

	Yes	No	N/A
Check belt tension and alignment	☐	☐	☐
Radiator clean and free from obstruction	☐	☐	☐
Radiator air outlet connected to outlet duct	☐	☐	☐
Check for possibility of hot air recirculation	☐	☐	☐
Engine generator set vent pipes routed upward toward radiator expansion tank	☐	☐	☐
Pipelines secure and undamaged	☐	☐	☐
Overflow clear and routed to avoid spillage	☐	☐	☐

Remote-Mounted Cooling System

	Yes	No	N/A
Pipelines cleaned and painted	☐	☐	☐
Device(s) aligned and fixed properly	☐	☐	☐
Pipelines fixed properly	☐	☐	☐
Expansion tank is of adequate size	☐	☐	☐
Pipelines isolated from generator set vibration	☐	☐	☐
Static head pressure is within system capability	☐	☐	☐
Auxiliary power supply is installed correctly	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
Fan rotational direction correct	☐	☐	☐
Overflow clear and routed to avoid spillage	☐	☐	☐
Engine generator set vent pipes routed upward toward radiator expansion tank	☐	☐	☐
Avoid air locks in pipelines – air bleed valves provided	☐	☐	☐
All proper electrical connections made	☐	☐	☐

Heat Exchanger and Cooling Tower

	Yes	No	N/A
Pipelines cleaned and painted	☐	☐	☐
Device(s) aligned and fixed properly	☐	☐	☐
Pipelines fixed properly	☐	☐	☐

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Heat Exchanger and Cooling Tower (continued)

	Yes	No	N/A
Expansion tank is of adequate size	☐	☐	☐
Pipelines isolated from generator set vibration	☐	☐	☐
Vent valves installed	☐	☐	☐
Static head pressure is within system capability	☐	☐	☐
Secondary circuit pump direction is accurate	☐	☐	☐
Secondary circuit pump is functional	☐	☐	☐
Potential equalization is functioning properly	☐	☐	☐
Overflow lines are clear and routed to avoid spillage	☐	☐	☐
Engine generator set vent pipes routed upward toward expansion tank	☐	☐	☐
Air bleed valves installed	☐	☐	☐
Cooling tower make up supply is complete	☐	☐	☐
Auxiliary power supply to fans is correctly installed	☐	☐	☐
All proper electrical connections made	☐	☐	☐

Mounting/Foundation

	Yes	No	N/A
Engine generator set is installed on proper mounts	☐	☐	☐
Static deflection area of mounts not blocked by components	☐	☐	☐
Surface is level	☐	☐	☐
Support structure is adequate to support engine generator set weight	☐	☐	☐
Engine generator set is supported at each mounting location	☐	☐	☐

Lube Oil System

	Yes	No	N/A
Engine is filled with oil to proper level	☐	☐	☐
No oil leaks present	☐	☐	☐
Flexible lines installed in make-up lube-oil system	☐	☐	☐
Oil type as specified in MTU manual (record type):	☐	☐	☐

_____

Starting System

	Yes	No	N/A
Battery and cables are free from damage	☐	☐	☐
Battery and cables installed, mounted, and wired properly	☐	☐	☐
Batteries filled up to appropriate level	☐	☐	☐
Idle charging voltage min. 27.6 VDC for 24 V system or 13.7 VDC for 12 V system	☐	☐	☐
Battery charger properly installed and wired	☐	☐	☐
Battery is located near starter with shortest cable run as possible	☐	☐	☐

Diesel Fuel System

	Yes	No	N/A
Fuel system is free of leakages	☐	☐	☐
Flexible lines installed at engine	☐	☐	☐
Pipeline size adequate to system	☐	☐	☐
Pipelines and connections undamaged	☐	☐	☐
Flow and return lines connected correctly	☐	☐	☐
Fuel lines free of tension, scuffing, or kinks	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
Adequate room is left for fuel tank inspections	☐	☐	☐

Diesel Fuel System (continued)

	Yes	No	N/A
Tank is not overfilled	☐	☐	☐
Tank is not in the vicinity of exhaust or other heat sources	☐	☐	☐
For electric fan driven fuel coolers: Fuel cooler plumbed and wired correctly	☐	☐	☐
Fuel returns to fuel tank without restriction, proper sized pipe	☐	☐	☐
Fuel prefilter installed before engine inlet	☐	☐	☐
Electronic day tank pump used from main storage to day tank	☐	☐	☐
Day tank controls/pumps installed	☐	☐	☐
Fuel transfer pump connected to emergency power	☐	☐	☐
Level indicator used for checking tank contents	☐	☐	☐
Leak sensors are in place	☐	☐	☐
All proper control and sensor connections are made	☐	☐	☐
Spill containment procedure in place per code	☐	☐	☐

Diesel Fuel System (Main Storage Tank)

	Yes	No	N/A
Isolating valves correctly positioned	☐	☐	☐
Transfer pump and controls operational	☐	☐	☐
Pipeline/tank heating system operational	☐	☐	☐
Fuel level monitoring system operational	☐	☐	☐
Check for leaks	☐	☐	☐

Day Tank

	Yes	No	N/A
Tank is fixed properly and mounted to substructure	☐	☐	☐
Tank vent line is plumbed to safe area	☐	☐	☐
Tank filling line is of adequate size	☐	☐	☐
All unused fittings are plugged	☐	☐	☐
Mechanical fuel level indicator installed	☐	☐	☐
Electrical fuel level indicator installed and tested	☐	☐	☐
Fuel level switches installed and adjusted	☐	☐	☐
System pump(s) connected to emergency power	☐	☐	☐
Potential equalization is installed properly	☐	☐	☐
System pump(s) installed correctly (flow direction)	☐	☐	☐
Refill function checked	☐	☐	☐
Leakage sensor in place	☐	☐	☐
Adequate space available for inspections	☐	☐	☐
Isolating and solenoid valves checked	☐	☐	☐
Tank filled	☐	☐	☐
Check for leaks	☐	☐	☐
Fire valves present	☐	☐	☐

Gas Fuel System (Americas Only)

	Yes	No	N/A
Dedicated gas supply line of proper size and material	☐	☐	☐
Check for gas filter/screen	☐	☐	☐
Check gas solenoid valve operation	☐	☐	☐
Check supply lines for leaks	☐	☐	☐
Check manual shut-off valve operation	☐	☐	☐
Solenoid valves correctly positioned	☐	☐	☐
Regulator set to correct pressure	☐	☐	☐
Gas leak detection equipment operational	☐	☐	☐
Shut-off devices operational	☐	☐	☐
Specified gas pressure is available at fuel inlet	☐	☐	☐

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Exhaust System

	Yes	No	N/A
Piping is installed and secured properly	☐	☐	☐
Flexible connectors installed at engine exhaust outlet	☐	☐	☐
Flexible connectors installed correctly	☐	☐	☐
Exhaust line condensate trap with drain installed	☐	☐	☐
Silencer is installed and secure	☐	☐	☐
Exhaust thimble installed per local codes	☐	☐	☐
Exhaust system below back pressure limit	☐	☐	☐
Exhaust piping diameter properly sized for length of run	☐	☐	☐
No diameter reductions downstream on exhaust pipes	☐	☐	☐
All exhaust system weight is properly supported	☐	☐	☐
Proper pipe wall thickness is maintained	☐	☐	☐
Exhaust lines are properly insulated	☐	☐	☐
Exhaust installed with a downward pitch to outlet	☐	☐	☐
Exhaust line protected from natural elements (rain cap installed)	☐	☐	☐
Exhaust gas prevented from re-entry to building	☐	☐	☐
Hot parts safety decals/guards are present	☐	☐	☐

Fire Alarm/Suppression System

	Yes	No	N/A
Fire alarm/suppression system present	☐	☐	☐

Engine Management System (Engine Governor)

	Yes	No	N/A
Engine Control Unit box is free of damage	☐	☐	☐
Engine Control Unit box is securely mounted to engine	☐	☐	☐
Electrical connections securely fastened	☐	☐	☐

Grounding

	Yes	No	N/A
Engine and generator are properly grounded	☐	☐	☐

Electrical and Control System

	Yes	No	N/A
Remote wiring connected correctly	☐	☐	☐
Cables free of tension, scuffing, or kinks	☐	☐	☐
All connections clean and secure	☐	☐	☐
Bus bar phase sequence, voltage, and frequency checked	☐	☐	☐
Control cables routed in separate conduits from phase leads	☐	☐	☐
Engine generator set controls energized and functional	☐	☐	☐
Software version of engine generator set controller recorded	☐	☐	☐
All LEDs on panel illuminate when LED test is pressed	☐	☐	☐
Emergency stop control operational	☐	☐	☐
Test certificates available for all cables	☐	☐	☐
Utility service breaker capacity verified	☐	☐	☐
Small power and lighting circuits operational	☐	☐	☐

Switchgear/Transfer Switch

	Yes	No	N/A
Cables installed to correct torque specification	☐	☐	☐
Phase cables to switchgear/transfer switch are correctly sized and clearly identified	☐	☐	☐
Switchgear protection settings checked	☐	☐	☐
All other connections are clean and secure	☐	☐	☐

Generator Circuit Breaker

	Yes	No	N/A
ON/OFF function	☐	☐	☐
Auxiliary contact	☐	☐	☐
Adjust over-current protection	☐	☐	☐
Adjust the trip unit	☐	☐	☐
Phase rotation checked	☐	☐	☐

Preparation for Running Checks

☐ Follow appropriate lockout/tagout procedure

Running Checks

	Yes	No	N/A
Engine generator set engine control switch in the RUN position. Start engine and verify whether there is sufficient oil pressure	☐	☐	☐
Allow engine to run for five minutes	☐	☐	☐
Check coolant level, add as necessary, and reinstall cap	☐	☐	☐
Allow engine to run for at least 20 minutes and check engine operating temperature	☐	☐	☐
Check the battery charger for proper operation	☐	☐	☐
If the speed is unstable, adjust to specifications	☐	☐	☐
Adjust the AC output voltage to match the utility voltage using the voltage adjusting control	☐	☐	☐
Check for oil, coolant, and exhaust leaks/recirculation	☐	☐	☐
Check temperature on city water-cooled models and adjust the thermostatic valve as necessary	☐	☐	☐
Engine generator set engine control switch in the OFF position	☐	☐	☐
Permission must be obtained from the building authority before transfer switch test is performed	☐	☐	☐
Test transfer switch	☐	☐	☐
Record the current phase for the three phase systems A _____ B _____ C _____			
Set the engine generator set exerciser with load to the customer's required exercise period	☐	☐	☐
Verify that all options on the transfer switch are adjusted and functional to the customer's requirements	☐	☐	☐

Record transfer switch delay settings:

TDES (Time Delay to Engine Start)	_____ sec.
TNE (Time Delay Normal to Emergency)	_____ sec.
TDN (Time Delay to Normal)	_____ min.
TDEC (Time Delay Engine Cooldown)	_____ min.

Mains Failure Test

Number of start trials: _____

Duration between mains failure and generator circuit breaker (GCB) closed (until emergency power source supplies load) _____ sec.

	Yes	No	N/A
Dyn. Frequency drift within limit of ISO 8528-5	☐	☐	☐
Static voltage drift during operation within limit of ISO 8528-5	☐	☐	☐
Static frequency drift during operation within limit of ISO 8528-5	☐	☐	☐

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Running Checks (record on chart)

Unless otherwise specified by local or state regulations, run the engine-generator set at full expected system load in excess of 30% of the nameplate rating). Record data at 15 minute intervals.

Time of Day	Generator Voltage, Volts	Generator Output A Phase, Amps	Generator Output B Phase, Amps	Generator Output C Phase, Amps	Generator Output Frequency, Hz	Ambient Room Temperature	Engine Oil Pressure	Battery Charger Volts (DC)	Coolant Temperature	Run Time, Minutes	Notes

Shutdowns

	Yes	No	N/A
Emergency stop (also external)	☐	☐	☐
Over-frequency/over speed	☐	☐	☐
Under-frequency	☐	☐	☐
Over-voltage	☐	☐	☐
Under-voltage	☐	☐	☐
Oil pressure Lo Lo	☐	☐	☐
Engine temperature Hi Hi	☐	☐	☐

Check and verify any additional protective devices and list:

_____

_____

_____

Additional Comments/Notes:

_____

_____

_____

_____

_____

_____

_____

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MTU ONSITE ENERGY
Form B - Engine Generator Set Installation and Commissioning

Customer Acknowledgement (Literature and Instructions)

☐ Verify that the customer has the appropriate engine/engine-generator set and transfer switch (if provided by MTU Onsite Energy) literature. Instruct the customer in the operation and maintenance of the power system.

I _____ received instructions on _____
Please print name of person receiving instructions. Date

_____ (signature)

To be filled out by the commissioning technician only.

Completed by (signature): _____

Print Name: _____

Company: _____

Date: _____

Note: Completion of this checklist does not relieve the installer of contract obligations.

To be filled out by the customer/client.

Witnessed by (signature): _____

Print Name: _____

Company: _____

Location: _____

Date: _____

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14.3 Two (2) Year 3000 Hour Basic Standby Limited Warranty_OE-M-GEN-S-006

STANDBY LIMITED WARRANTY
Two (2) Year / 3,000 Hour Basic

LIMITED WARRANTY

Your MTU Onsite Energy product has been manufactured and inspected with care by experienced craftspeople. If you are the original consumer, MTU Onsite Energy warrants, for the limited warranty period indicated below, each product will be free from defects in materials and workmanship, and will perform under normal use and service from valid start-up performed by MTU Onsite Energy. This Limited Warranty shall apply only when the product has been properly installed, serviced, and operated in accordance with the applicable MTU Onsite Energy instruction manuals. If this Limited Warranty applies, the liability of MTU Onsite Energy shall be limited to the replacement, repair, or appropriate adjustment of the product, at MTU Onsite Energy's option. This Limited Warranty does not apply to malfunctions caused by normal wear and tear, or by damage, unreasonable use, misuse, repair, or service by unauthorized persons.

LIMITED WARRANTY PERIOD

Engine Generator Set: Parts and labor for twenty-four (24) months will begin with the first commissioning of the product(s). In all cases, the warranty period will expire not later than thirty-six (36) months from the date of shipment ex-works MTU Onsite Energy or after 3,000 operation hours, whichever occurs first. Accessories: Parts and labor for one (1) year from date of shipment. For a description of accessories and items excluded from this Limited Warranty, review the listings below.

LIMITED WARRANTY CONDITIONS

Before there is any protection under this Limited Warranty, the distributor must: (1) complete the MTU Onsite Energy Warranty and the Start-Up Validation and Pre-Inspection form, and return them to MTU Onsite Energy within 60 days of the start-up date, and (2) complete the engine registration form and return it to the manufacturer as stated in the instructions with engine registration form (when applicable). In addition, this Limited Warranty is not valid or enforceable unless: (1) all supporting maintenance records are kept on file with the end user and made available upon request from factory, (2) the generator set is routinely exercised in accordance with operating instructions, and (3) the installation meets the general guidelines, standards, recommendations (as laid out in the Installation Guide provided with the product), and all local standards and codes applicable in the location of installation.

Engine generator sets that are stored by Owner / Buyer longer than 180 days from date of shipment are subject to special requirements. Contact MTU Onsite Energy's Service Center for instructions.

TO OBTAIN WARRANTY SERVICE

Warranty service may only be performed by MTU Onsite Energy authorized service providers. **Service provided by unauthorized persons will void this Limited Warranty. Non-MTU Onsite Energy replacement part(s) will void this Limited Warranty.** Contact your nearest MTU Onsite Energy Service Representative to obtain warranty service. For assistance in locating your nearest authorized service representative, see contact information at the bottom of this page.

TIM-ID: 0000076812 - 001

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED. NO WARRANTIES SHALL BE IMPLIED OR OTHERWISE CREATED UNDER THE UNIFORM COMMERCIAL CODE, INCLUDING BUT NOT LIMITED TO A WARRANTY OF MERCHANTABILITY OR A WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.
MTU ONSITE ENERGY SHALL NOT BE LIABLE FOR ANY CLAIM GREATER IN AMOUNT THAN THE PURCHASE PRICE OF THE PRODUCT AT ISSUE, AND IN NO EVENT SHALL MTU ONSITE ENERGY BE LIABLE

STANDBY LIMITED WARRANTY
Two (2) Year / 3,000 Hour Basic

FOR ANY SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES. STATE LAWS REGARDING THE RIGHTS OF CONSUMERS MAY VARY FROM STATE TO STATE.

1. The following items are not considered nor will they be covered under this Limited Warranty. If there are questions as to coverage under this Limited Warranty, it is advisable to contact the factory in advance of filing a claim.
   a. Battery or batteries of any type or kind. The battery manufacturer's warranty, if any, is the only warranty that applies to batteries. Any warranty claim should be handled with the manufacturer according to its policies.
   b. Adjustments to fuel systems or governor system at time of start-up or any time after. A warranty claim for such adjustments is acceptable only when a defective part has been replaced, returned to the factory, and approved as defective.
   c. Normal maintenance costs, including but not limited to adjustments, loose and/or leaking fittings or clamps, and tune-ups performed during start-up or anytime thereafter.
   d. Due to shipping, manufacturer is not responsible for loose connections. All connections must be checked at time of start-up.
   e. Non-MTU Onsite Energy replacement part(s) will void this Limited Warranty.
   f. Products that are modified in any form without the written consent of MTU Onsite Energy will void this Limited Warranty.
   g. Shipping damage of any type.
   h. Any installation errors or damage of the equipment when shipped as ordered.
   i. Any overtime travel or labor to make repairs under warranty.
   j. Any special access fees required to gain access to MTU Onsite Energy equipment, including but not limited to any training or safety policy requirements to gain access.
   k. Additional costs associated with inaccessible installations, including but not limited to removal and reinstallation of the generator set.
   l. Rental equipment used during warranty work including but not limited to generators, rigging equipment such as a crane or boom truck, load banks, and special test equipment above factory requirements.
   m. Excess mileage charges. Any authorized service provider may perform warranty service anywhere, but will only be paid for mileage expenses from the nearest service center and limited to 400 miles / 644 Kilometers round-trip.
   n. Any equipment not factory approved and engineered for use on MTU Onsite Energy products. This includes but is not limited to aftermarket items such as special fuel systems, enclosures, exhaust systems, or switch gear that had been sought out and quoted by a third party to be included in billing of the MTU Onsite Energy equipment.
   o. Misuse or abuse during installation and thereafter.
   p. Normal wear and tear, maintenance, and consumable items that are not required as part of a warranty repair. Consumable items include but are not limited to belts, hoses, coolant, oil, filters, and fuses.
   q. Acts of nature or acts of God such as lightning, wind, flood, tornado, hurricane, or earthquake.
   r. Any damage due to situations beyond the control of the manufacturing of the product or workmanship of the product.
   s. Installation or operation outside the guidelines as stated in the Installation Guide and Owner's Manual.
   t. Diesel engine "Wet Stacking" due to lightly loaded diesel engines.
   u. Misapplication of the equipment such as usage outside the original design parameters as stated on the nameplate of the equipment.
   v. Travel expense on portable equipment.
   w. Trailer lights, wiring, and brakes.

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x. More than one trip to the job site because a service vehicle was not stocked with normal service parts.
y. Lodging expense of person(s) performing service, unless approved in advance by factory.
z. Engine fluids.
aa. Units purchased at the standby power rating that are being used in a prime power application.
ab. Any repair labor time that is determined to be excessive, e.g., two or more people performing a one-person job.
ac. Any expenses associated with investigating performance complaints in which no defect is found.
ad. Any associated costs for replacing components that are found not to be defective.
ae. Any adjustments covered in the start-up and inspection forms that are to be completed during start-up.

2. The accessories that are limited to one (1) year parts and labor from date of shipment include but are not limited to:
   a. Cords, receptacles, and cord reels
   b. Gas flex pipes
   c. Housing lights, space heaters, and associated equipment

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100 Power Drive / Mankato, MN 56001 / 800-325-5450

14.4 MTU Onsite Energy Registration

Important MTU Onsite Energy Registration

Please complete the MTU Onsite Energy registration using one of the following methods:

Please complete the MTU Onsite Energy product registration at: http://registration.mtuonsiteenergy.com

Or

Please complete and return the MTU Onsite Energy product registration card found below to MTU Onsite Energy.

The product registration details are used to communicate after sales and logistics support (spare parts, documentation updates, etc.)

(Complete and detach the Product Registration Card below)

_____
_____
_____

Postcard

MTU Onsite Energy Corporation
P.O. Box
100 Power Drive
Mankato, MN 56002

TIM-ID: 0000001680 - 001

Important MTU Onsite Energy Registration

(Complete and detach the Product Registration Card below)

Quality is extremely important to MTU Onsite Energy and we want to hear from you. Please take the time to tell us what you think about MTU Onsite Energy products.
Generator Set Serial Number: _____Date generator set was received:_____ Date installed:_____

Contact Name:_____Contact Number:_____E-mail :_____

Describe your level of satisfaction with each of the following:

	Excellent	Very Good	Good	Satisfactory	Unsatisfactory	N/A
Timely Receipt of Product:	O	O	O	O	O	O
Product Installation:	O	O	O	O	O	O
Start-up:	O	O	O	O	O	O
Ease of Operation:	O	O	O	O	O	O
Overall Product Quality:	O	O	O	O	O	O

Did you receive the following?

	Yes	No
Warranty Validation Form:	O	O
Product Installation:	O	O
Start-up:	O	O
Ease of Operation:	O	O
Overall Product Quality:	O	O

Describe the quality of the following:

	Excellent	Very Good	Good	Satisfactory	Unsatisfactory	N/A
Operation & Maintenance Manual:	O	O	O	O	O	O
Installation & Operation: Guide:	O	O	O	O	O	O

Will you purchase MTU Onsite Energy products in the future? **Yes / No**
Will you recommend MTU Onsite Energy products in the future? **Yes / No**
What MTU Onsite Energy product changes would you recommend?_____
What value-added products and services would you like to see MTU Onsite Energy Offer?_____
Additional Comments:_____
_____
_____

Please contact MTU Onsite Energy at 800.325.5450 with any questions or concerns.
Thank you for taking the time to complete the Product Registration & Customer Satisfaction Survey.

TIM-ID: 0000001680 - 001

CIRCUIT BREAKER ENCLOSURE - DIESEL
80-125 kW Standby / 72-111 kW Prime Data Sheet

CIRCUIT BREAKER ENCLOSURE

This circuit breaker enclosure data sheet is used in conjunction with dimensional drawings to assist with submittal documentation and specification requirements. This document summarizes the enclosure dimensions and mounting positions for the MTU 4R0120 DS80, MTU 4R0120 DS100, and MTU 4R0120 DS125 circuit breakers, including small and large size enclosures. The dimensional drawings will govern and should be referenced for installation.

SMALL ENCLOSURE

- Small enclosure supplied with select 360 frame alternator applications.
- Right side breakers shown. Left side breakers optional.
- Reference Figure 1.1 and Table 1.1 for breaker mounting positions.

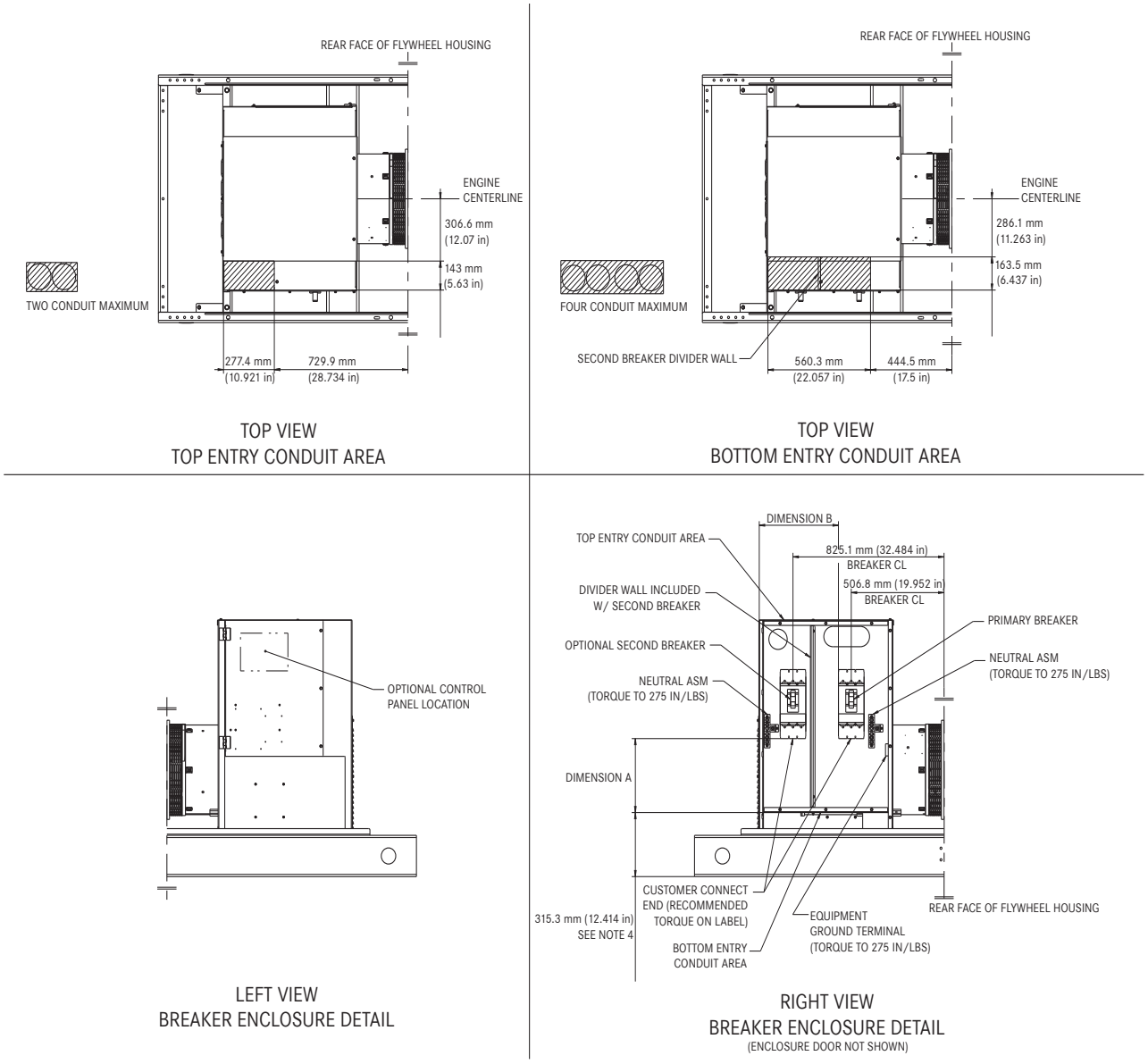

Figure 1: Small Enclosure (Drawing ID: XZG2100100031)

TIM-ID: 0000100959 - 006

CIRCUIT BREAKER ENCLOSURE - DIESEL
80-125 kW Standby / 72-111 kW Prime Data Sheet

Available Circuit Breakers		Enclosure Data				
Breaker Frame	Amperage	Output Wire Range 90 °C Cu (wires per lug)	Wire Bending Space[1] Dimension A mm (in)	Wire Gutter Space[1,2] Dimension B mm (in)	Conduit Quantity	Conduit Size[3] in
H-Frame	15 - 150	(1) 4 - 3/0	459 (18.08)	450 (17.72)	1	2.5
J-Frame	175	(1) 4 - 3/0	445 (17.52)	450 (17.72)	1	2.5
J-Frame	200 - 250	(1) 3/0 - 350	445 (17.52)	450 (17.72)	1	3
L-Frame 100%	300 - 400	(2) 2/0 - 500	364 (14.35)	433 (17.03)	2	3.5
L-Frame 80%	300 - 600	(2) 2/0 - 500	364 (14.35)	433 (17.03)	2	3.5

Table 1: Small Enclosure Data

1. Meets or exceeds NFPA 70, NEC 312.6(A), and NEC 312.6(B).
2. Top entry only available for single breaker applications.
3. Based on flexible metal conduit at 40% fill using THHN wire.
4. Add 205 mm (8.08 in) for bases with integrated single wall fuel tank (see Figure 1).

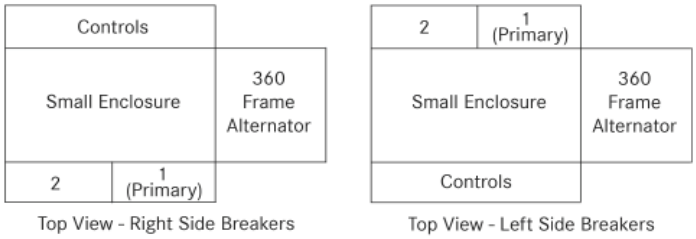

Figure 1.1: Small Enclosure Breaker Mounting Positions

Breaker Frame	
Position 1 (Primary)	Position 2
H / J / L	-
H / J / L	H / J / L

Table 1.1: Small Enclosure Breaker Mounting Positions

TIM-ID: 0000100959 - 006

CIRCUIT BREAKER ENCLOSURE - DIESEL
80-125 kW Standby / 72-111 kW Prime Data Sheet

LARGE ENCLOSURE

- Large enclosure supplied with all 430 frame alternator applications and select 360 frame alternator applications.
- Right side primary breaker shown. Left side primary breaker optional.
- Reference Figure 2.1 and Table 2.1 for breaker mounting positions.

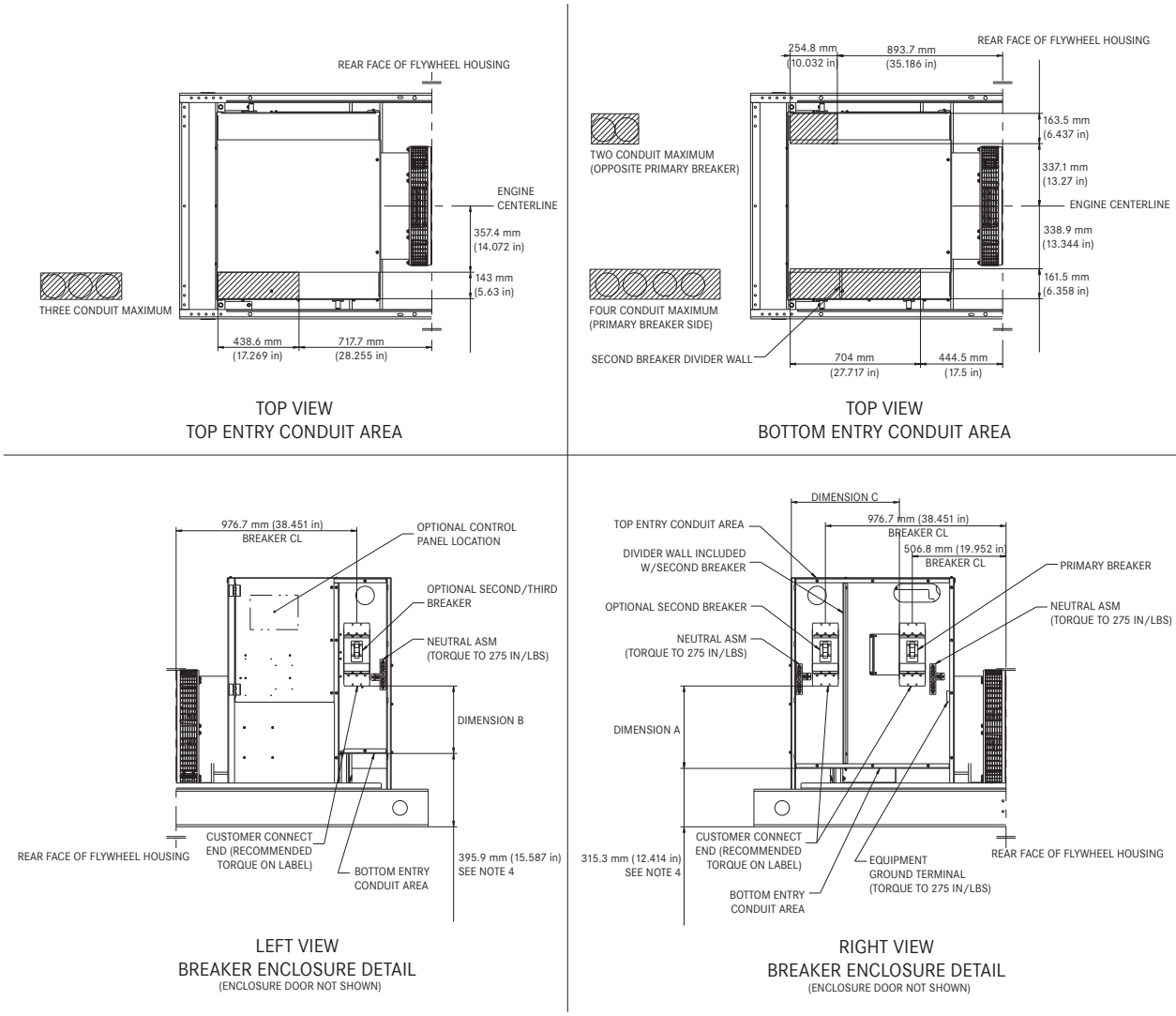

Figure 2: Large Enclosure (Drawing ID: XZG2100100031)

TIM-ID: 0000100959 - 006

CIRCUIT BREAKER ENCLOSURE - DIESEL
80-125 kW Standby / 72-111 kW Prime Data Sheet

Available Circuit Breakers		Enclosure Data					
Breaker Frame	Amperage	Output Wire Range 90 °C Cu (wires per lug)	Wire Bending Space[1] Dimension A mm (in)	Wire Bending Space[1] Dimension B mm (in)	Wire Gutter Space[1,2] Dimension C mm (in)	Conduit Quantity	Conduit Size[3] in
H-Frame	15 - 150	(1) 4 - 3/0	532 (20.93)	451 (17.76)	602 (23.69)	1	2.5
J-Frame	175	(1) 4 - 4/0	518 (20.37)	437 (17.2)	602 (23.69)	1	2.5
J-Frame	200 - 250	(1) 3/0 - 350	518 (20.37)	437 (17.2)	602 (23.69)	1	3
L-Frame 100%	300 - 400	(2) 2/0 - 500	443 (17.44)	362 (14.27)	584 (23)	2	3.5
L-Frame 80%	300 - 600	(2) 2/0 - 500	443 (17.44)	362 (14.27)	584 (23)	2	3.5
M-, P-Frame	250 - 800	(3) 250 - 500	407 (16.01)	n/a	451 (17.74)	3	3.5

Table 2: Large Enclosure Data

1. Meets or exceeds NFPA 70, NEC 312.6(A), and NEC 312.6(B).
2. Top entry only available for single breaker applications.
3. Based on flexible metal conduit at 40% fill using THHN wire.
4. Add 205 mm (8.08 in) for bases with integrated single wall fuel tank (see Figure 2).

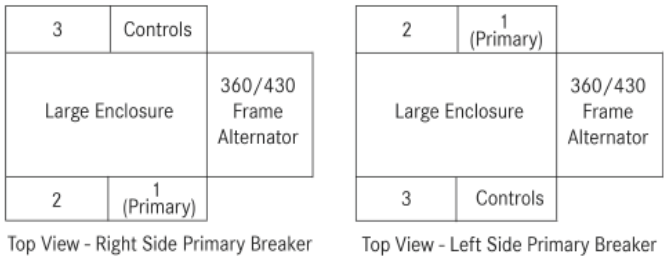

Figure 2.1: Large Enclosure Breaker Mounting Positions

Breaker Frame		
Position 1 (Primary)	Position 2	Position 3
H / J / L	-	-
H / J / L	H / J / L	-
H / J / L	H / J / L	H / J / L
P/M	-	-
P/M	H/J	-
P/M	H/J	H / J / L
P/M		L

Table 2.1: Large Enclosure Breaker Mounting Positions

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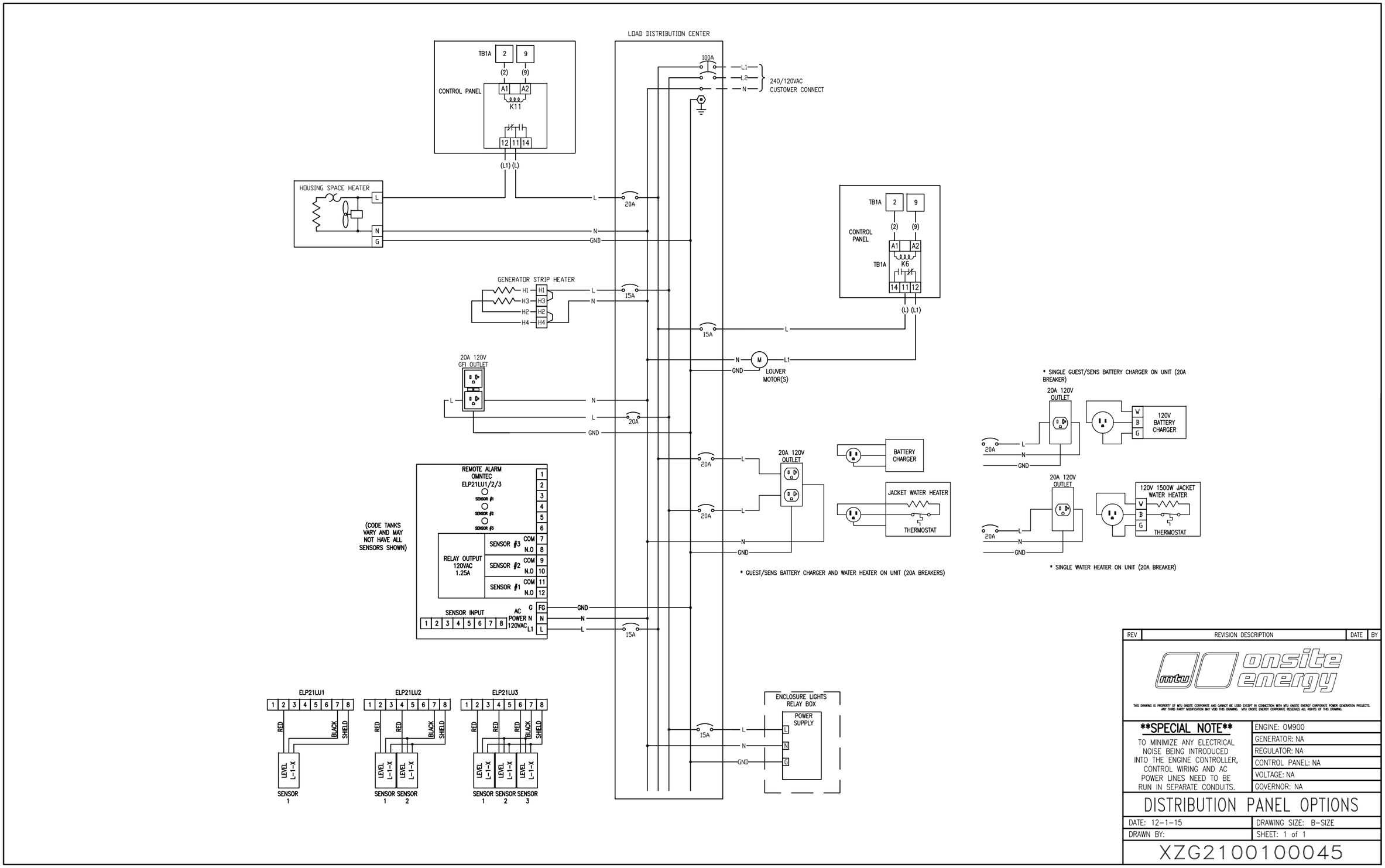
15 80-200 kW Electrical Drawings

15.1 Mercedes-Benz (OM924/926) 80-200 kW Distribution Panel Options - XZG2100100045 581
15.2 Mercedes-Benz (OM924/926) 80-200 kW Breaker Diagram - XZG2100100045 583
15.3 Mercedes-Benz (OM924/926) 80-200 kW Engine Diagram - XZG2100100045 585
15.4 Mercedes-Benz (OM924/926) 80-200 kW Generator Diagram - XZG2100100045 587
15.5 Mercedes-Benz (OM924/926) 80-200 kW MGC-1500 Face Panel - XZG2100100045 589
15.6 Mercedes-Benz (OM924/926) 80-200 kW Options - XZG2100100045 593

15.1 Mercedes-Benz (OM924/926) 80-200 kW Distribution Panel Options - XZG2100100045



REV	REVISION DESCRIPTION	DATE	BY

THIS DRAWING IS PROPERTY OF MTU ONSITE CORPORATE AND CANNOT BE USED EXCEPT IN CONNECTION WITH MTU ONSITE ENERGY CORPORATE POWER GENERATION PROJECTS. ANY THIRD PARTY MODIFICATION MAY VOID THIS DRAWING. MTU ONSITE ENERGY CORPORATE RESERVES ALL RIGHTS OF THIS DRAWING.

****SPECIAL NOTE****

TO MINIMIZE ANY ELECTRICAL NOISE BEING INTRODUCED INTO THE ENGINE CONTROLLER, CONTROL WIRING AND AC POWER LINES NEED TO BE RUN IN SEPARATE CONDUITS.

ENGINE: OM900	
GENERATOR: NA	
REGULATOR: NA	
CONTROL PANEL: NA	
VOLTAGE: NA	
GOVERNOR: NA	

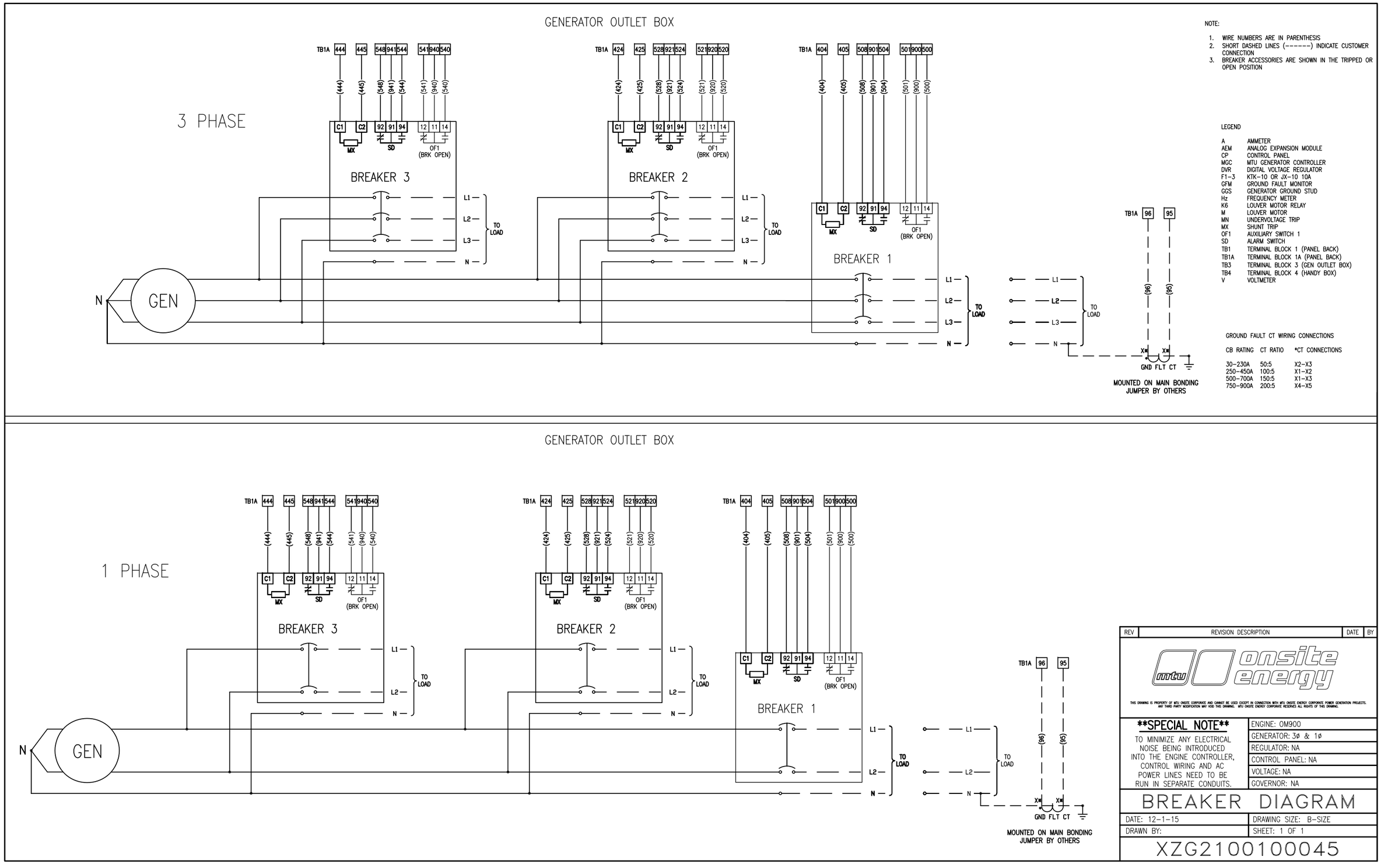
DISTRIBUTION PANEL OPTIONS

DATE: 12-1-15	DRAWING SIZE: B-SIZE
DRAWN BY:	SHEET: 1 of 1

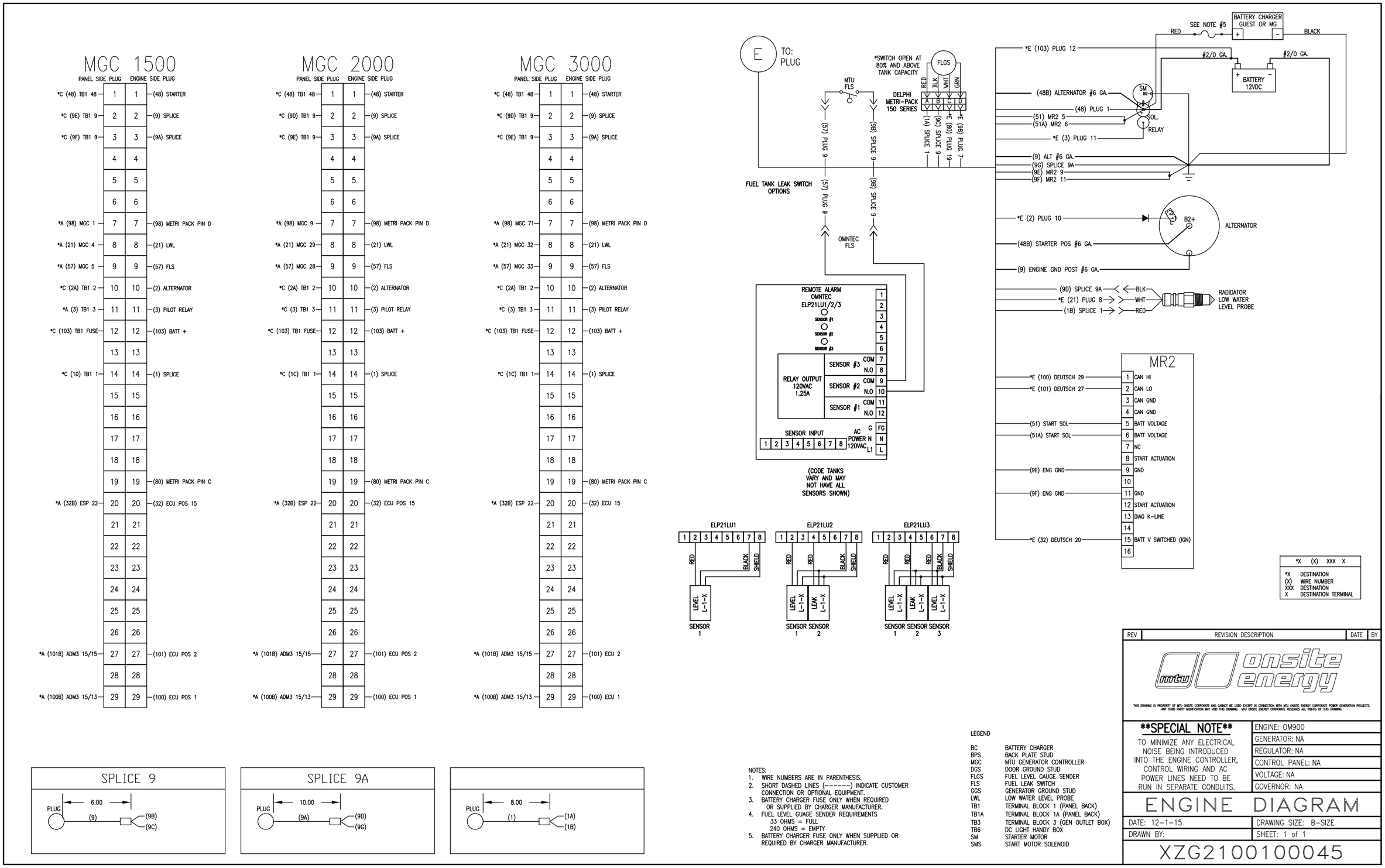
XZG2100100045

TIM-ID: 0000104099 - 001

15.2 Mercedes-Benz (OM924/926) 80-200 kW Breaker Diagram - XZG2100100045



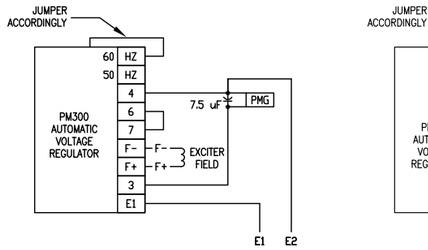
15.3 Mercedes-Benz (OM924/926) 80-200 kW Engine Diagram - XZG2100100045



15.4 Mercedes-Benz (OM924/926) 80-200 kW Generator Diagram - XZG2100100045

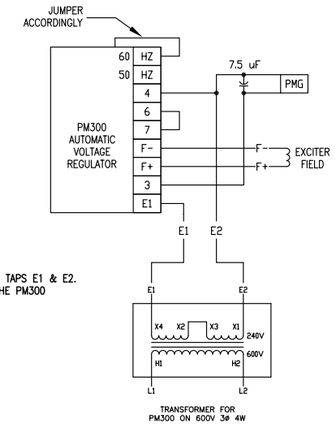
PM300

480V & LESS



ON 480V & 380V UNITS WIRE PM300 TO INNER TAPS E1 & E2. FOR ALL OF THE OTHER VOLTAGE UNITS WIRE THE PM300 DIRECTLY TO THE LINES.

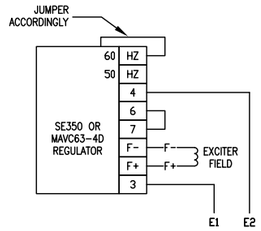
600V



TRANSFORMER FOR PM300 ON 600V 3ø 4W

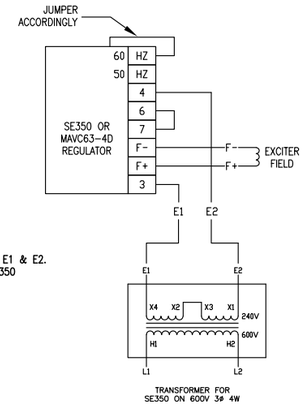
SE350

480V & LESS



ON 480V & 380V UNITS WIRE SE350 TO INNER TAPS E1 & E2. FOR ALL OF THE OTHER VOLTAGE UNITS WIRE THE SE350 DIRECTLY TO THE LINES.

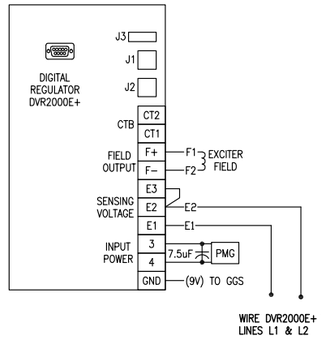
600V



TRANSFORMER FOR SE350 ON 600V 3ø 4W

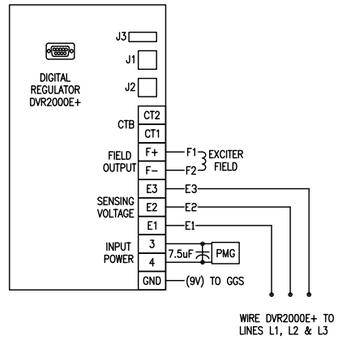
DVR2000E+

1ø

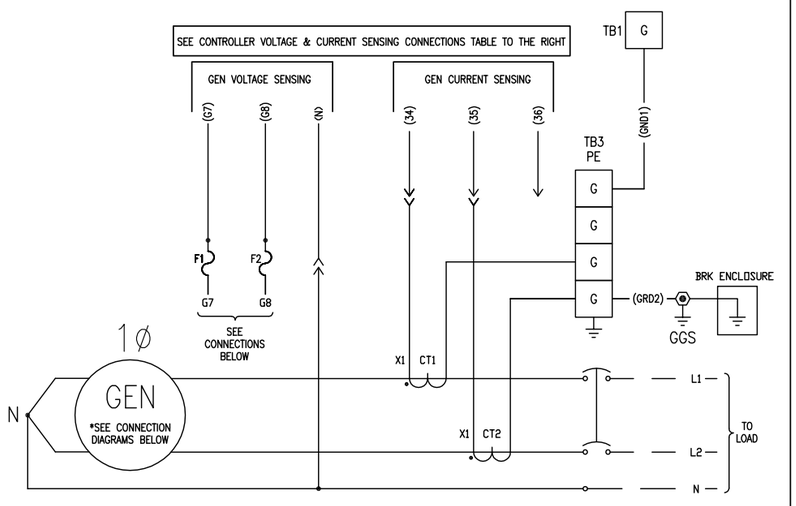


WIRE DVR2000E+ TO LINES L1 & L2

3ø

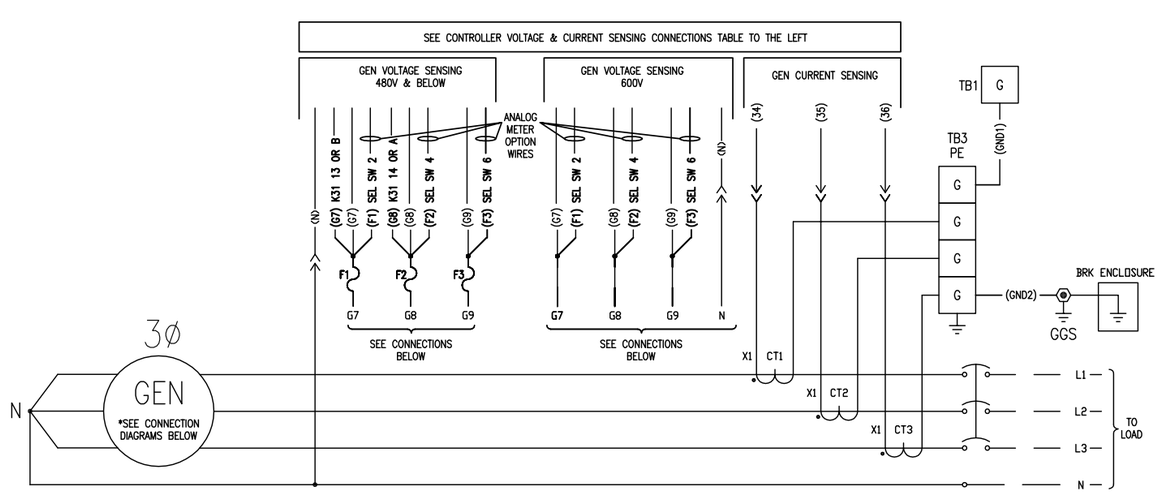


WIRE DVR2000E+ TO LINES L1, L2 & L3



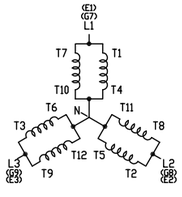
CONTROLLER VOLTAGE & CURRENT SENSING CONNECTIONS

NCP		MGC & PIN #		
	TB1	1500	2000	3000
WIRE #	G7	45	41	86
	G8	43	39	88
	G9	41	37	90
	N	40	35	91
	34	38	69	1
	35	36	72	3
	36	34	75	5



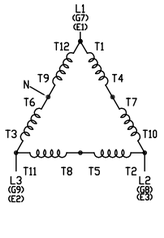
LOW WYE 3ø

HZ	L-L	L-LO
60	190	110
	208	120
	220	127
	230	133
50	190	110
	200	115
	208	120
	220	127



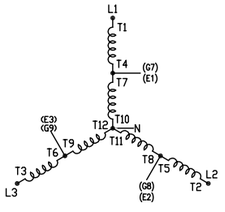
DELTA 3ø

HZ	L-L	L-LO
60	240	120
	277	139
50	200	100
	220	110
	240	120



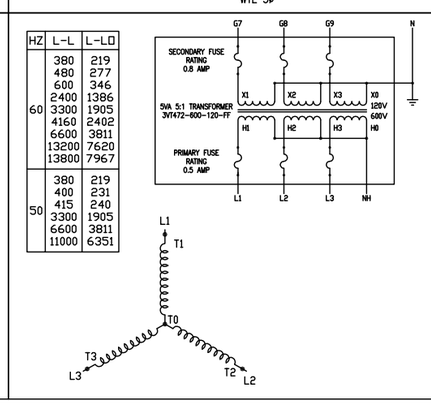
HIGH WYE 3ø

HZ	L-L	L-LO
60	380	219
	416	240
	440	254
	460	266
	480	277
50	380	219
	400	231
	415	240
	440	254



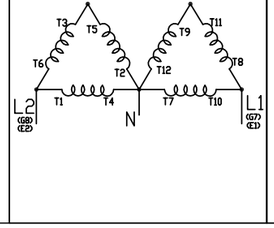
WYE 3ø

HZ	L-L	L-LO
60	380	219
	480	277
	600	346
	2400	1386
	3300	1905
	4160	2402
	6600	3811
	13200	7620
	13800	7967
50	380	219
	400	231
	415	240
	3300	1905
	6600	3811
	11000	6351



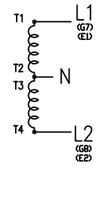
DOUBLE DELTA 1ø

HZ	L-L	L-LO
60	240	120
	277	139
50	200	100
	220	110
	240	120



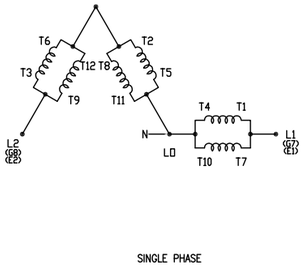
4 WIRE DEDICATED 1ø

HZ	L-L	L-LO
60	240	120
	277	139
50	200	100
	220	110
	240	120



PARALLEL LOW ZIGZAG 1ø

HZ	L-L	L-LO
60	200	100
	220	110
	240	120
50	220	110



SINGLE PHASE

REV	REVISION DESCRIPTION	DATE	BY

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****SPECIAL NOTE****

TO MINIMIZE ANY ELECTRICAL NOISE BEING INTRODUCED INTO THE ENGINE CONTROLLER, CONTROL WIRING AND AC POWER LINES NEED TO BE RUN IN SEPARATE CONDUITS.

ENGINE: OM900	
GENERATOR: ALL	
REGULATOR: SE350/DVR2000E+/PM300	
CONTROL PANEL: NA	
VOLTAGE: ALL	
GOVERNOR: NA	

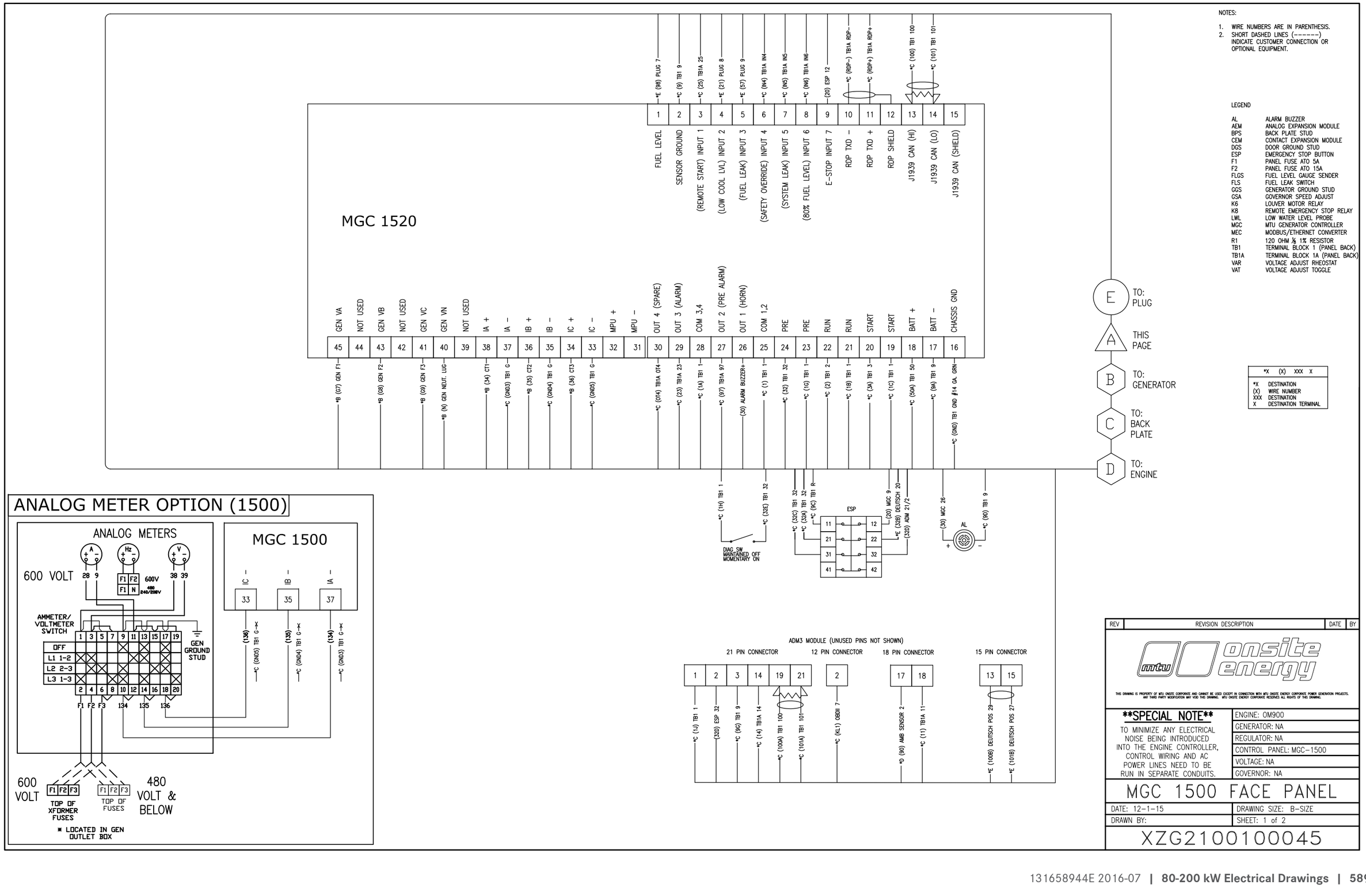
GENERATOR DIAGRAM

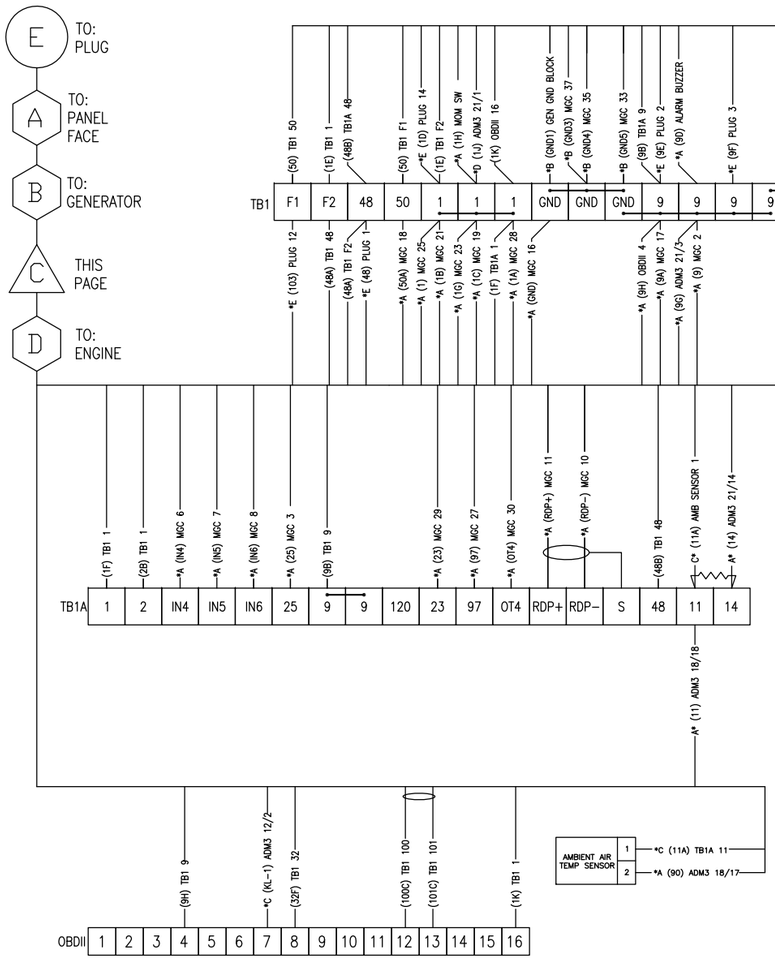
DATE: 7-6-16	DRAWING SIZE: B-SIZE
DRAWN BY:	SHEET: 1 OF 1

XZG2100100045

TIM-ID: 0000104102 - 002

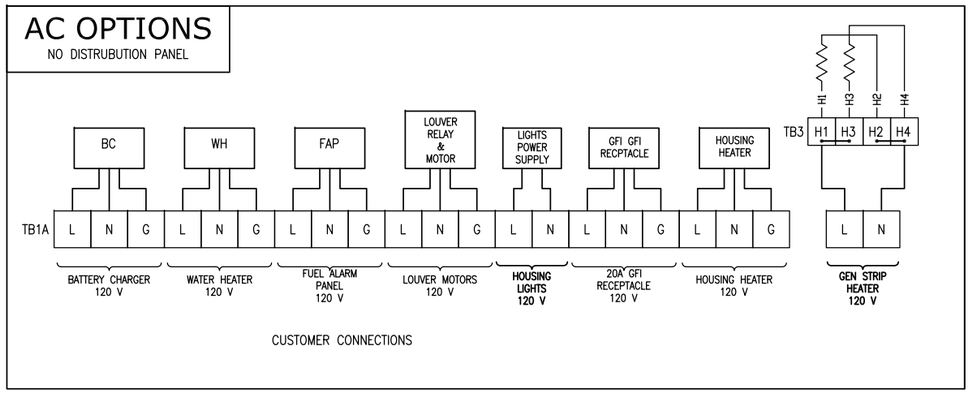
15.5 Mercedes-Benz (OM924/926) 80-200 kW MGC-1500 Face Panel - XZG2100100045





AC OPTIONS

NO DISTRUBUTION PANEL



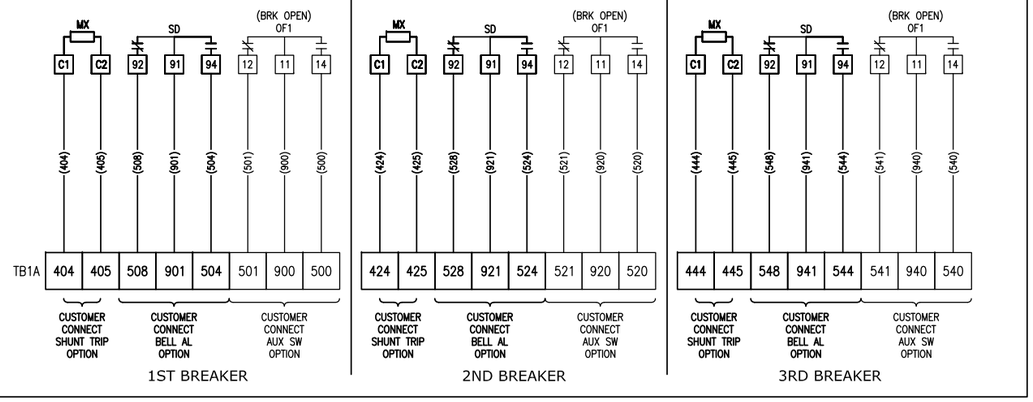
CUSTOMER CONNECTIONS

AC CUSTOMER CONNECT

SEE PAGE 3 FOR TERMINAL DESIGNATION

BREAKER OPTIONS

MX = SHUNT TRIP
SD = BELL ALARM
OF1 = AUX SWITCH



NOTES:

1. WIRE NUMBERS ARE IN PARENTHESIS.
2. SHORT DASHED LINES (-------) INDICATE CUSTOMER CONNECTION OR OPTIONAL EQUIPMENT.

LEGEND:

AEM	ANALOG EXPANSION MODULE
BPS	BACK PLATE STUD
CEM	CONTACT EXPANSION MODULE
MGC	MTU GENERATOR CONRTOLLER
DGS	DOOR GROUND STUD
F1	PANEL FUSE ATO 5A
F2	PANEL FUSE ATO 15A
K1	ENGINE RUN RELAY
K2	ENGINE FAIL RELAY
K3	MINOR ALARM RELAY
K6	LOUVER MOTOR RELAY
K8	REMOTE ESTOP RELAY
K10	ENGINE RUN RELAY
LVR	LOUVER MOTOR RELAY
MEC	MODBUS/ETHERNET CONVERTER
R2	RESISTOR 12K OHM 1/4W
TB1	TERMINAL BLOCK 1 (PANEL BACK)
TB1A	TERMINAL BLOCK 1 (PANEL BACK)

*X	(X)	XXX	X
*X	DESTINATION		
(X)	WIRE NUMBER		
XXX	DESTINATION		
X	DESTINATION TERMINAL		

REV	REVISION DESCRIPTION	DATE	BY

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****SPECIAL NOTE****

TO MINIMIZE ANY ELECTRICAL NOISE BEING INTRODUCED INTO THE ENGINE CONTROLLER, CONTROL WIRING AND AC POWER LINES NEED TO BE RUN IN SEPARATE CONDUITS.

ENGINE: OM900	
GENERATOR: NA	
REGULATOR: NA	
CONTROL PANEL: MGC-1500	
VOLTAGE: NA	
GOVERNOR: NA	

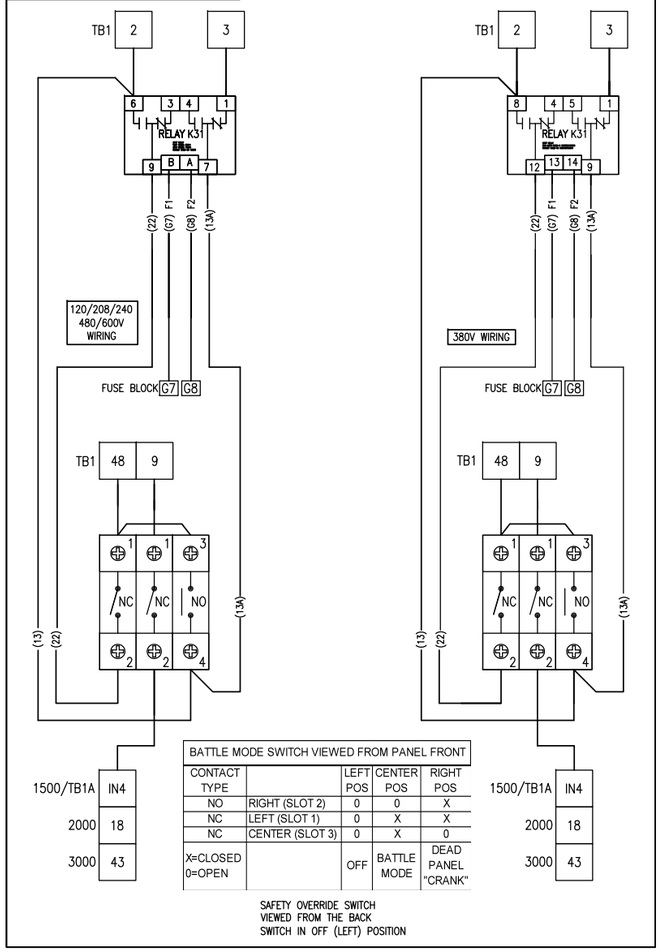
1500 BACK PLATE

DATE: 12-1-15	DRAWING SIZE: B-SIZE
DRAWN BY:	SHEET: 2 of 2

XZG2100100045

TIM-ID: 0000104103 - 001

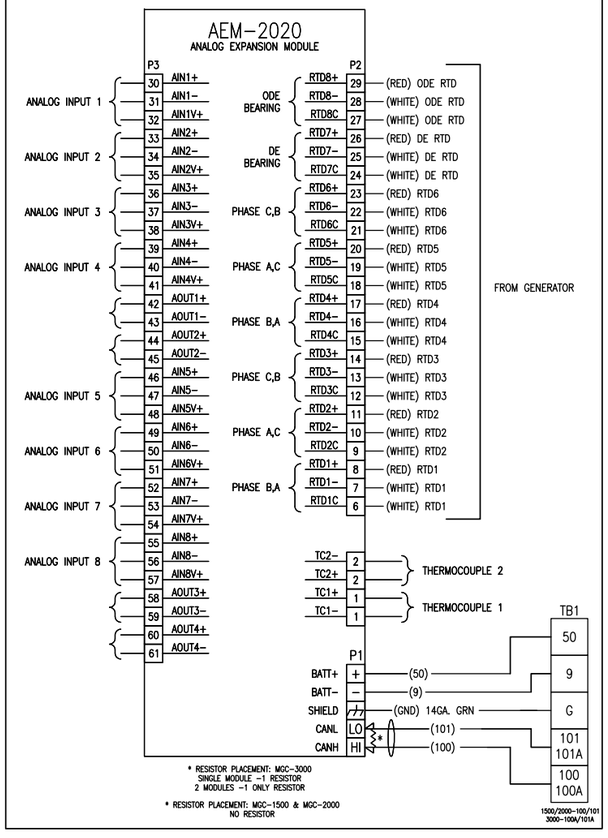
SAFETY OVERRIDE SWITCH



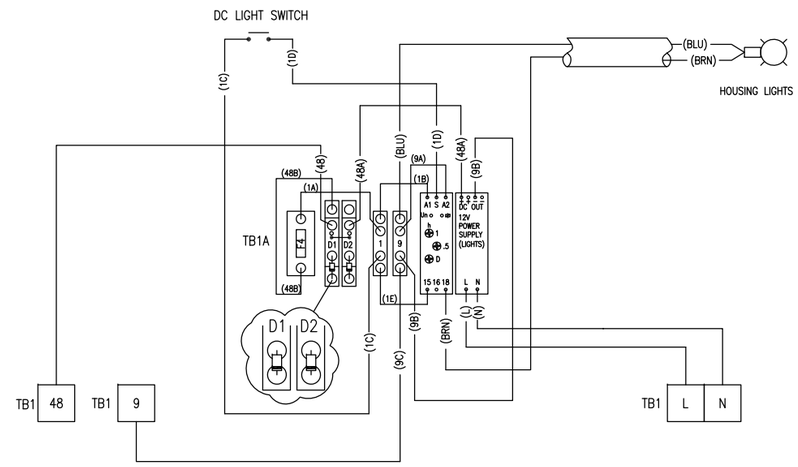
BATTLE MODE SWITCH VIEWED FROM PANEL FRONT				
CONTACT TYPE		LEFT POS	CENTER POS	RIGHT POS
NO	RIGHT (SLOT 2)	0	0	X
NC	LEFT (SLOT 1)	0	X	X
NC	CENTER (SLOT 3)	0	X	0
X=CLOSED 0=OPEN		OFF	BATTLE MODE	DEAD PANEL "CRANK"

SAFETY OVERRIDE SWITCH
VIEWED FROM THE BACK
SWITCH IN OFF (LEFT) POSITION

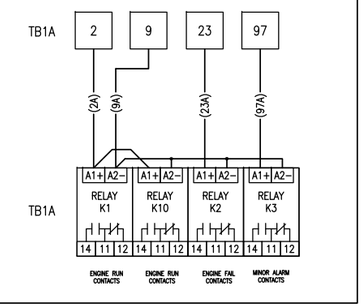
AEM OPTION



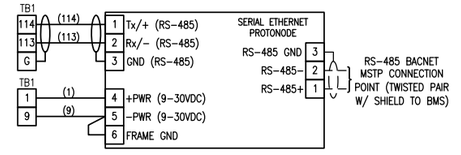
HOUSING LIGHT OPTION



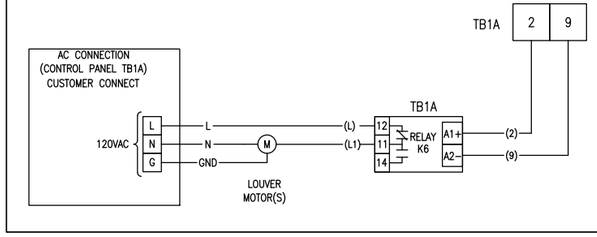
4 RELAY OPTION



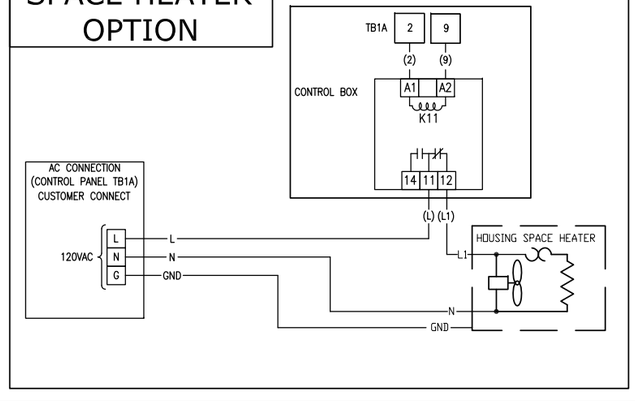
BACKNET CONVERTOR



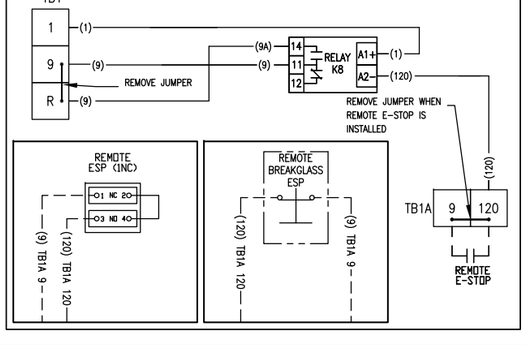
LOUVER MOTOR(S) OPTION



SPACE HEATER OPTION



REMOTE E-STOP OPTION



REV	REVISION DESCRIPTION	DATE	BY

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****SPECIAL NOTE****

TO MINIMIZE ANY ELECTRICAL NOISE BEING INTRODUCED INTO THE ENGINE CONTROLLER, CONTROL WIRING AND AC POWER LINES NEED TO BE RUN IN SEPARATE CONDUITS.

ENGINE:	OM924/OM926
GENERATOR:	NA
REGULATOR:	NA
CONTROL PANEL:	NA
VOLTAGE:	NA
GOVERNOR:	NA

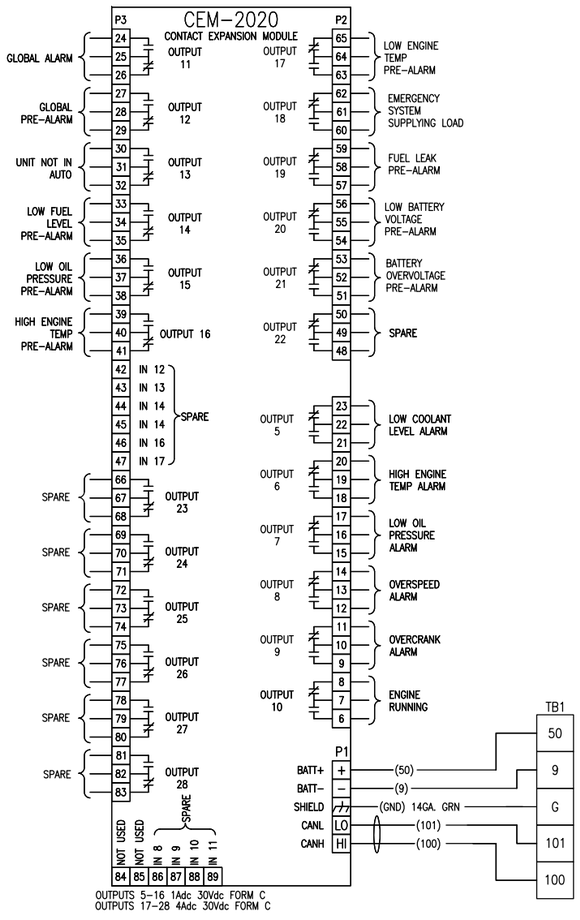
OPTION PAGE

DATE: 12–1–15	DRAWING SIZE: B–SIZE
DRAWN BY:	SHEET: 1 OF 2

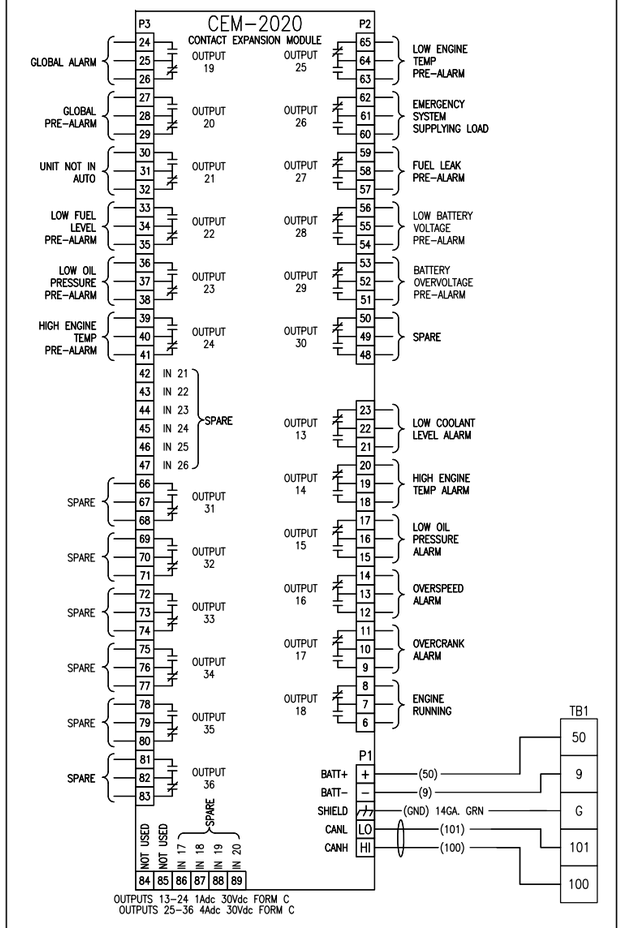
XZG2100100045

TIM-ID: 0000104106 - 001

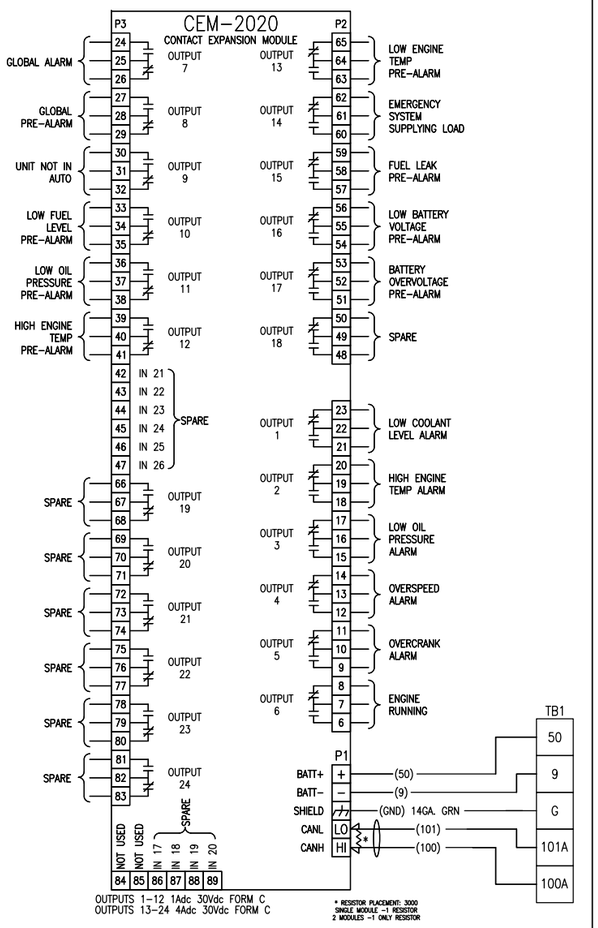
CEM OPTION 1500



CEM OPTION 2000



CEM OPTION 3000



REV	REVISION DESCRIPTION	DATE	BY

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SPECIAL NOTE	
TO MINIMIZE ANY ELECTRICAL NOISE BEING INTRODUCED INTO THE ENGINE CONTROLLER, CONTROL WIRING AND AC POWER LINES NEED TO BE RUN IN SEPARATE CONDUITS.	ENGINE: OM924/OM926
	GENERATOR: NA
	REGULATOR: NA
	CONTROL PANEL: NA
	VOLTAGE: NA
	GOVERNOR: NA

OPTION PAGE

DATE: 12-1-15	DRAWING SIZE: B-SIZE
DRAWN BY:	SHEET: 2 OF 2

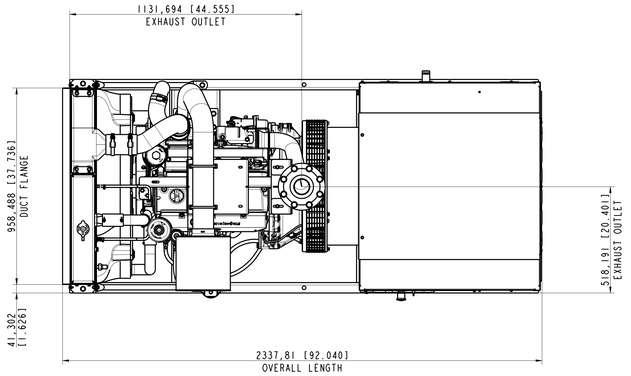
XZG2100100045

TIM-ID: 0000104106 - 001

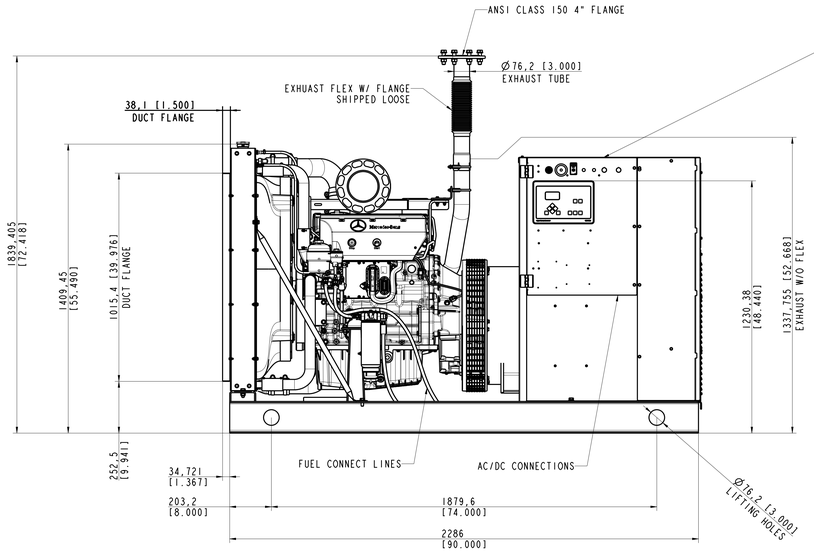
16 Drawings

16.1 XZG2100100021 599

		Stand-By	Prime
60 Hz Models (kWe)	DG04RMI20A1N	80	72
	DG04RMI20A2N	100	90
	DG04RMI20A3N	125	111
50 Hz Models (kVA)	DG04RMI20A1L	89	80
	DG04RMI20A2L	111	100
	DG04RMI20A3L	139	125

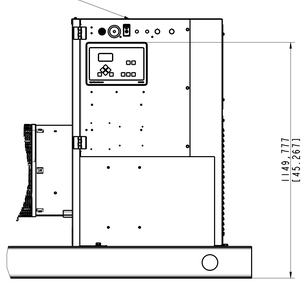


TOP VIEW



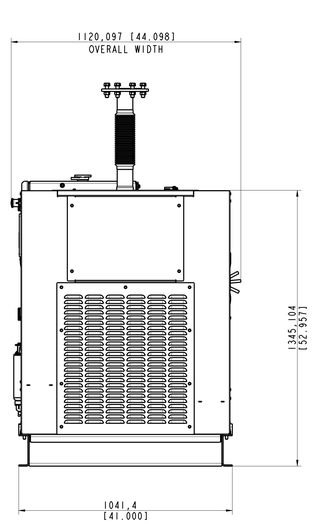
LEFT VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATIONS:
1. 430 GEN, ALL BREAKER SIZES
2. 360 GEN, P-FRAME BREAKER



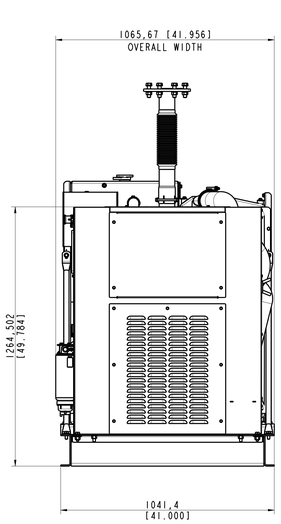
LEFT VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATION:
1. 360 GEN, H, J OR L-FRAME BREAKERS



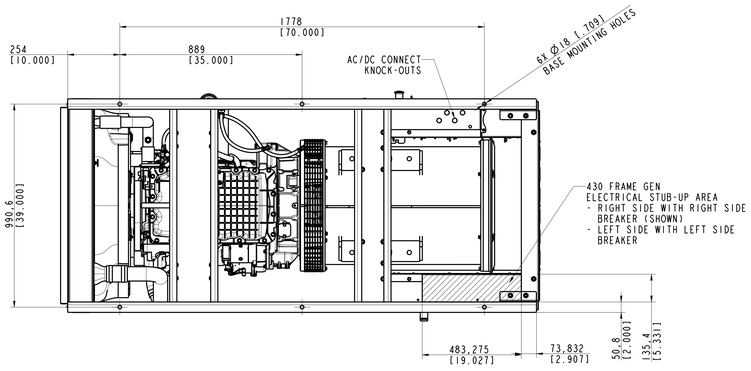
BACK VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATIONS:
1. 430 GEN, ALL BREAKER SIZES
2. 360 GEN, P-FRAME BREAKER

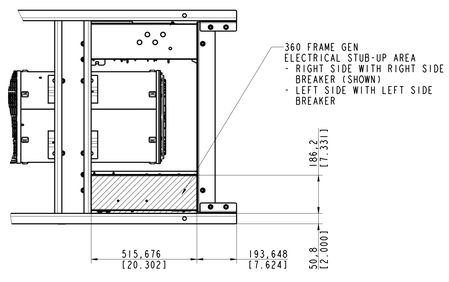


BACK VIEW

OUTLET BOX SHOWN USED WITH CONFIGURATION:
1. 360 GEN, H, J & L-FRAME BREAKERS



BOTTOM VIEW



BOTTOM VIEW

STANDARD SCOPE OF SUPPLY

WITH NON-HOUSED/NON-TANKED BASE

GENSET DIMENSIONAL

Aufgeführte Normen Relevant Standards	Personnes Ext.	Abmass in Position cm	Nachtr. Nov.Ltr.	Name vor Frequenz	Änderung/Revision	Änderungs-Nr. Revision Notice No.	Datum Date	Name Chef. Chief.
							09.04.2015	kost

Oberflächenangaben nach WN9033 Surface Specification per WN9033	Massstab Scale 1:10	Masse/Mass kg 2650.795	Formatgrösse A0
Allgemeine Fertigungsvorschriften nach WNN 332 Production Specification per WNN 332	Werkstoff Material		
	Halbfertig, Modell, Gussnr. Semifinished Product, Pattern, Nr.		
	Benennung/title /		
Prof. Datum/Date Name	ABMASSZEICHNUNG		
Drawn 09.04.2015 Kost	OPU BASE		
Check 09.04.2015 Anderson	DIMENSIONAL DRAWING		
Appr. 09.04.2015 Carsten	OM924 GENSET		
Dept. EDMN Carsten	Zeichnungs-Nr./Drawing No. XZG2100100021		Blatt/Sheet lv.3

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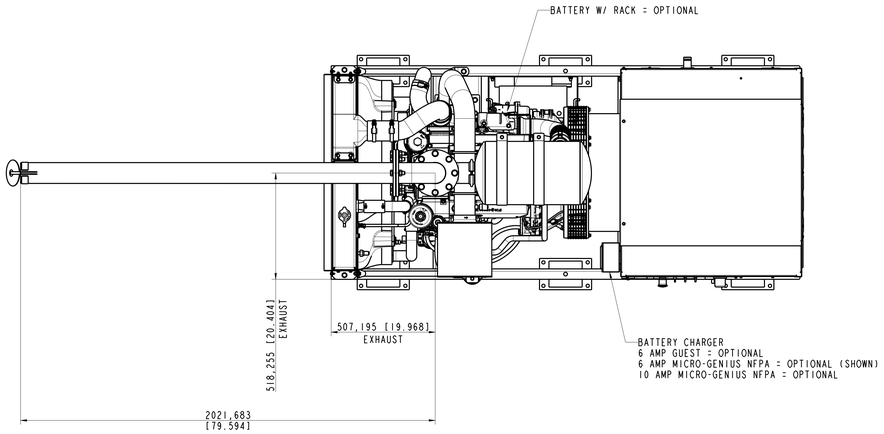
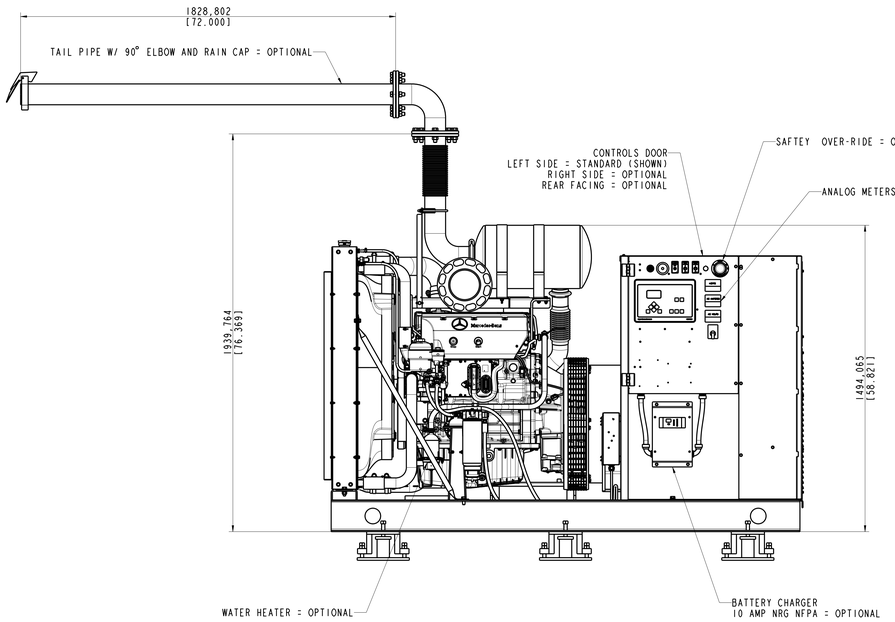
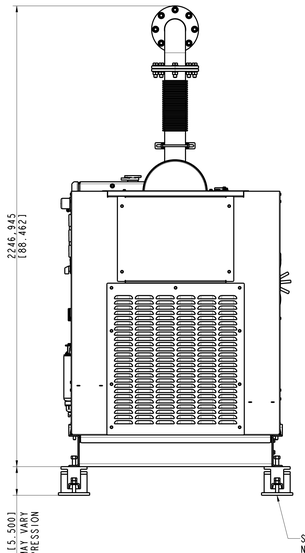
		Stand-By	Prime
60 Hz Models (kWe)	DG04RM120A1N	80	72
	DG04RM120A2N	100	90
	DG04RM120A3N	125	111
50 Hz Models (kVA)	DG04RM120A1L	89	80
	DG04RM120A2L	111	100
	DG04RM120A3L	139	125



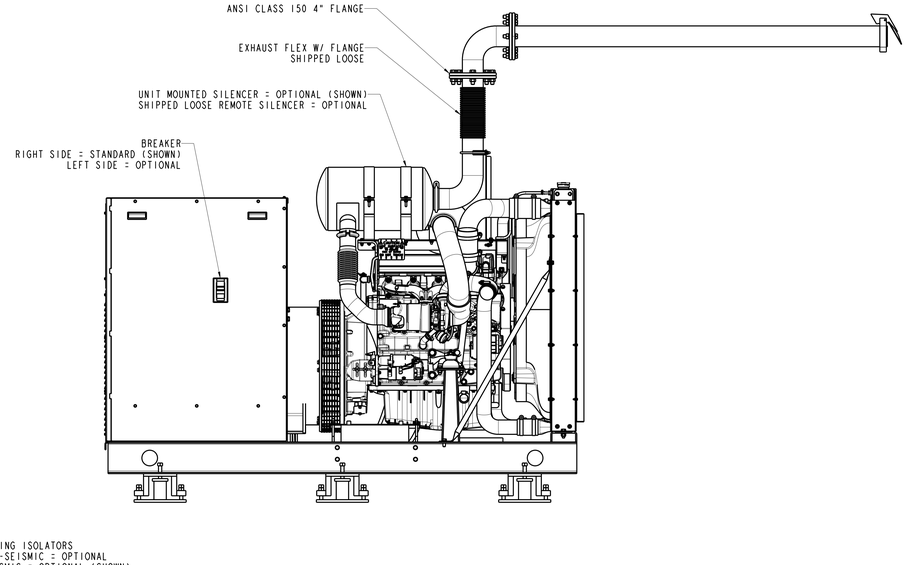
TOP VIEW



LEFT VIEW



BACK VIEW



RIGHT VIEW

OPTIONAL SCOPE OF SUPPLY

WITH NON-HOUSED/NON-TANKED BASE

GENSET DIMENSIONAL

Aufgeführte Normen Relevant Standards	Passiviert Cl	Änderung vom Datum Modification	Ausgl. Ver. Ers.	Ausgl. vor Frequenz	Änderung/Revision	Änderungs-Nr. Revision Notice No.	Datum Date	Name	Gepr. Check

Oberflächenangaben nach WN5030
Surface Specification per WN5033
Allgemeine Fertigungsvorschriften nach WNN 332
Production Specification per WNN 332

Bestellvermerk
Order Remark

Werkstoff
Material

Halbzeug, Modell, Gezeunt
Semifinished Product, Pattern, Die

Bezeichnung/Title

ABMASSZEICHNUNG
OPU BASE
DIMENSIONAL DRAWING
CM924 GENSET

Prüf. Check

Datum/Date Name

Bearb. Draw. 09.04.2015 Kost
Konstr. Design 09.04.2015 Anderson
Norm. Stand. 09.04.2015 Carsten
Gen. Appr. 09.04.2015 Carsten

Maßstab Scale 1:10

Masse/Mass 2650.795 kg

Formatklasse Format Class A0

Zeichnungs-Nr./Drawing No. XZG2100100021

Blatt Sheet 2v.3

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Onsite Energy

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		Stand-By	Prime
60 Hz Models (kWe)	DG04RM120A1N	80	72
	DG04RM120A2N	100	90
	DG04RM120A3N	125	111
50 Hz Models (kVA)	DG04RM120A1L	89	80
	DG04RM120A2L	111	100
	DG04RM120A3L	139	125

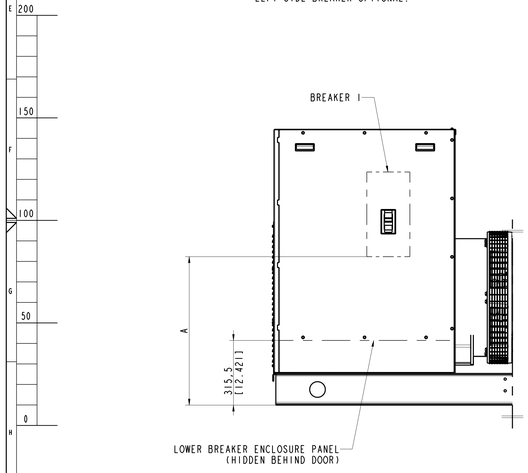
SINGLE BREAKER

BREAKER 1: UP TO 1200 AMP

MAXIMUM TOP ENTRY CONDUIT FITTING ACCOMMODATIONS:
QTY 2, 3.00" FITTINGS

MAXIMUM BOTTOM ENTRY CONDUIT FITTING ACCOMMODATIONS:
QTY 4, 3.50" FITTINGS, OR
QTY 3, 4.00" FITTINGS

RIGHT SIDE BREAKER SHOWN.
LEFT SIDE BREAKER OPTIONAL.



RIGHT VIEW

MARATHON GENERATOR	SQUARE-D BREAKER	
GENERATOR FRAME SIZE	BREAKER FRAME SIZE	DIMENSION "A"
360-FRAME	H-FRAME	768.64 [30.26]
	J-FRAME	754.41 [29.70]
	L-FRAME	673.88 [26.53]
	M/P-FRAME	724.03 [28.51]
430-FRAME	H-FRAME	849.24 [33.43]
	J-FRAME	835.02 [32.87]
	L-FRAME	760.48 [29.94]
	M/P-FRAME	724.03 [28.51]

DUAL BREAKER

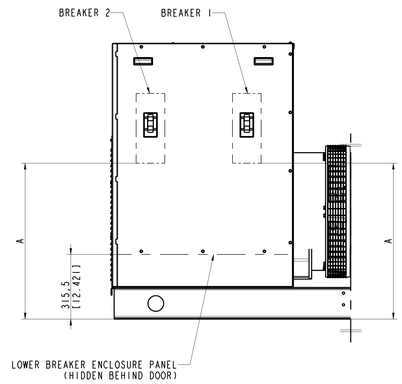
BREAKER 1: UP TO 600 AMP 80% RATED
OR 400 AMP @100% RATED

MAXIMUM CONDUIT FITTING ACCOMMODATIONS:
QTY 2, 3.00" FITTINGS
BOTTOM ENTRY ONLY

BREAKER 2: UP TO 600 AMP 80% RATED
OR 400 AMP @100% RATED

MAXIMUM CONDUIT FITTING ACCOMMODATIONS:
QTY 2, 3.00" FITTINGS
BOTTOM ENTRY ONLY

RIGHT SIDE BREAKERS SHOWN.
LEFT SIDE BREAKERS OPTIONAL.



RIGHT VIEW

MARATHON GENERATOR	SQUARE-D BREAKER	
GENERATOR FRAME SIZE	BREAKER FRAME SIZE	DIMENSION "A"
360-FRAME	H-FRAME	768.64 [30.26]
	J-FRAME	754.41 [29.70]
	L-FRAME	673.88 [26.53]
	M/P-FRAME	-
430-FRAME	H-FRAME	849.24 [33.43]
	J-FRAME	835.02 [32.87]
	L-FRAME	760.48 [29.94]
	M/P-FRAME	-

DUAL BREAKER

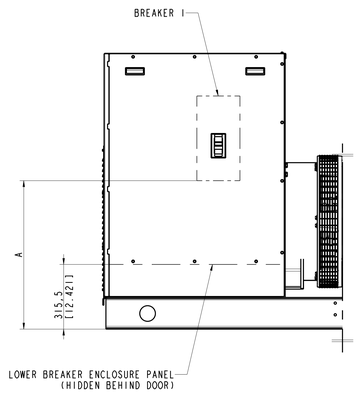
BREAKER 1: UP TO 1200 AMP

MAXIMUM CONDUIT FITTING ACCOMMODATIONS:
QTY 4, 3.50" FITTINGS, OR
QTY 3, 4.00" FITTINGS
BOTTOM ENTRY ONLY

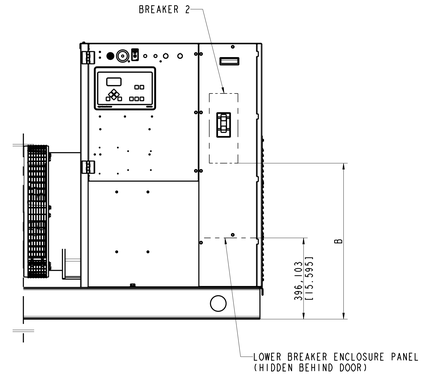
BREAKER 2: UP TO 600 AMP 80% RATED
OR 400 AMP @100% RATED

MAXIMUM CONDUIT FITTING ACCOMMODATIONS:
QTY 2, 3.00" FITTINGS
BOTTOM ENTRY ONLY

RIGHT SIDE BREAKER 1, LEFT SIDE BREAKER 2 SHOWN.
LEFT SIDE BREAKER 1, RIGHT SIDE BREAKER 2 OPTIONAL.



RIGHT VIEW



LEFT VIEW

MARATHON GENERATOR	SQUARE-D BREAKER		
GENERATOR FRAME SIZE	BREAKER FRAME SIZE	DIMENSION "A"	DIMENSION "B"
360-FRAME	H-FRAME	-	849.24 [33.43]
	J-FRAME	-	835.02 [32.87]
	L-FRAME	-	760.48 [29.94]
	M/P-FRAME	724.03 [28.51]	-
430-FRAME	H-FRAME	-	849.24 [33.43]
	J-FRAME	-	835.02 [32.87]
	L-FRAME	-	760.48 [29.94]
	M/P-FRAME	724.03 [28.51]	-

BREAKER OPTIONS

Aufgeführte Normen / Relevant Standards

Pos. / Pos.	Änderungs-Nr. / Revision Notice No.	Änderung/Revision	Ausg. var. / Frequency	Ausführ. / Rev.Str.	Datum / Date	Name	Gepr. / Check

Oberflächenangaben nach MTM033 / Surface Specification per MTM033
Allgemeine Fertigungsvorschriften nach MAN 332 / Production Specification per MAN 332

Prod. / Datum/Date / Name
Erstellt / Drawn: 09.04.2015 Host
Geprüft / Checked: 09.04.2015 Anderson
Norm. / Stand.: 09.04.2015 Carsten
Appr. / Dept.: EQMN Carsten

Maßstab / Scale: 1:10
Masse/Mass: 2650.795 kg
Format/Size: A0
Werkstoff / Material:
Halbzeug,Modell,Gezeut / Semi-finished Product, Pattern,Die:
Benennung/Title: ABMASSZEICHNUNG / OPU BASE / DIMENSIONAL DRAWING / OM924 GENSET
Zeichnungs-Nr./Drawing No.: XZG2100100021
Blatt / Sheet: 3v.3

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Chapter 38 CONTROL

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38.1 **CONTROLS**

SAVE DATE: Jul/4/2017 3:44:40 PM

PUMP CONTROL & ALARM PANEL

CONTROL SYSTEM ON

EMERGENCY POWER OFF

POWER ON OFF

STATION #1

IN USE
ON BY OUTSIDE PUSH BUTTON

MV-1
FILLER PIPE#1 VALVE OPEN

STATION #2

IN USE
ON BY OUTSIDE PUSH BUTTON

MV-1
FILLER PIPE#2 VALVE OPEN

PUMP IN USE

WP-1

WP-2

FILTER BLOCED

GENERATOR TROUBLE

PUMP TROUBLE

ALARM
ACKNOWLEDGE

ALARM CONDITIONS

ANY ALARM CONDITION #1-10

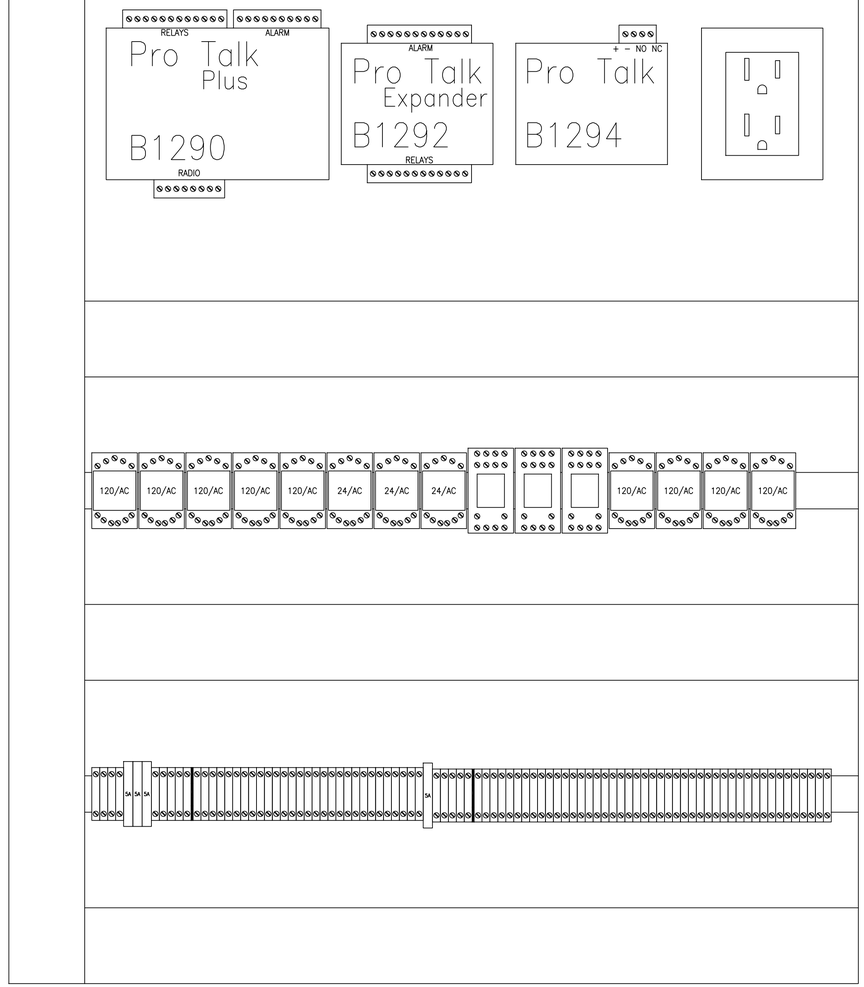
CHLORINATION ALARM

DOMESTIC WATER TANK EMPTY
DOMESTIC WATER PUMP FAILURE

WASTE WATER TANK FULL

PUMP ROOM HIGH TEMPERATURE

PUMP ROOM LOW TEMPERATURE
HEAT TRACE CONTROLLER TROUBLE



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DRAWING NUMBER	DRAWING TITLE	REVISION LETTER	REVISION	PROJECT NUMBER	NAME	DATE	CHECKED BY	DESIGNED BY	STATUS OF DRAWING	DATE
	REFERENCE DRAWINGS	0	AS BUILT	08-2009	SR	JULY/16	GF	GF	100%	

DRAWN BY

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PERMIT STAMP

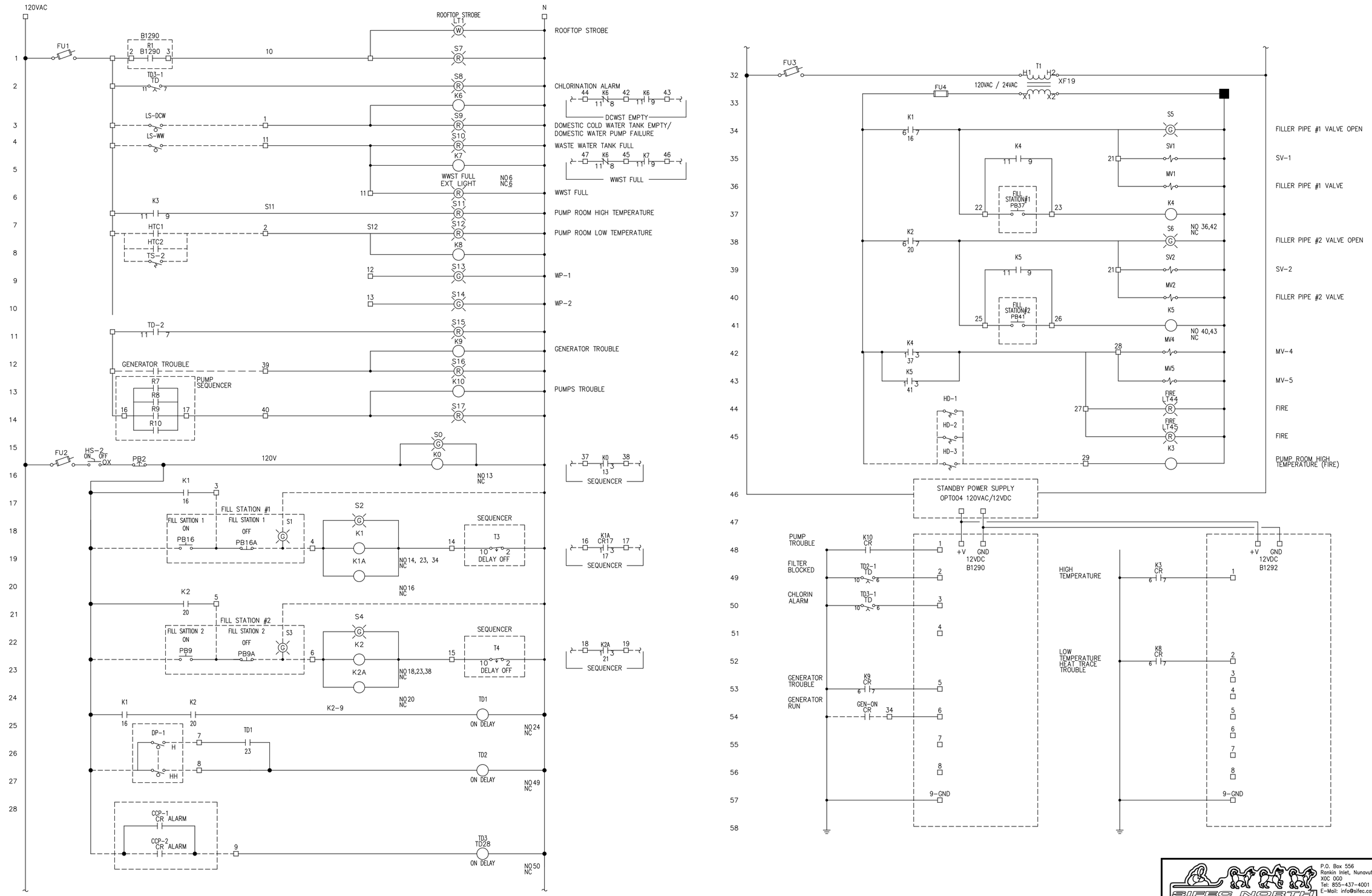
GOVERNMENT OF NUNAVUT

LOCATION
IGLOOLIK
NUNAVUT

TITLE
ELECTRICAL
PUMP CONTROL & ALARM PANEL
CHEMATICS
TRUCK FILL STATION

SCALE	SHEET	DRAWING NO.	REV.	REV. DATE
NTS	1 OF 1	IGLOOLIK TRUCK FILL PANNEL		28/07/16

FILENAME: X:\&SIFEC\YGT12 - IGLOOLIK TRUCKFILL STATION\DWG\E-DRAWINGS\IGLOOLIK TRUCK FILL PANNEL.DWG



SAVE DATE: juil./4/2017 3:28:56

FILENAME: P:\&SIFEC\YGT12 - IGLOOLIK TRUCKFILL STATION\DWG\E-DRAWINGS\PUMP CONTROL & ALARM SYSTEM.DWG

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DRAWING NUMBER	DRAWING TITLE	REVISION LETTER	REVISION	PROJECT NUMBER	DRAWN BY NAME	DRAWN BY DATE	CHECKED BY	DESIGNED BY	STATUS OF DRAWING	DATE
REFERENCE DRAWINGS										
					SR	8/26/16	GF	GF		
		0	AS BUILT	08-2009	SR	JULY/16	GF	GF		
		0	AS BUILT	08-2009	LHF	JUN/16	GF	GF	100%	

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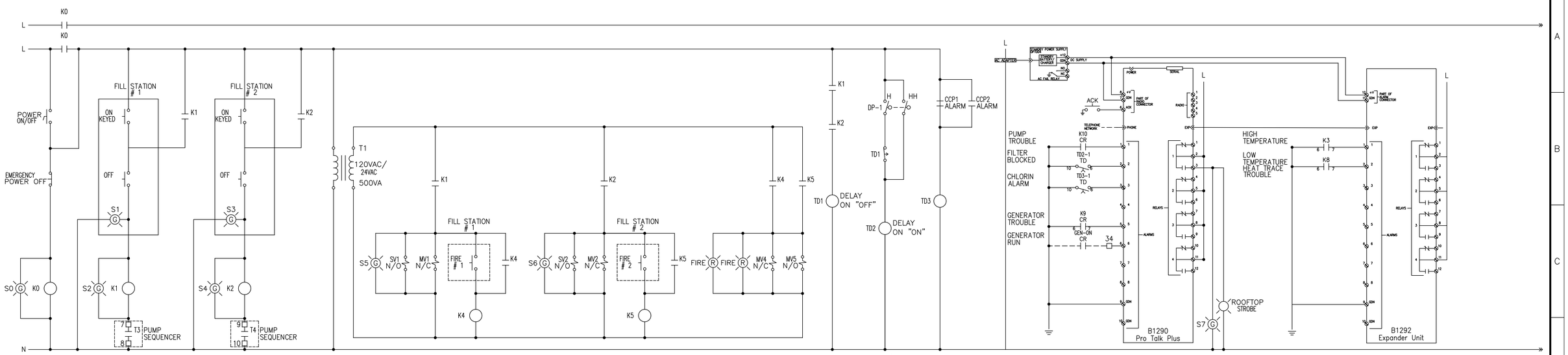
GOVERNMENT OF NUNAVUT

LOCATION
IGLOOLIK
NUNAVUT

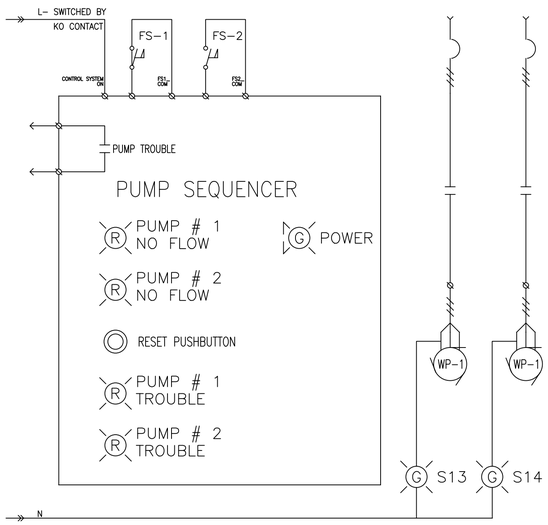
TITLE
ELECTRICAL
PUMP CONTROL & ALARM SYSTEM PANEL
SCHEMATICS
TRUCK FILL STATION

SCALE	SHEET	DRAWING NO.	REV.	REV. DATE
NTS	1 OF 1	PUMP CONTROL & ALARM SYSTEM		08/26/16



1 / E5 PUMP CONTROL SYSTEM & ALARM SYSTEM LADDER LOGIC DIAGRAM

N/A



Alarms:

1- ALARM ACTIVATES IF A FLOW SWITCH (FS-1 OR FS-2) SENSE NO FLW IN 15 (ADJUSTABLE) SECONDS AFTER ITS RELEVANT PUMP (WP-1 OR WP-2, TIMER TD-1 AND TD-2) IS TURN ON
ACTION: CHECK THE PUMP CONTROLLER, DETERMINE WHICH PUMP FAILED AND WHY. REPAIR THE PROBLEM, RESET THE PUMP SEQUENCER AND ACKNOWLEG=DGE THE ALARM CONTROLLER.
2- ALARM ACTIVATES IF A DIFFERENTIAL PRESSURE SWITCH (DP-1) SENSES HIGHER THAN SET (H) (ADJUSTEBLE) PRESSURE ACROSS FILTERS IN 15 SECONDS (ADJUSTABLE) AFTER ONE PUMP IS TURNED ON. ALARM ACTIVATES IF A DIFFERETIAL PRESSURE METER (DP-1) SENSE HIGHER THAN SET H/H (ADJUSTABLE) PRESSURE ACROSS FILTERS IN 15 SECONDS (ADJUSTABLE) AFTER TWO PUMPS ARE TURNED ON.
ACTION: CLEAN ALL 3 WATER FILTRES, ONE AT THE TIME. ACKNOLEDGE ALARME CONTROLLER.
3- ALARM ACTIVATES IF EITHER CHLORINATION CONTROLLER PANNRLS CCP1 OR CCP2 SENSES OUT-OF-SPEC CONDICTION FOR 15 SECONDS (ADJUSTABLE).
ACTION: DETERMINE THE REASON FOR THE CHLORINATION CONTROLLER ALARM. FIX THE PROBLEM AND RESET THE CHLORINATION CONTROLLERS AND ACKNOLEDGE THE ALARM CONTROLLER.
4- ALARM ACTIVATES IF CHLORINE MIXING SYSTEM SENSES TROUBLE.
ACTION: CHECK THE CHLORINATION MIXING SYSTEM AND FIX THE PROBLEM. RESET THE CHLORINE MIXING SYSTEM AND ACKNOLEDGE ALAMR CONTROLLER.
5- ALARM ACTIVATES IF GENERATOR CONTROLLER SENSES OUT-OF-SPEC CONDITION WITH GENERATOR.
ACTION: CHECK THE GENERATOR CONTROLLER AND DETERMINE THE CAUSE FOR THE ALRM. FIS THE PROBLEM AND RESET THE GENERATOR CONTROLLER AND ACKNOLEDGE ALEARM CONTROLLER.
6- ALARM ACTIVATES IF NORMAL GRID POWER IS LOST AND AUTOMATIC TRANSFER SWITCH ENGAGES EMERGENCY GENERATOR.
ACTION: DETERMINE THE REASON WHY THE GENERATOR IS RUNNING. ENSURE THE GENERATOR HAS ENOUGH FUEL IF THE POWER OUTAGE IS PROLONGED. ACKNOLEDGE ALARM CONTROLLER.
7- ALARM ACTIVATES IF DOMESTIC COLD WATER STORAGE TANK(DCWST) LOW LEVEL FLOAT SWITCH (LS-DCW)DETECTS LOW WATER LEVEL. THIS ALARM IS ONLY A LOCAL ALARM.
ACTION: ARRANGE TO RE-FILL THE DCWST AND ACKNOLEDGE THE ALARM.
8- ALARM ACTIVATES IF WASTE WATER STORAGE TANK (WWST) HIGH LEVEL FLOAT SWITCH (LS-WW) DETECTS HIGH WATER LEVEL. THIS ALARM IS ONLY A LOCAL ALARM.
ACTION: ARRANGE TO PUMP OUT THE WWST AND ACKNOLEDGE THE ALARM.
9- ALARM ACTIVATES IFANY OF THE ROOM FIRE ALARM HEAT DETECTORS (SD-1,-2 OR -3) SENSE HIGH ROOM TEMPERATURE.
ACTION: DETERMINE THE REASON FOR THE HIGH TEMPERATURE. FIX THE PROBLEM. ACKNOLEDGE THE ALARM.
10- ALARM ACTIVATES IF THE ROOM THERMOSTAT (TS-2) SENSES LOW ADJUSTABLE ROOM TEMPERATURE OR IF ANY OF THE 2 HEAT TRACE CONTROLLERS SENSES TROUBLE WITH THE HEAT TRACE CABLES.
ACTION: DETERMINE WHAT IS CAUSING THE ALARM. TAKE APPRPRIATE ACTION(A) PROVIDE TEMPORARY HEAT SOURCE FOE THE PUMP ROOM IF THE ROOM TEMPERATURE FALLS BELOW SET POINT (10°C ADJUSTABLE), OR (B) DETERMINE WHICH HEAT TRACE CONTROLLER ALARMED AND TAKE ACTION TO FIX THE PROBLEM. ACKNOLEDGE THE ALARM.

ALARM REPORTING UNIT RELAYS:

1- PROGRAMMED TO TURN "ON" WITH ANY OF THE 1-10 ALARM INPUTS TURN "ON" AN OUTDOOR STROBE BEACON LOCATED OUTSIDE THE PUMP STATION TO DISPLAY THAT THE PUMP STATION REQUIRES ATTENTION. TURN "ON" AN INDICATOR LIGHT ON THE MAIN LABELED "ANY ALARM CONDITION #1-10".

PUMP SEQUENCER OPERATION:

BY DEPRESSING THE "ON" PUSHBUTTON AT FILL STATION #1 OR #2 (SEQUENCER INPUT CONTACTS S1ON OR S2ON) THE SEQUENCER STARTS THE "NEXT" PUMP WITH THE DELAYS OF 3 SECONDS. DEPRESSING THE SAME "ON" PUSHBUTTON AGAIN WILL DO NOTHING UNTIL THE RELEVANT "OFF" BUTTON IS PRESSED. ONCE THE PUMP IS RUNNING, IT CAN BE TURNED "OFF" BY DEPRESSING THE "OFF" PUSH BUTTON (SEQUENCER INPUT CONTACTS S1OFF OR S2OFF) AT THE INITIATING FILL STATION. DEPRESSING THE SAME "OFF"PUSHBUTTON AGAIN WILL DO NOTHING. BASED ON THE ABOVE, 1 OR 2 PUMPS CAN RUN SIMULTANEOUSLY.
THE SEQUENSER OF THE "NEXT PUMP" IS WP-1 -> WP-2 -> WP-1 -> WP-2 -> ETC....
FLOW SWITCHES WILL PROVIDE FEEDBACK SO THAT WHEN A PUMP IS TURNED "ON" IT ACTUALLY DELIVERS WATER. THE "NEXT" PUMP "ON". THIS WILL CAUSE THE AFFECTED PUMP TO BE TAKEN OUT FROM THE SEQUENCER OF THE "NEXT PUMP". IT WILL ALSO TURN "ON" A "PUMP # TROUBLE" ALARM LIGHT AND TURN "ON" A SET OF DRY OUTPUT ALARM CONTACTS "PUMP TROUBLE". LATCHING OF A FAILED PUMP "OFF" CAN BE RESET BY DEPRESSING A "RESET" BUTTON ON THE PUMP SEQUENCER.

S0 CONTROL SYSTEM ON

EMERGENCY POWER OFF

OFF ON POWER

STATION #1

S2 IN USE (ON BY OUTSIDE PUSHBUTTON)

S5 MV-1 (FILLER PIPE #1 VALVE OPEN)

STATION #2

S4 IN USE (ON BY OUTSIDE PUSHBUTTON)

S6 MV-2 (FILLER PIPE #2 VALVE OPEN)

PUMP IN USE

S13 WP-1

S14 WP-2

S15 FILTER BLOCKED

S16 GENERATOR TROUBLE

S17 PUMP TROUBLE

ALARM ACKN

ACK

ALARM CONDITION

S7 ANY ALARM CONDITION #1-10

S8 CHLORINATION ALARM

S9 DOMESTIC WATER PUMP FAILLURE
DOMESTIC COLD WATER TANK EMPTY/

S10 WASTE WATER TANK FULL

S11 PUMP ROOM HIGH TEMPERATURE

S12 PUMP ROOM LOW TEMPERATURE/
HEAT TRACE CONTROLLER TROUBLE

2 / E5 PUMP CONTROL SYSTEM PANEL BOARD LAYOUT

N/A

RED

GREEN		
ON	OFF	FIRE
P/B	P/B	P/B

CONTROLS TO BE PLACED ON FILL ARM IN MID-ROAD LOCATION FOR BOTH TRUCK FILL SPOTS

3 / E5 FILL ARM CONTROL BOX LAYOUT

N/A

ALARM REPORTING UNIT

ALARM #	ALARM DESCRIPTION	ALARM CONDITION	ALARM GENERATED BY
1	PUMP TROUBLE	NO FLOW WATER WHEN PUMP TURN ON	PUMP SEQUENCER & WATER PUMP FLOW SWITCHES FS-1--2
2	FILTER BLOCKED	INSUFFICIENT FLOW OF WATER WHEN PUMP IS RUNNING	DIFFERENTIAL PRESSURE SWITCH DP-1
3	CHLORINATION STOPPED	INSUFFICIENT FLOW OF CHLORINE WHEN CCP-1 OR CCP-2 IS RUNNING	CHLORINATION CONTROLLER PANEL CCP-1 OR CCP-2
4	CHLORINE FEED TROUBLE	CHLORINE MIXING SYSTEM TROUBLE	CHLORINE MIXING SYSTEM CMS-1 OR CMS-2
5	EMERGENCY GENERATOR TROUBLE	ANY OUT-OF-SPEC CONDITION	GENERATOR CONTROLLER
6	EMERGENCY GENERATOR RUNNING	NORMAL GRID POWER LOST	AUTOMATIC TRANSFER SWITCH ATS
7	WATER STORAGE TANK EMPTY	LOW LEVEL IN DOMESTIC COLD WATER STORAGE TANK	FRESH WATER STORAGE TANK LOW LEVEL FLOAT SWITCH LS-DCW
8	WASTE WATER TANK FULL	HIGH LEVEL IN WASTE WATER STORAGE TANK	WASTE WATER STORAGE TANK HIGH LEVEL FLOAT SWITCH LS-WW
9	PUMP STATION HIGH TEMPERATURE	HIGH PUMP STATION ROOM TEMPERATURE	3 ROOM HEAT DETECTORS HD-1--3
10	PUMP STATION LOW TEMPERATURE	LOW PUMP STATION ROOM TEMPERATURE	ROOM THERMOSTAT & 2 HEAT TRACE CONTROLLERS

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REFERENCE DRAWINGS					DRAWN BY					
					SR	08/26/16	GF	GF		
		0	AS BUILT	08-2009	SR	JULY/16	GF	GF	100%	

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ELECTRICAL
PUMP CONTROL & ALARM SYSTEM
SCHEMATICS &SEQUENCE OF OPERATION
TRUCK FILL STATION

SCALE NTS | SHEET 1 OF 1

DRAWING NO. PUMP CONTROL SYSTEM | REV. 2 | REV. DATE 08/26/16

SAVE DATE: jul./4/2017 3:28:46

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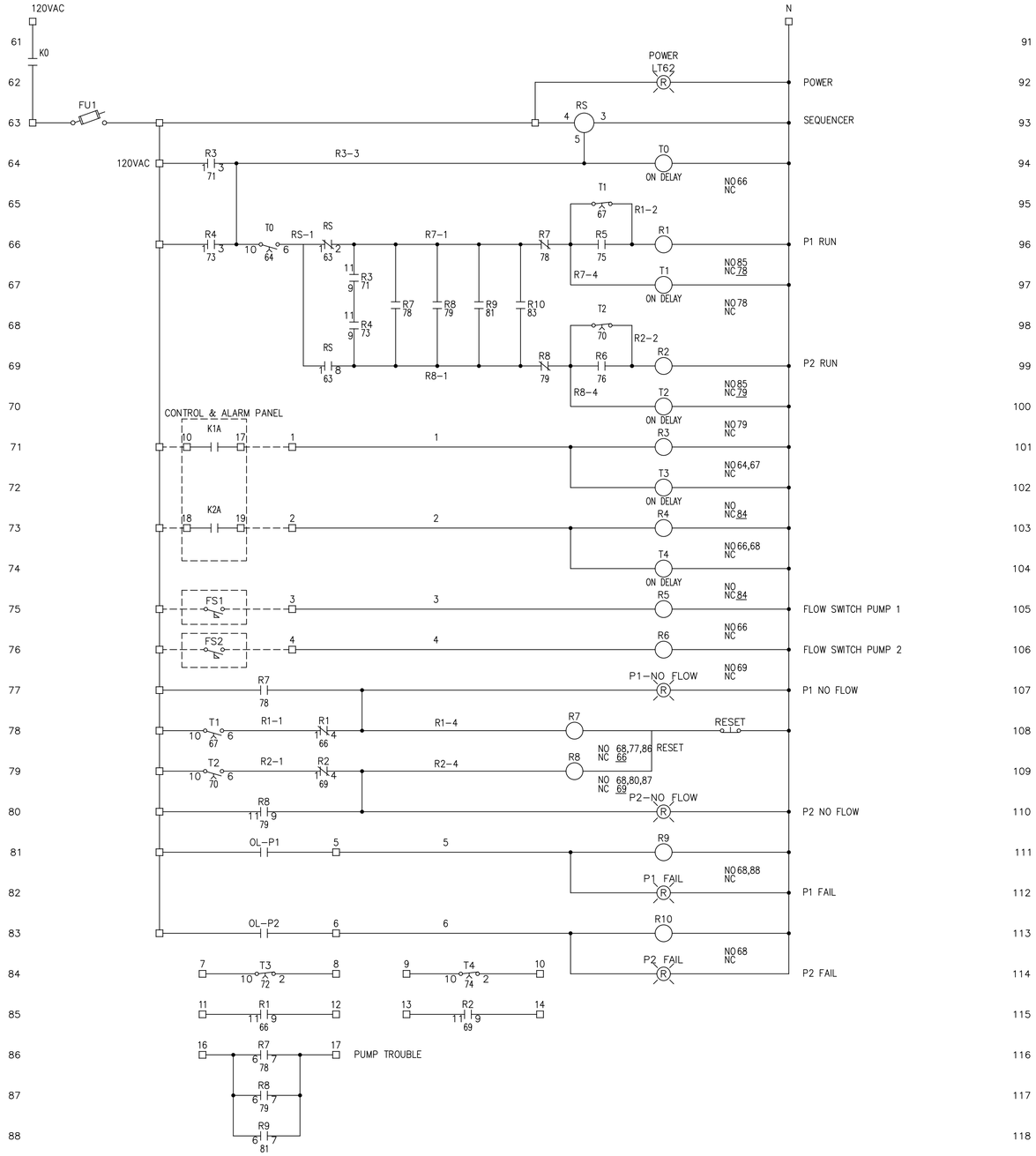
SAVE DATE: sept./20/2018 2:42:07



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REFERENCE DRAWINGS		0	AS BUILT	08-2009	LHF	JUN/16	GF	GF	100%	
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PUMP SEQUENCER PANEL
SCHEMATICS
TRUCK FILL STATION

SCALE	SHEET	DRAWING NO.	REV.	REV. DATE
NTS	1 OF 1	PUMP SEQUENCER PANEL		27/06/16

FILENAME: P:\&SIFEC\YGT12 - IGLOOLIK TRUCKFILL STATION\DWG\E-DRAWINGS\PUMP SEQUENCER PANEL.DWG

Chapter 39 FORM

MANUFACTURER/DISTRIBUTOR:

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Lachute, QC
J8H 3R8
Phone: 450-562-7391
Fax: 450-562-7391

39.1 **DAILY MORNING REPORT**

39.2 **DAILY LOG SHEET**

Log Sheet for SIFEC **Site: Igloolik Truck Fill** **Date:** **Stroke %:**

Chlorine Type : _____

Serial Number	Time	Truck Number	Inside the Water Plant			After filling the Truck		Turbidity		Reading at Garage				Name of the operator	
			Free Chlorine, mg/L (Probe)	Free Chlorine, mg/L (Pocket Hach)	Total Chlorine mg/L	Free chlorine mg/L	Total Chlorine mg/L	Raw Water NTU	Treated water after 20 minutes Contact time NTU	Time	Free Chlorine, mg/l (ppm)	Total Chlorine, mg/l (ppm)	NTU		Stroke per Minute
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															

Igloolik Truckfill - Daily Morning Report

Date:	

		Time Started	Time Stopped	Initial of trainer
Name of Operator / Trainer :				
Name of Operator / Trainer :				
Name of Trainee :				
Name of Trainee :				
Name of Trainee :				
Name of Trainee :				

	Yes/No	If Yes, type of alarm?	Initial of trainee
Alarm:			

Calibration Required ?	**Yes/No**	Initial of trainee
Pocket Colorimeter		
Ph Probe		
Free Chlorine Probe		

Filter/Strainer Cleaning	**Date**	Initial of trainee
Last Strainer Cleaning?		
Last 20 Micron Filter Replacement?		
Last 20 Micron Filter Cleaning?		
Last 5 Micron Filter Replacement ?		
Last 5 Micron Filter Cleaning ?		
Last 1 Micron Filter Replacement?		
Last 1 Micron Filter Cleaning ?		

Free Chlorine Measurements	**PPM**	Initial of trainee
Probe Reading (Controller Display)		
Pocket Colorimeter Reading		

pH Measurements	**pH**	Initial of trainee
PH probe reading		
Portable PH reading		

Water Temperature Measurements	**˚C**	Initial of trainee
Probe Reading (Controller Display)		

Turbidity Measurements	**NTU**	Initial of trainee
Portable Instrument Reading		

Flow Meter Readings	**Total M^3**	Initial of trainee
Flow Meter Before Filter		
Flow Meter After Filter		

Reading Taken During First Truck Fill

Flow Meter Readings	**M^3/Minute**	Initial of trainee
Flow Meter Before Filter		
Flow Meter After Filter		
VFD Outputs		
VFD Frequency (Hertz)		
VFD Current (Amps)		

Filter Pressure Readings	**PSI**	Initial of trainee
Absolute Pressure Before Strainer		
Strainer Differential Pressure		
20 micron Filter Differential Pressure		
5 micron Filter Differential Pressure		
1 micron Filter Differential Pressure		

Comments :