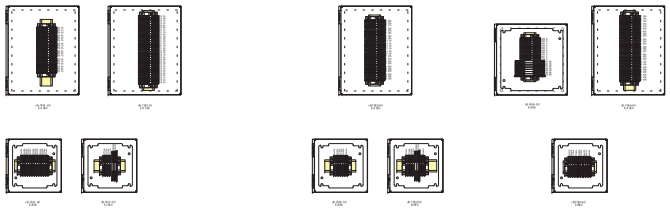
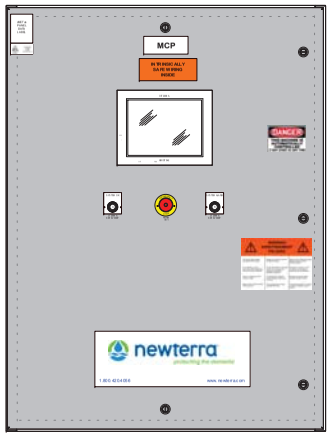
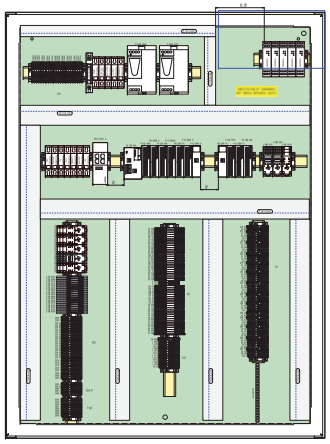


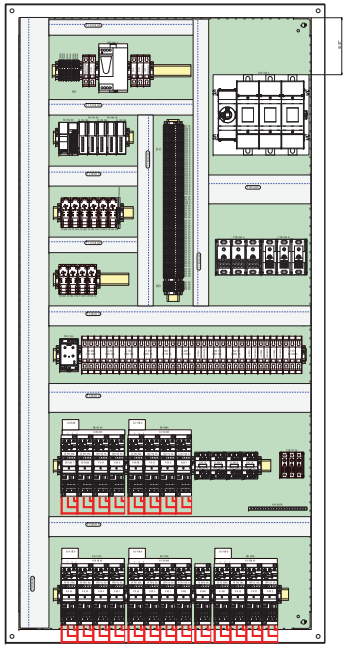


PANEL OUTER DOOR



MCP
ENABLEMENT 20Y
PANEL INTERIOR

PANEL OUTER DOOR



MPP
ENABLEMENT 20Y
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: PANEL LAYOUTS

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	8	71

1704432 - AGNICO EAGLE MINE - C

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INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	9	71

1704432 - AGNICO EAGLE MINE - C

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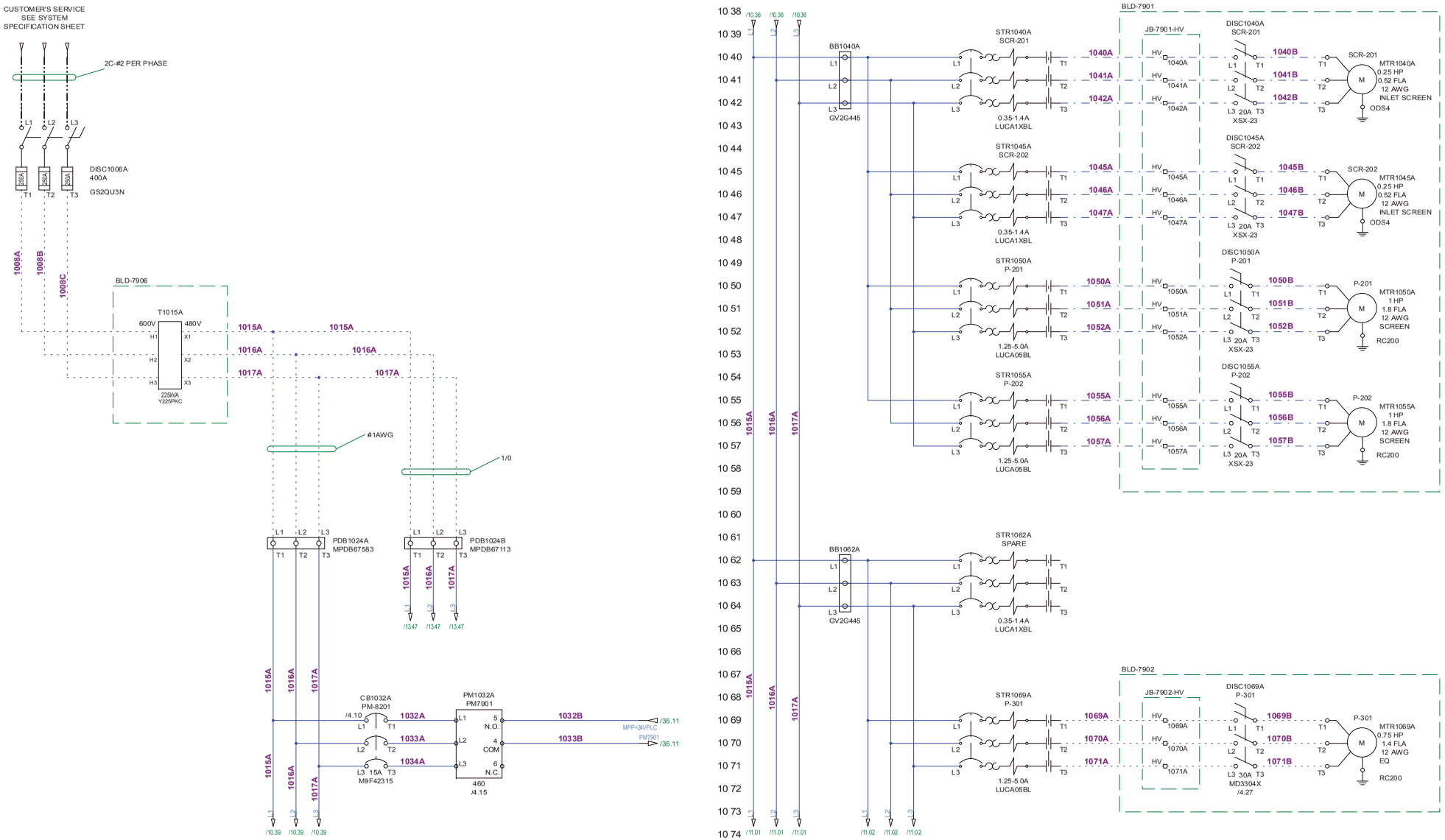

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 600V/480V POWER DISTRIBUTION MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	10	71

1704432 - AGNICO EAGLE MINE - C

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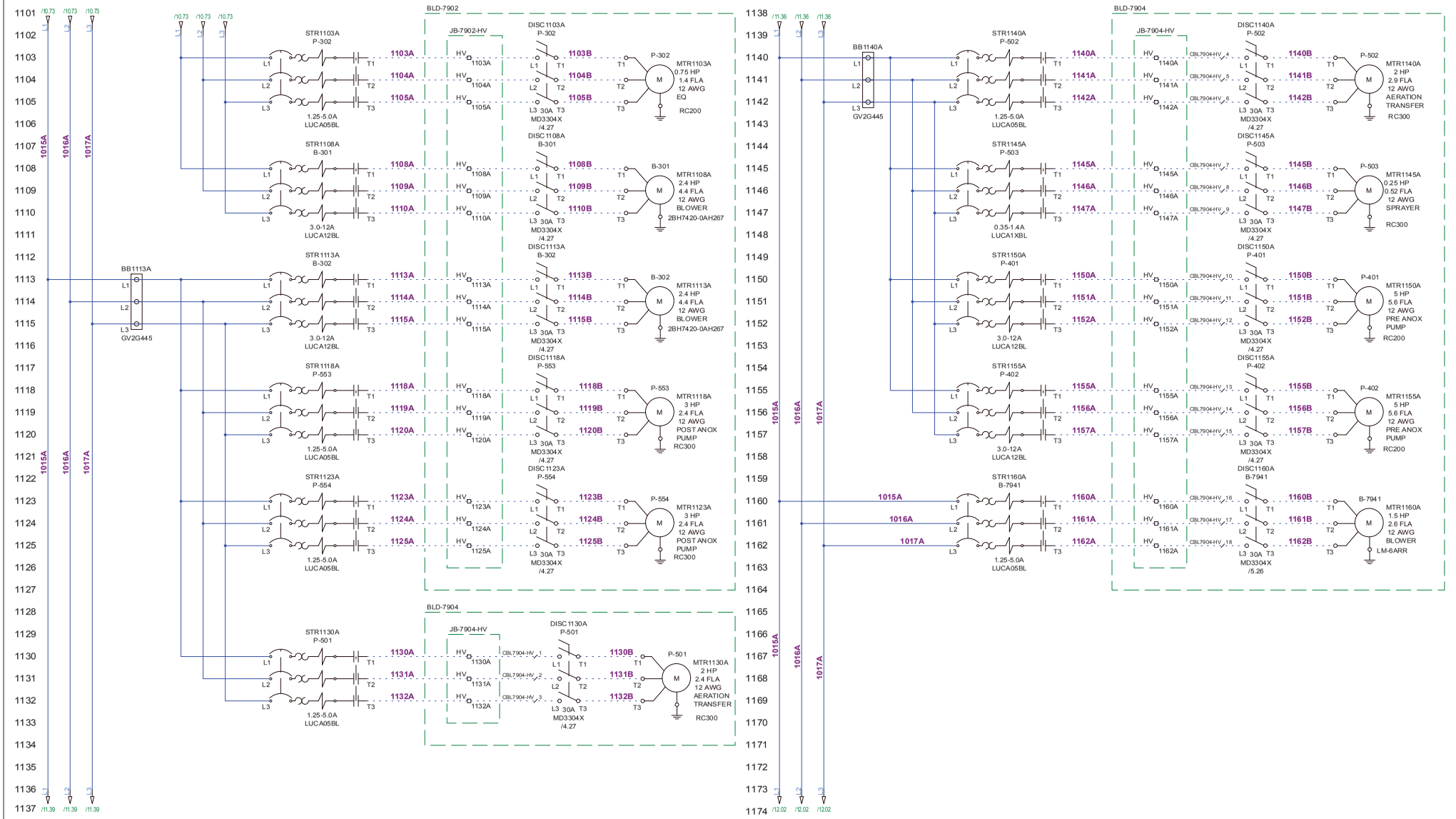

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 1 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	11	71

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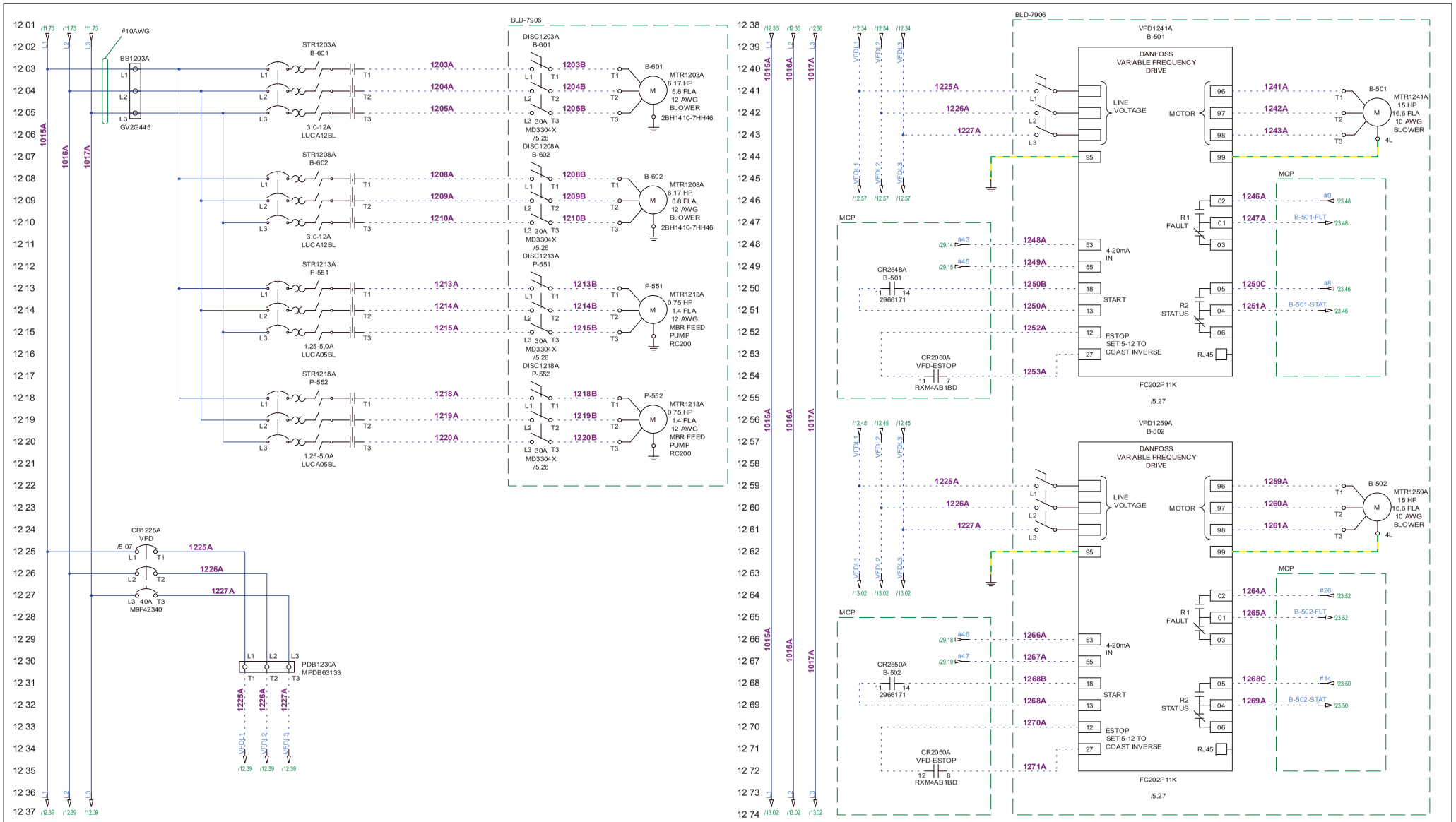

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 2 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	12	71

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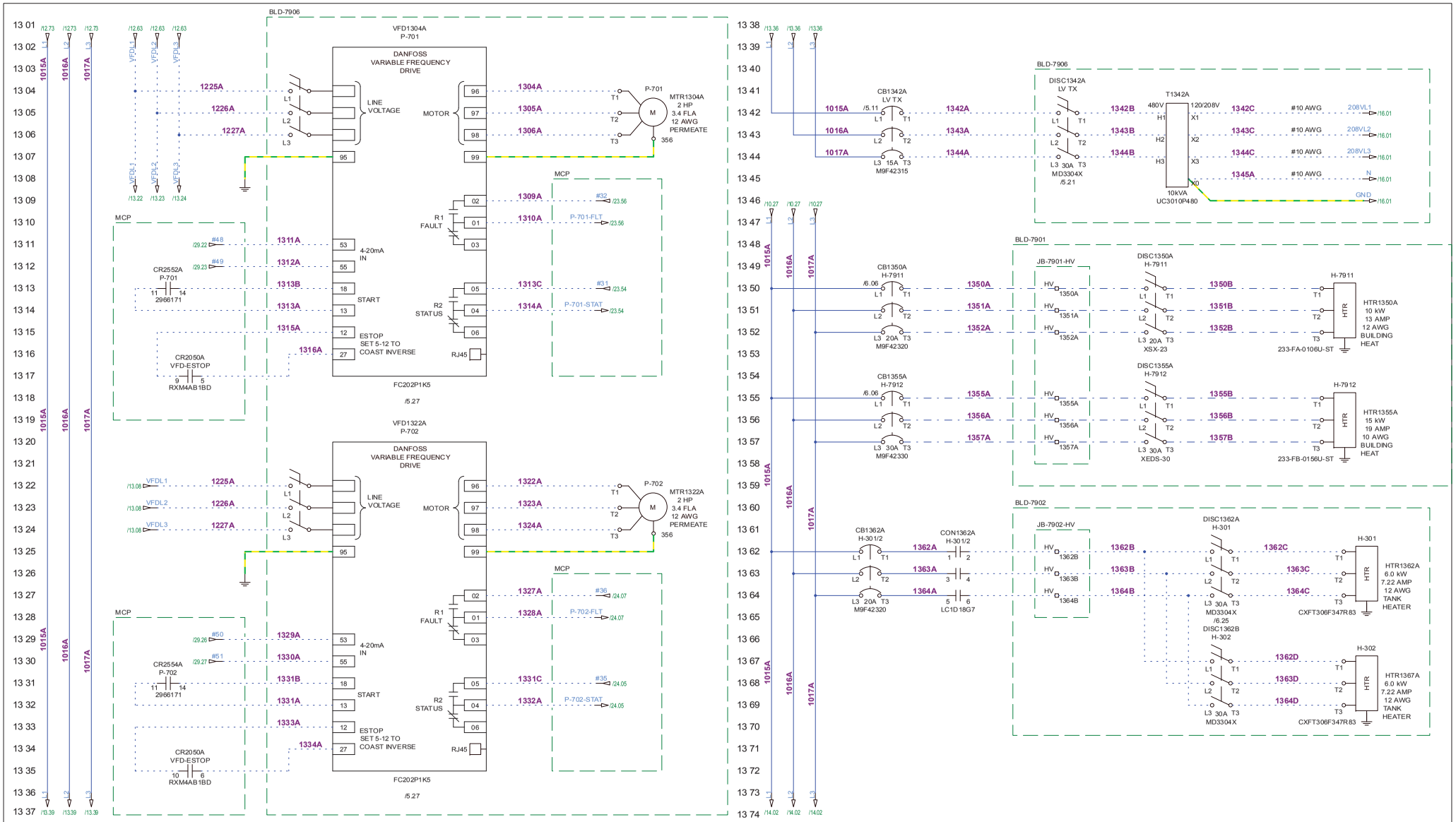

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 3 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	10/05/17	13	71

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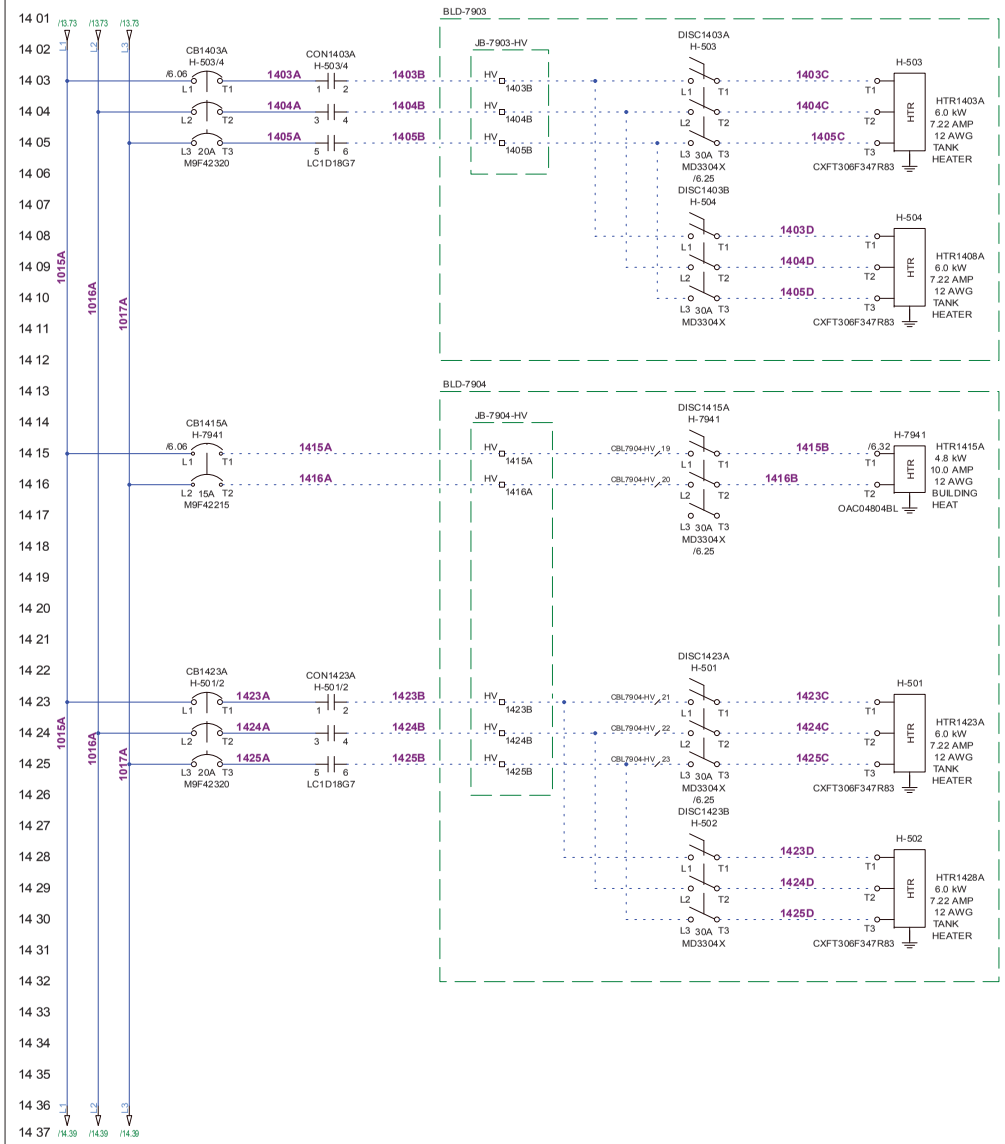

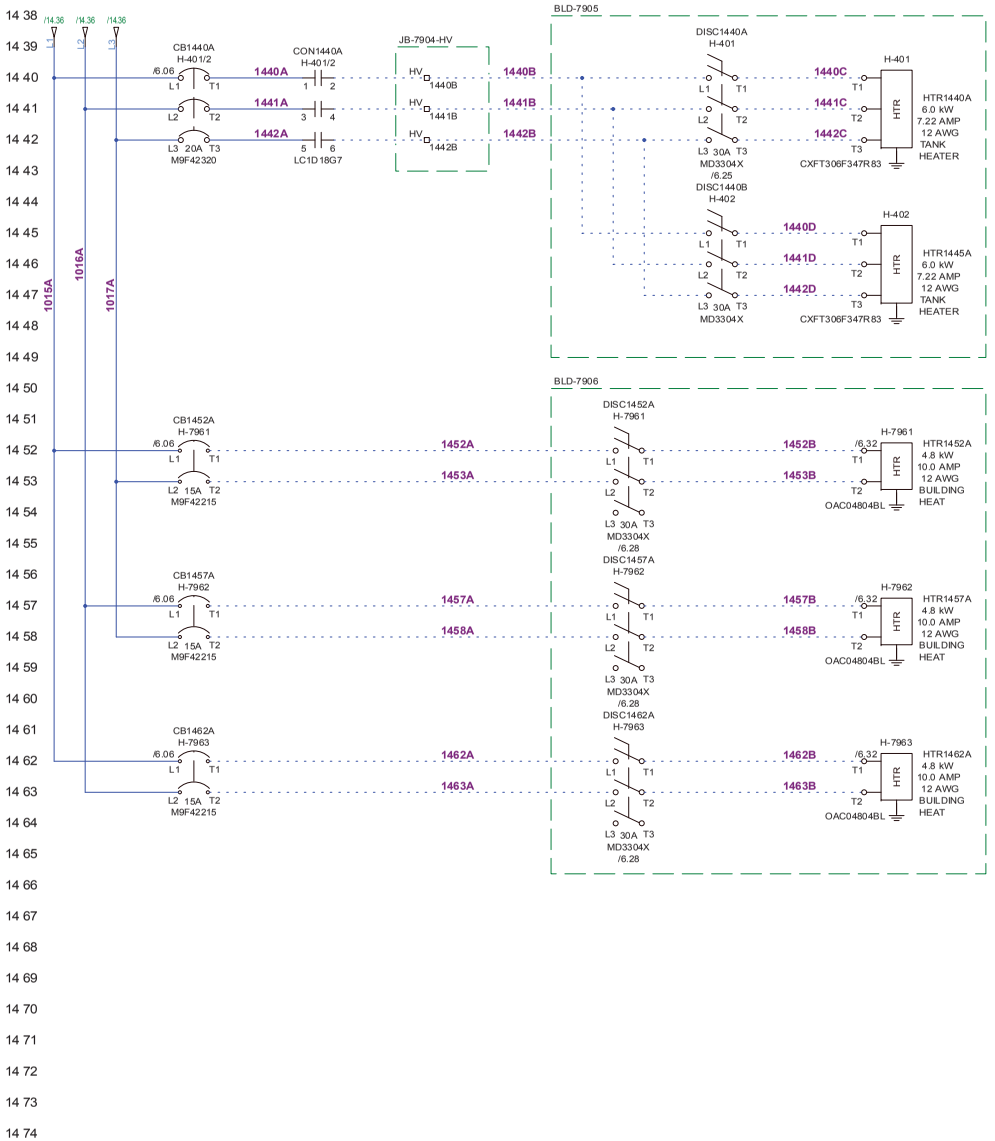

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

3. DEVICES IN BLD-7903 ARE ONLY REQUIRED FOR THE 400 MAN OPTION. IF THE 400 MAN IS NOT REQUIRED, STOP WIRING AT BASE OF P2019A CONNECTOR.
4. USE TANDEM FERRULES FOR CONNECTING WIRES TO DISTRIBUTION LUG

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 4 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	14	71

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WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	23/05/17	15	71

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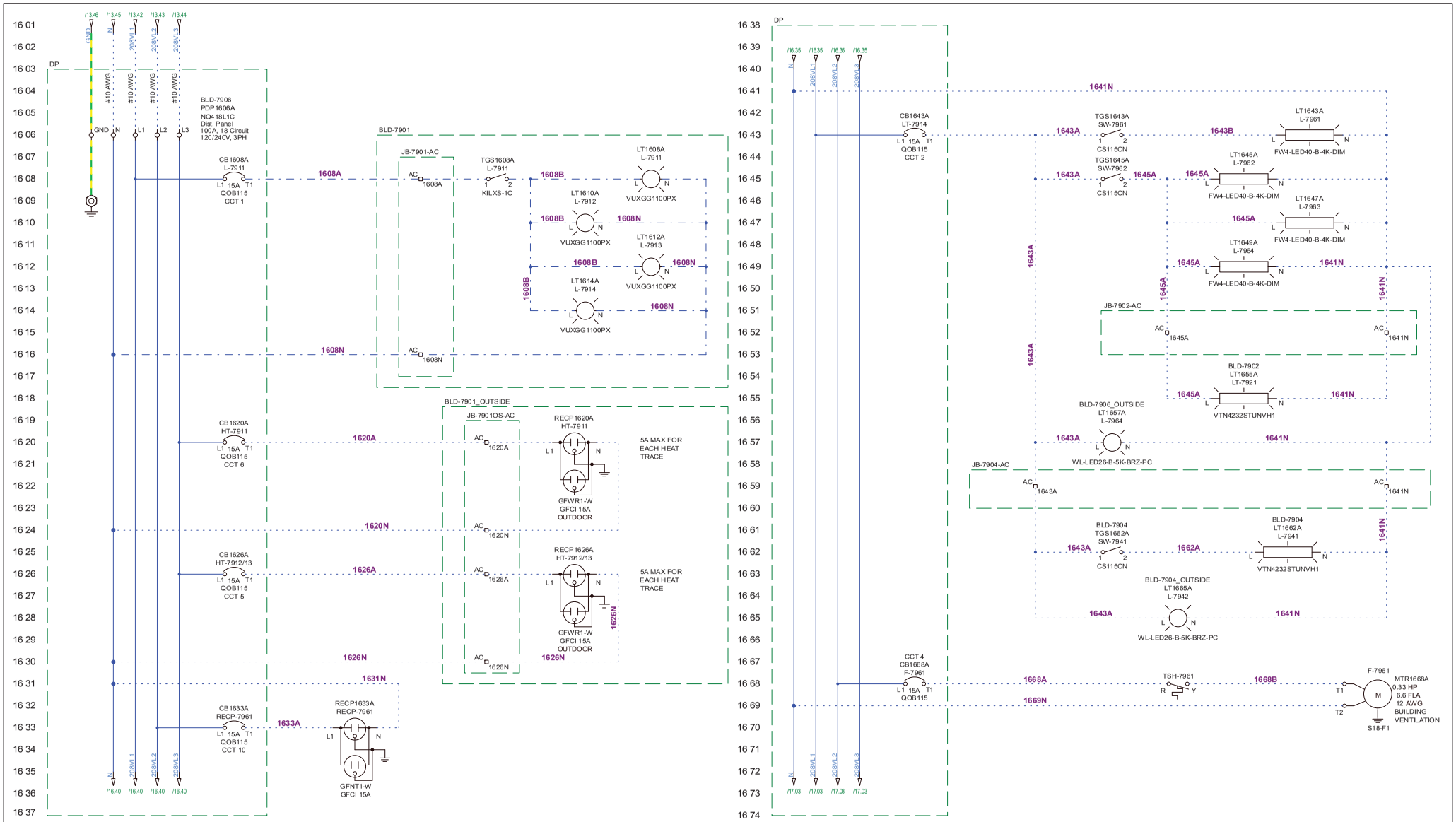

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
LV DISTRIBUTION PANEL
SHEET 1 OF 2
BLD-7906

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	16	71

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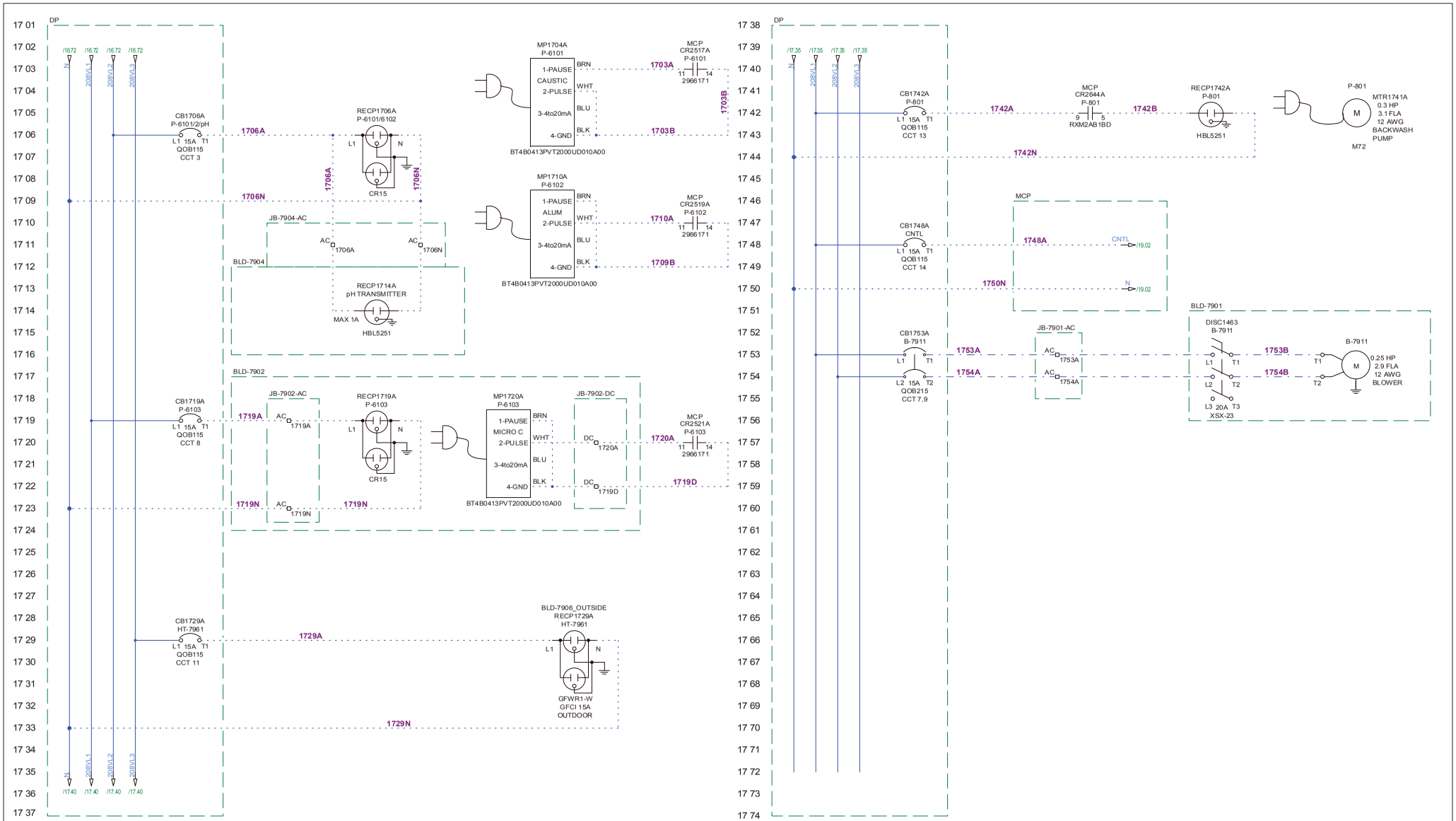

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
LV DISTRIBUTION PANEL
SHEET 2 OF 2
BLD-7906

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

BLD-7906

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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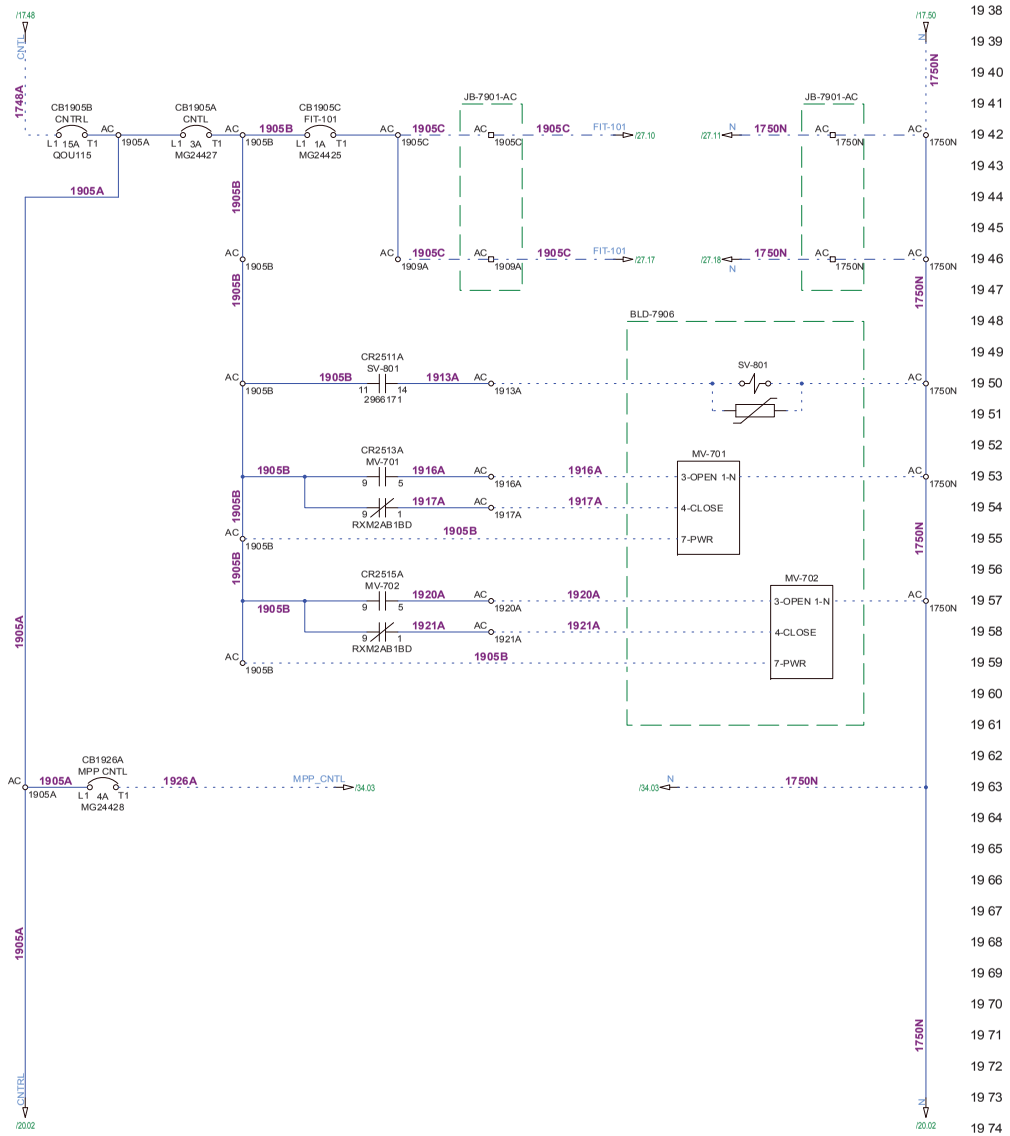

INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP - 120VAC CONTROL POWER
MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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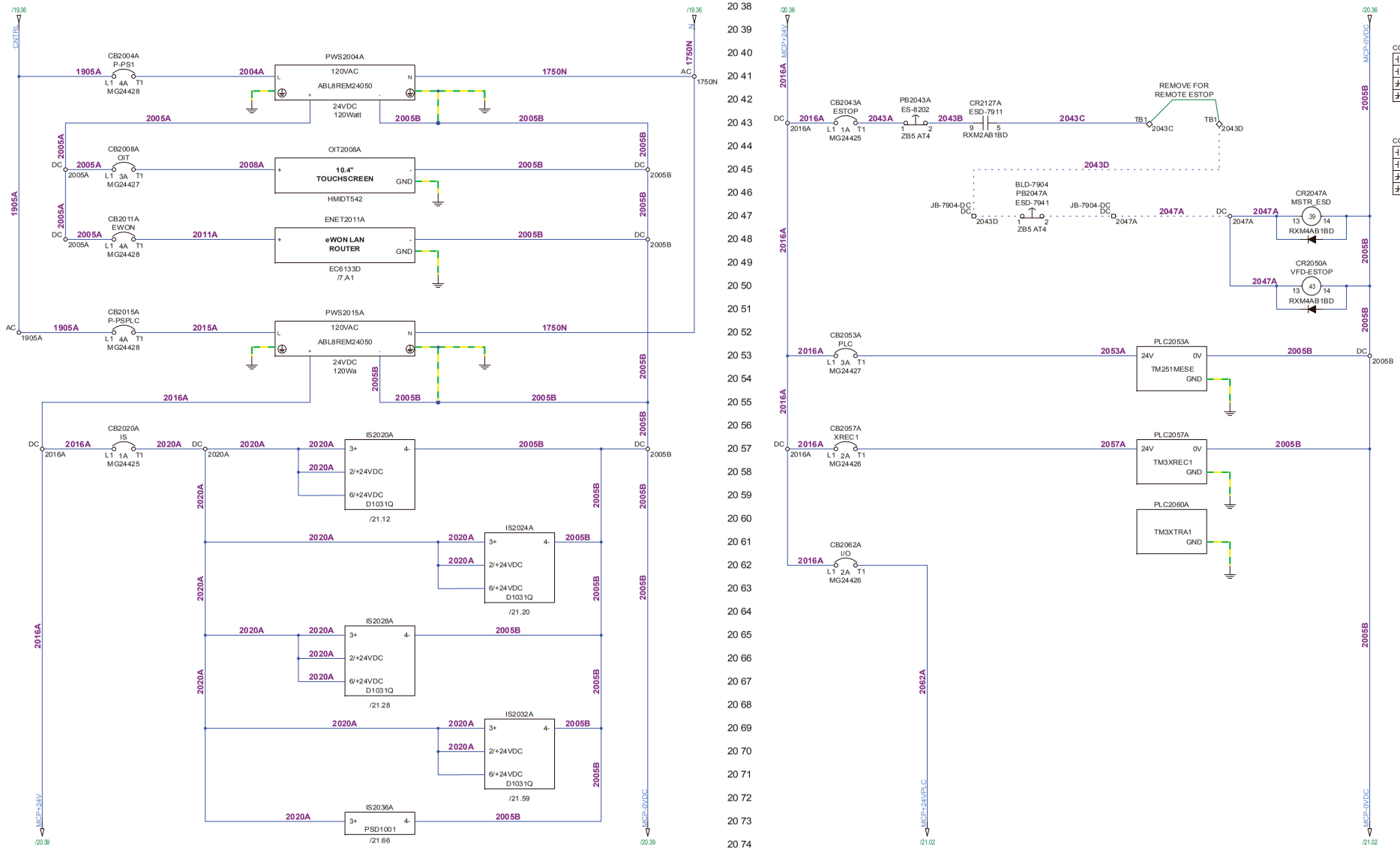

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP - 24VDC CONTROL POWER MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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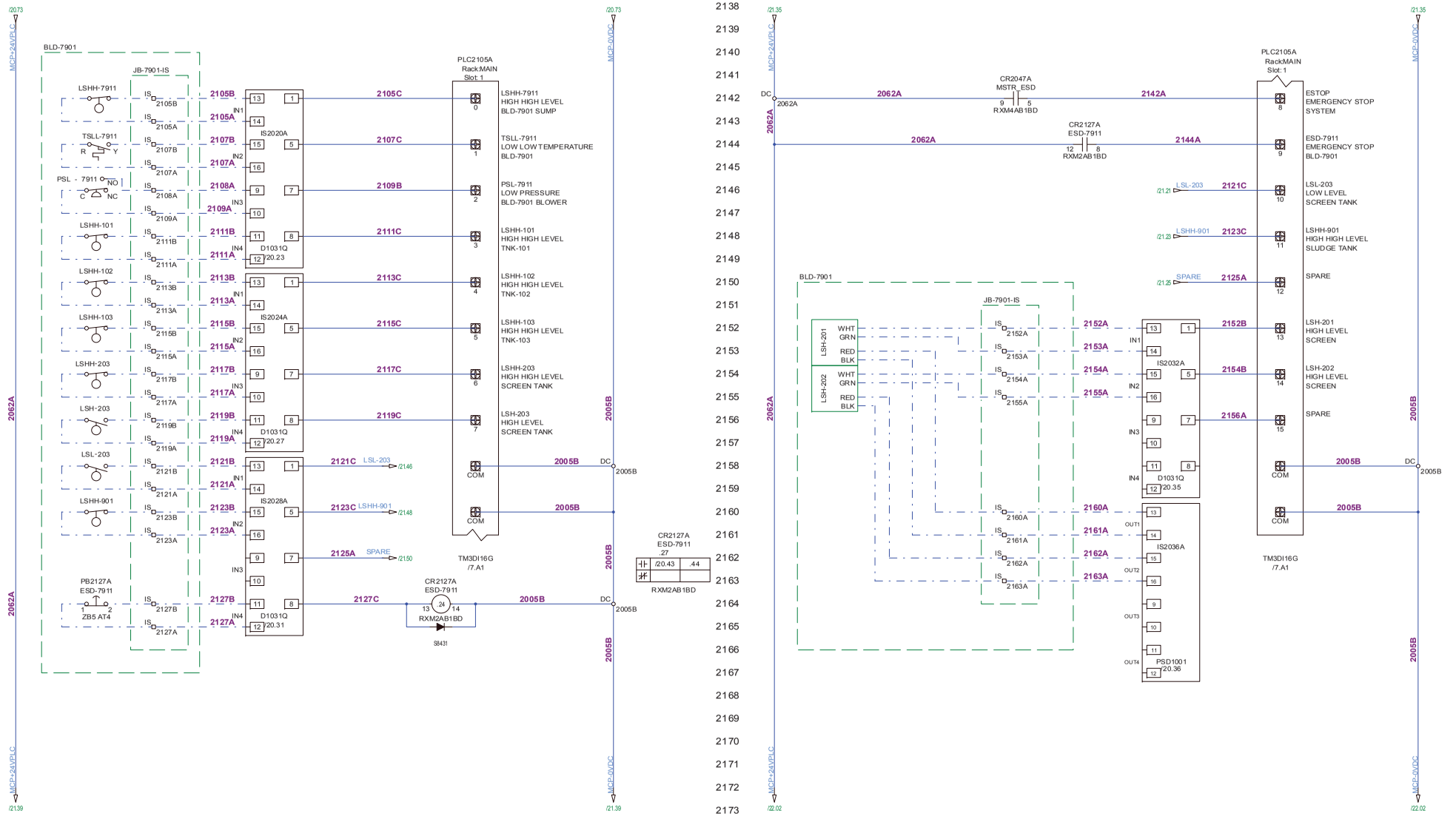

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE INPUTS SHEET 1 OF 4 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	21	71

1704432 - AGNICO EAGLE MINE - C

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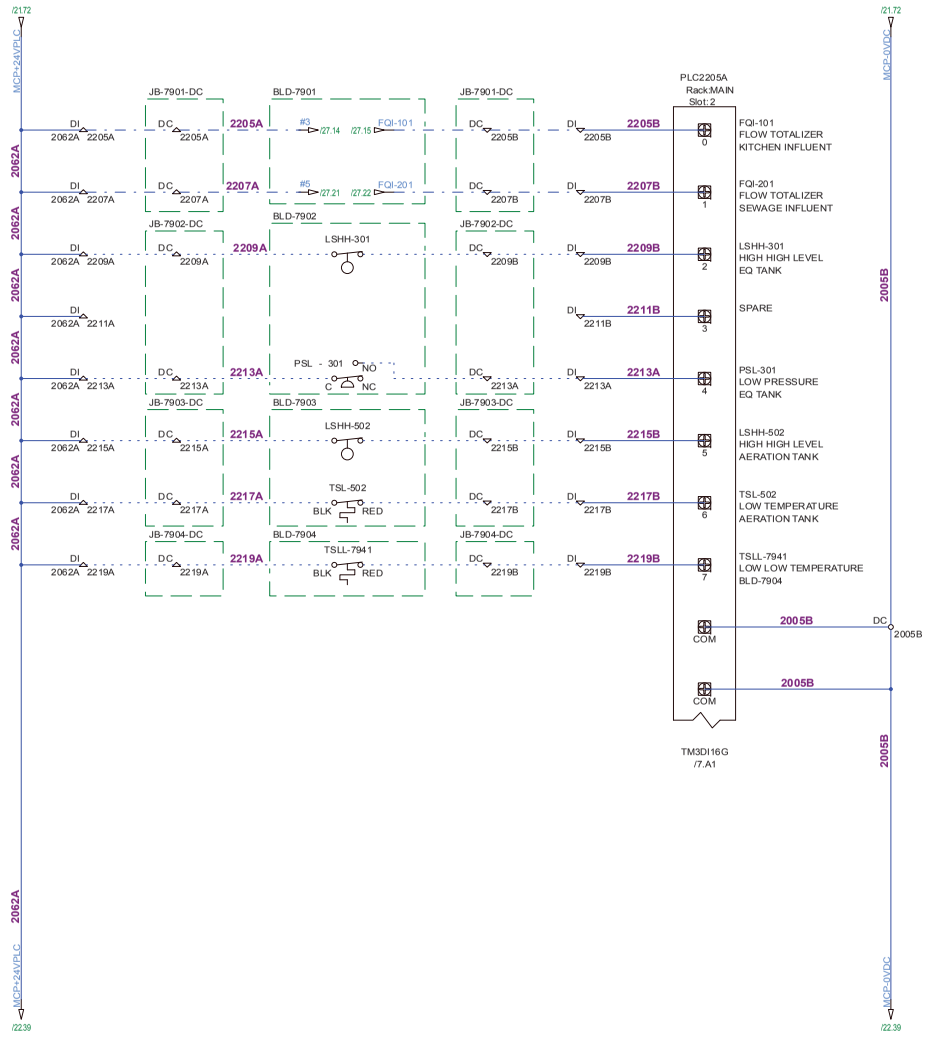

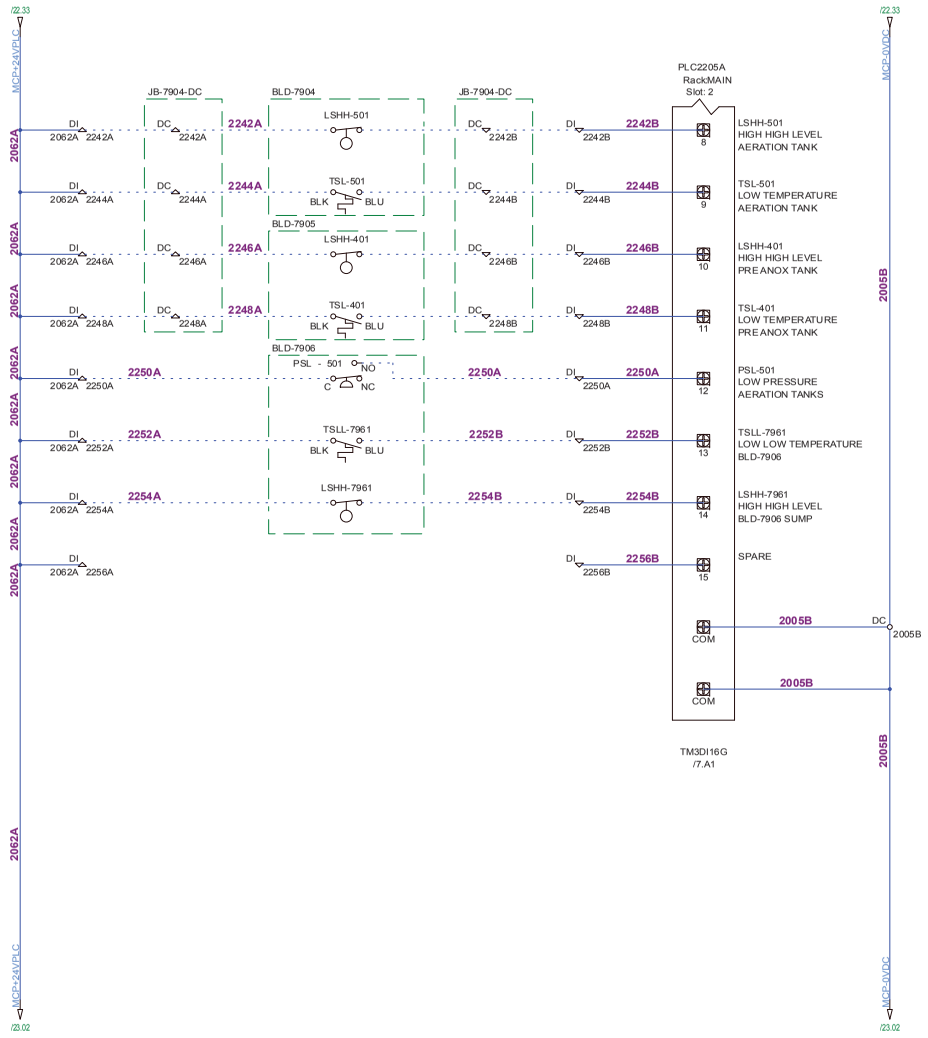

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE INPUTS
SHEET 2 OF 4
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	22	71

1704432 - AGNICO EAGLE MINE - C

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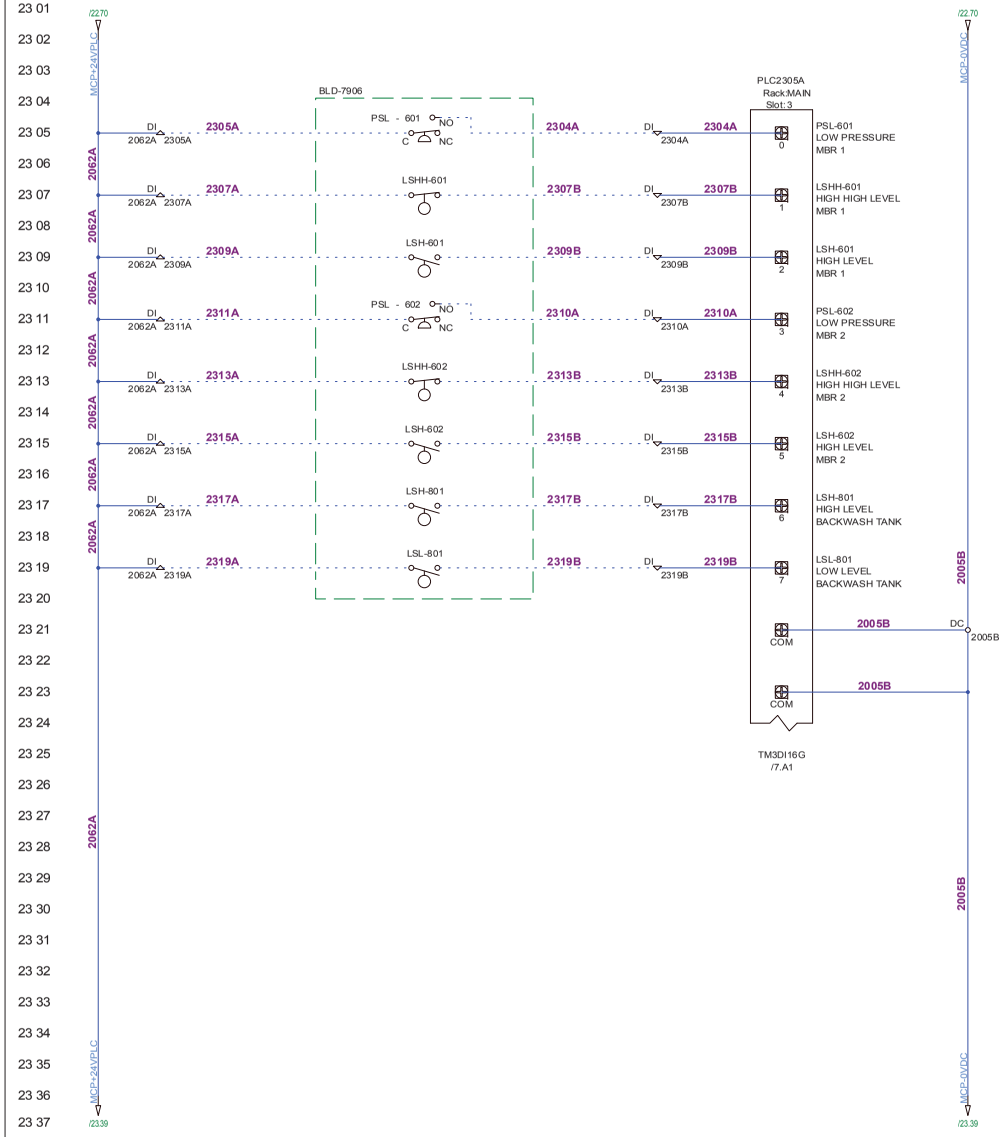

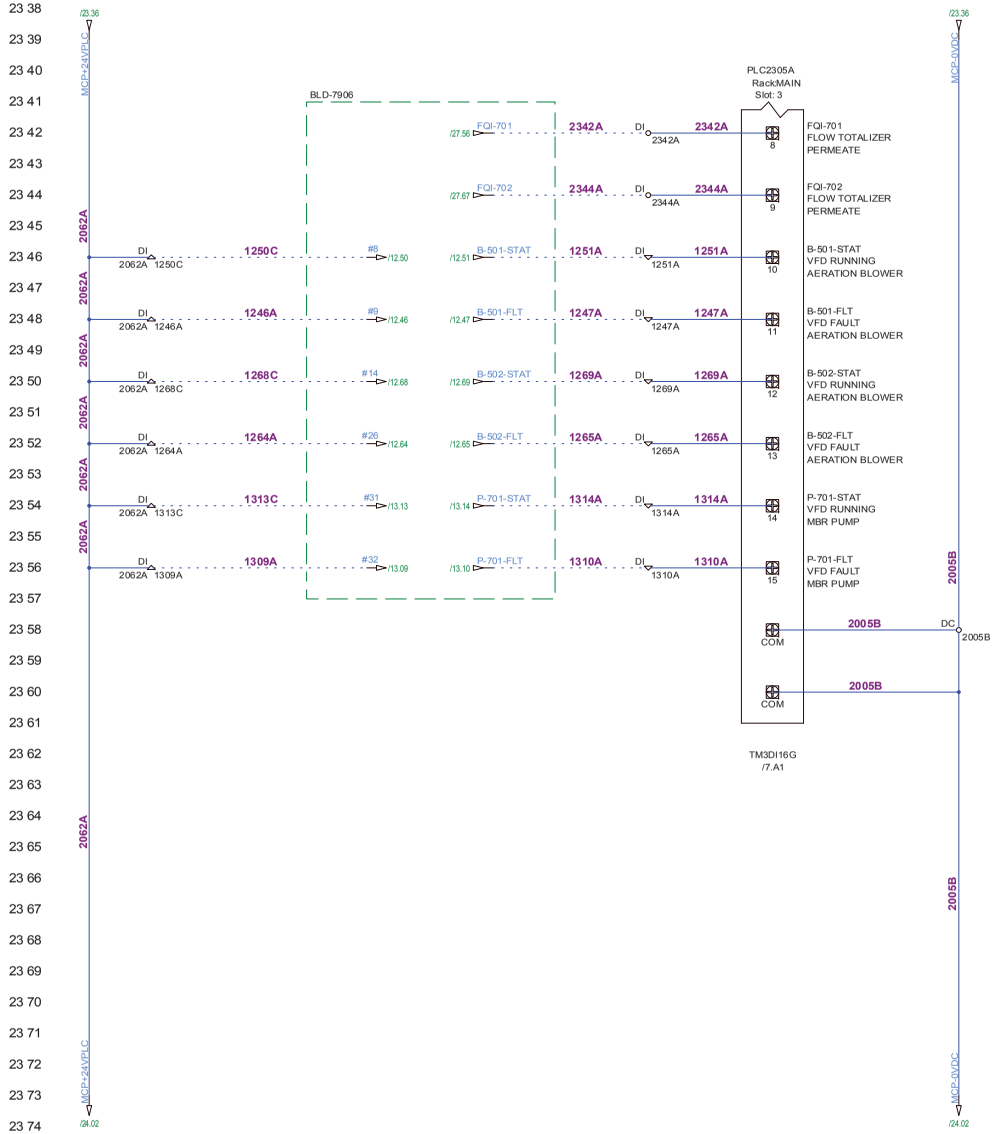

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE INPUTS SHEET 3 OF 4 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	23	71

1704432 - AGNICO EAGLE MINE - C

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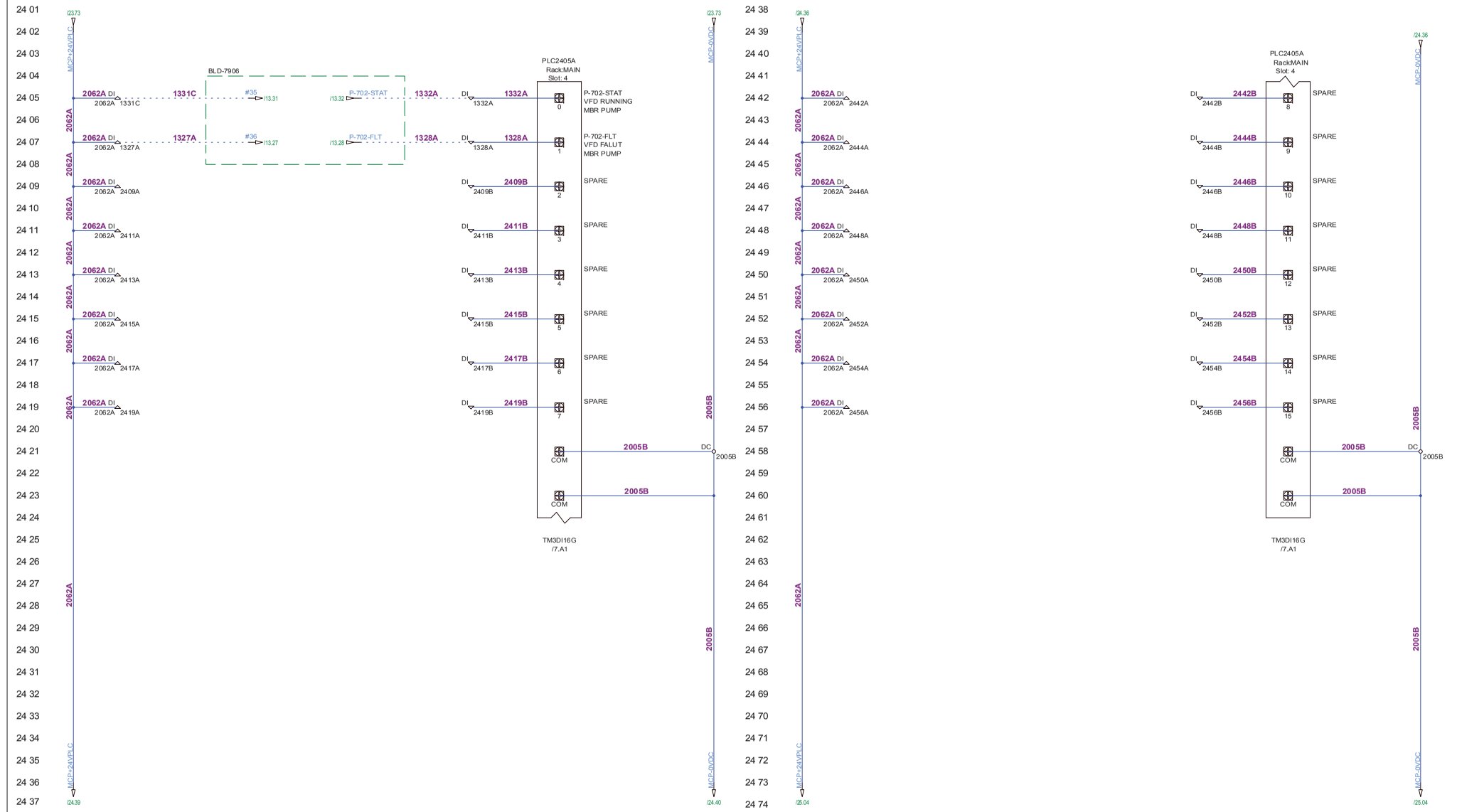

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE INPUTS
SHEET 4 OF 4
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	25/05/17	24	71

1704432 - AGNICO EAGLE MINE - C

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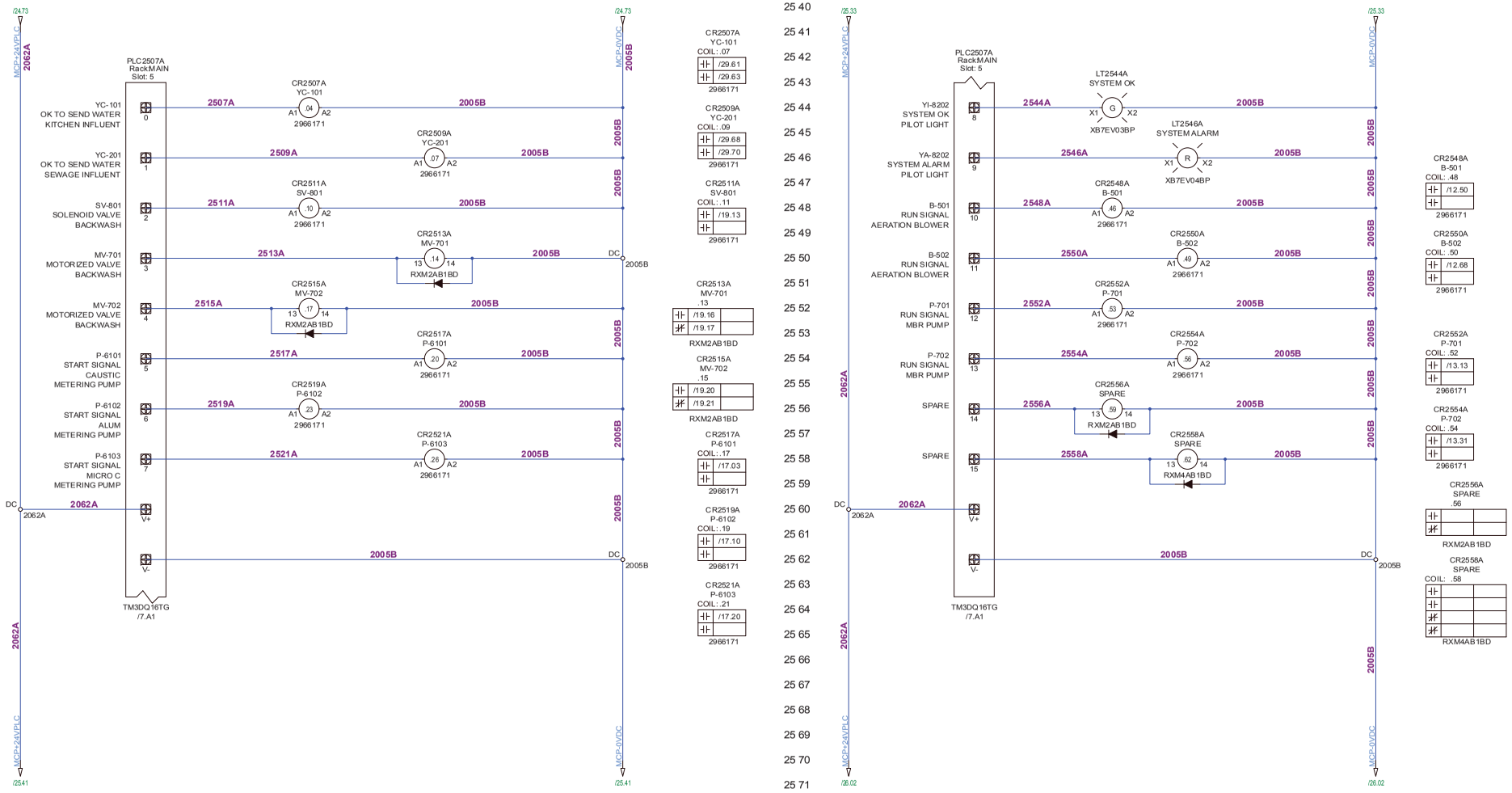

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE OUTPUTS
SHEET 1 OF 2
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	25	71

1704432 - AGNICO EAGLE MINE - C

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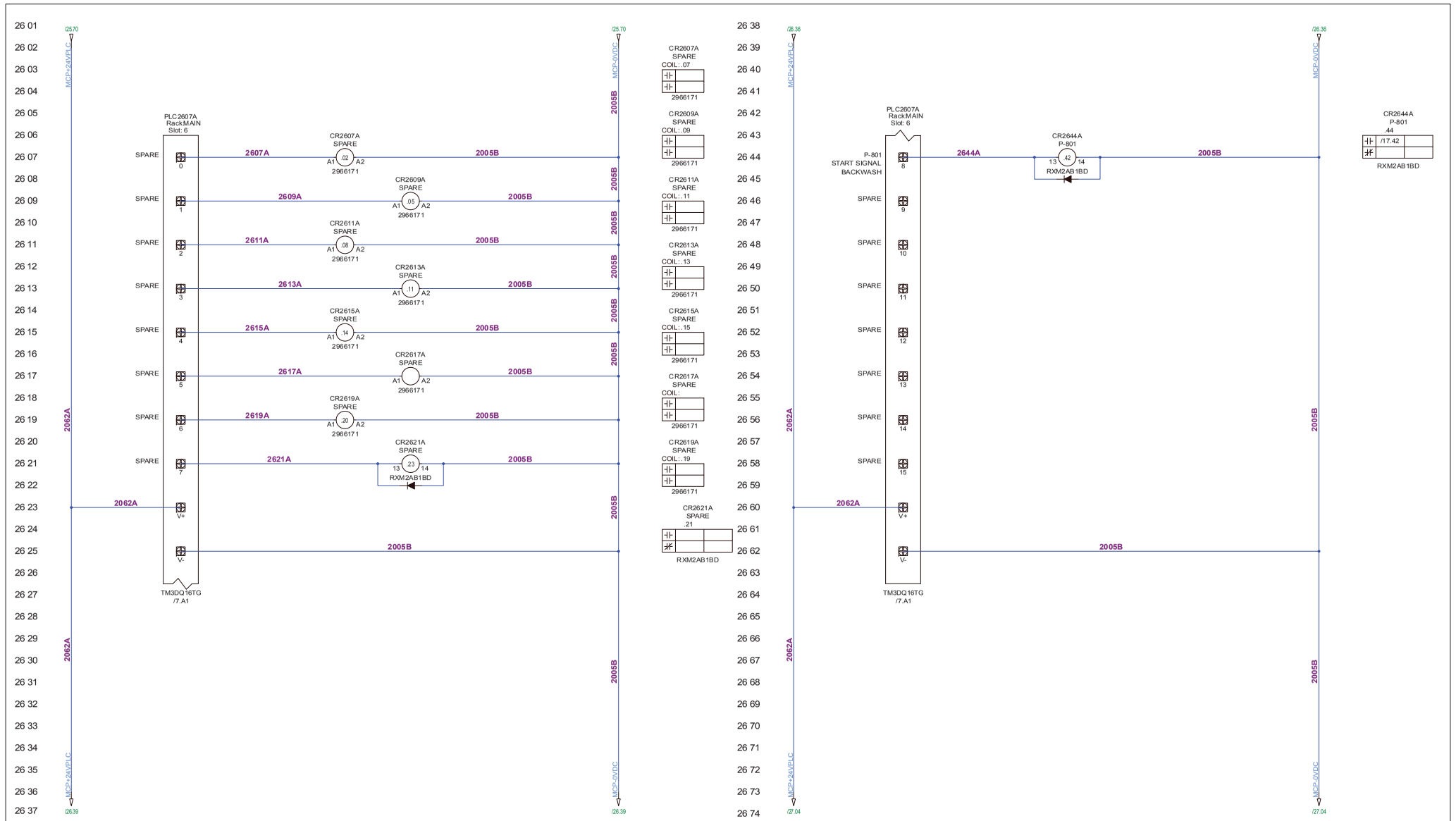

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE OUTPUTS SHEET 2 OF 2 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	25/05/17	26	71

1704432 - AGNICO EAGLE MINE - C

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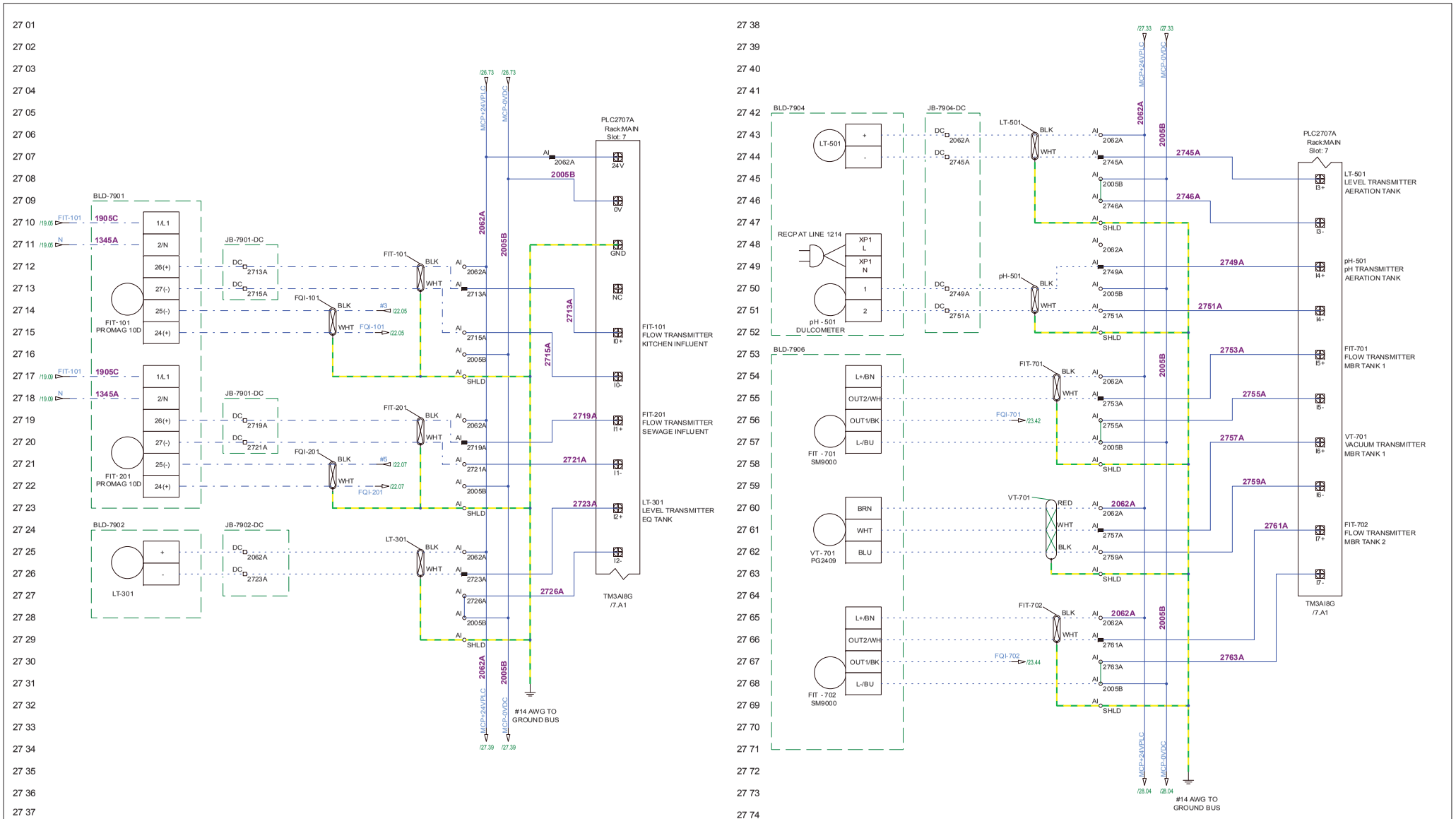

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP ANALOG INPUTS SHEET 1 OF 2 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	27	71

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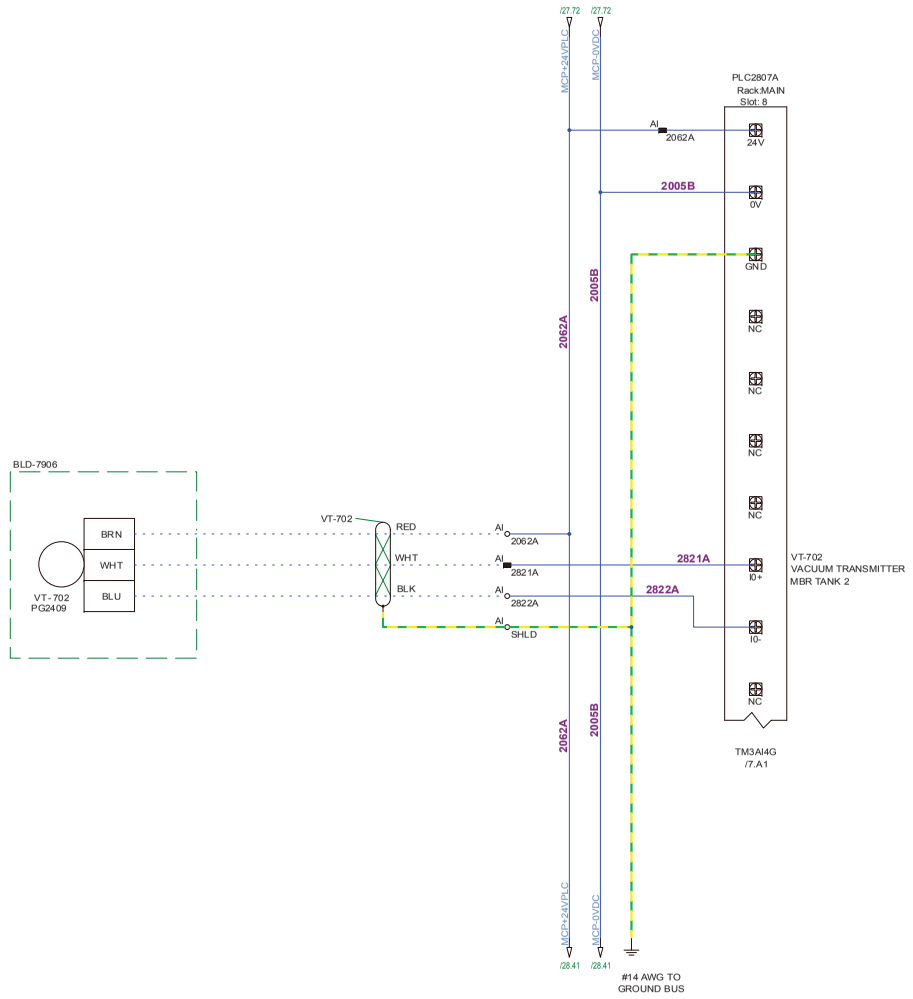

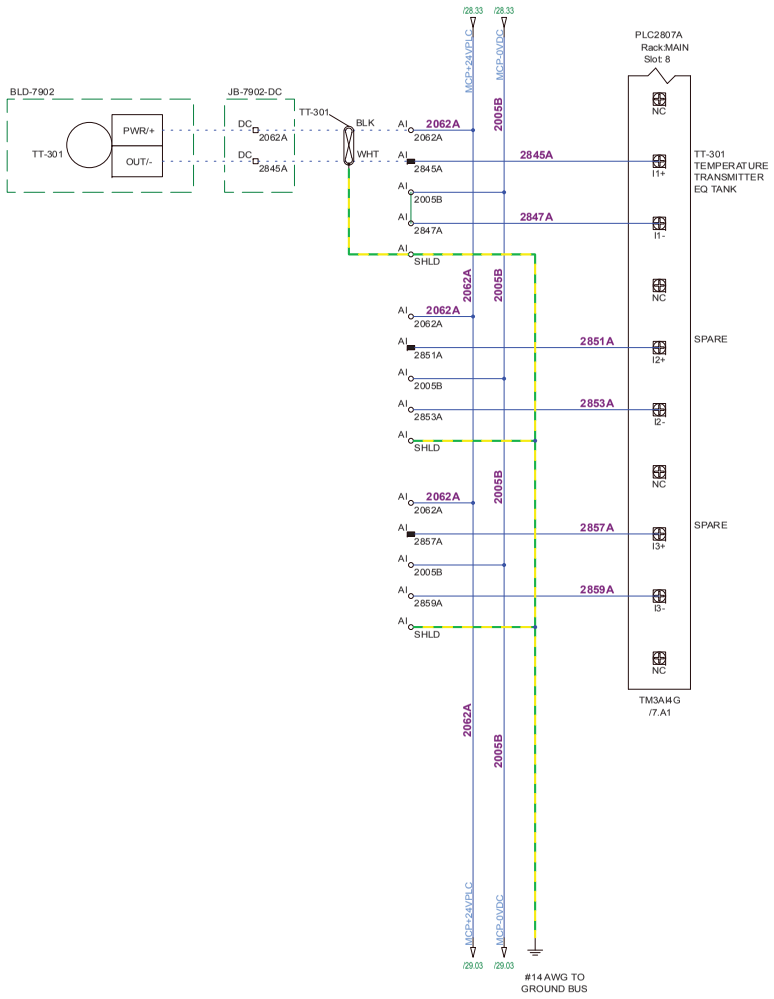

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP ANALOG INPUTS
SHEET 2 OF 2
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	28	71

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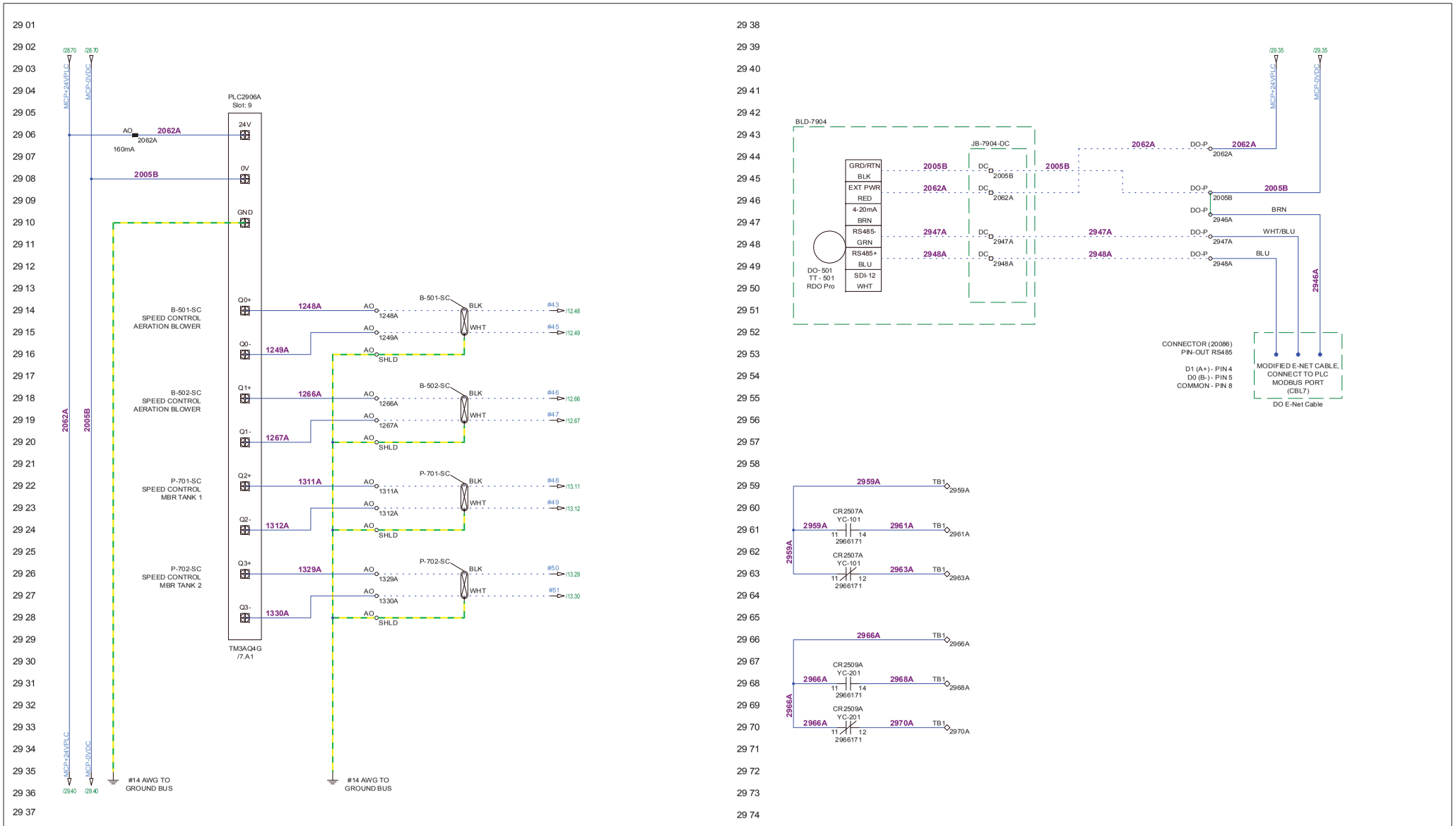

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP ANALOG OUTPUTS, DO/TT
PROBE & CUSTOMER CONNECTIONS
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	29	71

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INTENTIONALLY BLANK

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INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	30	71

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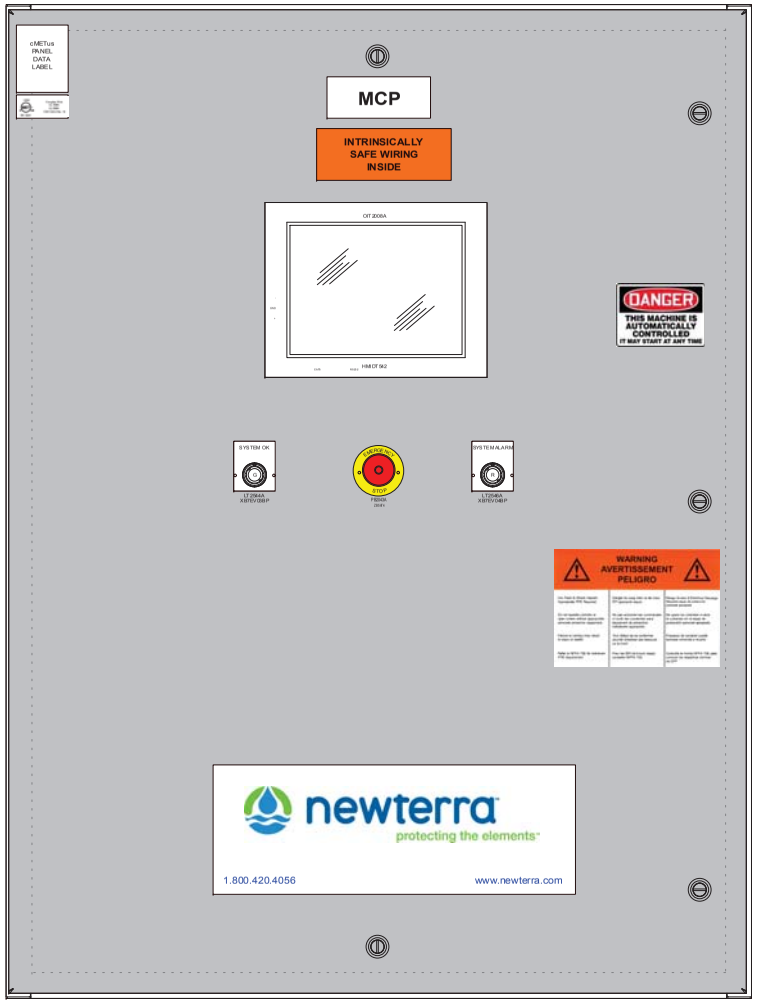
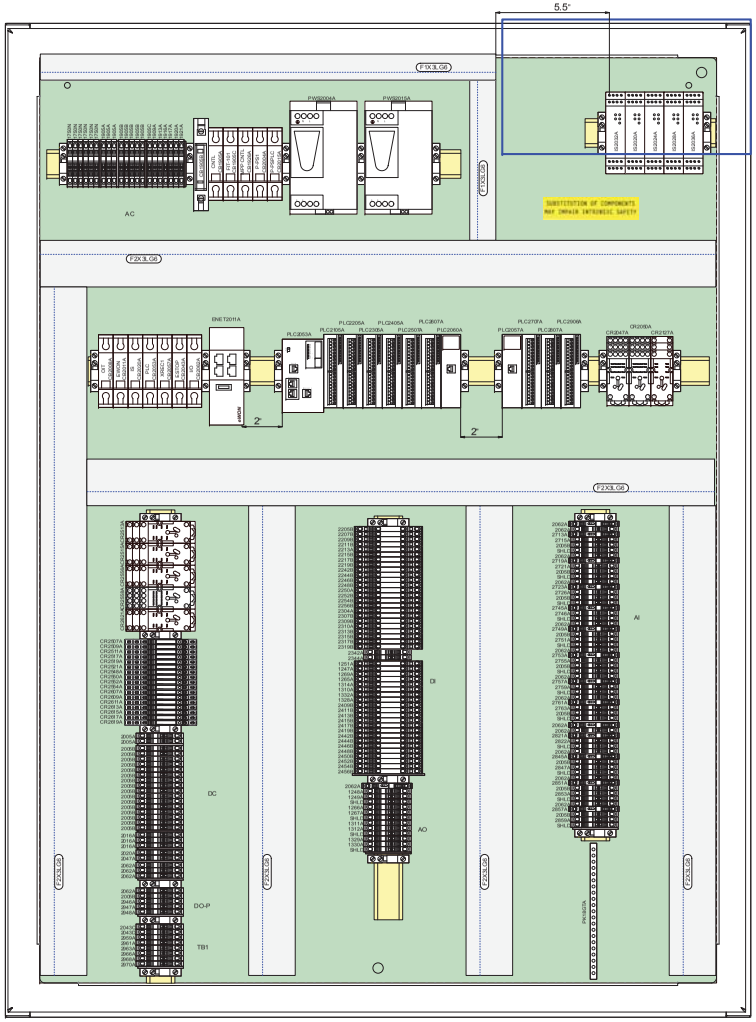


PANEL OUTER DOOR



MCP
EN4SD483612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT

MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	31	71

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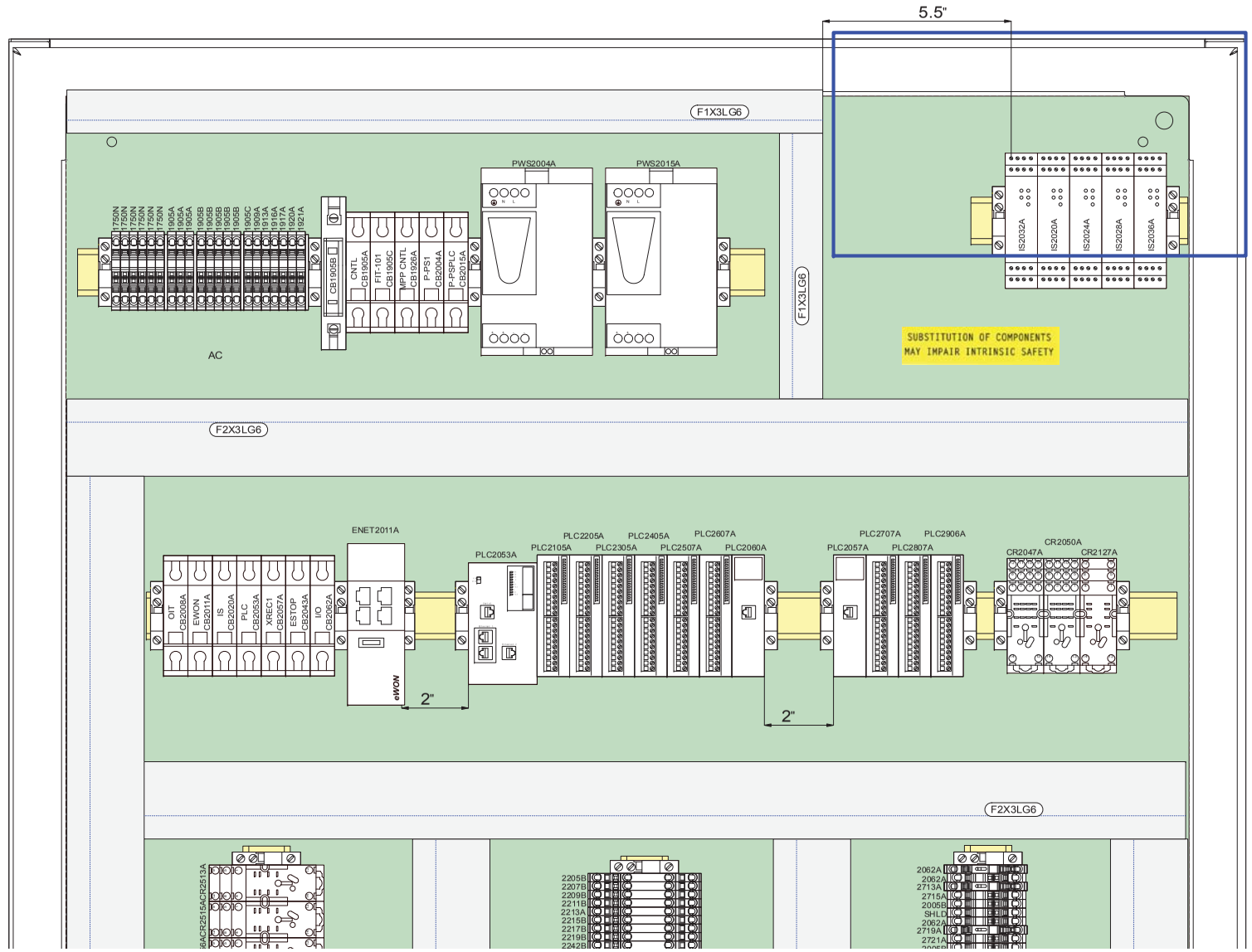

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT TOP MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	32	71

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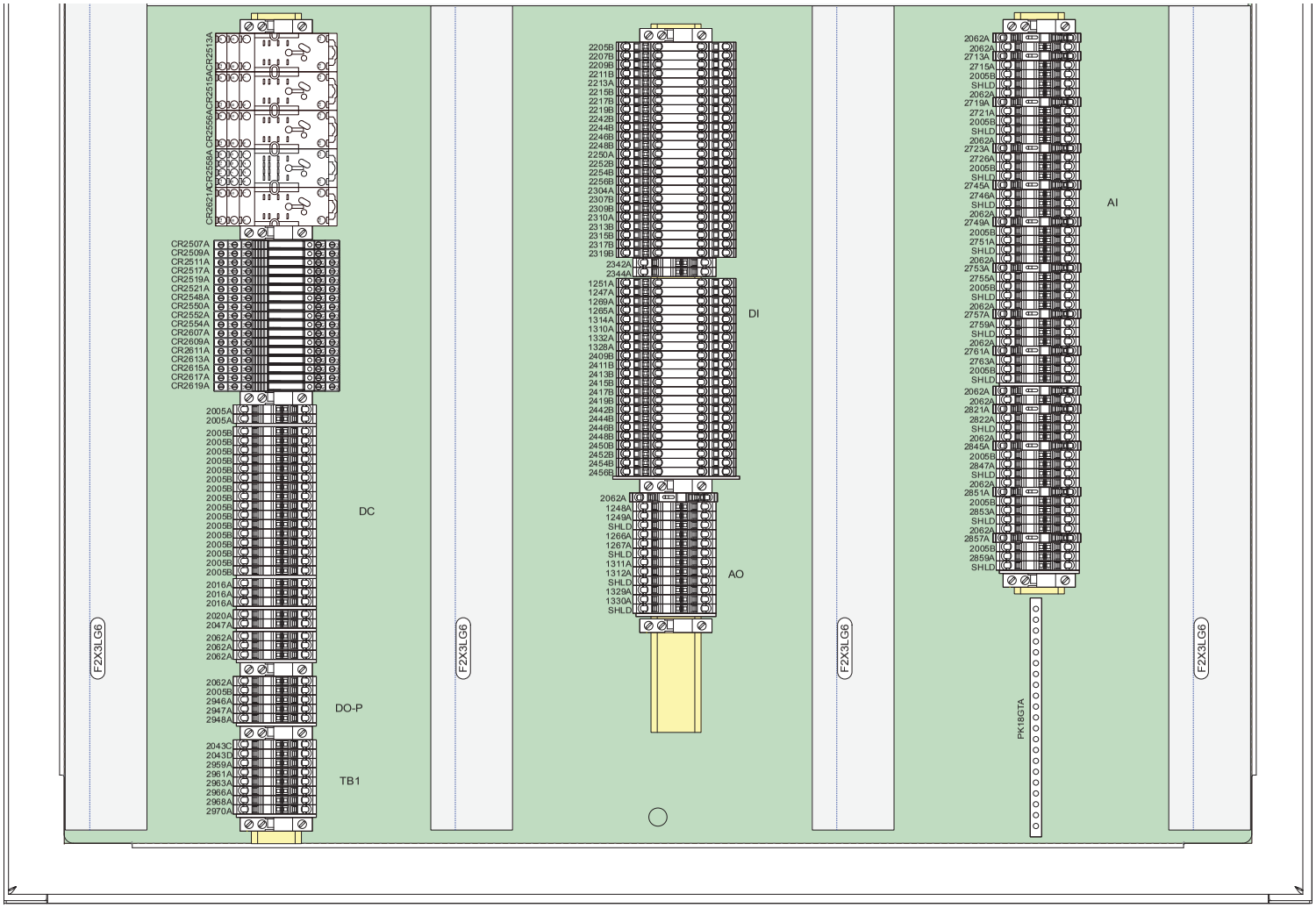

MCP

EN4SD483612GY

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT BOTTOM MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	33	71

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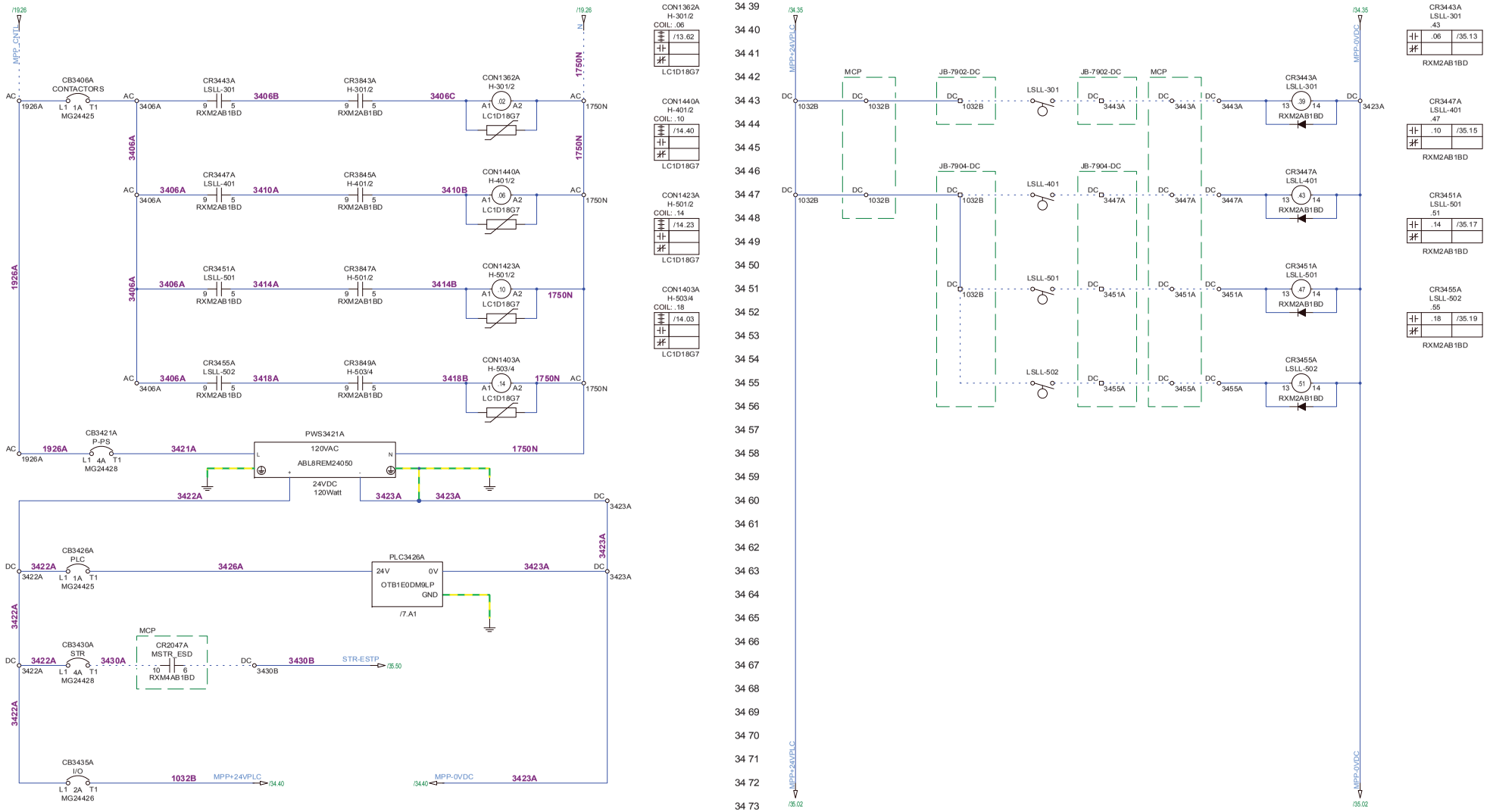

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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CANADA K6V 5Y6
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C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP 120VAC & 24VDC CONTROL POWER MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	34	71

1704432 - AGNICO EAGLE MINE - C

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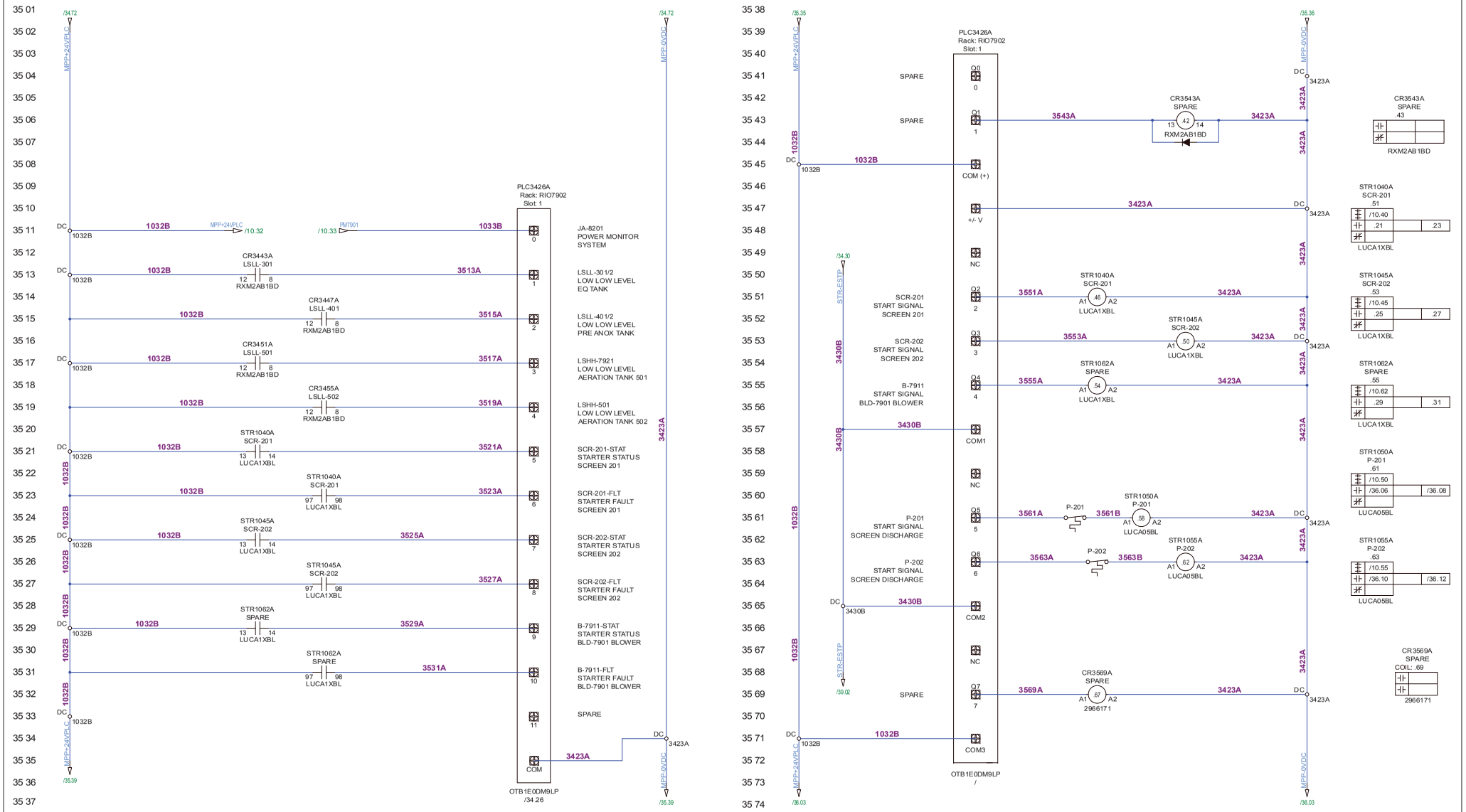

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP OTB I/O
DISCRETE INPUTS/OUTPUTS
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	35	71

1704432 - AGNICO EAGLE MINE - C

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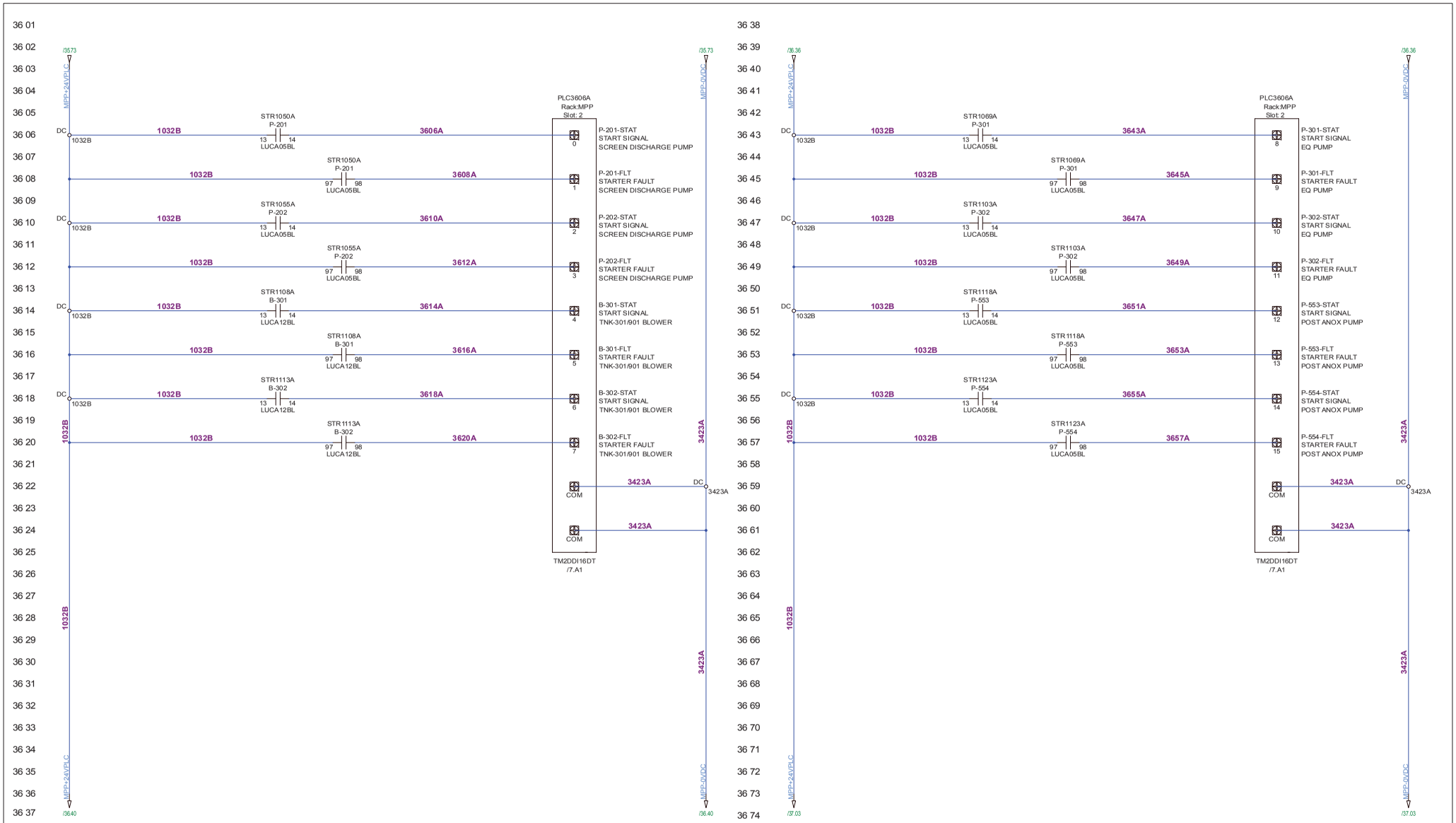
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MPP+24VPLC
DC
1032B
STR1050A
P-201
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LUCA05BL
3606A
PLC3606A
Rack:MPP
Slot: 2
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P-201-STAT
START SIGNAL
SCREEN DISCHARGE PUMP
97 98
3608A
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P-201-FLT
STARTER FAULT
SCREEN DISCHARGE PUMP
STR1055A
P-202
3610A
2
P-202-STAT
START SIGNAL
SCREEN DISCHARGE PUMP
3612A
3
P-202-FLT
STARTER FAULT
SCREEN DISCHARGE PUMP
STR1108A
B-301
LUCA12BL
3614A
4
B-301-STAT
START SIGNAL
TNK-301/901 BLOWER
3616A
5
B-301-FLT
STARTER FAULT
TNK-301/901 BLOWER
STR1113A
B-302
3618A
6
B-302-STAT
START SIGNAL
TNK-301/901 BLOWER
3620A
7
B-302-FLT
STARTER FAULT
TNK-301/901 BLOWER
3423A
COM
TM2DDI16DT
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/3640
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MPP-0VDC
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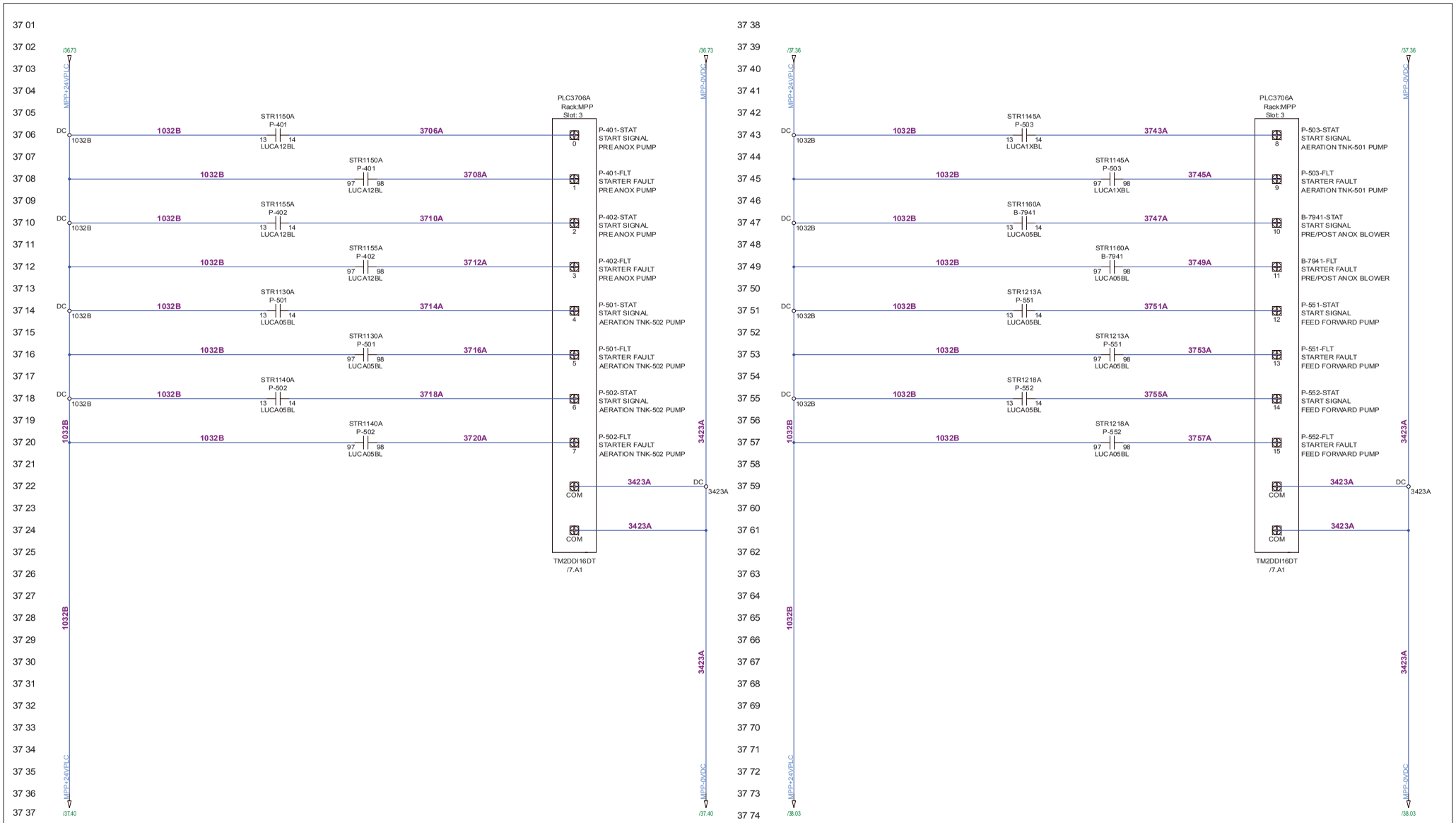

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP DISCRETE INPUTS
SHEET 2 OF 2
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	37	71

1704432 - AGNICO EAGLE MINE - C

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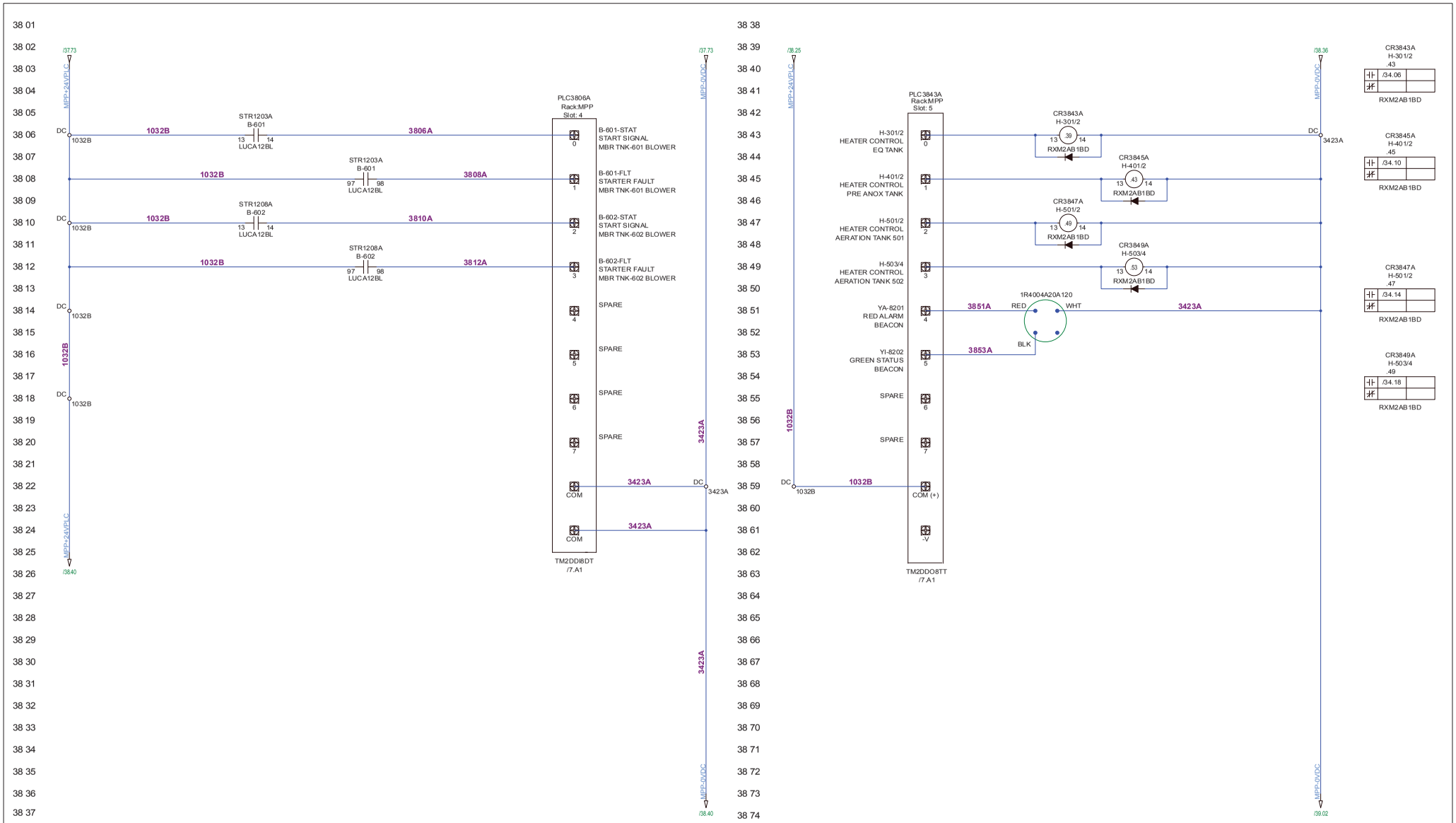

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP DISCRETE INPUTS & OUTPUTS MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	38	71

1704432 - AGNICO EAGLE MINE - C

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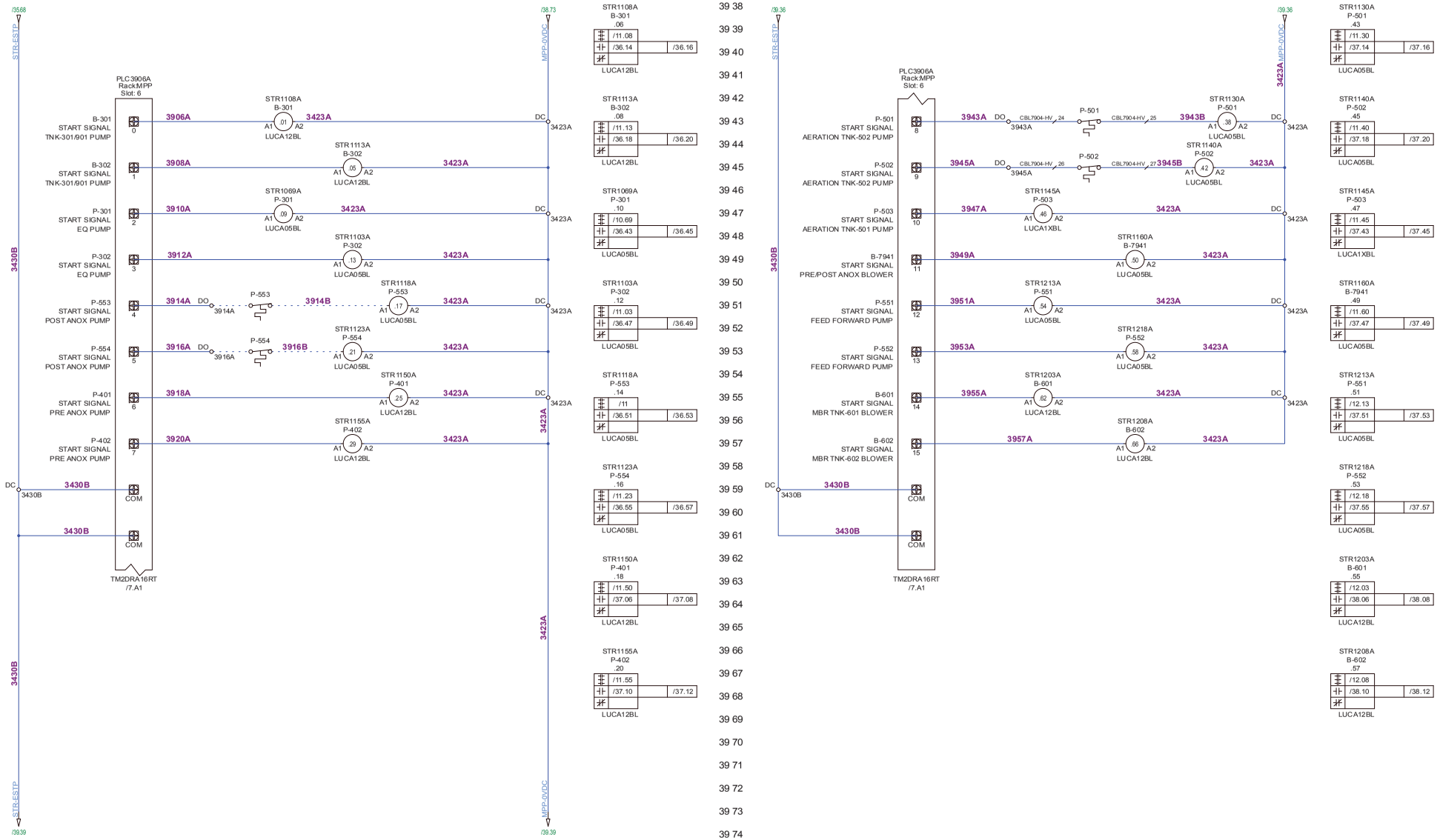

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP RELAY OUTPUTS

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	39	71

1704432 - AGNICO EAGLE MINE - C

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INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP SPARE SHEET

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	40	71

1704432 - AGNICO EAGLE MINE - C

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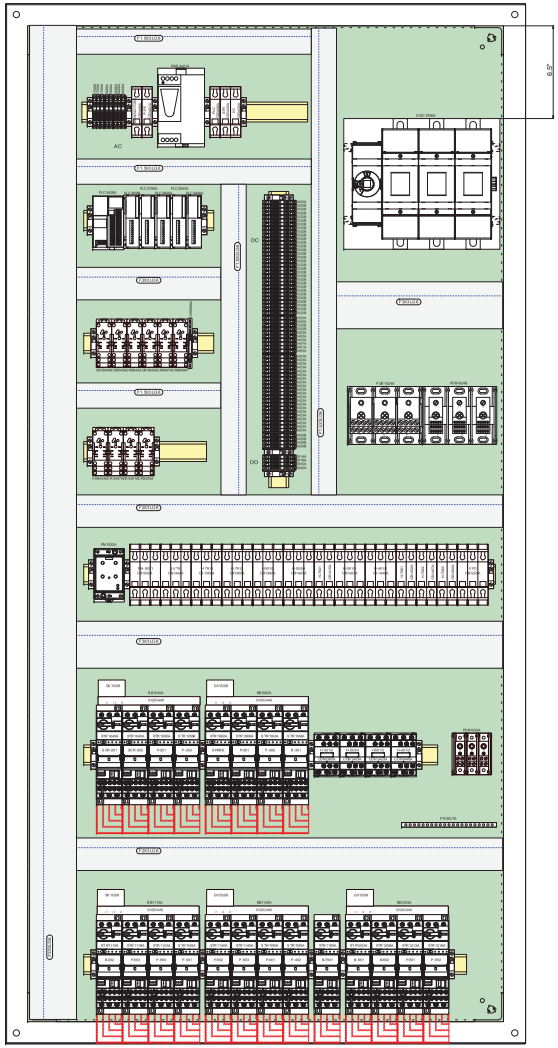
PANEL OUTER DOOR



MPP
EN4SD723612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	41	71

1704432 - AGNICO EAGLE MINE - C

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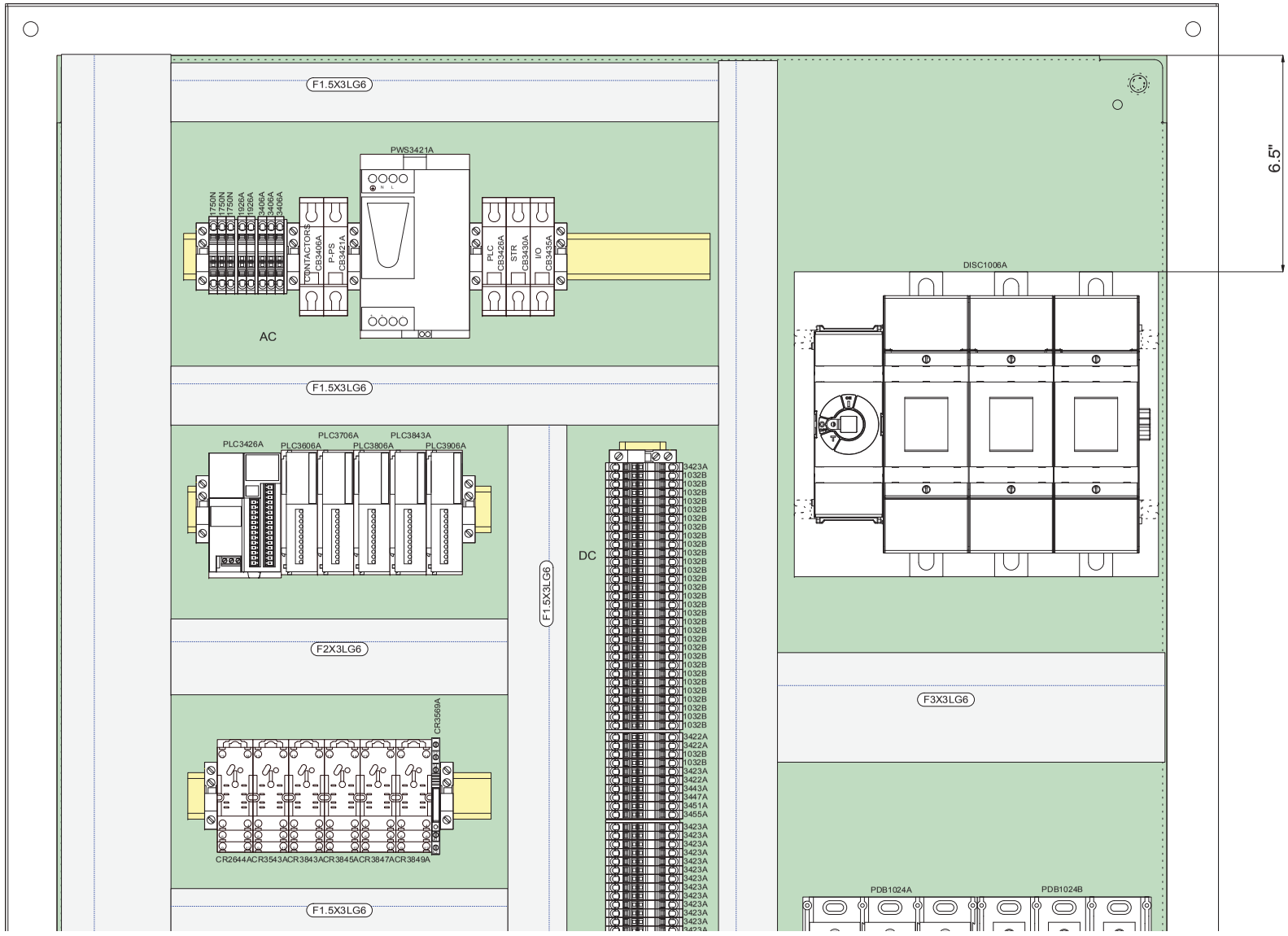

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP PANEL LAYOUT
TOP
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	42	71

1704432 - AGNICO EAGLE MINE - C

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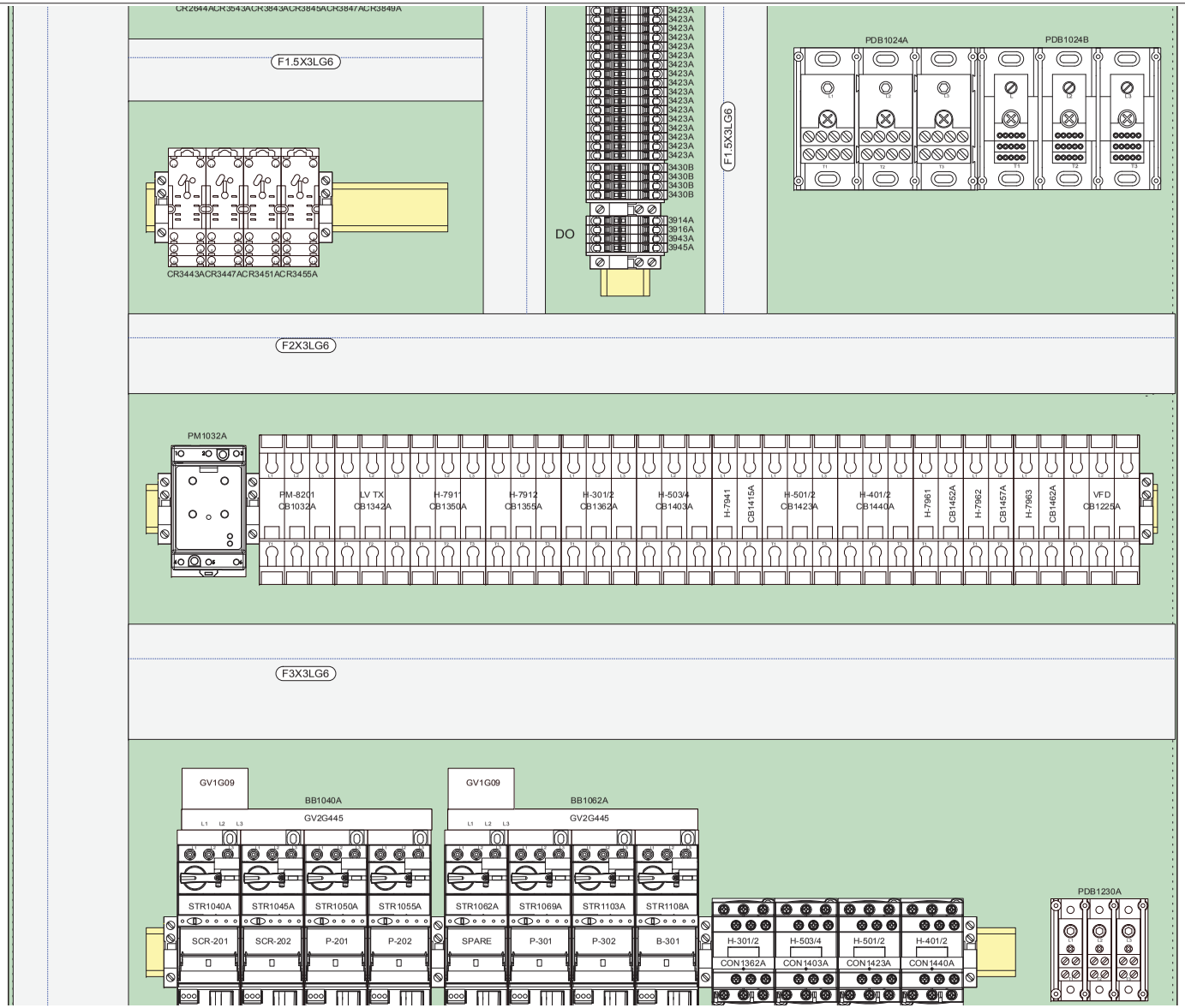

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT MIDDLE MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	43	71

1704432 - AGNICO EAGLE MINE - C

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MPP
EN4SD723612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT BOTTOM MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	44	71

1704432 - AGNICO EAGLE MINE - C

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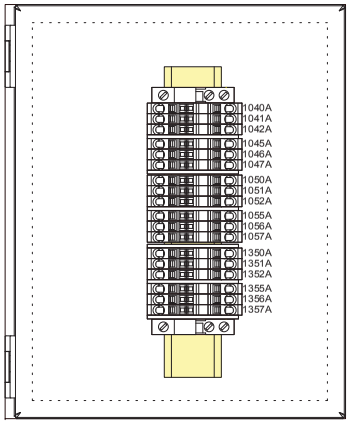
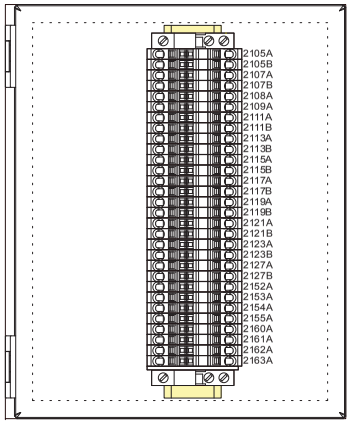


JB-7901-HV
EJ1084



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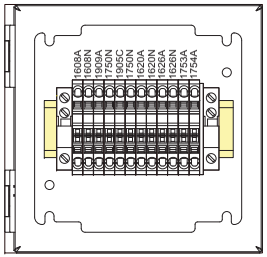

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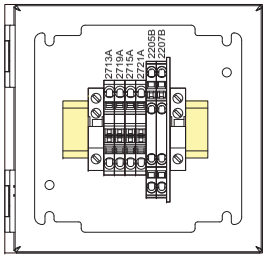

JB-7901-DC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7901'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	45	71

1704432 - AGNICO EAGLE MINE - C

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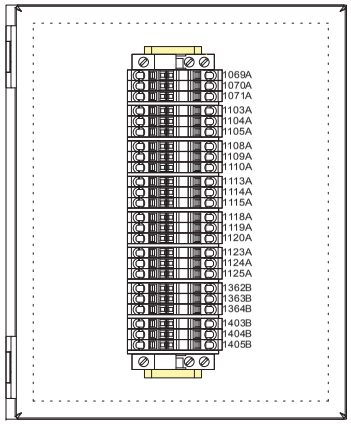
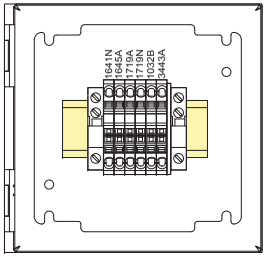
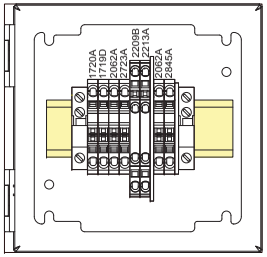


JB-7902-HV
EJ1084



JB-7902-AC
EJ664



JB-7902-DC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7902'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	46	71

1704432 - AGNICO EAGLE MINE - C

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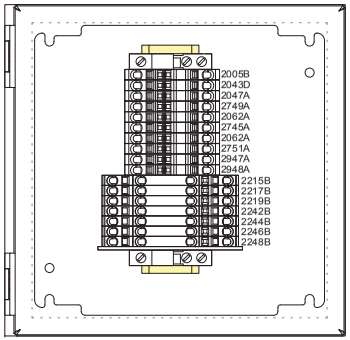
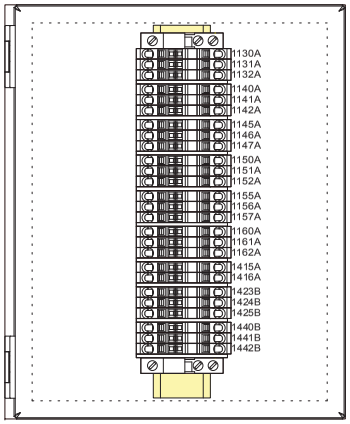
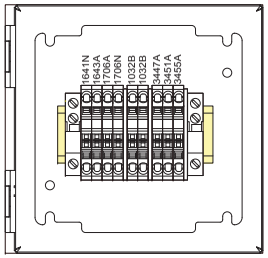


JB-7904-DC
EJ884



JB-7904-HV
EJ1084



JB-7904-AC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7904'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	47	71

1704432 - AGNICO EAGLE MINE - C

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MPP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37557	2QPL	Pad Lockable Qurater Turn Latch	Hammond	MPP
1	18396	460	190-480V, 3PH Power/Phase Monitor	Symcom	PM1032A
25	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB1, TB5, TB13, TB14, TB15, TB17, TB19, TB20, TB21, TB22, TB23, TB24,
					TB25, TB26, TB27, TB28, TB31, TB34, TB38, TB39, TB40, TB41, TB42, TB43,
					TB44
8	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1, TS5, TS6, TS7, TS8, TS9, TS10, TS11
1	23751	2966171	Relay, SPDT, 24VDC Coil	Phoenix Contact	CR3569A
7	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB16, TB30, TB32, TB33, TB35, TB36, TB37
69	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3), DC(66)
5	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(5)
1	35707	ABL8REM24050	24VDC Power Supply, 120W, 5A	Schneider Electric	PWS3421A
3	12404	AJT250	Fuse,GLD AJT250250A 600V Time Delay, Class J	Ferraz Shawmut	DISC1006A(3)
1	24694	Arc Flash	Panel Label - Arc Flash Tri-lingual	Panel	8.11D
5	27397	C1.5LG6	Wire Duct Cover, 1.5", Grey	Panduit	WD8, WD9, WD10, WD12, WD16
3	27399	C2LG6	Wire Duct Cover, 2", Grey	Panduit	WD7, WD13, WD15
3	27405	C3LG6	Wire Duct Cover, 3", Grey	Panduit	WD1, WD4, WD11
1	38090	EN4SD723612GY	72" x 36" x 12" NEMA4 Steel Enclosure	Hammond	MPP
1	38041	EP7236	72" x 36" Backplate	Hammond	MPP
1	37558	EZPMFHD	Mounting Feet, Zinc, Set of 4	Hammond	MPP
5	27396	F1.5X3LG6	Wire Duct, 1.5"x3", Grey, Narrow Finger	Panduit	WD8, WD9, WD10, WD12, WD16
3	27398	F2X3LG6	Wire Duct, 2"x3", Grey, Narrow Finger	Panduit	WD7, WD13, WD15
3	27404	F3X3LG6	Wire Duct, 3"x3", Grey, Narrow Finger	Panduit	WD1, WD4, WD11
1	27929	GS1AW503	Terminal Lug, 2@#2AWG-600MCM, for use in 400A,600A,800A	Schneider Electric	DISC1006A
1	27712	GS2AE2	Shaft for Rotary Thru Door Handle	Schneider Electric	DISC1905
1	27713	GS2AH140	Through Door Rotary Handle	Schneider Electric	DISC1905
1	27928	GS2AP53	Terminal Shroud Kit 400A	Schneider Electric	DISC1006A
1	27927	GS2QU3N	Internal Fusible switch, 400A, Class J	Schneider Electric	DISC1006A
6	17158	GV1G09	Combination Starter, Busbar Top Mount	Schneider Electric	BB1040A, BB1062A, BB1113A, BB1140A, BB1203A, STR1160A
5	22546	GV2G445	Busbar 4 TeSysU Starters, #6AWG 63A MAX	Schneider Electric	BB1040A, BB1062A, BB1113A, BB1140A, BB1203A
4	10254	LC1D18G7	Contactor (TeSys D) Non-Reversing, 18A(AC3) 125A(AC1), 3-Pole (3 NO)	Schneider Electric	CON1362A, CON1403A, CON1423A, CON1440A
15	37367	LU9BN11C	TeSysU Prewired Coil Connection, Front Connection	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1069A, STR1103A, STR1108A,
					STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A, STR1203A,
					STR1208A

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP BILL OF MATERIAL
MODULE 8201 - SHEET 1 OF 2

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	31/05/17	48	71

1704432 - AGNICO EAGLE MINE - C

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MPP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
21	19269	LUA1C20	Combination Starter, 1NO Ready, 1NO Fault Aux. Contact Module	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1062A, STR1069A, STR1103A,
					STR1108A, STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A,
					STR1150A, STR1155A, STR1160A, STR1203A, STR1208A, STR1213A, STR1218A
21	19264	LUB12	Combination Starter, 12A Power Base, 3/7.5/10HP	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1062A, STR1069A, STR1103A,
					STR1108A, STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A,
					STR1150A, STR1155A, STR1160A, STR1203A, STR1208A, STR1213A, STR1218A
4	19503	LUCA1XBL	Combination Starter, TeSysU Standard Control Unit 0.35-1.4A, 24VDC coil	Schneider Electric	STR1040A, STR1045A, STR1062A, STR1145A
11	21191	LUCA05BL	Combination Starter, TeSysU Standard Control Unit 1.25-5.0A, 24V/60mA DC coil	Schneider Electric	STR1050A, STR1055A, STR1069A, STR1103A, STR1108A, STR1113A, STR1130A,
					STR1140A, STR1160A, STR1213A, STR1218A
6	22706	LUCA12BL	Combination Starter, TeSysU Standard Control Unit 3-12A, 24V/60mA DC coil	Schneider Electric	STR1118A, STR1123A, STR1150A, STR1155A, STR1203A, STR1208A
4	38092	M9F42215	Breaker, Multi9, 480/277V 15 AMP 2P C Trip Curve, 10k SCCR	Schneider Electric	CB1415A, CB1452A, CB1457A, CB1462A
2	38069	M9F42315	Breaker, Multi9 480/277V 15 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1032A, CB1342A
5	38070	M9F42320	Breaker, Multi9 480/277V 20 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1350A, CB1362A, CB1403A, CB1423A, CB1440A
1	38071	M9F42330	Breaker, Multi9 480/277V 30 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1355A
2	38136	MG24425	Breaker, 240V 1 AMP 1P C	Schneider Electric	CB3406A, CB3426A
1	38137	MG24426	Breaker, 240V 2 AMP 1P C	Schneider Electric	CB3435A
1	38138	MG24427	Breaker, 240V 3 AMP 1P C	Schneider Electric	CB3421A
1	38139	MG24428	Breaker, 240V 4 AMP 1P C	Schneider Electric	CB3430A
2	26722	MPDB67113	Power Block, 175A 1Pri 12Sec Aluminum, 2/0-#14Pri #10-14Sec	MERSEN	PDB1024A, PDB1024B
6	26741	MPDBC6667	Power Block, MPDBC6667 safety cover,	MERSEN	PDB1024A(3), PDB1024B(3)
1	36638	NT-CV-12	Panel Label - newterra Decal	Panel	8.11E
1	36639	NT-PS	Panel Label - newterra Sticker	Panel	8.11F
1	36316	OTB1E0DM9LP	OTB RIO Adapter, Ethernet	Schneider Electric	PLC3426A
1	10586	PK18GTA	NQ Panelboard Ground Bus	Schneider Electric	GB1
10	22324	RXM2AB1BD	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC	Schneider Electric	CR3443A, CR3447A, CR3451A, CR3455A, CR3541A, CR3543A, CR3843A, CR3845A,
					CR3847A, CR3849A
10	22326	RXZE2S108M	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays	Schneider Electric	CR3443A, CR3447A, CR3451A, CR3455A, CR3541A, CR3543A, CR3843A, CR3845A,
					CR3847A, CR3849A
1	36317	TM2DDI8DT	TM2 8 point DI Expansion Module	Schneider Electric	PLC3806A
2	37596	TM2DDI16DT	TM2 16 point DI Expansion Module	Schneider Electric	PLC3606A, PLC3706A
1	38119	TM2DDO8TT	TM2 8 point DO Expansion Module, Removable Terminal Blocks	Schneider Electric	PLC3843A
1	38209	TM2DRA16RT	TM2 16RO Expansion Module	Schneider Electric	PLC3906A

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PROJ. NO: 1704432

TITLE AND LOCATION: MPP BILL OF MATERIAL MODULE 8201 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	31/05/17	49	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37557	2QPL	Pad Lockable Qurater Turn Latch	Hammond	MCP
1	26829	8GB_Micro	8GB Micro USB Key	Generic	OIT2008A
1	26511	17-200161	USB TypeA F-F Bulkhead Connector	Conec	USB71A
1	20698	20698	Mounting Bracket, Antenna & Surge Protector		ENET2011A
27	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB2, TB3, TB4, TB5, TB6, TB10, TB11, TB12, TB13, TB14, TB15, TB16, TB37,
					TB38, TB39, TB42, TB43, TB44, TB45, TB46, TB47, TB52, TB54, TB57, TB58,
					TB59, TB65
6	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1, TS2, TS3, TS8, TS9, TS10
17	23751	2966171	Relay, SPDT, 24VDC Coil	Phoenix Contact	CR2507A, CR2509A, CR2511A, CR2517A, CR2519A, CR2521A, CR2548A, CR2550A,
					CR2552A, CR2554A, CR2607A, CR2609A, CR2611A, CR2613A, CR2615A, CR2617A,
					CR2619A
14	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB29, TB31, TB33, TB34, TB49, TB50, TB55, TB56, TB60, TB61, TB62, TB63,
					TB64, TB66
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB48
10	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(6), AO(4)
83	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	AI(44), AO(8), DC(26), DO-P(5)
48	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DI(48)
15	29545	3036369	Fused Terminal, 28-10AWG, 6.3A, 500V	Phoenix Contact	AI(14), AO
8	23741	3037148	Terminal, Yellow, 28-12AWG, 30A, 600V	Phoenix Contact	TB1(8)
15	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(15)
2	35707	ABL8REM24050	24VDC Power Supply, 120W, 5A	Schneider Electric	PWS2004A, PWS2015A
1	24694	Arc Flash	Panel Label - Arc Flash Tri-lingual	Panel	8.11C
2	27402	C1LG6	Wire Duct Cover, 1", Grey	Panduit	WD2, WD11
6	27399	C2LG6	Wire Duct Cover, 2", Grey	Panduit	WD1, WD3, WD8, WD9, WD10, WD12
1	27949	C5E-STPRD-S3	Red Industrial Ethernet Cable, RJ45, 3ft, STP	Canada Computer	CBL5
2	27950	C5E-STPRD-S7	Industrial Ethernet Cable, RJ45, 7ft, STP	Canada Computer	CBL1, CBL3
1	27951	C5E-STPRD-S10	Industrial Ethernet Cable, RJ45, 10ft, STP	Canada Computer	CBL2
1	27953	C5E-STPRD-S25	Industrial Ethernet Cable, RJ45, 25ft, STP	Canada Computer	CBL6
4	12475	D1031Q	4Ch Discrete, Transistor Output, Intrinsically Safe Barrier	GM International	IS2020A, IS2024A, IS2028A, IS2032A
1	24602	E100502	Industrial RJ45 Jack	Belden	ETH71A
1	29140	EC6133D	eWON Cosy 131 LAN/Cell Router, 24VDC Power	eWON	ENET2011A
1	37906	EN4SD483612GY	48" x 36" x 12" NEMA4 Steel Enclosure	Hammond	MCP
1	37907	EP4836	48" x 36" Backplate	Hammond	MCP

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PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 1 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	50	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37558	EZPMFHD	Mounting Feet, Zinc, Set of 4	Hammond	MCP
2	27400	F1X3LG6	Wire Duct, 1"x3", Grey, Narrow Finger	Panduit	WD2, WD11
6	27398	F2X3LG6	Wire Duct, 2"x3", Grey, Narrow Finger	Panduit	WD1, WD3, WD8, WD9, WD10, WD12
14	20369	GSB1/10	Fuse,GLD GSB1/10100mA 250V Fast Acting, Miniature 5x20mm	Ferraz Shawmut	AI(14)
1	36555	GSB16/100	Fuse, 160mA 250V Fast Acting, Miniature 5x20mm	Ferraz Shawmut	AO
1	20569	GW195-180-SM-NM	Cellular Modem Antenna Cable - 15Ft. N-Male to SMA-Male	Airlink_Communications	ENET2011A
1	36126	HMIDT542	Touchscreen, 10.4" TOUCH SMART DISPLAY	Schneider Electric	OIT2008A
1	36124	HMIG3U	HMI Linux Processor, for use with HMIDT smart displays	Schneider Electric	OIT2008A
1	26892	IS Wiring Inside	Panel Label - IS Wiring Inside	Panel	8.11A
4	38136	MG24425	Breaker, 240V 1 AMP 1P C	Schneider Electric	CB1905C, CB1909A, CB2020A, CB2043A
2	38137	MG24426	Breaker, 240V 2 AMP 1P C	Schneider Electric	CB2057A, CB2062A
5	38138	MG24427	Breaker, 240V 3 AMP 1P C	Schneider Electric	CB1905A, CB2004A, CB2008A, CB2015A, CB2053A
2	38139	MG24428	Breaker, 240V 4 AMP 1P C	Schneider Electric	CB1926A, CB2011A
1	36639	NT-PS	Panel Label - newterra Sticker	Panel	8.11D
1	10586	PK18GTA	NQ Panelboard Ground Bus	Schneider Electric	GB1
1	23504	PSD1001	4Ch Power Supply, 15V - 20mA	GM International	IS2036A
1	11482	QOU1PA	Breaker Lock for 1 pole QOU breakers	Schneider Electric	CB1905B
1	10270	QOU115	Breaker, SQD QOU115 1240V 15A 1P DIN Mount, 10k SCCR	Schneider Electric	CB1905B
5	22324	RXM2AB1BD	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC	Schneider Electric	CR2127A, CR2513A, CR2515A, CR2556A, CR2621A
2	21888	RXM4AB1BD	Relay, SQT RXM4AB1BD, Miniature Relay, 4PDT, 24 VDC, 6A contacts	Schneider Electric	CR2050A, CR2558A
1	21887	RXM4AB1F7	Relay, SQT RXM4AB1F7, Miniature Relay, 4PDT, 120VAC, 6A contacts	Schneider Electric	CR2047A
5	22326	RXZE2S108M	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays	Schneider Electric	CR2127A, CR2513A, CR2515A, CR2556A, CR2621A
3	21889	RXZE2S114M	Relay, SQT RXZE2S114M, Base/Socket for RXM4 4P Relays	Schneider Electric	CR2047A, CR2050A, CR2558A
1	26891	Substitution of IS	Panel Label - Substitution of IS Components	Panel	8.11B
1	36089	TM3AI4G	TM3 4-channel AI Expansion Module	Schneider Electric	PLC2807A
1	36090	TM3AI8G	TM3 8-channel AI Expansion Module	Schneider Electric	PLC2707A
1	36543	TM3AQ4G	TM3 4-channel AO Expansion Module	Schneider Electric	PLC2906A
4	36087	TM3DI16G	TM3 16DI Expansion Module	Schneider Electric	PLC2105A, PLC2205A, PLC2305A, PLC2405A
2	36088	TM3DQ16TG	TM3 16DO Expansion Module	Schneider Electric	PLC2507A, PLC2607A
1	36558	TM3XREC1	TME Bus Receiver Module	Schneider Electric	PLC2057A
1	36557	TM3XTRA1	TME Bus Transmitter Module	Schneider Electric	PLC2060A
1	28484	TM251MESE	M251 Controller, Dual Ethernet	Schneider Electric	PLC2053A
1	24550	USB_A-A	6ft, USB MaleA/MaleA	Generic	CBL4

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PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 2 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	51	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	25880	WMLPVDB800	Cellular Modem Antenna, N-Female, White	Airlink_Communications	ENET2011A
1	21650	XB7EV03BP	Button, XB7EV03GP, GREEN LED PILOT LIGHT 24VDC	Schneider Electric	LT2544A
1	21649	XB7EV04BP	Button, XB7EV03GP, RED LED PILOT LIGHT 24VDC	Schneider Electric	LT2546A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2043A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2043A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2043A

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PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 3 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	52	71

1704432 - AGNICO EAGLE MINE - C

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JB-7901-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB1, TB3
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB2
3	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3)
3	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-AC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-AC BILL OF MATERIAL MODULE 8203 - SHEET 1 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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1704432 - AGNICO EAGLE MINE - C

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JB-7901-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB4, TB5
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS2
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB1
4	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(4)
2	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-DC

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-DC BILL OF MATERIAL MODULE 8203 - SHEET 2 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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1704432 - AGNICO EAGLE MINE - C

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JB-7901-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB4, TB11
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS2
7	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB1, TB5, TB6, TB7, TB8, TB9, TB10
21	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(21)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-HV BILL OF MATERIAL MODULE 8203 - SHEET 3 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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1704432 - AGNICO EAGLE MINE - C

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JB-7901-IS - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB12, TB14
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS3
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB13
30	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	IS(30)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-IS

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-IS BILL OF MATERIAL
MODULE 8203 - SHEET 4 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	56	71

1704432 - AGNICO EAGLE MINE - C

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JB-7901OS-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB5, TB8
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS3
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB7
2	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
2	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901OS-AC

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901OS-AC BILL OF MATERIAL
MODULE 8203 - SHEET 5 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	57	71

1704432 - AGNICO EAGLE MINE - C

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JB-7902-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB6, TB10
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS4
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB9
4	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(4)
2	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-AC

NOTES:

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-AC BILL OF MATERIAL
MODULE 8203 - SHEET 6 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	58	71

1704432 - AGNICO EAGLE MINE - C

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JB-7902-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB11, TB13
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS5
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB12
4	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(4)
3	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(3)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-DC

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-DC BILL OF MATERIAL
MODULE 8203 - SHEET 7 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	59	71

1704432 - AGNICO EAGLE MINE - C

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JB-7902-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB15, TB17
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS4
8	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB16, TB18, TB19, TB20, TB21, TB22, TB23, TB24
24	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(24)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-HV BILL OF MATERIAL MODULE 8203 - SHEET 8 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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DMB	30/05/17	60	71

1704432 - AGNICO EAGLE MINE - C

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JB-7904-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB14, TB15
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS6
3	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB11, TB16, TB17
2	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
7	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(7)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-AC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7904-AC BILL OF MATERIAL MODULE 8203 - SHEET 9 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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DMB	30/05/17	61	71

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JB-7904-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB18, TB20
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS5
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB19
14	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(14)
7	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(7)
1	38221	EJ884	8" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-DC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7904-DC BILL OF MATERIAL
MODULE 8203 - SHEET 10 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	62	71

1704432 - AGNICO EAGLE MINE - C

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JB-7904-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB21, TB23
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS6
9	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB22, TB24, TB25, TB26, TB27, TB28, TB29, TB30, TB31
26	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(26)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7904-HV BILL OF MATERIAL MODULE 8203 - SHEET 11 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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1704432 - AGNICO EAGLE MINE - C

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BLD-7901 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	19534	KIL SWB1	1/2" Dead End Box	Killark	TGS1608A
1	19533	KILXS-1C	NEMA7, 1P, 20A Switch	Killark	TGS1608A
4	18642	VUXGG1100PX	100W Incandescent, Medium Base, CL1Div2	Killark	LT1608A, LT1610A, LT1612A, LT1614A
1	22112	XEDS-30	Unfused Disconnect, CL1Div1&2, 30A, 20HP@480V	Killark	DISC1355A
6	26831	XSX-23	Unfused Disconnect, CL1Div1&2, 20A, 10HP@600V	Killark	DISC1040A, DISC1045A, DISC1050A, DISC1055A, DISC1062A, DISC1350A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2127A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2127A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2127A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7901 BILL OF MATERIAL
MODULE 8901 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	64	71

1704432 - AGNICO EAGLE MINE - C

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BLD-7901_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	36085	GFWR1-W	GFCI 15A, 125V Duplex Receptacle, Weather Resistant, White	Leviton	RECP1620A, RECP1626A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7901 BILL OF MATERIAL
MODULE 8901 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	65	71

1704432 - AGNICO EAGLE MINE - C

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BLD-7902 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1069A, DISC1103A, DISC1108A, DISC1113A, DISC1118A, DISC1123A,
					DISC1362A, DISC1403A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7902 BILL OF MATERIAL MODULE 8902

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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BLD-7904 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	23293	20RC15/10	Receptacle Cover, PVC Single Cover		RECP1714A
1	23789	CR15	15A, 125V Duplex Receptacle, Commercial Grade	Hubbell	RECP1706A
1	12567	CS115CN	1P Switch, 15A, 120V, Commercial	Leviton	TGS1662A
1	22672	FSC10	PVC FSC Box, 1 Gang	Royal Pipe Systems	TGS1662A
1	23791	HBL5251	15A, 125V, Single Receptacle, Heavy Duty	Hubbell	RECP1714A
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1130A, DISC1140A, DISC1145A, DISC1150A, DISC1155A, DISC1160A,
					DISC1415A, DISC1423A
1	26171	RTSC15/10	PVC Switch Cover, 1 Gang	Royal Pipe Systems	TGS1662A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2047A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2047A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2047A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7904 BILL OF MATERIAL MODULE 8904 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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BLD-7904_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	38204	WL-LED26-B-5K-BRZ-PC	Wall Pack, 24W LED c/w PhotoEye	RAB Design	LT1665A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7904 BILL OF MATERIAL
MODULE 8904 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	68	71

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BLD-7905 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1440A

BLD-7906 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	23293	20RC15/10	Receptacle Cover, PVC Single Cover		RECP1742A
2	12567	CS115CN	1P Switch, 15A, 120V, Commercial	Leviton	TGS1643A, TGS1649A
2	38093	FC202P1K5	Variable Frequency Drive, Danfoss FC202 P1K5, VFD 480V 2HP, 3.4A 3PH, IP55, w/ L	Danfoss	VFD1304A, VFD1322A
2	38094	FC202P11K	Variable Frequency Drive, Danfoss FC202 P11K, VFD 480V 15HP, 21A 3PH, IP55, w/ L	Danfoss	VFD1241A, VFD1259A
2	22672	FSC10	PVC FSC Box, 1 Gang	Royal Pipe Systems	TGS1643A, TGS1649A
4	38205	FW4-LED40-B-4K-DIM	Flourescent Light, Vaportight 4Ft, LED 40W, 120-277V	RAB Design	LT1643A, LT1645A, LT1647A, LT1649A
1	10185	GFNT1-W	GFCI 15A, 125V Duplex Receptacle, White	Leviton	RECP1633A
1	23791	HBL5251	15A, 125V, Single Receptacle, Heavy Duty	Hubbell	RECP1742A
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1203A, DISC1208A, DISC1213A, DISC1218A, DISC1342A, DISC1452A,
					DISC1457A, DISC1462A
1	20775	MH32	18 Circuit NQ Tub, NEMA1	Schneider Electric	PDP1606A
1	20814	NC26S	18 Circuit NQ/NF Trim	Schneider Electric	PDP1606A
1	20896	NQ418L1C	Distribution Panel, 120/240V, 3Ph, 100A Cu Bus, 18 Circuit	Schneider Electric	PDP1606A
11	19029	QOB115	Breaker, SQD QOB115 120V 15A Bolt On, 10k SCCR	Schneider Electric	CB1608A, CB1620A, CB1626A, CB1633A, CB1643A, CB1668A, CB1706A, CB1719A,
					CB1729A, CB1742A, CB1748A
1	19340	PK12GTA	NQ Panelboard Ground Bus	Schneider Electric	PDP1606A
2	26171	RTSC15/10	PVC Switch Cover, 1 Gang	Royal Pipe Systems	TGS1643A, TGS1645A
1	25526	UC3010P480	Dist. Transformer, 10kVA, 480V:120/208V	BeMag	T1342A
1	38182	Y225PKC	Autotransformer, 225kVA, 600V:480, 480:380V, 50/60Hz	Hammond	T1015A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7906 BILL OF MATERIAL
MODULE 8906 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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DMB	30/05/17	70	71

1704432 - AGNICO EAGLE MINE - C

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BLD-7906_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	36085	GFWR1-W	GFCI 15A, 125V Duplex Receptacle, Weather Resistant, White	Leviton	RECP1729A
1	38204	WL-LED26-B-5K-BRZ-PC	Wall Pack, 24W LED c/w PhotoEye	RAB Design	LT1657A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7906 BILL OF MATERIAL
MODULE 8906 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	71	71

1704432 - AGNICO EAGLE MINE - C

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APPENDIX B

Packing Slip

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Project Packing List

PMProjNum **1704432**

Agnico Eagle - Amaruq Mine WWTP

Shipping Notes:

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
0	24612	Container, 40' x 8' x 9'6", Once Use, High Cu	1	---
7901	ea	30,480kg rated, Forklift Pockets, CSC Plate,	1	
	Type: I	ABS/BV/LR Certs. Steel Checkerplate ---	1704432-0001	1
10	10959	Junction Box, PVC, 6" x 6" x 4"	5	Added by production team
	ea		5	
	Type: I	Junction Box, PVC, 6" x 6" x 4"	1704432-9999	###
10	37975	Junction Box, 6" x 6" x 4", Hammond EJ664	1	Added by production team
	ea	with Back Panel and Hinged Lid, NEMA 4	1	
	Type: I	Junction Box, 6" x 6" x 4", Hammond EJ664	1704432-9999	###
10	P1128	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1	Added by production team
	ea		1	
	Type: I	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1704432-9999	####
10	37795	Sealant, MetalSafe, Liquid Rubber, Black 3.7	6	---
-	ea		6	
	Type: P	---	1704432-0134	1
10	37796	Sealant, Polyurethane, Self Leveling, Grey 8	8	---
-	ea		8	
	Type: P	---	1704432-0131	1
10	29551	Insulation, Backer Rod, 7/8" x 15'	10	---
-	ea		10	
	Type: P	---	1704432-0131	2
10	37794	Insulation, Backer Rod, 3/8" x 30'	10	---
-	ea		10	
	Type: P	---	1704432-0131	3
10	22772	Foam, Spray, Tiger Foam, 200BF, Fast Rise	2	---
-	ea		2	
	Type: P	---	1704432-0131	4
10	21768	Chemical, Bacteria, Dry for Start Up, 25lbs p	5	---
-	pail	25 lb per pail (Buy in Pail Quantities)	5	
	Type: I	BI-CHEM CWT Blend CAN product BioRem ---	1704432-0143	1
10	37797	Tape, Seam, 4" x 50', Paintable	1	---
4	ea		1	
	Type: P	---	1704432-0134	2

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
15	27536	Weather Barrier, Blueskin, 9" x 50' Roll	4	---
-	ea		0	
	Type: P	---		0
15	38671	3/4" copper pipe insulation foam 6' long	20	---
-	ea		0	
	Type: P	---		0
15	38672	Insulation, rigid foam sheet, 3", R10, codebo	10	---
-	ea	Blue Styrefoam	0	
	Type: P	---		0
15	10088	Elbow, 90deg, PVC 40, 6", SxS, 406-060G	2	---
-	ea		0	
	Type: I	---	1704432-0170	1
15	16240	Pipe, PVC 40 (Clear), 6"	4	---
-	ft	10ft Length, 40-060CL	0	
	Type: X	---		0
15	P1188	Flexible Coupling, 6" x 6"	4	---
-	ea		0	
	Type: I	---	1704432-0170	2
15	9998	Misc Part, Parts not included in purchasing	6	---
-	ea		0	
	Type: P	Aeration connection pipes 3 - Pre to Air 3 - Air to air		0
15	9998	Misc Part, Parts not included in purchasing	4	---
-	ea		0	
	Type: P	vent stack		0
15	9998	Misc Part, Parts not included in purchasing	2	---
-	ea		0	
	Type: P	MBR Overflow Pipes		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7902	ea		0	
	Type: P	container 7902		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7903	ea		0	
	Type: P	Container 7903		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7904	ea		0	
	Type: P	Container 7904		0

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
15	9998	Misc Part, Parts not included in purchasing	1	---
7905	ea		0	
	Type: P	Container 7905		0
100	P1128	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1	Added by production team
	ea		1	
	Type: I	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1704432-9999	###
500	10951	Elbow, 45deg, PVC 40, 6", SxS, 417-060G	1	---
-	ea		1	
	Type: I	---	1704432-0089	22
500	M1489	Filter, Silencer, Solberg, FS-230P-300	2	---
B501/2	ea	3"	2	
	Type: P	---	1704432-0091	1
500	36870	Transmitter, pH, Prominent pH Sensor PHER	1	MBR
PH-501	ea	requires probe holder p/n 36871	1	
	Type: P	-	1704432-0071	4
6100	15871	Spill Containment, Single Drum, Eagle 1633	3	---
-	ea		3	
	Type: P	---	1704432-0161	1
6100	19891	Pump, Metering, Misc	1	---
P-610X	ea	See Description for part details	1	
	Type: P	- BT4B0708PVT2000UD010A01 Flow: 1.88GPH / 7.10L/H Pressure: 102PSI / 07BAR Options Included: - dosing head material PV PVDF - sealmaterial T st.diaphragm w. PTFE seal - execution of dosing head 2 w. Bleed.v. , w/o. valvespr. - hydraulic-connection 0 standard-connection - execution 0 Hous.RAL5003/hoodRAL2003 - Logo 0 w. PM-Logo - type of voltage U universal 100-240 V - cable and plug D 2m USA 115 V - relay function 0 without relay - supplies 1 STDR. FV,IV,TB for PP, PV, NP - control system type 0 without lock - control version A external analog 0-20mA/4-20mA - Remote stop 0 Pause break con., Niv. break - auxiliar frequency 1 external callable frequency	1704432-0162	1
6100	25823	Pump, Metering, Parts, Multi-function Valve	3	---
p-610x	ea	PVDF, 87PSIG Size 2	3	
	Type: P	740427 ---	1704432-0162	2

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
7906	20890	Container, Misc	1	---
7906	ea	See description	1	
	Type: P	53 foot Hi Cube Strong Industrial Steel Used Shipping Container As-is Where-is	1704432-0027	1
7906	24305	Hood, Louver, 21"	1	---
7906	ea	Fits 18" Louver	1	
	Type: I	---	1704432-0049	84
7906	24547	Hood, Fan, 15"	1	---
f7961	ea	Fits 12" Fan	1	
	Type: I	---	1704432-0049	83

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APPENDIX C

Testing Checklists/Pre-Commissioning Test Checklist

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Pre-Commissioning Checklist – 1704432

Please note that **newterra** has a limited number of Technicians. In order to successfully support your startup, **newterra** requires that the Pre-Commissioning Checklist be returned at least 10 business days prior to mobilizing a Technician to site (subject to Technician availability). **newterra** will not mobilize to site until the Pre-Commissioning Checklist has been executed and returned to service@newterra.com. Or by Fax to: 289.203.1319.

If newterra startup activities are delayed due to lack of site readiness then there may be additional charges associated with overtime and/ or additional days on site.

newterra highly recommends that the system is started by a factory trained startup technician to ensure the long term success of your project. We understand that this may not always be feasible in which case we would require a highly skilled technician capable of troubleshooting both mechanical and electrical aspects of a process treatment system and be familiar with our manual, equipment and capable of training the operator on operating and maintenance requirements of the treatment system.

The purpose of this report is to ensure that the customer is prepared for startup.

Checklist	Customer Initial	newterra Initial
Complete a visual inspection of all units when placed on the pad. **Record any damage to the systems that may have occurred during shipping and provide photos to newterra.		
Verify that system has been installed on a solid, level area		
Verify that system has been installed in accordance with the system layout drawing.		
Verify that the required approvals are in place to allow the system to discharge air and water.		
Verify site power is installed to the control panel and necessary electrical approvals have been completed.		
Verify that all high voltage wiring is completed and wired according to the Field Aid/ project O&M manual.		
Verify that all low voltage wiring is completed and wired according to the Field Aid/ project O&M manual.		
Verify that all process piping has been installed and terminated.		
Verify that all field piping is completed and wells are connected to the operating system.		
Verify that a phone line is installed and activated for alarm autodialer, if required.		
Please read through the packing list (located in the manual) and ensure the correct equipment was delivered.		
There are some items that have shipped loose with your system that will need to be installed prior to start up, these may include exterior components such as stacks, filters and hoods. Sufficient hardware should have been supplied to facilitate installation.		
Some unions in the system may have been loosened for shipment. This is done to prevent damaging susceptible equipment, especially flow meters. All unions in the systems should be checked and tightened.		

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Any external equipment such as tanks, well pumps, oxidizers, etc. need to be installed, plumbed and wired prior to start up.		
Some items may have been secured with brackets or tie downs for shipment – ensured these have been removed (eg. reciprocating compressors/ stacked blowers).		
In colder climates, if you do not plan on starting up the system before the winter months, please refer to your O&M manual for instructions on extended shutdowns. It is imperative that the correct measures be taken to prevent freezing water from damaging your system.		
If the system has been winterized, ensure all anti-freeze has been drained and disposed of in accordance with local regulations.		
Email pictures of power connection, site piping connections and installed equipment to service@newterra.com.		

MBR Specific Checks	**Customer Initial**	**newterra Initial**
Verify that Ethernet network is installed and activated if required.		
If Ethernet is to be used on site please provide 2 Static IP Addresses ____.____.____.____ ____.____.____.____		
Verify fresh water is available for Wet Test.		
Is waste activated sludge from an operating WWTP available for start-up (Seed Sludge)		
Verify Sufficient amount of sewage is available to start system (Check with newterra to determine actual amounts required).		

RO Specific Checks	**Customer Initial**	**newterra Initial**
Ensure all tanks are clean and free of dirt and debris		
Verify that a Fresh Water supply is installed to system.		
Ensure that the necessary chemicals for system operation and cleaning are available for use for starting the installation and commissioning phase.		
Verify the feed water quality		
Verify building process flow and instrumentation matches P&ID drawing. Check off drawing components against actual		
DO NOT LOAD THE MEMBRANES UNTIL DIRECTED as all system inlet piping must be flushed thoroughly before it is connected to the RO system.		

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DA Specific Checks	Customer Initial	newterra Initial
GENERAL INSTALLATION		
Stainless Steel nameplate present, visible and contains make and model information in agreement with vendor drawings		
Vessel Saddles Bolted To Structural Steel		
Vessel Properly Insulated for Personnel Protection at a minimum		
Access Platform Properly installed for full access to heater section		
Vessel Manway Gaskets appear to be undamaged		
VESSEL INTERNALS		
Heater Section Tray Assemblies Properly fastened and have been installed per the O & M manual.		
Equalizer connection to storage tank is unobstructed by any shipping materials		
Spray Nozzles appear unobstructed and undamaged by shipping		
PIPING		
Pipes properly insulated for Personnel protection at a minimum		
Relief valve installed and discharge piping run to roof		
Piping systems properly flushed		
Vent Valve is installed and fully open for initial vessel fill		
Steam Control Valve and Muffling plate installed as per drawings		
Low pressure steam trap isolated and discharge piped to flash separator		
Low pressure flash steam lines installed and isolated for initial testing		
Vacuum breaker installed per manufacturer's instructions		
Overflow trap installed with discharge piped to Blowdown Tank		
Condensate control valve installed and isolated for initial testing		
Strainer within condensate control valve station installed and cleaned		
Makeup control valve installed and isolated for initial testing		
Strainer within makeup control valve station installed and cleaned		
Level bridle and gauge glass column installed as per manufacturer's drawings. Vessel isolation valves closed for initial fill.		
Sight glass sections installed with proper washers and do not have any apparent cracks or defects.		
Level switches installed at proper heights relative to the vessel according to the manufacturer's drawings		
Level transmitter properly installed as per instrument installation detail IS-8308		
Pressure transmitter is properly installed as per instrument installation detail IS-8127		
Pressure and temperature Gauges installed with isolation valves as needed.		
Deaerator Steam flow transmitter properly installed as per instrumentation installation detail IS-8308		
Vessel Drain valve installed and fully closed for initial fill		

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Chemical feed connection valved and capped. Proper chemical feed is not required at this stage of commissioning		
All remaining spare connections on the storage tank and heater section should be tightly secured with a blind flange.		
CONTROL AND POWER WIRING		
120 volt power is run to Deaerator control panel		
Three Level switches are wired back to Deaerator Control Panel		
Pressure Transmitter is wired back to Deaerator Control Panel		
Level Transmitter is wired back to Deaerator Control Panel		
Steam Pressure Control Valve is wired back to Deaerator Control Panel		
Makeup Water Control Valve is wired back to Deaerator Control Panel		
Deaerator Steam flow transmitter is wired back to existing panel.		

Comments:
Note any deficiencies or damage to the system on arrival.

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In the event additional parts are required to be sent for commissioning, please provide a shipping address, contact name and cell number

_____

_____

_____

Provide a list of PPE required or any additional Health and Safety or training requirements that will be required for site access.

_____

_____

_____

_____

Site Address: _____

Onsite Contact Name & Cell Number: _____

Customer Sign-off: _____Date: _____

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Misc			
Confirm that all items have been received in accordance witht the packing list			
All items are undamaged. Any damages are to be reported to newterra as soon as possible.			
Inspect all exterior of containers and note any damages, Take pictures of any damages and report to the newterra project manager as sooon as possible.			
Inspect WWTP placement location and confirm that it is firm and level. It not report to the newterra project manager as soon as possible. WWTP needs to be firm and level otherwise the operation of the WWTP can be compromised.			
Containers may be placed in a on-site storage location until ready for placement. Containers should be placed and installed before freezing temperatures			
Civil			
Placement of container on site. 6 containers. After container placement, inspct for any damages and take pictures. Report damages to newterra project manager.		Lifting - crane equiv required to move container. Fine placement via forklifts or equiv. Firm/Level base for containers See Appendix A of this manual for container layout	
Install Liquid Rubber Container Seal as per attached drawing.			
Electrical			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Site power has been connected and verified as per system design criteria			
All internal electrical connections have been terminated			
Confirm Phase Monitor is not in alarm			
Site voltage measured:		L1/L2:	
		L2/L3:	
		L3/L1:	
		L1/GRD:	
		L2/GRD:	
		L3/GRD:	
Check field wiring and piping as per drawings at Appendix A of the O&M Manual			
Check panel for loose wiring, Correct as required			
Check voltage on AC transformer			
Check voltage on DC transformer			
Check I.S. barrier is grounded as per input drawing			
All customer wiring has been completed in accordance with the electrical drawing in Appendix A.			
Mechanical			
Connect all internal piping and hose connections between the containers and external piping hook ups as per P&ID at Appendix A.			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Inspect the EQ, Pre-Anox, Aeration and Post-Anox Tanks and install anodes. Confirm that the tanks are clean and diffusers & hose connecting are secure.			
Inspect MBR tanks and removing transportation securing straps. Ensuring all hoses and fittings are tight and connected.			
MBR tank - Ensure that the membranes have not moved or shifted in the cassette. Re-secure as necessary. Ensure that the diffusers have not shitfted and are secure. Re-secure as necessary.			
Inspect the screens (SCR-201/202) and ensure that the rotating brushes are still aligned. Adjust as necessary.			
Inspect TNK-101/102/103, TNK-201 & TNK-6101/6102 and ensure that they are clean and free of any debris.			
Ensure all unions and fittings are tight, as some are loosened to prevent stress in shipping			
Check alignment of motors, Correct as required			
Check all motor belt tensions, Correct as required			
Check alignment of pulleys for all belt driven blowers			
Install the permeate header to the membrane tank and connect all piping/hoses.			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Ensure that the backwash tank (TNK-801) and sludge tank (TNK-901) are clean and free of debris. Clean as necessary.			

Installation Acceptance Sign-Off Form

1704432 - Amaruq Mine WWTP

newterra is pleased to announce that the Installation phase of 1704432, has successfully been completed. In order to move to the Commissioning phase, a visual inspection and walkthrough of the plant will be required, followed by signoff of this document. Installation signoff will be conditional on the completion of items listed in a Punchlist created during this walkthrough.

	Installation Signoff		Customer Acceptance
Name:	_____	**Name:**	_____
Company:	_____	**Company:**	_____
Date:	_____	**Date:**	_____
Signature:	_____	**Signature:**	_____

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Ensure availability of on-site emergency eyewash station and personal protection equipment.			
Ensure that all tanks are clean and free of any dirt or debris (this is to prevent obstruction or damage to the piping, pumps, and membranes).			
Ensure that all connections have been provided and joints have been tightened.			
Check the placement of the air diffusers in the equalization tank(s) and aeration tank(s) if incorrectly positioned, proper adjustment has to be performed.			
Verify membrane modules are secure within the membrane tanks and that there is no lateral movement (less than an inch) of the membrane modules			
Verify building process flow and instrumentation matches P&ID drawing. Check off drawing components against actual (preferably with the customer present). Ensure this document is placed in the commissioning binder			

Commissioning Checklist

	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Measure and Verify influent characterisitics and record.			
Confirm that the custoomers piping and lectrical connections to the WWTP are complete			
Confirm if any grinder pumps are upstream of the WWTP. Advise the newterra project manager as soon as possible.			
Have all rotating equipment oiled and greased as per manufactured recommendations			
Fill system with water and check for leaks (liquid and vapor) by filling the EQ tank first and then process the water thru the system by tank			
Check rotation of all motors that were field wired			
Ensure that proper electrical grounding and lightning protection installed by customer			

Parameters	Unit	Influent*	Effluent
pH	s.u.	6 - 9	6.5 – 8.5
Fat, Oil, Grease (FOG)	mg/L	< 30	< 5
Biological Oxygen Demand (BOD)	mg/L	907.5	< 25
Total Suspended Solids (TSS)	mg/L	262.5	< 25
Total Kjeldahl Nitrogen (TKN)	mgN/L	130	-
Unionized Ammonia Nitrogen (NH_3-N)	mgN/L	-	< 1.25
Nitrate Nitrogen (NO_3-N)	mgN/L	-	< 5
Total Phosphorus (TP)	mgP/L	12	< 0.5
Fecal Coliform	CFU/100mL	-	< 200**
Total Residual Chlorine	mg/L	-	< 0.02
Alkalinity (assumed)	mg/L as $CaCO_3$	471	-
Total Dissolved Solids(TDS)	mg/L	< 1,200	-

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Check voltage + amperage + name plate info against mechanical test record on all motors **NOT** recorded in FAT. Please include this in the commissioning binder			
Fill out mechanical test record on each motor and check amperage and voltage. Document amperage on the System test records in the operating manual in the Field test load section			
Check overload settings for all motors			
Test position of ball float switches for proper start/stop level as per the P&ID and control narrative in this manual and observed on the HMI.			
Check that PLC Run light is on and no alarm lights are present on the PLC			
Wet test all control inputs and outputs (See Device Verification section in this checklist)			
Test analogue inputs (See Device Verification section in this checklist)			
Wet test all shut down alarms (See Control Narrative at Appendix K in this manual)			
Manually test all permeate stopping alarms(See Control Narrative at Appendix K in this manual)			
Test vacuum and pressure relief valve			
Check the setting of level switches/transmitters			
Check the hydraulic flow through the plant			
Check if all the ancillary equipment and controls of the plant function as per design			
Fill the system with potable water using the inlet and confirm piping & repair any leaks.			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Confirm heater and fan operation in the screen container.			
Fill TNK-101/102/103 and check for leaks. FIT-101 operations. Confirm operation of all level switches			
Confirm operation of SCR-201/202 and pump P-201/202. Check for leaks and repair as necessary. Confirm operation of FIT-201. Confirm operation of all level switches			
Fill EQ Tank (TNK-501), check for leaks. Confirm tank heater operation. Confirm LT-301 operation via the HMI display for values. Confirm operation of P-301/302 Confirm B-301/302 operation and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Confirm operation of H-301/302, TSLL-301 and all level switches			
Fill Pre-Anox tank with water (TNK-401) and confirm operation of educators and P-401/402			
Confirm operation of H-401/402, TSL-401 and all level switches			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Fill Aeration Tanks (TNK-501/502), check for leaks. Confirm tank heater operation. Confirm LT-501/DO-501/PH-501 operation via the HMI display for values. Confirm operation of P-501/502/503. Confirm operation of the sprayer. Confirm operation of B-501/502 and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Confirm operation of H-501/502/503/504, TSL-501/502 and all level switches			
Fill Post Post-Anox Tank (TNK-551) with water and check for leaks. Conform operation of P-554/555. Confirm operation of educators. Confirm operation of P-551/552			
Fill MBR tanks with water (TNK-601/602) and check for leaks. Confirm level switch operation. Confirm operation of B-601/602, confirm all level switch operation, and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Perform electrical and instrumentation (E&I) functional checks and adjustment of level switches.			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Turn on the air blower(s) for the equalization tank(s) and blower(s) for aeration tank(s), and check for: o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Manually check water temperature and DO (dissolved oxygen): with a hand-held DO meter and adjust air flow to keep it up to 0.5 – 1 mg/L for equalization tank(s) and 2 - 3 mg/L for aeration tank(s); check the DO readings on the touch screen.			
DO Control System: check automatic ON/OFF of Aeration Tank air blowers at low and high settings of DO without the return of aerated water from the membrane tanks to aeration tanks (i.e. turn off transfer pump(s) from aeration tank(s) to membrane tank(s) and turn of recirculation pump(s) from membrane tank(s) to aeration tank(s), if included), and record blower ON/OFF duration.			
Fill membrane Tank, check for leaks. Confirm operation of P-601/701/702/801/6101/6102. Perform manual backwash to confirm operation. Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Confirm operation of all container fan and heaters.			
Fill sludge holding tank with water. Confirm diffuser operation and level switch operation. Confirm P-901 operation.			
Introduce seed sludge from cusomer thru the influent and process. See Section 6 of the manual for the procedure. If seed sludge is unavailable, then use dry bacteria.			

newterra clean water. modular solutions. simple.	Membrane Inspection (Clean Water)		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Inspect membrane module that all bolts are secure			
Ensure all hose clamps are secure			
Fill tank until membranes are completely submerged, re-check bubble pattern			
Enable membrane operation from the PLC screen			
Start the transfer pump(s) from the Post Anox tank(s) to the membrane tank(s) and fill the membrane tank(s) with potable water.			
Start the air blowers for the membrane tank(s) and check for an even distribution of air across the membrane filter area and air bubble uniformity above the membrane module/cassette.			
Check hydraulic flow pattern through the membranes and between membrane module/ cassette and tank wall.			
Make a clean copy of the Clean Water Testing Sheet presented in Appendix K of this O&M Manual.			
Record all checked parameters in the Clean Water Testing Sheet:			
Pre-prime the permeate pumps according to manufacturer'smfg instructions			
Start the permeate (vacuum) pumps.			

newterra clean water. modular solutions. simple.	Membrane Inspection (Clean Water)		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Record and set the initial vacuum settings on the system to determine correct TMP of the membranes. This step is required based on the Vacuum transmitter located higher than the water level.			
Record the vacuum (TMP) on the gauge(s) on the permeate line [for clean water could be 0.05 to 0.07 bar (20" to 29" WC)].			
Record water temperature and DO with a hand-held DO meter.			
Gradually increase the permeate flow while recording the vacuum (TMP) on the gauges up to the anticipated peak wastewater flow.			
Ensure membrane module is securely fastened to membrane tank and no movement is detected. Ensure wheels are chocked to prevent membrane module movement during operation			

newterra clean water. modular solutions. simple.	Full Automatic System Test		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/*
Record Membrane Performance after 3 min at the design flow for each membrane cassette with clean water record findings in 'MBR Test Preformance' data sheet			
Introduce Waste Activated Sludge (inject slowly through normal waste water inlet, always pre-screen)		Sludge Obtained From: MLSS:	
Record Membrane Performance after 3 min at the design flow for each membrane cassette in 'MBR Preformance' data sheet			

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Membrane Performance (test)

MBR Number	Flow	Flux	Permeability	Date	Operator Initials

Influent-Effluent

1 Confirm Influent/Effluent parameters - below are the design parameters.

Parameters	Unit	Influent*	Effluent
pH	s.u.	6 - 9	6.5 – 8.5
Fat, Oil, Grease (FOG)	mg/L	< 30	< 5
Biological Oxygen Demand (BOD)	mg/L	907.5	< 25
Total Suspended Solids (TSS)	mg/L	262.5	< 25
Total Kjeldahl Nitrogen (TKN)	mgN/L	130	-
Unionized Ammonia Nitrogen (NH_3-N)	mgN/L	-	< 1.25
Nitrate Nitrogen (NO_3-N)	mgN/L	-	< 5
Total Phosphorus (TP)	mgP/L	12	< 0.5
Fecal Coliform	CFU/100mL	-	< 200**
Total Residual Chlorine	mg/L	-	< 0.02
Alkalinity (assumed)	mg/L as $CaCO_3$	471	-
Total Dissolved Solids(TDS)	mg/L	< 1,200	-

	newterra clean water. modular solutions. simple.	**Influent-Effluent**	
2	Record here the actual influent and effluent valves from lab testing		

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Device Verification Checklist

Device Tag	Device Type	Operation Verified	Notes	Train 1	Train 2
FIT-201	Flow Transmitter				
FIT-202	Flow Transmitter				
SCR-201	rotary brush screen				
SCR-202	rotary brush screen				
LSHH-201	Level Switch				
LSHH-202	Level Switch				
LSHH-101	Level Switch				
LSHH-102	Level Switch				
LSHH-103	Level Switch				
LSHH-203	Level Switch				
LSH-203	Level Switch				
LSL-203	Level Switch				
P-201	Pump				
P-202	Pump				
H-7911	Container heaters				
H-7912	Container heaters				
TSL-7911	Temperature low level				
LSHH-7911	Level Switch				
B-7911 and PDS-7911	Blower				
EQ Tank diffuser Grid	diffusers				
B-302/301 and PSL-301	Blower				
LSHH-301	Level Switch				
LSLL-301	Level Switch				
LT-301	Level Transmitter				
TSLL-301	Temperature sensor				
H-301 and H-302	Tank heater				
P-301/302	Pump				
Pre-Anox Educator					
H-7941 and TSLL-7901	Container heater				
P-401 and P-402					
H-401 and H-402	Tank heaters				
LSHH-401	Level Switch				
LSLL-401	Level Switch				
TSL-401	Temperature Sensor				
B-7941	Blower				
Aeration Tank diffuser grid	diffusers - TNK-501				
H-501/502	Tank heater				
LSLL-501	level switch				
TSL-501	temperature sensor				
LSHH-501	level switch				
LT-501	level transmitter				
DO-501	DO sensor				
PH-501	PH sensor				
P-501	pump				
P-502	pump				
P-503	pump				

Device Tag	Device Type	Operation Verified	Notes	Train 1	Train 2
B-501/502 and PSL-501	blower				
P-6101	Soda Ash/Caustic dosing pump				
P-6102	Alum dosing pump				
Aeration Tank diffuser grid	diffusers - TNK-502				
H-503/504	Tank heater				
LSLL-502	level switch				
TSL-501	temperature sensor				
LSHH-502	level switch				
Educators	Post-Anox Educators TNK-551				
P-553/554	Pumps				
P-551/552	Pumps				
P-6103	MicroC dosing				
B-601 and PSL-601	MBR Blower				
LSHH-601	Level Switch				
LSH-601	Level Switch				
MBR tank diffuser grid	diffusers - TNK-601				
P-701	permeate pump				
VT-701	Vacuum transmitter				
MV-701	Soleniod valve				
FIT-701	flow transmitter				
B-602 and PSL-602	MBR Blower				
LSHH-602	Level Switch				
LSH-602	Level Switch				
MBR tank diffuser grid	diffusers - TNK-602				
P-702	permeate pump				
VT-702	Vacuum transmitter				
MV-702	Motorized valve				
FIT-702	flow transmitter				
SV-801	Backwash valve				
P-801	backwash pump				
LSH-801	Level Switch				
LSL-801	Level Switch				
SV-801	Soleniod valve				
H-7961	container heaters				
H-7962	container heaters				
H-7963	container heaters				
TSL-7961	Temperature sensor				
F-7961	Container fan				
LSHH-7961	Level Switch				
LSHH-7962	Level Switch				
LSHH-901	level switch				
sludge inlet tank diffuser grid	diffusers - TNK-901				

Commissioning Acceptance Sign-Off Form

1704432 - Amaruq Mine WWTP

Newterra is pleased to announce that the Commissioning phase of 1704432 - Amaruq Mine WWTP, has successfully been completed. In order to move to the Training phase, a visual inspection and walkthrough of the plant will be required, followed by signoff of this document. Commissioning signoff will be conditional on the completion of items listed in the Punchlist created during this walkthrough.

	Installation Signoff		Customer Acceptance
Name:	_____	**Name:**	_____
Company:	_____	**Company:**	_____
Date:	_____	**Date:**	_____
Signature:	_____	**Signature:**	_____

newterra smart technology. sustainable solutions.™	Customer Training Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Review the operating manual with the customer explaining the various components of the manual and sources of information.			
Review the startup and shutdown procedure with operator.			
Review operation of treatment system and describe the maintenance required for each piece of equipment.			
Describe operation of panel and panel components.			
Run through complete logic and alarm sequence with customer			
Train customer to troubleshoot alarms based on input conditions to the PLC or relays in the panel.			
Discuss the operating logic with the customer so they understand how the system is configured to work.			
Have customer/operator sign training sheet			
Note name of individual and company with whom logic was reviewed:			

Training Completion Sign-Off Form

1704432 - Amaruq Mine WWTP

Newterra is pleased to announce that the training of the following operator(s) has been sucessfully completed:

	Installation Signoff		Customer Acceptance
Name:		**Name:**	
Company:		**Company:**	
Date:		**Date:**	
Signature:		**Signature:**	

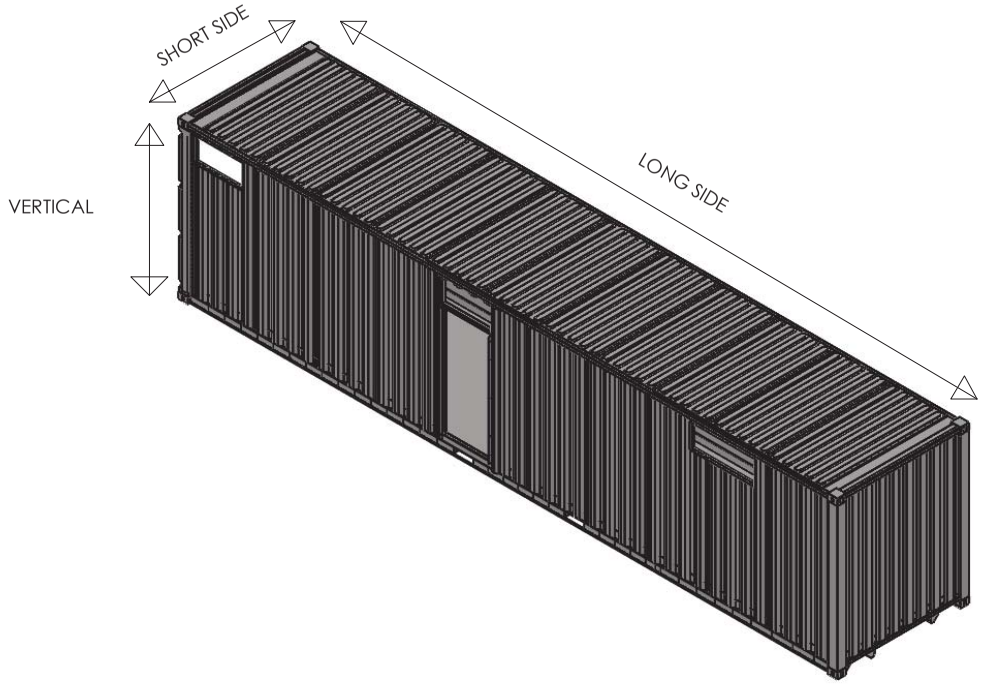
COMPONENT	LONG SIDE (40') QTY.	SHORT SIDE (8') QTY.	VERTICAL (9' 6") QTY.
LIQUID RUBBER (37795)	2 (7.0L)	1 (1.40L)	1 (1.70L)
TAPE (37797)	1 (40')	1 (8')	1 (9' 6")
POLYURETHANE SEALANT (37796)	2 (1.0L)	1 (0.40L)	-
7/8" BACKER ROD (29551)	-	1 (8')	-
3/8" BACKER ROD (37794)	2 (40')	-	1 (9' 6")
SPRAY FOAM (22772)	-	1 (1.33 ft^3)	-

NOTE:

QUANTITIES OF COMPONENTS LISTED ARE FOR A SINGLE SEAL IN THE DIRECTION SPECIFIED.

A COMPLETE SEAL OF A MULTI-CONTAINER SYSTEM MAY REQUIRE THE SUMMATION OF MULTIPLE SEALS IN MULTIPLE DIRECTIONS.

THIS TABLE IS TO GIVE ROUGH ESTIMATES ON THE QUANTITIES REQUIRED.



GENERAL TOLERANCES
.XX ± 1/8"
.XXX ± 1/16"
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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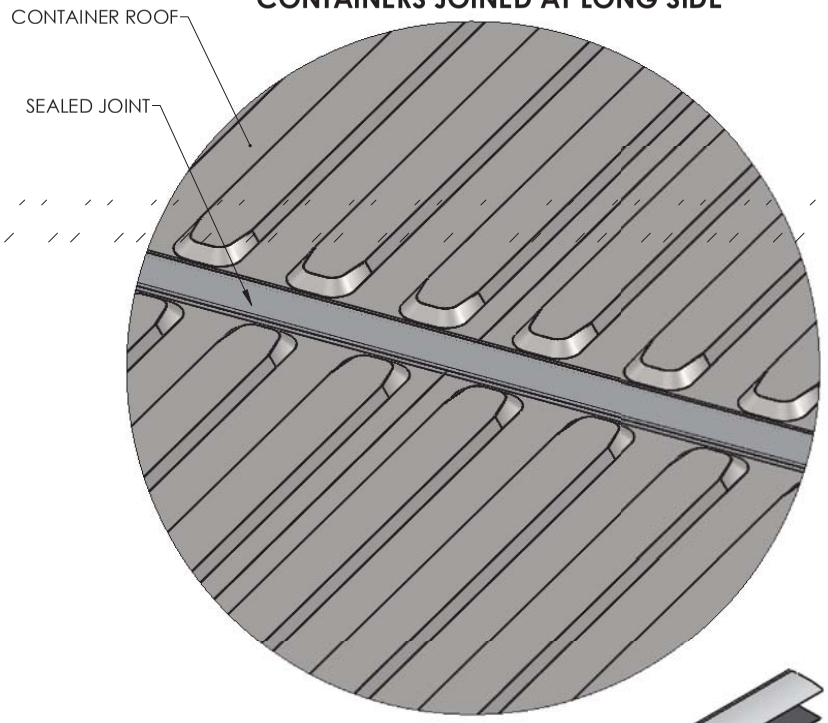
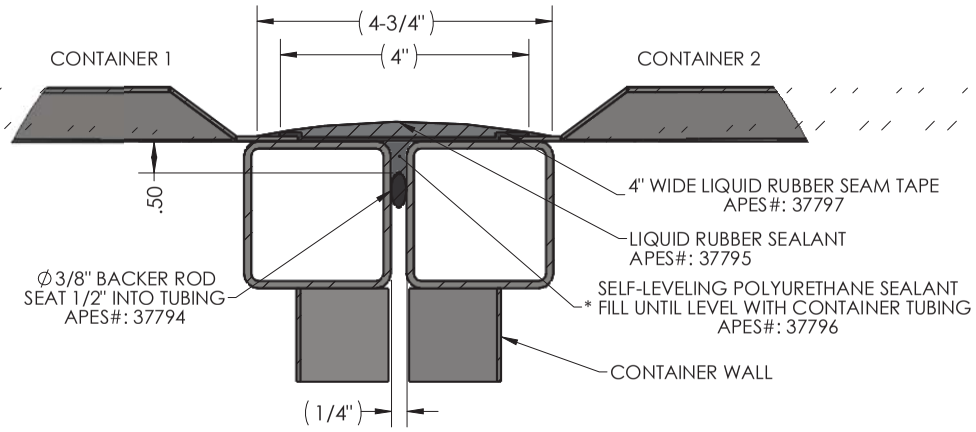
LEVEL	DATE	BY	REVISION
B1	27/02/17	GH	FOR PRODUCTION - REVISED SEALING METHOD
B	11 Nov 2015	OM	FOR PRODUCTION
A1	26 Aug 2015	OM	FOR REVIEW
A	22 July 2015	OM	FOR REVIEW

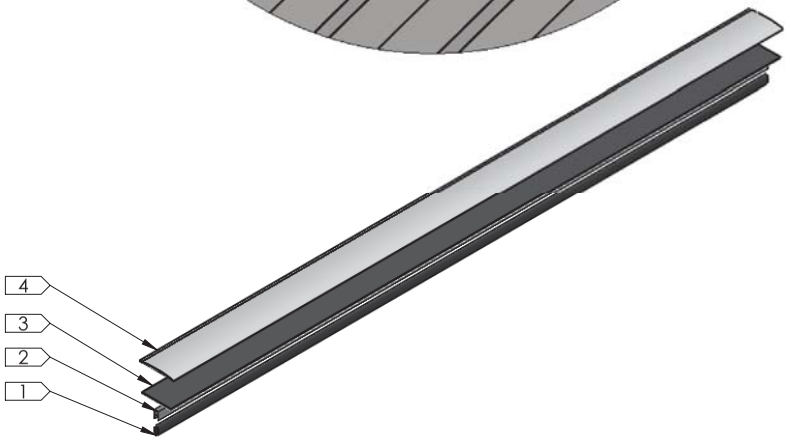
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 1 OF 7

CONTAINERS JOINED AT LONG SIDE





SECTION A-A
CONTAINERS JOINED ALONG LONG SIDE
SCALE 1 : 2



TYPICAL STEPS FOR SEALING LONG SIDE OF CONTAINER JOINTS

1. PUSH BACKER ROD INTO GAP BETWEEN CONTAINER TUBING; 1/2" DOWN.
2. APPLY SELF LEVELING POLYURETHANE SEALANT ON TOP OF BACKER ROD UNTIL LEVEL WITH TUBING.
3. APPLY LIQUID RUBBER TAPE CENTERED OVER GAP, 4" WIDE. ENSURE SMOOTH TIGHT TO SURFACE SEAL.
4. APPLY LIQUID RUBBER SEALANT WITH A MINIMUM CENTERED WIDTH OVER THE GAP OF 4 3/4". ENSURE NONE OF THE TAPE IS VISIBLE AFTER THIS APPLICATION.

GENERAL TOLERANCES
.XX ± 1/8"
.XXX ± 1/16"
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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DWG. NO:
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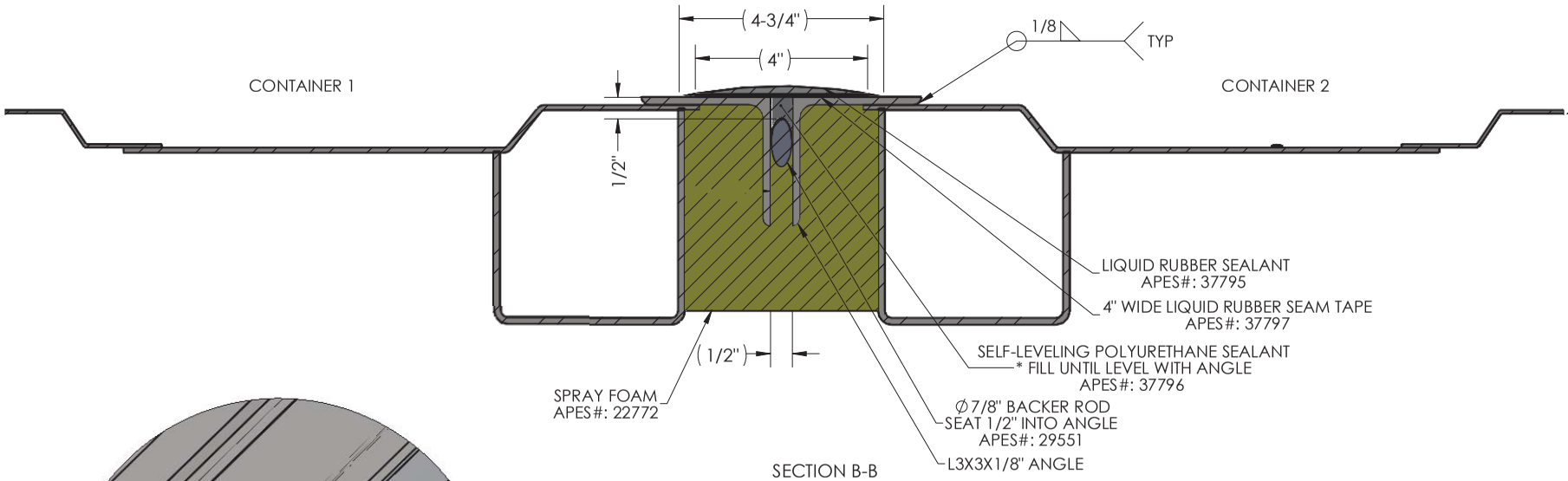
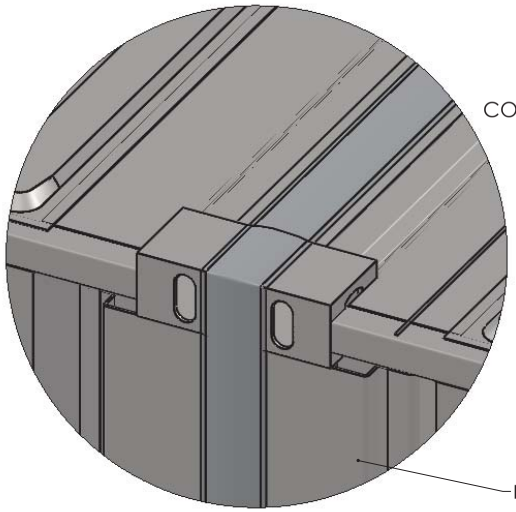
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 2 OF 7

CONTAINERS JOINED ALONG SHORT SIDE - BARN DOOR END TO BARN DOOR END



SECTION B-B
CONTAINERS JOINED ALONG SHORT SIDE - BARN DOOR END TO BARN DOOR END
SCALE 1 : 2.5



STEPS FOR SEALING SHORT SIDE OF CONTAINERS:

1. PERFORM STEPS 1-4 OF TYPICAL SEALING OUTLINED ON PAGE 1 ON TOP OF CONTAINERS.
2. FILL UNDERSIDE AS SHOWN WITH SPRAY FOAM WHEN POLYURETHANE LEVELING SEALANT HAS SET.
3. FOLLOW STEPS 3 & 4 AND ADD SPRAY FOAM TO BARN DOOR END VERTICAL SEALS.

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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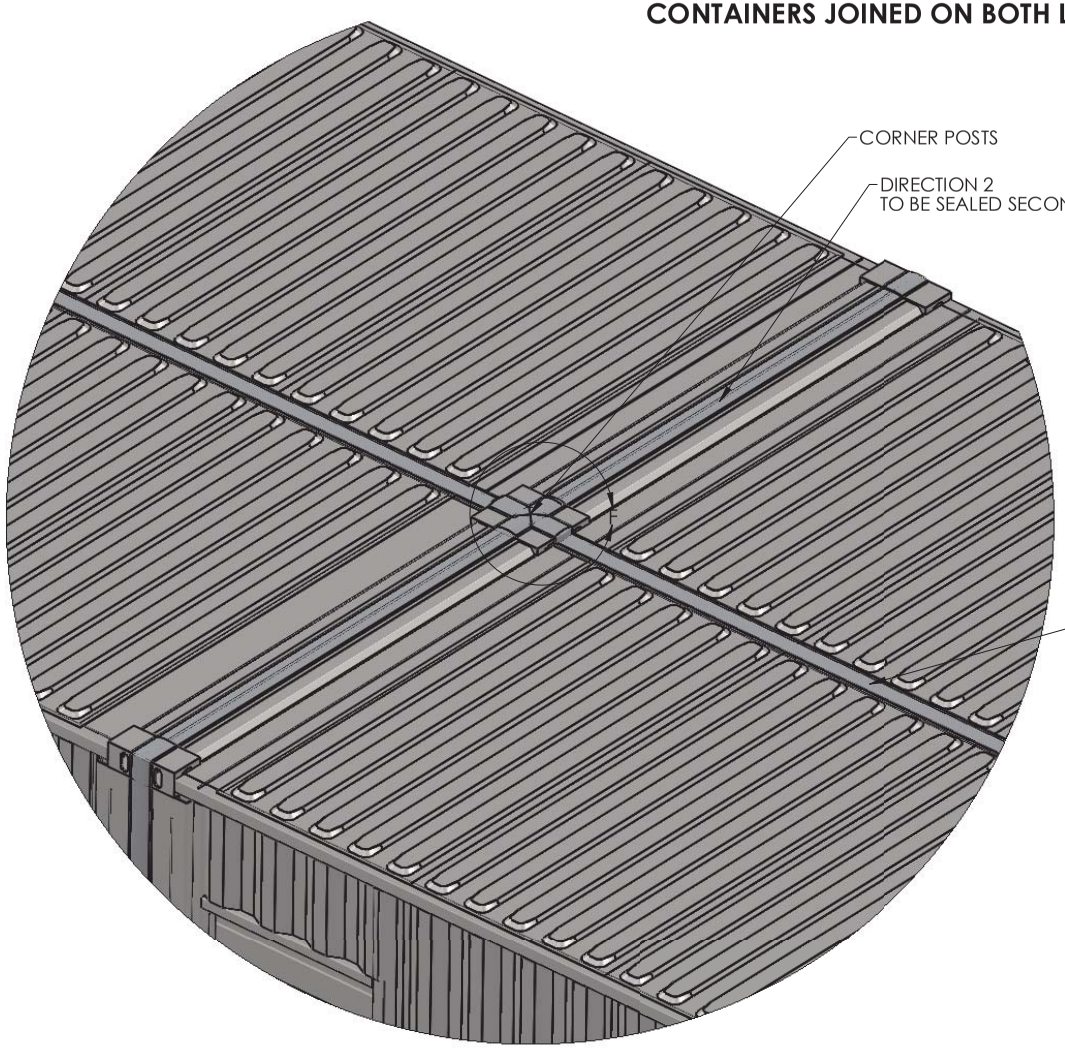
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 3 OF 7

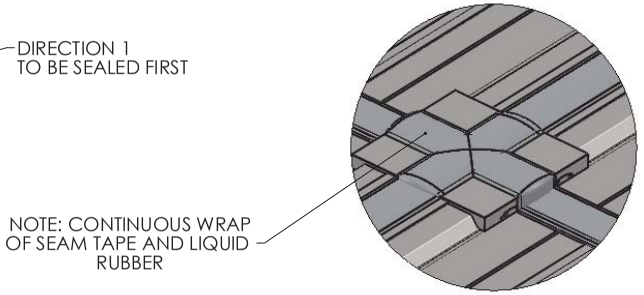
CONTAINERS JOINED ON BOTH LONG AND SHORT SIDES



STEPS FOR SEALING ABOVE CONTAINERS JOINED IN BOTH DIRECTIONS:

1. CLEAN AND PRIME AREA
2. PERFORM STEPS 1 TO 4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 IN DIRECTION 1 - ALONG LONG SIDE FIRST WITH ∅3/8" BACKER ROD.
3. PERFORM STEPS 1 TO 4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 IN DIRECTION 2 - ALONG THE SHORT SIDE WITH ∅7/8" BACKER ROD.
4. PERFORM STEPS 3 & 4 WHEN SEALING CORNER POST JOINTS. (TAPE AND LIQUID RUBBER).

NOTE: WHEN SEALING DIRECTION 1 & 2 CONTINUE WRAP OF TAPE AND RUBBER ACROSS THE CORNER POSTS.



DETAIL F
CORNER POST JOINTS
SCALE 1 : 10

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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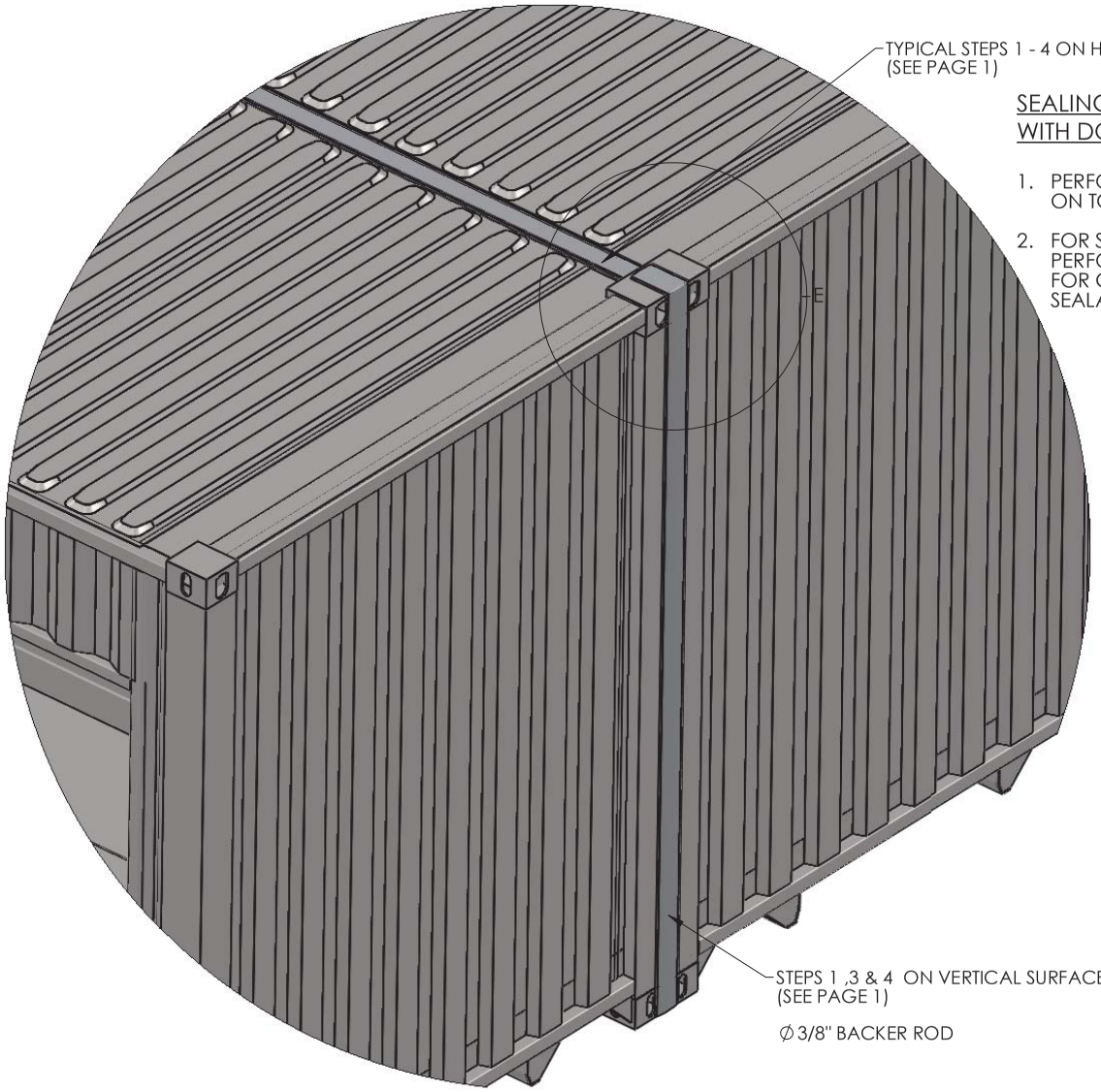
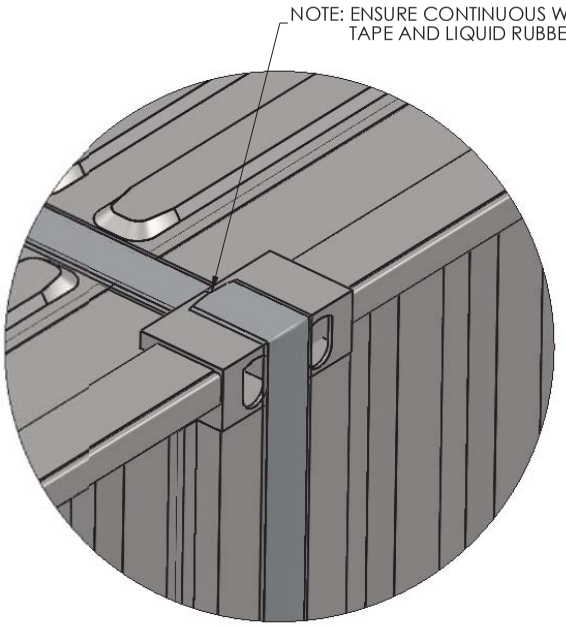
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 4 OF 7



SEALING ABOVE CONTAINERS JOINED ON LONG SIDE WITH DOORWAY / PATH THROUGH CLOSE TO CONTAINERS END

1. PERFORM STEPS 1-4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 ON TOP OF CONTAINERS.
2. FOR SEALING VERTICAL AREA:
   PERFORM STEPS 3 & 4 ON CORNER POSTS.
   FOR GAP USE STEPS 1, 3 & 4 WITH ∅3/8" BACKER ROD. IGNORE USE OF POLYURETHANE SEALANT.



DETAIL E
SCALE 1 : 8

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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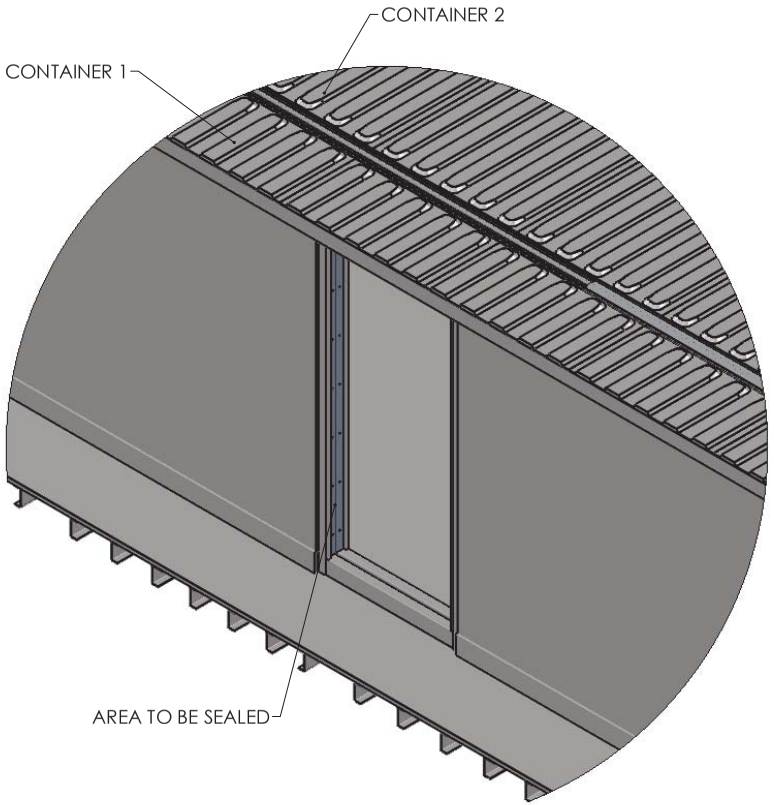
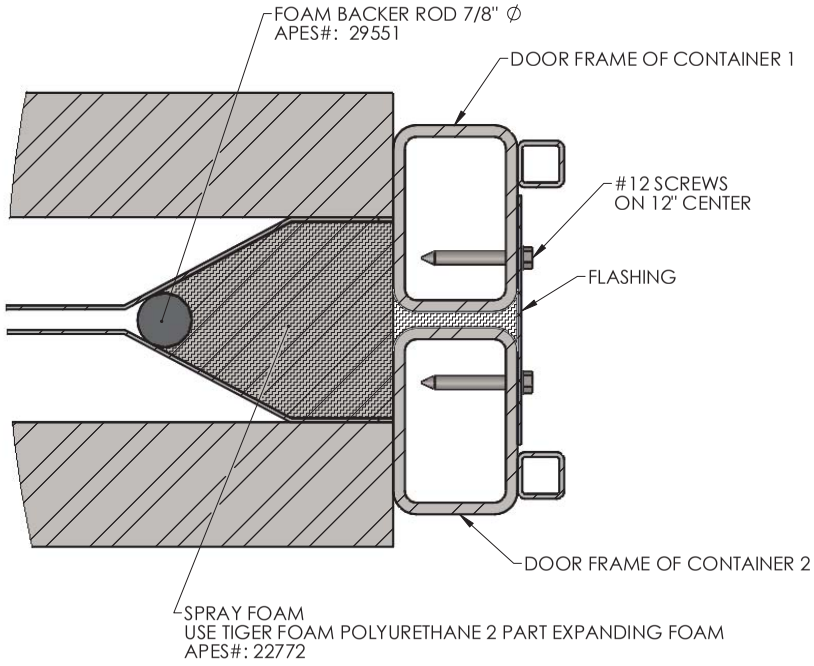
A	22 July 2015	OM	FOR REVIEW

DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 5 OF 7

INSIDE SEALING OF WALKWAYS





DETAIL D
DOORWAYS SEALING
SCALE 1 : 2

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 15
SHEET 6 OF 7

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

APPENDIX D

Recommended Spare parts List

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1704432 - AGNICO EAGLE MINE - A1

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Electrical**	**Spare**	10270	Breaker, SQD QOU115 1240V 15A 1P DIN Mount, 10k SCCR
1	**Electrical**	**Spare**	11482	Breaker Lock for 1 pole QOU breakers
3	**Electrical**	**Spare**	12404	Fuse,GLD AJT250250A 600V Time Delay, Class J
1	**Electrical**	**Spare**	12475	4Ch Discrete, Transistor Output, Intrinsically Safe Barrier
1	**Electrical**	**Spare**	12547	Contactor (TeSys D) Non-Reversing, 9A(AC3) 125A(AC1), 3-Pole (3 NO)
1	**Electrical**	**Spare**	17158	Combination Starter, Busbar Top Mount
1	**Electrical**	**Spare**	18396	190-480V, 3PH Power/Phase Monitor
4	**Electrical**	**Spare**	18642	100W Incandescent, Medium Base, CL1Div2
5	**Electrical**	**Spare**	19029	Breaker, SQD QOB115 120V 15A Bolt On, 10k SCCR
1	**Electrical**	**Spare**	19264	Combination Starter, 12A Power Base, 3/7.5/10HP
1	**Electrical**	**Spare**	19269	Combination Starter, 1NO Ready, 1NO Fault Aux. Contact Module
1	**Electrical**	**Spare**	19503	Combination Starter, TeSysU Standard Control Unit 0.35-1.4A, 24VDC coil
5	**Electrical**	**Spare**	20369	Fuse,GLD GSB1/10100mA 250V Fast Acting, Miniature 5x20mm
1	**Electrical**	**Spare**	21191	Combination Starter, TeSysU Standard Control Unit 1.25-5.0A, 24V/60mA DC coil
1	**Electrical**	**Spare**	21887	Relay, SQT RXM4AB1F7, Miniature Relay, 4PDT, 120VAC, 6A contacts
1	**Electrical**	**Spare**	21888	Relay, SQT RXM4AB1BD, Miniature Relay, 4PDT, 24 VDC, 6A contacts
1	**Electrical**	**Spare**	21889	Relay, SQT RXZE2S114M, Base/Socket for RXM4 4P Relays
2	**Electrical**	**Spare**	22324	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC
2	**Electrical**	**Spare**	22326	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays
1	**Electrical**	**Spare**	22546	Busbar 4 TeSysU Starters, #6AWG 63A MAX
1	**Electrical**	**Spare**	22706	Combination Starter, TeSysU Standard Control Unit 3-12A, 24V/60mA DC coil
1	**Electrical**	**Spare**	23504	4Ch Power Supply, 15V - 20mA
4	**Electrical**	**Spare**	23751	Relay, SPDT, 24VDC Coil
1	**Electrical**	**Spare**	26829	8GB Micro USB Key
1	**Electrical**	**Spare**	28484	M251 Controller, Dual Ethernet
1	**Electrical**	**Spare**	29140	eWON Cosy 131 LAN/Cell Router, 24VDC Power
2	**Electrical**	**Spare**	35707	24VDC Power Supply, 120W, 5A
1	**Electrical**	**Spare**	36087	TM3 16DI Expansion Module
1	**Electrical**	**Spare**	36088	TM3 16DO Expansion Module
1	**Electrical**	**Spare**	36089	TM3 4-channel AI Expansion Module
1	**Electrical**	**Spare**	36090	TM3 8-channel AI Expansion Module
1	**Electrical**	**Spare**	36126	Touchscreen, 10.4" TOUCH SMART DISPLAY
1	**Electrical**	**Spare**	36316	OTB RIO Adapter, Ethernet
1	**Electrical**	**Spare**	36317	TM2 8 point DI Expansion Module

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Electrical**	**Spare**	36543	TM3 4-channel AO Expansion Module
1	**Electrical**	**Spare**	36555	Fuse, 160mA 250V Fast Acting, Miniature 5x20mm
1	**Electrical**	**Spare**	36557	TME Bus Transmitter Module
1	**Electrical**	**Spare**	36558	TME Bus Receiver Module
1	**Electrical**	**Spare**	37596	TM2 16 point DI Expansion Module
1	**Electrical**	**Spare**	37906	48" x 36" x 12" NEMA4 Steel Enclosure
1	**Electrical**	**Spare**	38069	Breaker, Multi9 480/277V 15 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38070	Breaker, Multi9 480/277V 20 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38071	Breaker, Multi9 480/277V 30 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38092	Breaker, Multi9, 480/277V 15 AMP 2P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38093	Variable Frequency Drive, Danfoss FC202 P1K5, VFD 480V 2HP, 3.4A 3PH, IP55, w/ Line Side Fusible Disc
1	**Electrical**	**Spare**	38094	Variable Frequency Drive, Danfoss FC202 P11K, VFD 480V 15HP, 21A 3PH, IP55, w/ Line Side Fusible Disc
2	**Electrical**	**Spare**	38136	Breaker, 240V 1 AMP 1P C
2	**Electrical**	**Spare**	38137	Breaker, 240V 2 AMP 1P C
2	**Electrical**	**Spare**	38138	Breaker, 240V 3 AMP 1P C
2	**Electrical**	**Spare**	38139	Breaker, 240V 4 AMP 1P C
2	**Electrical**	**Spare**	38204	Wall Pack, 24W LED c/w PhotoEye
1	**Electrical**	**Spare**	38209	TM2 16RO Expansion Module
1	**Mechanical**	**Spare**	9999	Pump, Metering, Prominent, Rebuild Kit, BT4B0708PVT2000UD010A01, Flow: 1.88GPH / 7.10L/H, Pressure: 102PSI / 07BAR
1	**Mechanical**	**Spare**	11518	Blower, Sutorbilt, Model 4L-RHC
1	**Mechanical**	**Maintenance**	11529	Filter, Element, Solberg, 30P, Paper element, for newterra PN M1096
1	**Mechanical**	**Spare**	11772	Blower, Part, Belt drive, 15hp
1	**Mechanical**	**Maintenance**	11792	Filter, Element, Solberg, 230P, Paper element for newterra PN M1489
1	**Mechanical**	**Maintenance**	12014	Filter, Element, Solberg, 18P, Paper element, for newterra PN M1406
1	**Mechanical**	**Spare**	12026	Motor, Teco, 1hp, 1800rpm, 143T
1	**Mechanical**	**Maintenance**	12930	Oil, Blower, Aeon PD blower oil
1	**Mechanical**	**Spare**	15185	Motor, Teco, 15hp, 3600rpm, 254T
1	**Mechanical**	**Spare**	16196	Gauge, Pressure, 0-15psi, Indumart, P16T2-FG-15
5	**Mechanical**	**Spare**	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30
4	**Mechanical**	**Spare**	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL
2	**Mechanical**	**Spare**	21552	Switch, Level, Tether Weight
10	**Mechanical**	**Spare**	21828	Anode, Magnesium, mounted on wire with washer
1	**Mechanical**	**Spare**	23439	Transmitter, Pressure, KPSI 750 series 0-10ft H20
1	**Mechanical**	**Spare**	24163	Heater, Immersion, Caloritech 6KW 460V 3ph
1	**Mechanical**	**Spare**	25747	Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel
1	**Mechanical**	**Spare**	27810	Transmitter, Pressure/ Vacuum, IFM efector
1	**Mechanical**	**Spare**	28469	Pump, Centrifugal, Price Pumps Type 26 EPR Seal 0542
1	**Mechanical**	**Spare**	28617	Pump, Centrifugal, Price Pump 1/4hp 460V 3ph 1800RPM

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Mechanical**	**Spare**	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	28712	Flow meter, IFM efector, SM9000, Magnetic flow meter
1	**Mechanical**	**Spare**	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	33737	Switch, Level, Ultrasonic, Flowline, LU10-1405
8	**Mechanical**	**Spare**	35983	#10 Stainless Back 3" Trim, 16" Length, 0.5 Black Poly Brush
1	**Mechanical**	**Spare**	36395	Pump, Sump, Zoeller N72 Non-Automatic Operation
1	**Mechanical**	**Spare**	36870	Transmitter, pH, Prominent pH Sensor PHER 112SE
1	**Mechanical**	**Spare**	36973	Pump, Centrifugal, Price, Misc
2	**Mechanical**	**Spare**	37662	Valve, Ball, PVC, 2", True-Union, FPM O-rings
1	**Mechanical**	**Spare**	38186	Pump, Centrifugal, Price Pump 1hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	38219	Gear Motor, 230/460V 50/60 3P, 60/50hz 1/4hp
1	**Mechanical**	**Spare**	38596	Transmitter, Dissolved Oxygen, Optical, RDO PRO-X, Sensor Cap Replacement Kit, 0088720
1	**Mechanical**	**Spare**	M1254	Pump, Progressive Cavity, Moyno, 35601
4	**Mechanical**	**Spare**	M1343	Switch, Level, Mech Float, Narrow Angle, N.O., Blue

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APPENDIX E

Technical Specs and Brochures for Parts and Equipment

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TAG	newterra Part Number	Part Description	Extended Part Description	Page
-	21299	Valve, Relief, Back Pressure, Kunkle, 1", Liquid Service	Set @ 50 PSI, 0019-E01-MG0050	E-8
-	M1096	Filter, Silencer, Solberg, FS-30P-200		E-40
-	M1406	Filter, Silencer, Solberg, FS-18P-150	1	E-40
B-301/2	25404	Blower, Elmo, 2BH7420-0AH267 2.4HP	230/460V 3ph	E-45
B-501/2	11518	Blower, Sutorbilt, Model 4L-RHC	Orientation: Horizontal (Flow Down) Driven Shaft Position: RHC (Right Hand Central) Flow Requirement: 487 scfm Altitude: 100' Inlet Pressure: Outlet Pressure:4.4 Inlet Air Temp: 68 Discharge Air Temp: 126 Noise: RPM: 3352 Horsepower Consumed:13.2 Motor Included with Package Blower calculation sheet and blower curve supplied by Engineering	E-73
B-501/2	15185	Motor, Teco, 15hp, 3600rpm, 254T	208-230/460, 3ph, CSA/UR	E-73
B-501/2	38094	VFD, Danfoss 15HP, 380-480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBXCXXXXDX	E-159
B-501/2	M1489	Filter, Silencer, Solberg, FS-230P-300	3"	E-249
B601/2	21232	Blower, Elmo G200 2BH-1510-7HH56-Z	230/460V 3P 6.2 HP	E-251
B-7911	25747	Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel	Arrangement #4, Direct Drive, bottom discharge c/w	E-283
B7914	22618	Blower, Cincinnati, LM-6, Direct drive	- Cast Aluminum Housing -6.3 x 2.5 STEELWheel - Slip fit inlet - Slip fit discharge - Motor base - 1.5hp, 460V, 3ph, 60Hz, 3600 rpm, TEFC, CCW/TH 769CFM @ 2.25	E-283
DO-501	27325	Transmitter, Dissolved Oxygen, Optical	RDO Pro-x (10m cable)	E-298
F-7961	M1072	Fan, Building, 12", 1/4hp, 1750rpm, 120V, 1ph, TEAO	CSA Approved, S12-E1	E-328

TAG	newterra Part Number	Part Description	Extended Part Description	Page
FM 701 702	28712	Flow meter, IFM efector, SM9000, Magnetic flow meter	G2 connection 0 -300 L/min	E-336
FT-102/2	27200	Flow meter, Endress, Promag 10D50 2"	10D50-4LGA1RA0B4AAM1 Compact head	E-381
H	24384	Heater, Forced Air, Ouellet, 4.8kW, OAC04804BL	460V 1ph	E-521
H-301/302 H-401/402 H-501/502 H-503/504	24163	Heater, Immersion, Caloritech 6KW 460V 3ph	3" Flanged Heater with Moisture Resistant Term Box	E-525
H-7911	38187	Heater, Forced Air, Indeeco, 15KW, 233 Series	480V/3ph. EXP, 1/4HP Fan, w thermostat SIZE 2	E-526
H-7912	38188	Heater, Forced Air, Indeeco, 10KW, 233 Series	480V/3ph. EXP, 1/4HP Fan, w thermostat	E-526
HMI	26421	HMI, HMIGTO5310	10.4" TFT Color Touchscreen, Ethernet, USB, Serial	E-534
LS	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LS	M1343	Switch, Level, Mech Float, Narrow Angle, N.O., Blue	Tilt Float Level Switch w 40' cable	E-684
LS-101/2/3	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LSHH	12351	Switch, Level, Almeg, Vertical, ATB3-48B	1/4NPT	E-687
LSHH- 101.102/103 LSHH-301 LSHH-401 LSHH-501 LSHH-502 LSHH-601/602	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LSHH-7901	12351	Switch, Level, Almeg, Vertical, ATB3-48B	1/4NPT	E-687
LSLL-301/401/ 501/502	M1108	Switch, Level, Mech Float, Wide Angle, N.O., Red	13A, SPST, N/O, Red	E-684
LT-301/501	23439	Transmitter, Pressure, KPSI 750 series 0-10ft H20	Part Number 750S14D4A004.334000.000B10015B	E-688
M-701/702	24353	Valve, Actuated Ball Valve 1.5" Brass 2 way	w/ limit switches PMP electric Actuator 120V OM-1	E-722
MCP	28484	PLC, TM251MESE	M251 Controller 2 Ethernet port	E-739
MCP	29140	Modem/Router, EC6133D	eWON Cosy 131 Ethernet plus with GSM 3G+	E-851

TAG	newterra Part Number	Part Description	Extended Part Description	Page
Membranes	28424	Membrane, Microclear Cassette, MCXL2 - Type M	surface area is 8 m2	E-881
Membranes	36037	MBR, Air Diffuser, FLEXAIR 91 1105 T SERIES		E-900
MPP	18396	Motor Saver, 460 w/Diagnostic 3ph	Finger Safe, DIN Rail Mountable	E-920
P-201/2	38186	Pump, Centrifugal, Price Pump 1hp 460V 3ph 3600RPM	PN: RC200AI-300-26566-100-36-3X6	E-928
P-301/2	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM	PN: RC200AI-250-26566-75-36-3T7	E-928
P-401/2	36973	Pump, Centrifugal, Price, Misc	RC300AI-4.33-26566-500-36-3T7 200GPM @ 60 FEET PRESSURE 3600RPM 5HP TEFC 460v3P	E-928
P-501/2	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM	PN: RC200AI-388-26566-200-36-3T6	E-928
P503	28617	Pump, Centrifugal, Price Pump 1/4hp 460V 3ph 1800RPM	PN: RC200AI-388-26566-25-18-3T6	E-928
P-551/2	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM	PN: RC200AI-250-26566-75-36-3T7	E-928
P-553/4	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM	PN: RC200AI-388-26566-200-36-3T6	E-928
P-6101,2,3	21192	Pump, Metering, Prominent, Misc	BT4B0708PVT2000UD010A01 Flow: 1.88GPH / 7.10L/H Pressure: 102PSI / 07BAR	E-947
P-610x	25823	Pump, Metering, Parts, Multi-function Valve	PVDF, 87PSIG Size 2	E-1063
P-701/2	38093	VFD, Danfoss 2HP, 380-480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBXCXXXXDX	E-159
P-701/702	12026	Motor, Teco, 1hp, 1800rpm, 143T	208-230/460V, 3ph, CSA/UR	E-1091
P-701/702	M1254	Pump, Progressive Cavity, Moyno, 35601	15gpm@25psi, 1200rpm, NPSH: 2 feet	E-1125
P-801	36395	Pump, Sump, Zoeller N72 Non-Automatic Operation	All Plastic Construction	E-1129
PH-501	27936	Transmitter, pH, Prominent Dulcometer pH or ORP	4-20mA output, 7781499	E-1145
PI-201/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249

TAG	newterra Part Number	Part Description	Extended Part Description	Page
PI-301	16196	Gauge, Pressure, 0-15psi, Indumart, P16T2-FG-15	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-301/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-401/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-501/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-551/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-553/554 PI-703/704	16203	Gauge, Pressure, 0-60psi, Indumart, P16T2-FG-60	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-601/602	30098	Gauge, Pressure, 0-15psi, Indumart, P16K2-FG-15		E-1249
PSL-301	10218	Switch, Pressure, 1823-2	0.5-2" wc, Dwyer, Nema 1	E-1250
PSL501	10547	Switch, Pressure, 1823-40	5-44" wc, Dwyer, Nema 1	E-1250
PSL-601/2	10547	Switch, Pressure, 1823-40	5-44" wc, Dwyer, Nema 1	E-1250
PSL-7911	10218	Switch, Pressure, 1823-2	0.5-2" wc, Dwyer, Nema 1	E-1250
PSL-7911	12877	Meter, Flow, Pitot Tube, 4"	Multi-Point Averaging	E-1254
SCR-201/2	33737	Switch, Level, Ultrasonic, Flowline, LU10-1405	Long Style	E-1257
SCR-201/2	35907	Filter, Rotary screen, Newterra 17" wide SCR-50	0.5mm Wedge Wire	E-1277
SCR-201/2	38219	Gear Motor, 230/460V 50/60 3P, 60/50hz 1/4hp	SK1SI63/H10-56C-63L/4 FRD DIV2 NSD+ 400:1 Nord Gear, 4.3 RPM, CSA CL1 DIV2	E-1278
TNK-101/2	26009	Tank, Closed Top, Cylindrical, 2100 gal, Norwesco - no drain	87dia 89 tall, 1.9sg, Heavy Walled, blue	E-1348
TNK-103	23980	Tank, closed top, cylindrical, ACO CT-450-DT	450 Imp. Gal., 16" lid with locking strap	E-1364
TNK-201	38224	Tank, Open Top, Rectangular, 192 gal	540 US Gal 72x36x48	E-1365
TNK-401/502	38229	Eductor Mixing, Elmridge ME20P	Poly Pro 3/4" inlet	E-1366

TAG	newterra Part Number	Part Description	Extended Part Description	Page
TNK-801	21203	Tank, Open Top, Cylindrical, 60 Imp gal, OT-60	Aco Tanks With Lid, 22x44 270Liter	E-1368
TNK-901	26009	Tank, Closed Top, Cylindrical, 2100 gal, Norwesco - no drain	87dia 89 tall, 1.9sg, Heavy Walled, blue	E-1348
TSL-301/401/ 501/502	15653	Switch, Temperature, Probe, A19AAF-12C	25-225 deg F, 10 foot Capillary Tube	E-1369
TSLL/TSH	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
TSLL7911	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
TSLL-7941	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
VT-701 702	27810	Transmitter, Pressure/ Vacuum, IFM efector	PG2409 Scale -14.5- 14.5 PSI 4-20mA	E-1375

Valve, Relief, Back Pressure, Kunkle, 1", Liquid Service
Set @ 50 PSI, 0019-E01-MG0050

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Definitions and Commonly Used Terms

A.S.M.E.
American Society of Mechanical Engineers.

A.P.I.
American Petroleum Institute

PRV
Relief Valve, Safety Valve, Safety Relief Valve.

Back Pressure
The pressure that exists at the outlet of a pressure relief device as a result of the pressure in the discharge system. It is the sum of the superimposed and built-up back pressures.

Built-up Back Pressure
The increase in pressure in the discharge header that develops as a result of flow after the pressure relief device opens.

Blowdown
The difference in pressure between the opening pressure and reclose pressure. May be expressed in percent of set pressure or "psig."

Body/Nozzle/Seat
The stationary seating surface, the inlet.

Cap
The pressure screw cover and/or lever housing. May be screwed, bolted, packed, or plain lever.

Chatter
Abnormal, rapid reciprocating movement of the disc on the seat of a pressure relief valve.

Coefficient of Discharge
The ratio of the measured relieving capacity to the theoretical relieving capacity.

Disc
The moveable seating surface.

Gag
A device attached to a safety or safety relief valve that prevents it from opening at the set pressure.

Guide
That portion of the valve used to guide the disc.

Lift
The distance between the seat and disc seating surfaces when the valve is in the full open position.

MAWP
Maximum allowable working pressure. This data is found on the pressure vessel nameplate and is the maximum pressure at which the lowest set safety valve must be set (stamped).

N.B.
National Board of Boiler and Pressure Vessel Inspectors.

Operating Pressure
The gauge pressure at which a pressure vessel is maintained in normal operation. The operating pressure should not be in excess of 90 percent of the PRV set pressure.

Accumulation
The permitted increase in pressure developed after the valve has opened. Usually expressed in percentage, maximum allowable accumulations are established by applicable codes for operating and fire contingencies.

Pre-open/Warn
An audible or visual discharge at a pressure slightly lower than the set pressure. Warns the operator that the valve is about to operate.

Pressure Relief Device
A device actuated by inlet static pressure and designed to open during an emergency or abnormal condition to prevent a rise of internal fluid pressure in excess of a specified value. The device may also be designed to prevent excessive internal vacuum. The device may be a pressure relief valve, a non-reclosing pressure relief device, or a vacuum relief valve.

psia
Pounds per square inch absolute or absolute pressure. Absolute pressure is equal to gauge pressure plus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

psig
Pounds per square inch gauge or gauge pressure. Differential pressure across the valve, equal to absolute pressure inside the pressure vessel minus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

Relief Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve. The valve opens normally in proportion to the pressure increase over the opening pressure. A relief valve is used primarily with incompressible fluids (liquids).

Safety Relief Valve
A spring-loaded pressure relief valve that may be used as either a safety or relief valve depending on the application.

Safety Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve and characterized by rapid opening or pop action. A safety valve is normally used with compressible fluids.

Set Pressure
The gauge pressure at which a safety valve visibly and audibly opens or at which a relief valve discharges a 1" long unbroken stream of liquid.

Spindle/Stem
The rod connecting to the disc.

Stamped Capacity
The rated relieving capacity that appears on the device nameplate. The stamped capacity is based on the set pressure or burst pressure plus the allowable overpressure for compressible fluids and the differential pressure for incompressible fluids.

Superimposed Back Pressure
The static pressure that exists at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system coming from other sources and may be constant or variable.

Warn Ring or Regulator Ring
The control ring which surrounds the seat, used to control preopen and blowdown.

Yoke/Bonnet
The portion of a safety/relief valve that surrounds the spring; the spring housing.

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ASME Codes

The ASME (American Society of Mechanical Engineers) boiler and pressure vessels code requirements for overpressure protection as they relate to Kunkle products is as follows:

ASME Section I

This code applies to boilers where steam or other vapor is generated at a pressure of 15 psig [1.03 barg] or greater and high temperature water boilers intended for operation at pressures exceeding 160 psig [11.03 barg] and/or temperatures exceeding 250°F [121°C].

Boiler Pressure Accumulation

No more than 6 percent above the highest pressure at which any valve is set, or no more than 6 percent above MAWP.

Set Pressure

The set pressure of a one valve installation cannot be higher than the MAWP. The set pressure of the second or other valves in a multiple valve installation can be up to 3 percent above the MAWP. The complete range of valve settings for multiple valve installations cannot be greater than 10 percent of the highest set pressure. For high temperature water boilers, this 10 percent range may be exceeded.

ASME Section IV

This code applies to steam boilers operating at pressures not greater than 15 psig [1.03 barg] and hot water heating boilers operating at pressures not greater than 160 psig [11.03 barg] and/or temperatures not exceeding 250°F [121°C].

Steam Boilers

Valve capacity must be selected to prevent the boiler pressure from rising more than 5 psig [0.35 barg] above the MAWP.

Hot Water Boilers

Safety valve must be set to relieve at a pressure not greater than the MAWP of the boiler. If more than one safety valve is used, the secondary valve(s) may be set up to 6 psig [0.41 barg] above the MAWP for boilers with MAWPs up to and including 60 psig [4.13 barg], and 5 percent for boilers with MAWPs greater than 60 psig [4.13 barg]. Capacity must be selected to prevent the pressure from rising more than 10 percent above the set pressure of the highest set valve if more than one valve is used.

Tanks/Heat Exchangers High Temperature Water-to-Water Heat Exchangers

Valve(s) must be set at a pressure not greater than the MAWP and with sufficient capacity to prevent the pressure from increasing more than 10 percent above the MAWP.

Steam to Hot Water Supply

Valve(s) must be a least 1" [25 mm] diameter with set pressure not greater than MAWP of the tank.

High Temperature Water to Steam Heat Exchanger

Valve(s) must be set at a pressure not greater than 15 psig [1.03 barg] and with sufficient capacity to prevent the pressure from rising more than 5 psig [0.35 barg] above the MAWP.

ASME Section VIII

This code applies to unfired pressure vessels with an inside diameter larger than 6" [130 mm] and designed for use at or above 15 psig [1.03 barg]. Valve(s) must prevent the pressure from rising more than 10 percent or 3 psig [0.21 barg], whichever is greater, above the MAWP. For a single valve installation, the set pressure may not be greater than the MAWP. For multiple valve installations, the first valve cannot be set higher than the MAWP, but the other valves can be set up to 5 percent above the MAWP. The pressure rise for multiple valve installations can be 16 percent or 4 psig [0.27 barg], whichever is greater. When the vessel is exposed to an external heat source, such as fire, the pressure rise can be 21 percent above the MAWP.

Notes

1. MAWP - Maximum allowable working pressure.
2. Information stated above is based on latest code at time of publication.

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ASME Codes – Requirements

National Board

Kunkle valves are manufactured at facilities that meet the manufacturing requirements of the ASME Sections I, IV, and VIII codes for pressure relief valves. Valves that have the relief capacity certified by the National Board of Boiler and Pressure Vessel Inspectors bear the following code symbol stamp on the nameplate and the letters NB. Most Kunkle Valves have NB certified capacities.

Code Stamps

"V" - applies to all ASME Section I valves

"HV" - applies to all ASME Section IV valves

"UV" - applies to all ASME Section VIII valves

Notes

1. Information stated above is based on latest code at time of publication.
2. Non-code liquid valves are capacity rated at 25 percent overpressure.
3. Non-code air/gas/vapor and steam valves are capacity rated at 10 percent overpressure.

Power Boiler - Section I - Code "V"

Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown
15 – 66	[1.03 – 4.55]		2 – 4 psig [0.14 – 0.28 barg]
67 – 100	[4.62 – 6.90]		2 psi [0.14 barg] - 6%
101 - 250	[6.96 - 17.24]		2% - 6%
251 – 374	[17.31 – 25.79]		2% - 15 psig [1.03 barg]
375 – 1000	[25.86 – 68.96]		2% - 4%
15 – 69	[1.03 – 4.75]	±2 psig [±0.14 barg]	
70 – 300	[4.83 – 20.69]	±3%	
301 – 1000	[20.95 – 68.96]	±10% psig [±0.69 barg]	
1001 and up	[69.03 and up]	±1%	

1. Overpressure would be 2 psig [0.14 barg] for pressures between 15 psig [1.03 barg] and 70 psig [4.83 barg]. Pressures above 70 psig [4.83 barg] would have an overpressure of 3%.
2. Maximum blowdown for "Special Use" Section I is 10%.

Heating Boiler - Section IV - Code "HV"

	Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 psig Steam	15	[1.03]	±2 psig [±0.14 barg]	2 – 4 psig [0.14 – 0.28 barg]	5 psig [0.34 barg]
Hot Water	15 – 60	[1.03 – 4.14]	±3 psig [±0.21 barg]	N/A	10%
Hot Water	61 – 160	[4.20 – 11.0]	±5%	N/A	10%

Unfired Pressure Vessel - Section VIII - Code "UV"

Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 – 30	[1.03 – 2.07 barg]	±2 psig [±0.14 barg]	N/A	3 psig [0.21 barg]
31 – 70	[2.14 – 4.83 barg]	±2 psig [±0.14 barg]	N/A	10%
71 and up	[4.90 barg and up]	±3%	N/A	10%

Non-code Set Pressure Tolerance

Set Pressure, psig [barg]	Set Pressure Tolerance, psig [barg]
Below 15 psig [1.03 barg] to 10 psig [0.69 barg]	+/- 2.0 psig [±0.14 barg]
Below 10 psig [0.69 barg] to 5.0 psig [0.34 barg]	+/- 1.0 psig [±0.07 barg]
Below 5.0 psig [0.34 barg] to 0.0 psig [0.0 barg]	+/- 0.5 psig [±0.003 barg]
Below 0.0-inch Hg [0.0 mb] to 10-inch Hg [337 mb]	+/- 1.0-inch Hg [±33.7 mb]
Below 10-inch Hg [337 mb] to 20-inch Hg [674 mb]	+/- 2.0-inch Hg [±67.4 mb]
Below 20-inch Hg [674 mb]	+/- 4.0-inch Hg [±134.8 mb]

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General Safety and Relief Valve Information

Kunkle Factory Standard Seat Tightness

Code Section	Service	Performance Standard
I and VIII	Steam	No visible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
VIII	Air/Gas	No audible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
IV and VIII	Liquid	No visible leakage for 30 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
IV	Steam	No visible leakage for 30 seconds at 12 psig [0.83 barg].

API - 527 Seat Tightness

Model	Code Section	Service	Performance Standard
300/600 6000 900	I and VIII	Steam	API 527 - No visible leakage for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
6010 (O-ring seat) 916/917 (soft seat) 918/919 (soft seat)	VIII	Air/Gas	API 527 - Bubble-tight for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
910/912 911/913	VIII	Air/Gas	API 527 - D and E orifice: 40 bubbles/min, F thru J orifice: 20 bubbles/min at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
916/917 (soft seat) 918/919 (soft seat)	VIII	Liquid	API 527 - No leakage for 1 minute at 10% below nameplate set pressure, or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
910/912 911/913	VIII	Liquid	API 527 - 10 cc/h for inlet sizes less than 1" or 10 cc/h/in of inlet valve size for inlet sizes 1" and larger at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.

Note

API 527 is not available on air service for:

a. Plain lever "J" orifice Models 900 and 6000.
b. Plain lever Model 900 above 444 psig [30.6 barg] set pressure.

The terms "safety valve" and "relief valve" are frequently used interchangeably. This is satisfactory to the extent that both safety and relief valves of the spring-loaded type are similar in external appearance and both serve the broad general purpose of limiting media (liquid or gaseous) pressures by discharging some of the pressurized liquid or gas. Some authorities restrict "safety valves" to those installed on boilers, superheaters, and fired vessels - all others being classified as relief valves. We prefer, however, to define them briefly as follows:

Safety valves are used on gaseous service (which include air and steam). Their design always includes a huddling chamber which utilizes the expansion forces of these gases to effect quick opening (popping) and closing actions. The difference between the opening and closing pressures is termed "blowdown," and for Section I and IV steam safety valves blowdown limitations are carefully stated in the ASME Power Boiler Code. Relief valves are normally used for liquid service although safety valves may be so used. Ordinarily, relief valves do not have an accentuated huddling chamber nor a regulator ring for varying or adjusting blowdown. They therefore operate with a semi-modulating action in proportion to the system pressure. Such relieving action is desirable to protect piping systems from water hammer.

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Safety and Relief Valve Pointers

1. ASME Codes require that steam and air safety valves have test levers, although levers may be omitted on valves used in hazardous or toxic gas service.
2. Steam safety valves may be used for air service but not vice versa. Liquid valves should be used on liquid only.
3. Safety/relief valves should be installed vertically with the drain holes open or piped to a convenient location.
4. The inlet to and outlet from a safety/relief valve must be at least as large as the valve connections.
5. Every safety/relief valve is individually tested and set by Kunkle.
6. In the event you have safety/relief valve problems, first check the accuracy and cleanliness of pressure gauges and then refer to "Recommended Installation" for help in determining the cause of your problem. Feel free to consult your sales representative.
7. When ordering, we need to know size, type of connections, model number, pressure setting, required relieving capacity, and service media, or advise your complete requirements so that we can make a selection for you.
8. Following are procedures on the operation and testing of safety/relief valves:
   A. Avoid excessive operation of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
   B. Test the valve by raising the operating pressure to the set pressure of the safety/relief valve, allowing it to open and reset as it would in normal service.
   C. Do not hand operate the valve with less than 75 percent of the stamped set pressure exerted on the underside of the disc. When hand operating, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

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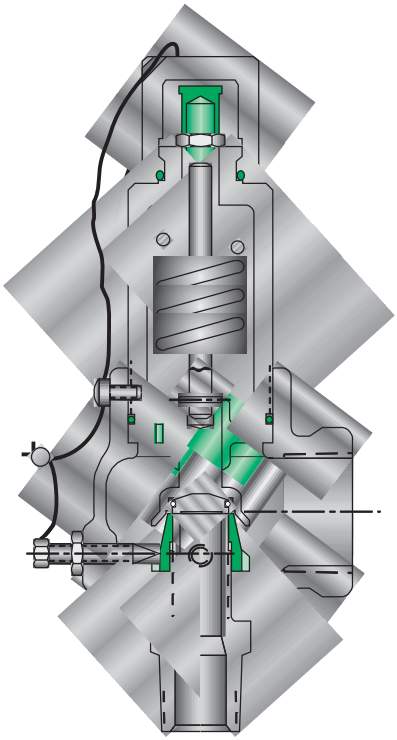
Safety and Relief Valve Principles of Operation

Kunkle direct spring operated pressure relief valves consist of a nozzle threaded into a cast body housing which is flanged to a pressurized system. A disc is held against the nozzle by a spring, which is contained in a bonnet. The spring is adjusted by a compression screw to permit the calibration of opening or set pressure.

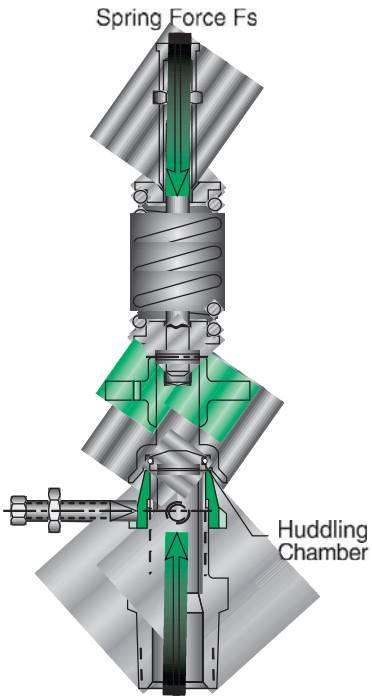


An adjustable nozzle ring, threaded onto the nozzle, controls the geometry of the fluid exit control chamber (huddling chamber). The huddling chamber geometry is very important in controlling valve opening and closing pressures, and stability of operation. The nozzle ring is locked into position by a ring pin assembly. A cap attached to the top of the bonnet seals the internal calibration adjustments. Refer to the illustration above for the location of these important components.

Under normal system operation the valve remains in the closed position because the spring force (Fs) is greater than the system pressure acting on the internal nozzle seating area (PA). If system pressure increases to a point when these forces are equal, the valve begins to simmer. The disc lifts and fluid flows through the valve. When pressure in the system returns to a safe level, the valve closes.

Just prior to reaching set point, the pressure relief valve leaks system fluid into the huddling chamber. The fluid now acts on a larger area of the disc inside the huddling chamber (PAh), causing the valve to experience an instantaneous increase in the opening force. Refer to the Figure on page 7 to see relationship between Nozzle Area (A) and the Huddling Chamber Area (Ah). System pressure acting on the larger area will suddenly open the pressure relief valve at a rapid rate.

Although the opening is rapid and dramatic, the valve does not open fully at set point. The system pressure must increase above the set point to open the valve to its full lift and full capacity position. Maximum lift and certified flow rates will be achieved within the allowable limits (overpressure) established by various codes and standards. All pressure relief valves are allowed an overpressure allowance to reach full rated flow.



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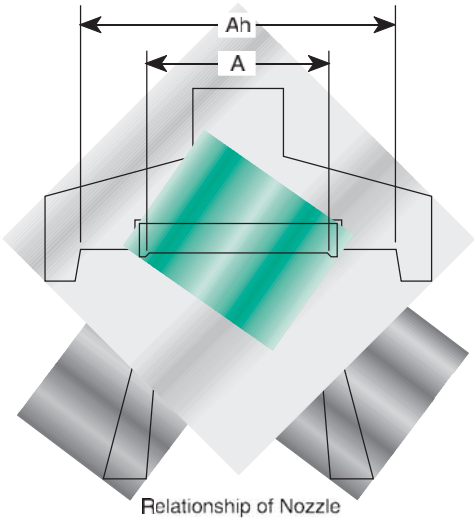
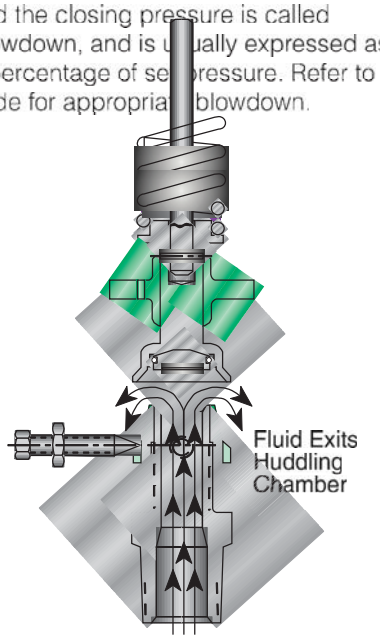
Safety and Relief Valve Principles of Operation



Relationship of Nozzle Area to Huddling Chamber Area

Once the valve has controlled the pressure excursion, system pressure will start to reduce. Since the huddling chamber area is now controlling the exit fluid flow, system pressure must reduce below the set point before the spring force is able to close the valve. The difference between the set pressure and the closing pressure is called blowdown, and is usually expressed as a percentage of set pressure. Refer to code for appropriate blowdown.



Valve Opens, Force P_{Ah} Acting on Disc

The nozzle ring adjustment changes the shape and volume of the huddling chamber, and its position will affect both the opening and closing characteristics of the valve. When the nozzle ring is adjusted to its top position, the huddling chamber is restricted to its maximum. This ring position will usually make the valve pop very distinctly with a minimum simmer (leakage before opening), but the blowdown will increase. When the nozzle ring is lowered to its lowest position, minimal restriction to the huddling chamber occurs. At this position, simmer increases and the blowdown decreases. The final ring position is somewhere between these two extremes to provide acceptable performance.

Liquid Service Operation

On liquid service, a different dynamic situation exists. Liquids do not expand when flowing across orifices, and a small amount of fluid flow across the nozzle will produce a large local pressure drop at the nozzle orifice. This local pressure drop causes the spring to reclose the valve if the fluid flow is minimal. Liquids leaking into the huddling chamber can quickly drain out by gravity and prevent fluid pressure from building up on the secondary area of the huddling chamber. Liquid relief valves are thus susceptible to a phenomenon called chatter, especially at low fluid flow rates. Chatter is the rapid opening and closing of the pressure relief valve and is often destructive in nature.

Since no visible or audible pop is heard at set point, liquid set pressure is defined as the pressure when the first heavy flow occurs (first steady vertical flow).

Ordering Information

Purchase orders must show the Size, Model Number, Set Pressure, and Service. (Include flange rating with size when applicable.)

1. To make a proper catalog selection, the following information will be needed:
   - A. Connection sizes (in and out), and types (male, female, flanged; 125#, 150#, 250#, 300#, etc.)
   - B. Material of construction
     - a. Bronze
     - b. Iron
     - c. Steel
     - d. Stainless Steel or other
   - C. Pressure setting
   - D. Service (steam, air, gas, etc., including any applicable codes or standards)
   - E. Capacity required, if available
   - F. Unusual conditions (temperature, location, etc.)

     Be sure to use the capacity correction factors for superheated steam, liquid overpressure (10 percent), air-gas temperature and density correction.
   - G. If valve is to be "equal to" another brand, provide nameplate information or specification data from brand being replaced.
2. Ordering data for replacement valves may be obtained from the valve nameplate or stamping.

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Valve Selection

The most critical consideration when selecting a pressure relief valve is that the valve will be capable of passing the maximum expected flow capacity. To properly select a relief valve the user must first determine the following:

1. The set pressure at which the valve is to operate. This pressure is based on the pressure limits of the system and the applicable codes. The set pressure of the primary pressure relief valve must not exceed the maximum allowable pressure of the system, but should be at least 10 percent above the maximum operating pressure.
2. The physical properties of the fluid media to be relieved. Capacity values are given in the Kunkle catalogs based on air, saturated steam, and water. Kunkle valves will relieve many other fluids, but information such as molecular weight, specific gravity, viscosity, ratio of specific heats, compressibility factor, and process temperature may be necessary to insure accurate valve selection.
3. The required relieving capacity. The ASME Boiler and Pressure Vessel Code, American Petroleum Institute Recommended Practices, and other applicable standards have many rules for obtaining the required relieving capacity and should be referenced when making this determination. The user must consider all sources of pressure generation in the system that will be protected by the pressure relief valve. Examples of pressure generation sources are pumps, heat input that may cause the system fluid to boil or expand, etc. The pressure relief valve(s) selected must exceed the worst case source of flow generation to prevent the system pressure from exceeding acceptable limits.

Once the previous information has been collected, the pressure relief valve may be sized by using the capacity charts (included in each model's catalog sheet) or by performing sizing calculations (see Valve Sizing, pages 14-25). The user will also want to consider other important factors such as:

- Connection size and type. This information is given in the Valve Selection Guide and in each of the Model Catalog sheets. Please note that the inlet to and outlet from a pressure relief valve must be at least as large as the valve connections to prevent valve malfunction.
- Pipe Size. Connection pipe sizes should not be determined by equipment connections, but rather by the relieving capacity of the PRV.
- Applicable code compliance. The ASME Code Summary section gives important information about pressure relief valves from the code. Pressure relief valve users are strongly encouraged to reference the full version of the code for important rules that may not be included in this manual.
- Maximum allowable seat leakage. The General Safety and Relief Valve Information (page 6) section of this manual shows the leakage acceptance criteria applied to each Kunkle valve. Pressure relief valve users should keep in mind that if "zero leakage" is a requirement, a soft seated valve must be selected.
- Environmental conditions. Environmental conditions play a significant role in how pressure relief valves operate. Extremely high ambient temperatures may affect the set pressure of the valve, extremely low temperatures combined with moisture can cause valves to "freeze up" and prevent proper operation, and vibration may severely shorten the service life of the valve. The Valve Selection Guide (pages 11-13) in this manual has general information on the pressure and temperature limits for each valve series. For specific model limitations refer to the individual model catalog. For vibration service, please contact your local Kunkle representative for assistance.
- Valve options. Each Kunkle model is offered with useful options such as pressure tight caps, lift lever options, or vibration dampening preparation. When selecting valve options, keep in mind that there are code requirements that may dictate what options may be used. For instance the ASME code dictates that all air, steam and hot water (140°F+[60°C+]) pressure relief valves must be equipped with a lift lever. Refer to the individual model catalogs for listings of available options.
- Installation space. The individual model catalogs show envelope dimensions for each configuration and size.

For assistance on valve sizing and selection, please contact your local sales representative.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Steam (ASME Section I - Power Boilers)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[1] Press.		Min/Max Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
300, 600	CS	SS		X	1¼ - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-29/427]
920, 921, 927 (special use – 10% blowdown)	CS	SS	X		½ - 2"	[12.7 - 50.8]	15/1400	[1.0/96.5]	-20/800	[-29/427]
6010, 6021, 6121, 6182 6186, 6221, 6283	Bronze	Brass	X		½ - 2½"	[12.7 - 63.5]	3/250	[0.69/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		½ - 2½"	[12.7 - 63.5]	3/300	[0.69/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Steam (ASME Section VIII - Unfired Steam Equipment)

1 and 2	Bronze	Brass	X		½ - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
264, 265	CS	SS	X		½ - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		½ - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS		X	1¼ - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/750	[-29/399]
910	CS	SS	X	O	½ - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911	SS	SS	X	O	½ - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912	Bronze	Brass	X		½ - 2"	[12.7 - 50.8]	3/250	[0.21/17.2]	-320/406	[-195/208]
913	Bronze	SS	X		½ - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/425	[-195/219]
6010, 6021, 6121, 6182, 6186, 6221, 6283	Bronze	Brass	X		½ - 2½"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		½ - 2½"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Steam (ASME Section IV - Low Pressure Steam Heating Boilers)

930	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	15 only	[1.0]	250 only	[122]
6933, 6934	Bronze	Brass	X		½ - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6935	Bronze	SS	X		½ - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6254	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	15 only	[1.0]	250 only	[122]

Steam (Non-code)[2]

40R, 40RL	SS	SS	X		½ - ¾"	[12.7 - 19.05]	1/400	[0.07/27.6]	-60/850	[-51/454]

X = Standard O = Optional

Notes

1. Set pressures less than 15 psig [1.0 barg] are non-code only.
2. See also ASME Section VIII steam valves for non-code steam applications.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Air/Gas (ASME Section VIII)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[3] Press.		Min/Max[4] Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
1 and 2	Brass	Brass	X		1/2 - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
30	Brass	Brass	X		1/4"	[6.35]	60/4000	[4.1/275.8]	20/300	[-6.6/150]
189	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	1000/2500	[69/344.8]	-320/350	[-195/177]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS		X	1 1/4 - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-195/427]
330[5]	Aluminum	SS	X		1/4"	[6.35]	1000/5500	[69/379.3]	-20/185	[-29/85]
330S, 333S[5]	Aluminum	SS			1/4"	[6.35]	2000/6500	[138/448.3]	-20/185	[-29/85]
337	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	1/60	[0.07/4.14]	-20/406	[-29/208]
338	Aluminum	Brass	X		2"	[50.8]	5/30	[0.3/2.07]	-30/400	[-34/204]
363	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/1000	[3.4/69]	-320/350	[-195/177]
389	SS	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/2500	[3.4/172.4]	-320/350	[-195/177]
541 (Buna disc), 542 (Viton® disc), 548 (SS disc)	Brass	Brass	X		1/4 - 1/2"	[6.35 - 12.7]	3/400	[0.21/27.6]	-20/400	[-29/204]
910, 916 (soft seat)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
6010, 6121, 6182 6186, 6221, 6283[1]	Bronze	Brass	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6320	Bronze	SS	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Air/Gas[2] (Non-code)

230 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	300/1500	[20.7/103.4]	-20/185	[-29/85]
803 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	1000/6000	[69/413.8]	-20/185	[-29/85]
818 (Teflon® seat)	CS	SS/Brass	X		2"	[50.8]	120/150	[8.3/10.3]	-20/300	[-29/150]

Air/Gas (Vacuum) in Hg [mm Hg]

215V	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	2/29	[50/736]	-20/406	[-29/208]
910, 916 (soft seat)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/425	[-195/219]

X = Standard O = Optional

Notes

1. Soft seat available on some models.
2. See also Section VIII air valves for non-code air/gas applications.
3. Set pressures less than 15 psig [1.0 barg] are non-code only.
4. Temperature limits of soft seats determine operating limits of valve.
5. Kynar® or Urethane Seat.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range in	Inlet Size Range [mm]	Min/Max[1] Press. psig	Min/Max[1] Press. [barg]	Min/Max[2] Temp. °F	Min/Max[2] Temp. [°C]
Liquid (ASME Section IV - Hot Water Boilers)										
537 (soft seat)	Iron/Bronze		Brass	X	3/4 - 2"	[19.05 - 50.8]	15/160	[1.0/11]	-20/250	[-29/121]
Liquid (ASME Section VIII)										
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
Liquid (Non-code)										
19, 20	Bronze	Bronze	X	O	1/2 - 3"	[12.7 - 76.2]	1/300	[0.07/20.7]	-60/406	[-51/208]
19M, 20M	Bronze	SS	X	O	2 1/2 - 3"	[63.5 - 76.2]	1/500	[0.07/34.5]	-60/406	[-51/208]
71S	Iron	SS	X		1/2 - 2"	[12.7 - 50.8]	1/250	[0.07/17.2]	-20/406	[-29/208]
171, 171P	CS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/550	[-29/288]
171S	SS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/550	[-29/288]
91	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	5/400	[0.34/27.6]	-20/406	[-29/208]
218,228	Iron	Bronze	X		3, 4, and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
140	SS	SS	X		3/8 - 1/2"	[9.5 - 12.7]	10/300	[0.69/20.7]	-60/406	[-51/208]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
Liquid - Underwriters Laboratories (UL) For Oil Services										
200A	Bronze	Brass	X		3/4 - 1 1/2"	[19.05 - 38.1]	1/200	[0.07/13.8]	-60/406	[-51/208]
200H	Bronze	SS	X	O	3/4 - 2"	[19.05 - 50.8]	1/200	[0.07/13.8]	-60/406	[-51/208]
Liquid - Underwriters Laboratories (UL) and Factory Mutual Research (FM) For Fire Pump Water Relief										
218, 228	Iron	Bronze	X	X	3, 4 and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
918 (soft seat)[2, 3]	Bronze	Brass	X		3/4 - 1"	[19.05 - 25.4]	60/250	[4.1/17.2]	-20/406	[-29/208]
Other - Drip Pan Elbow										
299	Iron	N/A	X	X	2 - 8"	[50.80 - 203.2]	N/A	N/A	-20/406	[-29/208]

X = Standard O = Optional

Notes

1. Set pressures below 15 psig [1.0 barg] are non-code only.
2. Temperature limits of soft seats determine operating limits of valve.
3. FM Approved only.

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Valve Sizing

After the required relieving capacity has been determined, the pressure relief valve may be sized by using the capacity charts that are included in each model's catalog sheet. The capacities given in those charts may be adjusted for special conditions such as fluid density and temperature by using the correction factors given in Tables B through D (pages 18-20). Valves may also be sized by performing sizing calculations per the formulas (pages 15 and 16) in this section.

Most Kunkle valves may be sized by using the "Coefficient Method" (listed below). These valves typically are high lift valves where the nozzle bore is the flow controlling orifice. This calculation method involves selecting the valve model and corresponding flow coefficient and orifice area from Table A (page 16) and then using the capacity formula (page 14) for the service in which the valve will function.

Kunkle Models 30, 541, 542, and 548 use the "Slope Method" for sizing calculations. These valves are typically low lift valves, where the annular orifice between the disc and the nozzle seat is the flow controlling orifice. These models are characterized by having a linear increase in capacity with respect to inlet pressure. The "slope" defines this direct relationship of inlet pressure to capacity. Consult your sales representative for sizing assistance.

Kunkle Models 1, 2, 19, 20, 200, 71S, 171, 171S, 91, 218, 228, and 140 use the "KA Method" for sizing calculations. This method is similar to the slope method, in that it is used for low lift valves and is empirically derived. The major difference is that the relationship between inlet pressure and capacity is not linear. These valves are characterized by having low lift that varies with inlet pressure, which makes the flow controlling orifice area indeterminate. Consult your sales representative for sizing assistance.

IV-A Coefficient Method

Follow these steps for calculating what orifice size is necessary to flow the required capacity:

1. Select the Model Family that you are interested in from the Valve Selection Guide (pages 10-13).
2. From Table A (page 17), record the Flow Coefficient (K_d) corresponding to the service in which the valve will operate.
3. Select the proper formula(s) for the service in which the valve will operate. Calculate the minimum required orifice area.
4. Select the Orifice/Size Designation from Table A (page 17) that has a Flow Area closest to, but not less than the minimum required orifice area calculated in step 3.

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Valve Sizing

U.S. Units | **Metric Units**

Steam - Sections I, IV and VIII (15 psig and above)

$$A = \frac{W}{51.5\ K_d\ P_1\ K_{sh}}$$

$$A = \frac{W}{52.5\ K_d\ P_1\ K_{sh}}$$

Steam - Non Code (less than 15 psig)

$$A = \frac{W}{735\ F_2\ K_d}\sqrt{\frac{TZ}{M\ P_1\ (P_1 - P_2)}}$$

$$A = \frac{W}{558\ F_2\ K_d}\sqrt{\frac{TZ}{M\ P_1\ (P_1 - P_2)}}$$

Air - Section VIII (15 psig and above)

$$A = \frac{V\sqrt{MTZ}}{6.32\ C\ K_d\ P_1}$$

Volumetric Flow

$$A = \frac{V\sqrt{MTZ}}{17.02\ C\ K_d\ P_1}$$

Volumetric Flow

$$A = \frac{W}{C\ K_d\ P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

$$A = \frac{1.316W}{C\ K_d\ P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

Air - Non-Code (less than 15 psig)

$$A = \frac{V}{4645.2\ F_2\ K_d}\sqrt{\frac{MTZ}{P_1\ (P_1 - P_2)}}$$

$$A = \frac{V}{12503\ F_2\ K_d}\sqrt{\frac{MTZ}{P_1\ (P_1 - P_2)}}$$

Liquid - Section VIII (15 psig and above)

$$A = \frac{Q}{38\ K_d}\sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

$$A = \frac{Q}{5.094\ K_d}\sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

Liquid - Non-Code

$$A = \frac{Q}{38\ K_d}\sqrt{\frac{G}{(1.25\ p_1 - p_2)}}$$

$$A = \frac{Q}{5.094\ K_d}\sqrt{\frac{G}{(1.25\ p_1 - p_2)}}$$

F_2 - Coefficient of Subcritical Flow

$$F_2 = \sqrt{\left(\frac{k}{k-1}\right)\left(r\right)^{2/k}\left[\frac{1 - r^{(k-1)/k}}{1 - r}\right]}$$

Note

1. Consult your sales representative for sizing assistance for product groups: Fig. 1 and 2; Fig. 19, 20, 200; Fig. 30; Fig. 71S, 171, 171S; Fig. 91, 218, 228; Fig. 140; and Fig. 541, 542 and 548.

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Valve Sizing

Sizing Coefficient Method

A = Required effective discharge area of the valve, in^2 [cm^2]

W = Mass Flow Rate, lb/hr [kg/hr]

V = Volumetric Flow Rate (gases, vapors) in SCFM [Nm^3/hr] at standard atmospheric conditions of 14.7 psia and 60°F [1.013 bara/0°C]

Q = Volumetric Flow Rate (liquids) in GPM [m^3/hr] at standard atmospheric conditions of 14.7 psia and 70°F [1.013 bara/21°C]

K_d = ASME Flow Coefficient of Discharge

P_1 = See chart below

P_2 = Atmospheric Pressure = 14.7 psia

p_1 = Set Pressure (psig)

p_2 = Back Pressure (psig)

F_2 = Coefficient of Subcritical Flow

k = Ratio of Specific Heat - 1.31 for Steam, 1.4 for Air

r = Ratio of Back Pressure to Upstream Relieving Pressure = P_2/P_1

M = Molecular Weight of Process Medium

T = Relieving Temperature, °R = °F + 460 [°K = °C + 273]

Z = Compressibility Factor (assume Z = 1 if unknown)

C = Gas Constant based on k (if unknown, use C = 315)

G = Specific Gravity of process fluid at 70°F [21°C]

K_{sh} = Superheat Steam Correction Factor

Allowable Overpressure

Designation	Section	Definition
P_1	Section I Steam (15 psig and above)	Set pressure + 3% or 2 psi overpressure (whichever is greater) + 14.7 psia
P_1	Section IV Steam (15 psig and above)	Set pressure + 5 psi overpressure + 14.7 psia for Low Pressure Steam Boilers
P_1	Section IV Hot Water (15 psig and above)	Set pressure + 10% overpressure + 14.7 psia for Hot Water Boilers
P_1	Non-Code Steam (below 15 psig)	Set pressure + 10% overpressure + 14.7 psia
P_1	Section VIII Steam (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	Non-Code Air (below 15 psig)	Set pressure + 10% overpressure + 14.7 psia
P_1	Section VIII Air (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	Non-Code Liquid (below 15 psig)	Set pressure (psig)
P_1	Section VIII Liquid (15 psig and above)	Set pressure (psig)

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Valve Sizing

Table A

Model Family	Orifice/Size Designation	Flow Area in²	Flow Area [cm²]	Flow Coefficient (K_d) Non-Code and ASME Section VIII Air/Gas and Steam	ASME Section I Steam	ASME Section IV Steam	Non-Code and ASME Section VIII Liquid
189	C	0.034	[0.219]	0.874			
	D	0.034	[0.219]	0.874			
264	C	0.110	[0.710]	0.766			0.408
	D	0.110	[0.710]	0.766			0.408
	E	0.110	[0.710]	0.766			0.408
337	H	1.838	[11.858]	0.860			
	J	2.786	[17.974]	0.860			
	K	4.037	[26.045]	0.860			
537	D	0.533	[3.439]			0.806	
	E	0.833	[5.374]			0.806	
	G	1.767	[11.400]			0.806	
	H	3.142	[20.271]			0.806	
910	D	0.121	[0.781]	0.878	0.878		0.710
	E	0.216	[1.394]	0.878	0.878		0.710
	F	0.337	[2.174]	0.878	0.878		0.710
	G	0.553	[3.568]	0.878	0.878		0.710
	H	0.864	[5.574]	0.878	0.878		0.710
	J	1.415	[9.129]	0.878	0.878		0.710
930	H	5.080	[32.774]			0.818	
	J	6.350	[40.968]			0.818	
	K	7.620	[49.161]			0.818	
6010	D	0.121	[0.781]	0.878	0.878	0.878	
	E	0.216	[1.394]	0.878	0.878	0.878	
	F	0.337	[2.174]	0.878	0.878	0.878	
	G	0.553	[3.568]	0.878	0.878	0.878	
	H	0.864	[5.574]	0.878	0.878	0.878	
	J	1.415	[9.129]	0.878	0.878	0.878	
6252	J	1.414	[9.123]	0.878	0.878	0.878	
	K	2.022	[13.045]	0.878	0.878	0.878	
	L	3.138	[20.245]	0.878	0.878	0.878	
	M	3.960	[25.548]	0.878	0.878	0.878	
	N	4.774	[30.800]	0.878	0.878	0.878	
	P	7.018	[45.277]	0.878	0.878	0.878	
	Q	12.155	[78.419]	0.878	0.878	0.878	
	R	17.600	[113.548]	0.878	0.878	0.878	

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Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 280 [138]	300 [149]	320 [160]	340 [171]	360 [182]	380 [193]	400 [205]	420 [216]	440 [227]	460 [238]	480 [249]	500 [260]	520 [271]	540 [282]	560 [293]
15	[1.03]	250	[121]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
20	[1.38]	259	[126]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
40	[2.76]	287	[142]		1.00	1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
60	[4.14]	308	[153]			1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
80	[5.52]	324	[162]				1.00	1.00	.99	.99	.98	.97	.96	.94	.93	.92	.91	.90
100	[6.90]	338	[170]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
120	[8.27]	350	[177]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
140	[9.65]	361	[183]						1.00	1.00	.99	.98	.96	.95	.94	.93	.92	.91
160	[11.0]	371	[188]						1.00	1.00	.99	.98	.97	.95	.94	.93	.92	.91
180	[12.4]	380	[193]							1.00	.99	.98	.97	.96	.95	.93	.92	.91
200	[13.8]	388	[198]							1.00	.99	.99	.97	.96	.95	.93	.92	.91
220	[15.2]	395	[202]							1.00	1.00	.9	.98	.96	.95	.94	.93	.92
240	[16.6]	403	[206]								1.00	.99	.98	.97	.95	.94	.93	.92
260	[17.9]	409	[210]								1.00	.99	.98	.97	.96	.94	.93	.92
280	[19.3]	416	[213]								1.00	1.00	.98	.97	.96	.95	.93	.92
300	[20.7]	422	[217]									1.00	.99	.98	.96	.95	.93	.92
350	[24.1]	436	[225]									1.00	1.00	.99	.96	.96	.94	.93
400	[27.6]	448	[231]										1.00	.99	.96	.96	.95	.93
450	[31.0]	460	[238]											1.00	.96	.96	.96	.94
500	[34.5]	470	[243]											1.00	.96	.96	.96	.94
550	[37.9]	480	[249]												.97	.97	.97	.95
600	[41.4]	489	[254]												.97	.97	.97	.97
650	[44.8]	497	[258]													1.00	.99	.97
700	[48.3]	506	[263]													1.00	.99	.97
750	[51.7]	513	[267]													1.00	1.00	.98
800	[55.2]	520	[271]														1.00	.99
850	[58.6]	527	[275]														1.00	.99
900	[62.1]	533	[278]														1.00	1.00
950	[65.5]	540	[282]															1.00
1000	[69.0]	546	[286]															1.00
1050	[72.4]	552	[289]															1.00
1100	[75.9]	558	[292]															
1150	[79.3]	563	[295]															
1200	[82.7]	569	[298]															

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.

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Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 580 [305]	600 [316]	620 [326]	640 [338]	660 [349]	680 [360]	700 [371]	720 [382]	740 [393]	760 [405]	780 [416]	800 [427]	900 [482]	1000 [537]	1100 [593]
15	[1.03]	250	[121]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
20	[1.38]	259	[126]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
40	[2.40]	287	[142]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
60	[4.14]	308	[153]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
80	[5.52]	324	[162]	.89	.89	.88	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
100	[6.90]	338	[170]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
120	[8.27]	350	[177]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
140	[9.65]	361	[183]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
160	[11.0]	371	[188]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
180	[12.4]	380	[193]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
200	[13.8]	388	[198]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.78	.75	.72
220	[15.2]	395	[201]	.91	.90	.89	.88	.87	.86	.85	.84	.8	.83	.82	.81	.78	.75	.72
240	[16.6]	403	[206]	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.81	.78	.75	.72
260	[17.9]	409	[209]	.91	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.81	.78	.75	.72
280	[19.3]	416	[213]	.91	.90	.91	.88	.87	.86	.85	.85	.84	.83	.82	.82	.78	.75	.72
300	[20.7]	422	[217]	.91	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.78	.75	.72
350	[24.1]	436	[224]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.83	.82	.78	.76	.72
400	[27.6]	448	[231]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.79	.76	.72
450	[31.0]	460	[238]	.93	.92	.91	.89	.88	.87	.86	.86	.85	.84	.83	.82	.79	.76	.72
500	[34.5]	470	[243]	.93	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
550	[37.9]	480	[249]	.94	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
600	[41.4]	489	[254]	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.84	.83	.79	.76	.73
650	[44.8]	497	[258]	.95	.94	.92	.91	.90	.89	.87	.86	.86	.85	.84	.83	.79	.76	.73
700	[48.3]	506	[263]	.96	.94	.93	.91	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
750	[51.7]	513	[267]	.96	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
800	[55.2]	520	[271]	.97	.95	.94	.92	.91	.90	.88	.87	.86	.85	.84	.84	.80	.76	.73
850	[58.6]	527	[275]	.98	.96	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.76	.73
900	[62.1]	533	[278]	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.77	.73
950	[65.5]	540	[282]	.99	.97	.95	.94	.92	.91	.89	.88	.87	.86	.85	.84	.80	.77	.73
1000	[69.0]	546	[286]	.99	.98	.96	.94	.93	.91	.90	.89	.87	.86	.85	.84	.80	.77	.73
1050	[72.4]	552	[289]	1.00	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.80	.77	.73
1100	[75.9]	558	[292]	1.00	.99	.98	.95	.94	.92	.91	.89	.88	.87	.86	.85	.81	.77	.73
1150	[79.3]	563	[295]	1.00	.99	.98	.96	.94	.92	.91	.90	.88	.87	.86	.85	.81	.77	.73
1200	[82.7]	569	[298]	1.00	.99	.98	.97	.95	.93	.91	.90	.89	.87	.86	.85	.81	.77	.73

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.

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Valve Sizing

Table C - Air and Gas Temperature Correction Factors

Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc
0	1.062	90	0.972	260	0.849	440	0.760
10	1.051	100	0.964	280	0.838	460	0.752
20	1.041	120	0.947	300	0.828	480	0.744
30	1.030	140	0.931	320	0.817	500	0.737
40	1.020	160	0.916	340	0.806	550	0.718
50	1.009	180	0.902	360	0.796	600	0.701
60	1.000	200	0.888	380	0.787	650	0.685
70	0.991	220	0.874	400	0.778	700	0.669
80	0.981	240	0.862	420	0.769	750	0.656

For temperatures other than 60°F at valve inlet, multiply standard SCFM by Tc.

Table D - Gas and Liquid Relative Density Correction Factors

Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc
0.07	3.770	0.60	1.290	1.05	0.975	1.70	0.768
0.08	3.530	0.65	1.240	1.10	0.955	1.80	0.745
0.09	3.333	0.70	1.195	1.15	0.933	1.90	0.725
0.10	3.160	0.75	1.155	1.20	0.913	2.00	0.707
0.20	2.240	0.80	1.117	1.25	0.895	2.50	0.633
0.30	1.825	0.85	1.085	1.30	0.877	3.00	0.577
0.40	1.580	0.90	1.055	1.40	0.845	3.50	0.535
0.50	1.414	0.95	1.025	1.50	0.817	4.00	0.500
0.55	1.350	1.00	1.000	1.60	0.791	4.50	0.471

For a specific gravity other than air or water (=1.0), multiply CFM or GPM by Dc.

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Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Acetone	58.08	1.12	329
Acetylene (Ethyne)	26.04	1.26	343
Air	28.97	1.40	356
Ammonia, Anhydrous	17.03	1.31	348
Argon	39.95	1.67	378
Benzene (Benzol or Benzole)	78.11	1.12	329
Boron Trifluoride	67.82	1.20	337
Butadiene-1,3 (Divinyl)	54.09	1.12	329
Butane-n (Normal Butane)	58.12	1.09	326
Butylene (1-Butene)	56.11	1.11	328
Carbon Dioxide	44.01	1.29	346
Carbon Disulfide (C. Bisulfide)	76.13	1.21	33
Carbon Monoxide	28.01	1.40	356
Carbon Tetrachloride	153.82	1.11	328
Chlorine	70.91	1.36	353
Chloromethane (Methyl Chloride)	50.49	1.28	345
Cyclohexane	84.16	1.09	326
Cyclopropane (Trimethylene)	42.08	1.11	328
Decane-n	142.29	1.04	320
Diethylene Glycol (DEG)	106.17	1.07	323
Dimethyl Ether (Methyl Ether)	46.07	1.11	328
Dowtherm A	165.00	1.05	321
Dowtherm E	147.00	1.00	315
Ethane	30.07	1.19	336
Ethyl Alcohol (Ethanol)	46.07	1.13	330
Ethylene (Ethene)	28.05	1.24	341
Ethylene Glycol	62.07	1.09	326
Ethylene Oxide	44.05	1.21	338
Fluorocarbons:			
12, Dichlorodifluoromethane	120.93	1.14	331
13, Chlorotrifluoromethane	104.47	1.17	334
13B1, Bromotrifluoromethane	148.93	1.14	331
22, Chlorodifluoromethane	86.48	1.18	335
115, Chloropentafluoroethane	154.48	1.08	324
Glycerine (Glycerin or Glycerol)	92.10	1.06	322
Helium	4.00	1.67	378
Heptane	100.21	1.05	321

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Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Hexane	86.18	1.06	322
Hydrogen	2.02	1.41	357
Hydrogen Chloride, Anhydrous	36.46	1.41	357
Hydrogen Sulfide	34.08	1.32	349
Isobutane (2-Methylpropane)	58.12	1.10	327
Isoprene (2-Methyl-1, 3 Butadiene)	68.12	1.09	326
Isopropyl Alcohol (Isopropanol)	60.10	1.09	326
Krypton	83.80	1.71	380
Methane	16.04	1.31	348
Methyl Alcohol (Methanol)	32.04	1.20	337
Methylamines, Anhydrous			
Monomethylamine (Methylamine)	31.06	1.02	317
Dimethylamine	45.08	1.15	332
Trimethylamine	59.11	1.18	335
Methyl Mercapton (Methanethiol)	48.11	1.20	337
Naphthalene (Napthaline)	128.17	1.07	323
Natural Gas (specific gravity = 0.60)	17.40	1.27	344
Neon	20.18	1.64	375
Nitrogen	28.01	1.40	356
Nitrous Oxide	44.01	1.30	347
Octane	114.23	1.05	321
Oxygen	32.00	1.40	356
Pentane	72.15	1.07	323
Propadiene (Allene)	40.07	1.69	379
Propane	44.10	1.13	330
Propylene (Propene)	42.08	1.15	332
Propylene Oxide	58.08	1.13	330
Styrene	104.15	1.07	323
Sulfur Dioxide	64.06	1.28	345
Sulfur Hexafluoride	146.05	1.09	326
Steam	18.02	1.31	348
Toluene (Toluol or Methylbenzene)	92.14	1.09	326
Triethylene Glycol (TEG)	150.18	1.04	320
Vinyl Chloride Monomer (VCM)	62.50	1.19	336
Xenon	131.30	1.65	376
Xylene (p-Xylene)	106.17	1.07	323

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Acetaldehyde	0.779	68	20
Acetic Acid	1.051	68	20
Acetone	0.792	68	20
Ammonia, Anhydrous	0.666	68	20
Automotive Crankcase and Gear Oils:			
SAE-5W Through SAE 150	0.88-0.94	60	15.6
Beer	1.01	60	15.6
Benzene (Benzol)	0.880	68	20
Boron Trifluoride	1.57	-148	-100
Butadiene - 1, 3	0.622	68	20
Butane-n (Normal Butane)	0.579	68	20
Butylene (1-Butene)	0.600	68	20
Carbon Dioxide	1.03	-4	-20
Carbon Disulfide (C. Bisulfide)	1.27	68	20
Carbon Tetrachloride	1.60	68	20
Chlorine	1.42	68	20
Chloromethane (Methyl Chloride)	0.921	68	20
Crude Oils:			
32.6 Deg API	0.862	60	15.6
35.6 Deg API	0.847	60	15.6
40 Deg API	0.825	60	15.6
48 Deg API	0.79	60	15.6
Cyclohexane	0.780	68	20
Cyclopropane (Trimethylene)	0.621	68	20
Decane-n	0.731	68	20
Diesel Fuel Oils	0.82-0.95	60	15.6
Diethylene Glycol (DEG)	1.12	68	20
Dimethyl Ether (Methyl Ether)	0.663	68	20
Dowtherm A	0.998	68	20
Dowtherm E	1.087	68	20
Ethane	0.336	68	20
Ethyl Alcohol (Ethanol)	0.79	68	20
Ethylene (Ethene)	0.569	-155	-104
Ethylene Glycol	1.115	68	20
Ethylene Oxide	0.901	68	20

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Fluorocarbons:			
R12, Dichlorodifluoromethane	1.34	68	20
R13, Chlorotrifluoromethane	0.916	68	20
R13B1, Bromotrifluoromethane	1.58	68	20
R22, Chlorodifluoromethane	1.21	68	20
R115, Chloropentafluoromethane	1.31	68	20
Fuel Oils, Nos. 1, 2, 3, 5 and 6	0.82-0.95	60	15.6
Gasolines	0.68-0.74	60	15.6
Glycerine (Glycerin or Glycerol)	1.26	68	20
Heptane	0.685	68	20
Hexane	0.660	68	20
Hydrochloric Acid	1.64	60	15.6
Hydrogen Sulfide	0.78	68	20
Isobutane (2-Methylpropane)	0.558	68	20
Isoprene (2-Methyl - 1, 3-Butadiene)	0.682	68	20
Isopropyl Alcohol (Isopropanol)	0.786	68	20
Jet Fuel (average)	0.82	60	15.6
Kerosene	0.78-0.82	60	15.6
Methyl Alcohol (Methanol)	0.792	68	20
Methylamines, Anhydrous:			
Monomethylamine (Methylamine)	0.663	68	20
Dimethylamine	0.656	68	20
Trimethylamine	0.634	68	20
Methyl Mercapton (Methanethiol)	0.870	68	20
Nitric Acid	1.50	60	15.6
Nitrous Oxide	1.23	-127	-88.5
Octane	0.703	68	20
Pentane	0.627	68	20
Propadiene (Allene)	0.659	-30	-34.4
Propane	0.501	68	20
Propylene (Propene)	0.514	68	20
Propylene Oxide	0.830	68	20
Styrene	0.908	68	20
Sulfur Dioxide	1.43	68	20

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Sulfur Hexafluoride	1.37	68	20
Sulfuric Acid:			
95–100%	1.839	68	20
60%	1.50	68	20
20%	1.14	68	20
Toluene (Toluol or Methylbenzene)	0.868	68	20
Triethylene Glycol (TEG)	1.126	68	20
Vinyl Chloride Monomer (VCM)	0.985	-4	-20
Water, fresh	1.00	68	20
Water, sea	1.03	68	20
Xylene (p-Xylene)	0.862	68	20

Sizing - Determining K_v and K_w

U.S. Units

$$R = \frac{V_L\,(2{,}800\ G)}{\mu\sqrt{A}}$$

or

$$R = \frac{12{,}700\ V_L}{U\sqrt{A}}$$

Metric Units

$$R = \frac{31{,}313\ V_L\ G}{\mu\sqrt{A}}$$

Determining K_v

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

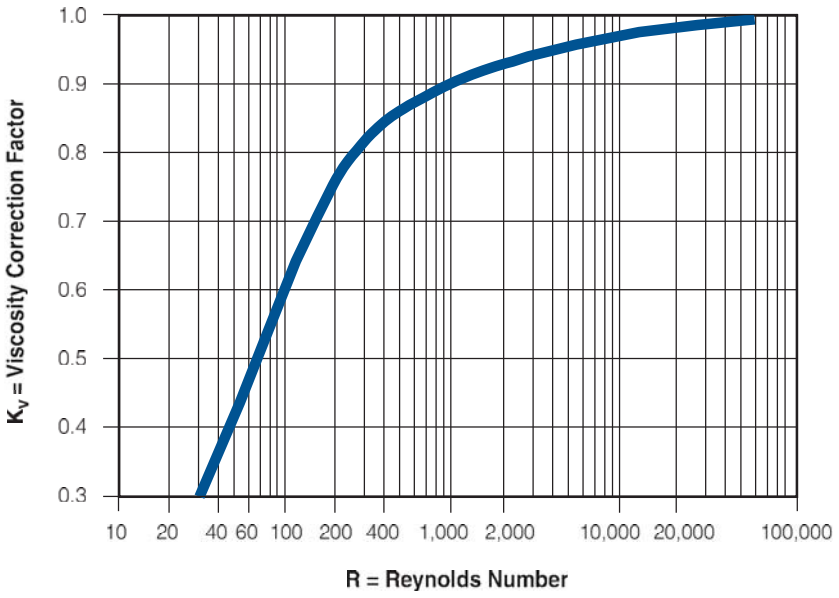
G = Specific gravity of liquid at flowing temperature referred to water = 1.00 at 70°F [21°C]

μ = Absolute viscosity at the flowing temperature, in centipoises

A = Effective discharge area, in square inches [cm²] (from manufacturer's standard orifice areas)

U = Viscosity at the flowing temperature, in Saybolt Universal seconds

After the value of R is determined, the factor K_V is obtained from the graph. Factor K_V is applied to correct the "preliminary required discharge area." If the corrected area exceeds the "chosen standard orifice area," the calculations should be repeated using the next larger standard orifice size.



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Conversion Factors

Absolute Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	poise	Centipoise	$\frac{gm}{cm-sec}$	$\frac{lb}{ft-sec}$
poise	—	100	1	0.0672
centipoise	0.01	—	0.01	0.000672
$\frac{gm}{cm-sec}$	1	100	—	0.0672
$\frac{lb}{ft-sec}$	14.88	1488	14.88	—

Notes

1. Kinematic viscosity x specific gravity = absolute viscosity.
2. Centistokes x specific gravity = centipoise.
3. Saybolt Second Universal (SSU) x 0.216 x specific gravity = centipoise.

Kinematic Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	stoke	Centistoke	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$
stoke	—	100	1	0.001076
centistoke	0.01	—	0.01	1.076 x 10-5
$\frac{cm2}{sec}$	1	100	—	0.001076
$\frac{ft2}{sec}$	929.0	92900	929.0	—

Liquid Flow Conversions

Given	To find desired value, multiply "Given" value by factor below				
	l/hr	gpm - US	gpm - Imp	barrels/day	m^3/hr
l/hr (litres/hour)	—	0.00440	0.003666	0.1510	0.0010
gpm (US gallons per minute)	227.1	—	0.8327	34.29	0.2271
gpm (Imperial gallons per minute)	272.8	1.201	—	41.18	0.2728
barrels/day (petroleum - 42 US gallons)	6.624	0.02917	0.02429	—	0.006624
$m^3$3/hr (cubic meters per hour)	1000	4.403	3.666	151.0	—
m^3/s (cubic meters per second)	3.6×10^6	0.02917	0.02429	—	0.006624
kg/hr (kilograms per hour)	$\frac{1}{G}$	$\frac{1}{227.1G}$	$\frac{1}{272.8G}$	$\frac{0.151}{G}$	$\frac{1}{1000G}$
lb/hr (pounds per hour)	$\frac{1}{2.205G}$	$\frac{1}{500.8G}$	$\frac{1}{601.5G}$	$\frac{1}{14.61G}$	$\frac{1}{2205G}$

Note

1. G = Specific gravity of liquid at its relieving temperature compared to that of water at 68°F [20°C], where $G_{water} = 1.00$.

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Conversion Factors

Notes

1. M = Molecular weight of vapor or gas.
2. Volumetric flow (per time unit of hour or minute as shown) in standard cubic feet per minute at 14.7 psia [1.013 bara], 60°F [16°C].
3. Weight flow in pounds per hour.
4. Weight flow in kilograms per hour.
5. Volumetric flow (per time unit of hour or minute as shown) at 1.013 bara 32°F [0°C]. This represents the commercial standard, known as the Normal Temperature and Pressure (NTP).

   Conversions from one volumetric flow rate to another or to weight flow (and vice versa) may only be done when the volumetric flow is expressed in the standard conditions shown above. If flows are expressed at temperature or pressure bases that differ from those listed above, they must first be converted to the standard base.

Gas Flow Conversions

Given	To find desired value, multiply "Given" value by factor below					
	SCFM	SCFH	lb/hr	[kg/hr]	[Nm³/hr]	[Nm³/min]
scfm[2]	—	60	$\frac{M}{6.32}$	$\frac{M}{13.93}$	1.608	0.0268
scfh[2]	0.01677	—	$\frac{M}{379.2}$	$\frac{M}{836.1}$	0.0268	0.000447
lb/hr[3] or #/hr[3]	$\frac{6.32}{M}$	$\frac{379.2}{M}$	—	0.4536	$\frac{10.17}{M}$	$\frac{0.1695}{M}$
kg/hr[4]	$\frac{13.93}{M}$	$\frac{836.1}{M}$	2.205	—	$\frac{22.40}{M}$	$\frac{0.3733}{M}$
Nm³/hr[5]	0.6216	37.30	$\frac{M}{10.17}$	$\frac{M}{22.40}$	—	0.01667
Nm³/min[5]	37.30	2238	5.901 M	2.676 M	60	—

If flow is expressed in actual volume, such as cfm (cubic feet per minute) or acfm (actual cfm) as is often done for compressors, where the flow is described as displacement or swept volume, the flow may be converted to scfm as follows (or from flow expressed in m³/hr to Nm³/hr).

Inch-Pound Units

$$SCFM = \left(\begin{matrix}cfm \\ or \\ acfm\end{matrix}\right) x \frac{14.7 + p}{14.7} \times \frac{520}{460 + t}$$

Where:

p = gauge pressure of gas or vapor in psig

t = temperature of gas or vapor in °F

Metric Units

$$Nm^3/hr = m^3hr = x \frac{1.013 + p}{1.013} \times \frac{273}{273 + t}$$

Where:

p = gauge pressure of gas or vapor in barg

t = temperature of gas or vapor in °C

Notes

1. Also expressed as kp/cm² and kgf/cm².
2. Normal Temperature and Pressure (NTP) Conditions are, at sea level, equal to 1.013 bara or 1.033 kg/cm² (kilograms force per square centimeter absolute) at a base temperature of 32°F [0°C]. This differs slightly from Metric Standard Conditions (MSC), which uses 1.013 bara 60°F [15°C] for the base temperature.
3. Inch-Pound Standard Conditions are, at sea level, equal to 14.7 psia (pounds force per square inch absolute), rounded up from 14.696 psia, and at a base temperature of 60°F [16°C].

Pressure Conversion

Given	To find desired value, multiply "Given" value by factor below			
	kPa	psig	kg/cm²	barg
kPa (kilopascal)	—	0.1450	0.0102	0.0100
psig (pounds/in²)[3]	6.895	—	0.0703	0.06895
kg/cm²[1][1](kilograms/cm²)	98.07	14.22	—	0.9807
barg	100.00	14.50	1.020	—

Area Conversion

Given	To find desired value, multiply "Given" value by factor below			
	in²	ft²	mm²	cm²
in²	—	0.006944	645.16	6.4516
cm²	0.155	1.076×10^{-3}	100	—
ft²	144	—	92900	929
mm²	0.00155	1.076×10^{-5}	—	0.01

Temperature Conversion

Degrees Celsius (°C)	Degrees Fahrenheit (°F)
C + 273.15 = K (Kelvin)	F + 459.67 = R (Rankine)
(C x 1.8) + 32 = F (Fahrenheit)	(F - 32) x 0.556 = C (Celsius)

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Installation

1. Before installing a new safety/relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Install the valve in a vertical position so that discharge piping and code required drains can be properly piped to prevent build-up of back pressure and accumulation of foreign material around the valve seat area.
3. Avoid over-tightening as this can distort safety/relief valve seats. One need only remember that as the vessel and valve are heated, the expansion involved will grasp the valve more firmly.
4. When installing flange connected valves, use new gaskets and draw the mounting bolts down evenly.
5. Do not use the valve outlet or cap as a lever for installation. Use only flat jawed wrenches on the flats provided.
6. Avoid excessive "popping" of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
7. Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the safety/relief valve.
8. Avoid having the operating pressure too near the safety/relief valve set pressure. A very minimum differential of 5 psig or 10 percent (whichever is greater) is recommended. An even greater differential is desirable, when possible, to assure better seat tightness and valve longevity. Safety/relief valves in high-temperature hot water and organic fluid service are more susceptible to damage and leakage than safety valves for steam. It is recommended that the maximum allowable working pressure of the boiler and the safety/relief valve setting be selected substantially higher than the operating pressure. A differential of 30-40 percent is recommended.
9. Avoid discharge piping where its weight is carried by the safety/relief valve. Even though supported separately, changes in temperature alone can cause piping strain. We recommend that drip pan elbows or flexible connections be used wherever possible (see Type A, B, C Installation, page 29).
10. Apply a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage.

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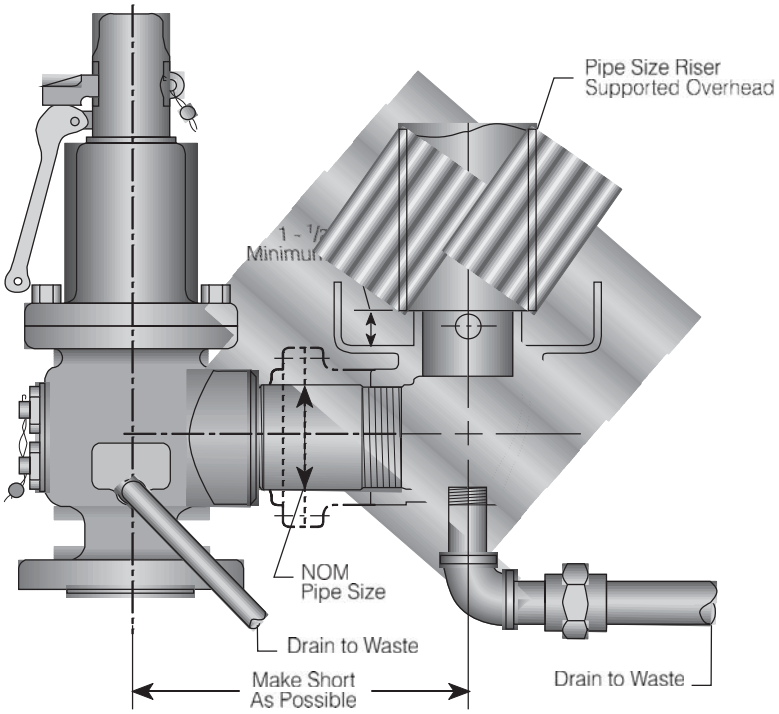
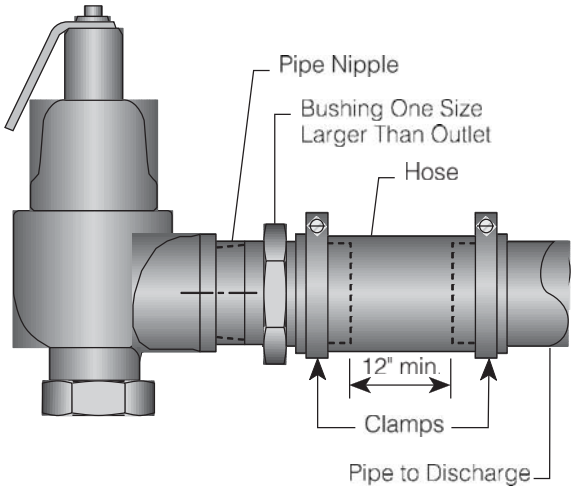
Installation

Recommended Discharge Installation

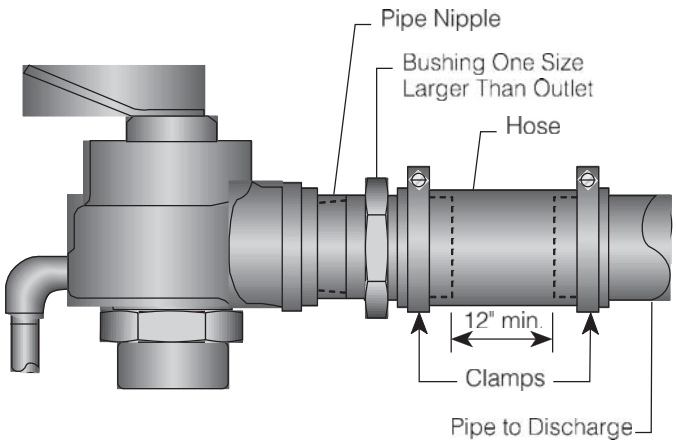
Type "A" Installation



Type "B" Installation



Type "C" Installation



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Maintenance

1. Develop a regular program of visual inspection, looking for clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.
2. Test the valve every two to six months (depending on valves' age and condition) preferably by raising the system pressure to the valves set pressure or operating the hand lever (see #3 in Operation).
3. Do not paint, oil, or otherwise cover any interior or working parts of any safety valve. They do not require any lubrication or protective coating to work properly.

When safety/relief valves require repair, service adjustments, or set pressure changes, work shall be accomplished by the manufacturer, or holders of "V," "UV," and/or "VR" stamps.

Guarantee

Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by buyer or user, accident, corrosion, chemical attack, or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle) immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced hereunder shall continue to be warranted for the remainder of the unexpired warranty period, if any. Any repair or replacement of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Black Mountain, North Carolina and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement goods or parts to buyer to repair defective goods, buyer agrees to install sold replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle) shall in no event be liable for any labor or material costs of buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality tests or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle) The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only, unless expressly stated as warranties. Except for the limited express warranty set forth in this section, Tyco Valves & Controls LP, Black Mountain (Kunkle) expressly disclaims all warranties, express and implied, oral and written, including, without limitation, any warranties regarding services rendered ancillary hereto, and the implied warranties of merchantability and fitness for a particular purpose, whether arising from statute, common law, civil code, custom or otherwise. Tyco Valves & Controls LP, Black Mountain's (Kunkle) warranty obligations and buyer's remedies for breach of warranty, except as to title, are solely and exclusively as stated in this section. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle), either before or after execution of this document, shall be made except in writing by the President, Vice President, or Director, Sales and Marketing of Tyco Valves & Controls LP, Black Mountain (Kunkle).

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2. Shipping Dates. The shipping dates, if any, set forth herein are approximate and are not guaranteed. Seller shall not be liable for any loss or damage for delay, non-delivery or other impairment of performance due to the actions or inactions of government, military authority, or Buyer, or by any reason of "force major," which shall be deemed to mean all other causes whatsoever not reasonably within the control of Seller, including, but not limited to, acts of God, war, riot, sabotage, fires, floods, strikes, lockouts or other industrial disturbances, delays of carriers, and inability to secure materials, fuel labor, transportation or manufacturing facilities at Seller's expected prices. Any delay resulting from any such cause shall extend shipping dates correspondingly. Seller shall in no event be liable for any special, incidental or consequential damages arising from delay irrespective of the reason thereof, and receipt by Buyer shall constitute acceptance of delivery and waiver of any claims due to delay. Should delivery be delayed due to Buyer's actions or inactions, or should delivery be delayed at the request of Buyer, the selling price of the goods shall automatically escalate at the rate of two percent [2%] per month for the duration of the delay or in an amount equal to Seller's increased cost, whichever is greater.
3. Drawings. If drawings are submitted herewith they are submitted only to show the general style, arrangement and approximate dimensions of the goods offered. No work is to be based on drawings unless the drawings are certified. Dimensional drawings certified by Seller will be furnished if agreed. In no event will manufacturing or proprietary drawings be supplied.
4. Risk of Loss. Buyer bears the risk of loss for damage to or destruction of the goods from and after the time same said goods are delivered either to the carrier for shipment to Buyer or to the Buyer, whichever occurs first, and regardless of whether or not Buyer may have the right to reject or revoke acceptance of said goods.
5. Shipment. If delivery specified is F.O.B. Seller's plant with freight allowed, Buyer shall pay to Seller, in addition to the purchase price, any and all transportation charges (including insurance).
6. Taxes. In addition to any prices specified herein, Buyer shall pay the gross amount of any present or future sales, use, excise, value-added, or other tax (whether federal, state, local or foreign) applicable to the price, sale, possession, or delivery of any goods or services furnished hereunder or to the use thereof by Buyer, or Buyer shall furnish Seller with a tax-exemption certificate acceptable to the levying taxing authority.
7. Payments. Buyer shall make payment in full for all goods ordered hereunder prior to shipment to Buyer, unless Buyer has entered into and agreed to Seller's Standard Credit Application and Agreement, in which event such Agreement is incorporated herein by reference and made a part hereof, unless and until such Agreement is terminated. The prices specified are in USA currency.
8. Warranties; Remedies. Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by Buyer or user, accident, corrosion, chemical attack or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and Buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to Buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon Buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle), immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Houston, Texas and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse Buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement good or parts to buyer to repair defective goods, Buyer agrees to install said replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle), shall in no event be liable for any labor or material costs of Buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality test or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle). The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only unless expressly stated as warranties. EXCEPT FOR THE LIMITED EXPRESS WARRANTY SET FORTH IN THIS SECTION, KUNKLE EXPRESSLY DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, ORAL AND WRITTEN, INCLUDING, WITHOUT LIMITATION, AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER ARISING FROM STATUTE, COMMON LAW, CIVIL CODE, CUSTOM OR OTHERWISE. KUNKLE'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES FOR BREACH OF WARRANTY, EXCEPT AS TO TITLE, ARE SOLELY AND EXCLUSIVELY AS STATED IN THIS SECTION. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle) either before or after execution of this document, shall be made except in writing by the President or a Vice President of Tyco Valves & Controls LP, Black Mountain (Kunkle).
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Terms and Conditions of Sales

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11. Returns; Cancellations. No goods may be returned except on prior written approval of Seller. Orders placed with and accepted by Seller may not be canceled except with the written consent of Seller prior to shipment and Buyer's acceptance of Seller's cancellation charges which shall protect Seller against all costs and losses. Seller shall have the right to cancel the sale of any or all of the goods sold hereunder, without liability to Buyer except for the refund of monies already paid hereunder, the event manufacture or sale of the goods is or becomes technically or economically impractical.
12. Product Modification. Seller reserves the right to discontinue the manufacture of, or charge or modify the design and/or construction of goods sold pursuant to this document for the purpose of product improvement, without incurring any obligation to Buyer with respect thereto.
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SMALL COMPACT FILTER SILENCERS
w/ "Hockey Puck" *Patented* Element
"FS" Series 1/4" - 1" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Hobby
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers

FEATURES & SPECIFICATIONS

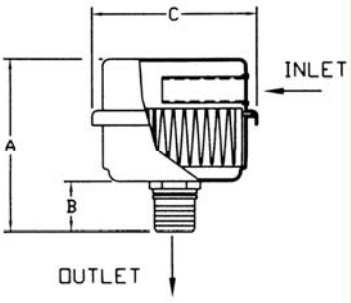
- Patented high grade element w/**Built-in** Butterfly gasket seal
  Creates positive seal between housing hemispheres
  New seal with each element, Minimizes parts
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable **Compact** carbon steel construction with black powder coated finish
- Ability to mount vertically, horizontally
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- A single noise attenuation graph is insufficient; please inquire for your specific requirement

OPTIONS (Inquiries Encouraged)

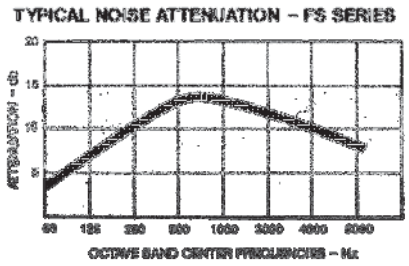
- Various media available
- Epoxy coated housings
- Straight Through Design (Vertical)
- Custom connections

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-05-025	FS-04-025	1/4"	70	16	64	7	7	14	1	0.11
I	FS-05-038	FS-04-038	3/8"	70	16	64	10	14	14	1	0.11
S	FS-07-038	FS-06-038	3/8"	90	16	83	14	14	20	1	0.23
I	FS-05-050	FS-04-050	1/2"	76	22	64	10	14	14	1	0.11
I	FS-07-050	FS-06-050	1/2"	97	22	83	17	20	20	1	0.23
S	FS-11-050	FS-10-050	1/2"	105	22	105	20	20	60	1	0.45
I	FS-07-075	FS-06-075	3/4"	106	32	83	20	20	20	1	0.23
I	FS-11-075	FS-10-075	3/4"	114	32	105	34	43	60	1	0.45
I	FS-11-100	FS-10-100	1"	114	32	105	43	60	60	1	0.45

Note: Model offerings and design parameters may change without notice.

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SMALL COMPACT FILTER SILENCERS
w/ Standard Filter Design
"FS" Series 1/2" - 3" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

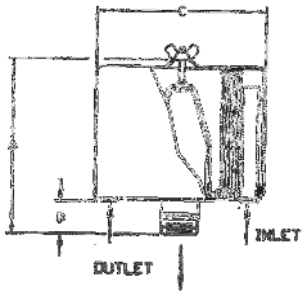
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with baked enamel finish and powder coated weatherhood
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

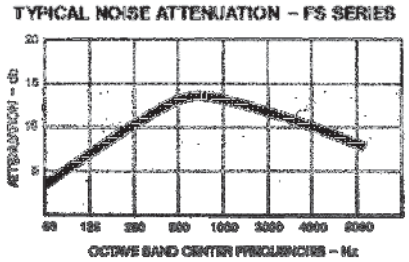
- 1/8" tap holes
- Pressure Drop Indicator
- Available in ***Stainless Steel***
- Epoxy coated housings
- Various media available
- Custom connections, MPT

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-15-050	FS-14-050	1/2"	102	38	152	17	17	60	1	0.8
I	FS-15-075	FS-14-075	3/4"	102	38	152	34	43	60	2	0.9
I	FS-15-100	FS-14-100	1"	102	38	152	43	60	60	3	0.9
S	FS-19P-100	FS-18P-100	1"	168	41	152	60	94	170	3	1.4
I	FS-19P-126	FS-18P-126	1 1/4"	168	41	152	94	119	170	5	1.5
I	FS-19P-151	FS-18P-151	1 1/2"	168	41	152	119	145	170	5	2
I	FS-31P-201	FS-30P-201	2"	184	57	254	145	230	332	5	4
S	FS-231P-201	FS-230P-201	2"	311	57	254	230	230	510	5	6
I	FS-31P-251	FS-30P-251	2 1/2"	191	64	254	170	332	332	5	4
S	FS-231P-251	FS-230P-251	2 1/2"	318	64	254	332	332	510	9	7
I	FS-231P-301	FS-230P-301	3"	330	76	254	340	510	510	9	7

Note: Model offerings and design parameters may change without notice.

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COMPACT FILTER SILENCERS

"FS" Series 3" - 6" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

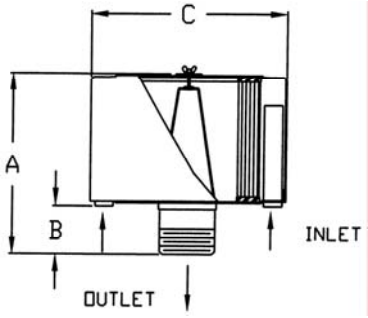
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

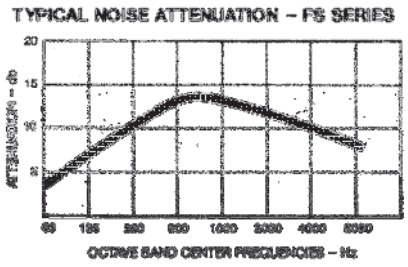
- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-301	FS-234P-301	3"	330	76	406	340	510	970	9	13
S	FS-245P-301	FS-244P-301	3"	330	76	406	340	510	1500	9	14
E	FS-275P-301	FS-274P-301	3"	330	76	406	340	510	1870	9	15
I	FS-235P-401	FS-234P-401	4"	356	102	406	510	885	970	9	14
S	FS-245P-401	FS-244P-401	4"	356	102	406	765	885	1500	9	14
E	FS-275P-401	FS-274P-401	4"	356	102	406	765	885	1870	9	15
I	FS-245P-501	FS-244P-501	5"	356	102	406	850	1360	1500	14	15
S	FS-275P-501	FS-274P-501	5"	356	102	406	1105	1360	1870	14	16
I	FS-275P-601	FS-274P-601	6"	394	133	406	1105	1870	1870	18	17

Note: Model offerings and design parameters may change without notice.

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COMPACT FILTER SILENCERS

"FS" Series DN80 - DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
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- Polyester: 99%+ removal efficiency standard to 5 micron
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- Interchangeable media: Polyester, Paper, HEPA
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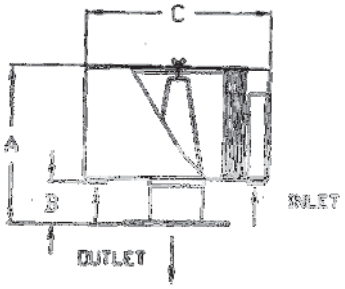
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

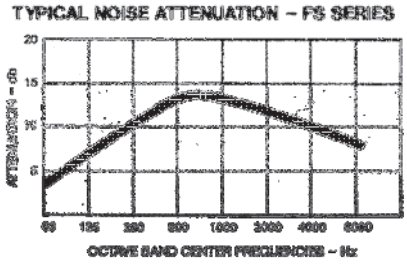
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





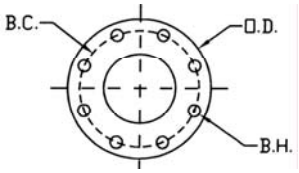
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-DN80	FS-234P-DN80	DN80	330	76	406	340	510	970	9	13
S	FS-245P-DN80	FS-244P-DN80	DN80	330	76	406	340	510	1500	9	14
E	FS-275P-DN80	FS-274P-DN80	DN80	330	76	406	340	510	1870	9	15
I	FS-235P-DN100	FS-234P-DN100	DN100	356	102	406	510	885	970	9	15
S	FS-245P-DN100	FS-244P-DN100	DN100	356	102	406	765	885	1500	9	16
E	FS-275P-DN100	FS-274P-DN100	DN100	356	102	406	765	885	1870	9	18
I	FS-245P-DN125	FS-244P-DN125	DN125	356	102	406	850	1360	1500	14	17
S	FS-275P-DN125	FS-274P-DN125	DN125	356	102	406	1105	1360	1870	14	18
I	FS-275P-DN150	FS-274P-DN150	DN150	394	133	406	1105	1870	1870	18	19

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10



Note: Model offerings and design parameters may change without notice.

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“BIG BOY” FILTER SILENCERS

"FS" Series DN200-DN300 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Cement
- Power Plants
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

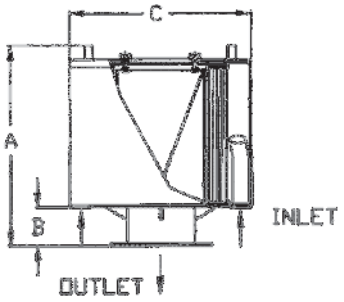
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish
- Low pressure drop center bracket and outlet pipe design
- 1/8” tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Several element sizes available per given connection (safety factor)
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

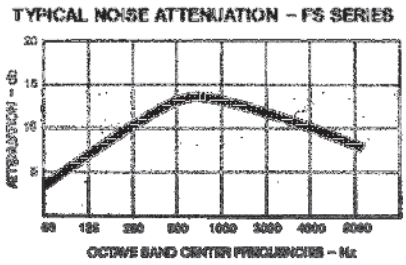
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





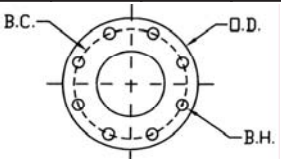
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-377P-DN200	FS-376P-DN200	DN200	584	152	572	2450	3060	3105	12	54
S	FS-385P-DN200	FS-384P-DN200	DN200	584	152	724	2450	3060	5605	12	56
E	FS-485P-DN200	FS-484P-DN200	DN200	787	152	724	3060	3060	8000	12	62
I	FS-385P-DN250	FS-384P-DN250	DN250	584	152	724	3060	5610	5610	16	59
S	FS-485P-DN250	FS-484P-DN250	DN250	787	152	724	4420	5610	8000	16	64
E	FS-685P-DN250	FS-384P(2)-DN250	DN250	965	152	724	4900	5610	11220	16	74
I	FS-385P-DN300	FS-384P-DN300	DN300	584	152	724	4420	5610	5610	24	61
S	FS-485P-DN300	FS-484P-DN300	DN300	787	152	724	4420	7990	8000	24	70
E	FS-685P-DN300	FS-384P(2)-DN300	DN300	965	152	724	5950	7990	11220	24	79
E	FS-485P(2)-DN300	FS-484P(2)-DN300	DN300	1346	152	724	7345	7990	16000	24	88

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN200	340	295	22	8	14
DN250	395	350	22	12	14
DN300	445	400	22	12	14



Note: Model offerings and design parameters may change without notice.

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B-301/2 - Blower, Elmo, 2BH7420-0AH267 2.4HP

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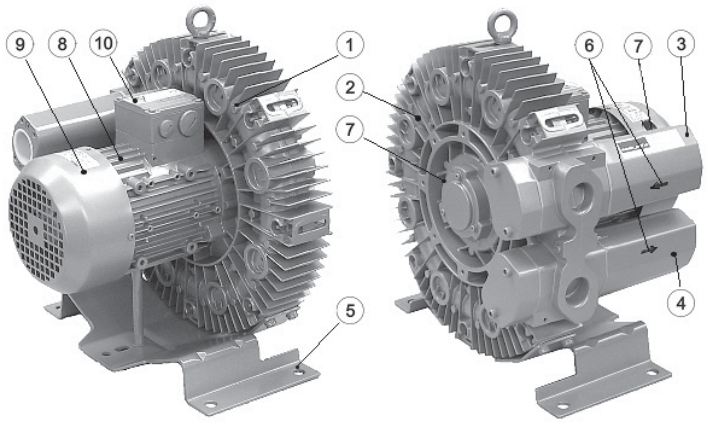

Fig. 1: Design of gas-ring vacuum pump/compressor

1 Vacuum pump/compressor housing
2 Vacuum pump/compressor cover
3 Inlet connection with muffler
4 Discharge connection with muffler
5 Base
6 Flow direction arrow
7 Rotating direction arrow
8 Drive motor
9 Fan guard (over external fan)
10 Terminal box

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1 Safety

1.1 Definitions

To point out dangers and important information, the following signal words and symbols are used in these operating instructions:

1.1.1 Safety alert symbol

The **safety alert symbol** ⚠ is located in the safety precautions in the highlighted heading field on the left next to the signal word (DANGER, WARNING, CAUTION).

Safety precautions **with** a safety alert symbol indicate a danger of **injuries**.

Be sure to follow these safety precautions to protect against **injuries or death**!

Safety precautions **without** a safety alert symbol indicate a danger of **damage**.

1.1.2 Signal words

DANGER
WARNING
CAUTION
NOTICE
NOTE

The **signal words** are located in the safety precautions in the highlighted heading field.

They follow a certain hierarchy and indicate (in conjunction with the safety alert symbol, see Chapter 1.1.1) the **seriousness of the danger** and the **type of warning.**

See the following explanations:

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1.3 Residual risks

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2 Intended Use

These operating instructions

- apply to gas-ring vacuum pumps/compressors of the G-BH7 series, models 2BH72, 2BH73, 2BH74, 2BH75 and 2BH76,
- contains instructions concerning transport and handling, installation, commissioning, operation, shut-down, storage, servicing and disposal of the G-BH7,
- must be completely read and understood by all operating and servicing personnel before beginning to work with or on the G-BH7,
- must be strictly observed,
- must be available at the site of operation of the G-BH7.

About the operating and servicing personnel of the G-BH7

- These persons must be trained and authorized for the work to be carried out.
- Work on electrical installations may be carried out by trained and authorized electricians only.

The G-BH7s

- are pump-motor units for generating vacuum or gauge pressure;
- are used to **extract, pump and compress the following gases**:
  - Air,
  - Non-flammable, non-aggressive, non-toxic and non-explosive gases or gas-air mixtures.
  - For differing gases/gas-air mixtures, inquire with the Service Department.
- are equipped with one of the following kind of drive motors:
  - 3-phase AC drive motor with a standard or explosion-protected design
  - Single-phase AC drive motor

  These operating instructions apply **only to** pump-motor units with a **standard design**.

  For the explosion-protected design

3 Technical Data

3.1 Mechanical data

Weight

Single-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7210-0..1.-.	**16**	35
2BH7310-0..1.-.	**16**	35
2BH7310-0..2.-.	**17**	38
2BH7410-0..1.-.	**23**	51
2BH7510-0..1.-.	**26**	57
2BH7510-0..2.-.	**29**	64
2BH7610-0..1.-.	**32**	71
2BH7610-0..3.-.	**35**	77

Two-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7220-0..2.-.	**24**	53
2BH7220-0..5.-.	**28**	62
2BH7320-0..5.-.	**30**	66
2BH7420-0..2.-.	**33**	73
2BH7420-0..5.-.	**39**	86
2BH7520-0..2.-.	**40**	88
2BH7520-0..7.-.	**51**	112
2BH7620-0..3.-.	**48**	106
2BH7620-0..5.-.	**65**	143

Three-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7530-0..8.-.	**68**	150
2BH7630-0..6.-.	**94**	207

Minimum distances

Minimum distance to fan guard (for sucking in cooling air):

Model	[mm] approx.	[inches] approx.
2BH72	**34**	1.34
2BH73	**34**	1.34
2BH74	**52**	2.05
2BH75	**52**	2.05
2BH76	**53**	2.09

Minimum distance to face of vacuum pump/compressor cover:

Model	[mm] approx.	[inches] approx.
2BH7…	**30**	1.18

Vibrations

The following table provides information on the maximum permissible loading due to vibrations.

Model	Vibration velocity V_{eff}	
	[mm/s] ≤	**[ft/s] ≤**
2BH72.. - 2BH75..	**3.0**	0.010
2BH76..	**3.5**	0.011

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Noise level

Measuring-surface sound-pressure level as per EN ISO 3744, measured at a distance of **1 m** [3.28 ft] at an operating point of approximately 2/3 of the permissible total pressure difference with the lines connected without a vacuum or pressure relief valve, tolerance ±3 dB (A).

Single-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7210-0..1.-.	70	70
2BH7310-0..1.-.		70
2BH7310-0..2.-.		70
2BH7410-0..1.-.		70
2BH7510-0..1.-.		70
2BH7510-0..2.-.		70
2BH7610-0..1.-.		71
2BH7610-0..3.-.		71

Two-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7220-0..2.-.	70	70
2BH7220-0..5.-.		70
2BH7320-0..5.-.		70
2BH7420-0..2.-.		70
2BH7420-0..5.-.		70
2BH7520-0..2.-.		70
2BH7520-0..7.-.		71
2BH7620-0..3.-.		71
2BH7620-0..5.-.		72

Three-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7530-0..8.-.	67	73
2BH7630-0..6.-.	77	80

Temperature increase

The information listed in the following tables corresponds to the heating of vacuum pump/compressor housings and the air exiting compared to the ambient temperature during operation with a permissible total pressure difference and an air pressure of **1,013 mbar** [14.7 psi]. At lower air pressures these values increase.

Single-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7210-0..1.-.	**52**	**61**	94	110
2BH7310-0..1.-.	**61**	**61**	110	110
2BH7310-0..2.-.	**81**	**86**	146	155
2BH7410-0..1.-.	**90**	**101**	162	182
2BH7510-0..1.-.	**93**	**111**	167	200
2BH7510-0..2.-.	**120**	**112**	216	202
2BH7610-0..1.-.	**118**	**124**	212	223
2BH7610-0..3.-.	**118**	**124**	212	223

Two-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7220-0..2.-.	**55**	**77**	99	139
2BH7220-0..5.-.	**74**	**110**	133	198
2BH7320-0..5.-.	**81**	**124**	146	223
2BH7420-0..2.-.	**89**	**80**	160	144
2BH7420-0..5.-.	**121**	**117**	218	211
2BH7520-0..2.-.	**89**	**102**	160	184
2BH7520-0..7.-.	**125**	**110**	225	198
2BH7620-0..3.-.	**124**	**126**	223	227
2BH7620-0..5.-.	**124**	**128**	223	230

Three-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7530-0..8.-.	**120**	**120**	216	216
2BH7630-0..6.-.	**120**	**120**	216	216

Tightening torques for screw connections

The following values apply if no other information is available.

With non-electrical connections, property classes of 8.8 and 8 or higher as per ISO 898-1 are assumed.

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3.2 Electrical data

See rating plate.

3.3 Operating conditions

Temperatures

Temperature of pumped gases:	max. permissible temperature: **+40°C** [+104°F] Nominal value: **+15°C** [+59°F] Pump-motor units for higher fluid temperatures on request.
Ambient temperature (standard design)[1]:	max. permissible temperature: **+40°C** [+104°F] min. permissible temperature: **-15°C** [+5°F] Nominal value: **+25°C** [+77°F] Ambient temperatures between **25°C** [+77°F] and **40°C** [+104°F] affect the permissible total pressure difference (see Section "Permissible total pressure difference"). At higher temperatures the winding may be damaged and the grease change interval may be shortened.

Pressures

Min. inlet pressure:	See rating plate.
Max. discharge pressure during compressor operation:	See rating plate.
Max. permissible pressure in pump-motor unit:	**2.5 bar abs.** [36.2 psia] At this pressure the operation of the pump-motor unit may be considerably impaired. Provide a corresponding protective device (e.g. pressure relief valve) if necessary.
Permissible total pressure difference:	The total pressure difference specified on the rating plate only applies under the following conditions: • Ambient temperature: **25°C** [77°F]. • Inlet temperature (temperature of pumped gases at inlet connection): **15°C** [59°F]. • Pressure: during vacuum-pump operation: **1,013 mbar** [14.7 psia] at discharge connection; during compressor operation: **1,013 mbar** [14.7 psia] at inlet connection; At an ambient temperature of **40°C** [104°F] the total pressure difference specified on the rating plate must be reduced by 10%. If the ambient temperature is between **25°C** [77°F] and **40°C** [104°F], then the total pressure difference specified on the rating plate must be reduced linearly to the temperature by between 0 and 10 %.

Installation altitude

Max. of **1,000 m** [3,280 ft] above sea level.

When installing the pump-motor unit at an altitude of more than **1,000 m** [3,280 ft] above sea level, first inquire with the Service department.

[1] For design with frequency converter, see separate operating instructions.

4 Transport and Handling

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5 Installation

The pump-motor unit is ready to connect on delivery.

However, if the time from delivery to commissioning of the pump-motor unit exceeds a certain period, the lubrication of the rolling bearings must be renewed.
See Chapter 8.2, "Storage conditions", Section "Lubrication of rolling bearings after longer storage", Pg. 23 for information on this topic.

Carry out the following work to install the pump-motor unit:

- Installation and securing,
- Attachment of the included loose muffler if necessary,
- Attachment of threaded flange or hose flange (available as accessories) for the connection of inlet or discharge pipe to the muffler,
- Electrical connection,
- Connection of inlet and discharge connection to the system.

5.1 Installation

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Components for reducing noise on the pump-motor unit:

- **Mufflers** (included as standard equipment): On delivery the pump-motor units are equipped with attached mufflers as standard. The noise radiation is considerably reduced by the mufflers. See Fig. 2 to Fig. 4, Pg. 18 ff.
- **Additional mufflers** (available as an option): The additional mufflers enable a further noise reduction. They may only be used with free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere **without piping**.
- **Noise protection hoods** (available as an option): Noise protection hoods are suitable for installation in rooms and in the open. They reduce both the total sound pressure level and tonal components that are perceived as particularly annoying.

Installation variants/axis position:

Basically, when installing the pump-motor unit, the following variants are possible with a different axis position (horizontal or vertical):

- Horizontal installation
- Vertical installation on the vacuum pump/compressor cover ("cover installation")
- Vertical mounting on the wall.

Basically, all variants are possible with all models.

However, a distinction must be made between a design with and a design without a **condensed water opening** for the axis position:

- The pump-motor units without a condensed water opening can be installed and secured in any axis position.
- The pump-motor unit with a condensed water opening may only be installed and secured horizontally with the base at the bottom.

Horizontal installation

Screw the base of the pump-motor unit to the surface with suitable mounting elements.

Proceed as follows:

- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the surface with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!

Vertical installation on the vacuum pump/compressor cover ("cover installation")

With vertical installation of the pump-motor unit with the vacuum pump/compressor cover facing downward, rubber feet must be used.

Proceed as follows:

- The rubber feet are available as accessories. They are delivered in a set of 3.
  On the upper section they are provided with stud bolts and on the lower section with a threaded hole.
- Mount the rubber feet on the pump-motor unit: Screw the stud bolts of the rubber feed into the holes on the face of the vacuum pump/compressor cover and tighten them.
- Mount the pump-motor unit together with the rubber feet on the installation surface:
  Select suitable mounting elements for the threaded hole.
  Screw the rubber feet to the surface or foundation via the threaded hole.

Vertical mounting on the wall

With vertical mounting of the pump-motor unit on the wall, the pump-motor unit is mounted via the holes in the base.

Proceed as follows:

- Position the pump-motor unit as close to the wall as possible on a stable supporting plate with sufficient load-bearing capacity.
  The pump-motor unit must be positioned with the base toward the wall.
- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the wall with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!
- Remove the supporting plate.

Eye bolt:

Following installation, the eye bolt must be either firmly tightened or removed.

5.2 Electrical connection (motor)

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- For the tightening torques for terminal board connections (except terminal strips), see Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10.
- For terminals with clamping straps (e.g. as per DIN 46282), the conductors must be inserted so that approximately the same clamping height results on both sides of the bar. Individual conductors must therefore be bent into a U-shape or connected with a cable lug (DIN 46234).

This also applies to:

- the protective conductor,
- the outer ground conductor.

Both conductors can be recognized from their color (green/yellow).

5.3 Connecting pipes/hoses (vacuum pump/compressor)

Mufflers:

The pump-motor units are delivered with mufflers (indicated with arrows in the following illustrations) for the inlet and discharge connections as standard equipment.

With **single-impeller pump-motor units**, the mufflers are already mounted on delivery.

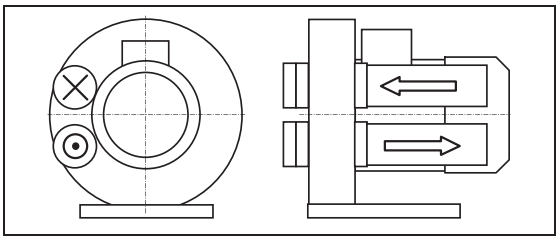

Fig. 2: 2BH721 ... 2BH761 (single-impeller pump-motor units)

With **two-impeller and three-impeller pump-motor units**, the inlet-side muffler is included loose for packaging-related reasons and must be mounted by the operator.

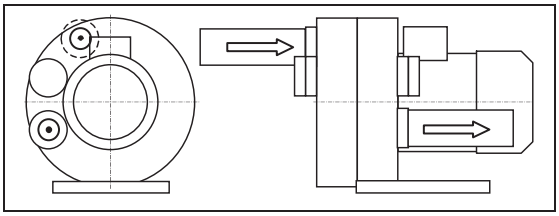

Fig. 3: 2BH722 ... 2BH762 (two-impeller pump-motor units with two-stage design)

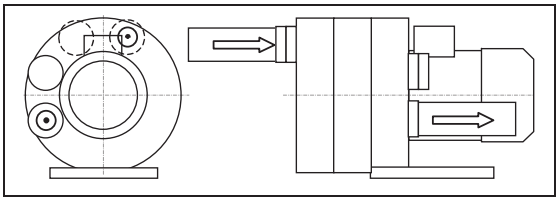

Fig. 4: 2BH723 ... 2BH763 (three-impeller pump-motor units with three-stage design)

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6 Commissioning

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6.2 Start-up and shut-down

Start-up

- Open shut-off device in intake/discharge pipe.
- Switch on power supply for drive motor.

Shut-down:

- Switch off power supply for drive motor.
- Close shut-off device in intake/discharge pipe.

7 Operation

 © Gardner Denver Deutschland GmbH

- Provide mufflers on inlet and discharge side with sealing plugs.

8.2 Storage conditions

To prevent standstill damage during storage, the environment must provide the following conditions:

- dry,
- dust-free,
- low-vibration (effective value of vibration speed $v_{eff} \leq 2.8$ mm/s).
- Ambient temperature: max. **+40°C** [+104°F].

9.1 Repairs/troubleshooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise.	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service*)
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service*)
	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service*)
Protective motor switch trips when motor is switched on. Power consumption too high.	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service*)
		Clean filters, mufflers and connection pipes if necessary.	Service*)
	Compressor is jammed.	See fault: "Motor does not start; humming noise" with cause: "Impeller is jammed.".	Service*)
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service*)
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service*)
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service*)
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service*)
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service*)
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

*) Only when the maintenance manual is at hand: rectification by the operator.

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9.2 Service/After-sales service

Our Service is available for work (in particular the installation of spare parts, as well as maintenance and repair work), not described in these operating instruction.

A list of spare parts with an exploded drawing is available on the Internet at www.gd-elmorietschle.com.

Observe the following when **returning** pump-motor unit:

- The pump-motor unit must be delivered complete, i.e. not dismantled.
- The pump-motor unit may not present a danger to the workshop personnel.
  If the pump-motor unit has come into contact with dangerous substances, then the procedure described in Chapter 9.3, "Decontamination and Declaration of Clearance", Pg. 25, must be used.
- The original rating plate of the pump-motor unit must be properly mounted, intact and legible.
  All warranty claims are voided for pump-motor units delivered for a damage expertise without the original rating plate or with a destroyed original rating plate.
- In case of warranty claims, the manufacturer must be informed of the operating conditions, operating duration etc. and additional detailed information provided on request if necessary.

9.3 Decontamination and Declaration of Clearance

EU declaration of conformity

Manufacturer:	Gardner Denver Deutschland GmbH Industriestraße 26 97616 Bad Neustadt • Germany
Representative for the compilation of technical documents:	Holger Krause Industriestraße 26 97616 Bad Neustadt • Germany
Description and identification of the machine:	Vacuum pumps/Compressors (Side channel blower) Series G-BH7 Types 2BH72..-.....-. 2BH73..-.....-. 2BH74..-.....-. 2BH75..-.....-. 2BH76..-.....-.

The machine described above meets the following applicable Community harmonisation legislation:

2006/42/EC	European Parliament and Council Directive 2006/42/EC from 17th May 2006 on machinery and amending Directive 95/16/EC.
2004/108/EC*)	Directive 2004/108/EC of the European Parliament and Council from 15th December 2004 for the application of the legal regulations of the EU member states concerning electrical devices and repealing Directive 89/336/EEC

Harmonised standards applied:

EN 1012-1:2010	Compressors and vacuum pumps - Safety requirements - Part 1: Compressors
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements IEC 60204-1:2005 (amended)
EN 60034-1:2010/ AC:2010	Rotating electrical machines - Part 1: Rating and performance IEC 60034-1:2010 (amended)

Bad Neustadt, 18.04.2012
(Place and date of issue)

Andreas Bernklau, product management/attorney
(Name and function)

Dr. Rudi Dittmar, development
(Name and function)

*) Only applicable for version with frequency converter 2FC

664.44436.40.000

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Statement on health safety and on the protection of the environment

- For the safety of our employees and to comply with statutory requirements on handling substances harmful to the health and the environment, this statement must be enclosed, fully completed, with **each** unit/system sent.
- **Without the fully completed statement, repair/disposal is not possible and delays are unavoidable!**
- The statement is to be completed and signed by suitably qualified, authorised personnel at the operating organisation.
- In the case of shipment to Germany, the statement is to be completed in German or English.
- The statement is to be attached to the outside of the packing on shipment.
- If necessary, the carrier is to be informed.

1. **Product designation (type):** .....
2. **Serial number (no. BN):** .....
3. **Reason for sending:** .....
4. **The unit/system**
   has **not** come into contact with hazardous substances. There will be **no** hazards for personnel or the environment during repair/disposal. Continue with "6. Legally binding statement“
   has come into contact with hazardous substances. Continue with "5. Information on the contamination“
5. **Information on the contamination** (if necessary provide more information on an additional sheet)
   The unit/system was used in the following application:

   .....
   and has come into contact with the following classifiable substances or substances presenting a hazard to health/environment:

Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):

   The unit/system has been emptied in accordance with the operating instructions, flushed and cleaned externally.

   Safety data sheets in accordance with the applicable regulations are enclosed (sheet).

   The following safety precautions are necessary for handling (e.g. personal protective equipment):

   .....

   .....
6. **Legally binding statement**
   I herewith guarantee that the details specified are true and complete and that I, as signatory, am in a position to judge that this is so.
   We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We are obliged to indemnify the contractor against claims for damages by third parties arising from incomplete or incorrect specifications. We are aware that, irrespective of this statement, we are directly liable to third parties - in particular including the contractor's employees tasked with repair/disposal.

Company/institute: .....

Name, position: ..... Phone: .....

Street: ..... Fax: .....

Post code, city: .....

Country: ..... Stamp:

Date, signature: .....

© Gardner Denver Deutschland GmbH
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97605 Bad Neustadt
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Fax: +49 7622 392 300
E-mail: er.de@gardnerdenver.com
Internet: www.gd-elmorietschle.com
610.44436.40.000
Edition: 04.2012
English

AIRCOM TECHNOLOGIES inc.

16781, Hymus, Kirkland (Québec) H9H 3L4
T.: 514 695-4740 F.: 514 695-0581
www.aircom.ca info@aircom.ca

Pression & Vide • Pressure & Vacuum

B-501/2 - Blower, Sutorbilt, Model 4L-RHC, Orientation: Horizontal (Flow Down) Driven Shaft Position: RHC (Right Hand Central) Flow Requirement: 487 scfm

OPERATION & MAINTENANCE MANUAL

AIRCOM PACKAGE

WITH

SUTORBILT

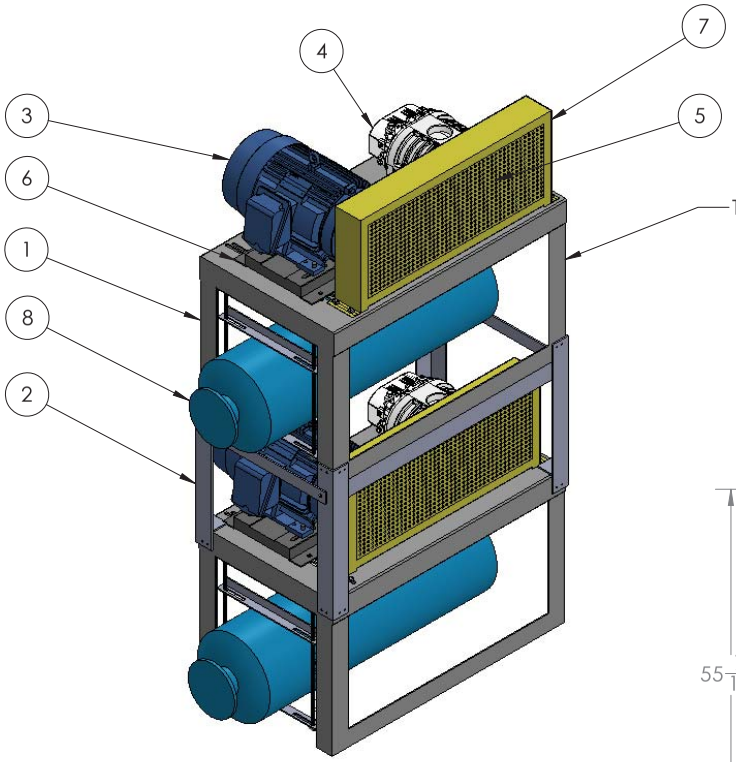
POSITIVE DISPLACEMENT BLOWER

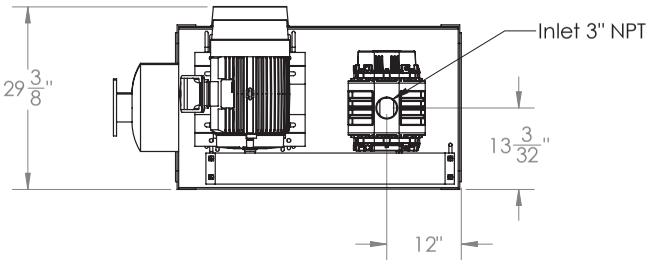
YOUR REFERENCE: PO # 1704432-0008 (Blower) & 1704432-0009 (Package)

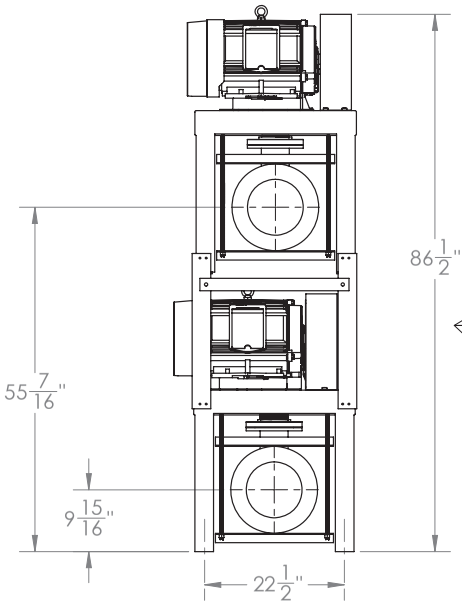
OUR REFERENCE: 222850 & 222851

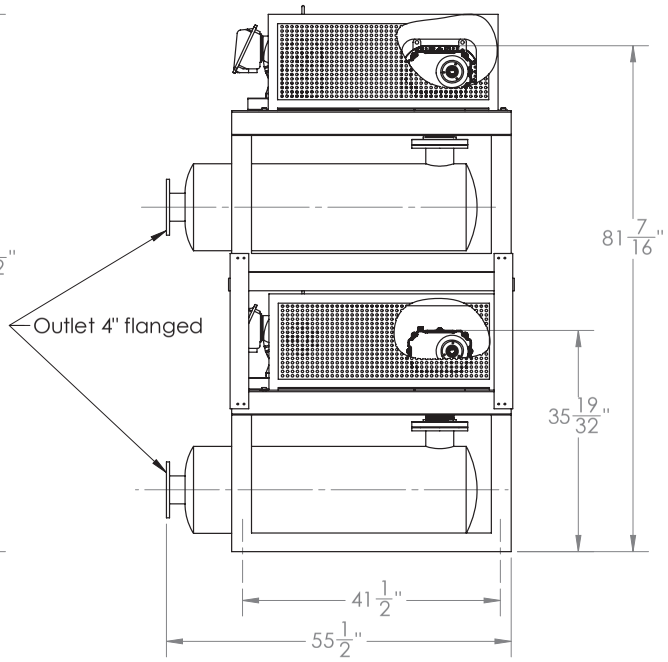
TABLE OF CONTENTS

	ITEM
Package drawing(s) including scope of supply …….…… ……..…	1
Drive (belt or coupling) data sheet(s)…….……	2
Blower performance data sheet(s)……..	3
Motor manual(s) / data sheet(s)…..…..… ……..…….……..….	4
Gardner Denver blower parts list, operating and service manual …….…...	5
Maintenance data sheet – Spare parts list ……..…	6









ITEM NO.	DESCRIPTION	QTY.
1	Elevated base, Steel	2
2	Extension base, Steel	1
3	Motor,15HP (supplied by Newterra)	2
4	Blower, Sutorbilt, Model 4L	2
5	Belt Drive 15HP	2
6	Motor slide base	2
7	Guard for belt drive, Steel	2
8	Silencer, URBY4 4in flanged	2

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION | DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	Alex C.	01/06/2017
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

AIRCOM TECHNOLOGIES

TITLE:
Blower Package
Sutorbilt 4L Stacked

SIZE	DWG. NO.	REV
B	0960	1

SCALE: 1:20 | WEIGHT: | SHEET 1 OF 1

E-75

Maska Pulleys Inc.
180, Boul. Gagnon, Ste-Claire
Qc, Canada G0R 2V0
Tel:(418)883-4322 Fax:(418)883-5015
www.maskapulleys.com

Selection Parameters

Family: Classic & Narrow belts drives

Shaft diameter Driver: 1-5/8 Inch
Shaft diameter Driven: 7/8 Inch
Service Factor: 1.4
Driver power: 13.3 hp
Rpm Driver: 3525
Rpm Driven: 3364 **Tolerance:** -0% +3%
Center distance : Minimum: 23.5 Inch
Maximum: 24.5 Inch
Belts: A,AX,B,BX,C,CX,3V,3VX,5V,5VX,8V

Max. Hub Load: 9999
Rim Speed min.: 900 FPM
Rim Speed max.: 6500 FPM
Nbr of Grooves min.: 1
Nbr of Grooves max.: 15

Pitch Diameter (Inch)

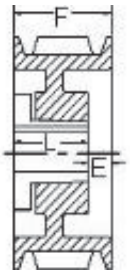
	Min.	Max.
Driver	0.50	71.00
Driven	0.50	71.00

Actual Drive Values

Maximum number of results: 20

Rpm: 3417
Service Factor: 1.55
BeltSpeed (fpm): 5859
List Price: 194.90
Center distance (Inch): 23.6
Power/Belt (hp): 10.3
Deflection (inch): 0.37
Deflection Force (lbs): 3.1
Hub Loads (lbs): 130

Driver Sheave: 2B64

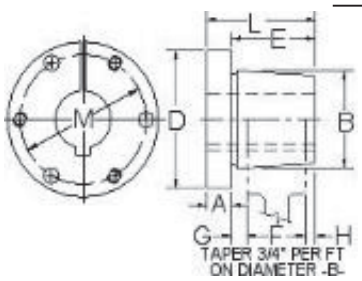


List Price: 68.00
Weight: 7.35 lbs

D.D. A or 4L Belt: 6.00"
D.D. B or 5L Belt: 6.40"
E: 7/16"
F: 1 3/4"
L: 1 5/16"
O.D.: 6.75"

Constuction type: Web

Driver Bushing: SDSX1-5/8

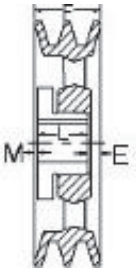


List Price: 17.30
Weight: 1.10 lbs

A: 7/16"
B: 2 3/16"
D: 3 3/16"
E: 7/8"
F: 3/4"
G: 1/4"
H: -1/8"
Keyseat: 3/8 x 3/16"
L: 1 5/16"
M: 2 11/16"

Set screw - Dimensions: 1/4-20 UNC x 1/4
Product specifications: Standard with set screw over keyway.
Hex bolt: 3=1/4-20 UNC x 1-3/8

Driven Sheave: 2MBL69



List Price: 64.60
Weight: 6.55 lbs

D.D. A or 4L Belt: 6.2"
D.D. B or 5L Belt: 6.6"
E: 1/16"
F: 1 3/4"
L: 1 11/32"
M: 11/32"
O.D.: 6.95"

Constuction type: Arms

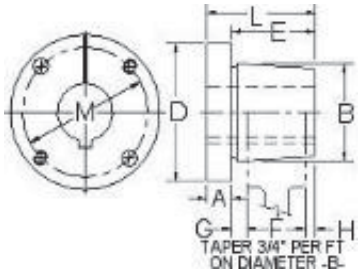
Recommended Drive Selections are designed for use with Maska components (sheaves, bushings and V-belts) which meet or exceed MPTA & RMA standards. The use of lesser quality products could affect life expectancy of drive.Selections and Pricing are as accurate as possible. Maska is not responsible for ANY pricing or design errors.Price shown are for standard products only. For non-standard products or products that need dynamic balancing, contact Maska for pricing.

Driven Bushing: LX7/8

List Price: 9.00
Weight: 0.90 lbs

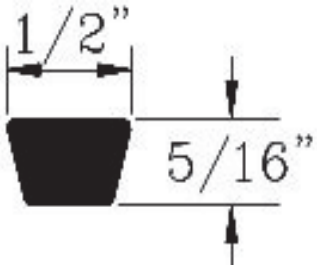
Set screw - Dimensions: 1-8UNCx1-1/2
Hex bolt: 2 = 1/4-20UNC X 7/8

A: 11/32"
B: 1 5/8"
D: 2 1/2"
E: 1"
F: 29/32"
G: 3/16"
H: -3/32"
Keyseat: 3/16 x 3/32"
L: 1 11/32"
M: 2"



Belts: VBA65 (Qty:2)

List Price: 18.00
Weight: 0.30 lbs



Recommended Drive Selections are designed for use with Maska components (sheaves, bushings and V-belts) which meet or exceed MPTA & RMA standards. The use of lesser quality products could affect life expectancy of drive.Selections and Pricing are as accurate as possible. Maska is not responsible for ANY pricing or design errors.Price shown are for standard products only. For non-standard products or products that need dynamic balancing, contact Maska for pricing.

QuickPik™

Sutorbilt Legend - 4L

Product Information

CORRECTED VALUES	ORIGINAL UNITS	ENGLISH UNITS	METRIC UNITS
Ambient Pressure	100 ALTI-FT	14.642 PSIA	1.01 bar a
Elevation	100 ALTI-FT	100 ALTI-FT	30 alti-m
Inlet Pressure	14.642 PSIA	0.000 PSIG	0 bar g
Inlet Pressure Loss	0.3 PSIG	0.300 PSIG	0.021 bar g
Inlet Temp	68 F	68 °F	20 °C
Inlet Flow	487 SCFM	499 ICFM	848 m³/h
Discharge Pressure	4.4 PSIG	4.400 PSIG	0.303 bar g
Discharge Pressure Loss	0.2 PSIG	0.200 PSIG	0.014 bar g
MEASURED VALUES	**ORIGINAL UNITS**	**ENGLISH UNITS**	**METRIC UNITS**
Speed	3364 RPM	3364 RPM	3364 RPM
RPM % Of Max	93	93	93
Power	13.3 HP	13.3 HP	9.9 kW
Discharge Temp	126 °F	126 °F	52 °C
Temp % of Max	48	48	48
Noise	88 dBa	88 dBa	88 dBa
Pressure % of Max	70	70	70

PHYSICAL	
Weight	155 lbs.
Gear Diameter / Center Distance	4 in.
Connection Size	3i/3d in.
Case Length	8 in.
WR^2	0.924 lb-ft^2
Orientation	horizontal
PERFORMANCE	
Max Delta P	7 PSI
Max Temp	260 °F
Max Speed	3600 RPM
Min Speed	955 RPM
Max Case Pressure	25 PSIG
Max Delta T	160 °F

QuickPik™

AMBIENT GAS PARAMETERS	ENGLISH UNITS	METRIC UNITS
Molecular Weight	28.866 lbm/lbmol	28.866 kg/kgmol
R Value	53.523 ft.lbf/lbm.R	0.288 kJ/kg.K
Density	0.075 lbm/ft ^{3}	1.196 kg/m^3

GAS MIX:	VOL
Air	100%

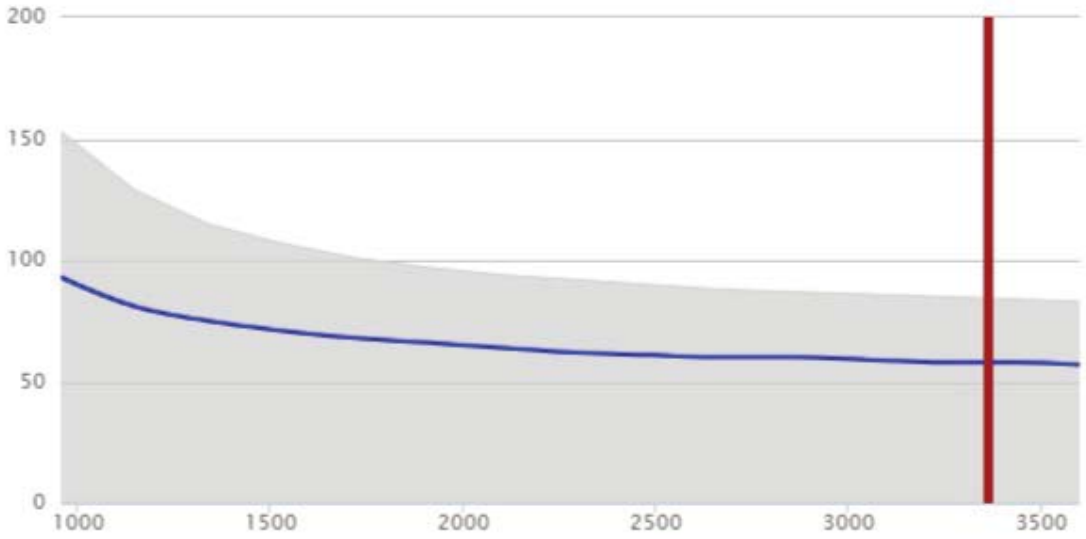
Performance Curves

Temperature Rise

DEFINED CONDITIONS
58 F

RPM
3364

Published Data
Defined Conditions

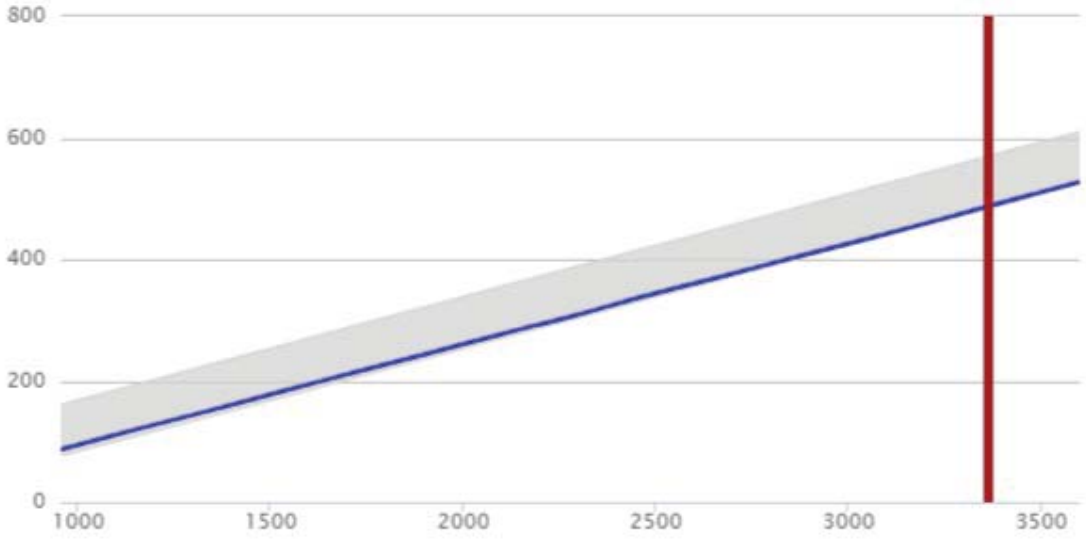


Flow

DEFINED CONDITIONS
487 SCFM

RPM
3364

Published Data
Defined Conditions



QuickPik™

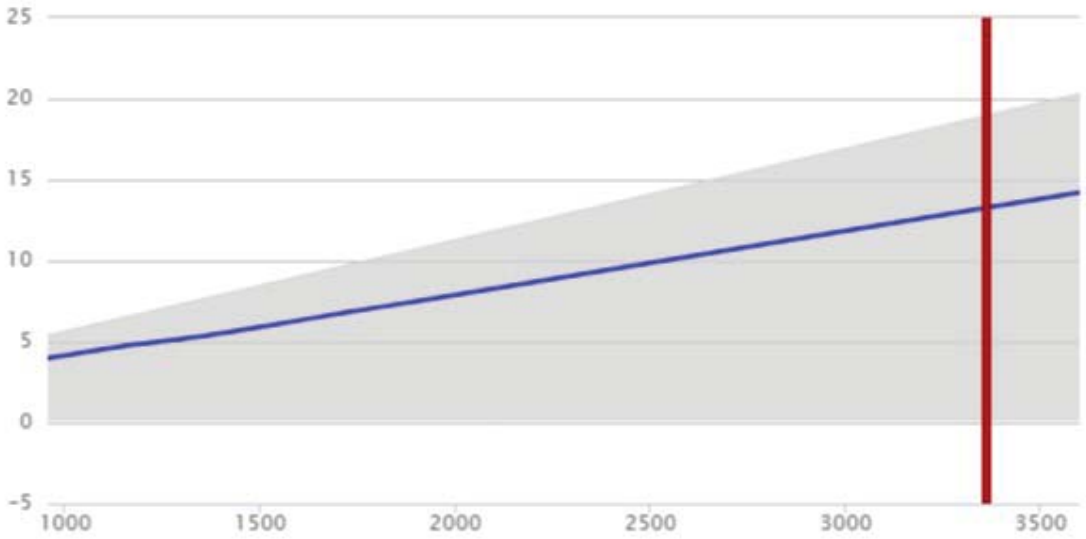
Performance Curves

Power

DEFINED CONDITIONS
13.3 HP

RPM
3364

Published Data
Defined Conditions

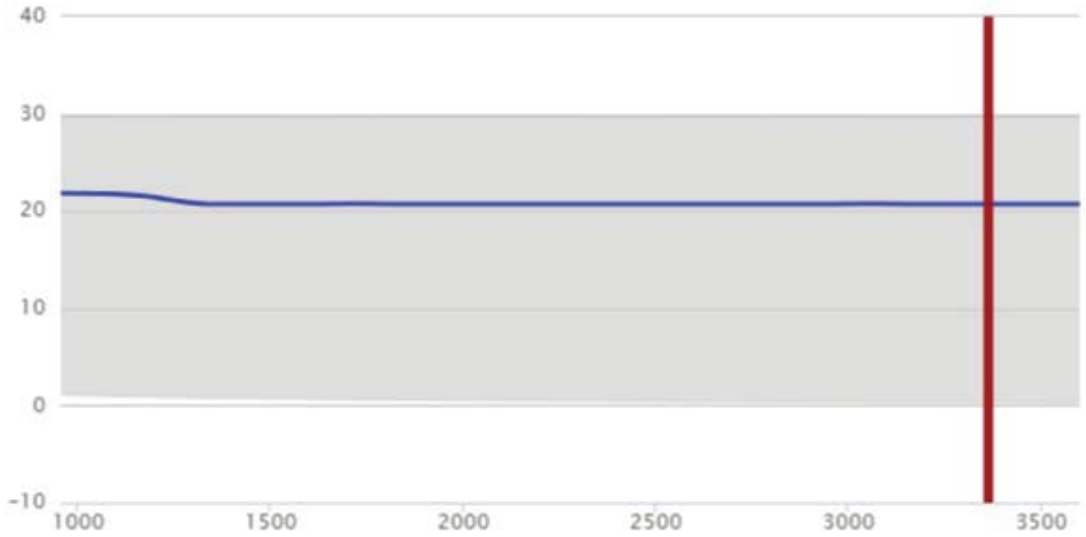


Torque

DEFINED CONDITIONS
20.8 ft-lb

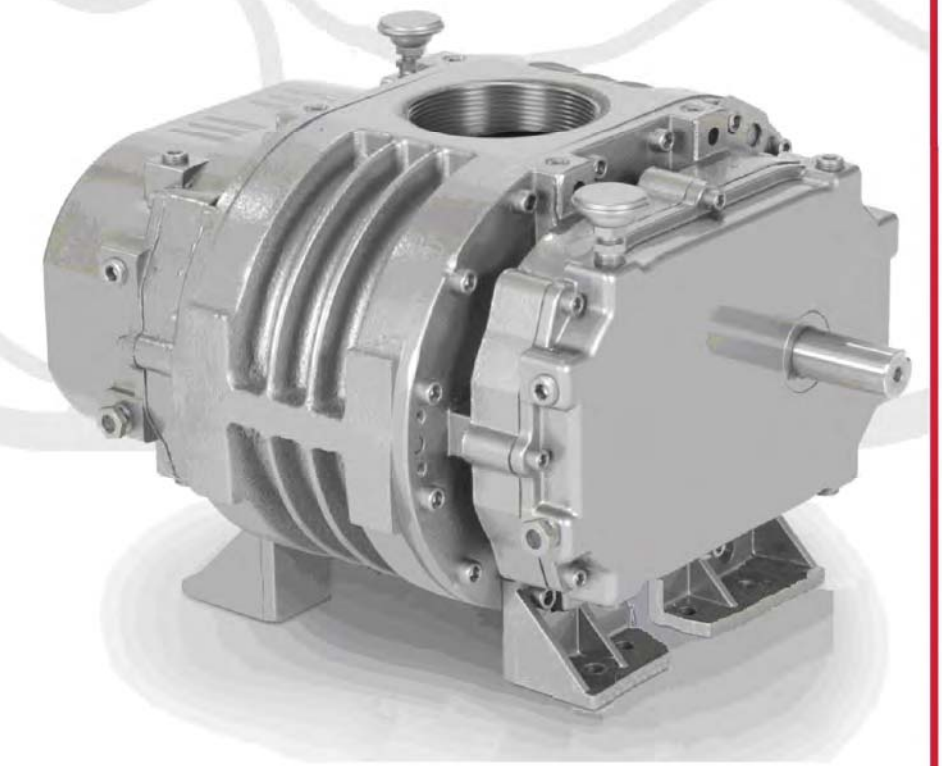
RPM
3364

Published Data
Defined Conditions



Gardner Denver

PARTS LIST OPERATING AND SERVICE MANUAL



LEGEND
"R" SERIES BLOWERS

3" – 5" GEAR DIAMETER

Models
GAB_ _ R _
GAC_ _ R _
GAE_ _ R _

ENERGY STAR PARTNER

SB-7-632
Version 05
July 8, 2015

MAINTAIN BLOWER RELIABILITY AND PERFORMANCE
WITH GENUINE GARDNER DENVER
PARTS AND SUPPORT SERVICES

Factory genuine parts, manufactured to design tolerances, are developed for optimum dependability - - - specifically for your blower. Design and material innovations are born from years of experience with hundreds of different blower applications. When you specify factory genuine parts you are assured of receiving parts that incorporate the most current design advancements manufactured in our state-of-the-art blower factory under exacting quality standards.

Your AUTHORIZED DISTRIBUTOR offers all the backup you require. A worldwide network of authorized distributors provides the finest product support in the blower industry.

1. Trained technical representatives to assist you in selecting the correct replacement parts.

2. Complete inventory of new machines and new, genuine factory parts.

3. A full line of factory tested AEON® PD blower lubricants, specifically formulated for optimum performance in all blowers.

4. Authorized distributor service technicians are factory-trained and skilled in blower maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair service.

INSTRUCTIONS FOR DETERMINING BLOWER CONFIGURATION

1. Face the blower drive shaft.
2. In a **VERTICAL** configuration, air flow is horizontal.
3. In a **HORIZONTAL** configuration, air flow is vertical.
4. In a vertical configuration, a **BOTTOM HAND** exists when the drive shaft is below the horizontal center line of the blower. A **TOP HAND** exits when the drive shaft is above the horizontal center line of the blower.
5. In a horizontal configuration, a **RIGHT HAND** exists when the drive shaft is to the right of the vertical center line of the blower. A **LEFT HAND** exists when the drive shaft is to the left of the vertical center line of the blower.

INSTRUCTIONS FOR ORDERING REPAIR PARTS

For pricing, and ordering information contact your nearest AUTHORIZED FACTORY DISTRIBUTOR. When ordering parts, specify Blower **MODEL** and **SERIAL NUMBER** (see nameplate on unit).

Rely upon the knowledge and experience of your AUTHORIZED DISTRIBUTOR and let them assist you in making the proper parts selection for your blower.

To Contact Gardner Denver or locate your local distributor:
Visit: www.contactgd.com/mobile

Or

Call: (217)222-5400

GARDNER DENVER LUBRICANT ORDER INFORMATION

Re-order Part Numbers for Factory Recommended Lubricants.

Gear and Drive End

AEON PD Synthetic Lubricant, AEON PD-XP—Extreme Duty Synthetic Lubricant or AEON PD-FG—Food Grade Synthetic Lubricant

AEON PD Synthetic Lubricant

Description	Part Number
1 Quart	28G23
Case/12Quarts	28G24
1 Gallon Container	28G40
Case/6 Gallons	28G41
5 Gallon Pail	28G25
55 Gallon Drum	28G28

AEON PD-XD – Extreme Duty Synthetic Lubricant

Description	Part Number
1 Quart	28G46
Case/12Quarts	28G47
1 Gallon Container	28G42
Case/6 Gallons	28G43
5 Gallon Pail	28G44
55 Gallon Drum	28G45

AEON PD-FG – Food Grade Synthetic Lubricant

Description	Part Number
1 Quart	28H97
Case/12Quarts	28H98
1 Gallon Container	28H333
Case/6 Gallons	28H334
5 Gallon Pail	28H99
55 Gallon Drum	28H100

Drive End

AEON PD Grease

Description	Part Number
Case/10 Tubes (14oz/Tube	28H283

Call your local Gardner Denver Distributor to place your order for Gardner Denver lubricants. Your Authorized Gardner Denver Distributor is:

FOREWORD

Sutorbilt® blowers are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine, the owner must exercise care in its operation and maintenance. This manual is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

⚠ DANGER
Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING
Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION
Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE
Notice is used to notify people of installation, operation or maintenance information which is important but not hazard-related.

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious. Some general safety precautions are given below:

⚠ DANGER

Failure to observe these notices could result in injury to or death of personnel.

- **Keep fingers and clothing away from revolving fan, drive coupling, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers or break any connections, etc., in the blower air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock can and may be fatal.**
- **Blower unit must be grounded in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the blower motor base to the unit base.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine may be automatically controlled and may start at any time.**

⚠ WARNING

Failure to observe these notices could result in damage to equipment.

- **Stop the unit if any repairs or adjustments on or around the blower are required.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine maybe automatically controlled and may start at any time.**
- **Do not exceed the rated maximum speed shown on the nameplate.**
- **Do not operate unit if safety devices are not operating properly. Check periodically. Never bypass safety devices.**

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SUTORBILT LEGEND SERIES BLOWERS
MATRIX/MENU

NOTICE TO CUSTOMER – To find the construction options for Your blower unit, FILL IN THE BALANCE OF LETTERS OR NUMBERS FROM YOUR UNIT NAMEPLATE

	G	A				R	
COLUMN NUMBER:	1	2	3	4	5	6	7

FOLLOW THE LINE DOWN AND OVER FROM EACH SPACE THUS FILLED IN TO FIND THE APPROPRICATE CONSTRUCTION OPTION WITH WHICH YOUR MACHINE IS EQUIPPED.

COLUMN 1 – BASIC DESIGNATOR

COLUMN 2 – PRODUCT FAMILY

COLUMN 3 – GEAR DIAMETER

B	3”	E	5”
C	4”		

COLUMN 4 – CASE LENGTH

- L - Low Pressure
- M - Medium Pressure
- H - High Pressure

COLUMN 5 – CONFIGURATION

- A Vertical-Top Hand -Central Timed
- B Vertical-Bottom Hand – Central Timed
- C Horizontal – Left Hand – Central Timed
- D Horizontal – Right Hand – Central Timed

COLUMN 6 – DESIGN VERSION

COLUMN 7 – ADDITIONAL DESCRIPTION

	SEALS	CLEARANCES	LUBRICATION
A.	Lip	Standard	Grease-Splash
B.	Mechanical	Standard	Grease-Splash
C.	Lip	High Temperature	Grease-Splash
D.	Lip	Standard	Dual-Splash
E.	Mechanical	Standard	Dual-Splash
F.	Lip	High Temperature	Dual-Splash
G.	Mechanical	High Temperature	Dual-Splash

INTRODUCTION
YOUR KEY TO TROUBLE FREE SERVICE

Thank you for investing in Gardner Denver quality. The Gardner Denver reputation for rugged dependability has been earned by over 50 years of service in demanding, industrial operations where downtime cannot be tolerated and efficient blower performance is expected.

Your Gardner Denver Sutorbilt blower is a precision engineered blower that has been carefully manufactured and thoroughly tested at the state-of the art Gardner Denver Blower Factory in Sedalia, Missouri.

As with other precision machinery, there are several relatively simple installation, operation and maintenance procedures that you must observe to assure optimum blower performance. There is no guesswork in the manufacture of your highly advanced Sutorbilt blower and there must be none in preparing the blower to get the job done in the field.

The purpose of this manual is to help you properly install, operate and maintain your Sutorbilt blower. It is essential that you review all sections of this manual in preparation for installing your blower. Follow the instructions for installing your blower. Follow the instructions carefully and you will be rewarded with trouble-free Gardner Denver Sutorbilt service year in and year out.

SECTION 1
EQUIPMENT CHECK

Before uncrating, check the packing slip carefully to be sure all the parts have been received. All accessories are listed as separate items on the packing slip, and small important accessories such as relief valves can be overlooked or lost. After every item on the packing slip has been checked off, uncrate carefully.

NOTICE
Register a claim with the carrier for lost or damaged equipment.

⚠WARNING
Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in installation and operation of this equipment in the system or facility.

STORAGE

Your Gardner Denver Blower was packaged at the factory with adequate protection to permit normal storage for up to six (6) months.

If the unit is to be stored under adverse conditions or for extended periods of time, the following additional measures should be taken to prevent damage.

1. Store the blower in a clean, dry, heated (if possible) area.
2. Make certain inlet and discharge air ports are tightly covered to prevent foreign material from entering the air box.
3. All exposed, non-painted surfaces should be protected against rust and corrosion.
4. Provide adequate protection to avoid accidental mechanical damage.
5. In high humidity or corrosive environments, additional measures may be required to prevent rusting of the blower internal surfaces.
6. To prevent rusting of gears, bearings, etc., the oil reservoirs may be filled with normal operating oil.

⚠CAUTION
Before running the blower, drain the oil and replace to the proper operating level with clean, fresh lubricant.

7. Rotate the blower shaft (10 to 25 turns) weekly during storage. Inspect the blower shaft (near the shaft seal area) monthly and spray with rust inhibitor if needed.
8. For long term storage (over six (6) months), contact Gardner Denver Compressor Division Customer Service for recommendations.

REMOVING PROTECTIVE MATERIALS

The shaft extension is protected with rust inhibitor which can be removed with any standard solvent.

⚠CAUTION
Follow the safety directions of the solvent manufacturer.

Blower inlet and outlet are temporarily capped to keep out dirt and other contaminants during shipment. These covers must be removed before start-up.

The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventative to protect the machine during shipment. Remove this film upon initial startup, using any commercial safety solvent. Position the blower so that the inlet and discharge connections are in the vertical position (vertical airflow). On vertically mounted units, it will be necessary to lay the unit on its side supporting the ends of the unit so as not to restrict the port on the bottom side. Place a shallow pan on the under side of the unit. With the blower disconnected from power, spray the solvent in the top port, rotating the impellers by spinning the shaft manually. Continue this procedure until the unit is visibly clean.

⚠WARNING
Rotating components will cause severe injury in case of personal contact. Keep hands and loose clothing away from blower inlet and discharge ports.

SECTION 2
INSTALLATION

LOCATION

Install the blower in a well lit, clean dry place with plenty of room for inspection and maintenance.

FOUNDATIONS

For permanent installation we recommend concrete foundations be provided, and the equipment should be grouted to the concrete. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each. Before grouting, equipment must be leveled, free of all strains, and anchored so no movement will occur during setting of grout. After grout has completely hardened, a recheck is necessary to compensate for shrinkage, etc. If required, add shims under blower feet after final tightening of foundation anchor bolts to remove strain from the blower housing.

Where jack screws or wedges are used during grouting, they must be backed off and wedges removed before final tightening of anchor bolts. Refer to grouting instructions.

Where a concrete foundation is not feasible, care must be taken to insure that equipment is firmly anchored to adequate structural members, restricting movement and vibration.

MOUNTING CONFIGURATIONS

The blower flex-mount design enables horizontal and vertical mounting configurations with top or bottom hand, right or left hand shaft positioning. The units are center timed allowing rotation in either direction (refer to Figure 2-1).

REPOSITIONING THE MOUNTING FEET.

1. Position the mounting feet to the desired location and snug the capscrew.
2. Place the blower on its feet on a flat surface.
3. Loosen mounting feet capscrews and level unit up. The bench or blower base flatness should be within .002 of an inch.

NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

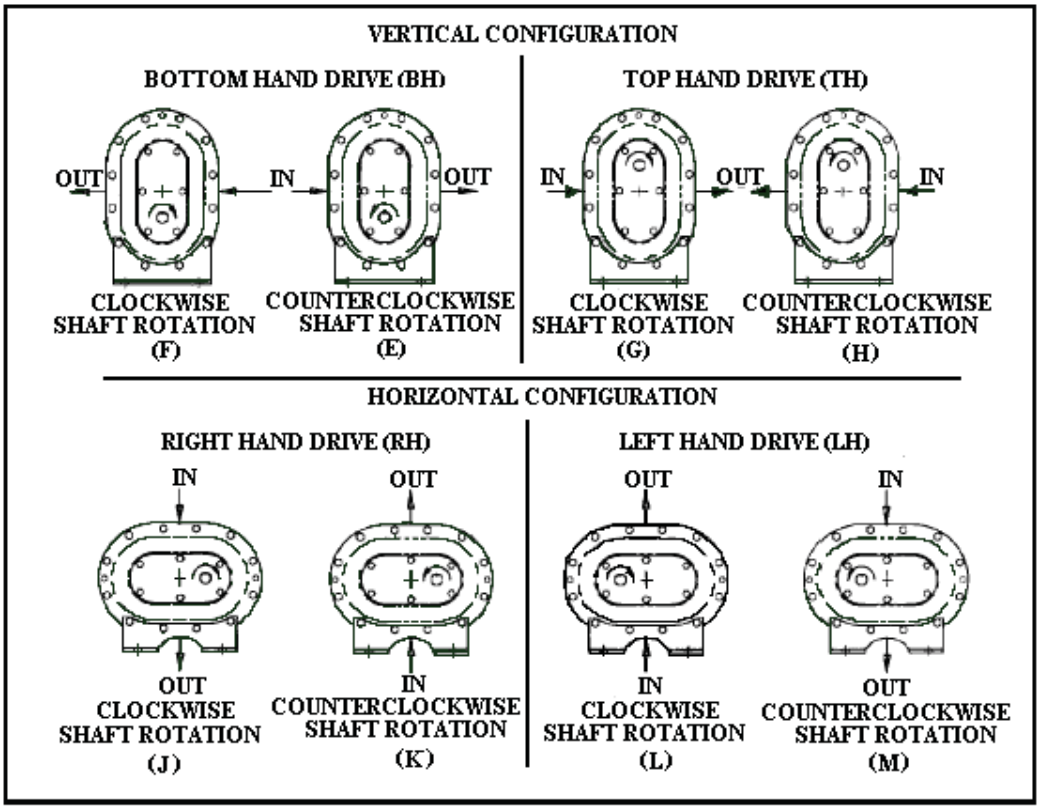


FIGURE 2-1 – BLOWER MOUNTING CONFIGURATIONS

4. Secure the mounting feet capscrews to the torque value in Figure 7-9, page 38.

NOTICE
When changing mounting configuration, it may be necessary to reposition breather/oil fill (B), oil level gauge (H) and drain plug (A). Refer to Figure 3-1, page 17, for correct location.

DRIVE INSTALLATION

When selecting a V-belt drive, check to be sure the shaft overhung load limitation is not exceeded. Refer to FIGURE 2-2, page 15, for overhung load calculations and limitations.

Belt drives must be carefully aligned. Motor and blower pulleys must be parallel to each other and in the same plane within 1/32 inch. Belt tension should be carefully adjusted to the belt manufacturer's recommendation using a belt tension gauge. Check tension frequently during the first day of operation.

⚠WARNING
Over tightening belts leads to heavy bearing loads and premature failure.

On the direct connected units, alignment and lubrication of couplings to specifications of the coupling manufacturer is very important. When mounted drives are supplied from the factory proper alignment has been established before shipment. However, during shipping, handling and installation, it is likely that the alignment has been disturbed and final adjustment must be made before startup.

⚠WARNING

Exceeding overhung load limitations leads to unwarrantable premature bearing failure and shaft breakage.

The location of the sheave on the blower shaft greatly affects the stress in the shaft. The optimum blower sheave positioning is as close as possible to the blower drive cover, not to exceed dimension "C" in Drive Shaft Illustration, FIGURE 2-2, page 15

The calculated shaft moment must not exceed the maximum allowable moment listed in Maximum Allowable Moment Chart, FIGURE 2-2 page 15. If the calculated shaft moment exceed the maximum allowable moment:

- Increase Sheave Diameters to Reduce Belt Pull
- Use Jackshaft Drive
- Use Direct Coupled or Gearbox Drive

To calculate shaft moment for a given V-Belt Drive Arrangement:

1. Use the formula for Calculation of Belt Pull, FIGURE 2-2, page 15, to calculate belt pull. Refer to Arc of Contact Factor Chart, Figure 2-2, page 15.
2. Insert the calculated belt pull into the formula for Calculation of Shaft Moment, FIGURE 2-2, page 15 to arrive at the calculated shaft moment.

PIPING

Inlet and discharge connections on all blowers are large enough to handle maximum volume with minimum friction loss. Reducing the pipe diameter on either inlet or discharge will only create additional line loss and increase the overall pressure differential. Excessive weight of piping and fittings will cause internal misalignment and premature wear. Never allow the blower to carry the weight of the pipe. If possible, a spool or sleeve-type expansion joint should be installed between the unit and the piping. Where a flexible connection is not practical, the weight of the rigid connection must be separately supported.

All system piping must be cleaned internally before connecting to the blower.

⚠WARNING

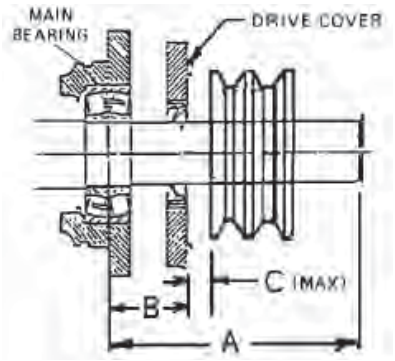
Sutorbilt blowers are shipped dry from the factory. Do not attempt to operate the blower before following proper lubrication instructions. Permanent damage to the gears, bearings and seals will occur.

Gear Diameter (Inches)	GREASE SPLASH Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	2.88	.85	.38	385
4	3.49	1.10	.38	490
5	3.90	1.40	.38	1245

MAXIMUM ALLOWABLE MOMENT

Gear Diameter (Inches)	DUAL SPLASH LUBE Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	3.07	1.18	.25	385
4	3.62	1.27	.25	650
5	3.85	1.39	.25	1370

MAXIMUM ALLOWABLE MOMENT



Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac
0.000	1.000	0.250	0.966	0.500	0.926	0.750	0.879	1.000	0.823	1.250	0.751
0.025	0.997	0.275	0.962	0.525	0.922	0.775	0.874	1.025	0.816	1.275	0.742
0.050	0.994	0.300	0.958	0.550	0.917	0.800	0.869	1.050	0.810	1.300	0.734
0.075	0.990	0.325	0.954	0.575	0.913	0.825	0.864	1.075	0.803	1.325	0.725
0.100	0.987	0.350	0.951	0.600	0.908	0.850	0.858	1.100	0.796	1.350	0.716
0.125	0.983	0.375	0.947	0.625	0.904	0.875	0.852	1.125	0.789	1.375	0.706
0.150	0.980	0.400	0.943	0.650	0.899	0.900	0.847	1.150	0.782	1.400	0.697
0.175	0.977	0.425	0.939	0.675	0.894	0.925	0.841	1.175	0.774	1.425	0.687
0.200	0.973	0.450	0.935	0.700	0.889	0.950	0.835	1.200	0.767		
0.225	0.969	0.475	0.930	0.725	0.884	0.975	0.829	1.225	0.759		

ARC OF CONTACT FACTORS

$$\text{Belt Pull} = \left[\frac{2.5 - Ac}{Ac}\right] \times \left[\frac{125954 \times Hp \times S.F.}{D \times RPM}\right]$$

Key:
- Ac = Arc of Contact Factor (Refer to Arc of Contact Factor Chart above)
- Hp = Blower Horsepower for Operating Conditions
- S.F. = Actual Drive Service Factor
- D = Blower Sheave Pitch Diameter in Inches
- RPM = Blower Sheave Speed
- Z = $\left[\frac{\text{Large Sheave Pitch Diameter (in)} - \text{Small Sheave Pitch Diameter (in)}}{\text{Sheave Center Distance (in)}}\right]$

CALCULATION OF BELT PULL

$$\text{Shaft Moment (LB-IN)} = \text{Belt Pull} \times \left[B + C + \left(\frac{\text{Sheave Width}}{2}\right)\right]$$

CALCULATION OF SHAFT MOMENT

FIGURE 2-2 – BELT DRIVE OVERHUNG LOAD CALCULATIONS

AIR FILTERS AND FILTER SILENCERS

⚠WARNING

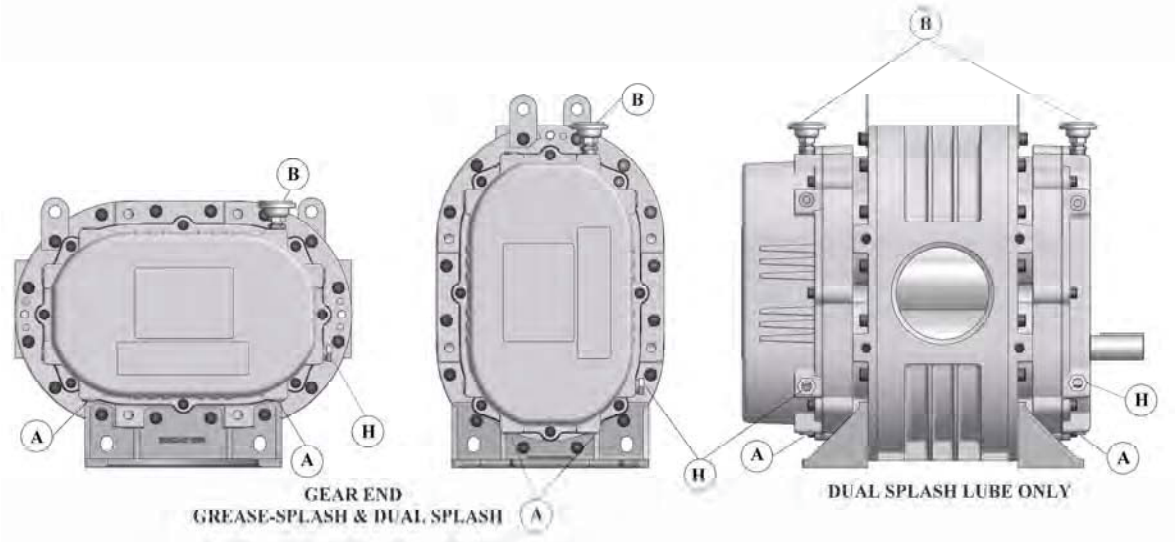
Servicing the air filters is one of the most important maintenance operations to be performed to insure long blower life.

Servicing frequency of filter elements is not time predictable. A differential pressure indicator, with a continuous gauge reading, should be installed across the inlet filter. It will tell how much of the service life of the filter element has been used. It will also eliminate both premature filter servicing and premature blower failure due to a plugged filter when the filter pressure drop is used to establish maintenance points. In all cases refer to the filter manufacturer's service instructions. Due to the many types of filters, it is not practical to give specific instructions covering all models.

NOTICE

No matter what type of filter is used, always make sure all seats, gaskets, clamps and hose connections on the filter and inlet line are absolutely air tight. Each time the filter is serviced, inspect interior of the blower for dirt.

SECTION 3
LUBRICATION



A. OIL DRAIN PLUG
B. BREATHER/OIL FILL
C. GREASE FITTING
E. GREASE VENTS
H. OIL LEVEL GAUGE

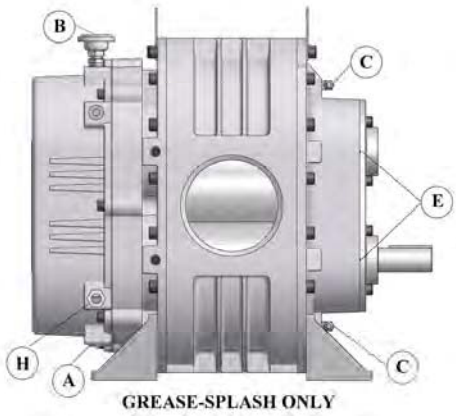


FIGURE 3-1 - LUBRICATION

DRIVE END LUBRICATION (For Grease – Splash Lube Blowers)

Drive end bearings are grease lubricated at the factory with Lithium Complex based grease. **For relubrication, use Gardner Denver AEON PD Grease, Part Number 28H283.** AEON PD Grease is a high temperature, high performance grease that is formulated with antiwear additives to provide superior service under the severe operating conditions of positive displacement blowers. It contains rust inhibitors which provide excellent protection against rust and corrosion.
If you choose not to use AEON PD Grease, select compatible base grease. The grease should be NLGI Grade 2 EP, contain rust inhibitors, and be suitable for blower discharge temperatures up to 350° F (177° C). Completely clean or purge the factory--filled grease from the blower. **Do not mix different types of grease as they may not be compatible. Substitutions may cause early bearing failure.**

Re-grease bearings every 500 hours of operation. Lubricate each bearing through the grease fittings located at C in FIGURE 3-1 (2 places). When re-greasing, the old grease will be forced out of the vents (E in FIGURE 3-1). To prevent damage to seals, these vents must be open at all times.

⚠ WARNING
Do not over--grease bearings as this could cause premature bearing failure.

DRIVE END LUBRICATION (For Dual Splash Lube Blowers)

At the drive end, the bearings are lubricated by the slinger, which must be on the lowest rotor when in a vertical configuration.

Approximate oil sump capacities are listed in Figure 3-2.

NOTICE
Machines are shipped without oil in the sump. Do not operate before adding lubricant.

Lubrication Instructions

Filling procedure
Refer to Figure 3-1, page 17. Remove the breather (B) from the drive cover. Add oil to the drive sump until oil reaches the center of the oil level gauge (H). Secure breather (B) in the drive cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, for approximate oil capacities.

Legend "R" Series, Grease-Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	grease	0.6 PT (9 oz.)	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)
4	4	0.9 PT (14 oz.)	grease	0.9 PT (14 oz.)	1.5 PT (24 oz.)	grease	1.5 PT (24 oz.)
5	5	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)	2.5 PT (40 oz.)	grease	2.5 PT (40 oz.)

Note: Quantities are for purchase estimates only.

Legend "R" Series, Dual Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	0.3 PT (5 oz.)	0.9 PT (14 oz.)	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)
4	4	0.9 PT (14 oz.)	0.4 PT (6 oz.)	1.3 PT (20 oz.)	1.5 PT (24 oz.)	0.7 PT (11 oz.)	2.2 PT (35 oz.)
5	5	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)	2.5 PT (40 oz.)	1.2 PT (19.1 oz)	3.7 PT (59.1 oz.)

Note: Quantities are for purchase estimates only.

FIGURE 3-2 – APPROXIMATE OIL CAPACITIES

GEAR END LUBRICATION (For Grease – Splash Lube and Dual Splash Lube Blowers)
At the gear end, the timing gear teeth are lubricated by being partially submerged in oil. The gear teeth serve as oil slingers for gear end bearings.

Approximate oil sump capacities are listed in Figure 3-2.

⚠WARNING

Do not overfill as this will tend to cause excessive heating of the gears and may damage the unit.

NOTICE

Machines are shipped without oil in the sump. Do not operate before adding lubricant.

LUBRICATION INSTRUCTIONS

Filling procedure Refer to FIGURE 3-1, page 17. Remove the breather (B) from the gear cover. Add oil to the gear case until oil reaches the center of the oil level gauge (H). Secure breather (B) in the gear cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, page 18, for approximate oil capacities.

RECOMMENDED LUBRICANT

AEON PD Synthetic Blower Lubricant is recommended. Refer to FIGURE 3-3, for AEON PD, AEON PD-FG (Food Grade) and AEON PD-XD (Extreme Duty) part numbers. Order AEON PD from your Gardner Denver Distributor or call Gardner Denver directly.

Convenient Package Sizes	AEON PD Part No.	AEON PD-FG Part No.	AEON PD-XD Part No.
1 quart	28G23	28H97	28G46
Case 12 quarts	28G24	28H98	28G47
1 gallon	28G40	28H333	28G42
Case 6 gallons	28G41	28H334	28G43
5 gallon pail	28G25	28H99	28G44
55 gallon drum	28G28	28H100	28G45

FIGURE 3-3 – AEON PD SYNTHETIC LUBRICANT

AEON PD is formulated especially for positive displacement blower service to provide maximum blower protection at any temperature. One fill of AEON PD will last a minimum of 4 times longer than a premium mineral oil. Refer to FIGURE 3-4.

		Ambient Temperatures			
		Less than 10° F	10°F to 32°F	32°F to 90°F	Greater than 90°F
Blower Discharge Temperature	Less than 32°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG		
	32° F to 100° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	
	100° F to 225°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG
	225° F to 300° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD XD
	Greater than 300°F			AEON PD XD	AEON PD XD

FIGURE 3-4 – SYNTHETIC LUBRICANT CHART

AEON PD Synthetic Lubricant should be drained after 6000 hours of operation. Re-fill with fresh AEON PD oil. If mineral oil is used, perform the above oil change maintenance every 1500 hours. Recommended service intervals are for normal blower operating conditions. Severe operating conditions may warrant more frequent oil changes. Laboratory analysis of lubricant should be used to help determine the optimum oil change interval.

For best performance and equipment protection, use AEON PD Synthetic Lubricant, which has been specifically formulated for positive displacement blowers. If you choose not to use AEON PD Synthetic Blower Lubricant, select an oil with rust and oxidation inhibitors, anti-foam additives, and the viscosities listed in FIGURE 3-5. Do not use an oil that contains EP additives.

NOTICE
Flush the oil whenever a change is made from one type of oil to another.

Drain the current lubricant as thoroughly as possible. Refill with the new lubricant. Fill to normal level of the blower, which is at the middle of the sight glass when the machine is not operating. Run the blower for one hour. Shut off the blower and drain the lubricant completely. Refill the blower again with the new lubricant.

Blower Discharge Temperature	Ambient Temperature			
	Less than 10° F*	10° F to 32° F**	32° F to 90° F	Greater than 90° F
Less than 32° F (0° C)	ISO 100	ISO 100		
32° F to 100° F (0° C to 38° C)	ISO 100	ISO 100	ISO 150	
100° F to 225° F (38° C to 105° C)	ISO 100	ISO 100	ISO 150	ISO 220
225° F to 300° F (105° C to 149° C)	ISO 150	ISO 150	ISO 220	ISO 220
Greater than 300° F (149° C)			***	***

* For ambient temperatures less than 10° F, but not less than –20° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is required.

** For ambient temperatures 10° F to 32° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is recommended.

*** The lubricant viscosity must be 70 SUS minimum at the lubricant operating temperature.

The pour point of the lubricant should be at least 5° to 10° F below the minimum expected ambient temperature.

For continuous operation, where the lubricant temperature exceeds 200° F, synthetic lubricant is recommended.

FIGURE 3-5 – LUBRICATION RECOMMENDATION

SECTION 4
OPERATION

Future operating problems can be avoided if proper precautions are observed when the equipment is first put into service.

Before starting under power, the blower should be turned over by hand to make certain there is no binding or internal contact.

Each size blower has limits on pressure differential, running speed and discharge temperature which must not be exceeded. These limits are shown in "Maximum Operating Limitations", FIGURE 4-1, below.

⚠WARNING

Operating beyond the specified operating limitations will result in damage to the unit.

It is important that the pressures and temperatures are measured directly at the ports of the blower to avoid error that may be caused by intervening pipe runs, fittings, etc.

Relief valves must be used to protect against excessive pressure or vacuum conditions. These valves should be tested at initial startup to be sure they are adjusted to relieve at or below the maximum pressure differential rating of the blower.

NOTICE

Relief valves should be placed as close as possible to the blower inlet or discharge.

In some instances, pressure may be relieved at a lower point than the blower maximum in order to protect the motor or the equipment served by the blower.

Discharge temperature switches are recommended to protect against excessive inlet restriction or inlet temperatures. Check valves in the discharge line on pressure blowers and in the inlet line on vacuum blowers are recommended to protect the blower from motoring backwards when shut down under load.

LIMITATIONS

For information regarding limitations, refer to FIGURE 4-1, below.

MAXIMUM / MINIMUM OPERATING LIMITATIONS

SIZE	MAX. RPM	MIN. RPM VERT.	MIN RPM HORIZ.	MAX. PRESSURE PSI	MAX VAC IN HG	MAX. TEMPERATURE RISE ° F	MAX. DISCHARGE TEMPERATURE ° F
3LR	3600	1528	1091	7	14	160	260
3MR	3600	1528	1091	12	15	180	280
3HR	3600	1528	1091	15	16	220	320
4LR	3600	1337	955	7	14	160	260
4MR	3600	1337	955	10	16	185	285
4HR	3600	1337	955	15	16	210	310
5LR	2850	1070	764	7	14	160	260
5MR	2850	1070	764	13	16	180	280
5HR	2850	1070	764	15	16	200	300

DO NOT EXCEED THESE LIMITS

NOTICE

Blower speed, line losses, elevation, and increased inlet temperatures will affect the maximum operating limitations. The minimum RPM for the blowers is based on lubrication only. The blowers may only be operated down to the minimum RPM, when the temperature rise and discharge temperature are below the maximum limitations as shown.

FIGURE 4-1 – MAXIMUM / MINIMUM OPERATING LIMITATIONS

BLOWER STARTUP CHECKLIST

This startup procedure should be followed during the initial installation and after any shutdown periods or after the blower has been worked on or moved to new location. It is suggested that the steps be followed in sequence and checked off (√) in the boxes provided.

- ☐ 1. Check the unit and all piping for foreign material and clean if required.
- ☐ 2. Check the flatness of the feet and the alignment of the drive. Feet that are bolted down in a bind can cause housing distortion and internal rubbing. Misaligned V-drives can cause the rotors to rub against the headplates and cause a reduction in the volumetric efficiency of the unit. Misaligned couplings can ruin bearings.
- ☐ 3. If the blower is V-belt driven, check the belt tension and alignment. Over-tensioned belts create heavy bearing/shaft loads which lead to premature failure.
- ☐ 4. Be sure adequate drive guards are in place to protect the operator from severe personal injury and incidental contact.
- ☐ 5. Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Too little oil will ruin bearings and gears. Too much oil will cause overheating and can ruin gears and cause other damage. Insure that grease lubricated bearings are properly lubricated.
- ☐ 6. With motor electrical power locked out and disconnected, turn the drive shaft by hand to be certain the impellers do not bind.
- ☐ 7. “Jog” the unit with the motor a few times to check that rotation is in the proper direction, and to be certain it turns freely and smoothly.
- ☐ 8. The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventive to protect the machine during the shipping and installation period. This film should be removed upon initial startup.
- ☐ 9. Start the unit and operate 15 minutes at no load. During this time, check for hot spots and other indications of interference.
- ☐ 10. Apply the load and observe the operation of the unit for one hour. Check frequently during the first day of operation.
- ☐ 11. If malfunctions occur, do not continue to operate. Problems such as knocking rotors can cause serious damage if the unit is operated without correction.

SAFETY PRECAUTIONS

1. Do not operate blower with open inlet or outlet port.
2. Do not exceed specified vacuum or pressure limitations.
3. Do not operate above or below recommended blower speed range.
4. Blower is not to be used where non-sparking equipment is specified.
5. Do not operate without belt guard or coupling shield.

Do not exceed sheave or coupling manufacturer's rim speed limit.

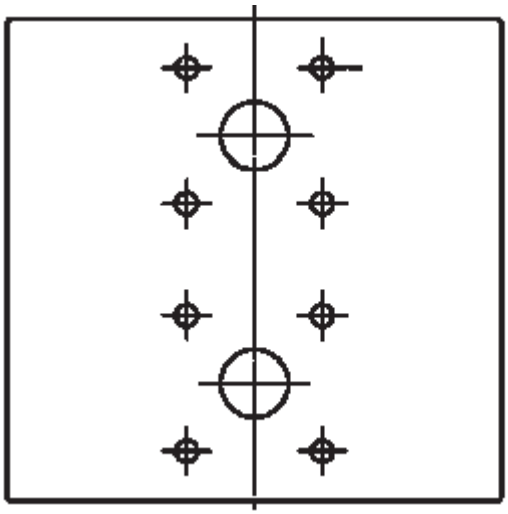
6. The blower and blower discharge piping may be extremely hot and cause skin burns on contact.

TROUBLE SHOOTING

No matter how well the equipment is designed and manufactured, there may be times when servicing will be required due to normal wear, the need for adjustment, or various external causes. Whenever equipment needs attention, the operator or repairman should be able to locate the cause and correct the trouble quickly. The Trouble Shooting Chart below is provided to assist the mechanic in those respects.

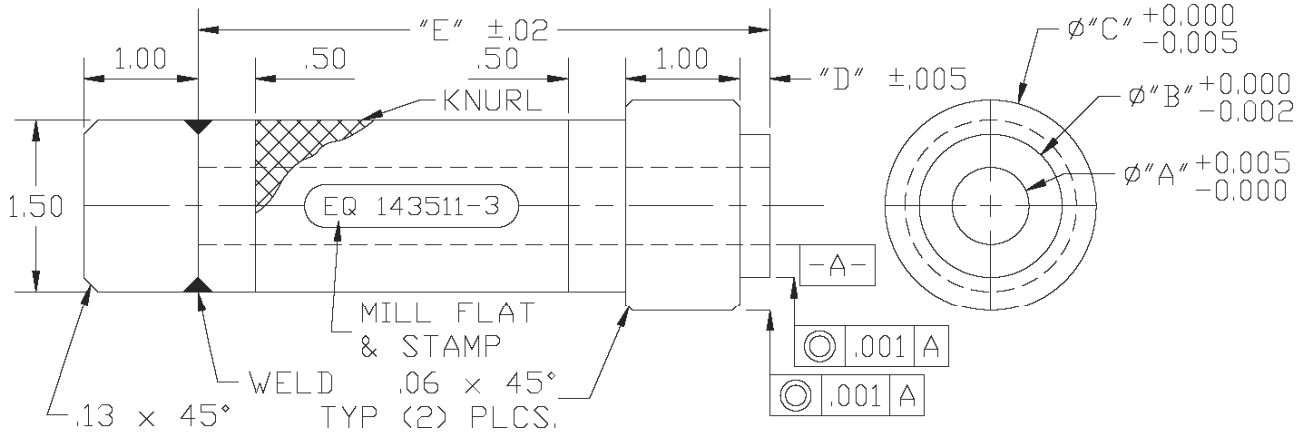
PROBLEM	POSSIBLE CAUSES	SOLUTION
Knocking	1. Unit out of time. 2. Distortion due to improper mounting or pipe strains. 3. Excessive pressure differential. 4. Worn gears. 5. Worn bearings.	1. Re-time impellers 2. Check mounting alignment and relieve pipe strains. 3. Reduce to manufacturer's recommended pressure. Examine relief valve, re-set if necessary. 4. Replace timing gears. 5. Replace bearings..
Excessive blower temperature.	1. Too much oil in gear case. 2. Too low operating speed. 3. Dirty air Filter. 4. Clogged filter or muffler. 5. Excessive pressure differential. 6. Worn impeller clearances. 7. Internal contact.	1. Reduce oil level. 2. Increase blower speed. 3. Clean or replace air filter 4. Remove cause of obstruction. 5. Reduce pressure differential across the blower. 6. Replace impeller. 7. Correct clearances.
Impeller end or tip drag.	1. Insufficient assembled clearances. 2. Case or frame distortion. 3. Excessive operating pressure. 4. Excessive operating temperature.	1. Correct clearances. 2. Check mounting and pipe strain. 3. Remove cause. 4. Remove cause
Lack of volume.	1. Slipping belts. 2. Worn clearances. 3. Dirty air filter	1. Tighten belts. 2. Re-establish proper clearances. 3. Clean or replace air filter.
Excessive bearing or gear wear.	1. Improper lubrication.	1. Correct lubrication level. Replace dirty oil.
Loss of oil.	1. Headplate, gear case or drive cover vents plugged. 2. Worn Seal.	1. Clean vents. 2. Replace seals.

ORDER SPECIAL TOOLS BY PART NUMBER. SEE PAGE 2 FOR ORDERING INSTRUCTIONS.



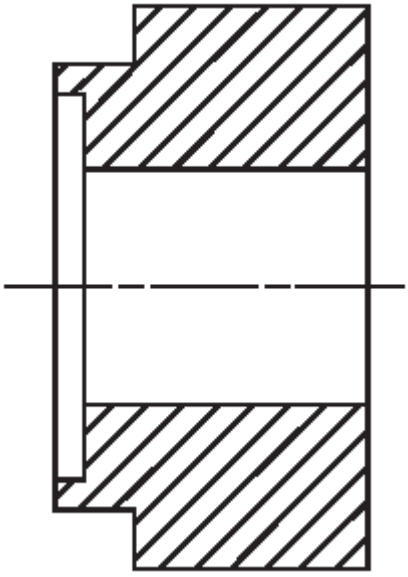
Unit Size	Part Number
3”	201GAA340
4”	202GAA340
5”	203GAA340

FIGURE 5-1 – PULLER PLATE



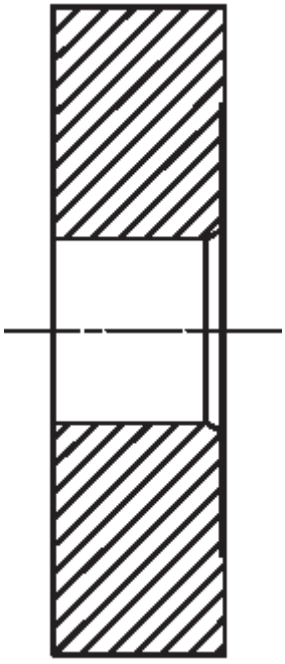
PART NO.	SIZE	"A"	"B"	"C"	"D"	"E"
EQ 143511-3	3"	.790	1.435	2.044	.335	5.50
EQ 143511-4	4"	1.000	1.624	2.436	.395	6.25
EQ 143511-5	5"	1.184	2.247	2.829	.695	7.00

FIGURE 5-2 – SEAL DRIVE



Unit Size	Part Number
3”	205GAA074
4”	206GAA074
5”	207GAA074

FIGURE 5-3 – MECHANICAL SEAL INSTALLATION TOOL



Unit Size	Part Number
3”	201GAA074
4”	202GAA074
5”	203GAA074

FIGURE 5-4 – BEARING PRESS TOOL – MECHANICAL SEAL UNITS

SECTION 6
DISASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Drain oil from gear case by removing drain plug (2).
2. Remove the socket head bolts (5) from the gear cover (3).
3. Remove the gear cover from the gear headplate.

NOTICE
The cover and gear headplate gasket tends to bond tightly to both surfaces. After socket head bolt removal, it is sometimes necessary to take a ball peen hammer and a blunt chisel and drive off the cover.

IMPORTANT:

MARK ALL PARTS WITH A CENTER PUNCH SO THEY CAN BE REASSEMBLED IN THE SAME POSITION (IMPELLERS, HEADPLATES, AND GEARS).

4. If the timing gears appear undamaged, the gear backlash must be checked to see if the gears can be salvaged.
   - A. Mount a magnetic base dial indicator on the gear headplate (see FIGURE 6-1).
   - B. Lock one impeller stationary by wedging a feeler gauge between the impeller and the headplate.
   - C. The tip of the indicator should be placed at the center of the contact surface on a tooth of the gear on the free shaft.
   - D. Rock the impeller back and forth by hand and read the total rotational movement to the nearest .0005 inches. Do this at four gear mesh positions 90 degrees apart.
   - E. Permissible gear backlash is shown below.

GEAR DIA.	GEAR BACKLASH
3”	.0015 - .0025
4”	.0015 - .0025
5”	.002 - .003

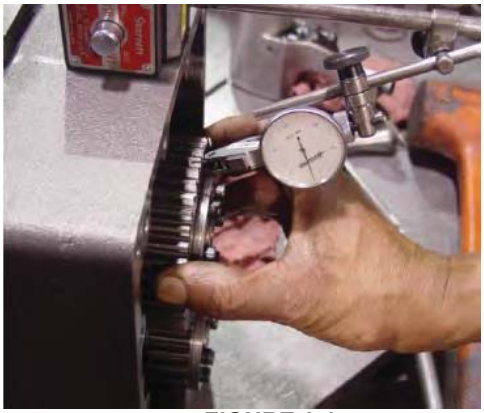


FIGURE 6-1

FIGURE 6-2

FIGURE 6-3

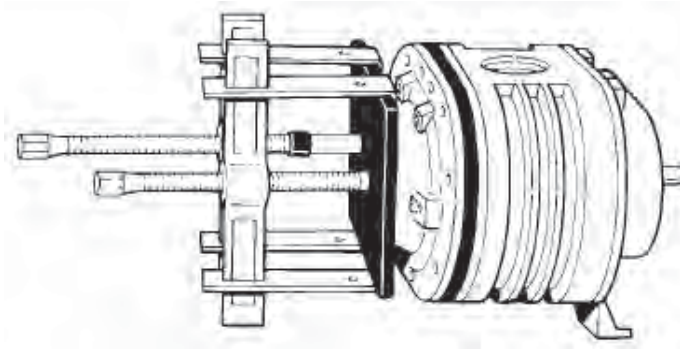


FIGURE 6-4

NOTICE
If backlash is above the specified limit, the gears are not necessarily unusable. Excessive play could be caused by worn bearings.

5. If timing gears appear to be reusable, match marktiming gear toothmesh by making small punch marks on the ends of meshing gear teeth with a pin punch and hammer (see FIGURE 6-2, page 27). The impeller tip to valley (throat) and the case to headplates should also be matchmarked to facilitate blower reassembly.
6. Remove all cap screws from both gear locking assemblies (see FIGURE 6-3). Thread 3 of these cap screws into the threaded holes in the outer ring of each locking assembly. Tighten the screws evenly to remove the locking assembly from each gear. Remove the gears (9) from both rotor shafts.

NOTICE
Blowers with mechanical seals have two wavy washers (28) located between the bearings and the cover on the drive end.

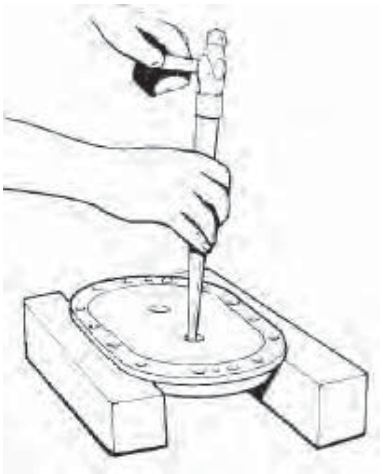


FIGURE 6-5

7. Remove the socket head cap screws (30) from the drive end bearing cover (29) and remove the cover. Support the external surface of the drive end cover near the oil seal with blocks of wood. Drive the oil seal from the cover using a hammer and punch. Discard the seal as it will not be reused. Replace oil seals each time the drive end cover is removed.

   For Dual Splash Version
   Remove the socket cap screws (84) from each slinger and remove slingers.

   For Dual Splash Version with Mechanical Seal
   Remove the socked cap screws (84) from each slinger and remover slingers. Remove flat head cap screws (86) from wavy spring retainer plates and remove retainer plate and wavy spring.

8. Remove mounting foot (17) from the drive headplate (24) by removing the capscrews (16).
9. Remove the capscrews (21) which secure the drive headplate (24) to the impeller case (22).
10. Using the puller plate shown on page 25, bolt to the drive headplate using the tapped holes on used to secure the drive cover.
11. Install a gear puller to each shaft and attach puller arms to the plate. Turn each puller only half a revolution at a time keeping the advance of the shafts as uniform as possible (see Figure 6-4). After the headplate has been removed, detach the puller plate.
12. Remove the two drive end bearings (35 and 80 for dual splash lube) or (14 and 35 for grease) from the drive headplate (24) using a ball peen hammer and punch (see Figure 6-5, page 28).

⚠ CAUTION
Exercise care not to damage the headplate bearing bores when removing bearings.

13. The oil seals can now be driven out of the drive headplate with hammer and punch (see Figure 6-5, page 28). Discard the seals as they will not be reused. Replace oil seals each time the headplate is removed.

   For Mechanical Seal Version
   Remove mechanical seal from the drive headplate.

NOTICE
Seals and bearings should be replaced during overhaul as a matter of service policy.

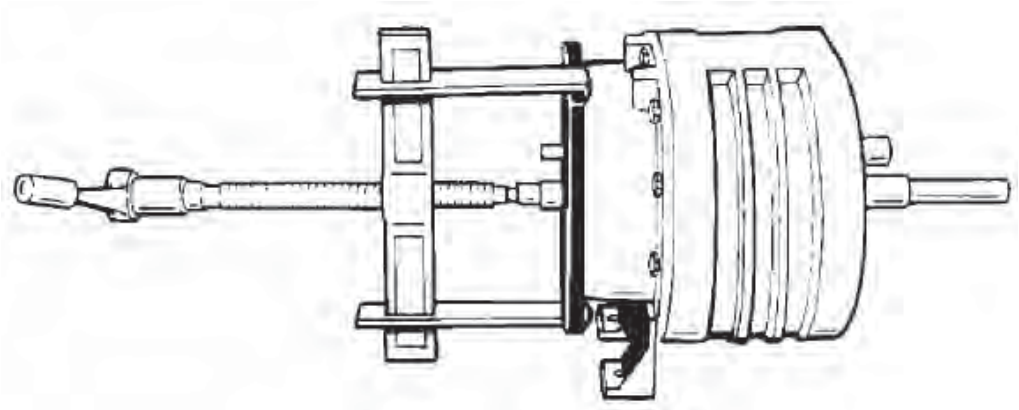


FIGURE 6-6

14. Remove the four bearing retaining screws (10), and washers (12) from the gear headplate.

    For Mechanical Seal Version
    Remove bearing retainer plate by removing 8 screws.

15. Attach puller plate to the gear headplate using the tapped holes on the bearing housing.

16. Install a gear puller to one of the shafts and attach puller arms to the plate (see Figure 6-6).

17. Remove mounting foot (17) from the gear headplate by removing 4 capscrews (16).

18. Push the impeller shaft through the gear headplate and remove the impeller assembly(23) (see Figure 6-6). Remove the other impeller assembly following the same procedure.

19. Remove the cap screws (21) securing the gear headplate to the impeller case. Located near each dowel pin on the headplate is a threaded hole. Insert a 5/16-18 UNC capscrew into each of the threaded holes. Tighten the screws evenly until the headplate separates from the impeller case.

20. Remove the two gear and bearings (14) from the gear headplate (18) as done in step 12.

21. Remove the oil seals (15) from gear headplate (19) as done in step 13.

SECTION 7
ASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Make sure all metallic parts are clean and free of any nicks or burrs.
2. Lubricate the outside diameter of the lip seal (15) with a light oil or grease. Install seals in both the drive headplate (24) and gear headplate (18). Use the seal driver (Figure 5-2). The seal lip should always face towards the bearing or lubricant. New seals should be installed each time the headplate is removed.

NOTICE
Make sure seals are fully seated. Use extreme care when installing.

MECHANICAL SEALS ONLY

A. Lightly coat the headplate bores with assembly lubricant.

B. Refer to Figure 7-1. Install mechanical seal (A) into the headplate bore (C) using a press and the correct driver shown on page 26. Drive the seal securely on to its seat.

⚠ CAUTION
Use extreme care when installing seals in the headplate bores. Do not attempt to install the mechanical seals without the use of a press. Blows from a hammer or mallet can damage the fragile seal surface. Too much force can crush the seal casing. Make certain the seal is properly seated and undamaged before proceeding.

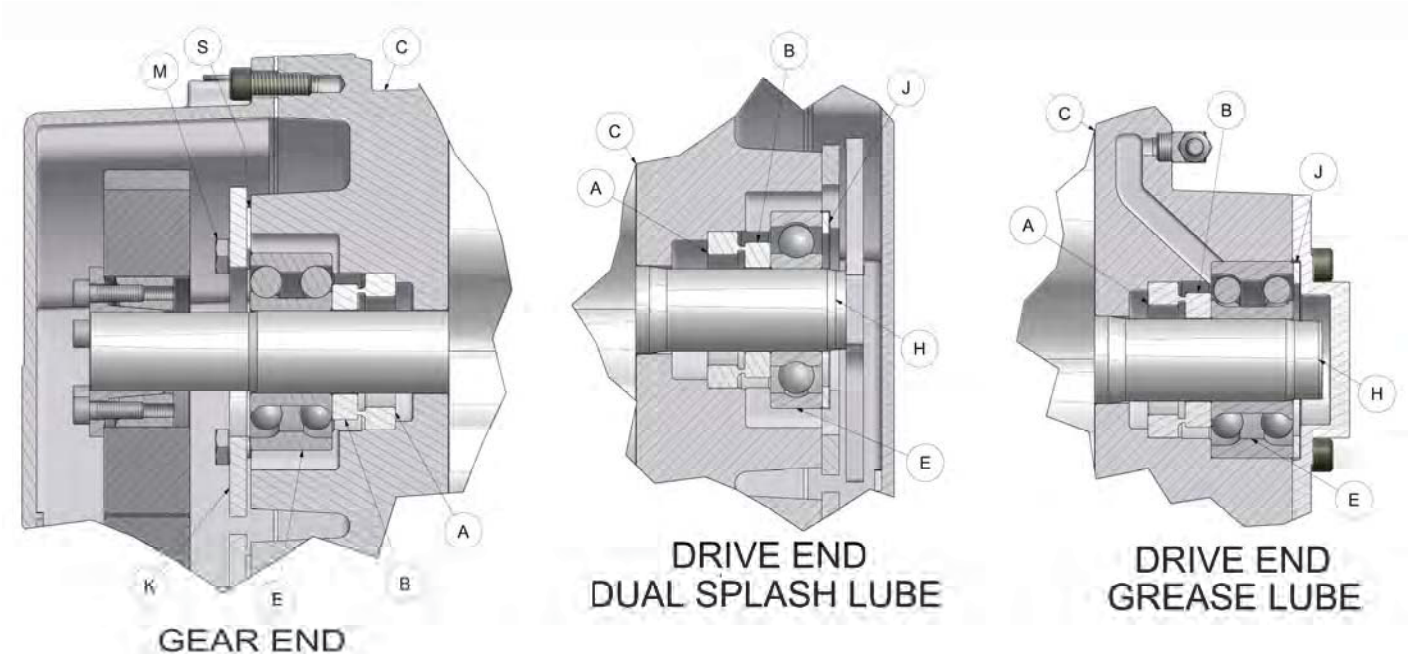


FIGURE 7-1

FIGURE 7-2

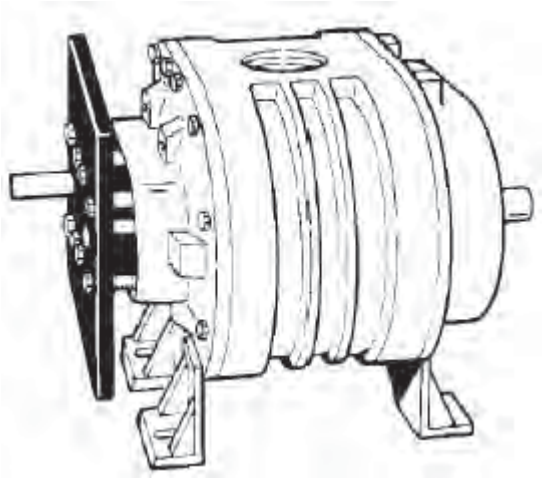


FIGURE 7-3

3. Assemble gear headplate (18) and mounting foot (17) to the impeller case with cap screws (21) and where the mounting foot is secured to the headplate use capscrews (16). The two positioning dowel pins (19) will ensure proper alignment of the headplate and impeller case. Also secure lifting lugs using capscrews (21) (see exploded assembly drawing on page 39. Refer to Figure 7-9, page 38, for torque specifications.

⚠ CAUTION
Seals are delicate; use extreme care when installing impeller shafts in the headplate bores. A piece of light shim stock wrapped around the shaft keyway will prevent cutting the seal lip.

4. Apply a light oil or grease on the shaft seal areas and the bearing areas. Insert impellers into the gear headplate using the same headplate bores as used in the original assembly.
5. Position blower so that impellers are vertical, with the drive end on top. It will be necessary to use blocks in order for the unit to set level. Measure the total end clearance using a depth micrometer (see Figure 7-2).

NOTICE
If more than .007" shim is required, put .007" on the drive end and the remaining on the gear end.

If total clearance is not within the limits specified in Figure 7-4, page 33, it may be necessary to shim the case to obtain the proper total end clearance. The shim should be placed between the drive headplate and impeller case.

6. Assemble drive headplate (24) to impeller case as in step 3 with the gear headplate. If shims were required, place shims between drive headplate and impeller case.

MECHANICAL SEALS ONLY

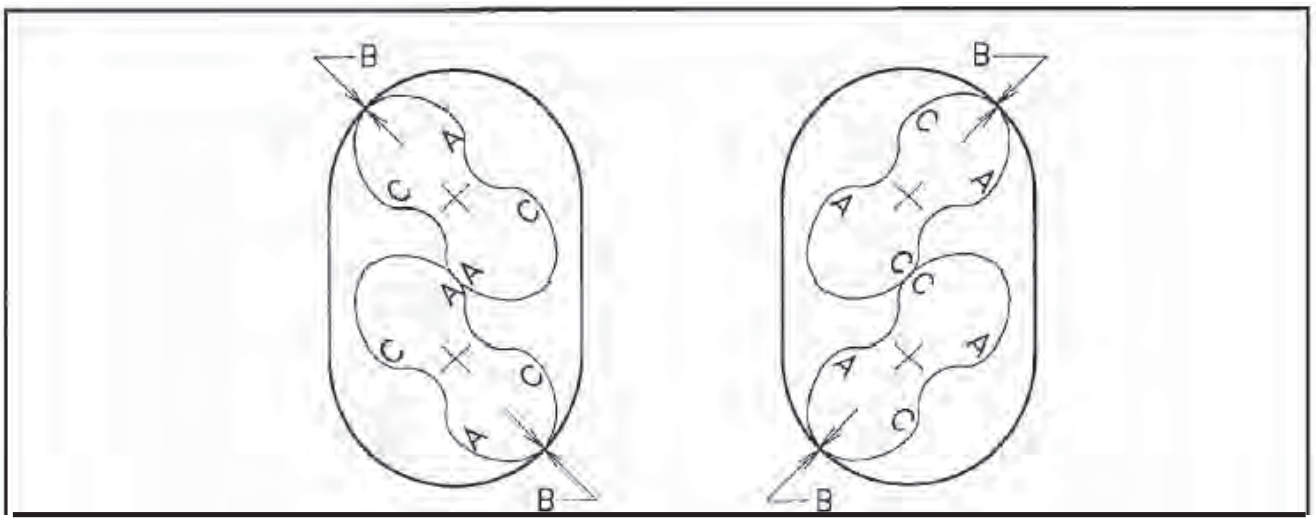
A. Refer to Figure 7-1, page 31. Lightly coat the impeller shaft (H) and the inside diameter of the mating ring (B) with assembly lubricant.

B. Install the mating ring (B) on the shaft only far enough to get the bearing (E) started on the shaft.

⚠ CAUTION
Do not drive the mating ring down to the mechanical seal, as this can damage the seal.

C. Lightly lubricate the bearing inner race (E) with a light oil or grease.

D. Using a press, install the bearing on the shaft with the bearing driver shown on page 24.



INTERNAL CLEARANCES FOR STANDARD UNITS ONLY

	3H	3M	3L	4H	4M	4L	5H	5M	5L
TOTAL END CLEARANCE	0.007-0.011			0.007-0.011			0.007-0.011		
IMPELLER TO GEAR HEADPLATE	0.003-0.005			0.003-0.005			0.003-0.005		
IMPELLER TIMING (A-A) (C-C)	0.005-0.007	.006-.008		0.006-0.008	.007-.010		.007-.010	.008-.010	
TIP TO CASE CLEARANCE (B-B)	0.002 min.			0.002 min.			0.002 min.		

FIGURE 7-4

The bearing driver will position the mating ring (B) to the correct depth with respect to the mechanical seal (A).

7. Apply a light oil to the drive headplate bearing bore, bearing inside diameter, and shaft seat. Install the drive end bearings (14and 35 for grease) or (80 and 35 for dual splash lube) as far as possible without force.
8. Attach the puller plate shown on page 25, to the drive headplate using the tapped holes used on the drive headplate (see FIGURE 7-3, page 32). Tighten the bolts so that the advance of the bearings stay as uniform as possible. Bearings should be pressed until flush with the drive headplate.
9. Lubricate the gear end bearing fits with a light oil as described previously. Install gear end bearings (14) as far as possible without force. Use the plate, used to install the drive end bearings, to press the bearings on the shafts as described in Step 8. Press bearings into the gear headplate until completely seated in the bearing bore.

NOTICE
Bearings will not be flush with gear headplate bores when completely seated.

10. Impellers should now be checked for free axial movement by hitting the ends of the impeller shafts with the palm of your hand.
11. Push the impellers against the gear headplate and recheck the total end clearance between the drive headplate and the impellers (see FIGURE 7-4).
    A. If total end clearance is insufficient, loosen impeller case to headplate bolts on either headplate, and move the headplate away from the case far enough to insert a paper shim in the amount equal to the insufficient clearance. Retighten case bolts and again check the total end clearance. Refer to FIGURE 7-4 for correct clearance.
    B. Excessive end clearances normally will require new impeller assemblies, but in some circumstances the impeller case can be removed and reduced in width by machining off the amount of excess clearance.
    C. Apply Loctite 246 on the 4 bearing retaining screws. Install 4 bearing screws and washers into the gear end headplate. Tighten screws evenly to the torque value given in FIGURE 7-9.

For Mechanical Seal Version

Install 8 bearing retaining screws and washers into the gear bearing retainer plates. Tighten screws evenly.

12.

A. Dual Splash Version

Install slingers on both shafts. Hold .31" +/_.01" gap between face of the bearing and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-5).

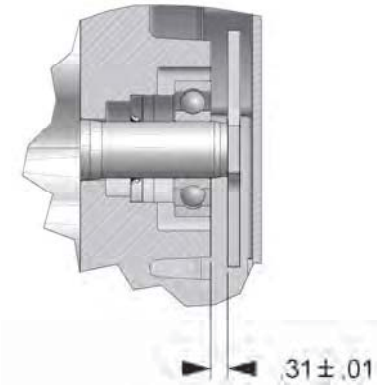


Figure 7-5

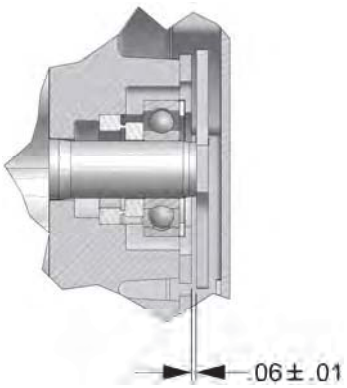


Figure 7-6

B. For Dual Splash Version with Mechanical Seal

Install slingers on both shafts. Hold .06"+_.01" gap between wavy spring retainer plates and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-6).

13. **SETTING IMPELLER END CLEARANCES**

Refer to FIGURE 7-7, page 34. The outer races of the gear end bearings are clamped against the headplate (F) by the bearing retaining screws or by bearing retainer plate (mechanical seal version) (B).

This is referred to as the "fixed end". The interference fit between the shaft and the bearing inner race (H) keeps the shaft from moving axially. Adjustment is by movement of the shaft through the gear end bearing inner race (H).

A. Check the total end clearance by adding the clearance between the impellers and the drive headplate to the clearance between the impellers and the gear headplate.

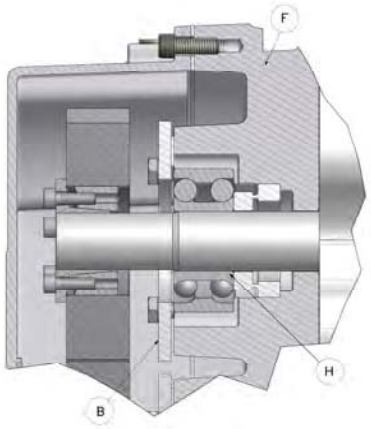


Figure 7-7

NOTICE
Check the clearance over the entire width of the impeller and consider the tightest spot.

B. Divide the end clearance by 3 and distribute approximately 1/3 on the gear end and the remaining 2/3 on the drive end.
C. To move the impeller assembly toward the drive end, lightly tap the shaft at the gear end with a soft face mallet.

D. To move the impeller assembly toward the gear end, lightly tap the shaft at the drive end with a soft face mallet.

E. To set the fixed end, insert the feeler gauge in the amount specified in FIGURE 7-4, page 33, between the headplate and the impeller at the gear end.

F. Tap lightly until the feeler gauge is snug. Adjust both impellers using the same procedure. Rotate the impellers checking for clearance through a complete revolution.

SETTING IMPELLER END CLEARANCE WITH MECHANICAL SEALS

Refer to FIGURE 7-1, page 31. The gear end bearings are held in position by the force created by the wavy spring (J) on the drive end and the bearing retainer (K) on the gear end. This is referred to as the fixed end. The interference fit between the shaft (H) and the bearing inner race (E) keeps the shaft from moving axially.

End clearance adjustment is by movement of the bearing retainer (K). Tightening the bearing retainer screws (M) moves the bearing to load the wavy spring (J), and the impeller is forced toward the drive end. Relaxing the screws allows the wavy spring to return the impeller toward the gear end.

A. Assemble drive cover to drive headplate. Refer to Step 15 with the exception of the use of wavy springs (J) installed between the drive end bearings and the wavy spring retainer plates.

B. Back out retainer screws (M) until both impellers are tight against the gear headplate.

C. With feeler gauge, measure the clearance between each impeller and the drive headplate. This value is the total end clearance.

D. Measure the clearance between the gear headplate and bearing retainer (K) at point (S).

E. Subtract 1/3 of the total end clearance from the clearance measured at point (S). This value is the amount of shim (13) that should be placed between the retainer and the headplate at point (S).

F. Tighten the bearing retainer screws (M) to the torque value given in FIGURE 7-9, page 38. With the retainer screws secure, approximately 1/3 of the total end clearance should be on the gear end and the remaining 2/3 on the drive end.

1. INSTALLING THE TIMING GEARS

If reusing the timing gears, the gears should be returned to their original positions.

A. Obtain 2 gear locking assemblies. Clean the inside and outside diameters of both locking assemblies. Clean the inside diameter of 2 gears. Clean the outside diameter of the both rotor shafts. Lightly oil the surfaces that have been cleaned. Note: DO NOT USE MOLYBDENUM DISULFIDE, MOLYKOTOE, OR ANY OTHER SIMILAR LUBRICANTS.

B. Slide a locking assembly into a gear. Install the gear and locking ring assembly onto the idler rotor shaft. Push the locking assembly firmly until flush with the end of the idler rotor shaft and hand tighten the 7 cap screws. Align and adjust the connections.

C. Use a torque wrench to tighten the screws to 75 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs. is applied to them a second time.

D. Tighten the screws further to 150 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs. is applied to them a second time.

E. Slide the second locking assembly into a gear. Install the gear and locking ring assembly onto the drive rotor shaft. Note the circular mark on each gear indicates the position of the largest runout. These marks must be 180 degrees apart when the gears are installed.

F. Push the locking assembly firmly until flush with the end of drive rotor shaft and hand tighten all cap screws but leave them loose enough that the gear can be rotated on the shaft.

G. The first step in setting the interlobe clearance is to measure the total clearance between two meshing lobes. This is accomplished by determining the maximum feeler gauge thickness that will fit between the rotor lobes near the pitch diameter. The clearance should be measured along the entire length of the meshing lobes. This measurement should be taken for each of the 2 interlobe meshes. The location of the smallest total interlobe clearance should be marked on the rotor lobes. Refer to diagram in FIGURE 7-4, page 33. Use feeler gauges to check clearances between impeller lobes at positions A—A and C—C. Add the clearances, and divide the total clearance evenly between A—A and C—C.

H. Rotate the rotors until the two lobes that have the smallest total interlobe clearance (as determined in step G) are visible through the discharge port. Lock the idler rotor from turning by wedging a shop rag between the tip of a lobe and the air cylinder. Insert feeler gauges with a thickness equal to the half clearance (determined in step G) between the drive rotor and the idler rotor lobe. Pull the drive rotor tight against the feeler gauges (drive rotor, feeler gauges, and idler rotor must be tight against each other). While holding the drive rotor tight against the feeler gages rotate (in the direction that the rotor turns) the gear on the drive rotor until a tooth on it contacts a tooth on the gear on the idler rotor. Hand tighten the 7 capscrews in the drive gear locking assembly. Align and adjust the connection.

I. Use a torque wrench to tighten the screws to 75 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs is applied to them a second time.

J. Tighten the screws further to 150 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs is applied to them a second time.

K. Check gear backlash four places at 90 degree intervals as described in the disassembly procedure (Item 4).

⚠ CAUTION

These impeller-to-impeller and impeller-to-case clearances are extremely critical. Even though the blower may turn freely by hand when cold, under operating conditions, the parts expand, and the rotors are subject to slight defection.

If the clearances are not sufficient, the impellers may contact each other or the housing with destructive results. If the clearances are too great, the blower may not develop the pressure or airflow that is required to perform its function.

14. Impeller tip to case clearance should be checked at this time by inserting the correct thickness feeler gauge between the tip and the case and rotating the impeller (see FIGURE 7-4, page 34). Repeat the procedure on both impellers.

NOTICE

When checking the tip to case clearance, move the feeler gauge over the entire length of the impeller to ensure that the tips do not bind along their length.

FIGURE 7-8

NOTICE

Replacement gears have minimum backlash marks on the outside diameter of the gear face. These marks should be located 180 degrees from each other (see FIGURE 7-8).

NOTICE

The gear used for adjustment should be flush with its mate on completion of the timing.

NOTICE

If any of the four gear backlash readings are not within the specified limits, the gears must be replaced.

15. Replace drive shaft oil seal (31) in the drive end cover (29). The seal lip should always face towards the bearing or lubricant.

Grease Units

Pack bearing cavities with recommended grease and secure drive cover with socket head cap screws (30) to drive headplate.

Dual Splash Units

Install drive end gasket (7). Gently slide the drive end cover (29) over the drive shaft and tap cover down over dowel pins until flush. Install and tighten drive cover bolts (30).

Refer to FIGURE 7-9, for torque specifications.

⚠ CAUTION
Exercise care not to damage the seal lip as it passes over the shaft keyway.

16. Assemble the gear cover (3) and gasket (7) to the gear headplate (18) using socket head screw (5). Tighten the capscrews alternately and evenly. Refer to FIGURE 7-9 for torque specifications.

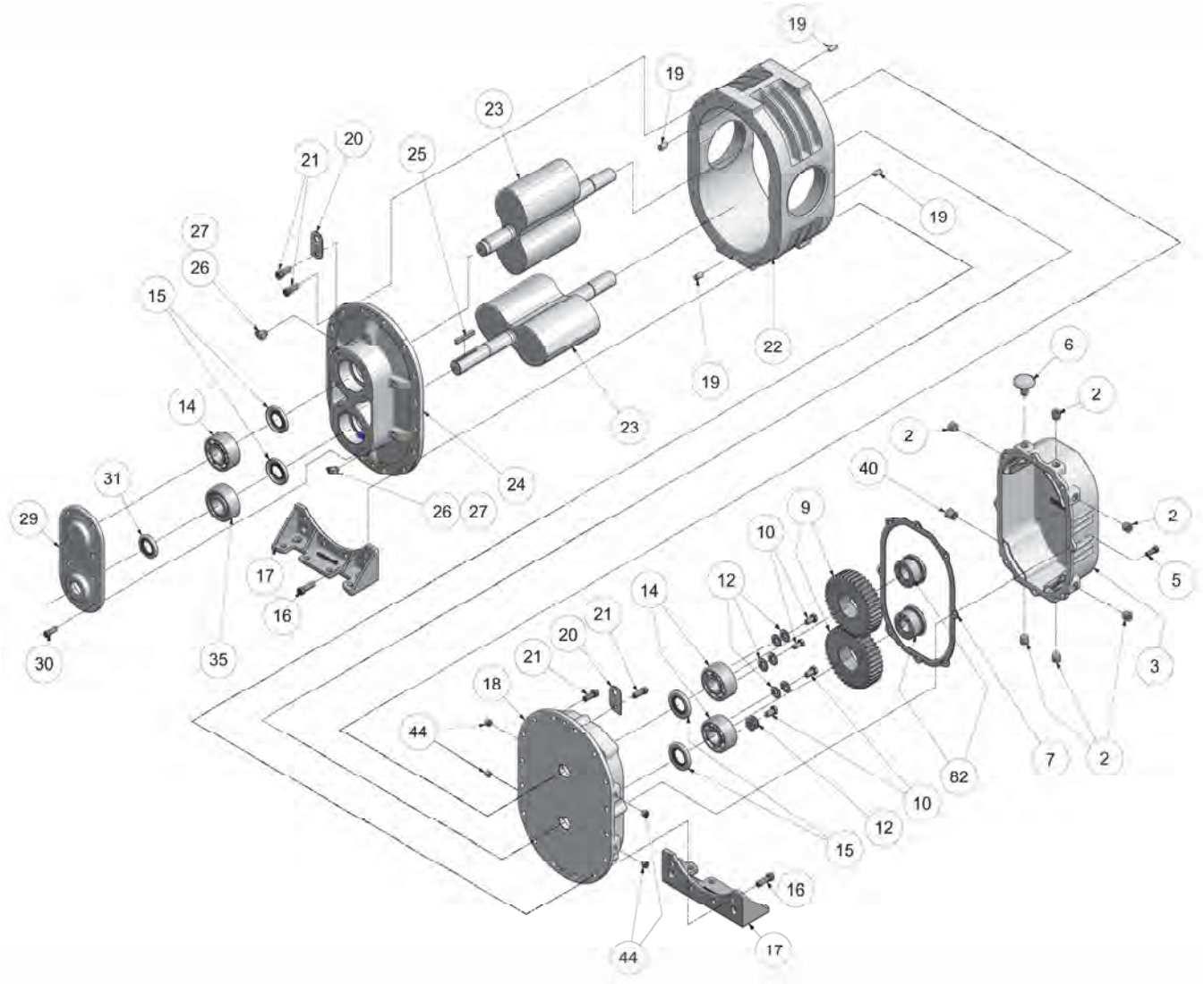
17. Place the blower on its feet on a flat surface. Loosen cap screws (16) and level the unit up. The bench or blower base flatness should be within .002 of an inch. Re-tighten cap screws (16) to the specification in FIGURE 7-9.

NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

	GEAR DIAMETER		
FASTENERS	**3**	**4**	**5**
CAPSCREW (21)	23 – 30	42 – 45	42 – 45
CAPSCREW (16)	23 – 30	42 – 45	42 – 45
SOCKET HD CAPSCREW (5)	6 – 8	16 – 18	11 – 13
SOCKET HD CAPSCREW (30)	6 – 8	16 – 18	11 – 13
CAPSCREW (10)	6 – 8	38 – 42	38 – 42

NOTE: ( ) DENOTES ITEMS IN EXPLODED VIEW DRAWINGS ON PAGES 39 AND 43.

FIGURE 7-9 – TORQUE (FT-LBS)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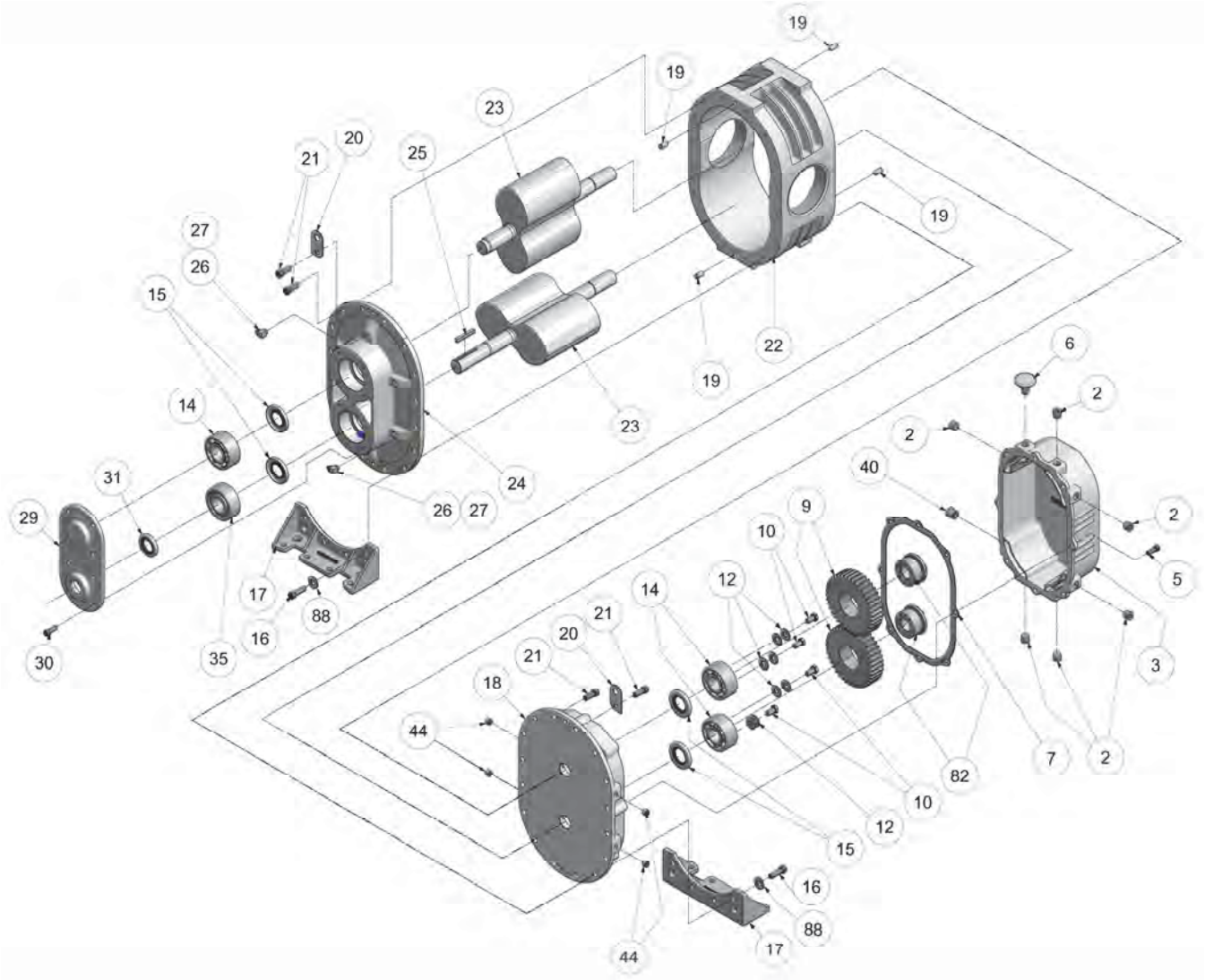
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_R Δ Δ= (A or C)	Size – 3M GABM_R Δ Δ= (A or C)	Size -- 3L GABL_R Δ Δ= (A or C)
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Washer	4	95A2	95A2	95A2
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Oil Seal	4	900891030601	900891030601	900891030601
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	302GAB006	302GAB006	302GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900873033501	900873033501	900873033501
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Lip Seal, Grease Splash Lube	1	302GAB6010	302GAB6010	302GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.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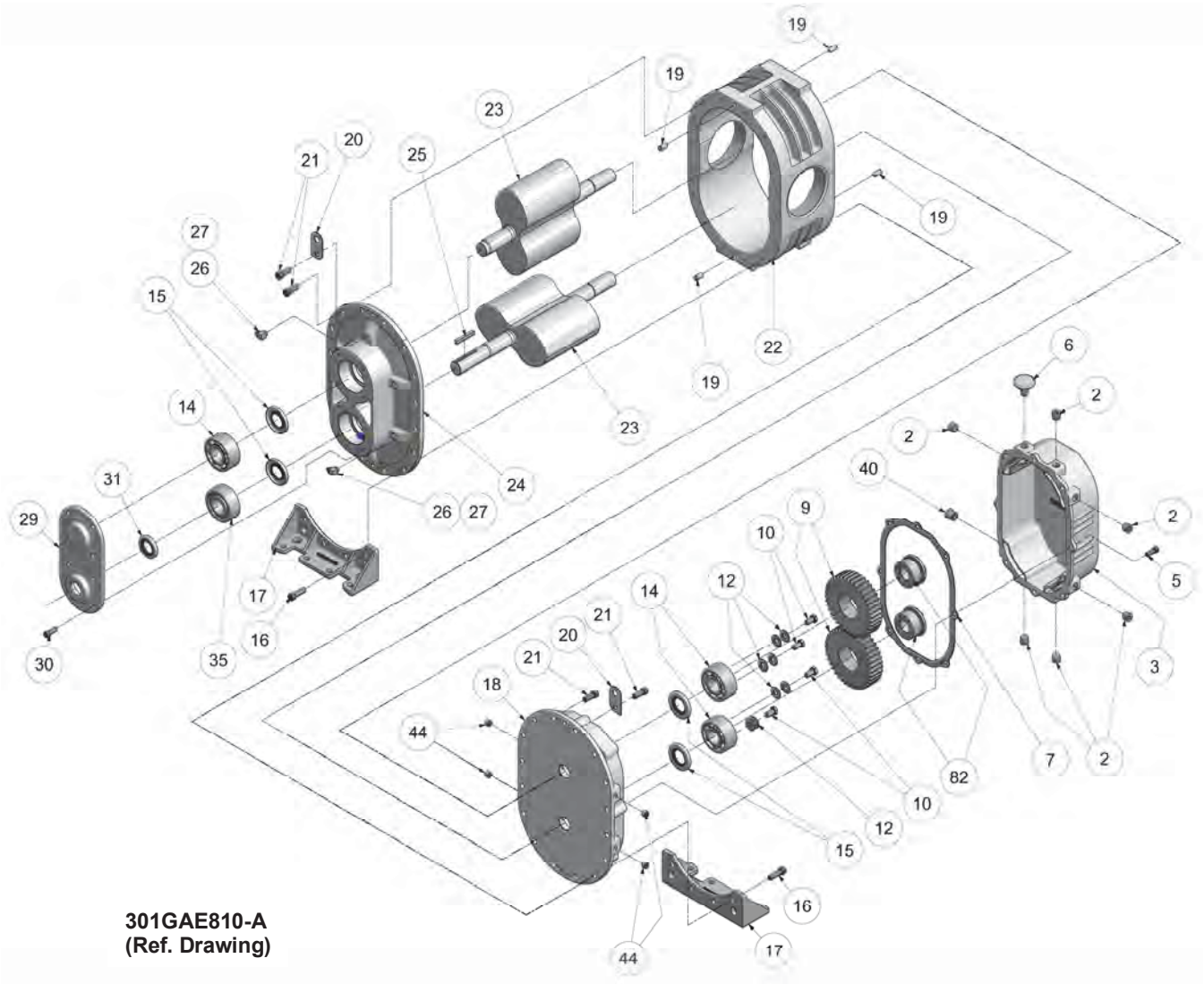
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R Δ Δ= (A or C)	Size – 4M GACM_R Δ Δ= (A or C)	Size -- 4L GACL_R Δ Δ= (A or C)
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	302GAC006	302GAC006	302GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	300GAC006	300GAC006	300GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Grease Splash Lube	1	300GAC6010	300GAC6010	300GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.



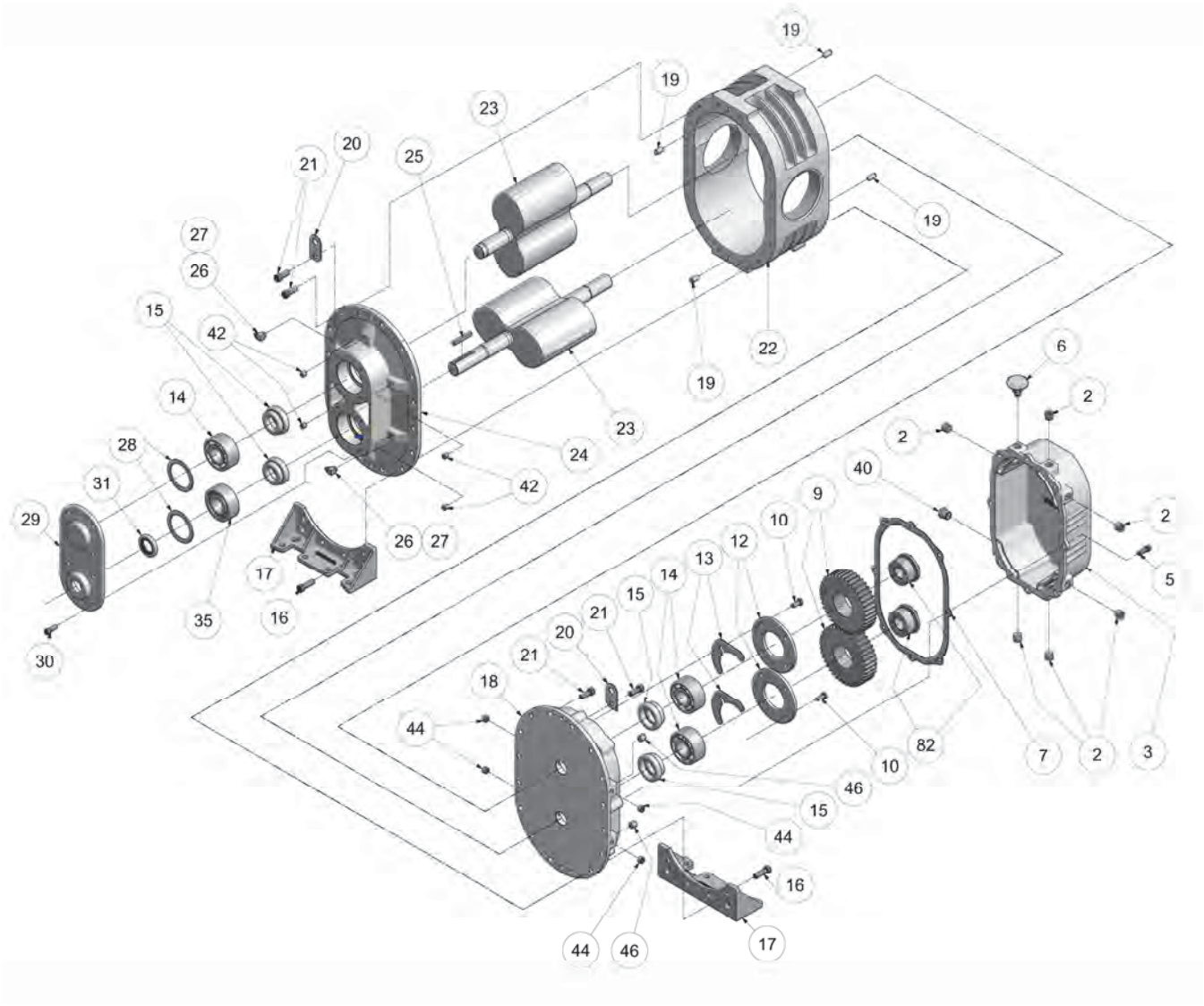
301GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Lip Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (A or C)	Size – 5M GAEM_R Δ Δ= (A or C)	Size -- 5L GAEL_R Δ Δ= (A or C)
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	8500397	8500397	8500397
* 15	Oil Seal	4	60DD714	60DD714	60DD714
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	301GAE006	301GAE006	301GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	206GAE006	206GAE006	206GAE006
25	Key-Square	1	900639910305	900639910305	900639910305
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900883050401	900883050401	900883050401
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Roller	1	12BA155	12BA155	12BA155
40	Oil Level Gauge	1	40P34	40P34	40P34
44	Screw	4	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
82	Locking Assembly	2	22G43	22G43	22G43
** 105	Overhaul Kit 5" R VERS Lip Seal, Grease Splash Lube	1	300GAE6010	300GAE6010	300GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.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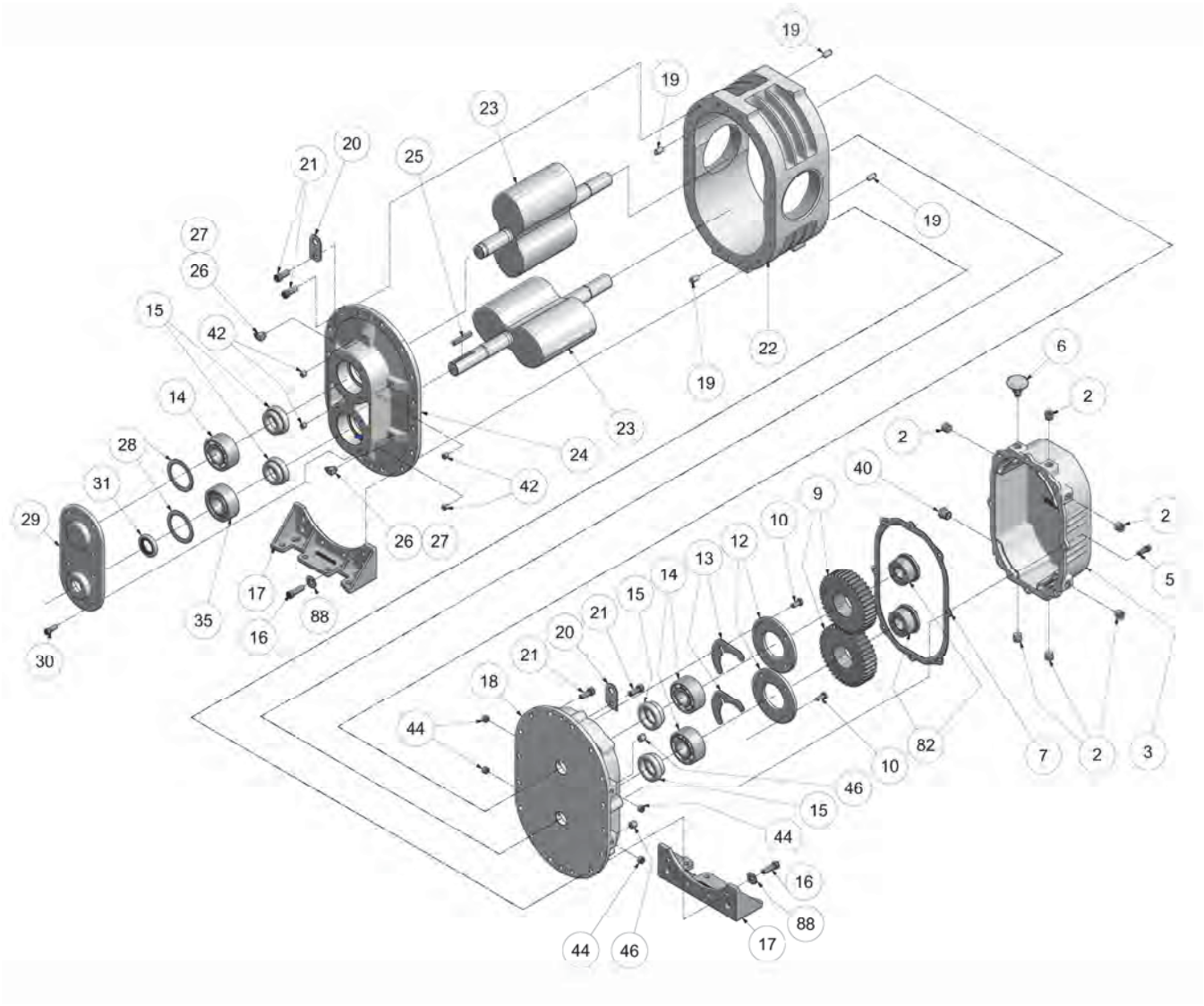
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Mechanical Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_RB	Size – 3M GABM_RB	Size -- 3L GABL_RB
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set	1	900881032200	900881032200	900881032200
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal	4	900871020003	900871020003	900871020003
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883030301	900883030301	900883030301
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170203	900669170203	900669170203
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Mechanical Seal, Grease Splash Lube	1	303GAB6010	303GAB6010	303GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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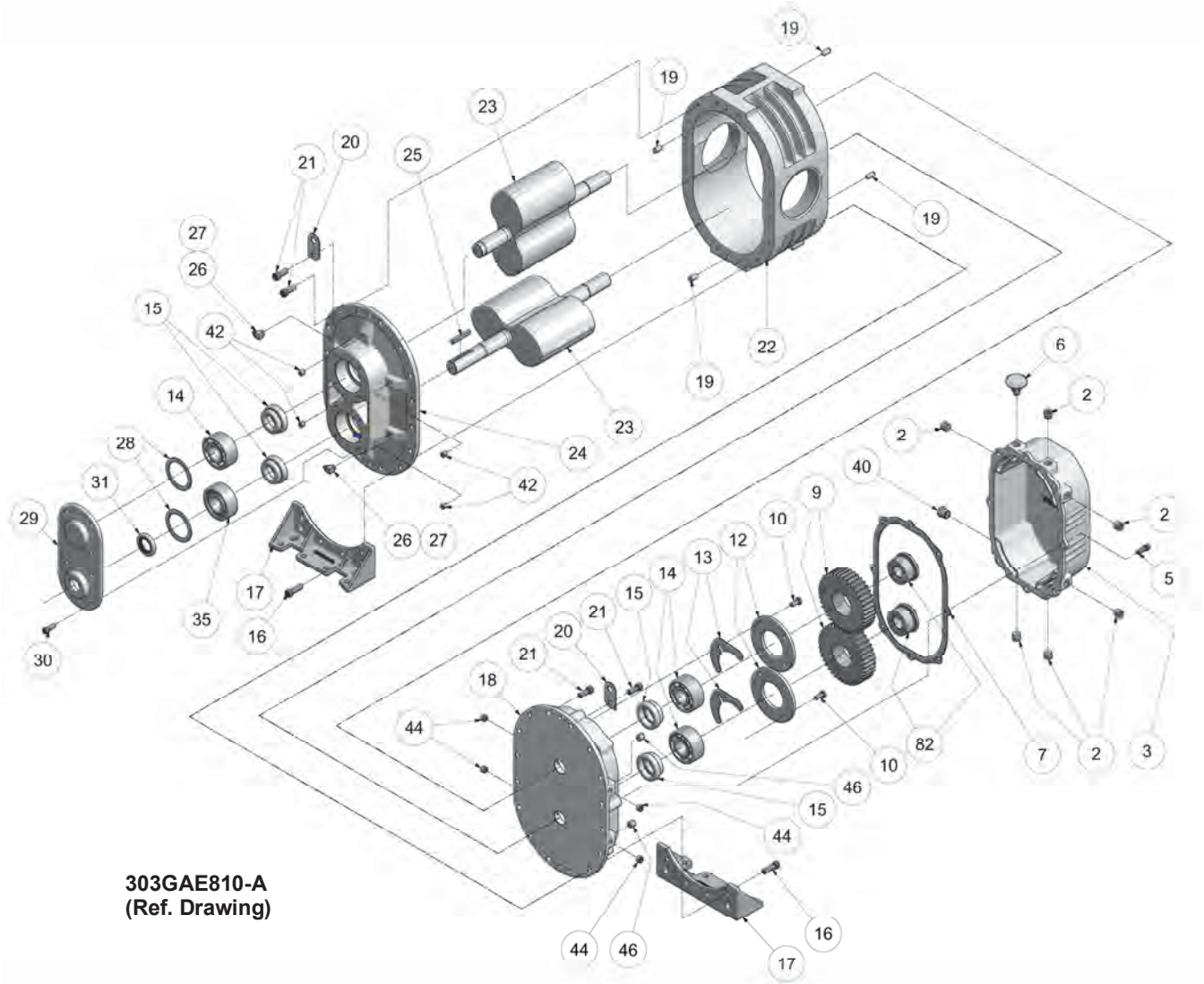
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Mechanical Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_RB	Size – 4M GACM_RB	Size -- 4L GACL_RB
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883040201	900883040201	900883040201
* 13	Shim Set	1	900881042900	900881042900	900881042900
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal	4	900871020004	900871020004	900871020004
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883041201	900883041201	900883041201
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170304	900669170304	900669170304
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Grease Splash Lube	1	302GAC6010	302GAC6010	302GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION



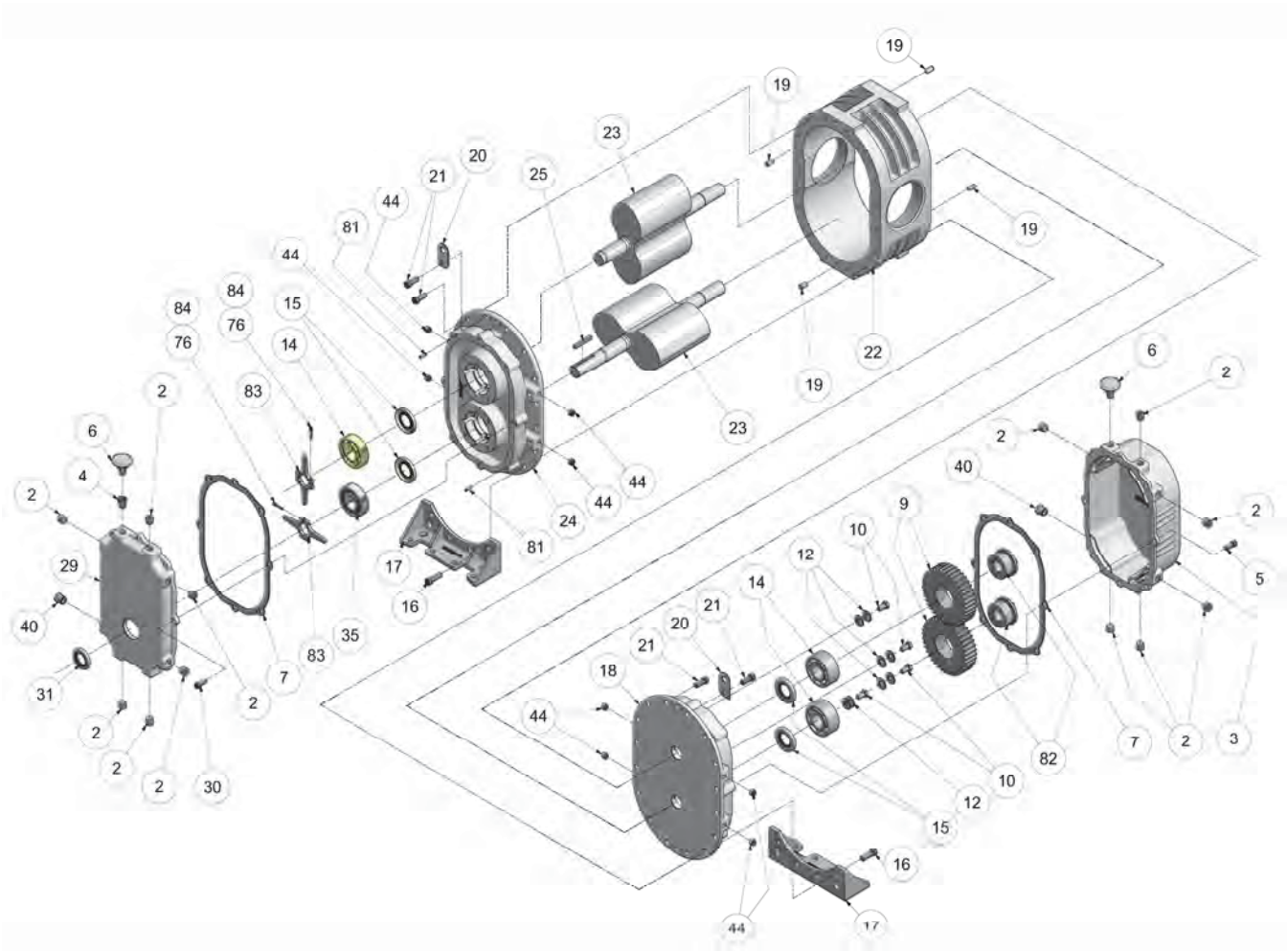
303GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Mechanical Seal Grease Splash Lube

	Ref. No.	Description	No. Req'd	Size – 5H GAEH_RB	Size – 5M GAEM_RB	Size -- 5L GAEL_RB
	2	Plug	6	64AC3	64AC3	64AC3
	3	Gear Case	1	304GAE602	304GAE602	304GAE602
	5	Screw	8	75P40	75P40	75P40
	6	Breather	1	5L359	5L359	5L359
*	7	Gasket	1	300GAE715	300GAE715	300GAE715
	9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
*	10	Screws	8	75A33P	75A33P	75A33P
	12	Bearing Retainer	2	900883050501	900883050501	900883050501
*	13	Shim Set	1	900881052900	900881052900	900881052900
*	14	Ball Bearing	3	8500397	8500397	8500397
*	15	Mechanical Seal	4	900871020005	900871020005	900871020005
	16	Screw	8	75P56	75P56	75P56
	17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
	18	Bearing Housing Gear End	1	303GAE006	303GAE006	303GAE006
	19	Dowel Pin	4	62M48	62M48	62M48
	20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
	21	Screw	24	75P55	75P55	75P55
	22	Impeller Case	1	900883051701	900883051801	900883051901
	23	Rotor Group				
		5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
		5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
	24	Bearing Housing Drive End	1	207GAE006	207GAE006	207GAE006
	25	Key-Square	1	900639910305	900639910305	900639910305
	26	Pipe Fitting	2	40E9	40E9	40E9
	27	Cap	2	40P58	40P58	40P58
*	28	Wavy Spring	2	900669170405	900669170405	900669170405
	29	Drive Cover	1	900883050401	900883050401	900883050401
	30	Screw	8	75P189	75P189	75P189
*	31	Oil Seal	1	60DD726	60DD726	60DD726
*	35	Bearing – Roller	1	12BA155	12BA155	12BA155
	40	Oil Level Gauge	1	40P34	40P34	40P34
	42	Plug	4	64AC1	64AC1	64AC1
	44	Screw	4	76F92	76F92	76F92
**	45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
	46	Plug	4	64AC2	64AC2	64AC2
**	54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
**	55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
**	56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
	82	Locking Assembly	2	22G43	22G43	22G43
**	105	Overhaul Kit 5" R VERS Mechanical Seal, Grease Splash	1	302GAE6010	302GAE6010	302GAE6010
**	900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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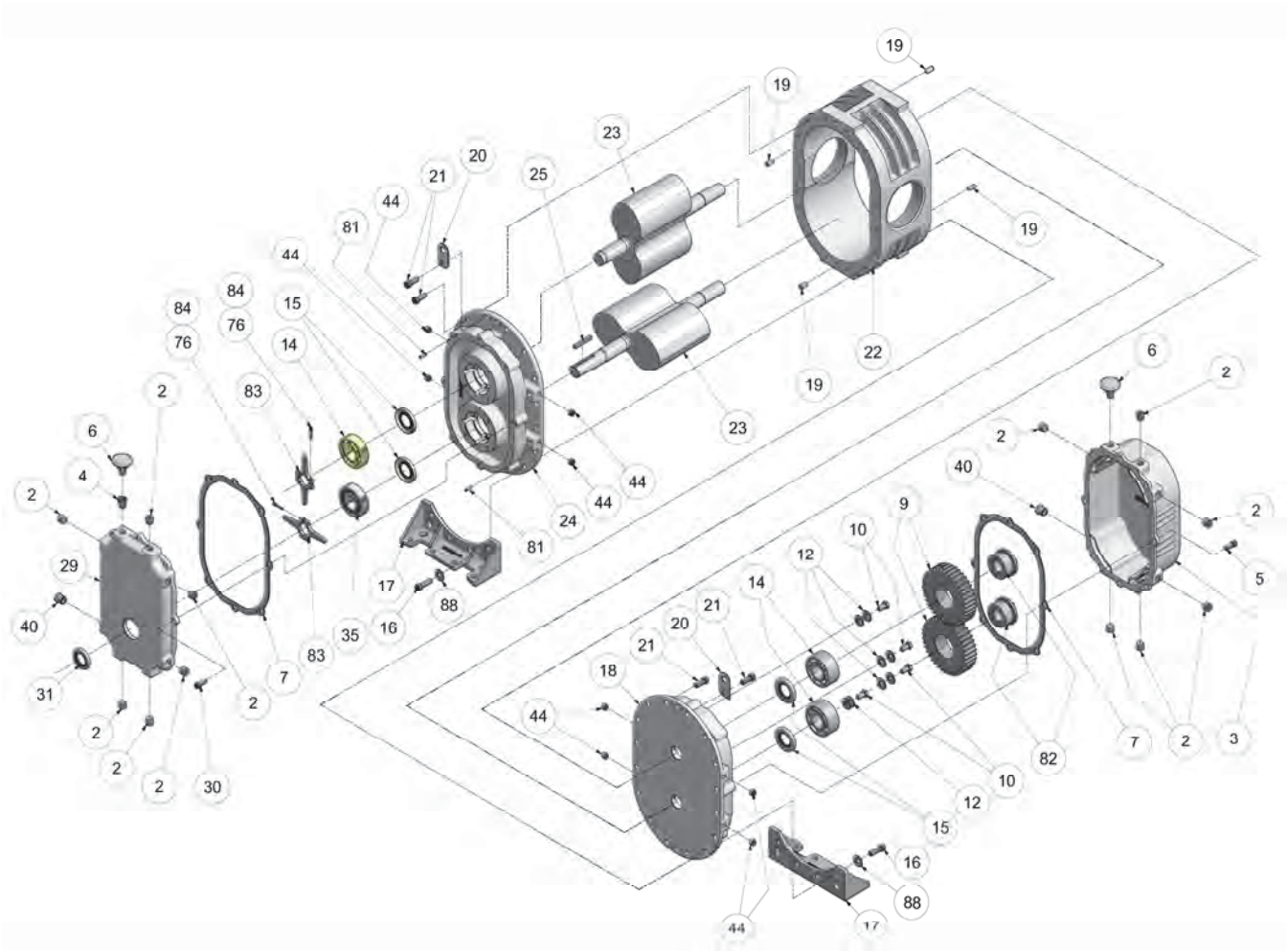
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Lip Seal Dual Splash Lube

	Ref. No.	Description	No. Req'd	Size – 3H GABH_R △ △= (D or F)	Size – 3M GABM_R △ △= (D or F)	Size -- 3L GABL_R △ △= (D or F)
	2	Plug	12	64AC2	64AC2	64AC2
	3	Gear Case	1	303GAB602	303GAB602	303GAB602
	5	Screw	8	75P7	75P7	75P7
	6	Breather	2	5L358	5L358	5L358
*	7	Gasket	2	300GAB715	300GAB715	300GAB715
	9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
*	10	Screws	4	75A33P	75A33P	75A33P
	12	Washer	8	95A2	95A2	95A2
*	14	Ball Bearing	3	12BA143	12BA143	12BA143
*	15	Oil Seal	4	900891030601	900891030601	900891030601
	16	Screw	4	75P56	75P56	75P56
	17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
	18	Bearing Housing Gear End	1	302GAB006	302GAB006	302GAB006
	19	Dowel Pin	4	62M48	62M48	62M48
	20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
	21	Screw	20	75P55	75P55	75P55
	22	Impeller Case	1	900873034301	900873033801	900873034201
	23	Rotor Group				
		3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
		3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
	24	Bearing Housing Drive End	1	303GAB006	303GAB006	303GAB006
	25	Key-Square	1	900639910304	900639910304	900639910304
	29	Drive Cover	1	302GAB477	302GAB477	302GAB477
	30	Screw	8	75P7	75P7	75P7
*	31	Oil Seal	1	60DD725	60DD725	60DD725
*	35	Bearing – Spherical	1	12BA153	12BA153	12BA153
	40	Oil Level Gauge	2	40P82	40P82	40P82
	44	Screw	8	76F1	76F1	76F1
**	45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
**	54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
**	55	Shim Case .0010"	1	201GAB732	201GAB732	201GAB732
**	56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
	76	Compound, Loctite	50	25BC877	25BC877	25BC877
	81	Dowel Pin	2	62M13	62M13	62M13
	82	Locking Assembly	2	22G45	22G45	22G45
	83	Slinger	2	300GAB173	300GAB173	300GAB173
	84	Screw	2	75LM13	75LM13	75LM13
**	105	Overhaul Kit 3" R VERS Lip Seal, Dual Splash Lube	1	301GAB6010	301GAB6010	301GAB6010
**	900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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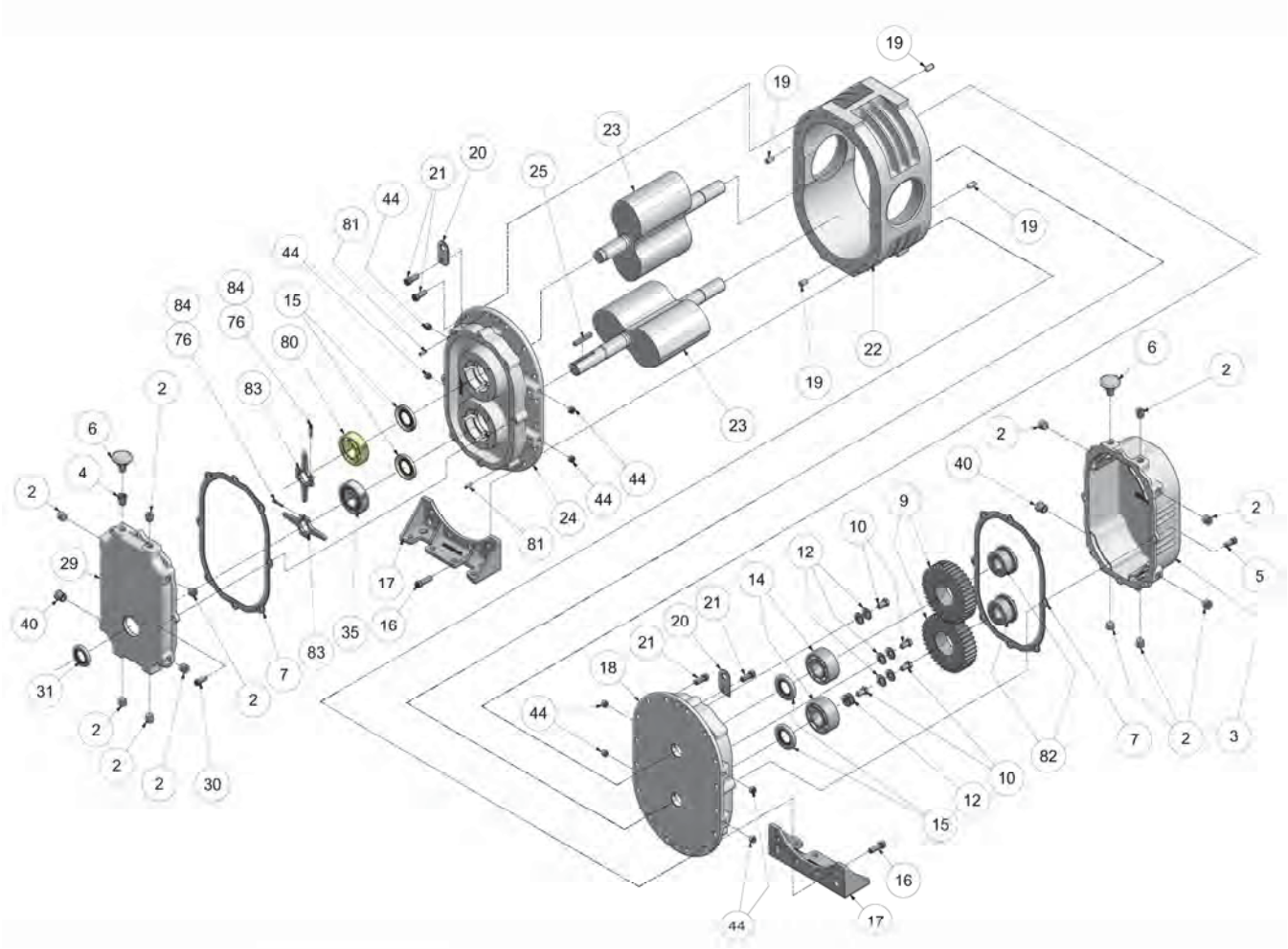
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Lip Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R Δ Δ= (D or F)	Size – 4M GACM_R Δ Δ= (D or F)	Size -- 4L GACL_R Δ Δ= (D or F)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	302GAC006	302GAC006	302GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	303GAC006	303GAC006	303GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
29	Drive Cover	1	302GAC477	302GAC477	302GAC477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Spherical	1	12BA255	12BA255	12BA255
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G44	22G44	22G44
83	Slinger	2	300GAC173	300GAC173	300GAC173
84	Screw	2	75LM14	75LM14	75LM14
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Dual Splash Lube	1	301GAC6010	301GAC6010	301GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION



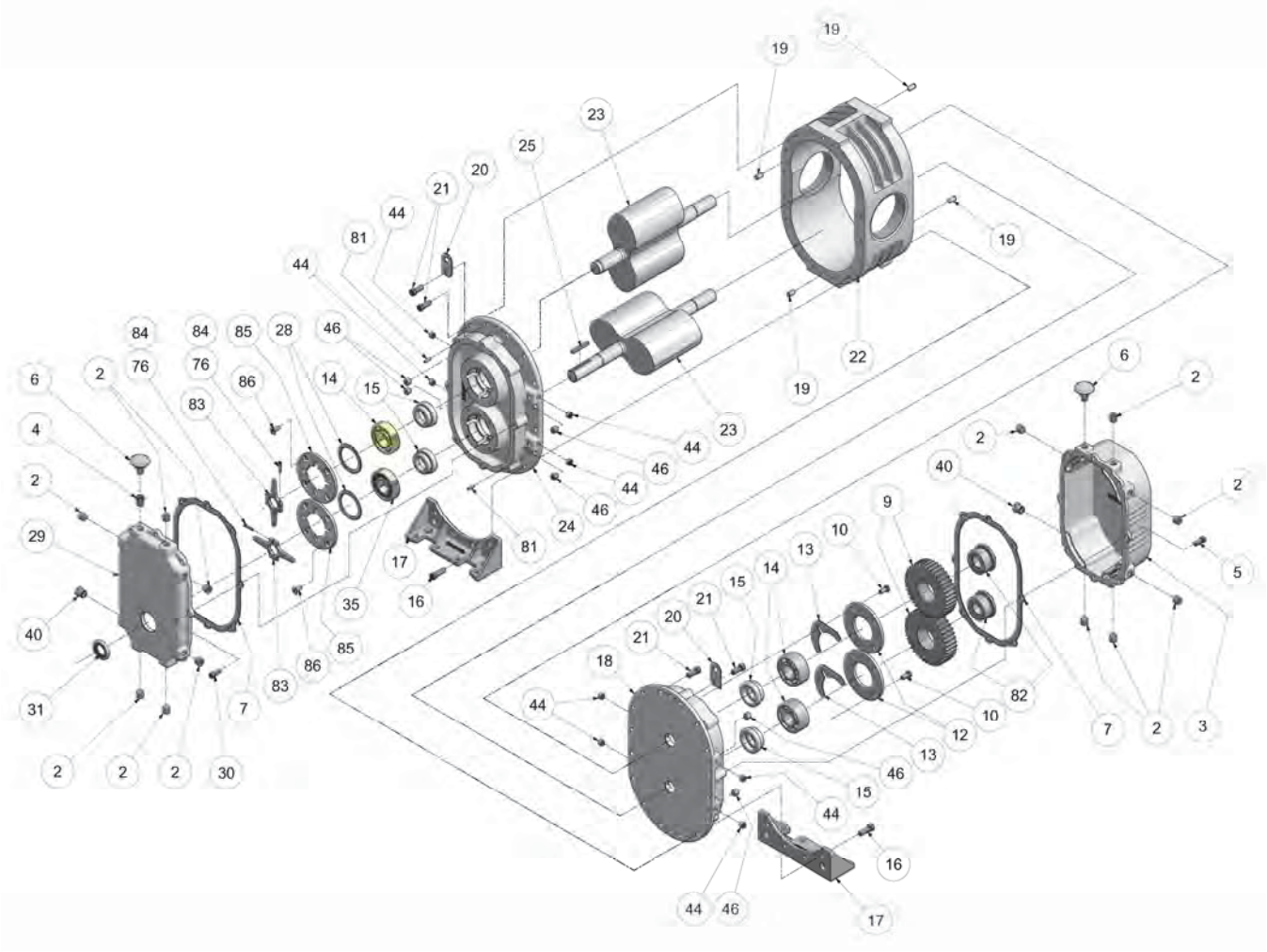
300GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Lip Seal — Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (D or F)	Size – 5M GAEM_R Δ Δ= (D or F)	Size -- 5L GAEL_R Δ Δ= (D or F)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	2	8500397	8500397	8500397
* 15	Oil Seal	4	60DD714	60DD714	60DD714
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	301GAE006	301GAE006	301GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
25	Key-Square	1	900639910305	900639910305	900639910305
29	Drive Cover	1	300GAE477	300GAE477	300GAE477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Spherical	1	12BA253	12BA253	12BA253
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
76	Compound, Loctite	5	25BC877	25BC877	25BC877
* 80	Bearing – Conrad	1	12BA254	12BA254	12BA254
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G43	22G43	22G43
83	Slinger	2	300GAE173	300GAE173	300GAE173
84	Screw	2	75LM14	75LM14	75LM14
** 105	Overhaul Kit 5" R VERS Lip Seal, Dual Splash Lube	1	301GAE6010	301GAE6010	301GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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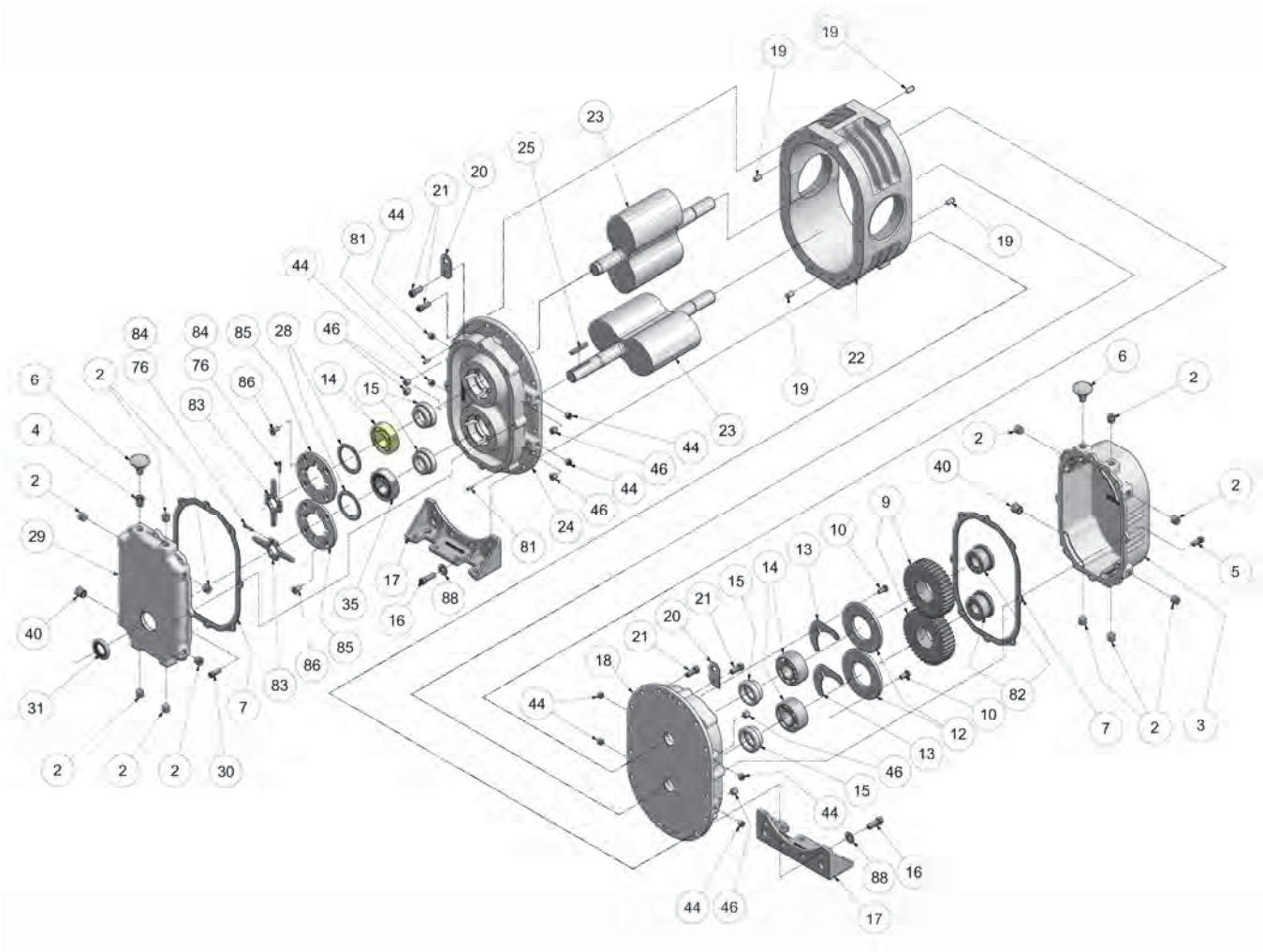
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_R △ △= (E or G)	Size – 3M GABM_R △ △= (E or G)	Size -- 3L GABL_R △ △= (E or G)
2	Plug	12	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	2	5L358	5L358	5L358
* 7	Gasket	2	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set	1	900881032200	900881032200	900881032200
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal	4	900871020003	900871020003	900871020003
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	305GAB006	305GAB006	305GAB006
25	Key-Square	1	900639910304	900639910304	900639910304
* 28	Wavy Spring	2	900669170203	900669170203	900669170203
29	Drive Cover	1	302GAB477	302GAB477	302GAB477
30	Screw	6	75P7	75P7	75P7
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Spherical	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	2	40P82	40P82	40P82
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G45	22G45	22G45
83	Slinger	2	300GAB173	300GAB173	300GAB173
84	Screw	2	75LM13	75LM13	75LM13
85	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
86	Screw	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 3" R VERS Mechanical Seal Dual, Splash	1	304GAB6010	304GAB6010	304GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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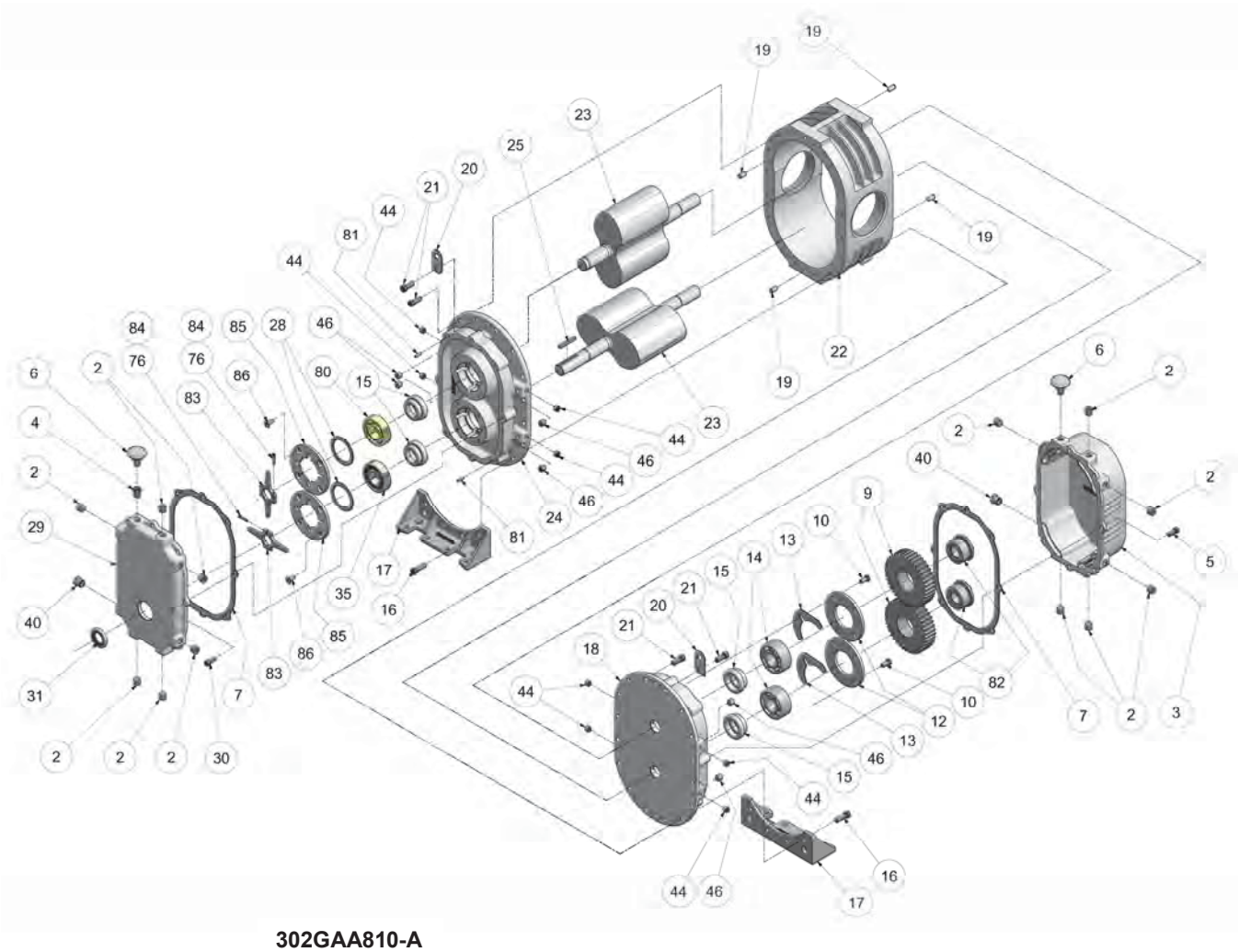
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R △ △= (E or G)	Size – 4M GACM_R △ △= (E or G)	Size -- 4L GACL_R △ △= (E or G)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883040201	900883040201	900883040201
* 13	Shim Set	1	900881052900	900881052900	900881052900
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal	4	900871020004	900871020004	900871020004
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	305GAC006	305GAC006	305GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
* 28	Wavy Spring	2	900669170304	900669170304	900669170304
29	Drive Cover	1	302GAC477	302GAC477	302GAC477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Spherical	1	12BA255	12BA255	12BA255
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G44	22G44	22G44
83	Slinger	2	300GAC173	300GAC173	300GAC173
84	Screw	2	75LM14	75LM14	75LM14
85	Bearing Retainer	2	300GAC205	300GAC205	300GAC205
86	Screw	8	75LM214	75LM214	75LM214
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Dual Splash	1	303GAC6010	303GAC6010	303GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION



302GAA810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (E or G)	Size – 5M GAEM_R Δ Δ= (E or G)	Size -- 5L GAEL_R Δ Δ= (E or G)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883050501	900883050501	900883050501
* 13	Shim Set	1	900881052900	900881052900	900881052900
* 14	Ball Bearing	2	8500397	8500397	8500397
* 15	Mechanical Seal	4	900871020005	900871020005	900871020005
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	303GAE006	303GAE006	303GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	304GAE006	304GAE006	304GAE006
25	Key-Square	1	900639910305	900639910305	900639910305
* 28	Wavy Spring	2	900669170405	900669170405	900669170405
29	Drive Cover	1	300GAE477	300GAE477	300GAE477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Spherical	1	12BA253	12BA253	12BA253
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC2	64AC2	64AC2
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
76	Compound, Loctite	5	25BC877	25BC877	25BC877
* 80	Bearing – Conrad	1	12BA254	12BA254	12BA254
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G43	22G43	22G43
83	Slinger	2	300GAE173	300GAE173	300GAE173
84	Screw	2	75LM14	75LM14	75LM14
85	Bearing Retainer	2	300GAE205	300GAE205	300GAE205
86	Screw	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 5" R VERS Mechanical Seal, Dual	1	303GAE6010	303GAE6010	303GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION

Gardner Denver

WARRANTY
SUTORBILT BLOWERS
Legend SERIES

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver (the "Com pany") warrants to each original retail purchaser ("Purchaser") of its products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

BARE BLOWERS

Basic grease lubricated bare blowers, consisting of all parts within, are warranted for 18 months from date of initial use or 24 months from date of shipment to the first purchaser, whichever occurs first. Basic dual splash lubricated bare blowers, consisting of all parts within, are warranted for 24 months from date of initial use or 30 months from date of shipment to the first purchaser, whichever occurs first. Any disassembly or partial disassembly of the blower, or failure to return the "unopened" blower per Company instructions, will be cause for denial of warranty.

OTHER COMPONENTS

All other components are warranted for 12 months from date of initial use or 18 months from date of shipment to first purchaser, whichever comes first. The Company reserves the right to withdraw the Warranty where evidence indicates application outside the stated performance area, or where there is evidence of abuse.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedules caused by, but not limited to, location or inaccessibility of equipment, or labor provided by unauthorized service personnel is not provided by this warranty.

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by the Company, transportation prepaid by Purchaser, to establish a claim under this warranty. Replacement parts provided under the terms of the warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO THE PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

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NOTES

NOTES

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For additional information, contact your local representative or visit:
www.contactgd.com/mobile

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ENERGY STAR PARTNER

Member

NTTC

Please recycle after use.

NOTES

MAINTENANCE DATA SHEET

FOR POSITIVE DISPLACEMENT BLOWER

-

SPARE PARTS

MODEL: Sutorbilt 4L, GACLBRA (modified to horizontal)
SERIAL NUMBER: S520806 & S520818

MAINTENANCE FOR ONE UNIT

Item	**Type / Part number**	**Qty.**	**Maintenance /Replacement**	**Unit price**
Oil / Blower gear side *	AEON PD*	1.5 pt.	6000 hours	34$ for 1 L, 365 $ for 12x1L
Grease / Blower drive side	28H282	**	500 hours	34$ for 14 oz.
Overhaul Kit***	300GAC6010	1	When needed	428$
Belts	VBA65	2	When needed	24$

* AEON PD is synthetic oil with superior properties than mineral oil. If mineral oil is used instead of AEON PD oil, replacement must be done after 500 hours.

** Fill with new grease until old grease is flushed.

*** Overhaul kit consist of bearings, seals, gaskets, shims, taper pins and bearing retainer screws.

Conditions : CAD Dollar, net 30, taxes extra, price valid for 2017, minimum order of 75 $, FOB Montreal, PQ.

B-501/2	38094	VFD, Danfoss 15HP, 380-480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBXCXXXXDX
P-701/2	38093	VFD, Danfoss 2HP, 380-480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBXCXXXXDX

Operating Guide

VLT® AQUA Drive FC 202

0.25–90 kW

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1 Introduction

1.1 Purpose of the Operating Guide

This operating guide provides information for safe installation and commissioning of the frequency converter.

The operating guide is intended for use by qualified personnel.
Read and follow the instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the frequency converter.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

- The *VLT® AQUA Drive FC 202 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® AQUA Drive FC 202 Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See *www.vlt-drives.danfoss.com/Support/Technical-Documentation/* for listings.

1.3 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1.1 shows the manual version and the corresponding software version.

Edition	Remarks	Software version
MG20MDxx	The parameter list is updated to reflect software version 2.6x. Editorial update.	2.6x

Table 1.1 Manual and Software Version

1.4 Product Overview

1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the frequency converter, the motor, and equipment driven by the motor.
- System and motor status surveillance.

Depending on configuration, the frequency converter can be used in standalone applications or form part of a larger appliance or installation.

The frequency converter is allowed for use in residential, industrial, and commercial environments in accordance with local laws, standards, and emission limits as described in the design guide.

Single-phase frequency converters (S2 and S4) installed in the EU
The following limitations apply:

- Units with an input current below 16 A and an input power above 1 kW (1.5 hp) are only intended for professional use in trades, professions, or industries and not for sale to the general public.
- Designated application areas are public pools, public water supplies, agriculture, commercial buildings, and industries. All other single-phase units are only intended for use in private low-voltage systems interfacing with public supply only at a medium or high-voltage level.
- Operators of private systems must ensure that the EMC environment complies with IEC 610000-3-6 and/or the contractual agreements.

NOTICE

In a residential environment, this product can cause radio interference, in which case supplementary mitigation measures may be required.

Foreseeable misuse
Do not use the frequency converter in applications, which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

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1.4.2 Features

The VLT® AQUA Drive FC 202 is designed for water and wastewater applications. The range of standard and optional features includes:

- Cascade control.
- Dry run detection.
- End-of-curve detection.
- SmartStart.
- Motor alternation.
- Deragging.
- 2-step ramps.
- Flow confirmation.
- Check valve protection.
- Safe Torque Off.
- Low flow detection.
- Pre/post lubrication.
- Pipe fill mode.
- Sleep mode.
- Real-time clock.
- User-configurable info texts.
- Warnings and alarms.
- Password protection.
- Overload protection.
- Smart logic control.
- Dual power rating (high/normal overload).

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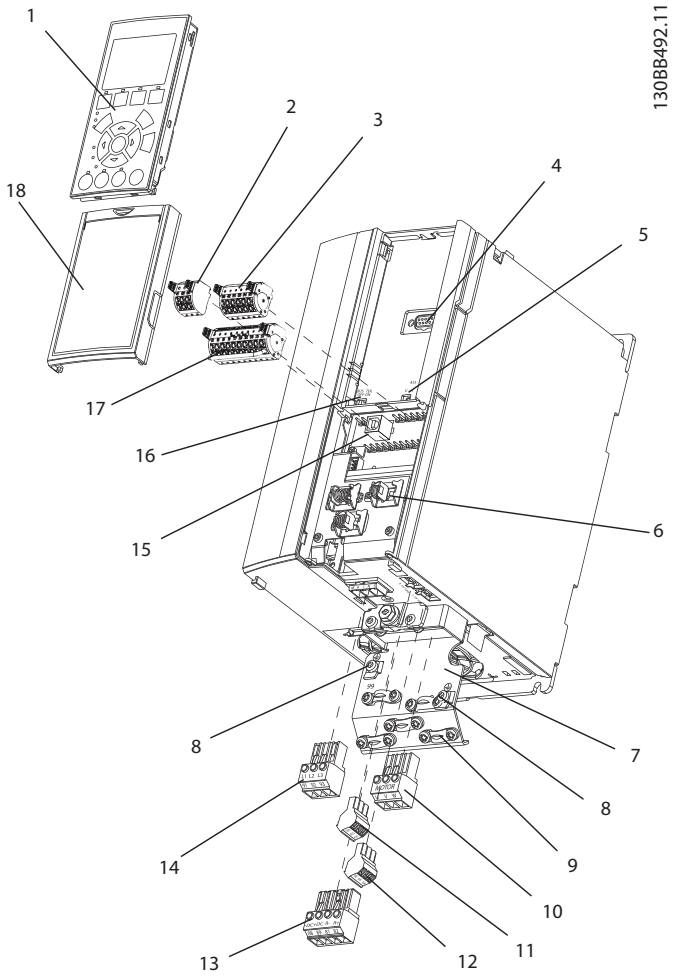
1.4.3 Exploded Views



1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 fieldbus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable shield connector	15	USB connector
7	Ground termination plate	16	Fieldbus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V supply
9	Shielded cable grounding clamp and strain relief	18	Cover

Illustration 1.1 Exploded View Enclosure Size A, IP20

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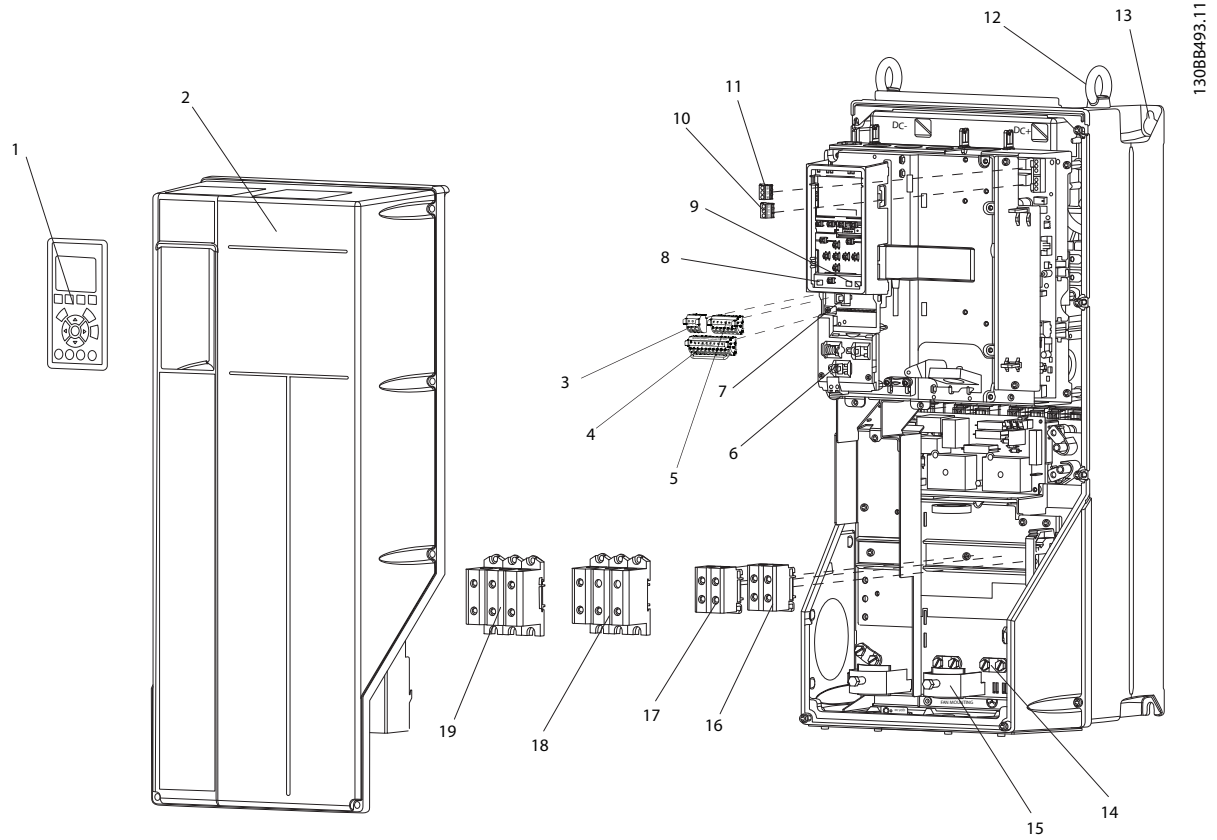

1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital I/O and 24 V supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable shield connector
6	Cable shield connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Fieldbus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)	–	–

Illustration 1.2 Exploded View Enclosure Sizes B and C, IP55 and IP66

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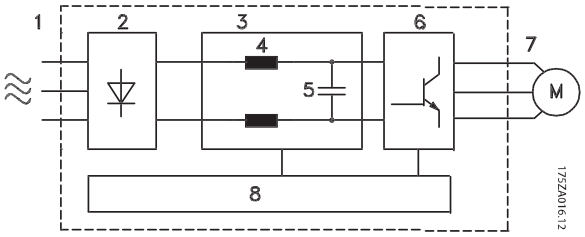
Illustration 1.3 is a block diagram of the internal components of the frequency converter.



Area	Title	Functions
1	Mains input	• 3-phase AC mains supply to the frequency converter.
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power.
3	DC bus	• The intermediate DC bus circuit handles the DC current.
4	DC reactors	• Filter the intermediate DC circuit voltage. • Prove mains transient protection. • Reduce RMS current. • Raise the power factor reflected back to the line. • Reduce harmonics on the AC input.
5	Capacitor bank	• Stores the DC power. • Provides ride-through protection for short power losses.
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7	Output to motor	• Regulated 3-phase output power to the motor.
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control. • User interface and external commands are monitored and performed. • Status output and control can be provided.

Illustration 1.3 Frequency Converter Block Diagram

1.4.4 Enclosure Sizes and Power Ratings

For enclosure sizes and power ratings of the frequency converters, refer to *chapter 8.9 Power Ratings, Weight, and Dimensions*.

1.5 Approvals and Certifications

Table 1.2 Approvals and Certifications

More approvals and certifications are available. Contact the local Danfoss partner. Frequency converters of enclosure size T7 (525–690 V) are UL certified for only 525–600 V.

The frequency converter complies with UL 508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

For compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to *ADN-compliant Installation* in the product-specific design guide.

1.6 Disposal

Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

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2 Safety

2.1 Safety Symbols

The following symbols are used in this guide:

⚠WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel are allowed to install and operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this manual.

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- **Only qualified personnel must perform installation, start-up, and maintenance.**

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
- **Disconnect or lock PM motor.**
- **Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in *Table 2.1*.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

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2

Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200–240	0.25–3.7 kW (0.34–5 hp)	–	5.5–45 kW (7.5–60 hp)
380–480	0.37–7.5 kW (0.5–10 hp)	–	11–90 kW (15–121 hp)
525–600	0.75–7.5 kW (1–10 hp)	–	11–90 kW (15–121 hp)
525–690	–	1.1–7.5 kW (1.5–10 hp)	11–90 kW (15–121 hp)

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly can result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

⚠WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this guide.**

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury when the frequency converter is not properly closed.

- **Ensure that all safety covers are in place and securely fastened before applying power.**

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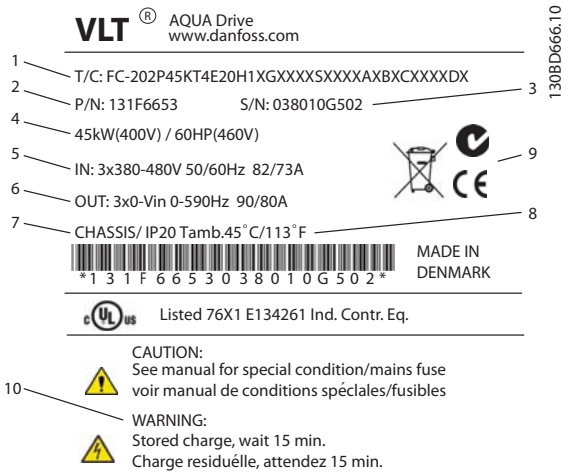
3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configuration.

- Make sure the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the frequency converter visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.



1	Type code
2	Ordering number
3	Serial number
4	Power rating
5	Input voltage, frequency, and current (at low/high voltages)
6	Output voltage, frequency, and current (at low/high voltages)
7	Enclosure type and IP rating
8	Maximum ambient temperature
9	Certifications
10	Discharge time (Warning)

Illustration 3.1 Product Nameplate (Example)

NOTICE

Do not remove the nameplate from the frequency converter. Removing the nameplate voids the warranty.

3.1.2 Storage

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

NOTICE

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the frequency converter. Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock

The frequency converter complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

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3

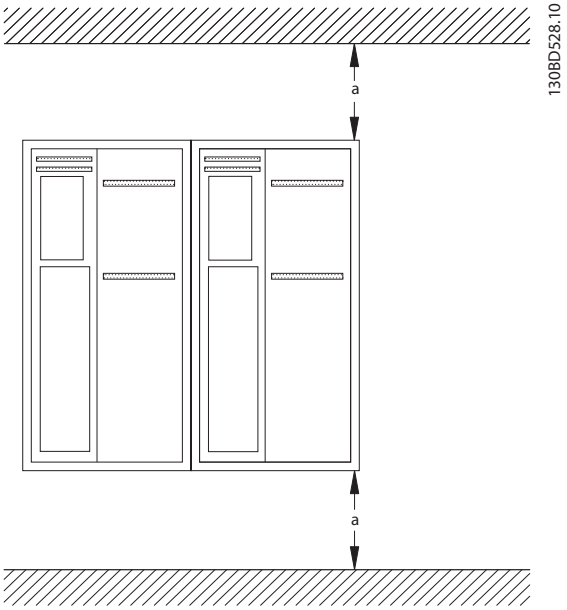
3.3 Mounting

NOTICE

Improper mounting can result in overheating and reduced performance.

Cooling

- Ensure that top and bottom clearance for air cooling is provided. See *Illustration 3.2* for clearance requirements.



Enclosure	A2–A5	B1–B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.9)	200 (7.9)	225 (8.9)

Illustration 3.2 Top and Bottom Cooling Clearance

Lifting

- To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight, and Dimensions*.
- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use the hoist rings on the unit, when provided.

Mounting

1. Ensure that the strength of the mounting location supports the unit weight. The frequency converter allows side-by-side installation.
2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mounting, when provided.

Mounting with backplate and railings

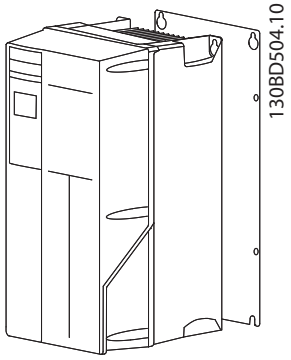


Illustration 3.3 Proper Mounting with Backplate

NOTICE

A backplate is required when mounted on railings.

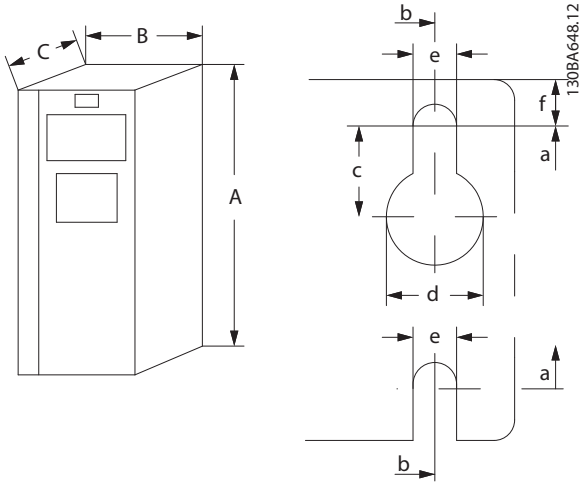


Illustration 3.4 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight, and Dimensions*)

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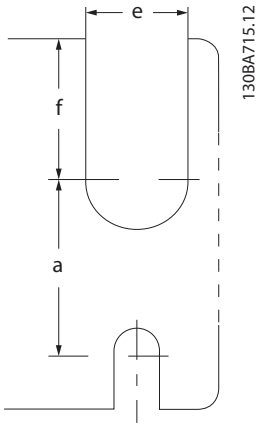

Illustration 3.5 Top and Bottom Mounting Holes (B4, C3, and C4)

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4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or to use shielded cables could result in death or serious injury.

- **Run output motor cables separately, or**
- **Use shielded cables.**

⚠CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation may lead to the RCD not providing the intended protection.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side.**

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in *chapter 8.8 Fuses and Circuit Breakers*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C (167 °F) rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Grounding

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 frequency converter to another in a daisy-chain fashion (see *Illustration 4.1*).
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (7 AWG). Separately terminate 2 ground wires, both complying with the dimension requirements.

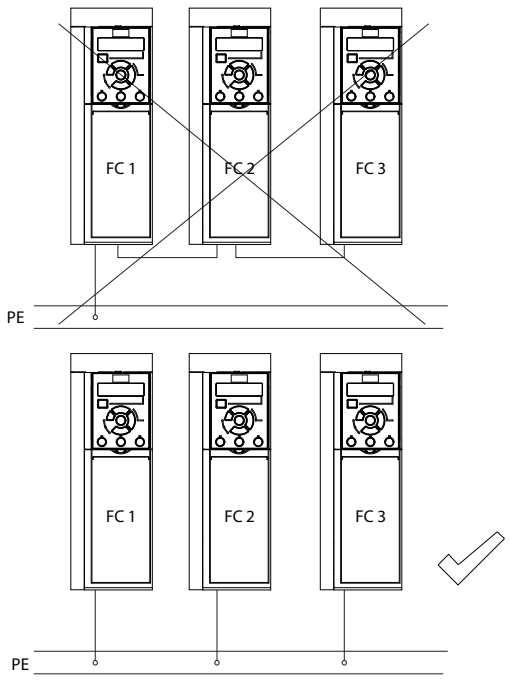

Illustration 4.1 Grounding Principle

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For EMC-compliant installation

- Establish electrical contact between the cable shield and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment (see *chapter 4.6 Motor Connection*).
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

NOTICE

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

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4.4 Wiring Schematic

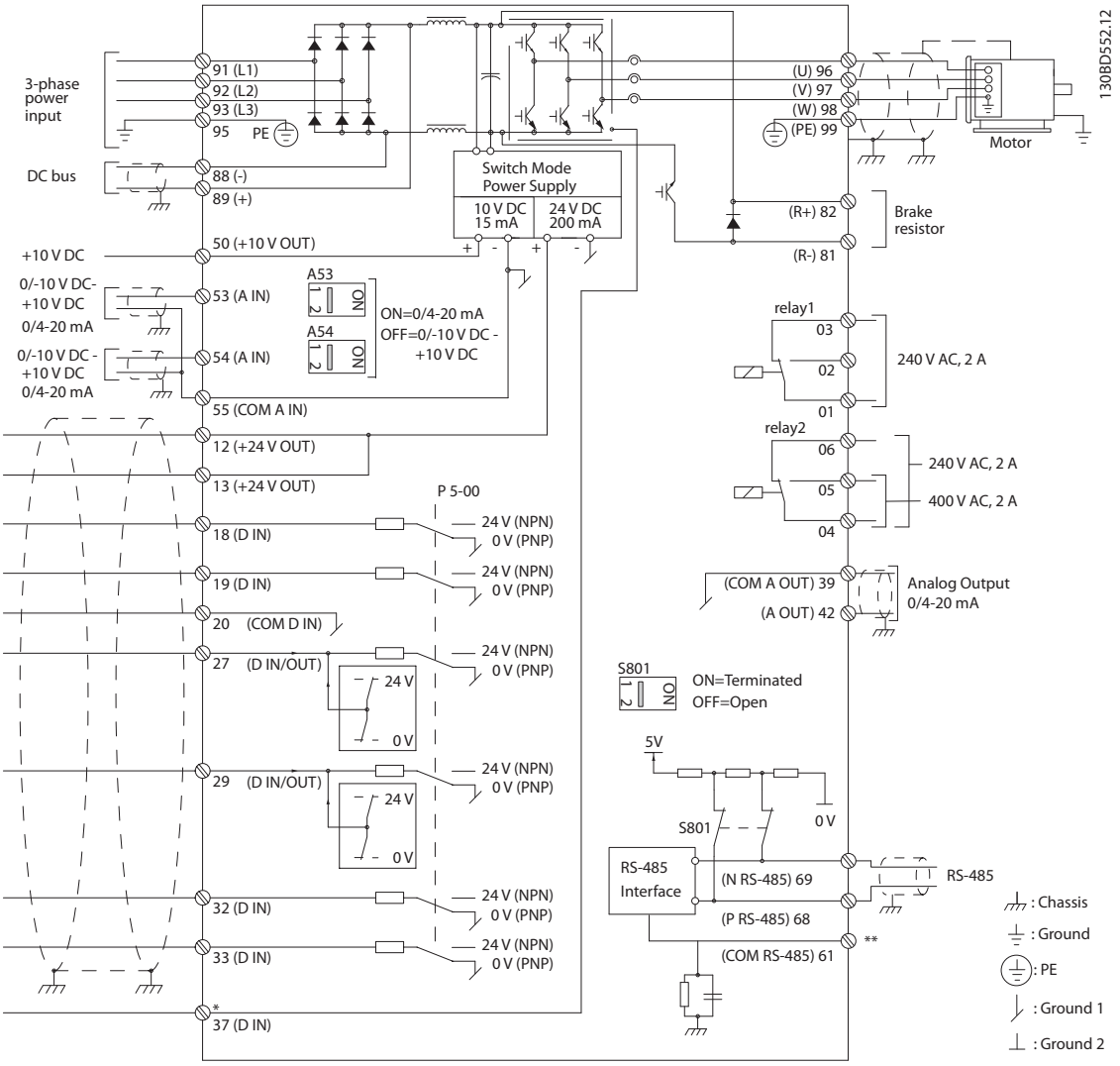

Illustration 4.2 Basic Wiring Schematic

A=Analog, D=Digital

*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the *VLT® Frequency Converters - Safe Torque Off Operating Guide*.

**Do not connect cable shield.

NOTICE

Actual configurations vary with unit types and optional equipment.

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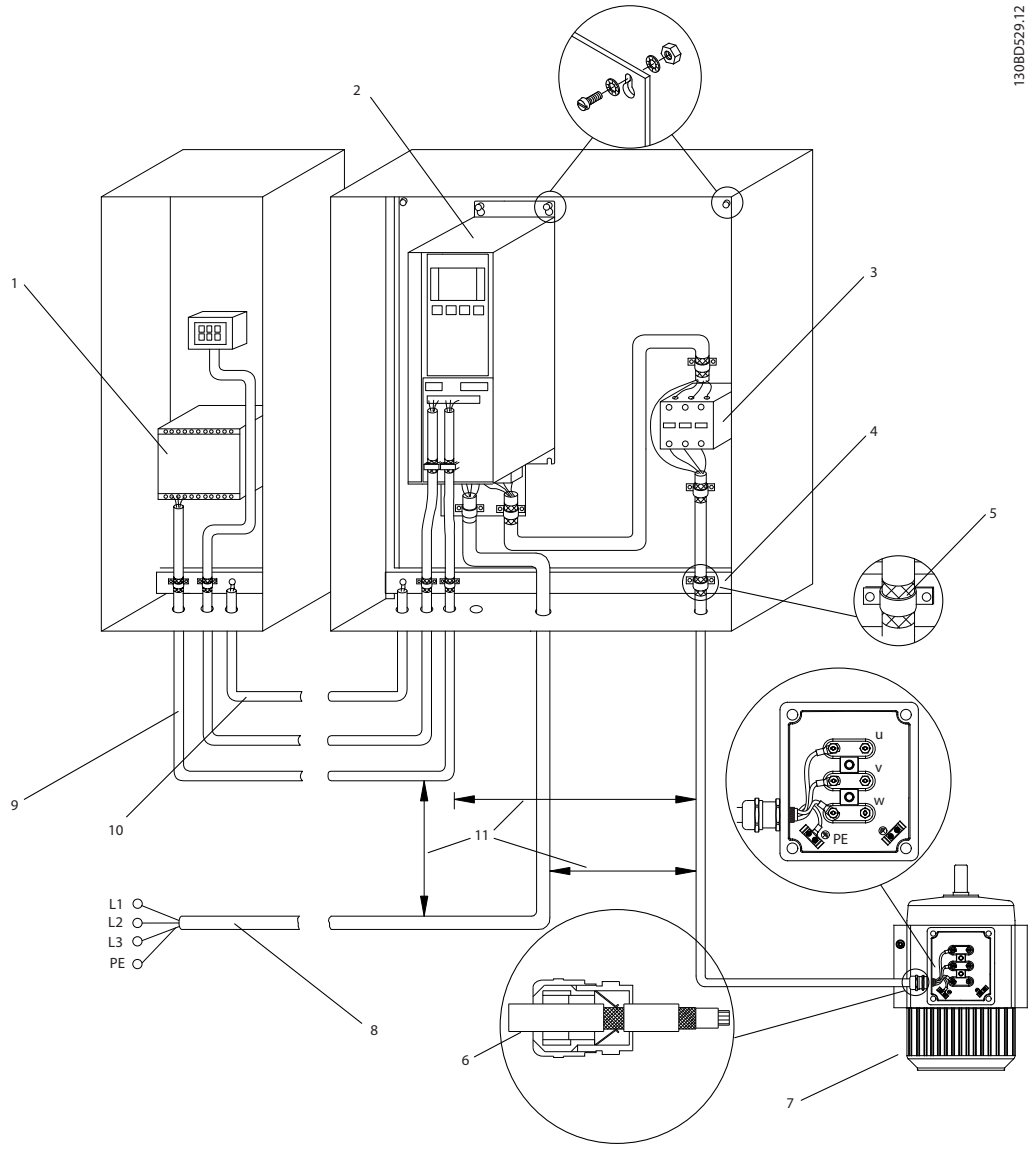

1	PLC	6	Cable gland
2	Frequency converter	7	Motor, 3-phase, and PE
3	Output contactor	8	Mains, 3-phase, and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalizing minimum 16 mm^2 (5 AWG)

Illustration 4.3 EMC-compliant Connection of Mains

NOTICE

EMC INTERFERENCE

Use shielded cables for motor and control wiring and separate cables for input power, motor wiring, and control wiring. Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance. Minimum clearance requirement between power, motor, and control cables is 200 mm (7.9 in).

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4.5 Access

1. Remove the cover with a screwdriver (See *Illustration 4.4*) or by loosening the attaching screws (See *Illustration 4.5*).

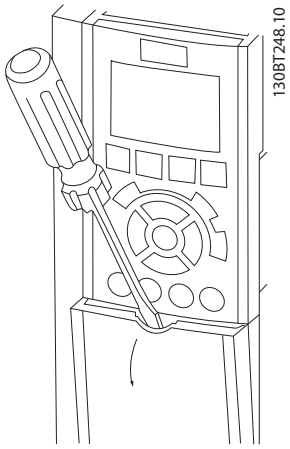

Illustration 4.4 Access to Wiring for IP20 and IP21 Enclosures

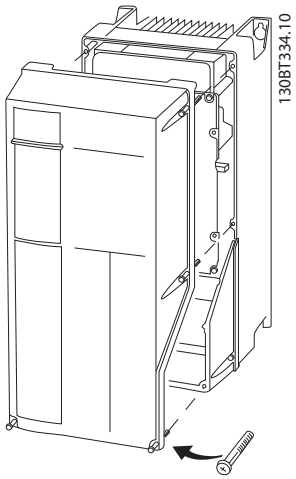

Illustration 4.5 Access to Wiring for IP55 and IP66 Enclosures

Tighten the cover screws using the tightening torques specified in *Table 4.1*.

Enclosure	IP55	IP66
A4/A5	2 (18)	2 (18)
B1/B2	2.2 (19)	2.2 (19)
C1/C2	2.2 (19)	2.2 (19)
No screws to tighten for A2/A3/B3/B4/C3/C4.		

Table 4.1 Tightening Torques for Covers [N•m (in-lb)]

4.6 Motor Connection

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or use shielded cables could result in death or serious injury.

- Run output motor cables separately, or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring asynchronous motor) between the frequency converter and the motor.

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable shield and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.6*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.6*.
5. Tighten the terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.

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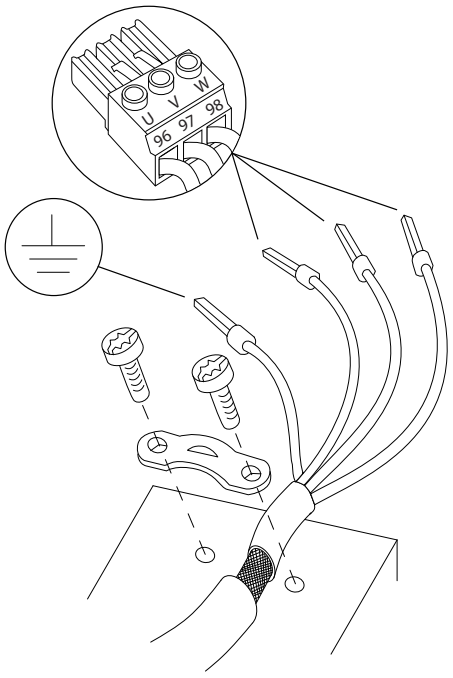

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Illustration 4.6 Motor Connection

Illustration 4.7 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

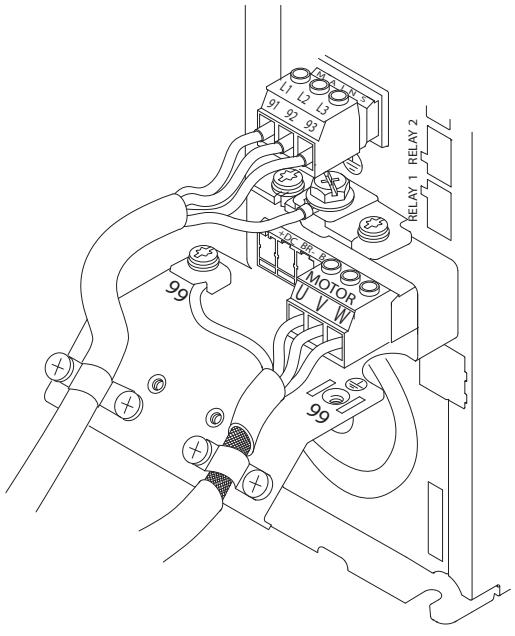

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Illustration 4.7 Example of Motor, Mains, and Ground Wiring

4.7 AC Mains Connection

- Size the wiring based on the input current of the frequency converter. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 4.7*).
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to *[0] Off* to avoid damage to the DC link and to reduce ground capacity currents in accordance with IEC 61800-3.

4.8 Control Wiring

- Isolate the control wiring from the high-power components in the frequency converter.
- When the frequency converter is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 4.8*.

4.8.1 Control Terminal Types

Illustration 4.8 and *Illustration 4.9* show the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 4.2*.

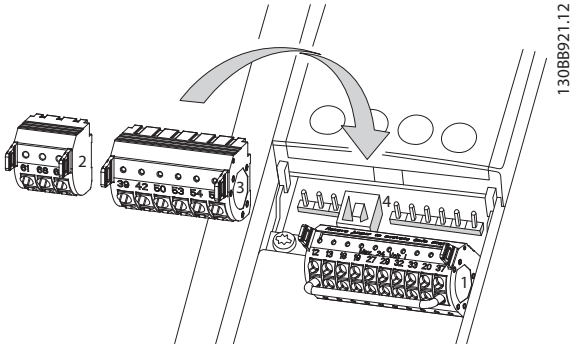

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Illustration 4.8 Control Terminal Locations

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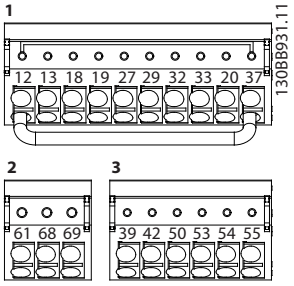

Illustration 4.9 Terminal Numbers

- **Connector 1** provides:
  - 4 programmable digital inputs terminals.
  - 2 extra digital terminals programmable as either input or output.
  - 24 V DC terminal supply voltage.
  - Optional customer supplied 24 V DC voltage.
- **Connector 2** terminals (+)68 and (-)69 are for an RS485 serial communication connection.
- **Connector 3** provides:
  - 2 analog inputs.
  - 1 analog output.
  - 10 V DC supply voltage.
  - Commons for the inputs and output.
- **Connector 4** is a USB port available for use with the MCT 10 Set-up Software.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Digital Inputs/Outputs			
12, 13	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
18	*Parameter 5 -10 Termina l 18 Digital Input*	*[8] Start*	Digital inputs.
19	*Parameter 5 -11 Termina l 19 Digital Input*	*[0] No operation*	
32	*Parameter 5 -14 Termina l 32 Digital Input*	*[0] No operation*	
33	*Parameter 5 -15 Termina l 33 Digital Input*	*[0] No operation*	
27	*Parameter 5 -12 Termina l 27 Digital Input*	*[2] Coast inverse*	For digital input or output. Default setting is input.
29	*Parameter 5 -13 Termina l 29 Digital Input*	*[14] Jog*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	Safe Torque Off (STO)	Safe input (optional). Used for STO.
Analog Inputs/Outputs			
39	–	–	Common for analog output
42	*Parameter 6 -50 Termina l 42 Output*	Speed 0 – High Limit	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω
50	–	+10 V DC	10 V DC analog supply voltage for potenti-ometer or thermistor. 15 mA maximum
53	*Parameter group 6-1* Analog Input 53*	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	*Parameter group 6-2* Analog Input 54*	Feedback	
55	–	–	Common for analog input
Serial Communication			

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Terminal description			
Terminal	Parameter	Default setting	Description
61	–	–	Integrated RC-Filter for cable shield. ONLY for connecting the shield if EMC problems occur.
68 (+)	*Parameter group 8-3* FC Port Settings*	–	RS485 Interface. A control card switch is provided for termination resistance.
69 (-)	*Parameter group 8-3* FC Port Settings*	–	
Relays			
01, 02, 03	*Parameter 5 -40 Function Relay* [0]	*[9] Alarm*	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	*Parameter 5 -40 Function Relay* [1]	*[5] Running*	

Table 4.2 Terminal Description

Extra terminals

- 2 form C relay outputs. Location of the outputs depends on frequency converter configuration.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 4.10*.

NOTICE

Keep control wires as short as possible and separate from high-power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

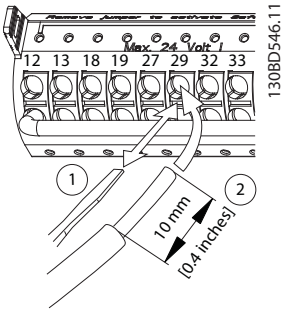

Illustration 4.10 Connecting Control Wires

2. Insert the bare control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

A jumper wire is required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive 24 V DC external interlock command.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. The jumper provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, it indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

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4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter setting

- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE

Disconnect power to the frequency converter before changing switch positions.

1. Remove the LCP (see *Illustration 4.11*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

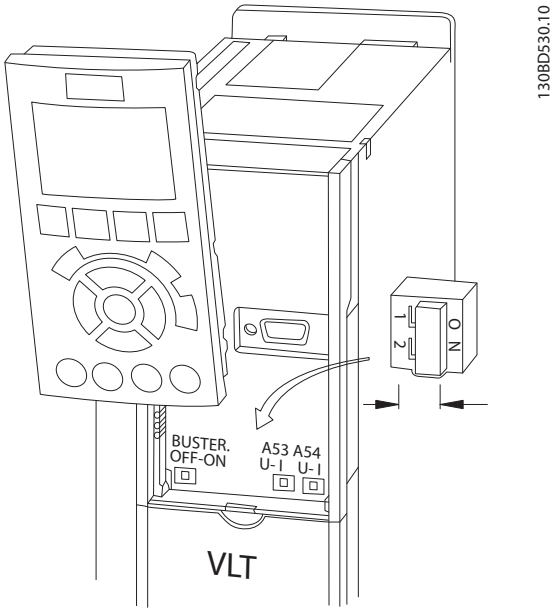

Illustration 4.11 Location of Terminal 53 and 54 Switches

To run STO, more wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Guide* for further information.

4.8.5 RS485 Serial Communication

Connect RS485 serial communication wiring to terminals (+)68 and (-)69.

- Use shielded serial communication cable (recommended).
- See *chapter 4.3 Grounding* for proper grounding.

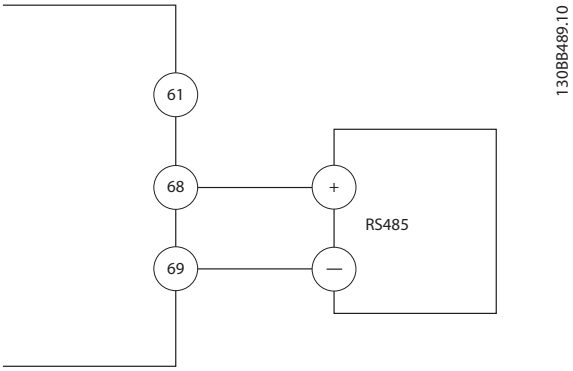

Illustration 4.12 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following:

1. Protocol type in *parameter 8-30 Protocol*.
2. Frequency converter address in *parameter 8-31 Address*.
3. Baud rate in *parameter 8-32 Baud Rate*.

- 2 communication protocols are internal to the frequency converter:
  - Danfoss FC.
  - Modbus RTU.
- Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-** Communications and Options*.
- Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications and makes more protocol-specific parameters available.
- Option cards for the frequency converter are available to provide extra communication protocols. See the option card documentation for installation and operation instructions.

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4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.3*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers, residing on the input power side of the frequency converter, or output side to the motor. Ensure that they are ready for full-speed operation. • Check the function and installation of any sensors used for feedback to the frequency converter. • Remove any power factor correction caps on the motor. • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that the motor wiring and control wiring are separated, shielded, or in 3 separate metallic conduits for high frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that the control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see *chapter 3.3 Mounting*.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that the motor and mains cables are in separate conduit or separated shielded cables.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 4.3 Installation Check List

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury if the frequency converter is not properly closed.

- **Before applying power, ensure that all safety covers are in place and securely fastened.**

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5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

Before applying power:

1. Close the cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

5.2 Applying Power

Apply power to the frequency converter using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.
4. Apply power to the unit. Do not start the frequency converter now. For units with a disconnect switch, turn it to the ON position to apply power to the frequency converter.

5.3 Local Control Panel Operation

The local control panel (LCP) is the combined display and keypad on the front of the unit.

The LCP has several user functions:

- Start, stop, and control speed when in local control.
- Show operational data, status, warnings, and cautions.
- Program frequency converter functions.
- Manually reset the frequency converter after a fault when auto reset is inactive.

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the product relevant *programming guide* for details on use of the NLCP.

NOTICE

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, code number 130B1000). For more information and downloads, see *www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm*.

5.3.1 Graphic Local Control Panel Layout

The graphic local control panel (GLCP) is divided into 4 functional groups (see *Illustration 5.1*).

A. Display area.

B. Display menu keys.

C. Navigation keys and indicator lights.

D. Operation keys and reset.

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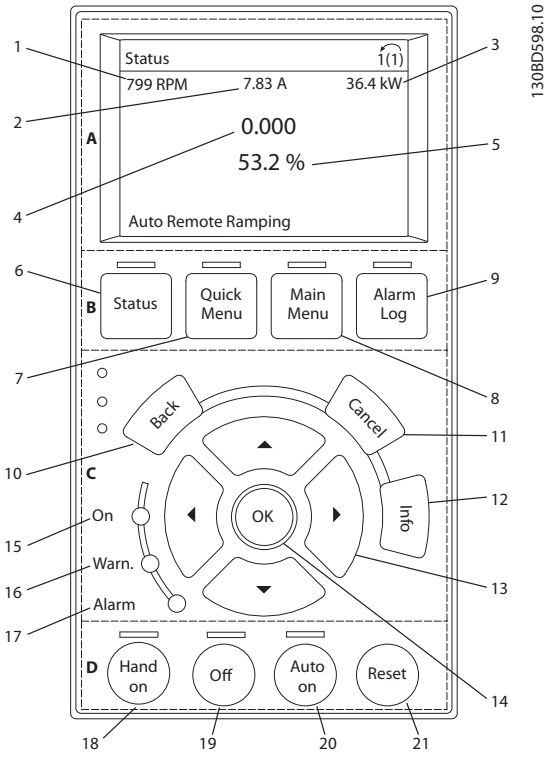

Illustration 5.1 GLCP

A. Display area

The display area is activated when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V DC external supply.

The information shown on the LCP can be customized for user applications. Select options in the *Quick Menu Q3-13 Display Settings*.

Display	Parameter	Default setting
1	*Parameter 0-20 Display Line 1.1 Small*	*[1617] Speed [RPM]*
2	*Parameter 0-21 Display Line 1.2 Small*	*[1614] Motor Current*
3	*Parameter 0-22 Display Line 1.3 Small*	*[1610] Power [kW]*
4	*Parameter 0-23 Display Line 2 Large*	*[1613] Frequency*
5	*Parameter 0-24 Display Line 3 Large*	*[1602] Reference %*

Table 5.1 Legend to *Illustration 5.1*, Display Area

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.2 Legend to *Illustration 5.1*, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also 3 frequency converter status indicator lights in this area.

	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode is not changed.
12	Info	Press for a definition of the function being showed.
13	Navigation Keys	Press the navigation keys to move between items in the menu.
14	OK	Press to access parameter groups or to enable a selection.

Table 5.3 Legend to *Illustration 5.1*, Navigation Keys

	Indicator	Color	Function
15	On	Green	The ON indicator light activates when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V external supply.
16	Warn	Yellow	When warning conditions are met, the yellow WARN indicator light comes on and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red alarm LED to flash and an alarm text is shown.

Table 5.4 Legend to *Illustration 5.1*, Indicator Lights (LEDs)

5

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D. Operation keys and reset
Operation keys are at the bottom of the LCP.

	Key	Function
18	[Hand On]	Starts the frequency converter in local control. • An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the motor but does not remove power to the frequency converter.
20	[Auto On]	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter manually after a fault has been cleared.

Table 5.5 Legend to *Illustration 5.1*, Operation Keys and Reset

NOTICE

The display contrast can be adjusted by pressing [Status] and the [▲]/[▼] keys.

5.3.2 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in *chapter 9.2 Parameter Menu Structure*.

Programming data is stored internally in the frequency converter.

- For back-up, upload data into the LCP memory.
- To download data to another frequency converter, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

5.3.3 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Press [Main Menu], select *parameter 0-50 LCP Copy* and press [OK].
3. Select *[1] All to LCP* to upload data to the LCP or select *[2] All from LCP* to download data from the LCP.
4. Press [OK]. A progress bar shows the uploading or downloading progress.
5. Press [Hand On] or [Auto On] to return to normal operation.

5.3.4 Changing Parameter Settings

Access and change parameter settings from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
3. Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
4. Press [▲] [▼] to change the value of a parameter setting.
5. Press [◄] [►] to shift digit when a decimal parameter is in the editing state.
6. Press [OK] to accept the change.
7. Press either [Back] twice to enter *Status*, or press [Main Menu] once to enter the *Main Menu*.

View changes
Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list only shows parameters, which are changed in the current edit set-up.
- Parameters, which were reset to default values, are not listed.
- The message *Empty* indicates that no parameters are changed.

5.3.5 Restoring Default Settings

NOTICE

Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the frequency converter. Initialization is carried out through *parameter 14-22 Operation Mode* (recommended) or manually.

- Initialization using *parameter 14-22 Operation Mode* does not reset frequency converter settings such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

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Recommended initialization procedure via *parameter 14-22 Operation Mode*

1. Press [Main Menu] twice to access parameters.
2. Scroll to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to *[2] initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. The start-up may take slightly longer than normal.

6. *Alarm 80, Drive initialized to default value* is shown.
7. Press [Reset] to return to operating mode.

Manual initialization procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. The start-up may take slightly longer than usual.

Manual initialization does not reset the following frequency converter information:

- *Parameter 15-00 Operating hours*.
- *Parameter 15-03 Power Up's*.
- *Parameter 15-04 Over Temp's*.
- *Parameter 15-05 Over Volt's*.

5.4 Basic Programming

5.4.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically at first power-up or after initialization of the frequency converter.
- Follow the on-screen instructions to complete the commissioning of the frequency converter. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the programming guide.

NOTICE

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

The SmartStart configures the frequency converter in 3 phases, each consisting of several steps, see *Table 5.6*.

Phase		Action
1	Basic Programming	Perform the programming
2	Application Section	Select and program appropriate application: • Single pump/motor. • Motor alternation. • Basic cascade control. • Master/slave.
3	Water and Pump Features	Go to water and pump dedicated parameters.

Table 5.6 SmartStart, Setup in 3 Phases

5.4.2 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to *parameter group 0-** Operation/Display* and press [OK].

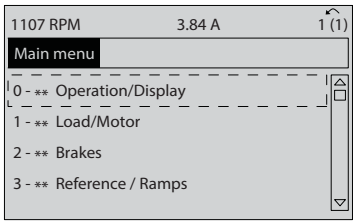

Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to *parameter group 0-0* Basic Settings* and press [OK].

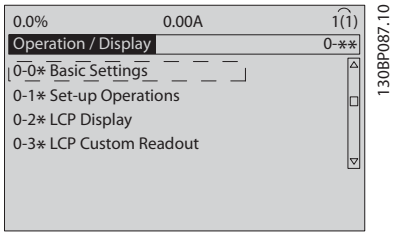

Illustration 5.3 Operation/Display

5

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4. Press the navigation keys to scroll to *parameter 0-03 Regional Settings* and press [OK].

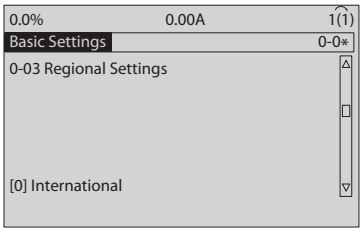

Illustration 5.4 Basic Settings

5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for several basic parameters).
6. Press [Main Menu] on the LCP.
7. Press the navigation keys to scroll to *parameter 0-01 Language*.
8. Select the language and press [OK].
9. If a jumper wire is in place between control terminals 12 and 27, leave *parameter 5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *[0] No operation* in *parameter 5-12 Terminal 27 Digital Input*.
10. Make the application-specific settings in the following parameters:
    - 10a *Parameter 3-02 Minimum Reference*.
    - 10b *Parameter 3-03 Maximum Reference*.
    - 10c *Parameter 3-41 Ramp 1 Ramp Up Time*.
    - 10d *Parameter 3-42 Ramp 1 Ramp Down Time*.
    - 10e *Parameter 3-13 Reference Site*. Linked to Hand/Auto Local Remote.

5.4.3 Asynchronous Motor Set-up

Enter the following motor data. Find the information on the motor nameplate.

1. *Parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP]*.
2. *Parameter 1-22 Motor Voltage*.
3. *Parameter 1-23 Motor Frequency*.
4. *Parameter 1-24 Motor Current*.
5. *Parameter 1-25 Motor Nominal Speed*.

For optimum performance in VVC+ mode, extra motor data is required to set up the following parameters. Find the data in the motor datasheet (this data is typically not available on the motor nameplate). Run a complete automatic motor adaptation (AMA) using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the parameters manually. *Parameter 1-36 Iron Loss Resistance (Rfe)* is always entered manually.

6. *Parameter 1-30 Stator Resistance (Rs)*.
7. *Parameter 1-31 Rotor Resistance (Rr)*.
8. *Parameter 1-33 Stator Leakage Reactance (X1)*.
9. *Parameter 1-34 Rotor Leakage Reactance (X2)*.
10. *Parameter 1-35 Main Reactance (Xh)*.
11. *Parameter 1-36 Iron Loss Resistance (Rfe)*.

Application-specific adjustment when running VVC+
VVC+ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

5.4.4 PM Motor Setup in VVC+

NOTICE

Only use permanent magnet (PM) motor with fans and pumps.

Initial programming steps

1. Activate PM motor operation
   Parameter 1-10 Motor Construction, select *[1] PM, non salient SPM.*
2. Set *parameter 0-02 Motor Speed Unit* to *[0] RPM*.

Programming motor data
After selecting PM motor in *parameter 1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Adv. Motor Data* and *1-4** are active.
The necessary data can be found on the motor nameplate and in the motor datasheet.

Program the following parameters in the listed order:

1. *Parameter 1-24 Motor Current*.
2. *Parameter 1-26 Motor Cont. Rated Torque*.
3. *Parameter 1-25 Motor Nominal Speed*.
4. *Parameter 1-39 Motor Poles*.
5. *Parameter 1-30 Stator Resistance (Rs)*.
   Enter line to common stator winding resistance (Rs). If only line-line data is available, divide the line-line value with 2 to achieve the line to common (startpoint) value.
6. *Parameter 1-37 d-axis Inductance (Ld)*.
   Enter line to common direct axis inductance of the PM motor.

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If only line-line data is available, divide the line-line value by 2 to achieve the line-common (startpoint) value.

7. *Parameter 1-40 Back EMF at 1000 RPM*.
   Enter line-to-line back EMF of the PM motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no frequency converter is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between 2 lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is for example 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *parameter 1-40 Back EMF at 1000 RPM*.

Test motor operation

1. Start the motor at low speed (100–200 RPM). If the motor does not turn, check installation, general programming, and motor data.
2. Check if the start function in *parameter 1-70 PM Start Mode* fits the application requirements.

Rotor detection
This function is the recommended choice for applications where the motor starts from standstill, for example pumps or conveyors. On some motors, a sound is heard when the impulse is sent out. This does not harm the motor.

Parking
This function is the recommended choice for applications where the motor is rotating at slow speed, for example windmilling in fan applications. *Parameter 2-06 Parking Current* and *parameter 2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC+ PM settings. Recommended settings in different applications can be found in *Table 5.7*.

Application	Settings
Low inertia applications I_{Load}/I_{Motor} <5	*Parameter 1-17 Voltage filter time const.* to be increased by factor 5–10. *Parameter 1-14 Damping Gain* should be reduced. *Parameter 1-66 Min. Current at Low Speed* should be reduced (<100%).
Low inertia applications 50>I_{Load}/I_{Motor} >5	Keep calculated values.
High inertia applications I_{Load}/I_{Motor} > 50	*Parameter 1-14 Damping Gain*, *parameter 1-15 Low Speed Filter Time Const.*, and *parameter 1-16 High Speed Filter Time Const.* should be increased.
High load at low speed <30% (rated speed)	*Parameter 1-17 Voltage filter time const.* should be increased. *Parameter 1-66 Min. Current at Low Speed* should be increased (>100% for a prolonged time can overheat the motor).

Table 5.7 Recommended Settings in Different Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

The starting torque can be adjusted in *parameter 1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.5 SynRM Motor Set-up with VVC+

This section describes how to set up a SynRM motor with VVC+.

NOTICE

The SmartStart wizard covers the basic configuration of SynRM motors.

Initial programming steps
To activate SynRM motor operation, select *[5] Sync. Reluctance* in *parameter 1-10 Motor Construction*.

Programming motor data
After performing the initial programming steps, the SynRM motor-related parameters in *parameter groups 1-2* Motor Data*, *1-3* Adv. Motor Data*, and *1-4* Adv. Motor Data II* are active.

Use the motor nameplate data and the motor datasheet to program the following parameters in the order listed:

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1. *Parameter 1-23 Motor Frequency*.
2. *Parameter 1-24 Motor Current*.
3. *Parameter 1-25 Motor Nominal Speed*.
4. *Parameter 1-26 Motor Cont. Rated Torque*.

Run a complete AMA using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the following parameters manually:

1. *Parameter 1-30 Stator Resistance (Rs)*.
2. *Parameter 1-37 d-axis Inductance (Ld)*.
3. *Parameter 1-44 d-axis Inductance Sat. (LdSat)*.
4. *Parameter 1-45 q-axis Inductance Sat. (LqSat)*.
5. *Parameter 1-48 Inductance Sat. Point*.

Application-specific adjustments

Start the motor at nominal speed. If the application does not run well, check the VVC+ SynRM settings. *Table 5.8* provides application-specific recommendations:

Application	Settings
Low-inertia applications I_{Load}/I_{Motor}<5	Increase *parameter 1-17 Voltage filter time const.* by factor 5–10. Reduce *parameter 1-14 Damping Gain*. Reduce *parameter 1-66 Min. Current at Low Speed* (<100%).
Low-inertia applications 50>I_{Load}/I_{Motor}>5	Keep the default values.
High-inertia applications I_{Load}/I_{Motor}>50	Increase *parameter 1-14 Damping Gain*, *parameter 1-15 Low Speed Filter Time Const.*, and *parameter 1-16 High Speed Filter Time Const.*
High-load at low speed <30% (rated speed)	Increase *parameter 1-17 Voltage filter time const.* Increase *parameter 1-66 Min. Current at Low Speed* to adjust the starting torque. 100% current provides nominal torque as starting torque. Working at a current level higher than 100% for a prolonged time can cause the motor to overheat.
Dynamic applications	Increase *parameter 14-41 AEO Minimum Magnetisation* for highly dynamic applications. Adjusting *parameter 14-41 AEO Minimum Magnetisation* ensures a good balance between energy efficiency and dynamics. Adjust *parameter 14-42 Minimum AEO Frequency* to specify the minimum frequency at which the frequency converter should use minimum magnetization.
Motor sizes less than 18 kW (24 hp)	Avoid short ramp-down times.

Table 5.8 Recommendations for Various Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the damping gain value in small steps. Depending on the motor, this parameter can be set to 10–100% higher than the default value.

5.4.6 Automatic Energy Optimization (AEO)

NOTICE

AEO is not relevant for permanent magnet motors.

AEO is a procedure which minimizes voltage to the motor, as a result of that reducing energy consumption, heat, and noise.

To activate AEO, set *parameter 1-03 Torque Characteristics* to *[2] Auto Energy Optim. CT* or *[3] Auto Energy Optim. VT*.

5.4.7 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimizes compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the entered nameplate data.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select *[2] Enable reduced AMA*.
- If an output filter is connected to the motor, select *[2] Enable reduced AMA*.

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- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.
- Run this procedure on a cold motor for best results.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to *parameter group 1-** Load and Motor* and press [OK].
3. Scroll to *parameter group 1-2* Motor Data* and press [OK].
4. Scroll to *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicates when it is complete.
8. The advanced motor data is entered in *parameter group 1-3* Adv. Motor Data*.

5.5 Checking Motor Rotation

NOTICE

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the frequency converter, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in *parameter 4-12 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to *parameter 1-28 Motor Rotation Check* and press [OK].
3. Scroll to *[1] Enable*.

The following text appears: *Note! Motor may run in wrong direction*.

4. Press [OK].
5. Follow the on-screen instructions.

NOTICE

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any 2 of the 3 motor wires on the motor or frequency converter side of the connection.

5.6 Local-control Test

1. Press [Hand On] to provide a local start command to the frequency converter.
2. Accelerate the frequency converter by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

If acceleration or deceleration problems occur, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* for resetting the frequency converter after a trip.

5.7 System Start-up

The procedure in this section requires wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check the sound and vibration levels of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.3 Warning and Alarm Types* or *chapter 7.4 List of Warnings and Alarms*.

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6 Application Set-up Examples

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

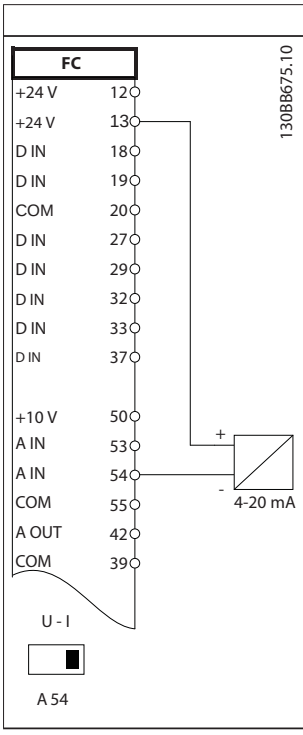
NOTICE

When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

6

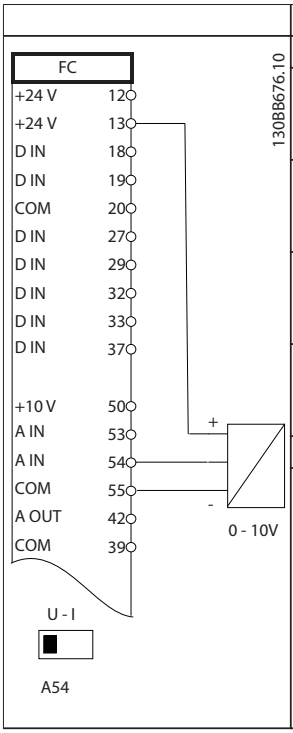
6.1 Application Examples

6.1.1 Feedback



	Parameters	
	Function	**Setting**
	Parameter 6-22 Terminal 54 Low Current	4 mA*
	Parameter 6-23 Terminal 54 High Current	20 mA*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value		
Notes/comments: D IN 37 is an option.		

Table 6.1 Analog Current Feedback Transducer



	Parameters	
	Function	**Setting**
	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
	Parameter 6-21 Terminal 54 High Voltage	10 V*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value		
Notes/comments: D IN 37 is an option.		

Table 6.2 Analog Voltage Feedback Transducer (3-wire)

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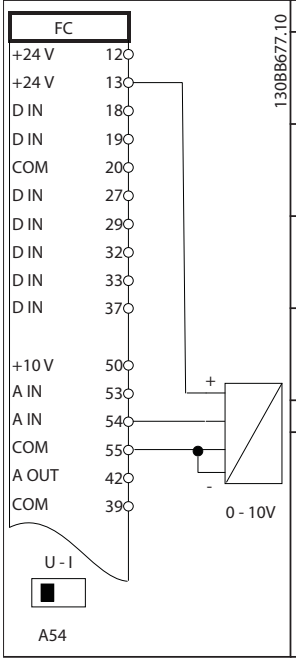
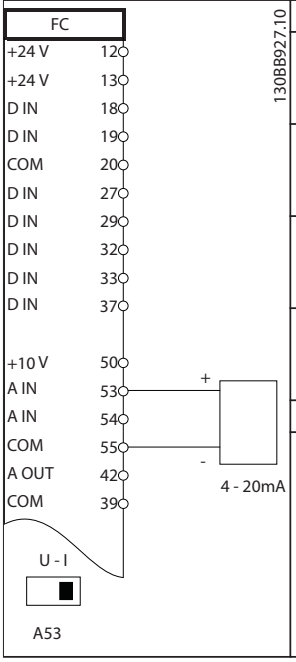


Parameters	
Function	**Setting**
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value	
Notes/comments: D IN 37 is an option.	

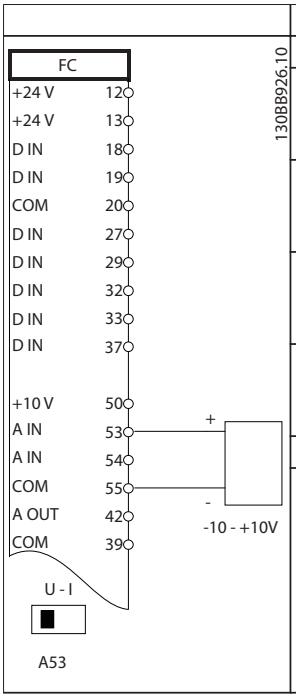
Table 6.3 Analog Voltage Feedback Transducer (4-wire)



Parameters	
Function	**Setting**
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

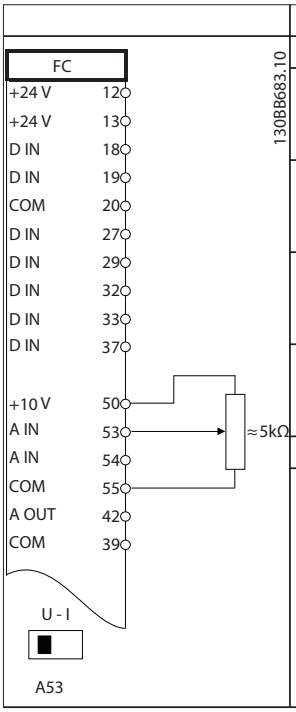
Table 6.5 Analog Speed Reference (Current)

6.1.2 Speed



Parameters	
Function	**Setting**
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.4 Analog Speed Reference (Voltage)



Parameters	
Function	**Setting**
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.6 Speed Reference (Using a Manual Potentiometer)

6

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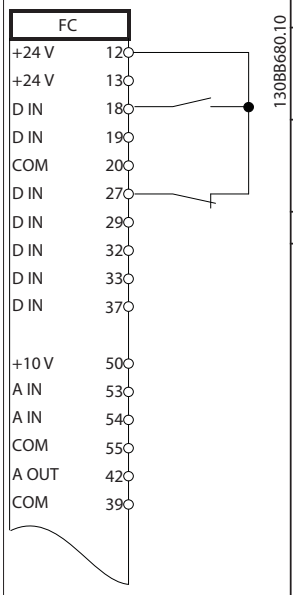
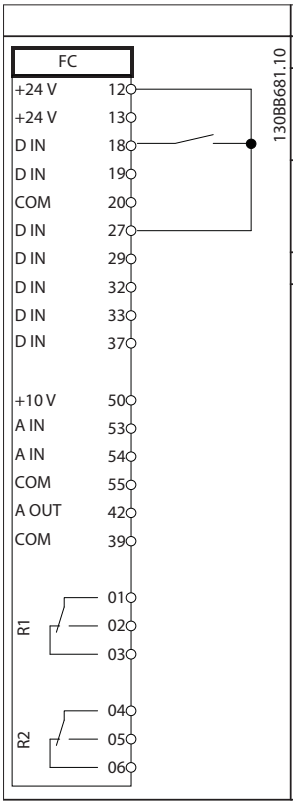
6.1.3 Run/Stop



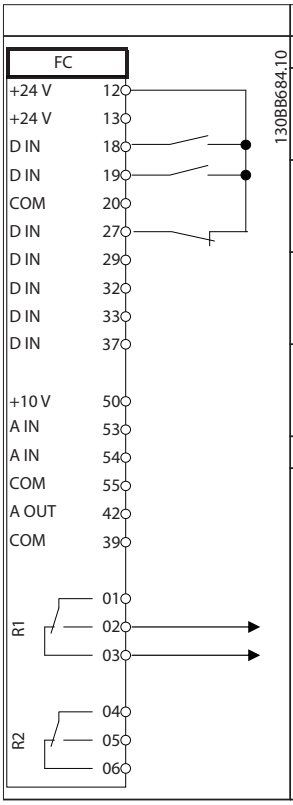
Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.7 Run/Stop Command with External Interlock



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
* = Default value	
Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

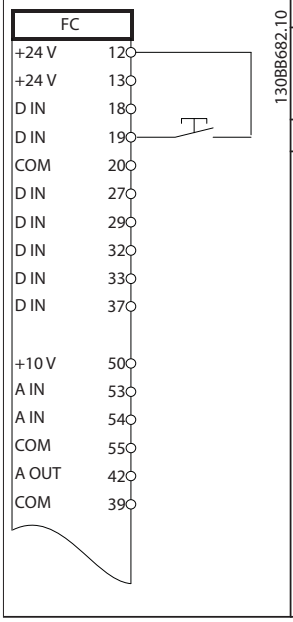
Table 6.8 Run/Stop Command without External Interlock



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-11 Terminal 19 Digital Input	*[52] Run Permissive*
Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
Parameter 5-40 Function Relay	*[167] Start command act.*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.9 Run Permissive

6.1.4 External Alarm Reset



Parameters	
Function	**Setting**
Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.10 External Alarm Reset

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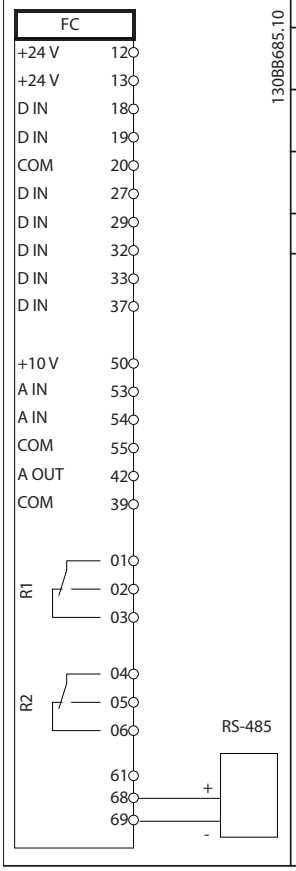
6.1.5 RS485



Parameters	
Function	**Setting**
Parameter 8-30 Protocol	FC*
Parameter 8-31 Address	1*
Parameter 8-32 Baud Rate	9600*
* = Default value	
Notes/comments: Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.	

Table 6.11 RS485 Network Connection

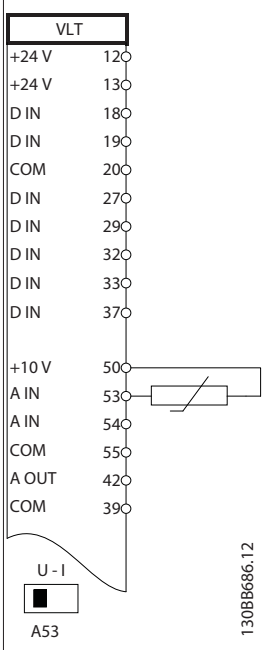
6.1.6 Motor Thermistor

⚠CAUTION

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

- **Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.**



Parameters	
Function	**Setting**
Parameter 1-90 Motor Thermal Protection	*[2] Thermistor trip*
Parameter 1-93 Thermistor Source	*[1] Analog input 53*
* = Default value	
Notes/comments: If only a warning is required, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN 37 is an option.	

Table 6.12 Motor Thermistor

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7 Maintenance, Diagnostics, and Troubleshooting

This chapter includes:

- Maintenance and service guidelines.
- Status messages.
- Warnings and alarms.
- Basic troubleshooting.

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the frequency converter is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the frequency converter at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, contact the local Danfoss supplier.

7

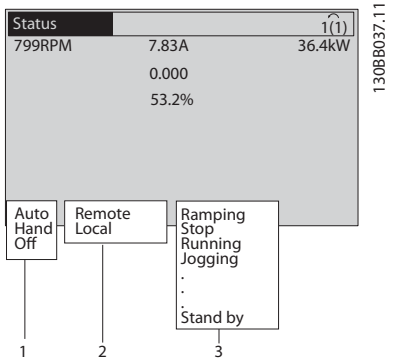
⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

7.2 Status Messages

When the frequency converter is in *Status* mode, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 7.1*).



1	Operating mode (see *Table 7.1*)
2	Reference site (see *Table 7.2*)
3	Operation status (see *Table 7.3*)

Illustration 7.1 Status Display

Table 7.1 to *Table 7.3* describe the status messages shown.

Off	The frequency converter does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The frequency converter is controlled from the control terminals and/or the serial communication.
Hand On	Control the frequency converter via the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 7.1 Operating Mode

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand On] control or reference values from the LCP.

Table 7.2 Reference Site

AC Brake	*[2] AC brake* is selected in *parameter 2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	AMA was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.

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Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *parameter 2-12 Brake Power Limit (kW)* has been reached.
Coast	• *[2] Coast inverse* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	*[1] Control Ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault* at mains fault. • The frequency converter ramps down the motor using a controlled ramp down.
Current High	The frequency converter output current is above the limit set in *parameter 4-51 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC Hold	*[1] DC hold* is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold/Preheat Current*.
DC Stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • The DC brake cut-in speed is reached in *parameter 2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • *[5] DC-brake inverse* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • *[20] Freeze output* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal options *[21] Speed up* and *[22] Speed down*. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	*[19] Freeze reference* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal options *[21] Speed up* and *[22] Speed down*.
Jog request	A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *parameter 3-19 Jog Speed [RPM]*. • *[14] Jog* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function is selected as a reaction for a monitoring function (for example, for the no signal function). The monitoring function is active.
Motor check	In *parameter 1-80 Function at Stop*, *[2] Motor Check* is selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
OVC control	Overvoltage control is activated via *parameter 2-17 Over-voltage Control*, *[2] Enabled*. The connected motor supplies the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(Only frequency converters with a 24 V external supply installed). Mains supply to the frequency converter was removed, and the control card is supplied by the external 24 V.

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Protection md	Protection mode is active. The unit detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.
Qstop	The motor is decelerating using *parameter 3-81 Quick Stop Ramp Time*. • *[4] Quick stop inverse* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function is activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.
Running	The frequency converter drives the motor.
Sleep Mode	The energy-saving function is enabled. The motor has stopped, but restarts automatically when required.
Speed high	Motor speed is above the value set in *parameter 4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
Standby	In auto-on mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.
Start delay	In *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated, and the motor starts after the start delay time expires.
Start fwd/rev	*[12] Enable start forward* and *[13] Enable start reverse* are selected as options for 2 different digital inputs (*parameter group 5-1* Digital Inputs*). The motor starts in forward or reverse direction depending on which terminal is activated.
Stop	The frequency converter received a stop command from the LCP, digital input, or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred, and the motor is stopped. When the cause of the alarm is cleared, cycle power to the frequency converter. The frequency converter can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication.

Table 7.3 Operation Status

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NOTICE

In auto/remote mode, the frequency converter requires external commands to execute functions.

7.3 Warning and Alarm Types

Warnings
A warning is issued when an alarm condition is impending, or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition ceases.

Alarms
An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

Trip
An alarm is issued when the frequency converter is tripped, meaning that the frequency converter suspends operation to prevent frequency converter or system damage. The motor coasts to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. After the fault condition is remedied, the frequency converter can be reset. It is then ready to start operation again.

Resetting the frequency converter after trip/trip lock
A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Trip lock
Input power is cycled. The motor coasts to a stop. The frequency converter continues to monitor the frequency converter status. Remove input power to the frequency converter, correct the cause of the fault, and reset the frequency converter.

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Warning and alarm displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

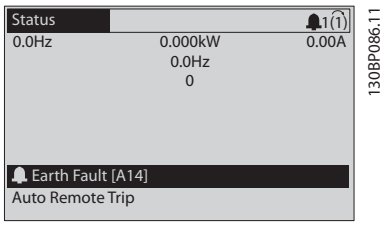
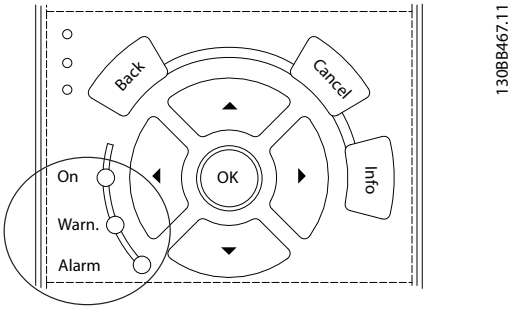


Illustration 7.2 Alarm Example

In addition to the text and alarm code in the LCP, there are 3 status indicator lights.



	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

Illustration 7.3 Status Indicator Lights

7.4 List of Warnings and Alarms

The warning/alarm information in this chapter defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

WARNING 1, 10 Volts low
The control card voltage from terminal 50 is <10 V. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or improper wiring of the potentiometer can cause this condition.

Troubleshooting

- Remove the wiring from terminal 50.
- If the warning clears, the problem is with the customer wiring.
- If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or signals from a faulty device cause this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common. VLT® Analog I/O Option MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 3, No motor
No motor has been connected to the output of the frequency converter.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears in case of a fault in the input rectifier on the frequency converter. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high
The DC-link voltage is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The DC-link voltage is lower than the low-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the frequency converter trips after some time.

Troubleshooting

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.

WARNING/ALARM 8, DC under voltage
If the DC-link voltage drops below the undervoltage limit, the frequency converter checks if a 24 V DC back-up supply is connected. If no 24 V DC back-up supply is

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connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the frequency converter voltage.
- Perform an input voltage test.
- Perform a soft charge circuit test.

WARNING/ALARM 9, Inverter overload

The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while issuing an alarm. The frequency converter *cannot* be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.
- Compare the output current shown on the LCP with measured motor current.
- Show the thermal load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter should increase. When running below the frequency converter continuous current rating, the counter should decrease.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *parameter 1-90 Motor Thermal Protection*. The fault occurs when the motor overload exceeds 100% for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure the motor data in parameters *1-20* through *1-25* is set correctly.
- If an external fan is used, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp

The thermistor may be disconnected. Select whether the frequency converter issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *parameter 1-93 Thermistor Source* selects terminal 53 or 54.
- When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50.
- If a KTY sensor is used, check for correct connection between terminals 54 and 55.
- If using a thermal switch or thermistor, check that the programming if *parameter 1-93 Thermistor Source* matches sensor wiring.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this from a warning-only condition to a warning followed by an alarm.

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp down, extend the ramp-down time.
- If torque limit occurs while running, possibly increase the torque limit. Be sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or fast acceleration with high-inertia loads can cause this fault. If extended mechanical brake control is selected, the trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Check that the motor size matches the frequency converter.
- Check *parameters 1-20* to *1-25* for correct motor data.

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ALARM 14, Earth (ground) fault
There is current from the output phases to ground, either in the cable between the frequency converter and the motor, or in the motor itself.

Troubleshooting

- Remove power from the frequency converter and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Perform current sensor test.

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact the local Danfoss supplier:

- *Parameter 15-40 FC Type*.
- *Parameter 15-41 Power Section*.
- *Parameter 15-42 Voltage*.
- *Parameter 15-43 Software Version*.
- *Parameter 15-45 Actual Typecode String*.
- *Parameter 15-49 SW ID Control Card*.
- *Parameter 15-50 SW ID Power Card*.
- *Parameter 15-60 Option Mounted*.
- *Parameter 15-61 Option SW Version* (for each option slot).

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Troubleshooting

- Remove power from the frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter. The warning is only active when *parameter 8-04 Control Timeout Function* is NOT set to *[0] Off*.
If *parameter 8-04 Control Timeout Function* is set to *[5] Stop and trip*, a warning appears and the frequency converter ramps down until it trips, then it shows an alarm.

Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Timeout Time*.
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

WARNING/ALARM 22, Hoist mechanical brake
When this warning is active, the LCP shows the type of issue.
0 = The torque ref. was not reached before timeout.
1 = There was no brake feedback before timeout.

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational but without the brake function. Remove power from the frequency converter and replace the brake resistor (see *parameter 2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistance value set in *parameter 2-16 AC brake Max. Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation. If a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Remove power from the frequency converter and remove the brake resistor.

This alarm/warning could also occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistor Klixon inputs, see *Brake Resistor Temperature Switch* in the *design guide*.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working. Check *parameter 2-15 Brake Check*.

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ALARM 29, Heat Sink temp
The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heatsink temperature. The trip and reset points vary based on the frequency converter power size.

Troubleshooting
Check for the following conditions:

- Ambient temperature too high.
- Motor cable too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

This alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules.

Troubleshooting

- Check the fan resistance.
- Check the soft charge fuses.
- Check the IGBT thermal sensor.

ALARM 30, Motor phase U missing
Motor phase U between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase U.

ALARM 31, Motor phase V missing
Motor phase V between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the frequency converter and the motor is missing.

Troubleshooting

- Remove power from the frequency converter and check motor phase W.

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault
The fieldbus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the frequency converter is lost and *parameter 14-10 Mains Failure* is NOT set to *[0] No Function*.

Troubleshooting

- Check the fuses to the frequency converter and mains power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 7.4* is shown.

Troubleshooting

- Cycle power.
- Check that the option is properly installed.
- Check for loose or missing wiring.

Contact the Danfoss supplier or Danfoss service if necessary. Note the code number for further trouble-shooting directions.

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service.
256–258	Power EEPROM data is defective or too old.
512	The control board EEPROM data is defective or too old.
513	Communication timeout reading EEPROM data.
514	Communication timeout reading EEPROM data.
515	Application-oriented control cannot recognize the EEPROM data.
516	Cannot write to the EEPROM because a write command is in progress.
517	Write command is under timeout.
518	Failure in the EEPROM.
519	Missing or invalid barcode data in EEPROM.
783	Parameter value outside of minimum/maximum limits.
1024–1279	Sending a CAN telegram failed.
1281	Digital signal processor flash timeout.
1282	Power micro software version mismatch.
1283	Power EEPROM data version mismatch.
1284	Cannot read digital signal processor software version.
1299	The option SW in slot A is too old.
1300	The option SW in slot B is too old.
1301	The option SW in slot C0 is too old.
1302	The option SW in slot C1 is too old.
1315	The option SW in slot A is not supported (not allowed).
1316	The option SW in slot B is not supported (not allowed).
1317	The option SW in slot C0 is not supported (not allowed).
1318	The option SW in slot C1 is not supported (not allowed).
1379	The option A did not respond when calculating the platform version.
1380	The option B did not respond when calculating the platform version.

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Number	Text
1381	The option C0 did not respond when calculating the platform version.
1382	The option C1 did not respond when calculating the platform version.
1536	An exception in the application-oriented control is registered. Debug information written in LCP.
1792	The DSP watchdog is active. Debugging of power part data, motor-oriented control data not transferred correctly.
2049	Power data restarted.
2064–2072	H081x: Option in slot x restarted.
2080–2088	H082x: Option in slot x issued a power-up wait.
2096–2104	H983x: Option in slot x issued a legal power-up wait.
2304	Could not read any data from power EEPROM.
2305	Missing SW version from power unit.
2314	Missing power unit data from power unit.
2315	Missing SW version from power unit.
2316	Missing lo_statepage from power unit.
2324	The power card configuration is determined to be incorrect at power-up.
2325	A power card has stopped communicating while main power is applied.
2326	The power card configuration is determined to be incorrect after the delay for power cards to register.
2327	Too many power card locations are registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD.
2562	No communication from ATACD to DSP (state running).
2816	Stack overflow control board module.
2817	Scheduler slow tasks.
2818	Fast tasks.
2819	Parameter thread.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
2836	cfListMempool too small.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with control board hardware.
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5376–6231	Out of memory.

Table 7.4 Code Numbers for Internal Faults

ALARM 39, Heat sink sensor
No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be in the power card, in the gatedrive card, or the ribbon cable between the power card and the gatedrive card.

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove the short circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove the short circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For X30/6, check the load connected to X30/6 or remove the short circuit connection. Check *parameter 5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short circuit connection. Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 46, Power card supply
The supply on the power card is out of range.

There are 3 supplies powered by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the VLT® 24V DC Supply MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

WARNING 47, 24 V supply low
The 24 V DC supply is measured on the control card. The external 24 V DC back-up supply may be overloaded, otherwise contact the Danfoss supplier.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of the allowable limits. The supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*, the frequency converter shows a warning. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping) the frequency converter trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss Service.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong. Check the settings in *parameters 1-20* to *1-25*.

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ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings.

ALARM 53, AMA motor too big
The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range
The parameter values of the motor are outside of the acceptable range. AMA does not run.

ALARM 56, AMA interrupted by user
The user has interrupted the AMA.

ALARM 57, AMA internal fault
Try to restart AMA several times, until the AMA is carried out. Repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. Usually this is not critical.

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ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in parameters *1-20* to *1-25* are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock
External interlock has been activated. To resume normal operation:

1. Apply 24 V DC to the terminal programmed for external interlock.
2. Reset the frequency converter via
   - 2a Serial communication.
   - 2b Digital I/O.
   - 2c The [Reset] key.

WARNING 62, Output frequency at maximum limit
The output frequency is higher than the value set in *parameter 4-19 Max Output Frequency*.

WARNING 64, Voltage Limit
The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

WARNING/ALARM 65, Control card over temperature
The control card has reached its trip temperature of 75 °C (167 °F).

WARNING 66, Heat sink temperature low
The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* at 5% and *parameter 1-80 Function at Stop*.

Troubleshooting
- Check the temperature sensor.
- Check the sensor wire between the IGBT and the gatedrive card.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
STO is activated.

Troubleshooting
- To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting
- Check the operation of the door fans.
- Check that the filters for the door fans are not blocked.
- Check that the gland plate is properly installed on IP21/IP54 (NEMA 1/12) frequency converters.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible.

Troubleshooting
- Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 71, PTC 1 safe stop
Safe Torque Off is activated from the VLT® PTC Thermistor Card MCB 112 (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to T37 again (when the motor temperature reaches an acceptable level) and when the digital input from the MCB 112 is deactivated. When that happens, a reset signal must be is be sent (via bus, digital I/O, or by pressing [Reset]).

NOTICE

If automatic restart is enabled, the motor may start when the fault is cleared.

ALARM 72, Dangerous failure
Safe Torque Off (STO) with trip lock. Unexpected signal levels on Safe Torque Off (STO) and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe Stop auto restart
Safe Torque Off (STO). With automatic restart enabled, the motor can start when the fault is cleared.

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WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units. When replacing an enclosure size F module, this warning occurs if the power-specific data in the module power card does not match the rest of the frequency converter. If the power card connection is lost, the unit also triggers this warning.

Troubleshooting
- Confirm that the spare part and its power card are the correct part number.
- Ensure that the 44-pin cables between the MDCIC and power cards are mounted properly.

WARNING 77, Reduced power mode
This warning indicates that the frequency converter is operating in reduced power mode (that is, less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter is set to run with fewer inverters and remains on.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also, the MK102 connector on the power card could not be installed.

ALARM 80, Drive initialised to default value
Parameter settings are initialized to default settings after a manual reset.

Troubleshooting
- Reset the unit to clear the alarm.

ALARM 81, CSIV corrupt
CSIV (Customer-specific initialization values) file has syntax errors.

ALARM 82, CSIV parameter error
CSIV (Customer-specific initialization values) failed to initialize a parameter.

ALARM 85, Dang fail PB
PROFIBUS/PROFIsafe error.

ALARM 92, No flow
A no-flow condition is detected in the system. *Parameter 22-23 No-Flow Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 93, Dry pump
A no-flow condition in the system with the frequency converter operating at high speed can indicate a dry pump. *Parameter 22-26 Dry Pump Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 94, End of curve
The feedback is lower than the setpoint. This condition can indicate leakage in the system. *Parameter 22-50 End of Curve Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *Parameter 22-60 Broken Belt Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 100, Derag limit fault
The *Deragging* feature failed during execution. Check the pump impeller for blockage.

WARNING/ALARM 104, Mixing fan fault
The fan monitor checks that the fan is spinning at frequency converter power-up or whenever the mixing fan is turned on. If the fan is not operating, the fault is issued. The mixing-fan fault can be configured as a warning or an alarm trip by *parameter 14-53 Fan Monitor*.

Troubleshooting
- Cycle power to the frequency converter to determine if the warning/alarm returns.

WARNING 250, New spare part
A component in the frequency converter has been replaced. To resume normal operation, reset the frequency converter.

WARNING 251, New typecode
The power card or other components have been replaced and the type code changed.

Troubleshooting
- Reset to remove the warning and resume normal operation.

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7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See *Table 4.3*.	Check the input power source.
	Missing or open fuses, or circuit breaker tripped.	See *Open fuses and tripped circuit breaker* in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50–55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM).	–	Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting.	–	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.	–	Contact supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the frequency converter.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch is open or missing motor connection.	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit.
	LCP stop.	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operating mode) to run the motor.
	Missing start signal (Standby).	Check *parameter 5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check *parameter 5-12 Terminal 27 Digital Input* for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *No operation*.
	Wrong reference signal source.	Check the following: • Reference signal: Local, remote, or bus reference. • Preset reference. • Terminal connection. • Scaling of terminals. • Reference signal availability.	Program the correct settings. Check *parameter 3-13 Reference Site*. Set preset reference active in *parameter group 3-1* References*.
Motor running in wrong direction	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program the correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in *parameter group 5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.	–	See *chapter 5.5 Checking Motor Rotation*.

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Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits are set incorrectly.	Check the output limits in *parameter 4-13 Motor Speed High Limit [RPM]*, *parameter 4-14 Motor Speed High Limit [Hz]* and *parameter 4-19 Max Output Frequency*.	Program the correct limits.
	Reference input signal is not scaled correctly.	Check the reference input signal scaling in *parameter group 6-0* Analog I/O Mode* and *parameter group 3-1* References*. Check the reference limits in *parameter group 3-0* Reference Limit*.	Program the correct settings.
Motor speed unstable	Possible incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check the PID settings.	Check the settings in *parameter group 1-6* Load Depen. Setting*. For closed-loop operation, check the settings in *parameter group 20-0* Feedback*.
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check the motor settings in *parameter groups 1-2* Motor Data, 1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*.
Motor does not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times.	Check the brake parameters. Check the ramp time settings.	Check *parameter groups 2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase-to-phase short circuit.	The motor or panel has a short phase-to-phase. Check the motor and panel phase for short circuits.	Eliminate any short circuits detected.
	Motor overload.	Motor is overloaded for the application.	Perform a start-up test and verify that the motor current is within the specifications. If the motor current exceeds the nameplate full load current, the motor may run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform a pre-startup check for loose connections.	Tighten any loose connections.
Mains current imbalance >3%	Problem with the mains power (See *alarm 4, Mains phase loss* description).	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the frequency converter.	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalance leg stays on the same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance >3%	Problem with the motor or motor wiring.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check the motor and motor wiring.
	Problem with the frequency converter.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the frequency converter. Contact the Danfoss supplier.
Frequency converter acceleration problems	Motor data was entered incorrectly.	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*. Check that motor data is entered correctly.	Increase the ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. Increase the current limit in *parameter 4-18 Current Limit*. Increase the torque limit in *parameter 4-16 Torque Limit Motor Mode*.
Frequency converter deceleration problems	Motor data was entered incorrectly.	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*. Check that motor data is entered correctly.	Increase the ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *parameter 2-17 Over-voltage Control*.

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Symptom	Possible cause	Test	Solution
Acoustic noise or vibration	Resonances.	Bypass critical frequencies by using parameters in *parameter group 4-6* Speed Bypass*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in *parameter 14-03 Overmodulation*.	
		Change the switching pattern and frequency in *parameter group 14-0* Inverter Switching*.	
		Increase resonance dampening in *parameter 1-64 Resonance Damping*.	

Table 7.5 Troubleshooting

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8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 1x200–240 V AC

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7	P5K5	P7K5	P15K	P22K
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7	5.5	7.5	15	22
Typical shaft output at 240 V [hp]	1.5	2.0	2.9	4.0	4.9	7.5	10	20	30
Protection rating IP20/Chassis	A3	–	–	–	–	–	–	–	–
Protection rating IP21/Type 1	–	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP55/Type 12	A5	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP66/NEMA 4X	A5	B1	B1	B1	B1	B1	B2	C1	C2
Output current									
Continuous (3x200–240 V) [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8	59.4	88
Intermittent (3x200–240 V) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.4	65.3	96.8
Continuous kVA at 208 V [kVA]	2.4	2.7	3.8	4.5	6.0	8.7	11.1	21.4	31.7
Maximum input current									
Continuous (1x200–240 V) [A]	12.5	15	20.5	24	32	46	59	111	172
Intermittent (1x200–240 V) [A]	13.8	16.5	22.6	26.4	35.2	50.6	64.9	122.1	189.2
Maximum pre-fuses [A]	20	30	40	40	60	80	100	150	200
Additional specifications									
Maximum cable cross-section (mains, motor, brake) [mm^2 (AWG)]	0.2–4 (4–10)					10 (7)	35 (2)	50 (1/0)	95 (4/0)
Maximum cable cross-section for mains with disconnect switch [mm2 (AWG)]	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	2 x 50 (2 x 1/0)[9) 10)]
Maximum cable cross-section for mains without disconnect switch [mm2 (AWG)]	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	95 (4/0)
Cable insulation temperature rating [°C (°F)]	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)
Estimated power loss[3)] at rated maximum load [W][4)]	44	30	44	60	74	110	150	300	440
Efficiency[5)]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.1 Mains Supply 1x200–240 V AC, Normal Overload 110% for 1 Minute, P1K1–P22K

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8.1.2 Mains Supply 3x200–240 V AC

Type designation	PK25		PK37		PK55		PK75	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.25		0.37		0.55		0.75	
Typical shaft output at 208 V [hp]	0.34		0.5		0.75		1	
Protection rating IP20/Chassis[6] Protection rating IP21/Type 1	A2		A2		A2		A2	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	A4/A5		A4/A5		A4/A5		A4/A5	
Output current								
Continuous (3x200–240 V) [A]	1.8		2.4		3.5		4.6	
Intermittent (3x200–240 V) [A]	2.7	2.0	3.6	2.6	5.3	3.9	6.9	5.1
Continuous kVA at 208 V [kVA]	0.65		0.86		1.26		1.66	
Maximum input current								
Continuous (3x200–240 V) [A]	1.6		2.2		3.2		4.1	
Intermittent (3x200–240 V) [A]	2.4	1.8	3.3	2.4	4.8	3.5	6.2	4.5
Maximum pre-fuses [A]	10		10		10		10	
Additional specifications								
Maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))							
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	6, 4, 4 (10, 12, 12)							
Estimated power loss[3] at rated maximum load [W (hp)][4]	21 (0.03)		29 (0.04)		42 (0.06)		54 (0.07)	
Efficiency[5]	0.94		0.94		0.95		0.95	

Table 8.2 Mains Supply 3x200–240 V AC, PK25–PK75

Type designation	P1K1		P1K5		P2K2		P3K0		P3K7	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	1.1		1.5		2.2		3.0		3.7	
Typical shaft output at 208 V [hp]	1.5		2		3		4		5	
Protection rating IP20/Chassis[6] Protection rating IP21/Type 1	A2		A2		A2		A3		A3	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	A4/A5		A4/A5		A4/A5		A5		A5	
Output current										
Continuous (3x200–240 V) [A]	6.6		7.5		10.6		12.5		16.7	
Intermittent (3x200–240 V) [A]	9.9	7.3	11.3	8.3	15.9	11.7	18.8	13.8	25	18.4
Continuous kVA at 208 V [kVA]	2.38		2.70		3.82		4.50		6.00	
Maximum input current										
Continuous (3x200–240 V) [A]	5.9		6.8		9.5		11.3		15.0	
Intermittent (3x200–240 V) [A]	8.9	6.5	10.2	7.5	14.3	10.5	17.0	12.4	22.5	16.5
Maximum pre-fuses [A]	20		20		20		32		32	
Additional specifications										
Maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm² (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Maximum cable cross-section[2] for mains disconnect [mm²] [(AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss[3] at rated maximum load [W (hp)][4]	63 (0.09)		82 (0.11)		116 (0.16)		155 (0.21)		185 (0.25)	
Efficiency[5]	0.96		0.96		0.96		0.96		0.96	

Table 8.3 Mains Supply 3x200–240 V AC, P1K1–P3K7

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Type designation	P5K5		P7K5		P11K		P15K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	3.7	5.5	5.5	7.5	7.5	11	11	15
Typical shaft output at 208 V [hp]	5.0	7.5	7.5	10	10	15	15	20
IP20/Chassis[7]	B3		B3		B3		B4	
Protection rating IP21/Type 1 Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	B1		B1		B1		B2	
Output current								
Continuous (3x200–240 V) [A]	16.7	24.2	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (3x200–240 V) [A]	26.7	26.6	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA at 208 V [kVA]	6.0	8.7	8.7	11.1	11.1	16.6	16.6	21.4
Maximum input current								
Continuous (3x200–240 V) [A]	15.0	22.0	22.0	28.0	28.0	42.0	42.0	54.0
Intermittent (3x200–240 V) [A]	24.0	24.2	35.2	30.8	44.8	46.2	67.2	59.4
Maximum pre-fuses [A]	63		63		63		80	
Additional specifications								
IP20 maximum cable cross-section[2] for mains, brake, motor, and load sharing [mm² (AWG)]	10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		35, –, – (2, –, –)	
Protection rating IP21 maximum cable cross-section[2] for mains, brake, and load sharing [mm² (AWG)]	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35, –, – (2, –, –)	
Protection rating IP21 maximum cable cross-section[2] for motor [mm² (AWG)]	10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		10, 10, – (8, 8, –)		35, 25, 25 (2, 4, 4)	
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	16, 10, 10 (6, 8, 8)						35 (2)	
Estimated power loss[3] at rated maximum load [W (hp)][4]	239 (0.33)	310 (0.42)	239 (0.33)	310 (0.42)	371 (0.51)	514 (0.7)	463 (0.63)	602 (0.82)
Efficiency[5]	0.96		0.96		0.96		0.96	

Table 8.4 Mains Supply 3x200–240 V AC, P5K5–P15K

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Type designation	P18K		P22K		P30K		P37K		P45K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	15	18.5	18.5	22	22	30	30	37	37	45
Typical shaft output at 208 V [hp]	20	25	25	30	30	40	40	50	50	60
Protection rating IP20/Chassis[7]	B4		C3		C3		C4		C4	
Protection rating IP21/Type 1 Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	C1		C1		C1		C2		C2	
Output current										
Continuous (3x200–240 V) [A]	59.4	74.8	74.8	88.0	88.0	115	115	143	143	170
Intermittent (3x200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA at 208 V [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
Maximum input current										
Continuous (3x200–240 V) [A]	54.0	68.0	68.0	80.0	80.0	104	104	130	130	154.0
Intermittent (3x200–240 V) [A]	81.0	74.8	102	88.0	120	114	156	143	195	169.0
Maximum pre-fuses [A]	125		125		160		200		250	
Additional specifications										
Protection rating IP20 maximum cable cross-section for mains, brake, motor, and load sharing [mm² (AWG)]	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm² (AWG)]	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake, and load sharing [mm² (AWG)]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2] for disconnect [mm² (AWG)]	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss[3] at rated maximum load [W (hp)][4]	624 (0.85)	737 (1)	740 (1)	845 (1.2)	874 (1.2)	1140 (1.6)	1143 (1.6)	1353 (1.8)	1400 (1.9)	1636 (2.2)
Efficiency[5]	0.96		0.97		0.97		0.97		0.97	

Table 8.5 Mains Supply 3x200–240 V AC, P18K–P45K

8.1.3 Mains Supply 1x380–480 V AC

Type designation	P7K5	P11K	P18K	P37K
Typical shaft output [kW]	7.5	11	18.5	37
Typical shaft output at 240 V [hp]	10	15	25	50
Protection rating IP21/Type 1	B1	B2	C1	C2
Protection rating IP55/Type 12	B1	B2	C1	C2
Protection rating IP66/NEMA 4X	B1	B2	C1	C2
Output current				
Continuous (3x380–440 V) [A]	16	24	37.5	73
Intermittent (3x380–440 V) [A]	17.6	26.4	41.2	80.3
Continuous (3x441–480 V) [A]	14.5	21	34	65
Intermittent (3x441–480 V) [A]	15.4	23.1	37.4	71.5
Continuous kVA at 400 V [kVA]	11.0	16.6	26	50.6
Continuous kVA at 460 V [kVA]	11.6	16.7	27.1	51.8
Maximum input current				
Continuous (1x380–440 V) [A]	33	48	78	151
Intermittent (1x380–440 V) [A]	36	53	85.5	166

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Type designation	P7K5	P11K	P18K	P37K
Continuous (1x441–480 V) [A]	30	41	72	135
Intermittent (1x441–480 V) [A]	33	46	79.2	148
Maximum pre-fuses [A]	63	80	160	250
Additional specifications				
Maximum cable cross-section for mains, motor, and brake [mm^2] (AWG)]	10 (7)	35 (2)	50 (1/0)	120 (4/0)
Estimated power loss[3] at rated maximum load [W (hp)][4]	300 (0.41)	440 (0.6)	740 (1)	1480 (2)
Efficiency[5]	0.96	0.96	0.96	0.96

Table 8.6 Mains Supply 1x380–480 V AC, Normal Overload 110% for 1 Minute, P7K5–P37K

8.1.4 Mains Supply 3x380–480 V AC

Type designation	PK37		PK55		PK75		P1K1		P1K5	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.37		0.55		0.75		1.1		1.5	
Typical shaft output at 460 V [hp]	0.5		0.75		1.0		1.5		2.0	
Protection rating IP20/Chassis[6]	A2		A2		A2		A2		A2	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	A4/A5		A4/A5		A4/A5		A4/A5		A4/A5	
Output current										
Continuous (3x380–440 V) [A]	1.3		1.8		2.4		3.0		4.1	
Intermittent (3x380–440 V) [A]	2.0	1.4	2.7	2.0	3.6	2.6	4.5	3.3	6.2	4.5
Continuous (3x441–480 V) [A]	1.2		1.6		2.1		2.7		3.4	
Intermittent (3x441–480 V) [A]	1.8	1.3	2.4	1.8	3.2	2.3	4.1	3.0	5.1	3.7
Continuous kVA at 400 V [kVA]	0.9		1.3		1.7		2.1		2.8	
Continuous kVA at 460 V [kVA]	0.9		1.3		1.7		2.4		2.7	
Maximum input current										
Continuous (3x380–440 V) [A]	1.2		1.6		2.2		2.7		3.7	
Intermittent (3x380–440 V) [A]	1.8	1.3	2.4	1.8	3.3	2.4	4.1	3.0	5.6	4.1
Continuous (3x441–480 V) [A]	1.0		1.4		1.9		2.7		3.1	
Intermittent (3x441–480 V) [A]	1.5	1.1	2.1	1.5	2.9	2.1	4.1	3.0	4.7	3.4
Maximum pre-fuses [A]	10		10		10		10		10	
Additional specifications										
Protection ratings IP20, IP21 maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Protection ratings IP55, IP66 maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4, 4, 4 (12, 12, 12)									
Maximum cable cross-section[2] for disconnect [mm^2 (AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss[3] at rated maximum load [W (hp)][4]	35 (0.05)		42 (0.06)		46 (0.06)		58 (0.08)		62 (0.08)	
Efficiency[5]	0.93		0.95		0.96		0.96		0.97	

Table 8.7 Mains Supply 3x380–480 V AC, PK37–P1K5

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Type designation	P2K2		P3K0		P4K0		P5K5		P7K5	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	2.2		3.0		4.0		5.5		7.5	
Typical shaft output at 460 V [hp]	2.9		4.0		5.3		7.5		10	
Protection rating IP20/Chassis[6)]	A2		A2		A2		A3		A3	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	A4/A5		A4/A5		A4/A5		A5		A5	
Output current										
Continuous (3x380–440 V) [A]	5.6		7.2		10		13		16	
Intermittent (3x380–440 V) [A]	8.4	6.2	10.8	7.9	15.0	11.0	19.5	14.3	24.0	17.6
Continuous (3x441–480 V) [A]	4.8		6.3		8.2		11		14.5	
Intermittent (3x441–480 V) [A]	7.2	5.3	9.5	6.9	12.3	9.0	16.5	12.1	21.8	16.0
Continuous kVA at 400 V [kVA]	3.9		5.0		6.9		9.0		11.0	
Continuous kVA at 460 V [kVA]	3.8		5.0		6.5		8.8		11.6	
Maximum input current										
Continuous (3x380–440 V) [A]	5.0		6.5		9.0		11.7		14.4	
Intermittent (3x380–440 V) [A]	7.5	5.5	9.8	7.2	13.5	9.9	17.6	12.9	21.6	15.8
Continuous(3x441–480 V) [A]	4.3		5.7		7.4		9.9		13.0	
Intermittent (3x441–480 V) [A]	6.5	4.7	8.6	6.3	11.1	8.1	14.9	10.9	19.5	14.3
Maximum pre-fuses [A]	20		20		20		30		30	
Additional specifications										
Protection ratings IP20, IP21 maximum cable cross-section[2)] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))									
Protection ratings IP55, IP66 maximum cable cross-section[2)] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4, 4, 4 (12, 12, 12)									
Maximum cable cross-section[2)] for disconnect [mm^2 (AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss[3)] at rated maximum load [W (hp)][4)]	88 (0.12)		116 (0.16)		124 (0.17)		187 (0.25)		225 (0.31)	
Efficiency[5)]	0.97		0.97		0.97		0.97		0.97	

Table 8.8 Mains Supply 3x380–480 V AC, P2K2–P7K5

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Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	7.5	11	11	15	15	18.5	22.0	22.0	22.0	30
Typical shaft output at 460 V [hp]	10	15	15	20	20	25	30	30	30	40
Protection rating IP20/Chassis[7]	B3		B3		B3		B4			B4
Protection rating IP21/Type 1	B1		B1		B1		B2		B2	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	B1		B1		B1		B2		B2	
Output current										
Continuous (3x380–440 V) [A]	–	24	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (3x380–440 V) [A]	–	26.4	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (3x441–480 V) [A]	–	21	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (3x441–480 V) [A]	–	23.1	33.6	29.7	43.2	37.4	54.4	44	64	61.6
Continuous kVA at 400 V [kVA]	–	16.6	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA at 460 V [kVA]	–	16.7	16.7	21.5	21.5	27.1	27.1	31.9	31.9	41.4
Maximum input current										
Continuous (3x380–440 V) [A]	–	22	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (3x380–440 V) [A]	–	24.2	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (3x441–480 V) [A]	–	19	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (3x441–480 V) [A]	–	20.9	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
Maximum pre-fuses [A]	–	63		63		63		63		80
Additional specifications										
Protection ratings IP21, IP55, IP66 maximum cable cross-section[2] for mains, brake, and load sharing [mm^2 (AWG)]	16, 10, 16 (6, 8, 6)						35, –, – (2, –, –)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section[2] for motor [mm^2 (AWG)]	10, 10,– (8, 8,–)						35, 25, 25 (2, 4, 4)			
Protection rating IP20 maximum cable cross-section[2] for mains, brake, motor, and load sharing [mm^2 (AWG)]	10, 10,– (8, 8,–)						35, –, – (2, –, –)			
Maximum cable cross-section[2] for disconnect [mm^2 (AWG)]	16, 10, 10 (6, 8, 8)									
Estimated power loss[3] at rated maximum load [W (hp)][4]	291 (0.4)	392 (0.53)	291 (0.4)	392 (0.53)	379 (0.52)	465 (0.63)	444 (0.61)	525 (0.72)	547 (0.75)	739 (1)
Efficiency[5]	0.98		0.98		0.98		0.98		0.98	

Table 8.9 Mains Supply 3x380–480 V AC, P11K–P30K

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Type designation	P37K		P45K		P55K		P75K		P90K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	30	37	37	45	45	55	55	75	75	90
Typical shaft output at 460 V [hp]	40	50	50	60	60	75	75	100	100	125
Protection rating IP20/Chassis[6]	B4		C3		C3		C4		C4	
Protection rating IP21/Type 1	C1		C1		C1		C2		C2	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	C1		C1		C1		C2		C2	
Output current										
Continuous (3x380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (3x380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (3x441–480 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (3x441–480 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA at 400 V [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA at 460 V [kVA]	41.4	51.8	51.8	63.7	63.7	83.7	83.7	104	103.6	128
Maximum input current										
Continuous (3x380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (3x380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (3x441–480 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (3x441–480 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
Maximum pre-fuses [A]	100		125		160		250		250	
Additional specifications										
Protection rating IP20 maximum cable cross-section for mains and motor [mm² (AWG)]	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection rating IP20 maximum cable cross-section for brake and load sharing [mm² (AWG)]	35 (2)		50 (1)		50 (1)		95 (4/0)		95 (4/0)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm² (AWG)]	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm² (AWG)]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss[3] at rated maximum load [W (hp)][4]	570 (0.78)	698 (0.95)	697 (0.95)	843 (1.1)	891 (1.2)	1083 (1.5)	1022 (1.4)	1384 (1.9)	1232 (1.7)	1474 (2)
Efficiency[5]	0.98		0.98		0.98		0.98		0.99	

Table 8.10 Mains Supply 3x380–480 V AC, P37K–P90K

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8.1.5 Mains Supply 3x525–600 V AC

Type designation	PK75		P1K1		P1K5		P2K2	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	0.75		1.1		1.5		2.2	
Typical shaft output [hp]	1		1.5		2		3	
Protection rating IP20/Chassis Protection rating IP21/Type 1	A3		A3		A3		A3	
Protection rating IP55/Type 12	A5		A5		A5		A5	
Output current								
Continuous (3x525–550 V) [A]	1.8		2.6		2.9		4.1	
Intermittent (3x525–550 V) [A]	2.7	2.0	3.9	2.9	4.4	3.2	6.2	4.5
Continuous (3x551–600 V) [A]	1.7		2.4		2.7		3.9	
Intermittent (3x551–600 V) [A]	2.6	1.9	3.6	2.6	4.1	3.0	5.9	4.3
Continuous kVA at 550 V [kVA]	1.7		2.5		2.8		3.9	
Continuous kVA at 550 V [kVA]	1.7		2.4		2.7		3.9	
Maximum input current								
Continuous (3x525–600 V) [A]	1.7		2.4		2.7		4.1	
Intermittent (3x525–600 V) [A]	2.6	1.9	3.6	2.6	4.1	3.0	6.2	4.5
Maximum pre-fuses [A]	10		10		10		20	
Additional specifications								
Maximum cable cross-section[2)] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section[2)] for mains disconnect [mm^2 (AWG)]	6,4,4 (10,12,12)							
Estimated power loss[3)] at rated maximum load [W (hp)][4)]	35 (0.05)		50 (0.07)		65 (0.09)		92 (0.13)	
Efficiency[5)]	0.97		0.97		0.97		0.97	

Table 8.11 Mains Supply 3x525–600 V AC, PK75–P2K2

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Type designation	P3K0		P4K0		P5K5		P7K5	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	3.0		4.0		5.5		7.5	
Typical shaft output [hp]	4		5		7.5		10	
Protection rating IP20/Chassis Protection rating IP21/Type 1	A2		A2		A3		A3	
IP55/Type 12	A5		A5		A5		A5	
Output current								
Continuous (3x525–550 V) [A]	5.2		6.4		9.5		11.5	
Intermittent (3x525–550 V) [A]	7.8	5.7	9.6	7.0	14.3	10.5	17.3	12.7
Continuous (3x551–600 V) [A]	4.9		6.1		9.0		11.0	
Intermittent (3x551–600 V) [A]	7.4	5.4	9.2	6.7	13.5	9.9	16.5	12.1
Continuous kVA at 550 V [kVA]	5.0		6.1		9.0		11.0	
Continuous kVA at 550 V [kVA]	4.9		6.1		9.0		11.0	
Maximum input current								
Continuous (3x525–600 V) [A]	5.2		5.8		8.6		10.4	
Intermittent (3x525–600 V) [A]	7.8	5.7	8.7	6.4	12.9	9.5	15.6	11.4
Maximum pre-fuses [A]	20		20		32		32	
Additional specifications								
Maximum cable cross-section[2)] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section[2)] for mains disconnect [mm^2 (AWG)]	6,4,4 (10,12,12)							
Estimated power loss[3)] at rated maximum load [W (hp)][4)]	122 (0.17)		145 (0.2)		195 (0.27)		261 (0.36)	
Efficiency[5)]	0.97		0.97		0.97		0.97	

Table 8.12 Mains Supply 3x525–600 V AC, P3K0–P7K5

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Type designation	P11K		P15K		P18K		P22K		P30K		P37K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	7.5	11	11	15	15	18.5	18.5	22	22	30	30	37
Typical shaft output [hp]	10	15	15	20	20	25	25	30	30	40	40	50
Protection rating IP20/ Chassis	B3		B3		B3		B4		B4		B4	
Protection rating IP21/ Type 1 Protection rating IP55/ Type 12 Protection rating IP66/ NEMA 4X	B1		B1		B1		B2		B2		C1	
Output current												
Continuous (3x525–550 V) [A]	11.5	19	19	23	23	28	28	36	36	43	43	54
Intermittent (3x525–550 V) [A]	18.4	21	30	25	37	31	45	40	58	47	65	59
Continuous (3x551–600 V) [A]	11	18	18	22	22	27	27	34	34	41	41	52
Intermittent (3x551–600 V) [A]	17.6	20	29	24	35	30	43	37	54	45	62	57
Continuous kVA at 550 V [kVA]	11	18.1	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
Continuous kVA at 575 V [kVA]	11	17.9	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
Maximum input current												
Continuous at 550 V [A]	10.4	17.2	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	16.6	19	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	9.8	16	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	15.5	17.6	26	22	32	27	39	34	50	41	56	52
Maximum pre-fuses [A]	40		40		50		60		80		100	
Additional specifications												
Protection rating IP20, maximum cable cross-section[2] for mains, brake, motor, and load sharing [mm² (AWG)]	10, 10,– (8, 8,–)						35,–,– (2,–,–)					
Protection ratings IP21, IP55, IP66 maximum cable cross-section[2] for mains, brake, and load sharing [mm² (AWG)]	16, 10, 10 (6, 8, 8)						35,–,– (2,–,–)					
Protection ratings IP21, IP55, IP66 maximum cable cross-section[2] for motor [mm² (AWG)]	10, 10,– (8, 8,–)						35, 25, 25 (2, 4, 4)					
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	16, 10, 10 (6, 8, 8)										50, 35, 35 (1, 2, 2)	
Estimated power loss[3] at rated maximum load [W (hp)][4]	220 (0.3)	300 (0.41)	220 (0.3)	300 (0.41)	300 (0.41)	370 (0.5)	370 (0.5)	440 (0.6)	440 (0.6)	600 (0.82)	600 (0.82)	740 (1)
Efficiency[5]	0.98		0.98		0.98		0.98		0.98		0.98	

Table 8.13 Mains supply 3x525–600 V AC, P11K–P37K

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Type designation	P45K		P55K		P75K		P90K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	37	45	45	55	55	75	75	90
Typical shaft output [hp]	50	60	60	75	75	100	100	125
Protection rating IP20/Chassis	C3		C3		C4		C4	
Protection rating IP21/Type 1 Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	C1		C1		C2		C2	
Output current								
Continuous (3x525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (3x525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (3x525–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (3x525–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA at 525 V [kVA]	51.4	61.9	61.9	82.9	82.9	100	100.0	130.5
Continuous kVA at 575 V [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
Maximum input current								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
Maximum pre-fuses [A]	150		160		225		250	
Additional specifications								
Protection rating IP20 maximum cable cross-section for mains and motor [mm² (AWG)]	50 (1)				150 (300 MCM)			
Protection rating IP20 maximum cable cross-section for brake and load sharing [mm² (AWG)]	50 (1)				95 (4/0)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm² (AWG)]	50 (1)				150 (300 MCM)			
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm² (AWG)]	50 (1)				95 (4/0)			
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	50, 35, 35 (1, 2, 2)				95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss[3] at rated maximum load [W (hp)][4]	740 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1500 (2)	1500 (2)	1800 (2.5)
Efficiency[5]	0.98		0.98		0.98		0.98	

Table 8.14 Mains supply 3x525–600 V AC, P45K–P90K

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8.1.6 Mains Supply 3x525–690 V AC

Type designation	P1K1		P1K5		P2K2		P3K0		P4K0		P5K5		P7K5	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	1.1		1.5		2.2		3.0		4.0		5.5		7.5	
Typical shaft output [hp]	1.5		2		3		4		5		7.5		10	
IP20/Chassis	A3		A3		A3		A3		A3		A3		A3	
Output current														
Continuous (3x525–550 V) [A]	2.1		2.7		3.9		4.9		6.1		9.0		11.0	
Intermittent (3x525–550 V) [A]	3.2	2.3	4.1	3.0	5.9	4.3	7.4	5.4	9.2	6.7	13.5	9.9	16.5	12.1
Continuous (3x551–690 V) [A]	1.6		2.2		3.2		4.5		5.5		7.5		10.0	
Intermittent (3x551–690 V) [A]	2.4	1.8	3.3	2.4	4.8	3.5	6.8	5.0	8.3	6.1	11.3	8.3	15.0	11.0
Continuous kVA at 525 V [kVA]	1.9		2.5		3.5		4.5		5.5		8.2		10.0	
Continuous kVA at 690 V [kVA]	1.9		2.6		3.8		5.4		6.6		9.0		12.0	
Maximum input current														
Continuous (3x525–550 V) [A]	1.9		2.4		3.5		4.4		5.5		8.1		9.9	
Intermittent (3x525–550 V) [A]	2.9	2.1	3.6	2.6	5.3	3.9	6.6	4.8	8.3	6.1	12.2	8.9	14.9	10.9
Continuous (3x551–690 V) [A]	1.4		2.0		2.9		4.0		4.9		6.7		9.0	
Intermittent (3x551–690 V) [A]	2.1	1.5	3.0	2.2	4.4	3.2	6.0	4.4	7.4	5.4	10.1	7.4	13.5	9.9
Additional specifications														
Maximum cable cross–section[2] for mains, motor, brake, and load sharing [mm^2 (AWG)]	4, 4, 4 (12, 12, 12) (minimum (24)													
Maximum cable cross–section[2] for mains disconnect [mm^2 (AWG)]	6, 4, 4 (10, 12, 12)													
Estimated power loss[3] at rated maximum load [W (hp)][4]	44 (0.06)		60 (0.08)		88 (0.12)		120 (0.16)		160 (0.22)		220 (0.3)		300 (0.41)	
Efficiency[5]	0.96		0.96		0.96		0.96		0.96		0.96		0.96	

Table 8.15 A3 Enclosure, Mains Supply 3x525–690 V AC IP20/Protected Chassis, P1K1–P7K5

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Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	5.9	7.5	7.5	11	11	15	15	18.5	18.5	22
Typical shaft output at 550 V [hp]	7.5	10	10	15	15	20	20	25	25	30
Typical shaft output at 690 V [kW]	7.5	11	11	15	15	18.5	18.5	22	22	30
Typical shaft output at 690 V [hp]	10	15	15	20	20	25	25	30	30	40
IP20/Chassis	B4		B4		B4		B4		B4	
IP21/Type 1 IP55/Type 12	B2		B2		B2		B2		B2	
Output current										
Continuous (3x525–550 V) [A]	11	14	14.0	19.0	19.0	23.0	23.0	28.0	28.0	36.0
Intermittent (60 s overload) (3x525–550 V) [A]	17.6	15.4	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (3x551–690 V) [A]	10	13	13.0	18.0	18.0	22.0	22.0	27.0	27.0	34.0
Intermittent (60 s overload) (3x551–690 V) [A]	16	14.3	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous kVA at 550 V [kVA]	10	13.3	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous kVA at 690 V kVA]	12	15.5	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
Maximum input current										
Continuous at 550 V [A]	9.9	15	15.0	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) at 550 V [A]	15.8	16.5	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Continuous (at 690 V) [A]	9	14.5	14.5	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) at 690 V [A]	14.4	16	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Additional specifications										
Maximum cable cross–section[2] for mains, motor, brake, and load sharing [mm² (AWG)]	35, 25, 25 (2, 4, 4)									
Maximum cable cross–section[2)] for mains disconnect [mm² (AWG)]	16,10,10 (6, 8, 8)									
Estimated power loss[3)] at rated maximum load [W (hp)][4)]	150 (0.2)	220 (0.3)	150 (0.2)	220 (0.3)	220 (0.3)	300 (0.41)	300 (0.41)	370 (0.5)	370 (0.5)	440 (0.6)
Efficiency[5)]	0.98		0.98		0.98		0.98		0.98	

Table 8.16 B2/B4 Enclosure, Mains Supply 3x525–690 V AC IP20/IP21/IP55 – Chassis/NEMA 1/NEMA 12, P11K–P22K

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Type designation	P37K		P45K		P55K		P75K/N75K[8]		P90K/N90K[8]	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	22	30	30	37	37	45	45	55	55	75
Typical shaft output at 550 V [hp]	30	40	40	50	50	60	60	75	75	100
Typical shaft output at 690 V [kW]	30	37	37	45	45	55	55	75	75	90
Typical shaft output at 690 V [hp]	40	50	50	60	60	75	75	100	199	125
IP20/Chassis	B4		C3		C3		D3h		D3h	
IP21/Type 1 IP55/Type 12	C2		C2		C2		C2		C2	
Output current										
Continuous (3x525–550 V) [A]	36.0	43.0	43.0	54.0	54.0	65.0	65.0	87.0	87.0	105
Intermittent (60 s overload) (3x525–550 V) [A]	54.0	47.3	64.5	59.4	81.0	71.5	97.5	95.7	130.5	115.5
Continuous (3x551–690 V) [A]	34.0	41.0	41.0	52.0	52.0	62.0	62.0	83.0	83.0	100
Intermittent (60 s overload) (3x551–690 V) [A]	51.0	45.1	61.5	57.2	78.0	68.2	93.0	91.3	124.5	110
Continuous kVA at 550 V [kVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100
Continuous kVA at 690 V [kVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
Maximum input current										
Continuous at 550 V [A]	36.0	49.0	49.0	59.0	59.0	71.0	71.0	87.0	87.0	99.0
Intermittent (60 s overload) at 550 V [A]	54.0	53.9	72.0	64.9	87.0	78.1	105.0	95.7	129	108.9
Continuous at 690 V [A]	36.0	48.0	48.0	58.0	58.0	70.0	70.0	86.0	–	–
Intermittent (60 s overload) at 690 V [A]	54.0	52.8	72.0	63.8	87.0	77.0	105	94.6	–	–
Additional specifications										
Maximum cable cross-section for mains and motor [mm² (AWG)]	150 (300 MCM)									
Maximum cable cross-section for brake and load sharing [mm² (AWG)]	95 (3/0)									
Maximum cable cross-section[2] for mains disconnect [mm² (AWG)]	95 (3/0)						185, 150, 120 (350 MCM, 300 MCM, 4/0)		–	
Estimated power loss[3] at rated maximum load [W (hp)][4]	600 (0.82)	740 (1)	740 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1500 (2)	1500 (2)	1800 (2.5)
Efficiency[5]	0.98		0.98		0.98		0.98		0.98	

Table 8.17 B4, C2, C3 Enclosure, Mains Supply 3x525–690 V AC IP20/IP21/IP55 – Chassis/NEMA1/NEMA 12, P30K–P75K

For fuse ratings see chapter 8.8 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

3) Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598–2, refer to www.danfoss.com/vltenergyefficiency.

4) Efficiency measured at nominal current. For energy efficiency class see chapter 8.4.1 Ambient Conditions. For part load losses see www.danfoss.com/vltenergyefficiency.

5) Measured using 5 m (16 ft) shielded motor cables at rated load and rated frequency.

6) Enclosure sizes A2+A3 can be converted to IP21 using a conversion kit. See also chapters Mechanical mounting and IP21/Type 1 Enclosure kit in the design guide.

7) Enclosure sizes B3+B4 and C3+C4 can be converted to IP21 using a conversion kit. See also chapters Mechanical mounting and IP21/Type 1 Enclosure kit in the design guide.

8) Enclosure sizes for N75K, N90K are D3h for IP20/Chassis, and D5h for IP54/Type 12.

9) Two wires are required.

10) Variant not available in IP21.

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8.2 Mains Supply

Mains supply (L1, L2, L3)	
Supply voltage	200–240 V ±10%
Supply voltage	380–480 V ±10%
Supply voltage	525–600 V ±10%
Supply voltage	525–690 V ±10%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the frequency converter continues until the DC-link voltage drops below the minimum stop level. Typically, this corresponds to 15% below the lowest rated supply voltage of the frequency converter. Power-up and full torque cannot be expected at mains voltage <10% below the lowest rated supply voltage of the frequency converter.

Supply frequency	50/60 Hz +4/-6%

The frequency converter power supply is tested in accordance with IEC61000-4-28, 50 Hz +4/-6%.

Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cosφ) near unity	(>0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤7.5 kW (10 hp)	Maximum 2 times/minute
Switching on input supply L1, L2, L3 (power-ups) 11–90 kW (15–125 hp)	Maximum 1 time/minute
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/480/600/690 V maximum.

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8.3 Motor Output and Motor Data

Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1)]
Switching on output	Unlimited
Ramp times	1–3600 s

1) Dependent on power size.

Torque characteristics, normal overload	
Starting torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes[2)]
Overload torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes[2)]

Torque characteristics, high overload	
Starting torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes[2)]
Overload torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes[2)]

2) Percentage relates to the nominal torque of the frequency converter, dependent on power size.

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8.4 Ambient Conditions

Environment	
Enclosure size A	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size B1/B2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size B3/B4	IP20/Chassis
Enclosure size C1/C2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure size C3/C4	IP20/Chassis
Enclosure kit available ≤ enclosure size A	IP21/TYPE 1/IP4X top
Vibration test enclosure A/B/C	1.0 g
Maximum relative humidity	5–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated	Class 3C2
Aggressive environment (IEC 721-3-3), coated	Class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	Maximum 50 °C (122 °F)

Derating for high ambient temperature, see chapter Special Conditions in the design guide.

Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to 149/158 °F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)

Derating for high altitude, see chapter Special Conditions in the design guide.

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[1)]	IE2

1) Determined according to EN50598-2 at:

- *Rated load.*
- *90% rated frequency.*
- *Switching frequency factory setting.*
- *Switching pattern factory setting.*

8.5 Cable Specifications

Maximum motor cable length, shielded/armored	150 m (492 ft)
Maximum motor cable length, unshielded/unarmored	300 m (984 ft)
Maximum cross-section to motor, mains, load sharing, and brake[1)]	
Maximum cross-section to control terminals, rigid wire	1.5 mm^2 or 2 x 0.75 mm^2 (16 AWG)
Maximum cross-section to control terminals, flexible cable	1 mm^2 (18 AWG)
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm^2 (20 AWG)
Minimum cross-section to control terminals	0.25 mm^2 (24 AWG)

1) See electrical data tables in chapter 8.1 Electrical Data for more information.

It is mandatory to ground the mains connection properly using T95 (PE) of the frequency converter. The ground connection cable cross-section must be at least 10 mm^2 (8 AWG) or 2 rated mains wires terminated separately according to EN 50178. See also*chapter 4.3.1 Grounding* . Use unshielded cable.

8.6 Control Input/Output and Control Data

Control card, RS485 serial communication	
Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

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Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switches S201 and S202
Voltage mode	Switch S201/S202 = OFF (U)
Voltage level	0–10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/S202=On (I)
Current level	0/4-20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	200 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

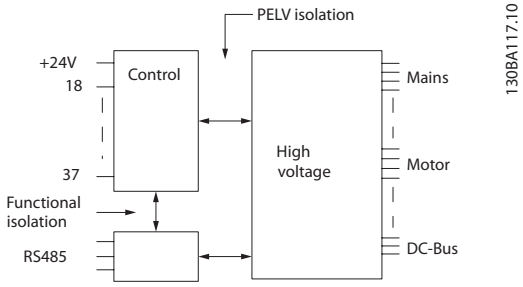

Illustration 8.1 PELV Isolation of Analog Inputs

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Maximum resistor load to common at analog output	500 Ω
Accuracy on analog output	Maximum error 0.8% of full scale
Resolution on analog output	8 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27[1)], 29[1)], 32, 33,
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

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Digital output	
Programmable digital/pulse outputs	2
Terminal number	27, 29[1)]
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33	110 kHz (push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	See *Digital inputs*
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error 0.1% of full scale

Control card, 24 V DC output	
Terminal number	12, 13
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs	
Programmable relay outputs	2
Relay 01 terminal number	1-3 (break), 1-2 (make)
Maximum terminal load (AC-1)[1)] on 1-3 (NC), 1-2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1-2 (NO), 1-3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1)] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4-6 (break), 4-5 (make)
Maximum terminal load (AC-1)[1)] on 4-5 (NO) (resistive load)[2) 3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4-5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4-5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4-5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 4-6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4-6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4-6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4-6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC, 10 mA, 24 V AC, 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 parts 4 and 5.

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

2) Overvoltage category II.

3) UL applications 300 V AC 2 A.

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Control card, 10 V DC output	
Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control characteristics	
Resolution of output frequency at 0–590 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: Maximum error of ±8 RPM

All control characteristics are based on a 4-pole asynchronous motor.

Control card performance	
Scan interval	5 ms

Control card, USB serial communication	
USB standard	1.1 (full speed)
USB plug	USB type B "device" plug

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NOTICE

Connection to a PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB connection is not galvanically isolated from protective earth. Use only an isolated laptop/PC as a connection to the USB connector on the frequency converter, or an isolated USB cable/converter.

8.7 Connection Tightening Torques

	Torque [N•m (in-lb)]					
Enclosure	**Mains**	**Motor**	**DC connection**	**Brake**	**Ground**	**Ground**
A2	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A3	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A4	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
A5	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
B1	1.8 (16)	1.8 (16)	1.5 (13)	1.5 (13.3)	3 (27)	0.6 (5)
B2	4.5 (40)	4.5 (40)	3.7 (33)	3.7 (33)	3 (27)	0.6 (5)
B3	1.8 (16)	1.8 (16)	1.8 (16)	1.8 (16)	3 (27)	0.6 (5)
B4	4.5 (40)	4.5 (40)	4.5 (40)	4.5 (40)	3 (27)	0.6 (5)
C1	10 (89)	10 (89)	10 (89)	10 (89)	3 (27)	0.6 (5)
C2	14/24 (124/221)[1)]	14/24 (124/221)[1)]	14 (124)	14 (124)	3 (27)	0.6 (5)
C3	10 (89)	10 (89)	10 (89)	10 (89)	3 (27)	0.6 (5)
C4	14/24 (124/221)[1)]	14/24 (124/221)[1)]	14 (124)	14 (124)	3 (27)	0.6 (5)

Table 8.18 Terminal Tightening Torques

1) For different cable dimensions x/y, where x≤95 mm^2 (3 AWG) and y≥95 mm^2 (3 AWG).

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8.8 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (first fault).

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Recommendations

- gG type fuses.
- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the frequency converter is equal to or lower than the energy provided by Moeller types.

Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damage inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *chapter 8.8.1 CE Compliance* to *chapter 8.8.2 UL Compliance* are suitable for use on a circuit capable of delivering 100000 A_{rms} (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 A_{rms}.

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8.8.1 CE Compliance

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0.25–2.2 (0.34–3)	gG-10 (0.25–1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	3.0–3.7 (4–5)	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
A4	0.25–2.2 (0.34–3)	gG-10 (0.25–1.5) gG-16 (2.2)	gG-32	PKZM0-25	25
A5	0.25–3.7 (0.34–5)	gG-10 (0.25–1.5) gG-16 (2.2–3) gG-20 (3.7)	gG-32	PKZM0-25	25
B1	5.5–11 (7.5–15)	gG-25 (5.5) gG-32 (7.5)	gG-80	PKZM4-63	63
B2	15 (20)	gG-50	gG-100	NZMB1-A100	100
B3	5.5–11 (7.5–15)	gG-25	gG-63	PKZM4-50	50
B4	15–18 (20–24)	gG-32 (7.5) gG-50 (11) gG-63 (15)	gG-125	NZMB1-A100	100
C1	18.5–30 (25–40)	gG-63 (15) gG-80 (18.5) gG-100 (22)	gG-160 (15–18.5) aR-160 (22)	NZMB2-A200	160
C2	37–45 (50–60)	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250
C3	22–30 (30–40)	gG-80 (18.5) aR-125 (22)	gG-150 (18.5) aR-160 (22)	NZMB2-A200	150
C4	37–45 (50–60)	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250

Table 8.19 200–240 V, Enclosure Sizes A, B, and C

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Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–4.0 (1.5–5)	gG-10 (0.37-3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5–7.5 (7.5–10)	gG-16	gG-32	PKZM0-25	25
A4	1.1–4.0 (1.5–5)	gG-10 (0.37-3) gG-16 (4)	gG-32	PKZM0-25	25
A5	1.1–7.5 (1.5–10)	gG-10 (0.37-3) gG-16 (4-7.5)	gG-32	PKZM0-25	25
B1	11–18.5 (15–25)	gG-40	gG-80	PKZM4-63	63
B2	22–30 (30–40)	gG-50 (18.5) gG-63 (22)	gG-100	NZMB1-A100	100
B3	11–18 (15–24)	gG-40	gG-63	PKZM4-50	50
B4	22–37 (30–50)	gG-50 (18.5) gG-63 (22) gG-80 (30)	gG-125	NZMB1-A100	100
C1	37–55 (50–75)	gG-80 (30) gG-100 (37) gG-160 (45)	gG-160	NZMB2-A200	160
C2	75–90 (100–125)	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
C3	45–55 (60–75)	gG-100 (37) gG-160 (45)	gG-150 (37) gG-160 (45)	NZMB2-A200	150
C4	75–90 (100–125)	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250

Table 8.20 380–480 V, Enclosure Sizes A, B, and C

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Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–4.0 (1.5–5)	gG-10	gG-25	PKZM0-25	25
A3	5.5–7.5 (7.5–10)	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
A5	1.1–7.5 (1.5–10)	gG-10 (0.75-5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11–18 (15–24)	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22–30 (30–40)	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
B3	11–18.5 (15–25)	gG-25 (11) gG-32 (15)	gG-63	PKZM4-50	50
B4	22–37 (30–50)	gG-40 (18.5) gG-50 (22) gG-63 (30)	gG-125	NZMB1-A100	100
C1	37–55 (50–75)	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37-45) aR-250 (55)	NZMB2-A200	160
C2	75–90 (100–125)	aR-200 (75)	aR-250	NZMB2-A250	250
C3	45–55 (60–75)	gG-63 (37) gG-100 (45)	gG-150	NZMB2-A200	150
C4	75–90 (100–125)	aR-160 (55) aR-200 (75)	aR-250	NZMB2-A250	250

Table 8.21 525–600 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Danfoss	Maximum trip level [A]
A3	1.1 (1.5)	gG-6	gG-25	CTI25M 10-16	16
	1.5 (2)	gG-6	gG-25	CTI25M 10-16	16
	2.2 (3)	gG-6	gG-25	CTI25M 10-16	16
	3 (4)	gG-10	gG-25	CTI25M 10-16	16
	4 (5)	gG-10	gG-25	CTI25M 10-16	16
	5.5 (7.5)	gG-16	gG-25	CTI25M 10-16	16
	7.5 (10)	gG-16	gG-25	CTI25M 10-16	16
B2	11 (15)	gG-25	gG-63	–	–
	15 (20)	gG-25	gG-63	–	–
	18 (24)	gG-32	–	–	–
	22 (30)	gG-32	–	–	–
C2	30 (40)	gG-40	–	–	–
	37 (50)	gG-63	gG-80	–	–
	45 (60)	gG-63	gG-100	–	–
	55 (75)	gG-80	gG-125	–	–
	75 (100)	gG-100	gG-160	–	–
C3	37 (50)	gG-100	gG-125	–	–
	45 (60)	gG-125	gG-160	–	–

Table 8.22 525–690 V, Enclosure Sizes A, B, and C

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8.8.2 UL Compliance

Recommended maximum fuse													
Power [kW (hp)]	Maximum prefuse size [A]	Bussmann JFHR2	Bussmann RK1	Bussmann J	Bussmann T	Bussmann CC	Bussmann CC	Bussmann CC	SIBA RK1	Littelfuse RK1	Ferraz-Shawmut CC	Ferraz-Shawmut RK1	Ferraz-Shawmut J
1.1 (1.5)	15	FWX-15	KTN-R15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLN-R15	ATM-R15	A2K-15R	HSJ15
1.5 (2)	20	FWX-20	KTN-R20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLN-R20	ATM-R20	A2K-20R	HSJ20
2.2 (3)	30[1)]	FWX-30	KTN-R30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30	5012406-032	KLN-R30	ATM-R30	A2K-30R	HSJ30
3.0 (4)	35	FWX-35	KTN-R35	JKS-35	JJN-35	–	–	–	–	KLN-R35	–	A2K-35R	HSJ35
3.7 (5)	50	FWX-50	KTN-R50	JKS-50	JJN-50	–	–	–	5014006-050	KLN-R50	–	A2K-50R	HSJ50
5.5 (7.5)	60[2)]	FWX-60	KTN-R60	JKS-60	JJN-60	–	–	–	5014006-063	KLN-R60	–	A2K-60R	HSJ60
7.5 (10)	80	FWX-80	KTN-R80	JKS-80	JJN-80	–	–	–	5014006-080	KLN-R80	–	A2K-80R	HSJ80
15 (20)	150	FWX-150	KTN-R150	JKS-150	JJN-150	–	–	–	2028220-150	KLN-R150	–	A2K-150R	HSJ150
22 (30)	200	FWX-200	KTN-R200	JKS-200	JJN-200	–	–	–	2028220-200	KLN-R200	–	A2K-200R	HSJ200

Table 8.23 1x200–240 V, Enclosure Sizes A, B, and C

1) Siba allowed up to 32 A.

2) Siba allowed up to 63 A.

Recommended maximum fuse													
Power [kW (hp)]	Maximum prefuse size [A]	Bussmann JFHR2	Bussmann RK1	Bussmann J	Bussmann T	Bussmann CC	Bussmann CC	Bussmann CC	SIBA RK1	Littelfuse RK1	Ferraz-Shawmut CC	Ferraz-Shawmut RK1	Ferraz-Shawmut J
7.5 (10)	60	FWH-60	KTS-R60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R60	–	A6K-60R	HSJ60
11 (15)	80	FWH-80	KTS-R80	JKS-80	JJS-80	–	–	–	2028220-100	KLS-R80	–	A6K-80R	HSJ80
22 (30)	150	FWH-150	KTS-R150	JKS-150	JJS-150	–	–	–	2028220-160	KLS-R150	–	A6K-150R	HSJ150
37 (50)	200	FWH-200	KTS-R200	JKS-200	JJS-200	–	–	–	2028220-200	KLS-200	–	A6K-200R	HSJ200

Table 8.24 1x380–500 V, Enclosure Sizes B and C

- *KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.*
- *FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.*
- *JJS-fuses from Bussmann may substitute JJN for 240 V frequency converters.*
- *KLSR fuses from Littelfuse may substitute KLNR fuses for 240 V frequency converters.*
- *A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V frequency converters.*

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	Recommended maximum fuse					
Power [kW (hp)]	Bussmann Type RK1 [1]	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann	Bussmann Type CC
0.25–0.37 (0.34–0.5)	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.55–1.1 (0.75–1.5)	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5 (2)	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2 (3)	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0 (4)	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7 (5)	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5–7.5 (7.5–10)	KTN-R-50	JKS-50	JJN-50	–	–	–
11 (15)	KTN-R-60	JKS-60	JJN-60	–	–	–
15 (20)	KTN-R-80	JKS-80	JJN-80	–	–	–
18.5–22 (25–30)	KTN-R-125	JKS-125	JJN-125	–	–	–
30 (40)	KTN-R-150	JKS-150	JJN-150	–	–	–
37 (50)	KTN-R-200	JKS-200	JJN-200	–	–	–
45 (60)	KTN-R-250	JKS-250	JJN-250	–	–	–

Table 8.25 3x200–240 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1[2]	Bussmann Type JFHR2[3]	Littelfuse JFHR2	Ferraz-Shawmut JFHR2[4]	Ferraz-Shawmut J
0.25–0.37 (0.34–0.5)	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	–	–	HSJ-6
0.55–1.1 (0.75–1.5)	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	–	–	HSJ-10
1.5 (2)	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	–	–	HSJ-15
2.2 (3)	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	–	–	HSJ-20
3.0 (4)	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	–	–	HSJ-25
3.7 (5)	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	–	–	HSJ-30
5.5–7.5 (7.5–10)	5014006-050	KLN-R-50	–	A2K-50-R	FWX-50	–	–	HSJ-50
11 (15)	5014006-063	KLN-R-60	–	A2K-60-R	FWX-60	–	–	HSJ-60
15 (20)	5014006-080	KLN-R-80	–	A2K-80-R	FWX-80	–	–	HSJ-80
18.5–22 (25–30)	2028220-125	KLN-R-125	–	A2K-125-R	FWX-125	–	–	HSJ-125
30 (40)	2028220-150	KLN-R-150	–	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
37 (50)	2028220-200	KLN-R-200	–	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
45 (60)	2028220-250	KLN-R-250	–	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.26 3x200–240 V, Enclosure Sizes A, B, and C

1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.

2) A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V frequency converters.

3) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.

4) A50X fuses from Ferraz-Shawmut may substitute A25X for 240 V frequency converters.

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	Recommended maximum fuse					
Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
–	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.1–2.2 (1.5–3)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3 (4)	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4 (5)	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 (10)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11 (15)	KTS-R-40	JKS-40	JJS-40	–	–	–
15 (20)	KTS-R-50	JKS-50	JJS-50	–	–	–
22 (30)	KTS-R-60	JKS-60	JJS-60	–	–	–
30 (40)	KTS-R-80	JKS-80	JJS-80	–	–	–
37 (50)	KTS-R-100	JKS-100	JJS-100	–	–	–
45 (60)	KTS-R-125	JKS-125	JJS-125	–	–	–
55 (75)	KTS-R-150	JKS-150	JJS-150	–	–	–
75 (100)	KTS-R-200	JKS-200	JJS-200	–	–	–
90 (125)	KTS-R-250	JKS-250	JJS-250	–	–	–

Table 8.27 3x380–480 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1	Bussmann JFHR2	Ferraz-Shawmut J	Ferraz-Shawmut JFHR2[1)]	Littelfuse JFHR2
–	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	–	–
1.1–2.2 (1.5–3)	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	–	–
3 (4)	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	–	–
4 (5)	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	–	–
5.5 (7.5)	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	–	–
7.5 (10)	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	–	–
11 (15)	5014006-040	KLS-R-40	–	A6K-40-R	FWH-40	HSJ-40	–	–
15 (20)	5014006-050	KLS-R-50	–	A6K-50-R	FWH-50	HSJ-50	–	–
22 (30)	5014006-063	KLS-R-60	–	A6K-60-R	FWH-60	HSJ-60	–	–
30 (40)	2028220-100	KLS-R-80	–	A6K-80-R	FWH-80	HSJ-80	–	–
37 (50)	2028220-125	KLS-R-100	–	A6K-100-R	FWH-100	HSJ-100	–	–
45 (60)	2028220-125	KLS-R-125	–	A6K-125-R	FWH-125	HSJ-125	–	–
55 (75)	2028220-160	KLS-R-150	–	A6K-150-R	FWH-150	HSJ-150	–	–
75 (100)	2028220-200	KLS-R-200	–	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
90 (125)	2028220-250	KLS-R-250	–	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.28 3x380–480 V, Enclosure Sizes A, B, and C

1) Ferraz-Shawmut A50QS fuses may substitute A50P fuses.

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	Recommended maximum fuse									
Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC	SIBA Type RK1	Littelfuse Type RK1	Ferraz-Shawmut Type RK1	Ferraz-Shawmut J
0.75–1.1 (1–1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2 (2–3)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3 (4)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4 (5)	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5 (10)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11–15 (15–20)	KTS-R-35	JKS-35	JJS-35	–	–	–	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
18 (24)	KTS-R-45	JKS-45	JJS-45	–	–	–	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
22 (30)	KTS-R-50	JKS-50	JJS-50	–	–	–	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
30 (40)	KTS-R-60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
37 (50)	KTS-R-80	JKS-80	JJS-80	–	–	–	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
45 (60)	KTS-R-100	JKS-100	JJS-100	–	–	–	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
55 (75)	KTS-R-125	JKS-125	JJS-125	–	–	–	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
75 (100)	KTS-R-150	JKS-150	JJS-150	–	–	–	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
90 (125)	KTS-R-175	JKS-175	JJS-175	–	–	–	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 8.29 3x525–600 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power [kW (hp)]	Maximum pre-fuse [A]	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	Littelfuse E81895 RK1/JDDZ	Ferraz-Shawmut E163267/E2137 RK1/JDDZ	Ferraz-Shawmut E2137 J/HSJ
11–15 (15–20)	30	KTS-R-30	JKS-30	JJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
22 (30)	45	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
30 (40)	60	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
37 (50)	80	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
45 (60)	90	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
55 (75)	100	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
75 (100)	125	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
90 (125)	150	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.30 3x525–690 V, Enclosure Sizes B and C

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8.9 Power Ratings, Weight, and Dimensions

Enclosure size [kW (hp)]		A2		A3		A4	A5
3x525–690 V	T7	–		–		–	–
3x525–600 V	T6	–		0.75–7.5 (1–10)		–	0.75–7.5 (1–10)
3x380–480 V	T4	0.37–4.0 (0.5–5)		5.5–7.5 (7.5–10)		0.37–4.0 (0.5–5)	0.37–7.5 (0.5–10)
1x380–480 V	S4	–		–		1.1–4.0 (1.5–5)	–
3x200–240 V	T2	0.25–3.0 (0.34–4)		3.7 (0.5)		0.25–2.2 (0.34–3)	0.25–3.7 (0.34–5)
1x200–240 V	S2	–		1.1 (1.5)		1.1–2.2 (1.5–3)	1.1 (1.5)
IP NEMA		20 Chassis	21 Type 1	20 Chassis	21 Type 1	55/66 Type 12/4X	55/66 Type 12/4X
Height [mm (in)]							
Height of backplate	A[1)]	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with de-coupling plate for fieldbus cables	A	374 (14.7)	–	374 (14.7)	–	–	–
Distance between mounting holes	a	257 (10.1)	350 (13.8)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)
Width [mm (in)]							
Width of backplate	B	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of backplate with 1 C option	B	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of backplate with 2 C options	B	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	–	242 (9.5)
Distance between mounting holes	b	70 (2.8)	70 (2.8)	110 (4.3)	110 (4.3)	171 (6.7)	215 (8.5)
Depth[2)] [mm (in)]							
Without option A/B	C	205 (8.1)	205 (8.1)	205 (8.1)	205 (8.1)	175 (6.9)	200 (7.9)
With option A/B	C	220 (8.7)	220 (8.7)	220 (8.7)	220 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]							
	c	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.2 (0.32)
	d	ø11 (0.43)	ø11 (0.43)	ø11 (0.43)	ø11 (0.43)	ø12 (0.47)	ø12 (0.47)
	e	ø5.5 (0.22)	ø5.5 (0.22)	ø5.5 (0.22)	ø5.5 (0.22)	ø6.5 (0.26)	ø6.5 (0.26)
	f	9 (0.35)	9 (0.35)	9 (0.35)	9 (0.35)	6 (0.24)	9 (0.35)
Maximum weight [kg (lb)]		4.9 (10.8)	5.3 (11.7)	6.6 (14.6)	7 (15.4)	9.7 (21.4)	14 (31)

1) See *Illustration 3.4* and *Illustration 3.5* for top and bottom mounting holes.
2) Depth of enclosure varies with different options installed.

Table 8.31 Power Ratings, Weight, and Dimensions, Enclosure Sizes A2-A5

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Enclosure size [kW (hp)]		B1	B2	B3	B4	C1	C2	C3	C4
3x525–690 V	T7	–	11–30 (15–40)	–	–	–	37–90 (50–125)	–	–
3x525–600 V	T6	11–18.5 (15–25)	22–30 (30–40)	11–18.5 (15–25)	22–37 (30–50)	37–55 (50–75)	75–90 (100–125)	45–55 (60–75)	75–90 (100–125)
3x380–480 V	T4	11–18.5 (15–25)	22–30 (30–40)	11–18.5 (15–25)	22–37 (30–50)	37–55 (50–75)	75–90 (100–125)	45–55 (60–75)	75–90 (100–125)
1x380–480 V	S4	7.5 (10)	11 (15)	–	–	18 (24)	37 (50)	–	–
3x200–240 V	T2	5.5–11 (7.5–15)	15 (20)	5.5–11 (7.5–15)	15–18.5 (20–25)	18.5–30 (25–40)	37–45 (50–60)	22–30 (30–40)	37–45 (50–60)
1x200–240 V	S2	1.5–3.7 (2–5)	7.5 (10)	–	–	15 (20)	22 (30)	–	–
IP NEMA		21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis
Height [mm (in)]									
Height of backplate	A[1)]	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)
Height with de-coupling plate for fieldbus cables	A	–	–	419 (16.5)	595 (23.4)	–	–	630 (24.8)	800 (31.5)
Distance between mounting holes	a	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)
Width [mm (in)]									
Width of backplate	B	242 (9.5)	242 (9.5)	165 (6.5)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of backplate with 1 C option	B	242 (9.5)	242 (9.5)	205 (8.1)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of backplate with 2 C options	B	242 (9.5)	242 (9.5)	165 (6.5)	231 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Distance between mounting holes	b	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)
Depth[2)][mm (in)]									
Without option A/B	C	260 (10.2)	260 (10.2)	248 (9.8)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
With option A/B	C	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
Screw holes [mm (in)]									
	c	12 (0.47)	12 (0.47)	8 (0.32)	–	12 (0.47)	12 (0.47)	–	–
	d	ø19 (0.75)	ø19 (0.75)	12 (0.47)	–	ø19 (0.75)	ø19 (0.75)	–	–
	e	ø9 (0.35)	ø9 (0.35)	6.8 (0.27)	8.5 (0.33)	ø9 (0.35)	ø9 (0.35)	8.5 (0.33)	8.5 (0.33)
	f	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)
Maximum weight [kg (lb)]		23 (51)	27 (60)	12 (26.5)	23.5 (52)	45 (99)	65 (143)	35 (77)	50 (110)

1) See *Illustration 3.4* and *Illustration 3.5* for top and bottom mounting holes.
2) Depth of enclosure varies with different options installed.

Table 8.32 Power Ratings, Weight, and Dimensions, Enclosure Sizes B1–B4, C1–C4

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9 Appendix

9.1 Symbols, Abbreviations, and Conventions

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM Motor	Permanent magnet motor
PWM	Pulse width modulation
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 9.1 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures. Bullet lists indicate other information.

Italicized text indicates:

- Cross-reference.
- Link.
- Parameter name.
- Parameter group name.
- Parameter option.
- Footnote.

All dimensions in drawings are in [mm] (in).

9.2 Parameter Menu Structure

NOTICE

The availability of some parameters depends on the hardware configuration (installed options and power rating).

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0-	**Operation / Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups / Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Password Access
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1-	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-03	Torque Characteristics
1-04	Overload Mode
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM/SYN RM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-33	Stator Leakage Reactance (X1)
1-34	Rotor Leakage Reactance (X2)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-38	q-axis Inductance (Lq)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-44	d-axis Inductance Sat. (LdSat)
1-45	q-axis Inductance Sat. (LqSat)
1-46	Position Detection Gain
1-47	Torque Calibration
1-48	Inductance Sat. Point
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-55	V/f Characteristic - V
1-56	V/f Characteristic - f
1-58	Flying Start Test Pulses Current
1-59	Flying Start Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Damping
1-65	Resonance Damping Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Pump Start Max Time to Trip
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
1-94	ATEX ETR cur.lim. speed reduction
1-98	ATEX ETR interpol. points freq.
1-99	ATEX ETR interpol points current
2-	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold/Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
3-	**Reference / Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-84	Initial Ramp Time
3-85	Check Valve Ramp Time
3-86	Check Valve Ramp End Speed [RPM]
3-87	Check Valve Ramp End Speed [HZ]
3-88	Final Ramp Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4-	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low
4-53	Warning Speed High
4-54	Warning Reference Low
4-55	Warning Reference High
4-56	Warning Feedback Low
4-57	Warning Feedback High
4-58	Missing Motor Phase Function
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
5-	**Digital In/Out**
5-0*	**Digital I/O mode**
5-00	Digital I/O Mode
5-01	Terminal 27 Mode
5-02	Terminal 29 Mode
5-1*	**Digital Inputs**
5-10	Terminal 18 Digital Input
5-11	Terminal 19 Digital Input
5-12	Terminal 27 Digital Input
5-13	Terminal 29 Digital Input
5-14	Terminal 32 Digital Input
5-15	Terminal 33 Digital Input
5-16	Terminal X30/2 Digital Input
5-17	Terminal X30/3 Digital Input
5-18	Terminal X30/4 Digital Input
5-19	Terminal 37 Digital Input
5-20	Terminal X46/1 Digital Input
5-21	Terminal X46/3 Digital Input
5-22	Terminal X46/5 Digital Input
5-23	Terminal X46/7 Digital Input
5-24	Terminal X46/9 Digital Input
5-25	Terminal X46/11 Digital Input
5-26	Terminal X46/13 Digital Input
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6-	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-1*	**Analog Input 53**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-17	Terminal 53 Live Zero
6-2*	**Analog Input 54**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-27	Terminal 54 Live Zero
6-3*	**Analog Input X30/11**
6-30	Terminal X30/11 Low Voltage

6-31 Terminal X30/11 High Voltage
6-34 Term. X30/11 Low Ref./Feedb. Value
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B-501/2 - Filter, Silencer, Solberg, FS-230P-300

SMALL COMPACT FILTER SILENCERS WITH STANDARD FILTER DESIGN
"FS" Series 1/2" - 3" MPT

APPLICATIONS

- Blowers-PD Type
- Blowers-Side Channel
- Compressor-Piston
- Compressor-Screw
- Construction\Contractor Industry
- Dental
- Engines
- Hydraulic Breathers - fine filtration
- Industrial & Severe Duty
- Medical
- Pneumatic Conveying Systems
- Sparging
- Waste Water Aeration
- Workshop

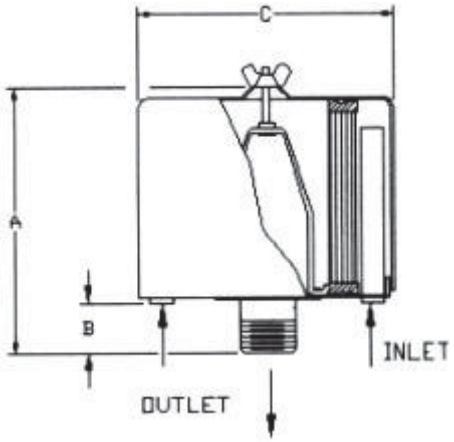
FEATURES & SPECIFICATIONS

- ;99%+ removal efficiency std: Paper=2 micron, Polyester=5 micron
- Durable carbon steel construction with powder coated finish or galvanized steel
- Filter change out differential: 10"-15" in. H_2O above initial delta P
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Interchangeable elements: Polyester, Paper, HEPA
- Low pressure drop center bracket and outlet pipe design
- Pressure drop graphs available upon request
- Temp (continuous): min -15° F (-26° C) max 220° F (104° C)
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Typical noise attenuation up to 15 dB's (due to the wide range of applications and machines these units are used on, a single graph is insufficient. Please inquire for your specific requirement)

OPTIONS

- 1/8" tap holes for differential pressure gauges
- Available in *Stainless Steel*
- Epoxy coated housings
- Hot dipped galvanized housings
- Special connections, BSPT/Metric
- Various elements available

Line Drawing



***All measurements are shown in standards.**

Typical Lead Times:
- Normally in stock
- 1 - 2 weeks
- 5 - 7 weeks
- 3 - 4 weeks
- 8 + weeks

Add To Order	Model Number	Element Type	Outlet in. NPT or FLG	Connection Style	Dim A in.	Dim B in.	Dim C in.	Rated Flow Piston SCFM	Rated Flow Screw Blower Fan SCFM	Element Parent Flow SCFM	Tube Count	Approx. Weight lbs.	CAD
■	FS-15-050	Polyester	0.5	MPT	4	1.5	6	10	10	35	1	1.8	CAD
■	FS-15-075	Polyester	0.75	MPT	4	1.5	6	20	25	35	2	2	CAD
■	FS-15-100	Polyester	1	MPT	4	1.5	6	25	35	35	3	2.1	CAD
■	FS-19P-100	Polyester	1	MPT	6.63	1.5	6	35	55	100	3	3	CAD
■	FS-19P-125	Polyester	1.25	MPT	6.63	1.63	6.1	55	70	100	5	3.3	CAD
■	FS-19P-150	Polyester	1.5	MPT	6.63	1.5	6	70	85	100	5	3.5	CAD

	FS-231P-200	Polyester	2	MPT	12.25	2.25	10	135	135	300	5	14	CAD
	FS-31P-200	Polyester	2	MPT	7.25	2.25	10	85	135	195	5	7.8	CAD
	FS-231P-250	Polyester	2.5	MPT	12.5	2.5	10	195	195	300	9	14.5	CAD
	FS-31P-250	Polyester	2.5	MPT	7.5	2.5	10	100	195	195	5	8.2	CAD
	FS-231P-300	Polyester	3	MPT	13	3	10	200	300	300	9	15	CAD
	FS-14-050	Paper	0.5	MPT	4	1.5	6	10	10	35	1	1.8	CAD
	FS-14-075	Paper	0.75	MPT	4	1.5	6	20	25	35	2	2	CAD
	FS-14-100	Paper	1	MPT	4	1.5	6	25	35	35	3	2.1	CAD
	FS-18P-100	Paper	1	MPT	6.63	1.5	6	35	55	100	3	3	CAD
	FS-18P-125	Paper	1.25	MPT	6.63	1.63	6.1	55	70	100	5	3.3	CAD
	FS-18P-150	Paper	1.5	MPT	6.63	1.5	6	70	85	100	5	3.5	CAD
	FS-230P-200	Paper	2	MPT	12.25	2.25	10	135	135	300	5	14	CAD
	FS-30P-200	Paper	2	MPT	7.25	2.25	10	85	135	195	5	8.2	CAD
	FS-230P-250	Paper	2.5	MPT	12.5	2.5	10	195	195	300	9	14.5	CAD
	FS-30P-250	Paper	2.5	MPT	7.5	2.5	10	100	195	195	5	8.2	CAD
	FS-230P-300	Paper	3	MPT	13	3	10	200	300	300	9	15	CAD

Solberg Mfg.
1151 W. Ardmore Ave.·Itasca, IL 60143·(630)773-1363· Fax: (630)773-0727

SFS_2-2

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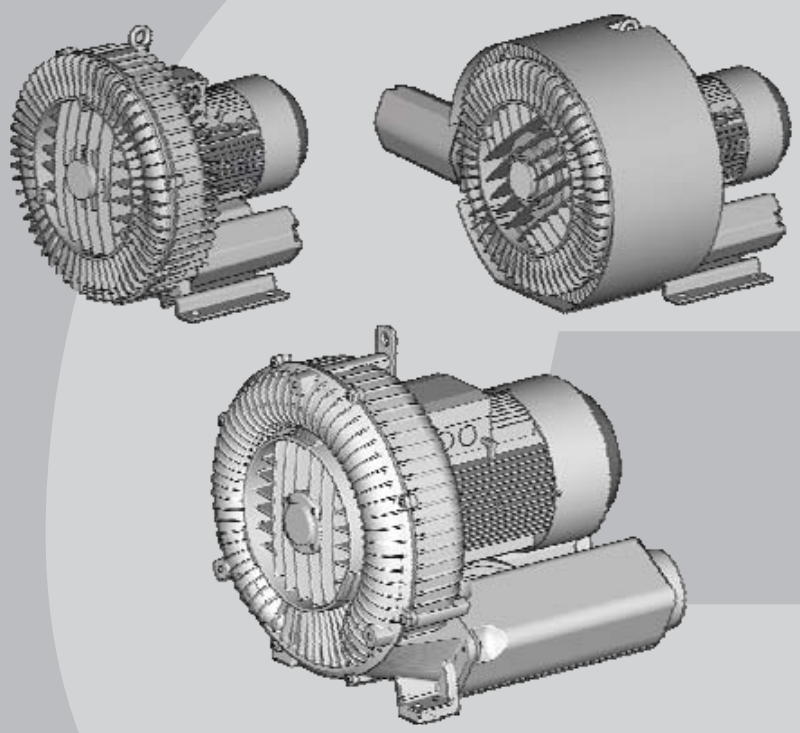
Original operating instructions · English

B601/2 - Blower, Elmo G200 2BH-1510-7HH56-Z

Operating instructions G-BH1, G-BH9

Elmo Rietschle
A Gardner Denver Product

CE



2BH1 1
2BH1 2
2BH1 3
2BH1 4
2BH1 5
2BH1 6
2BH1 8
2BH1 9
2BH9 23

G-Serie
G-Series
Seitenkanal
Side Channel

E-251

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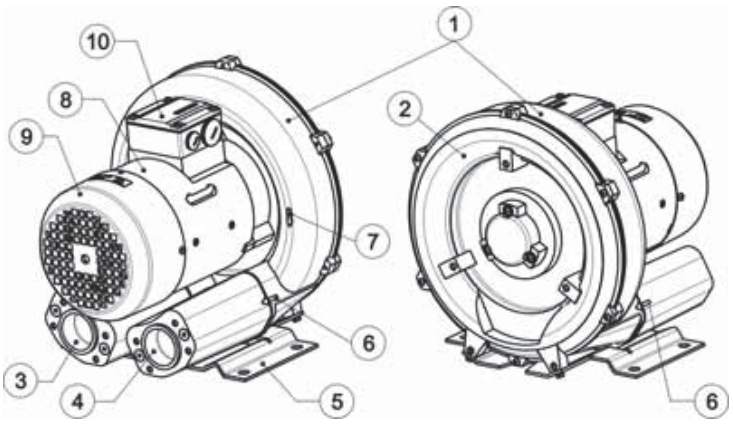

Fig. 1: Design of gas-ring vacuum pump/compressor

1 Vacuum pump/compressor housing
2 Vacuum pump/compressor cover
3 Inlet connection with muffler
4 Discharge connection with muffler
5 Base
6 Arrow indicating delivery direction
7 Arrow indicating direction of rotation
8 Drive motor
9 Fan guard (over external fan)
10 Terminal box

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1 Safety

1.1 Definitions

To point out dangers and important information, the following signal words and symbols are used in these operating instructions:

1.1.1 Safety alert symbol

The **safety alert symbol** ⚠ is located in the safety precautions in the highlighted heading field on the left next to the signal word (DANGER, WARNING, CAUTION).

Safety precautions **with** a safety alert symbol indicate a danger of **injuries**.

Be sure to follow these safety precautions to protect against **injuries or death**!

Safety precautions **without** a safety alert symbol indicate a danger of **damage**.

1.1.2 Signal words

DANGER **WARNING** **CAUTION** **NOTICE** **NOTE**	The **signal words** are located in the safety precautions in the highlighted heading field. They follow a certain hierarchy and indicate (in conjunction with the safety alert symbol, see Chapter 1.1.1) the **seriousness of the danger** and the **type of warning.** See the following explanations:

⚠ DANGER

Danger of injuries.
Indicates an imminently hazardous situation, that **will** result in **death or serious injury** if the corresponding measures are not taken.

⚠ WARNING

Danger of injuries.
Indicates a potentially hazardous situation, that **could** result in **death or serious injury** if the corresponding measures are not taken.

⚠ CAUTION

Danger of injuries.
Indicates a potentially hazardous situation, that may result in **minor or moderate injury** if the corresponding measures are not taken.

CAUTION

Danger of damage.
Indicates a potentially hazardous situation that may result in **property damage** if the corresponding measures are not taken.

NOTICE

Indicates a possible **disadvantage**, i.e. undesirable conditions or consequences can occur if the corresponding measures are not taken.

NOTE

Indicates a possible **advantage** if the corresponding measures are taken; tip.

1.2 General safety precautions

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
These operating instructions

- must have been read completely and understood before beginning any work with or at the pump-motor unit,
- must be strictly observed,
- must be available at the operating location of the pump-motor unit.

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
Only operate the pump-motor unit

- for the purposes indicated under "Intended Use"!
- with the fluids indicated under 'Intended Use'!
- with the values indicated under 'Technical Data'!

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
All work on and with the pump-motor unit (transport, installation, operation, shut-down, maintenance, disposal) may only be carried out by **trained, reliable expert personnel**!

⚠ WARNING

When working on the unit, there is a danger of injury, e.g. in the form of cuts/cutting off, crushing and burns!
During all work on and with the pump-motor unit (transport, installation, operation, shut-down, maintenance, disposal) wear **personal safety equipment (safety helmet, protective gloves, safety shoes)**!

⚠ WARNING

Hair and clothing can be pulled into the unit or caught and wound up moving parts!
Do not wear long, loose hair or wide, loose clothes! Use a hair net!

⚠ DANGER

Electrical danger!
Work on electrical installations may be carried out by trained and authorized electricians only!

⚠ DANGER

Electrical danger!
Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

⚠ DANGER

Electrical danger!
Do not open the motor terminal box until absence of electricity has been ensured!

⚠ WARNING

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries),
sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!
Use mounting elements, connections, lines, fittings and containers with sufficient freedom from leaks and strength for the pressures which occur.

Check the mounting elements, connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals!

⚠ WARNING

Danger from rotating parts (external fan, impeller, shaft):
Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!
Start-up and operation only under the following conditions:

- The pump-motor unit must be completely assembled. When doing so, pay particular attention to the following components:
  - the vacuum pump/compressor cover,
  - the muffler on inlet and discharge connections,
  - the fan guard.
- The pipes/hoses must be connected to inlet and discharge connections.
- Inlet and discharge connections and the connected pipes/hoses may not be closed, clogged or soiled.
- Check the mounting elements, connections of the pipe/hose connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals.

⚠ WARNING

Danger from rotating parts (external fan, impeller, shaft):
Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!
Before beginning work on the pump-motor unit, take the following measures:

- Shut down pump-motor unit and secure against being switched on again.
- Attach a sign on the system controller and on the control elements for the pump-motor unit: "DANGER! Maintenance work on vacuum pump/compressor! Do not switch on!"
- Wait for pump-motor unit to come to a complete stop. Observe run-on time!
- Allow pump-motor unit to cool!
- Shut-off lines. Release pressure.
- Make sure that no vacuum or gauge pressure is present in the lines/tanks to be opened.
- Make sure that no fluids can escape.

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⚠ WARNING

Danger from rotating impeller:
Cutting/cutting of off extremities!
The rotating impeller is accessible with the inlet and discharge connections open!

Do not reach into the unit through open connections!

Do not insert objects into the unit through the openings!

⚠ WARNING

Danger from rotating impeller:
Cutting/cutting of off extremities!
The rotating impeller is accessible with the inlet and discharge connections open!

With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, the following therefore applies:

Provide the inlet and discharge connections of the pump-motor unit either with additional mufflers or with additional piping of a sufficient length to prevent access to the impeller!

⚠ WARNING

Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!
High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover). Do not touch during operation!
Allow to cool after shut-down!

1.3 Residual risks

⚠ WARNING

Danger zone:
Hot surface up to approx. 160°C [320°F].

Hazard:
Possible burns.

Protective measures:
Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover).

⚠ WARNING

Danger zone:
Fan guard

Hazard:
Long, loose hair can be drawn into external fan through fan guard grate, even with fan guard mounted!

Protective measures:
Wear hair net!

⚠ WARNING

Danger zone:
Missing or defective muffler inlet or discharge connection.

Hazard:
Possible serious hearing damage due to emitted noise.

Protective measures:
Have missing or defective mufflers replaced. Conduct a noise measurement in the system after installing the pump-motor unit. The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.

⚠ WARNING

Danger zone:
Environment of pump-motor unit.

Hazard:
Possible serious hearing damage due to emitted noise.

Protective measures:
Conduct a noise measurement in the system during operation after installing the pump-motor unit.

The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.
- With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, attach an additional muffler.

2 Intended Use

This operating manual

- is intended for side channel compressors of the
  G-BH1 and G-BH9 series, types 2BH1 1 2BH1 2 2BH1 3 2BH1 4 2BH1 5 2BH1 6 2BH1 8 2BH1 9 2BH9 23,
- contains instructions bearing on transport and handling, installation, commissioning, operation, shut-down, storage, servicing and disposal of the G-BH1,G-BH9,
- must be completely read and understood by all operating and servicing personnel before beginning to work with or on the G-BH1, G-BH9,
- must be strictly observed,
- must be available at the site of operation of the G-BH1, G-BH9.

About the operating and servicing personnel of the G-BH1, G-BH9

- These persons must be trained and authorized for the work to be carried out.
- Work on electrical installations may be carried out by trained and authorized electricians only.

The G-BH1,G-BH9

- are pump-motor units for generating vacuum or gauge pressure;
- are used to **extract**, **pump** and **compress the following gases**:
  - Air,
  - Non-flammable, non-aggressive, non-toxic and non-explosive gases or gas-air mixtures.
  - With differing gases/gas-air mixtures, inquire with the Service Department.
- are equipped with one of the following kind of drive motors:
  - 3-phase AC drive motor with a standard or explosion-protected design
  - Single-phase AC drive motor

  These operating instructions apply **only to** pump-motor units with a **standard design**. For an explosion-protected design (EEx e II), see the separate operating instructions.
- are intended for industrial applications,
- are designed for continuous operation. With increased switch-on frequency (6x per hour with equal pauses and operating times) or with increased gas inflow and ambient temperature, the excess temperature limit of the coil and the bearing can be exceeded. Consult the manufacturer when using under such conditions.

When operating the G-BH1, G-BH9 the limits listed in Chapter 3, "Technical Data", Pg. 7 ff. must always be complied with.

Foreseeable Misuse

It is prohibited

- to use the G-BH1, G-BH9 in applications other than industrial applications unless the necessary protection is provided on the system, e.g. guards suitable for children's fingers;
- to use the device in rooms in which explosive gases can occur if the G-BH1, G-BH9 is not expressly intended for this purpose;
- to extract, to deliver and to compress explosive, flammable, corrosive or toxic fluids, unless the G-BH1, G-BH9 is specifically designed for this purpose;
- to operate the G-BH1 with values other than those specified in Chapter 3, "Technical Data", Pg. 7 ff.

Any unauthorized modifications of the G-BH1, G-BH9 are prohibited for safety reasons.

The operator is only permitted to perform the maintenance and service work described in these operating instructions.

Maintenance and servicing work which goes beyond this may only be carried out by companies which have been authorised by the manufacturer (ask the service department for details).

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3 Technical Data

3.1 Mechanical data

Weight

Single-impeller design		
	Weight	
Type	[kg] approx.	[lbs] approx.
2BH1100-7..0.	9	20
2BH1200-7..0.	9	20
2BH1300-7..0.	9	20
2BH1300-7..1.	10	22
2BH1300-7..2.	11	24
2BH1330-7..0.	10	22
2BH1330-7..1.	11	24
2BH1330-7..2.	12	26
2BH1400-7..0.	13	29
2BH1400-7..1.	16	35
2BH1400-7..2.	17	37
2BH1430-7..0.	14	31
2BH1430-7..1.	17	37
2BH1430-7..2.	18	40
2BH1500-7..0.	20	44
2BH1500-7..1.	22	49
2BH1500-7..2.	23	51
2BH1500-7..3.	25	55
2BH1530-7..0.	21	46
2BH1530-7..1.	23	51
2BH1530-7..2.	24	53
2BH1530-7..3.	26	57
2BH1600-7..0.	27	60
2BH1600-7..1.	30	66
2BH1600-7..2.	36	79
2BH1600-7..3.	40	88
2BH1600-7..6.	32	71
2BH1600-7..7.	39	86
2BH1630-7..0.	29	64
2BH1630-7..1.	32	71
2BH1630-7..2.	37	82
2BH1630-7..3.	43	95
2BH1630-7..6.	34	75
2BH1630-7..7.	40	88

Single-impeller design		
	Weight	
Type	[kg] approx.	[lbs] approx.
2BH180.-7..0.	117	258
2BH180.-7..1.	126	278
2BH180.-7..2.	132	291
2BH183.-7..0.	120	265
2BH183.-7..1.	129	284
2BH183.-7..2.	135	298
2BH190.-7..0.	179	395
2BH190.-7..1.	198	437
2BH190.-7..3.	210	463
2BH193.-7..0.	179	395
2BH193.-7..1.	198	437
2BH193.-7..3.	209	463
2BH923..-…P	167	368
2BH923..-…Q	145	320
2BH923..-…H	151	333

Two-impeller design		
	Weight	
Type	[kg] approx.	[lbs] approx.
2BH1310-7..2.	15	33
2BH1410-7..3.	25	55
2BH1410-7..4.	27	60
2BH1510-7..4.	40	88
2BH1510-7..5.	44	97
2BH1610-7..1.	43	95
2BH1610-7..2.	48	106
2BH1610-7..3.	54	119
2BH1610-7..4.	66	146
2BH1610-7..5.	73	161
2BH1610-7..7.	50	110
2BH1610-7..8.	62	137
2BH1640-7..3.	54	119
2BH1640-7..4.	69	152
2BH1640-7..5.	75	165
2BH1640-7..8.	62	137
2BH181.-7..1.	171	377
2BH181.-7..2.	177	390

Two-impeller design		
Type	Weight [kg] approx.	Weight [lbs] approx.
2BH181.-7..3.	203	448
2BH181.-7..4.	215	474
2BH184.-7..2.	177	390
2BH184.-7..3.	203	448
2BH191.-7..1.	274	604
2BH191.-7..2.	288	635
2BH191.-7..3.	299	659
2BH191.-7..4.	309	681
2BH1940-7B.2.	275	606
2BH1940-7B.3.	314	692
2BH1940-7B.4.	324	714
2BH1943-7..2.	330	728
2BH1943-7..3.	339	747
2BH1943-7..4.	349	769

Minimum distances

Minimum distance to fan guard (for sucking in cooling air):

Type	[mm]	[inches]
2BH1 1.. - 2BH1 4	34	1.34
2BH1 5.. - 2BH1 9	53	2.09
2BH923…	52	2.05

Minimum distance to face of vacuum pump/compressor cover:

Type	[mm]	[inches]
2BH1 1.. - 2BH1 5	20	0.79
2BH1 6..	30	1.18
2BH1 8.. - 2BH1 9	40	1.57
2BH923..	52	2.05

Noise level

Measuring-surface sound-pressure level as per EN ISO 3744, measured at a distance of 1 m [3.28 ft] at an operating point of approximately 2/3 of the permissible total pressure difference with the lines connected without a vacuum or pressure relief valve, tolerance ±3 dB (A).

Single-impeller design		
Type	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1100-7..0.	52	55
2BH1200-7..0.	57	61
2BH1300-7..0.	53	56
2BH1300-7..1.	53	56
2BH1300-7..2.	53	56
2BH1330-7..0.	53	56
2BH1330-7..1.	53	56
2BH1330-7..2.	53	56
2BH1400-7..0.	63	64
2BH1400-7..1.	63	64
2BH1400-7..2.	63	64
2BH1430-7..0.	63	64
2BH1430-7..1.	63	64
2BH1430-7..2.	63	64
2BH1500-7..0.	64	70
2BH1500-7..1.	64	70
2BH1500-7..2.	64	70
2BH1500-7..3.	64	70
2BH1530-7..0.	64	70
2BH1530-7..1.	64	70
2BH1530-7..2.	64	70
2BH1530-7..3.	64	70
2BH1600-7..0.	69	72
2BH1600-7..1.	69	72
2BH1600-7..2.	69	72
2BH1600-7..3.	69	72
2BH1600-7..6.	69	72
2BH1600-7..7.	69	72
2BH1630-7..0.	69	72

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Single-impeller design		
Type	**1-m measuring-surface sound pressure level L [dB (A)]**	
	50 Hz approx.	**60 Hz approx.**
2BH1630-7..1.	69	72
2BH1630-7..2.	69	72
2BH1630-7..3.	69	72
2BH1630-7..6.	69	72
2BH1630-7..7.	69	72
2BH180.-7..0.	70	74
2BH180.-7..1.	70	74
2BH180.-7..2.	70	74
2BH183.-7..0.	70	74
2BH183.-7..1.	70	74
2BH183.-7..2.	70	74
2BH190.-7..0.	74	79
2BH190.-7..1.	74	79
2BH190.-7..3.	74	79
2BH193.-7..0.	75	80
2BH193.-7..1.	75	80
2BH193.-7..3.	75	80
2BH923..	79	81

Two-impeller design		
Type	**1-m measuring-surface sound pressure level L [dB (A)]**	
	50 Hz approx.	**60 Hz approx.**
2BH1310-7..2.	55	61
2BH1410-7..3.	66	69
2BH1410-7..4.	66	69
2BH1510-7..4.	72	74
2BH1510-7..5.	72	74
2BH1610-7..1.	73	76
2BH1610-7..2.	73	76
2BH1610-7..3.	73	76
2BH1610-7..4.	73	76
2BH1610-7..5.	73	76
2BH1610-7..7.	73	76
2BH1610-7..8.	73	76
2BH1640-7..3.	74	78
2BH1640-7..4.	74	78
2BH1640-7..5.	74	78
2BH1640-7..8.	74	---
2BH181.-7..1.	74	---
2BH181.-7..2.	74	78
2BH181.-7..3.	74	78
2BH181.-7..4.	74	78
2BH184.-7..2.	74	78
2BH184.-7..3.	74	78
2BH191.-7..1.	74	84
2BH191.-7..2.	74	84
2BH191.-7..3.	74	84
2BH1940-7B.2.	75	84
2BH1940-7B.3.	75	84
2BH1940-7B.4.	75	84
2BH1943-7..2.	75	84
2BH1943-7..3.	75	84
2BH1943-7..4.	75	84

Sound power level

Sound power level L_W as per EN ISO 3744, tolerance ±3 dB (A).

Two-impeller design		
	Sound power level L_W [dB (A)]	
Type	50 Hz	60 Hz
2BH191.	-	98
2BH1940	-	98
2BH1943	-	99
2BH923..	-	93

Tightening torques for screw connections

The following values apply if no other information is available.

With non-electrical connections, property classes of 8.8 and 8 or higher as per ISO 898-1 are assumed.

	Tightening torques for non-electrical connections	
Thread	[Nm]	[ft lbs]
M4	2.7 - 3.3	1.99 - 4.44
M5	3.6 - 4.4	2.65 - 3.25
M6	7.2 - 8.8	5.31 - 6.5
M8	21.6 - 26.4	15.9 - 19.5
M10	37.8 - 46.2	27.9 - 34.1
M12	63.0 - 77.0	46.5 - 56.8

The following information for electrical connection applies to all terminal board connections with the exception of terminal strips.

	Tightening torques for electrical connections	
Thread	[Nm]	[ft lbs]
M4	0.8 - 1.2	0.59 - 0.89
M5	1.8 - 2.5	1.33 - 1.84

Especially for metal and plastic threaded cable glands and pipe unions, the following values apply:

	Tightening torques for metal threaded glands/unions	
Thread	[Nm]	[ft lbs]
M12x1,5	4 - 6	2.95 - 4.43
M16x1,5	5 - 7.5	3.69 - 5.53
M25x1,5	6 - 9	4.43 - 6.64
M32x1,5	8 - 12	5.9 - 8.85
M40x1,5		

	Tightening torques for plastic threaded glands/unions	
Thread	[Nm]	[ft lbs]
M12x1,5	2 - 3.5	1.48 - 2.58
M16x1,5	3 - 4	2.21 - 2.95
M25x1,5	4 - 5	2.95 - 3.69
M32x1,5	5 - 7	3.69 - 5.16
M40x1,5		

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3.2 Electrical data

See rating plate.

3.3 Operating conditions

Temperatures

Temperature of pumped gases:	max. permissible temperature: +40°C [+104°F] Nominal value: +15°C [+59°F] Pump-motor units for higher fluid temperatures on request.
Ambient temperature:	max. permissible temperature: +40°C [+104°F] min. permissible temperature: -15°C [+5°F] Nominal value: +25°C [+77°F] Ambient temperatures between 25°C [+77°F] and 40°C [+104°F] affect the permissible total pressure difference. At higher temperatures the winding may be damaged and the grease change interval may be shortened.

Pressures

Min. suction pressure:	See rating plate
Max. discharge pressure in compressor mode:	See rating plate

* The total pressure difference, shown on the rating plate, applies only for the following conditions:

- Ambient temperature: 25°C
- Pressure for vacuum operation: 1013 mbar at pressure connection;
- Pressure for compressor operation: 1013 mbar at suction connection;
- Intake temperature (temperature of conveyed gases at suction connection): 15°C
  For ambient temperatures between 25°C and 40°C, the total pressure difference specified on the rating plate must be reduced (at 40°C by 10%).

Consultation with the manufacturer is essential for such operational conditions.

Installation altitude

Max. of 1,000 m [3,280 ft] above sea level.

When installing the pump-motor unit at an altitude of more than 1,000 m [3,280 ft] above sea level, first inquire with the Service department.

4 Transport and Handling

⚠ WARNING

Tipping or falling can lead to crushing, broken bones etc.! Sharp edges can cause cuts!
Wear personal safety equipment (gloves, safety shoes and protective helmet) during transport!

⚠ WARNING

Danger from tipping or falling loads!
Prior to transport and handling make sure that all components are securely assembled and secure or remove all components the fasteners of which have been loosened!

Manual handling:

⚠ WARNING

Danger from lifting heavy loads!
Manual handling of the unit is only permitted within the following limits:

- max. 30 kg [max. 66 lbs] for men
- max. 10 kg [max. 22 lbs] for women
- max. 5 kg [max. 11 lbs] for pregnant women

For the weight of the pump-motor unit, see Chapter 3.1, "Mechanical data", Section "Weight", Pg. 7. For weights above the given values use suitable lifting appliances and handling equipment!

Handling by means of lifting equipment:

⚠ WARNING

Danger from tipping or falling loads!
When transporting with lifting equipment, observe the following basic rules:

- Before each transport, check the tight fit of the eye bolt/lifting attachment, see "Tightening torques for screw connections", p. 10.
- The lifting capacity of lifting equipment and lifting gear must be at least equal to the unit's weight. For the weight of the pump-motor unit, see Chapter 3.1, "Mechanical data", Section "Weight", Pg. 7.
- The pump-motor unit must be secured so that it cannot tip or fall.
- Do not stand or walk under suspended loads!

The transport must be carried out in different ways depending on the type:

- 2BH11., 2BH12., 2BH13., 2BH14., 2BH15. (single-impeller): Manual handling
- 2BH15. (two-impeller), 2BH16., 2BH18., 2BH19., 2BH923…
  Transport with crane, hooked onto eye bolt/lifting attachment (1 attachment point)
- 2BH1943:
  Transport with crane, hooked with lifting belts onto eye bolt and onto the holes in the two feet of the vacuum pump/compressor housing (3 attachment points).

For **transport with a crane**, the pump-motor unit can be hooked into the crane hook as follows:

- directly on the eye bolt/lifting attachment (With 2BH194 the eye bolt and the two foot holes should be used)

or possibly

- with lifting belts.

Eye bolt/lifting attachment:

Types with a weight of up to 30 kg [66 lbs] are **not** equipped with an eye bolt/lifting attachment (2BH11., 2BH12., 2BH13., 2BH14., 2BH15 [single-impeller]).

Types with a weight of more than 30 kg [66 lbs] are equipped with an eye bolt/lifting attachment as **standard** (2BH15. [two-impeller], 2BH16., 2BH18., 2BH19., 2BH9…).

The eye bolt/lifting attachment is mounted on the vacuum pump/compressor housing.

In case of possible removal and remounting of the eye bolt, it must be ensured that the eye level is positioned exactly in the axis direction of the pump-motor unit. Lay shims under the eye bolt if necessary.

The eye bolt/lifting attachment must be firmly tightened.

Loads laterally to the ring level are not permissible. Heavy impact loads during transport must be avoided.

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5 Installation

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you many not carry out any work with or on the pump-motor unit!

⚠ DANGER

Danger from missing view into area of pump-motor unit!
When operating the control elements without a view into the area of the pump-motor unit, there is a danger that the pump-motor unit will be switched on while other persons are still performing work on it. Extreme injuries are possible!

Provide control elements at a location with a view of the pump-motor unit.

⚠ DANGER

Electrical danger!
The pump-motor unit must be installed so that the electrical device cannot be damaged by external influences!

In particular, the feed pipes must be securely routed, e.g. in cable ducts, in the floor etc.

⚠ WARNING

Danger from balance damage caused by vibration!
Vibrating environments can cause balance damage!

Install the pump-motor unit on a solid foundation or on a solid mounting surface.

Check screw glands/unions for mounting the pump-motor unit on the mounting surface regularly for strength and firm seating.

⚠ WARNING

Danger from crushing due to pump-motor unit tipping over!
Wear personal safety equipment (protective gloves and safety shoes). Handle the unit with the appropriate care. Install the pump-motor unit on a solid foundation or on a solid mounting surface! Check screw glands/unions for mounting the pump-motor unit on the mounting surface regularly for strength.

⚠ WARNING

Danger of fire from flammable substances!
The pump-motor unit must never come into contact with flammable substances.

⚠ WARNING

Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!
High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

The pump-motor unit must be installed so that accidental touch of its surface is not possible. Cover the pump-motor unit with a suitable touch protection (e.g. perforated plate cover or wire cover).

⚠ WARNING

Danger of injuries from flying parts!
Select installation so that parts that are thrown out through the grate if the external fan breaks cannot hit persons!

⚠ CAUTION

Danger of tripping and falling!
Make sure the unit does not present a danger of tripping. Lay cables and pipes so that they cannot be reached during operation(recessed in floor, in ducts on the wall etc.).

CAUTION

Danger of overheating due to hot surface of pump-motor unit!
High temperatures can occur on the surface of the pump-motor unit.

Temperature sensitive parts, such as lines or electronic components, may not come into contact with the surface of the pump-motor unit.

The pump-motor unit is ready to connect on delivery. However, if the time from delivery to commissioning of the pump-motor unit exceeds a certain period, the lubrication of the rolling bearings must be renewed.
See Chapter 8.2, "Storage conditions", Section "Lubrication of rolling bearings after longer storage", Pg. 24 for information on this topic.

Carry out the following work to install the pump-motor unit:

- Installation and securing,
- Attachment of the included loose muffler if necessary,
- Attachment of threaded flange or hose flange (available as accessories)
  for the connection of inlet or discharge pipe to the muffler,
- Electrical connection,
- Connection of inlet and discharge connection to the system.

5.1 Installation

⚠ WARNING

For an installation that differs from the following specifications, it is necessary to inquire with the Service Department!

Ambient conditions:

The pump-motor unit is suitable for installation in the following environments:

- In a dusty or damp environment,
- in buildings,
- in the open.
  When properly installed in the open, the pump-motor unit must be protected from exposure to intensive sunlight, e.g. by attaching a protective roof. Otherwise, no special protective devices against the effects of weathering are required.

The drive motors of the pump-motor units have the following design:

- with degree of protection IP55 (see rating plate),
- with tropicalized insulation.

Installation conditions:

The pump-motor unit must be installed as follows:

- on level surfaces,
- at a maximum height of 1000 m [3280 ft] above sea level.
  When installing at an altitude of more than 1,000 m [3,280 ft] above sea level, first inquire with the Service Department.

Minimum distances:

To ensure sufficient cooling of the pump-motor unit, it is absolutely necessary that the required minimum distances to the **fan guard** and to the **face of the vacuum pump/compressor cover** be maintained. see Chapter 3.1, "Mechanical data", Section "Minimum distances", Pg. 8.

The minimum distances to the face of the vacuum pump/compressor cover are especially important when installing on the vacuum pump/compressor cover or near a wall.

CAUTION

To ensure sufficient cooling of the pump-motor unit, also observe the following:

- Ventilation screens and openings must remain clear.
- Discharge air of other units may not be directly sucked in again!

Noise radiation:

To reduce the noise radiation, the following must be observed:

- Do not mount pump-motor unit on noise-conducting or noise-radiating parts (e.g. thin walls or sheet-metal plates).
- Provide pump-motor unit with sound-insulating intermediate layers (e.g. rubber buffers under the base of the pump-motor unit) if necessary.
- Install the pump-motor unit on a stable foundation or on a rigid mounting surface. This provides for smooth, low-vibration running of the pump-motor unit.

Components for reducing noise on the pump-motor unit:

- **Mufflers** (included as standard equipment):
  On delivery the pump-motor units are equipped with attached mufflers as standard. The noise radiation is considerably reduced by the mufflers. See Fig. 2 to Fig. 9, Pg. 18 ff.
- **Additional silencer** (available as an accessory for the 2BH1):
  The additional mufflers enable a further noise reduction. They may only be used with free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere **without piping**.

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- **Sound protection hood** (available as an accessory for the 2BH1):
  Noise protection hoods are suitable for installation in rooms and in the open. They reduce both the total sound pressure level and tonal components that are perceived as particularly annoying.

Installation variants/axis position:

Basically, when installing the pump-motor unit, the following variants are possible with a different axis position (horizontal or vertical):

- Horizontal installation
- Vertical installation on the vacuum pump/compressor cover ("cover installation")
- Vertical mounting on the wall

Basically, all variants are possible with all type.

Exceptions

- For the 2BH1943, vertical axis mounting on the compressor cover ("cover position") is necessary.
- For the 2BH923, only horizontal axis mounting and vertical axis mounting on the compressor cover are possible.
- For units with condensate water opening, horizontal axis mounting with a foot below is necessary.

Horizontal axis mounting

The foot of the unit has fastening holes.

- Screw the foot of the unit to the base using suitable screws.
  All fastening holes must have screws!

Vertical axis mounting on the compressor cover ("cover position")

For vertical axis mounting on the compressor cover, use spring elements.

Spring elements are available as accessories and come in a set of 3. The upper part has a threaded stud and the lower part a threaded hole.

- fFastening spring elements to the unit:
  Screw threaded studs of the spring elements into the holes on the front side of the compressor cover and tighten.
- Fastening the unit with spring elements to the foundation:
  Select suitable fastening elements for the threaded hole.
  Screw spring elements over the threaded hole into the base or foundation.

Vertical axis mounting on the wall with the compressor cover pointing downward

For vertical axis mounting of the unit on the wall, the unit is fastened using the holes in the foot. The foot of the unit has fastening holes.

- Place the unit with the foot to the wall on a base plate with sufficient load-bearing capability in the mounting position.
- Screw the foot of the unit to the wall using suitable screws.
  All fastening holes must have screws!
- Remove the base plate.

Eye bolt/lifting attachment:

After set-up, the eye bolt/lifting attachment can be removed.

5.2 Electrical connection (motor)

⚠ DANGER

Electrical danger!
Malpractice can result in severe injuries and material damage!

⚠ DANGER

Electrical danger!
The electrical connection may be carried out by trained and authorized electricians only!

⚠ DANGER

Electrical danger!
Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

CAUTION

Incorrect connection of the motor can lead to serious damage to the unit!

Regulations:

The electrical connection must be carried out as follows:

- according to the applicable national and local laws and regulations,
- according to the applicable system-dependent prescriptions and requirements,
- according to the applicable regulations of the utility company.

Electrical power supply:

Observe the **rating plate**.
It is imperative that the operating conditions correspond to the data given on the rating plate!

Deviations permissible without reduction in performance:

- ±5 % voltage deviation
- ±2 % frequency deviation

Connection to drive-motor terminal box:

Open the required cable entry openings on the terminal box. Here the following two cases are differentiated:

- The cable entry opening is prefabricated and provided with a sealing plug.
- Screw out sealing plug.

OR

- The cable entry opening is closed off with a casting skin (only on pump-motor units with drive-motor axis heights of 100 to 160 in standard design).
- Break out casting skin using a suitable tool. For example, use a metal pin with a corresponding diameter or a chisel and hammer.

CAUTION

When pounding out the casting skin on the cable entry openings in the terminal box, the terminal box or its parts can be damaged (e.g. terminal board, cable connections).

Proceed with suitable caution and precision when doing so! Prevent flash formation!

Mount cable glands on the terminal box. Proceed as follows:

- Select one cable gland in each case which is suitable for the cable diameter.
- Insert this cable gland in the opening of the terminal box.
  Use a reducer if necessary.
- Screw on the cable gland so that no moisture, dirt etc. can penetrate into the terminal box.

Carry out the connection and the arrangement of the jumpers in accordance with the **circuit diagram in the terminal box**.

Connect the protective conductor to the terminal with the following symbol:
.

The electrical connection must be carried out as follows:

- The electrical connection must be permanently safe.
- There may be no protruding wire ends.
- Clearance between bare live parts and between bare live parts and ground: ≥ 5.5 mm [0.217"] (at a nominal voltage of $U_N \leq 690V$).
- For the tightening torques for terminal board connections (except terminal strips), see Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10.
- For terminals with clamping straps (e.g. as per DIN 46282), the conductors must be inserted so that approximately the same clamping height results on both sides of the bar. Individual conductors must therefore be bent into a U-shape or connected with a cable lug (DIN 46234).

This also applies to:

- the protective conductor,
- the outer ground conductor.

Both conductors can be recognized from their color (green/yellow).

⚠ DANGER

Electrical danger!
The terminal box must be free from

- foreign bodies,
- dirt,
- humidity.

Terminal box cover and cable entries must be tightly closed so as to make them dustproof and waterproof. Check for tightness at regular intervals.

⚠ DANGER

Electrical danger!
Clearance between bare live parts and between bare live parts and ground:

at least **5.5 mm [0.217"]** (at a nominal voltage of $U_N \leq 690V$).

There may be no protruding wire ends!

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For **motor overload protection**:

- Use motor circuit breakers.
- This must be adjusted to the specified nominal current (see rating plate).

⚠ DANGER

Electrical danger!
There is danger of an electrical shock when a defective pump-motor unit is touched!

Mount motor circuit breaker.
Have electrical equipment checked regularly by an electrician.

Interference immunity of drive motor:

For drive motors with integrated sensors, the operator must provide for a sufficient interference immunity itself. Select a suitable sensor signal cable (e.g. with screening, connection as for a motor power-supply cable) and analyzing unit.

Operation with frequency converter:

⚠ WARNING

Pump-motor units with a UL approbation may not be operated on frequency converters in the US without testing by a suitable test agency!

With a power supply by a frequency converter, the following must be observed:

- High-frequency current and voltage harmonics in the motor supply cables can lead to emitted electromagnetic interference. This is dependent on the converter design (type, manufacturer, interference suppression measures).
- Be sure to observe the EMC notes of the converter manufacturer!
- Use screened power supply cables if necessary. For optimal screening, the screen must be conductively connected over a large area to the metal terminal box of the drive motor with a screwed metal gland.
- In the case of drive motors with integrated sensors (e.g. PTC thermistors) interference voltage can occur on the sensor cable depending on the converter type.
- Limit speed:
  see specifications on the rating plate.

5.3 Connecting pipes/hoses (vacuum pump/compressor)

Mufflers:

The pump-motor units are delivered with mufflers (indicated with arrows in the following illustrations) for the inlet and discharge connections as standard equipment.

On delivery the mufflers are already mounted on the following pump-motor units.

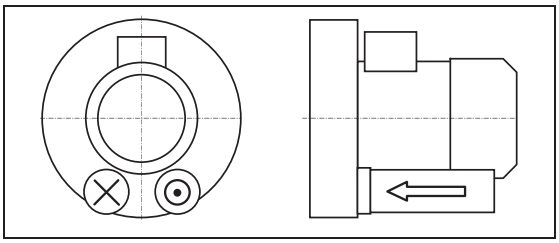

Fig. 2: 2BH1… (single-impeller pump-motor units), 2BH9 23

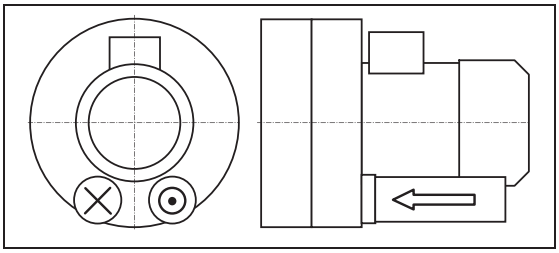

Fig. 3: 2BH1640 (two-impeller pump-motor unit with double-flow design)

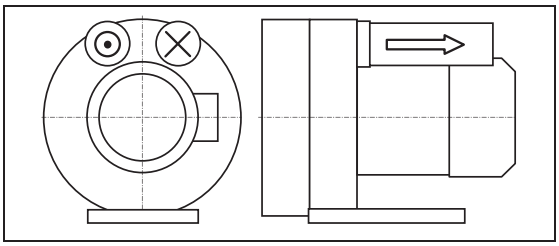

Fig. 4: 2BH1840-7G... (two-impeller pump-motor unit with double-flow design)

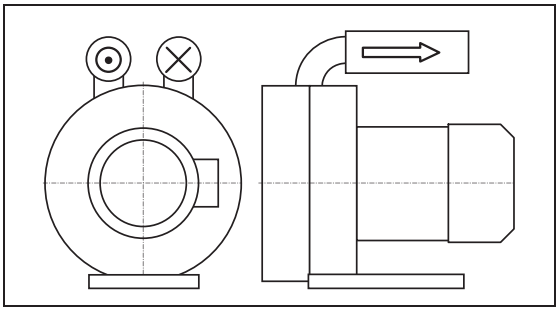

Fig. 5: 2BH1840-7J... (two-impeller pump-motor unit with double-flow design)

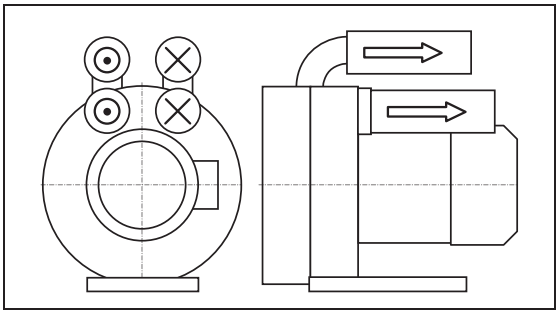

Fig. 6: 2BH1840-7L... (two-impeller pump-motor unit with double-flow design)

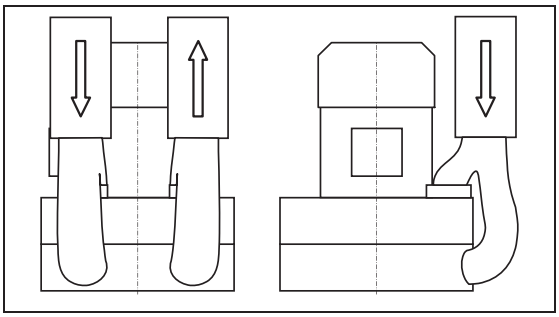

Fig. 7: 2BH1943 (two-impeller pump-motor unit with double-flow design)

On **two-impeller pump-motor units with a two-stage design of the types 2BH1310 to 2BH1910** the discharge-side muffler is included loose for packing-related reasons and must be mounted by the customer.

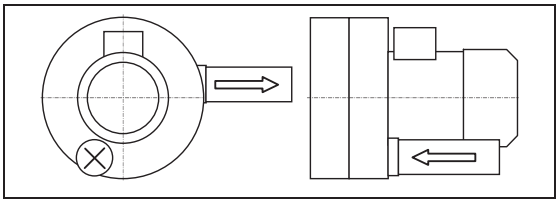

Fig. 8: 2BH1310 ... 2BH1610, 2BH1910 (two-impeller pump-motor units with a two-stage design)

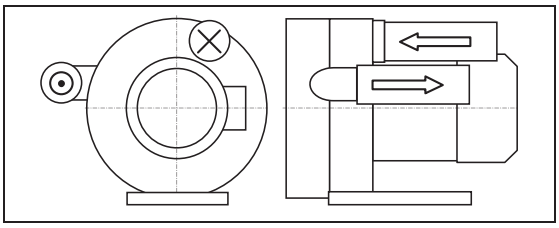

Fig. 9: 2BH1810 (two-impeller pump-motor unit with a two-stage design)

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⚠ WARNING

Danger from rotating impeller:
Cutting/cutting of off extremities!

The rotating impeller is accessible with the inlet and discharge connections open!

With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, the following therefore applies:

Provide the inlet and discharge connections of the pump-motor unit either with additional mufflers or with additional piping of a sufficient length to prevent access to the impeller!

Connections:

To prevent foreign bodies from entering the unit, all connections are sealed off when delivered. Do not remove the sealing plugs until immediately before connecting the pipes/hoses.

The following applies for the arrangement of the pipe/hose connections:

The **pumped gases** are sucked in via the inlet connection (see Chapter 5.3.1, Pg. 19) and discharged via the discharge connection (see Chapter 5.3.2, Pg. 19).

The **shaft rotating direction** is marked with an arrow on the back of the vacuum pump/compressor housing (Fig. 1, Pg. 2, Item 7).

The **delivery direction of the gases** is marked with arrows on both connections (Fig. 1, Pg. 2, Item 6).

⚠ WARNING

Danger from interchanging inlet and pressure line!

Interchanged inlet and pressure lines can lead to damage to the pump-motor unit and the system, and as a result of this to serious injuries!

Make sure that the inlet and pressure line cannot be confused when connecting.

Look for the clear marking with the arrow indicating the delivery direction on the inlet and discharge connections.

⚠ WARNING

Danger due to vacuum and gauge pressure!

Danger due to escaping fluid!

During operation, connected pipes and vessels are vacuumized or pressurized!

Use only mounting elements, connections, lines, fittings and containers with sufficient freedom from leaks and strength for the pressures which occur.

Make sure that the mounting elements and connections are mounted sufficiently firmly and leak-free!

CAUTION

If the pumped gases are passed on on the discharge side in a closed pipe system, then it must be ensured that the pipe system is adapted to the maximum discharge pressure. See Chapter 3.3: "Operating conditions", Section "Pressures", Pg. 11. Connect a pressure relief valve upstream if necessary.

NOTICE

Attach pipes/hoses free of mechanical tensions. Support the weight of the pipes/hoses.

5.3.1 Inlet connection

The inlet connection with the related muffler (Fig. 1, Pg. 2, Item 3) is marked with an arrow pointing into the vacuum pump/compressor. Connect the inlet pipe here. The pumped gases are sucked in via this.
Procedure: see Chapter 5.3.3.

⚠ WARNING

Danger from solid bodies and impurities in the pump-motor unit!

If solid bodies penetrate into the pump-motor unit, blades of the impellers can break and broken pieces can be thrown out.

Install a filter in the inlet pipe.
Replace filter regularly!

5.3.2 Discharge connection

The discharge connection with the related muffler (Fig. 1, Pg. 2, Item 4) is marked with an arrow pointing out of the vacuum pump/compressor. Connect the discharge pipe here. The pumped gases are discharged via this. Procedure: see Chapter 5.3.3.

5.3.3 Procedure when connecting pipes/hoses

Attach the pipes/hoses to the unit as described in the following. The pipes/hoses are connected differently to inlet and discharge connections depending on the muffler design and the type of line (pipe or hose):

- Muffler with inside threads:
  The pipe is screwed directly into the muffler.
- Muffler without inside thread:
  - Screw threaded flange (available as an accessory) onto the muffler.
  - Screw the pipe into the threaded flange.
- Hose connection:
  - for 2BH1 Screw the hose flange (available as an accessory) onto the silencer.
  - Push the hose onto the hose flange and secure it with a hose clamp. See Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10 for information on this topic.

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6 Commissioning

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!

Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.? Otherwise you many not carry out any work with or on the pump-motor unit!

⚠ WARNING

Danger from rotating parts (external fan, impeller, shaft): Cutting/cutting off of extremities, Grasping/winding up of hair and clothing!

Danger due to vacuum and gauge pressure: sudden escape of fluids (skin and eye injuries), sudden drawing in of hair and clothing!

Danger due to escaping fluid: Burns!

Start-up and operation only under the following conditions:

- The pump-motor unit must be completely assembled. When doing so, pay particular attention to the following components:
  - the vacuum pump/compressor cover,
  - the muffler on inlet and discharge connections,
  - the fan guard.
- The pipes/hoses must be connected to inlet and discharge connections.
- Inlet and discharge connections and the connected pipes/hoses may not be closed, clogged or soiled.
- Check the mounting elements, connections of the pipe/hose connections, lines, fittings and containers for strength, leaks and firm seating at regular intervals.

6.1 Preparation

⚠ WARNING

Danger from closed connections!

With closed/soiled intake or discharge connections vacuum or gauge pressure results in the pump-motor unit.

This can overheat and damage the drive motor winding.

Before start-up, make sure that the inlet and discharge connections are not closed, clogged or soiled!

CAUTION

Before starting up again after a longer standstill: Measure the insulation resistance of the motor. With values ≤ 1 kΩ per volt of nominal voltage, the winding is too dry.

Measures before start-up:

- If a shut-off device is installed in the discharge pipe:
  Make sure that the unit is NOT operated with the shut-off device closed.
- Before starting up the pump-motor unit, observe the values specified on the rating plate. Specifications on the drive-motor nominal current apply at a gas entry and ambient temperature of +40° C [104°F].
- Adjust the motor circuit breaker to the drive-motor nominal current.

Check direction of rotation:

- The intended rotating direction of the shaft is marked with arrows on the vacuum pump/compressor housing (Fig. 1, Pg. 2, Item. 7).
- The gas delivery direction is marked with arrows on the inlet and discharge connections (Fig. 1, Pg. 2, Item 6).
- Make sure the pipes/hoses on the inlet and discharge connections are properly connected.
- Switch the pump-motor unit on briefly and then off again.
- Compare the actual rotating direction of the external fan with the intended shaft rotating direction indicated with the arrows shortly before the pump-motor unit comes to a standstill.
- If necessary, reverse the direction of rotation of the motor.

⚠ WARNING

Danger due to rotating parts! Danger due to vacuum and gauge pressure! Danger due to escaping fluid!
Test runs may also only be conducted with the pump-motor unit completely mounted.

⚠ DANGER

Electrical danger!
The electrical connection may be carried out by trained and authorized electricians only!

⚠ DANGER

Electrical danger!
Before beginning work on the unit or system, the following measures must be carried out:

- Deenergize.
- Secure against being switched on again.
- Determine whether deenergized.
- Ground and short-circuit.
- Cover or block off adjacent energized parts.

Check operating speeds:

Observe the operating speed specified on the rating plate. This may not be exceeded, as otherwise the noise radiation, vibration behavior, grease consumption duration and bearing change interval worsen. To prevent damage as a result of higher speeds, it may be necessary to inquire with the Service Department as to the maximum speed.

⚠ WARNING

Danger of hearing damage due to noise radiation!
For the noise emission of the pump-motor unit measured by the manufacturer, see Chapter 3.1, "Mechanical data", Section "Noise level", Pg. 8. However, the actual noise emission during operation is highly dependent on the installation and system conditions. Conduct a noise measurement in the system during operation after installing the pump-motor unit. The following measures can be taken from 85 dB(A) and must be taken from 90 dB(A):

- Mark noise area with a warning sign.
- Wear hearing protection.
- With free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere without piping, attach an additional muffler.

6.2 Start-up and shut-down

Start-up

- Open shut-off device in intake/discharge pipe.
- Switch on power supply for drive motor.

Shut-down:

- Switch off power supply for drive motor.
- Close shut-off device in intake/discharge pipe.

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7 Operation

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?
Otherwise you many not carry out any work with or on the pump-motor unit!

Also **be sure** to read the safety precautions in Chapter 6, "Commissioning", Pg. 21!

Starting up and shutting down

See Chapter 6, "Commissioning", Sub-Chapter 6.2, "Start-up and shut-down", Pg. 22.

Also be sure to observe the following important notes especially for operation:

⚠ WARNING

Danger of burns from hot surfaces of the pump-motor unit and from hot fluids!
High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Do not touch during operation!
Allow to cool after shut-down!

CAUTION

Danger of overheating due to hot surface of pump-motor unit!
High temperatures of up to approx. 160°C [320°F] can occur on the surface of the pump-motor unit.

Temperature sensitive parts, such as lines or electronic components, may not come into contact with the surface of the pump-motor unit.

CAUTION

Danger of overheating!
During operation the standstill heating may, if installed, **not** be switched on!

CAUTION

Danger of rusting due to collection of condensed water in drive motor area!
On drive motors with closed condensed water openings:
Remove closures occasionally to allow any water which has collected to drain off.

CAUTION

Danger of bearing damage!
Heavy mechanical impacts must be avoided during operating and while at a standstill.

8 Shut-Down and Longer Standstills

8.1 Preparing for shut-down or longer standstill

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?
Otherwise you many not carry out any work with or on the pump-motor unit!

CAUTION

Danger of rusting due to collection of condensed water in drive motor area!
On drive motors with closed condensed water openings:
Remove closures occasionally to allow any water which has collected to drain off.

CAUTION

Danger of bearing damage!
Avoid mechanical shocks during operation and shut-down.

Prior to shut-down or longer standstill, proceed as follows:

- Switch off the pump-motor unit.
- Close shut-off device in inlet and pressure line if installed.
- Disconnect pump-motor unit from power supply.
- Release pressure.
  When doing so, open pipes/hoses slowly and carefully so that the vacuum or gauge pressure in the pump-motor unit can be released.
- Remove pipes/hoses.
- Provide mufflers on inlet and discharge side with sealing plugs.

8.2 Storage conditions

To prevent standstill damage during storage, the environment must provide the following conditions:

- dry,
- dust-free,
- low-vibration (V_{eff} ≤ 2.8 mm/s [0.11"/sec]).
- Ambient temperature:
  min. -30°C [-22°F]
  max. 40°C [+104°F].

CAUTION

Danger of overheating due to high temperature!
When storing in an environment with a temperature of over 40°C [104°F], the winding may be damaged and the grease change interval may be shortened.

Lubrication of rolling bearings after longer storage:

The new pump-motor unit may at first be stored following delivery. If the time from deliver to commissioning exceeds the following periods, the lubrication of the rolling bearings must be renewed:

- Under advantageous storage conditions (as specified above): 4 years.
- Under disadvantageous storage conditions (e.g. high humidity, salty air, sandy or dusty air): 2 years.

In these cases open rolling bearings must be relubricated and closed rolling bearings must be completely replaced. In this case be sure to inquire with the Service Department. In particular, exact information with regard to the procedure and grease type are required.

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
All maintenance work on the pump-motor unit must always be performed by the Service Department!

Maintenance work on the pump-motor unit may only be conducted by the operator itself when the related **maintenance manual** on hand!

Inquire with the Service Department!

Commissioning after longer standstill:

Before recommissioning after a longer standstill, measure the insulation resistance of the drive motor. With values ≤ 1 kΩ per volt of nominal voltage, the winding is too dry.

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9 Servicing

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
Have you read the safety precautions in Chapter 1, "Safety", Pg. 3 f.?

Otherwise you many not carry out any work with or on the pump-motor unit!

⚠ WARNING

Improper use of the unit can result in serious or even fatal injuries!
All maintenance work on the pump-motor unit must always be performed by the Service Department!

Maintenance work on the pump-motor unit may only be conducted by the operator itself when the related **maintenance manual** on hand!

Inquire with the Service Department!

9.1 Emptying/Rinsing/Cleaning

Before any maintenance/servicing work, empty, rinse and clean the outside of the unit.

- Empty unit with air and rinse until all residues have been removed.
- Clean the outside of the unit with compressed air.
  - Wear gloves and protective safety glasses.
  - Secure the surrounding area.
  - Clean the entire surface of the unit and exterior fan with compressed air.

9.2 Repairs/troubleshooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise..	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service*)
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service*)
	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service*)
Protective motor switch trips when motor is switched on. Power consumption too high.	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service*)
		Clean filters, mufflers and connection pipes if necessary.	Service*)
	Compressor is jammed.	See fault: "Motor does not start; humming noise." with cause: "Impeller is jammed.".	Service*)

Fault	Cause	Remedy	Carried out by
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service*)
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service*)
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service*)
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service*)
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service*)
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

*) Only when the maintenance manual is at hand: rectification by the operator.

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9.3 Service/After-sales service

Our Service is available for work (in particular the installation of spare parts, as well as maintenance and repair work), not described in these operating instruction.

A list of spare parts with an exploded drawing is available on the Internet at www.gd-elmorietschle.com.

Observe the following when **returning** pump-motor unit:

- The pump-motor unit must be delivered complete, i.e. not dismantled.
- The pump-motor unit may not present a danger to the workshop personnel.
  Each pump motor unit on delivery to the workshop must be accompanied with a fully completed "Statement on health safety and on the protection of the environment", Pg. 29.
- The original rating plate of the pump-motor unit must be properly mounted, intact and legible.
  All warranty claims are voided for pump-motor units delivered for a damage expertise without the original rating plate or with a destroyed original rating plate.
- In case of warranty claims, the manufacturer must be informed of the operating conditions, operating duration etc. and additional detailed information provided on request if necessary.

10 Disposal

Have the entire pump-motor unit scrapped by a suitable disposal company. No special measures are required when doing so.
For additional information on disposing of the unit, ask the Service Department.

11 Explosion-Protected Design

An additional set of operating instructions with supplementary or specific information is provided with these pump-motor units.

EU declaration of conformity

Manufacturer:	Gardner Denver Deutschland GmbH Industriestraße 26 97616 Bad Neustadt Germany
Responsible for documentation:	Holger Krause Industriestraße 26 97616 Bad Neustadt Germany
Designation:	G series Side channel blower G-BH1, G-BH9 Types 2BH1 1 2BH1 2 2BH1 3 2BH1 4 2BH1 5 2BH1 6 2BH1 8 2BH1 9 2BH9 23

The side channel blower described above meets the following applicable Community harmonisation legislation:

2004/108/EC[*)]	Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
2006/42/EC	Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC The protection targets of the directive 2006/95/EC have been met

Harmonised standards applied:

EN 1012-1:2010	Compressors and vacuum pumps - Safety requirements - Part 1: Air compressors
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements

Bad Neustadt, 26.09.2011
(Place and date of issue)
Thomas Kurth, Managing Director
(Name and function)

(Signature)

[*)] Only applicable for version with frequency converter 2FC

664.44434.40.000

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Statement on health safety and on the protection of the environment

- For the safety of our employees and to comply with statutory requirements on handling substances harmful to the health and the environment, this statement must be enclosed, fully completed, with **each** unit/system sent.
- **Without the fully completed statement, repair/disposal is not possible and delays are unavoidable!**
- The statement is to be completed and signed by suitably qualified, authorised personnel at the operating organisation.
- In the case of shipment to Germany, the statement is to be completed in German or English.
- The statement is to be attached to the outside of the packing on shipment.
- If necessary, the carrier is to be informed.

1. **Product designation (type):** .....
2. **Serial number (no. BN):** .....
3. **Reason for sending:** .....
4. **The unit/system**
   - ☐ has **not** come into contact with hazardous substances. There will be **no** hazards for personnel or the environment during repair/disposal. Continue with "6. Legally binding statement“
   - ☐ has come into contact with hazardous substances. Continue with "5. Information on the contamination“
5. **Information on the contamination** (if necessary provide more information on an additional sheet)
   The unit/system was used in the following application:

   .....

   and has come into contact with the following classifiable substances or substances presenting a hazard to health/environment:

Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):

   - ☐ The unit/system has been emptied in accordance with the operating instructions, flushed and cleaned externally.
   - ☐ Safety data sheets in accordance with the applicable regulations are enclosed (..... sheet).
   - ☐ The following safety precautions are necessary for handling (e.g. personal protective equipment):

     .....

     .....
6. **Legally binding statement**
   I herewith guarantee that the details specified are true and complete and that I, as signatory, am in a position to judge that this is so.
   We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We are obliged to indemnify the contractor against claims for damages by third parties arising from incomplete or incorrect specifications. We are aware that, irrespective of this statement, we are directly liable to third parties - in particular including the contractor's employees tasked with repair/disposal.

Company/institute:	.....		
Name, position:	.....	Phone:	.....
Street:	.....	Fax:	.....
Post code, city:	.....		
Country:	.....	Stamp:	
Date, signature:	.....		

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Gardner Denver

Elmo Rietschle is a brand of Gardner Denver's Industrial Products Group and part of Blower Operations.

B-7911 - Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel
B7914 - Blower, Cincinnati, LM-6, Direct drive

cincinnati fan

Form: OMM-01-0509
Effective: 5/4/09
Supersedes OMM-01-0207
Part No.: 01218

Installation, Safety, Operation & Maintenance Instructions And Parts List

For Models PB, PBS, SPB, LM and LMF.

Arrangement 4 Blowers

NOTE

READ ENTIRE MANUAL, INCLUDING "SECTION IV. INITIAL UNIT STARTUP" BEFORE ATTEMPTING TO INSTALL AND OPERATE THIS EQUIPMENT.

BLOWER SPECIFICATIONS

BLOWER SERIAL NUMBER: _____ **MFG. DATE:** _____

NOTE: The serial number above is a required reference for any assistance. It is stamped on the blower nameplate.

BLOWER SPECIFICATIONS:

Model: _____ **Arrangement:** _____ **Rotation:** _____ **Discharge:** _____

Nominal Inlet Size: _____ (in Inches) **Wheel Size and Type:** _____

BLOWER PERFORMANCE DATA: (If entered on order)

CFM: _____ **SP:** _____ (Inches of Water Gauge) **Motor BHP:** _____

Density: _____ **Altitude:** _____ (Ft. above S.L.) **Airstream Temperature:** _____**°F.**

Fan RPM: _____ **Maximum Safe Fan RPM:** _____ **DO NOT EXCEED THIS RPM**

MOTOR DATA: (This section is completed only if the motor was supplied by Cincinnati Fan)

HP: _____ **RPM:** _____ **Voltage:** _____ **Phase:**_____

Hz: _____ **Frame Size:** _____ **Enclosure:** _____ **Efficiency:** _____

IF Motor is EXP, Class(es) & Group(s) are:_____

Manufacturers Model Number: _____ **CFV Part Number:** _____

ATTENTION: RECEIVING DEPARTMENT

All Cincinnati Fan products are packaged to minimize any damage during shipment. The freight carrier is responsible for delivering all items in their original condition as received from Cincinnati Fan. The individual receiving this equipment is responsible for inspecting this unit for any obvious or concealed damage. If any damage is found, it should be noted on the bill of lading before the freight is accepted and the receiver must file a claim with the freight carrier.

LONG TERM STORAGE NOTICE

If this blower will NOT be installed and put into operation within 30 days, refer to the "Long Term Storage Instructions" on pages 12 and 13. Failure to follow all applicable long term storage instructions, will void your warranty. This blower should be stored indoors in a clean, dry location.

⚠ DANGER				
Hazardous voltage can cause electrical shock and death.	High speed rotating equipment can cause severe personal injury.	Lock out/Tag out to prevent personal injury BEFORE starting ANY service or inspection.	Avoid injury. NEVER operate without ALL required safety guards in place.	Avoid injury. You MUST read and understand all instructions in this manual BEFORE installing.

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I. GENERAL

A. Unpacking:

Be careful not to damage or deform any parts of the blower when removing it from the packaging container. **All the packaging material should be kept in the event the blower needs to be returned.**

Handling:

Handling of the blower should be performed by trained personnel and be consistent with all safe handling practices. Verify that all lifting equipment is in good operating condition and has the proper lifting capacity. The blower should be lifted using well-padded chains, cables or lifting straps with spreader bars. Some blower models have lifting eye locations provided in the blower base. **NEVER lift the blower by an inlet or discharge flange, motor shaft, motor eye bolt, or any other part of the blower assembly that could cause distortion of the blower assembly.**

B. Safety Instructions & Accessories:

1. **Safety Instructions:**
   All installers, operators and maintenance personnel should read AMCA Publication 410-96, **"Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans".** This manual is included with the blower. Additional copies can be requested by writing us at Cincinnati Fan, 7697 Snider Rd., Mason, OH 45040-9135
2. **Sound:**
   Some blowers can generate sound that could be hazardous to personnel. It is the responsibility of the user to measure the sound levels of the blower and/or system, determine the degree of personnel exposure, and comply with all applicable safety laws and requirements to protect personnel from excessive noise.

3. Air Pressure and Suction:

In addition to the normal dangers of rotating machinery, the blower can present additional hazards from the suction or pressure created at the blower inlet or discharge. Suction at the blower inlet can draw materials into the blower where they become high velocity projectiles at the discharge and cause severe personal injury or death. It can also be extremely dangerous to persons in close proximity to the inlet or discharge as the forces involved can overcome the strength of most individuals.

⚠ WARNING

NEVER OPERATE A BLOWER WITH A NON-DUCTED INLET AND/OR DISCHARGE. IF THE BLOWER INLET AND/OR DISCHARGE IS NON-DUCTED, IT IS THE USERS RESPONSIBILITY TO INSTALL AN INLET AND/OR DISCHARGE GUARD.

4. Temperature:

Many blowers, blower components and all motors operate at temperatures that could burn someone if they come in contact with them. If this potential hazard could exist in your installation, steps must be taken by the user to protect anyone from coming in contact with this equipment.

5. Spark Resistance; (Per AMCA Standard 99-0401-86 and ISO 13499)

⚠ DANGER

NO GUARANTEE OF ANY LEVEL OF SPARK RESISTANCE IS IMPLIED BY SPARK RESISTANT CONSTRUCTION. IT HAS BEEN DEMONSTRATED THAT ALUMINUM IMPELLERS RUBBING ON RUSTY STEEL CAN CAUSE HIGH INTENSITY SPARKS. AIR STREAM MATERIAL AND DEBRIS OR OTHER SYSTEM FACTORS CAN ALSO CAUSE SPARKS.

6. Safety Accessories;

Guards:

All moving parts must be guarded to protect personnel. Safety requirements can vary, so the number and types of guards required to meet company, local, state and OSHA regulations must be determined and specified by the actual user or operator of the equipment.

NEVER start any blower without having all required safety guards properly installed. All blowers should be checked on a regular schedule, for missing or damaged guards. If any required guards are found to be missing or defective, the power to the blower should be immediately turned off and locked out in accordance with OSHA regulations. Power to the blower should NOT be tuned back on until the required guards have been repaired or replaced.

This blower can become dangerous due to a potential “windmill” effect, even though all electrical power has been turned off or disconnected. The blower wheel should be **carefully** secured to prevent any rotational turning ***BEFORE*** working on any parts of the blower/motor assembly that could move.

7. Access or Inspection Doors:

⚠ DANGER

NEVER OPEN ANY ACCESS OR INSPECTION DOORS WHILE THE BLOWER IS OPERATING. SERIOUS INJURY OR DEATH COULD RESULT FROM THE AFFECTS OF AIR PRESSURE, AIR SUCTION OR MATERIAL THAT IS BEING CONVEYED. DISCONNECT OR LOCK OUT POWER TO THE BLOWER AND LET THE BLOWER WHEEL COME TO A COMPLETE STOP *BEFORE* OPENING ANY TYPE OF ACCESS OR INSPECTION DOOR.

II. INSTALLATION

A. Vibration:

Before any mounting method is selected, the user should be aware of the effects vibration will have on the blower, motor and other parts. Improper blower installation can cause excessive vibration causing premature wheel and/or motor bearing failure, that is not covered under warranty. Vibration eliminator pads, springs or bases should be properly installed to prevent any blower vibration from transmitting to the foundation, support structure or ducting.

⚠ WARNING

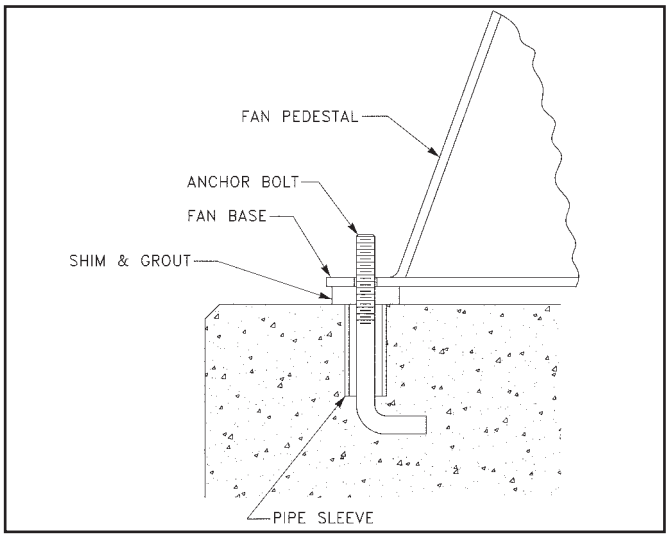
SHUT THE BLOWER DOWN IMMEDIATELY IF THERE IS ANY SUDDEN INCREASE IN VIBRATION.

B. Mounting Methods:

1. Floor Mounted Units;

Centrifugal blowers should be mounted on a flat, level, concrete foundation weighing 2-3 times the weight of the complete blower/motor assembly. It is recommended that the foundation be at least 6 inches larger than the base of the blower. The foundation should include anchor bolts such as shown in **Fig. 1** on page 4. Place the blower over the anchor bolts and shim under each bolt until the blower is level. After shimming, flat washers, lock washers and lock nuts should be tightened at each anchor bolt. Any gaps between the blower base and the foundation should be grouted. If the blower will be sitting on some type of vibration pads or mounts, follow the recommended mounting procedures supplied with the vibration elimination equipment.

Fig. 1



2. Elevated Units;

Improper mounting of elevated blowers can cause vibration problems. The structure that the blower/motor assembly will be mounted on must be strong enough to support at least 3 times the weight of the entire blower/motor assembly. **An insufficient support will cause excessive vibration and lead to premature wheel and/or motor bearing failure**. Bracing of the support structure must be sufficient enough to prevent any side sway. The entire structure should be welded at all connection joints to maintain constant alignment of the platform.

⚠ DANGER

THE IMPROPER DESIGN OF AN ELEVATED PLATFORM STRUCTURE COULD RESULT IN A RESONANT CONDITION, AND CONSEQUENTLY, CAUSE A LIFE THREATENING, CATASTROPHIC, STRUCTURAL FAILURE.

C. Duct Work Connections:

All duct connections to the blower should include flexible connectors between the ducting and the blower inlet and/or discharge. This will eliminate distortion, noise and vibration from transmitting to the duct and building. The connectors should be selected to handle the operating conditions for air volume and pressure that the blower will produce. **All ducting or accessories, added by the user, should be independently supported. DO NOT use the blower/motor assembly to support any additional weight.** Inlet and/or discharge duct elbows should be located a minimum of 2 blower wheel diameters from the blower. Any duct elbows located closer than 2 wheel diameters to the blower inlet or discharge **WILL** reduce the air performance and blower efficiency. Any duct elbows near the blower discharge should be in the **same rotational direction** as the **blower rotation**.

Non-Ducted Blower Inlet:

Any blower with no ducting on the inlet **must** have an inlet guard. The blower should be located so the blower inlet is, at least, 1 wheel diameter away from any wall or bulkhead to eliminate a reduction in air flow.

Non-Ducted Blower Discharge:

Any blower with no ducting on the discharge **must** have a discharge guard.

D. Safety Guards:

Cincinnati Fan offers guards, as optional, to keep your blower in compliance with OSHA safety regulations. These include inlet or discharge guards. Any blowers built with high temperature construction, a “heat slinger guard” is standard. It is the responsibility of the user to make sure this blower meets all local, state and OSHA safety regulations. If you have a specific guard requirement not covered by OSHA, please contact the local Cincinnati Fan sales office for assistance.

E. Dampers and Valves: (Airflow control devices)

If the blower is supplied with any type of air flow control device, it should be closed before initial start-up of the blower to minimize overloading of the motor. Any airflow control device, with bearings, should be maintained in accordance with the manufacturers instructions. Any air flow control device, with an automatic control mechanism, should be adjusted per the manufacturers recommendations.

F. Set Screw and Taper-lock Bushing Torque Values:

All blower wheel set screws are tightened to the proper torque prior to shipment. Some wheels may have taper-lock hubs and split, taper-lock bushings to secure the wheel to the motor shaft.

NOTE: Check all set screw or taper-lock bushing torques. Forces encountered during shipment, handling, rigging and temperature can affect factory settings. For correct torque values, see **Tables 1** and **2** below.

Table 1

SET SCREW TORQUE VALUES		
Diameter & Number of Treads/Inch	**Hex Wrence Size (Across Flats)**	**Required Torque (Inch Pounds)**
1/4-20	1/8"	65
5/16-18	5/32"	165
3/8-16	3/16"	228
7/16-14	7/32"	348
1/2-13	1/4"	504
5/8-11	5/16"	1104

Table 2

TORQUE VALUES FOR TAPER-LOCK BUSHINGS	
Taper-lock Bushing Size	**Required Torque (Inch Pounds)**
H	95
B	192
P	192
Q	350
R	350

⚠ CAUTION

Set screws should NEVER be used more than once. If the set screws are loosened, they MUST be replaced. Use only knurled, cup-point, set screws with a nylon locking patch.

III. ELECTRICAL

A. Disconnect Switches:

All blower motors should have an independent disconnect switch located in close visual proximity to turn off the electrical service to the blower motor. **Disconnects must be locked out in accordance with OSHA "lock out-tag out" procedures any time inspection or maintenance is being performed on the blower and/or motor assembly. The "lock out-tag out" procedure should be performed by a licensed electrician or authorized personnel.** All disconnects should be sized in accordance with the latest NEC codes (National Electric Codes) and any local codes and should be installed only by a licensed electrician. "Slow blow" or "time delay" fuses or breakers should be used since the initial start-up time for the blower motor, although rare, can be up to 10 seconds.

B. Motors:

⚠ DANGER

ALL WIRING CONNECTIONS, INSPECTION AND MAINTENANCE OF ANY MOTOR MUST BE PERFORMED BY A LICENSED ELECTRICIAN IN ACCORDANCE WITH THE MOTOR MANUFACTURERS RECOMMENDATIONS, ALL ELECTRICAL CODES AND OSHA REGULATIONS. FAILURE TO PROPERLY INSTALL, MAKE WIRING CONNECTIONS, INSPECT OR PERFORM ANY MAINTENANCE TO A MOTOR CAN RESULT IN MOTOR FAILURE, PROPERTY DAMAGE, EXPLOSION, ELECTRICAL SHOCK AND DEATH.

1. **DO NOT connect or operate a motor without reading the motor manufacturers instructions supplied with the blower.** The basic principle of motor maintenance is: **KEEP THE MOTOR CLEAN AND DRY.** This requires periodic inspections of the motor. The frequency of the inspections depends on the type of motor, the service and environment it will be subjected to and the motor manufacturers instructions.
2. **Cleaning:** Cleaning should be limited to exterior surfaces only. **Follow motor manufacturers cleaning instructions.**
3. **Lubrication:** Most small motors have sealed bearings that are permanently lubricated for the life of the motor. Some larger motors have grease plugs that should be replaced with grease fittings to perform re-lubrication. These motors, or any motor with grease fittings, should be lubricated in accordance with the motor manufacturers recommendations. Lubrication frequency depends on the motor horsepower, speed and service. **BE SURE** you use compatible grease and **DO NOT** over grease.
4. **Location:** If the motor will be outside and subjected to the weather, it is recommended that a weather cover be installed to keep rain and snow off of the motor. No motors are guaranteed to be "watertight". Be careful to allow enough openings between the motor and the motor cover to let the motor "breath". If the back end of the motor is covered, the cover should be no closer than 3" to the back of the motor for proper ventilation.

5. **Wiring Connections:** All wiring connections should be made for the proper voltage and phase as shown on the motor nameplate. Connections should follow the motor manufacturers recommendations as shown on the wiring schematic. This wiring diagram will be located on the outside of the motor, inside of the motor conduit box or on the motor nameplate. **Reversing some wires might be necessary to get the correct blower rotation.**
6. **Motors with Thermal Overload Protection:** If a motor is equipped with thermal overloads, the thermal overload must be wired per the wiring schematic to be operable. ***There are 3 types of thermal overloads:***
   a. **Automatic:** These will automatically shut the motor down if the internal temperature exceeds the design limits.

⚠ DANGER

MAKE SURE YOU LOCK OUT THE POWER TO THE MOTOR BEFORE INSPECTING ANY MOTOR WITH AUTOMATIC THERMALS. WHEN THE THERMALS COOL DOWN, THEY WILL ALLOW THE MOTOR TO AUTOMATICALLY START UP AGAIN, UNLESS YOU HAVE LOCKED OUT THE POWER TO THE MOTOR.

   b. **Manual:** These motors will have a button on them. If the motor overheats, it will shut down. After you have inspected the motor and eliminated the over heating problem, you will need to "reset" it by pushing the button. **You should still lock out the power BEFORE inspecting the motor.**
   c. **Thermostats:** This type of thermal is a temperature sensing device **ONLY**. If the motor overheats, the thermostats will open or close (depending on the type) and send a **"signal"** to the electrical box. ***THEY WILL NOT TURN THE MOTOR OFF.*** **These are pilot circuit devices that must be connected to the magnetic starter circuit.**

7. **EXPLOSION PROOF Motors:** No motor is explosion proof. Explosion proof (EXP) motors are designed so if there is an explosion **WITHIN** the motor, the explosion will be **CONTAINED INSIDE** the motor and not allowed to get out to the atmosphere. All explosion proof motors must be selected based on the atmosphere and/or the environment the motor will be operating in. Explosion proof motors are designed, rated, and labeled for their operating conditions based on Classes, Groups and "T" Codes. **The Class, Group and "T" Code of an EXP motor MUST be selected based on the atmosphere and/or environmental conditions the motor will be operating in. Consult the NEC (National Electric Code) and the NFPA (National Fire Protection Association) for the proper EXP motor Class, Group and "T" Code required for your specific application and location.**

⚠ DANGER

IF AN EXPLOSION PROOF MOTOR IS USED IN AN AREA CONTAINING VOLITILE LIQUIDS, GASES, FUMES OR DUST FOR WHICH THE MOTOR WAS NOT DESIGNED TO OPERATE IN, AN EXPLOSION AND/OR FIRE CAN OCCUR.

NOTICE:

   a. **All EXP motors have some type of thermal overload as required by UL (Underwriters Laboratories). Refer to all of Section 6 above.**
   b. **All EXP motors are required to have the UL (Underwriters Laboratories) and CSA (Canadian Standards Association) listing numbers on the motor name plate or on a separate plate attached to the motor. The Class, Group and "T" Code the motor is designed for must also be listed.**

8. **Normal Motor Operating Temperatures:**
   Using your hand to test the normal running temperature of a motor can be a very painful experience;
   The normal operating temperature of a fully loaded, open type, electric motor operating in a 70°F. (21° C.) ambient temperature is 174°F. (79° C.)

C. Maximum Blower Speed and Motor Speed Controllers:

If you will be using any type of motor speed controller with this blower, **DO NOT** exceed the **maximum safe blower speed**. Installing and using a speed control device requires special training and certification as required by the speed control manufacturer. See the manufacturers instructions for proper use, installation and wiring connections for the maximum speed settings. It may also be necessary to "block out" some speeds to eliminate a resonant vibration problem. The maximum safe blower speed is shown on the data sheet shipped with the blower. If you have lost the data sheet, contact Cincinnati Fan or our sales office for your area. You must have the serial number from the **blower** name plate for us to determine the maximum safe blower speed. Cincinnati Fan will only extend the motor manufacturers warranty, when used with a speed controlling device, if the motor has the words **"Inverter Duty"** marked on the motor name plate. If the motor does not have **"Inverter Duty"** marked on the motor name plate, and you have a motor failure, you will be required to contact the motor manufacturer for any service or warranty claims.

IV. INITIAL UNIT STARTUP

NOTICE: Failure to complete and document all the following pre-startup and both post-startup checks, listed in sections A (below) and B on page 8, could void all warranties.

A. Pre-Startup & Post-Startup Checks: (Check blocks as each step is completed. Retain this for your records.)

A1. Pre-Startup Checks Completed By: _____ DATE: _____

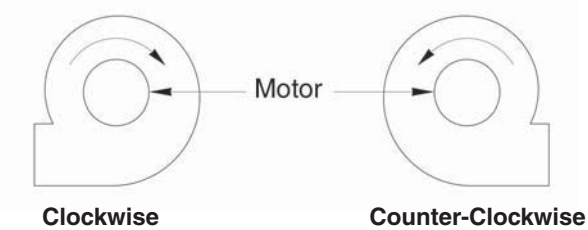
A2. 8 Hour, Post-Startup Checks Completed By: _____ DATE: _____

A3. 3 Day, Post-Startup Checks Completed By: _____ DATE: _____

MAKE SURE POWER TO THE MOTOR IS LOCKED OUT BEFORE STARTING PRE-STARTUP OR POST-STARTUP CHECKS.

1. ☐☐☐ If possible, *CAREFULLY* spin the blower wheel by hand to ensure it rotates freely and no rubbing or clicking noise is heard.
2. ☐☐☐ Check all blower, foundation and duct work hardware to make sure it is tight.
3. ☐☐☐ Check all blower wheel set screws to make sure they are tight per **Table 1** on page 5.
4. ☐☐☐ If the wheel has a taper-lock bushing, make sure the bolts are tightened per **Table 2** on page 5.
5. ☐☐☐ Make certain there is no foreign material in the blower or duct work that can become a projectile.
6. ☐☐☐ Make sure any inspection doors in the duct work are securely bolted or locked.
7. ☐☐☐ Ensure all electrical power components are properly sized and matched for your electrical system.
8. ☐☐☐ Check that all required guards are properly secured.
9. ☐☐☐ Any dampers should be fully opened and closed to make sure there is no binding or interference.
10. ☐☐☐ If your blower is mounted on an elevated support structure, make sure the structure is welded at all the joint connections and the structure is properly braced to prevent “side sway”.
11. ☐☐☐ Close any dampers to minimize load on motor. Especially on blowers with high temperature construction. **Never** subject a “cold” blower to a “hot” gas stream. If the blower will be handling “hot gases” greater than 150°F (65°C) it is imperative that the blower be subjected to a gradual rate of temperature increase, not to exceed 15°F/minute (8°C/minute). The same temperature limits are also important when the blower is experiencing a drop in temperature until the temperature drops down to 150°F (65°C). Only, when the entire blower has reached an equilibrium temperature of 150°F (65°C), or less, should the power be turned off.
12. ☐☐☐ Make sure the power source connections to the blower motor are per the motor manufacturers instructions.
13. ☐☐☐ Make sure the blower wheel is stationary prior to startup. **Starting a blower with a wheel that is rotating backwards can cause wheel damage.**
14. ☐☐☐ Apply power to the blower motor momentarily (i.e. “bump start”) to check for proper blower wheel rotation. If the blower is rotating in the wrong direction, reconnect the motor leads per the motor manufacturers wiring schematic. **Blower rotation is determined by viewing the blower from the motor side of the blower, NOT from the inlet side**. After reconnecting the leads, repeat this step. **See Fig. 2 below.**

Fig. 2



Clockwise (CW) Rotation **Counter-Clockwise (CCW) Rotation**

15. ☐☐☐ Apply power to the blower motor and let it come up to full speed. **Turn off the power.** Look and listen for any unusual noise or mechanical abnormality while the blower wheel is still spinning. If any are noticed, lock out the power, wait for the blower wheel to come to a complete stop, locate the cause and correct it.
16. ☐☐☐ Unlock power and start the blower.
17. ☐☐☐ Measure, record and keep the following motor data for future reference and comparison:
(Single phase motors will only have L1 and L2 leads)

Amperage draw on each motor lead: L1 _____ L2 _____ L3 _____
(Running amps **SHOULD NOT** exceed the motor nameplate amps for the voltage being operated on)

Voltage coming to motor leads: L1_____ L2_____ L3_____
(Should be about the same input voltage on all leads)

B. Vibration:

The blower was balanced at the factory to comply with ANSI/AMCA Standard 204-05, Category BV-2. However, rough handling in shipment and/or erection, weak and/or non-rigid foundations, and misalignment may cause a vibration problem after installation. After installation, the vibration levels should be checked by personnel experienced with vibration analysis and vibration analysis equipment.

NOTE:

The blower SHOULD NOT be operated if the vibration velocity of the fan exceeds 0.50 inches per second, filter out, if the blower is rigidly mounted. If the blower is mounted on isolators or on an isolator base, it SHOULD NOT be operated if the vibration velocity of the blower exceeds 0.75 inches per second, filter out.

Vibration readings for direct driven blowers should be taken on the motor at the top, sides and end as per **Fig. 3** below. After you have taken your vibration readings, write them down in the spaces below and keep for future comparison.

⚠ DANGER

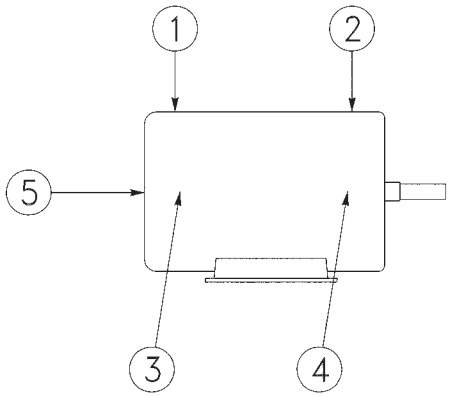
If the blower is going to be conveying material, it is the users responsibility to periodically turn the blower off and lock out the power. The blower wheel should then be checked for material build-up and/or erosion. If material has built up on any parts of the wheel, it MUST be removed and cleaned before it is put back into service. If any parts of the wheel have been eroded, the wheel MUST be replaced. Failure to perform this inspection can cause excessive vibration that will damage the blower and/or motor bearings. When vibration becomes excessive, it will lead to complete blower failure that could cause property damage, severe personal injury and death. The user must determine the frequency of this inspection based on the actual circumstances of their operation, BUT checking the vibration readings should NEVER exceed a 12 month period. For the AMCA/ANSI standard for vibration limits, see Fig. 4 on page 9.

Fig. 3

VIBRATION METER PROBE POSITIONS

For Arrangement 4 Blowers

	1	2	3	4	5
A					
B					
C					

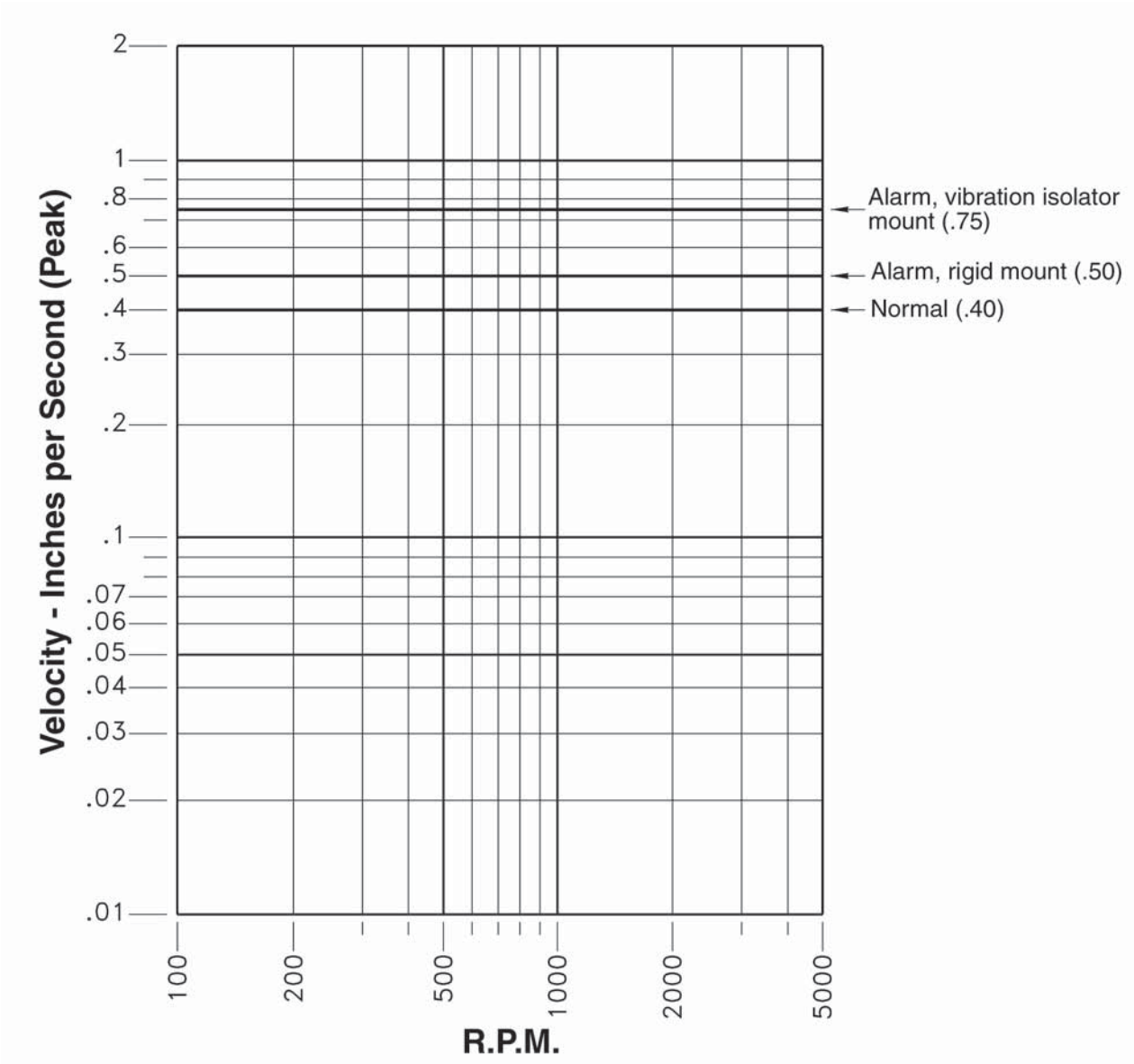


A Pre-Startup ..... Readings taken by: _____ **Date:** _____

B 8 Hour Post-Startup ..... Readings taken by: _____ **Date:** _____

C 3 Day Post-Startup ..... Readings taken by: _____ **Date:** _____

Fig. 4 Vibration Severity Chart



V. ROUTINE INSPECTION & MAINTENANCE

Periodic inspection of all the blower parts is the key to good maintenance and trouble-free operation. The frequency of inspections must be determined by the user and is dependent upon the severity of the application. **BUT,** it should **NEVER** exceed a 12 month period. The user should prepare an inspection and maintenance schedule and make sure it is adhered to.

⚠ WARNING

BEFORE STARTING ANY INSPECTION OR MAINTENANCE, BE SURE BLOWER IS TURNED OFF, POWER IS LOCKED OUT AND THE BLOWER WHEEL HAS BEEN CAREFULLY SECURED TO PREVENT WIND MILLING. IF THE OPERATING CONDITIONS OF THE BLOWER ARE TO BE CHANGED (SPEED, PRESSURE, TEMPERATURE, ETC.) CONSULT CINCINNATI FAN, OR OUR SALES OFFICE FOR YOUR TERRITORY, TO DETERMINE IF THE UNIT WILL OPERATE SAFELY AT THE NEW CONDITIONS.

A. Hardware:

All blower and foundation hardware should be checked to make sure it is tight. Wheel set screws or taper-lock bushings should be tightened to the torque values shown in **Tables 1 and 2** on page 5.

NOTE: If any set screws have come loose, they must be thrown away and replaced. **NEVER** use set screws more than once. **Replace with knurled, cup-point set screws with a nylon locking patch.**

B. Motor Bearing Lubrication:

1. Motor Bearings:

Most smaller motors have sealed bearings that never require re-lubrication for the life of the motor. For any motors with grease fittings, consult the motor manufacturers recommendations with reference to the lubrication frequency and the type of grease that should be used.

DO NOT over grease the motor bearings. Generally, 1-2 shots should be enough. Use a hand operated grease gun at no more than 40 PSI. ***IF POSSIBLE, CAREFULLY*** **lubricate the motor bearings while the motor is running.**

C. Wheel Balance:

All blower wheels are balanced at the factory. It is not uncommon that additional "trim balancing" is required after the blower is assembled. Trim balancing of the blower assembly, in the field, is typically always necessary for all replacement wheels. **After any wheel is installed, the final balance of the entire blower assembly should be checked.** Refer to Section B on page 8 and Fig. 4 on page 9. Air stream material or chemicals can cause abrasion or corrosion of the blower parts. This wear is generally uneven and, over time, will lead to the wheel becoming unbalanced, causing excessive vibration. When that happens, the wheel must be rebalanced or replaced. The other air stream components should also be inspected for wear or structural damage and cleaned or replaced if necessary. **After cleaning any blower wheel, it should be balanced and then "trim balanced" on the motor shaft.**

There are three ways to balance a blower wheel:

1. **Add balancing weights for fabricated aluminum, steel or stainless steel wheels:**
   Balance weights should be rigidly attached to the wheel at a location that will not interfere with the blower housing nor disrupt air flow. They should (if at all possible) be welded to the wheel. When trim balancing the wheel, **on the blower,** be sure to ground the welder **directly** to the blower wheel. Otherwise, the welding current will likely pass through the motor and damage the motor bearings.
2. **Grinding off material for cast aluminum wheels:**
   If you are grinding on the wheel to remove material, be very careful not to grind too much in one area. That could affect the structural integrity of the wheel.
3. **Forward curved wheels, Model LM only (also known as squirrel cage or multivane wheels).**
   These wheels have balancing clips attached to individual blades around the wheel. That is the only proper way to balance this type of wheel.
   NOTE:
   Removing any forward curve wheel from the blower to clean it, requires special attention when reinstalling the wheel back into the blower housing. Make sure you reinstall the wheel so the proper wheel-to-inlet clearance is maintained. Failure to do this will affect the blowers airflow (CFM), static pressure (SP) capabilities and efficiency. Consult Cincinnati Fan or our local sales office for your area for assistance if necessary.

D. Vibration:

As mentioned previously in this manual, excessive vibration can cause premature motor bearing failure that could lead to catastrophic failure of the blower. After performing any routine maintenance, the vibration readings should be taken again. New readings should be taken (maximum every 12 months) and compared to the readings you recorded in **Figure 3**, on page 8, during the initial startup. **If any major differences are present, the cause should be determined and corrected before the blower is put back into operation.**

The most common causes of vibration problems are:

1. Wheel unbalance.
2. Mechanical looseness.
3. Poor blower inlet and/or discharge conditions.
4. Foundation stiffness.

E. Dampers and Valves: (Airflow control devices)

Turn off and lock out power to the blower motor. Any dampers or valves should be periodically inspected to make sure all parts are still operable within their full range and there is no interference with any other damper or blower components. Any bearings or seals should be checked for their proper function. The manufacturers maintenance instructions should be followed.

F. Safety Equipment & Accessories:

It is the users responsibility to make sure that all safety guards required by the company, local, state and OSHA regulations are properly attached and fully functional at all times. If any guards become defective or non-functional at any time, **the power to the blower MUST be turned off and locked out** until complete repairs and/or replacements have been made, installed and inspected by authorized personnel.

Any accessories used in conjunction with the blower should also be inspected to make sure they are functioning within their intended limits and design specifications. The manufacturers maintenance manuals should be referred to for correct maintenance procedures. These accessories include, but are not limited to, the following:

Shaft seals, inspection doors, vibration isolators or vibration bases, air flow or pressure measuring equipment, hoods, controls, special coatings, silencers, expansion joints, valves, flexible connectors and filters.

VI. ORDERING REPLACEMENT PARTS:

Under normal conditions, you should not need any spare or replacement parts for at least 24 months after shipment from Cincinnati Fan. That does not include any wear due to abrasion, corrosion, excessive temperatures, abuse, misuse, accident or any severe conditions the fan was not designed for.

NOTICE:

1. **If this blower is vital to any process that could cost you lost revenue, we strongly recommend that you keep a replacement blower wheel and motor at your location.**

2. **If this blower is vital for the safety of any people and/or animals, we strongly recommend that you keep a complete blower/motor assembly, as originally ordered, at your location.**

To order any parts or complete units, contact us for the name of our sales office for your area. Or you can find them on our website at: **www.cincinnatifan.com**

WE MUST HAVE THE BLOWER SERIAL NUMBER FROM THE BLOWER NAME PLATE TO IDENTIFY PARTS CORRECTLY.

VII. TROUBLESHOOTING

⚠ DANGER

Troubleshooting should only be performed by trained personnel. Any potential electrical problems should only be checked by a licensed electrician. All safety rules, regulations and procedures MUST be followed. Failure to follow proper procedures can cause property damage, severe bodily injury and death.

Potential problems and causes listed below are in no order of importance or priority. The causes are only a list of the most common items to check to correct a problem. If you find the cause of a problem, **DO NOT** assume it is the **ONLY** cause of that problem. Different problems can have the same causes.

PROBLEM	CAUSE
Excessive Vibration	1. Loose mounting bolts, wheel set screws, taper-lock hubs. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Bent motor shaft. 5. Worn motor bearings. 6. Motor out of balance. 7. Inadequate structural support. 8. Support structure not sufficiently cross braced. 9. Weak or resonant foundation. 10. Foundation not flat and level.
Airflow (CFM) Too Low	1. Blower wheel turning in wrong direction (**rotation**). 2. Actual system static pressure (**SP**) is higher than expected. 3. Motor speed (**RPM**) too low. 4. Dampers or valves not adjusted properly. 5. Leaks or obstructions in duct work. 6. Filters dirty. 7. Inlet and/or discharge guards are clogged. 8. Duct elbow too close to blower inlet and/or discharge. 9. Improperly designed duct work 10. Blower wheel not properly located relative to the inlet bell (**LM** Model only).
Airflow (CFM) Too High	1. Actual system static pressure (**SP**) is lower than expected. 2. Motor speed (**RPM**) too high. 3. Filter not in place. 4. Dampers or valves not adjusted properly.

PROBLEM	CAUSE
Motor Overheating	**NOTE: A normal motor will operate at 174°F. See B-8 on page 6.** 1. Actual system static pressure **(SP)** is lower than expected. 2. Voltage supplied to motor is too high or too low. 3. Motor speed (**RPM**) too high or defective motor. 4. Air density higher than expected. 5. Motor wired incorrectly or loose wiring connections. 6. Cooling fan cover on back of motor is clogged. (Fan cooled motors only.)
Excessive Noise	1. Wheel rubbing inside of housing. 2. Worn or corroded blower wheel. 3. Accumulation of foreign material on blower wheel. 4. Loose mounting bolts, wheel set screws, or taper-lock hubs. 5. Bent motor shaft. 6. Worn motor bearings. 7. Motor out of balance. 8. Motor bearings need lubrication. 9. Vibration originating elsewhere in system. 10. System resonance or pulsation. 11. Inadequate or faulty design of blower support structure. 12. Blower operating near "stall" condition due to incorrect system design or installation.
Fan Doesn't Operate	1. Motor wired incorrectly. 2. Incorrect voltage supply. 3. Defective fuses or circuit breakers. 4. Power turned off elsewhere. 5. Motor wired incorrectly or loose wiring connections. 6. Defective motor.

VIII. LONG TERM STORAGE INSTRUCTIONS: (Storage exceeding 30 days after receipt of equipment)

NOTE: Failure to adhere to these instructions voids all warranties in their entirety.

1. Storage site selection:
   a. Level, well-drained, firm surface, in clean, dry and warm location. Minimum temperature of 50°F (10°C).
   b. Isolated from possibility of physical damage from construction vehicles, erection equipment, etc.
   c. Accessible for periodical inspection and maintenance.
2. The blower should be supported under each corner of its base to allow it to "breath". Supports (2 x 4's, timbers, or railroad ties) should be placed diagonally under each corner.
3. If the equipment is to be stored for more than three (3) months, the entire blower assembly must be loosely covered with plastic, **but not tightly wrapped**.
4. Storage Maintenance:

   A periodic inspection and maintenance log, by date and action taken, must be developed and maintained for each blower. See example below. Each item must be checked monthly.

EXAMPLE:

Storage / Maintenance Schedule Log

ITEM	ACTION	DATES CHECKED
1	Re-inspect units to insure any protective devices used are functioning properly. Check for scratches in the finish which will allow corrosion or rust to form.	
2	Rotate wheel a minimum of 10 full revolutions to keep the motor bearing grease from separating and drying out. ***This is a critical step.***	

Long Term Storage instructions continued on page 13.

5. General Motor Procedure:

   If the motor is not put into service immediately, the motor must be stored in a clean, dry, warm location. Minimum temperature of 50°F. (10°C,). Several precautionary steps must be performed to avoid motor damage during storage.

   a. Use a “Megger” each month to ensure that integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
   b. **DO NOT** lubricate the motor bearings during storage. Motor bearings are packed with grease at the factory.
   c. If the storage location is damp or humid, the motor windings **must** be protected from moisture. This can be done by applying power to the motor’s space heaters, (IF AVAILABLE) while the motor is in storage. If the motor does not have space heaters, storing it in a damp or humid location will, very quickly, cause internal corrosion and motor failure which is not warranted.

   ***NOTE*:**
   For specific storage instructions, for the <u>actual</u> motor and any accessory parts that were supplied, refer to the manufacturer’s instructions.

IX. LIMITED WARRANTY:

Cincinnati Fan & Ventilator Company (Seller) warrants products of its own manufacture, against defects of material and workmanship under normal use and service for a period of eighteen (18) months from date of shipment or twelve (12) months from date of installation, whichever occurs first. This warranty does not apply to any of Seller's products or any part thereof which has been subject to extraordinary wear and tear, improper installation, accident, abuse, misuse, overloading, negligence or alteration. This warranty does not cover systems or materials not of Seller's manufacture. On products furnished by Seller, but manufactured by others, such as motors, Seller extends the same warranty as Seller received from the manufacturer thereof. Expenses incurred by Purchaser's in repairing or replacing any defective product will not be allowed except where authorized in writing and signed by an officer of the Seller.

The obligation of the Seller under this warranty shall be limited to repairing or replacing F.O.B. the Seller's plant, or allowing credit at Seller's option. **THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EITHER EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF THE SELLER. THE PURCHASER ACKNOWLEDGES THAT NO OTHER REPRESENTATIONS WERE MADE TO PURCHASER OR RELIED UPON BY PURCHASER WITH RESPECT TO THE QUALITY OR FUNCTION OF THE PRODUCTS HEREIN SOLD.**

Removal of the Sellers nameplate or any generic fan nameplate containing the fan serial number voids all warranties, either written or implied. Failure to complete and document all the pre-startup and post startup checks and perform the suggested routine maintenance checks voids all warranties, either written or implied.

LIMITATION OF LIABILITY:

Notice of any claim, including a claim for defect in material or workmanship, must be given to Seller in writing within 30 days after receipt of the equipment or other products. Seller reserves the right to inspect any alleged defect at Purchaser's facility before any claim can be allowed and before adjustment, credit, allowance replacement or return will be authorized. See **RETURNS** below. Seller's liability with respect to such defects will be limited to the replacement, free of charge, of parts returned at Purchaser's expense F.O.B. Seller's plant and found to be defective by the Seller.

IN NO EVENT WILL SELLER BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, INCLUDING WITHOUT LIMITATION DAMAGES FOR INJURY TO PERSONS OR PROPERTY, LOST PROFITS OR REVENUE, LOST SALES OR LOSS OF USE OF ANY PRODUCT SOLD HEREUNDER. PURCHASER'S SOLE AND EXCLUSIVE REMEDY AGAINST SELLER WILL BE THE REPLACEMENT OF DEFECTIVE PARTS AS PROVIDED HEREIN OR REFUND OF THE PURCHASE PRICE FOR DEFECTIVE PRODUCTS, AT SELLER'S SOLE OPTION. SELLER'S LIABILITY ON ANY CLAIM, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, FOR ANY LOSS OR DAMAGE ARISING OUT OF OR IN CONNECTION WITH PURCHASER'S ORDER OR THE PRODUCTS OR EQUIPMENT PURCHASED HEREUNDER, SHALL IN NO CASE EXCEED THE PURCHASE PRICE OF THE EQUIPMENT GIVING RISE TO THE CLAIM.

RESPONSIBILITY:

It is the understanding of the Seller that Purchaser and/or User will use this equipment in conjunction with additional equipment or accessories to comply with all Federal, State and local regulations. The Seller assumes no responsibility for the Purchaser's or Users compliance with any Federal, State and local regulations.

RETURNS:

Cincinnati Fan & Ventilator Company assumes no responsibility for any material returned to our plant without our permission. An **RMA** (Return Material Authorization) number must be obtained and clearly shown on the outside of the carton or crate and on a packing slip. Any items returned must be shipped freight prepaid. Failure to comply will result in refusal of the shipment at our receiving department.

DISCLAIMER

This manual, and all its content herein, is based on all applicable known material at the time this manual was created. **Any parts of this manual are subject to change at any time and without notice.**

If any statements, diagrams and/or instructions contained herein, **for components not manufactured by the Seller,** conflict with instructions in the manufacturer's manual (i.e.: motors, dampers, etc.), the instructions in the manufacturer's manual, for that component take precedent.

Should you want the latest version of this manual, please contact us or our sales office for your area. Or, you can print a current version by going to our website at: **www.cincinnatifan.com**

cincinnati fan

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X. PARTS DRAWING:

PLEASE NOTE

Cincinnati Fan manufactures many models and arrangements with special variations. For that reason, the maintenance manuals contained on our website do not include a parts drawing nor the completed blower or fan specifications on page 1. For the parts drawing of all the standard components and specifications for the specific blower or fan that you have, please contact our local Cincinnati Fan sales office for your area.

You will need to give them the serial number shown on the blower or fan nameplate so they can supply you the correct information.

Click on ***"Contact a Sales Rep"*** on our website for the name and contact information for our local sales office for your area. **www.cincinnatifan.com**

Innovations in Water Monitoring

Operator's Manual

RDO® PRO-X Process Optical Dissolved Oxygen Probe

DO-501 - Transmitter, Dissolved Oxygen, OpticalRDO Pro-x (10m cable)

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The presence of the Waste Electrical and Electronic Equipment (WEEE) marking on the product indicates that the device is not to be disposed via the municipal waste collection system of any member state of the European Union.

For products under the requirement of WEEE directive, please contact your distributor for the proper decontamination information and take back program, which will facilitate the proper collection, treatment, recovery, recycling, and safe disposal of the device.

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Optical RDO PRO-X Dissolved Oxygen Probe Specifications

Optical RDO PRO-X Dissolved Oxygen Probe	
Sensor Type	Optical (luminescent) dissolved oxygen sensor
RDO PRO-X Probe	Range: 0 to 50 mg/L concentration
	Accuracy: ±0.1 mg/L, 0 to 8 mg/L ±0.2 mg/L, 8 to 20 mg/L ±10% of reading, 20 to 50 mg/L
	Resolution: 0.01 mg/L
	Response time: T90 < 45 sec; T95 < 60 sec @ 25°C
	Storage conditions: -5° to 60° C (23° to 140° F)
RDO-X Sensor Cap	Usage life: 2 years typical
	Storage conditions: 1° to 60° C (33° to 140° F), in factory container
Temperature sensor	Range: 0° to 50° C (32° to 122° F)
	Accuracy: ±0.1° C typical
	Resolution: 0.01° C
Transmitter/local display	Optional, or use with Con TROLL PRO System
Communications options	Modbus/RS485, 4-20 mA, SDI-12
Max. power consumption	50 mA at 12 VDC
Measure current	6 mA typical at 24 VDC
Idle current (no measurement or communication)	160 µA typical at 24 VDC
Maximum cable length	Up to 1,219 m (4,000 ft) (for Modbus and 4-20 mA) or up to 60.96 (200 ft) for SDI-12
Cable options	10 m fixed stripped-and-tinned; Twist-lock connector with user-selectable cable length
Internal mounting thread	1¼ - 11 ½ NPT
IP rating	IP-67 with cap off, IP-68 with cap installed
Compliance	Heavy industrial, IEC 61000-6-2:2005
Salinity compensation	Fixed or real-time capable (using controller)
Barometric pressure	Fixed or real-time capable (using controller)
Maximum pressure	150 psi from 0 to 50° C; 300 psi @ 25° C
Warranty	Probe: 3 years from date of shipment RDO-X Sensor Cap: 2 years in typical applications
Methods	Standard Methods 4500-O; In-Situ Methods 1002-8-2009,1003-8-2009, 1004-8-2009 (EPA approved)

Introduction

The RDO PRO-X Probe is a rugged, reliable instrument designed to deliver accurate dissolved oxygen (DO) data across a wide measurement range and to reduce maintenance costs. The probe features the latest optical technology for DO measurement.

System Description

The RDO PRO-X system consists of the following items.

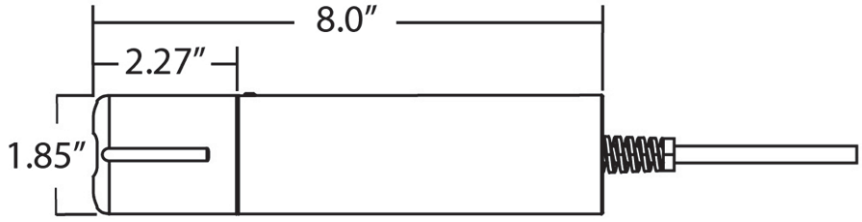
- Black probe body with removable nose cone
- Optical RDO-X Sensor Cap
- Titanium thermistor

RuggedCable System

- 10-m standard length with stripped-and-tinned ends
- Customized lengths with titanium twist-lock connectors

1	Cable end, stripped-and-tinned
2	Nose cone
3	RDO-X Sensor Cap
4	Thermistor

1	Probe
2	Cable end, twist-lock connector and RuggedCable System



Serial Numbers

The probe serial number is engraved on the side of the unit. The cap serial number is programmed on the memory chip inside the cap.

Unpack the Probe

1. Remove the probe from the box and other packaging materials.
2. Unscrew the nose cone from the probe and remove the red protective dust cap from the sensor. Save the dust cap for later use.

1	Dust cap
2	Nose cone

3. Remove the RDO cap from the storage sleeve.

4. Align the arrow on the cap with the index mark on the probe and firmly press the cap onto the probe, without twisting, until it seals over the probe body.

1	Alignment arrow on cap
2	Cap installed over lens
3	Nose cone

✔ Do not allow moisture or atmospheric humidity inside the cap. Keep the cap in its sealed package until you are ready to install it. Install promptly. Ensure that O-ring grooves are dry and that the O-ring is not rolled or pinched inside the cap.
The typical cap lifetime is two years after the first reading has been taken.

5. Reattach the nose cone.

Calibrate the RDO PRO-X Probe

Calibrate the sensor with the Comm Kit Software and the RDO PRO Communication Device, or calibrate the sensor directly with your controller.

1-Point Calibration

The optical Rugged Dissolved Oxygen sensor is very stable. The factory calibration should produce readings within 3% accuracy. If you require readings with greater accuracy we recommend that you perform a 1-point, 100% water-saturated air calibration as described below.

Water-Saturated Air

1. Remove the storage cap from the top of the calibration chamber and replace it with the vented calibration cap.

1	Storage cap
2	Vented calibration cap

Figure 6.1 Storage cap and vented calibration cap shown together

2. Place the sponge wafer in the bottom of the calibration chamber and saturate with approximately 10 mL water.
3. Gently dry the instrument and sensing material with a paper towel, making sure there is no water or debris on the instrument or on the sensing surface.
4. Place the instrument into the calibration chamber about 2.5 cm (1 in.) above the water-saturated sponge.

Figure 6.2 Calibration chamber with water-saturated sponge

5. Allow 5 to 10 minutes for temperature stabilization prior to starting the calibration procedure. Do not leave the instrument in the calibration chamber for more than 30

minutes. This can allow condensation to form on the sensing material, which will produce false low readings after calibration. If condensation does occur, remove the instrument, dry the sensing material, place the instrument in the chamber, and calibrate.

2-Point Calibration

100% and 0% Saturation

We recommend that you perform the 0 % oxygen calibration only if you intend to measure dissolved oxygen at a concentration of less than 4 mg/L.

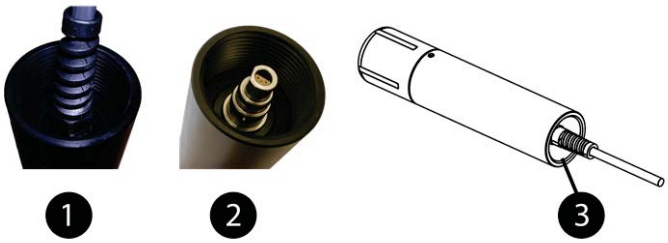
1. Set up the calibration procedure as previously described, and perform a water-saturated air calibration.
2. Remove the water-saturated sponge from the calibration chamber and fill the chamber to the fill line with approximately 60 mL of fresh sodium sulfite solution.

1	Fill line
2	Temperature sensor

2. Place the instrument into the solution. Leave at least 13 mm (0.5 in.) between the surface of the sensing material and the bottom of the chamber.
3. Ensure that the temperature sensor is completely submerged in the solution.
4. Allow at least 5 minutes for the temperature to stabilize prior to performing the calibration procedure.
5. Once calibration is complete, remove the sensor, and thoroughly rinse to remove all of the sodium sulfite.

Probe Deployment

The cable end of the RDO PRO-X Probe is internally threaded (1¼ - 11½ NPT) and can be attached to a male threaded pipe. When deployed, make sure that the nose cone and thermistor are completely submerged.



1	10 m cable attached
2	Twist-lock connector
3	1 1/4 NPT threading

Care and Maintenance

Clean the RDO-X Sensor Cap

1. The cap and nose cone must remain on the probe.
2. Rinse the sensor with clean water from a squirt bottle or spray bottle.
3. Gently wipe with a soft-bristled brush or soft cloth if biofouling is present. Use Alconox to remove grease.
4. If extensive fouling or mineral build-up is present, soak the cap end in vinegar for 15 minutes, then soak in deionized (DI) water for 15 minutes.

> ⚠ Do not use organic solvents—they will damage the sensing element. Do not remove the cap from the sensor prior to cleaning.

5. After cleaning, perform a 1- or 2-point user calibration or calibration check.

Clean the Optical Window

1. Clean the optical window only when you change the cap. See full instructions in the sensor cap replacement kit.
2. Remove the cap and gently wipe the lens with the supplied lens cloth.

> ⚠ Do not wet the lens area with water or any solution. Use only the supplied lens cloth for cleaning. Do not use any other cloth or material.

Clean the Probe

With the RDO cap installed on probe, gently scrub the probe with a soft-bristled brush or nylon dish scrubber. Use Alconox to remove grease or other matter. Soak in vinegar and DI water to remove mineral deposits or extensive fouling.

RDO-X Sensor Cap Storage

Prior to installation–Store in factory supplied container.

Installed–Store in the calibration chamber with the storage cap attached and a few drops of clean water.

Replace the RDO-X Sensor Cap

The RDO cap has a 2-year typical life after the sensor takes its first reading. Replacement caps are available from In-Situ Inc. or your authorized In-Situ distributor.

1. Remove the probe nose cone.
2. Use a lint-free cloth to remove any moisture from the probe.

3. Pull the used RDO cap off of the sensor, without twisting.
4. Remove the existing O-rings from the sensor.

> ⚠ Ensure that there is no moisture in the O-ring grooves. Do not touch or clean the lens with anything other than the supplied lens wipe.

5. Use your finger to apply a very light layer of silicone-based lubricant around the O-ring grooves.
6. Place the O-rings on the sensor. Apply another thin layer of lubricant to the O-rings and grooves.

> ✔ Note: Do not transfer grease to the lens or sensor pins.

7. Clean the sensor lens with the wipe provided in the kit and allow it to thoroughly dry. Inspect for scratches or dirt.
8. Remove the new cap from its sealed packaging and attach it to the sensor, being careful to press firmly, without twisting, until it seals over the lens. Make sure that the O-rings are not pinched or rolled between the cap and sensor.
9. Replace the nose cone.
10. Perform a 1- or 2-point calibration.

Maintain Desiccant

Desiccant installed in a controller or transceiver protects probe electronics from condensation. A desiccant pack changes color from blue to pink as it becomes saturated with moisture.

> ⚠ It is extremely important to use the proper size desiccant for your deployment and to change desiccant often. Desiccant should be changed before the entire pack has turned pink, and you should use enough to effectively keep cables and probes dry until your next scheduled maintenance. Desiccant lifespan is dependent on site conditions.

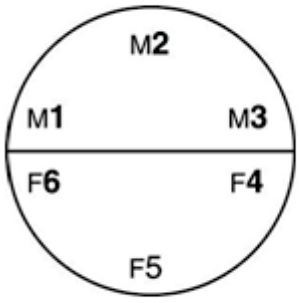
Controller Requirements and Connections

The RDO PRO-X Probe may be connected to a controller or logger for communication via the following options.

- Analog (4-20 mA) provides a configurable 4-20 mA current loop output
- SDI-12
- RS485 Modbus
- RS232 to Modbus

Wiring Overview

Refer to diagrams on the following pages. Trim and insulate unused wires. The shielded wire should be connected to a chassis ground or earth ground.

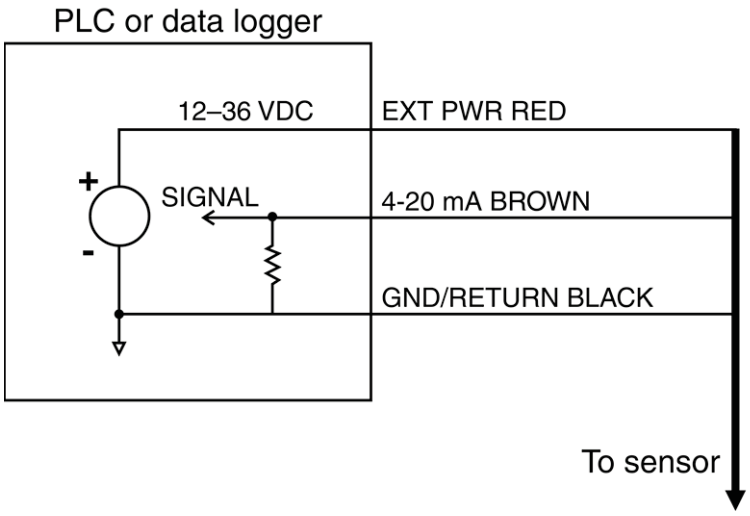


Signal	Color
Ground/Return	Black
External Power	Red
4-20 mA	Brown
RS485 (-)	Green
RS485 (+)	Blue
SDI-12	White

⚠ The inside of the controller must be kept free of moisture and humidity. Condensed moisture can migrate through the wiring and cause the probe to fail. Therefore, desiccant should be installed in the controller and be replaced on a regular basis.

Analog (4-20 mA) 3-wire

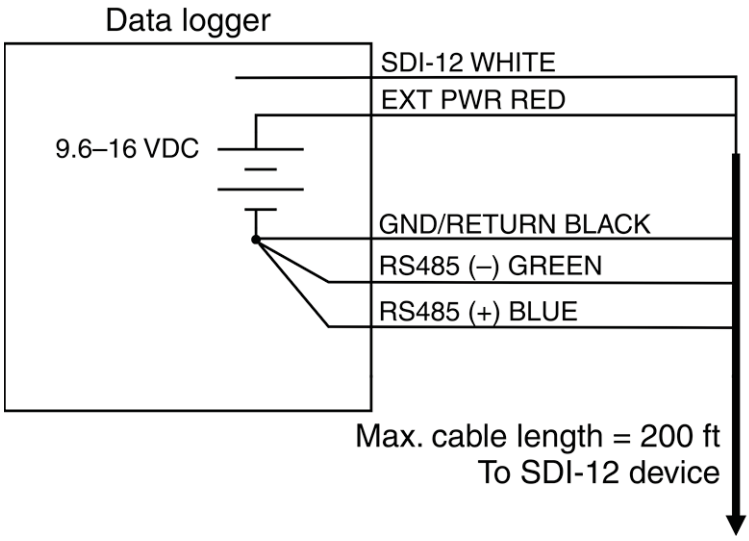
Signal	Color
Ground/Return	Black
External Power (12-36 VDC)	Red
4-20 mA	Brown



✔ Cable length must not exceed 1219 m (4000 ft.)
Analog signal must be enabled in Win-Situ 5 Software or the Comm Kit Software prior to use.

SDI-12 (3-wire)

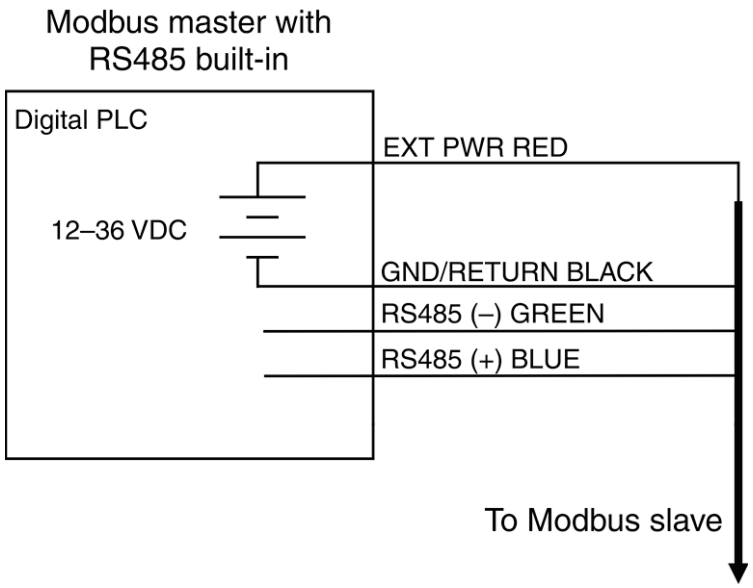
Signal	Color
Ground/Return	Black
External Power (9.6-16 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue
SDI-12	White



✔ Cable length must not exceed 60.96 m (200 ft.)

Modbus Master with Built-in RS485

Signal	Color
Ground/Return	Black
External Power (12-36 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue

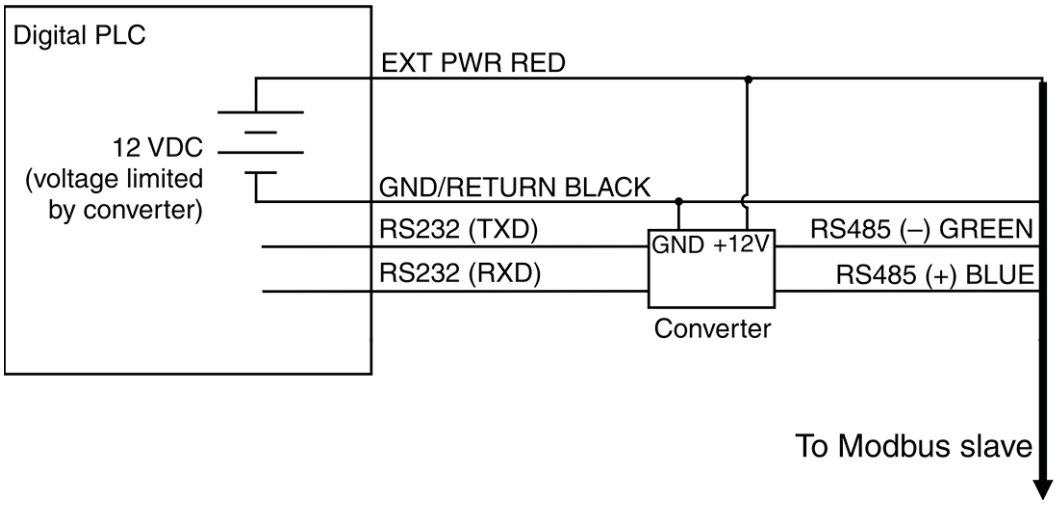


✔ Cable length must not exceed 1219 m (4000 ft.)

Modbus Master with Built-in RS232 (Converter Required)

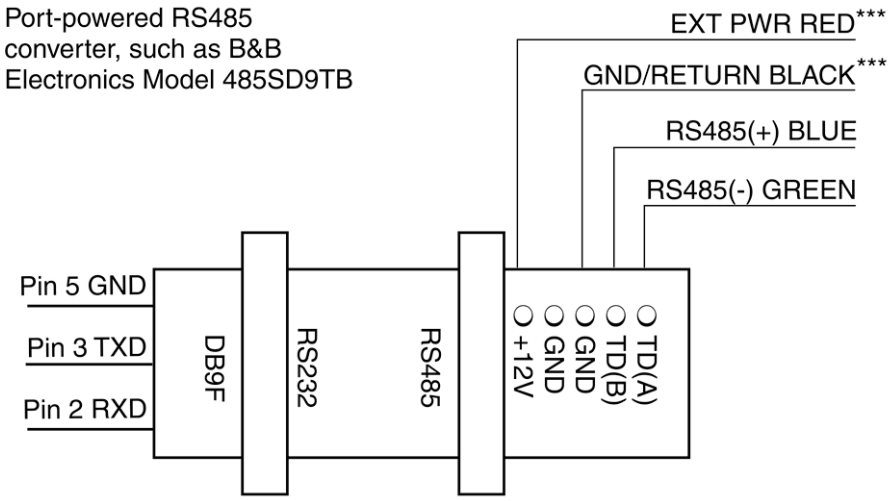
Signal	Color
Ground/Return	Black
External Power (12 VDC, voltage limited by converter)	Red
RS485 (-)	Green
RS485 (+)	Blue

Modbus master with
RS232 built-in
(converter required)



✔ Cable between converter and master must not exceed 60.96 m (20 ft.)
Cable between master and slave must not exceed 1219 m (4000 ft.)

Converter



*** Required if port power is not available

Power Connections

The red wire provides power for all system modes. Analog output is disabled by default. However, the 4-20 mA current loop output can be continuous in Modbus or SDI-12 mode as long as Modbus device register 9507 is set to 1.

Communications

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time–whichever one is currently in use will block communication on the other.

Modbus Registers

Common Registers

Register	Size	Mode & Access Level (R/W)	Data Type	Description
9001	1	R/W	ushort	Device ID = 31 for RDO PRO-X
9002	2	R/W	ulong	Device serial number
9004	3	R/W	time	Manufacture date

Sensor Status Registers

Register	Size	Mode & Access Level (R/W)	Data Type	Description
0005	3	R1	time	Cap start date/time 0 = no cap
0008	3	R1	time	Cap end of usable life date/time 0 = no cap

Device Specific Register 0042 Data Quality ID

Register 0042 is responsible for returning the various data quality IDs for the RDO sensor. For a list of the Data Quality IDs and definitions, see the Sensor Health Table in the Service and Troubleshooting section of this manual.

Device Specific Registers

Register	Size	Mode & Access Level (R/W)	Data Type	Description
Dissolved Oxygen Concentration				
0038	2	R1	float	Measured value, C_o
0040	1	R1	ushort	Parameter ID = 20
0041	1	R1/W2	ushort	Units ID 117 = mg/L (default) 118 = ug/L
0042	1	R1	ushort	Data quality ID (See the Sensor Health Table)
0043	2	R1/W3	float	Offline sentinel value (default = 0.0)
0045	1	R1	16 bits	Available units = 0x0030 (48)
Temperature				
0046	2	R1	float	Measured value
0048	1	R1	ushort	Parameter ID = 1
0049	1	R1/W2	ushort	Units ID 1= °C (default) 2= °F
0050	1	R1	ushort	Data quality ID
0051	2	R1/W3	float	Offline sentinel value (default = 0.0)
0053	1	R1	16 bits	Available units = 0x00030 (3)
Dissolved Oxygen % Saturation				
0054	2	R1	float	Measured value
0056	1	R1/W2	ushort	Parameter ID = 21
0057	1	R1/W2	ushort	Units ID 177 = percent saturation (default)
0058	1	R1	ushort	Data quality ID
0059	2	R1/W3	float	Offline sentinel value (default = 0.0)
0061	1	R1	16 bits	Available units = 0x0001 (1)
Oxygen Partial Pressure				
0062	2	R1	float	Measured value
0064	1	R1	ushort	Parameter ID = 2 (pressure)
0065	1	R1/W2	ushort	Units ID 26 = torr (default)
0066	1	R1	ushort	Data quality ID
0067	2	R1/W3	float	Offline sentinel value (default = 0.0)
0069	1	R1	16 bits	Available Units = 0x0200 (512)

Dissolved Oxygen Equations

Dissolved Oxygen Concentration

DO concentration is internally calculated in mg/L. Conversion to other units is as follows:

$\mu g/L = 1000 * mg/L$

Oxygen concentration C_o (mg/L) is calculated as:

$$C_o = 31.9988 \times 1E6 \times (\rho P_o / k_o M)\,(1 - \Theta_o) \times S_c$$

Where:

P_o is the partial pressure of O_2 in atmospheres.

$$P_{torr} = 759.999876 \times P_{atm}$$

S_c is the salinity correction:

$$\ln S_c = S(B_0 + B_1 T_s + B_2 T_s^2 + B_3 T_s^3) + C_0 S^2$$

$B_0 = -6.246090 \times 10^{-3}$

$B_1 = -7.423444 \times 10^{-3}$

$B_2 = -1.048635 \times 10^{-2}$

$B_3 = -7.987907 \times 10^{-3}$

$C_0 = -4.679983 \times 10^{-7}$

T_s is the scaled temperature:

$$T_s = \ln[(298.15 - t) / (273.15 + t)]$$

t is temperature in degrees C.

S is the salinity in PSU.

k_o is Henry's constant:

$$\ln k_o = 3.71814 + (5596.17/T) - (1{,}049{,}668/T^2)$$

T is temperature in Kelvin.

Θ_o is the negative of the second pressure coefficient:

$$\Theta_o = 0.000975 - (1.426 \times 10^{-5} t) + (6.436 \times 10^{-8} t^2)$$

t is temperature in degrees C.

ρ is the density of water in g/cm^3:

$$\ln \rho = -0.589581 + (326.785/T) - (45{,}284.1/T^2)$$

T is the temperature in Kelvin.

Molar mass of water: M = 18.0152 g/mole

References:

Benson and Krause. Jr.. 1980. The concentration and isotopic fractionation of gases dissolved in freshwater in equilibrium with the atmosphere. *Limnol, Oceanogr*, 25(4), 662-671.

Gordon and Garcia. 1992. Oxygen Solubility in Seawater: Better Fitting Equations. *Limnol, Oceaongr*, 37(6), 1307-1312.

Dissolved Oxygen, % Saturation

$O_2\%Sat = O_2Reading / O_2100\%Sat$

Where:

O_2 reading is the mg/L reading from the RDO Sensor.

O_2 100% Sat is the theoretical saturation value in mg/L and is derived as:

$$O_2100\%Sat = 31.9988 \times 10^6 \times \frac{\rho\,[0.20946 \times (P - P_{wv})] \times (1 - \Theta_o P) \times S_c}{k_o M}$$

Where:

ρ is the density of water in g/cm^3:

$$\ln \rho = -0.589581 + (326.785/T) - (45{,}284.1/T^2)$$

T is the temperature in Kelvin.

P is the atmospheric pressure in atm.

P_{wv} is the partial pressure of water vapor at saturation in atm:

$$\ln P_{wv} = 11.8571 - (3{,}840.70/T) - (216{,}961/T^2)$$

k_o is Henry's constant:

$$\ln k_o = 3.71814 + (5596.17/T) - (1{,}049{,}668/T^2)$$

T is the temperature in Kelvin.

Molar mass of water: M = 18.0152 g/mole

Θ_o is the negative of the second pressure coefficient:

$$\Theta_o = 0.000975 - (1.426 \times 10^{-5} t) + (6.436 \times 10^{-8} t^2)$$

t is temperature in degrees C.

S_c is the salinity correction:

$$\ln S_c = S(B_0 + B_1 T_s + B_2 T_s^2 + B_3 T_s^3) + C_0 S^2$$

$$B_0 = -6.246090 \times 10^{-3}$$

$$B_1 = -7.423444 \times 10^{-3}$$

$$B_2 = -1.048635 \times 10^{-2}$$

$$B_3 = -7.987907 \times 10^{-3}$$

$$C_0 = -4.679983 \times 10^{-7}$$

T_s is the scaled temperature:

$$T_s = \ln [(298.15 - t) / (273.15 + t)]$$

Where t is temperature in °C

S is the salinity in PSU

References:

Benson and Krause. Jr.. 1980. The concentration and isotopic fractionation of gases dissolved in freshwater in equilibrium with the atmosphere. *Limnol, Oceanogr*, 25(4), 662-671.

Calibration Registers

Register	Size	Mode & Access Level (R/W)	Data Type	Description
0118	2	R1/W3	float	Live salinity value (PSU)
0120	2	R1/W3	float	Default salinity value (PSU, default = 0.0)
0122	2	R1/W3	float	Live barometric pressure (mbar)
0124	2	R1/W3	float	Default barometric pressure (mbar, default = 1013.25)
0126	2	R1/W3	float	100% saturation calibration reading (mg/L)
0128	2	R1/W3	float	100% saturation temperature reading (°C)
0130	2	R1/W3	float	100% saturation salinity value (PSU)
0132	2	R1/W3	float	100% saturation barometric pressure (mbar)
0134	2	R1/W3	float	0% saturation calibration reading (mg/L)
0136	2	R1/W3	float	0% saturation temperature reading (°C)
0138	2	R1/W3	float	Calibration slope (default = 1.0)
0140	2	R1/W3	float	Calibration offset (default = 0.0)

Live Salinity Value

The live salinity value is used to correct the oxygen concentration value for salinity. Values must be written in Practical Salinity Units (PSU) in the range 0 to 42 PSU. This is not a measured parameter.

Default Salinity Value

The default salinity value is loaded into the live salinity value register when power is first applied to the probe. The default salinity value is used in calculations until a live salinity value is written. This is not a measured parameter.

Live Barometric Pressure

The live barometric pressure is used in the calculation of percent saturation and to determine the theoretical saturation point during calibration. Values must be written in millibars in the range 506.625 to 1114.675 mbar. This is not a measured parameter.

Default Barometric Pressure

The default barometric pressure is loaded into the live barometric pressure register when power is applied to the probe. The default barometric pressure is used in calculations until a live barometric pressure is written. This is not a measured parameter.

100% Saturation Calibration Values

These values represent the sensor conditions while the probe is in a 100% saturation calibration environment. These are not measured values, they are written by the controller during the calibration process.

Writes to these registers are only accepted if the probe is in the calibration mode. The probe will return exception 0x85 (invalid device command sequence) if an attempt is made to write these registers when the calibration mode is off.

0% Saturation Calibration Values

These values represent the sensor conditions while the probe is in a 0% saturation calibration environment. These are not measured values, they are written by the controller during the calibration process.

Writes to these registers are only accepted if the probe is in the calibration mode. The probe will return exception 0x85 (invalid device command sequence) if an attempt is made to write these registers when the calibration mode is off.

Calibration Slope and Offset

These values represent the slope and offset that will be applied to the raw concentration reading from the sensor to generate the final values reported by the sensor parameters. These registers may be written independently of the normal internal calibration procedure.

Entering Calibration Registers

The sensor is calibrated using the following procedure.

1. Optional: Read the Sensor Data Cache Timeout register 9463 and store the value.
2. Write the Sensor Data Cache Timeout register 9463 to a value less than your intended sample rate and greater than 1000 milliseconds. This will ensure that you get new sensor readings during the stabilization process.
3. Optional: Read the temperature units register 0049 and saturation units register 0041 and store their values.
4. Write the temperature units register 0049 to its default value (1) and write the saturation units register 0041 to its default value (117).
5. Write the Calibration Mode On command (0xE000) to the sensor command register 9305.
6. Update the live salinity and barometric pressure registers if necessary.
7. Prompt the user to place the probe in a 100% saturation environment.
8. Read the oxygen concentration and temperature parameters. When these values have reached equilibrium, record them in their respective 100% saturation calibration registers. Write the current live salinity and barometric pressure readings to their respective calibration registers.
9. Place the sensor in a 0% saturation environment. When these registers have reached equilibrium, record them in their respective 0% saturation calibration registers. If a zero calibration is not to be performed, these registers can be set to zero or left at their previous values.

10. Write the Calibration Update command (0xE001) to the sensor command register. The sensor will calculate a new slope and offset, write the current time to the last user calibration time register, and set the next user calibration time register to zero (disabled). If the concentrations at 100% and 0% saturation are equal, the probe will return an exception response with code 0x97 (invalid calibration) and not attempt to compute a new slope and offset due to possible division by zero. If the slope does not calculate between 0.85 and 1.20 inclusive, or if the offset does not calculate between -0.2 and +0.2 inclusive, then the probe will return an exception response with code 0x97 (invalid calibration).The slope and offset will be available for read but will not be committed to flash.
11. Optional: Read the last user calibration time register, add the next calibration interval, and write the result to the next user calibration time register.
12. Write the Calibration Mode Off command (0xE002) to the sensor command register to place the sensor in normal operation. If the calibration mode is turned off without a calibration update command, or the calibration command returned an exception, the previous calibration shall be restored.
13. Optional: If you saved the temperature and saturation parameter units at the start of the process, write the original values back.
14. Optional: If you saved the Sensor Data Cache Timeout register 9463 at the start of the process, write the original value back.

Calibration Calculations

Calibrated oxygen reading:

$$O_{2RC} = c_o + c_1 \times O_{2RU}$$

Where:

$$c1 = (O_2100\%Sat)/(O_{2RUS} - O_{2RUZ})$$

$$c_o = -c_1 \times O_{2RUZ}$$

Where:

$O_2100\%Sat$ is the theoretical 100% saturation point

O_{2RUS} is the un-calibrated reading at 100% saturation

O_{2RUZ} is the un-calibrated reading at 0% saturation

References:

Standard Methods for the Examination of Water and Wastewater. 20th Ed. 2008. 4500-0 C. Azide Modification. American Public Health Association, USA.

Service

The RDO PRO-X Probe contains no user-serviceable parts. Do not attempt to open the probe case or service the unit yourself.

RDO-X Software Troubleshooting

✔ Sensor health diagnostics indicate when the RDO sensor has been damaged in the field. If the sensor has sustained moderate damage, the probe provides a DO value that includes a (DIS or Data Quality ID 5) warning. The same warning is included with readings taken after the sensor has reached its 24-month recommended lifespan.

However, if the sensor has been severely damaged, an error message is shown (ERR or Data Quality ID 3), a DO value is not provided and the sentinel value is shown. This prevents you from receiving an erroneous reading.

Sensor Health Table

The following error messages appear in the software and the data file when a sensor issue has been detected.

Abbreviation	Data Quality ID	Text	Description
None	0	None	Normal Data Quality
UC	1	User Cal Expired	Parameter measured without errors using an expired user calibration.
FC	2	Factory Cal Expired	Parameter measured without errors using an expired factory calibration.
ERR	3	Unknown Error	Parameter measured with error, sentinel value supplied.
WU	4	Sensor Warm-up	Sensor is warming up, sentinel value supplied.
DIS	5	Sensor Warning	Parameter measured but does not meet normal quality criteria. The sensor has sustained moderate damage, or the recommended lifespan has been reached.

Abbreviation	Data Quality ID	Text	Description
CAL	6	Sensor Calibrating	Sensor is calibrating, calibration value supplied.
OL	7	Sensor Missing	Sensor communication failed, sentinel value supplied. Make sure the sensor cap is installed and properly seated.

Appendix A - Communication Device

The Communication Device is an accessory product that can be used to calibrate and set up RDO probes.

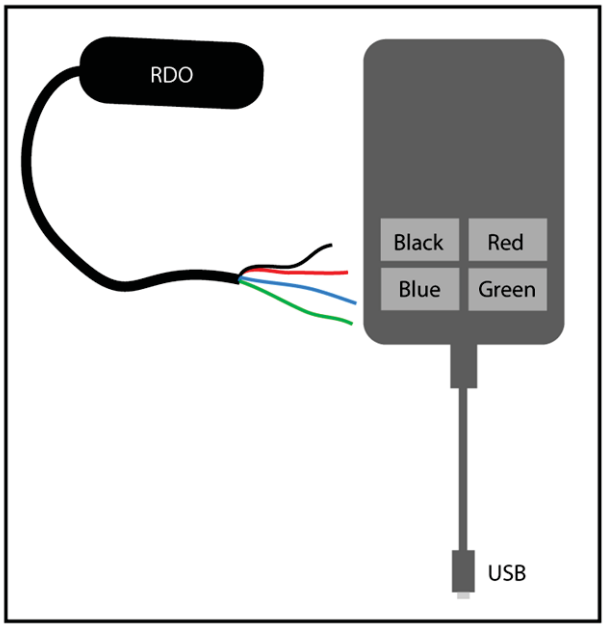
Install and Open the Software

The Comm Kit Software must be installed on a computer before you connect to the probe.

Connect the Probe to the Communication Device

The Communication Device connects a stripped-and-tinned probe to a computer via USB connection.

1. Disconnect the instrument from the PLC.
2. The communication device includes an electrical connection diagram label. To attach the instrument to the communication device, depress a lever and insert the appropriate wire in the location specified by the diagram.
3. Attach the USB connector to a USB port on the computer. Follow the directions provided in the Communication Device Kit to set up the probe.



Declaration of Similarity

Equipment

Type of equipment: Measurement instrumentation
Product name: RDO PRO-X Optical Dissolved Oxygen Probe
Model: RDO PRO-X Dissolved Oxygen Probe

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Category Standards

- **Immunity**
  EN 61000-6-2, Electromagnetic Compatibility (EMC) – part 6-2: Generic standards – Immunity for industrial environments
- **Emissions**
  Class A requirements of CISPR 11: 2004, Specification for limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

Supplementary Information:
The device complies with the requirements of the EU Directive 73/23/EEC, and the CE mark is affixed accordingly.

Summary

We confirm that the equipment referenced above, without reasonable doubt, will fulfill the requirements concerning electromagnetic compatibility according to the above mentioned standards harmonized with the 2004/108/EC for Electromagnetic Compatibility (EMC) Directive—part 6-2. The RDO PRO Optical Dissolved Oxygen Sensor was tested and found to be in compliance in the month of October 2008.

Date of Issue: October 7, 2013

Signature:

Name: Ben Kimbell
Title: Vice President of Research and Development

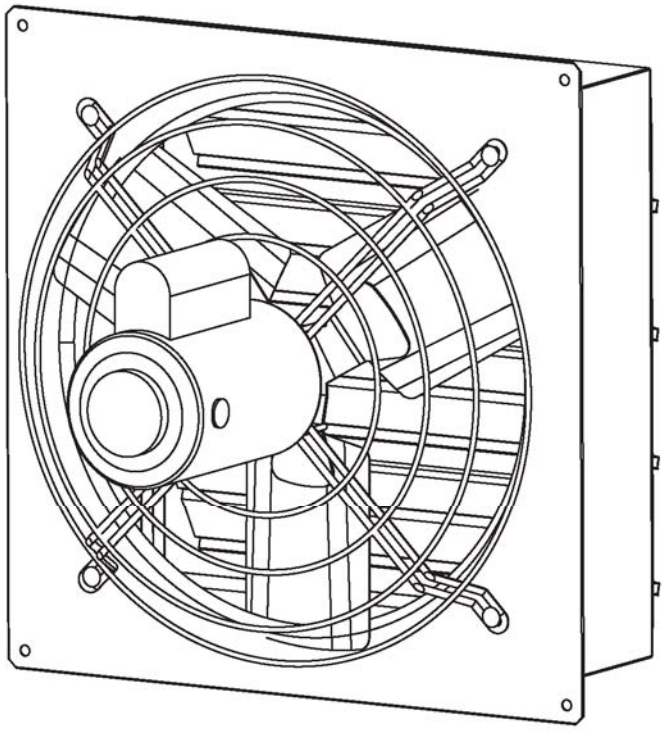
Test Report reference: 3161946DEN-003

F-7961 - Fan, Building, 12", 1/4hp, 1750rpm, 120V, 1ph, TEAOCSA Approved, S12-E1

CANARM®

Standard Exhaust Fans

Instruction Manual



WARRANTY

CANARM Ltd. warrants every new fan to be free of defects in material and workmanship, to the extent that, within a period of one year from the date of purchase CANARM Ltd. shall either repair or replace at CANARM's option, any unit or part thereof, returned freight prepaid, and found to be defective.
This warranty does not include any labour or transportation costs incidental to the removal and reinstallation of the unit at the user's premises.
Components repaired or replaced are warranted through the remainder of the original warranty period only.
This warranty applies to the original purchaser-user only; it is null and void in case of alteration, accident, abuse, neglect, and operation not in accordance with instructions.

NOTICE: No warranty claims will be honored by CANARM Ltd. unless prior authorization is obtained.

Installation or Product problems? Do not return to store of purchase.
Contact Canarm Service at 1-800-265-1833 (CANADA) 1-800-267-4427 (U.S.A.)
1-800-567-2513 (EN FRANCAIS) Monday to Friday 8:00 - 5:00pm e.s.t.

CANARM®

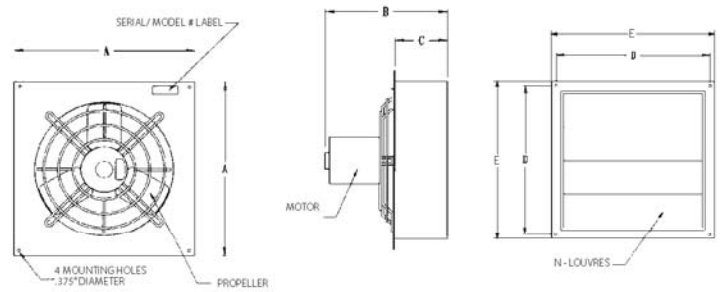
Instruction Manual for Standard Exhaust Fans

Read Instructions Completely Before Installation & Save For Reference

Congratulations on the purchase of your quality built direct drive, wall exhaust ventilation fan. All of these models use totally enclosed ball bearing motors with thermal over load protection. Variable speed motors are high efficiency motors which save on electrical costs and can be run as a single speed motor. The motors are mounted on heavy gauge welded steel rod motor mounts that have a powder coated finish. Fans come fully assembled and 100% of fans are tested for proper operation before shipping.

Standard Fans:

These models have a rugged, welded steel box housing with a powder coated finish and aluminum or plastic exhaust louvers that are supported by long life nylon bushings. The louvers open automatically when the fan starts up and close when the fan stops.



Fan Dimensions							
Fan Size	A	B	C	D	E	N	Framing
8"	13-1/4"	10"	4"	12"	10-3/4"	2	11x11
10"	15-1/4"	10"	4"	14"	12-3/4"	2	13x13
12"	17-1/4"	14"	6"	16"	14-3/4"	3	15x15
14"	19-1/4"	14"	6"	18"	16-3/4"	3	17x17
16"	21-1/4"	14"	6"	20"	18-3/4"	4	19x19
18"	23-1/4"	15"	6"	22"	20-3/4"	4	21x21
20"	25-1/4"	16"	6"	24"	22-3/4"	5	23x23
24"	29-1/4"	16"	6"	28"	26-3/4"	5	27x27
30"	35-1/4"	19"	6"	34"	32-3/4"	8	33x33
36"	41-1/4"	16"	6"	40"	38-3/4"	10	39x39

Explosion Proof Fans:

Explosion proof fans are equipped with explosion proof motors and aluminum blades so sparks cannot occur if a metal object obstructs the blade path. Explosion proof fans have the same quality welded steel box housing and heavy gauge welded guard as the standard fans. These fans should be used to ventilate hazardous areas. Locations are considered hazardous if the atmosphere contains or may contain gas, vapor, or dust in explosive quantities.

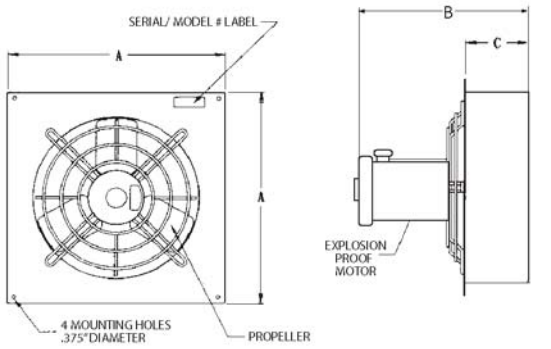
The motor ambient temperature is not to exceed +40ºC or -25ºC unless the motor nameplate specifically permits another value. Canarm explosion proof fans are approved for the hazardous classifications below only.

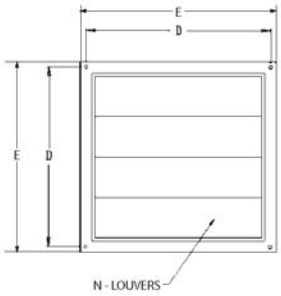
Class 1, Division 1 (Gases, Vapors)

~~Group A~~	Acetylene
~~Group B~~	Butadiene, ethylene oxide, hydrogen, Propylene oxide
Group C	Acetaldehyde, cyclopropane, diethlether, Ethylene, isoprene
Group D	Acetone, acrylonitrile, ammonia, benzene, Butane, ethylene dichloride, gasoline, hexane, methane, methanol, naphtha, propane, propylene styrene, toluene, vinyl, acetate, vinyl chloride, xylene

Class 2, Division 1 (Combustible Dusts)

~~Group E~~	Aluminum, magnesium and other metal dusts with similar characteristics
Group F	Carbon black, coke or coal dust
Group G	Flour, starch or graindust





Fan Dimensions							
Fan Size	A	B	C	D	E	N	Framing
12"	17-1/4"	20-1/2"	6"	16"	14-3/4"	3	15x15
18"	23-1/4"	20-1/2"	6"	22"	20-3/4"	4	21x21
24"	29-1/4"	20-1/2"	6"	28"	26-3/4"	5	27x27

INSTALLATION

Installation is fast and simple. A sturdy framed wall opening should be prepared in advance to the size indicated for your fan in the charts above. With lag bolts for wooden frames or nut, bolt and lock washers for steel frames, secure the fan using the four mounting holes provided, one in each corner of the fan.

ELECTRICAL CONNECTIONS

WARNING: BE SURE POWER IS OFF AT THE ELECTRICAL PANEL BEFORE WIRING.

WARNING: ALL ELECTRICAL WORK SHOULD BE PERFORMED BY A QUALIFIED ELECTRICIAN.

These fans are supplied with single, two or variable speed motors. Single and two speed motors are 120V only. Variable speed motors are dual voltage. All dual voltage motors are pre-wired at 240V in our factory. Rewire motor as per motor nameplate if running fan at 120V. Please see the motor nameplate for wiring diagram. Make electrical connections in motor connection box as per the motor nameplate. Follow ***Chart #1*** for wire sizes. Two speed fans require a two speed control or 3 position toggle switch to change from high/ low/off. See wiring diagram with control for 2 speed wiring instructions.

CHART# 1

Table A Minimum Wire Sizes for Three-Phase Motors

Motor	25 to 50 Feet			100 Feet			150 to 200 Feet		
HP	200V	230V	460V	200V	230V	460V	200V	230V	460V
1/8	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*
1/6	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14	14(16)*	14(18)*
1/4	14(18)*	14(18)*	14(18)*	14(16)*	14(18)*	14(18)*	14	14	14(18)*
1/3	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*	12	14	14(18)*
1/2	14(16)*	14(18)*	14(18)*	12	14(16)*	14(18)*	10	12	14(18)*
3/4	14(16)*	14(16)*	14(18)*	12	14	14(18)*	10	10	14(16)*
1	14	14(16)*	14(18)*	12	12	14(18)*	8	10	14(16)*
1-1/2	12	14	14(18)*	10	10	14(16)*	6	8	14
2	12	12	14(18)*	8	10	14(16)*	6	6	12
3	10	12	14(18)*	6	8	14	4	6	12

Table B Minimum Wire Sizes for Single-Phase Motors

Motor	25 Feet			100 Feet			150 to 200 Feet		
HP	200V	230V	460V	200V	230V	460V	200V	230V	460V
1/8	14(18)*	14(18)*	14	14(18)*	12	14(18)*	10	8	14
1/6	14(16)*	14(18)*	12	14(18)*	10	14(16)*	6	6	12
1/4	14	14(18)*	10	14(16)*	8	14	6	4	10
1/3	14	14(18)*	10	14(16)*	8	14	6	4	10
1/2	12	14(18)*	8	14	6	12	4	3	8
3/4	10	14(16)*	6	12	4	10	2	1	6
1	10	14(16)*	6	12	4	10	2	1	6
1-1/2	8	14	6	12	3	8	1	1/0	6
2	8	14	4	10	2	8	1/0	2/0	4
3	6	12	3	8	1/0	6	2/0	4/0	3

NOTE:
- NEC Article 310-5 - * Minimum conductor size for general wiring at 115-440VAC is number 14AWG.
- Above wire sizes based on approximate 5% voltage drop during starting; copper conductors; and 75ºC type THHW, THW, THWN, RH, RHW insulation etc. For aluminum wire, increase two wire size steps minimum. See NEC Article 310 for ampacities af aluminum conductors.
- Type S, SO, SJ, SJO, etc flexible cable wire sizes. See NEC Article 400 for ampacity.

OPERATION

WARNING: VARIABLE SPEED FANS SHOULD HAVE THE MINIMUM SPEED SET TO OPEN LOUVERS AT LEAST ONE INCH FOR PROPER MOTOR COOLING AND TO PREVENT MOTOR FAILURE.
All fans are direct drive. Fans with variable speed motors can be operated as an energy efficient single speed fan or in variable operation with the proper controller. As mentioned above two speed fans require a two speed control or 3 position toggle switch to change from high speed to low and off.

WARNING: GUARDING SHOULD BE USED IF FANS ARE MOUNTED LOWER THAN SEVEN FEET (2 METRES) OFF FLOOR OR GROUND LEVEL.

ACCESSORIES
Canarm provides a complete line of manual and thermostatic controls. Canarm also offers wall mount exhaust shutter kits, replacement shutter sets, and weather protection hoods.

MAINTENANCE
Motors are equipped with automatic overload protection and may restart without warning. Always disconnect from power before attempting service. Motor, blade and louvers should be kept clean of any buildup to prevent premature motor failure and to achieve proper performance. Automatic louvers should be kept operating freely. As with all mechanical equipment scheduled inspections should include checking that all hardware is secure and blade set screws are tight.

WARRANTY

CANARM Ltd. warrants every new fan to be free of defects in material and workmanship, to the extent that, within a period of one year from the date of purchase CANARM Ltd. shall either repair or replace at CANARM's option, any unit or part thereof, returned freight prepaid, and found to be defective.
This warranty does not include any labour or transportation costs incidental to the removal and reinstallation of the unit at the user's premises.
Components repaired or replaced are warranted through the remainder of the original warranty period only.
This warranty applies to the original purchaser-user only; it is null and void in case of alteration, accident, abuse, neglect, and operation not in accordance with instructions.

NOTICE: No warranty claims will be honored by CANARM Ltd. unless prior authorization is obtained.

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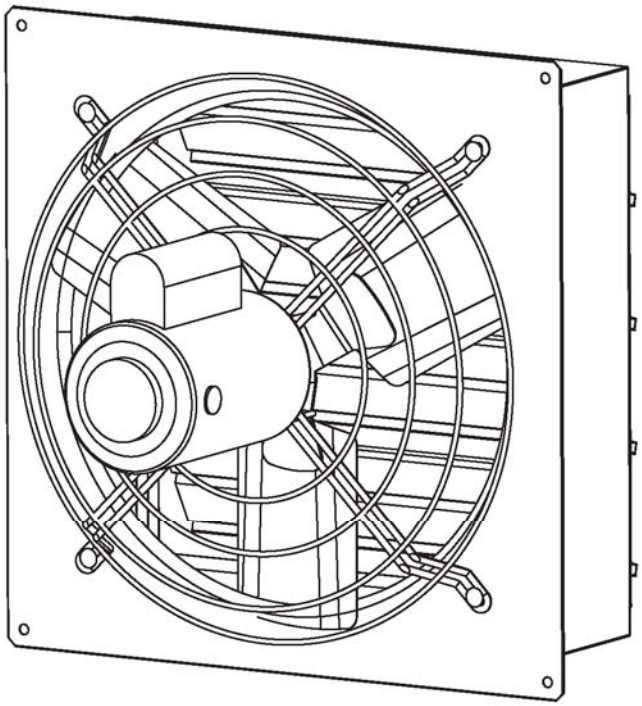
CANARM®

Ventilateurs d'évacuation Standard

Manuel de l'usager



GARANTIE

Canarm Ltée. garantie que chaque nouveau ventilateur ne comporte aucune défectuosité dans le matèriel et la main-d'oeuvre, et de ce fait, Canarm Ltée. remplacera ou réparera à son choix, tout unité ou partie de cette unité qui comporte une defectuosité, pour une période de un an suivant la date d'achat. L'unité doit être retournée frais de port payé et une défectuosité doit être décelée. Cette garantie ne couvre pas les frais de démontage et de réinstallation de l'unité sur les lieux de l'usager.
Les éléments réparés ou remplacés sont garanties pour la durée de la garantie originale seulement. Cette garantie s'applique à l'acheteur-usage initial seulement, elle est nulle dans le cas d'altérations, d'accident, d'abus, de négligence ou si l'opération n'est pas conforme aux instructions.

N.B.: Aucune réclamation ne sera honorée par Canarm Ltée. à moins d'autorisation obtenue au préalable.

Problèmes d'installation ou d'utilisation? Ne retournez pas au magasin. Communiquez avec le service à la clientèle chez Canarm au 1-800-265-1833 (Canada) 1-800-267-4427 (USA) 1-800-567-2513 (en français) du lundi au vendredi entre 8:00h et 17:00h HNE

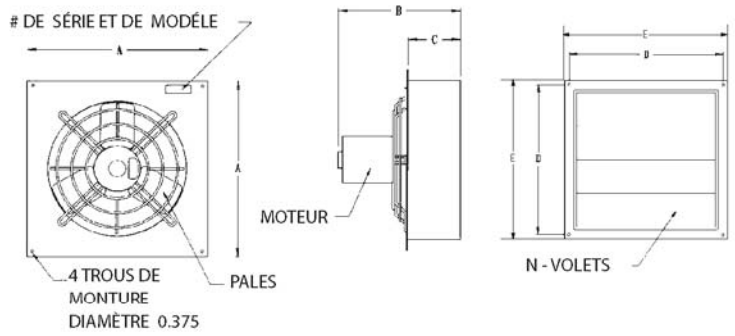
Mode d'emploi du Ventilateur d'évacuation Standard

Veuillez lire les instructions suivantes avant de procéder à l'installation et gardez ce manuel comme référence

Félicitations sur l'achat de votre ventilateur d'évacuation mural à entraînement direct de qualité. Tous ces modéles comportent un moteur fermé à roulements sur bille avec une protection thermique contre la surcharge. Les moteurs à vitesse variable sont hautement efficaces et consomment peu d'énergie et de plus, ils peuvent être opérés comme un moteur à vitesse simple.
Les moteurs sont soutenus par une monture de moteur trés robuste en tiges d'acier soudées de haut calibreet sont revĺtues d'un fini poudré. Les ventilateurs vous sont livrés tout assemblé et 100% de nos ventilateurs sont testés avant la livraison.

VENTILATEUR STANDARD:

Ces modéles portent un boîtier robuste en acier soudé avec un fini poudré ainsi que des volets en aluminium ou en plastique qui sont retenus par des douilles en nylon de longue durée. Les volets s'ouvrent automatiquement lorsque le ventilateur démarre et se ferment lorsqu'il s'arrête.



Dimensions du Ventilateur							
Ventilateur	A	B	C	D	E	N	Encadrement
8"	13-1/4"	10"	4"	12"	10-3/4"	2	11x11
10"	15-1/4"	10"	4"	14"	12-3/4"	2	13x13
12"	17-1/4"	14"	6"	16"	14-3/4"	3	15x15
14"	19-1/4"	14"	6"	18"	16-3/4"	3	17x17
16"	21-1/4"	14"	6"	20"	18-3/4"	4	19x19
18"	23-1/4"	15"	6"	22"	20-3/4"	4	21x21
20"	25-1/4"	16"	6"	24"	22-3/4"	5	23x23
24"	29-1/4"	16"	6"	28"	26-3/4"	5	27x27
30"	35-1/4"	19"	6"	34"	32-3/4"	8	33x33
36"	41-1/4"	16"	6"	40"	38-3/4"	10	39x39

VENTILATEUR ANTI-EXPLOSIF:

Les ventilateurs anti-explosifs sont munis de moteurs et de pales qui sont contre les explosions afin qu'une étincelle ne puisse pas se produire si un objet en métal obstruerait le mouvement de la pale. Les ventilateurs anti-explosifs sont fabriqués du même boîtier en acier robuste et de qualité et du même grillage à haut calibre que les ventilateurs Standard. Ces ventilateurs devront être utilisés pour ventilé les endroits hasardeux. L'endroit est considéré hasardeux si l'atmosphére contient ou peut contenir un gaz, une vapeur, ou de la poussiére en quantité explosive.

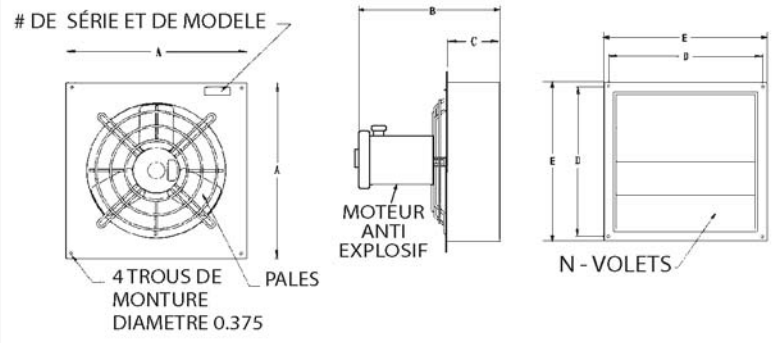
La température ambiante du moteur ne devrait pas excéder +40ºC ou -25ºC à moins que la plaque sur le moteur indique spécifiquement une autre valeur. Les ventilateurs anti-explosifs Canarm sont approuvés pour les classes hasardeuse ci-dessou seulement.

Classe 1, Division 1 (Gas et vapeurs)

~~Groupe~~ A	Aceetylène
~~Groupe~~ B	Butadiène, oxyde d'éthylène, hydrogène, oxyde de propylène
Groupe C	Acétaldéhyde, cyclopropane, diéthléther, éthylène, isoprène
Groupe D	Acétone, acrylonitrile, ammoniac, benzène, butane, éthylène dichloride, gazoline, hexane, méthane, méthanol, naphtha,propane, propylène styrène, toluène, vinyle, acétate, vinyle chloride, xylène

Classe 2, Division 1 (Poussières Combustibles)

~~Groupe~~ E	Aluminium, magnésium, et autres poussières de métal avec des caracteristiques similaires.
Groupe F	Carbon noir, coke ou poussière de charbon
Groupe G	Farine, amidon ou poussière de grain



Dimensions du Ventilateur							
Ventilateur	A	B	C	D	E	N	Encadrement
12"	17-1/4"	20-1/2"	6"	16"	14-3/4"	3	15x15
18"	23-1/4"	20-1/2"	6"	22"	20-3/4"	4	21x21
24"	29-1/4"	20-1/2"	6"	28"	26-3/4"	5	27x27

INSTALLATION

L'installation est simple et rapide. Un encadrement robuste dans l'ouverture du mur devrait être préparé à l'avance aux grandeurs mentionnes pour votre ventilateur dans le tableau ci-dessus. A l'aide de boulons pour cadrage de bois ou d'écrous, boulons et rondelles de blocage pour cadrage de métal, posez le ventilateur à l'aide des quatres trous de montage fournies, un dans chacun des coins.

CONNEXIONS ÉLECTRIQUES

MISE EN GARDE: FERMEZ LE COURANT AU DISJONCTEUR AVANT PROCÉDER AUX RACCORDEMENTS.

MISE EN GARDE: TOUS LES TRAVAUX ÉLECTRIQUES DEVRONT ÊTRE EXÉCUTÉS PAR UN ÉLECTRICIEN QUALIFIÉ.
Ces ventilateurs portent un moteur à une, deux ou vitesse variable. Les moteurs à une ou deux vitesses peuvent recevoir du 120V seulement. Les moteurs à vitesse variable sont à voltage double. Tous les moteurs à voltage double sont préparés en usine pour recevoir du 240V. Suivez les indications sur la plaque du moteur pour rebrancher le moteur sur le 120V. Faîtes les connexions dans la boîte de connexion du moteur selon les indications sur la plaque du moteur. Consultez le ***Tableau #1*** pour la grandeur de fil à être utilisé. Les ventilateurs à deux vitesses demandent un contrôle à 2 vitesses ou un interrupteur à levier 3 postions pour changer la vitesse de grande/petite/fermé. Consultez le diagramme fournie avec le contrôle pour l'installation à 2 vitesses.

TABLEAU #1

Tableau A Grosseur minium de fil pour moteur à trois phases

Moteur	25 à 50 Pieds			100 Pieds			150 à 200 Pieds		
HP	200V	230V	460V	200V	230V	460V	200V	230V	460V
1/8	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*
1/6	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14(18)*	14	14(16)*	14(18)*
1/4	14(18)*	14(18)*	14(18)*	14(16)*	14(18)*	14(18)*	14	14	14(18)*
1/3	14(18)*	14(18)*	14(18)*	14(16)*	14(16)*	14(18)*	12	14	14(18)*
1/2	14(16)*	14(18)*	14(18)*	12	14(16)*	14(18)*	10	12	14(18)*
3/4	14(16)*	14(16)*	14(18)*	12	14	14(18)*	10	10	14(16)*
1	14	14(16)*	14(18)*	12	12	14(18)*	8	10	14(16)*
1-1/2	12	14	14(18)*	10	10	14(16)*	6	8	14
2	12	12	14(18)*	8	10	14(16)*	6	6	12
3	10	12	14(18)*	6	8	14	4	6	12

Tableau B Grosseur minium de fil pour moteur à phase simple

Moteur	25 à 50 Pieds			100 Pieds			150 à 200 Pieds		
HP	200V	230V	460V	200V	230V	460V	200V	230V	460V
1/8	14(18)*	14(18)*	14	14(18)*	12	14(18)*	10	8	14
1/6	14(16)*	14(18)*	12	14(18)*	10	14(16)*	6	6	12
1/4	14	14(18)*	10	14(16)*	8	14	6	4	10
1/3	14	14(18)*	10	14(16)*	8	14	6	4	10
1/2	12	14(18)*	8	14	6	12	4	3	8
3/4	10	14(16)*	6	12	4	10	2	1	6
1	10	14(16)*	6	12	4	10	2	1	6
1-1/2	8	14	6	12	3	8	1	1/0	6
2	8	14	4	10	2	8	1/0	2/0	4
3	6	12	3	8	1/0	6	2/0	4/0	3

N.B.:
- Article 310-5 NEC grosseur minium de conducteur pour filage général à 115- 440VAC est le numéro 14AWG
- Les grandeurs de fils ci-dessus sont basés sur une baisse approximative de 5% lors du départ; conducteurs en cuivre; et isolation type 75C THHW, THW, RH, RHW etc. Pour un fil en aluminium, augmentez le fil d'un minimum de deux grandeurs. Voir Article 310 NEC pour ampacités des conducteurs en aluminium.
- Type S, SO, SJ, SJO, ETC.. grandeur de fil de cable flexible. Voir article 400 NEC pour ampérage relatif.

OPÉRATION:

MISE EN GARDE: LES VENTILATEURS À VITESSE VARIABLE DEVRAIENT ÊTRE AJUSTÉS AFIN QUE LA VITESSE MINIUM OUVRE LES VOLETS D'AU MOINS 1" AFIN DE PERMETTRE UN AÉRATION ADÉQUATE DU MOTEUR. Tous les ventilateurs sont à entraînement direct. Les ventilateurs avec moteur à vitesse variable peuvent étre opérés comme moteur à une vitesse économe d'énergie ou comme moteur variable avec un contrôle adéquat. Tel que mentionné, les ventilateurs à 2 vitesses requiËrent un contrôle à 2 vitesses ou un interrupteur à levier à 3 positions pour pouvoir changer la vitesse du moteur de grande à petite.

MISE EN GARDE: UNE GRILLE INTÉRIEUR DEVRAIT ÊTRE UTILSÉ SI LE VENTILATEUR EST INSTALLÉ À MOINS DE 7 PEIDS (2 METRE) DU SOL.

ACCESSOIRES:

Canarm vous offre une gamme complète de contrôle manuel et thermostatique. Canarm vous offre également des ensembles de volets muraux d'évacuation, les volets de remplacement ainsi que des capots de protection contre les intempéries.

ENTRETIEN:

Les moteurs comportent une protection automatique contre la surcharge et pourraient démarrer sans avertissement. Débrancher toujours l'unité avant de procéder à l'entretien. Le moteur, les pales et les volets devraient être nettoyés régulièrement pour éviter une accumulation de saleté qui pourrait endommager le moteur et nuire au bon fonctionnement de votre ventilateur. Les volets automatiques devraient pouvoir opérer librement. Comme pour tout les appareils mécaniques, des inspections régulières devront être entreprises afin de s'assurer que toute la quincaillerie et les vis à pales soient bien serrées.

GARANTIE

Canarm Ltée. garantie que chaque nouveau ventilateur ne comporte aucune défectuosité dans le matériel et la main-d'oeuvre, et de ce fait, Canarm Ltée. remplacera ou réparera à son choix, tout unité ou partie de cette unité qui comporte une defectuosité, pour une période d'un an suivant la date d'achat. L'unité doit être retournée frais de port payé et une défectuosité doit être décelée. Cette garantie ne couvre pas les frais de démontage et de réinstallation de l'unité sur les lieux de l'usager. Les éléments réparés ou remplacés sont garanties pour la durée de la garantie originale seulement. Cette garantie s'applique à l'acheteur-usager initial seulement; elle est nulle dans le cas d'altérations, d'accident, d'abus, de négligence ou si l'opération n'est pas conforme aux instructions.

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FM 701/702 - Flow meter, IFM efector, SM9000, Magnetic flow meter

ifm electronic

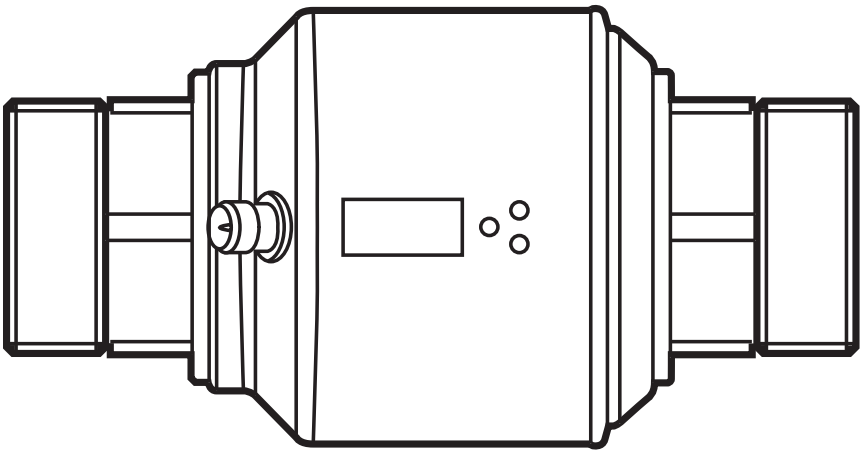
CE

Operating instructions
Magnetic-inductive flow meter

UK

efector300®

SM9000
SM9100
SM2000
SM2100



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1 Preliminary note

1.1 Symbols used

▶ Instructions

> Reaction, result

[…] Designation of pushbuttons, buttons or indications

→ Cross-reference

Important note
Non-compliance can result in malfunction or interference.

Information
Supplementary note.

1.2 Warning signs used

⚠ CAUTION

Warning of personal injury.
Slight reversible injuries may result.

2 Safety instructions

- Please read this document prior to set-up of the unit. Ensure that the product is suitable for your application without any restrictions.
- If the operating instructions or the technical data are not adhered to, personal injury and/or damage to property can occur.
- Improper or non-intended use may lead to malfunctions of the unit or to unwanted effects in your application. That is why installation, electrical connection, set-up, operation and maintenance of the unit must only be carried out by qualified personnel authorised by the machine operator.
- In order to guarantee the correct condition of the device for the operating time it is necessary to use the device only for media to which the wetted materials are sufficiently resistant (→ Technical data).
- The responsibility whether the measurement devices are suitable for the respective application lies with the operator. The manufacturer assumes no liability for consequences of misuse by the operator. Improper installation and use of the devices result in a loss of the warranty claims.
- For medium temperatures above 50 °C some parts of the housing can heat up to over 65 °C. Moreover, during installation or in case of a fault (e.g. housing damage) media under high pressure or hot media can leak from the system. To avoid personal injury, take the following measures:
  ▶ Install the unit according to the applicable rules and regulations.
  ▶ Ensure that the system is free of pressure during installation.

- ▶ Protect the housing against contact with flammable substances and unintentional contact. To do so, equip the unit with suitable protection (e.g. protective cover).
- ▶ Do not press the pushbuttons manually; instead use another object (e.g. ballpoint pen).

3 Functions and features

Pressure Equipment Directive (PED): The units comply with section 3, article 3 of the Directive 97/23/EC and must be designed and manufactured for non-super-heated liquids of group 2 fluids in accordance with the sound engineering practice.

The unit monitors liquid media.

The unit detects the 3 process categories volumetric flow quantity, consumed quantity and medium temperature.

Application area

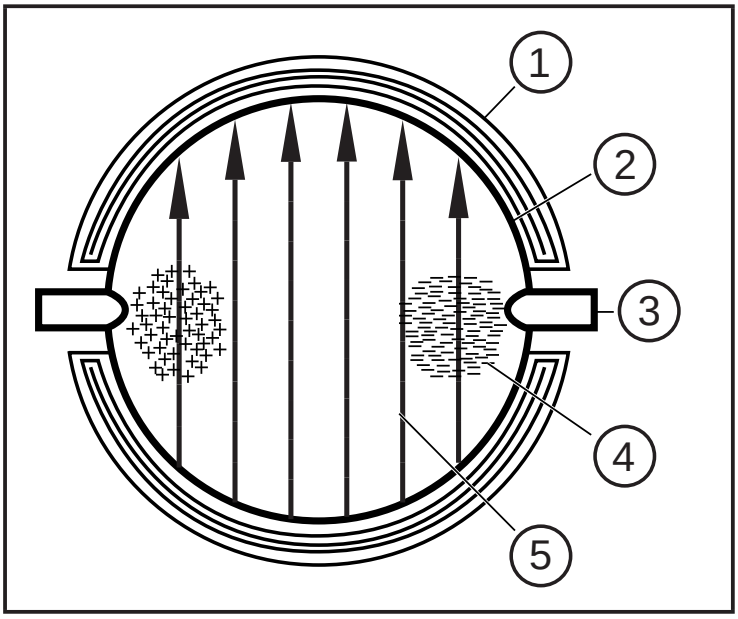
Conductive liquids with the following properties:

- Conductivity: ≥ 20 µS/cm
- Viscosity: < 70 mm^2/s at 40 °C

4 Function

4.1 Measuring principle for volumetric flow monitoring

The magnetic-inductive measuring principle means that a magnetic field is generated in the measuring pipe via current-carrying coils. When a conductive medium flows through the measuring pipe, the ions therein are diverted perpendicularly to the magnetic field. Positive and negative charge carriers flow in opposite directions. The voltage induced is measured by two electrodes that are in contact with the medium. This signal voltage is directly proportional to the average flow velocity. The volumetric flow quantity is derived from the inside pipe diameter.



1: Field coil
2: Measuring pipe
3: Electrode
4: Charge carrier in the medium
5: Magnetic field

UK

Both electrodes must be wetted by the medium. Otherwise the signal [SEnS] for empty pipe is provided, if empty pipe detection is enabled.

4.2 Processing of the measured signals

The unit displays the current process values.

It generates 2 output signals according to the parameter setting.

OUT1/IO-Link: 5 selection options	Parameter setting
- Switching signal for volumetric flow limit values	(→ 10.3.1)
- or frequency signal for volumetric flow quantity	(→ 10.3.4)
- or pulse signal for quantity meter	(→ 10.4.1)
- or switching signal for preset counter	(→ 10.4.2)
- or switching signal for empty pipe detection	(→ 10.6.9)

OUT2: 6 selection options	Parameter setting
- Switching signal for volumetric flow limit values	(→ 10.3.2)
- or switching signal for temperature limit value	(→ 10.5.1)
- or analogue signal for volumetric flow quantity	(→ 10.3.3)
- or analogue signal for temperature	(→ 10.5.2)
- or input for external reset signal (InD)	(→ 10.4.7)
- or switching signal for empty pipe detection	(→ 10.6.9)

4.3 Volumetric flow monitoring

4.3.1 Volumetric flow quantity

The signals for measuring the volumetric flow quantity can be provided as follows:

1. Two switching signals for volumetric flow quantity limit values on output 1 and output 2. On the switching functions → 4.7.
2. A frequency signal (10 Hz...10 kHz) on output 1.
   On the frequency functions → 4.9.
3. An analogue signal proportional to the volumetric flow (4...20 mA or 0...10 V) on output 2. On the analogue functions → 4.8.

4.3.2 Direction of flow

In addition to the flow velocity, the unit also detects the flow direction. An arrow on the unit indicates the positive flow direction.

The flow direction can be inversed (→ 10.6.3).

▶ Use the supplied label to mark the changed flow direction.

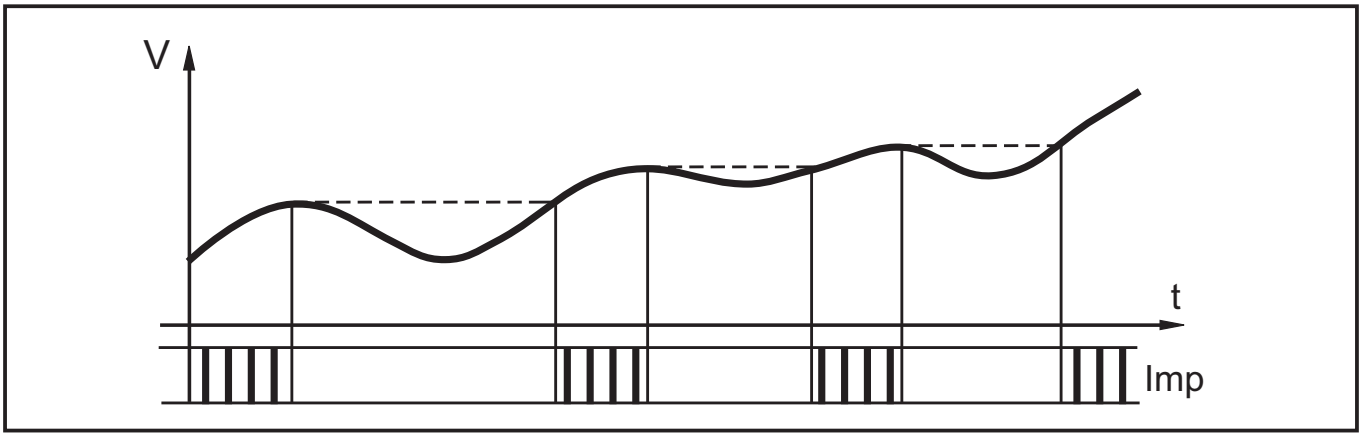
Direction of flow in accordance with "flow direction" > process value and display positive. Direction of flow against the "flow direction" > process value and display negative.

Only positive process values are processed for the signal output (limit values and analogue values for volumetric flow).

4.4 Consumed quantity monitoring (totaliser function)

The unit has an internal mass flow meter which continuously totals the volumetric flow. The sum corresponds to the current consumed quantity since the last reset.

- The quantity meter takes account of the flow direction for totalisation.
  - Flow according to the marked flow direction (arrow "flow direction"): meter adds.
  - Flow against the marked flow direction: meter subtracts (→ 10.6.12).
  - Meter pulses are only provided as the sum increases. After subtraction (consumed quantity decreases), the pulses are only provided again when the consumed quantity has exceeded the previous maximum value.



V = volumetric flow quantity, Imp = output pulses

- The current meter reading can be displayed (→ 11.1 Reading the process value).
- In addition the value before the last reset is stored. This value can also be displayed (→ 11.1 Reading the process value).

The meter saves the totalled consumed quantity every 10 minutes. In the event of a power failure this value is retained as the current meter reading. If a time-controlled reset is set, the elapsed time of the set reset interval is also stored. So the possible data loss can be maximum 10 minutes.

There are different ways to reset the meter

→ 10.4.4 Manual counter reset
→ 10.4.5 Time-controlled counter-reset
→ 10.4.7 Configure counter reset using an external signal

4.4.1 Consumed quantity monitoring with pulse output

Output 1 indicates a counting pulse when the set volumetric flow quantity has been reached (→ 10.4.1).

4.4.2 Consumed quantity monitoring with preset counter

Output 1 switches when the set volumetric flow quantity has been reached (→ 10.4.2).
2 types of monitoring are possible:

1. Time-dependent quantity monitoring (→ 10.4.5 Time-controlled counter-reset).
   - If the quantity x is reached during t, output 1 switches and remains switched until the meter is reset.

- If the quantity x is not reached during the time t, the meter is automatically reset and counting starts again; output 1 does not switch.

2. Quantity monitoring not time-dependent (→ 10.4.6 Deactivation of the counter reset).
   - If the quantity x is reached, output 1 switches and remains switched until the meter is reset.

4.5 Temperature monitoring

The following signals are provided for temperature monitoring:

- A switching signal for temperature limit values on output 2. On the switching functions → 4.7.
- An analogue signal proportional to the temperature (4...20 mA or 0...10 V) on output 2. On the analogue functions → 4.8.

4.6 Empty pipe detection

The unit detects when the two electrodes are not wetted by the medium (→ 4.1 Measuring principle for volumetric flow monitoring). The empty pipe detection can be activated or deactivated (→ 10.6.9). If it is active and the pipe is empty, the unit reacts as follows:

> [SEnS] is indicated in the display.

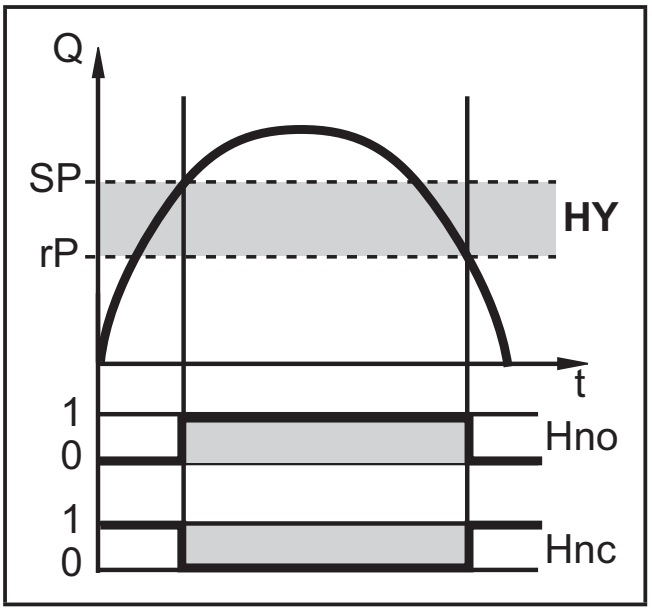
> The flow is set to zero.

The empty pipe detection can be set as time-depending or not time depending (→ 10.6.10).

4.7 Volumetric flow or temperature monitoring / switching function

OUTx changes its switching state if it is above or below the set switching limits (SPx, rPx). The following switching functions can be selected:

4.7.1 Hysteresis function



Example of volumetric flow monitoring
HY = hysteresis

Normally open: [OUx] = [Hno]

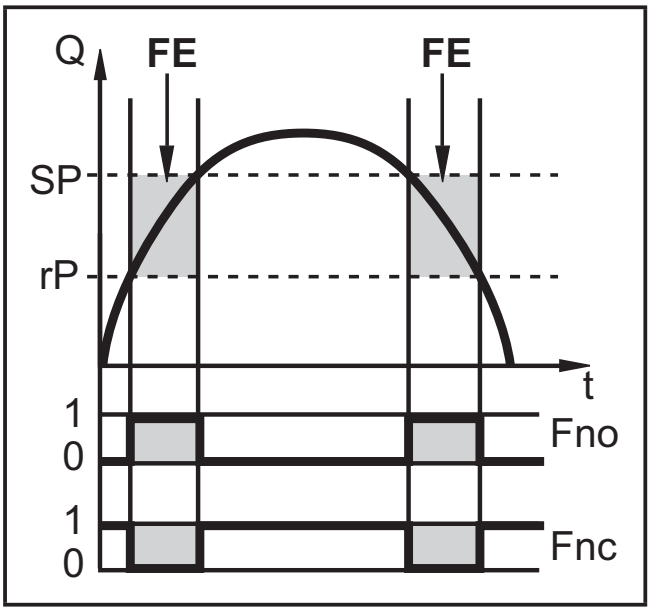
Normally closed: [OUx] = [Hnc]

First the set point (SPx) is set, then the reset point (rPx) with the requested difference.

When SPx is adjusted rPx is changed automatically; the difference remains constant.

UK

4.7.2 Window function



Example of volumetric flow monitoring
FE = window

Normally open: [OUx] = [Fno]

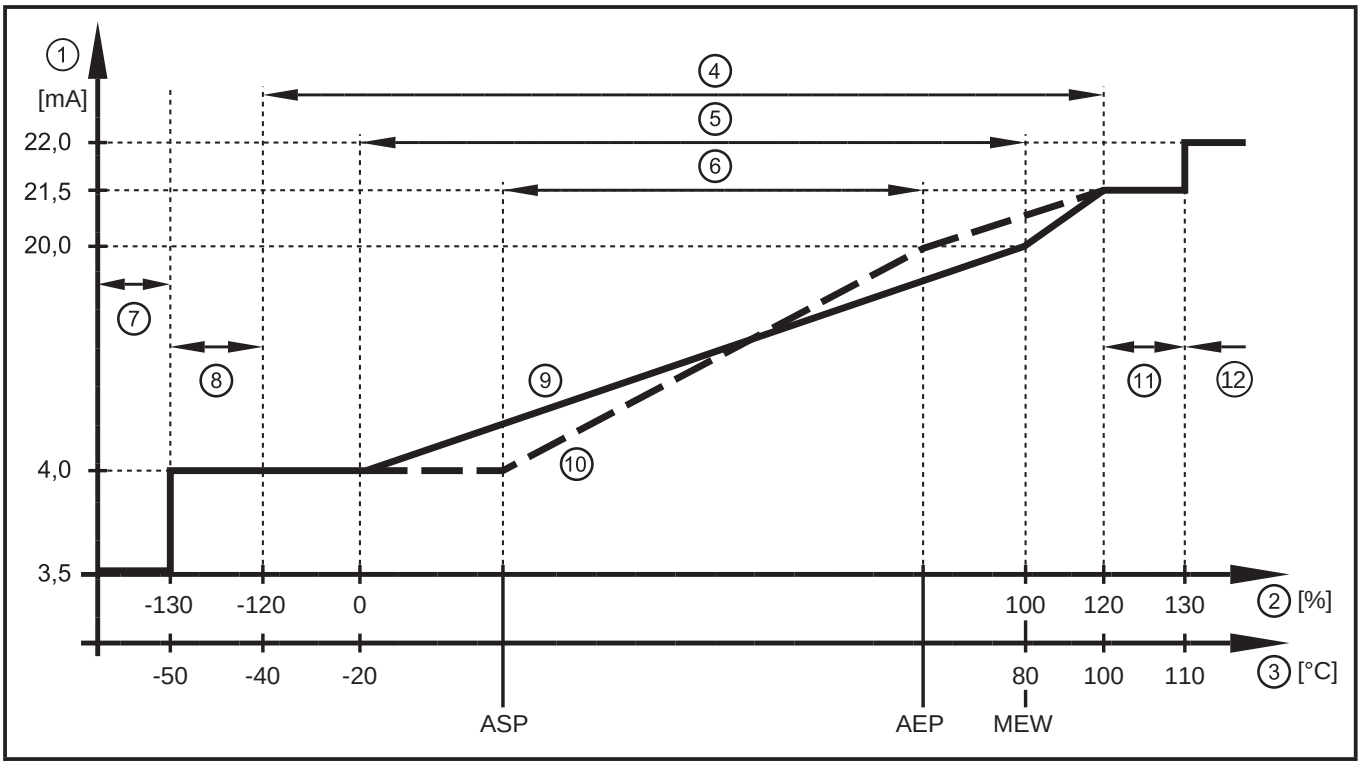
Normally closed: [OUx] = [Fnc]

The width of the window can be set by means of the difference between SPx and rPx.
SPx = upper value
rPx = lower value.

When set to the window function the set and reset points have a fixed hysteresis of 0.25 % of the final value of the measuring range. This keeps the switching state of the output stable if the volumetric flow varies slightly.

4.8 Volumetric flow or temperature monitoring / analogue function

4.8.1 Current output



Characteristics of the analogue output according to the standard IEC 60947-5-7

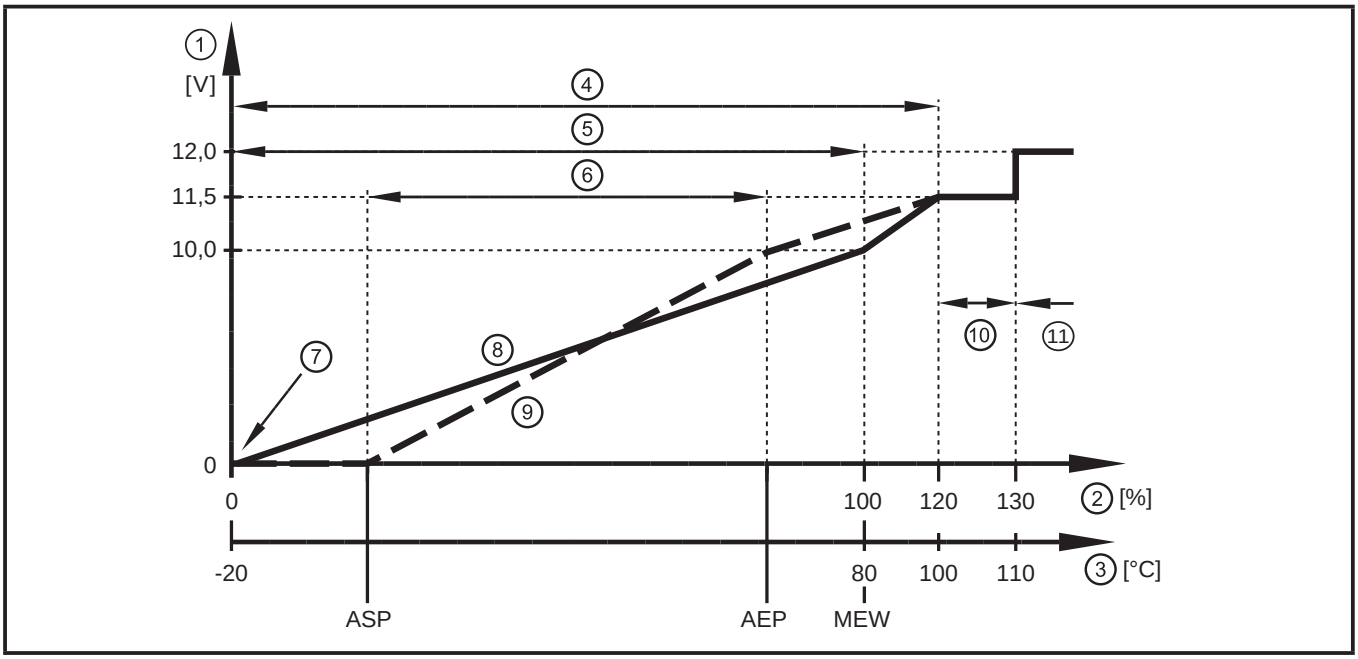
1: Output current
2: Volumetric flow quantity
3: Temperature
4: Display range
5: Measuring range
6: Range between analogue start point and analogue end point
7: The unit is in the error state (FOU = OFF).
8: The process value transmitted in an analogue way is therefore below the display range.
9: Curve of the analogue signal at factory setting
10: Curve of the analogue signal with shifted ASP and AEP
11: The process value transmitted in an analogue way is therefore above the display range.
12: The unit is in the error state (FOU = ON).

ASP = analogue start point: determines at which measured value the output signal is 4 mA
AEP = analogue end point: determines at which measured value the output signal is 20 mA
VMR = final value of the measuring range = 100 %

Minimum distance between ASP and AEP = 20 % of the measuring range

In the set scaling range the output signal is between 4 and 20 mA.

4.8.2 Voltage output



Characteristics of the analogue output according to the standard IEC 60947-5-7

1: Output voltage
2: Volumetric flow quantity
3: Temperature
4: Display range
5: Measuring range
6: Range between analogue start point and analogue end point
7: The unit is in the error state (FOU = OFF) or the process value transmitted in an analogue way is below the display range.
8: Curve of the analogue signal at factory setting
9: Curve of the analogue signal with shifted ASP and AEP
10: The process value transmitted in an analogue way is therefore above the display range.
11: The unit is in the error state (FOU = ON).

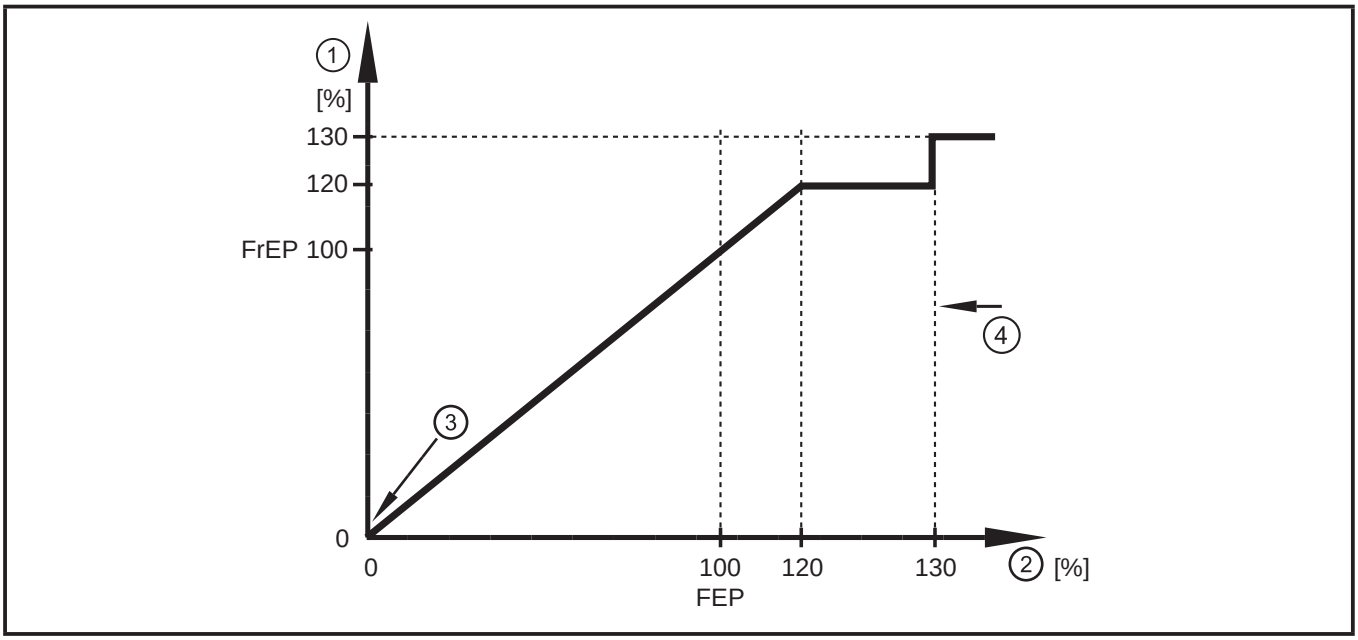
ASP = analogue start point: determines at which measured value the output signal is 0 V
AEP = analogue end point: determines at which measured value the output signal is 10 V
VMR = final value of the measuring range = 100 %

Minimum distance between ASP and AEP = 20 % of the measuring range

In the set scaling range the output signal is between 0 and 10 V.

UK

4.9 Volumetric flow monitoring / frequency output



Output curve frequency output
1: Frequency output
2: Volumetric flow quantity Q
3: The unit is in the error state (FOU = OFF) or the process value transmitted in an analogue way is below the display range.
4: The unit is in the error state (FOU = ON).

FrEP = configured frequency at FEP (→ 10.3.4 Setting the frequency value for volumetric flow)

4.10 Start-up delay

The start-up delay dST influences the switching outputs of the volumetric flow monitoring.

If the start-up delay is active (dST > 0), note: As soon as the volumetric flow quantity exceeds the LFC (LFC = low flow cut-off → 4.11), the following processes are carried out:

> The start-up delay is activated.

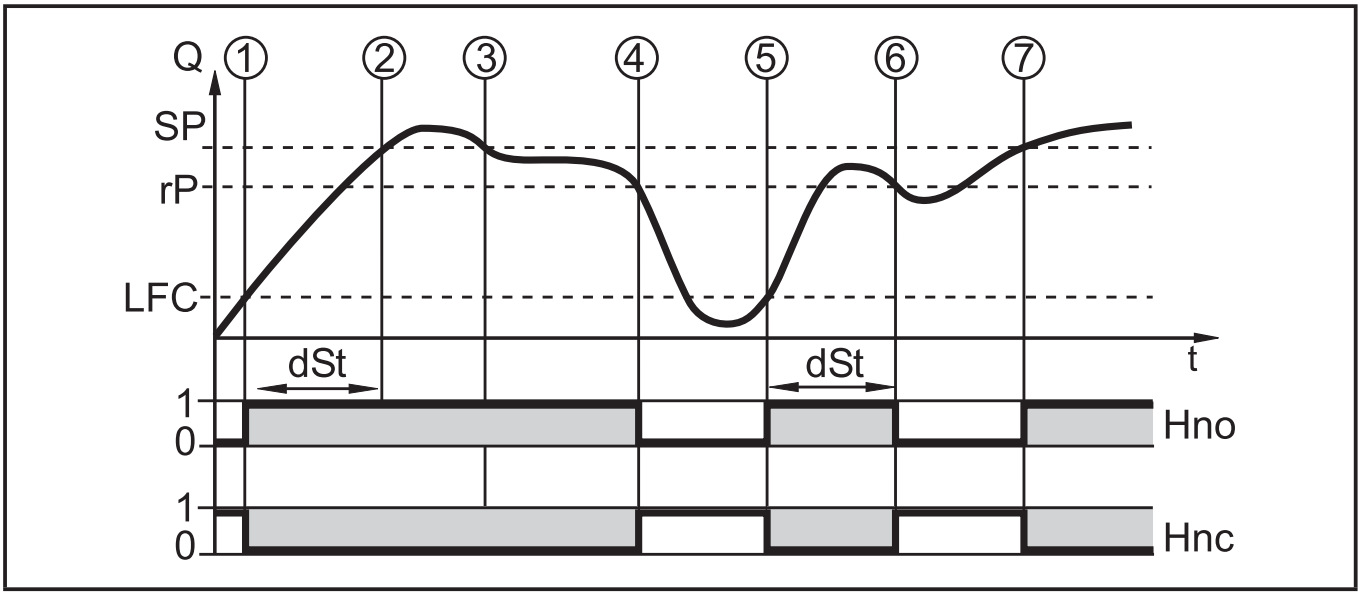
> The outputs switch as programmed:
ON for NO function, OFF for NC function.

After the start of the start-up delay there are 3 options:

1. The volumetric flow quantity increases quickly and reaches the set point / good range within dST.
> Outputs remain active.

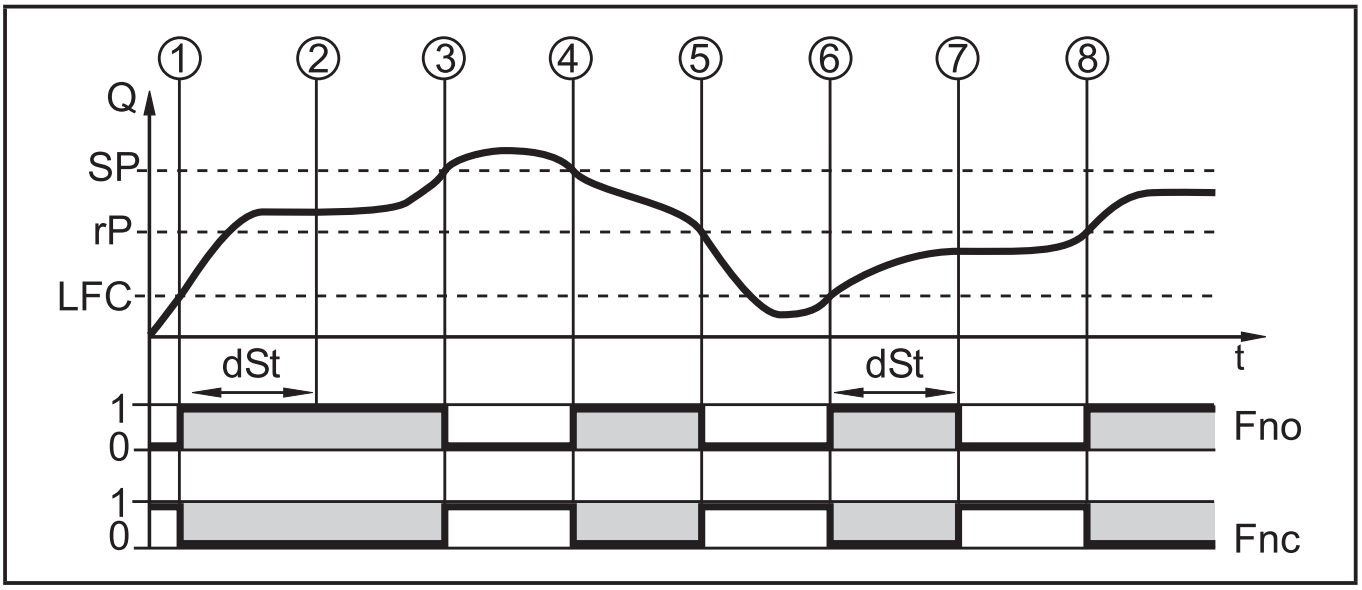
2. The volumetric flow increases slowly and does not reach the set point /good range within dST.
   > Outputs are reset.
3. Volumetric flow quantity falls below LFC within dST.
   > Outputs are reset at once; dST is stopped.

Example: dST for hysteresis function



	Condition	Reaction
1	Volumetric flow quantity Q reaches LFC	dST starts, output becomes active
2	dST elapsed, Q reached SP	output remains active
3	Q below SP but above rP	output remains active
4	Q below rP	output is reset
5	Q reaches again LFC	dST starts, output becomes active
6	dST elapsed, Q has not reached SP	output is reset
7	Q reaches SP	output becomes active

Example: dST for window function



	Condition	Reaction
1	Volumetric flow quantity Q reaches LFC	dST starts, output becomes active.
2	dST elapsed, Q reached good range	output remains active
3	Q above SP (leaves good range)	output is reset
4	Q again below SP	output becomes active again
5	Q below rP (leaves good range)	output is reset again
6	Q reaches again LFC	dST starts, output becomes active
7	dST elapsed, Q has not reached good range	output is reset
8	Q reaches good range	output becomes active

4.11 Low flow cut-off (LFC)

With this function small volumetric flow quantities can be ignored (→ 10.6.13). Flows below the LFC value are evaluated by the sensor as standstill (Q = 0).

4.12 Simulation

With this function small volumetric flow quantities can be suppressed (→ 10.7.3). The simulation does not have any effect on the totaliser or the current flow. The outputs operate as previously set.
When the simulation starts, the value of the totaliser is saved and then the simulated totaliser is set to 0. The simulated flow value then has an effect on the simulated totaliser. When the simulation is finished, the original totaliser value is restored.

During the simulation the original totaliser value remains saved without any changes even if there is a real flow.

5 Installation

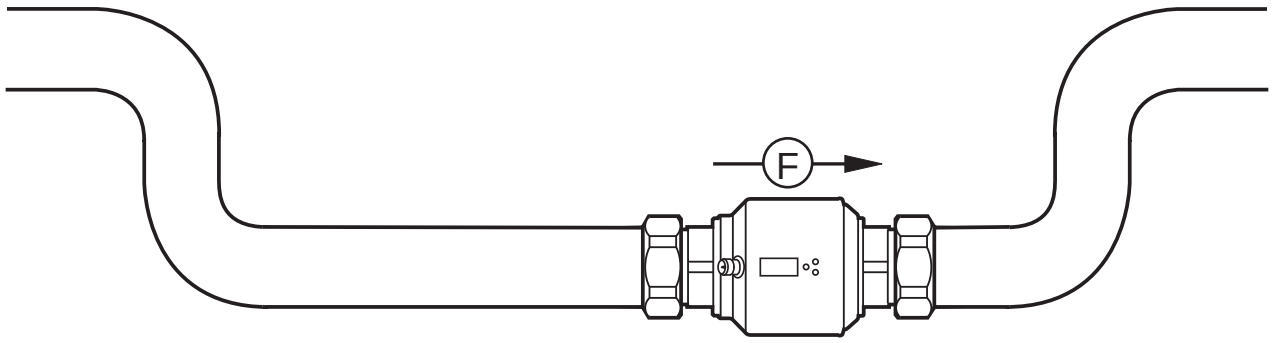
▶ Avoid deposits, accumulated gas and air in the pipe system.

5.1 Recommended installation position

Example of an optimised installation:

UK

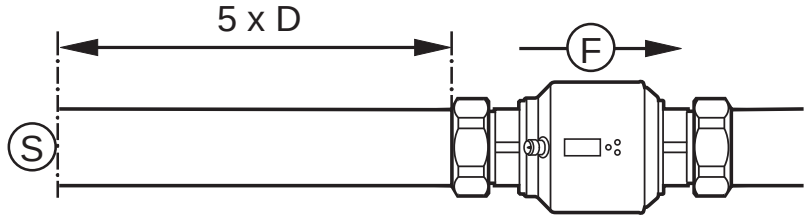
1



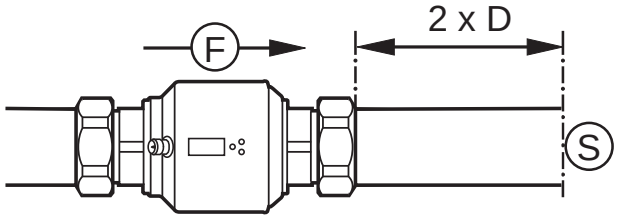
▶ Install the unit so that the measuring pipe is completely filled.

▶ Arrange for inlet and outlet pipe lengths. Disturbances caused by bends, valves, reductions, etc. are compensated for. It applies in particular: No shut-off and control devices are allowed directly in front of the unit.

2

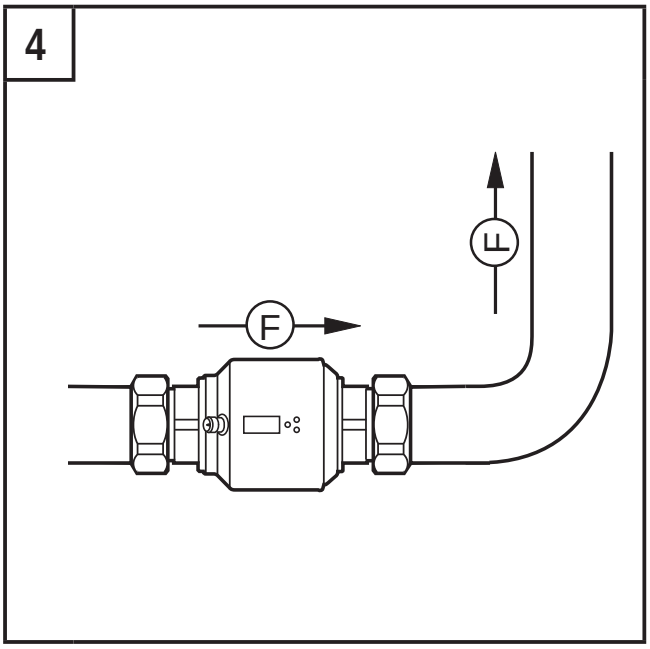


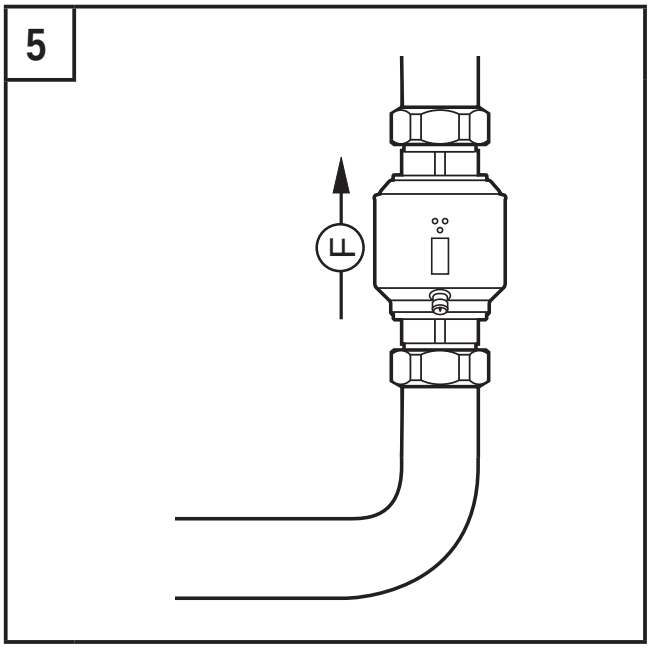
3



S = disturbance; D = pipe diameter; F = flow direction

▶ Install in front of or in a rising pipe:



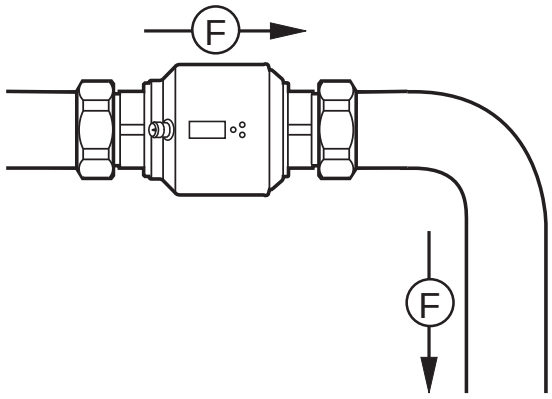


F = flow direction

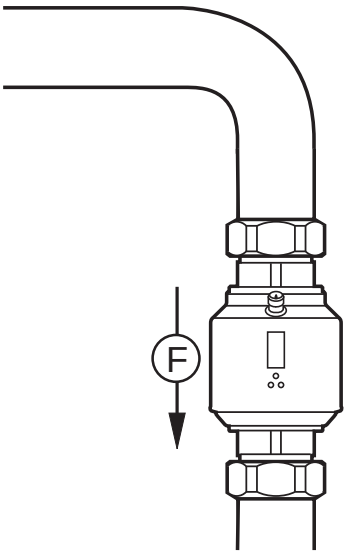
With empty pipe detection:
▶ Install the unit according to figure 1, 4 or 5.

5.2 Not recommended installation position

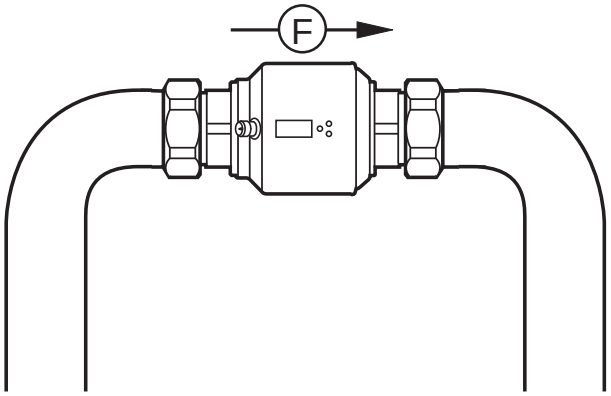
▶ Avoid the following installation positions:



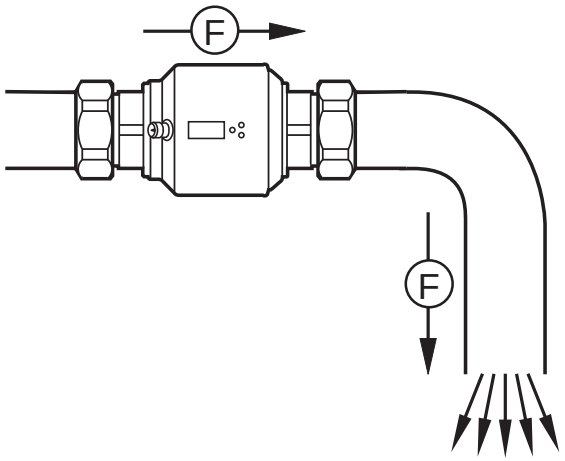
Directly in front of a falling pipe.



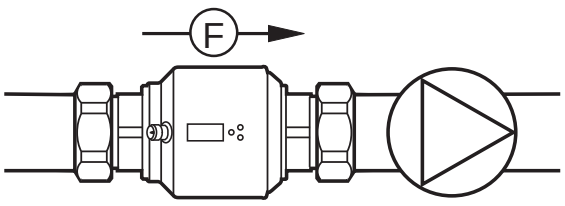
In a falling pipe.



At the highest point of the pipe system.



Directly in front of the spout of the pipe.



On the suction side of a pump.

F = flow direction

The unit can be installed independently of the orientation if the following is ensured:

- No air bubbles can form in the pipe system.
- The pipes are always completely filled.

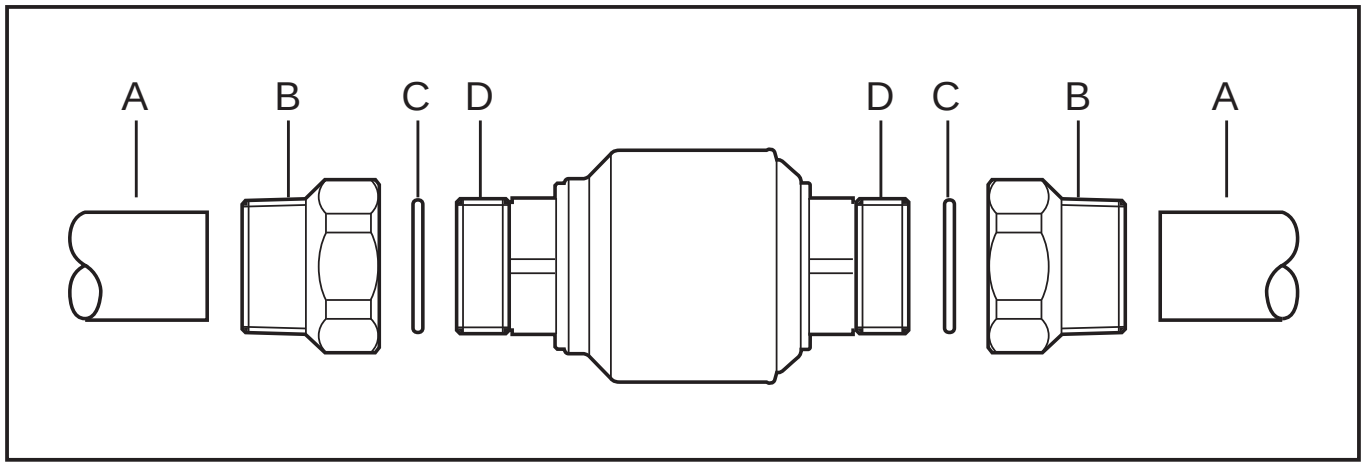
5.3 Grounding

If installed in an ungrounded pipe system (e.g. plastic pipes), the unit must be grounded (functional earth).

Ground brackets for the M12 connector are available as accessories (→ www.ifm.com).

5.4 Installation in pipes

The unit can be installed in pipes using adapters. The adapters have to be ordered separately as accessories (→ www.ifm.com).



1. Screw the adapter (B) into the pipe (A).
2. Place the seals (C) and install the unit according to the marked flow direction.

   ▶ To mount the adapters on the process connection of the sensor use suitable lubricants.
3. Screw the adapter (B) with the threads (D) until it is hand-tight.
4. Tighten the two adapters in opposite direction (tightening torque: 30 Nm).

After installation air bubbles in the system can affect the measurement.
Corrective measures:

▶ Rinse the system after installation for ventilation (rinsing quantity > 15 l/min.).

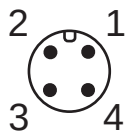
In case of horizontal installation: As a result of design requirements a small quantity of the medium always remains in the measuring channel after switching off the pump.

6 Electrical connection

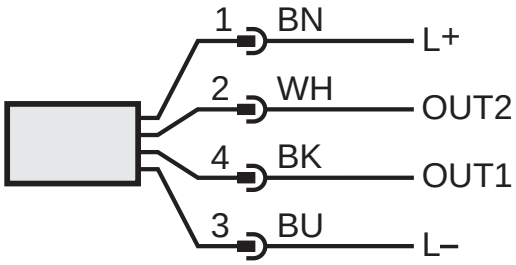
The unit must be connected by a qualified electrician.
The national and international regulations for the installation of electrical equipment must be adhered to.
Voltage supply according to EN 50178, SELV, PELV.

▶ Disconnect power.

▶ Connect the unit as follows:



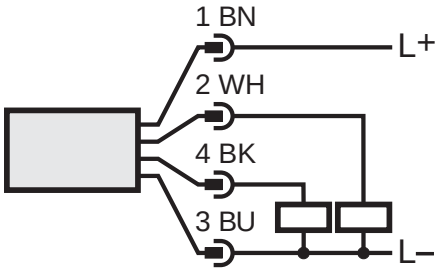
BK: black
BN: brown
BU: blue
WH: white



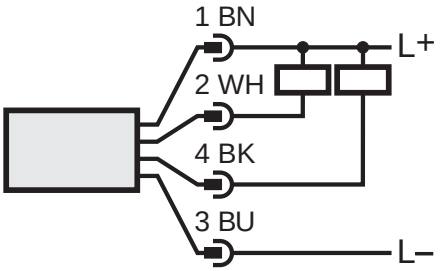
Colours to DIN EN 60947-5-6

Sample circuits:

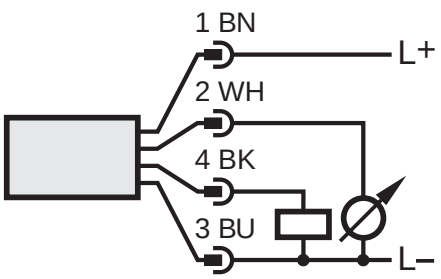
2 x positive switching



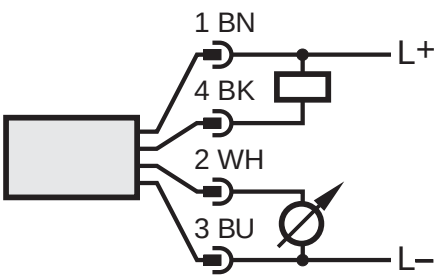
2 x negative switching



1 x positive switching / 1 x analogue



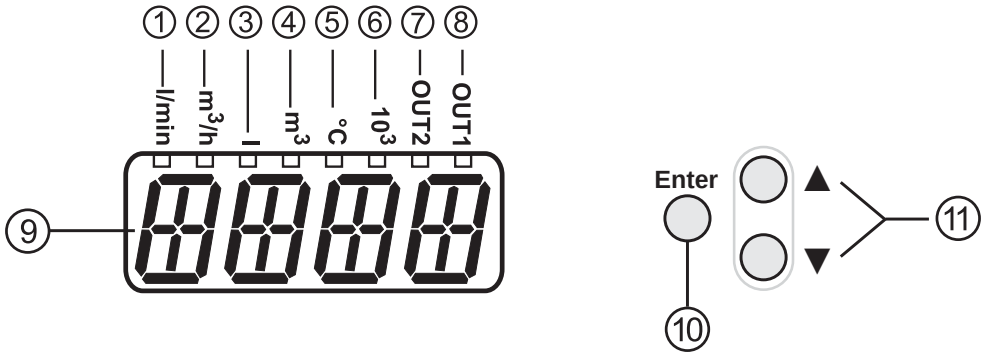
1 x negative switching / 1 x analogue



E-356

Pin 1	L+
Pin 3	L-
Pin 4 (OUT1)	• Switching signal: limit values for volumetric flow • Pulse signal: 1 pulse every time the defined volumetric flow quantity is reached. • Switching signal: quantity meter reached preset value • Frequency signal for volumetric flow quantity • Switching signal: empty pipe detection • IO-Link
Pin 2 (OUT2/ InD)	• Switching signal: limit values for volumetric flow • Switching signal: limit values for temperature • Analogue signal for volumetric flow quantity • Analogue signal for temperature • Switching signal: empty pipe detection • Input for external reset signal (InD)

7 Operating and display elements

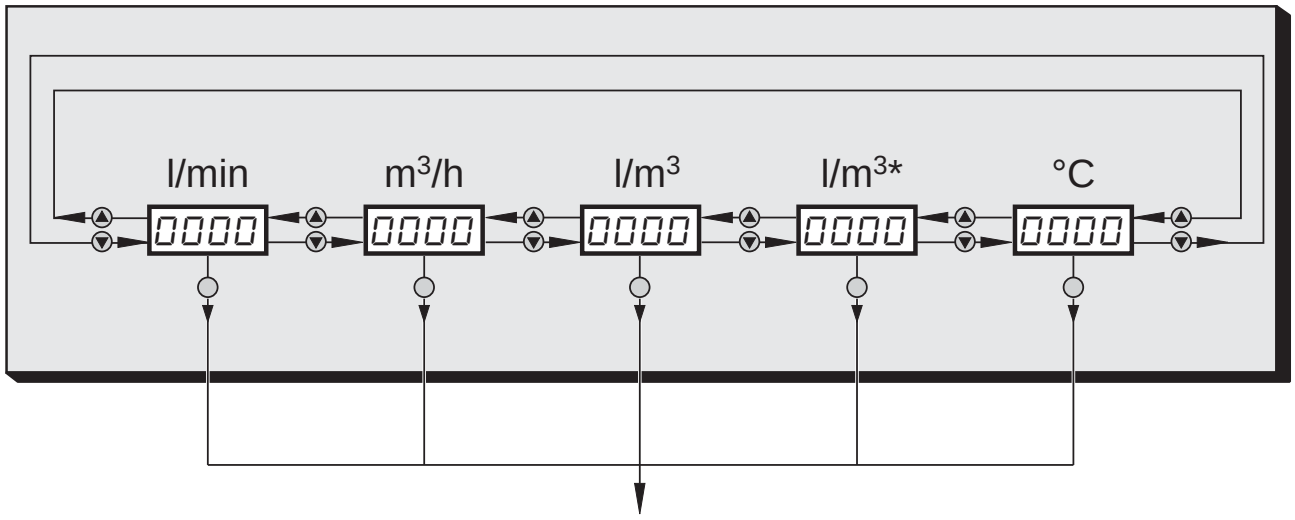


1 to 8: Indicator LEDs
• LEDs 1-6 = Unit of the currently represented numerical value → 11.1 Reading the process value • LED 7 = switching state of output OUT2 / of input InD • LED 8 = switching status of output OUT1
9: Alphanumeric display, 4 digits
• Current volumetric flow quantity (with setting [SELd] = [FLOW]) • Meter reading of the totaliser (with setting [SELd] = [TOTL]) • Current medium temperature (with setting [SELd] = [TEMP]) • Parameters and parameter values

10: [Enter] button
• Selecting the parameters • Reading the set values • Confirming the parameter values Representation in → 8 Menu: ○
11: Buttons up [▲] and down [▼]
• Selection of the parameters • Activation of the setting functions • Changing the parameter values • Change of the display unit in the normal operating mode (Run mode) • Locking / unlocking Representation in → 8 Menu: ▲ and ▼

8 Menu

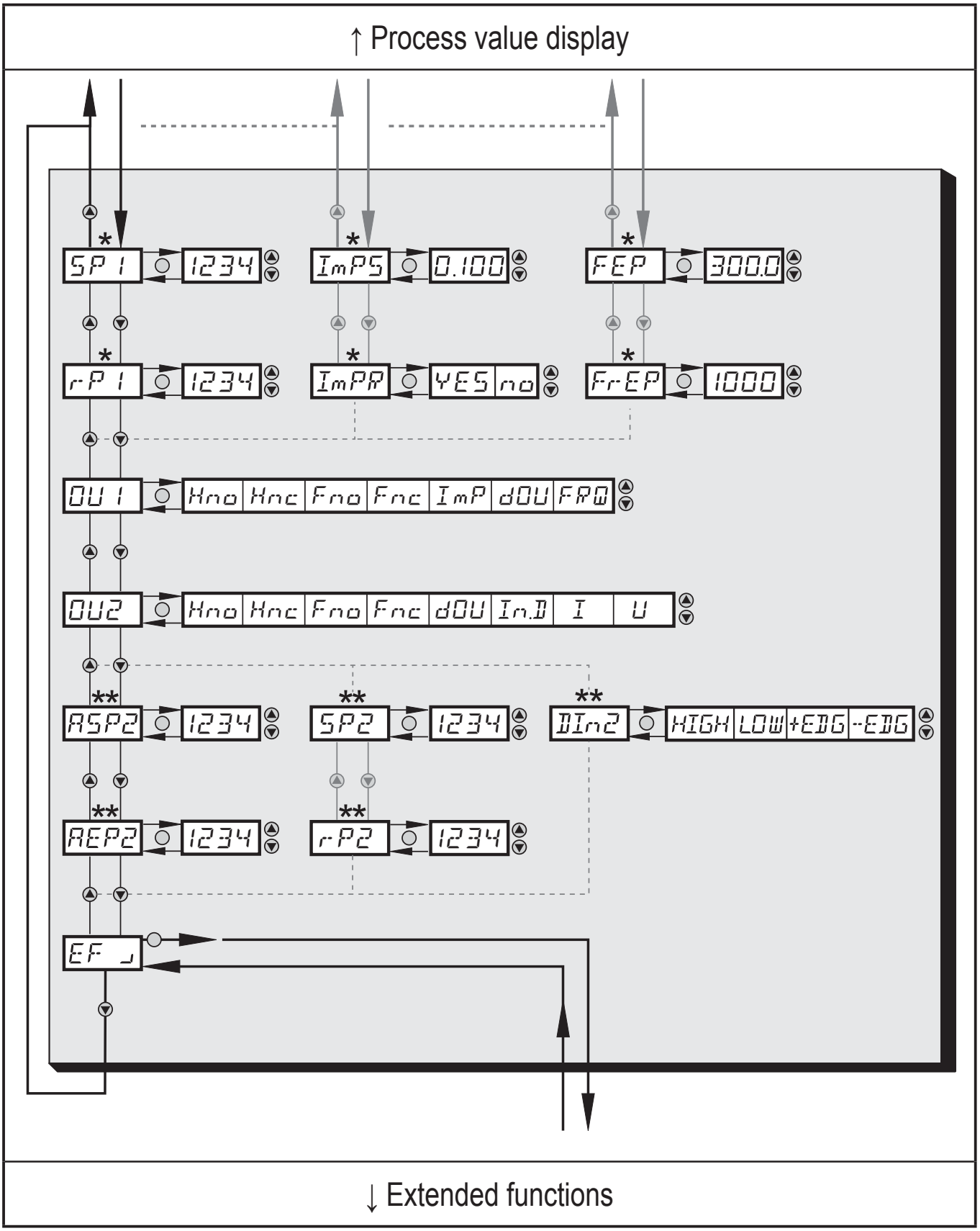
8.1 Process value display



* Stored totaliser value

↓ Main menu

8.2 Main menu

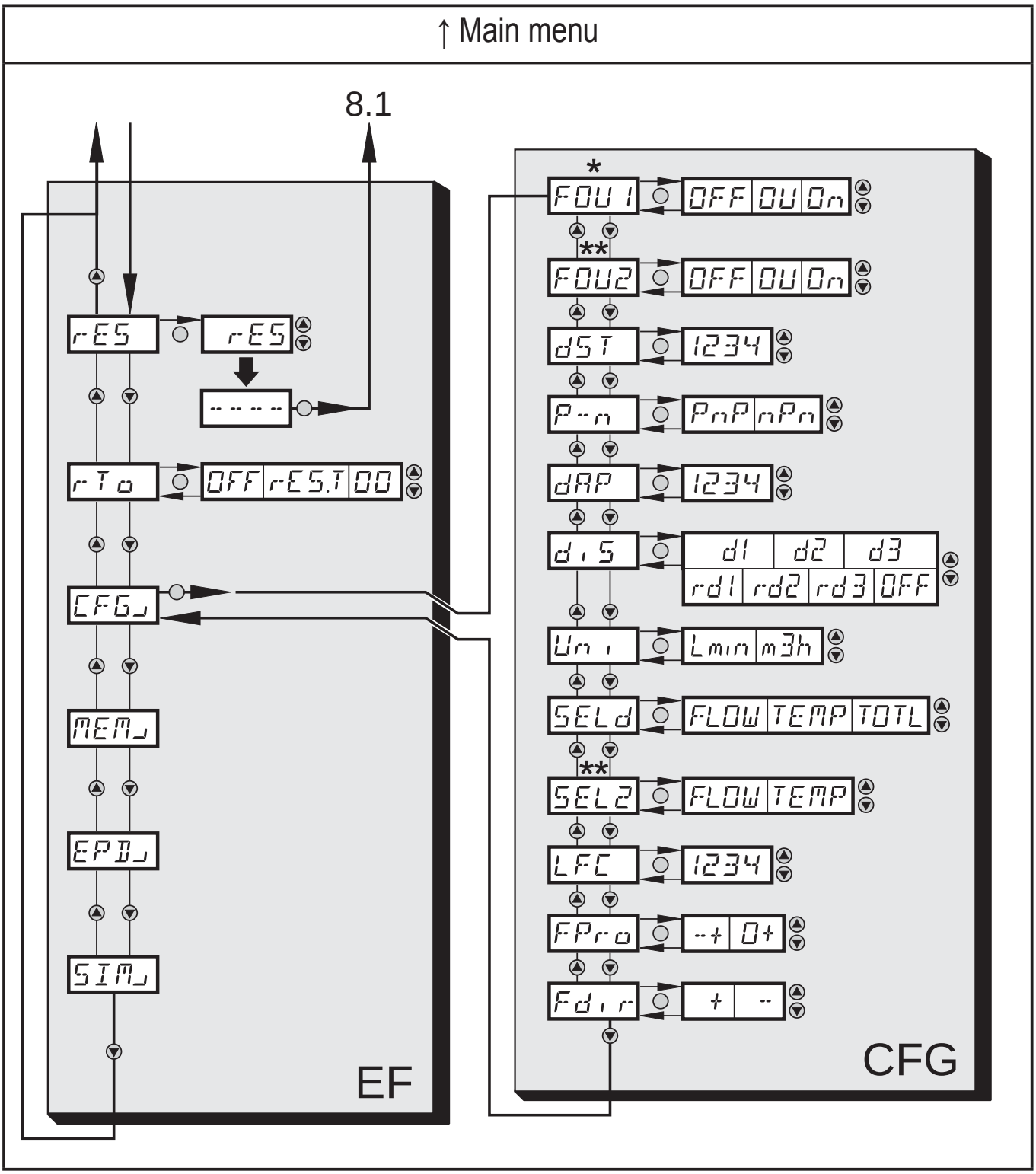


* The parameters are only displayed when selected at OU1.
** The parameters are only displayed when selected at OU2.

8.2.1 Explanation main menu

SP1	Maximum limit value for the set process value
rP1	Minimum limit value for the set process value
ImPS	Pulse value
ImPR	Pulse reset
FEP	Frequency output of the end point of the flow value
FrEP	Frequency output of the end point of the frequency
OU1	Output function for OUT1 (volumetric flow or consumed quantity)
OU2	Output function for OUT2 (volumetric flow or temperature)
	As an alternative: configure OUT2 (Pin2) as input for external reset signal: Setting: [OU2] = [In.D]
Hno	Hysteresis normally open
Hnc	Hysteresis normally closed
Fno	Window normally open
Fnc	Window normally closed
ImP	Pulse output
FRQ	Frequency output
dOU	Diagnostic output
I	Current output
U	Voltage output
In.D	External input
ASP2	Analogue start value for the set process value
AEP2	Analogue end value for the set process value
SP2	Maximum limit value for the set process value
rP2	Minimum limit value for the set process value
DIn2	Configuration of the input (Pin2) for counter reset
EF	Extended functions / opening of menu level 2

8.3 Extended functions – Basic settings



* The parameters are only displayed when selected at OU1.
** The parameters are only displayed when selected at OU2.

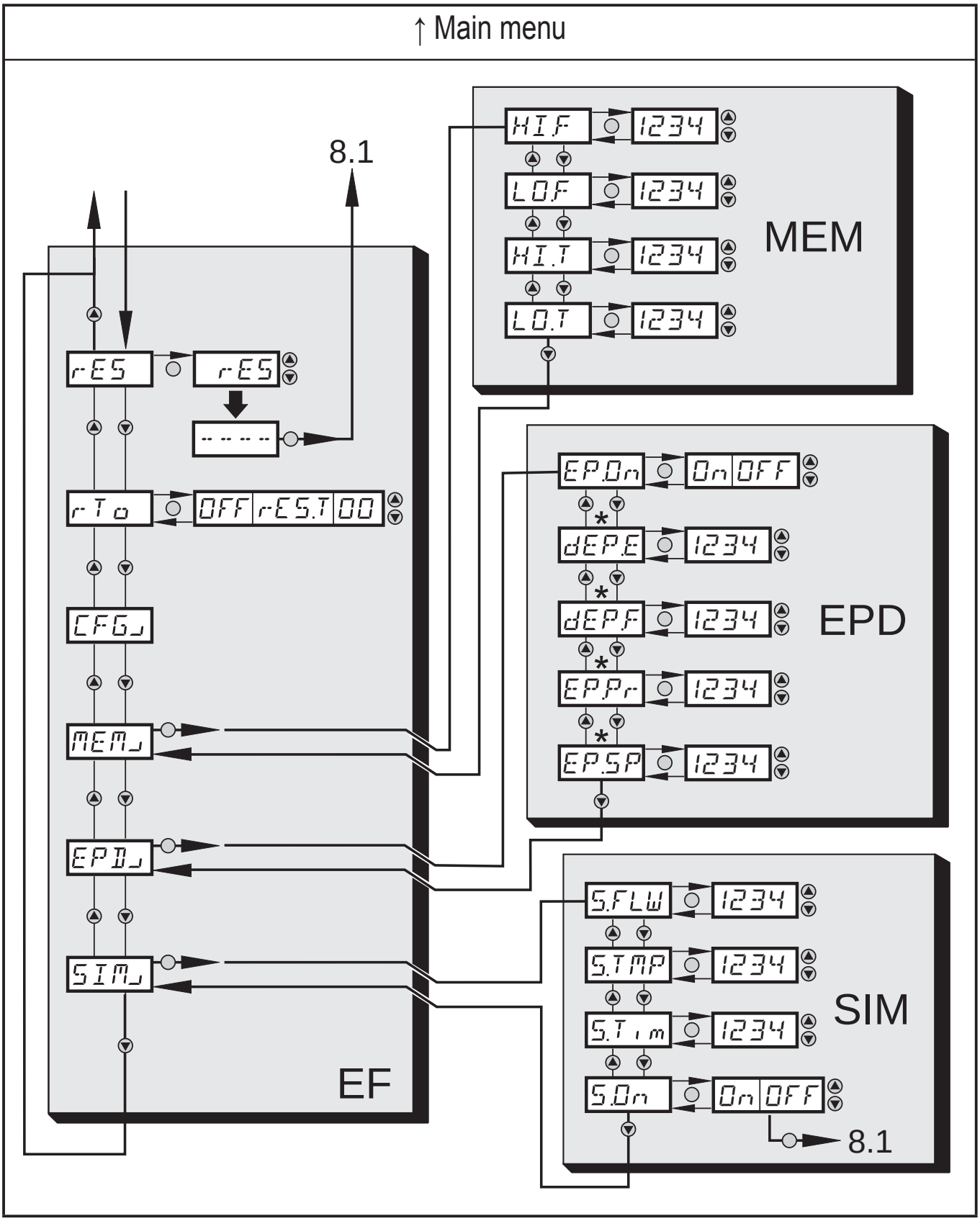
8.3.1 Explanation extended functions (EF)

rES	Restore the factory setting
rTo	Counter reset: manual reset / time-controlled reset
CFG	Submenu basic settings
MEM	Submenu min/max memory
EPD	Submenu empty pipe
SIM	Submenu simulation

8.3.2 Submenu basic settings (CFG)

FOU1	Behaviour of output 1 in case of an error
FOU2	Behaviour of output 2 in case of an error
dST	Start-up delay of volumetric flow monitoring
P-n	Output logic: pnp / npn
dAP	Measured value damping / damping constant in seconds
diS	Update rate and orientation of the display
Uni	Standard unit of measurement for volumetric flow: litres/minute or cubic metres/hour
SELd	Standard measuring unit of the display: volumetric flow value / medium temperature / meter reading
SEL2	Standard unit of measurement for evaluation via OUT2
LFC	Low flow cut-off
FPro	Totaliser: behaviour with negative flow
Fdir	Direction of flow

8.4 Extended functions – Min/max memory – Emtpy pipe – Simulation



* Parameters are only displayed for the selection EP.On = On.

8.4.1 Explanation extended functions (EF)

rES	Restore the factory setting
rTo	Counter reset: manual reset / time-controlled reset
CFG	Submenu basic settings
MEM	Submenu min/max memory
EPD	Submenu empty pipe
SIM	Submenu simulation

8.4.2 Submenu min/max memory (MEM)

HI.F	Max. value flow
LO.F	Min. value flow
HI.T	Max. value temperature
LO.T	Min. value temperature

8.4.3 Submenu empty pipe (EPD)

EP.On	Empty pipe detection on / off
dEP.E.	Delay time empty signal
dEP.F	Delay time full signal
EP.Pr	Current measured value of empty pipe detection
EP.SP	Switch point of empty pipe detection

8.4.4 Submenu simulation (SIM)

S.FLW	Simulation flow value
S.TMP	Simulation temperature value
S.TIM	Simulation time
S.ON	Simulation start

9 Set-up

After power on and expiry of the power-on delay time (approx. 5 seconds) the unit is in the normal operating mode. It carries out its measurement and evaluation functions and generates output signals according to the set parameters.

- During the power-on delay time the outputs are switched as programmed:
  - ON with normally open function (Hno / Fno)
  - OFF with normally closed function (Hnc / Fnc).
- If output 2 is configured as analogue output, the output signal is at 20 mA (current output) or 10 V (voltage output).

10 Parameter setting

Parameters can be set before installation and set-up of the unit or during operation.

If you change parameters during operation, this will influence the function.

▶ Ensure that there will be no malfunctions in your plant.

During parameter setting the unit remains in the operating mode. It continues to monitor with the existing parameter until the parameter setting has been completed.

⚠ CAUTION

For medium temperatures above 50 °C some parts of the housing can heat up to over 65 °C.

▶ Do not press the pushbuttons manually; instead use another object (e.g. ballpoint pen).

10.1 IO-Link

10.1.1 General information

This unit has an IO-Link communication interface which requires an IO-Link-capable module (IO-Link master) for operation.

The IO-Link interface enables direct access to the process and diagnostic data and provides the possibility to set the parameters of the unit during operation.

In addition communication is possible via a point-to-point connection with a USB adapter cable.

You will find more detailed information about IO-Link at www.ifm.com/gb/io-link.

10.1.2 Device-specific information

You will find the IODDs necessary for the configuration of the IO-Link unit and detailed information about process data structure, diagnostic information and parameter addresses at www.ifm.com/gb/io-link.

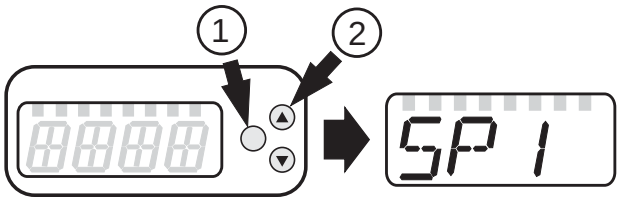
10.1.3 Parameter setting tools

You will find all necessary information about the required IO-Link hardware and software at www.ifm.com/gb/io-link.

10.2 Parameter setting in general

Select the parameter

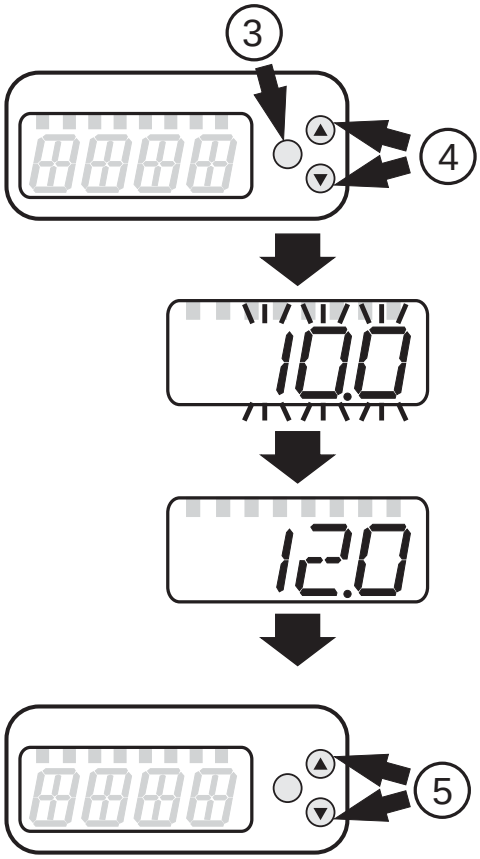
1. Press [Enter] briefly.
2. Press [▲] or [▼] until the requested parameter is displayed**.**



Changing the parameter value

3. Press [Enter] briefly.
   > The currently set value is displayed.
4. Keep [▲] or [▼] pressed for 1 s
   > Display flashes first, then permanent.
5. Change value by pressing [▲] or [▼].

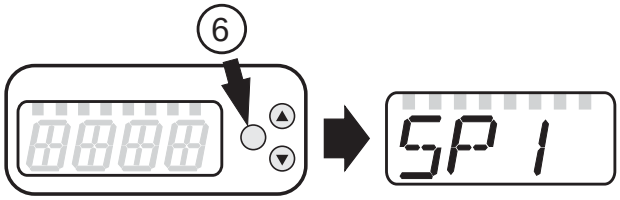
[▲] or [▼] pressed.
> Faster cycle of the numerical values.



Confirm the parameter value

6. Press [Enter] briefly.

> The parameter is displayed again. The new setting value is saved.



Finish parameter setting and change to the process value display:

▶ Wait for 30 seconds

or

▶ Change from the submenu to the main menu, from the main menu to the process value display with [▲] or [▼].

If [C.Loc] is displayed when an attempt is made to modify a parameter value, an IO-Link communication is active (temporary locking). If [S.Loc] is displayed, the sensor is permanently locked via software. This locking can only be removed using a parameter setting software.

10.2.1 Switching between the menu levels

Change to the submenu	Switching to the next submenu via the parameters [EF], [CFG], [MEM], [EPD] or [SIM]. ▶ Select a submenu with [▲] or [▼] and switch to the submenu by pressing [Enter].
Back to the process value display	▶ Wait for 30 seconds or ▶ Change from the submenu to the main menu, from the main menu to the process value display with [▲] or [▼].

10.2.2 Locking / unlocking

The unit can be locked electronically to prevent unintentional settings. Setting at the factory: not locked.

Locking is also possible via an IO-Link capable parameter setting tool.

Locking	▶ Make sure that the unit is in the normal operating mode. ▶ Press [▲] and [▼] simultaneously for 10 s. > [Loc] is displayed. During operation: [LOC] is briefly displayed if you try to change parameter values.
Unlocking	▶ Press [▲] and [▼] simultaneously for 10 s. > [uLoc] is displayed.

10.2.3 Timeout

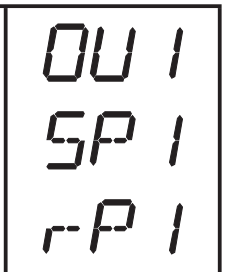
If no button is pressed for 30 s during parameter setting, the unit returns to the operating mode with unchanged parameter.

10.3 Settings for consumed quantity monitoring

10.3.1 Settings for limit value monitoring with OUT1

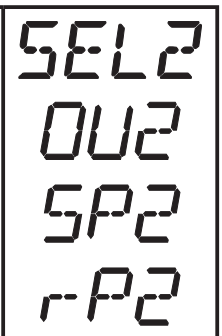
▶ Select [OU1] and set the switching function:
- [Hno] = hysteresis function/NO,
- [Hnc] = hysteresis function/NC,
- [Fno] = window function/NO,
- [Fnc] = window function/NC.

▶ Select [SP1] and set the value at which the output switches.
▶ Select [rP1] and set the value at which the output switches off.



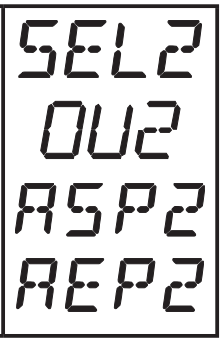
10.3.2 Settings for limit value monitoring with OUT2

- ▶ Select [SEL2] and set [FLOW].
- ▶ Select [OU2] and set the switching function.
  - [Hno] = hysteresis function/NO,
  - [Hnc] = hysteresis function/NC,
  - [Fno] = window function/NO,
  - [Fnc] = window function/NC.
- ▶ Select [SP2] and set the value at which the output switches.
- ▶ Select [rP2] and set the value at which the output switches off.



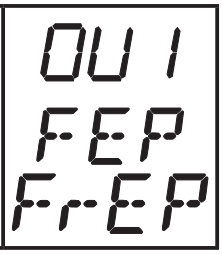
10.3.3 Setting the analogue value for volumetric flow

- ▶ Select [SEL2] and set [FLOW].
- ▶ Select [OU2] and set the function:
  - [I] = current signal proportional to volumetric flow (4…20 mA);
  - [U] = voltage signal proportional to volumetric flow (0…10 V).
- ▶ Select [ASP2] and set the value at which the minimum value is provided.
- ▶ Select [AEP2] and set the value at which the maximum value is provided.



10.3.4 Setting the frequency value for volumetric flow

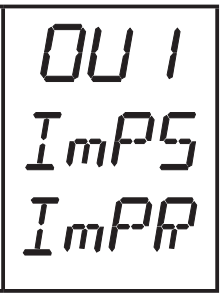
- ▶ Select [OU1] and set [FRQ].
- ▶ Select [FEP] and set the flow value at which the frequency set in FrEP is provided.
- ▶ Select [FrEP] and set the frequency.



10.4 Settings for consumed quantity monitoring

10.4.1 Settings for quantity monitoring via pulse output

- ▶ Select [OU1] and set [ImP].
- ▶ Select [ImPS] and set the volumetric flow quantity at which 1 pulse is provided (→ 10.4.3).
- ▶ Select [ImPR] and set [YES].
- > Pulse repetition is active. Output 1 provides a counting pulse each time the value set in [ImPS] is reached.



10.4.2 Settings for quantity monitoring via the preset counter

- ▶ Select [OU1] and set [ImP].
- ▶ Select [ImPS] and set the volumetric flow quantity at which output 1 switches (→ 10.4.3).
- ▶ Select [ImPR] and set [no].
- > Pulse repetition is not active. The output switches ON if the value set in [ImPS] is reached. It remains set until the counter is reset.

10.4.3 Setting the pulse value

UK

- ▶ Select [ImPS].
- ▶ Press [Enter] briefly.
- > The currently set value is displayed.
- ▶ Keep [▲] or [▼] pressed until "cccc" is displayed.
- ▶ Press [▲] or [▼] to select the setting range.
- > With each press of the pushbutton the display changes to the next setting range (decimal point shifts and / or LED changes).
- ▶ Press [Enter] to confirm the setting range.
- ▶ Press [▲] or [▼] until the requested numerical value is displayed.
- ▶ Press [Enter] briefly.

Setting ranges:

LED*	Unit	Display	Value	Step increment
3	l	000.1...999.9	0.1...999.9 l	0.1 l
4	m³	0.001...9.999	0.001...9.999 m³	0.001 m³
4	m³	00.01...99.99	0.01...99.99 m³	0.01 990 m³
4	m³	000.1...999.9	0,1...999,9 990 m³	0.1 990 m³
4 + 6	m³ x 10³	0.001...9.999	1...9999 m³	1 m³
4 + 6	m³ x 10³	00.01...99.99	10...99 990 m³	10 m³
4 + 6	m³ x 10³	000.1...999.9	100...999 900 m³	100 m³

* indicator LED → 7 Operating and display elements

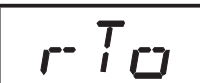
10.4.4 Manual counter reset

- ▶ Select [rTo] and set [rES.T].
- > The counter is reset to zero.

10.4.5 Time-controlled counter-reset

▶ Select [rTo] and set the requested value (intervals of hours, days or weeks). > The counter is reset automatically with the value now set.	

10.4.6 Deactivation of the counter reset

▶ Select [rTo] and set [OFF]. > The meter is only reset after overflow (= factory setting).	

10.4.7 Configure counter reset using an external signal

▶ Select [OU2] and set [InD]. ▶ Select [DIn2] and set the reset signal: - [HIGH] = reset for high signal, - [LOW] = reset for low signal, - [+EDG] = reset for rising edge, - [-EDG] = reset for falling edge.	

10.5 Settings for temperature monitoring

10.5.1 Settings for limit value monitoring with OUT2

▶ Select [SEL2] and set [TEMP]. ▶ Select [OU2] and set the switching function. - [Hno] = hysteresis function/NO, - [Hnc] = hysteresis function/NC, - [Fno] = window function/NO, - [Fnc] = window function/NC. ▶ Select [SP2] and set the value at which the output switches. ▶ Select [rP2] and set the value at which the output switches off.	

10.5.2 Setting the analogue value for temperature

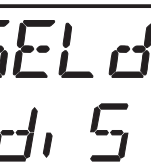
▶ Select [SEL2] and set [TEMP]. ▶ Select [OU2] and set the function: - [I] = temperature-proportional current signal (4…20 mA); - [U] = temperature-proportional voltage signal (0…10 V). ▶ Select [ASP2] and set the value at which the minimum value is provided. ▶ Select [AEP2] and set the value at which the maximum value is provided.	

10.6 User settings (optional)

10.6.1 Setting of the standard unit of measurement for volumetric flow

▶ Select [Uni] and set the unit of measurement: [Lmin] or [m3h]. The setting only has an effect on the volumetric flow value. The counter values (consumed quantity) are automatically displayed in the unit of measurement providing the highest accuracy.	

10.6.2 Configuration of the standard display

▶ Select [SELd] and determine the standard measuring unit: - [FLOW] = the current volumetric flow value in the standard unit of measurement is displayed. - [TOTL] = display indicates the current meter count in l, m^3 or 1000 m^3. - [TEMP] = the current medium temperature in °C is displayed. ▶ Select [diS] and set the update rate and orientation of the display: - [d1] = update of the measured values every 50 ms. - [d2] = update of the measured values every 200 ms. - [d3] = update of the measured values every 600 ms. - [rd1], [rd2], [rd3] = display as for d1, d2, d3; rotated by 180°. - [OFF] = the display is switched off in the operating mode.	

10.6.3 Changing the direction of the flow rate measurement

▶ Select [Fdir] and set the direction of flow: [+] = flow in the direction of the flow arrow (= factory setting) [-] = flow against the flow arrow ▶ label over the arrow	

10.6.4 Setting the output logic

▶ Select [P-n] and set [PnP] or [nPn].	

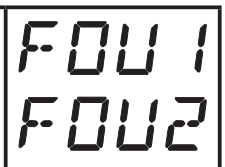
10.6.5 Setting the start-up delay

▶ Select [dST] and set the numerical value in seconds.	

10.6.6 Setting the measured value damping

▶ Select [dAP] and set the damping constant in seconds (τ value 63 %).	

10.6.7 Setting the error behaviour of the outputs

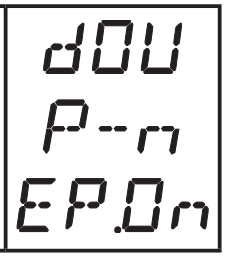


▶ Select [FOU1] and set the value:

1. Switching output:
   - [On] = output 1 switches ON in case of an error.
   - [OFF] = output 1 switches OFF in case of an error.
   - [OU1] = output 1 switches irrespective of the error as defined with the parameters.
2. Frequency output:
   - [On] = 130% of FrEP
   - [OFF] = 0 Hz
   - [OU1] = continues running

▶ Select [FOU2] and set the value:
- [On] = output 2 switches ON in case of an error, the analogue signal goes to the upper error value.
- [OFF] = output 2 switches OFF in case of an error, the analogue signal goes to the lower error value.
- [OU2] = output 2 switches irrespective of the error as defined with the parameters. The analogue signal corresponds to the measured value.

10.6.8 Configuring the empty pipe detection as diagnostic output



▶ Select [OU1] or [OU2] and set [dOU].
▶ Select [P-n] and set [PnP] or [nPn].

The empty pipe detection is only effective if it is activated at [EP. On] → 10.6.9. When the empty pipe state is detected, the diagnostic output is inactive.

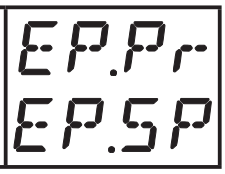
10.6.9 Activating / deactivating empty pipe detection

▶ Select [EP.On] and set the function:
- [OFF] = empty pipe detection deactivated.
- [On] = empty pipe detection activated.

10.6.10 Time-delay empty pipe detection

▶ Select [dEP.E] and set the delay time from 0…30 s, at which the signal should be provided when the pipe is empty.
▶ Select [dEP.F] and set the delay time from 0…30 s, at which the signal should be provided when the pipe is full.

10.6.11 Setting of the empty pipe detection

▶ Select [EP.Pr] to display the current value of the empty pipe detection in percent. ▶ Select [EP.SP] and set the switch point of empty pipe detection.	

10.6.12 Setting the counting method of the totaliser

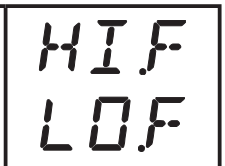
▶ Select [FPro] and set the value: [-+] = totalling the volumetric flow values with the correct sign. [0+] = totalling only positive volumetric flow values.	

10.6.13 Setting the low flow cut-off

▶ Select [LFC] and set the limit value.	

10.7 Service functions

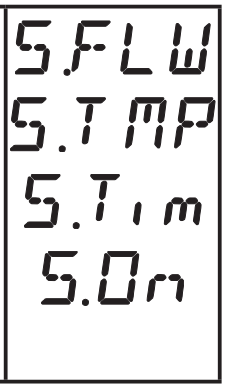
10.7.1 Reading the min/max values for the volumetric flow

▶ Select [HI.F] or [LO.F] [HI.F] = max. value, [LO.F] = min. value. Delete memory: ▶ Select [HI.F] or [LO.F]. ▶ Press [Enter] briefly. ▶ Keep [▲] or [▼] pressed. > [----] is displayed. ▶ Press [Enter] briefly. It makes sense to delete the memories as soon as the unit operates under normal operating conditions for the first time.	

10.7.2 Reading the min/max values for the temperature

▶ Select [HI.T] or [LO.T] [HI.T] = max. value, [LO.T] = min. value. Delete memory: ▶ Select [HI.T] or [LO.T]. ▶ Press [Enter] briefly. ▶ Keep [▲] or [▼] pressed. > [----] is displayed. ▶ Press [Enter] briefly. It makes sense to delete the memories as soon as the unit operates under normal operating conditions for the first time.	

10.7.3 Simulation menu

▶ Select [S.FLW] and set the flow value to be simulated. ▶ Select [S.TMP] and set the temperature value to be simulated. ▶ Select [S.Tim] and set the time of the simulation in minutes. ▶ Select [S.On] and set the function: - [On]: The simulation starts. The values are simulated for the time set at [S.Tim]. [SIM] is displayed simultaneously with the process values. Cancel with [Enter]. - [OFF]: The simulation is not active.	

10.7.4 Resetting all parameters to factory setting

▶ Select [rES]. ▶ Press [Enter] briefly. ▶ Keep [▲] or [▼] pressed. > [----] is displayed. ▶ Press [Enter] briefly. For the factory settings please refer to the end of these instructions → 13. We recommend taking down your own settings in that table before carrying out a reset.	

11 Operation

11.1 Reading the process value

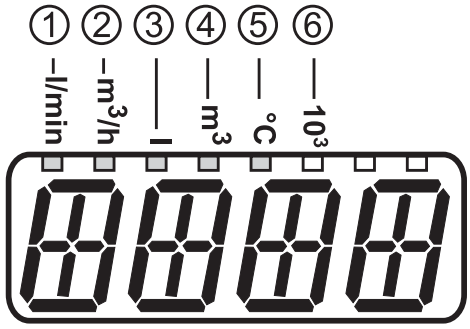
The LEDs 1-6 signal which process value is currently displayed.The process value to be displayed as standard (temperature, flow velocity or meter reading of the totaliser) can be preset → 10.6.2 Configuration of the standard display. A standard unit of measurement can be defined for the flow velocity (l/min or m^3/h → 10.6.1).

Further process values can be read in addition to the preset standard display:

▶ Press the buttons [▲] or [▼].

> The LED of the selected process value display is lit and the current process value is displayed.

> After 30 seconds the display changes to the standard display.



LED			Process value display	Unit
1	□		Current flow volume per minute	l/min
2	□		Current flow volume per hour	m^3 / h
3	□	Totaliser *	Current consumed quantity since the last reset	l
3	⌸		Consumed quantity before the last reset	L
4	□		Current consumed quantity since the last reset	m^3
4	⌸		Consumed quantity before the last reset	m^3
4 + 6	□		Current consumed quantity since the last reset	m^3 x 10^3
4 + 6	⌸		Consumed quantity before the last reset	m^3 x 10^3
5	□		Current medium temperature	°C

□ LED is lit; ⌸ LED flashes

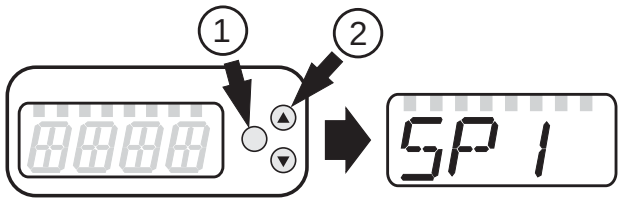
* The consumed quantity is automatically displayed in the unit of measurement providing the highest accuracy.

11.2 Reading the parameter value

To display the currently set parameter value, take the following steps:

Select the parameter

1. Press [Enter] briefly.
2. Press [▲] or [▼] until the requested parameter is displayed**.**

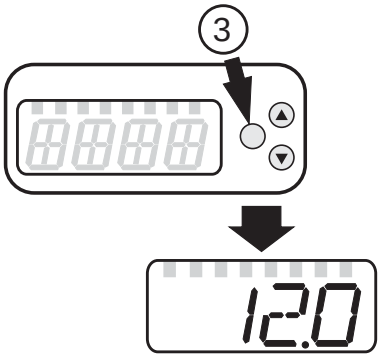


Display the parameter value

3. Press [Enter] briefly.

> The currently set value is displayed for 30 s.

By pressing [Enter] briefly several times, the display switches between parameter and parameter value.



Switching to the process value display

▶ Wait for 30 seconds

or

▶ Change from the submenu to the main menu, from the main menu to the process value display with [▲] or [▼].

11.3 Error indications

	Warning message
[SC1]	Short circuit in OUT1. LED8 for OUT1 flashes (→ 7 Operating and display elements).
[SC2]	Short circuit in OUT2. LED7 for OUT2 flashes (→ 7 Operating and display elements).
[SC]	Short circuit in both outputs. LED7 and LED8 flash (→ 7 Operating and display elements).
[OL]	Detection zone of volumetric flow or temperature exceeded. Measured value between 120 % and 130 % of the final value of the measuring range.
[UL]	Below the detection zone of volumetric flow or temperature. Measured value between -120 % and -130 % of the final value of the measuring range.
[Err]	• Unit faulty / malfunction. • Measured value greater than 130 % of the final value of the measuring range. • Measured value lower than -130 % of the final value of the measuring range.
[C.Loc]	Setting pushbuttons locked, parameter change rejected. Active IO-Link communication.
[S.Loc]	Setting pushbuttons locked, parameter change rejected. Unlock using parameter setting software.
[SEnS]	• Sensor signal invalid. • Measuring pipe not sufficiently filled. • Medium with too low a conductivity.
[IOE.n]	Malfunctioning. The unit is faulty and must be replaced.

12 Technical data

Technical data and scale drawing at www.ifm.com.

13 Factory setting

	Factory setting	User setting
SP1	20 % *	
rP1	19.5 % *	
ImPS	0.1	
ImPR	YES	
OU1	Hno	
OU2	I	
SP2 (FLOW)	40 % *	
rP2 (FLOW)	39.5 % *	
SP2 (TEMP)	20 °C	
rP2 (TEMP)	-19.6 °C	
ASP2 (FLOW)	0 % *	
AEP2 (FLOW)	100 % *	
ASP2 (TEMP)	-20 °C	
AEP2 (TEMP)	80 °C	
FEP	100 % *	
FrEP	1 kHz	
FDir	+	
FPro	- +	
LFC	5 l/min	
DIn2	+EDG	
FOU1	OFF	
FOU2	OFF	
dST	0	
P-n	PnP	
dAP	0.6 s	
rTo	OFF	
diS	d2	

Uni	**Lmin**	
SELd	**FLOW**	
SEL2	**FLOW**	
EP.On	**OFF**	
dEP.E	**0 s**	
dEP.F	**2 s**	
EP.SP	**75 %**	
S.FLW	**20 %**	
S.TMP	**20 °C**	
S.Tim	**3 min**	

* of the final value of the measuring range

BA00082D/06/EN/16.15
71280120

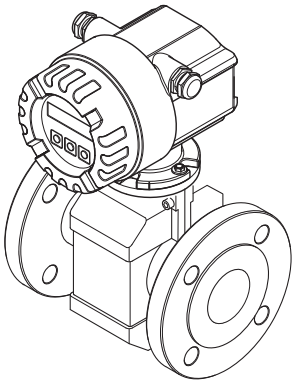
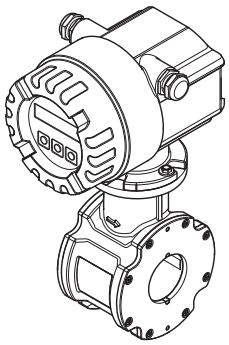
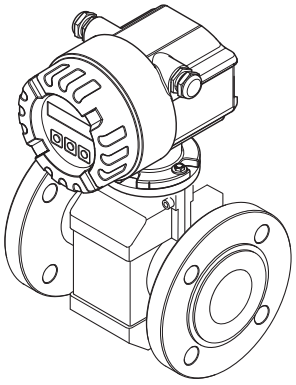
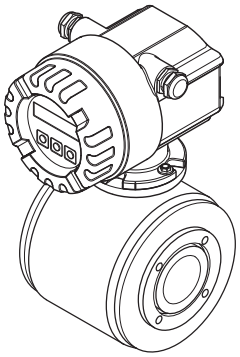
Valid as of software version
V 1.04.00 (device software)

FT-102/2 - Flow meter, Endress, Promag 10D50 2"10D50-4LGA1RA0B4AAM1 Compact head

Operating Instructions
Proline Promag 10
HART

Electromagnetic flowmeter

HART®
FIELD COMMUNICATION PROTOCOL

Endress+Hauser
People for Process Automation

E-381

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1 Safety instructions

1.1 Designated use

The measuring device described in this Operating Manual is to be used only for measuring the flow rate of conductive fluids in closed pipes.

Most liquids can be measured as of a minimum conductivity of 50 µS/cm.

Examples:
- Acids, alkalis
- Drinking water, wastewater, sewage sludge
- Milk, beer, wine, mineral water, etc.

Resulting from incorrect use or from use other than that designated the operational safety of the measuring devices can be suspended. The manufacturer accepts no liability for damages being produced from this.

1.2 Installation, commissioning and operation

Please note the following:
- Installation, connection to the electricity supply, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorized to perform such work by the facility's owner-operator. The specialist must have read and understood this Operating Manual and must follow the instructions it contains.
- The device must be operated by persons authorized and trained by the facility's owner-operator. Strict compliance with the instructions in the Operating Manual is mandatory.
- With regard to special fluids, including fluids used for cleaning, Endress+Hauser will be happy to assist in clarifying the corrosion-resistant properties of wetted materials. However, minor changes in temperature, concentration or in the degree of contamination in the process may result in variations in corrosion resistance. For this reason, Endress+Hauser does not accept any responsibility with regard to the corrosion resistance of wetted materials in a specific application.
  The user is responsible for the choice of suitable wetted materials in the process.
- If welding work is performed on the piping system, do not ground the welding appliance through the Promag flowmeter.
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams. The transmitter must be grounded apart from when special protective measures are taken (e.g. galvanically isolated SELV or PELV power supply)
- Invariably, local regulations governing the opening and repair of electrical devices apply.

1.3 Operational safety

Please note the following:
- Measuring systems for use in hazardous environments are accompanied by separate Ex documentation, which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory. The symbol on the front of this Ex documentation indicates the approval and the certification body (e.g. Ex Europe, FM USA, CSA Canada).
- The measuring device complies with the general safety requirements in accordance with EN 61010-1, the EMC requirements of IEC/EN 61326 and NAMUR Recommendations NE 21 and NE 43.
- Depending on the application, the seals of the process connections of the Promag H sensor require periodic replacement.
- When hot fluid passes through the measuring tube, the surface temperature of the housing increases. In the case of the sensor, in particular, users should expect temperatures that can be close to the fluid temperature. If the temperature of the fluid is high, implement sufficient measures to prevent burning or scalding.

- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Operating Instructions.

1.4 Return

The measuring device must be returned if repairs or a factory calibration are required, or if the wrong measuring device has been ordered or delivered. According to legal regulations, Endress+Hauser, as an ISO-certified company, is required to follow certain procedures when handling returned products that are in contact with medium.

To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

1.5 Notes on safety conventions and icons

The devices are designed to meet state-of-the-art safety requirements, have been tested, and left the factory in a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010-1 "Safety requirements for electrical equipment for measurement, control and laboratory use".
The devices can, however, be a source of danger if used incorrectly or for anything other than the designated use. Consequently, always pay particular attention to the safety instructions indicated in this Operating Manual by the following icons:

Warning!
"Warning" indicates an action or procedure which, if not performed correctly, can result in injury or a safety hazard. Comply strictly with the instructions and proceed with care.

Caution!
"Caution" indicates an action or procedure which, if not performed correctly, can result in incorrect operation or destruction of the device. Comply strictly with the instructions.

Note!
"Note" indicates an action or procedure which, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.

2 Identification

2.1 Device designation

The flow measuring system consists of the following components:

- Promag 10 transmitter
- Promag D/E/H/L/P/W sensor

In the *compact version*, the transmitter and sensor form a single mechanical unit; in the *remote version* they are installed separately.

2.1.1 Nameplate of the transmitter

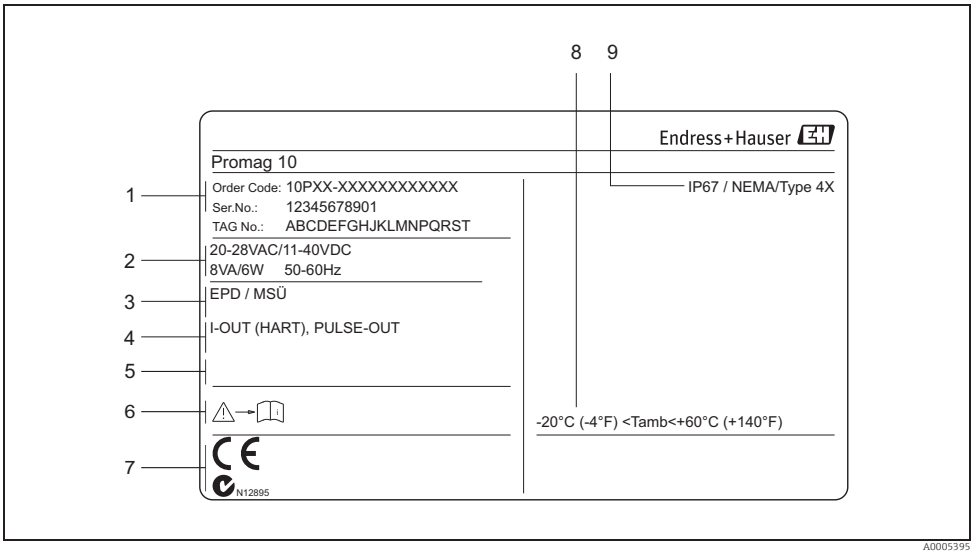


Fig. 1: Nameplate specifications for the "Promag 10" transmitter (example)

1 Ordering code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits.
2 Power supply, frequency, power consumption
3 Additional information:
EPD/MSÜ: with Empty Pipe Detection
4 Outputs available:
I-OUT (HART): with current output (HART)
PULSE-OUT: with pulse/status output
5 Reserved for information on special products
6 Observe device documentation
7 Reserved for additional information on device version (approvals, certificates)
8 Permitted ambient temperature range
9 Degree of protection

2.1.2 Nameplate of the sensor

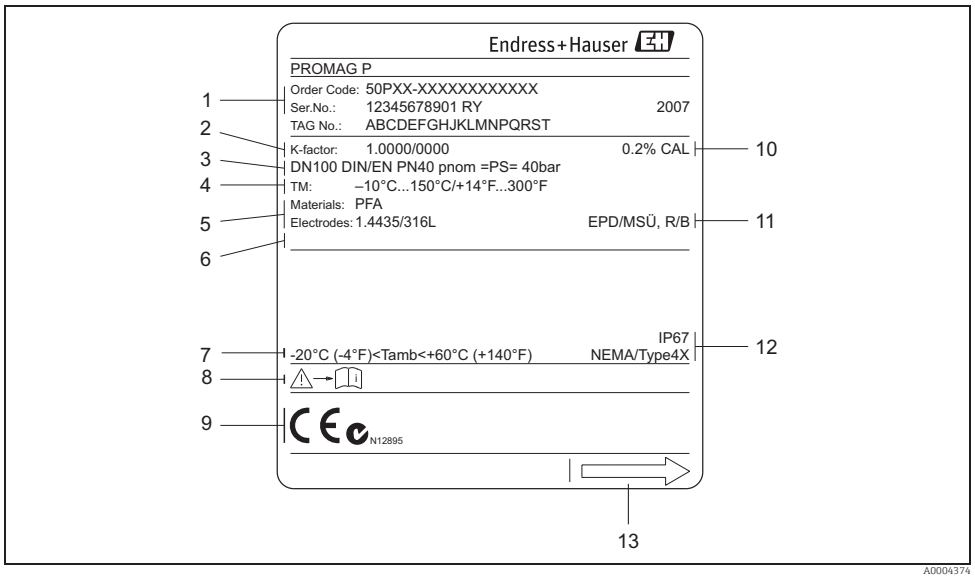


Fig. 2: Nameplate specifications for the "Promag" sensor (example)

1 *Ordering code/serial number: See the specifications on the order confirmation for the meanings of the individual letters and digits.*
2 *Calibration factor with zero point*
3 *Nominal diameter/Pressure rating*
4 *Fluid temperature range*
5 *Materials: lining/measuring electrodes*
6 *Reserved for information on special products*
7 *Permitted ambient temperature range*
8 *Observe device documentation*
9 *Reserved for additional information on device version (approvals, certificates)*
10 *Calibration tolerance*
11 *Additional information (examples):*
- *EPD/MSÜ: with Empty Pipe Detection electrode*
- *R/B: with reference electrode*

12 *Degree of protection*
13 *Flow direction*

2.1.3 Nameplate, connections

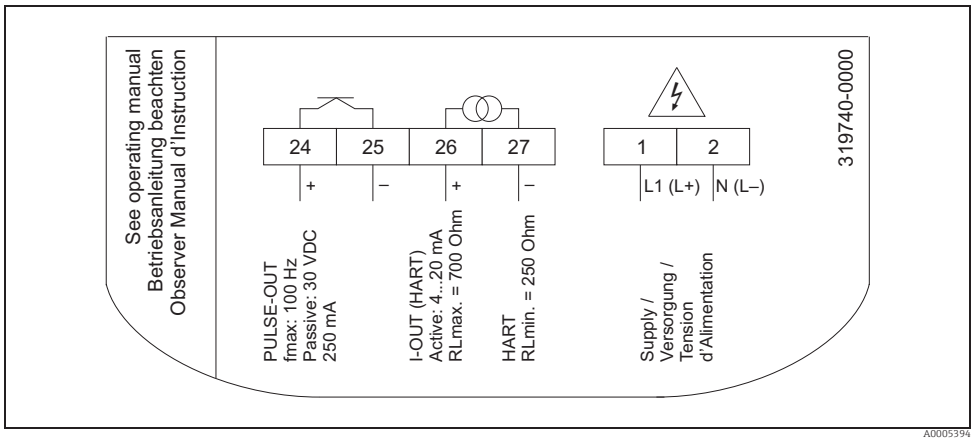


Fig. 3: Nameplate specifications for transmitter (example)

2.2 Certificates and approvals

The devices are designed to meet state-of-the-art safety requirements in accordance with sound engineering practice. They have been tested and left the factory in a condition in which they are safe to operate.

The devices comply with the applicable standards and regulations in accordance with EN 61010-1 "Safety requirements for electrical equipment for measurement, control and laboratory use" and with the EMC requirements of IEC/EN 61326.

The measuring system described in this Operating Manual is therefore in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

2.3 Registered trademarks

KALREZ® and VITON®
Registered trademarks of E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP®
Registered trademark of Ladish & Co., Inc., Kenosha, USA

HART®
Registered trademark of the HART Communication Foundation, Austin, USA

FieldCare®, Fieldcheck®, Applicator®
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

3 Installation

3.1 Incoming acceptance, transport and storage

3.1.1 Incoming acceptance

On receipt of the goods, check the following:
- Check the packaging and the contents for damage.
- Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Transport

The following instructions apply to unpacking and to transporting the device to its final location:
- Transport the devices in the containers in which they are delivered.
- Do not remove the protective plates or caps on the process connections until you are ready to install the device. This is particularly important in the case of sensors with PTFE linings.

Special notes on flanged devices

Caution!
- The wooden covers mounted on the flanges from the factory protect the linings on the flanges during storage and transportation. In case of Promag L they are additionally used to hold the lap joint flanges in place. Do not remove these covers until immediately before the device in the pipe.
- Do not lift flanged devices by the transmitter housing, or the connection housing in the case of the remote version.

Transporting flanged devices DN ≤ 300 (12")

Use webbing slings slung round the two process connections.
Do not use chains, as they could damage the housing.

Warning!
Risk of injury if the measuring device slips. The center of gravity of the assembled measuring device might be higher than the points around which the slings are slung.
At all times, therefore, make sure that the device does not unexpectedly turn around its axis or slip.

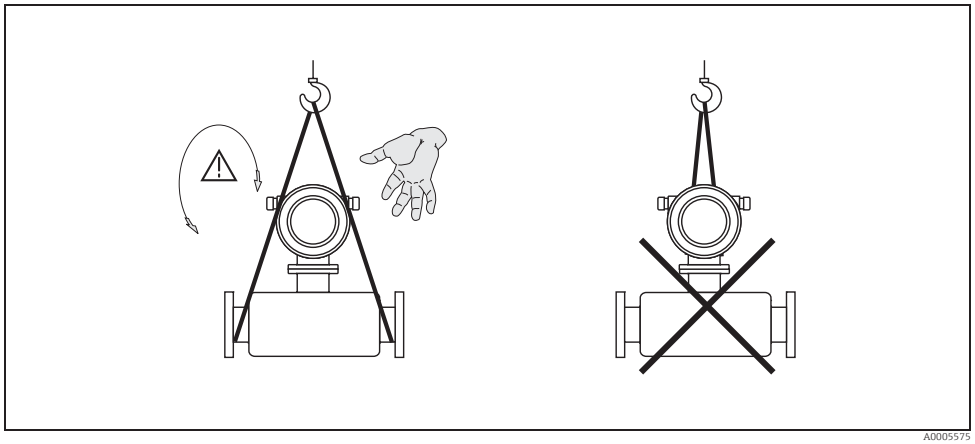


Fig. 4: Transporting sensors with DN ≤ 300 (12")

Transporting flanged devices DN ≥ 350 (14")

Use only the metal eyes on the flanges for transporting the device, lifting it and positioning the sensor in the piping.

Caution!
Do not attempt to lift the sensor with the tines of a fork-lift truck beneath the metal casing. This would buckle the casing and damage the internal magnetic coils.

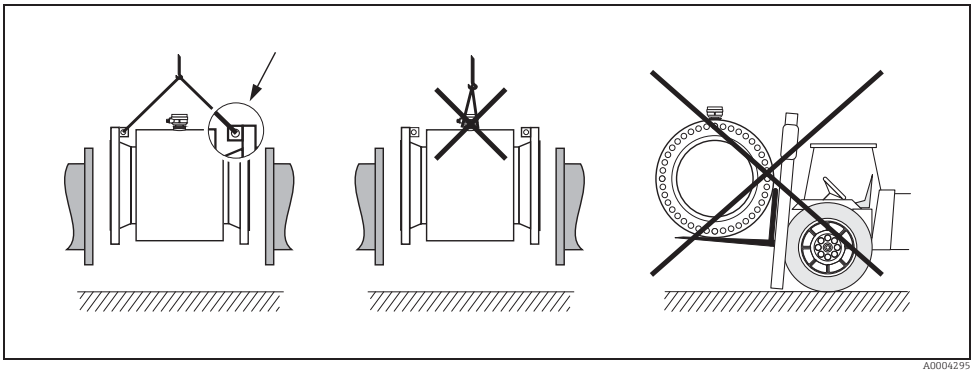


Fig. 5: Transporting sensors with DN ≥ 350 (14")

3.1.3 Storage

Please note the following:
- Pack the measuring device in such a way as to protect it reliably against impact for storage (and transportation). The original packaging provides optimum protection.
- The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors → 86.
- Do not remove the protective plates or caps on the process connections until you are ready to install the device. This is particularly important in the case of sensors with PTFE linings.
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- Choose a storage location where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the liner.

3.2 Installation conditions

3.2.1 Dimensions

The dimensions and installation lengths of the sensor and transmitter can be found in the "Technical Information" for the device in question. This document can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section on → 🖹 107.

3.2.2 Mounting location

Entrained air or gas bubble formation in the measuring tube can result in an increase in measuring errors.
Avoid the following locations:
- Highest point of a pipeline. Risk of air accumulating!
- Directly upstream from a free pipe outlet in a vertical pipeline.

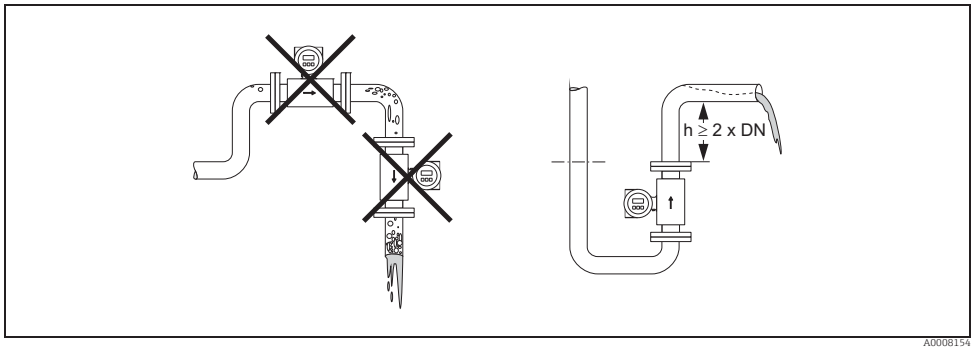


Fig. 6: Mounting location

Installation of pumps

Do not install the sensor on the intake side of a pump. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. Information on the lining's resistance to partial vacuum can be found on → 🖹 90.

It might be necessary to install pulse dampers in systems incorporating reciprocating, diaphragm or peristaltic pumps. Information on the measuring system's resistance to vibration and shock can be found on → 🖹 87.

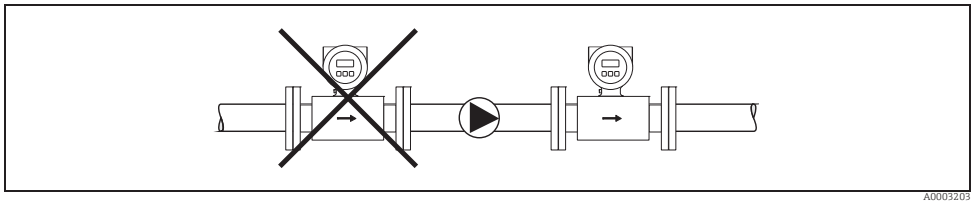


Fig. 7: Installation of pumps

Partially filled pipes

Partially filled pipes with gradients necessitate a drain-type configuration.
The Empty Pipe Detection function (EPD → 68) offers additional protection by detecting empty or partially filled pipes.

Caution!
Risk of solids accumulating. Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.

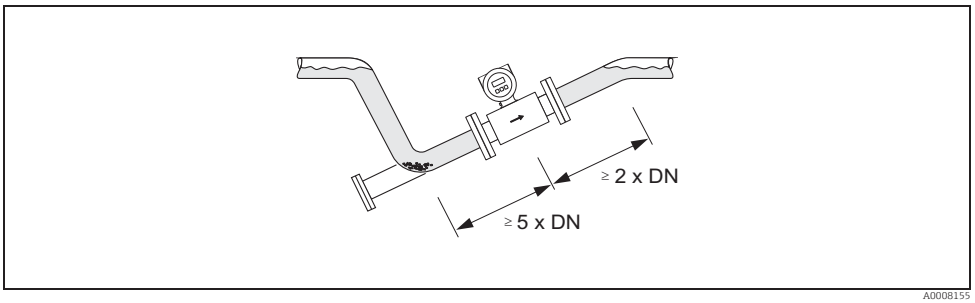


Fig. 8: Installation in a partially filled pipe

Down pipes

Install a siphon or a vent valve downstream of the sensor in down pipes whose length h ≥ 5 m (16.4 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube.
This measure also prevents the system losing prime, which could cause air pockets.
Information on the lining's resistance to partial vacuum can be found on → 90.

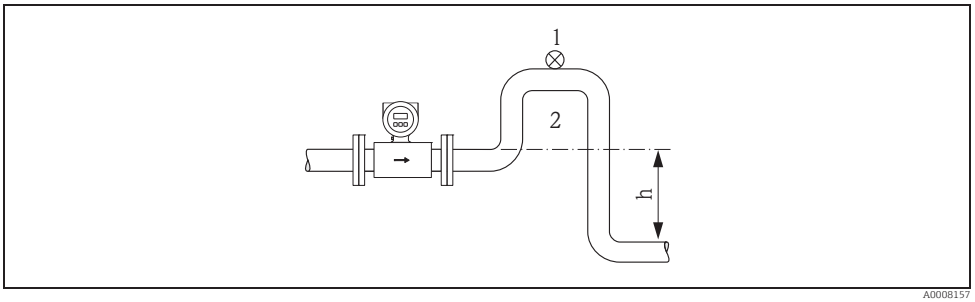


Fig. 9: Measures for installation in a down pipe

1 Vent valve
2 Pipe siphon
h Length of down pipe

3.2.3 Orientation

An optimum orientation position helps avoid gas and air accumulations and deposits in the measuring tube. However, Promag offers the additional Empty Pipe Detection (EPD) function to ensure the detection of partially filled measuring tubes, e.g. in the case of degassing fluids or varying process pressure.

Vertical orientation

This is the ideal orientation for self-emptying piping systems and for use in conjunction with Empty Pipe Detection.

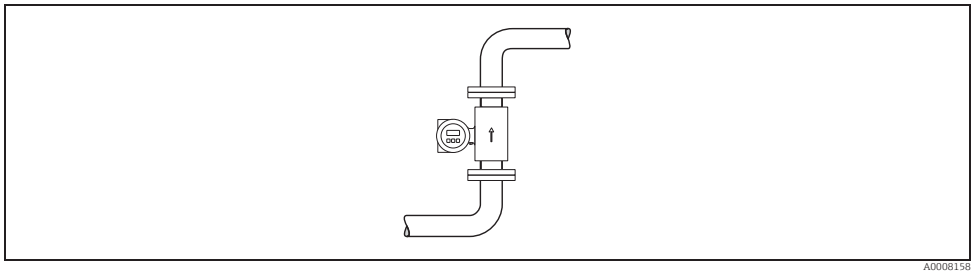


Fig. 10: Vertical orientation

Horizontal orientation

The measuring electrode plane should be horizontal. This prevents brief insulation of the two measuring electrodes by entrained air bubbles.

Caution!
Empty Pipe Detection functions correctly only when the measuring device is installed horizontally and the transmitter housing is facing upward (→ 10). Otherwise there is no guarantee that Empty Pipe Detection will respond if the measuring tube is only partially filled or empty.

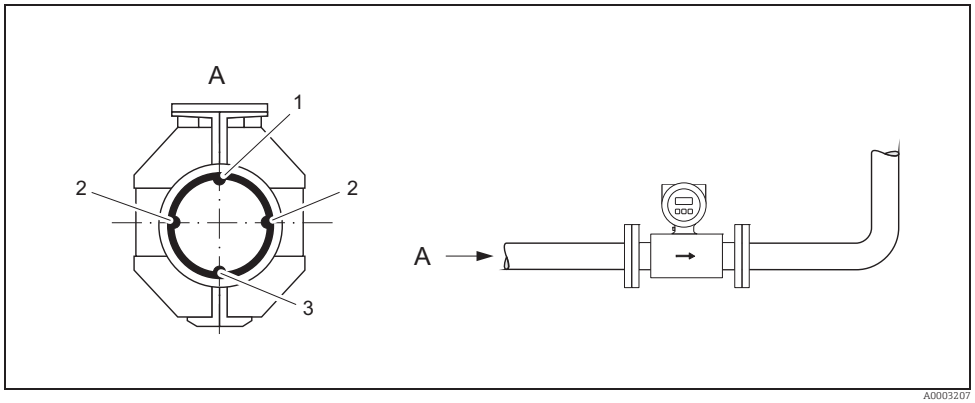


Fig. 11: Horizontal orientation

1 EPD electrode for the detection of empty pipes (not with Promag D and Promag H (DN 2 to 15 / 1/12 to ½"))
2 Measuring electrodes for signal detection
3 Reference electrode for the potential equalization (not with Promag D and H)

Inlet and outlet run

If possible, install the sensor upstream from fittings such as valves, T-pieces, elbows, etc.

The following inlet and outlet runs must be observed in order to meet accuracy specifications:
- Inlet run: ≥ 5 × DN
- Outlet run: ≥ 2 × DN

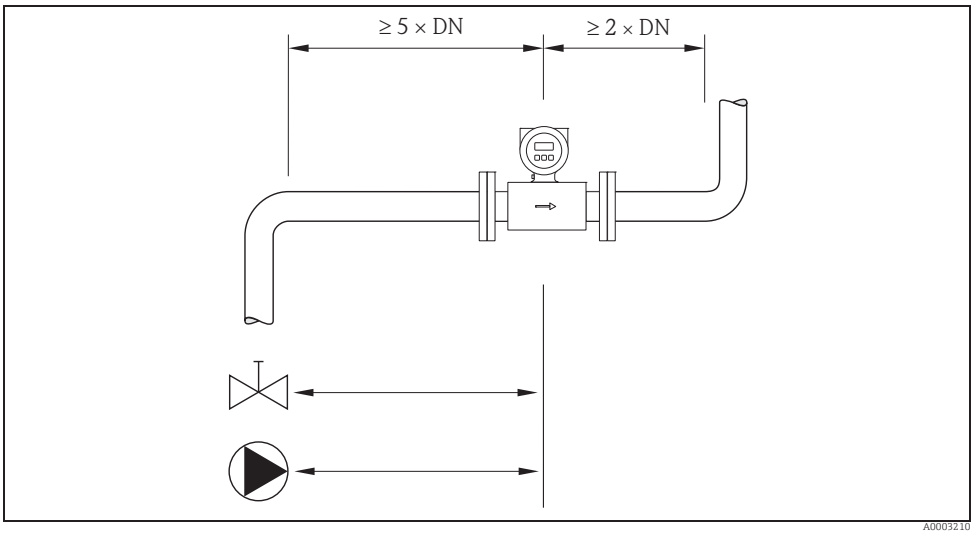


Fig. 12: Inlet and outlet runs

3.2.4 Vibrations

Secure the piping and the sensor if vibration is severe.

Caution!
If vibrations are too severe, we recommend the sensor and transmitter be mounted separately. Information on resistance to vibration and shock can be found on → 87.

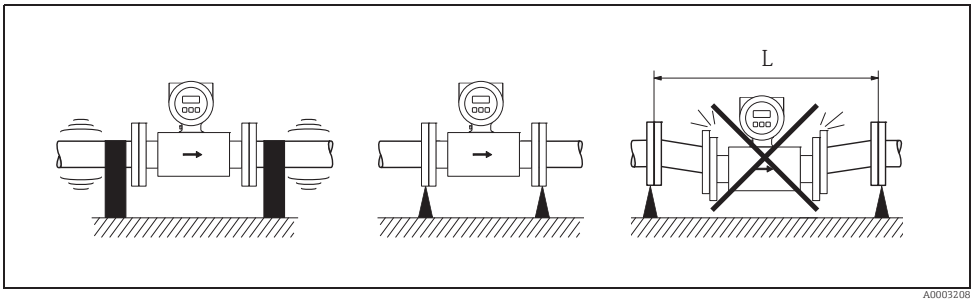


Fig. 13: Measures to prevent vibration of the device (L > 10 m (32.8 ft))

3.2.5 Foundations, supports

If the nominal diameter is DN ≥ 350 (14"), mount the sensor on a foundation of adequate load-bearing strength.

Caution!
Risk of damage.
Do not support the weight of the sensor on the metal casing: the casing would buckle and damage the internal magnetic coils.

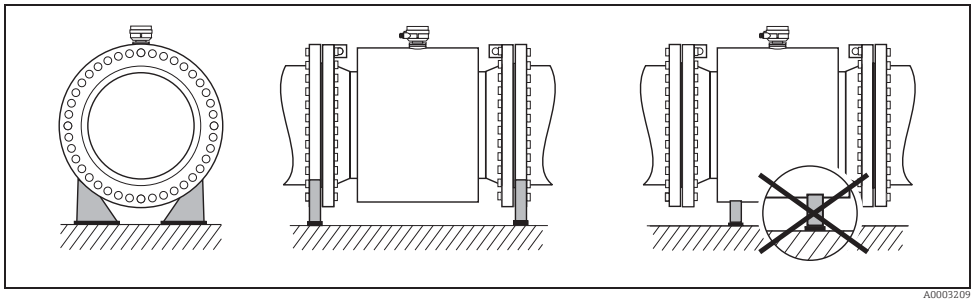


Fig. 14: Correct support for large nominal diameters (DN ≥ 350 / 14")

3.2.6 Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes.
The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids. The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders.

Note!
The nomogram only applies to liquids of viscosity similar to water.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram read off the pressure loss as a function of flow velocity (*downstream* from the reduction) and the d/D ratio.

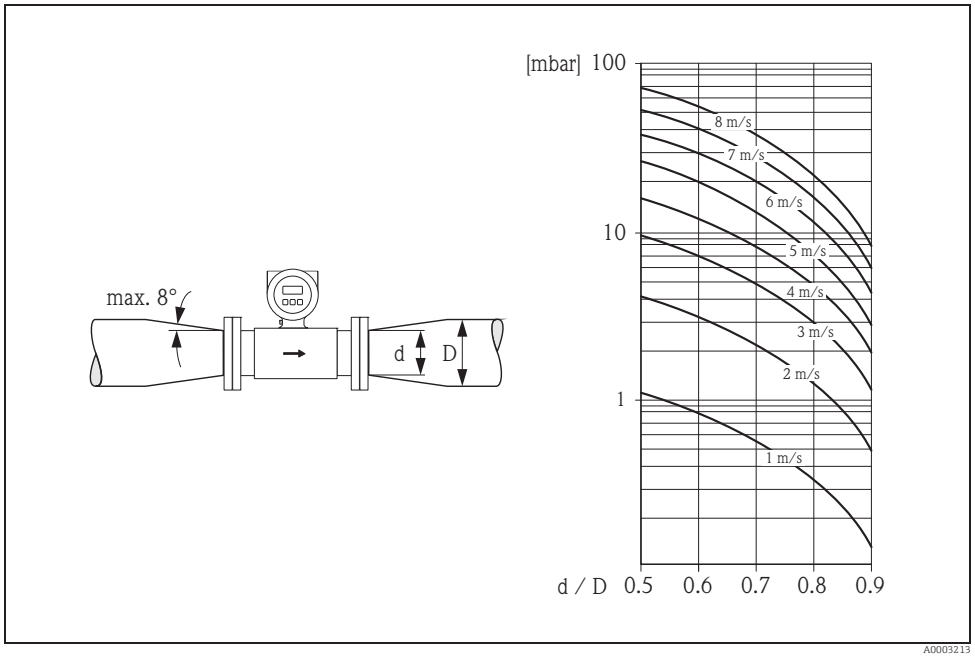


Fig. 15: Pressure loss due to adapters

3.2.7 Nominal diameter and flow rate

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor. The optimum velocity of flow is between 2 and 3 m/s (6.5 to 9.8 ft/s)

The velocity of flow (v), moreover, has to be matched to the physical properties of the fluid:
- v < 2 m/s (6.5 ft/s): for abrasive fluids
- v > 2 m/s (6.5 ft/s): for fluids producing buildup

Note!
Flow velocity can be increased, if necessary, by reducing the nominal diameter of the sensor (→ 15).

Recommended flow (SI units)

Nominal diameter	Promag D	Promag E/P	Promag H	Promag L	Promag W
[mm]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [dm³/min]				
2	–	–	0.06 to 1.8	–	–
4	–	–	0.25 to 7	–	–
8	–	–	1 to 30	–	–
15	–	4 to 100	4 to 100	–	–
25	9 to 300	9 to 300	9 to 300	9 to 300	9 to 300
32	–	15 to 500	–	15 to 500	15 to 500
40	25 to 700	25 to 700	25 to 700	25 to 700	25 to 700
50	35 to 1100	35 to 1100	35 to 1100	35 to 1100	35 to 1100
65	60 to 2000	60 to 2000	60 to 2000	60 to 2000	60 to 2000
80	90 to 3000	90 to 3000	90 to 3000	90 to 3000	90 to 3000
100	145 to 4700	145 to 4700	145 to 4700	145 to 4700	145 to 4700
125	–	220 to 7500	–	220 to 7500	220 to 7500
[mm]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [m³/h]				
150	–	20 to 600	–	20 to 600	20 to 600
200	–	35 to 1100	–	35 to 1100	35 to 1100
250	–	55 to 1700	–	55 to 1700	55 to 1700
300	–	80 to 2400	–	80 to 2400	80 to 2400
350	–	110 to 3300	–	110 to 3300	110 to 3300
375	–	–	–	140 to 4200	140 to 4200
400	–	140 to 4200	–	140 to 4200	140 to 4200
450	–	180 to 5400	–	180 to 5400	180 to 5400
500	–	220 to 6600	–	220 to 6600	220 to 6600
600	–	310 to 9600	–	310 to 9600	310 to 9600
700	–	–	–	420 to 13500	420 to 13500
750	–	–	–	480 to 15200	480 to 15200
800	–	–	–	550 to 18000	550 to 18000
900	–	–	–	690 to 22500	690 to 22500
1000	–	–	–	850 to 28000	850 to 28000
1050	–	–	–	950 to 40000	950 to 40000
1200	–	–	–	1250 to 40000	1250 to 40000
1400	–	–	–	–	1700 to 55000
1600	–	–	–	–	2200 to 70000
1800	–	–	–	–	2800 to 90000
2000	–	–	–	–	3400 to 110000

Recommended flow (US units)

Nominal diameter	Promag D	Promag E/P	Promag H	Promag L	Promag W
[inch]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [gal/min]				
1/12"	–	–	0.015 to 0.5	–	–
1/8"	–	–	0.07 to 2	–	–
8"	–	–	0.25 to 8	–	–
½"	–	1.0 to 27	1.0 to 27	–	–
1"	2.5 to 80	2.5 to 80	2.5 to 80	2.5 to 80	2.5 to 80
1 ¼"	–	4 to 130	–	–	4 to 130
1 ½"	7 to 190	7 to 190	7 to 190	7 to 190	7 to 190
2"	10 to 300	10 to 300	10 to 300	10 to 300	10 to 300
2 ½"	16 to 500	16 to 500	16 to 500	16 to 500	16 to 500
3"	24 to 800	24 to 800	24 to 800	24 to 800	24 to 800
4"	40 to 1250	40 to 1250	40 to 1250	40 to 1250	40 to 1250
5"	–	60 to 1950	–	60 to 1950	60 to 1950
6"	–	90 to 2650	–	90 to 2650	90 to 2650
8"	–	155 to 4850	–	155 to 4850	155 to 4850
10"	–	250 to 7500	–	250 to 7500	250 to 7500
12"	–	350 to 10600	–	350 to 10600	350 to 10600
14"	–	500 to 15000	–	500 to 15000	500 to 15000
15"	–	–	–	600 to 19000	600 to 19000
16"	–	600 to 19000	–	600 to 19000	600 to 19000
18"	–	800 to 24000	–	800 to 24000	800 to 24000
20"	–	1000 to 30000	–	1000 to 30000	1000 to 30000
24"	–	1400 to 44000	–	1400 to 44000	1400 to 44000
28"	–	–	–	1900 to 60000	1900 to 60000
30"	–	–	–	2150 to 67000	2150 to 67000
32"	–	–	–	2450 to 80000	2450 to 80000
36"	–	–	–	3100 to 100000	3100 to 100000
40"	–	–	–	3800 to 125000	3800 to 125000
42"	–	–	–	4200 to 135000	4200 to 135000
48"	–	–	–	5500 to 175000	5500 to 175000
[inch]	Min./max. full scale value (v ≈ 0.3 or 10 m/s) in [Mgal/d]				
54"	–	–	–	–	9 to 300
60"	–	–	–	–	12 to 380
66"	–	–	–	–	14 to 500
72"	–	–	–	–	16 to 570
78"	–	–	–	–	18 to 650

3.2.8 Length of connecting cable

In order to ensure measuring accuracy, comply with the following instructions when installing the remote version:

- Fix cable run or lay in armored conduit. Cable movements can falsify the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- Ensure potential equalization between sensor and transmitter, if necessary.
- The permitted connecting cable length L_{max} is determined by the fluid conductivity (→ 16). A minimum conductivity of 50 µS/cm is needed for all fluids.
- The maximum connecting cable length is 10 m (33 ft) when empty pipe detection (EPD → 68) is switched on.

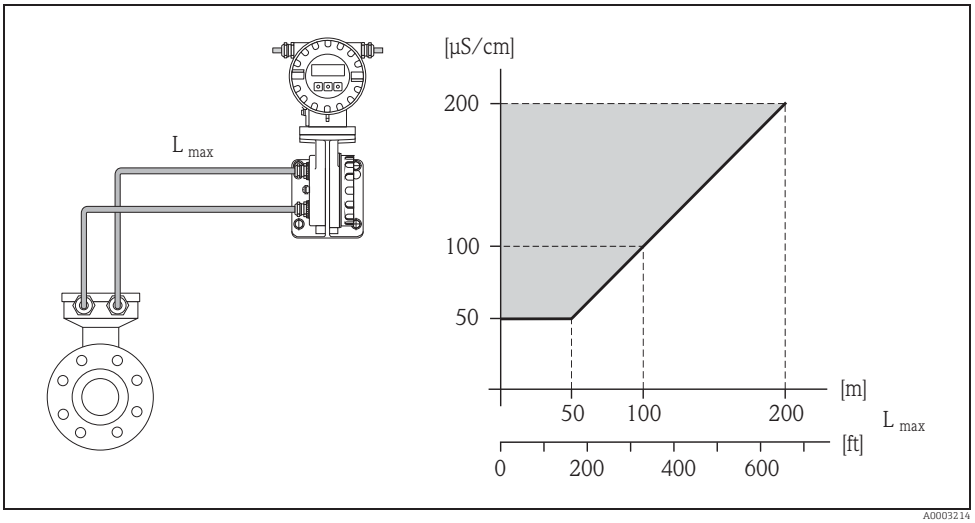


Fig. 16: Permissible cable length for the remote version

Area shaded gray = permitted range
Lmax = connecting cable length in [m]
Fluid conductivity in [µS/cm]

3.3 Installation instructions

3.3.1 Installing the Promag D sensor

The sensor is installed between the pipe flanges with a mounting kit. The device is centered using recesses on the sensor (→ 20).

Note!
A mounting kit consisting of mounting bolts, seals, nuts and washers can be ordered separately (→ 70). Centering sleeves are provided with the device if they are required for the installation.

Caution!
When installing the transmitter in the pipe, observe the necessary torques (→ 21).

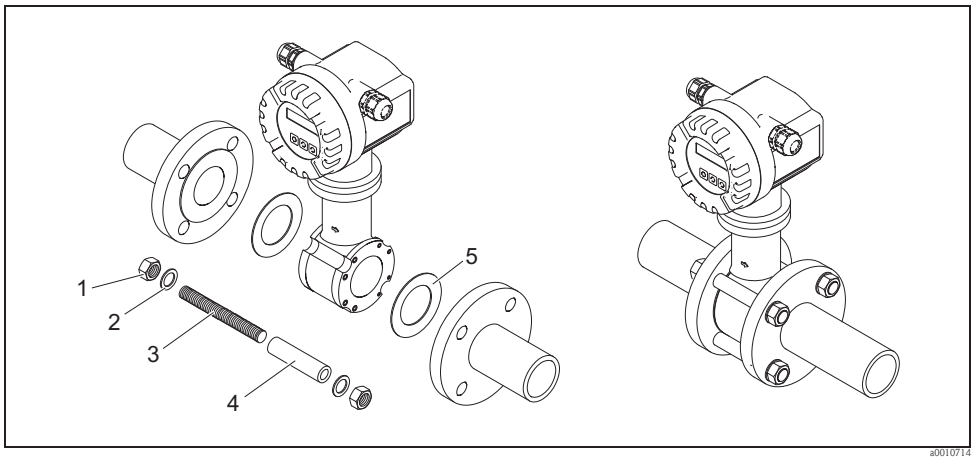


Fig. 17: Mounting the sensor

1 Nut
2 Washer
3 Mounting bolt
4 Centering sleeve
5 Seal

Seals

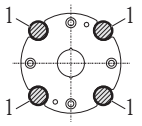
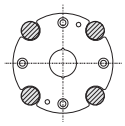
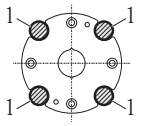
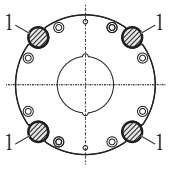
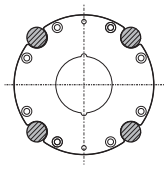
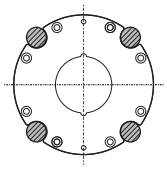
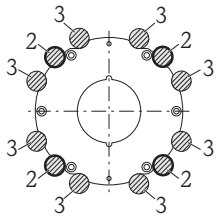
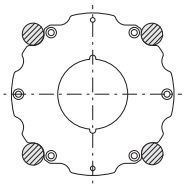
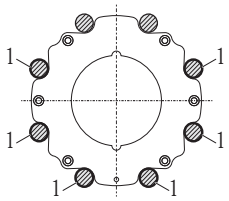
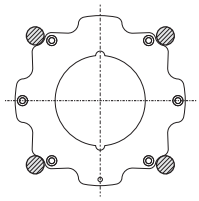
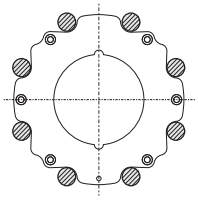
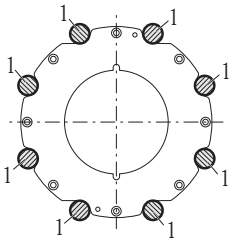
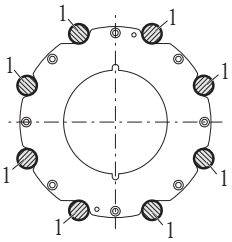
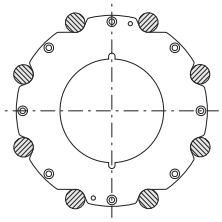
When installing the sensor, make sure that the seals used do not project into the pipe cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Note!
Use seals with a hardness rating of 70° Shore A.

Arrangement of the mounting bolts and centering sleeves

The device is centered using recesses on the sensor. The arrangement of the mounting bolts and the use of the centering sleeves supplied depend on the nominal diameter, the flange standard und the pitch circle diameter.

	Process connection		
	EN (DIN)	ASME	JIS
DN 25 to 40 (1 to 1 ½")	 A0010896	 A0010824	 A0010896
DN 50 (2")	 A0010897	 A0010825	 A0010825
DN 65 (–)	 A0012170	–	 A0012171
DN 80 (3")	 A0010898	 A0010827	 A0010826
DN 100 (4")	 A0012168	 A0012168	 A0012169

1 = Mounting bolts with centering sleeves
2 = EN (DIN) flanges: 4-hole → with centering sleeves
3 = EN (DIN) flanges: 8-hole → without centering sleeves

Screw tightening torques (Promag D)

Please note the following:
- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

The tightening torques apply to situations where an EPDM soft material flat seal (e.g. 70° Shore A) is used.

Tightening torques, mounting bolts and centering sleeves for EN (DIN) PN 16

Nominal diameter [mm]	Mounting bolts [mm]	Centering sleeve length [mm]	Tightening torque [Nm] with a process flange with a	
			smooth seal face	raised face
25	4 × M12 × 145	54	19	19
40	4 × M16 × 170	68	33	33
50	4 × M16 × 185	82	41	41
65[1)]	4 × M16 × 200	92	44	44
65[2)]	8 × M16 × 200	– [3)]	29	29
80	8 × M16 × 225	116	36	36
100	8 × M16 × 260	147	40	40

[1)] EN (DIN) flanges: 4-hole → with centering sleeves
[2)] EN (DIN) flanges: 8-hole → without centering sleeves
[3)] A centering sleeve is not required. The device is centered directly via the sensor housing.

Tightening torques, mounting bolts and centering sleeves for JIS 10 K

Nominal diameter [mm]	Mounting bolts [mm]	Centering sleeve length [mm]	Tightening torque [Nm] with a process flange with a	
			smooth seal face	raised face
25	4 × M16 × 170	54	24	24
40	4 × M16 × 170	68	32	25
50	4 × M16 × 185	– *	38	30
65	4 × M16 × 200	– *	42	42
80	8 × M16 × 225	– *	36	28
100	8 × M16 × 260	– *	39	37

* A centering sleeve is not required. The device is centered directly via the sensor housing.

Tightening torques, mounting bolts and centering sleeves for ASME Class 150

Nominal diameter [inch]	Mounting bolts [inch]	Centering sleeve length [inch]	Tightening torque [lbf · ft] with a process flange with a	
			smooth seal face	raised face
1"	4 × UNC 1/2" × 5.70"	– *	14	7
1 ½"	4 × UNC 1/2" × 6.50"	– *	21	14
2"	4 × UNC 5/8" × 7.50"	– *	30	27
3"	4 × UNC 5/8" × 9.25"	– *	31	31
4"	8 × UNC 5/8" × 10.4"	5.79	28	28

* A centering sleeve is not required. The device is centered directly via the sensor housing.

3.3.2 Installing the Promag E sensor

Caution!
- The protective covers mounted on the two sensor flanges guard the PTFE, which is turned over the flanges. Consequently, do not remove these covers until immediately before the sensor is installed in the pipe.
- The covers must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges.
- Observe in any case the necessary screw tightening torques on → 📄 23
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment

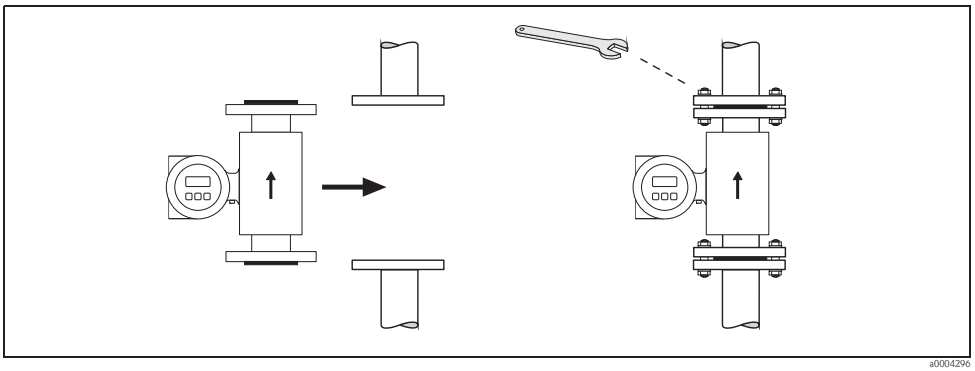


Fig. 18: Installing the Promag E sensor

Seals

Comply with the following instructions when installing seals:
- PTFE lining → No seals are required!
- For DIN flanges, use only seals according to EN 1514-1.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables for potential equalization can be ordered as an accessory (→ 📄 70).
- Information on potential equalization and detailed mounting instructions for the use of ground cables can be found on → 📄 50

Tightening torques for threaded fasteners (Promag E)

Please note the following:
- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

Tightening torques for:
- EN (DIN) → 🖹 23
- ASME → 🖹 24
- JIS → 🖹 24

Promag E tightening torques for EN (DIN)

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque [Nm]
15	PN 40	4 × M 12	11
25	PN 40	4 × M 12	26
32	PN 40	4 × M 16	41
40	PN 40	4 × M 16	52
50	PN 40	4 × M 16	65
65 *	PN 16	8 × M 16	43
80	PN 16	8 × M 16	53
100	PN 16	8 × M 16	57
125	PN 16	8 × M 16	75
150	PN 16	8 × M 20	99
200	PN 10	8 × M 20	141
200	PN 16	12 × M 20	94
250	PN 10	12 × M 20	110
250	PN 16	12 × M 24	131
300	PN 10	12 × M 20	125
300	PN 16	12 × M 24	179
350	PN 6	12 × M 20	200
350	PN 10	16 × M 20	188
350	PN 16	16 × M 24	254
400	PN 6	16 × M 20	166
400	PN 10	16 × M 24	260
400	PN 16	16 × M 27	330
450	PN 6	16 × M 20	202
450	PN 10	20 × M 24	235
450	PN 16	20 × M 27	300
500	PN 6	20 × M 20	176
500	PN 10	20 × M 24	265
500	PN 16	20 × M 30	448
600	PN 6	20 × M 24	242
600	PN 10	20 × M 27	345
600 *	PN 16	20 × M 33	658
* Designed acc. to EN 1092-1 (not to DIN 2501)			

Promag E tightening torques for ASME

Nominal diameter		ASME		Max. tightening torque PTFE	
[mm]	[inch]	Pressure rating [lbs]	Threaded fasteners	[Nm]	[lbf · ft]
15	½"	Class 150	4 × ½"	6	4
25	1"	Class 150	4 × ½"	11	8
40	1 ½"	Class 150	4 × ½"	24	18
50	2"	Class 150	4 × 5/8"	47	35
80	3"	Class 150	4 × 5/8"	79	58
100	4"	Class 150	8 × 5/8"	56	41
150	6"	Class 150	8 × ¾"	106	78
200	8"	Class 150	8 × ¾"	143	105
250	10"	Class 150	12 × 7/8"	135	100
300	12"	Class 150	12 × 7/8"	178	131
350	14"	Class 150	12 × 1"	260	192
400	16"	Class 150	16 × 1"	246	181
450	18"	Class 150	16 × 1 1/8"	371	274
500	20"	Class 150	20 × 1 1/8"	341	252
600	24"	Class 150	20 × 1 ¼"	477	352

Promag E tightening torques for JIS

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Max. tightening torque [Nm] PTFE
15	20K	4 × M 12	16
25	20K	4 × M 16	32
32	20K	4 × M 16	38
40	20K	4 × M 16	41
50	10K	4 × M 16	54
65	10K	4 × M 16	74
80	10K	8 × M 16	38
100	10K	8 × M 16	47
125	10K	8 × M 20	80
150	10K	8 × M 20	99
200	10K	12 × M 20	82
250	10K	12 × M 22	133
300	10K	16 × M 22	99

E-404

3.3.3 Installing the Promag H sensor

The sensor is supplied to order, with or without pre-installed process connections. Pre-installed process connections are secured to the sensor with 4 or 6 hex-head threaded fasteners.

Caution!
The sensor might require support or additional attachments, depending on the application and the length of the piping run. When plastic process connections are used, the sensor must be additionally supported mechanically. A wall-mounting kit can be ordered separately from Endress+Hauser as an accessory (→ 📄 70).

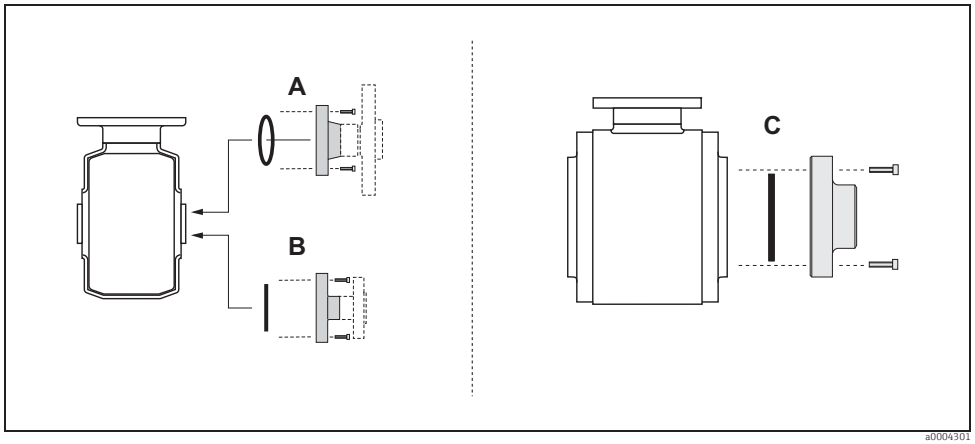


Fig. 19: Promag H process connections (DN 2 to 25 / 1/12 to 1", DN 40 to 100 / 1½ to 4")

A = DN 2 to 25 / process connections with O-ring
– Flanges (EN (DIN), ASME, JIS),
– External thread

B = DN 2 to 25 / process connections with aseptic gasket seal
– Weld nipples (DIN 11850, ODT/SMS)
– Tri-Clamp L14AM7
– Coupling (DIN 11851, DIN 11864-1, SMS 1145 (only DN 25)
– Flange DIN 11864-2

C = DN 40 to 100 / process connections with aseptic gasket seal
– Weld nipples (DIN 11850, ODT/SMS)
– Tri-Clamp L14AM7
– Coupling (DIN 11851, DIN 11864-1, SMS 1145)
– Flange DIN 11864-2

Seals

When installing the process connections, make sure that the seals are clean and correctly centered.

Caution!
- With metal process connections, you must fully tighten the screws. The process connection forms a metallic connection with the sensor, which ensures a defined compression of the seal.
- With plastic process connections, note the max. torques for lubricated threads (7 Nm / 5.2 lbf ft). With plastic flanges, always use seals between connection and counter flange.
- The seals must be replaced periodically, depending on the application, particularly in the case of gasket seals (aseptic version)!
  The period between changes depends on the frequency of cleaning cycles, the cleaning temperature and the fluid temperature. Replacement seals can be ordered as accessories → 📄 70.

Welding the transmitter into the piping (weld nipples)

Caution!
Risk of destroying the measuring electronics. Make sure that the welding machine is *not* grounded via the sensor or the transmitter.

1. Tack-weld the sensor into the pipe. A suitable welding jig can be ordered separately as an accessory (→ 🖹 70).
2. Loosen the screws on the process connection flange and remove the sensor, complete with the seal, from the pipe.
3. Weld the process connection to the pipe.
4. Reinstall the sensor in the pipe. Make sure that everything is clean and that the seal is correctly seated.

Note!
- If thin-walled foodstuffs pipes are not welded correctly, the heat could damage the installed seal. It is therefore advisable to remove the sensor and the seal prior to welding.
- The pipe has to be spread approximately 8 mm to permit disassembly.

Cleaning with pigs

If pigs are used for cleaning, it is essential to take the inside diameters of the measuring tube and process connection into account. All the dimensions and lengths of the sensor and transmitter are provided in the separate documentation "Technical Documentation".

3.3.4 Installing the Promag L sensor

Caution!
- The protective covers mounted on the two sensor flanges (DN 25 to 300 / 1 to 12") are used to hold the lap joint flanges in place and to protect the PTFE liner during transportation. Consequently, do not remove these covers until immediately before the sensor is installed in the pipe.
- The covers must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges.
- Observe in any case the necessary screw tightening torques on → 28
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment
- To comply with the device specification, a concentrical installation in the measuring section is required

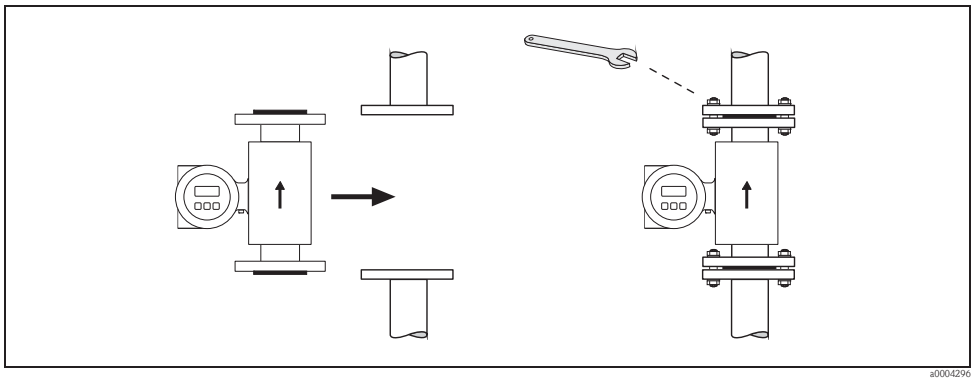


Fig. 20: Installing the Promag L sensor

Seals

Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are always necessary.
- Polyurethane lining → no seals are required.
- PTFE lining → no seals are required.
- For DIN flanges, use only seals according to EN 1514-1.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit!
Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables for potential equalization can be ordered as an accessory (→ 70).
- Information on potential equalization and detailed mounting instructions for the use of ground cables can be found on → 50.

Screw tightening torques (Promag L)

Please note the following:
- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

Promag L tightening torques for EN (DIN)

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
25	PN 10/16	4 × M 12	-	6	11
32	PN 10/16	4 × M 16	-	16	27
40	PN 10/16	4 × M 16	-	16	29
50	PN 10/16	4 × M 16	-	15	40
65*	PN 10/16	8 × M 16	-	10	22
80	PN 10/16	8 × M 16	-	15	30
100	PN 10/16	8 × M 16	-	20	42
125	PN 10/16	8 × M 16	-	30	55
150	PN 10/16	8 × M 20	-	50	90
200	PN 16	12 × M 20	-	65	87
250	PN 16	12 × M 24	-	126	151
300	PN 16	12 × M 24	-	139	177
350	PN 6	12 × M 20	111	120	-
350	PN 10	16 × M 20	112	118	-
400	PN 6	16 × M 20	90	98	-
400	PN 10	16 × M 24	151	167	-
450	PN 6	16 × M 20	112	126	-
450	PN 10	20 × M 24	153	133	-
500	PN 6	20 × M 20	119	123	-
500	PN 10	20 × M 24	155	171	-
600	PN 6	20 × M 24	139	147	-
600	PN 10	20 × M 27	206	219	-
700	PN 6	24 × M 24	148	139	-
700	PN 10	24 × M 27	246	246	-
800	PN 6	24 × M 27	206	182	-
800	PN 10	24 × M 30	331	316	-
900	PN 6	24 × M 27	230	637	-
900	PN 10	28 × M 30	316	307	-
1000	PN 6	28 × M 27	218	208	-
1000	PN 10	28 × M 33	402	405	-
1200	PN 6	32 × M 30	319	299	-
1200	PN 10	32 × M 36	564	568	-

* Designed acc. to EN 1092-1 (not to DIN 2501)

Promag L tightening torques for ASME

Nominal diameter		ASME	Threaded fasteners	Max. tightening torque					
		Pressure rating		Hard rubber		Polyurethane		PTFE	
[mm]	[inch]	[lbs]		[Nm]	[lbf · ft]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
25	1"	Class 150	4 × 5/8"	-	-	5	4	14	13
40	1 ½"	Class 150	8 × 5/8"	-	-	10	17	21	15
50	2"	Class 150	4 × 5/8"	-	-	15	11	40	29
80	3"	Class 150	4 × 5/8"	-	-	25	18	65	48
100	4"	Class 150	8 × 5/8"	-	-	20	15	44	32
150	6"	Class 150	8 × ¾"	-	-	45	33	90	66
200	8"	Class 150	8 × ¾"	-	-	65	48	87	64
250	10"	Class 150	12 × 7/8"	-	-	126	93	151	112
300	12"	Class 150	12 × 7/8"	-	-	146	108	177	131
350	14"	Class 150	12 × 1"	135	100	158	117	-	-
400	16"	Class 150	16 × 1"	128	94	150	111	-	-
450	18"	Class 150	16 × 1 1/8"	204	150	234	173	-	-
500	20"	Class 150	20 × 1 1/8"	183	135	217	160	-	-
600	24"	Class 150	20 × 1 ¼"	268	198	307	226	-	-

Promag L tightening torques for AWWA

Nominal diameter		AWWA	Threaded fasteners	Max. tightening torque					
		Pressure rating		Hartgummi		Polyurethane		PTFE	
[mm]	[inch]			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
700	28"	Class D	28 × 1 ¼"	247	182	292	215	-	-
750	30"	Class D	28 × 1 ¼"	287	212	302	223	-	-
800	32"	Class D	28 × 1 ½"	394	291	422	311	-	-
900	36"	Class D	32 × 1 ½"	419	309	430	317	-	-
1000	40"	Class D	36 × 1 ½"	420	310	477	352	-	-
1050	42"	Class D	36 × 1 ½"	528	389	518	382	-	-
1200	48"	Class D	44 × 1 ½"	552	407	531	392	-	-

Promag L tightening torques for AS 2129

Nominal diameter	AS 2129	Threaded fasteners	Max. tightening torque		
	Pressure rating		Hard rubber	Polyurethane	PTFE
[mm]			[Nm]	[Nm]	[Nm]
350	Table E	12 × M 24	203	-	-
400	Table E	12 × M 24	226	-	-
450	Table E	16 × M 24	226	-	-
500	Table E	16 × M 24	271	-	-
600	Table E	16 × M 30	439	-	-
700	Table E	20 × M 30	355	-	-
750	Table E	20 × M 30	559	-	-
800	Table E	20 × M 30	631	-	-
900	Table E	24 × M 30	627	-	-
1000	Table E	24 × M 30	634	-	-
1200	Table E	32 × M 30	727	-	-

Promag L tightening torques for AS 4087

Nominal diameter [mm]	AS 4087 Pressure rating	Threaded fasteners	Max. tightening torque		
			Hard rubber [Nm]	Polyurethane [Nm]	PTFE [Nm]
350	PN 16	12 × M 24	203	-	-
375	PN 16	12 × M 24	137	-	-
400	PN 16	12 × M 24	226	-	-
450	PN 16	12 × M 24	301	-	-
500	PN 16	16 × M 24	271	-	-
600	PN 16	16 × M 27	393	-	-
700	PN 16	20 × M 27	330	-	-
750	PN 16	20 × M 30	529	-	-
800	PN 16	20 × M 33	631	-	-
900	PN 16	24 × M 33	627	-	-
1000	PN 16	24 × M 33	595	-	-
1200	PN 16	32 × M 33	703	-	-

3.3.5 Installing the Promag P sensor

Caution!
- The protective covers mounted on the two sensor flanges guard the PTFE, which is turned over the flanges. Consequently, do not remove these covers until immediately before the sensor is installed in the pipe.
- The covers must remain in place while the device is in storage.
- Make sure that the lining is not damaged or removed from the flanges.

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges.
- Observe in any case the necessary screw tightening torques on → 31
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment

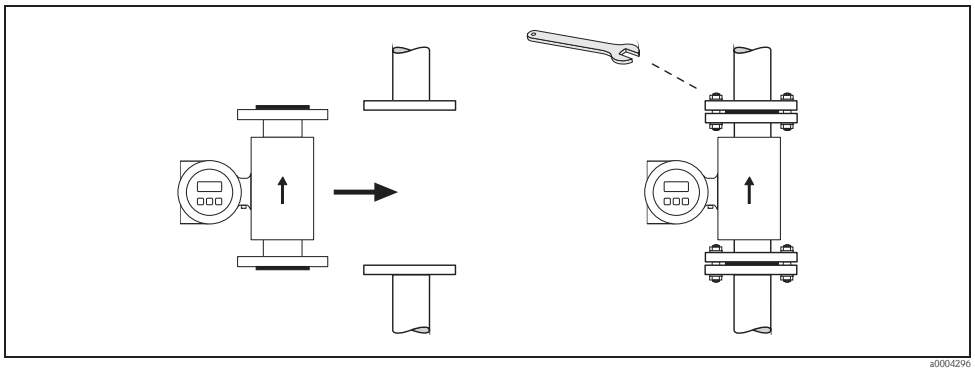


Fig. 21: Installing the Promag P sensor

Seals

Comply with the following instructions when installing seals:
- PTFE lining → No seals are required!
- For DIN flanges, use only seals according to EN 1514-1.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit! Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables for potential equalization can be ordered as an accessory (→ 70).
- Information on potential equalization and detailed mounting instructions for the use of ground cables can be found on → 50

Tightening torques for threaded fasteners (Promag P)

Please note the following:
- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

Tightening torques for:
- EN (DIN) → 32
- ASME → 32
- JIS → 33
- AS 2129 → 33
- AS 4087 → 33

Promag P tightening torques for EN (DIN)

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque [Nm]
25	PN 40	4 × M 12	26
32	PN 40	4 × M 16	41
40	PN 40	4 × M 16	52
50	PN 40	4 × M 16	65
65 *	PN 16	8 × M 16	43
65	PN 40	8 × M 16	43
80	PN 16	8 × M 16	53
80	PN 40	8 × M 16	53
100	PN 16	8 × M 16	57
100	PN 40	8 × M 20	78
125	PN 16	8 × M 16	75
125	PN 40	8 × M 24	111
150	PN 16	8 × M 20	99
150	PN 40	8 × M 24	136
200	PN 10	8 × M 20	141
200	PN 16	12 × M 20	94
200	PN 25	12 × M 24	138
250	PN 10	12 × M 20	110
250	PN 16	12 × M 24	131
250	PN 25	12 × M 27	200
300	PN 10	12 × M 20	125
300	PN 16	12 × M 24	179
300	PN 25	16 × M 27	204
350	PN 10	16 × M 20	188
350	PN 16	16 × M 24	254
350	PN 25	16 × M 30	380
400	PN 10	16 × M 24	260
400	PN 16	16 × M 27	330
400	PN 25	16 × M 33	488
450	PN 10	20 × M 24	235
450	PN 16	20 × M 27	300
450	PN 25	20 × M 33	385
500	PN 10	20 × M 24	265
500	PN 16	20 × M 30	448
500	PN 25	20 × M 33	533
600	PN 10	20 × M 27	345
600 *	PN 16	20 × M 33	658
600	PN 25	20 × M 36	731
* Designed acc. to EN 1092-1 (not to DIN 2501)			

Promag P tightening torques for ASME

Nominal diameter		ASME Pressure rating		Max. tightening torque PTFE	
[mm]	[inch]	[lbs]	Threaded fasteners	[Nm]	[lbf · ft]
25	1"	Class 150	4 × ½"	11	8
25	1"	Class 300	4 × 5/8"	14	10
40	1 ½"	Class 150	4 × ½"	24	18
40	1 ½"	Class 300	4 × ¾"	34	25
50	2"	Class 150	4 × 5/8"	47	35

Nominal diameter		ASME Pressure rating		Max. tightening torque PTFE	
[mm]	[inch]	[lbs]	Threaded fasteners	[Nm]	[lbf · ft]
50	2"	Class 300	8 × 5/8"	23	17
80	3"	Class 150	4 × 5/8"	79	58
80	3"	Class 300	8 × ¾"	47	35
100	4"	Class 150	8 × 5/8"	56	41
100	4"	Class 300	8 × ¾"	67	49
150	6"	Class 150	8 × ¾"	106	78
150	6"	Class 300	12 × ¾"	73	54
200	8"	Class 150	8 × ¾"	143	105
250	10"	Class 150	12 × 7/8"	135	100
300	12"	Class 150	12 × 7/8"	178	131
350	14"	Class 150	12 × 1"	260	192
400	16"	Class 150	16 × 1"	246	181
450	18"	Class 150	16 × 1 1/8"	371	274
500	20"	Class 150	20 × 1 1/8"	341	252
600	24"	Class 150	20 × 1 ¼"	477	352

Promag P tightening torques for JIS

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Max. tightening torque [Nm] PTFE
25	10K	4 × M 16	32
25	20K	4 × M 16	32
32	10K	4 × M 16	38
32	20K	4 × M 16	38
40	10K	4 × M 16	41
40	20K	4 × M 16	41
50	10K	4 × M 16	54
50	20K	8 × M 16	27
65	10K	4 × M 16	74
65	20K	8 × M 16	37
80	10K	8 × M 16	38
80	20K	8 × M 20	57
100	10K	8 × M 16	47
100	20K	8 × M 20	75
125	10K	8 × M 20	80
125	20K	8 × M 22	121
150	10K	8 × M 20	99
150	20K	12 × M 22	108
200	10K	12 × M 20	82
200	20K	12 × M 22	121
250	10K	12 × M 22	133
250	20K	12 × M 24	212
300	10K	16 × M 22	99
300	20K	16 × M 24	183

Promag P tightening torques for AS 2129

Nominal diameter [mm]	AS 2129 Pressure rating	Threaded fasteners	Max. tightening torque [Nm] PTFE
25	Table E	4 × M 12	21
50	Table E	4 × M 16	42

Promag P tightening torques for AS 4087

Nominal diameter [mm]	AS 4087 Pressure rating	Threaded fasteners	Max. tightening torque [Nm] PTFE
50	PN 16	4 × M 16	42

3.3.6 Installing the Promag W sensor

Note!
Bolts, nuts, seals, etc. are not included in the scope of supply and must be supplied by the customer.

The sensor is designed for installation between the two piping flanges.
- Observe in any case the necessary screw tightening torques on → 📄 34
- If grounding disks are used, follow the mounting instructions which will be enclosed with the shipment

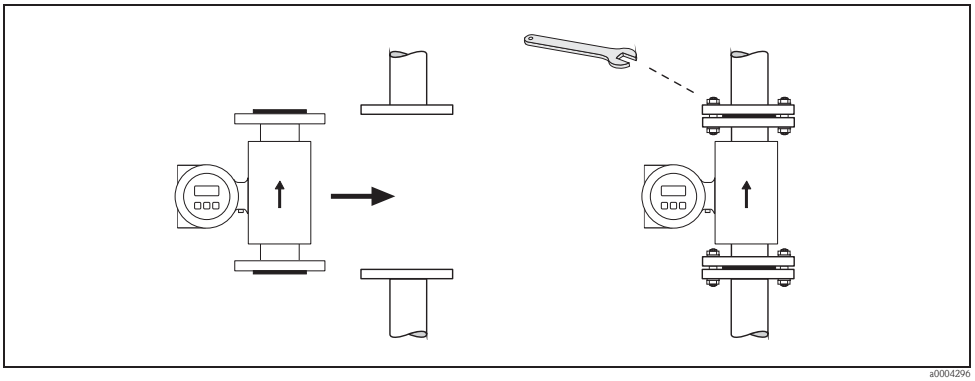


Fig. 22: Installing the Promag W sensor

Seals

Comply with the following instructions when installing seals:
- Hard rubber lining → additional seals are always necessary.
- Polyurethane lining → no seals are required.
- For DIN flanges, use only seals according to EN 1514-1.
- Make sure that the seals do not protrude into the piping cross-section.

Caution!
Risk of short circuit!
Do not use electrically conductive sealing compounds such as graphite! An electrically conductive layer could form on the inside of the measuring tube and short-circuit the measuring signal.

Ground cable

- If necessary, special ground cables for potential equalization can be ordered as an accessory (→ 📄 70).
- Information on potential equalization and detailed mounting instructions for the use of ground cables can be found on → 📄 50

Screw tightening torques (Promag W)

Please note the following:
- The tightening torques listed below are for lubricated threads only.
- Always tighten the screws uniformly and in diagonally opposite sequence.
- Overtightening the screws will deform the sealing faces or damage the seals.
- The tightening torques listed below apply only to pipes not subjected to tensile stress.

Tightening torques for:
- EN (DIN)→ 🖹 35
- JIS→ 🖹 37
- ASME→ 🖹 36
- AWWA → 🖹 37
- AS 2129 → 🖹 38
- AS 4087 → 🖹 38

Promag W tightening torques for EN (DIN)

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque [Nm] Hard rubber	Polyurethane
25	PN 40	4 × M 12	-	15
32	PN 40	4 × M 16	-	24
40	PN 40	4 × M 16	-	31
50	PN 40	4 × M 16	48	40
65*	PN 16	8 × M 16	32	27
65	PN 40	8 × M 16	32	27
80	PN 16	8 × M 16	40	34
80	PN 40	8 × M 16	40	34
100	PN 16	8 × M 16	43	36
100	PN 40	8 × M 20	59	50
125	PN 16	8 × M 16	56	48
125	PN 40	8 × M 24	83	71
150	PN 16	8 × M 20	74	63
150	PN 40	8 × M 24	104	88
200	PN 10	8 × M 20	106	91
200	PN 16	12 × M 20	70	61
200	PN 25	12 × M 24	104	92
250	PN 10	12 × M 20	82	71
250	PN 16	12 × M 24	98	85
250	PN 25	12 × M 27	150	134
300	PN 10	12 × M 20	94	81
300	PN 16	12 × M 24	134	118
300	PN 25	16 × M 27	153	138
350	PN 6	12 × M 20	111	120
350	PN 10	16 × M 20	112	118
350	PN 16	16 × M 24	152	165
350	PN 25	16 × M 30	227	252
400	PN 6	16 × M 20	90	98
400	PN 10	16 × M 24	151	167
400	PN 16	16 × M 27	193	215
400	PN 25	16 × M 33	289	326
450	PN 6	16 × M 20	112	126
450	PN 10	20 × M 24	153	133
450	PN 16	20 × M 27	198	196
450	PN 25	20 × M 33	256	253
500	PN 6	20 × M 20	119	123
500	PN 10	20 × M 24	155	171
500	PN 16	20 × M 30	275	300
500	PN 25	20 × M 33	317	360
600	PN 6	20 × M 24	139	147
600	PN 10	20 × M 27	206	219
600 *	PN 16	20 × M 33	415	443
600	PN 25	20 × M 36	431	516
700	PN 6	24 × M 24	148	139
700	PN 10	24 × M 27	246	246
700	PN 16	24 × M 33	278	318

Nominal diameter [mm]	EN (DIN) Pressure rating [bar]	Threaded fasteners	Max. tightening torque [Nm] Hard rubber	Polyurethane
700	PN 25	24 × M 39	449	507
800	PN 6	24 × M 27	206	182
800	PN 10	24 × M 30	331	316
800	PN 16	24 × M 36	369	385
800	PN 25	24 × M 45	664	721
900	PN 6	24 × M 27	230	637
900	PN 10	28 × M 30	316	307
900	PN 16	28 × M 36	353	398
900	PN 25	28 × M 45	690	716
1000	PN 6	28 × M 27	218	208
1000	PN 10	28 × M 33	402	405
1000	PN 16	28 × M 39	502	518
1000	PN 25	28 × M 52	970	971
1200	PN 6	32 × M 30	319	299
1200	PN 10	32 × M 36	564	568
1200	PN 16	32 × M 45	701	753
1400	PN 6	36 × M 33	430	398
1400	PN 10	36 × M 39	654	618
1400	PN 16	36 × M 45	729	762
1600	PN 6	40 × M 33	440	417
1600	PN 10	40 × M 45	946	893
1600	PN 16	40 × M 52	1007	1100
1800	PN 6	44 × M 36	547	521
1800	PN 10	44 × M 45	961	895
1800	PN 16	44 × M 52	1108	1003
2000	PN 6	48 × M 39	629	605
2000	PN 10	48 × M 45	1047	1092
2000	PN 16	48 × M 56	1324	1261
* Designed acc. to EN 1092-1 (not to DIN 2501)				

Promag W tightening torques for ASME

Nominal diameter [mm]	[inch]	ASME Pressure rating [lbs]	Threaded fasteners	Max. tightening torque Hard rubber [Nm]	[lbf · ft]	Polyurethane [Nm]	[lbf · ft]
25	1"	Class 150	4 × ½"	-	-	7	5
25	1"	Class 300	4 × 5/8"	-	-	8	6
40	1 ½"	Class 150	4 × ½"	-	-	10	7
40	1 ½"	Class 300	4 × ¾"	-	-	15	11
50	2"	Class 150	4 × 5/8"	35	26	22	16
50	2"	Class 300	8 × 5/8"	18	13	11	8
80	3"	Class 150	4 × 5/8"	60	44	43	32
80	3"	Class 300	8 × ¾"	38	28	26	19
100	4"	Class 150	8 × 5/8"	42	31	31	23
100	4"	Class 300	8 × ¾"	58	43	40	30
150	6"	Class 150	8 × ¾"	79	58	59	44
150	6"	Class 300	12 × ¾"	70	52	51	38
200	8"	Class 150	8 × ¾"	107	79	80	59
250	10"	Class 150	12 × 7/8"	101	74	75	55
300	12"	Class 150	12 × 7/8"	133	98	103	76
350	14"	Class 150	12 × 1"	135	100	158	117
400	16"	Class 150	16 × 1"	128	94	150	111
450	18"	Class 150	16 × 1 1/8"	204	150	234	173
500	20"	Class 150	20 × 1 1/8"	183	135	217	160
600	24"	Class 150	20 × 1 ¼"	268	198	307	226

Promag W tightening torques for JIS

Nominal diameter [mm]	JIS Pressure rating	Threaded fasteners	Max. tightening torque [Nm]	
			Hard rubber	Polyurethane
25	10K	4 × M 16	-	19
25	20K	4 × M 16	-	19
32	10K	4 × M 16	-	22
32	20K	4 × M 16	-	22
40	10K	4 × M 16	-	24
40	20K	4 × M 16	-	24
50	10K	4 × M 16	40	33
50	20K	8 × M 16	20	17
65	10K	4 × M 16	55	45
65	20K	8 × M 16	28	23
80	10K	8 × M 16	29	23
80	20K	8 × M 20	42	35
100	10K	8 × M 16	35	29
100	20K	8 × M 20	56	48
125	10K	8 × M 20	60	51
125	20K	8 × M 22	91	79
150	10K	8 × M 20	75	63
150	20K	12 × M 22	81	72
200	10K	12 × M 20	61	52
200	20K	12 × M 22	91	80
250	10K	12 × M 22	100	87
250	20K	12 × M 24	159	144
300	10K	16 × M 22	74	63
300	20K	16 × M 24	138	124

Promag W tightening torques for AWWA

Nominal diameter		AWWA Pressure rating	Threaded fasteners	Max. tightening torque			
				Hard rubber		Polyurethane	
[mm]	[inch]			[Nm]	[lbf · ft]	[Nm]	[lbf · ft]
700	28"	Class D	28 × 1 ¼"	247	182	292	215
750	30"	Class D	28 × 1 ¼"	287	212	302	223
800	32"	Class D	28 × 1 ½"	394	291	422	311
900	36"	Class D	32 × 1 ½"	419	309	430	317
1000	40"	Class D	36 × 1 ½"	420	310	477	352
1050	42"	Class D	36 × 1 ½"	528	389	518	382
1200	48"	Class D	44 × 1 ½"	552	407	531	392
1350	54"	Class D	44 × 1 ¾"	730	538	633	467
1500	60"	Class D	52 × 1 ¾"	758	559	832	614
1650	66"	Class D	52 × 1 ¾"	946	698	955	704
1800	72"	Class D	60 × 1 ¾"	975	719	1087	802
2000	78"	Class D	64 × 2"	853	629	786	580

Promag W tightening torques for AS 2129

Nominal diameter [mm]	AS 2129 Pressure rating	Threaded fasteners	Max. tightening torque [Nm] Hard rubber
50	Table E	4 × M 16	32
80	Table E	4 × M 16	49
100	Table E	8 × M 16	38
150	Table E	8 × M 20	64
200	Table E	8 × M 20	96
250	Table E	12 × M 20	98
300	Table E	12 × M 24	123
350	Table E	12 × M 24	203
400	Table E	12 × M 24	226
450	Table E	16 × M 24	226
500	Table E	16 × M 24	271
600	Table E	16 × M 30	439
700	Table E	20 × M 30	355
750	Table E	20 × M 30	559
800	Table E	20 × M 30	631
900	Table E	24 × M 30	627
1000	Table E	24 × M 30	634
1200	Table E	32 × M 30	727

Promag W tightening torques for AS 4087

Nominal diameter [mm]	AS 4087 Pressure rating	Threaded fasteners	Max. tightening torque [Nm] Hard rubber
50	Table E	4 × M 16	32
80	PN 16	4 × M 16	49
100	PN 16	4 × M 16	76
150	PN 16	8 × M 20	52
200	PN 16	8 × M 20	77
250	PN 16	8 × M 20	147
300	PN 16	12 × M 24	103
350	PN 16	12 × M 24	203
375	PN 16	12 × M 24	137
400	PN 16	12 × M 24	226
450	PN 16	12 × M 24	301
500	PN 16	16 × M 24	271
600	PN 16	16 × M 27	393
700	PN 16	20 × M 27	330
750	PN 16	20 × M 30	529
800	PN 16	20 × M 33	631
900	PN 16	24 × M 33	627
1000	PN 16	24 × M 33	595
1200	PN 16	32 × M 33	703

3.3.7 Turning the transmitter housing

1. Loosen the two securing screws.
2. Turn the bayonet lock as far as it will go.
3. Carefully lift the transmitter housing:
   – Promag D: approx. 10 mm (0.39 in) above the securing screws
   – Promag E/H/L/P/W: to the stop
4. Turn the transmitter housing to the desired position:
   – Promag D: max. 180° clockwise or max. 180° counterclockwise
   – Promag E/H/L/P/W: max. 280° clockwise or max. 20° counterclockwise
5. Lower the housing into position and re-engage the bayonet catch.
6. Retighten the two securing screws.

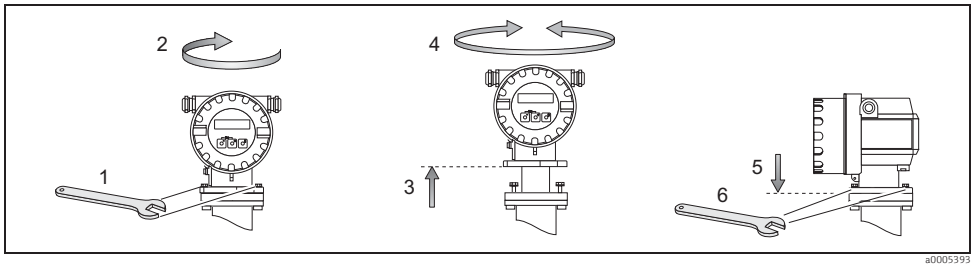


Fig. 23: Turning the transmitter housing

3.3.8 Turning the onsite display

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Remove the display module from the transmitter retaining rails.
3. Turn the display to the desired position (max. 4 × 45° in each direction).
4. Fit the display back onto the retaining rails.
5. Screw the cover of the electronics compartment firmly back onto the transmitter housing.

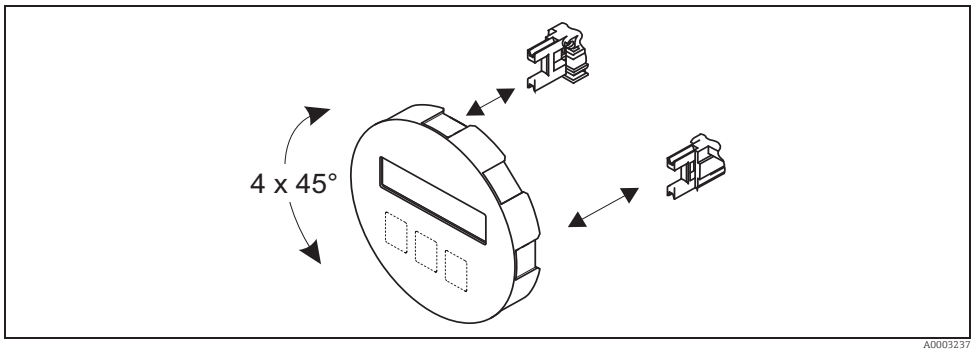


Fig. 24: Turning the local display

3.3.9 Mounting the transmitter (remote version)

The transmitter can be mounted in the following ways:
- Wall mounting
- Pipe mounting (with separate mounting kit, accessories → 📄 70)

The transmitter and the sensor must be mounted separate in the following circumstances:
- Poor accessibility
- Lack of space
- Extreme fluid/ambient temperatures (temperature ranges → 📄 86)
- Severe vibration (> 2 g/2 h per day; 10 to 100 Hz)

Caution!
- The ambient temperature range -20 to +60 °C (–4 to +140 °F) may not be exceeded at the mounting location. Avoid direct sunlight.
- If the device is mounted to a warm pipe, make sure that the housing temperature does not exceed +60 °C (+140 °F), which is the maximum permissible temperature.

Mount the transmitter as illustrated in → 🖼 25.

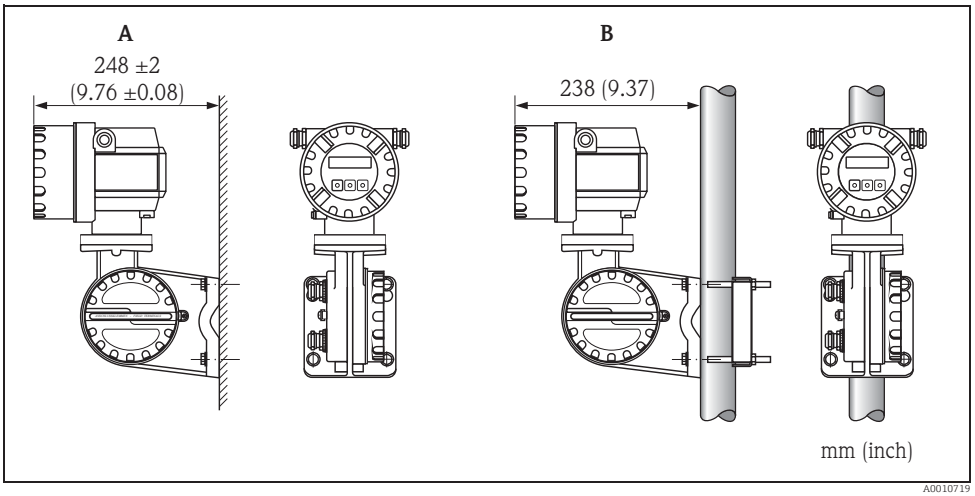


Fig. 25: Mounting the transmitter (remote version)

A Direct wall mounting
B Pipe mounting

3.4 Post-installation check

Perform the following checks after installing the measuring device in the pipe:

Device condition and specifications	Notes
Is the device damaged (visual inspection)?	–
Does the device correspond to specifications at the measuring point, including process temperature and pressure, ambient temperature, minimum fluid conductivity, measuring range, etc.?	→ 🖹 87
Installation	**Notes**
Does the arrow on the sensor nameplate match the actual direction of flow through the pipe?	–
Is the position of the measuring electrode plane correct?	→ 🖹 13
Is the position of the empty pipe detection electrode correct?	→ 🖹 13
Were all screws tightened to the specified torques when the sensor was installed?	Promag D → 🖹 21 Promag E → 🖹 23 Promag L → 🖹 28 Promag P → 🖹 31 Promag W → 🖹 34
Were the correct seals used (type, material, installation)?	Promag D → 🖹 19 Promag E → 🖹 22 Promag H → 🖹 25 Promag L→ 🖹 27 Promag P → 🖹 31 Promag W → 🖹 34
Are the measuring point number and labeling correct (visual inspection)?	–
Process environment / process conditions	**Notes**
Were the inlet and outlet runs respected?	Inlet run ≥ 5 × DN Outlet run ≥ 2 × DN
Is the measuring device protected against moisture and direct sunlight?	–
Is the sensor adequately protected against vibration (attachment, support)?	Acceleration up to 2 g by analogy with IEC 600 68-2-8

4 Wiring

Warning!
When using remote versions, only sensors and transmitters with the same serial number can be connected up. Measuring errors can occur if the devices are not connected in this way.

Note!
The device does not have an internal circuit breaker. For this reason, assign the device a switch or power-breaker switch capable of disconnecting the power supply line from the mains.

4.1 Connecting the remote version

4.1.1 Connecting Promag D/E/H/L/P/W

Warning!
- Risk of electric shock! Switch off the power supply before opening the device. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock! Connect the protective conductor to the ground terminal on the housing before the power supply is applied.

Caution!
- Only sensors and transmitters with the same serial number can be connected to one another. Communication problems can occur if the devices are not connected in this way.
- Risk of damaging the coil driver. Always switch off the power supply before connecting or disconnecting the coil cable.

Procedure

1. Transmitter: Loosen the securing clamp and remove the cover from the connection compartment (a).
2. Sensor: Remove the cover from the connection housing (b).
3. Feed the signal cable (c) and the coil cable (d) through the appropriate cable entries.

   Caution!
   Route the connecting cables securely (see "Length of connecting cable" → 18).
4. Terminate the signal and coil current cable as indicated in the table:
   Promag D/E/L/P/W → Refer to the table → 45
   Promag H → Refer to the "Cable termination" table → 46
5. Establish the wiring between the sensor and the transmitter.
   The electrical wiring diagram that applies to your device can be found:
   - In the corresponding graphic:
     → 26 (Promag D); → 27 (Promag E/L/P/W); → 28 (Promag H)
   - In the cover of the sensor and transmitter

   Note!
   The cable shields of the Promag H sensor are grounded by means of the strain relief terminals (see also the "Cable termination" table → 46)

   Caution!
   Insulate the shields of cables that are not connected to eliminate the risk of short-circuits with neighboring cable shields inside the connection housing.
6. Transmitter: Secure the cover to the connection compartment (a) and tighten the socket head cap screw of the securing clamp.
7. Sensor: Secure the cover on the connection housing (b).

Promag D

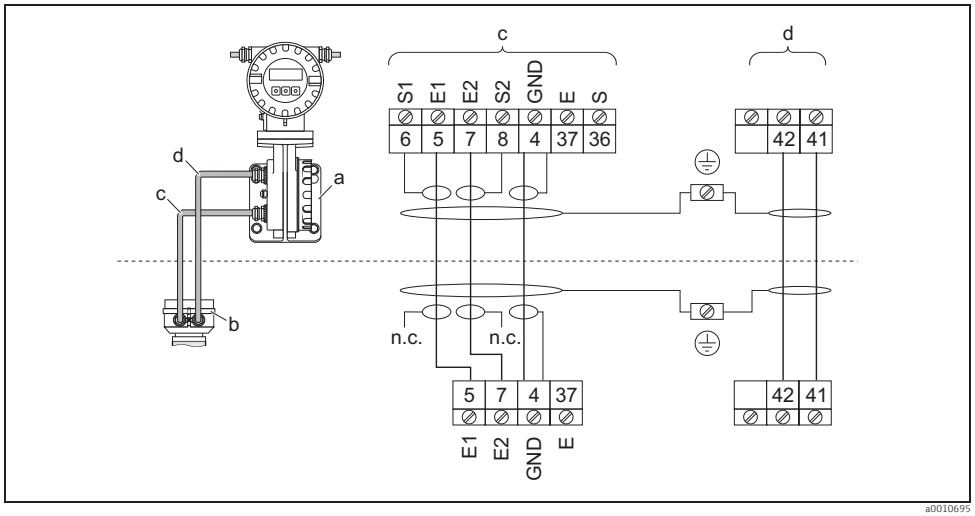


Fig. 26: Connecting the remote version of Promag D

a Wall-mount housing connection compartment
b Cover of the sensor connection housing
c Signal cable
d Coil current cable
n.c. Not connected, insulated cable shields

Wire colors/Terminal No.:
5/6 = braun, 7/8 = white, 4 = green, 37/36 = yellow

Promag E/L/P/W

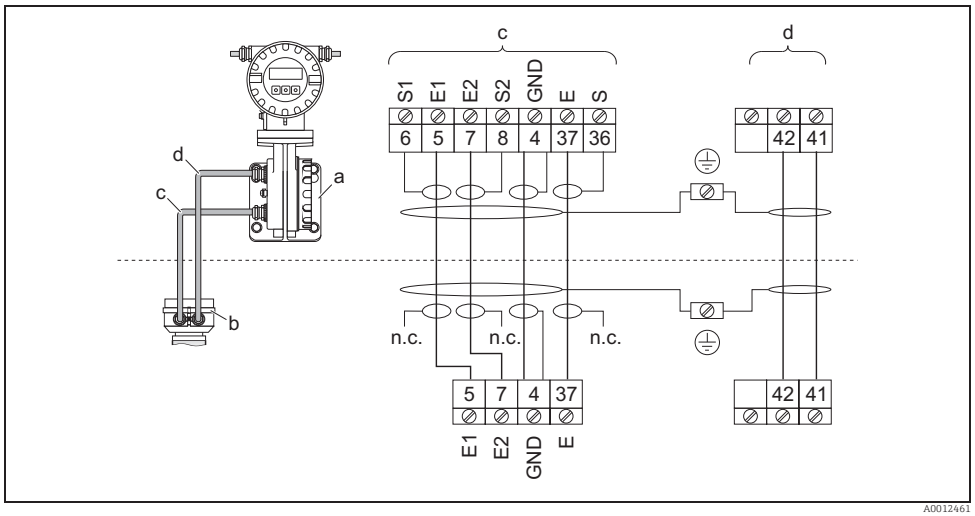


Fig. 27: Connecting the remote version of Promag E/L/P/W

a Wall-mount housing connection compartment
b Cover of the sensor connection housing
c Signal cable
d Coil current cable
n.c. Not connected, insulated cable shields

Wire colors/Terminal No.:
5/6 = braun, 7/8 = white, 4 = green, 37/36 = yellow

Promag H

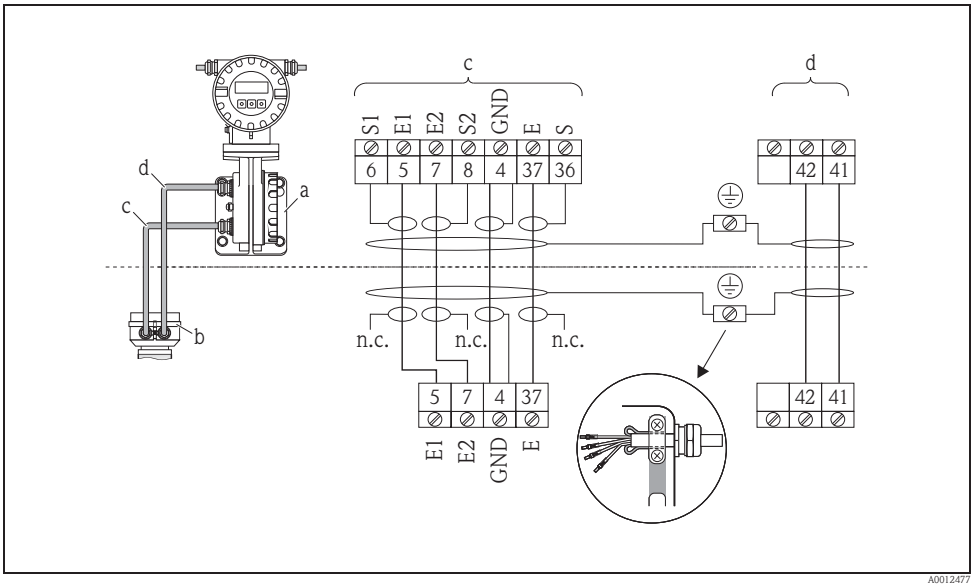


Fig. 28: Connecting the remote version of Promag H

a Wall-mount housing connection compartment
b Cover of the sensor connection housing
c Signal cable
d Coil current cable
n.c. Not connected, insulated cable shields

Wire colors/Terminal No.:
5/6 = braun, 7/8 = white, 4 = green, 37/36 = yellow

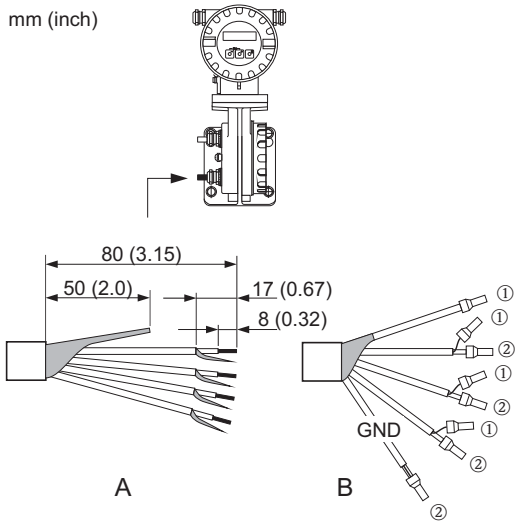
Cable termination for the remote version
Promag D/E/L/P/W

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Ferrules must be provided on the fine-wire cores (Detail B: ① = red ferrules, ∅ 1.0 mm; ② = white ferrules, ∅ 0.5 mm).

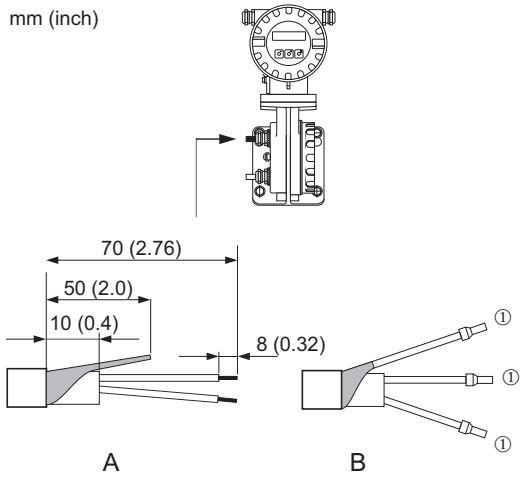
Caution!
When fitting the connectors, pay attention to the following points:
- *Signal cable* → Make sure that the ferrules do not touch the wire shield on the sensor side. Minimum distance = 1 mm (exception "GND" = green cable)
- *Coil current cable* → Insulate one core of the three-core wire at the level of the core reinforcement; you only require two cores for the connection.

TRANSMITTER

Signal cable

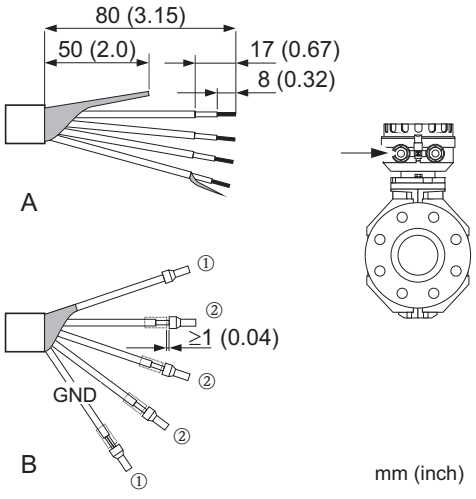


Coil current cable

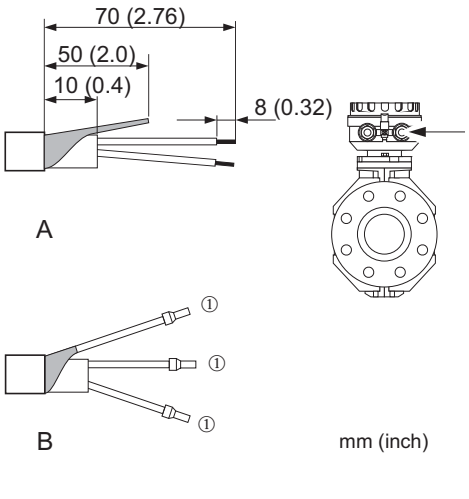


SENSOR

Signal cable



Coil current cable



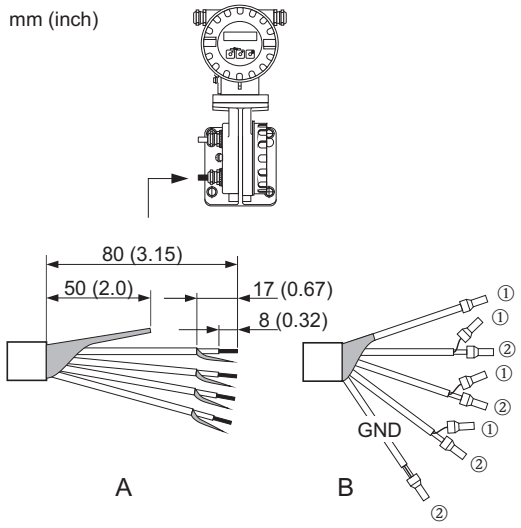
Cable termination for the remote version
Promag H

Terminate the signal and coil current cables as shown in the figure below (Detail A).
Ferrules must be provided on the fine-wire cores (Detail B: ① = red ferrules, ∅ 1.0 mm; ② = white ferrules, ∅ 0.5 mm).

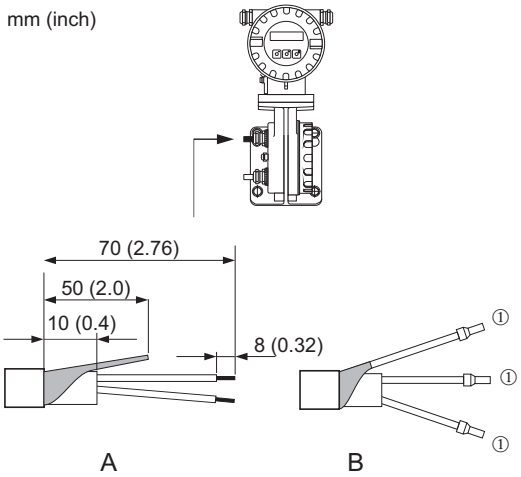
Caution!
When fitting the connectors, pay attention to the following points:
- *Signal cable* → Make sure that the ferrules do not touch the wire shield on the sensor side. Minimum distance = 1 mm (exception "GND" = green cable).
- *Coil current cable* → Insulate one core of the three-core wire at the level of the core reinforcement; you only require two cores for the connection.
- On the sensor side, reverse both cable shields approx. 15 mm over the outer jacket. The strain relief ensures an electrical connection with the connection housing.

TRANSMITTER

Signal cable

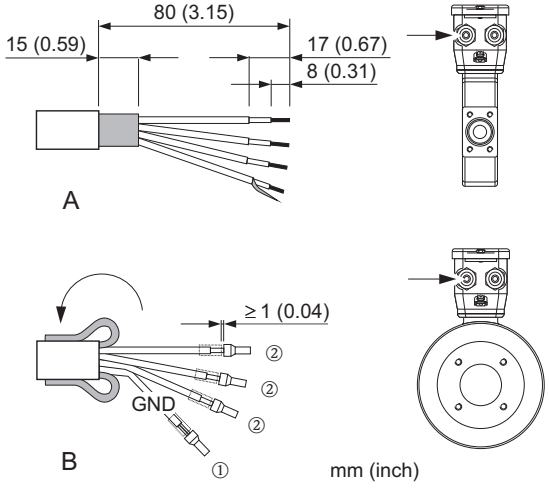


Coil current cable

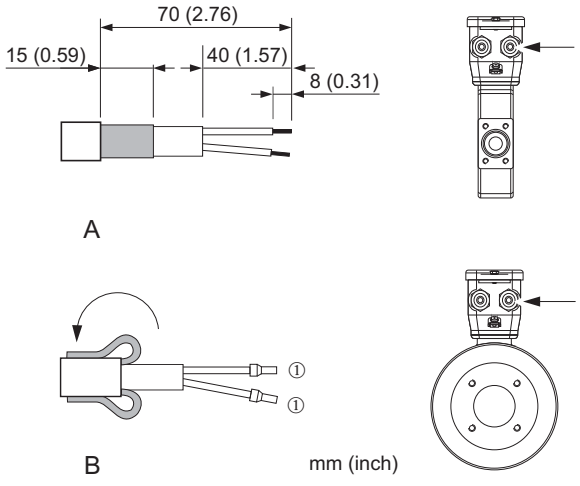


SENSOR

Signal cable



Coil current cable



4.1.2 Cable specifications

Signal cable

- 3 × 0.38 mm² PVC cable with common, braided copper shield (∅ ~7 mm) and individually shielded cores
- With Empty Pipe Detection (EPD): 4 × 0.38 mm² PVC cable with common, braided copper shield (∅ ~ 7 mm) and individually shielded cores
- Conductor resistance: ≤ 50 Ω/km
- Capacitance: core/shield: ≤ 420 pF/m
- Permanent operating temperature: –20 to +80 °C
- Cable cross-section: max. 2.5 mm²

Coil cable

- 2 × 0.75 mm² PVC cable with common, braided copper shield (∅ ~ 7 mm)
- Conductor resistance: ≤ 37 Ω/km
- Capacitance: core/core, shield grounded: ≤ 120 pF/m
- Operating temperature: –20 to +80 °C
- Cable cross-section: max. 2.5 mm²
- Test voltage for cable insulation: ≥ 1433 V AC r.m.s. 50/60 Hz or ≥ 2026 V DC

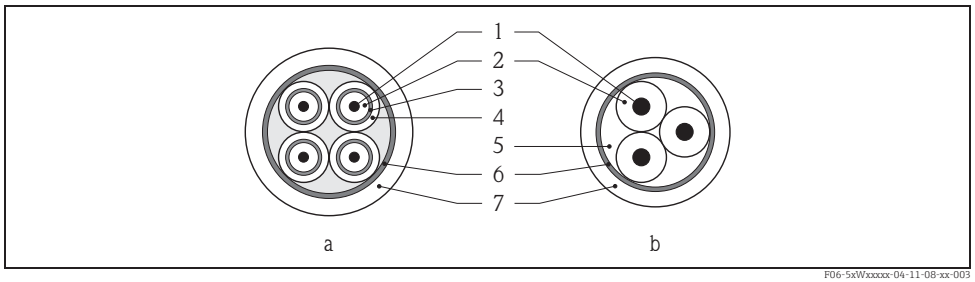


Fig. 29: Cable cross-section

a Signal cable
b Coil current cable

1 Core
2 Core insulation
3 Core shield
4 Core jacket
5 Core reinforcement
6 Cable shield
7 Outer jacket

Operation in zones of severe electrical interference:

The measuring device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of IEC/EN 61326.

Caution!
Grounding is by means of the ground terminals provided for the purpose inside the connection housing. Ensure that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible.

4.2 Connecting the measuring unit

4.2.1 Transmitter

Warning!
- Risk of electric shock!
  Switch off the power supply before opening the device. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.
- Risk of electric shock!
  Connect the protective conductor to the ground terminal on the housing before the power supply is applied.
- Compare the specifications on the nameplate with the local supply voltage and frequency. The national regulations governing the installation of electrical equipment also apply.
- The transmitter must be included in the building fuse system.

1. Unscrew cover of the electronics compartment from the transmitter housing.
2. Press the side latches and flip down the cover of the connection compartment.
3. Feed the cable for the power supply and the signal cable through the appropriate cable entries.
4. Remove the terminal connectors from the transmitter housing and connect the cable for the power supply and the signal cable:
   – Wiring diagram → 30
   – Terminal assignment → 49
5. Plug the terminal connectors back into the transmitter housing.

   Note!
   The connectors are coded so you cannot mix them up.
6. Secure the ground cable to the ground terminal.
7. Flip up the cover of the connection compartment.
8. Screw the cover of the electronics compartment firmly onto the transmitter housing.

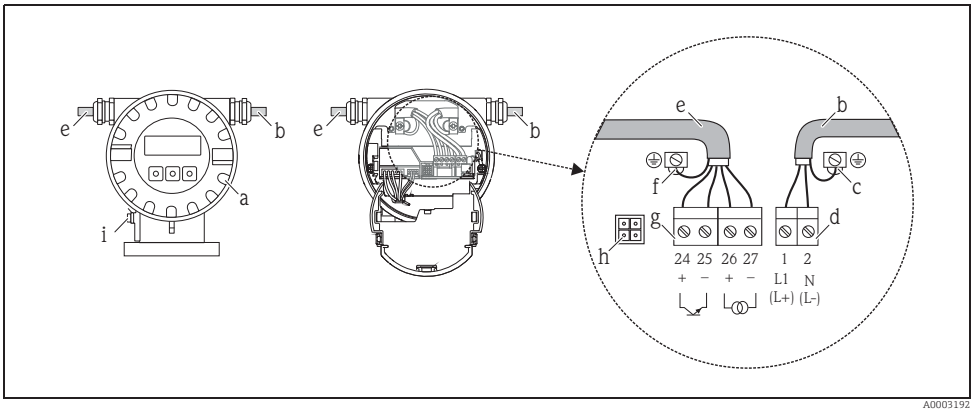


Fig. 30: Connecting the transmitter (aluminum field housing). Cable cross-section: max. 2.5 mm²

a Electronics compartment cover
b Cable for power supply: 85 to 250 V AC, 11 to 40 V DC, 20 to 28 V AC
c Ground terminal for power supply cable
*d Terminal connector for power supply: No. 1–2 → **49** (terminal assignment)*
e Signal cable
f Ground terminal for signal cable
*g Terminal connector for signal cable: No. 24–27 → **49** (terminal assignment)*
h Service connector
i Ground terminal for potential equalization

4.2.2 Terminal assignment

Order version	Terminal No. (outputs/power supply)		
	24 (+) / 25 (–)	26 (+) / 27 (–)	1 (L1/L+) / 2 (N/L–)
10***-**********A	Pulse output	Current output HART	Power supply

Note!
Functional values of the outputs and power supply → 83

4.2.3 HART connection

Users have the following connection options at their disposal:
- Direct connection to transmitter by means of terminals 26(+) and 27 (–)
- Connection by means of the 4 to 20 mA circuit.
- The measuring loop's minimum load must be at least 250 Ω.
- After commissioning, make the following settings:
  – CURRENT SPAN function → "4–20 mA HART"
  – Switch HART write protection on or off → 60

Connection of the HART handheld communicator

See also the documentation issued by the HART Communication Foundation, and in particular HCF LIT 20: "HART, a technical summary".

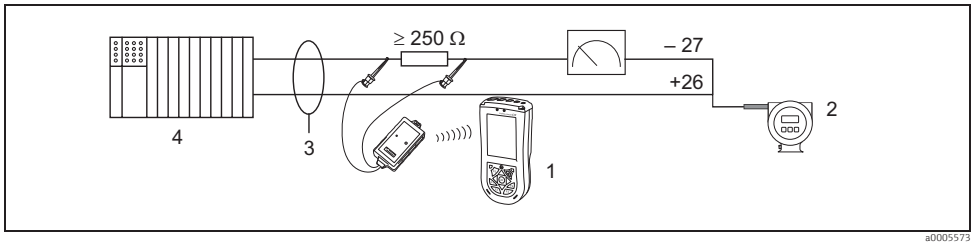


Fig. 31: Electrical connection of HART handheld Field Xpert SFX100

1 HART handheld Field Xpert SFX100
2 Auxiliary energy
3 Shielding
4 Other devices or PLC with passive input

Connection of a PC with an operating software

In order to connect a PC with an operating software (e.g. "FieldCare), a HART modem (e.g. Commubox FXA 195) is needed.

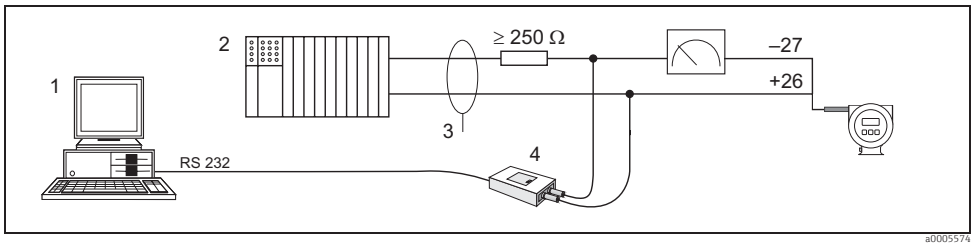


Fig. 32: Electrical connection of a PC with an operating software

1 PC with an operating software
2 Other evaluation devices or PLC with passive input
3 Shield
4 HART modem, e.g. Commubox FXA 195

4.3 Potential equalization

Warning!
The measuring system must be included in the potential equalization.

Perfect measurement is only ensured when the fluid and the sensor have the same electrical potential. This is ensured by the reference electrode integrated in the sensor as standard.

The following should also be taken into consideration for potential equalization:
- Internal grounding concepts in the company
- Operating conditions, such as the material/grounding of the pipes (see Table)

4.3.1 Potential equalization for Promag D

- No reference electrode is integrated!
  For the two ground disks of the sensor an electrical connection to the fluid is always ensured.
- Exampels for connections → 50

4.3.2 Potential equalization for Promag E/L/P/W

- Reference electrode integrated in the sensor as standard
- Exampels for connections → 51

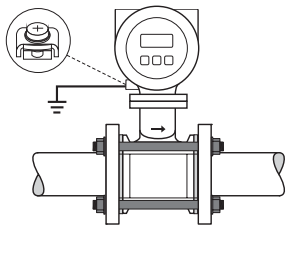
4.3.3 Potential equalization for Promag H

No reference electrode is integrated!
For the metal process connections of the sensor an electrical connection to the fluid is always ensured.

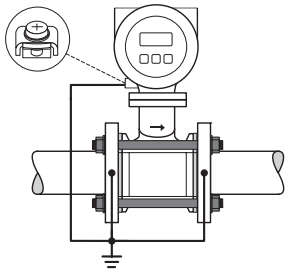
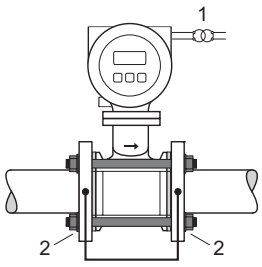
Caution!
If using process connections made of a synthetic material, ground rings have to be used to ensure that potential is equalized (→ 25). The necessary ground rings can be ordered separately from Endress+Hauser as accessories (→ 70).

4.3.4 Exampels for potential equalization connections for Promag D

Standard case

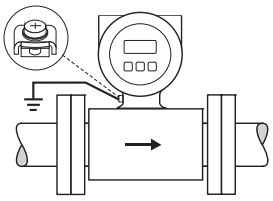
Operating conditions	Potential equalization
When using the measuring device in a: ▪ Metal, grounded pipe ▪ Plastic pipe ▪ Pipe with insulating lining Potential equalization takes place via the ground terminal of the transmitter (standard situation). Note! When installing in metal pipes, we recommend you connect the ground terminal of the transmitter housing with the piping.	 a0010702 *Fig. 33: Via the ground terminal of the transmitter*

Special cases

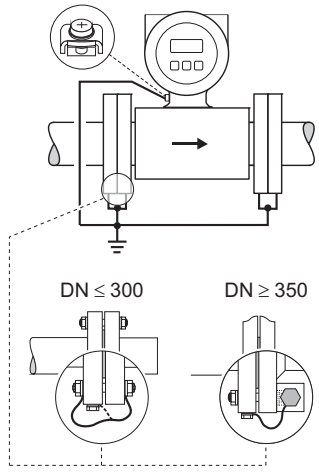
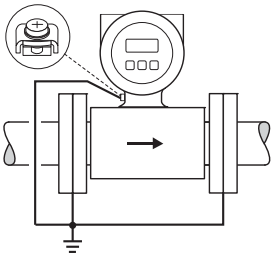
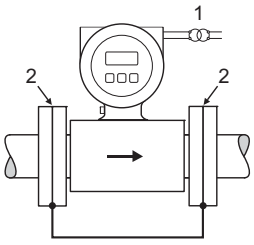
Operating conditions	Potential equalization
When using the measuring device in a: ▪ Metal pipe that is not grounded This connection method also applies in situations where: ▪ Customary potential equalization cannot be ensured ▪ Excessively high equalizing currents can be expected Potential equalization takes place via the ground terminal of the transmitter and the two pipe flanges. Here, the ground cable (copper wire, 6 mm² / 0.0093 in²) is mounted directly on the conductive flange coating with flange screws.	 a0010703 *Fig. 34: Via the ground terminal of the transmitter and the flanges of the pipe*
When using the measuring device in a: ▪ Pipe with a cathodic protection unit The device is installed potential-free in the pipe. Only the two flanges of the pipe are connected with a ground cable (copper wire, 6 mm² / 0.0093 in²). Here, the ground cable is mounted directly on the conductive flange coating with flange screws. Note the following when installing: ▪ The applicable regulations regarding potential-free installation must be observed. ▪ There should be no electrically conductive connection between the pipe and the device. ▪ The mounting material must withstand the applicable torques.	 a0010704 *Fig. 35: Potential equalization and cathodic protection* *1 Power supply isolation transformer* *2 Electrically isolated*

4.3.5 Exampels for potential equalization connections for Promag E/L/P/W

Standard case

Operating conditions	Potential equalization
When using the measuring device in a: ▪ Metal, grounded pipe Potential equalization takes place via the ground terminal of the transmitter (standard situation). Note! When installing in metal pipes, we recommend you connect the ground terminal of the transmitter housing with the piping.	 a0010702 *Fig. 36: Via the ground terminal of the transmitter*

Special cases

Operating conditions	Potential equalization
When using the measuring device in a: ■ Metal pipe that is not grounded This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured ■ Excessively high equalizing currents can be expected Both sensor flanges are connected to the pipe flange by means of a ground cable (copper wire, 6 mm² / 0.0093 in²) and grounded. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose. Ground cable installation depends on the nominal diameter: ■ DN ≤ 300: The ground cable is mounted directly on the conductive flange coating with the flange screws. ■ DN ≥ 350: The ground cable is mounted directly on the metal transport bracket. Note! The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser.	 a0010703 *Fig. 37: Via the ground terminal of the transmitter and the flanges of the pipe*
When using the measuring device in a: ■ Plastic pipe ■ Pipe with insulating lining This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured ■ Excessively high equalizing currents can be expected Potential equalization takes place using additional ground disks, which are connected to the ground terminal via a ground cable (copper wire, min. 6 mm² / 0.0093 in²). When installing the ground disks, please comply with the enclosed Installation Instructions.	 a0010702 *Fig. 38: Via the ground terminal of the transmitter*
When using the measuring device in a: ■ Pipe with a cathodic protection unit The device is installed potential-free in the pipe. Only the two flanges of the pipe are connected with a ground cable (copper wire, 6 mm² / 0.0093 in²). Here, the ground cable is mounted directly on the conductive flange coating with flange screws. Note the following when installing: ■ The applicable regulations regarding potential-free installation must be observed. ■ There should be no electrically conductive connection between the pipe and the device. ■ The mounting material must withstand the applicable torques.	 a0010704 *Fig. 39: Potential equalization and cathodic protection* *1 Power supply isolation transformer* *2 Electrically isolated*

4.4 Degree of protection

The devices meet all the requirements of IP 67 degree of protection.

Compliance with the following points is mandatory following installation in the field or servicing in order to ensure that IP 67 protection is maintained:
- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All threaded fasteners and screw covers must be firmly tightened.
- The cables used for connection must be of the specified outside diameter → 47.
- Firmly tighten the cable entries.
- The cables must loop down before they enter the cable entries ("water trap"). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Remove all unused cable entries and insert plugs instead.
- Do not remove the grommet from the cable entry.

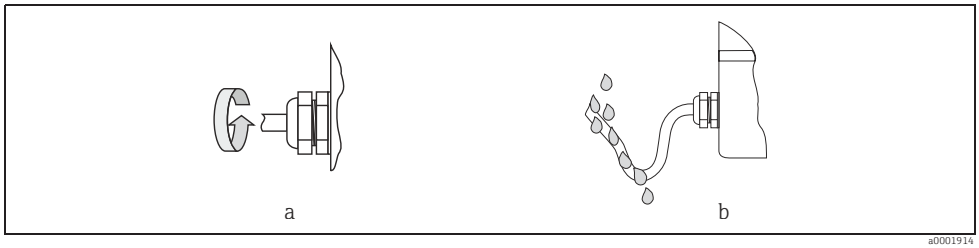


Fig. 40: Installation instructions, cable entries

Caution!
Do not loosen the threaded fasteners of the sensor housing, as otherwise the degree of protection guaranteed by Endress+Hauser no longer applies.

Note!
The Promag E/L/P/W sensors can be supplied with IP 68 rating (permanent immersion in water to a depth of 3 meters (10 ft)). In this case the transmitter must be installed remote from the sensor.
The Promag L sensors with IP 68 rating are only available with stainless steel flanges.

4.5 Post-connection check

Perform the following checks after completing electrical installation of the measuring device:

Device condition and specifications	Notes
Are cables or the device damaged (visual inspection)?	–
Electrical connection	**Notes**
Does the supply voltage match the specifications on the nameplate?	▪ 85 to 250 V AC (50 to 60 Hz) ▪ 20 to 28 V AC (50 to 60 Hz), 11 to 40 V DC
Do the cables used comply with the necessary specifications?	→ 🖹 47
Do the cables have adequate strain relief?	–
Is the cable type route completely isolated? Without loops and crossovers?	–
Are the power-supply and signal cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Only remote version: Is the flow sensor connected to the matching transmitter electronics?	Check serial number on nameplates of sensor and connected transmitter.
Only remote version: Is the connecting cable between sensor and transmitter connected correctly?	→ 🖹 42
Are all screw terminals firmly tightened?	–
Have the measures for grounding/potential equalization been correctly implemented?	→ 🖹 50
Are all cable entries installed, firmly tightened and correctly sealed? Cables looped as "water traps"?	→ 🖹 53
Are all housing covers installed and firmly tightened?	–

5 Operation

5.1 Display and operating elements

The local display enables you to read all important parameters directly at the measuring point and configure the device.
The display area consists of two lines; this is where measured values are displayed, and/or status variables (partially filled pipe, etc.). The assignment of the display lines in operating mode is specified. The top line displays the volume flow and the bottom line displays the totalizer status.

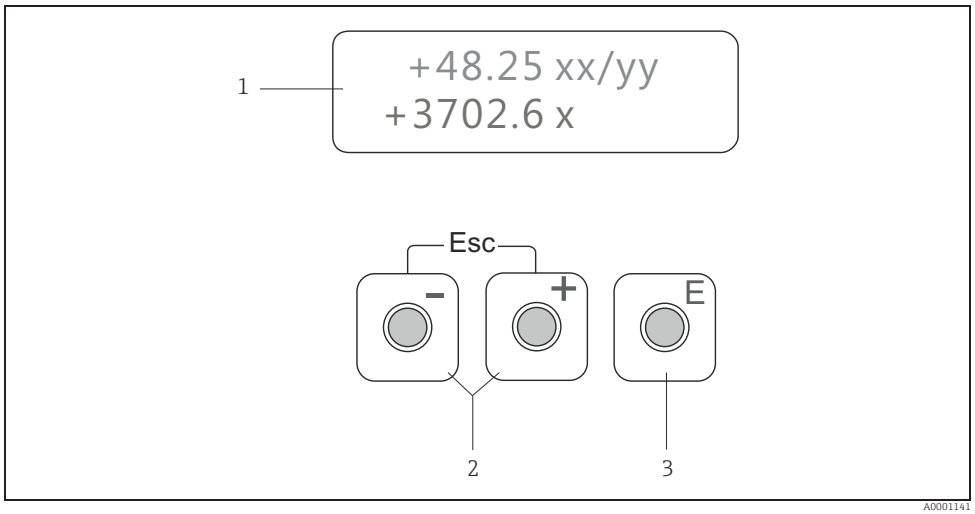


Fig. 41: Display and operating elements

1 Liquid crystal display
The two-line liquid-crystal display shows measured values, dialog texts, error messages and information messages. The display as it appears when normal measuring is in progress is known as the HOME position (operating mode).
- *Upper display line: Shows primary measured values, e.g. volume flow [e.g. in ml/min]*
- *Lower display line: Shows the totalizer status, [e.g. in m^3]*

2 Plus/minus keys
- *Enter numerical values, select parameters*
- *Select different function groups within the function matrix*

Press the +/- keys simultaneously to trigger the following functions:
- *Exit the function matrix step by step → HOME position*
- *Press and hold down +/- keys for longer than 3 seconds → Return directly to HOME position*
- *Cancel data entry*

3 Enter key
- *HOME position → Entry into the function matrix*
- *Save the numerical values you input or settings you change*

5.2 Brief operating instructions on the function matrix

Note!
- See the general notes on → 57.
- Function matrix overview → 108
- Detailed description of all functions → 109 ff.

The function matrix comprises two levels, namely the function groups and the functions of the function groups.
The groups are the highest-level grouping of the control options for the device. A number of functions is assigned to each group. You select a group in order to access the individual functions for operating and configuring the device.

1. HOME position → E → Enter the function matrix
2. Select a function group (e.g. OPERATION)
3. Select a function (e.g. LANGUAGE)
   Change parameter/enter numerical values:
   ± → select or enter enable code, parameters, numerical values
   E → save your entries
4. Exit the function matrix:
   – Press and hold down Esc key (Esc) for longer than 3 seconds → HOME position
   – Repeatedly press Esc key (Esc) → return step by step to HOME position

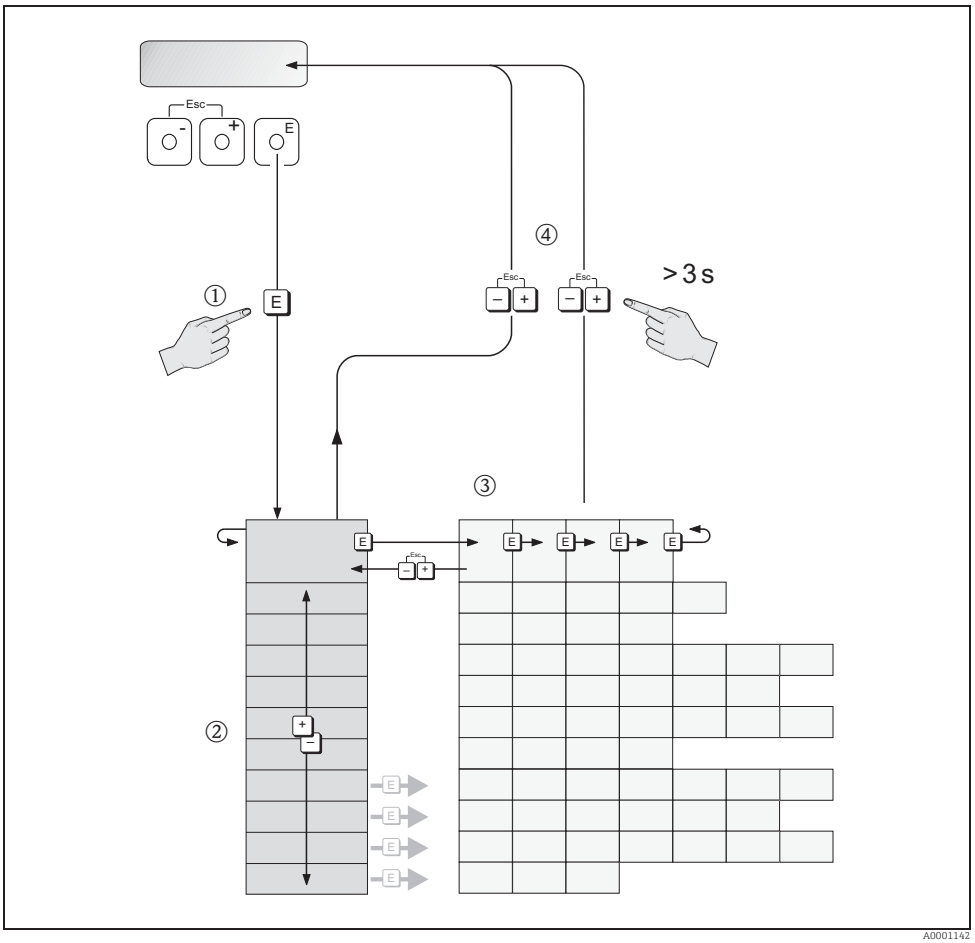


Fig. 42: Selecting functions and configuring parameters (function matrix)

5.2.1 General notes

The brief commissioning guide (→ 66) is adequate for commissioning in most instances. Complex measuring operations on the other hand necessitate additional functions that you can configure as necessary and customize to suit your process parameters. The function matrix, therefore, comprises a multiplicity of additional functions which, for the sake of clarity, are arranged in a number of function groups.

Comply with the following instructions when configuring functions:
- You select functions as described on → 56.
- You can switch off certain functions (OFF). If you do so, related functions in other function groups will no longer be displayed.
- Certain functions prompt you to confirm your data entries.
  Press ± to select "SURE [YES]" and press E again to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.

Note!
- The transmitter continues to measure while data entry is in progress, i.e. the current measured values are output via the signal outputs in the normal way.
- If the power supply fails, all preset and configured values remain safely stored in the EEPROM.

5.2.2 Enabling the programming mode

The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 10) has to be entered before settings can be changed.
If you use a code of your choice, you exclude the possibility of unauthorized persons accessing data, see ACCESS CODE function → 111.

Comply with the following instructions when entering codes:
- If programming is disabled and the ± operating elements are pressed in any function, a prompt for the code automatically appears on the display.
- If "0" is specified as the customer's code, programming is always enabled.
- The Endress+Hauser service organization can be of assistance if you mislay your personal code.

Caution!
Changing certain parameters such as all sensor characteristics, for example, influences numerous functions of the entire measuring system, particularly measuring accuracy. Normally, such parameters may not be changed! Please contact Endress+Hauser if you have any questions.

5.2.3 Disabling the programming mode

Programming is disabled if you do not press the operating elements within 60 seconds following automatic return to the HOME position.
You can also disable programming in the "ACCESS CODE" function by entering any number (other than the customer's code).

5.3 Displaying error messages

5.3.1 Type of error

Errors which occur during commissioning or measuring operation are displayed immediately. If two or more system or process errors occur, the error with the highest priority is the one shown on the display.

The measuring system distinguishes between two types of error:
- *System errors* → 📄 *74:*
  This group comprises all device errors, e.g. communication errors, hardware faults, etc.
- *Process errors* → 📄 76:
  This group comprises all application errors, e.g. empty pipe, etc.

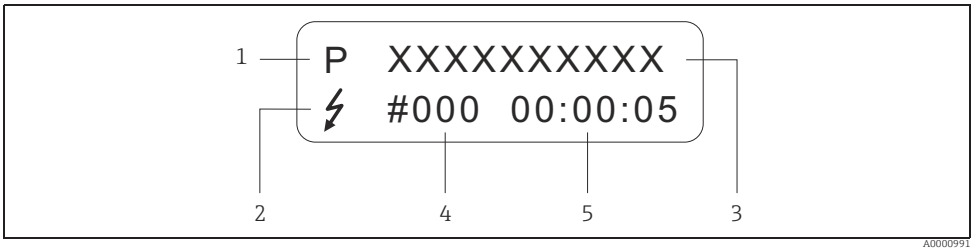


Fig. 43: Error messages on the display (example)

1 Error type:
– P = process error
– S = system error
2 Error message type:
– ϟ = fault message
– ! = notice message
3 Error designation: e.g. EMPTY PIPE = measuring tube is only partly filled or completely empty
4 Error number: e.g. #401
5 Duration of most recent error occurrence (in hours, minutes and seconds)

5.3.2 Error message types

Notice message (!)

- Displayed as → Exclamation mark (!), error type (S: system error, P: process error)
- The error in question has no effect on the outputs of the measuring device.

Fault message (ϟ)

- Displayed as → Lightning flash (ϟ), error type (S: system error, P: process error).
- The error in question has a direct effect on the outputs.
  The response of the individual outputs (failsafe mode) can be defined in the function matrix using the "FAILSAFE MODE" function → 📄 129.

Note!
For security reasons, error messages should be output via the status output.

5.4 Communication

In addition to local operation, the measuring device can be configured and measured values can be obtained by means of the HART protocol. Digital communication takes place using the 4–20 mA current output HART → 🖹 49.

The HART protocol allows the transfer of measuring and device data between the HART master and the field devices for configuration and diagnostics purposes.
The HART master, e.g. a handheld terminal or PC-based operating programs (such as FieldCare), require device description (DD) files which are used to access all the information in a HART device. Information is exclusively transferred using so-called "commands". There are three different command classes:

- *Universal commands:*
  All HART device support and use universal commands.
  The following functionalities are linked to them:
  – Identify HART devices
  – Reading digital measured values (volume flow, totalizer, etc.)
- *Common practice commands:*
  Common practice commands offer functions which are supported and can be executed by most but not all field devices.
- *Device-specific commands:*
  These commands allow access to device-specific functions which are not HART standard. Such commands access individual field device information, amongst other things, such as empty/full pipe calibration values, low flow cutoff settings, etc.

Note!
The device has access to all three command classes. A list of all the "Universal commands" and "Common practice commands" is provided on → 🖹 61.

5.4.1 Operating options

For the complete operation of the measuring device, including device-specific commands, there are DD files available to the user to provide the following operating aids and programs:

Field Xpert HART Communicator

Selecting device functions with a HART Communicator is a process involving a number of menu levels and a special HART function matrix.
The HART manual in the carrying case of the HART Communicator contains more detailed information on the device.

Operating program "FieldCare"

FieldCare is Endress+Hauser's FDT-based plant Asset Management Tool and allows the configuration and diagnosis of intelligent field devices. By using status information, you also have a simple but effective tool for monitoring devices. The Proline flow measuring devices are accessed via a service interface or via the service interface FXA193.

Operating program "SIMATIC PDM" (Siemens)

SIMATIC PDM is a standardized, manufacturer-independent tool for the operation, configuration, maintenance and diagnosis of intelligent field devices.

Operating program "AMS" (Emerson Process Management)

AMS (Asset Management Solutions): program for operating and configuring devices.

5.4.2 Current device description files

The following table illustrates the suitable device description file for the operating tool in question and then indicates where these can be obtained.

HART protocol:

Valid for device software:	1.04.XX	→ Function DEVICE SOFTWARE
Device data HART Manufacturer ID: Device ID:	 11_{hex} (ENDRESS+HAUSER) 56_{hex}	 → Function MANUFACTURER ID → Function DEVICE ID
HART version data:	Device Revision 5/ DD Revision 1	
Software release:	01.2012	

Operating program:	Sources for obtaining device descriptions:
Handheld Field Xpert SFX100	Use update function of handheld terminal
FieldCare / DTM	▪ www.endress.com → Download ▪ CD-ROM (Endress+Hauser order number 56004088) ▪ DVD (Endress+Hauser order number 70100690)
AMS	www.endress.com → Download
SIMATIC PDM	www.endress.com → Download

Tester/simulator:	Sources for obtaining device descriptions:
Fieldcheck	Update by means of FieldCare with the flow device FXA193/291 DTM in the Fieldflash module

Note!
The "Fieldcheck" tester/simulator is used for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed out and used for official certification. Contact your Endress+Hauser representative for more information.

5.4.3 Device variables

The following device variables are available using the HART protocol:

Code (decimal)	Device variable
0	OFF (not assigned)
1	Volume flow
250	Totalizer

At the factory, the process variables are assigned to the following device variables:
- Primary process variable (PV) → Volume flow
- Second process variable (SV) → Totalizer
- Third process variable (TV) → not assigned
- Fourth process variable (FV) → not assigned

5.4.4 Switching HART write protection on/off

The HART write protection can be switched on and off using the HART WRITE PROTECT device function → 🖹 121.

5.4.5 Universal and common practice HART commands

The following table contains all the universal commands supported by the device.

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Universal commands			
0	Read unique device identifier Access type = read	none	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 byte device ID: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = E+H – Byte 2: Device type ID, 69 = Promag 10 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Bytes 9-11: Device identification
1	Read primary process variable Access type = read	none	– Byte 0: HART unit code of the primary process variable – Bytes 1-4: Primary process variable Factory setting: Primary process variable = Volume flow ✎ Note! Manufacturer-specific units are represented using the HART unit code "240".
2	Read the primary process variable as current in mA and percentage of the set measuring range Access type = read	none	– Bytes 0-3: actual current of the primary process variable in mA – Bytes 4-7: % value of the set measuring range Factory setting: Primary process variable = Volume flow
3	Read the primary process variable as current in mA and four dynamic process variables Access type = read	none	24 bytes are sent as a response: – Bytes 0-3: primary process variable current in mA – Byte 4: HART unit code of the primary process variable – Bytes 5-8: Primary process variable – Byte 9: HART unit code of the second process variable – Bytes 10-13: Second process variable – Byte 14: HART unit code of the third process variable – Bytes 15-18: Third process variable – Byte 19: HART unit code of the fourth process variable – Bytes 20-23: Fourth process variable *Factory setting:* ▪ Primary process variable = Volume flow ▪ Second process variable = Totalizer ▪ Third process variable = OFF (not assigned) ▪ Fourth process variable = OFF (not assigned) The assignment of the process variables is fixed and cannot be changed. ✎ Note! Manufacturer-specific units are represented using the HART unit code "240".
6	Set HART shortform address Access type = write	Byte 0: desired address (0 to 15) Factory setting: 0 ✎ Note! With an address >0 (multidrop mode), the current output of the primary process variable is set to 4 mA.	Byte 0: active address

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
11	Read unique device identification using the TAG (measuring point designation) Access type = read	Bytes 0-5: TAG	Device identification delivers information on the device and the manufacturer. It cannot be changed. The response consists of a 12 byte device ID if the given TAG agrees with the one saved in the device: – Byte 0: fixed value 254 – Byte 1: Manufacturer ID, 17 = E+H – Byte 2: Device type ID, 69 = Promag 10 – Byte 3: Number of preambles – Byte 4: Universal commands rev. no. – Byte 5: Device-specific commands rev. no. – Byte 6: Software revision – Byte 7: Hardware revision – Byte 8: Additional device information – Bytes 9-11: Device identification
12	Read user message Access type = read	none	Bytes 0-24: User message ✎ Note! You can write the user message using Command 17.
13	Read TAG, descriptor and date Access type = read	none	– Bytes 0-5: TAG – Bytes 6-17: descriptor – Bytes 18-20: Date ✎ Note! You can write the TAG, descriptor and date using Command 18.
14	Read sensor information on primary process variable	none	– Bytes 0-2: Sensor serial number – Byte 3: HART unit code of sensor limits and measuring range of the primary process variable – Bytes 4-7: Upper sensor limit – Bytes 8-11: Lower sensor limit – Bytes 12-15: Minimum span ✎ Note! ▪ The data relate to the primary process variable (= volume flow). ▪ Manufacturer-specific units are represented using the HART unit code "240".
15	Read output information of primary process variable Access type = read	none	– Byte 0: Alarm selection ID – Byte 1: Transfer function ID – Byte 2: HART unit code for the set measuring range of the primary process variable – Bytes 3-6: upper range, value for 20 mA – Bytes 7-10: lower range, value for 4 mA – Bytes 11-14: Damping constant in [s] – Byte 15: Write protection ID – Byte 16: OEM dealer ID, 17 = E+H Factory setting: Primary process variable = Volume flow ✎ Note! Manufacturer-specific units are represented using the HART unit code "240".
16	Read the device production number Access type = read	none	Bytes 0-2: Production number
17	Write user message Access = write	Save any 32-character text in the device. Bytes 0-23: Desired user message	Displays the current user message in the device: Bytes 0-23: Current user message in the device
18	Write TAG, descriptor and date Access = write	With this parameter, you can store an 8 character TAG, a 16 character descriptor and a date: – Bytes 0-5: TAG – Bytes 6-17: descriptor – Bytes 18-20: Date	Displays the current information in the device: – Bytes 0-5: TAG – Bytes 6-17: descriptor – Bytes 18-20: Date
19	Write the device production number Access = write	Bytes 0-2: Production number	Bytes 0-2: Production number

The following table contains all the common practice commands supported by the device:

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
Common practice commands			
34	Write damping value for primary process variable Access = write	Bytes 0-3: Damping value of the primary process variable "volume flow" in seconds *Factory setting:* Primary process variable = Current output damping	Displays the current damping value in the device: Bytes 0-3: Damping value in seconds
35	Write measuring range of primary process variable Access = write	Write the desired measuring range: – Byte 0: HART unit code of the primary process variable – Bytes 1-4: upper range, value for 20 mA – Bytes 5-8: lower range, value for 4 mA *Factory setting:* Primary process variable = Volume flow Note! ▪ The start of the measuring range (4 mA) must correspond to the zero flow. ▪ If the HART unit code is not the correct one for the process variable, the device will continue with the last valid unit.	The currently set measuring range is displayed as a response: – Byte 0: HART unit code for the set measuring range of the primary process variable – Bytes 1-4: upper range, value for 20 mA – Bytes 5-8: lower range, value for 4 mA Note! Manufacturer-specific units are represented using the HART unit code "240".
38	Device status reset (configuration changed) Access = write	none Note! It is also possible to execute this HART command when write protection is activated (= ON)!	none
40	Simulate input current of primary process variable Access = write	Simulation of the desired output current of the primary process variable. An entry value of 0 exits the simulation mode: Bytes 0-3: Output current in mA *Factory setting:* Primary process variable = Volume flow Note! You can set the assignment of device variables to process variables using Command 51.	The momentary output current of the primary process variable is displayed as a response: Bytes 0-3: Output current in mA
42	Perform master reset Access = write	none	none
44	Write unit of primary process variable Access = write	Set unit of primary process variable. Only units which are suitable for the process variable are transferred to the device: Byte 0: HART unit code *Factory setting:* Primary process variable = Volume flow Note! ▪ If the written HART unit code is not the correct one for the process variable, the device will continue with the last valid unit. ▪ If you change the unit of the primary process variable, this has a direct impact on the system units.	The current unit code of the primary process variable is displayed as a response: Byte 0: HART unit code Note! Manufacturer-specific units are represented using the HART unit code "240".
48	Read additional device status Access = read	none	The device status is displayed in extended form as the response: Coding: see table → 65.

Command No. HART command / Access type		Command data (numeric data in decimal form)	Response data (numeric data in decimal form)
50	Read assignment of the device variables to the four process variables Access = read	none	Display of the current variable assignment of the process variables: – Byte 0: Device variable code to the primary process variable – Byte 1: Device variable code to the second process variable – Byte 2: Device variable code to the third process variable – Byte 3: Device variable code to the fourth process variable *Factory setting:* ▪ Primary process variable: Code 1 for volume flow ▪ Second process variable: Code 250 for totalizer ▪ Third process variable: Code 0 for OFF (not assigned) ▪ Fourth process variable: Code 0 for OFF (not assigned)
53	Write device variable unit Access = write	This command sets the unit of the given device variables. Only those units which suit the device variable are transferred: – Byte 0: Device variable code – Byte 1: HART unit code *Code of the supported device variables:* See information → 🖹 60 ✎ Note! ▪ If the written unit is not the correct one for the device variable, the device will continue with the last valid unit. ▪ If you change the unit of the device variable, this has a direct impact on the system units.	The current unit of the device variables is displayed in the device as a response: – Byte 0: Device variable code – Byte 1: HART unit code ✎ Note! Manufacturer-specific units are represented using the HART unit code "240".
59	Write number of preambles in response message Access = write	This parameter sets the number of preambles which are inserted in the response messages: Byte 0: Number of preambles (4 to 20)	As a response, the current number of the preambles is displayed in the response message: Byte 0: Number of preambles

5.4.6 Device status and error messages

You can read the extended device status, in this case, current error messages, via Command "48". The command delivers information which is partly coded in bits (see table below).

Note!
- You can find a detailed explanation of the device status and error messages and their elimination on → 📄 65
- Bits and bytes not listed are not assigned.

Byte	Bit	Error No.	Short error description
0	0	001	Serious device error
	1	011	Measuring amplifier has faulty EEPROM
	2	012	Error when accessing data of the measuring amplifier EEPROM
3	3	111	Totalizer checksum error
5	0	321	Coil current of the sensor is outside the tolerance.
7	3	351	Current output: Flow is out of range
8	3	359	Pulse output: The pulse output frequency is out of range
10	7	401	Measuring tube partially filled or empty
11	2	461	EPD calibration not possible because the fluid's conductivity is either too low or too high
	4	463	The EPD calibration values for empty pipe and full pipe are identical, and therefore incorrect.
12	7	501	Amplifier software version is loaded. Currently no other commands are possible.
14	3	601	Positive zero return active
18	3	691	Simulation of response to error (outputs) active
	4	692	Simulation of volume flow active

6 Commissioning

6.1 Function check

Make sure that all final checks have been completed before you start up your measuring point:
- Checklist for "Post-installation check" → 41
- Checklist for "Post-connection check" → 54

6.2 Switching on the measuring device

Once the connection checks have been successfully completed, it is time to switch on the power supply. The device is now operational. The measuring device performs a number of post switch-on self-tests. As this procedure progresses the following sequence of messages appears on the local display:

PROMAG 10 V 1.XX.XX	Start-up message

Normal measuring mode commences as soon as start-up completes.
Various measured-value and/or status variables (HOME position) appear on the display.

Note!
If start-up fails, an error message indicating the cause is displayed.

6.3 Brief commissioning guide

HOME position → E → +

Configure display	
UI language	→ 111
Display contrast	→ 112
Number of decimal places	→ 112

Select engineering units	
Volume flow	→ 109
Totalizer	→ 113

Configure outputs			
Current output		*Pulse/status output*	
Current range	→ 114	Operating mode	→ 116
Full scale value	→ 115	Pulse value	→ 116
		Pulse width	→ 116
		or	
		Assign status output	→ 117
		Switch-on point	→ 117

Complex applications The quickest way to find information on configuring additional functions is via the following pages:	
Operating matrix	→ 108
Index	→ 135

For optimum measurement results	
Low flow cut off	→ 122
Empty pipe detection	→ 122

6.4 Commissioning after installing a new electronics board

After startup, the device checks whether a serial number is available. If this is not the case, the following setup is started. Installing a new electronics board → 79.

6.4.1 "Commissioning" setup

Note!
- The setup can no longer be called up once a serial number has been entered and stored. If a parameter is entered incorrectly during the setup, this must be corrected in the relevant function via the function matrix.
- The appropriate information is documented on the nameplate of the sensor and on the inside of the housing cover, → 2 → 7.

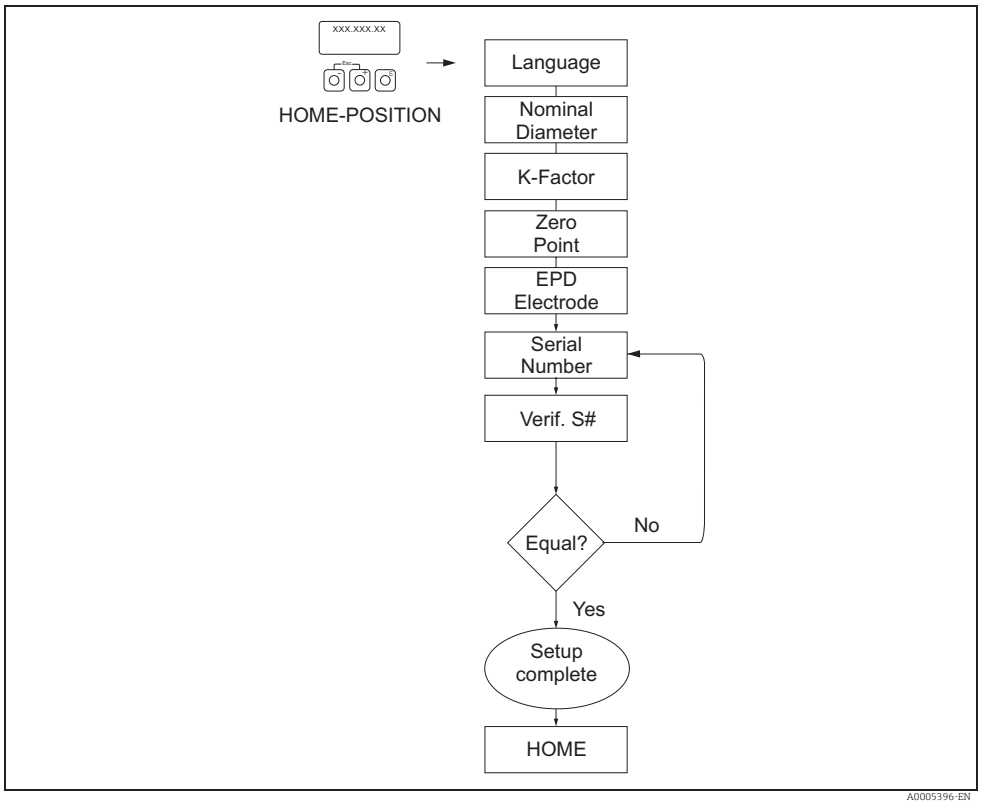


Fig. 44: The "Commissioning" setup starts after installation of a new electronics board if no serial number is present.

6.5 Empty-pipe/full-pipe adjustment

Flow cannot be measured correctly unless the measuring tube is completely full.
This status can be permanently monitored using the Empty Pipe Detection:
EPD = Empty Pipe Detection (with the help of an EPD electrode)

Caution!
More detailed information on empty-pipe and full-pipe adjustment can be found in the description of the functions:
- EPD ADJUSTMENT (carrying out the adjustment) → 123.
- EPD (switching empty pipe detection on and off) → 122

Note!
- The EPD function is not available unless the sensor is fitted with an EPD electrode.
- The devices are already calibrated at the factory with water (approx. 500 µS/cm). If the fluid conductivity differs from this reference, empty-pipe/full-pipe adjustment has to be performed again on site.
- The default setting for EPD when the devices are delivered is OFF; the function has to be activated if required.
- The EPD process error can be output by means of the configurable status output.

6.5.1 Performing empty-pipe and full-pipe adjustment (EPD)

1. Select the appropriate function in the function matrix:
   HOME → E → + → PROCESS PARAMETER → E → + → EPD ADJUSTMENT
2. Empty the piping. The wall of the measuring tube should still be wet with fluid during EPD empty pipe adjustment
3. Start empty-pipe adjustment: Select "EMPTY PIPE ADJUST" and press E to confirm.
4. After empty-pipe adjustment, fill the piping with fluid.
5. Start full-pipe adjustment: Select "FULL PIPE ADJUST" and press E to confirm.
6. Having completed the adjustment, select the setting "OFF" and exit the function by pressing E.
7. Now switch on empty pipe detection in the EPD function by selecting the option "ON".

   Caution!
   The adjustment coefficients must be valid before you can activate the EPD function. If adjustment is incorrect the following messages might appear on the display:
   – FULL = EMPTY
     The adjustment values for empty pipe and full pipe are identical. In cases of this nature you must repeat empty-pipe or full-pipe adjustment!
   – ADJUSTMENT NOT OK
     Adjustment is not possible because the fluid's conductivity is out of range.

7 Maintenance

No special maintenance work is required.

7.1 Exterior cleaning

When cleaning the exterior of measuring devices, always use cleaning agents that do not attack the surface of the housing and the seals.

7.2 Seals

The seals of the Promag H sensor must be replaced periodically, particularly in the case of gasket seals (aseptic version).
The period between changes depends on the frequency of cleaning cycles, the cleaning temperature and the fluid temperature.

Replacement seals (accessories) → 70.

8 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress+Hauser service organization can provide detailed information on the specific order codes on request.

8.1 Device-specific accessories

Accessory	Description	Order code
Proline Promag 10 transmitter	Transmitter for replacement or storage. Use the order code to define the following specifications: ▪ Approvals ▪ Degree of protection/version ▪ Cable for remote version ▪ Cable entry ▪ Display/power supply/operation ▪ Software ▪ Outputs/inputs	10XXX – XXXXX******

8.2 Measuring principle-specific accessories

Accessory	Description	Order code
Mounting set for Promag 10 transmitter	Mounting set for aluminum field housing (remote version). Suitable for Pipe mounting	DK5WM – B
Wall-mounting kit for Promag H	Wall-mounting kit for the Promag H sensor.	DK5HM – **
Cable for remote version	Coil and signal cables, various lengths.	DK5CA – **
Mounting kit for Promag D, wafer version	▪ Mounting bolts ▪ Nuts incl. washers ▪ Flange seals ▪ Centering sleeves (if required for the flange)	DKD** – **
Set of seals for Promag D	Set of seals consisting of two flange seals.	DK5DD – ***
Mounting kit for Promag H	▪ 2 process connections ▪ Threaded fasteners ▪ Seals	DKH** – ****
Set of seals for Promag H	For regular replacement of the seals of the Promag H sensor.	DK5HS – ***
Welding jig for Promag H	Weld nipple as process connection: welding jig for installation in pipe.	DK5HW – ***
Adapter connection for Promag A, H	Adapter connections for installing a Promag H instead of a Promag 30/33 A or Promag 30/33 H DN 25.	DK5HA – *****
Ground cable for Promag E/L/P/W	Ground cable for potential equalization.	DK5GC – ***
Ground disk for Promag E/L/P/W	Ground disk for potential equalization.	DK5GD – * * ***
Process display RIA45	Multifunctional 1-channel display unit: ▪ Universal input ▪ Transmitter power supply ▪ Limit relay ▪ Analog output	RIA45 – ******
Process display RIA251	Digital display device for looping into the 4 to 20 mA current loop.	RIA251 – **

Accessory	Description	Order code
Field display unit RIA16	Digital field display device for looping into the 4 to 20 mA current loop.	RIA16 – ***
Application Manager RMM621	Electronic recording, display, balancing, control, saving and event and alarm monitoring of analog and digital input signals. Values and conditions determined are output by means of analog and digital output signals. Remote transmission of alarms, input values and calculated values using a PSTN or GSM modem.	RMM621 – **********

8.3 Communication-specific accessories

Accessory	Description	Order code
HART Communicator Field Xpert SFX 100	Handheld terminal for remote configuration and for obtaining measured values via the HART current output (4 to 20 mA). Contact your Endress+Hauser representative for more information.	SFX100 – *******
Fieldgate FXA320	Gateway for remote interrogation of HART sensors and actuators via Web browser: ▪ 2-channel analog input (4 to 20 mA) ▪ 4 binary inputs with event counter function and frequency measurement ▪ Communication via modem, Ethernet or GSM ▪ Visualization via Internet/Intranet in Web browser and/or WAP cellular phone ▪ Limit value monitoring with alarm by e-mail or SMS ▪ Synchronized time stamping of all measured values.	FXA320 – *****
Fieldgate FXA520	Gateway for remote interrogation of HART sensors and actuators via Web browser: ▪ Web server for remote monitoring of up to 30 measuring points ▪ Intrinsically safe version [EEx ia]IIC for applications in hazardous areas ▪ Communication via modem, Ethernet or GSM ▪ Visualization via Internet/Intranet in Web browser and/or WAP cellular phone ▪ Limit value monitoring with alarm by e-mail or SMS ▪ Synchronized time stamping of all measured values ▪ Remote diagnosis and remote configuration of connected HART devices	FXA520 – ****
FXA195	The Commubox FXA195 connects intrinsically safe Smart transmitters with HART protocol to the USB port of a personal computer. This makes the remote operation of the transmitters possible with the aid of configuration programs (e.g. FieldCare). Power is supplied to the Commubox by means of the USB port	FXA195 – *

8.4 Service-specific accessories

Accessory	Description	Order code
Applicator	Software for selecting and planning flowmeters. The Applicator software can be downloaded from the Internet or ordered on CD-ROM for installation on a local PC. Contact your Endress+Hauser representative for more information.	DXA80 – *
Fieldcheck	Tester/simulator for testing flowmeters in the field. When used in conjunction with the "FieldCare" software package, test results can be imported into a database, printed out and used for official certification. Contact your Endress+Hauser representative for more information.	50098801
FieldCare	FieldCare is Endress+Hauser's FDT-based asset management tool. It can configure all intelligent field units in your system and helps you manage them. By using status information, it is also a simple but effective way of checking their status and condition.	See the product page on the Endress+Hauser Web site: www.endress.com
Memograph M graphic display recorder	The Memograph M graphic display recorder provides information on all the relevant process variables. Measured values are recorded correctly, limit values are monitored and measuring points analyzed. The data are stored in the 256 MB internal memory and also on a DSD card or USB stick. Memograph M boasts a modular design, intuitive operation and a comprehensive security concept. The ReadWin® 2000 PC software is part of the standard package and is used for configuring, visualizing and archiving the data captured. The mathematics channels which are optionally available enable continuous monitoring of specific power consumption, boiler efficiency and other parameters which are important for efficient energy management.	RSG40 – **********
FXA193	Service interface from the device to the PC for operation via FieldCare.	FXA193 – *

9 Troubleshooting

9.1 Troubleshooting instructions

Always start troubleshooting with the checklist below if faults occur after start-up or during operation. The routine takes you directly to the cause of the problem and the appropriate remedial measures.

Check the display	
No display visible and no output signals present.	1. Check the supply voltage → terminals 1, 2 2. Check the power line fuse → 🖹 81 85 to 250 V AC: TR5 1 A slow-blow / 250 V 11 to 40 V DC / 20 to 28 V AC: TR5 1.6A slow-blow / 250 V 3. Measuring electronics defective → order spare parts → 🖹 78
No display visible, but output signals are present.	1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → 🖹 79 2. Display module defective → order spare parts → 🖹 78 3. Measuring electronics defective → order spare parts → 🖹 78
Display texts are in a foreign language.	Switch off power supply. Press and hold down both the ± buttons and switch on the measuring device. The display text will appear in English (default) and is displayed at maximum contrast.
Measured value indicated, but no signal at the current or pulse output.	Electronics board defective → order spare parts → 🖹 78
↓	
Error messages on display	
Errors which occur during commissioning or measuring operation are displayed immediately. Error messages consist of a variety of icons: the meanings of these icons are as follows (example): – Error type: S = system error, P = process error – Error message type: ϟ = fault message, ! = notice message – EMPTY PIPE = Type of error, e.g. measuring tube is only partly filled or completely empty – 03:00:05 = duration of error occurrence (in hours, minutes and seconds) – #401 = error number ☝ Caution! ▪ See the information on → 🖹 58! ▪ The measuring system interprets simulations and positive zero return as system errors, but displays them as notice message only.	
Error number: No. 001 – 399 No. 501 – 699	System error (device error) has occurred → 🖹 74
Error number: No. 401 - 499	Process error (application error) has occurred → 🖹 76
↓	
Other error (without error message)	
Some other error has occurred.	Diagnosis and rectification → 🖹 76

9.2 System error messages

Serious system errors are always recognized by the device as "Fault message", and are shown as a lightning flash (ϟ) on the display. Fault messages immediately affect the outputs. Simulations and positive zero return, on the other hand, are only classed and displayed as notice messages.

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. Necessary procedures must be carried out before you return the measuring device to Endress+Hauser → 🖹 5.
Always enclose a duly completed "Declaration of Contamination" form. You will find a master copy of this form at the back of this manual.

Note!
- The error types listed in the following correspond to the factory settings.
- Also observe the information on → 🖹 58

Type	Error message / No.	Cause	Remedy (Replace electronics board → 🖹 79)
S = System error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs)			
No. # 0xx→ Hardware error			
S ϟ	CRITICAL FAIL. # 001	Serious device error	Replace electronics board.
S ϟ	AMP HW EEPROM # 011	Electronics board: Defective EEPROM	Replace electronics board.
S ϟ	AMP SW EEPROM # 012	Amplifier: Error accessing EEPROM data.	The EEPROM data blocks in which an error has occurred are displayed in the TROUBLESHOOTING function. Press Enter to acknowledge the errors in question; default values are automatically inserted instead of the errored parameter values. Note! The measuring device has to be restarted if an error has occurred in a totalizer block (see error No. 111 / CHECKSUM TOTAL).
No. # 1xx→ Software error			
S ϟ	GAIN ERROR AMP # 101	Impermissible gain deviation compared to reference.	Replace electronics board.
S ϟ	CHECKSUM TOTAL. # 111	Totalizer checksum error	1. Restart the measuring device 2. Replace electronics board if necessary.
No. # 3xx→ System limits exceeded			
S ϟ	TOL. COIL CURR. # 321	Sensor: Coil current is out of tolerance.	Warning! Switch off power supply before manipulating the coil current cable, coil current cable connector or measuring electronics boards! Remote version: 1. Check wiring of terminals 41/42 → 🖹 42 2. Check coil current cable connector. Compact and remote version: Replace measuring electronics boards if necessary
S !	CURRENT RANGE # 351	Current output: flow is out of range.	– Change the upper or lower limit setting, as applicable. – Increase or reduce flow, as applicable.

Type	Error message / No.	Cause	Remedy (Replace electronics board → 79)
S !	RANGE PULSE # 359	Pulse output: the pulse output frequency is out of range.	1. Increase the setting for pulse weighting 2. When selecting the pulse width, choose a value that can still be processed by a connected counter (e.g. mechanical counter, PLC etc.). *Determine the pulse width:* – Variant 1: Enter the minimum duration that a pulse must be present at the connected counter to ensure its registration. – Variant 2: Enter the maximum (pulse) frequency as the half "reciprocal value" that a pulse must be present at the connected counter to ensure its registration. Example: The maximum input frequency of the connected counter is 10 Hz. The pulse width to be entered is: 1 / (2 · 10 Hz) = 50 ms 3. Reduce flow.
No. # 5xx→ Application error			
S !	SW.-UPDATE ACT. # 501	Electronics board: New software version being loaded, no other commands are possible at present.	Wait until process is completed and restart device.
S !	UP-/DOWNL. ACT. # 502	Data are being uploaded or downloaded via FieldCare. ✎ Note! Measuring device configuration is locked during the upload/download.	Wait until uploading/downloading process is finished.
No. # 6xx→ Simulation mode active			
S !	POS. ZERO-RET. # 601	Positive zero return active	Switch off positive zero return.
S ϟ	SIM. FAILSAFE # 691	Simulation of response to error (outputs) active.	Switch off simulation.
S !	SIM. VOL. FLOW # 692	Simulation of volume flow active.	Switch off simulation.

9.3 Process error messages

Process errors are permanently defined as fault messages or notice messages.

Type	Error message / No.	Cause	Remedy / spare part
P = Process error ϟ = Fault message (with an effect on the outputs) ! = Notice message (without an effect on the outputs)			
P !	EMPTY PIPE # 401	Measuring tube partially filled or empty	1. Check the process conditions of the plant 2. Fill the measuring tube
P !	ADJ. NOT OK # 461	EPD calibration not possible because the fluid's conductivity is either too low or too high.	The EPD function cannot be used with fluids of this nature.
P ϟ	FULL = EMPTY # 463	The EPD calibration values for empty pipe and full pipe are identical, therefore incorrect.	Repeat calibration, making sure procedure is correct → 🖹 68.

9.4 Process errors without messages

Symptoms	Rectification
Remark: You may have to change or correct certain settings in functions in the function matrix in order to rectify the fault.	
Flow values are negative, even though the fluid is flowing forwards through the pipe.	1. Remote version: – Switch off the power supply and check the wiring → 🖹 42 – If necessary, reverse the connections at terminals 41 and 42 2. Change the setting in the "INSTALLATION DIRECTION SENSOR" function accordingly
Measured-value reading fluctuates even though flow is steady.	1. Check grounding and potential equalization → 🖹 50 2. Check the fluid for presence of gas bubbles. 3. In the "SYSTEM DAMPING" function → increase the value
Measured-value reading shown on display, even though the fluid is at a standstill and the measuring tube is full.	1. Check grounding and potential equalization → 🖹 50 2. Check the fluid for presence of gas bubbles. 3. Activate the "LOW FLOW CUTOFF" function, i.e. enter or increase the value for the switching point.
Measured-value reading on display, even though measuring tube is empty.	1. Perform empty-pipe/full-pipe adjustment and then switch on Empty Pipe detection → 🖹 68 2. Remote version: Check the terminals of the EPD cable → 🖹 42 3. Fill the measuring tube.
The current output signal is always 4 mA, irrespective of the flow signal at any given time.	1. Select the "BUS ADDRESS" function and change the setting to "0". 2. Value for creepage too high. Reduce the value in the "LOW FLOW CUTOFF" function.
The fault cannot be rectified or some other fault not described above has arisen. In these instances, please contact your Endress+Hauser service organization.	The following options are available for tackling problems of this nature: Request the services of an Endress+Hauser service technician If you contact our service organization to have a service technician sent out, please be ready to quote the following information: – Brief description of the fault – Nameplate specifications (→ 🖹 6): order code, serial number Returning devices to Endress+Hauser The necessary procedures on → 🖹 5 must be carried out before you return a flowmeter requiring repair or calibration to Endress+Hauser. Always enclose a duly completed "Declaration of Conformity" form with the flowmeter. You will find a master copy of this form at the back of this manual. Replace transmitter electronics Components in the measuring electronics defective → order spare parts → 🖹 78

9.5 Response of outputs to errors

Note!
The response of the totalizer, current output, pulse output and status output is defined in the FAILSAFE MODE function (→ 129).

You can use positive zero return to set the signals of the current, pulse and status outputs to their fallback value, for example when measuring has to be interrupted while a pipe is being cleaned. This function takes priority over all other device functions: simulations, for example, are suppressed.

Failsafe mode of outputs and totalizers		
	Process/system error is current	**Positive zero return is activated**
Caution! System or process errors defined as "Notice messages" have no effect whatsoever on the inputs and outputs. See the information on → 58		
Current output	MINIMUM VALUE 4–20 mA (25 mA) → 2 mA 4–20 mA NAMUR →3.5 mA 4–20 mA US → 3.75 mA 4–20 mA (25 mA) HART → 2 mA 4–20 mA HART NAMUR →3.5 mA 4–20 mA HART US → 3.75 mA MAXIMUM VALUE 4–20 mA (25 mA) → 25 mA 4–20 mA NAMUR → 22.6 mA 4–20 mA US → 22.6 mA 4–20 mA (25 mA) HART → 25 mA 4–20 mA HART NAMUR → 22.6 mA 4–20 mA HART US → 22.6 mA HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Measured value display on the basis of the current flow measurement. The fault is ignored.	Output signal corresponds to "zero flow"
Pulse output	MIN/MAX VALUE → FALLBACK VALUE Signal output → no pulses HOLD VALUE Last valid value (preceding occurrence of the fault) is output. ACTUAL VALUE Fault is ignored, i.e. normal measured-value output on the basis of ongoing flow measurement.	Output signal corresponds to "zero flow"
Totalizer	*MINIMUM/MAXIMUM VALUE → STOP* The totalizers are paused until the error is rectified. *ACTUAL VALUE* The fault is ignored. The totalizer continues to count in accordance with the current flow value.	Totalizer stops
Status output	In the event of a fault or power supply failure: Status output → non-conductive	No effect on status output

9.6 Spare parts

Detailed troubleshooting instructions are provided in the previous sections → 🖹 73
The measuring device, moreover, provides additional support in the form of continuous self-diagnosis and error messages.

Fault rectification can entail replacing defective components with tested spare parts. The illustration below shows the available scope of spare parts.

Note!
You can order spare parts directly from your Endress+Hauser service organization by providing the serial number printed on the transmitter's nameplate → 🖹 6.

Spare parts are shipped as sets comprising the following parts:
- Spare part
- Additional parts, small items (threaded fasteners, etc.)
- Mounting instructions
- Packaging

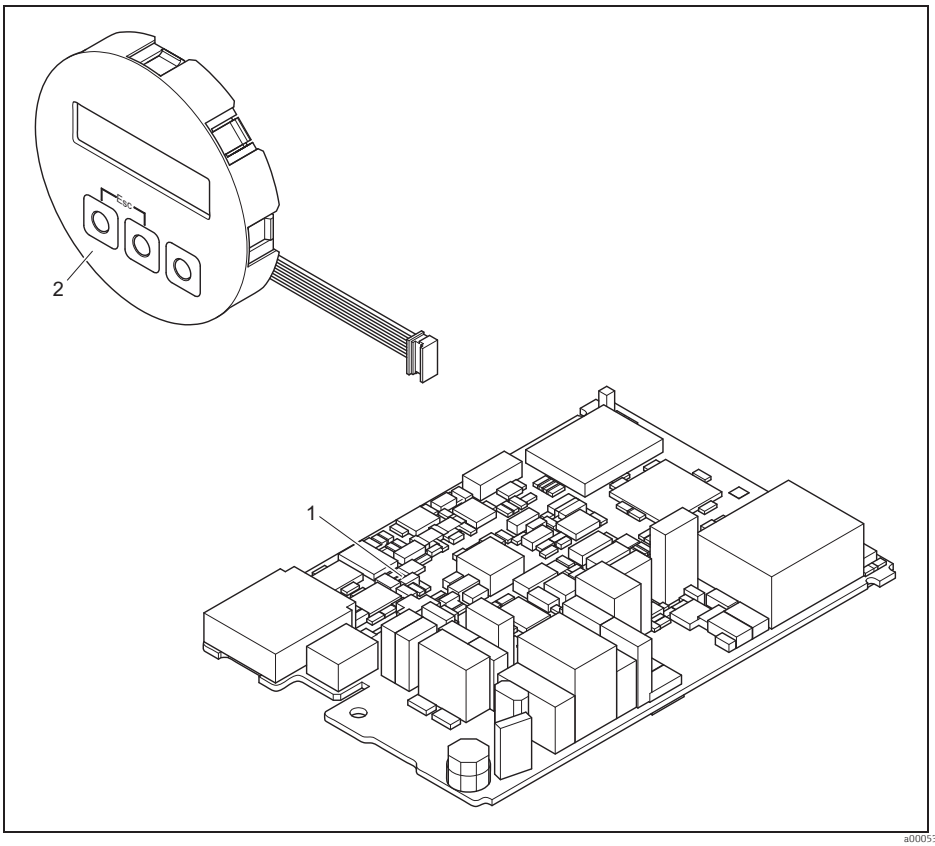


Fig. 45: Spare parts for Promag 10 transmitter

1 Electronics board
2 Display module

9.6.1 Removing and installing printed circuit boards

Field housing: removing and installing electronics boards → 46

Warning!
- Risk of electric shock!
  Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purpose-built for electrostatically sensitive devices!
- If you cannot guarantee that the dielectric strength of the device is maintained in the following steps, then an appropriate inspection must be carried out in accordance with the manufacturer's specifications.

Caution!
Use only original Endress+Hauser parts.

Note!
Commissioning a new electronics board: → 67

1. Switch off power supply.
2. Unscrew cover of the electronics compartment from the transmitter housing.
3. Remove the local display (a) from the connection compartment cover.
4. Press the side latches (b) and flip down the cover of the connection compartment.
5. Disconnect the connector of the electrode signal cable (c) and the coil current cable (d).
6. Disconnect the connector for the power supply (e) and the outputs (f).
7. Disconnect the connector of the local display (g).
8. Remove the cover from the connection compartment (h) by loosening the screws.
9. Plug out the ground cable (i) of the electronics board.
10. Pull entire module (plastic retainer and electronics board) out of the housing.
11. Press the side latches (j) slightly outwards and partly push out the electronics board towards the rear from the front.
12. Remove the electronics board from the plastic retainer from the rear.
13. Installation is the reverse of the removal procedure.

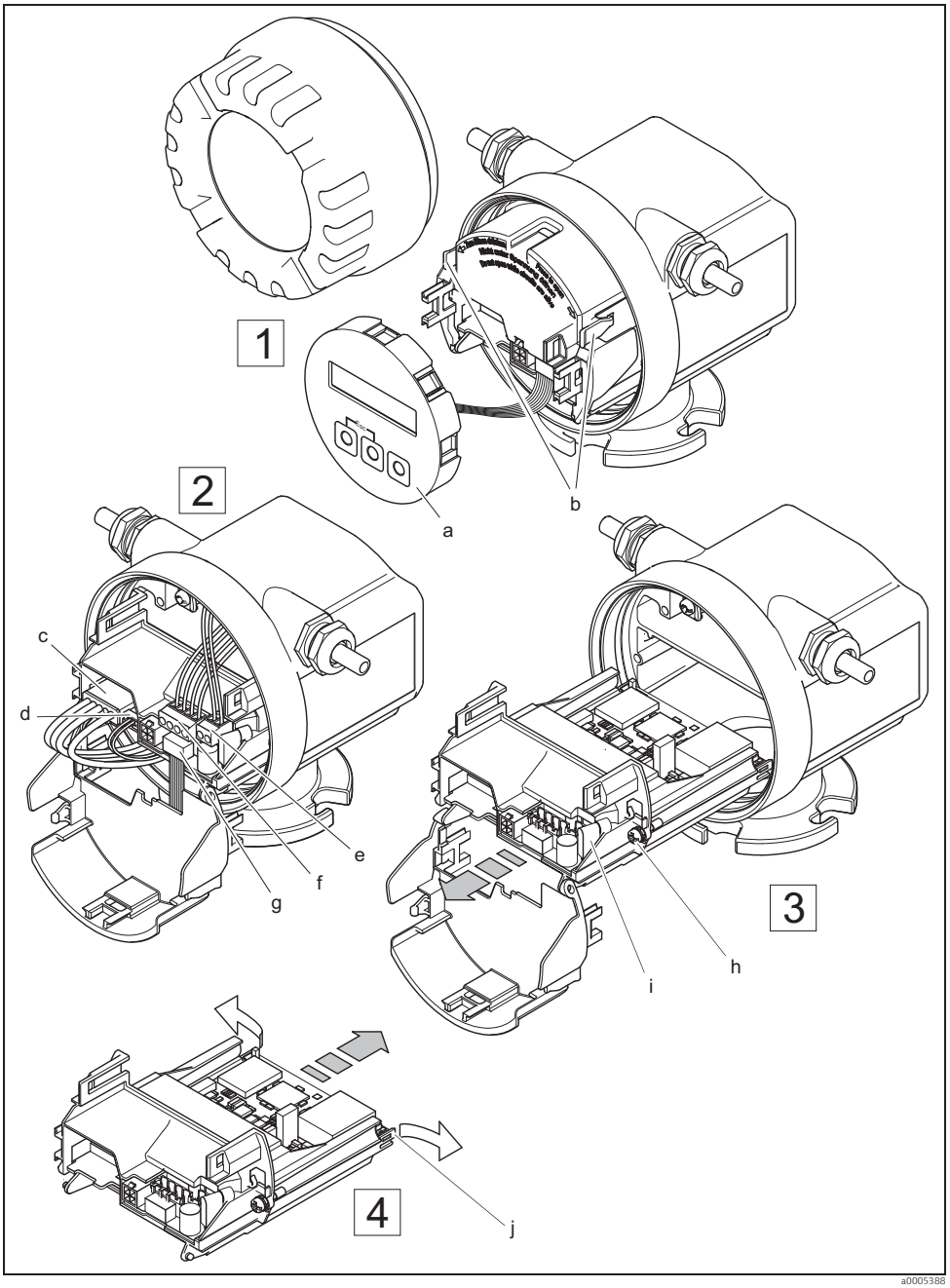


Fig. 46: Field housing: removing and installing printed circuit boards

a Local display
b Latches
c Connector of the electrode signal cable
d Connector of the coil current cable
e Connector for the power supply
f Connector for current output and pulse/status output
g Connector of local display
h Screws of electronics compartment cover
i Connector of the ground cable
j Latches for the electronics board

9.6.2 Replacing the device fuse

Warning!
Risk of electric shock!
Exposed components carry dangerous voltages. Make sure that the power supply is switched off before you remove the cover of the electronics compartment.

The main fuse is located on the electronics board (→ 47).
The procedure for replacing the fuse is as follows:

1. Switch off power supply.
2. Unscrew cover of the electronics compartment from the transmitter housing.
3. Press the side latches and flip down the cover of the connection compartment.
4. Remove the connector for the power supply (a).
5. Replace device fuse (b). Only use the following fuse type.
   Use only fuses of the following type:
   – Power supply 11 to 40 V DC / 20 to 28 V AC → 1.6 A slow-blow / 250 V TR5
   – Power supply 85 to 250 V DC → 1 A slow-blow / 250 V TR5
6. Installation is the reverse of the removal procedure.

Caution!
Use only original Endress+Hauser parts.

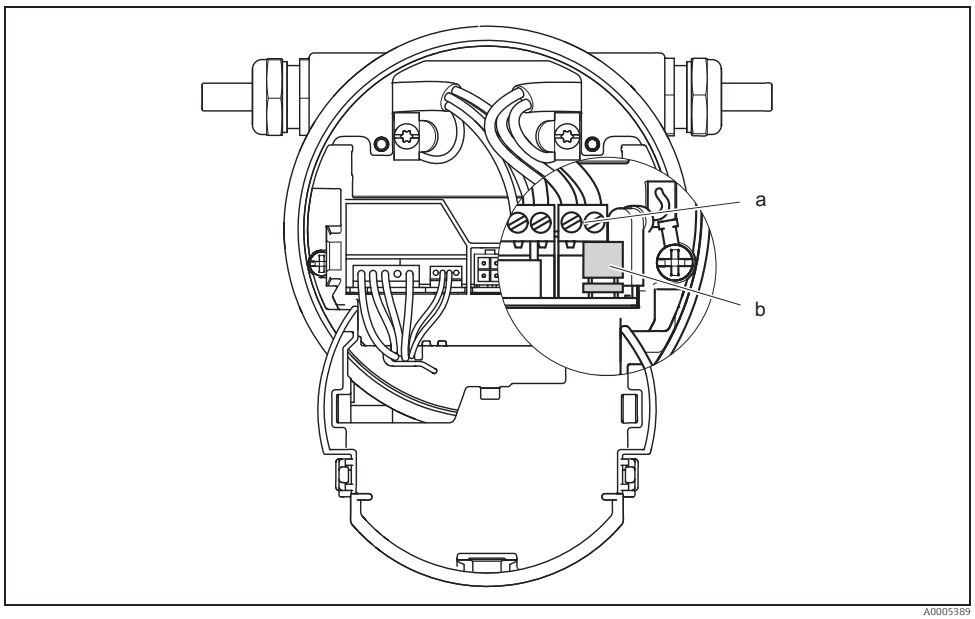


Fig. 47: Replacing the device fuse on the electronics board

a Connector for power supply
b Device fuse

9.7 Return

Caution!
Do not return a measuring device if you are not absolutely certain that all traces of hazardous substances have been removed, e.g. substances which have penetrated crevices or diffused through plastic.
Costs incurred for waste disposal and injury (burns, etc.) due to inadequate cleaning will be charged to the owner-operator.

The following steps must be taken before returning a flow measuring device to Endress+Hauser, e.g. for repair or calibration:
- Always enclose a duly completed "Declaration of contamination" form. Only then can Endress+Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EC REACH Regulation No. 1907/2006.
- Remove all residues. Pay special attention to the grooves for seals and crevices which could contain residues. This is particularly important if the substance is hazardous to health, e.g. flammable, toxic, caustic, carcinogenic, etc.

Note!
You will find a preprinted "Declaration of contamination" form at the back of these Operating Instructions.

9.8 Disposal

Observe the regulations applicable in your country!

9.9 Software history

Date	Software version	Changes to software	Operating Instructions
01.2012	V 1.04.00	Introduction of new nominal diameters; faster coil current control; calf-values to 2.5	71249469/15.14
11.2009	V 1.03.00	Introduction of Calf history	71106179/12.09 71105338/11.09
06.2009	V 1.02.00	Introduction of Promag L	71095705/06.09
03.2009	V 1.02.00	Introduction of Promag D; introduction of new nominal diameter.	71088674/03.09
10.2004	V 1.02.00	Software modification/extension Function: SELF CHECKING	50104787/05.05
09.2004	V 1.01.01	Software modification; extension of nominal diameter range	50104787/04.03
06.2004	V 1.01.00	Software extension; preparation for uploading/ downloading via ToF Tool - Fieldtool Package	50104787/04.03
08.2003	V 1.00.02	Production-related software modification	50104787/04.03
01.2003	V 1.00.00	Original software. Compatible with: ToF Tool - Fieldtool Package, HART Communicator DXR 275 (from OS 4.6) with Rev. 1, DD 1.	50104787/04.03

Note!
Uploads or downloads between the individual software versions are only possible with a special service software.

10 Technical data

10.1 Technical data at a glance

10.1.1 Application

→ 🖹 4

10.1.2 Function and system design

Measuring principle

Electromagnetic flow measurement on the basis of Faraday's Law.

Measuring system

→ 🖹 6

10.1.3 Input

Measured variable

Flow velocity (proportional to induced voltage)

Measuring range

Typically v = 0.01 to 10 m/s (0.033 to 33 ft/s) with the specified accuracy

Operable flow range

Over 1000 : 1

10.1.4 Output

Output signal

Current output

- Galvanically isolated
- Active: 4 to 20 mA, R_L <700 Ω (for HART: RL ≥250 Ω)
- Full scale value adjustable
- Temperature coefficient: typ. 2 µA/°C, resolution: 1.5 µA

Pulse/status output:

- Galvanically isolated
- Passive: 30 V DC / 250 mA
- Open collector
- Can be configured as:
  - Pulse output
    Pulse value and pulse polarity can be selected, max. pulse width adjustable (5 to 2000 ms), pulse frequency max. 100 Hz
  - Status output
    For example, can be configured for error messages, empty pipe detection, flow recognition, limit value

Signal on alarm

Current output

Failsafe mode can be selected (e.g. in accordance with NAMUR Recommendation NE 43) → 🖹 129

Pulse output

Failsafe mode can be selected → 🖹 129

Status output

"Not conductive" in the event of fault or power supply failure

Load

See "Output signal"

Low flow cut off

Low flow cut off, switch-on point can be selected as required

Galvanic isolation

All circuits for inputs, outputs, and power supply are galvanically isolated from each other.

10.1.5 Power supply

Electrical connections

→ 🖹 42

Supply voltage (power supply)

- 20 to 28 V AC, 45 to 65 Hz
- 85 to 250 V AC, 45 to 65 Hz
- 11 to 40 V DC

Cable entry

Power supply and signal cables (inputs/outputs):

- Cable entry M20 × 1.5 (8 to 12 mm/0.31 to 0.47 inch)
- Threads for cable entries ½" NPT, G ½"

Connecting cable for remote version:

- Cable entry M20 × 1.5 (8 to 12 mm/0.31 to 0.47 inch)
- Threads for cable entries ½" NPT, G ½"

Cable specifications

→ 🖹 47

Power consumption

Power consumption

- 20 to 28 V AC: <8 VA (incl. sensor)
- 85 to 250 V AC: <12 VA (incl. sensor)
- 11 to 40 V DC: <6 W (incl. sensor)

Switch-on current:

- Max. 3.3 A (<5 ms) for 24 V DC
- Max. 5.5 A (<5 ms) for 28 V DC
- Max. 16 A (<5 ms) for 250 V DC

Power supply failure

Lasting min. ½ cycle frequency: EEPROM saves measuring system data

Potential equalization

→ 🖹 50

10.1.6 Performance characteristics

Reference operating conditions

To DIN EN 29104 and VDI/VDE 2641:

- Fluid temperature: +28 ± 2 °C (+82 ± 4 °F)
- Ambient temperature: +22 ± 2 °C (+72 ± 4 °F)
- Warm-up period: 30 minutes

Installation:

- Inlet run >10 × DN
- Outlet run > 5 × DN
- Sensor and transmitter grounded.
- The sensor is centered in the pipe.

Maximum measured error

- Current output: plus typically ± 5 µA
- Pulse output: ± 0.5% o.r. ± 2 mm/s (o.r. = of reading)

Fluctuations in the supply voltage do not have any effect within the specified range.

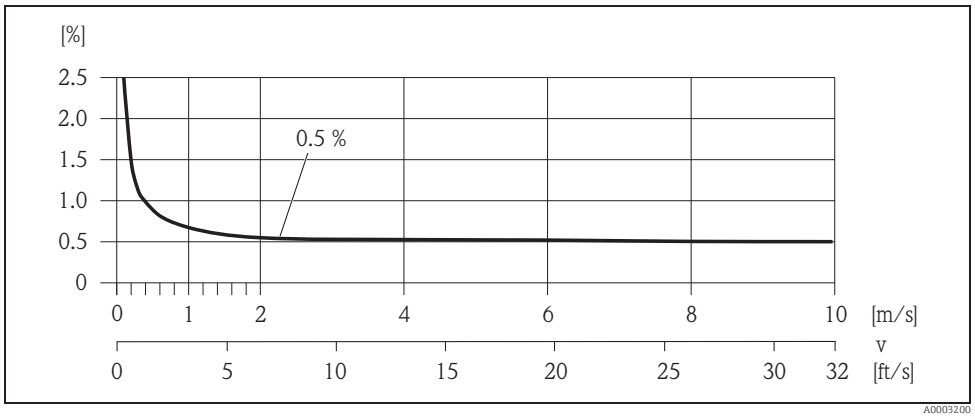


Fig. 48: Max. measured error in % of reading

Repeatability

Max. ± 0.2% o.r. ± 2 mm/s (o.r. = of reading)

10.1.7 Installation

Installation instructions

Any orientation (vertical, horizontal), restrictions and additional installation instructions → 11

Inlet and outlet runs

If possible, install the sensor upstream from fittings such as valves, T-pieces, elbows, etc. The following inlet and outlet runs must be observed in order to meet accuracy specifications (→ 14, → 12):
- Inlet run: ≥ 5 × DN
- Outlet run: ≥ 2 × DN

Adapters

→ 15

Length of connecting cable

- The permitted length of connecting cable L_{max} is determined by the fluid conductivity (→ 18, → 16). A minimum conductivity of 50 µS/cm is needed for all fluids.
- The maximum connecting cable length is 10 m (32.81 ft) when empty pipe detection (EPD → 68) is switched on.

10.1.8 Environment

Ambient temperature range

- Transmitter: −20 to +60 °C (−4 to +140 °F)

  Note!
  At ambient temperatures below −20 (−4 °F) the readability of the display may be impaired.
- Sensor (flange material carbon steel): −10 to +60 °C (+14 to +140 °F)

Caution!
- The permitted temperature range of the measuring tube lining may not be undershot or overshot (→ "Operating conditions: Process" → "Medium temperature range").
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- The transmitter must be mounted separate from the sensor if both the ambient and fluid temperatures are high.

Storage temperature

The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors.

Caution!
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- A storage location must be selected where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the liner.

Degree of protection

Standard: IP 67 (NEMA 4X) for transmitter and sensor

Shock and vibration resistance

Acceleration up to 2 g following IEC 600 68-2-6

CIP cleaning

Caution!
The maximum fluid temperature permitted for the device may not be exceeded.

CIP cleaning is possible:
Promag E (100 °C / 212 °F), Promag H/P

CIP cleaning is not possible:
Promag D/L/W

SIP cleaning

Caution!
The maximum fluid temperature permitted for the device may not be exceeded.

SIP cleaning is possible:
Promag H

SIP cleaning is not possible:
Promag D/E/L/P/W

Electromagnetic compatibility (EMC)

- As per IEC/EN 61326 and NAMUR Recommendation NE 21
- Emission: to limit value for industry EN 55011

10.1.9 Process

Medium temperature range

The permissible temperature depends on the lining of the measuring tube

Promag D

0 to +60 °C (+32 to +140 °F) for polyamide

Promag E

−10 to +110 °C (+14 to +230 °F) for PTFE,
Restrictions → see the following diagram

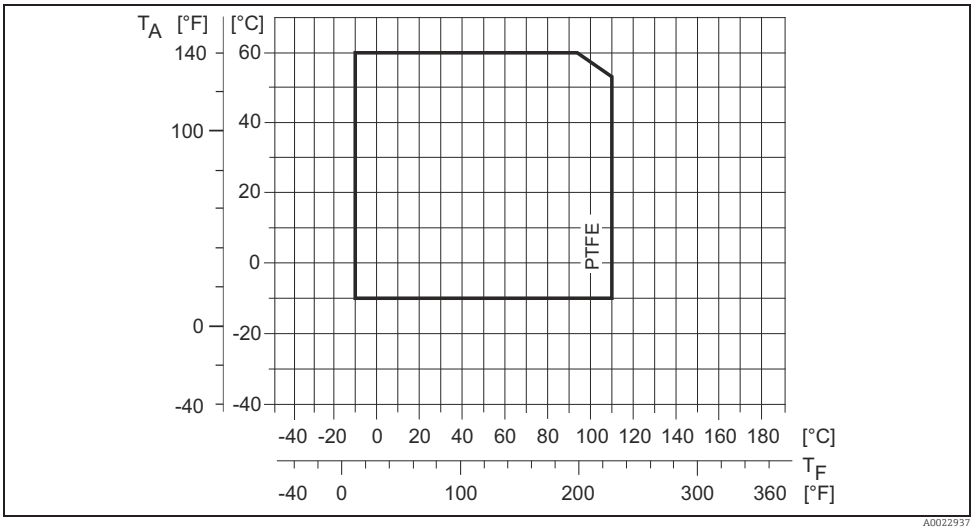


Fig. 49: Compact and remote version Promag E (TA = ambient temperature; TF = fluid temperature)

Promag H

Sensor:
- DN 2 to 25 (1/12 to 1"): −20 to +150 °C (−4 to +302 °F)
- DN 40 to 100 (1 ½ to 4"): −20 to +150 °C (−4 to +302 °F)

Seals:
- EPDM/Viton (FKM)/Kalrez: −20 to +150 °C (−4 to +302 °F)

Promag L

- 0 to +80 °C (+32 to +176 °F) for hard rubber (DN 350 to 2400 / 14 to 90")
- −20 to +50 °C (−4 to +122 °F) for polyurethane (DN 25 to 1200 / 1 to 48")
- −20 to +90 °C (−4 to +194 °F) for PTFE (DN 25 to 300 / 1 to 12")

Promag P

−40 to +130 °C (−40 to +266 °F) for PTFE (DN 25 to 600 / 1 to 24"),
Restrictions → see the following diagram

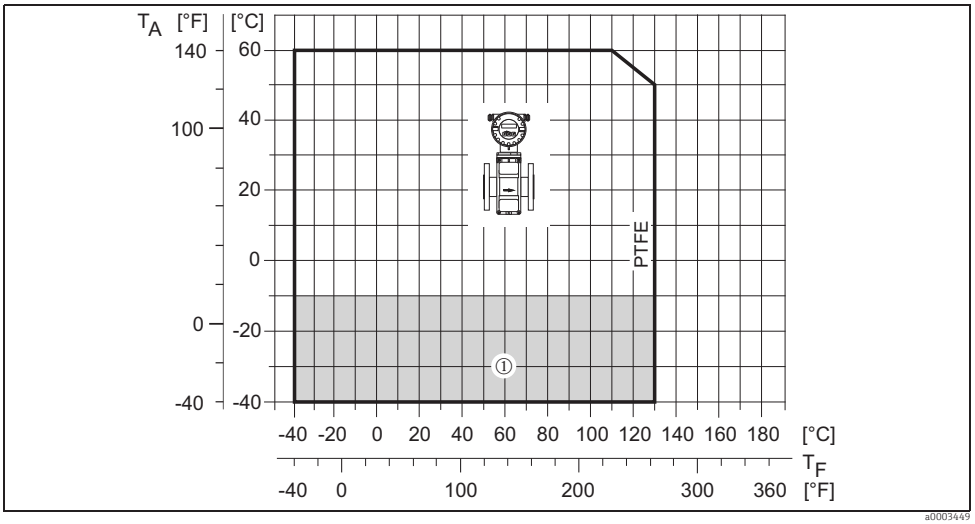


Fig. 50: Compact version Promag P with PTFE-lining

TA = ambient temperature; TF = fluid temperature
① = light gray area → temperature range from −10…−40 °C (−14…−40 °F) valid for stainless steel version only

Promag W

- 0 to +80 °C (+32 to +176 °F) for hard rubber (DN 65 to 2000 / 2 ½ to 78")
- −20 to +50 °C (−4 to +122 °F) for polyurethane (DN 25 to 1000 / 1 to 48")

Conductivity

The minimum conductivity is ≥ 50 µS/cm

Note!
Note that in the case of the remote version, the requisite minimum conductivity is also influenced by the length of the connecting cable → 18

Medium pressure range (nominal pressure)

Promag D

- EN 1092-1 (DIN 2501)
  - PN 16
- ASME B 16.5
  - Class 150
- JIS B2220
  - 10 K

Promag E

- EN 1092-1 (DIN 2501)
  - PN 10 (DN 200 to 600 / 8 to 24")
  - PN 16 (DN 65 to 600 / 3 to 24")
  - PN 40 (DN 15 to 150 / ½ to 2")
- ASME B 16.5
  - Class 150 (½ to 24")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 15 to 40 / ½ to 1½")

Promag H

The permissible nominal pressure depends on the process connection and the seal:
- PN 40, Class 150, 20 K → Couplings, flanges (with O-ring seal)
- PN 16 → Welding nipple, couplings, clamp, flange (with aseptic gasket seal)

Promag L

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2400 / 14 to 90")
  - PN 10 (DN 200 to 2400 / 8 to 90")
  - PN 16 (DN 25 to 300 / 1 to 12")
- EN 1092-1, lap joint flange, stampel plate
  - PN 10 (DN 25 to 300 / 1 to 12")
- ASME B16.5
  - Class 150 (1 to 24")
- AWWA
  - Class D (28 to 90")
- AS2129
  - Table E (350 to 1200 / 14 to 48")
- AS4087
  - PN 16 (350 to 1200 / 14 to 48")

Promag P

- EN 1092-1 (DIN 2501)
  - PN 10 (DN 200 to 600 / 8 to 24")
  - PN 16 (DN 65 to 600 / 3 to 24")
  - PN 25 (DN 200 to 600 / 8 to 24")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ASME B 16.5
  - Class 150 (1 to 24")
  - Class 300 (1 to 6")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 25 to 300 / 1 to 12")
- AS 2129
  - Table E (DN 25 / 1"), 50 / 2")
- AS 4087
  - PN 16 (DN 50 / 2")

Promag W

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2000 / 14 to 84")
  - PN 10 (DN 200 to 2000 / 8 to 84")
  - PN 16 (DN 65 to 2000 / 3 to 84")
  - PN 25 (DN 200 to 1000 / 8 to 40")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ASME B 16.5
  - Class 150 (1 to 24")
  - Class 300 (1 to 6")
- AWWA
  - Class D (28 to 78")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 25 to 300 / 1 to 12")
- AS 2129
  - Table E (DN 80 / 3", 100 / 4", 150 to 1200 / 6 to 48")
- AS 4087
  - PN 16 (DN 80 / 3", 100 / 4", 150 to 1200 / 6 to 48")

Pressure tightness

Promag D

Measuring tube: 0 mbar abs (0 psi abs) with a fluid temperature of ≤ 60 °C (140 °F)

Promag E (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures							
		25 °C		80 °C		100 °C		110 °C	
		77 °F		176 °F		212 °F		230 °F	
[mm]	[inch]	[mbar]	[psi]			[mbar]	[psi]	[mbar]	[psi]
15	½"	0	0	0	0	0	0	100	1.45
25	1"	0	0	0	0	0	0	100	1.45
32	–	0	0	0	0	0	0	100	1.45
40	1 ½"	0	0	0	0	0	0	100	1.45
50	2"	0	0	0	0	0	0	100	1.45
65	–	0	0	*	*	40	0.58	130	1.89

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures							
		25 °C		80 °C		100 °C		110 °C	
		77 °F		176 °F		212 °F		230 °F	
[mm]	[inch]	[mbar]	[psi]			[mbar]	[psi]	[mbar]	[psi]
80	3"	0	0	*	*	40	0.58	130	1.89
100	4"	0	0	*	*	135	1.96	170	2.47
125	–	135	1.96	*	*	240	3.48	385	5.58
150	6"	135	1.96	*	*	240	3.48	385	5.58
200	8"	200	2.90	*	*	290	4.21	410	5.95
250	10"	330	4.79	*	*	400	5.80	530	7.69
300	12"	400	5.80	*	*	500	7.25	630	9.14
350	14"	470	6.82	*	*	600	8.70	730	10.59
400	16"	540	7.83	*	*	670	9.72	800	11.60
450	18"	Partial vacuum is impermissible!							
500	20"								
600	24"								
* No value can be quoted.									

Promag H (Measuring tube lining: PFA)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures					
		25 °C	80 °C	100 °C	130 °C	150 °C	180 °C
[mm]	[inch]	77 °F	176 °F	212 °F	266 °F	302 °F	356 °F
2 to 100	1/12 to 4"	0	0	0	0	0	0

Promag L (Measuring tube lining: Polyurethane, Hard rubber)

Nominal diameter		Measuring tube lining	Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures		
			25 °C	50 °C	80 °C
[mm]	[inch]		77 °F	122 °F	176 °F
25 to 1200	1 to 48"	25 to 1200	1 to 48"	0	–
350 to 2400	14 to 90"	Hard rubber	0	0	0

Promag L (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures			
		25 °C		90 °C	
		77 °F		194 °F	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]
25	1"	0	0	0	0
32	–	0	0	0	0
40	1 ½"	0	0	0	0
50	2"	0	0	0	0
65	–	0	0	40	0.58
80	3"	0	0	40	0.58
100	4"	0	0	135	1.96
125	–	135	1.96	240	3.48
150	6"	135	1.96	240	3.48

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures			
		25 °C		90 °C	
		77 °F		194 °F	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]
200	8"	200	2.90	290	4.21
250	10"	330	4.79	400	5.80
300	12"	400	5.80	500	7.25

Promag P (Measuring tube lining: PTFE)

Nominal diameter		Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures									
		25 °C		80 °C		100 °C		130 °C		150 °C	180 °C
		77 °F		176 °F		212 °F		266 °F		302 °F	356 °F
[mm]	[inch]	[mbar]	[psi]			[mbar]	[psi]	[mbar]	[psi]		
25	1"	0	0	0	0	0	0	100	1.45	–	–
32	–	0	0	0	0	0	0	100	1.45	–	–
40	1 ½"	0	0	0	0	0	0	100	1.45	–	–
50	2"	0	0	0	0	0	0	100	1.45	–	–
65	–	0	0	*	*	40	0.58	130	1.89	–	–
80	3"	0	0	*	*	40	0.58	130	1.89	–	–
100	4"	0	0	*	*	135	1.96	170	2.47	–	–
125	–	135	1.96	*	*	240	3.48	385	5.58	–	–
150	6"	135	1.96	*	*	240	3.48	385	5.58	–	–
200	8"	200	2.90	*	*	290	4.21	410	5.95	–	–
250	10"	330	4.79	*	*	400	5.80	530	7.69	–	–
300	12"	400	5.80	*	*	500	7.25	630	9.14	–	–
350	14"	470	6.82	*	*	600	8.70	730	10.59	–	–
400	16"	540	7.83	*	*	670	9.72	800	11.60	–	–
450	18"	Partial vacuum is impermissible!									
500	20"										
600	24"										
* No value can be quoted.											

Promag W

Nominal diameter		Measuring tube lining	Resistance of measuring tube lining to partial vacuum Limit values for abs. pressure [mbar] ([psi]) at various fluid temperatures						
			25 °C	50 °C	80 °C	100 °C	130 °C	150 °C	180 °C
[mm]	[inch]		77 °F	122 °F	176 °F	212 °F	266 °F	302 °F	356 °F
25 to 1200	1 to 40"	Polyurethane	0	0	–	–	–	–	–
50 to 2000	2 to 78"	Hard rubber	0	0	0	–	–	–	–

Limiting flow

→ 🖹 16

Pressure loss

- No pressure loss if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 (see "Adapters" → 🖹 15)

10.1.10 Mechanical construction

Design, dimensions

The dimensions and installation lengths of the sensor and transmitter can be found in the "Technical Information" for the device in question. This document can be downloaded as a PDF file from www.endress.com. A list of the "Technical Information" documents available is provided in the "Documentation" section on → 🖹 107.

Weight (SI units)

Promag D

Weight data in kg				
Nominal diameter		Compact version	Remote version (without cable)	
[mm]	[inch]		Sensor	Transmitter
25	1"	2.9	2.5	3.1
40	1 ½"	3.5	3.1	3.1
50	2"	4.3	3.9	3.1
65	2 ½"	5.1	4.7	3.1
80	3"	6.1	5.7	3.1
100	4"	8.8	8.4	3.1
Transmitter Promag (compact version): 1.8 kg (Weight data valid without packaging material)				

Promag E

Weight data in kg							
Nominal diameter		Compact version					
		EN (DIN)				ASME	JIS
[mm]	[inch]	PN 6	PN 10	PN 16	PN 40	Class 150	10K
15	½"	–	–	–	6.5	6.5	6.5
25	1"	–	–	–	7.3	7.3	7.3
32	–	–	–	–	8.0	–	7.3
40	1½"	–	–	–	9.4	9.4	8.3
50	2"	–	–	–	10.6	10.6	9.3
65	–	–	–	12.0	–	–	11.1
80	3"	–	–	14.0	–	14.0	12.5
100	4"	–	–	16.0	–	16.0	14.7
125	–	–	–	21.5	–	–	21.0
150	6"	–	–	25.5	–	25.5	24.5
200	8"	–	45.0	46.0	–	45.0	41.9
250	10"	–	65.0	70.0	–	75.0	69.4
300	12"	–	70.0	81.0	–	110.0	72.3
350	14"	77.4	88.4	99.4	–	137.4	–
400	16"	89.4	104.4	120.4	–	168.4	–
450	18"	99.4	112.4	133.4	–	191.4	–
500	20"	114.4	132.4	182.4	–	228.4	–
600	24"	155.4	162.4	260.4	–	302.4	–

- Transmitter (compact version): 1.8 kg
- Weight data without packaging material

Weight data in kg								
Nominal diameter		Remote version (without cable)						
		Sensor						Transmitter
		EN (DIN)				ASME	JIS	
[mm]	[inch]	PN 6	PN 10	PN 16	PN 40	Class 150	10K	Wall-mount housing
15	½"	–	–	–	4.5	4.5	4.5	6.0
25	1"	–	–	–	5.3	5.3	5.3	
32	–	–	–	–	6.0	–	5.3	
40	1½"	–	–	–	7.4	7.4	6.3	
50	2"	–	–	–	8.6	8.6	7.3	
65	–	–	–	10.0	–	–	9.1	
80	3"	–	–	12.0	–	12.0	10.5	
100	4"	–	–	14.0	–	14.0	12.7	
125	–	–	–	19.5	–	–	19.0	
150	6"	–	–	23.5	–	23.5	22.5	
200	8"	–	43.0	44.0	–	43.0	39.9	
250	10"	–	63.0	68.0	–	73.0	67.4	
300	12"	–	68.0	79.0	–	108.0	70.3	
350	14"	73.1	84.1	95.1	–	133.1		
400	16"	85.1	100.1	116.1	–	164.1		
450	18"	95.1	108.1	129.1	–	187.1		
500	20"	110.1	128.1	178.1	–	224.1		
600	24"	158.1	158.1	256.1	–	298.1		

- Transmitter (remote version): 3.1 kg
- Weight data without packaging material

Promag H

Weight data in kg				
Nominal diameter		Compact version	Remote version (without cable)	
[mm]	[inch]	DIN	Sensor	Transmitter
2	1/12"	3.6	2	3.1
4	1/8"	3.6	2	3.1
8	3/8"	3.6	2	3.1
15	½"	3.7	1.9	3.1
25	1"	3.9	2.8	3.1
40	1 ½"	4.9	4.5	3.1
50	2"	7.4	7.0	3.1
65	2 ½"	7.9	7.5	3.1
80	3"	17.4	17.0	3.1
100	4"	16.9	16.5	3.1
Transmitter Promag (compact version): 1.8 (Weight data valid for standard pressure ratings and without packaging material)				

Promag L

Weight data in kg												
Nominal diameter		Compact version (including transmitter)[1]										
[mm]	[inch]	EN (DIN)						ASME/ AWWA		AS		
25	1"	PN 6	–	PN 10	–	PN 16	7.3	ASME / Class 150	7.9	PN 16	–	Tabelle E	–
32	1 ¼"		–		–		8.0		–		–		–
40	1 ½"		–		–		9.0		7.5		–		–
50	2"		–		–		9.4		7.6		–		–
65	2 ½"		–		–		10.4		–		–		–
80	3"		–		–		12.4		12.8		–		–
100	4"		–		–		14.4		16.1		–		–
125	5"		–		–		15.9		–		–		–
150	6"		–		–		23.9		24.4		–		–
200	8"		–		43.4		44.9		49.6		–		–
250	10"		–		63.4		70.7		75.1		–		–
300	12"		–		68.4		85.8		100		–		–
350	14"		77.4		88.4		103		137		99.4		99.4
375	15"		–		–		–		–		105		–
400	16"		89.4		104		124		168		120		120
450	18"		99.4		112		139		191		133		143
500	20"		114		132		174		228		182		182
600	24"		155		162		303		302		260		260
700	28"		190		240		288	AWWA / Class D	266		367		346
750	30"		–		–		–		318		445		433
800	32"		240		315		364		383		503		493
900	36"		308		393		456		470		702		690
1000	40"		359		468		579		587		759		761
1050	42"		–		–		–		670		–		–
1200	48"		529		717		866		901		–		1237
–	54"		–		–		–		1273		–		–
1400	–		784		1114		1274		–		–		–
–	60"		–		–		–		1594		–		–
1600	–		1058		1624		1872		–		–		–
1650	66"		–		–		–		2131		–		–
1800	72"		1418		2107		2409		2568		–		–
2000	78"		1877		2630		2997		3113		–		–
–	84"		–		–		–		3755		–		–
2200	–		2512		3422		–		–		–		–
–	90"		–		–		–		4797		–		–
2400	–		2996		4094		–		–		–		–
Transmitter Promag (compact version): 3.1 kg (Weight data valid without packaging material)													

1) Lap joint flanges / welded flanges DN > 300 (12")

Weight data in kg

Nominal diameter		Remote version (sensor plus sensor housing without cable)[1]											
[mm]	[inch]	EN (DIN)						ASME/ AWWA		AS			
25	1"	PN 6	–	PN 10	–	PN 16	5.3	ASME / Class 150	5.9	PN 16	–	Tabelle E	–
32	1 ¼"		–		–		6.0		–		–		–
40	1 ½"		–		–		7.0		5.5		–		–
50	2"		–		–		7.4		5.6		–		–
65	2 ½"		–		–		8.4		–		–		–
80	3"		–		–		10.4		10.8		–		–
100	4"		–		–		12.4		14.1		–		–
125	5"		–		–		13.9		–		–		–
150	6"		–		–		21.9		22.4		–		–
200	8"		–		41.4		42.9		47.6		–		–
250	10"		–		61.4		68.7		73.1		–		–
300	12"		–		66.4		83.8		98		–		–
350	14"		75.4		86.4		103		135		97.4		97.4
375	15"		–		102		–		–		103		–
400	16"		87.4		102		124		166		118		118
450	18"		97.4		110		139		189		131		141
500	20"		112		130		174		226		180		180
600	24"		153		160		303		300		258		258
700	28"		188		238		288	AWWA / Class D	264		365		344
750	30"		–		–		–		316		443		431
800	32"		238		313		364		381		501		491
900	36"		306		391		456		468		700		688
1000	40"		357		466		579		585		757		759
1050	42"		–		–		–		668		–		–
1200	48"		527		715		866		899				1235
–	54"		–		–		–		1271		–		–
1400	–		782		1112		1274		–		–		–
–	60"		–		–		–		1592		–		–
1600	–		1056		1622		1872		–		–		–
1650	66"		–		–		–		2129		–		–
1800	72"		1416		2105		2409		2566		–		–
2000	78"		1875		2628		2997		3111		–		–
–	84"		–		–		–		3753		–		–
2200	–		2510		3420		–		–		–		–
–	90"		–		–		–		4795		–		–
2400	–		2994		4092		–		–		–		–

Transmitter Promag (remote version): 3.4 kg
(Weight data valid without packaging material)

1) Lap joint flanges / welded flanges DN > 300 (12")

Weight data in kg						
Nominal diameter		Compact version[1]		Remote version (without cable)[1]		
[mm]	[inch]	EN (DIN)		Sensor EN (DIN)		Transmitter
25	1"	PN 10	5.8	PN 10	3.8	4.2
32	1 ¼"		5.4		3.4	4.2
40	1 ½"		6.3		4.7	4.2
50	2"		5.4		3.4	4.2
65	2 ½"		6.2		4.2	4.2
80	3"		7.2		5.2	4.2
100	4"		9.7		7.7	4.2
125	5"		13.2		11.2	4.2
150	6"		17.2		15.2	4.2
200	8"		35.7		33.7	4.2
250	10"		54.2		52.2	4.2
300	12"		55.2		53.2	4.2
Transmitter Promag (compact version): 1.8 kg (Weight data valid for standard pressure ratings and without packaging material)						

1) Lap joint flanges, stamped plate

Promag P

Weight data in kg														
Nominal diameter		Compact version						Remote version (without cable)						
								Sensor						Trans-mitter
[mm]	[inch]	EN (DIN) / AS*		JIS		ASME/ AWWA		EN (DIN) / AS*		JIS		ASME/ AWWA		
25	1"	PN 40	5.7	10K	5.7	Class 150	5.7	PN 40	5.3	10K	5.3	Class 150	5.3	3.1
32	1 ¼"		6.4		5.7		–		6.0		5.3		–	3.1
40	1 ½"		7.8		6.7		7.8		7.4		6.3		7.4	3.1
50	2"		9.0		7.7		9.0		8.6		7.3		8.6	3.1
65	2 ½"	PN 16	10.4		9.5		–	PN 16	10.0		9.1		–	3.1
80	3"		12.4		10.9		12.4		12.0		10.5		12.0	3.1
100	4"		14.4		13.1		14.4		14.0		12.7		14.0	3.1
125	5"		19.9		19.4		–		19.5		19.0		–	3.1
150	6"		23.9		22.9		23.9		23.5		22.5		23.5	3.1
200	8"	PN 10	43.4		40.3		43.4	PN 10	43		39.9		43	3.1
250	10"		63.4		67.8		73.4		63		67.4		73	3.1
300	12"		68.4		70.7		108.4		68		70.3		108	3.1
350	14"		113.4				172.4		113				173	3.1
400	16"		133.4				203.4		133				203	3.1
450	18"		173.4				253.4		173				253	3.1
500	20"		173.4				283.4		173				283	3.1
600	24"		233.4				403.4		233				403	3.1
Transmitter Promag (compact version): 1.8 kg (Weight data valid for standard pressure ratings and without packaging material) * Flanges according to AS are only available for DN 25 and 50.														

Promag W

Weight data in kg

Nominal diameter		Compact version						Remote version (without cable)						Transmitter
								Sensor						
[mm]	[inch]	EN (DIN) / AS*		JIS		ASME/ AWWA		EN (DIN) / AS*		JIS		ASME/ AWWA		
25	1"	PN 40	5.7	10K	5.7	Class 150	5.7	PN 40	5.3	10K	5.3	Class 150	5.3	3.1
32	1 ¼"		6.4		5.7		–		6.0		5.3		–	3.1
40	1 ½"		7.8		6.7		7.8		7.4		6.3		7.4	3.1
50	2"		9.0		7.7		9.0		8.6		7.3		8.6	3.1
65	2 ½"	PN 16	10.4		9.5		–	PN 16	10.0		9.1		–	3.1
80	3"		12.4		10.9		12.4		12.0		10.5		12.0	3.1
100	4"		14.4		13.1		14.4		14.0		12.7		14.0	3.1
125	5"		19.9		19.4		–		19.5		19.0		–	3.1
150	6"		23.9		22.9		23.9		23.5		22.5		23.5	3.1
200	8"	PN 10	43.4		40.3		43.4	PN 10	43		39.9		43	3.1
250	10"		63.4		67.8		73.4		63		67.4		73	3.1
300	12"		68.4		70.7		108.4		68		70.3		108	3.1
350	14"		113.4				172.4		113				173	3.1
400	16"		133.4				203.4		133				203	3.1
450	18"		173.4				253.4		173				253	3.1
500	20"		173.4				283.4		173				283	3.1
600	24"		233.4				403.4		233				403	3.1
700	28"		353.4			Class D	398.4		353			Class D	398	3.1
–	30"		–				458.4		–				458	3.1
800	32"		433.4				548.4		433				548	3.1
900	36"		573.4				798.4		573				798	3.1
1000	40"		698.4				898.4		698				898	3.1
–	42"	PN 6	–				1098.4	PN 6	–				1098	3.1
1200	48"		848.4				1398.4		848				1398	3.1
–	54"		–				2198.4		–				2198	3.1
1400	–		1298.4				–		1298				–	3.1
–	60"		–				2698.4		–				2698	3.1
1600	–		1698.4				–		1698				–	3.1
–	66"		–				3698.4		–				3698	3.1
1800	72"		2198.4				4098.4		2198				4098	3.1
–	78"		–				4598.4		–				4598	3.1
2000	–		2798.4				–		2798				–	3.1

Transmitter Promag (compact version): 1.8 kg
(Weight data valid for standard pressure ratings and without packaging material)
*Flanges according to AS are only available for DN 80, 100, 150 to 400, 500 and 600

Weight (US units)

Promag D

Weight data in lbs				
Nominal diameter		Compact version	Remote version (without cable)	
[mm]	[inch]		Sensor	Transformer
25	1"	6	6	7
40	1 ½"	8	7	7
50	2"	9	9	7
80	3"	13	13	7
100	4"	19	19	7
Transmitter Promag (compact version): 3.9 lbs (Weight data valid without packaging material)				

Promag E

Weight data in lbs				
Nominal diameter		Compact version	Remote version (without cable)	
			Sensor	Transmitter
		ASME	ASME	
[mm]	[inch]	Class 150	Class 150	Wall-mount housing
15	½"	14.3	9.92	13.2
25	1"	16.1	11.7	
40	1½"	20.7	16.3	
50	2"	23.4	19.0	
80	3"	30.9	26.5	
100	4"	35.3	30.9	
150	6"	56.2	51.8	
200	8"	99.2	94.8	
250	10"	165.4	161.0	
300	12"	242.6	238.1	
350	14"	303.0	293.5	
400	16"	371.3	361.8	
450	18"	422.0	412.6	
500	20"	503.6	494.1	
600	24"	666.8	657.3	

- Transmitter: 4.0 lbs (compact version); 6.8 lbs (remote version)
- Weight data without packaging material

Promag H

Weight data in lbs				
Nominal diameter		Compact version	Remote version (without cable)	
[mm]	[inch]		Sensor	Transformer
2	1/12"	8	4	7
4	1/8"	8	4	7
8	3/8"	8	4	7
15	½"	8	4	7
25	1"	9	6	7
40	1 ½"	11	10	7
50	2"	16	15	7
65	2 ½"	17	17	7
80	3"	38	37	7
100	4"	37	36	7
Transmitter Promag (compact version): 3.9 lbs (Weight data valid for standard pressure ratings and without packaging material)				

Promag L (ASME/AWWA)

Weight data in lbs					
Nominal diameter		Compact version[1]		Remote version1)	
[mm]	[inch]	ASME/AWWA		ASME/AWWA	
25	1"	ASME / Class 150	17.4	ASME / Class 150	13
32	1 ¼"		–		–
40	1 ½"		16.5		12.1
50	2"		16.8		12.3
65	2 ½"		–		–
80	3"		28.2		23.8
100	4"		35.5		31.1
125	5"		–		–
150	6"		53.8		49.4
200	8"		109		105
250	10"		166		161
300	12"		221		216
350	14"		302		298
375	15"		–		–
400	16"		370		366
450	18"		421		417
500	20"		503		498
600	24"		666		662
700	28"	AWWA / Class D	587	AWWA / Class D	582
750	30"		701		697
800	32"		845		840
900	36"		1036		1032
1000	40"		1294		1290
1050	42"		1477		1473
1200	48"		1987		1982
–	54"		2807		2803
1400	–		–		–
–	60"		3515		3510
1600	–		–		–
1650	66"		4699		4694
1800	72"		5662		5658
2000	78"		6864		6860
–	84"		8280		8275
2200	–		–		–
–	90"		10577		10573
2400	–		–		–
Transmitter Promag (compact version): 4.0 lbs Transmitter Promag (remote version): 6.8 lbs (Weight data valid without packaging material)					

1) Lap joint flanges / welded flanges DN > 300 (12")

Promag P (ASME/AWWA)

Weight data in lbs						
Nominal diameter		Compact version		Remote version (without cable)		
[mm]	[inch]				Sensor	Transformer
25	1"	Class 150	13	Class 150	12	7
40	1 ½"		17		16	7
50	2"		20		19	7
80	3"		27		26	7
100	4"		32		31	7
150	6"		53		52	7
200	8"		96		95	7
250	10"		162		161	7
300	12"		239		238	7
350	14"		380		381	7
400	16"		448		448	7
450	18"		559		558	7
500	20"		625		624	7
600	24"		889		889	7
Transmitter Promag (compact version): 3.9 lbs (Weight data valid for standard pressure ratings and without packaging material)						

Promag W (ASME/AWWA)

Weight data in lbs						
Nominal diameter		Compact version		Remote version (without cable)		
[mm]	[inch]				Sensor	Transformer
25	1"	Class 150	13	Class 150	12	7
40	1 ½"		17		16	7
50	2"		20		19	7
80	3"		27		26	7
100	4"		32		31	7
150	6"		53		52	7
200	8"		96		95	7
250	10"		162		161	7
300	12"		239		238	7
350	14"		380		381	7
400	16"		448		448	7
450	18"		559		558	7
500	20"		625		624	7
600	24"		889		889	7
700	28"	Class D	878	Class D	878	7
–	30"		1011		1010	7
800	32"		1209		1208	7
900	36"		1760		1760	7
1000	40"		1981		1980	7
–	42"		2422		2421	7
1200	48"		3083		3083	7
–	54"		4847		4847	7
–	60"		5950		5949	7
–	66"		8155		8154	7
1800	72"		9037		9036	7
–	78"		10139		10139	7
Transmitter Promag (compact version): 3.9 lbs (Weight data valid for standard pressure ratings and without packaging material)						

Material

Promag D

- Transmitter housing: powder-coated die-cast aluminum
- Sensor housing: powder-coated die-cast aluminum
- Measuring tube: polyamide, O-rings EPDM
  (Drinking water approvals: WRAS BS 6920, ACS, NSF 61, KTW/W270)
- Electrodes: 1.4435 (316, 316L)
- Ground disks: 1.4301 (304)

Promag E

- Transmitter housing: powder-coated die-cast aluminum
- Sensor housing
  – DN 15 to 300 (½ to 12"): powder-coated die-cast aluminum
  – DN 350 to 600 (14 to 24"): with protective lacquering
- Measuring tube
  – DN ≤ 300 (12"): stainless steel 1.4301 (304) or 1.4306 (304L) (with Al/Zn protective coating)
  – DN ≥ 350 (14"): stainless steel 1.4301 (304) or 1.4306 (304L) (with protective lacquering)
- Electrodes: 1.4435 (316, 316L), Alloy C22
- Flanges (with protective lacquering)
  – EN 1092-1 (DIN2501): RSt37-2 (S235JRG2); Alloy C22; Fe 410W B
  – ASME: A105
  – JIS: RSt37-2 (S235JRG2); HII
- Seals: to DIN EN 1514-1
- Ground disks: 1.4435 (316, 316L) or Alloy C22

Promag H

- Transmitter housing: powder-coated die-cast aluminum
- Window material: glass or polycarbonate
- Sensor housing: stainless steel 1.4301 (304)
- Wall mounting kit: stainless steel 1.4301 (304)
- Measuring tube: stainless steel 1.4301 (304)
- Liner: PFA (USP class VI; FDA 21 CFR 177.1550: 3A)
- Electrodes: 11.4435 (316, 316L) (optional: Alloy C22, tantalum, platinum)
- Flanges: connections generally made of 1.4404 (316L)
- Seals
  – DN 2 to 25: O-ring (EPDM, Viton, Kalrez), gasket seal (EPDM*, Viton, Silicone*)
  – DN 40 to 100: gasket seal (EPDM*, Silicone*)

  * = USP class VI; FDA 21 CFR 177.2600: 3A
- Ground rings: 1.4435 (316, 316L) (optional: Alloy C22)

Promag L

- Transmitter housing:
  – Compact housing: powder-coated die-cast aluminum
  – Wall-mounted housing: powder-coated die-cast aluminum

- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 1200 (14 to 48"): with protective lacquering
- Measuring tube:
  - DN ≤ 300 (12"); stainless steel 1.4301 (304) or 1.4306 (304L)
  - DN ≥ 350 (14"); stainless steel 202 or 304
- Electrodes: 1.4435 (316, 316L), Alloy C22
- Flange
  - EN 1092-1 (DIN 2501): DN ≤ 300: 1.4306; 1.4307; 1.4301 (304); 1.0038 (S235JRG2)
  - EN 1092-1 (DIN 2501): DN ≥ 350: A105; 1.0038 (S235JRG2)
  - AWWA: A181/A105; 1.0425 (316L) (P265GH); 1.0044 (S275JR)
  - AS 2129: A105; 1.0345 (P235GH); 1.0425 (316L) (P265GH); 1.0038 (S235JRG2); FE 410 WB
  - AS 4087: A105; 1.0425 (316L) (P265GH); 1.0044 (S275JR)
- Seals: to DIN EN 1514-1
- Ground disks: 11.4435 (316, 316L) or Alloy C22

Promag P/W

- Transmitter housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300: powder-coated die-cast aluminum
  - DN 350 to 2000: with protective lacquering
- Measuring tube
  - DN ≤ 300: stainless steel 1.4301 (304) or 1.4306 (304L)
    (Flange material: carbon steel with Al/Zn protective coating)
  - DN ≥ 350: stainless steel 1.4301 (304) or 1.4306 (304)
    (Flange material: carbon steel with protective lacquering)
- Electrodes: 1.4435 (316, 316L), Alloy C22
- Flange
  - EN 1092-1 (DIN2501): RSt37-2 (S235JRG2); Alloy C22; FE 410 WB
    (DN ≤ 300: with Al/Zn protective coating; DN ≥ 350 with protective lacquering)
  - ASME: A105
    (DN ≤ 300 with Al/Zn protective coating; DN ≥ 350 with protective lacquering)
  - AWWA (only Promag W): 1.0425 (with protective lacquering)
  - JIS: RSt37-2 (S235JRG2); HII; 1.0425
    (DN ≤ 300 with Al/Zn protective coating; DN ≥ 350 with protective lacquering)
  - AS 2129
    - (DN 25, 80, 100, 150 to 1200) A105 or RSt37-2 (S235JRG2)
    - (DN 50, 80, 350, 400, 500) A105 or St44-2 (S275JR)
      (DN ≤ 300 with Al/Zn protective coating; DN ≥ 350 with protective lacquering)
  - AS 4087: A105 or St44-2 (S275JR)
    (DN ≤ 300 with Al/Zn protective coating; DN ≥ 350 with protective lacquering)
- Seals: to DIN EN 1514-1
- Ground disks: 1.4435 (316, 316L) or Alloy C22

Material load diagram

The material load diagrams (pressure-temperature graphs) for the process connections are to be found in the "Technical Information" documents of the device in question:
List of supplementary documentation → 🖹 107.

Fitted electrodes

Promag D

- 2 measuring electrodes for signal detection

Promag E/L/P/W

- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection
- 1 reference electrode for potential equalization

Promag H

- 2 measuring electrodes for signal detection
- 1 EPD electrode for empty pipe detection (apart from DN 2 to 15)

Process connections

Promag D

Wafer version → without process connections

Promag E

Flange connection:
- EN 1092-1 (DIN 2501), DN ≤ 300 (12") form A, DN ≥ 350 (14") form B (Dimensions to DIN 2501, DN 65 PN 16 and DN 600 (24") PN 16 exclusively to EN 1092-1)
- ASME B16.5
- JIS B2220

Promag H

With O-ring:
- Flange EN (DIN), ASME, JIS
- External thread

With gasket seal:
- Weld nipple DIN 11850, ODT/SMS
- TriClamp L14 AM7
- Threaded joint DIN 11851, DIN 11864-1, SMS 1145
- Flange DIN 11864-2

Promag L

Flange connection:
- EN 1092-1 (DIN 2501)
  - DN ≤ 300 (12") = form A
  - DN ≥ 350 (14") = form B
- ASME B16.5
- AWWA C207
- AS

Promag P/W

Flange connections:
- EN 1092-1 (DIN 2501)
  - DN ≤ 300 = form A
  - DN ≥ 350 = flat face
  - DN 65 PN 16 and DN 600 PN 16 only as per EN 1092-1

- ASME
- AWWA (only Promag W)
- JIS
- AS

Surface roughness

All data relate to parts in contact with fluid.

- Liner → PFA: ≤ 0.4 µm (15 µin)
- Electrodes → 1.4435 (316, 316L), Alloy C22: 0.3 to 0.5 µm (12 to 20 µin)
- Process connection made of stainless-steel (Promag H):
  - with O-ring seal: ≤ 1.6 µm (63 µin)
  - with aseptic gasket seal: ≤ 0.8 µm (31.5 µin)
  - optional: ≤ 0.38 µm (15 µin)

10.1.11 Human interface

Display elements

- Liquid crystal display: unilluminated, two-line, 16 characters per line
- Display (operating mode) preconfigured: volume flow and totalizer status
- 1 totalizer

Note!
At ambient temperatures below −20 (−4 °F) the readability of the display may be impaired.

Operating elements

Local operation with three keys (⊟ ⊞ Ⓔ)

Remote operation

Operation via HART protocol and FieldCare

10.1.12 Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the Australian Communications and Media Authority (ACMA)

Ex approval

Information about currently available Ex versions (ATEX, FM, CSA, IECEx, NEPSI etc.) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are given in a separate documentation which is available upon request.

Sanitary compatibility

Promag D/E/L/P/W

No applicable approvals or certification

Promag H

- 3A authorization and EHEDG-certified
- Seals: in conformity with FDA (except Kalrez seals)

Drinking water approval

Promag D/L/W

- WRAS BS 6920
- ACS
- NSF 61
- KTW/W270

Promag E/H/P

No drinking water approval

Pressure Equipment Directive

Promag D/L

No pressure measuring device approval

Promag E/H/P/W

The devices can be ordered with or without a PED approval. If a device with a PED approval is required, this must be explicitly stated in the order. For devices with nominal diameters less than or equal to DN 25 (1"), this is neither possible nor necessary.

- With the PED/G1/x (x = category) marking on the sensor nameplate, Endress+Hauser confirms compliance with the "Essential Safety Requirements" specified in Annex I of the Pressure Equipment Directive 97/23/EC.
- Devices bearing this marking (PED) are suitable for the following types of medium: Media in Group 1 and 2 with a vapor pressure greater than, or smaller and equal to 0.5 bar (7.3 psi)
- Devices not bearing this marking (PED) are designed and manufactured according to good engineering practice. They meet the requirements of Art.3 Section 3 of the Pressure Equipment Directive 97/23/EC. The range of application is indicated in tables 6 to 9 in Annex II of the Pressure Equipment Directive.

Other standards and guidelines

- EN 60529:
  Degrees of protection by housing (IP code).
- EN 61010-1
  Safety requirements for electrical equipment for measurement, control and laboratory use
- IEC/EN 61326
  Electromagnetic compatibility (EMC requirements)
- ASME/ISA-S82.01
  Safety Standard for Electrical and Electronic Test, Measuring, Controlling and related Equipment - General Requirements. Pollution degree 2, Installation Category II.
- CAN/CSA-C22.2 (No. 1010.1-92)
  Safety requirements for Electrical Equipment for Measurement and Control and Laboratory Use. Pollution degree 2, Installation Category I.

10.1.13 Ordering information

Detailed ordering information is available from the following sources:
- In the Product Configurator on the Endress+Hauser website: www.endress.com → Select country → Instruments → Select device → Product page function: Configure this product
- From your Endress+Hauser Sales Center: www.endress.com/worldwide

Note!
Product Configurator - the tool for individual product configuration
- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

10.1.14 Accessories

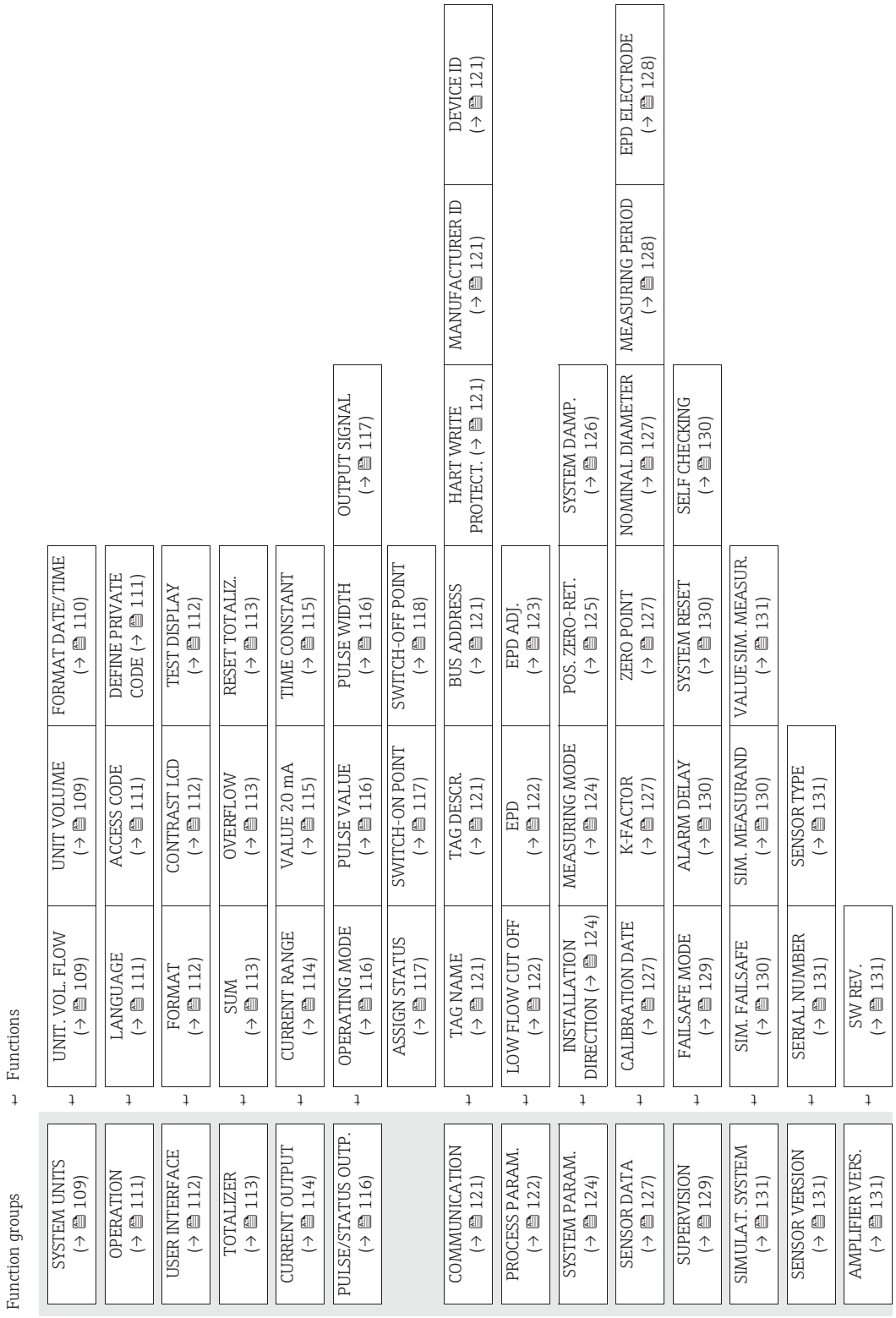
Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor.→ 70
Your Endress+Hauser service organization can provide detailed information on the specific order codes on request.

10.1.15 Documentation

- Flow measuring technology (FA00005D/06)
- Technical Information Promag 10D (TI00081D/06)
- Technical Information Promag 10E (TI01160D/06)
- Technical Information Promag 10H (TI00095D/06)
- Technical Information Promag 10L(TI00100D/06)
- Technical Information Promag 10P (TI00094D/06)
- Technical Information Promag 10W (TI00093D/06)

11 Appendix

11.1 Illustration of the function matrix



11.2 Group SYSTEM UNITS

Functional description SYSTEM UNITS	
Use this function group to select the unit required and displayed for the measured variable.	
UNIT VOLUME FLOW	Use this function to select the unit required and displayed for the volume flow. The unit you select here is also valid for: ▪ Volume flow display ▪ Current output ▪ Switch points (limit value for volume flow, flow direction) ▪ Low flow cut off Options: *Metric:* Cubic centimeter → cm^3/s; cm^3/min; cm^3/h; cm^3/day Cubic decimeter → dm^3/s; dm^3/min; dm^3/h; dm^3/day Cubic meter → m^3/s; m^3/min; m^3/h; m^3/day Milliliter → ml/s; ml/min; ml/h; ml/day Liter → l/s; l/min; l/h; l/day Hectoliter → hl/s; hl/min; hl/h; hl/day Megalith → Ml/s; Ml/min; Ml/h; Ml/day *US*: Cubic centimeter → cc/s; cc/min; cc/h; cc/day Acre foot → af/s; af/min; af/h; af/day Cubic foot → ft3/s; ft3/min; ft3/h; ft3/day Fluid ounce → oz f/s; oz f/min; oz f/h; oz f/day Gallon → gal/s; gal/min; gal/h; gal/day Kilo gallons → kgal/s; kgal/min; kgal/h; kgal/day Million gallons → Mgal/s; Mgal/min; Mgal/h; Mgal/day Barrel (normal fluids: 31.5 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day Barrel (beer: 31.0 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day Barrel (petrochemicals: 42.0 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day Barrel (filling tanks: 55.0 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day *Imperial*: Gallon → gal/s; gal/min; gal/h; gal/day Mega gallon → Mgal/s; Mgal/min; Mgal/h; Mgal/day Barrel (beer: 36.0 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day Barrel (petrochemicals: 34.97 gal/bbl) → bbl/s; bbl/min; bbl/h; bbl/day Factory setting: Depends on nominal diameter and country (dm^3/min to m^3/h or US-gal/min), corresponding to the full scale value unit factory setting → 🖹 132
UNIT VOLUME	Use this function to select the unit required and displayed for the volume. The unit you select here is also valid for: ▪ Totalizer status display ▪ Totalizer unit ▪ Pulse value (e.g. m^3/p) Options: *Metric* → cm^3; dm^3; m^3; ml; l; hl; Ml *US* → cc; af; ft3; oz f; gal; Mgal; bbl (normal fluids); bbl (beer); bbl (petrochemicals); bbl (filling tanks) *Imperial* → gal; Mgal; bbl (beer); bbl (petrochemicals) Factory setting: Depends on nominal diameter and country (dm^3 to m^3 or US-gal corresponding to the totalizer unit factory setting. → 🖹 132

Functional description SYSTEM UNITS	
FORMAT DATE/TIME	Use this function to select the format for the date and the time. The unit you select here is also valid for displaying the current calibration date (function CALIBRATION DATE on → 127 Options: DD.MM.YY 24H MM/DD/YY 12H A/P DD.MM.YY 12H A/P MM/DD/YY 24H Factory setting: DD.MM.YY 24H (SI units) MM/DD/YY 12H A/P (US units)

11.3 Group OPERATION

Functional description OPERATION	
LANGUAGE	Use this function to select the language for all texts, parameters and messages shown on the local display. Options: ENGLISH DEUTSCH FRANCAIS ESPANOL ITALIANO Factory setting: Depends on country, see factory setting → 🖹 132 ✎ Note! If you press the ⊕⊖keys simultaneously at startup, the language defaults to "ENGLISH".
ACCESS CODE	All data of the measuring system are protected against inadvertent change. Programming is disabled and the settings cannot be changed until a code is entered in this function. If you press the ℗ keys in any function, the measuring system automatically goes to this function and the prompt to enter the code appears on the display (when programming is disabled). You can activate programming by entering your private code (factory setting = 10, see also the subsequent DEFINE PRIVATE CODE function) User input: Max. 4-digit number: 0 to 9999 ✎ Note! ▪ The programming levels are disabled if you do not press the operating elements within 60 seconds following automatic return to the HOME position. ▪ You can also disable programming in this function by entering any number (other than the defined private code). ▪ The Endress+Hauser service organization can be of assistance if you mislay your personal code.
DEFINE PRIVATE CODE	Use this function to enter a personal code to enable programming. User input: 0 to 9999 (max. 4-digit number) Factory setting: 10 ✎ Note! ▪ This function only appears if the private code was entered in the ACCESS CODE function. ▪ Programming is always enabled with the code "0". ▪ Programming has to be enabled before this code can be changed. When programming is disabled this function is not available, thus preventing others from accessing your personal code.

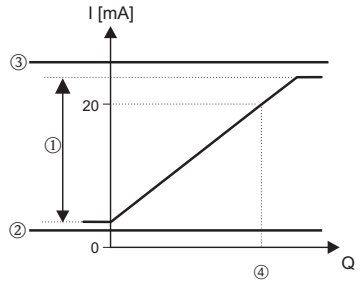
11.4 USER INTERFACE

Functional description USER INTERFACE	
FORMAT	Use this function to define the maximum number of places after the decimal point displayed for the reading in the main line. Options: XXXXX. XXXX.X XXX.XX XX.XXX X.XXXX Factory setting: X.XXXX ✎ Note! ▪ Note that this setting only affects the reading as it appears on the display, it has no influence on the accuracy of the system's calculations. ▪ The places after the decimal point as computed by the measuring device cannot always be displayed, depending on this setting and the engineering unit. In such instances an arrow appears on the display between the measuring value and the engineering unit (e.g. 1.2 → l/h), indicating that the measuring system is computing with more decimal places than can be shown on the display.
CONTRAST LCD	Use this function to optimize display contrast to suit local operating conditions. User input: 10 to 100% Factory setting: 50%
TEST DISPLAY	Use this function to test the operability of the local display and its pixels. Options: OFF ON Factory setting: OFF Test sequence: 1. Start the test by selecting ON. 2. All pixels of the main line and additional line are darkened for minimum 0.75 seconds. 3. The main line and additional line show an "8" in each field for minimum 0.75 seconds. 4. The main line and additional line show a "0" in each field for minimum 0.75 seconds. 5. The main line and additional line show nothing (blank display) for minimum 0.75 seconds. When the test completes the local display returns to its initial state and the setting changes to "OFF".

11.5 Group TOTALIZER

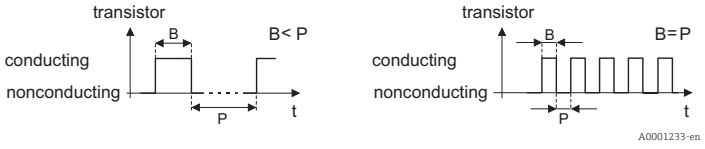
Functional description TOTALIZER	
SUM	The total for the totalizer's measured variable aggregated since measuring commenced appears on the display. This value can be positive or negative, depending on: ▪ Flow direction and/or ▪ Setting in the MEASURING MODE function → 🖹 124 Display: Max. 6-digit floating-point number, incl. sign and unit (e.g. 15467.4 m^3) ✎ Note! ▪ The totalizer's response to faults is defined in the central "FAILSAFE MODE" function → 🖹 129. ▪ The unit of the totalizer is defined in the UNIT VOLUME function → 🖹 109.
OVERFLOW	The total for the totalizer's overflow aggregated since measuring commenced appears on the display. Total flow quantity is represented by a floating-point number consisting of max. 7 digits. You can use this function to view higher numerical values (>9,999,999) as overflows. The effective quantity is thus the total of the OVERFLOW function plus the value displayed in the SUM function. Example: Reading for 2 overflows: 2 E7 dm^3 (= 20,000,000 dm^3) The value displayed in the function "SUM" = 196,845 dm^3 Effective total quantity = 20,196,845 dm^3 Display: Integer with exponent, including sign and unit, e.g. 2 E7 dm^3
RESET TOTALIZER	Use this function to reset the sum and the overflow of the totalizer to "zero" (= RESET). Options: NO YES Factory setting: NO

11.6 Group CURRENT OUTPUT

Functional description CURRENT OUTPUT	
Note! **The functions of the CURRENT OUTPUT group are only available if the "0" value was entered in the BUS ADDRESS function → 121.**	
CURRENT RANGE	Use this function to specify the current range. You can configure the current output either in accordance with the NAMUR recommendation (max. 20.5 mA) or for a maximum drive of 25 mA. Options: OFF 4-20 mA (25 mA) 4-20 mA (25 mA) HART 4-20 mA NAMUR 4-20 mA HART NAMUR 4-20 mA US 4-20 mA HART US Factory setting: 4-20 mA HART NAMUR Current range, work range and signal on alarm level  **A** | ① | ② | ③ OFF | 4 mA | - | - 4-20 mA (25 mA) | 4 - 24 mA | 2 | 25 4-20 mA (25 mA) HART | 4 - 24 mA | 2 | 25 4-20 mA NAMUR | 3,8 - 20,5 mA | 3,5 | 22,6 4-20 mA HART NAMUR | 3,8 - 20,5 mA | 3,5 | 22,6 4-20 mA US | 3,9 - 20,8 mA | 3,75 | 22,6 4-20 mA HART US | 3,9 - 20,8 mA | 3,75 | 22,6 A0005392 *A = Work range* *① = Work range* *② = Lower signal on alarm level* *③ = Upper signal on alarm level* *④ = Scaled full scale value* *Q = Flow* Note! ▪ If the measured value is outside the measuring range (defined in the VALUE 20 mA function → 115), a notice message is generated. ▪ The current output's response to faults is defined in the central FAILSAFE MODE function → 129.

Functional description CURRENT OUTPUT	
VALUE 20 mA	Use this function to assign the 20 mA current a full scale value. Positive and negative values are permitted. The required measuring range is defined by defining the VALUE 20 mA . In the SYMMETRY measuring mode → 🖹 124, the value assigned applies to both flow directions; in the STANDARD measuring mode it applies only to the flow direction selected. User input: 5-digit floating-point number, with sign Factory setting: Depends on nominal diameter and country, [value] / [dm^3...m^3 or US-gal...US-Mgal] Corresponds to the factory setting for the full scale value → 🖹 132 ✎ Note! ▪ The appropriate unit is taken from the SYSTEM UNITS group → 🖹 109. ▪ The value for 4 mA always corresponds to the zero flow (0 [unit]). This value is fixed and cannot be edited.
TIME CONSTANT	Use this function to enter a time constant defining how the current output signal reacts to severely fluctuating measured variables, either very quickly (enter a low time constant) or with damping (enter a high time constant). User input: Fixed-point number 0.01 to 100.00 s Factory setting: 1.00 s

11.7 Group PULSE/STATUS OUTPUT

Functional description PULSE/STATUS OUTPUT	
OPERATING MODE	Configuration of the output as a pulse or status output. The functions available in this function group vary, depending on which option you select here. Options: OFF PULSE STATUS Factory setting: PULSE
PULSE VALUE	✎ Note! This function is not available unless the PULSE setting was selected in the OPERATING MODE function. Use this function to define the flow at which a pulse is triggered. These pulses can be totaled by an external totalizer, and the total flow quantity since measuring started can be registered in this way. In the SYMMETRY measuring mode → 🖹 124, the value assigned applies to both flow directions; in the STANDARD measuring mode it applies only to the positive flow direction. User input: 5-digit floating-point number, [unit] Factory setting: Depends on nominal diameter and country, [value] [dm^3...m^3 or US-gal] / pulse; Corresponds to the factory setting for the pulse value → 🖹 132 ✎ Note! The appropriate unit is taken from the SYSTEM UNITS group.
PULSE WIDTH	✎ Note! This function is not available unless the PULSE setting was selected in the OPERATING MODE function. Use this function to enter the maximum pulse width of the output pulses. User input: 5 to 2000 ms Factory setting: 100 ms Pulse output is always with the pulse width (B) entered in this function. The pauses (P) between the individual pulses are automatically configured. However, they must at least correspond to the pulse width (B = P).  *P = Intervals between the individual pulses* *B = Pulse width entered (the illustration applies to positive pulses)* ☝ Caution! Buffering (pulse memory) takes place if the number of pulses is too large to output the pulses with the selected pulse width (see PULSE VALUE function on → 🖹 116). The system error message RANGE PULSE is displayed if more pulses are in the pulse memory than can be output in 4 seconds. ✎ Note! ▪ When selecting the pulse width, choose a value that can still be processed by a connected counter (e.g. mechanical counter, PLC etc.). ▪ The pulse output's response to faults is defined in the central FAILSAFE MODE function → 🖹 129.

Functional description PULSE/STATUS OUTPUT	
OUTPUT SIGNAL	Note! This function is not available unless the PULSE setting was selected in the OPERATING MODE function. Use this function to configure the output in such a way that it matches an external counter, for example. Depending on the application, you can select the direction of the pulses here. Options: PASSIVE - POSITIVE PASSIVE - NEGATIVE Factory setting: PASSIVE - NEGATIVE
ASSIGN STATUS OUTPUT	Note! This function is not available unless the STATUS setting was selected in the OPERATING MODE function. Configuration of the status output. Options: ON (operation) FAULT MESSAGE NOTICE MESSAGE FAULT MESSAGE or NOTICE MESSAGE EPD (empty pipe detection, only if active) FLOW DIRECTION VOLUME FLOW LIMIT VALUE Factory setting: FAULT MESSAGE Note! ▪ The behavior of the status output is a normally closed behavior, in other words the output is closed (trASMEstor conductive) when normal, error-free measuring is in progress. ▪ It is very important to read and comply with the information on the switching characteristics of the status output → 120.
SWITCH-ON POINT	Note! This function is not available unless LIMIT VALUE or FLOW DIRECTION was selected in the ASSIGN STATUS OUTPUT function. Use this function to assign a value to the switch-on point (status output pulls up). The value can be equal to, greater than or less than the switch-off point. Positive and negative values are permitted. User input: 5-digit floating-point number, [unit] Factory setting: 0 [unit] Note! ▪ The appropriate unit is taken from the SYSTEM UNITS group. ▪ Only the switch-on point is available for flow direction output (no switch-off point). If you enter a value not equal to the zero flow (e.g. 5), the difference between the zero flow and the value entered corresponds to half the switchover hysteresis.

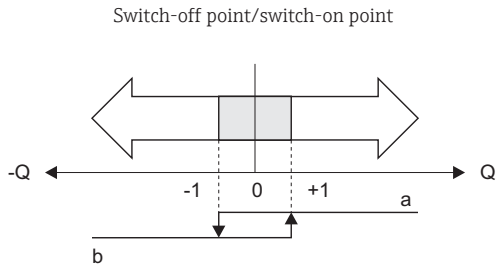
Functional description PULSE/STATUS OUTPUT	
SWITCH-OFF POINT	✎ Note! This function is not available unless LIMIT VALUE was selected in the ASSIGN STATUS OUTPUT function. Use this function to assign a value to the switch-off point (status output drops off). The value can be equal to, greater than or less than the switch-on point. Positive and negative values are permitted. User input: 5-digit floating-point number, [unit] Factory setting: 0 [unit] ✎ Note! ▪ The appropriate unit is taken from the SYSTEM UNITS group. ▪ If SYMMETRY is selected in the MEASURING MODE function and values with different signs are entered for the switch-on and switch-off points, the notice message "INPUT RANGE EXCEEDED" appears.

11.7.1 Information on the response of the status output

General

If you have configured the status output for "LIMIT VALUE" or "FLOW DIRECTION", you can configure the requisite switch points in the SWITCH-ON POINT and SWITCH-OFF POINT functions. When the measured variable in question reaches these predefined values, the status output switches as shown in the illustrations below.

Status output configured for flow direction



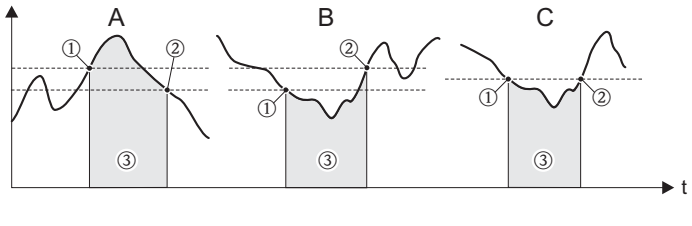
a = Status output conductive
b = Status output not conductive

The value you entered in the function SWITCH-ON POINT defines the switch point for the positive and negative directions of flow. If, for example, the switch point entered is = 1 m^3/h, the status output switches off at −1 m^3/h (not conductive) and switches on again at +1 m^3/h (conductive). Set the switch point to 0 if your process calls for direct switchover (no switching hysteresis). If low flow cut off is used, it is advisable to set hysteresis to a value greater than or equal to the low flow cut off rate.

Status output configured for limit value

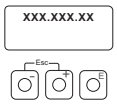
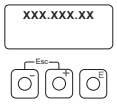
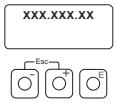
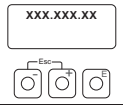
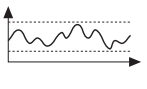
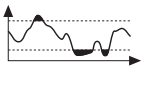
The status output switches as soon as the measured variable undershoots or overshoots a defined switch point.

Application: monitoring flow or process-related boundary conditions.



- A = Maximum safety:
  ① SWITCH-OFF POINT > ② SWITCH-ON POINT
- B = Minimum safety:
  ① SWITCH-OFF POINT < ② SWITCH-ON POINT
- C = Minimum safety:
  ① SWITCH-OFF POINT = ② SWITCH-ON POINT (this configuration should be avoided)
- ③ = Relay de-energized

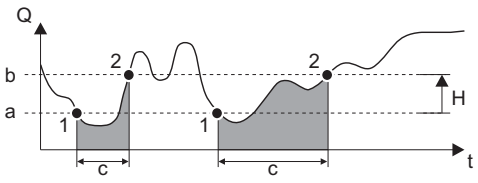
11.7.2 Switching behavior of the status output

Function	State	Open collector behavior (TrASMEstor)
ON (operation)	System in measuring mode 	conductive A0001237
	System not in measuring mode (power supply failed)	not conductive A0001239
Fault message	System OK 	conductive A0001237
	(System error or process error) fault → Response to error, outputs/inputs and totalizers	not conductive A0001239
Notice message	System OK 	conductive A0001237
	(System error or process error) Notice → Continuation of measuring	not conductive A0001239
Fault message or notice message	System OK 	conductive A0001237
	(System error or process error) Fault → Response to error or Notice → Continuation of measuring	not conductive A0001239
Empty pipe detection (EPD)	Measuring tube full	conductive A0001237
	Measuring tube partially filled / empty measuring tube	not conductive A0001239
Flow direction	Forwards A0001241	conductive A0001237
	Backwards A0001242	not conductive A0001239
Volume flow limit value	Limit value not overshot or undershot  A0001243	conductive A0001237
	Limit value overshot or undershot  A0001244	not conductive A0001239

11.8 Group COMMUNICATION

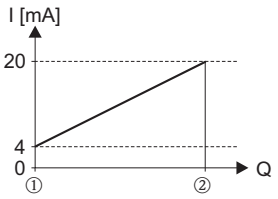
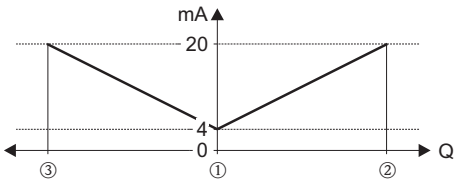
Functional description COMMUNICATION	
✎ **Note!** **The communication group is only visible if the HART option was selected in the CURRENT RANGE function.**	
TAG NAME	Use this function to enter a tag name for the measuring device. You can edit and read this tag name at the local display or via the HART protocol. User input: Max. 8-character text, permitted characters are: A-Z, 0-9, +,-, underscore, space, period Factory setting: "_ _ _ _ _ _ _ _" (no text)
TAG DESCRIPTION	Use this function to enter a tag description for the measuring device. You can edit and read this tag description at the local display or via the HART protocol. User input: Max. 16-character text, permitted characters are: A-Z, 0-9, +,-, underscore, space, period Factory setting: "_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _" (no text)
BUS ADDRESS	Use this function to define the address for the exchange of data with the HART protocol. User input: 0 to 15 Factory setting: 0 ✎ Note! Addresses 1 to 15: a constant 4 mA current is applied.
HART WRITE PROTECTION	Use this function to activate HART write protection. Options: OFF = function can be edited/read via the HART protocol ON = HART protocol write-protected (only readable) Factory setting: OFF
MANUFACTURER ID	Use this function to view the manufacturer ID in decimal numerical format. Display: – Endress+Hauser – 17 (≙ 11 hex) for Endress+Hauser
DEVICE ID	Use this function to view the device ID in hexadecimal numerical format. Display: 45 hex (≙ 69 dec) for Promag 10

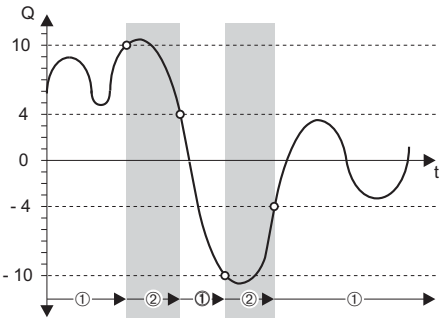
11.9 Group PROCESS PARAMETER

Functional description PROCESS PARAMETER	
SWITCH-ON POINT LOW FLOW CUT OFF	Use this function to enter the switch-on point for low flow cut off. Low flow cut off is active if the value entered is not equal to 0. The sign of the flow value is highlighted on the display to indicate that low flow cut off is active. User input: 5-digit floating-point number, [unit] Factory setting: Depends on nominal diameter and country, [value] / [dm^3...m^3 or US-gal] Corresponds to the factory setting for the low flow cut off → 🖹 132 ✎ Note! The appropriate unit is taken from the SYSTEM UNITS group. The switch-off point is specified as a positive hysteresis from the switch-on point with 50%.  A0001245 *Q* *Flow [volume/time]* *t* *Time* *H* *Hysteresis* *a* *SWITCH-ON POINT LOW FLOW CUT OFF = 200 dm^3/h* *b* *Low flow cut off switch-off point = 50%* *c* *Low flow cut off active* *1* *Low flow cut off is switched on at 200 dm^3/h* *2* *Low flow cut off is switched off at 300 dm^3/h*
EPD	Activating empty pipe detection (EPD). Options: OFF ON (empty pipe detection) Factory setting: OFF ✎ Note! ▪ The ON option is not available unless the sensor is fitted with an EPD electrode. ▪ The default setting for the EPD function when the device is delivered is OFF. The function must be activated as required. ▪ When delivered, the measuring device is calibrated with water (500 µS/cm). If the fluid differs from this conductivity, empty-pipe and full-pipe adjustment has to be performed on site. ▪ To activate the function (ON option), valid adjustment coefficients have to be available. ▪ The following error messages are displayed if the empty-pipe and full-pipe adjustment is incorrect: ▪ ADJUSTMENT FULL = EMPTY: the adjustment values for empty pipe and full pipe are identical. ▪ ADJUSTMENT NOT OK: adjustment is not possible as the fluid conductivity values are outside the permitted range. ▪ In cases of this nature you must repeat empty-pipe or full-pipe adjustment.

Functional description PROCESS PARAMETER	
EPD-MODE (continued)	Notes on empty pipe detection (EPD) ▪ Flow cannot be measured correctly unless the measuring tube is completely full. This status can be monitored at all times by means of the EPD. ▪ An empty or partially filled pipe is a process error. A default factory setting defines that a notice message is issued and that this process error does not have any effect on the outputs. ▪ The EPD process error can be output via the configurable status output. Response to partially filled pipe If the EPD is switched on and responds to a partially filled or empty pipe, the notice message "EMPTY PIPE" appears on the display and zero flow is indicated. If the pipe is partially empty and the EPD is not switched on, the response can vary in identically configured systems: ▪ Flow reading fluctuates ▪ Zero flow ▪ Excessively high flow values
EPD ADJUSTMENT	Use this function to activate adjustment for an empty or full measuring tube. Options: OFF EPD EMPTY PIPE ADJ. EPD FULL PIPE ADJUST Factory setting: OFF ✎ Note! An exact description of the procedure for an EPD empty-pipe/full-pipe adjustment is provided on → 🖹 68.

11.10 Group SYSTEM PARAMETER

Functional description SYSTEM PARAMETER	
INSTALLATION DIRECTION SENSOR	Use this function to reverse the sign of the flow quantity, if necessary. Options: FORWARDS (flow as indicated by the arrow) BACKWARDS (flow opposite to direction indicated by the arrow) Factory setting: FORWARDS ✎ Note! Ascertain the actual direction of fluid flow with reference to the direction indicated by the arrow on the sensor (nameplate).
MEASURING MODE	Use this function to select the measuring mode for all outputs and for the internal totalizer. Options: STANDARD SYMMETRY Factory setting: STANDARD The responses of the individual outputs and the internal totalizer in each of the measuring modes are described in detail on the following pages: Current output STANDARD Only the flow components for the selected flow direction are output, (positive or negative full scale value ② = flow direction). Flow components in the opposite direction are not taken into account (suppression). Example for current output:  A0001248 SYMMETRY The output signals of the current output are independent of the direction of flow (absolute amount of the measured variable). The "VALUE20mA" ③ (e.g. backflow) corresponds to the mirrored VALUE20mA ② (e.g. flow). Positive and negative flow components are taken into account. Example for current output:  A0001249 ✎ Note! The direction of flow can be output via the configurable status output.

Functional description SYSTEM PARAMETER	
MEASURING MODE (Contd)	Pulse output STANDARD Only flow components of the positive flow direction are output. Components in the opposite direction are not taken into account. SYMMETRY The absolute value of the positive and negative flow components is taken into account. Status output ✎ Note! The information is only applicable if LIMIT VALUE was selected in the function ASSIGN STATUS OUTPUT. STANDARD The status output signal switches at the defined switch points. SYMMETRY The status output signal switches at the defined switch points, irrespective of the sign. In other words, if you define a switch point with a positive sign, the status output signal switches as soon as the value is reached in the negative direction (negative sign), (see illustration). Example for the SYMMETRY measuring mode: Switch-on point: Q = 4 Switch-off point: Q = 10 ① = Status output switched on (conductive) ② = Status output switched off (nonconductive)  A0001247 Totalizer STANDARD Only positive flow components are output. Negative components are not taken into account. SYMMETRY The positive and negative flow components are balanced. In other words, net flow in the flow direction is registered.
POSITIVE ZERO RETURN	Use this function to interrupt evaluation of measured variables. This is necessary when a piping system is being cleaned, for example. This setting acts on all function and outputs of the measuring device. Options: OFF ON → Signal output is set to the "ZERO FLOW" value. Factory setting: OFF

Functional description SYSTEM PARAMETER	
SYSTEM DAMPING	Use this function to set the filter depth of the digital filter. This reduces the sensitivity of the measuring signal to interference peaks (e.g. high solids content, gas bubbles in the fluid, etc.). The system reaction time increases with the filter setting. User input: 0 to 4 Factory setting: 3 ✎ Note! ▪ The system damping acts on all functions and outputs of the measuring device. ▪ The higher the value set, the stronger the damping (higher response time).

11.11 Group SENSOR DATA

All sensor data (calibration factors, zero point and nominal diameter etc.) are set at the factory.

Caution!
Under normal circumstances you should not change the following parameter settings, because changes affect numerous functions of the entire measuring facility in general and the accuracy of the measuring system in particular. Therefore, the functions described below are provided with an additional prompt (with the code 10) once you enter your private code.

Functional description SENSOR DATA	
CALIBRATION DATE	Use this function to view the current calibration date and time for the sensor. User input: Calibration date and time. Factory setting: Calibration date and time of the current calibration. Note! The calibration date and time format is defined in the FORMAT DATE/TIME function, → 110 Selectable formats: DD.MM.YY 24H MM/DD/YY 12H A/P DD.MM.YY 12H A/P MM/DD/YY 24H
K-FACTOR	Use this function to display the current calibration factor (positive and negative flow direction) for the sensor. The calibration factor is determined and set at the factory. User input: 5-digit fixed-point number: 0.5000 to 2.0000 Factory setting: Depends on nominal diameter and calibration Note! This value is also provided on the sensor nameplate.
ZERO POINT	This function shows the current zero-point correction value for the sensor. Zero-point correction is determined and set at the factory. User input: Max. 4-digit number: -1000 to +1000 Factory setting: Depends on nominal diameter and calibration Note! This value is also provided on the sensor nameplate.
NOMINAL DIAMETER	This function shows the nominal diameter for the sensor. The nominal diameter depends on the size of the sensor and is set at the factory. Options: 2 to 2000 mm 1/12 to 78" Factory setting: Depends on the size of the sensor Note! This value is also provided on the sensor nameplate.

Functional description SENSOR DATA	
MEASURING PERIOD	Use this function to set the time for a full measuring period. The duration of the measuring period is calculated from the rise time of the magnetic field, the brief recovery time, the (automatically tracked) integration time and the empty pipe detection time. User input: 10 to 1000 ms Factory setting: Depends on nominal diameter
EPD ELECTRODE	Indicates whether the sensor is equipped with an EPD electrode. Display: YES NO Factory setting: YES → Electrode fitted as standard

11.12 Group SUPERVISION

Functional description SUPERVISION	
FAILSAFE MODE	The dictates of safety render it advisable to ensure that the device signal processing assumes a predefined state in the event of a fault. The setting you select here is valid for: ▪ Current output ▪ Pulse output ▪ Totalizer ✎ Note! This has no effect on the display. Options: MINIMUM VALUE MAXIMUM VALUE ACTUAL VALUE Factory setting: MINIMUM VALUE The response of the individual outputs and the totalizer is listed below. Current output: MINIMUM VALUE The current output adopts the value of the lower signal on alarm level (as defined in the CURRENT RANGE function → 🖹 114). MAXIMUM VALUE The current output is set to the upper value of the signal on alarm level. (The values in question can be found in the CURRENT RANGE function on → 🖹 114). ACTUAL VALUE Measured value output is based on the current flow measurement. The fault is ignored. Pulse output: MINIMUM or MAXIMUM VALUE Output is zero pulse ACTUAL VALUE Measured value output is based on the current flow measurement (fault is ignored). Totalizer: MINIMUM or MAXIMUM VALUE The totalizer is paused until the fault is rectified. ACTUAL VALUE The totalizer continues to count on the basis of the current flow value. The fault is ignored.

Functional description SUPERVISION	
ALARM DELAY	Use this function to define a time span in which the criteria for an error have to be satisfied without interruption before an error or notice message is generated. Depending on the setting and the type of error, this suppression acts on: ▪ Display ▪ Current output ▪ Pulse/status output User input: 0 to 100 s (in increments of one second) Factory setting: 0 s ☝ Caution! If this function is activated error and notice messages are delayed by the time corresponding to the setting before being forwarded to the higher-order controller (process controller, etc.). It is therefore imperative to check in advance in order to make sure whether a delay of this nature could affect the safety requirements of the process. If error and notice messages cannot be suppressed, a value of 0 seconds must be entered here.
SYSTEM RESET	Use this function to perform a reset of the measuring system. Options: NO RESTART SYSTEM (Restart without disconnecting main power) RESET DELIVERY (Restart without disconnecting main power, the saved settings of the delivery status (factory settings) are applied). Factory setting: NO
SELF CHECKING	Use this function to switch on and off the self-checking function of the electrode amplifier. When the function is switched on, the electrode signal circuit is checked against a reference voltage at 60-second intervals. If there is an impermissible deviation from the value, system error message #101 is output and displayed on the local display. Options: ON OFF Factory setting: OFF

11.13 Group SIMULATION SYSTEM

Functional description SIMULATION SYSTEM	
SIMULATION FAILSAFE MODE	Use this function to set all outputs and the totalizer to their defined failsafe modes, in order to check whether they respond correctly. During this time, the words "SIMULATION FAILSAFE MODE" appear on the display. Options: ON OFF Factory setting: OFF
SIMULATION MEASURAND	Use this function to set all outputs and the totalizer to their defined flow-response modes, in order to check whether they respond correctly. During this time, the words "SIMULATION MEASURAND" appear on the display. Options: OFF VOLUME FLOW Factory setting: OFF Note! ▪ The measuring device cannot be used for measuring while this simulation is in progress. ▪ The setting is not saved if the power supply fails.
VALUE SIMULATION MEASURAND	Note! This function is not available unless the SIMULATION MEASURAND function is active (= VOLUME FLOW). In this function, a freely selectable value (e.g. 12 m^3/s) is specified. This value is used to test downstream devices and the flowmeter itself. User input: 5-digit floating-point number [unit], with sign Factory setting: 0 [unit] Caution! The setting is not saved if the power supply fails. Note! The appropriate unit is taken from the SYSTEM UNITS group.

11.14 Group SENSOR VERSION

Functional description SENSOR VERSION	
SERIAL NUMBER	Use this function to view the serial number of the sensor.
SENSOR TYPE	Use this function to view the sensor type.

11.15 Group AMPLIFIER VERSION

Functional description AMPLIFIER VERSION	
SOFTWARE REVISION NUMBER	Use this function to view the software revision number of the electronics board.

11.16 Factory settings

11.16.1 SI units (not for USA and Canada)

Low flow cut off, full scale value, pulse value, totalizer

Nominal diameter		Low flow cut off		Full scale value current output		Pulse value		Totalizer
[mm]	[inch]	(approx. v = 0.04 m/s)		(approx. v = 2.5 m/s)		(approx. 2 pulses/s at v = 2.5 m/s)		
2	1/12"	0.01	dm³/min	0.5	dm³/min	0.005	dm³	dm³
4	1/8"	0.05	dm³/min	2	dm³/min	0.025	dm³	dm³
8	3/8"	0.1	dm³/min	8	dm³/min	0.10	dm³	dm³
15	½"	0.5	dm³/min	25	dm³/min	0.20	dm³	dm³
25	1"	1	dm³/min	75	dm³/min	0.50	dm³	dm³
32	1 ¼"	2	dm³/min	125	dm³/min	1.00	dm³	dm³
40	1 ½"	3	dm³/min	200	dm³/min	1.50	dm³	dm³
50	2"	5	dm³/min	300	dm³/min	2.50	dm³	dm³
65	2 ½"	8	dm³/min	500	dm³/min	5.00	dm³	dm³
80	3"	12	dm³/min	750	dm³/min	5.00	dm³	dm³
100	4"	20	dm³/min	1200	dm³/min	10.00	dm³	dm³
125	5"	30	dm³/min	1850	dm³/min	15.00	dm³	dm³
150	6"	2.5	m³/h	150	m³/h	0.025	m³	m³
200	8"	5.0	m³/h	300	m³/h	0.05	m³	m³
250	10"	7.5	m³/h	500	m³/h	0.05	m³	m³
300	12"	10	m³/h	750	m³/h	0.10	m³	m³
350	14"	15	m³/h	1000	m³/h	0.10	m³	m³
375	15"	20	m3/h	1200	m3/h	0.15	m3	m3
400	16"	20	m³/h	1200	m³/h	0.15	m³	m³
450	18"	25	m³/h	1500	m³/h	0.25	m³	m³
500	20"	30	m³/h	2000	m³/h	0.25	m³	m³
600	24"	40	m³/h	2500	m³/h	0.30	m³	m³
700	28"	50	m³/h	3500	m³/h	0.50	m³	m³
–	30"	60	m³/h	4000	m³/h	0.50	m³	m³
800	32"	75	m³/h	4500	m³/h	0.75	m³	m³
900	36"	100	m³/h	6000	m³/h	0.75	m³	m³
1000	40"	125	m³/h	7000	m³/h	1.00	m³	m³
–	42"	125	m³/h	8000	m³/h	1.00	m³	m³
1200	48"	150	m³/h	10000	m³/h	1.50	m³	m³
–	54"	200	m³/h	13000	m³/h	1.50	m³	m³
1400	–	225	m³/h	14000	m³/h	2.00	m³	m³
–	60"	250	m³/h	16000	m³/h	2.00	m³	m³
1600	–	300	m³/h	18000	m³/h	2.50	m³	m³
–	66"	325	m³/h	20500	m³/h	2.50	m³	m³
1800	72"	350	m³/h	23000	m³/h	3.00	m³	m³
–	78"	450	m³/h	28500	m³/h	3.50	m³	m³
2000	–	450	m³/h	28500	m³/h	3.50	m³	m³

Language

Country	Language
Austria	Deutsch
Belgium	English
Denmark	English
England	English
Finland	English
France	Francais
Germany	Deutsch
Holland	English
Hong Kong	English
International Instruments	English
Italy	Italiano
Japan	English
Malaysia	English
Norway	English
Singapore	English
South Africa	English
Spain	Espanol
Sweden	English
Switzerland	Deutsch
Thailand	English

11.16.2 US units (only for USA and Canada)

Low flow cut off, full scale value, pulse value, totalizer

Nominal diameter		Low flow cut off		Full scale value current output		Pulse value		Totalizer
[inch]	[mm]	(approx. v = 0.04 m/s)		(approx. v = 2.5 m/s)		(approx. 2 pulses/s at v = 2.5 m/s)		
1/12"	2	0.002	gal/min	0.1	gal/min	0.001	gal	gal
1/8"	4	0.008	gal/min	0.5	gal/min	0.005	gal	gal
3/8"	8	0.025	gal/min	2	gal/min	0.02	gal	gal
½"	15	0.10	gal/min	6	gal/min	0.05	gal	gal
1"	25	0.25	gal/min	18	gal/min	0.20	gal	gal
1 ¼"	32	0.50	gal/min	30	gal/min	0.20	gal	gal
1 ½"	40	0.75	gal/min	50	gal/min	0.50	gal	gal
2"	50	1.25	gal/min	75	gal/min	0.50	gal	gal
2 ½"	65	2.0	gal/min	130	gal/min	1	gal	gal
3"	80	2.5	gal/min	200	gal/min	2	gal	gal
4"	100	4.0	gal/min	300	gal/min	2	gal	gal
5"	125	7.0	gal/min	450	gal/min	5	gal	gal
6"	150	12	gal/min	600	gal/min	5	gal	gal
8"	200	15	gal/min	1200	gal/min	10	gal	gal
10"	250	30	gal/min	1500	gal/min	15	gal	gal
12"	300	45	gal/min	2400	gal/min	25	gal	gal
14"	350	60	gal/min	3600	gal/min	30	gal	gal
15"	375	60	gal/min	4800	gal/min	50	gal	gal
16"	400	60	gal/min	4800	gal/min	50	gal	gal
18"	450	90	gal/min	6000	gal/min	50	gal	gal
20"	500	120	gal/min	7500	gal/min	75	gal	gal
24"	600	180	gal/min	10500	gal/min	100	gal	gal
28"	700	210	gal/min	13500	gal/min	125	gal	gal
30"	–	270	gal/min	16500	gal/min	150	gal	gal
32"	800	300	gal/min	19500	gal/min	200	gal	gal
36"	900	360	gal/min	24000	gal/min	225	gal	gal
40"	1000	480	gal/min	30000	gal/min	250	gal	gal
42"	–	600	gal/min	33000	gal/min	250	gal	gal
48"	1200	600	gal/min	42000	gal/min	400	gal	gal
54"	–	1.3	Mgal/d	75	Mgal/d	0.0005	Mgal	Mgal
–	1400	1.3	Mgal/d	85	Mgal/d	0.0005	Mgal	Mgal
60"	–	1.3	Mgal/d	95	Mgal/d	0.0005	Mgal	Mgal
–	1600	1.7	Mgal/d	110	Mgal/d	0.0008	Mgal	Mgal
66"	–	2.2	Mgal/d	120	Mgal/d	0.0008	Mgal	Mgal
72"	1800	2.6	Mgal/d	140	Mgal/d	0.0008	Mgal	Mgal
78"	–	3.0	Mgal/d	175	Mgal/d	0.001	Mgal	Mgal
–	2000	3.0	Mgal/d	175	Mgal/d	0.001	Mgal	Mgal

Language

Country	Language
USA	English
Canada	English

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www.ouellet.com

INSTRUCTIONS "OAC" Series

WARNING

When using electrical appliances, basic precautions should always be taken to reduce the risk of fire, electrical shock and injury, including the following.

Read carefully these instructions before installation, operation of the heater. Failure to adhere to the instructions could result in fire, electric shock, serious personal injury, and death or property damage. Review frequently for continuing safe operation and instruction of future users, if necessary.

IMPORTANT INSTRUCTIONS

1- Read all instructions before installing or using this heater.
2- This heater is hot when in use. To avoid burns, do not let bare skin touch hot surfaces. Keep combustible materials, like furniture, pillows, bedding, papers, clothes, and curtains at least 36 in. (915 mm) from the front of the heater.
3- Extreme caution is necessary when any heater is used by or near children or invalids and whenever the heater is left operating and unattended.
4- Do not operate any heater after it malfunctions. Disconnect power at service panel and have heater inspected by a reputable electrician before reusing.
5- Do not use outdoors.
6- Do not insert or allow foreign objects to enter any ventilation or exhaust opening as this may cause an electric shock or fire, or damage the heater.
7- Do not block air intakes or exhaust in any way whatsoever.
8- This heater has hot and arcing or sparking parts inside. Do not use it in areas where gasoline, paint, or flammable liquids are used or stored.
9- Use this heater only as described in this manual. Any other use not recommended by the manufacturer may cause fire, electric shock, or injury.
10- **AMERICAN VERSION ONLY:** Some models (up to 6000W maximum and 240V maximum) include a visual alarm to warn that parts of the heater are getting excessively hot. If the light turns on, immediately turn the heater off and inspect for any objects on or adjacent to the heater that may have blocked the airflow or otherwise caused high temperatures to have occured. If no obstruction is visible, the heater must be checked by a qualified person. **DO NOT OPERATE THE HEATER WHEN THE ALARM LIGHT IS ON.**
11- The thermostat should not be considered an infallible device in cases where maintaining a temperature is considered critical. Examples: Hazardous material storage, computer server room, etc. In these particular cases, it is imperative to add a monitoring system to avoid the consequences of a thermostat failure.

OPERATING INSTRUCTIONS

1- The heater must be properly installed before it is used.
2- Turn the power on at the circuit breaker panel.
3- Electronic thermostat: be sure to set it on the fan mode.
4- Built-in thermostat: to set thermostat at the desired temperature, follow these steps:
   - Set thermostat at maximum temperature (turn clockwise).
   - When the desired temperature is reached, turn the thermostat counter-clockwise slowly until you hear a click.
   - The thermostat will keep this room temperature.
5- Built-in thermostat with control knob, the setting can be adjusted with the knob supplied, located on the front cover.
6- Built-in tamperproof thermostat: the setting can be adjusted through the hole in the front cover with a small slotted screwdriver.
7- **AMERICAN VERSION ONLY**:
   Some models (up to 6000W maximum and 240V maximum) include a visual alarm to warn that parts of the heater are getting excessively hot. If the light turns on, immediately turn the heater off and inspect for any objects on or adjacent to the heater that may have blocked the airflow or otherwise caused high temperatures to have occured.
   DO NOT OPERATE THE HEATER WHEN THE ALARM LIGHT IS ON.

OPTIONS:

Fan switch:
This option allows the use of the fan in continuous or automatic mode.
The switch can be switched through the upper grille with a screwdriver.
Position ON: The fan runs continuously, with or without heating demand.
Position AUTO: The fan operates in automatic mode, only during a heating demand.

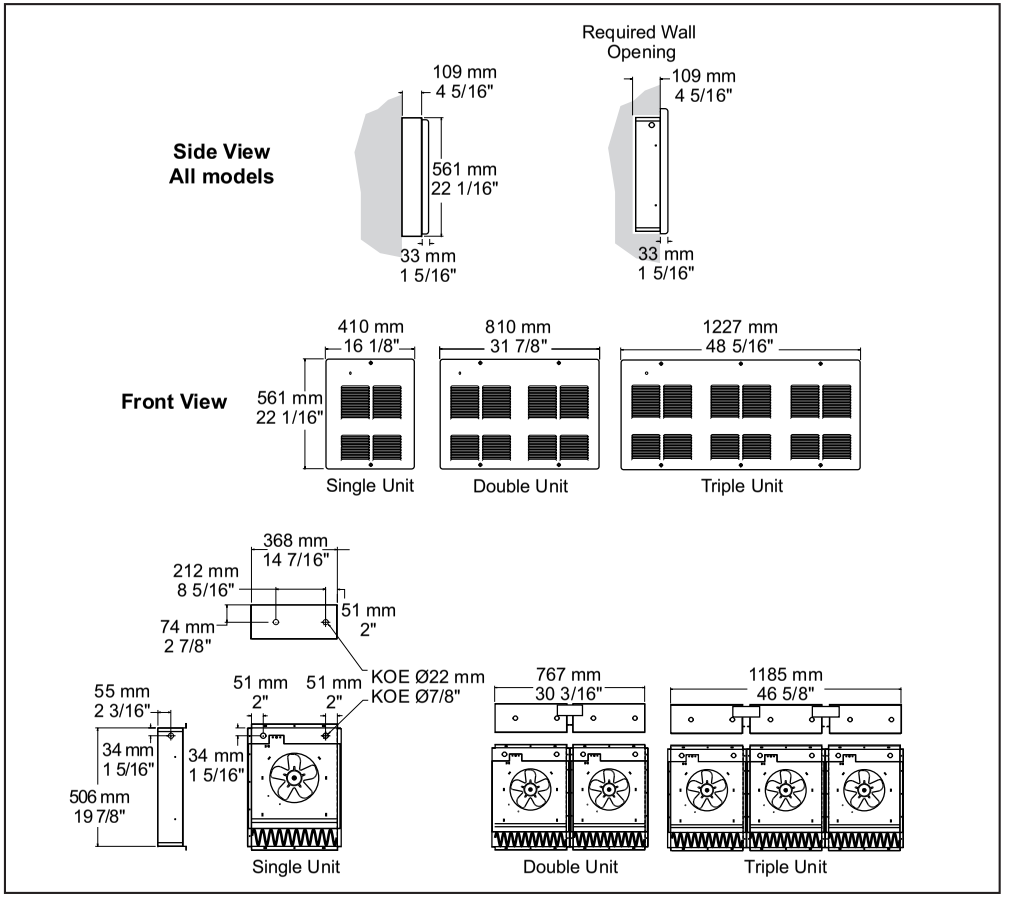
Heating switch:
This option allows the standby of the heating function of the heater.
The switch can be switched through the upper grille with a screwdriver.
Position ON: The heater is operating normally, depending of the heating demand from the thermostat.
Position STBY: The heater does not allow to heat the room, even with a heating demand from the thermostat.
However, the fan can be used for air circulation with the fan switch option, if applicable.

MAINTENANCE INSTRUCTIONS

1- Once a year, remove the front panel and use a vacuum cleaner to remove the dust accumulation inside the heater and through openings of the front panel.
2- Cleaning should be done while the heater is disconnected from the main service panel. Wait until the housing and heating element cool before performing maintenance.
3- Replace the front panel before energizing.
4- Any other servicing should be performed by a qualified technician.

WARRANTY

Please refer to the product sheet at www.ouellet.com.



SAVE THESE INSTRUCTIONS

INSTALLATION INSTRUCTIONS

RECESS MOUNTING:

1- Heater must be used with recess box.
2- Never install warm air outlet of heater less than 10 in. (250 mm) from floor or adjacent wall.
3- Provide a wall opening as:
   Depth : 4 5/16 in. (109 mm)
   Height : 19 7/8 in. (506 mm)
   Length : - Single unit : 14 7/16 in. (368 mm)
   - Double unit : 30 3/16 in. (767 mm)
   - Triple unit : 46 5/8 in. (1185 mm)
4- Remove the appropriate knock-out from the recess box for the electrical supply.
5- Attach firmly the recess box using provided screws. Make sure that the edge on each side of the recess box lean on the gypsum panel and not on the structural parts of the wall. See marking on the sides of the recess box.
6- Install the heater to the recess box and be sure that the heater is attach firmly with four (4) provided screws.
7- Connect the heater leads to the supply leads according to national and local codes. See wiring diagram in the front cover of the heater.
8- Make sure the fan rotates freely and that there is no foreign object in the heater.
9- Install the front cover using the provided screws. IMPORTANT: To insure that the front cover is not upside down, check if the logo is in the correct orientation.
10- To test the heater temporarily, set thermostat at maximum temperature.

SURFACE MOUNTING:

Model 4 in. (102 mm)

1- The surface box must be used with recess box.
2- Never install warm air outlet of heater less than 10 in. (250 mm) from floor or adjacent wall.
3- Locate the power supply leads behind the planned location of the heater (surface box).
4- Mount the surface box securely to the wall with provided screws. IMPORTANT: For a single surface box, there are two bracktets fixed at the top and bottom. Unfold the metal hooks to remove the brackets. Insert brackets in the surface box before continuing the installation. See illustration to install properly.
5- Follow instructions 4 to 10 as above for recess mounting.

SEMI-RECESSED MOUNTING:

Model 1 in. (25 mm) and Model 2 in. (51 mm)

1- The surface box must be used with recess box.
2- Never install warm air outlet of heater less than 10 in. (250 mm) from floor or adjacent wall.
3- Provide a wall opening as:
   Depth for 1 in. model : 3 5/16 in. (84 mm)
   Depth for 2 in. model : 2 5/16 in. (59 mm)
   Height : 19 7/8 in. (506 mm)
   Length : - Single unit : 14 7/16 in. (368 mm)
   - Double unit : 30 3/16 in. (767 mm)
   - Triple unit : 46 5/8 in. (1185 mm)
4- Locate the power supply leads behind the planned location of the heater (surface box).
5- Mount the surface box securely to the wall with provided screws. IMPORTANT: For a single surface box, model 2 in. (51 mm) there are two bracktets fixed at the top and bottom. Unfold the metal hooks to remove the brackets. Insert brackets in the surface box before continuing the installation. See illustration to install properly.
6- Follow instructions 4 to 10 as above for recess mounting.

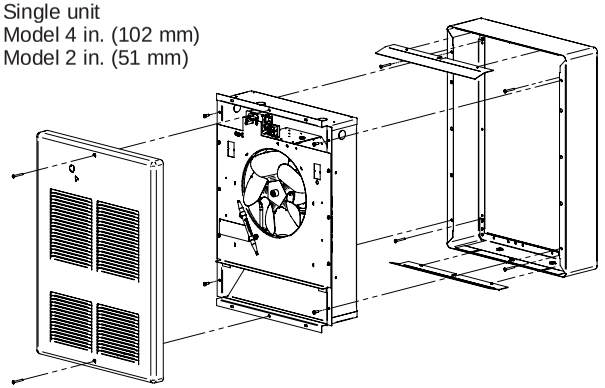
CAUTION:

High temperature, risk of fire, keep electrical cords, drapery, furnishings, and other combustibles at least 36 in. (915 mm) from the front of the heater. To reduce the risk of fire, do not store or use gasoline or other flammable vapors and liquids in the vicinity of the heater.

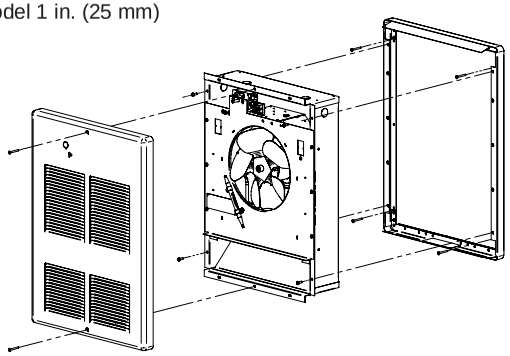
IMPORTANT

1- Do not obstruct front of heater for at least 48 in. (1220 mm).
2- Any remote thermostat or relay must be connected to the heater control terminal block.
3- Do not interrupt power supply to control this heater.

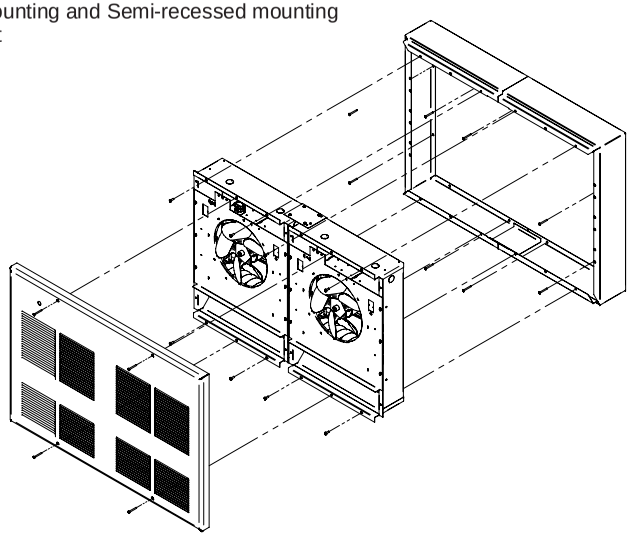
Surface mounting and Semi-recessed mounting
Single unit
Model 4 in. (102 mm)
Model 2 in. (51 mm)



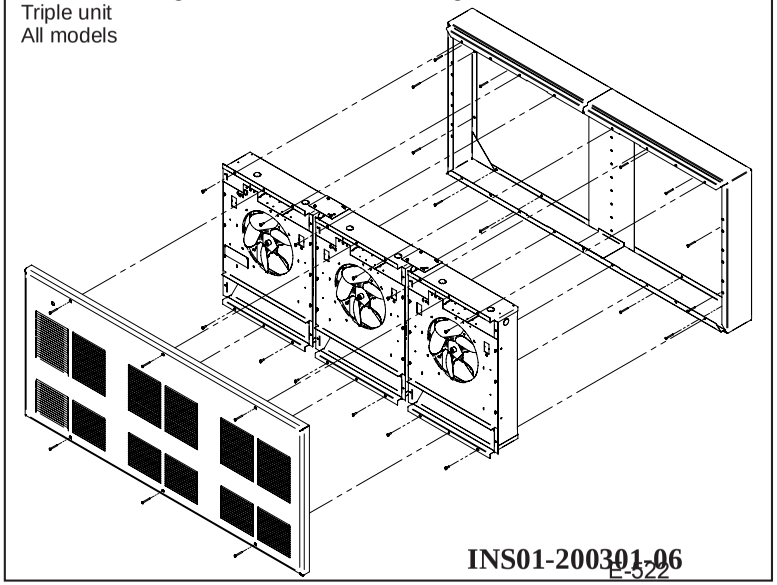
Semi-recessed mounting
Single unit
Model 1 in. (25 mm)



Surface mounting and Semi-recessed mounting
Double unit
All models

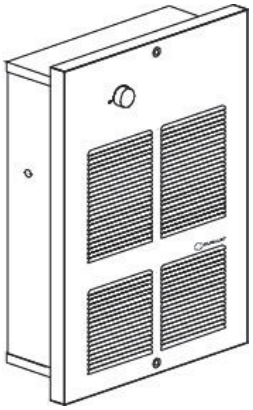


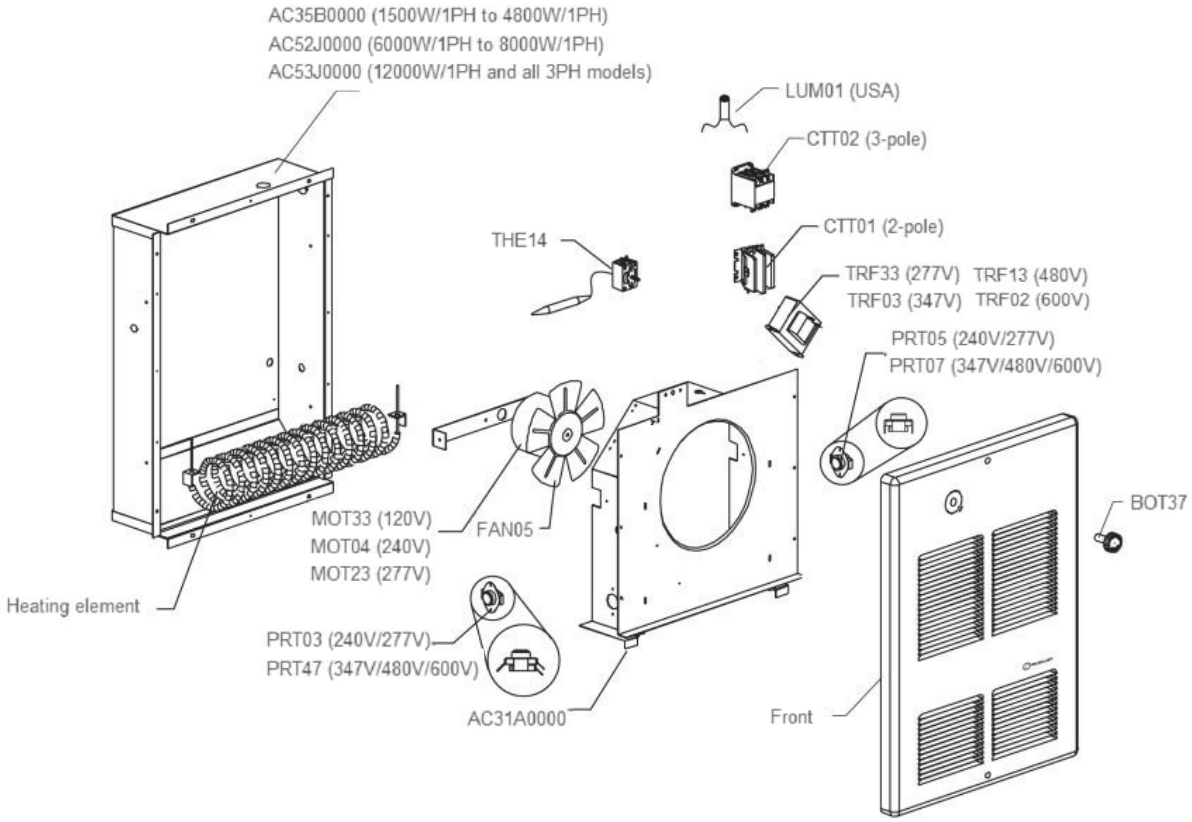
Surface mounting and Semi-recessed mounting
Triple unit
All models



OAC *series*

Commercial Wall Heater





Amp	Fusible *Fuse*	Porte fusible *Fuse holder*	
		Avant le 14 août 2013 *Before August 14, 2013*	After le 14 août 2013 *After August 14, 2013*
15	FUS02	FUS03	FUS07
30	FUS09	FUS07	FUS07

Watts (PH)	Devant *Front*
1500 (1) - 4000 (1)	AC07A000*
4800 (1)	AC29A000*
6000 (1) - 8000 (1)	AC11A000*
12000 (1) **	AC14A000*

* Couleurs sur mesure disponible sur demande. / Custom colors available upon request.
** 12000W/1PH et tous les modèles 3PH. / 12000W/1PH and all 3PH models.

Watts (PH)	Élément chauffant *Heating element*						
	120V	208V	240V	277V	347V	480V	600V
1500 (1)	ELO114	-	ELO71	ELU32	ELO66	ELU71	ELO67
2000 (1)	-	ELO72	ELO47	ELU20	ELO50	ELU24	ELO53
3000 (1)	-	-	ELO48	ELU21	ELO51	ELU25	ELO54
4000 (1)	-	ELO46	ELO49	ELU22	ELO52	ELU26	ELO55
4800 (1)	-	ELU30	ELU31	ELU33	ELO107	ELU58	ELO106
6000 (1)	-	-	ELO48	ELU21	ELO51	ELU25	ELO54
6000 (3)	-	ELO72	-	-	-	-	ELO53
8000 (1)	-	ELO46	ELO49	ELU22	ELO52	ELU26	ELO55
9000 (3)	-	ELO49	-	-	-	-	ELO54
12000 (1)	-	ELO46	ELO49	ELU22	ELO52	ELU26	ELO55
12000 (3)	-	ELO46	-	-	-	ELU26	ELO55

test

watts	volts	
	ELU26	

H-301/302H-401/402 H-501/502 H-503/504 - Heater, Immersion, Caloritech 6KW 460V 3ph

INC.
Tel.: (905) 829-4422
Fax: (905) 829-4430
Tel.: (705) 325-3473
Fax: (705) 325-2106
Tel.: (514) 334-3720
Fax: (514) 334-6491
Tel.: (716) 564-0010
Fax: (716) 564-0044

INSTALLATION AND MAINTENANCE INSTRUCTIONS IMMERSION HEATERS - TYPES CX & DX

1.0 INSTALLATION

1.1 Immersion heaters are designed for operation only while completely immersed in liquids. Never allow the heating elements to be exposed while energized or failure will result.

1.2 CAUTION: Use the heater only in liquids and at pressures for which it was designed. Normally copper sheath is recommended in water, steel or alloy sheath in oil, and the appropriate alloy sheath for heating chemical solutions. Check factory for recommendations.

1.3 In the case of flanged (and some screwplug type) heaters where a gasket seal is required, the gasket surface should be clean and dry before the heater is seated.

1.4 The terminals must be protected at all times from moisture or vapour. In hazardous locations, explosion resistant terminal housings must be used. In outdoor locations, moisture resistant housings are required.

1.5 Protect terminals of heating elements from drippings, condensation, fumes, spray or any other substance which could result in element contamination.

1.6 When melting solids by direct immersion, a surface vent should be provided to allow gases to escape. Operate the heater on $^1/_2$ voltage until melted material completely covers the heating elements. Heaters used for this purpose may require special design features. Check factory for recommendations.

2.0 WIRING AND CONTROL

2.1 Heaters must be wired by qualified personnel to electrical code requirements.

2.2 Check supply voltage for compliance with heater nameplate voltage.

2.3 A line voltage or pilot duty thermostat should be used to control the heater. The pilot duty thermostat must be used with a contactor and (if required) a transformer. Generally, heaters supplied with built-in thermostats will be factory prewired if suitable for line voltage operation. Integral thermostats not factory prewired are usually intended for pilot duty.

2.4 It is recommended that the control circuits be supplied from the isolated secondary windings of transformers obviating the need for two supply circuits, or as an alternative, that mechanical or electrical interlocking be provided so that both supplies must be disconnected before live parts can be made accessible.

2.5 If there is even the slightest possibility that the liquid level may fall below the elements, a level control switch or over-temperature sensing device affixed to the uppermost heating element is required. Check factory for recommendations.

2.6 Heaters with explosion resistant terminal housings must only be used in locations for which the heaters are certified.

a) Check heater nameplate information for approval code.

b) Never energize an explosion resistant heater unless the terminal housing cover is properly tightened.

c) An immersion heater for hazardous locations is approved for use only if an approved liquid level control is used to de-energize the heater under low liquid conditions.

3.0 START-UP INSPECTION

3.1 Check that all terminal connections are tight.

3.2 Heaters stored for prolonged periods may absorb moisture. Using a megger (insulation resistance tester) check the value of the insulation resistance to ground for each circuit. Initial readings of over 500,000 ohms to ground are normally acceptable. Should lower readings be observed, check factory for instructions.

4.0 MAINTENANCE

4.1 DISCONNECT POWER BEFORE SERVICING.

4.2 Remove the immersion heater periodically to inspect for corrosion, sludge built-up and for scale removal.

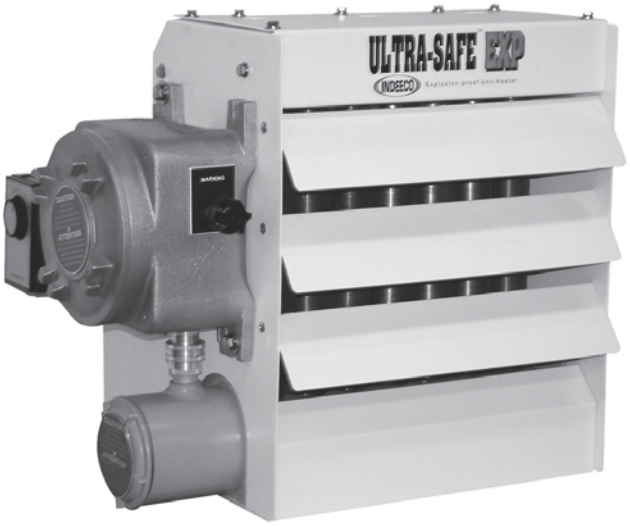
4.3 Periodically check electrical connections for tightness.

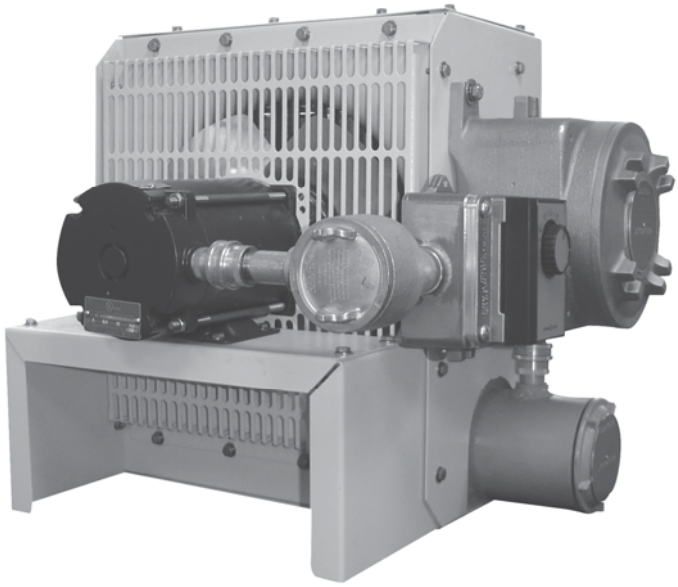
INDEECO

Owner's Manual

ULTRA-SAFE EXP Series

Electric Forced Air Heater for Hazardous Locations





This manual covers installation, maintenance and repair parts.

FM and CSA Approved for the following classified areas:
Class I, Divisions 1 & 2, Groups C & D
Class II, Divisions 1 & 2, Groups F & G
Operating Temperature Code T3C - 320°F (160°C)
Class I, Zones 1 & 2, Group IIB, T3 (FMUS & CSAUS only)
or
Class I, Divisions 1 & 2, Groups C & D
Class II, Divisions 1 & 2, Groups E, F & G
Operating Temperature Code T3C - 320ºF (160ºC)
Class I, Zones 1 & 2, Group IIB T3 (FMUS & CSAUS only)
See Data Plate for Specific Area Classification

For details on the particular hazardous environments having the potential for explosion, refer to Articles 500 through 516 of the National Electric Code, and/or Section 18 of the Canadian Electric Code, Part I.

C SA ® US

C FM US APPROVED

23-2199-83-1
E-526

WARNINGS

Installation and maintenance personnel should familiarize themselves with this manual and all the **WARNINGS** before installing or working on this heater to avoid potential hazardous conditions, severe property damage, personal injury or death.

1. To reduce the risk of ignition of hazardous atmospheres: Do not install where the operating temperature code limit exceeds the ignition temperature of the hazardous atmosphere.
2. Potentially lethal voltages are present. Be sure to lock the branch circuit disconnect switch in the OFF position and tag the circuit "Out for Maintenance" before working on this equipment.
3. Keep electrical enclosure covers tightly closed while in operation.
4. Hazard of Electric Shock. Heater must be grounded in accordance with the N.E.C. and/or C.E.C.
5. This heater should be installed by qualified personnel familiar with the National Electric Code and/or the Canadian Electrical Code requirements for hazardous locations. It is the responsibility of the installer to verify the safety and suitability of the installation.
6. Disassembly of the unit, for installation, is not required or authorized.
7. When connecting the room thermostat, be sure that the thermal cutouts remain connected in series with the controlling contactor. The unit must not operate without the thermal cutouts properly connected in the circuit.
8. Do not attempt to install a "Fan Only" switch on a standard unit heater and do not try to field modify a standard unit heater for this option. The heater must have been ordered for this option to have the necessary internal controls.
9. Replacement of electrical components should only be done by qualified personnel familiar with the requirements of maintaining electrical equipment in hazardous locations.
10. Replacement electrical components must be obtained from the factory in order to maintain the hazardous location rating.
11. The heat exchanger is a factory vacuum-sealed unit. Do not attempt to loosen or tighten any of the fill or drain plugs or attempt to operate the pressure relief valve. A loss of vacuum could cause nuisance tripping of the cutouts or high pressures which will cause the relief valve to actuate with an accompanying loss of liquid. Should leakage occur, remove unit from service and investigate cause.
12. The heat exchanger is filled with a mixture of water and inhibited propylene glycol. Contact with the fluid at operating temperatures may produce a burn hazard. The Material Safety Data sheets indicate that there is not a health hazard from coming in contact with the inhibited propylene glycol. Suggested first aid consists of flushing eyes with plenty of water and to wash off skin in flowing water or a shower.
13. Install and operate in an upright position only. Failure to comply will cause the overtemperature thermal cutouts to trip.
14. Installation minimum mounting clearances on nameplate must be maintained.
15. Use copper wire for supply connections according to size and rating on nameplate.
16. Do not attempt to override louver stops or operate unit with louvers fully closed.
17. "Warning Light", if supplied, will turn on if the high temperature thermal cutout opens. This could result if the heat exchanger is dirty, inlet air is obstructed, vacuum loss in heat exchanger, fan not turning or incorrect supply voltage. Disconnect power to unit before servicing.
18. Crackling noises within the heat exchanger at startup are normal.

WARRANTY WILL BE VOID IF INSTRUCTIONS ARE NOT FOLLOWED.

GENERAL

The air heaters are designed for comfort heating and should not be used in ambient temperatures exceeding 104ºF (40ºC). The units may be wall, pole or ceiling mounted. They utilize a hermetically sealed, liquid-to-air heat exchanger containing immersion type electric heating elements. A mixture of nontoxic propylene glycol and water is place in the heater core to act as a heat transfer fluid. The propylene glycol provides freeze damage protection to -49ºF (-45ºC). The unit is designed to give years of safe, trouble-free operation when properly installed and maintained.

INSTALLATION

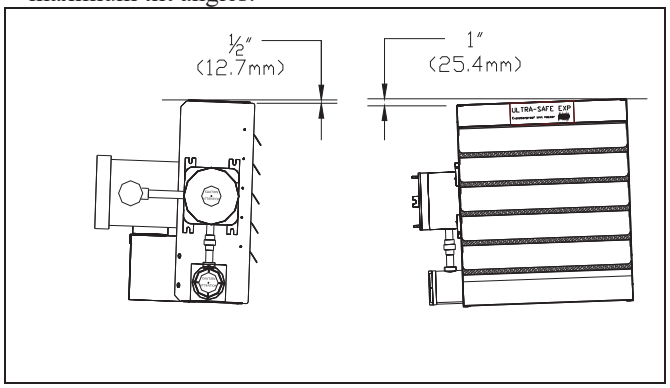
A. Site Selection:

The Heaters should not be mounted close to drapery or similar materials which could lay on the cabinet, or block the inlet or outlet of the heater. The heaters are intended for elevated mounting locations so that they blow warm air down to the floor area. A mounting height should be selected so that the heater is out of the way of possible moving equipment or personnel, yet low enough to deliver warm air to the selected area. See mechanical installation instructions for recommended installation heights.

B. Mechanical Installation:

Once an acceptable location has been determined, follow these instructions to complete the mechanical installation.

1. The Heaters are designed for use only while permanently mounted in an upright, level position. See figure below maximum tilt angles:



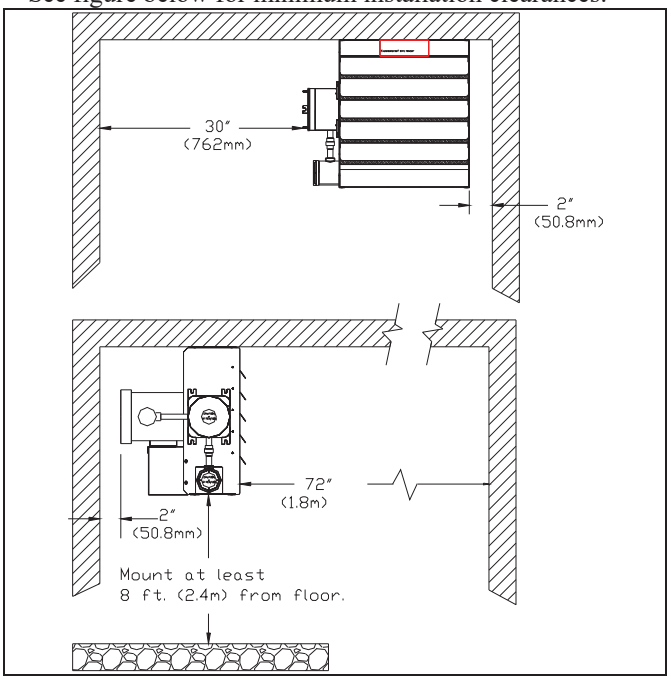
2. To ensure proper heating of floor surfaces, observe the following recommended maximum mounting heights (to bottom of heater):

Maximum Mounting Height from Floor:		
233-FA	233-FB	233-FC
9 ft.	10 ft.	13 ft.
(2.7m)	(3.0m)	(4.0m)

3. The supporting structure that the heater is attached to must have adequate strength to safely support the heater and be sufficient to keep the heater in its proper upright operating position. The maximum unit weights are:

MODEL	lbs	(kgs)
233-FA	150	68
233-FB	200	91
233-FC	250	114

4. See figure below for minimum installation clearances:



5. The heater may be suspended from overhead beams or mounted to a side wall or a 4" pipe using one of the approved mounting kits. Use of non-approved mounting kits voids all warranties, expressed or implied.
6. Wall mounting should be to structural steel. If the wall construction is plasterboard with wooden 2 X 4 framing or similar, it must be reinforced with angle iron or wooden cross braces.
7. Lock washers should be used on all mounting nuts and bolts to ensure they don't vibrate or work loose due to fan vibration or other vibration transmitted to the heater.

C. Electrical Installation:

Follow these instructions to complete the electrical installation:

1. External branch circuit protection is required. See nameplate ratings and follow Code recommendations.
2. Use only an approved explosion-proof means of wiring, such as mineral insulated cable or copper conductors in rigid conduit with conduit seals as required to make connection to the heater.
3. Follow the NEC and/or CEC and any local electrical and building codes related to the installation and intended use of the heater in an explosion-hazard area.
4. When doing any work on a heater, including the initial electrical connection, disconnect the electrical current at the main branch circuit switch, and lock the switch in the off (open) position and tag the circuit "Out for Maintenance" to prevent potential lethal shock hazards.
5. Confirm that the electrical power supply matches the nameplate voltage, phase, amperage and frequency rating of the heater to be connected.
6. Ensure conductors are of appropriate gauge size. The minimum gauge is stamped on the nameplate. Size all input conductors according to accepted standards consistent with the temperature rating of the wire being used. Use minimum 75°C rated wire.

7. Proper installation of the heater requires that an adequate grounding conductor be connected to the ground terminal. This terminal is painted green or marked with the letter "G" and is located on the inside of the control enclosure next to the power input opening.
8. Check and confirm all connections are securely fastened.
9. Before application of electrical power, check all connections to ensure compliance with the wiring diagram and any code requirements. Remove any foreign objects from the control boxes. Reinstall covers tightly.
10. On all 3-phase heaters, it is necessary to verify that the fan is rotating in the proper direction. If air delivery is not from the front of the heater, exchange any 2 input wires at the main contactor terminal located in the control enclosure.
11. The explosion-proof control box is designed with threaded joints and metal-to-metal contact at the lid or cover joint to prevent an explosion. Do not attempt to install gasket material of any type at these joints. A light coating of anti-seize compound is applied to the threads to prevent seizing.
12. See section titled "operation" before energizing the heater.

D. Field Installed Controls:

1. Power Disconnect Switch:
The NEC requires that a power disconnect switch be mounted within sight of the heater. The CEC or local codes may require a disconnect switch within sight of the heater. Refer to the electrical diagram and follow these steps:
   a.) The remote power disconnect switch must be an explosion-proof disconnect switch rated for the area classification.
   b.) The switch must be indicating and have a locked off position.
   c.) The switch must be rated for the nameplate voltage and current per the NEC, CEC and any local codes.
   d.) Follow steps 6 through 12 of the electrical installation instructions to complete the installation.

2. Room Thermostat:
Refer to the electrical wiring diagram and follow these steps:
   a.) Connect the remote thermostat across the leads marked "C" and "C1". The external thermostat will then be in series with the heater thermal high-limit switches and correct operation of the heater will result.
   b.) The wiring to the remote thermostat must be copper wire, 16 gauge minimum (for Class II) or 14 gauge minimum (Class I) and run in explosion-proof conduit with appropriate conduit seals installed per the NEC, CEC and any local codes.
   c.) Any room thermostat used with this heater must be of an explosion-proof type rated for the area classification, open on temperature rise, rated 250VAC, 75VA inductive capacity.
3. 'Fan Only' Switch:
Refer to the electrical wiring diagram and follow these steps:
   a.) Do not attempt to install a "Fan Only" switch on a standard unit heater and do not try to field modify a standard unit heater for this option. The heater must have been ordered for this option to have the necessary internal controls.
   b.) Connect the remote 'fan only' selector switch across the leads marked "C" and "F".
   c.) The wiring to the fan selector switch must be copper wire, 16 gauge minimum (for Class II) or 14 gauge minimum (for Class I) and run in explosion-proof conduit with appropriate conduit seals installed per the NEC, CEC and any local codes.
   d.) Any selector switch used with this heater must be an explosion-proof switch rated for the area classification, maintained 2 position selector switch rated for 250 VAC, 75 VA inductive.

OPERATION

The unit heater may be operated normally at ambient temperatures of 104°F (40°C) or less and at altitudes of 3,300 feet (1000m) or less in atmospheres containing less than 21% oxygen by volume, and as classified on the nameplate. All of these conditions must be met before attempting to operate the heater. The heater should never be operated in an oxygen-enriched atmosphere or at ambient temperatures above 104°F, (40°C). The heater may be operated at higher altitudes if the ambient temperatures are below 104°F, (40°C).

A. Initial Operation:

Check to make sure the mechanical and electrical installation is complete and that it is safe to operate the heater.

1.) Heater without built on or remotely mounted fan switch:
   a.) Set the temperature control thermostat to a setting above the current room temperature.
   b.) Energize the heater electrical supply circuit.
   c.) The heater and fan should come on and in 5 to 15 minutes reach a stable operating temperature. If the room temperature is high and the installation is above 3,300 feet, the unit heater may cycle on the thermal high limits of the motor or the heater.
   d.) Check out and report any unusual or questionable operating characteristics, such as noise, vibration, loss of fluid, etc. Note that crackling noises coming from the heat exchanger during warm up are normal.
   e.) Set the temperature control thermostat to the desired room temperature setting.
   f.) De-energize the heater electrical supply circuit until heater operation is required.
2.) Heater with fan switch:
   a.) Place the fan switch in the fan position.
   b.) Set the temperature control thermostat to a setting below the current room temperature.
   c.) Energize the heater electrical supply circuit.
   d.) The heater fan should come on but the heater should remain off.
   e.) Place the fan switch in the auto position.
   f.) The fan should go off.
   g.) Set the temperature control thermostat to a setting above the current room temperature.

h.) The fan and heater should operate. If the room temperature is high and the installation is above 3,300 feet (1000m), the unit heater may cycle on the thermal high limit cutouts of the motor or the heater.

i.) Check out and report any unusual or questionable operating characteristics, such as noise, vibration, loss of fluid, etc.
Note that crackling noises coming from the heat exchanger during warm up are normal.

j.) Set the fan switch and temperature control thermostat to the desired operating positions.

B. Normal Operation:

Prior to the start of the heating season, perform the electrical and mechanical steps outlined in the section titled "maintenance".

a.) Perform the Operation steps for the applicable temperature control option.

b.) Place all switches in their normal operating position and place the unit heater in service.

MAINTENANCE

Maintenance and repair must be performed by qualified personnel only.

A. Electrical:

1. Inspect all terminal connections, contactor and conductor insulation for damage, looseness, fraying, etc., as applicable. Tighten any loose terminals and replace or repair wire with damaged or deteriorated insulation. If contactor contacts are badly pitted, welded together, or burned, replace the contactor. Check all explosion-proof conduit for visible damage and tightness.
2. If reduced heat output is suspected, perform the mechanical checks. If low heat output is still suspected after completing the mechanical checks, verify the condition of the heating elements by using an amperage meter to check the current draw of each input line. All input lines should draw approximately equal current which should agree with nameplate rating. If they do not, one or more of the heating elements could be burned out and the heater/core assembly should be replaced.
3. The electric motor is permanently lubricated and thermally protected. Check for smooth and quiet running at all inspections. Replace motor if excessive bearing play is detected. Contact the factory for instructions.

B. Mechanical:

1. Never attempt to fill, drain or check the liquid level of the heat exchanger or check the action of the pressure relief valve. Contact the factory for instructions.
2. The explosion-proof control box is designed with threaded joints and metal-to-metal contact at the lid or cover joints to prevent an explosion. Do not attempt to install gasket material of any type at these joints. A light coating of anti-seize compound is applied to the threads to prevent seizing.
3. Annually check the tightness of all visible bolts and nuts, in particular the support structure bolts and nuts. Similarly check the motor mounting bolts and nuts.
4. Periodically, check the motor, fan and heater core fins for cleanliness. A dirty heat exchanger can cause the unit to over heat and cycle on the thermal cutouts. If the dirt is loose dust, clean with a vacuum or by air jet. If the dirt can't be vacuumed or blown off, use a warm water spray directed to the inlet side of the heat exchanger then to the outlet side. A soft bristled brush may be required to loosen stubborn deposits. Be careful not to bend the aluminum fins on the heat exchanger or the fan blade propeller. Allow unit to dry before re-energizing.
5. Check louvers for position tightness and equal angle settings. Check motor and fan for smooth running operation. Any unusual noise or vibration must be investigated and rectified.
6. Should there be any evidence of fluid leakage from the heater core, the heater should be repaired immediately. The heater will not operate properly with a low fluid level. Contact the factory for replacement core.

REPAIR AND REPLACEMENT

Maintenance and repair must be performed by qualified personnel only.

A. Replacing the Heat Exchanger Core:

The heat exchanger core is not field repairable. Contact factory for replacement.

1. Disconnect the heater electrical power supply, unwire and lower the heater from it's mounting location. Set heater face down on a table or on the floor.
2. Remove the cabinet bottom, cabinet top, wiring and heater enclosure covers.
3. Disconnect all heater wires from the contactor in the wiring enclosure. Disconnect the control wiring from thermal cutout.
4. Thread conduit into wiring enclosure to disconnect the heater terminal box.
5. With an assistant supporting the weight of the heat exchanger, remove the 3 heat exchanger mounting bolts. Carefully remove the heat exchanger out of the bottom of the cabinet.
6. Locate rating tag on the heat exchanger and verify that electrical ratings of the core to be installed match the electrical ratings on the heater nameplate.
7. To reinstall, slide the core through the bottom of the cabinet while an assistant lines up and installs the 3 heat exchanger mounting bolts.
8. Guide the heater lead wires back into the wiring enclosure.
9. Reconnect the heater lead wires to the contactor and the conduit.
10. Reattach the cabinet bottom and enclosure covers before mounting heater and energizing.

B. Replacing the Temperature High-Limit Cutouts:

1. Disconnect the heater electrical power supply and remove the heater enclosure cover.

2. Remove the wire barrier to expose the high limit cutout.
3. Disconnect the wires from the high limit cutout and mark their location.
4. Remove the two nuts used to attach the temperature high limit cutout.
5. Lift and remove the sheetmetal mounting plate.
6. Carefully lift and remove the temperature high limit cutout.
7. Use only factory supply parts for safe operation.
8. Lightly coat the new manual and automatic cutout bulbs with the supplied thermal transfer compound. This is critical for proper cutout operation.
9. Carefully slide the automatic cutout bulb into the **left** thermowell and the manual cutout bulb into the **right** thermowell.
10. Reinstall the sheetmetal plate. Note that the sheetmetal plate also acts as a stop to keep the cutout bulbs from backing out of the wells.
11. Carefully install the temperature high limit control to avoid putting kinks into the capillary.
12. Reattach the wires to the cutout and reinstall the wire barrier.
13. Ensure heater enclosure cover is in place before energizing heater.

C. Resetting the Manual Cutout:

All unit heaters contain a built-in manual reset thermal cutout with or without backup contactor.

1. Disconnect the heater electrical power supply and remove the heater enclosure cover.
2. Determine the reason for the manual reset thermal cutout actuating and rectify the situation. See section titled “maintenance”.
3. Reset the manual reset thermal cutout by pressing on the red stem in the center of the control.
4. Replace the heater enclosure cover securely.
5. Energize the heater electrical supply circuit.
6. The heater and fan should come on and in 5 to 15 minutes reach a stable operating temperature.
7. Check out and report any unusual or questionable operating characteristics, such as noise, vibration, loss of fluid, etc.
8. If heater operation appears normal, place the unit into normal operation.

D. Replacing the Fan Motor and Blade:

The fan motor is permanently lubricated and does not require any maintenance. If the fan motor is defective, a replacement must be obtained from the factory.

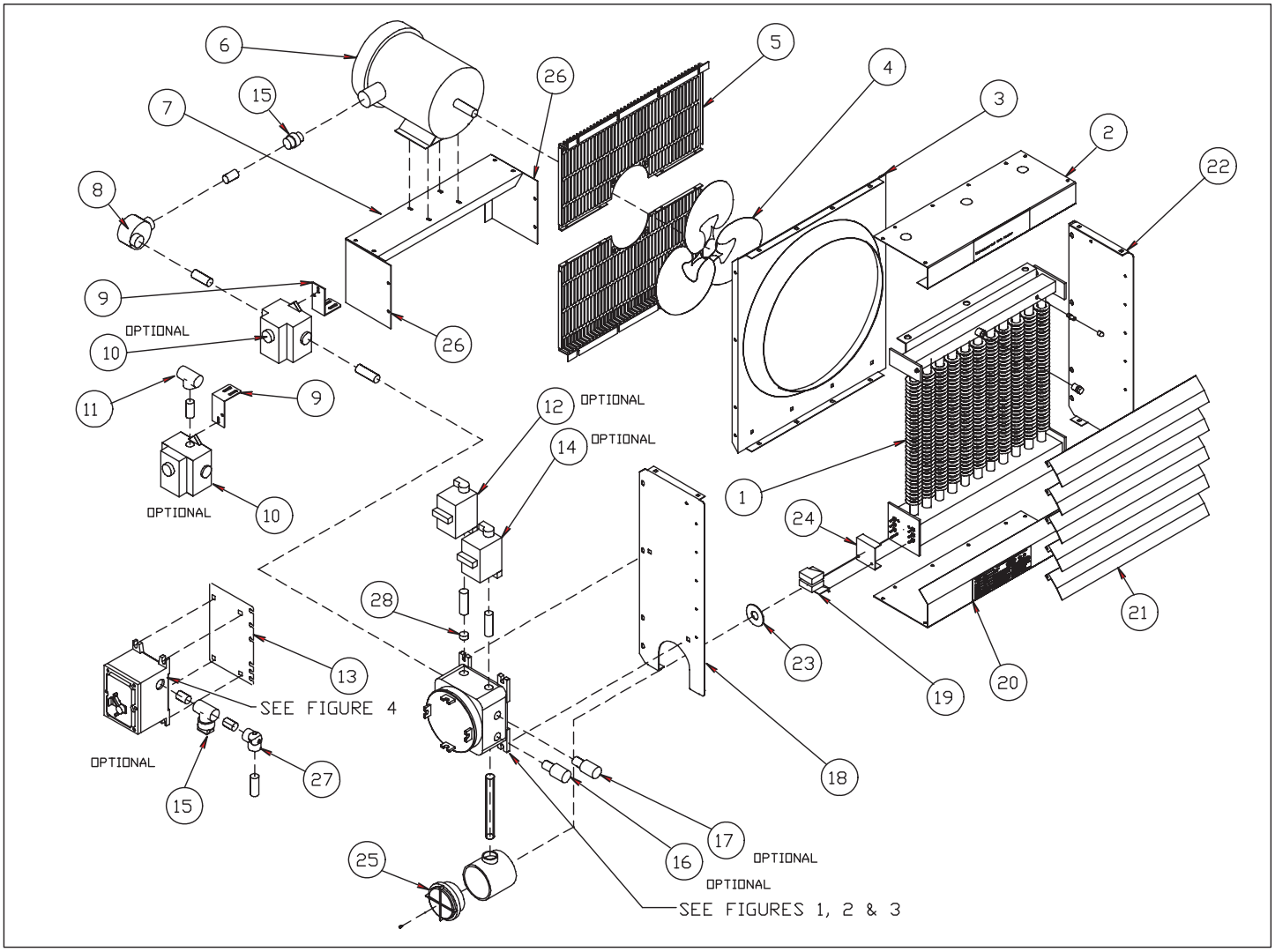
1. To replace the fan motor:
   a. Disconnect the heater electrical power supply.
   b. Disconnect the motor supply wires from the contactor in the wiring enclosure.
   c. Disassemble the conduit union located at the motor wiring hub.
   d. Remove top fan guard and motor mounting bolts.
   e. Lift motor out of heater assembly.
   f. Remove fan blade and conduit union from defective motor and install on new motor.
   g. Install new motor to heater using existing motor mounting hardware.
   h. Reinstall top fan guard and ensure that the fan blade rotates freely.
   i. Feed motor wires through conduit and into wiring enclosure.
   j. Reattach conduit union. Reconnect motor wires to contactor.
   k. Check fan rotation by momentarily energizing heater. Airflow should exit from front of heater cabinet. If rotation is incorrect, disconnect electrical power supply and reverse two of the motor lead wires at the contactor.
   l. Reattach wiring enclosure cover before placing heater back in service.

2. To replace the motor fan blade:
   a. Remove the top fan guard.
   b. Remove the four motor mounting bolts and disconnect the conduit union at the motor.
   c. Loosen the bolt that connects the fan blade to the motor shaft.
   d. Slide the motor back and tilt in order to remove the old blade & install a new one.
   e. Tighten the fan blade attachment bolt to the motor shaft.
   f. Reattach the motor conduit union and the four motor mounting bolts.
   g. Reinstall the top fan guard and ensure that the fan blade rotates freely.

REPLACEMENT PARTS

1. All replacements must be factory supplied to ensure safe heater operation.
2. Mark wires and refer to wiring diagram to ensure proper electrical connections.

Reference heater catalog number and item number in figures below when contacting factory for replacement parts. Contact factory for items not shown.



ITEM	DESCRIPTION
1	Heat Exchanger Core Assy.
2	Cabinet – Top
3	Fan Venturi
4	Fan Blade
5	Fan Guard
6	Fan Motor
7	Motor Support – Top
8	Motor Junction Box
9	Thermostat Support Bracket
10	Thermostat
11	Conduit Tee
12	Disconnect Switch – Small
13	Large Disconnect Support Bkt.
14	Fan Switch

ITEM	DESCRIPTION
15	Conduit Seal
16	Pilot Light – Bottom
17	Pilot Light – Top
18	Cabinet – Left Side
19	High Limit Cutout
20	Cabinet – Bottom
21	Cabinet - Louver
22	Cabinet – Right Side
23	High Limit Barrier
24	High Limit Mounting Bridge
25	Heater Enclosure Cover
26	Motor Support – Side
27	¾” Conduit Pull Elbow
28	Reducer Bushing

Select the Figure that corresponds to your heater.

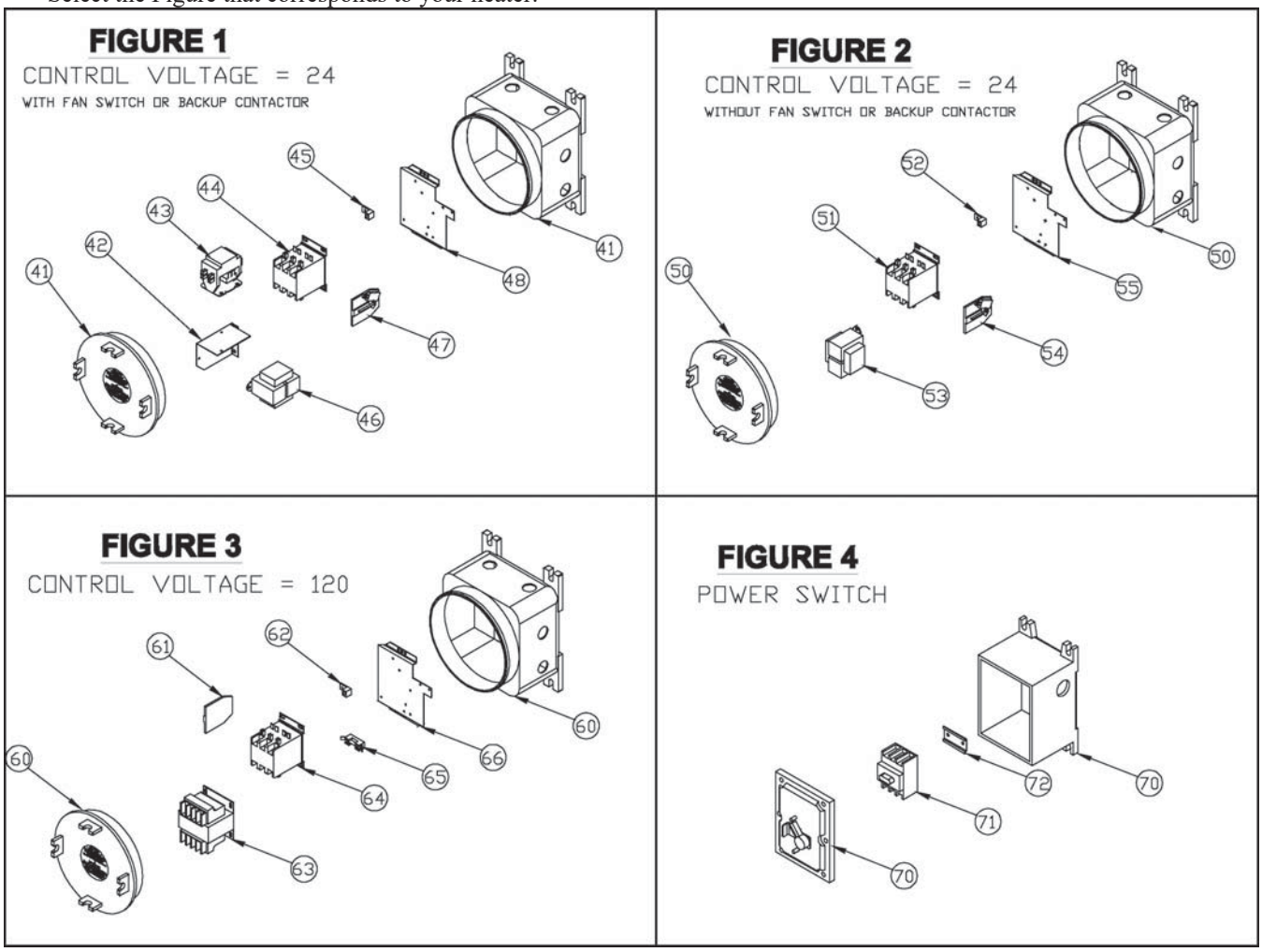


FIGURE 1:

ITEM	DESCRIPTION
41	Wiring Enclosure and Cover
42	Option Mounting Bridge
43	Option Contactor
44	Main Contactor
45	Ground Lug
46	Transformer
47	Auxiliary Contact
48	Main Mounting Bridge

FIGURE 2:

ITEM	DESCRIPTION
50	Wiring Enclosure and Cover
51	Main Contactor
52	Ground Lug
53	Transformer
54	Auxiliary Contact
55	Main Mounting Bridge

FIGURE 3:

ITEM	DESCRIPTION
60	Wiring Enclosure and Cover
61	Auxiliary Contact
62	Ground Lug
63	Transformer
64	Main Contactor
65	Transformer Fuse & Fuse Block
66	Main Mounting Bridge

FIGURE 4:

ITEM	DESCRIPTION
70	Switch Enclosure and Cover
71	Disconnect Switch
72	Disconnect Switch Track

Magelis
GTO HMI
User Manual

10/2014

EIO0000001133.03

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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 nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

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 a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book

At a Glance

Document Scope

This manual describes how to use the HMIGTO panels.

Validity Note

This documentation is valid for Vijeo Designer 6.2 or higher.

The technical characteristics of the devices described in this document also appear online. To access this information online:

Step	Action
1	Go to the Schneider Electric home page *www.schneider-electric.com*.
2	In the **Search** box type the reference of a product or the name of a product range. ● Do not include blank spaces in the model number/product range. ● To get information on grouping similar modules, use asterisks (*).
3	If you entered a reference, go to the **Product Datasheets** search results and click on the reference that interests you. If you entered the name of a product range, go to the **Product Ranges** search results and click on the product range that interests you.
4	If more than one reference appears in the **Products** search results, click on the reference that interests you.
5	Depending on the size of your screen, you may need to scroll down to see the data sheet.
6	To save or print a data sheet as a .pdf file, click **Download XXX product datasheet**.

The characteristics that are presented in this manual should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the manual and online information, use the online information as your reference.

Product Related Information

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter, and apply this product.

Follow all local and national safety standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Chapter 1
Overview

Overview

This chapter describes the panels and general topics such as package contents and standards.

What Is in This Chapter?

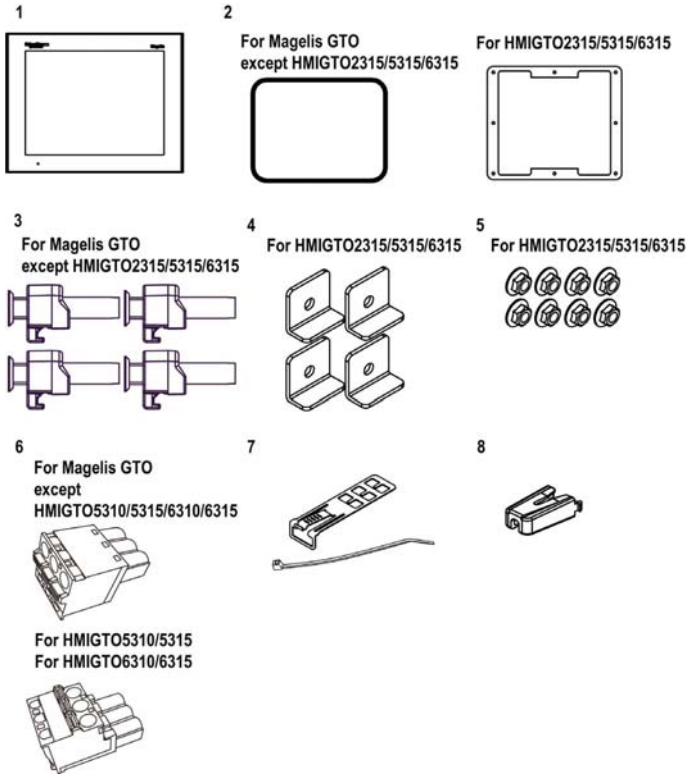
This chapter contains the following topics:

Topic	Page
HMIGTO Package Contents	10
Certifications and Standards	11
GTO Series of Panels	13

HMIGTO Package Contents

Overview

Verify all items listed here are present in your package:



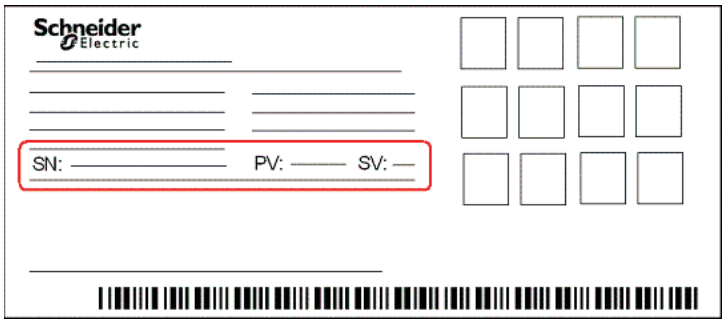
1 HMIGTO: 1
2 Installation gasket: 1 (attached to the panel)
3 Installation fasteners: 4 per set
4 Brackets: 4
5 M4 Hex Nuts: 8
6 DC power connector: 1[*1]
7 USB cable clamp Type A: 1 set (1 clip and 1 tie)
8 USB cable clamp mini-B: 1 (1 USB holder)
9 HMIGTO Quick Reference Guide: 1

This product has been carefully packed with special attention to quality. However, should you find anything damaged or missing, please contact your local distributor.

[*1] You can use the DC power connector for HMIGTO1300/1310/2300/2310/2315/3510/4310 to supply power to HMIGTO5310/5315/6310/6315. However the reverse is not possible. You cannot use the power connector for HMIGTO5310/5315/6310/6315 on HMIGTO1300/1310/2300/2310/2315/3510/4310.

Revision

You can identify the product version (PV), revision level (RL) and the software version (SV) from the unit product label.



Certifications and Standards

Introduction

Schneider Electric submitted this product for independent testing and qualification by third-party listing agencies. These agencies have certified this product as meeting the following standards.

Agency Certifications

The HMIGTO is manufactured in accordance with:

- Standard UL 508 and CSA C22.2 n°142 for Industrial Control Equipment
- Standard ANSI/ISA - 12.12.01 and CSA C22.2 n°213 for Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
  NOTE:
- For use in Pollution Degree 2 environments.
- For use on a flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.
- 24 Vdc input panel must be used with a Class 2 power supply.
- Suitable for use in Class I, Division 2 Groups A, B, C, and D Hazardous Locations.

- GOST certification.
  Please refer to product markings.
- ATEX certification by Technical Inspection Association.
  Please refer to product label.
- Merchant Navy rules. (Except Magelis GTOxxx5.)
  Products are designed to comply with Merchant Navy rules.
  Please refer to the Schneider Electric Web site for Merchant Navy rules installation guidelines.
- Standard EN1672-2 (Magelis GTOxxx5).
- FDA regulation 21 CFR 177 (Magelis GTOxxx5).

Refer to the Schneider Electric web site for installation guidelines.

For detailed information, contact your local distributor or see the catalog & marking on the product.

Hazardous Substances

The HMIGTO is a device for use in factory systems. When using the HMIGTO in a system, the system should comply with the following standards in regards to the installation environment and handling:

- WEEE, Directive 2002/96/EC
- RoHS, Directive 2011/65/EU
- RoHS China, Standard SJ/T 11363-2006

CE Markings

This product conforms to the necessary requirements of the following Directives for applying the CE label:

- 2006/95/EC Low Voltage Directive
- 2004/108/EC EMC Directive

This conformity is based on compliance with EN61000-6-4, EN61000-6-2

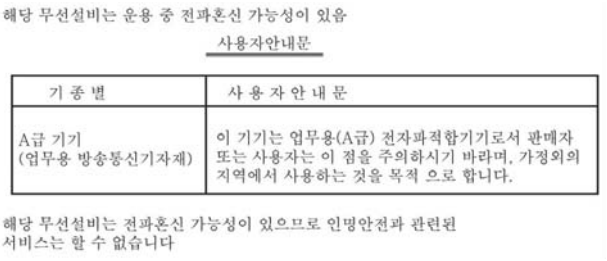
⚠ DANGER

POTENTIAL FOR EXPLOSION

- Verify that the power, input and output (I/O) wiring are in accordance with Class I, Division 2 wiring methods.
- Substitution of any component may impair suitability for Class I, Division 2.
- Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- Securely lock externally connected units and each interface before turning on the power supply.
- Do not use, connect, or disconnect USB cable unless area is known to be non-hazardous.
- Do not disconnect while circuit is live or unless the area is known to be free of ignitable concentrations.
- Potential electrostatic charging hazard. Wipe the front panel of the terminal with a damp cloth before turning ON.

Failure to follow these instructions will result in death or serious injury.

KC Markings



해당 무선설비는 운용 중 전파혼신 가능성이 있음

사용자안내문

기 종 별	사 용 자 안 내 문
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GTO Series of Panels

Critical systems, alarms and handling Requirements

Critical alarm indicators and system functions require independent and redundant protection hardware and/or mechanical interlocks.

When you cycle power, wait at least 10 seconds before restoring the power to the panel after it has been turned off. Switching the power OFF and ON quickly can damage the panel.

In the event the screen cannot be properly read, for example, if the backlight is not functioning, it may be difficult or impossible to identify a function. Functions that may present a hazard if not immediately executed, such as a fuel shut-off, must be provided independently of the panel. The machine's control system design must take into account the possibility of the backlight no longer functioning and the operator being unable to control the machine or making mistakes in the control of the machine.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.
- The machine control system design must take into account the possibility of the backlight no longer functioning and the operator being unable to control the machine, or making errors in the control of the machine.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not use this equipment as the only means of control for critical system functions such as motor start/stop or power control.
- Do not use this equipment as the only notification device for critical alarms, such as device overheating or overcurrent.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Handling the LCD panel

The following characteristics are specific to the LCD panel and are considered normal behavior:

- LCD screen may show unevenness in the brightness of certain images or may appear different when seen from outside the specified viewing angle. Extended shadows, or crosstalk may also appear on the sides of screen images.
- LCD screen pixels may contain black and white colored spots and color display may seem to have changed.
- When the same image is displayed on the screen for a long period, an afterimage may appear when the image is changed.

NOTE: Change the screen image periodically and try not to display the same image for a long period of time.

⚠ CAUTION

SERIOUS EYE AND SKIN INJURY

The liquid in the LCD panel contains an irritant:
- Avoid direct skin contact with the liquid.
- Wear gloves when you handle a broken or leaking unit.
- Do not use sharp objects or tools in the vicinity of the LCD touch panel.
- Handle the LCD panel carefully to prevent puncture, bursting, or cracking of the panel material.

Failure to follow these instructions can result in injury or equipment damage.

If the panel is damaged and any liquid comes in contact with your skin, immediately rinse the area with running water for at least 15 minutes. If the liquid gets in your eyes, immediately rinse your eyes with running water for at least 15 minutes and consult a doctor.

Chapter 2
Device Connectivity

Introduction

This chapter presents the equipment you can connect to the panel.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
System Design	16
Accessories	21

System Design

Introduction

The following diagrams represent equipment you can connect to the panel.

	COM1	COM2
HMIGTO1300	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO1310	RS-232C / RS-485 *(see page 18)*	–
HMIGTO2300	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO2310	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO2315	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO3510	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO4310	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO5310	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO5315	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO6310	RS-232C *(see page 16)*	RS-485 *(see page 19)*
HMIGTO6315	RS-232C *(see page 16)*	RS-485 *(see page 19)*

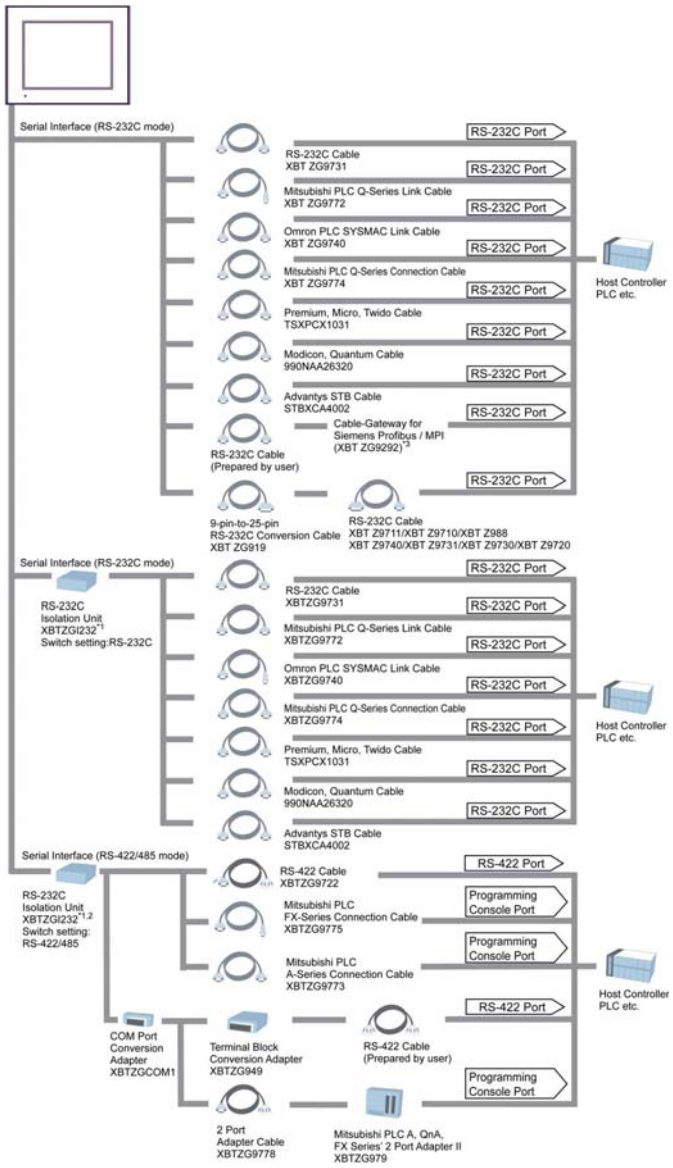
RUN Mode Peripherals - RS-232C

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

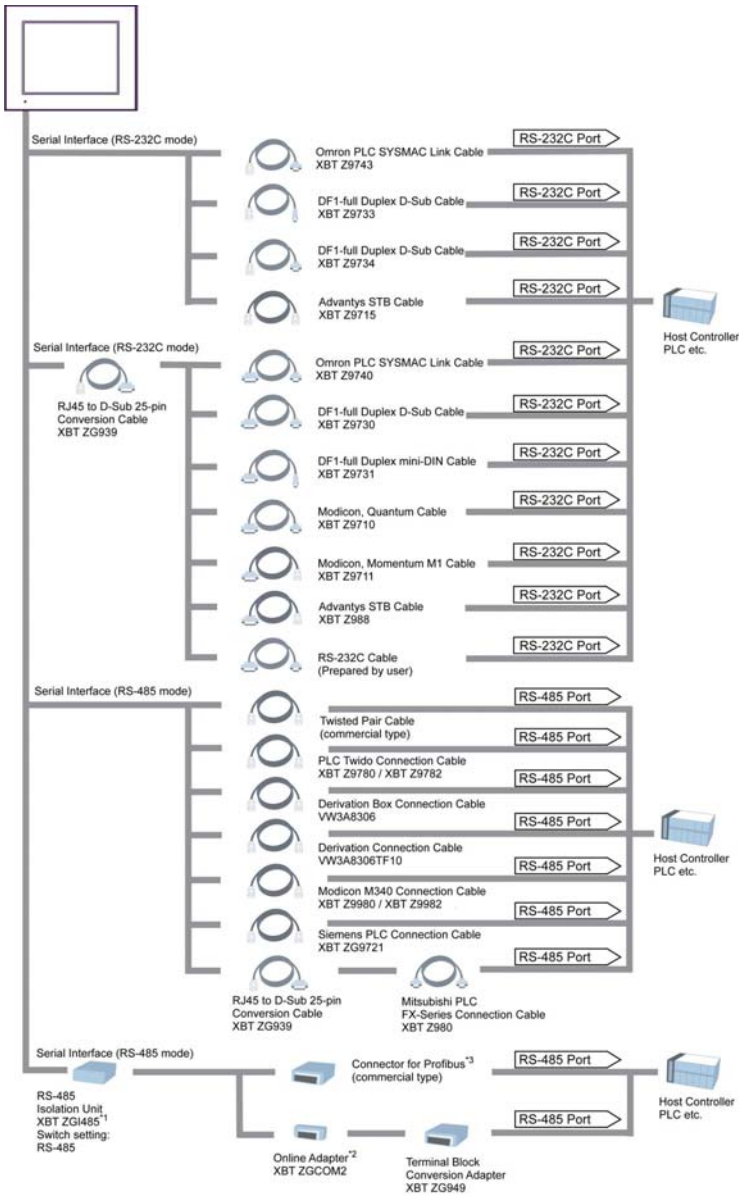


*1 When connecting the XBTZGI232, the COM port's pin 9 setting should be VCC. You can define COM port settings in Vijeo Designer or in the HMIGTO's offline menu.

*2 The RS-232C Isolation Unit works with only RS-422/485 (4 wire) communication.

*3 Cable-Gateway for Siemens Profibus / MPI (XBT ZG9292) is not supported by HMIGTO1310.

RUN Mode Peripherals - RS-232C / RS-485

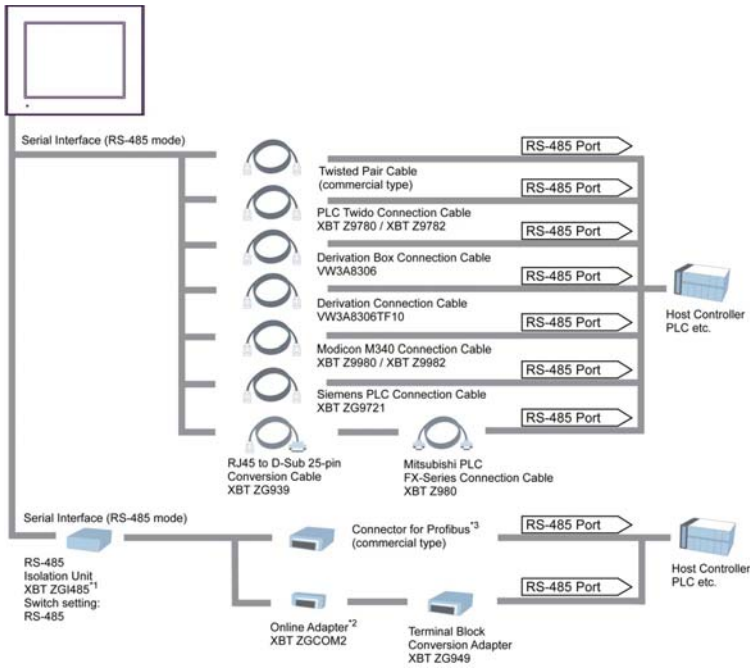


*1 Use the RS-485 Isolation Unit's USB port to supply power to itself. There is no need to set up a separate power supply.

*2 In 1:n, n:1, or n:m communication, you can use the online adapter as a terminal. (Use 1 unit in either communication setup.)

*3 The connector has a switch to control the terminal. Turn on the switch to enable communication.

RUN Mode Peripherals - RS-485

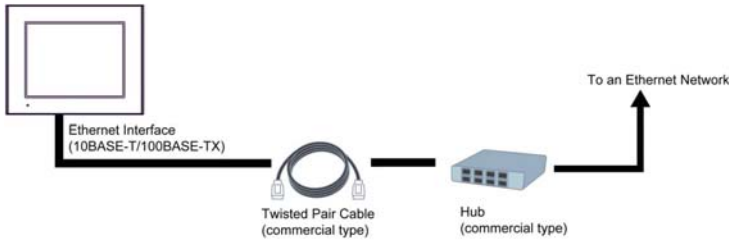


*1 Use the RS-485 Isolation Unit's USB port to supply power to itself. There is no need to set up a separate power supply.

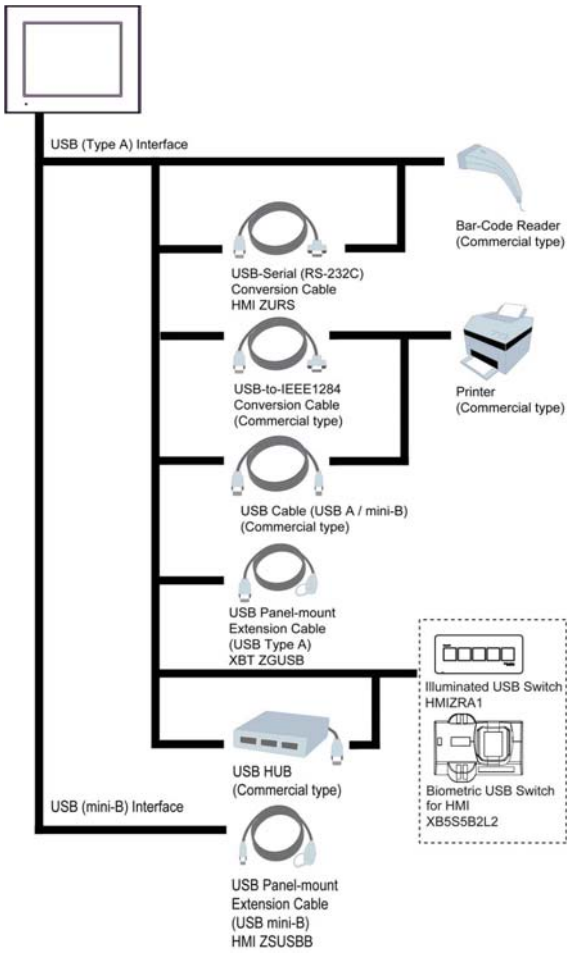
*2 In 1:n, n:1, or n:m communication, you can use the online adapter as a terminal. (Use 1 unit in either communication setup.)

*3 The connector has a switch to control the terminal. Turn on the switch to enable communication.

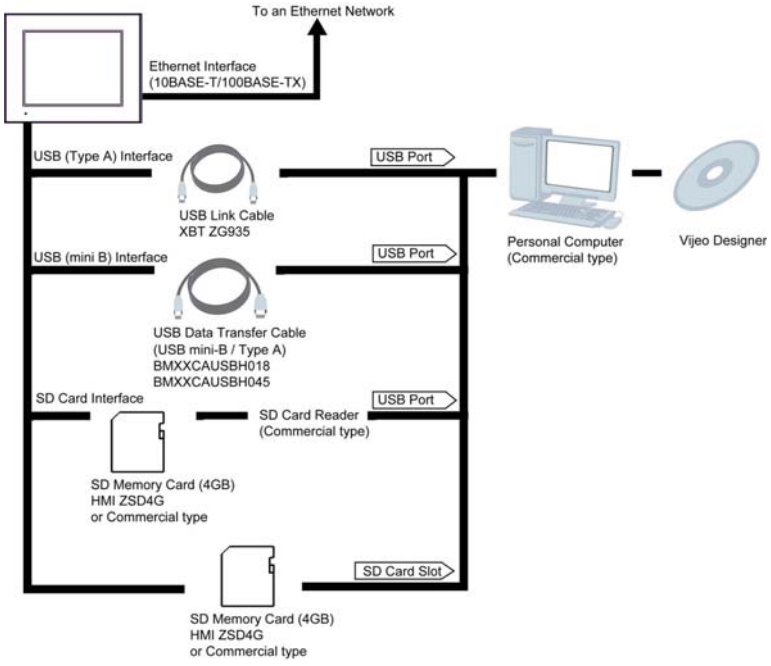
RUN Mode Peripherals - Ethernet Communication



RUN Mode Peripherals - USB Type A / mini-B Interface



Edit Mode Peripherals



Accessories

Serial Interface Items

Product Name	Product Number	Description
RS-232C Cable	XBT ZG9731	Connects a host controller to the panel. (RS-232C)
RS-422 Cable	XBT ZG9722	Connects a host controller to the panel. (RS-422)
Mitsubishi PLC Q-Series Link Cable	XBT ZG9772	Connects Mitsubishi PLC Q-Series (or other host controller) to the panel. (RS-232C)
Omron PLC SYSMAC Link Cable	XBT ZG9740 XBT Z9743 XBT Z9740	Connects Omron PLC SYSMAC Series unit (or other host controller) to the panel. (RS-232C)
Mitsubishi PLC A-Series Connection Cable	XBT ZG9773	Connects Mitsubishi PLC A or QnA Series programming console I/F to panel. (Simultaneous use of programming consoles is not possible.)
Mitsubishi PLC Q-Series Connection Cable	XBT ZG9774	Connects Mitsubishi PLC Q-Series programming console I/F to panel. (Simultaneous use of programming consoles is not possible.)
Mitsubishi PLC FX-Series Connection Cable	XBT ZG9775 XBT Z980	Connects Mitsubishi PLC FX-Series programming console I/F and panel. (Simultaneous use of programming consoles is not possible.)
Premium, Micro, Twido Cable	TSXPCX1031	Connects Premium, Micro, or Twido to the panel.
Modicon, Quantum Cable	990NAA26320 XBT Z9710	Connects Modicon or Quantum to the panel.
2 Port Adapter Cable	XBT ZG9778	Connects Mitsubishi PLC directly to the panel (D-sub 9 pin plug) using 2 port adapter II (RS-422).
Mitsubishi PLC A, QnA, FX Series 2 Port Adapter II	XBT ZG979	Enables simultaneous use of a panel and a Mitsubishi PLC A, QnA, or FX Series peripheral device.
Advantys STB Cable	STBXCA4002 XBT Z9715 XBT Z988	Connects Advantys STB to panel.
Terminal Block Conversion Adapter	XBT ZG949	Connects output from a panel's Serial Interface (D-sub 9 pin plug) directly with an RS-422 terminal block.
COM Port Conversion Adapter	XBT ZGCOM1	Connects optional RS-422 communication items to panel's COM1 port.
DF1-full Duplex D-Sub Cable	XBT Z9730 XBT Z9733 XBT Z9734	Connects DF1-full Duplex to HMIGTO.
DF1-full Duplex mini-DIN Cable	XBT Z9731 XBT Z9720	Connects DF1-full Duplex to HMIGTO.
Modicon, Momentum M1 Cable	XBT Z9711	Connects Modicon, Momentum M1 to HMIGTO.
PLC Twido Connection Cable	XBT Z9780 / XBT Z9782	Connects PLC Twido to HMIGTO.
Derivation Box Connection Cable	VW3A8306	Connects Derivation Box to HMIGTO.
Derivation Connection Cable	VW3A8306TF10	Connects Derivation to HMIGTO.
Modicon M340 Connection Cable	XBT Z9980 / XBT Z9982	Connects Modicon M340 to HMIGTO.
Siemens PLC Connection Cable	XBT ZG9721	Connects Siemens PLC to HMIGTO.
RS-232C Isolation Unit	XBT ZGI232	Connects a host controller to HMIGTO with isolation. (RS-232C and RS-422 are switchable.)
RS-485 Isolation Unit	XBT ZGI485	Connects a host controller to HMIGTO with isolation.
Cable-gateway for Siemens Profibus / MPI	XBT ZG9292	Connects Siemens Profibus / MPI units to HMIGTO.
RJ45 to D-Sub 25 pin Conversion Cable	XBT ZG939	Connects a RJ45 cable to HMIGTO (D-sub 9 pin plug).
9-pin to 25-pin RS-232C Conversion Cable	XBT ZG919	Connects a standard RS-232C cable (D-Sub 25-pin socket) to HMIGTO (D-sub 9 pin plug).
Online Adapter	XBT ZGCOM2	Terminal adapter for RS-485 communication.

USB Interface Items

Product Name	Product Number	Description
USB Transfer Cable	XBT ZG935	Downloads project data created with the software via the panel's USB I/F.
USB Front Cable	XBT ZGUSB	Extension cable attaching USB interface to front panel.
USB-Serial (RS-232C) Conversion Cable	HMIZURS	Cable for converting a panel's USB interface into a serial interface (RS-232C). Allows connection to modems*1 or bar code readers*1 that support RS-232C.
USB Transfer Cable (USB Type A/mini-B)	BMXXCAUSBH018 BMXXCAUSBH045	Cable for transferring screen data from a PC (USB Type A) to the panel (USB mini-B).
Remote USB port location for mini-USB	HMIZSUSBB XBT ZGUSBB	Extension cable that attaches to the USB (mini-B) interface on the front side of the operation panel.
Illuminated USB Switch	HMIZRA1	A unit of 5 illuminated switches with multiple color LED easily connected with HMIGTO via USB.
Biometric USB Switch for HMI	XB5S5B2L2	Fingerprint recognition unit easily connected with HMIGTO via USB.

Software

Product name	Description
Vijeo Designer (Version 6.1 or later)	Software you install on your computer to create project data for your HMIGTO.

SD Card Items

Product Name	Product Number	Description
SD Memory Card (4 GB)	HMIZSD4G	SD Memory Card (4 GB, CLASS4)

Option Items

Product Name	Product Number	Corresponding panel	Description
12.1-inch Screen Protection Sheet	XBT ZG66	HMIGTO6310/6315	Disposable, dirt-resistant sheet for the HMIGTO screen (5 sheets/set)
10.4-inch Screen Protection Sheet	XBT ZG65	HMIGTO5310/5315	
7.5-inch Screen Protection Sheet	XBT ZG64	HMIGTO4310	
7.0-inch Wide Screen Protection Sheet	XBT ZG63	HMIGTO3510	
5.7-inch Screen Protection Sheet	XBT ZG62	HMIGTO2300/2310/2315	
3.5-inch Screen Protection Sheet	XBT ZG60	HMIGTO1300/1310	
12.1-inch Environment Cover	XBT ZECOV6	HMIGTO6310	Disposable, environment cover for the HMIGTO screen (1 sheet/set)
10.4-inch Environment Cover	XBT ZECOV5	HMIGTO5310	
7.0/7.5-inch Environment Cover	XBT ZECOV4	HMIGTO3510/4310	
5.7-inch Environment Cover	XBT ZECOV2	HMIGTO2300/2310	
3.5-inch Environment Cover	XBT ZECOV1	HMIGTO1300/1310	

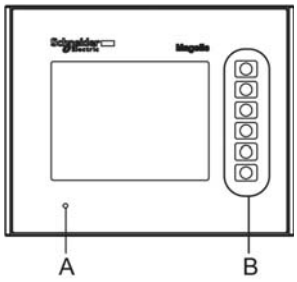
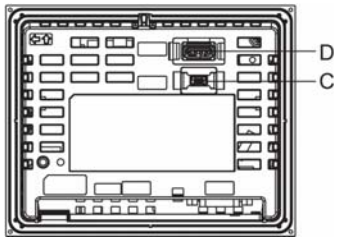
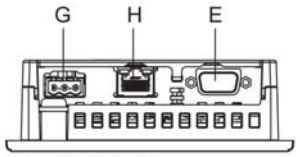
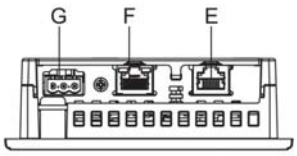
Maintenance Options

Product Name	Product Number	Corresponding panel	Description
Installation Fastener	HMI ZGFIX	HMIGTO except HMIGTO2315/5315/6315	Used to install the HMIGTO into a solid panel (4 pieces/set)
Installation System	HMI ZGFIX2	HMIGTO2315/5315/6315	Used to install the HMIGTO into a solid panel. Brackets (4 pieces/set) M4 Hex nuts (8 pieces/set)
12.1-inch Installation Gasket	HMI ZG56	HMIGTO6310	Provides dust and moisture resistance when HMIGTO is installed into a solid panel (1 piece)
	HMI ZG562	HMIGTO6315	
10.4-inch Installation Gasket	HMI ZG55	HMIGTO5310	
	HMI ZG552	HMIGTO5315	
7.0-inch Wide & 7.5-inch Installation Gasket	HMI ZG54	HMIGTO3510/4310	
5.7-inch Installation Gasket	HMI ZG52	HMIGTO2300/2310	
	HMI ZG522	HMIGTO2315	
3.5-inch Installation Gasket	HMI ZG51	HMIGTO1300/1310	
USB Clamp TypeA (1 port)	HMI ZGCLP1	Magelis GTO	Clamp to prevent disconnection of USB cable (USB/A, 1 port, 5 clamps/set)
USB Clamp mini-B (1 port)	HMI ZGCLP3	Magelis GTO	Clamp to prevent disconnection of USB cable (USB/mini-B, 1 port, 5 clamps/set)
DC Power Supply Connector	HMI ZGPWS	HMIGTO3510/4310 HMIGTO2300/2310/2315 HMIGTO1300/1310	Connector to connect DC power supply cables (5 pcs/set)
DC Power Supply Connector (Right-angle)	HMI ZGPWS2	HMIGTO6310/6315 HMIGTO5310/5315	Right-angle connector to connect DC power supply cables (5 pcs/set)
Battery for Memory Backup	HMI ZGBAT	HMIGTO (except HMIGTO1300/1310/2300)	Primary battery for memory and time data backup
Panel Cutout Adapter	XBT ZGGCO4	HMIGTO5310	Panel cutout adapter for mounting HMIGTO5310 in cutout for XBT GT5230.
Insert Label	HMI ZLYGO3	HMIGTO3510	Label insert for HMIGTO 7-inch Wide models.
	HMI ZLYGO1	HMIGTO1300/1310	Label insert for HMIGTO 3.5-inch models

Chapter 3
Parts Identification and Functions

Parts Identification and Functions

HMIGTO1300/1310 Parts Identification

Side	HMIGTO1300/1310
Front	
Rear	
Bottom	 HMIGTO1300  HMIGTO1310

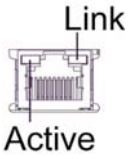
Part	Name	Description
A	Status LED	*1
B	Function Switches	Six switches (F1 to F6). You can define operations for these switches using Vijeo Designer.
C	USB (mini-B) Interface	Conforms to USB2.0 (mini-B) x 1. Communication Distance: 5 m (16.4 ft) or less.
D	USB (Type A) Interface	Conforms to USB2.0 (Type A) x 1. Power supply voltage: 5Vdc+/-5%. Output Current: 500 mA or less. Maximum communication distance: 5 m (16.4 ft).
E	Serial Interface (COM1)	HMIGTO1300: RS-232C Serial Interface. Connector: D-Sub 9 pin (plug) x 1. HMIGTO1310: RS-232C/485 Serial Interface. (You can switch the communication method via software.) Connector: Modular jack (RJ-45).

Part	Name	Description
F	Ethernet Interface*2	Ethernet transmission interface (10BASE-T/100BASE-TX) Connector: Modular jack (RJ-45) x 1. Ethernet Interface is not attached to HMIGTO1300.
G	Power Plug Connector	-
H	Serial Interface (COM2)	HMIGTO1300: RS-485 Serial Interface. Connector: Modular jack (RJ-45) x 1.

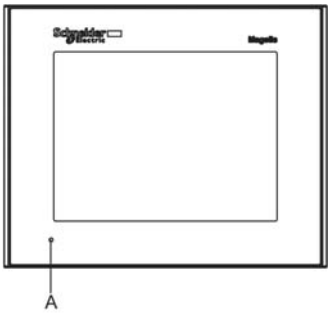
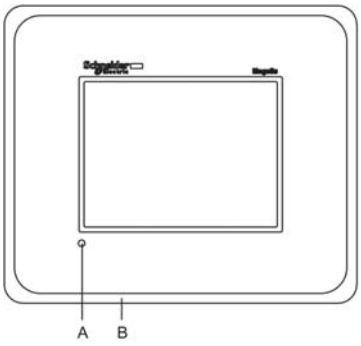
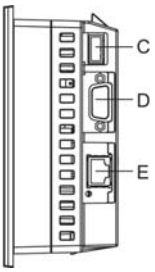
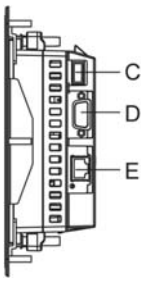
*1 Status LED operations are as shown below:

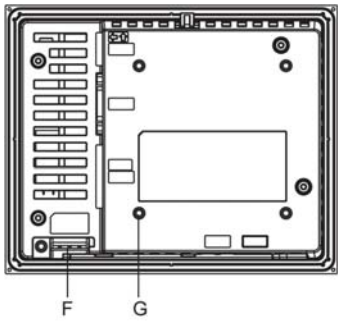
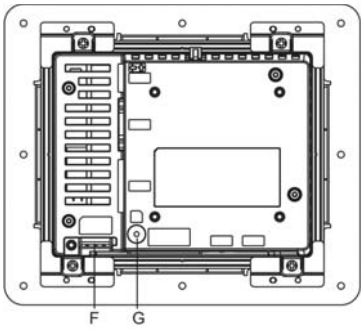
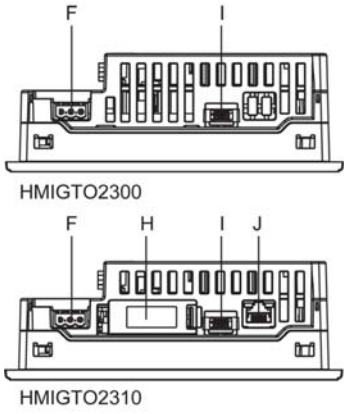
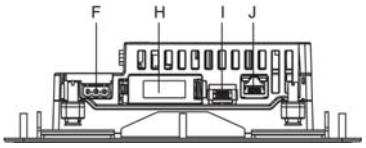
Color	Indicator	Description
Green	ON	Offline
		In operation
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
-	OFF	Power is turned OFF.

*2 Ethernet LED operations are as shown below.

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission.
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission failure.

HMIGTO2300/2310/2315 Parts Identification

Side	HMIGTO2300/HMIGTO2310	HMIGTO2315
Front		
Right		

Side	HMIGTO2300/HMIGTO2310	HMIGTO2315
Rear		
Bottom		

Part	Name	Description
A	Status LED	*1
B	Stainless Steel Bezel	HMIGTO2315 only.
C	USB (Type A) Interface	Conforms to USB2.0 (Type A) x 1. Power supply voltage: 5Vdc+/-5%. Output Current: 500 mA or less. Maximum communication distance: 5 m (16.4 ft).
D	Serial Interface (COM1)	RS-232C Serial Interface. Connector: D-Sub 9 pin (plug) x 1.
E	Serial Interface (COM2)*2	RS-485 Serial Interface. Connector: Modular jack (RJ-45).
F	Power Plug Connector	-
G	SD Card Access LED *3	This lamp lights up when SD Card is inserted. For more information, refer to SD Card Insertion/Removal *(see page 131)*. **NOTE:** SD Card Access LED is not available on HMIGTO2300.
H	SD Card Interface Cover/Replacement Battery Insertion Cover	For information on how to open the cover, and insert or remove the SD Card, refer to SD Card Insertion / Removal *(see page 131)*. For information on how to open the cover and replace the battery, refer to Replacing the Primary Battery *(see page 146)*. **NOTE:** This cover is not on HMIGTO2300.
I	USB (mini-B) Interface	Conforms to USB2.0 (mini-B) x 1. Communication Distance: 5 m (16.4 ft) or less.
J	Ethernet Interface *4	Ethernet transmission interface (10BASE-T/100BASE-TX) Connector: Modular jack (RJ-45) x 1. **NOTE:** Ethernet Interface is not available on HMIGTO2300.

*1 Status LED operations are as shown below:

Color	Indicator	Description
Green	ON	Offline
		In operation
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
-	OFF	Power is turned OFF.

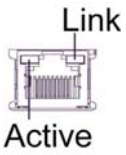
*2 COM2 LED operations are as shown below.

Color	Indicator	Description
Yellow	ON	Communication (sending or receiving data) is occurring.
	OFF	No communication.

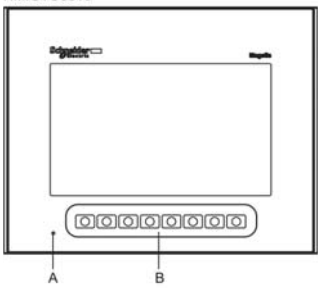
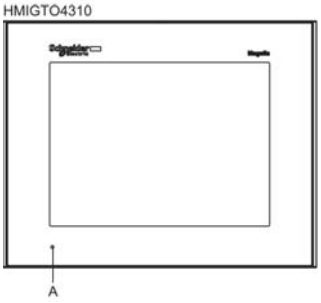
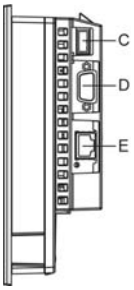
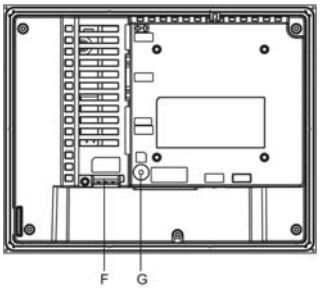
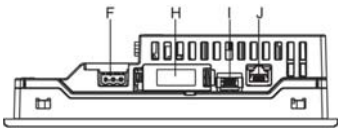
*3 SD Card Access LED operations are as shown below.

Color	Indicator	Description
Green (Active)	ON	The SD Card is inserted.
	OFF	The SD Card is not inserted or is not being accessed.

*4 Ethernet LED operations are as shown below.

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission.
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission failure.

HMIGTO3510/4310 Parts Identification

Side	HMIGTO3510/4310
Front	HMIGTO3510  HMIGTO4310 
Right	
Rear	
Bottom	

Part	Name	Description
A	Status LED	*1
B	Function Switches	HMIGTO3510 only. Eight switches (F1 to F8). You can define operations for these switches using Vijeo Designer.
C	USB (Type A) Interface	Conforms to USB2.0 (Type A) x 1. Power supply voltage: 5 Vdc+/-5%. Output Current: 500 mA or less. Maximum communication distance: 5 m (16.4 ft).
D	Serial Interface (COM1)	RS-232C Serial Interface. Connector: D-Sub 9 pin (plug) x 1.
E	Serial Interface (COM2)*2	RS-485 Serial Interface. Connector: Modular jack (RJ-45) x 1.
F	Power Plug Connector	-
G	SD Card Access LED *3	This lamp lights up when SD Card is inserted. For more information, refer to SD Card Insertion / Removal *(see page 131)*.
H	SD Card Interface Cover/Replacement Battery Insertion Cover	For information on how to open the cover, and insert or remove the SD Card, refer to SD Card Insertion / Removal *(see page 131)*. For information on how to open the cover and replace the battery, refer to Replacing the Primary Battery *(see page 146)*.
I	USB (mini-B) Interface	Conforms to USB2.0 (mini-B) x 1. Communication Distance: 5 m (16.4 ft) or less.
J	Ethernet Interface *4	Ethernet transmission interface (10BASE-T/100BASE-TX) Connector: Modular jack (RJ-45) x 1.

*1 Status LED operations are as shown below:

Color	Indicator	Description
Green	ON	Offline
		In operation
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
-	OFF	Power is turned OFF.

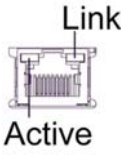
*2 COM2 LED operations are as shown below.

Color	Indicator	Description
Yellow	ON	Communication (sending or receiving data) is occurring.
	OFF	No communication.

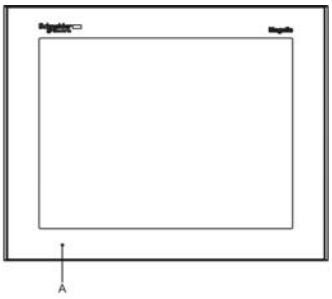
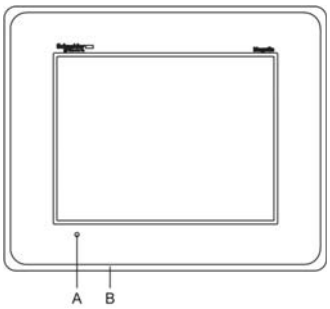
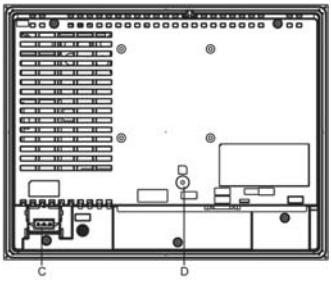
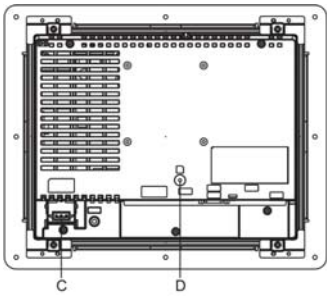
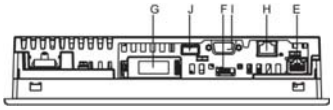
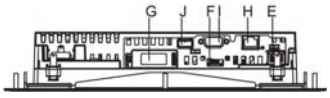
*3 SD Card Access LED operations are as shown below.

Color	Indicator	Description
Green (Active)	ON	The SD Card is inserted.
	OFF	The SD Card is not inserted or is not being accessed.

*4 Ethernet LED operations are as shown below.

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission.
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission failure.

HMIGTO5310/5315 Parts Identification

Side	HMIGTO5310	HMIGTO5315
Front		
Rear		
Bottom		

Part	Name	Description
A	Status LED	*1
B	Stainless Steel Bezel	HMIGTO5315 only.
C	Power Plug Connector	-
D	SD Card Access LED *2	This lamp lights up when SD Card is inserted. **NOTE:** Do not remove or insert the SD Card when the LED lamp is on. Doing so may damage data on the SD Card.
E	Ethernet Interface *3	Ethernet transmission interface (10BASE-T/100BASE-TX) Connector: Modular jack (RJ-45) x 1.
F	USB (mini-B) Interface	Conforms to USB2.0 (mini-B) x 1. Communication Distance: 5 m (16.4 ft) or less.
G	SD Card Interface Cover/Replacement Battery Insertion Cover	For information on how to open the cover, and insert or remove the SD Card, refer to SD Card Insertion/Removal *(see page 131)*. For information on how to open the cover and replace the battery, refer to Replacing the Primary Battery *(see page 146)*.
H	Serial Interface (COM2)*4	RS-485 Serial Interface. Connector: Modular jack (RJ-45).
I	Serial Interface (COM1)	RS-232C Serial Interface. Connector: D-Sub 9 pin (plug) x 1.
J	USB (Type A) Interface	Conforms to USB2.0 (Type A) x 1. Power supply voltage: 5Vdc+/-5%. Output Current: 500 mA or less. Maximum communication distance: 5 m (16.4 ft).

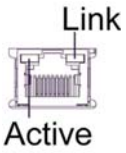
*1 Status LED operations are as shown below:

Color	Indicator	Description
Green	ON	Offline
		In operation
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
-	OFF	Power is turned OFF.

*2 SD Card Access LED operations are as shown below.

Color	Indicator	Description
Green (Active)	ON	The SD Card is inserted.
	OFF	The SD Card is not inserted or is not being accessed.

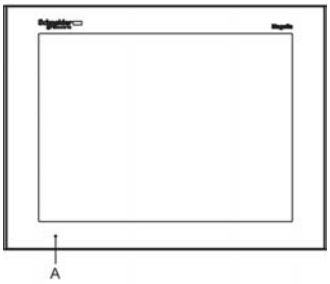
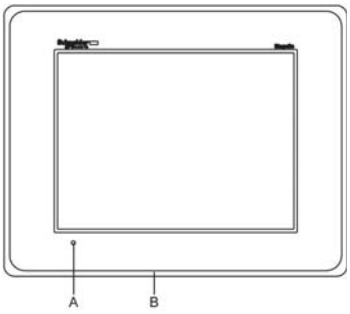
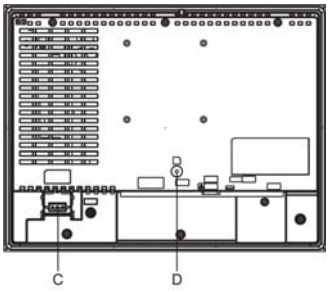
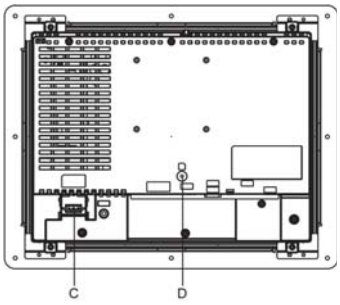
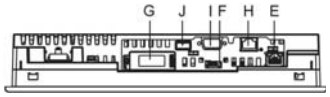
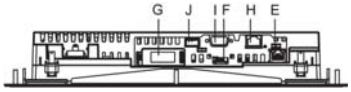
*3 Ethernet LED operations are as shown below.

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission.
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission failure.

*4 COM2 LED operations are as shown below.

Color	Indicator	Description
Yellow	ON	Communication (sending or receiving data) is occurring.
	OFF	No communication.

HMIGTO6310/6315 Parts Identification

Side	HMIGTO6310	HMIGTO6315
Front		
Rear		
Bottom		

Part	Name	Description
A	Status LED	*1
B	Stainless Steel Bezel	HMIGTO6315 only.
C	Power Plug Connector	-
D	SD Card Access LED *2	This lamp lights up when SD Card is inserted. **NOTE:** Do not remove or insert the SD Card when the LED lamp is on. Doing so may damage data on the SD Card.
E	Ethernet Interface *3	Ethernet transmission interface (10BASE-T/100BASE-TX) Connector: Modular jack (RJ-45) x 1.
F	USB (mini-B) Interface	Conforms to USB2.0 (mini-B) x 1. Communication Distance: 5 m (16.4 ft) or less.
G	SD Card Interface Cover/Replacement Battery Insertion Cover	For information on how to open the cover, and insert or remove the SD Card, refer to SD Card Insertion/Removal *(see page 131)*. For information on how to open the cover and replace the battery, refer to Replacing the Primary Battery *(see page 146)*.
H	Serial Interface (COM2)	RS-485 Serial Interface. Connector: Modular jack (RJ-45)
I	Serial Interface (COM1)	RS-232C Serial Interface. Connector: D-Sub 9 pin (plug) x 1.
J	USB (Type A) Interface	Conforms to USB2.0 (Type A) x 1. Power supply voltage: 5Vdc+/-5%. Output Current: 500 mA or less. Maximum communication distance: 5 m (16.4 ft).

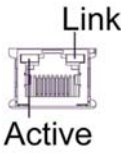
*1 Status LED operations are as shown below:

Color	Indicator	Description
Green	ON	Offline
		In operation
Orange	Flashing	Software starting up.
Red	ON	Power is turned ON.
-	OFF	Power is turned OFF.

*2 SD Card Access LED operations are as shown below.

Color	Indicator	Description
Green (Active)	ON	The SD Card is inserted.
	OFF	The SD Card is not inserted or is not being accessed.

*3 Ethernet LED operations are as shown below.

	Color	Indicator	Description
	Green (Active)	Flashing	Data transmission is occurring.
		OFF	No data transmission.
	Green (Link)	ON	Data transmission is available in 10BASE-T/100BASE-TX.
		OFF	No connection or subsequent transmission failure.

*4 COM2 LED operations are as shown below.

Color	Indicator	Description
Yellow	ON	Communication (sending or receiving data) is occurring.
	OFF	No communication.

Chapter 4
Specifications

Overview

This chapter presents the HMIGTO specifications.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
4.1	HMIGTO1300/1310	36
4.2	HMIGTO2300/2310/2315	50
4.3	HMIGTO3510/4310	68
4.4	HMIGTO5310/5315	84
4.5	HMIGTO6310/6315	101

Section 4.1
HMIGTO1300/1310

What Is in This Section?

This section contains the following topics:

Topic	Page
Electrical Specifications	37
Environmental Specifications	38
Structural Specifications	39
Display Specifications	40
Memory, Clock, Touch Panel and Function Switches	41
Interface Specifications	42
Specifications of Serial Interface COM1	43
Specifications of Serial Interface COM2	45
Dimensions	46

Electrical Specifications

Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		2 ms or less
	Power Consumption		9.6 W or less
		When power is not supplied to external devices	5.2 W or less
		Backlight OFF (Standby Mode)	4.2 W or less
		Backlight Dimmed (Brightness: 20%)	4.3 W or less
	In-Rush Current		30 A or less
Voltage Endurance			1,000 Vac 20 mA for 1 minute (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

Environmental Specifications

Physical Environment	Surrounding Air Temperature	0...50 °C (32...122 °F)
	Storage Temperature	-20...60 °C (-4...140 °F)
	Surrounding Air and Storage Humidity	10%...90% RH (Non condensing, wet bulb temperature 39 °C [102.2 °F] or less)
	Dust	0.1 mg/m^3 (10^{-7} oz/ft^3) or less (non-conductive levels)
	Pollution Degree	For use in Pollution Degree 2 environment
	Corrosive Gases	Free of corrosive gases
	Atmospheric Pressure (Operating Altitude)	800...1,114 hPa (2,000 m [6,561 ft] or lower)
Mechanical Environment	Vibration Resistance	IEC/EN 61131-2 compliant 5...9 Hz Single amplitude 3.5 mm (0.14 in.) 9...150 Hz Fixed acceleration: 9.8 m/s^2 X, Y, Z directions for 10 cycles (approx. 100 min.)
	Concussion Resistance	IEC/EN 61131-2 compliant 147 m/s^2, X, Y, Z directions for 3 times
Electrical Environment	Noise immunity	Noise Voltage: 1,000 Vp-p Pulse Width: 1 µs Rise Time: 1 ns (via noise simulator)
	Electrostatic Discharge Immunity	Contact Discharge Method: 6 kV (IEC/EN 61000-4-2 Level 3)

Air quality requirements

Do not operate or store the panel where chemicals evaporate, or where chemicals are present in the air:

- Corrosive chemicals: Acids, alkalines, liquids containing salt.
- Flammable chemicals: Organic solvents.

⚠ CAUTION

INOPERATIVE EQUIPMENT

Do not allow water, liquids, metal, and wiring fragments to enter the panel case.

Failure to follow these instructions can result in injury or equipment damage.

Structural Specifications

Grounding	Functional grounding: Grounding resistance of 100Ω, 2mm^2 (AWG 14) or thicker wire, or your country's applicable standard. (Same for FG and SG terminals)
Cooling Method	Natural air circulation
Structure *1	IP65f NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)
External Dimensions	W132 x H106 x D42 mm (W5.2 x H4.17 x D1.65 in.)
Panel Cut Dimensions	W118.5 x H92.5 mm (W4.67 x H3.64 in.)*2 Panel thickness area: 1.6...5 mm (0.06...0.2 in)*3
Weight	0.4 kg (0.9 lb) or less (main unit only)

*1 The front face of the HMIGTO, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification. Even though the HMIGTO's level of resistance is equivalent to these standards, oils that should have no effect on the HMIGTO can possibly harm the panel. This can occur in areas where either vaporized oils are present, or where low viscosity cutting oils are allowed to adhere to the panel for long periods of time. If the panel's front face protection sheet peels off, these conditions can lead to the ingress of oil into the panel and separate protection measures are suggested.

Also, if non-approved oils are present, they may cause deformation or corrosion of the front panel's plastic cover. Therefore, prior to installing the panel, be sure to confirm the type of conditions that will be present in the panel's operating environment. If the installation gasket is used for a long period of time, or if the panel and its gasket are removed from the panel, the original level of protection cannot be kept. To maintain the original protection level, be sure to replace the installation gasket regularly.

*2 For dimensional tolerance, everything +1/-0 mm (+0.04/-0 in.) and R in angle are below R3 (R0.12 in.)

*3 Even if the installation wall thickness is within the recommended range for the "Panel Cut Dimensions", depending on wall's material, size, and installation location of the panel and other devices, the installation wall could warp. To prevent warping, the installation surface may need to be strengthened.

The front face of the panel, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification.

⚠ CAUTION

EQUIPMENT DAMAGE

Ensure that the panel is not in permanent and direct contact with oils.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

STORAGE AND OPERATION OUTSIDE OF SPECIFICATIONS

- Store the panel in areas where temperatures are within the panel's specifications.
- Do not restrict or block the panel's rear-face ventilation slots.

Failure to follow these instructions can result in equipment damage.

NOTICE

GASKET AGING

- Inspect the gasket periodically as required by your operating environment to keep the initial IP level.
- Change the gasket at least once a year, or as soon as scratches or dirt become visible.

Failure to follow these instructions can result in equipment damage.

Display Specifications

		HMIGTO1310	HMIGTO1300
Display Type		TFT Color LCD	
Display Size		3.5”	
Resolution		320 x 240 pixels (QVGA)	
Effective Display Area		W70.56 x H52.92 mm (W2.78 x H2.08 in.)	
Display Colors		65,536 colors (No blink) / 16,384 colors (Blink)	
Backlight		White LED (Not user replaceable. When replacement is required, contact your local distributor.)	
Backlight Service Life		50,000 hours or more (continuous operation at 25 °C [77 °F] before backlight brightness decreased to 50%)	
Brightness Control		16 levels (Adjusted with touch panel or software	
Language Fonts		ASCII: (Code page 850) Alphanumeric (including European characters) Chinese: (GB2312-80 codes) Simplified Chinese fonts Japanese (except for XBT GT1000 series): ANK 158, Kanji: 6,962 (JIS Standards 1 & 2) (including 607 non-kanji characters) Korean: (KSC5601 - 1992 codes) Hangul fonts Taiwanese: (Big 5 codes) Traditional Chinese fonts	
Character sizes		8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts	
Font sizes		You can expand width up to 8 times, and expand height up to 8 times.*1	
Text	8 x 8 pixels	40 characters per row x 30 rows	
	8 x 16 pixels	40 characters per row x 15 rows	
	16 x 16 pixels	20 characters per row x 15 rows	
	32 x 32 pixels	10 characters per row x 7 rows	

*1 You can set up other font sizes using the software.

Memory, Clock, Touch Panel and Function Switches

Memory

	HMIGTO1310	HMIGTO1300
Application Memory *1	FLASH EPROM 96 MB	FLASH EPROM 64 MB
Application run DRAM	128 MB	128 MB
Data Backup	SRAM 512 KB (Rechargeable lithium battery for data backup)	SRAM 128 KB (Rechargeable lithium battery for data backup)

*1 Capacity available for user application.

NOTE:

- When the message "Battery level is low" is displayed, supply power to the panel and fully charge the battery. In 24 hours the battery charges to a level that allows backup operation. Completing a full charge requires about 120 hours (5 days).
- The lifetime of the rechargeable lithium battery is 10 years when the battery's ambient temperature is 40 °C (104 °F) or less, 4.1 years when the battery's ambient temperature is 50 °C (122 °F) or less, and 1.5 years when the battery's ambient temperature is 60 °C (140 °F) or less.
  When used for backup:
  Approximately 100 days with a fully charged battery.
  Approximately 6 days with a half-charged battery.

Clock

Clock Accuracy*1	±65 seconds/month (deviation at room temperature and power is OFF).

*1 Depending on the operating temperature and age of panel, the clock can deviate from -380 to +90 sec/month. For systems where this level of precision is insufficient, the user should monitor and make adjustments when required.

NOTE:

- When the message "Battery level is low" is displayed, supply power to the panel and fully charge the battery. In 24 hours the battery charges to a level that allows backup operation. Completing a full charge requires about 120 hours (5 days).
- The lifetime of the rechargeable lithium battery is 10 years when the battery's ambient temperature is 40 °C (104 °F) or less, 4.1 years when the battery's ambient temperature is 50 °C (122 °F) or less, and 1.5 years when the battery's ambient temperature is 60 °C (140 °F) or less.
  When used for backup:
  Approximately 100 days with a fully charged battery.
  Approximately 6 days with a half-charged battery.

Touch Panel

Touch Panel Type	Resistive Film (analog)
Touch Panel Resolution	1,024 x 1,024
Touch Panel Service Life	1 million times or more

Function Switches

Six switches (F1 to F6).

Interface Specifications

Serial Interface COM1

	HMIGTO1310	HMIGTO1300
Asynchronous Transmission	RS-232C / RS-485	RS-232C
Data Length	7 or 8 bits	
Stop Bit	1 or 2 bits	
Parity	None, odd or even	
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)	2,400...115,200 bps
Connector	Modular jack (RJ-45)	D-Sub 9 pin (plug)

Serial Interface COM2

	HMIGTO1300
Asynchronous Transmission	RS-485
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)
Connector	Modular jack (RJ-45)

USB Interface

	USB (Type A) Interface	USB (mini-B) Interface
Connector	USB 2.0 (Type A) x 1	USB 2.0 (mini-B) x 1
Power Supply Voltage	5 Vdc ±5%	-
Maximum Current Supplied	500 mA	-
Maximum Transmission Distance	5 m (16.4 ft)	

Ethernet Interface

	HMIGTO1310
Ethernet (LAN)	IEEE802.3i / IEEE802.3u, 10BASE-T/100BASE-TX
Connector	Modular jack (RJ45) x 1

NOTE: HMIGTO1300 does not have an Ethernet interface.

Specifications of Serial Interface COM1

Introduction

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

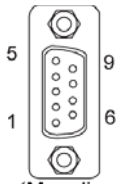
When using the SG terminal to connect an external device to the panel:

- Verify that a short-circuit loop is not created when you set up the system.
- For HMIGTO1300, connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.
- For HMIGTO1310, connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM1

HMIGTO1300: D-Sub 9 pin plug connector via an RS-232C cable.

Pin Connection	Pin No.	RS-232C		
		Signal Name	Direction	Meaning
 (Magelis GTO side)	1	CD	Input	Carrier Detect
	2	RD(RXD)	Input	Receive Data
	3	SD(TXD)	Output	Send Data
	4	ER(DTR)	Output	Data Terminal Ready
	5	SG	-	Signal Ground
	6	DR(DSR)	Input	Data Set Ready
	7	RS(RTS)	Output	Request to Send
	8	CS(CTS)	Input	Send possible
	9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A
	Shell	FG	–	Frame Ground (Common with SG)

You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

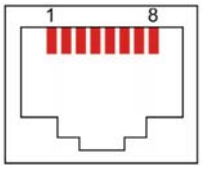
⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

HMIGTO1310: RJ-45 connector via an RS-232C or RS-485 cable.

Pin Connection	Pin No.	RS-232C/RS-485		
		Signal Name	Direction	Meaning
	1	RD(RXD)	Input	Receive Data (RS-232C)
	2	SD(TXD)	Output	Send Data (RS-232C)
	3	NC	–	–
	4	D1	Input/Output	Transfer Data (RS-485)
	5	D0	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request to Send
	7	NC	–	–
	8	SG	–	Signal Ground
	Shell	FG	–	Frame Ground (Common with SG)

⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

Specifications of Serial Interface COM2

Introduction

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

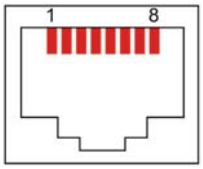
When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM2

HMIGTO1300: RJ-45 connector via an RS-485 cable

NOTE: When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Connection	Pin No.	RS-485		
		Signal Name	Direction	Meaning
	1	NC	–	–
	2	NC	–	–
	3	NC	–	–
	4	Line A	Input/Output	Transfer Data (RS-485)
	5	Line B	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request to Send
	7	NC	–	–
	8	SG	–	Signal Ground

⚠ CAUTION

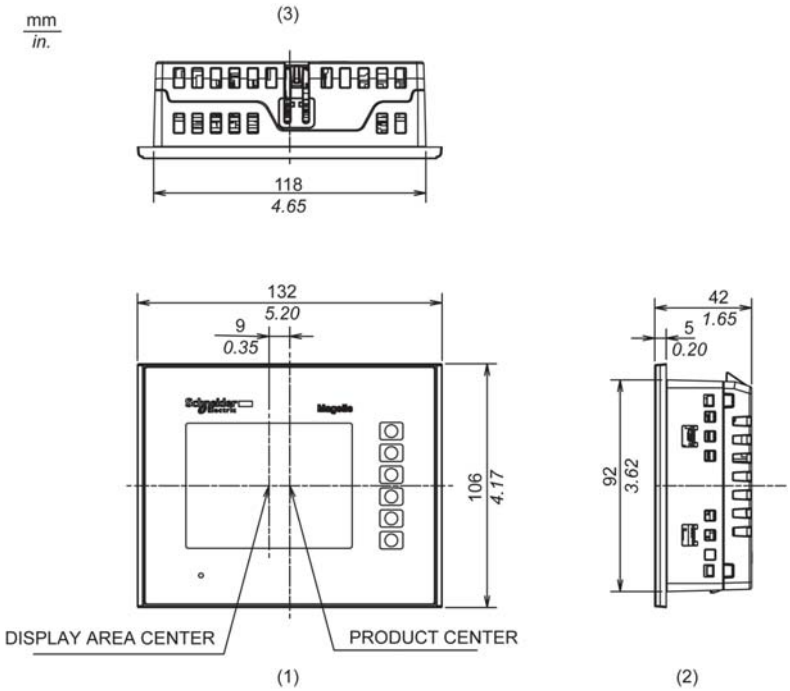
LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

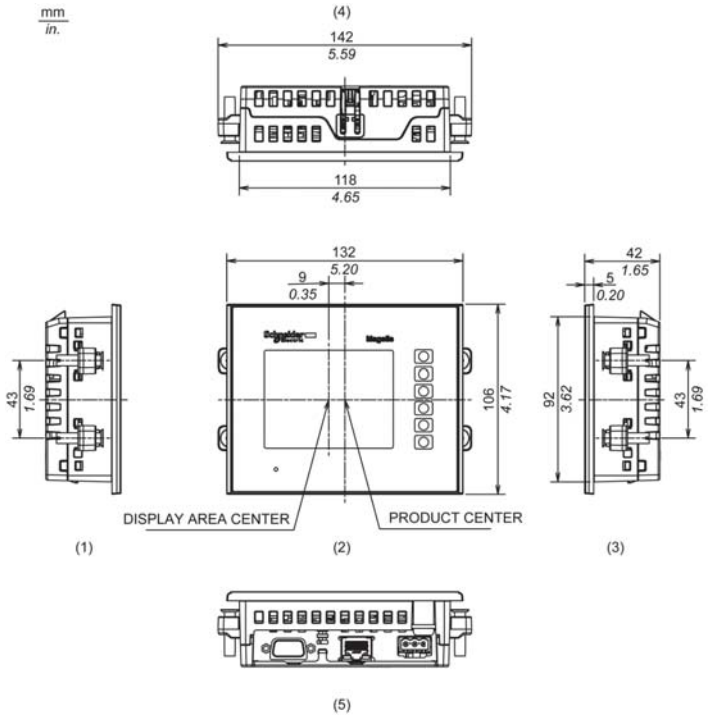
Dimensions

External Dimensions



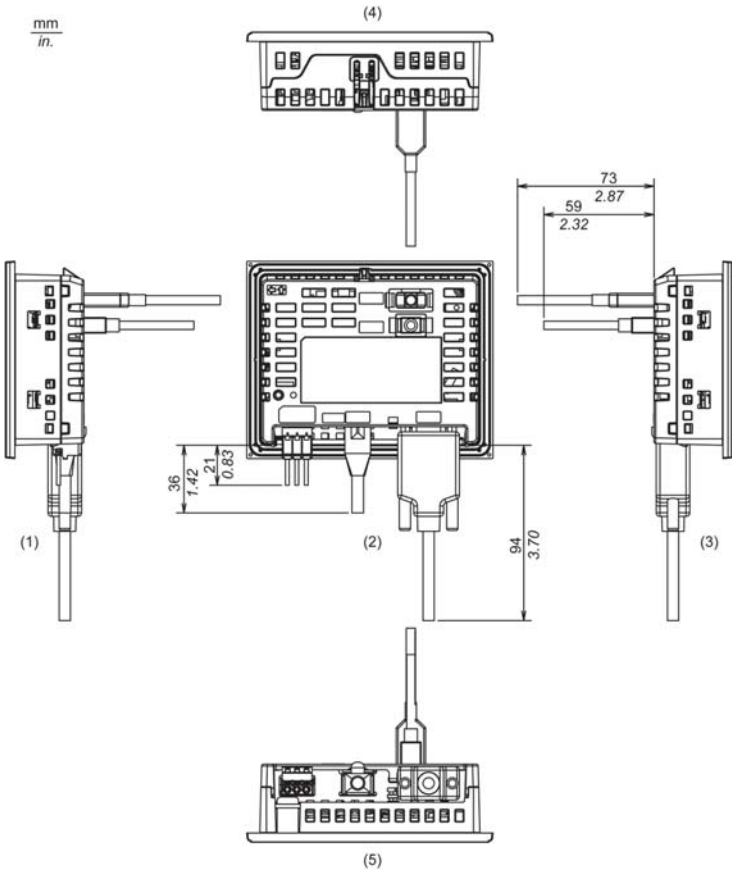
1 Front
2 Right Side
3 Top

Installation with Installation Fasteners



1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

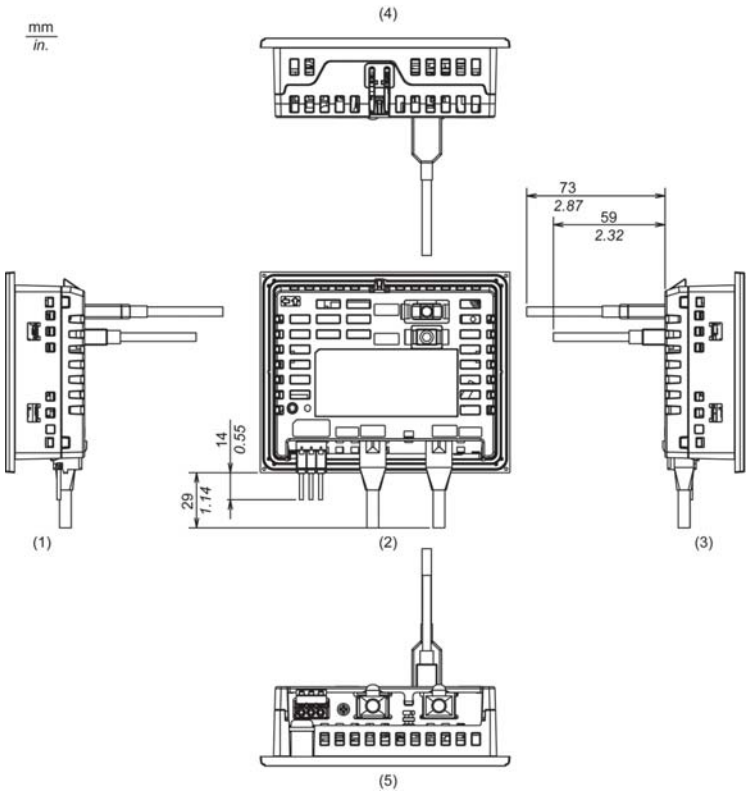
Dimensions with Cables: HMIGTO1300



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Dimensions with Cables: HMIGTO1310

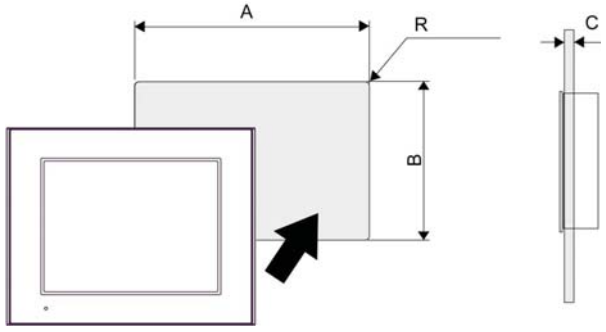


1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Panel Cut Dimensions

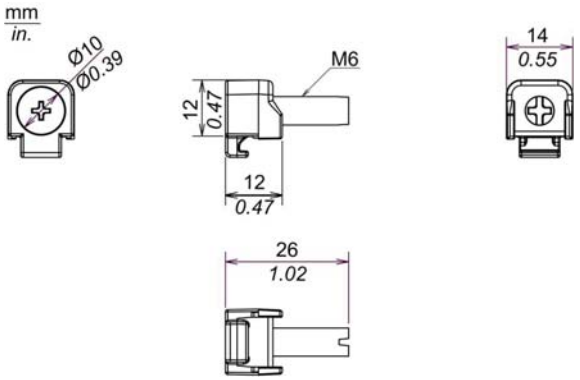
Create a panel cut and insert the panel into the opening from the front.



A	B	C	R
118.5 mm (+1, -0 mm) (4.67 in [+0.04, -0 in.])	92.5 mm (+1, -0 mm) (3.64 in. [+0.04, -0 in.])	1.6...5 mm (0.06...0.2 in)	3 mm (0.12 in.) maximum

NOTE: Before designing the panel cut, refer to Installation *(see page 120)*.

Installation Fastener Dimensions



Section 4.2
HMIGTO2300/2310/2315

What Is in This Section?

This section contains the following topics:

Topic	Page
Electrical Specifications	51
Environmental Specifications	52
Structural Specifications	53
Display Specifications	55
Memory, Clock, and Touch Panel	56
Interface Specifications	57
Specifications of Serial Interface COM1	58
Specifications of Serial Interface COM2	60
Dimensions	61

Electrical Specifications

Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		5 ms or less
	Power Consumption		10.5 W or less
		When power is not supplied to external devices	6.5 W or less
		Backlight OFF (Standby Mode)	4.5 W or less
		Backlight Dimmed (Brightness: 20%)	5 W or less
	In-Rush Current		30 A or less
Voltage Endurance			1,000 Vac, 20 mA for 1 minute (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

Environmental Specifications

		HMIGTO2310 / HMIGTO2315	HMIGTO2300
Physical Environment	Surrounding Air Temperature	0...55 °C (32 °F...131 °F)	0...50 °C (32...122 °F)
	Storage Temperature	-20...60 °C (-4...140 °F)	
	Surrounding Air and Storage Humidity	10...90% RH (Non condensing, wet bulb temperature 39 °C [102.2 °F] or less)	
	Dust	0.1 mg/m^3 (10^{-7} oz/ft^3) or less (non-conductive levels)	
	Pollution Degree	For use in Pollution Degree 2 environment	
	Corrosive Gases	Free of corrosive gases	
	Atmospheric Pressure (Operating Altitude)	800...1,114 hPa (2,000 m [6,561 ft] or lower)	
Mechanical Environment	Vibration Resistance	IEC/EN 61131-2 compliant 5...9 Hz Single amplitude 3.5 mm (0.14 in.) 9...150 Hz Fixed acceleration: 9.8 m/s^2 X, Y, Z directions for 10 cycles (approx. 100 min)	
	Concussion Resistance	IEC/EN 61131-2 compliant 147 m/s^2, X, Y, Z directions for 3 times	
Electrical Environment	Noise Immunity	Noise Voltage: 1,000 Vp-p Pulse Width: 1 µs Rise Time: 1 ns	
	Electrostatic Discharge Immunity	Contact Discharge Method: 6 kV (IEC/EN 61000-4-2 Level 3)	

Air quality requirements

Do not operate or store the panel where chemicals evaporate, or where chemicals are present in the air:

- Corrosive chemicals: Acids, alkalines, liquids containing salt.
- Flammable chemicals: Organic solvents.

⚠ CAUTION

INOPERATIVE EQUIPMENT

Do not allow water, liquids, metal, and wiring fragments to enter the panel case.

Failure to follow these instructions can result in injury or equipment damage.

Structural Specifications

	HMIGTO2300/HMIGTO2310	HMIGTO2315
Grounding	Functional grounding: Grounding resistance of 100Ω, 2mm^2 (AWG 14) or thicker wire, or your country's applicable standard. (Same for FG and SG terminals)	
Cooling Method	Natural air circulation	
Structure[*1]	IP65f NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)	IP66k NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)[*2]
External Dimensions	W169.5 x H137 x D59.5 mm (W6.67 x H5.39 x D2.34 in.)	W213.5 x H181 x D59.5 mm (W8.41 x H7.13 x D2.34 in.)
Panel Cut Dimensions	W156 x H123.5 mm (W6.14 x H4.86 in.) [*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.) [*4]	W195 x H162.5 mm (W7.68 x H6.40 in.) [*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.) [*4]
Weight	0.8 kg (1.8 lbs) or less (main unit only)	1.2 kg (2.6 lbs) or less (main unit only)

NOTE: [*1] The front face of the HMIGTO, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification. Even though the HMIGTO's level of resistance is equivalent to these standards, oils that should have no effect on the HMIGTO can possibly harm the panel. This can occur in areas where either vaporized oils are present, or where low viscosity cutting oils are allowed to adhere to the panel for long periods of time. If the panel's front face protection sheet peels off, these conditions can lead to the ingress of oil into the panel and separate protection measures are suggested.
Also, if non-approved oils are present, they may cause deformation or corrosion of the front panel's plastic cover. Therefore, prior to installing the panel, be sure to confirm the type of conditions that will be present in the panel's operating environment. If the installation gasket is used for a long period of time, or if the panel and its gasket are removed from the panel, the original level of protection cannot be kept. To maintain the original protection level, be sure to replace the installation gasket regularly.

[*2] When installing the HMIGTO in a panel, you may not be able to mount the HMIGTO flush with the panel. This occurs due to the thickness of the gasket. The difference in level between the HMIGTO and panel depends on how much the gasket is compressed.

NOTICE

EQUIPMENT DAMAGE

For food and beverage and pharmaceutical industries, when the HMIGTO is not flush with panel, use silicon to form a seal to prevent water, chemicals, or food from lodging into place. Otherwise, the panel face could leak.

Failure to follow these instructions can result in equipment damage.

[*3] For dimensional tolerance, everything +1/-0 mm (+0.04/-0 in.) and R in angle are below R3 (R0.12 in.)

[*4] Even if the installation wall thickness is within the recommended range for the "Panel Cut Dimensions", depending on wall's material, size, and installation location of the panel and other devices, the installation wall could warp. To prevent warping, the installation surface may need to be strengthened.

⚠ CAUTION

EQUIPMENT DAMAGE

Ensure that the panel is not in permanent and direct contact with oils.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

STORAGE AND OPERATION OUTSIDE OF SPECIFICATIONS

- Store the panel in areas where temperatures are within the panel's specifications.
- Do not restrict or block the panel's rear-face ventilation slots.

Failure to follow these instructions can result in equipment damage.

NOTICE

GASKET AGING

- Inspect the gasket periodically as required by your operating environment to keep the initial IP level.
- Change the gasket at least once a year, or as soon as scratches or dirt become visible.

Failure to follow these instructions can result in equipment damage.

Display Specifications

Display Type		TFT Color LCD
Display Size		5.7”
Resolution (pixels)		320 x 240 pixels (QVGA)
Effective Display Area		W115.2 x H86.4 mm (W4.54 x H3.40 in.)
Display Colors		65,536 colors (No blink) / 16,384 colors (Blink)
Backlight		White LED (Not user replaceable. When replacement is required, contact your local distributor.)
Backlight Service Life		50,000 hours or more (continuous operation at 25 °C [77 °F] before backlight decreases to 50%.)
Brightness Control		16 levels (Adjusted with touch panel or software)
Language Fonts		ASCII: (Code page 850) Alphanumeric (including European characters) Chinese: (GB2312-80 codes) Simplified Chinese fonts Japanese (except for XBT GT1000 series): ANK 158, Kanji: 6,962 (JIS Standards 1 & 2) (including 607 non-kanji characters) Korean: (KSC5601 - 1992 codes) Hangul fonts Taiwanese: (Big 5 codes) Traditional Chinese fonts
Character Sizes		8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts
Font Sizes		You can expand the width up to 8 times, and expand the height up to 8 times.*1
Text	8 x 8 pixels	40 characters per row x 30 rows
	8 x 16 pixels	40 characters per row x 15 rows
	16 x 16 pixels	20 characters per row x 15 rows
	32 x 32 pixels	10 characters per row x 7 rows

*1 You can set up other font sizes using the software.

Memory, Clock, and Touch Panel

Memory

	HMIGTO2310 / HMIGTO2315	HMIGTO2300
Application Memory *1	FLASH EPROM 96 MB	FLASH EPROM 64 MB
Application run DRAM	128 MB	128 MB
Data Backup	SRAM 512 KB (Replaceable lithium battery for data backup)	SRAM 128 KB (Rechargeable lithium battery for data backup)

*1 Capacity available for user application.

NOTE:

- When the message "Battery level is low" is displayed on the HMIGTO2300, supply power to the panel and fully charge the battery. In 24 hours the battery charges to a level that allows backup operation. Completing a full charge requires about 120 hours (5 days).
- The lithium battery's lifetime is: 10 years when the battery's ambient temperature is 40 °C (104 °F) or less, 4.1 years when the battery's ambient temperature is 50 °C (122 °F) or less, and 1.5 years when the battery's ambient temperature is 60 °C (140 °F) or less.
  When used for backup:
  Approximately 100 days, with a fully charged battery.
  Approximately 6 days, with a half-charged battery.

Clock

Clock Accuracy*1	±65 seconds/month (deviation at room temperature and power is OFF).

*1 Depending on the operating temperature and age of panel, the clock can deviate from -380 to +90 sec/month. For systems where this level of precision is insufficient, the user should monitor and make adjustments when required.

NOTE:

- When the message "Battery level is low" is displayed on the HMIGTO2300, supply power to the panel and fully charge the battery. In 24 hours the battery charges to a level that allows backup operation. Completing a full charge requires about 120 hours (5 days).
- The lithium battery's lifetime is: 10 years when the battery's ambient temperature is 40 °C (104 °F) or less, 4.1 years when the battery's ambient temperature is 50 °C (122 °F) or less, and 1.5 years when the battery's ambient temperature is 60 °C (140 °F) or less.
  When used for backup:
  Approximately 100 days, with a fully charged battery.
  Approximately 6 days, with a half-charged battery.

Touch Panel

Touch Panel Type	Resistive Film (analog)
Touch Panel Resolution	1,024 x 1,024
Touch Panel Service Life	1 million times or more

Interface Specifications

Serial Interface COM1

Asynchronous Transmission	RS-232C
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps
Connector	D-Sub 9 pin (plug)

Serial Interface COM2

Asynchronous Transmission	RS-485
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)
Connector	Modular jack (RJ-45)

USB Interface

	USB (Type A) Interface	**USB (mini-B) Interface**
Connector	USB 2.0 (Type A) x 1	USB 2.0 (mini-B) x 1
Power Supply Voltage	5 Vdc ±5%	-
Maximum Current Supplied	500 mA	-
Maximum Transmission Distance	5 m (16.4 ft)	

Ethernet Interface

	HMIGTO2310 / HMIGTO2315
Ethernet (LAN)	IEEE802.3i / IEEE802.3u, 10BASE-T/100BASE-TX
Connector	Modular jack (RJ45) x 1

SD Card Interface

HMIGTO2310/HMIGTO2315: SD Card slot x 1 (maximum 32 GB SD/SDHC Card)

NOTE: HMIGTO2300 does not have an SD Card interface.

Specifications of Serial Interface COM1

Introduction

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

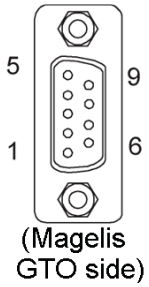
When using the SG terminal to connect an external device to the panel:

- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM1

HMIGTO2300 / HMIGTO2310/ HMIGTO2315: D-Sub 9 pin plug connector via an RS-232C cable.

Pin Connection	Pin No.	RS-232C		
		Signal Name	Direction	Meaning
 (Magelis GTO side)	1	CD	Input	Carrier Detect
	2	RD(RXD)	Input	Receive Data
	3	SD(TXD)	Output	Send Data
	4	ER(DTR)	Output	Data Terminal Ready
	5	SG	-	Signal Ground
	6	DR(DSR)	Input	Data Set Ready
	7	RS(RTS)	Output	Request to Send
	8	CS(CTS)	Input	Send possible
	9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A[*1]
	Shell	FG	–	Frame Ground (Common with SG)

NOTE: [*1] You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

Specifications of Serial Interface COM2

Introduction

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

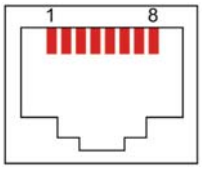
When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM2

HMIGTO2300 / HMIGTO2310/ HMIGTO2315: RJ45 connector via an RS-485 cable.

NOTE: When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Connection	Pin No.	RS-422/RS-485		
		Signal Name	Direction	Meaning
	1	NC	-	-
	2	NC	-	-
	3	NC	-	-
	4	Line A	Input/Output	Transfer Data (RS-485)
	5	Line B	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request To Send
	7	NC	-	-
	8	SG	-	Signal Ground

⚠ CAUTION

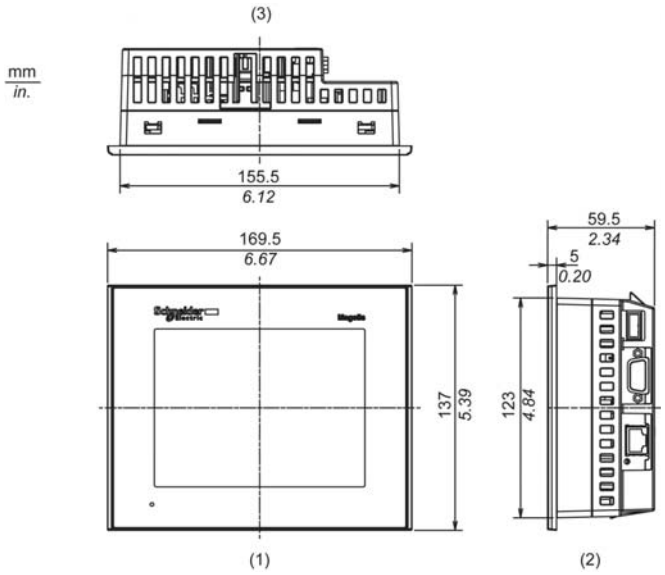
LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

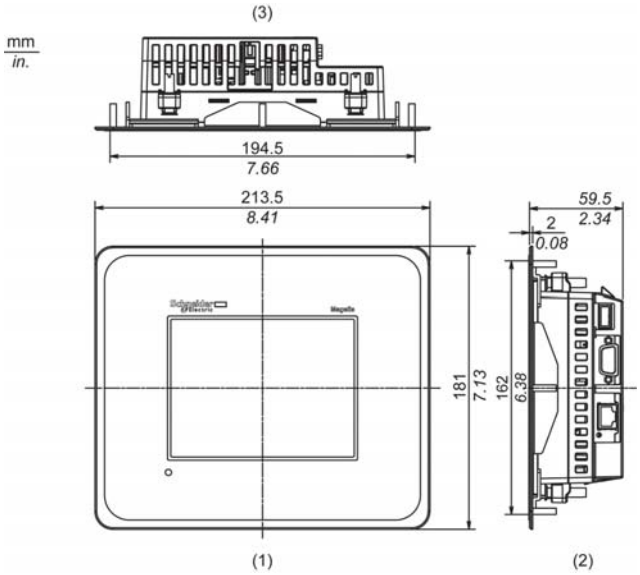
Dimensions

External Dimensions: HMIGTO2300/HMIGTO2310



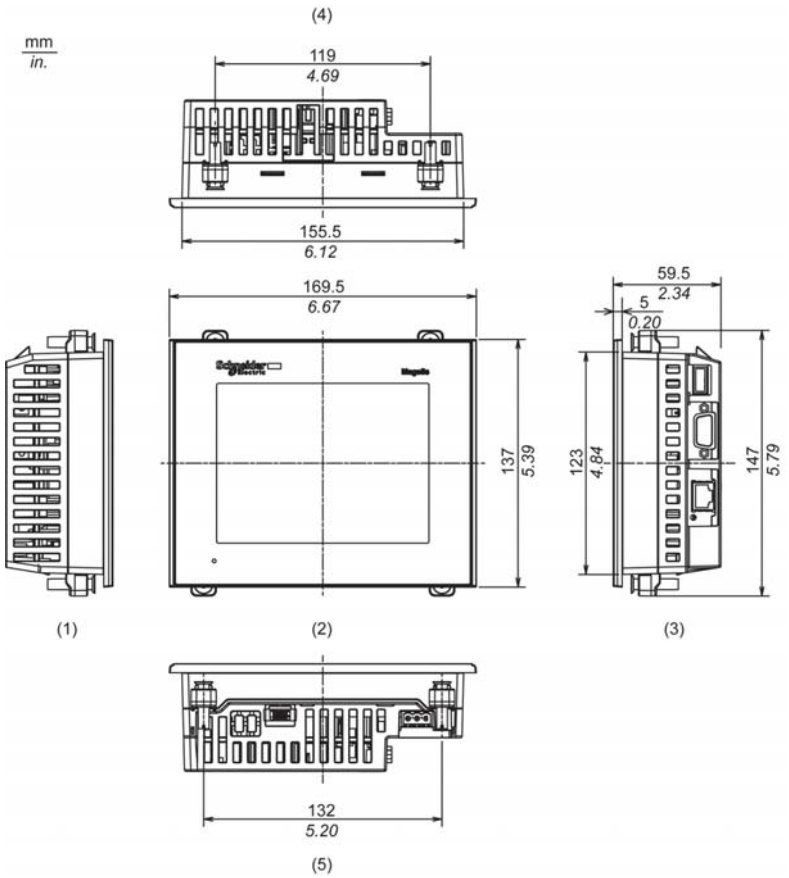
1 Front
2 Right Side
3 Top

External Dimensions: HMIGTO2315



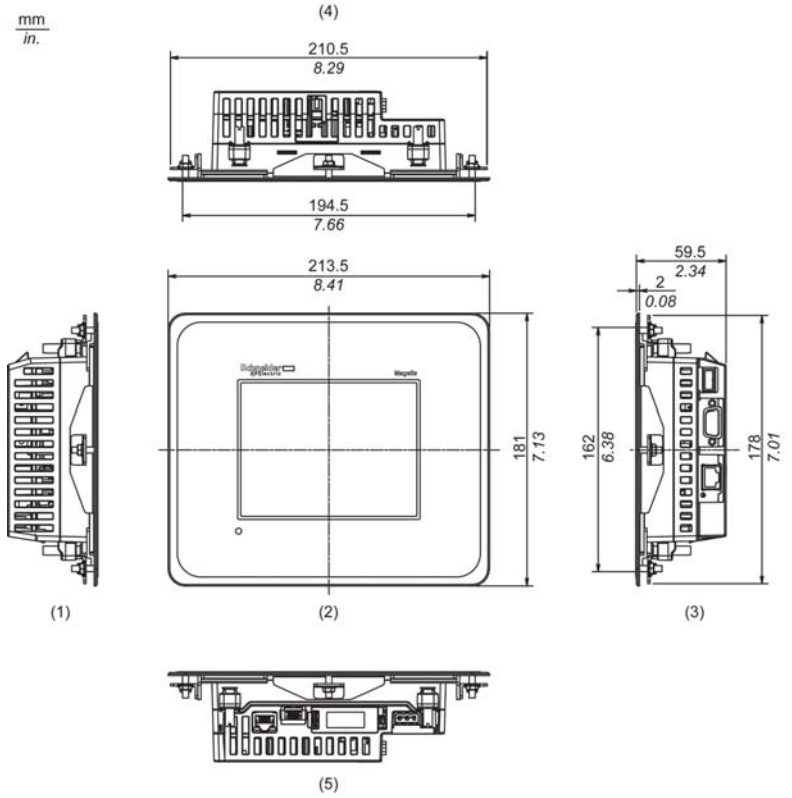
1 Front
2 Right Side
3 Top

Installation with Installation Fasteners: HMIGTO2300/HMIGTO2310



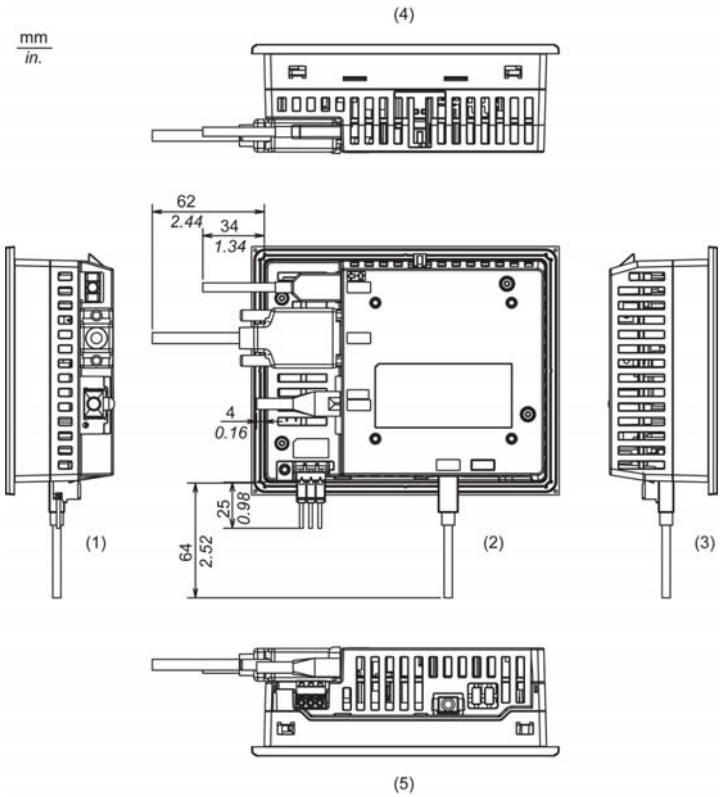
1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

Installation with Installation Fasteners: HMIGTO2315



1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

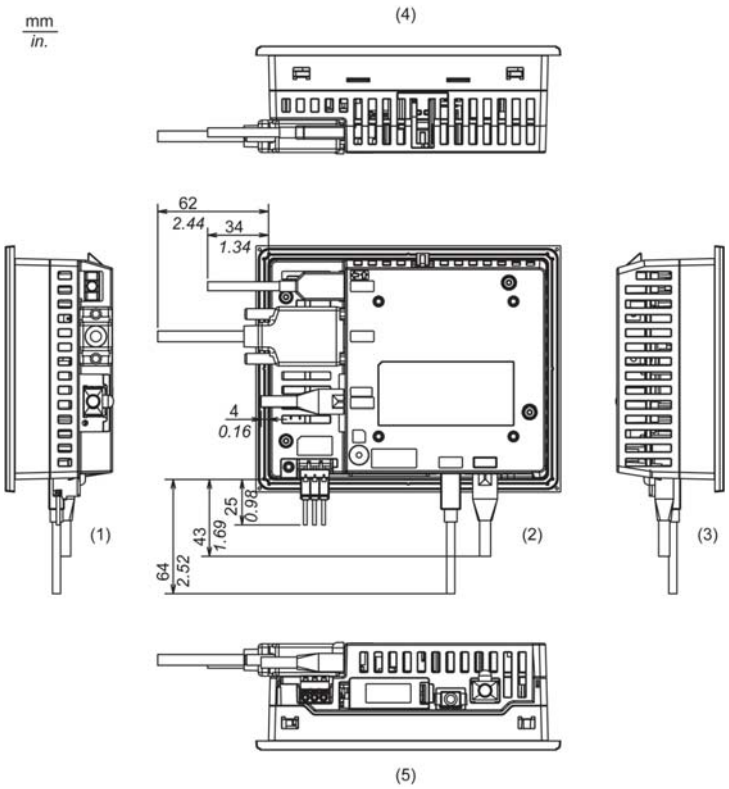
Dimensions with Cables: HMIGTO2300



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

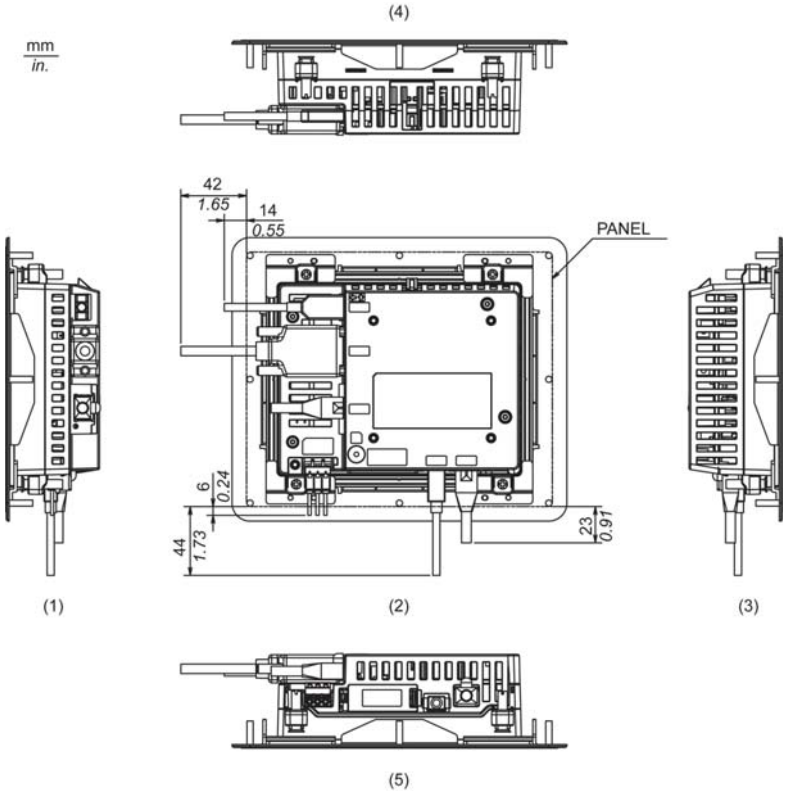
Dimensions with Cables: HMIGTO2310



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Dimensions with Cables: HMIGTO2315

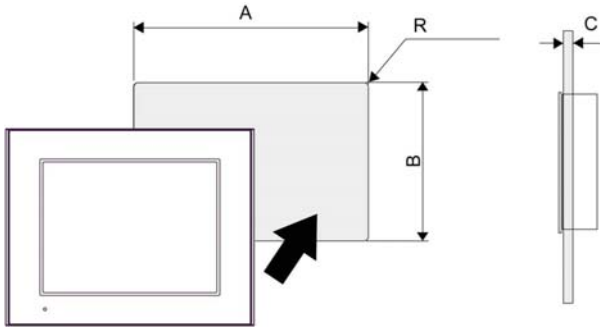


1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Panel Cut Dimensions

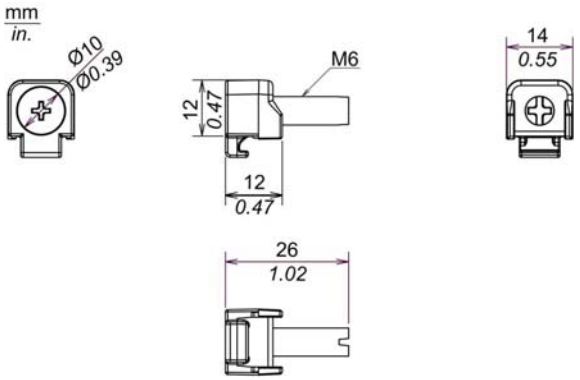
Create a panel cut and insert the panel into the opening from the front.



	A	B	C	R
HMIGTO2310 HMIGTO2300	156 mm (+1/-0) mm (6.14 in [+0.04, -0 in.])	123.5 mm (+1, -0 mm) (4.86 in [+0.04, -0 in.])	1.6...5 mm (0.06...0.2 in.)	3 mm (0.12 in.) maximum
HMIGTO2315	195 mm (+1/-0) mm (7.68 in [+0.04, -0in.])	162.5 mm (+1/-0) mm (6.40 in [+0.04, -0in.])		

NOTE: Before designing the panel cut, refer to Installation *(see page 120)*.

Installation Fastener Dimensions



Section 4.3
HMIGTO3510/4310

What Is in This Section?

This section contains the following topics:

Topic	Page
Electrical Specifications	69
Environmental Specifications	70
Structural Specifications	71
Display Specifications	72
Memory, Clock, Touch Panel, and Function Switches	73
Interface Specifications	74
Specifications of Serial Interface COM1	75
Specifications of Serial Interface COM2	77
Dimensions	78

Electrical Specifications

Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		5 ms or less
	Power Consumption		12 W or less
		When power is not supplied to external devices	8 W or less
		Backlight OFF (Standby Mode)	5 W or less
		Backlight Dimmed (Brightness: 20%)	5.5 W or less
	In-Rush Current		30 A or less
Voltage Endurance			1,000 Vac, 20 mA for 1 minute (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

Environmental Specifications

		HMIGTO4310	HMIGTO3510
Physical Environment	Surrounding Air Temperature	0...55 °C (32...131 °F)	0...50 °C (32...122 °F)
	Storage Temperature	-20...60 °C (-4...140 °F)	
	Surrounding Air and Storage Humidity	10...90% RH (Non condensing, wet bulb temperature 39 °C [102.2 °F] or less)	
	Dust	0.1 mg/m^3 (10^{-7} oz/ft^3) or less (non-conductive levels)	
	Pollution Degree	For use in Pollution Degree 2 environment	
	Corrosive Gases	Free of corrosive gases	
	Atmospheric pressure (Operating Altitude)	800...1,114 hPa (2,000 m [6,561 ft] or lower)	
Mechanical Environment	Vibration Resistance	IEC/EN 61131-2 5...9 Hz Single amplitude 3.5 mm (0.14 in.) 9...150 Hz Fixed acceleration: 9.8 m/s^2 X, Y, Z directions for 10 cycles (approx. 100 min)	
	Concussion Resistance	IEC/EN 61131-2 compliant 147 m/s^2, X, Y, Z directions for 3 times	
Electrical Environment	Noise Immunity	Noise Voltage: 1,000 Vp-p Pulse Width: 1 µs Rise Time: 1 ns	
	Electrostatic Discharge Immunity	Contact Discharge Method: 6 kV (IEC/EN 61000-4-2 Level 3)	

Air quality requirements

Do not operate or store the panel where chemicals evaporate, or where chemicals are present in the air:

- Corrosive chemicals: Acids, alkalines, liquids containing salt.
- Flammable chemicals: Organic solvents.

⚠ CAUTION

INOPERATIVE EQUIPMENT

Do not allow water, liquids, metal, and wiring fragments to enter the panel case.

Failure to follow these instructions can result in injury or equipment damage.

Structural Specifications

Grounding	Functional grounding: Grounding resistance of 100 Ω, 2 mm^2 (AWG 14) or thicker wire, or your country's applicable standard. (Same for FG and SG terminals)
Cooling Method	Natural air circulation
Structure*1	IP65f NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)
External Dimensions	W218 x H173 x D60 mm (W8.58 x H6.81 x D2.36 in.)
Panel Cut Dimensions	W204.5 x H159.5 mm (W8.05 x H6.28 in.)*2 Panel thickness area: 1.6...5 mm (0.06...0.2 in.)*3
Weight	1.2 kg (2.6 lb) or less (main unit only)

NOTE: *1 The front face of the HMIGTO, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification. Even though the HMIGTO's level of resistance is equivalent to these standards, oils that should have no effect on the HMIGTO can possibly harm the panel. This can occur in areas where either vaporized oils are present, or where low viscosity cutting oils are allowed to adhere to the panel for long periods of time. If the panel's front face protection sheet peels off, these conditions can lead to the ingress of oil into the panel and separate protection measures are suggested.
Also, if non-approved oils are present, they may cause deformation or corrosion of the front panel's plastic cover. Therefore, prior to installing the HMIGTO, be sure to confirm the type of conditions that will be present in the panel's operating environment. If the installation gasket is used for a long period of time, or if the HMIGTO and its gasket are removed from the panel, the original level of protection cannot be kept. To maintain the original protection level, be sure to replace the installation gasket regularly.

*2 For dimensional tolerance, everything +1/-0 mm (+0.04/-0 in.) and R in angle are below R3 (R0.12 in.)

*3 Even if the installation wall thickness is within the recommended range for the "Panel Cut Dimensions", depending on wall's material, size, and installation location of the panel and other devices, the installation wall could warp. To prevent warping, the installation surface may need to be strengthened.

⚠ CAUTION

EQUIPMENT DAMAGE

Ensure that the panel is not in permanent and direct contact with oils.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

STORAGE AND OPERATION OUTSIDE OF SPECIFICATIONS

- Store the panel in areas where temperatures are within the panel's specifications.
- Do not restrict or block the panel's rear-face ventilation slots.

Failure to follow these instructions can result in equipment damage.

NOTICE

GASKET AGING

- Inspect the gasket periodically as required by your operating environment to keep the initial IP level.
- Change the gasket at least once a year, or as soon as scratches or dirt become visible.

Failure to follow these instructions can result in equipment damage.

Display Specifications

		HMIGTO4310	HMIGTO3510
Display Type		TFT Color LCD	
Display Size		7.5”	7.0”
Resolution		640 x 480 pixels (VGA)	800 x 480 pixels (WVGA)
Effective Display Area		W153.7 x H115.8 mm (W6.05 x H4.56 in.)	W152.4 x H91.44 mm (W6.0 x H3.6 in.)
Display Colors		65,536 colors (No blink) / 16,384 colors Blink)	
Backlight		White LED (Not user replaceable. When replacement is required, contact your local distributor.)	
Backlight Service Life		50,000 hours or more (continuous operation at 25 °C [77 °F] before backlight brightness decreases to 50%)	
Brightness Control		16 levels (Adjusted with touch panel or software)	
Language Fonts		ASCII: (Code page 850) Alphanumeric (including European characters) Chinese: (GB2312-80 codes) Simplified Chinese fonts Japanese (except for XBT GT1000 series): ANK 158, Kanji: 6,962 (JIS Standards 1 & 2) (including 607 non-kanji characters) Korean: (KSC5601 - 1992 codes) Hangul fonts Taiwanese: (Big 5 codes) Traditional Chinese fonts	
Character sizes		8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts	
Font sizes		You can expand the width up to 8 times, and expand the height up to 8 times.*1	
Text	8 x 8 pixels	80 characters per row x 60 rows	100 characters per row x 60 rows
	8 x 16 pixels	80 characters per row x 30 rows	100 characters per row x 30 rows
	16 x 16 pixels	40 characters per row x 30 rows	50 characters per row x 30 rows
	32 x 32 pixels	20 characters per row x 15 rows	25 characters per row x 15 rows

*1 You can set up other font sizes using the software.

Memory, Clock, Touch Panel, and Function Switches

Memory

	HMIGTO4310	HMIGTO3510
Application Memory *1	FLASH EPROM 96 MB	FLASH EPROM 96 MB
Application run DRAM	128 MB	128 MB
Data Backup	SRAM 512 KB (Replaceable lithium battery for data backup)	SRAM 128 KB (Replaceable lithium battery for data backup)

*1 Capacity available for user application.

NOTE:

- When the message "Battery level is low" is displayed, supply power to the panel and fully charge the battery.

Clock

Clock Accuracy*1	±65 seconds/month (deviation at room temperature and power is OFF).

*1 Depending on the operating temperature and age of panel, the clock can deviate from -380 to +90 sec/month. For systems where this level of precision is insufficient, the user should monitor and make adjustments when required.

Touch Panel

Touch Panel Type	Resistive Film (analog)
Touch Panel Resolution	1,024 x 1,024
Touch Panel Service Life	1 million times or more

Function Switches

HMIGTO3510: Eight switches (F1 to F8).

Interface Specifications

Serial Interface COM1

Asynchronous Transmission	RS-232C
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps
Connector	D-Sub 9 pin (plug)

Serial Interface COM2

Asynchronous Transmission	RS-485
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)
Connector	Modular jack (RJ-45)

USB Interface

	USB (Type A) Interface	**USB (mini-B) Interface**
Connector	USB 2.0 (Type A) x 1	USB 2.0 (mini-B) x 1
Power Supply Voltage	5 Vdc ±5%	-
Maximum Current Supplied	500 mA	-
Maximum Transmission Distance	5 m (16.4 ft)	

Ethernet Interface

Ethernet (LAN)	IEEE802.3i / IEEE802.3u, 10BASE-T/100BASE-TX
Connector	Modular jack (RJ45) x 1

SD Card Interface

SD Card slot x 1 (maximum 32 GB SD/SDHC Card)

Specifications of Serial Interface COM1

Introduction

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

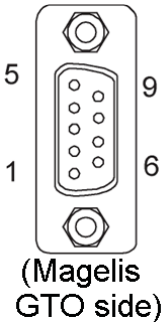
When using the SG terminal to connect an external device to the panel:

- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM1

HMIGTO3510 / HMIGTO4310: D-Sub 9 pin plug connector via an RS-232C cable.

Pin Connection	Pin No.	RS-232C		
		Signal Name	Direction	Meaning
 (Magelis GTO side)	1	CD	Input	Carrier Detect
	2	RD(RXD)	Input	Receive Data
	3	SD(TXD)	Output	Send Data
	4	ER(DTR)	Output	Data Terminal Ready
	5	SG	-	Signal Ground
	6	DR(DSR)	Input	Data Set Ready
	7	RS(RTS)	Output	Request to Send
	8	CS(CTS)	Input	Send possible
	9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A[*1]
	Shell	FG	–	Frame Ground (Common with SG)

NOTE: [*1] You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

Specifications of Serial Interface COM2

Introduction

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

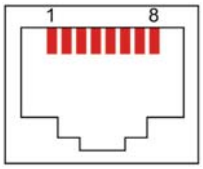
When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM2

HMIGTO3510 / HMIGTO4310: RJ45 connector via a RS-485 cable.

NOTE: When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Connection	Pin No.	RS-485		
		Signal Name	Direction	Meaning
	1	NC	-	-
	2	NC	-	-
	3	NC	-	-
	4	Line A	Input/Output	Transfer Data (RS-485)
	5	Line B	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request To Send
	7	NC	-	-
	8	SG	-	Signal Ground

⚠ CAUTION

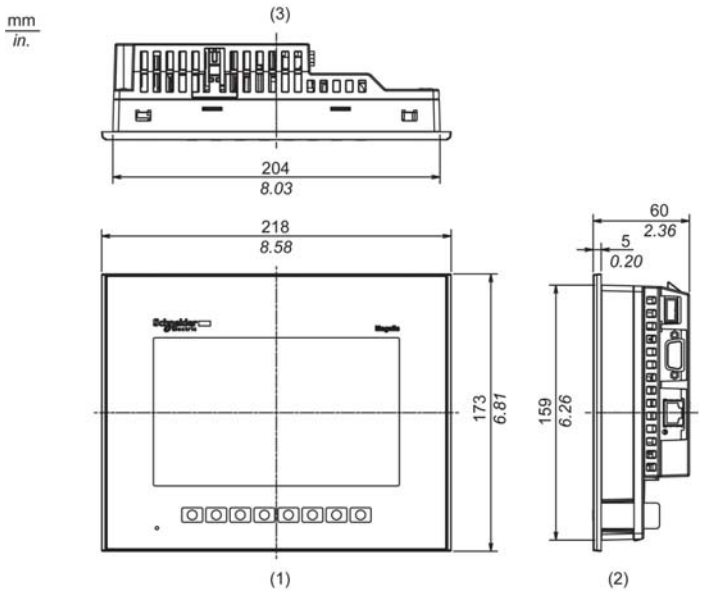
LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

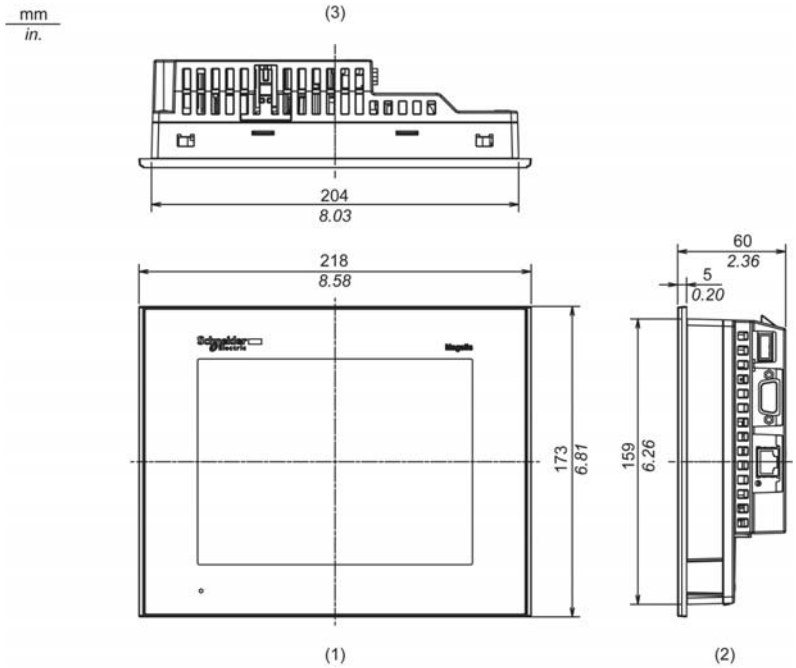
Dimensions

External Dimensions: HMIGTO3510



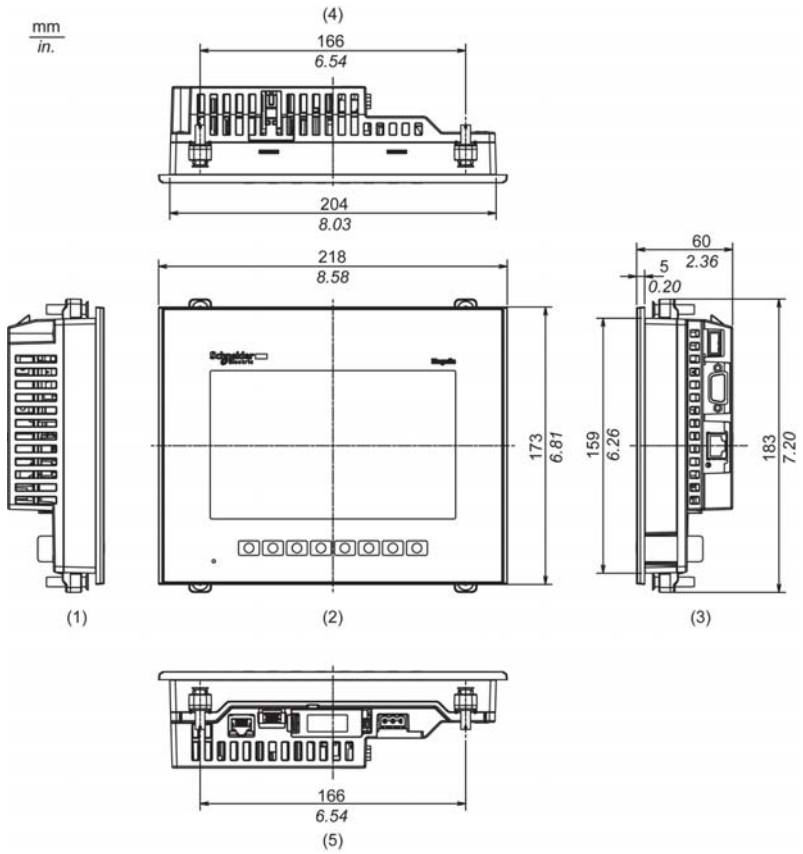
1 Front
2 Right Side
3 Top

External Dimensions: HMIGTO4310



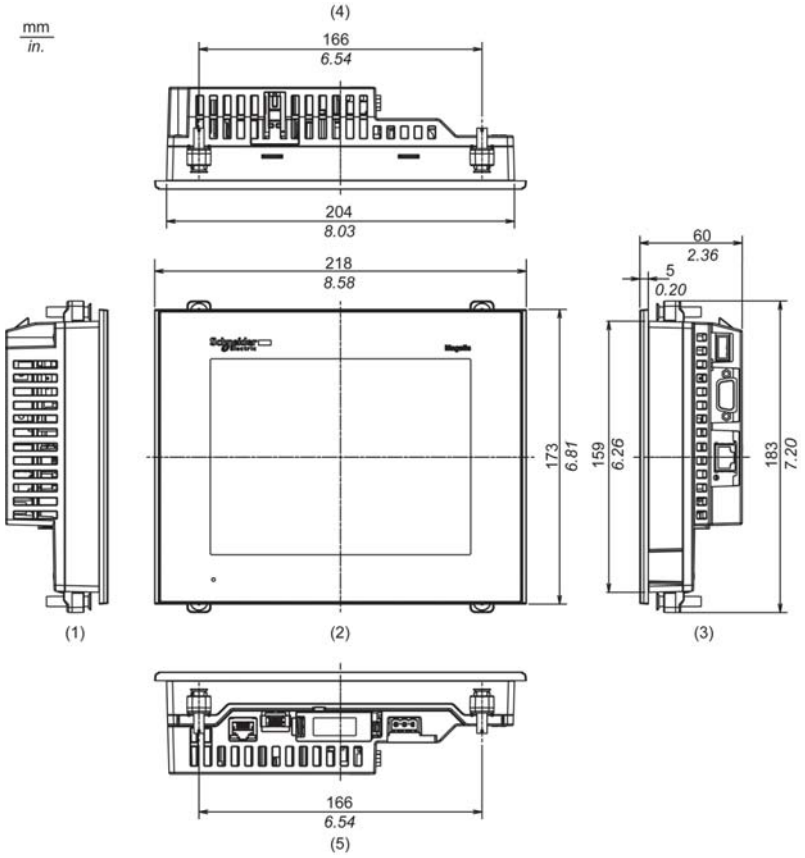
1 Front
2 Right Side
3 Top

Installation with Installation Fasteners: HMIGTO3510



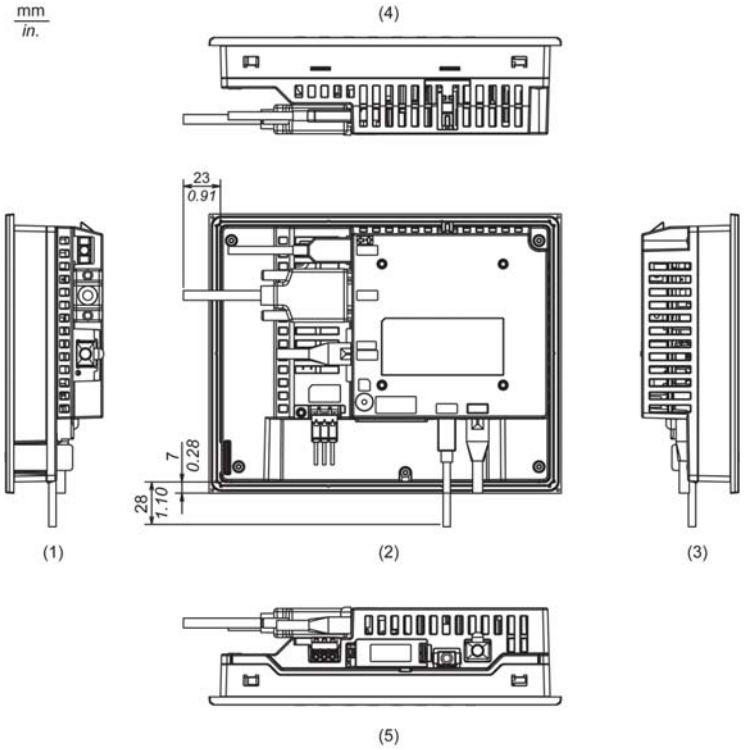
1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

Installation with Installation Fasteners: HMIGTO4310



1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

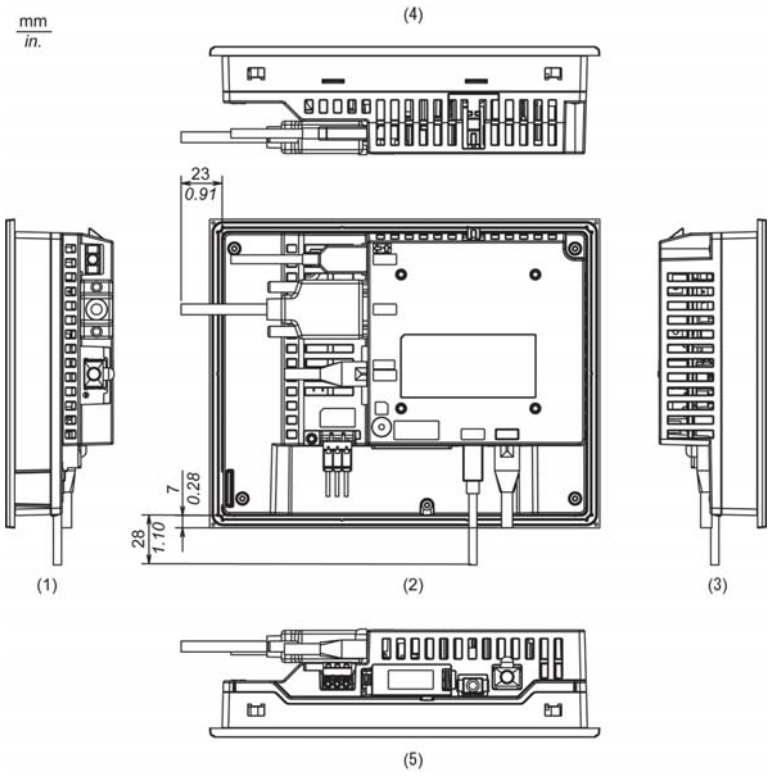
Dimensions with Cables: HMIGTO3510



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Dimensions with Cables: HMIGTO4310

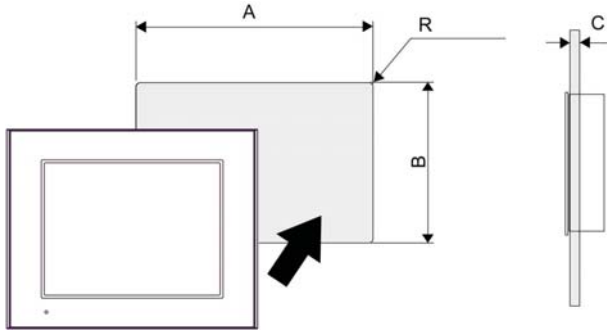


1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Panel Cut Dimensions

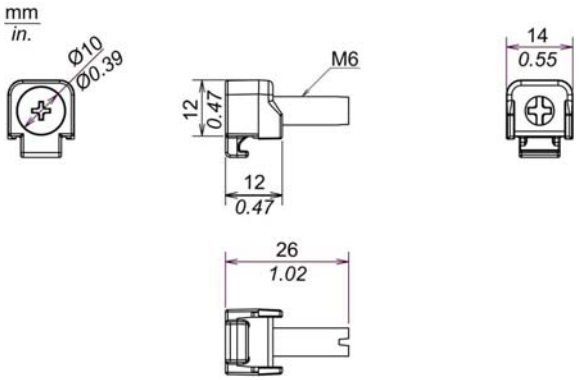
Create a panel cut and insert the panel into the opening from the front.



A	B	C	R
204.5 mm (+1, -0 mm) (8.05 in. [+0.04, -0 in.])	159.5 mm (+1, -0 mm) (6.28 in. [+0.04, -0 in.])	1.6...5 mm (0.06...0.2 in.)	3 mm (0.12 in.) maximum

NOTE: Before designing the panel cut, refer to Installation *(see page 120)*.

Installation Fastener Dimensions



Section 4.4
HMIGTO5310/5315

What Is in This Section?

This section contains the following topics:

Topic	Page
Electrical Specifications	85
Environmental Specifications	86
Structural Specifications	87
Display Specifications	89
Memory, Clock, and Touch Panel	90
Interface Specifications	91
Specifications of Serial Interface COM1	92
Specifications of Serial Interface COM2	94
Dimensions	95

Electrical Specifications

Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		10 ms or less
	Power Consumption		17 W or less
		When power is not supplied to external devices	12 W or less
		Backlight OFF (Standby Mode)	7 W or less
		Backlight Dimmed (Brightness: 20%)	8 W or less
	In-Rush Current		30 A or less
Voltage Endurance			1500 Vac, 20 mA for 1 min. (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

Environmental Specifications

Physical Environment	Surrounding Air Temperature	0...55 °C (32...131 °F)
	Storage Temperature	-20...60 °C (-4...140 °F)
	Surrounding Air and Storage Humidity	10...90% RH (Non condensing, wet bulb temperature 39 °C [102.2 °F] or less)
	Dust	0.1 mg/m^3 (10^{-7} oz/ft^3) or less (non-conductive levels)
	Pollution Degree	For use in Pollution Degree 2 environment
	Corrosive Gases	Free of corrosive gases
	Atmospheric Pressure (Operating Altitude)	800...1,114 hPa (2,000 m [6,561 ft] or lower)
Mechanical Environment	Vibration Resistance	IEC/EN 61131-2 compliant 5...9 Hz Single amplitude 3.5 mm (0.14 in.) 9...150 Hz Fixed acceleration: 9.8 m/s^2 X, Y, Z directions for 10 cycles (approx. 100 min.)
	Concussion Resistance	IEC/EN 61131-2 compliant 147 m/s^2, X, Y, Z directions for 3 times
Electrical Environment	Noise Immunity	Noise Voltage: 1,000 Vp-p Pulse Width: 1 µs Rise Time: 1 ns
	Electrostatic Discharge Immunity	Contact Discharge Method: 6 kV (IEC/EN 61000-4-2 Level 3)

Air quality requirements

Do not operate or store the panel where chemicals evaporate, or where chemicals are present in the air:

- Corrosive chemicals: Acids, alkalines, liquids containing salt.
- Flammable chemicals: Organic solvents.

⚠ CAUTION

INOPERATIVE EQUIPMENT

Do not allow water, liquids, metal, and wiring fragments to enter the panel case.

Failure to follow these instructions can result in injury or equipment damage.

Structural Specifications

	HMIGTO5310	HMIGTO5315
Grounding	Functional grounding: Grounding resistance of 100Ω, 2mm^2 (AWG 14) or thicker wire, or your country's applicable standard. (Same for FG and SG terminals)	
Cooling Method	Natural air circulation	
Structure[*1]	IP65f NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)	IP66k NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)[*2]
External Dimensions	W272.5 x H214.5 x D57 mm (W10.73 x H8.44 x D2.24 in.)	W316.5 x H258.5 x D57 mm (W12.44 x H10.18 x D2.24 in.)
Panel Cut Dimensions	W259 x H201 mm (W10.2 x H7.91 in.)[*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.)[*4]	W298 x H240 mm (W11.73 x H9.45 in.)[*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.)[*4]
Weight	2.0 kg (4.4 lb) or less (main unit only)	2.5 kg (5.5 lb) or less (main unit only)

NOTE: [*1] The front face of the HMIGTO, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification. Even though the HMIGTO's level of resistance is equivalent to these standards, oils that should have no effect on the HMIGTO can possibly harm the panel. This can occur in areas where either vaporized oils are present, or where low viscosity cutting oils are allowed to adhere to the panel for long periods of time. If the panel's front face protection sheet peels off, these conditions can lead to the ingress of oil into the panel and separate protection measures are suggested.
Also, if non-approved oils are present, they may cause deformation or corrosion of the front panel's plastic cover. Therefore, prior to installing the HMIGTO, be sure to confirm the type of conditions that will be present in the panel' operating environment. If the installation gasket is used for a long period of time, or if the HMIGTO and its gasket are removed from the panel, the original level of protection cannot be kept. To maintain the original protection level, be sure to replace the installation gasket regularly.
[*2] When installing the HMIGTO in a panel, you may not be able to mount the HMIGTO flush with the panel. This occurs due to the thickness of the gasket. The difference in level between the HMIGTO and panel depends on how much the gasket is compressed.

NOTICE

EQUIPMENT DAMAGE

For food and beverage and pharmaceutical industries, when the HMIGTO is not flush with panel, use silicon to form a seal to prevent water, chemicals, or food from lodging into place. Otherwise, the panel face could leak.

Failure to follow these instructions can result in equipment damage.

[*3] For dimensional tolerance, everything +1/-0 mm (+0.04/-0 in.) and R in angle are below R3 (R0.12 in.)

[*4] Even if the installation wall thickness is within the recommended range for the "Panel Cut Dimensions", depending on wall's material, size, and installation location of the panel and other devices, the installation wall could warp. To prevent warping, the installation surface may need to be strengthened.

⚠ CAUTION

EQUIPMENT DAMAGE

Ensure that the panel is not in permanent and direct contact with oils.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

STORAGE AND OPERATION OUTSIDE OF SPECIFICATIONS

- Store the panel in areas where temperatures are within the panel's specifications.
- Do not restrict or block the panel's rear-face ventilation slots.

Failure to follow these instructions can result in equipment damage.

NOTICE

GASKET AGING

- Inspect the gasket periodically as required by your operating environment to keep the initial IP level.
- Change the gasket at least once a year, or as soon as scratches or dirt become visible.

Failure to follow these instructions can result in equipment damage.

Display Specifications

Display Type		TFT Color LCD
Display Size		10.4”
Resolution		640 x 480 pixels (VGA)
Effective Display Area		W211.2 x H158.4 mm (8.31 x 6.24 in.)
Display Colors		65,536 colors (No blink) / 16,384 colors (Blink)
Backlight		White LED (Not user replaceable. When replacement is required, contract your local distributor.)
Backlight Service Life		50,000 hours or more (continuous operation at 25 °C [77 °F] before backlight brightness dimmed to 50%
Brightness Control		16 levels (Adjusted with the touch panel or software)
Language Fonts		ASCII: (Code page 850) Alphanumeric (including European characters) Chinese: (GB2312-80 codes) Simplified Chinese fonts Japanese: ANK 158, Kanji: 6,962 (JIS Standards 1 & 2) (including 607 non-kanji characters) Korean: (KSC5601 - 1992 codes) Hangul fonts Taiwanese: (Big 5 codes) Traditional Chinese fonts
Character Sizes		8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts
Font Sizes		You can expand the width up to 8 times, and expand the height up to 8 times.*1
Text	8 x 8 pixels	80 characters per row x 60 rows
	8 x 16 pixels	80 characters per row x 30 rows
	16 x 16 pixels	40 characters per row x 30 rows
	32 x 32 pixels	20 characters per row x 15 rows

*1 You can set up other font sizes using the software.

Memory, Clock, and Touch Panel

Memory

Application Memory *1	FLASH EPROM 96 MB
Application run DRAM	128 MB
Data Backup	SRAM 512 KB (Replaceable lithium battery for data backup)

*1 Capacity available for user application.

NOTE:

- When the message "Battery level is low" is displayed, supply power to the panel and fully charge the battery.

Clock

Clock Accuracy*1	±65 seconds/month (deviation at room temperature and power is OFF).

*1 Depending on the operating temperature and age of panel, the clock can deviate from -380 to +90 sec/month. For systems where this level of precision is insufficient, the user should monitor and make adjustments when required.

Touch Panel

Touch Panel Type	Resistive Film (analog)
Touch Panel Resolution	1,024 x 1,024
Service Life	1 million times or more

Interface Specifications

Serial Interface COM1

Asynchronous Transmission	RS-232C
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps
Connector	D-Sub 9 pin (plug)

Serial Interface COM2

Asynchronous Transmission	RS-485
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)
Connector	Modular jack (RJ-45)

USB Interface

	USB (Type A) Interface	**USB (mini-B) Interface**
Connector	USB 2.0 (Type A) x 1	USB 2.0 (mini-B) x 1
Power Supply Voltage	5 Vdc ±5%	-
Maximum Current Supplied	500 mA	-
Maximum Transmission Distance	5 m (16.4 ft)	

Ethernet Interface

Ethernet (LAN)	IEEE802.3i / IEEE802.3u, 10BASE-T/100BASE-TX
Connector	Modular jack (RJ45) x 1

SD Card Interface

SD Card slot x 1 (maximum 32 GB SD/SDHC Card)

Specifications of Serial Interface COM1

Introduction

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

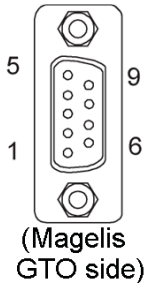
When using the SG terminal to connect an external device to the panel:

- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM1

HMIGTO5310 / HMIGTO5315: D-Sub 9 pin plug connector via an RS-232C cable.

Pin Connection	Pin No.	RS-232C		
		Signal Name	Direction	Meaning
 (Magelis GTO side)	1	CD	Input	Carrier Detect
	2	RD(RXD)	Input	Receive Data
	3	SD(TXD)	Output	Send Data
	4	ER(DTR)	Output	Data Terminal Ready
	5	SG	-	Signal Ground
	6	DR(DSR)	Input	Data Set Ready
	7	RS(RTS)	Output	Request to Send
	8	CS(CTS)	Input	Send possible
	9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A[*1]
	Shell	FG	–	Frame Ground (Common with SG)

NOTE: [*1] You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

Specifications of Serial Interface COM2

Introduction

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

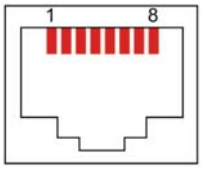
When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM2

HMIGTO5310 / HMIGTO5315: RJ45 connector via a RS-485 cable.

NOTE: When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Connection	Pin No.	RS-485		
		Signal Name	Direction	Meaning
	1	NC	-	-
	2	NC	-	-
	3	NC	-	-
	4	Line A	Input/Output	Transfer Data (RS-485)
	5	Line B	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request To Send
	7	NC	-	-
	8	SG	-	Signal Ground

⚠ CAUTION

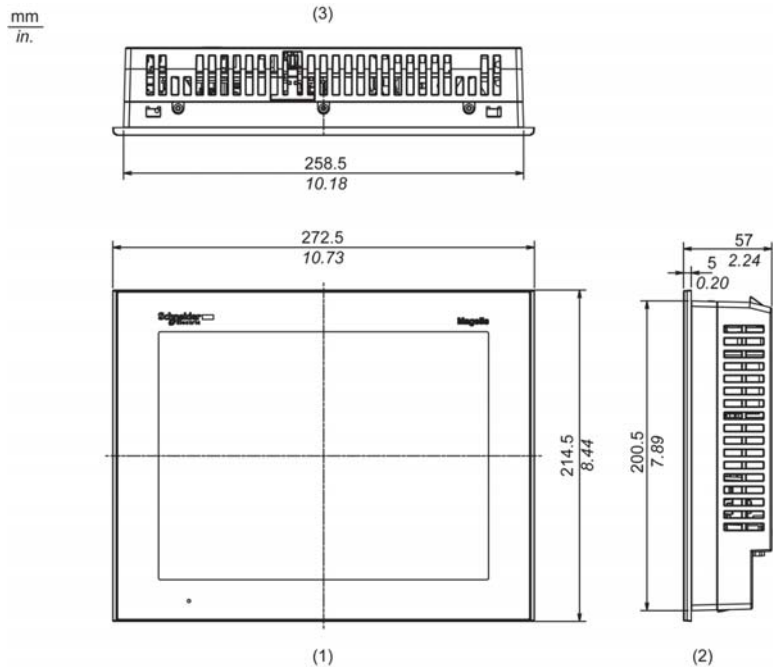
LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

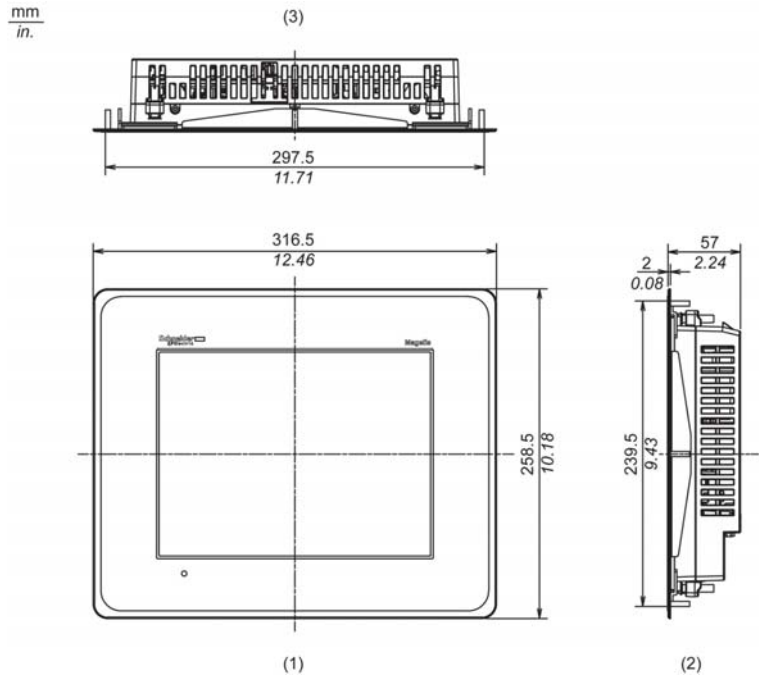
Dimensions

External Dimensions: HMIGTO5310



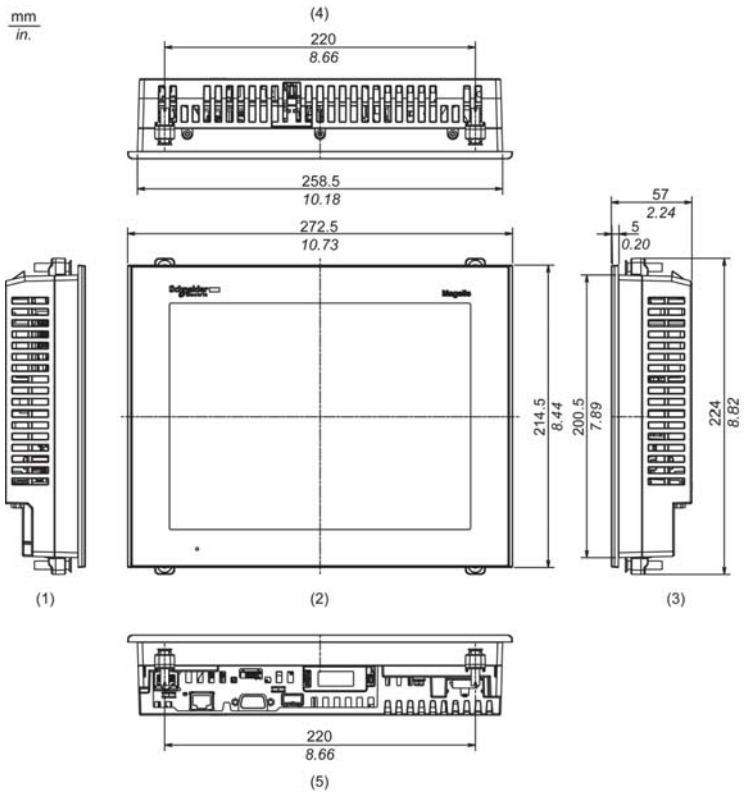
1 Front
2 Right Side
3 Top

External Dimensions: HMIGTO5315



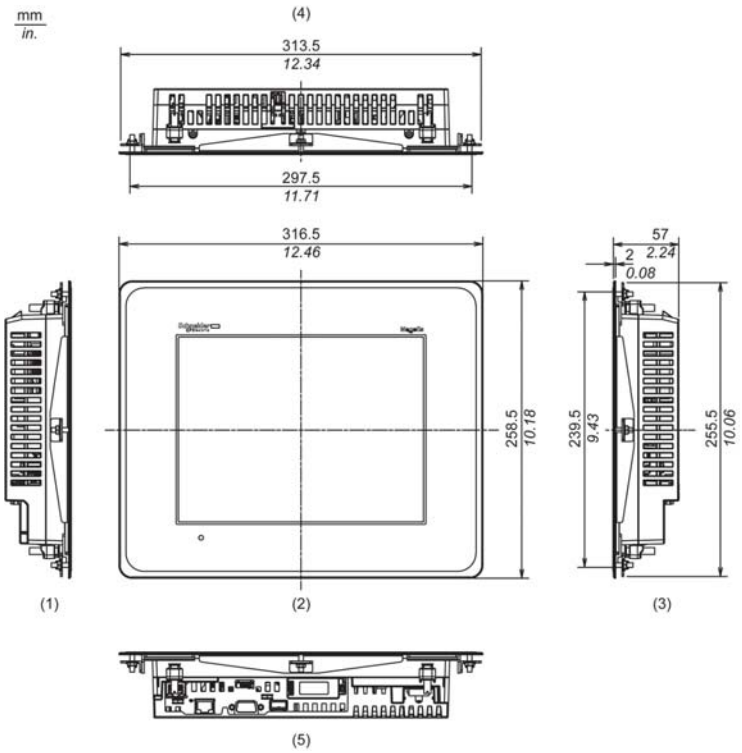
1 Front
2 Right Side
3 Top

Installation with Installation Fasteners: HMIGTO5310



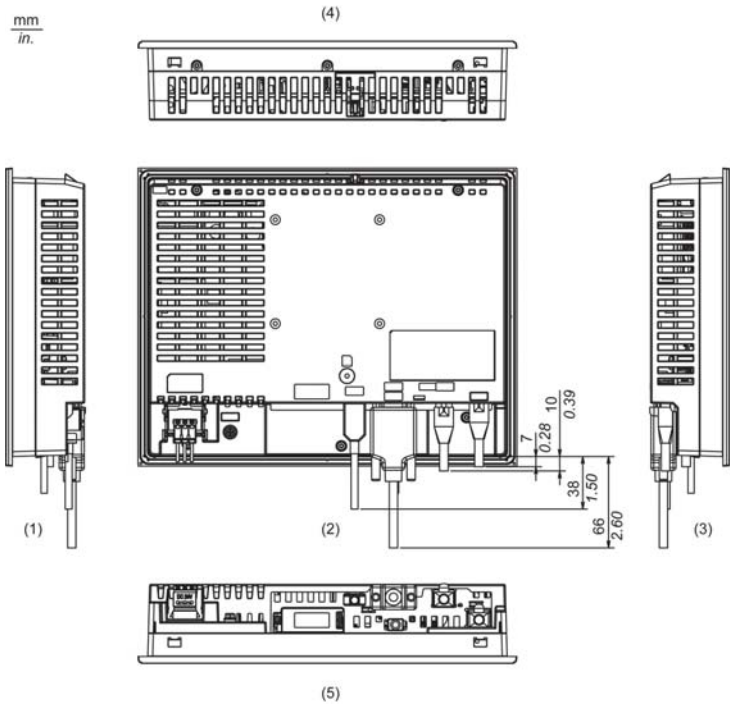
1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

Installation with Installation Fasteners: HMIGTO5315



1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

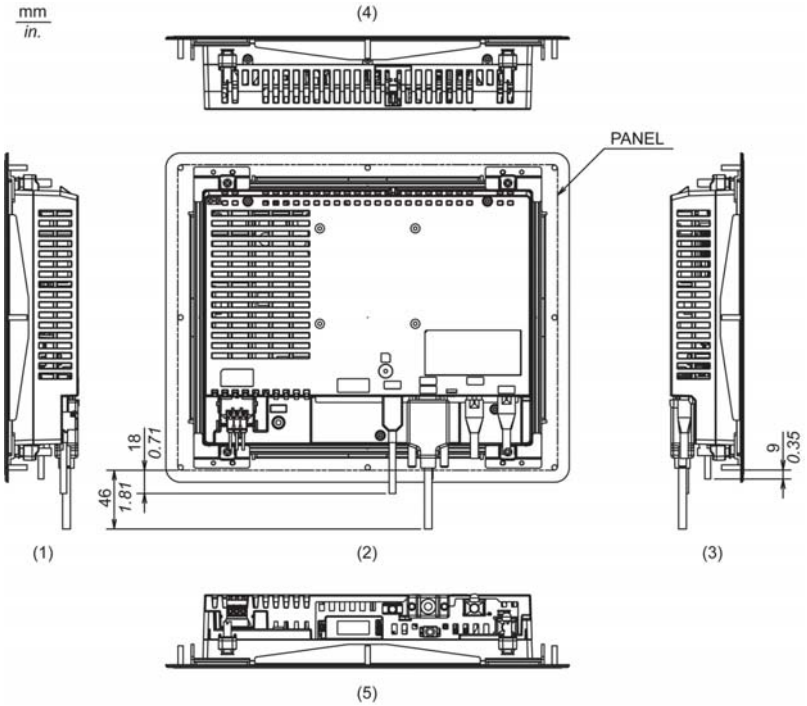
Dimensions with Cables: HMIGTO5310



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Dimensions with Cables: HMIGTO5315

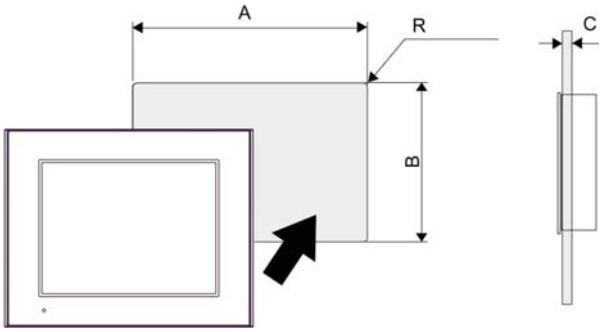


1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Panel Cut Dimensions

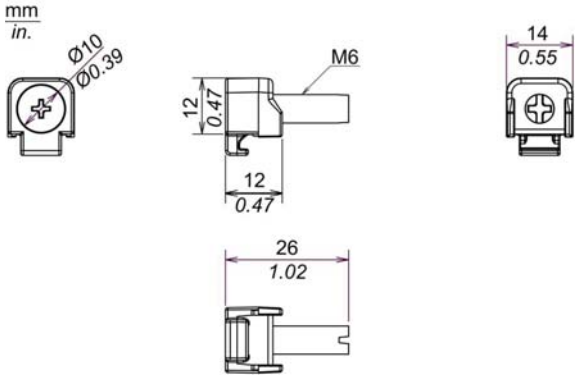
Create a panel cut and insert the panel into the opening from the front.



	A	B	C	R
HMIGTO5310	259 mm (+1, -0 mm) (10.2 in. [+0.04, -0 in.])	201 mm (+1, -0 mm) (7.91 in. [+0.04, -0 in.])	1.6...5 mm (0.06...0.2 in.)	3 mm (0.12 in.) maximum
HMIGTO5315	298 mm (+1, -0 mm) (11.73 in. [+0.04, -0 in.])	240 mm (+1, -0 mm) (9.45 in. [+0.04, -0 in.])		

NOTE: Before designing the panel cut, refer to Installation *(see page 120)*.

Installation Fastener Dimensions



Section 4.5
HMIGTO6310/6315

What Is in This Section?

This section contains the following topics:

Topic	Page
Electrical Specifications	102
Environmental Specifications	103
Structural Specifications	104
Display Specifications	106
Memory, Clock, and Touch Panel	107
Interface Specifications	108
Specifications of Serial Interface COM1	109
Specifications of Serial Interface COM2	111
Dimensions	112

Electrical Specifications

Power Supply	Rated Input Voltage		24 Vdc
	Input Voltage Limits		19.2...28.8 Vdc
	Voltage Drop		10 ms or less
	Power Consumption		17 W or less
		When power is not supplied to external devices	12 W or less
		Backlight OFF (Standby Mode)	7 W or less
		Backlight Dimmed (Brightness: 20%)	8 W or less
	In-Rush Current		30 A or less
Voltage Endurance			1,500 Vac, 20 mA for 1 minute (between charging and FG terminals)
Insulation Resistance			500 Vdc, 10 MΩ or more (between charging and FG terminals)

Environmental Specifications

Physical Environment	Surrounding Air Temperature	0...55 °C (32...131 °F)
	Storage Temperature	-20...60 °C (-4...140 °F)
	Surrounding Air and Storage Humidity	10...90% RH (Non condensing, wet bulb temperature 39 °C [102.2 °F] or less)
	Dust	0.1 mg/m^3 (10^{-7} oz/ft^3) or less (non-conductive levels)
	Pollution Degree	For use in Pollution Degree 2 environment
	Corrosive gases	Free of corrosive gases
	Atmospheric Pressure (Operating Altitude)	800...1,114 hPa (2,000 m [6,561 ft] or lower)
Mechanical Environment	Vibration Resistance	IEC/EN 61131-2 compliant 5...9 Hz Single amplitude 3.5 mm (0.14 in.) 9...150 Hz Fixed acceleration: 9.8 m/s^2 X, Y, Z directions for 10 cycles (approx.100 minute)
	Concussion Resistance	IEC/EN 61131-2 compliant 147 m/s^2, X, Y, Z directions for 3 times
Electrical Environment	Noise immunity	Noise Voltage: 1,000 Vp-p Pulse Width: 1 µs Rise Time: 1 ns
	Electrostatic Discharge Immunity	Contact Discharge Method: 6 kV (IEC/EN 61000-4-2 Level 3)

Air quality requirements

Do not operate or store the panel where chemicals evaporate, or where chemicals are present in the air:

- Corrosive chemicals: Acids, alkalines, liquids containing salt.
- Flammable chemicals: Organic solvents.

⚠ CAUTION

INOPERATIVE EQUIPMENT

Do not allow water, liquids, metal, and wiring fragments to enter the panel case.

Failure to follow these instructions can result in injury or equipment damage.

Structural Specifications

	HMIGTO6310	HMIGTO6315
Grounding	Functional grounding: Grounding resistance of 100 Ω, 2 mm^2 (AWG 14) or thicker wire, or your country's applicable standard. (Same for FG and SG terminals)	
Cooling Method	Natural air circulation	
Structure[*1]	IP65f NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)	IP66k NEMA #250 TYPE 4X/13 (on the front panel when properly installed in an enclosure)[*2]
External Dimensions	W315 x H241 x D56 mm (W12.4 x H9.49 x D2.2 in.)	W359 x H285 x D56 mm (W14.13 x H11.22 x D2.2 in.)
Panel Cut Dimensions	W301.5 x H227.5 mm (W11.87 x H8.96 in.)[*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.)[*4]	W340.5 x H266.5 mm (W13.41 x H10.49 in.)[*3] Panel thickness area: 1.6...5 mm (0.06...0.2 in.)[*4]
Weight	2.5 kg (5.5 lb) or less (main unit only)	3 kg (6.6 lb) or less (main unit only)

NOTE: [*1] The front face of the HMIGTO, installed in a solid panel, has been tested using conditions equivalent to the standards shown in the specification. Even though the HMIGTO's level of resistance is equivalent to these standards, oils that should have no effect on the HMIGTO can possibly harm the panel. This can occur in areas where either vaporized oils are present, or where low viscosity cutting oils are allowed to adhere to the panel for long periods of time. If the panel's front face protection sheet peels off, these conditions can lead to the ingress of oil into the panel and separate protection measures are suggested.

Also, if non-approved oils are present, they may cause deformation or corrosion of the front panel's plastic cover. Therefore, prior to installing the HMIGTO, be sure to confirm the type of conditions that will be present in the panel's operating environment. If the installation gasket is used for a long period of time, or if the HMIGTO and its gasket are removed from the panel, the original level of protection cannot be kept. To maintain the original protection level, be sure to replace the installation gasket regularly.

[*2] When installing the HMIGTO in a panel, you may not be able to mount the HMIGTO flush with the panel. This occurs due to the thickness of the gasket. The difference in level between the HMIGTO and panel depends on how much the gasket is compressed.

NOTICE

EQUIPMENT DAMAGE

For food and beverage and pharmaceutical industries, when the HMIGTO is not flush with panel, use silicon to form a seal to prevent water, chemicals, or food from lodging into place. Otherwise, the panel face could leak.

Failure to follow these instructions can result in equipment damage.

[*3] For dimensional tolerance, everything +1/-0 mm (+0.04/-0 in.) and R in angle are below R3 (R0.12in.)

[*4] Even if the installation wall thickness is within the recommended range for the "Panel Cut Dimensions", depending on wall's material, size, and installation location of the panel and other devices, the installation wall could warp. To prevent warping, the installation surface may need to be strengthened.

⚠ CAUTION

EQUIPMENT DAMAGE

Ensure that the panel is not in permanent and direct contact with oils.

Failure to follow these instructions can result in injury or equipment damage.

NOTICE

STORAGE AND OPERATION OUTSIDE OF SPECIFICATIONS

- Store the panel in areas where temperatures are within the panel's specifications.
- Do not restrict or block the panel's rear-face ventilation slots.

Failure to follow these instructions can result in equipment damage.

NOTICE

GASKET AGING

- Inspect the gasket periodically as required by your operating environment to keep the initial IP level.
- Change the gasket at least once a year, or as soon as scratches or dirt become visible.

Failure to follow these instructions can result in equipment damage.

Display Specifications

Display Type		TFT Color LCD
Display Size		12.1”
Resolution		800 x 600 pixels (SVGA)
Effective Display Area		W246.0 x H184.5 mm (W9.69 x H7.26 in.)
Display Colors		65,536 colors (No blink) / 16,384 colors (Blink)
Backlight		White LED (Not user replaceable. When replacement is required, contact your local distributor.)
Backlight Service Life		50,000 hours (continuous operation at at 25 °C [77 °F] before backlight brightness decreases to 50%)
Brightness Control		16 levels (Adjusted with touch panel or software)
Language Fonts		ASCII: (Code page 850) Alphanumeric (including European characters) Chinese: (GB2312-80 codes) Simplified Chinese fonts Japanese: ANK 158, Kanji: 6,962 (JIS Standards 1 & 2) (including 607 non-kanji characters) Korean: (KSC5601 - 1992 codes) Hangul fonts Taiwanese: (Big 5 codes) Traditional Chinese fonts
Character Sizes		8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts
Text	8 x 8 pixels	100 characters per row x 75 rows
	8 x 16 pixels	100 characters per row x 37 rows
	16 x 16 pixels	50 characters per row x 37 rows
	32 x 32 pixels	25 characters per row x 18 rows

*1 You can set up other font sizes using the software.

Memory, Clock, and Touch Panel

Memory

Application Memory*1	FLASH EPROM96 MB
Application run DRAM	128 MB
Data Backup	SRAM 512 KB (Replaceable lithium battery for backup memory)

*1 Capacity available for user application.

NOTE:

- When the message "Battery level is low" is displayed, supply power to the panel and fully charge the battery.

Clock

Clock Accuracy*1	±65 seconds/month (deviation at room temperature and power is OFF).

*1 Depending on the operating temperature and age of the panel, the clock can deviate from -380 to +90 sec/month. For systems where this level of precision is insufficient, the user should monitor and make adjustments when required.

Touch Panel

Touch Panel Type	Resistive Film (analog)
Touch Panel Resolution	1,024 x 1,024
Touch Panel Service Life	1 million times or more

Interface Specifications

Serial Interface COM1

Asynchronous Transmission	RS-232C
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps
Connector	D-Sub 9 pin (plug)

Serial Interface COM2

Asynchronous Transmission	RS-485
Data Length	7 or 8 bits
Stop Bit	1 or 2 bits
Parity	None, odd or even
Data Transmission Speed	2,400...115,200 bps, 187,500 bps (MPI)
Connector	Modular jack (RJ-45)

USB Interface

	USB (Type A) Interface	**USB (mini-B) Interface**
Connector	USB 2.0 (Type A) x 1	USB 2.0 (mini-B) x 1
Power Supply Voltage	5 Vdc ±5%	-
Maximum Current Supplied	500 mA	-
Maximum Transmission Distance	5 m (16.4 ft)	

Ethernet Interface

Ethernet (LAN)	IEEE802.3i / IEEE802.3u, 10BASE-T/100BASE-TX
Connector	Modular jack (RJ45) x 1

SD Card Interface

SD Card slot x 1 (maximum 32 GB SD/SDHC Card)

Specifications of Serial Interface COM1

Introduction

⚠ CAUTION

LOSS OF POWER

- Make sure all connections to the communication ports on the bottom and sides of the panel do not put excessive stress on the ports.
- Securely attach communication cables to the panel or cabinet.
- Use only D-Sub 9 pin cables with a locking system in good condition.

Failure to follow these instructions can result in injury or equipment damage.

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

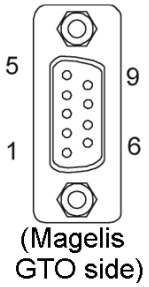
When using the SG terminal to connect an external device to the panel:

- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #5 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #5 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM1

HMIGTO6310 / HMIGTO6315: D-Sub 9 pin plug connector via an RS-232C cable.

Pin Connection	Pin No.	RS-232C		
		Signal Name	Direction	Meaning
 (Magelis GTO side)	1	CD	Input	Carrier Detect
	2	RD(RXD)	Input	Receive Data
	3	SD(TXD)	Output	Send Data
	4	ER(DTR)	Output	Data Terminal Ready
	5	SG	-	Signal Ground
	6	DR(DSR)	Input	Data Set Ready
	7	RS(RTS)	Output	Request to Send
	8	CS(CTS)	Input	Send possible
	9	CI(RI)/VCC	Input/–	Called Status Display +5V±5% Output 0.25A[*1]
	Shell	FG	–	Frame Ground (Common with SG)

NOTE: [*1] You can switch pin #9 between RI and VCC via software.

NOTICE

EQUIPMENT DAMAGE

Use only the rated current.

Failure to follow these instructions can result in equipment damage.

Interfit bracket is #4-40 (UNC).

⚠ CAUTION

LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only D-Sub 9 pin cables with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

Specifications of Serial Interface COM2

Introduction

The serial port is not isolated. The SG (signal ground) and FG (frame ground) terminals are connected inside the panel.

⚠⚠ DANGER

ELECTRIC SHOCK

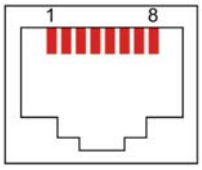
When using the SG terminal to connect an external device to the panel:
- Verify that a short-circuit loop is not created when you set up the system.
- Connect the #8 SG terminal to remote equipment when the host (PLC) unit is not isolated. Connect the #8 SG terminal to a known reliable ground connection to reduce the risk of damaging the circuit.

Failure to follow these instructions will result in death or serious injury.

Serial Interface COM2

HMIGTO6310 / HMIGTO6315: RJ45 connector via a RS-485 cable.

NOTE: When setting up RS-485 communication, the cable diagram for some equipment may require polarization on the terminal side. This terminal does not require any special setting as it handles polarization automatically.

Pin Connection	Pin No.	RS-485		
		Signal Name	Direction	Meaning
	1	NC	-	-
	2	NC	-	-
	3	NC	-	-
	4	Line A	Input/Output	Transfer Data (RS-485)
	5	Line B	Input/Output	Transfer Data (RS-485)
	6	RS(RTS)	Output	Request To Send
	7	NC	-	-
	8	SG	-	Signal Ground

⚠ CAUTION

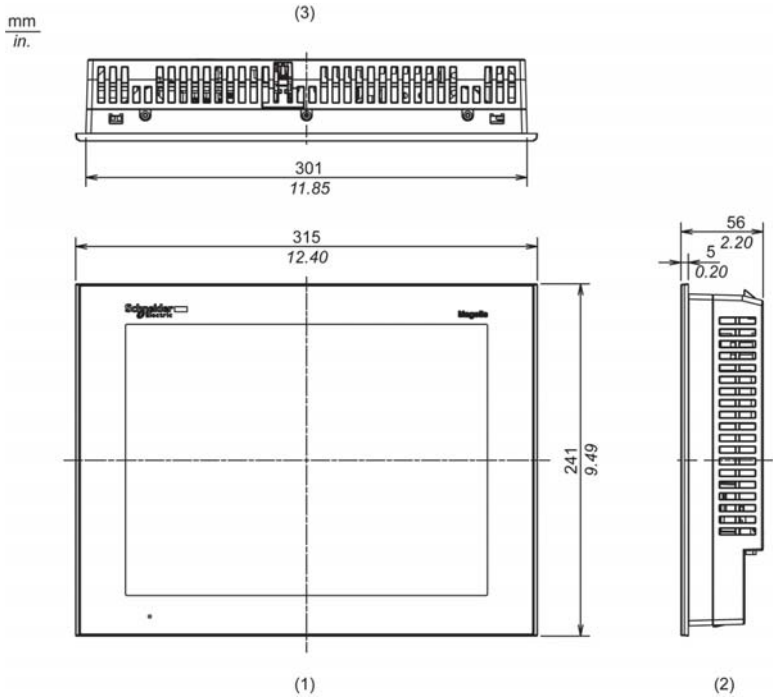
LOSS OF COMMUNICATION

- All connections to the communication ports must not put excessive stress on the ports.
- Securely attach communication cables to the panel wall or cabinet.
- Use only RJ45 with a locking tab in good condition.

Failure to follow these instructions can result in injury or equipment damage.

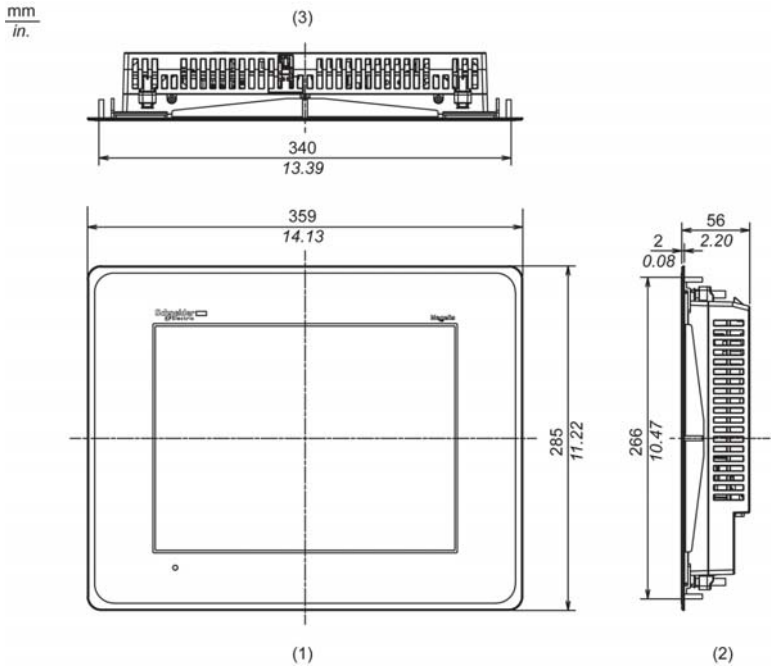
Dimensions

External Dimensions: HMIGTO6310



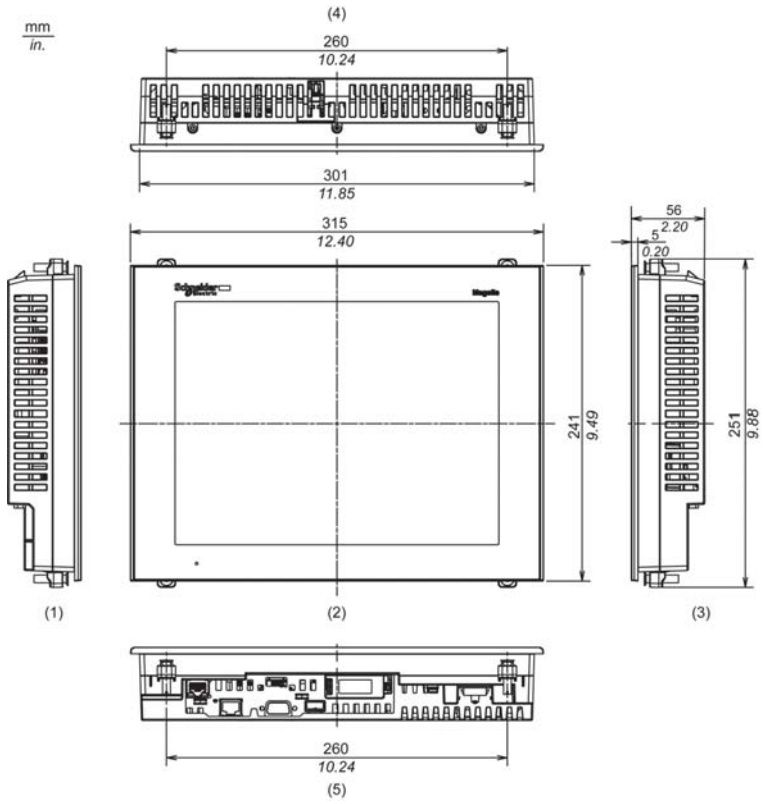
1 Front
2 Right Side
3 Top

External Dimensions: HMIGTO6315



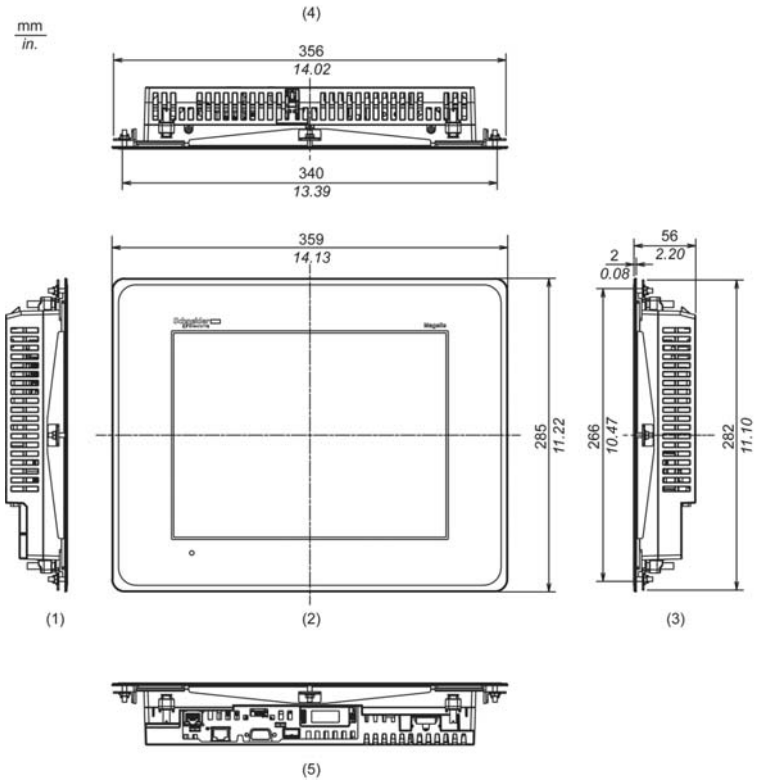
1 Front
2 Right Side
3 Top

Installation with Installation Fasteners: HMIGTO6310



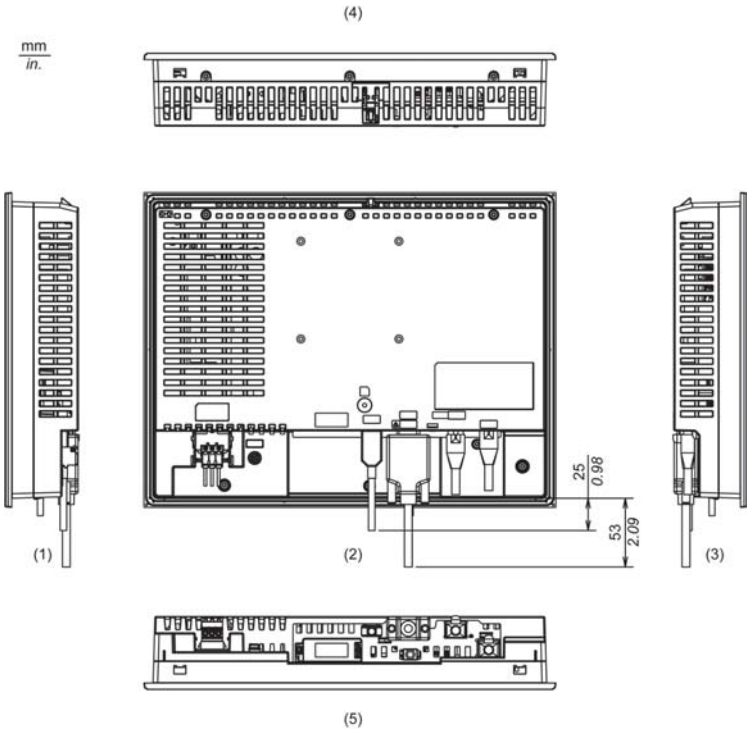
1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

Installation with Installation Fasteners: HMIGTO6315



1 Left Side
2 Front
3 Right Side
4 Top
5 Bottom

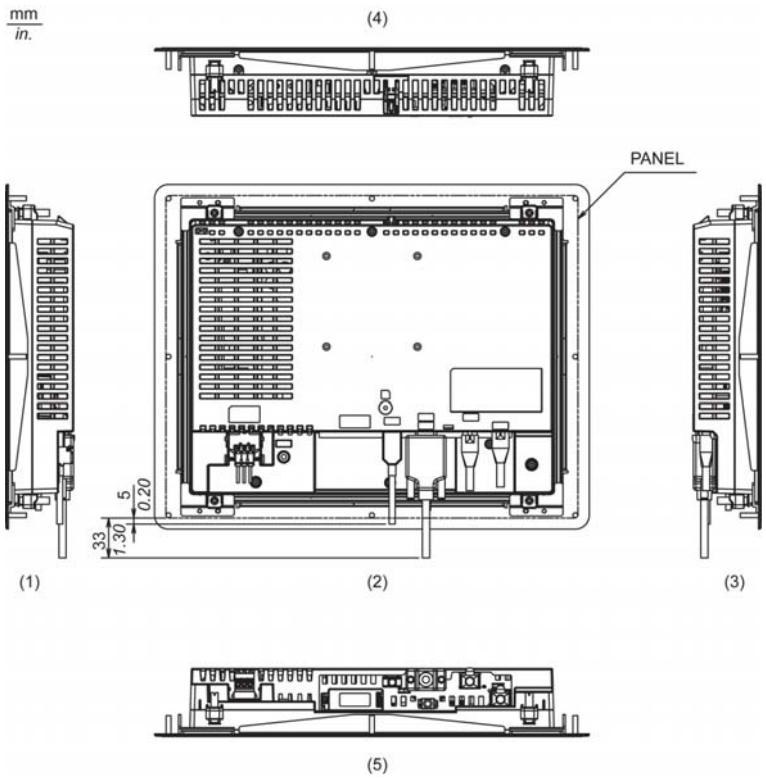
Dimensions with Cables: HMIGTO6310



1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Dimensions with Cables: HMIGTO6315

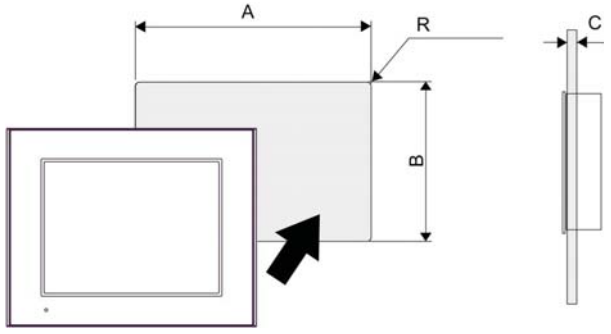


1 Left Side
2 Rear
3 Right Side
4 Top
5 Bottom

NOTE: All the above values are designed with cable bending in mind. The dimensions given here are representative values depending on the type of connection cable in use. Therefore, these values are intended for reference only.

Panel Cut Dimensions

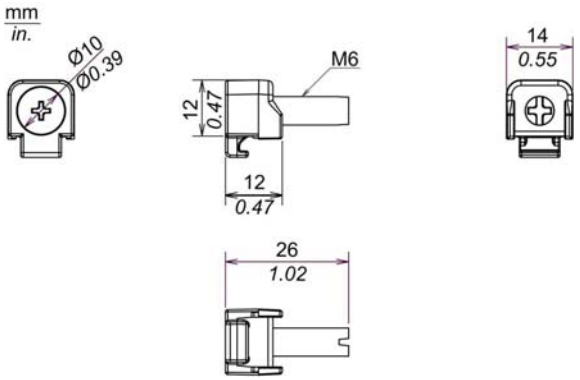
Create a panel cut and insert the panel into the opening from the front.



	A	B	C	R
HMIGTO6310	301.5 mm (+1, -0 mm) (11.87 [+0.04, -0 in.])	227.5 mm (+1, -0 mm) (8.96 in. [+0.04, -0 in.])	1.6...5 mm (0.06...0.2 in.)	3 mm (0.12 in.) maximum
HMIGTO6315	340.5 mm (+1, -0 mm) (13.41 [+0.04, -0 in.])	266.5 mm (+1, -0 mm) (10.49 in. [+0.04, -0 in.])		

NOTE: Before designing the panel cut, refer to Installation *(see page 120)*.

Installation Fastener Dimensions



Chapter 5
Installation and Wiring

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
5.1	Installation	120
5.2	Wiring Principles	125
5.3	SD Card Insertion/Removal	131
5.4	USB Cable Clamp	136

Section 5.1
Installation

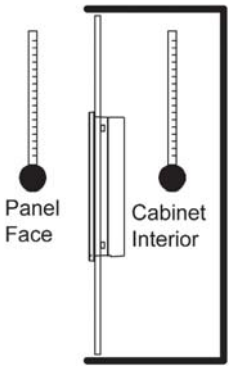
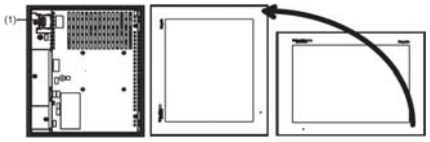
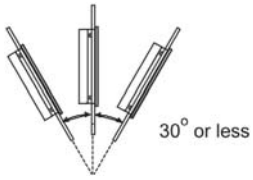
Installation Procedures

Introduction

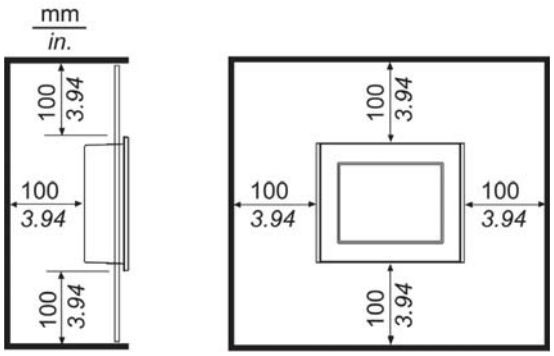
The installation fasteners are required when installing the panel.

Mount the panel in an enclosure that provides a clean, dry, robust and controlled environment. (HMIGTO except HMIGTO2315/HMIGTO5315/HMIGTO6315: IP65, Type 1, Type 4X [Indoor Use Only] or Type 13 Enclosure. HMIGTO2315/HMIGTO5315/HMIGTO6315: IP66k, Type 1, Type 4X [Indoor Use Only] or Type 13 Enclosure.)

Installation Requirements

Check that the installation wall or cabinet's surface is flat, in good condition and has no jagged edges. Metal reinforcing strips may be attached to the inside of the wall, near the panel-cut, to increase its rigidity.
Decide on the thickness of the enclosure wall, based on the level of strength required: 1.6...5 mm (0.06...0.2 in.).
Be sure that the surrounding air temperature and the ambient humidity are within their designated ranges. Surrounding air temperature: 0 to 50 °C (32 to 122 °F) or 0 to 55 °C (32 to 131 °F) (please see the Environment Specifications for your HMIGTO); ambient humidity: 10 to 90%RH; wet bulb temperature: maximum 39 °C [102 °F]. When installing the panel in a cabinet or enclosure, the surrounding air temperature is the cabinet's or enclosure's internal temperature. 
Be sure that heat from surrounding equipment does not cause the panel to exceed its standard operating temperature.
When mounting the panel vertically, ensure that the right side of the unit faces up. In other words, the power connector should be at the top.  **1** Power connector
When installing the panel in a slanted position, the panel face should not incline more than 30° . 
When installing the panel in a slanted position with an incline more than 30° , the ambient temperature must not exceed 40 °C (104 °F). You may need to use forced air cooling (fan, A/C) to ensure the ambient operating temperature is 40° C or less (104 °F or less).

For easier maintenance, operation and improved ventilation, install the panel at least 100 mm (3.94 in.) away from adjacent structures and other equipment as shown in the following illustration:



The holes on the rear of the panel (except HMIGTO1300/1310) do not correspond to VESA 75 mm standards. Do not attach the panel to a commercial-type VESA arm.

Panel Mounting Procedure: (except HMIGTO2315/HMIGTO5315/HMIGTO6315)

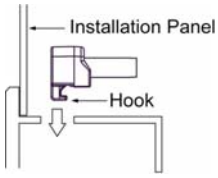
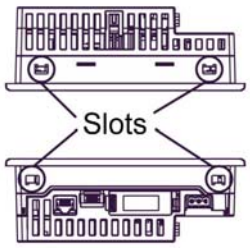
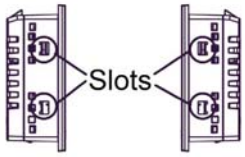
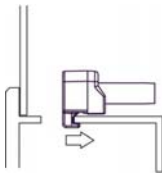
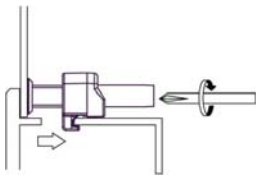
NOTICE

PANEL UNSTEADY WHEN UNSECURED

Keep HMIGTO stabilized in the panel-cut while you are installing or removing the screw fasteners.

Failure to follow these instructions can result in equipment damage.

Step	Action
1	Place the panel on a clean and level surface with the display facing downward.
2	Check that the panel's gasket is seated securely into the gasket's groove, which runs around the perimeter of the panel frame.
3	Cut a hole in the installation panel as defined by the HMIGTO's panel cutout dimensions. HMIGTO1300/HMIGTO1310 *(see page 48)* HMIGTO2300/HMIGTO2310 *(see page 66)* HMIGTO3510/HMIGTO4310 *(see page 82)* HMIGTO5310 *(see page 99)* HMIGTO6310 *(see page 116)*
4	Insert the HMIGTO into the panel-cut.

Step	Action
5	Insert the installation fasteners into the HMIGTO's insertion slots on the top and bottom sides (left and right sides for the HMIGTO1300/1310). Slide the fasteners to the back. If the fasteners are not correctly attached, the HMIGTO may shift or fall out.  HMIGTO2310  HMIGTO1310 
6	Insert each of the fasteners shown below. Make sure you pull the fastener back until it is flush with the rear of the attachment hole insert. 
7	Use a Phillips screwdriver to tighten each fastener screw and secure the panel in place. The necessary torque is 0.5 Nm (4.4 lb•in). 

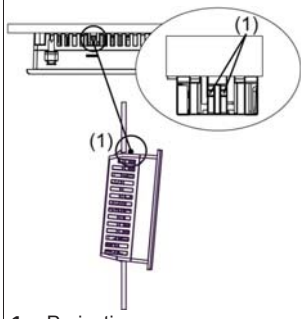
NOTICE

BROKEN ENCLOSURE

- Do not exert more than 0.5 Nm (4.4 lb•in) of torque when tightening the fastener's screws.
- Use on flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.

Failure to follow these instructions can result in equipment damage.

Removal Procedure: (except HMIGTO2315/HMIGTO5315/HMIGTO6315)

Step	Action
1	Loosen the installation fasteners (4) from the HMIGTO.
2	Remove the HMIGTO slowly from the panel while pressing the projections on the top of the HMIGTO.  **1** Projections **NOTE:** ● You could damage the HMIGTO if you try and remove it without holding down the projections. ● Watch your fingers so they do not get caught when holding down the projections.

⚠ CAUTION

RISK OF INJURY

Do not drop the HMIGTO when you remove it from the panel.

- Hold the HMIGTO in place after removing the fasteners.
- Use both hands.

Failure to follow these instructions can result in injury or equipment damage.

HMIGTO2315/HMIGTO5315/HMIGTO6315 Panel Mounting Procedure

⚠ CAUTION

RISK OF INJURY

Do not drop the HMIGTO when you install or remove it from the panel.

- Hold the HMIGTO in place after removing the M4 Hex nuts and brackets.
- Use both hands.

Failure to follow these instructions can result in injury or equipment damage.

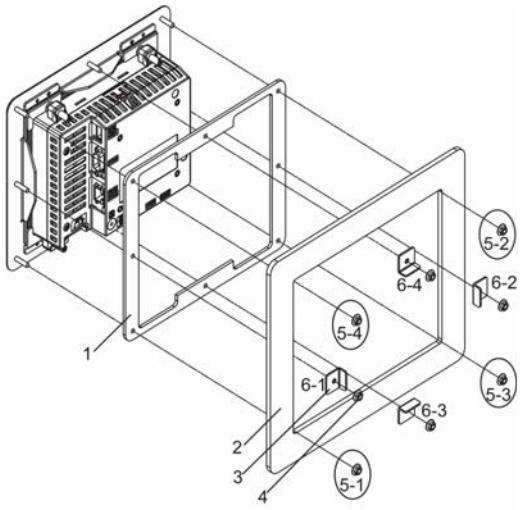
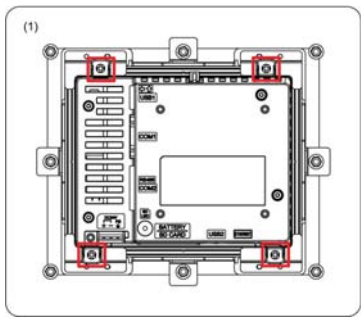
NOTICE

PANEL UNSTEADY WHEN UNSECURED

Keep panel stabilized in the panel-cut while you are installing or removing the M4 Hex nuts and brackets.

Failure to follow these instructions can result in equipment damage.

Step	Action
1	Place the panel on a clean and level surface with the display facing downward.
2	Confirm that the panel's gasket is seated properly on the rear of the panel.
3	Cut a hole in the panel as defined by the HMIGTO panel cutout dimensions. HMIGTO2315 *(see page 66)* HMIGTO5315 *(see page 99)* HMIGTO6315 *(see page 116)*

Step	Action
4	Insert the HMIGTO into the panel-cut.  **1** Gasket **2** Panel **3** Brackets **4** M4 Hex Nut **5** Please read Step 5. **6** Please read Step 6.
5	Tighten the four corners of the rear of the panel with the M4 Hex nuts, in the order shown in the example in Step 4. Use an M4 box-type screwdriver to tighten each M4 Hex nut and secure the panel in place. The necessary torque is 0.5 Nm (4.4 lb•in). If the M4 Hex nuts are not correctly attached, the panel may shift or fall out.
6	Attach the bracket onto the screws in the middle between the M4 Hex nuts in the order shown in the example in Step 4. Use an M4 box-type screwdriver to tighten each M4 Hex nut and secure the panel in place. The necessary torque is 0.5 Nm (4.4 lb•in). If the M4 Hex nuts are not correctly attached, the panel may shift or fall out.
7	Tighten all the M4 Hex nuts again. The necessary torque is 0.5 Nm (4.4 lb•in). **NOTE:** Do not loosen the installation fasteners, marked with red squares below.  **1** Panel

NOTICE

BROKEN ENCLOSURE

- Do not exert more than 0.5 Nm (4.4 lb•in) of torque when tightening the M4 Hex nuts.
- Use on flat surface of a Type 1, Type 4X (Indoor Use Only) or Type 13 Enclosure.

Failure to follow these instructions can result in equipment damage.

Section 5.2
Wiring Principles

Overview

This section presents the HMIGTO wiring principles.

What Is in This Section?

This section contains the following topics:

Topic	Page
Connecting the Power Cord	126
Connecting the Power Supply	128
Grounding	130

Connecting the Power Cord

⚠ WARNING

EXCESSIVE ELECTROMAGNETIC INTERFERENCE

- When the functional ground (FG) terminal is connected, be sure the wire is grounded. Not grounding the HMIGTO can result in excessive Electromagnetic Interference (EMI). Grounding is required to meet EMC level immunity.
- Remove power before wiring the HMIGTO's power terminals.
- The DC model uses only 24 Vdc power. Using any other level of power can damage both the power supply and the HMIGTO.
- Since the HMIGTO is not equipped with a power switch, be sure to connect a power switch to the power supply.
- Be sure to ground the HMIGTO's FG terminal.
- Replace and secure all elements of the system before applying power to the HMIGTO.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

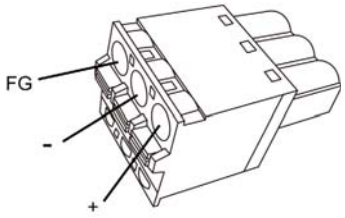
NOTE: The shield ground (SG) and FG terminals are connected internally in the panel.

DC Power Cord Preparation

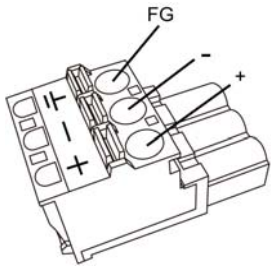
- Make sure the ground wire is either the same or heavier gauge than the power wires.
- Do not use aluminum wires in the power supply's power cord.
- If the ends of the individual wires are not twisted correctly, the wires may create a short circuit.
- Wherever possible, use wires that are 0.75 to 2.5 mm^2 (AWG 18 - 13) for the power cord, and twist the wire ends before attaching the terminals.
- The conductor type is solid or stranded wire.
- Field wiring terminal marking for wire type (75 °C [167 °F] copper conductors only).

DC Power Supply Connector (Plug) Specifications: Spring Clamp Terminal Blocks

HMIGTO1300/1310 / HMIGTO2300/2310/2315 / HMIGTO3510/4310

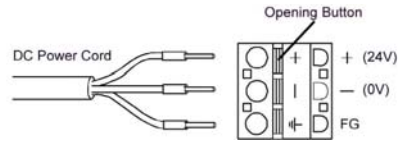
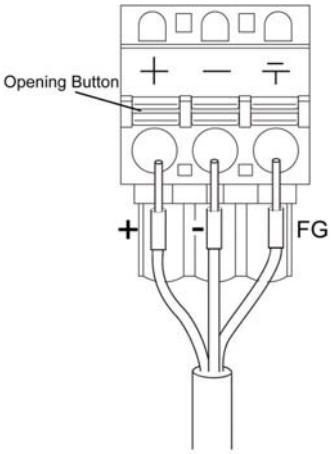


HMIGTO5310/5315 / HMIGTO6310/6315



Connection	Wire
+	24 Vdc
-	0 Vdc
FG	Grounded terminal connected to the panel chassis.

How to connect the DC Power Cord

Step	Action
1	Confirm the power cord is not connected to the power supply.
2	Check the rated voltage and remove the “DC24V” sticker on the DC power supply connector.
3	Remove 10 mm (0.39 in.) of the vinyl membrane off the ends of the power cord wires.
4	If using stranded wire, twist the ends. Tinning the ends with solder reduces risk of fraying and ensures good electrical transfer.
5	Push the Opening button with a small and flat screwdriver to open the desired pin hole.
6	Insert each pin terminal into its corresponding hole. Release the Opening button to clamp the pin in place. HMIGTO1300/1310 / HMIGTO2300/2310/2315 / HMIGTO3510/4310  HMIGTO5310/5315 / HMIGTO6310/6315 
7	After inserting all three pins, insert the power plug into the power connector on the panel.

NOTE:

- Do not solder the wire directly to the power receptacle pin.
- To prevent the possibility of a terminal short, use a pin terminal that has an insulating sleeve.
- You can connect the DC power supply connector for HMIGTO1300/1310, HMIGTO2300/2310/2315, or HMIGTO3510/4310 to HMIGTO5310/5315 or HMIGTO6310/6315 units. However, the reverse is not possible. You cannot connect the DC power supply connector for HMIGTO5310/5315 or HMIGTO6310/6315 to HMIGTO1300/1310, HMIGTO2300/2310/2315, or HMIGTO3510/4310 units.

Connecting the Power Supply

Precautions

- You must use a 24 Vdc input unit with a Class 2 power supply.
- To increase the electromagnetic noise resistance, make sure you twist the ends of the power cord wires before connecting them to the power plug.
- The panel's power supply cord should not be bundled with or kept close to main circuit lines (high voltage, high current), or input/output signal lines.
- Connect a lightning surge absorber to handle power surges.
- To reduce electromagnetic noise, make the power cord as short as possible.

⚠ WARNING

SHORT CIRCUIT, FIRE, OR UNINTENDED EQUIPMENT OPERATION

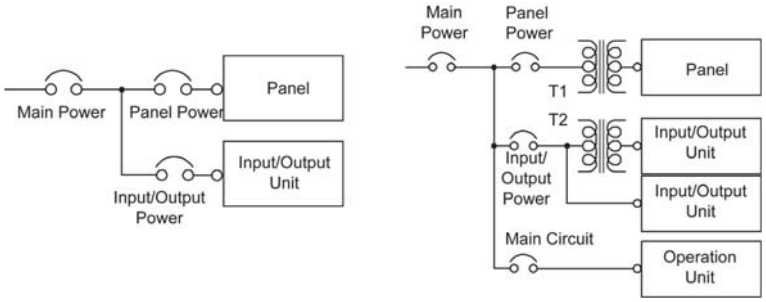
Avoid excessive force on the power cable to prevent accidental disconnection

- Securely attach power cables to the HMIGTO or cabinet.
- Use the designated torque to tighten the unit terminal block screws.
- Install and fasten the HMIGTO on installation panel or cabinet prior to connecting power supply and communication lines.

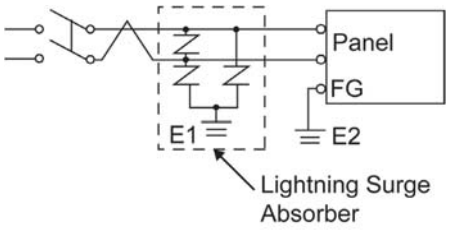
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Power Supply Connections

When supplying power to the panel, separate the input/output and power lines, as shown.

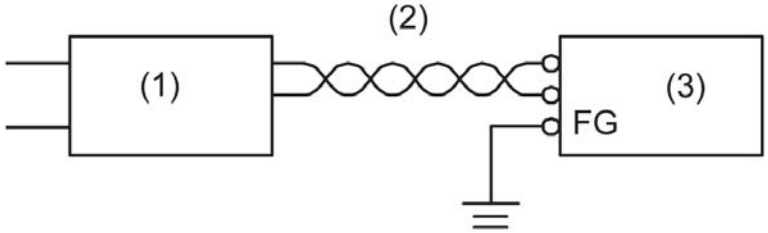


NOTE:
The following shows a lightning surge absorber connection:



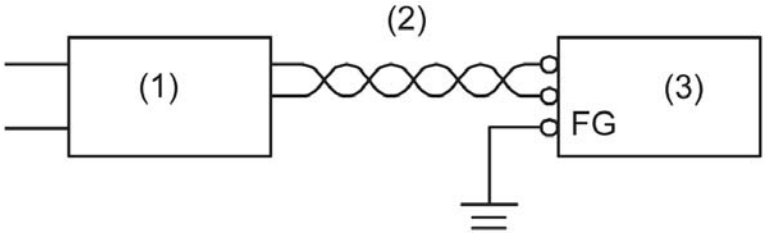
- Ground the surge absorber (E1) separately from the panel (E2).
- Select a surge absorber that has a maximum circuit voltage greater than that of the peak voltage of the power supply.

If the supplied voltage exceeds the panel range, connect a constant voltage transformer.



1 Constant voltage transformer
2 Twisted-pair cord
3 panel

Select a power supply low in noise for between the line and ground. If there is an excess amount of noise, connect an insulating transformer.



1 Insulating transformer
2 Twisted-pair cord
3 panel

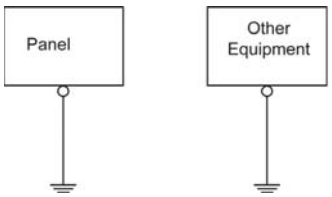
NOTE: Use constant voltage and insulating transformers with capacities exceeding the Power Consumption value.

Grounding

Exclusive Grounding

When supplying power to the panel, separate the input/output and power lines as shown below.

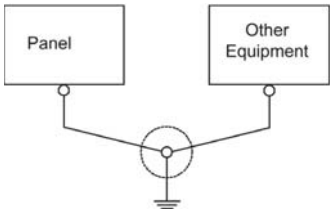
Connect the frame ground (FG) terminal on the power plug to an exclusive ground.



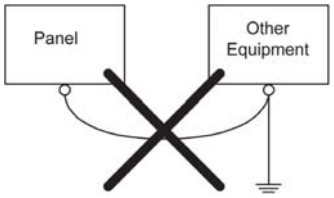
Precautions

Electromagnetic Interference (EMI) can be created if the devices are improperly grounded. EMI can cause loss of communication. Do not use common grounding, except for the authorized configuration described below. If exclusive grounding is not possible, use a common grounding point.

Correct grounding



Incorrect grounding



- Check that the grounding resistance is 100 Ω or less.[*1]
- The FG wire should have a cross sectional area greater than 2 mm^2 (AWG 14) [(1)]. Create the connection point as close to the panel as possible, and make the wire as short as possible. When using a long grounding wire, replace the thin wire with a thicker wire, and place it in a duct.
- FG and SG terminals are internally connected in the panel. When connecting an external device to the panel using the SG terminal, check that you do not create a short-circuit loop when you set up the system.

[*1] Observe local codes and standards. Ensure the ground connection has a resistance of 100 Ω and that the ground wire has a cross-section of at least 2 mm^2 or AWG 14.

Section 5.3
SD Card Insertion/Removal

What Is in This Section?

This section contains the following topics:

Topic	Page
Introduction	132
Inserting the SD Card	133
Removing the SD Card	134
SD Card Data Backup	135

Introduction

NOTICE

LOSS OF DATA

When using the HMIGTO and a SD Card, observe the following to avoid losing valuable data:

- Since accidental data loss can occur at any time, back up HMIGTO screen and SD Card data regularly. Once HMIGTO data is lost, it cannot be recovered.
- While a SD Card is accessed, do not turn OFF or reset the HMIGTO, and do not insert or remove the SD Card. Doing so could damage the SD Card, or corrupt its data.
- Before using the SD Card, familiarize yourself with the SD Card's front and rear face orientation, as well as the position of the SD Card connectors. If the SD Card is not positioned correctly when inserted into the HMIGTO, the card's internal data and HMIGTO could become damaged.

Failure to follow these instructions can result in equipment damage.

NOTICE

LOSS OF DATA

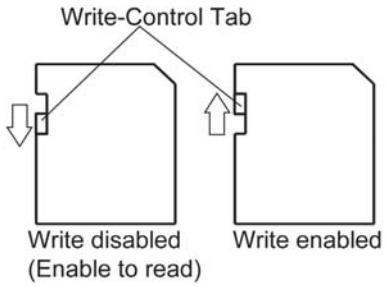
When handling the SD Card, follow the instructions below to prevent internal data on the SD Card from being destroyed or a SD Card malfunction from occurring:

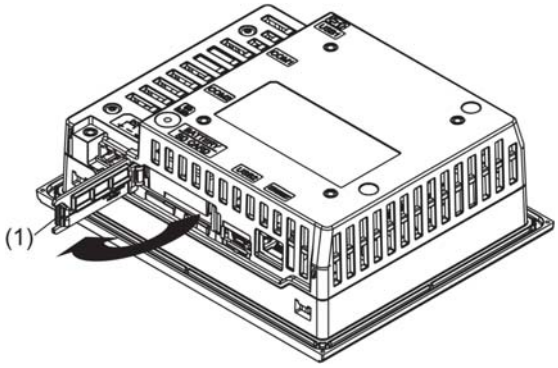
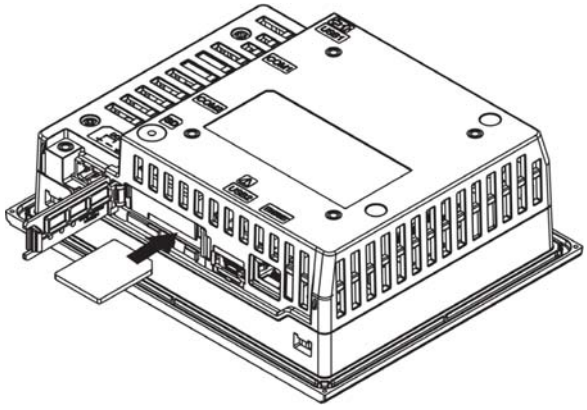
- Avoid storing the SD Card where there is static electricity or electromagnetic waves.
- Avoid storing the SD Card in direct sunlight, near a heater, or other locations where high temperatures can occur.
- Do not bend the SD Card.
- Do not drop or strike the SD Card against another object.
- Keep the SD Card dry.
- Do not touch the SD Card connectors.
- Do not disassemble or modify the SD Card.
- Use only SD Cards formatted using FAT or FAT32. The HMIGTO does not recognize NTFS formatted SD Cards. Format the SD Card on your computer using FAT or FAT32.

Failure to follow these instructions can result in equipment damage.

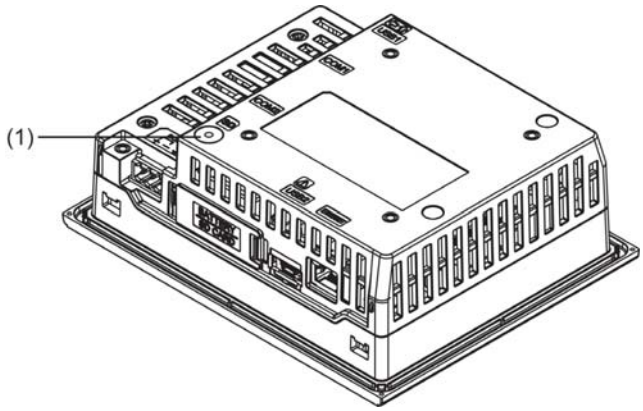
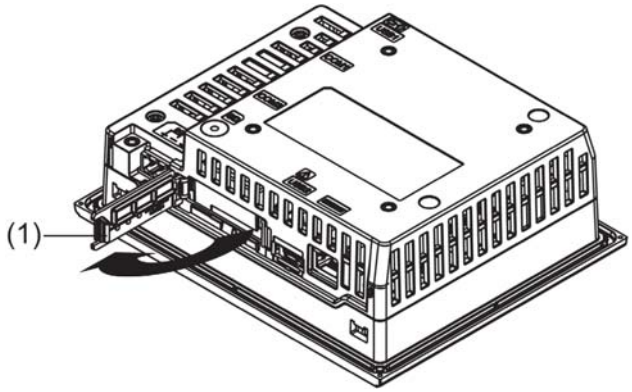
Inserting the SD Card

NOTE: As shown in the image below (example on the left-hand side), you can set the Write-Control Tab to prevent write operations to the SD Card. Push the tab up, as shown in the example on the right-hand side, to release the lock and enable writing to the SD Card. Before using a commercial-type SD Card, read the manufacturer's instructions.



Step	Action
1	Pull on the tab and open the SD Card cover.  **1** Tab
2	Insert the SD Card into the SD Card interface, and push until you hear it "click". 
3	Close the SD Card cover.

Removing the SD Card

Step	Action
1	Make sure the SD Card Access LED is off.  **1** SD Card Access LED
2	Push down the tab on the SD Card cover, then pull open the cover.  **1** Tab
3	Push the SD Card once to release, and pull out the card. After removing the card, close the cover. **NOTE:** After using the SD Card, store the SD Card in its case or other safe location.

SD Card Data Backup

To make your backups, you can either insert the SD Card directly into the SD Card interface on your computer, or use a commercially available SD Card reader.

Section 5.4
USB Cable Clamp

Overview

This section presents the USB cable clamp.

What Is in This Section?

This section contains the following topics:

Topic	Page
USB Cable Clamp for USB (Type A)	137
USB Holder for USB (mini-B)	139

USB Cable Clamp for USB (Type A)

Introduction

When using a USB device, attaching a USB cable clamp to the USB interface to prevent the USB cable from being disconnected.

⚠ DANGER

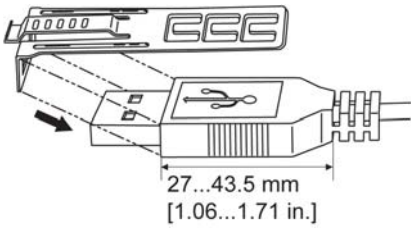
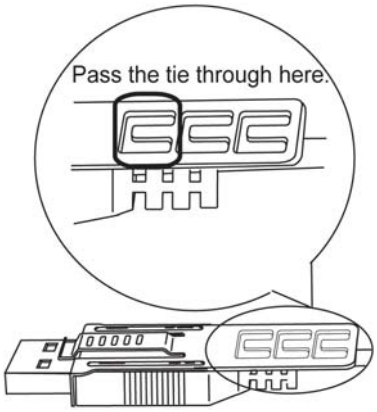
POTENTIAL FOR EXPLOSION

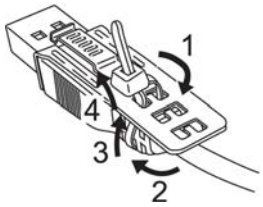
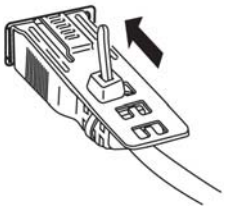
- Verify the power, input, and output (I/O) wiring are in accordance with Class I, Division 2 wiring methods.
- Substitution of any components may impair suitability for Class I, Division 2.
- Confirm that the USB cable has been fixed with the USB cable clamp before using the USB interface.
- Remove power before attaching or detaching any connectors to or from the unit.

Failure to follow these instructions will result in death or serious injury.

Attaching the USB Cable Clamp

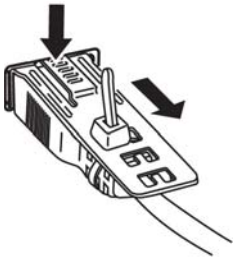
NOTE: Watch your fingers. The edge of the clip is sharp.

Step	Action
1	Mount the clip to the USB mark connector shell so that it overlaps. The clip matches the 27 to 43.5 mm [1.06 to 1.71 in.] length of the USB connector. 
2	Align the clip and the USB cable connector shell. Adjust the position of the holes where the clip is attached. To ensure stability, select the clip-hole position that is closest to the base of the connector shell. 

Step	Action
3	As shown, pass the tie through the clip hole. Next, turn the tie and pass it through the head so that the USB cable can pass through the center of the tie loop. The clip is now attached to the USB cable.  **NOTE:** ● Check the direction of the head beforehand. Make sure the USB cable is through the center of the tie loop and that the tie can pass through the head. ● You can substitute the tie provided with commercially available ties with a width of 4.8 mm [0.19 in.] and thickness of 1.3 mm [0.05 in.].
4	While pressing the grip on the clip, insert the cable from step 3 all the way into the USB host interface. Make sure that the clip tab is secured to the USB cable attached to the HMIGTO. 

Removing the USB Cable

Remove the USB cable while pushing the grip section of the clip.



USB Holder for USB (mini-B)

Introduction

When using a USB device, you can attach a USB holder to the USB (mini-B) interface to prevent the USB cable from being disconnected.

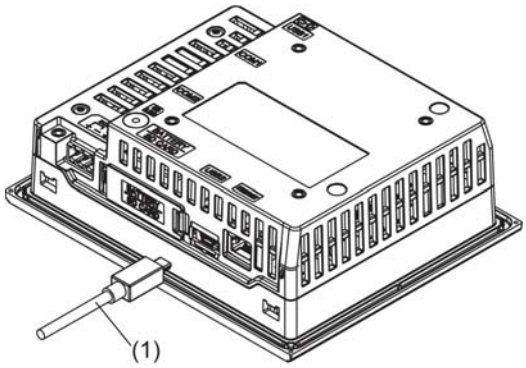
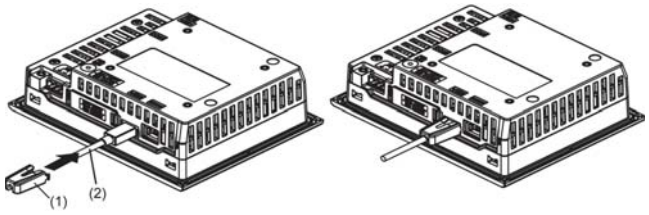
⚠ DANGER

POTENTIAL FOR EXPLOSION

- Verify the power, input, and output (I/O) wiring are in accordance with Class I, Division 2 wiring methods.
- Substitution of any components may impair suitability for Class I, Division 2.
- Confirm that the USB cable has been fixed with the USB cable clamp before using the USB interface.
- Remove power before attaching or detaching any connectors to or from the unit.

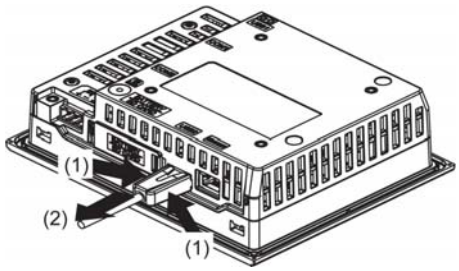
Failure to follow these instructions will result in death or serious injury.

Attaching the USB Holder

Step	Action
1	Insert the USB cable into the USB (mini-B) interface.  **1** USB cable
2	Attach the USB holder to fix the USB cable in place. Insert the USB holder into the USB (mini-B) interface.  **1** USB holder **2** USB cable

Removing the USB Holder

Remove the USB holder by pressing the tabs from the sides.



1 USB holder
2 USB cable

Chapter 6
Maintenance

Overview

This chapter explains how to maintain your panel.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Regular Cleaning	142
Replacing the Installation Gasket	143
Periodic Check Points	145
Replacing the Primary Battery	146

Regular Cleaning

Cleaning the display

NOTICE
EQUIPMENT DAMAGE ● Power off the panel before cleaning it. ● Do not use hard or pointed objects to operate the touch panel as you may damage the panel surface. ● Do not use paint thinner, organic solvents, or a strong acid compound to clean the unit. **Failure to follow these instructions can result in equipment damage.**

When the surface or the frame of the display gets dirty, soak a soft cloth in water with a neutral detergent, wring the cloth tightly and wipe the display.

Replacing the Installation Gasket

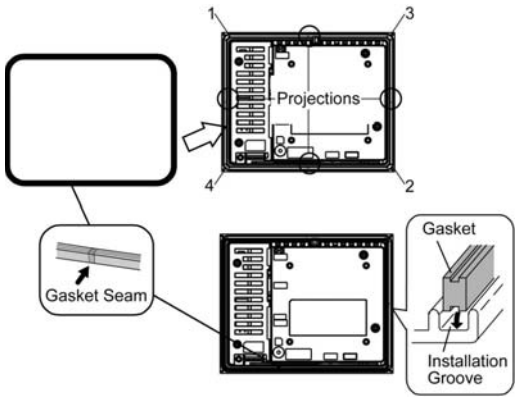
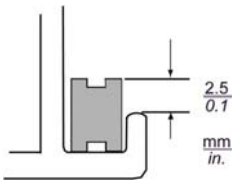
Overview

The installation gasket provides protection against dust and moisture.

NOTICE
GASKET AGING ● Inspect the gasket periodically as required by your operating environment to keep the initial IP level. ● Change the gasket at least once a year, or as soon as scratches or dirt become visible. **Failure to follow these instructions can result in equipment damage.**

Installing the Installation Gasket

NOTE: For instructions on how to install the installation gasket when using HMIGTO2315/HMIGTO5315/HMIGTO6315, see HMIGTO2315/HMIGTO5315/HMIGTO6315 Panel Mounting Procedure *(see page 123)*.

Stage	Description
1	Place the panel on a flat, level surface, with the display face pointing down.
2	Remove the gasket from the panel.
3	Attach the new gasket to the panel. Position the gasket in the installation groove so that the gasket seam is at the bottom of the panel. First, insert the gasket into the 4 corners, in the order shown in the image below. Then, insert the rest of the gasket into the installation groove. **NOTE:** ● The center of the panel bezel's installation groove is ribbed. Make sure you insert the gasket all the way in without catching the ribbed sections. ● When using a tool to insert the gasket, make sure the tool does not catch the rubber gasket and cause a tear. 
4	The upper surface of the gasket should protrude approximately 2.0 mm (0.06 in.) from the groove. Check the gasket is inserted correctly before installing the HMIGTO into a panel. 

The gasket must be inserted correctly into the groove for IP65f moisture resistance for the panel. (IP66k moisture resistance for HMIGTO2315/HMIGTO5315/HMIGTO6315.)

⚠ CAUTION

EQUIPMENT DAMAGE

- Since the gasket is flexible but not elastic, be careful not to stretch it unnecessarily.
- Make sure the gasket seam is not inserted into any of the panel corners.
- Insert the gasket in the installation groove

Failure to follow these instructions can result in injury or equipment damage.

Periodic Check Points

Operation Environment

- Is the operating temperature within the allowable range? Refer to Environmental Specifications *(see page 38)*, *(see page 52)*, *(see page 70)*, *(see page 86)*, *(see page 103)*.
- Is the operating humidity within the specified range? (10%RH to 90%RH, dry bulb temperature of 39 °C [102.2 °F] or less)
- Is the operating atmosphere free of corrosive gasses?

When the HMIGTO is inside a panel, the ambient environment refers to the interior of the panel.

Electrical Specifications

Is the input voltage appropriate?

- 100 Vac to 240 Vac 50/60 Hz
- 19.2 Vdc to 28.8 Vdc

Related Items

- Are all power cords and cables connected properly? Are there any loose cables?
- Are all mounting brackets holding the unit securely?
- Are there scratches or traces of dirt on the installation gasket?

Replacing the Primary Battery

Introduction

The replacement battery HMI ZGBAT (sold separately) for the primary battery in the HMIGTO is available from Schneider Electric.

NOTE: The HMIGTO1300/1310 and HMIGTO2300 are not equipped with a primary battery.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Follow the procedures step by step to replace the battery correctly and safely.
- Before replacing the battery, turn OFF the HMIGTO's power.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

EXPLOSION, FIRE, OR CHEMICAL HAZARD

- Use only the replacement battery HMI ZGBAT manufactured by Schneider Electric.
- Do not cause a short circuit.
- Recycle or properly dispose of used batteries.

Failure to follow these instructions will result in death or serious injury.

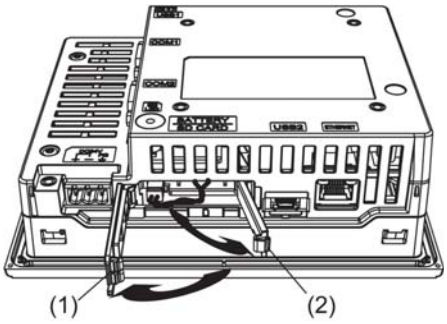
NOTICE

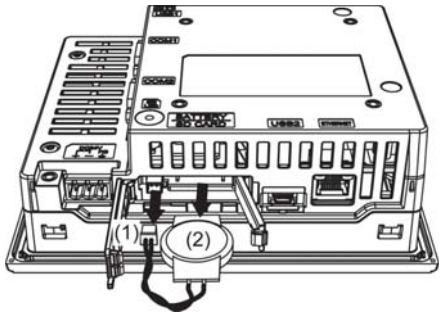
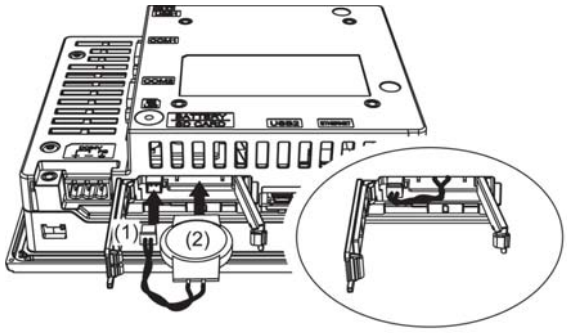
LOSS OF DATA

The primary battery is non-rechargeable, and is used for data backup of memory and the internal clock. If the primary battery is depleted, the backup data is lost. One month before the primary battery is completely depleted, a message will appear to indicate it is time to replace the primary battery.

- Replace the battery within one month after the message appears. Otherwise, backup data may be lost.
- Complete replacing the battery within ten minutes of shutting down the HMIGTO.
- The primary battery replacement time (within a month after the message appears) is only a guideline. When backup SRAM data and clock data is lost after the message appears, Schneider Electric does not perform data recovery/retrieval. Schneider Electric does not accept any responsibility for the loss of data.
- Replace the primary battery regularly every five years after you purchase the HMIGTO.

Failure to follow these instructions can result in equipment damage.

Step	Action
1	Disconnect the power supply from the HMIGTO.
2	Touch the housing or ground connection (not the power supply) to discharge any electrostatic charge from your body.
3	Open the SD Card Interface Cover by pressing its tab. Next, open the Replacement Battery Insertion Cover by pressing its tab.  **1** SD Card Interface Cover / Tab **2** Replacement Battery Insertion Cover / Tab

Step	Action
4	Remove the primary battery and connector.  **1** Connector **2** Primary battery
5	Attach the new primary battery and connector. 
6	First close the replacement battery cover, then close the SD Card Interface Cover. **NOTE:** Make sure the cables are inserted completely inside the enclosure. Otherwise, you can damage the cables when you close the cover.
7	Reconnect the power supply to the HMIGTO.

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LS	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float
LS	M1343	Switch, Level, Mech Float, Narrow Angle, N.O., Blue	Tilt Float Level Switch w 40' cable
LS-101/2/3	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float
LSHH-101.102/103 LSHH-301 LSHH-401 LSHH-501 LSHH-502 LSHH-601/602	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float
LSLL-301/401/501/502	M1108	Switch, Level, Mech Float, Wide Angle, N.O., Red	13A, SPST, N/O, Red

Form 237
Sheet P/N 7801165
Rev. D

Warrick®
Series M Mechanical Tilt Float Switch
Installation and Operation Bulletin

Specifications

Cord	16 gauge, 2 or 3 conductor SJOW, Oil Resistant CPE
Contact Rating	13 amp @ 120/240 VAC, 1/2hp
Contact Design	SPST, Normally Open or Normally Closed, Common with N.O. & N.C. (Form C)
Temperature Rating	32°F (0°C) to 194°F (90°C) Dry and 140°F (60°C) Water Resistant
Overall Weight	1.0 lbs. (not including weight)
Tether Method	Tie-wrap nylon, weight: 2.5 lbs.
Approvals	U.L. Recognized, CSA Certified

Installation

Tether Tie-Wrap (Fig 1)
Attach cord, using a tie-wrap, to a stationary structure. This is known as the tether point, it will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Tether-Weight (Fig 2)
Place tension-brand over the cord before installation. Place the weight at the desired position and secure with the tension-band. This position will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Determine tether point using charts below as a reference

Notes:
1. To Prevent Motor Burnout - In a pumpdown application make sure the turn-off level is at least 2 inches above the intake of the submersible pump.

2. Securing Tether Points - Make sure levels are correct and that floats are free from any obstructions before securing tether points.

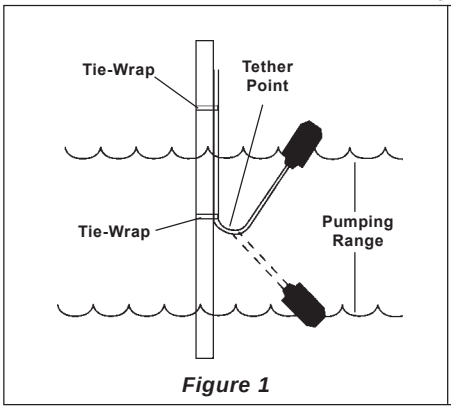


Figure 1

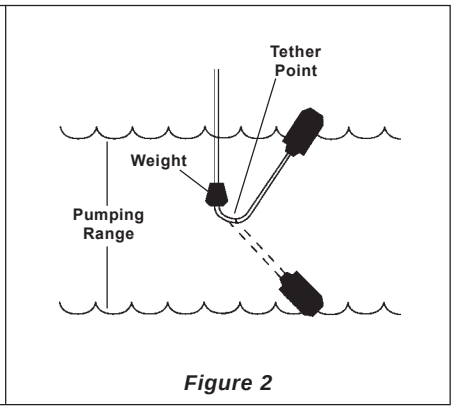
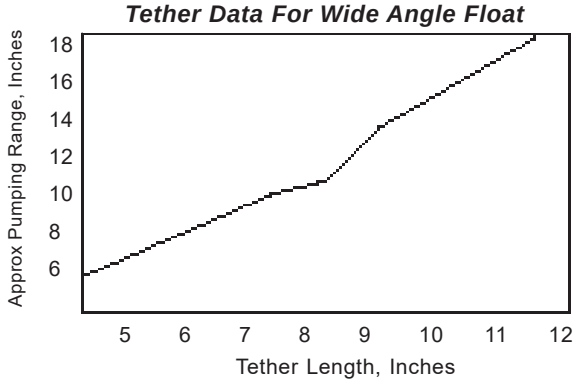
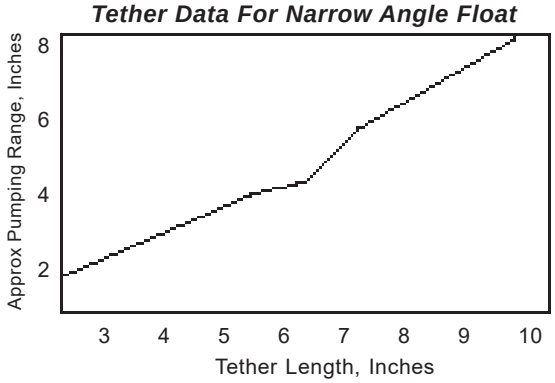


Figure 2

Tether Data For Wide Angle Float

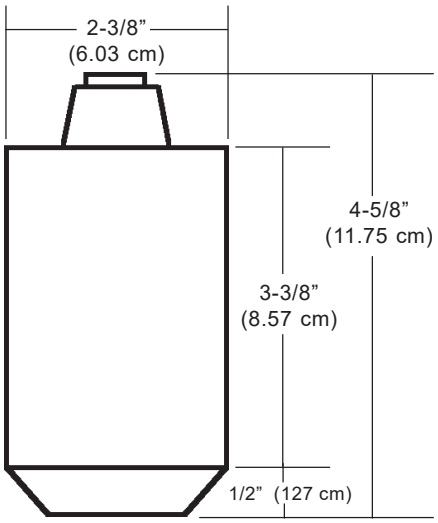


Tether Data For Narrow Angle Float

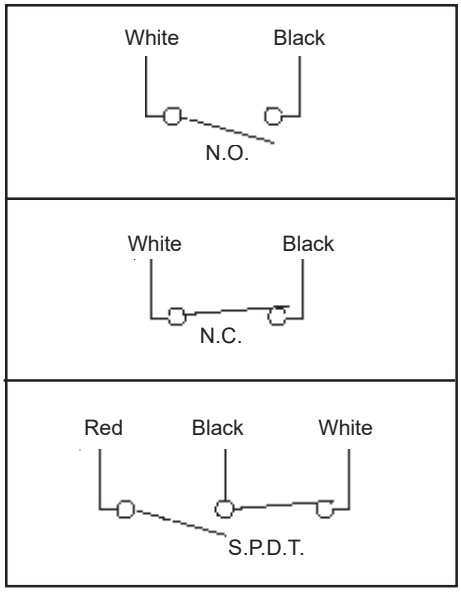


Notes:
1. Narrow angle pumping range is approximately 2 In. to 8 In.
2. Wide angle pumping range is approximately 5 In. to 18 In.

Dimensions



Contact Configurations



Important Points:

- Gems products must be maintained and installed in strict accordance with the National Electrical Code and the applicable Gems Product Instruction Bulletin that covers installation, operation and proper maintenance. Failure to observe this information may result in serious injury or damages.
- For hazardous area applications involving such things as, but not limited to, ignitable mixtures, combustible dust and flammable materials, use an appropriate explosionproof enclosure or intrinsically safe interface device.
- Please adhere to the pressure and temperature limitations shown throughout this catalog for our level and flow sensors. These limitations must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of Gems products. Take care in the proper selection of materials of construction, testing is required.
- NSF-approved sensors are made of materials approved for potable water applica tions according to Standard 61.
- Stainless steel is generally regarded as safe by NSF and FDA.
- Life expectancy of switch contacts varies with application. Contact Gems if life cycle testing is required.
- Ambient temperature changes do affect switch set points, since the gravity of a liquid can vary with temperature.
- Our sensors have been designed to resist shock and vibration. However, shock and vibration should be minimized.
- Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Our sensors must not be field-repaired.
- Physical damage sustained by product may render it unserviceable.

Return Policy

Returns are accepted on stock items up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Return the goods - freight prepaid - in the original container and include original packing slip. C. O. D. returns are not accepted. Gems reserves the right to apply restocking charges.

Tel: 860-793-4357
Fax: 860-793-4563

Gems Sensors Inc.
One Cowles Road
Plainville, CT 06062-1198
Tel: 860-793-4579
Fax: 860-793-4580

LSHH - Switch, Level, Almeg, Vertical, ATB3-48B
LSHH-7901 - "LSLL-301/401/ 501/502"M1108Switch, Level, Mech Float, Wide Angle, N.O., Red13A, SPST, N/O, Red
Switch, Level, Almeg, Vertical, ATB3-48B

ATB 3 and ATS3 Series Spec Sheet
Level Switch - Small Size - Heavy Duty

The ATB3 is designed for high or low level alarm or switch point applications in rugged situations similar to oil tank reservoirs or industry vessels that require a more robust level switch. Notice the larger brass one piece machined hex to get a wrench on - this model also has an optional brass set screw locking collar in place of the clip.

Internal reed switch selection is the same Almeg quality standard but we've beefed up the external part as well as fully encapsulated the reed switch to maintain a complete moisture free environment. The leads are wire wrapped (not clipped) soldered and heat shrink sealed to the reed switch before encapsulating.

The TRUE closed cell Buna float will not swell or take on moisture - even if cut or drilled. It is designed like a tight bee hive or honey comb construction.

100% of our controls are tested before shipping.

The ATB3 is available in a single order or OEM applications.

LT-301/501 - Transmitter, Pressure, KPSI 750 series 0-10ft H20Part Number 750S14D4A004.334000.000B10015B

KPSI®

Level Transducers

KPSI® User's Manual

18th Edition

February 2010

E-688

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Our Company

Pressure Systems is an ISO9001:2000 certified U.S. manufacturer of submersible and non-submersible (above ground) pressure transducers for environmental, industrial and municipal applications. Our KPSI™ Level and Pressure Transducers have been specified in thousands of projects throughout the United States, Canada and Europe by geologists, system integrators, national engineering firms and a variety of government agencies. Typical applications include, but are not limited to, pump control, tank level monitoring, sewage lift station operation, reservoirs, weirs, flumes, site remediation, watershed management, storm water/well monitoring, pump/pipeline pressures and compressor pressures.

Website and E-Mail

You may visit our website at www.PressureSystems.com to look at our latest new product releases, application notes, product certifications and specifications, as well as Intrinsic Safety control installation drawings. E-mail your questions and comments to us: sales@PressureSystems.com.

E-commerce

Orders may be placed on-line by visiting our e-commerce site *(www.LEVELandPRESSURE.com)* or by contacting the factory or local representative.

Applicable Products

This manual provides information applicable to the use of the following KPSI Level and Pressure Transducers:

Please note: Series 500 and Series 550 (waterMONITOR) have separate manuals.

Level Transducers (Submersible)
Series 700/710/720/730/735
Series 320/330/335/340
Series 300DS
Series 705
Series 750

Pressure Transducers (Non-submersible)
Series 27/28/30

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1.0 Product Description

General Characteristics

KPSI™ Level and Pressure Transducers use isolated-diaphragm sensors that are specifically designed for use with hostile fluids and gases. These sensors utilize a silicon pressure cell that has been fitted into a stainless steel or titanium package with an integral, compliant stainless steel or titanium barrier diaphragm. This sensor assembly is housed in a rugged 316 stainless steel or titanium case which provides for a variety of level ranges from 2.3 ft (0.75 m) H_2O through 4614 ft (1408 m) H_2O and pressure inputs from 0-1 (7 kPa) through 0-15000 psi (103 mPa). Our devices feature internal signal conditioning. Standard outputs are 4-20 mA and VDC.

All units containing active electronic components have surge and reverse polarity protection. For ease of use in the field, our transducers are permanently laser engraved with our logo and name, wiring information, part number (P/N), serial number (S/N), date of manufacture (DOM), range, excitation and output. Transducers are offered in diameters of 1.0 (25 mm) and 0.75 inches (19 mm).

Care and Handling

Our transducers are designed for rugged use. However, they need protection from over pressure and sharp impact. When lowering them into a liquid, penetrate the surface slowly and only to the depth necessary. Avoid dropping the unit from above the surface. Clean all transducers by rinsing them in a mild detergent. Direct probing of the diaphragm or attempts to remove protective screens will damage the sensor, voiding the warranty.

Calibration

All transducers are shipped with calibration information unique to each transducer. Make sure you keep each calibration report. However, should you misplace your calibration sheet, you can contact the factory and request a duplicate. All KPSI™ Transducer calibrations are traceable to the National Institute of Standards and Technology (NIST).

Approvals

Most of our products have UL and FM certification for intrinsic safety. Their respective installation control drawings can be downloaded from our website. Several of our product lines also carry ABS approval. Most products are CE compliant to EN 61326-1:2006 and EN 61326-2-3:2006. CE compliant units are labeled accordingly.

2.0 Product Accessories and Options

Nose Caps

There are several different user-installable nose caps for the 700, 710, 720, 730, 735 submersible level transducers. The ported nose cap (Delrin) with #8-32UNC-2B threaded hole is best used where weights are required and for those installations where users may encounter sharp, protruding objects. The open-face nose cap which allows maximum contact with the liquid media is ideal for wastewater and "greasy" applications where clogging of the sensor is a concern. The piezometer nose cap allows the unit to be buried in saturated soil without damage to the sensor diaphragm. The 1/4" male NPT pressure nose cap is not only useful for calibration purposes but also allows the device to be used as a submersible or above ground pressure transducer.

810 SuperDry™ Vent Filter or 815 Aneroid Bellows

All submersible transducers with vented gauge format are supplied with a protective barrier that guards against moisture buildup in the cable vent tube. The 810 SuperDry™ vent filter is installed free of charge and is guaranteed to operate maintenance free for one year. We also offer the 815 Aneroid Bellows as a maintenance free option that can be used on submersibles with accuracies of: ±1%, ±0.5%, or ±0.25% FSO. These barriers ensure reliable operation and long life as they protect sensitive electronic components from mildew and prevent the formation of a liquid column in the vent tube. Any such liquid column directly affects calibration of the transducer.

Sacrificial Anodes

Our sacrificial anodes are made from a special zinc alloy formulated to guarantee continued effectiveness over long periods. Because the anodes are 95% galvanic, they will not corrode unless there is an electrolytic demand. The anode maintains a high driving potential throughout its 12 month life, is self-sluffing and always exposes new zinc for the best possible protection. For those applications where cable buoyancy is a problem, the sacrificial anode can be substituted for hanging weights.

Sacrificial Anodes provide cathodic protection against galvanic corrosion for our submersible pressure transducers. Galvanic corrosion occurs when dissimilar metals are placed in contact with an electrolyte. This condition causes a potential difference to exist between the two metals, causing electron flow between them. Corrosion of the less corrosion-resistant metal is increased and attack of the more resistant metal is decreased. The 820 Sacrificial Anode is clamped to the exterior of a one-inch bore submersible transducer. We also offer a 1" diameter pencil anode, the 825, that attaches to the nose cap of either a 3/4" or 1" bore submersible transducer.

Absolute/Sealed Gage Transducer

The sealed gage option for submersible transducers eliminates the need for a vent filter. The standard output of a sealed gauge transducer is 4 mA at 14.70 psia. Before ordering a sealed gauge transducer, the customer should determine the altitude (above sea level) of the installation and inform PSI's Customer Service of this value before order entry. During manufacture, the output of the transducer will be adjusted to compensate for the altitude difference, if applicable.

Polyurethane & ETFE Jacketed Cable

Most installations of our submersible level transducers connect our polyurethane or ETFE cable to a junction box. From this junction box (P/N 840), users typically run their own cable to the required instrumentation. Polyurethane-jacketed cable is used for most applications while ETFE material is recommended for more aggressive environments.

Specifications for our standard polyurethane and ETFE jacketed cable are as follows:

Specifications	Standard Submersible Cable	Standard Non-Submersible Cable
Weight	0.05 lbs/ft (0.07 kg/m)	0.025 lbs/ft (0.035 kg/m)
Min. OD	0.28" (7.10 mm)	0.189" (4.8 mm)
Max OD	0.31" (7.87 mm)	0.19" (4.9 mm)
Conductors	4 - 22 AWG	22 AWG
Insulation Conductors Outer jacket	PVC Polyurethane or ETFE	Color coded PVC
Shield	36 gauge spiral tinned copper wire foil shield with drain wire	Aluminum/polyester foil facing outward
Vent Tube	Polyethylene, .060" ID (1.52 mm)	Drain wire 7/32 tinned copper

- **Chemical resistance of polyurethane:** Potable Water, Wastewater, Borax, Butane, Animal Fat, Carbonic Acid, Citric Acid, Cod Liver Oil, Corn Oil, Glycerin, Glycol, Mineral Oils, Potassium Nitrate, Potassium Sulfate, Silicone Oils, Stoddard Solvent, Tannic Acid (10), Tartaric Acid, Turbine Oil.

- **Chemical resistance of ETFE:** Acetic Acid (Glacial), Acetic Anhydride, Acetone, Aluminum Chloride, Anti-Freeze, Bromine, Calcium Chloride, Calcium Hydroxide, Chlorine, Copper Chloride, Ferrous Chloride, Hydrochloric Acid, Ketones, Lacquer Thinners, Sulfuric Acid.

The vented cable termination end is specially prepared at the factory to eliminate the potential for moisture migration. Where the lead wires emerge from under the jacket, there's potting material and a shrink tube "boot", every effort should be made to leave this feature intact. Should the cable be longer than needed for the installation, it is recommended that the excess length be accommodated in a service loop and that the potted end of the cable **NOT** be shortened.

The cable attached to this instrument is specifically engineered for submersible applications. The polyurethane outer jacket provides long term reliability under most conditions. The cable should be handled carefully, however, as the jacket may be subject to cutting should it be "raked" over extremely sharp edges. To guard against water incursion should an inadvertent minor cut occur, we have incorporated an exclusive "water block" feature immediately beneath the jacket. The cable is fully shielded, with the shield connected to the metal housing at the transducer end and terminated in a drain wire at the termination or user end. The shield should always be terminated to a good earth ground, unless the transducer is installed in an area where galvanic corrosion is known to be a serious problem.

Lightning Protection

Lightning and surge protection for VDC, SDI-12 and 4-20 mA output are available. This is achieved through the use of 2 protectors, one is integral to the transducer housing and one is provided for the outside line located at the surface and grounded to a DIN-Rail. Please remember this option must be factory installed at the time of order entry or as a factory upgrade. **This option cannot be installed in the field.** Lightning protection is also available for unit only. Contact customer service for details.

Featuring quick response and low clamping voltages, these devices protect against fast rising voltage transients as well as severe current surges associated with lightning discharges up to 20,000 amperes. Following a surge, the protector automatically restores the line to normal operation and awaits the next surge without having to reset a breaker or replace a fuse. The power supply needs to be limited to 150 mA to avoid lock up of the gas tube after a suppression event. **Transducers installed with this option have a lifetime warranty *against damage due to voltage surge***.

Please note: When using the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

½" Male NPT Conduit Fitting

Submersible level transducers can be attached to a rigid conduit and the cable run through the conduit. To achieve this, all of our submersible transducers can be fitted with an optional ½" NPT male conduit fitting (specify "Electrical Connection Option 4" when ordering) where the cable exits the transducer. This fitting can be mated to a standard rigid conduit.

Electrical Outputs

We offer the industry standard 0-5 VDC and 4-20 mA outputs. In addition we also offer a variety of voltage output ranges.

Reverse Signal Output

For some applications, it is important to know how far the water is from the top of the tank or the surface of the ground. If specified by the customer, our factory can set the transducer so that zero pressure reads full scale electrical output and maximum pressure reads zero electrical output.

Temperature Output

A temperature output option is available for most transducers having 4-20 mA pressure output. The temperature sensor requires an excitation of 9-28 VDC and is calibrated for a temperature range of -20 to 60ºC with an accuracy of ±4ºC.

Output Option 6 (4-20mA output for -20 to 60ºC) (mA Reading x 5) - 40 = Temperature ºC

Example:	Reading is 20mA	(20 x 5) - 40 = 60ºC
	Reading is 12mA	(12 x 5) - 40 = 20ºC
	Reading is 4mA	(4 x 5) - 40 = -20ºC

Cable Hanger

We can supply an optional cable hanger (P/N 12-90-0931) to help end users secure the cable. The cable hanger can be positioned anywhere on the cable by pushing the ends together. Once positioned, the cable hanger expands and provides a snug grip on the cable.

When mounting the transducer in a well casing, the cable hanger can be secured to a hook on the well plate or an eye bolt may be attached to the side of the well casing. The cable hanger loop is then secured to the eye bolt by using any number of types of fasteners. A similar technique can be used when working in stilling wells for surface water level measurement. In this case, the loop-end of the cable hanger can be attached directly to a screw or bolt bored into the still well shelf.

Submersible Cable Splicing Kit

Our field-installable cable splice kit (P/N 830) allows you to splice polyurethane and ETFE submersible cable. It is most commonly used for well applications where the more expensive ETFE cable is required for suspension in corrosive media where the liquid level is fairly shallow, but the well is hundreds of feet in depth. It is also used in emergency situations where cable must be spliced together to get an application up and running.

3.0 Installation & Maintenance Tips

General Installation Procedures

The following is important installation and preventive maintenance information. Our Customer Service or Applications Engineering Support staff can provide additional instruction.

1. **Transducer Anchors:** Most users either suspend our submersible transducers in stilling wells or attach them to rigid conduit. This is done to prevent damage to the transducer from shock caused by water turbulence. It is not advisable to tie your transducer to a pump or to piping, as any problem with the transducer could require that the pump be pulled from the installation. This could prove to be *very expensive*. (Please refer to the Cable Anchoring Schemes drawing in **Appendix A**.)

   Some applications use our optional bracket (P/N 49-06-00PC) to clamp the transducer to a fixed object (i.e., wall, ladder, step) or require the unit to be suspended without any protective still well or attachment device. In all installations, care should be taken to ensure no damage occurs to the cable.

2. **Transducer Submersion:** Damage to submersible cable is one of the most frequent causes of transducer failure. Lower your transducer into the liquid slowly, making sure the cable does not drag over sharp edges and only to the depth necessary. Avoid dropping the unit from the surface. This does not apply to Series 27, 28, and 30 transducers.

3. **SuperDry™ Vent Filter (Desiccant) or Aneroid Bellows Installation** (For submersible transducers vented gage pressure format only) ***Always*** install a desiccant vent filter or aneroid bellows immediately after transducer installation**.** Failure to use one or the other could result in premature failure of the transducer; which would not be covered by warranty. If you use a desiccant filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. The most common failure mode of our transducers is moisture and corrosion damage due to lack of use or maintenance of the vent filter. This will allow air into the desiccant filter and allows the transducer to properly vent with changes in barometric pressure.

   To install/replace either the aneroid bellows or the vent filter, simply unplug the old unit from the vent tube and plug the 0.062" x 1" stainless steel connector tube (supplied with each filter or bellows) into the vent tube. (Installation and mounting instructions are supplied with each aneroid bellows and vent filter.) The diagram on page 16 shows typical vent filter and aneroid bellows hookups.

4. **Cable Protection** An inexpensive way to protect the cable from damage is to order the submersible pressure transducer with a ½" conduit attachment. Connect an inexpensive flexible 5/8" garden hose to the ½" conduit fitting with an equally inexpensive female PVC ½" NPT x 3/4" NHT swivel fitting, available at your local hardware store

5. **Bending of Cable** Our polyurethane and ETFE jacketed cables are quite flexible. Care needs to be taken to ensure that when bending the cable to suit your installation you do not crimp the vent tube inside the cable. Consequently, do not bend the cable more than a radius of 1 inch.

6. **Cable Compression** Many users require a compression fitting to secure our ETFE and polyurethane jacketed cable as it enters a junction box. Care needs to be taken that you do not over-tighten the fitting so as to damage the cable.

7. **4-20 mA Wiring** When connecting a 2-wire 4-20 mA transducer to a typical power supply and mA meter, verify that the meter has an input impedance of at least 10 Ohms. If you are unsure of the input impedance, then a 10 Ohm resistor may be placed in series with the meter and transducer. Connect the + (red) lead of the transducer to the + terminal of the power supply. If the 10 Ohm resistor is required, connect it to the - (black) lead of the transducer. Use a short length of 22 AWG or heavier wire to connect the + terminal of the meter to the resistor (if it is required) or the - (black) wire of the transducer. Connect the - terminal of the meter to the - terminal of the power supply with a length of 22 AWG or heavier wire. Connect the drain wire from the transducer to a good earth ground. (See **Appendix**, page **14** for wiring diagram.) Please refer to "**Maximum Cable Lengths and Minimum Supply Voltage**" in **Appendix C**, page **22** to verify minimum loop supply voltage requirements.

8. **VDC Wiring** To connect a 3 wire VDC output transducer to a typical power supply and the voltmeter, connect the - terminal of the power supply to the - input terminal of the meter with a length of 22 AWG or heavier wire. Connect the - excitation (black) lead of the transducer to the - input terminal of the meter. Connect the + input terminal of the meter to the signal lead (white) of the transducer. Connect the + terminal of the power supply to the + lead (red) of the transducer. Connect the drain wire to a good earth ground. (See **Appendix A**, **page 14**.)

9. **The Model 750** comes standard with a field removable diaphragm protector (one-inch or 25 mm standoff). The diaphragm protector can easily be taken off by removing six (6) fasteners located on the bottom of the unit.

10. **Sealed-Gage Transducer Configured For Altitude Above Sea Level** Since sealed-gauge transducers are normally calibrated at sea level, there may be considerable error induced when used at a higher elevation. If the transducer was calibrated without taking into consideration the difference in atmospheric pressure at sea level and the higher elevation, an offset error will occur. In order to eliminate error due to this difference, the customer must identify the elevation where the transducer will be installed. The nominal atmospheric pressure at the location is calculated and the transducer will be ranged accordingly. Not all KPSI Transducers are available in a sealed pressure format. Please refer to the appropriate datasheet for availability.

11. **Position Sensitivity** The transducer should be installed so that the diaphragm located behind the nose cap is oriented in a vertical position, otherwise the unit could exhibit an offset.

General Maintenance Tips for Submersible Transducers

1. **Desiccant Maintenance**

If you use a desiccant vent filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. Remember that Pressure Systems' improved 810 SuperDry™ Vent Filter are designed to be effective for at least one year before requiring replacement.

2. **Clogged Nose Piece or Dirty Diaphragm**

Either of these conditions could result in erroneous readings from your transducer.

Your transducer may be cleaned in accordance with the procedures listed in step 4, below.

3. **Cleaning your transducer**

Materials required:

- Plastic bowls 8-12 inches (200-300 mm) in diameter and 4-6 inches (100 - 150 mm) deep
- Supply of clean, lint-free cleaning rags
- 32 ounce bottle of "The Works-Tub and Shower Cleaner" (a mild detergent) manufactured by Lime-O-Sol Company in Ashley, IN 46705 and available locally through Wal-Mart, K-Mart, Target, and Ace Hardware stores at $2 to $4 per bottle

Preparation: Prior to cleaning your pressure transducer, ensure that all procedures have been followed in the proper cleaning of the cable and transducer to remove any hazardous materials. The vent filter (or bellows) must be properly attached. The cable should be coiled to ensure ease of handling and it must be protected against the possibility of accidental abrasion and/or penetration of the cable jacket by sharp objects. A lead length of 1 to 1 ½ feet (0.3 - 0.45 m) of cable from the transducer should be allowed to facilitate handling during cleaning. The protective covering (or similar protective device) that is shipped with each transducer should be attached to the transducer at all times. It should only be removed prior to installation or cleaning.

Your work surface needs to be clean and free of clutter and large enough to accommodate all materials required in addition to the transducer and cable. Fill one of the bowls with fresh water, one with a mild detergent mixed with water and the last with 16 ounces (0.45 kg) of "The Works".

Cleaning:

Step 1: Holding the cable 6 inches (150 mm) from the transducer, immerse the unit in the bowl containing the mild detergent and stir for 20-30 seconds. Remove and rinse in the bowl containing the fresh water, using the same stirring motion used in the mild detergent. Rinse and wipe dry.

Step 2: Holding the body of the transducer with one hand so that you are looking at the retaining screen protecting the sensor, carefully remove the sensor nose piece by simply unscrewing it from the transducer body. *Do not touch the sensor diaphragm with your finger or any other object. Also, do not try to dry the inside portion of the transducer, as you risk damaging the pressure sensor*.

Step 3: Place the transducer in a vertical position with the sensing end facing downward in the bowl containing "The Works" solution for approximately 15-20 seconds. Rinse in the bowl containing clean water and wipe dry the external casing only. Place the protective screen in the same solution for 15-20 seconds, rinse and wipe dry.

Step 4: Holding the transducer in a vertical position so that you can see the face of the sensor, screw the protective nose piece back into place.

4. Cleaning the Lightning Protection Data Line Protector

4.0 Warranty and Product Return Procedure

Any transducer/transmitter that is less than 2 years old (see DOM) which does not meet the product's specifications and exhibits **no obvious physical damage to the housing, sensor, or cable (cuts),** will be replaced under warranty.

Units 2-3 years old: Units that fall within this age group and exhibit no obvious physical damage to the housing, sensor, or cable (cuts), may be replaced at a discounted list price.

Units greater than 3 years old: Units that fall within this age group are not replaced under warranty.

Merchandise Return Procedures

Contact the **Applications Support Group** or the **Customer Service Department** at Pressure Systems if your transducer is not operating properly. Our staff is available for troubleshooting at **(757) 865-1243** or toll free at **1-800-328-3665** during normal working hours, Eastern time. If your transducer or accessory needs to be returned to Pressure Systems, obtain a *Returned Merchandise Authorization* (RMA) from the Customer Service Department prior to shipment. Be prepared to supply the following information when requesting the RMA:

- Part number
- Serial number
- Complete description of problems/symptoms
- **Bill To** and **Ship To** address
- Purchase order number (not required for warranty repairs)
- Customer contact and telephone number

The above information, including the RMA number, must be on the customer's shipping documents that accompany the equipment to be repaired. Pressure Systems also requests that the outside of the shipping container be labeled with the RMA number to assist in tracking the repairs. All equipment should be sent to the following address:

ATTN: KPSI TRANSDUCER REPAIR DEPARTMENT (7-digit RMA number)
Pressure Systems, Inc.
34 Research Drive
Hampton, Virginia 23666

Prior to returning to Pressure Systems, the transducer and cable must be cleaned per instructions provided on the cleaning certificate supplied when the transducer was delivered. The certificate can also be found on Pressure Systems website:

www.PressureSystems.com/cleaning.html

The completed certificate must accompany the transducer when shipped to Pressure Systems. If the transducer has been used in media other than potable water, PSI customer service must be notified at the same time an RMA number is requested. PSI reserves the right to reject any shipment deemed to be unsanitary or environmentally unsafe to handle. If these guidelines are not met, the package will be sent back unopened and at the customer's expense. ***Please***

include the attached vent filter or aneroid bellow with each returned vented gage submersible transducer.

Pressure Systems will return warranty items prepaid via UPS GROUND. If the customer desires another method of return shipment, Pressure Systems will prepay and add the shipping charges to the repair bill.

Incoming freight charges are the customer's responsibility. The customer is also responsible for shipping charges to and from Pressure Systems for all equipment not under warranty.

Once the return is received, it typically takes 5-10 working days for the technician to make a fault determination.

A cable reconnect fee will be charged when the customer requests a different length of cable.

Restocking Policy

Pressure Systems does allow standard products to be returned for credit in the event it is no longer required, providing the products are in new and unused condition. A restocking fee will be assessed depending on the model type and variety.

A **25% restocking fee** applies to the following models, providing they are vented-gage reference format and [pressure ranges above 3 psig (20 kPa) and below 100 psig (690 kPa)].

27	320	700	710
28	342	705	720
Display Meters - all models			750

A **50% restocking fee** applies to the following models. This also applies to all other models with sealed-gage and absolute pressure formats as well as vented-gage reference formats with [pressure ranges below 3 psig (20 kPa) and above 100 psig (690 kPa)].

30	335
300DS	730
330	735

NOTE: Expedite premiums and shipping charges are non-refundable.

Please consult the individual manuals for the Series 500 and Series 550 (waterMONITOR) for the restocking policy.

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Appendix A

Drawings and Diagrams

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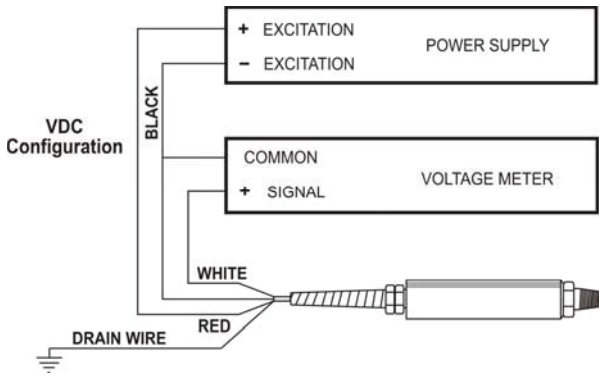
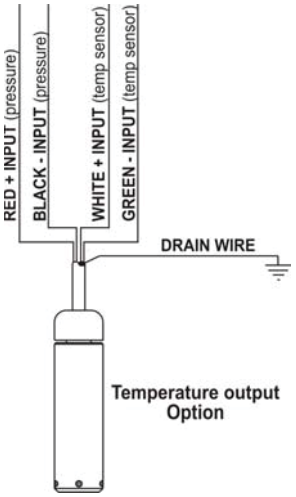
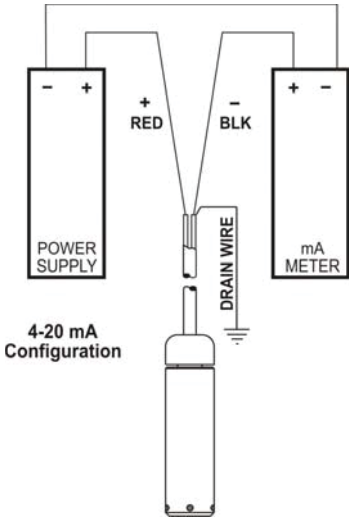
Wiring Diagram VDC, mA, and Temp Output



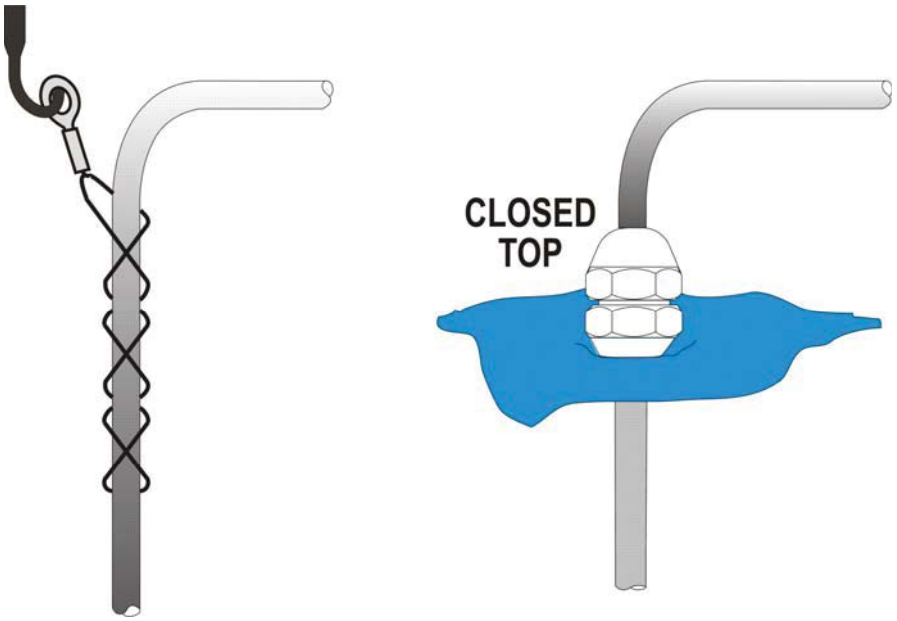




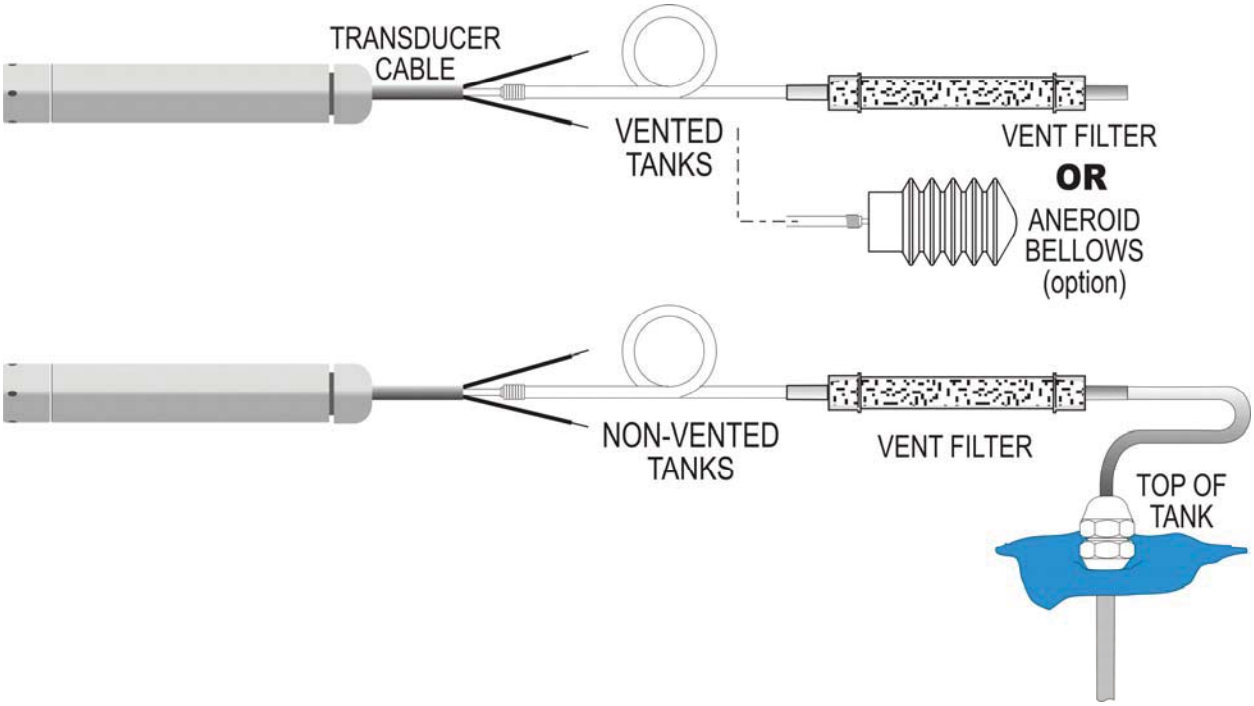
Notes:

1. These diagrams depict typical installations. Refer to your power supply and instrumentation Manufacturer for the specifics of your application.

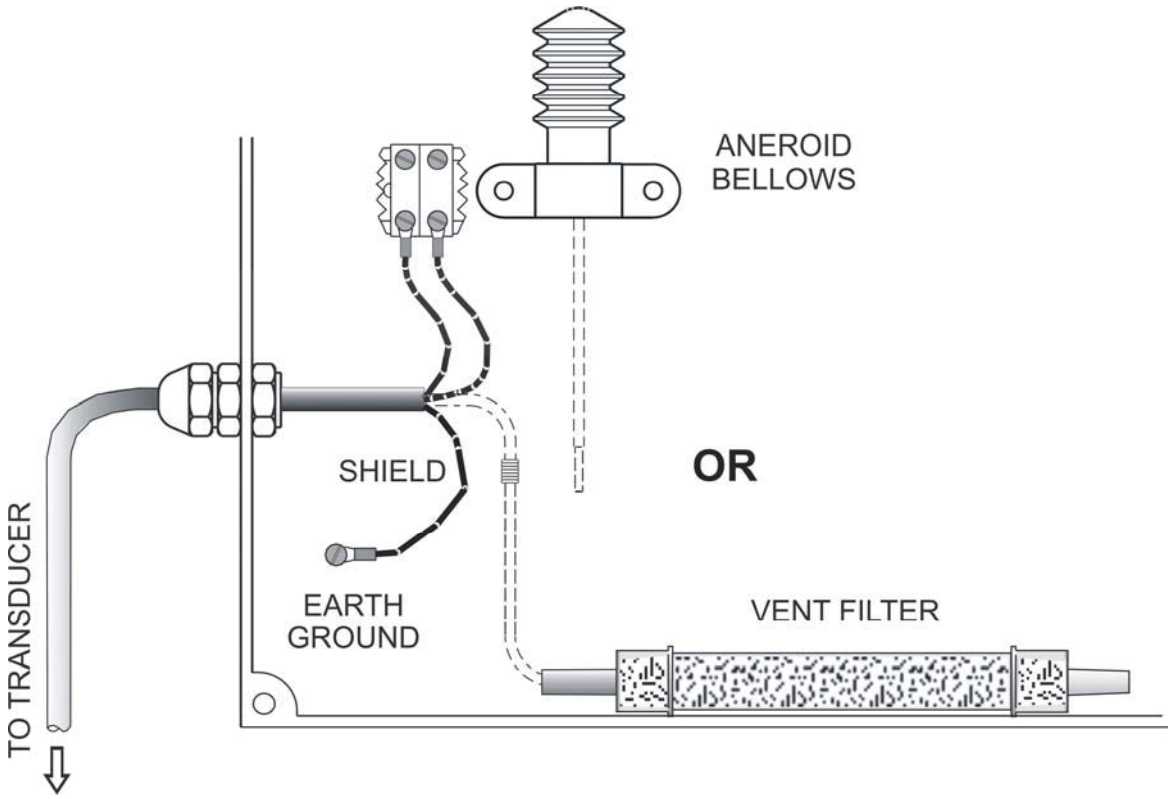
Cable Anchoring Schemes



Reference Connection Schemes



Submersible Cable Termination



Appendix B

1. Question: What installation ideas do you have to help me get rid of electrical noise interfering with the signal?

Answer: An ounce of prevention goes a long way. Either try to eliminate the source of noise or move the transducer as far away from it as possible. We strongly encourage you to secure our cable shield to a good earth ground and that you use a 4-20 mA signal output. Armed with these precautions and the fact that many of our transducers are CE approved for electromagnetic interference, you should have few problems.

2. Question: The cable on the submersible transducer always seems to get cut and damaged. What am I doing wrong?

Answer: This is the most common problem that our users encounter. Make sure that all of your colleagues and staff understand the importance of handling the cable with care. The cable should not be bent around rough or sharp edges. Always use a cable reel during transport. Where possible, suspend the unit in a perforated 2" (50 mm) PVC pipe and thread the cable through protective conduit to the nearest junction box.

3. Question: I have an application where the transducer is frequently damaged by voltage spikes. What can be done to prevent this?

Answer: At a minimum, make sure the cable shield is connected to an earth ground as near as possible to the transducer. We can provide a surge protection kit for both our submersible and non-submersible transducers. See page 4. These kits will handle typical spikes that might come in through the power lines as well as surges that travel through the ground due to nearby lightning strikes

4. Question: How much impact shock can your submersible transducers withstand?

Answer: Our transducers are not shock tested and the lower pressure ranges can be damaged if dropped from several feet onto an unforgiving surface like concrete. We recommend that the protective shipping foam remain in place until the unit is installed.

5. Question: What is the response time of your transducer?

Answer: From initial power up, the transducer output will stabilize within a fraction of a second. The frequency response is rather low, probably less than 1 kHz, but it depends on the application, the media, plumbing, etc. Call our factory for application assistance if frequency response is critical in your application.

6. Question: How do I attach your vent filter or aneroid bellows to my cable vent tube?

Answer: The vent filter can be mounted anywhere convenient, preferably out of the weather. It can be mounted in any position and connects to the cable vent tube via the extension tube with metal connector tube provided. The aneroid bellows must be mounted in a way that its movement is not encumbered. It is provided with a mounting base.

7. Question: What is the best way to mark my cable?

Answer: Use white vinyl marking tape available from your local hardware or electronic stores. These same stores may also sell cable marking kits.

8. Question: Any ideas for preventing marine growth on your submersible transducers?

Answer: You might want to try waterproof grease. Remove the threaded nose cap to facilitate applying the grease**. Take care not to damage the diaphragm when applying the grease and not to trap air bubbles against the sensing diaphragm.**

9. Question: How many measurements can you make before the diaphragm on the sensor fails?

Answer: In normal operation - millions of cycles. We find that sensor failure is rarely due to diaphragm fatigue.

10. Question: What is the turnaround time on repairs?

Answer: Once we receive a unit into our facility it takes less than 10 working days to complete an evaluation.

11. Question: What is the longest length of cable you have attached to a submersible transducer?

Answer: Two thousand feet (610 meters).

12. Question: Why do you use 316 SS housings and sensors for your standard transducers?

Answer: It offers a good combination of corrosion resistance and reasonable cost. As an option, we do offer titanium for more aggressive environments.

13. Question: What wire gauge should I limit myself to when connecting to your 22 AWG wire?

Answer: Use 22 AWG or heavier.

14. Question: Does it make any difference if I mount the transducer in a vertical or horizontal position?

Answer: Yes. Our units will experience a certain amount of position sensitivity. You should mount it in a vertical position throughout the measurement cycle. If you lay the transducer down, the user must realize than an offset will occur.

15. Question: What happens when you freeze your transducer in a column of water?

Answer: We have frozen our transducers in a container of water in a home freezer, with no resulting damage. However, depending on the level range of the unit, over pressure of the unit is possible. In harsh environments where debris is common and ice shifts, you might expect damage to both the transducer and cable.

16. Question: Why would I choose a KPSI Transducer versus a competitor?

Answer: Reliable, long lasting products
Rapid delivery
Lightning protection lifetime warranty
Excellent pre & post sales/application support
No hassle service

Appendix C

Troubleshooting Techniques

Quick Check Procedure

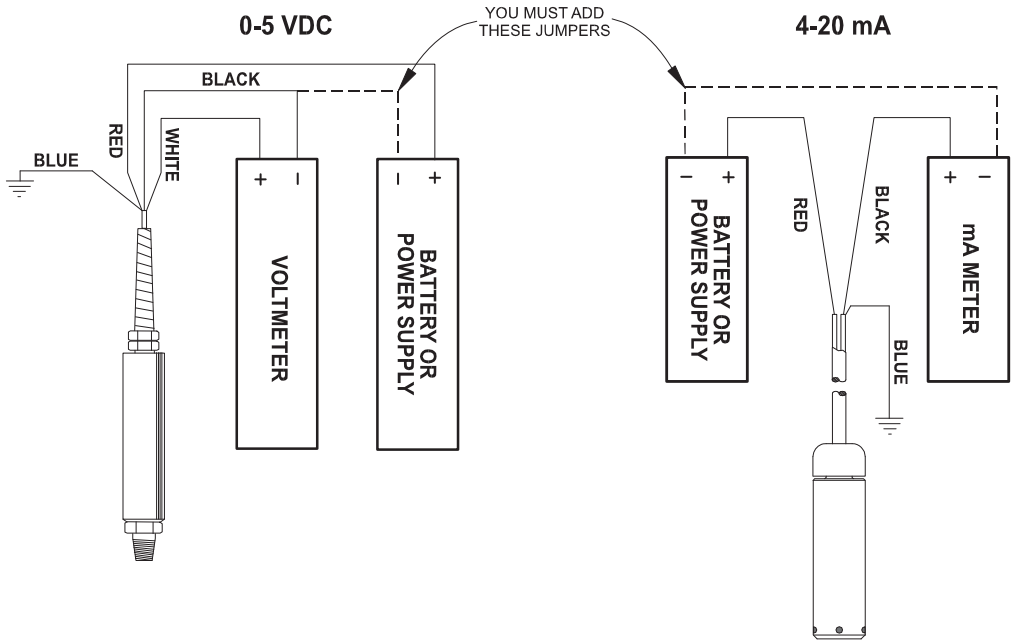
The following is a quick field checkout procedure for KPSI Level and Pressure Transducers. It will be referred to throughout the troubleshooting section.

Should a problem be encountered with a transducer or transmitter, it is sometimes helpful to test the transducer independently from the rest of the system, thereby establishing where to concentrate the troubleshooting effort.

On the next page is a simple hookup diagram for the most common types of electrical output, a 0-5 VDC transducer and a 4-20 mA transmitter. In either case, the "power supply" can be a common 12 volt lantern battery, or even a 9 volt transistor radio battery, although the lifetime of a 9 volt battery will be limited. The meter should be a digital type capable of reading at least 2 digits to the right of the decimal point. Use 22 gage or heavier hookup wire or clip leads for jumpers. If your unit has other than a 0-5 VDC or 4-20 mA output, please call Applications Support at **(800) 328-3665** for assistance.

Once your transducer is correctly configured per one of the diagrams below, orient the transducer in a vertical position with the pressure port down and then read the zero output on your meter. For a 0-5 VDC output, the zero should be between 0 and 0.10 volts, and for a 4-20 mA output, between 3.80 and 4.20 mA. For Series 300, the values do not change for VDC output but the values for mA are between 3.80 and 4.20 mA. If the output is outside of these limits, you may, at your option, choose to troubleshoot the transducer per the suggested measurements shown below. Otherwise, contact our Customer Service Department at **(800) 328-3665** for a Return Material Authorization number (RMA).

If the zero output is within these limits, the problem will more than likely be found elsewhere in your system.



When an error is observed at a customer's installation, it is important to determine if the fault lies in the transducer or the instrument reading the transducer signal, ie. digital panel meter, programmable logic controller, etc. . To do this, a second instrument should be used to confirm the observations. The second instrument may be a handheld DMM (Digital Multi-Meter) or a dedicated milliammeter capable of reading 4-20 mA of current to a resolution of at least 0.1 mA. The diagram above illustrates the attachment of the meter in series with the black (negative signal) wire of the transducer using a 9-28 VDC power supply for transducer excitation. Some suggested power supplies are:

- 1 - 12 VDC automotive battery.
- 2 - 6 VDC lantern batteries connected in series (for a total of 12 VDC).
- 2 - 9 VDC transistor batteries connected in series (for a total of 18 VDC).

Batteries are suggested to power the transducer during testing to eliminate the possibility that line noise is passing through an improperly filtered, grounded, or damaged power supply. All measurements should be recorded and sent to Pressure Systems along with the transducer to assist in the evaluation process.

Further Measurements:

0-5 VDC	Should read:	4-20 mA	Should read:
+Excitation (white) to Shield (drain)	> 2.5 Mohms	+Excitation (red) to Shield (drain)	> 2.5 Mohms
-Excitation (black) to Shield (drain)	> 2.5 Mohms	-Excitation (black) to Shield (drain)	> 2.5 Mohms
+Output (red) to Shield (drain)	> 2.5 Mohms	Shield (drain) to Housing	< 2 ohms
Shield (blue) to Housing	< 2 ohms		

Maximum Cable Lengths and Minimum Supply Voltage

The maximum length of cable to be used with our submersible transducers is largely dependent upon the type of electrical output of the transducer. For a 0-5 VDC output, a maximum cable length of 100 feet (30 m) is recommended. A voltage output is more susceptible to electrical interference than a 4-20 mA signal. A 4-20 mA signal can be transmitted much longer distances, depending upon such factors as temperature, wire size, length of the wire, power supply, and voltage requirements of any devices to be powered. At 25ºC the 22 AWG conducting copper wire used in our polyurethane jacketed cable has a resistance of 16.45 ohms per 1000 feet (304 m).

Using Ohms Law (E=IR) where E=voltage, I=current and R =resistance, one finds that a 20 mA signal requires .329 volts to drive it along 1000 feet (304 m) of 22 AWG copper wire (E=16.45 x .020). This drop is seen on both the supply and return wire for a total loop voltage drop of 0.658 volts

To find out how much voltage is required to drive our Series 700 submersible level transducer's 4-20 mA signal 10,000 feet, just add the minimum power requirement of the 700 (9 VDC) to the resistance offered by 10,000 feet (3048 m) of our polyurethane jacketed cable (10,000÷1000 x .658=6.58). The resulting power requirement is 15.58 VDC (9 + 6.58).

Connect the cable shield (drain wire) to a good earth ground. This will protect the transducer from relatively minor transient voltages. The only exception to this rule is if high rates of electrolytic corrosion have been previously experienced with grounded submersible devices. In this case it may be better to leave the shield disconnected.

Please note: When using products with the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

Troubleshooting Techniques

1. Symptom: ***Transducer fails to give output of any kind.***

Procedure: Isolate the problem to either the transducer or the power supply/readout. See the Quick Check Procedures (above) for this check. If it can be determined that the transducer is no longer operable, remove it from service for further analysis. If the transducer output falls within the limits described above, the fault lies somewhere else in your system.

2. Symptom: ***Transducer has failed and has been removed for analysis.***

Procedure: Inspect the cable for physical damage. Cuts in the cable jacket can result in liquid incursion into the transducer housing, which can cause permanent damage. If operational, the cable can be repaired by using a splice kit (P/N 830) supplied by Pressure Systems.

Inspect the transducer housing. It should be intact and free of corrosion. If the outer surface of the transducer is pitted, this could be an indication of galvanic corrosion caused by stray ground currents. If this is the case, the transducer will probably require replacement. If the external case exhibits none of these characteristics, carefully unscrew the nosepiece and look into the pressure sensing end of the transducer. The concentric rings of the sensing diaphragm should be visible. If they are not, it could be that residue has accumulated on the diaphragm, preventing it from responding properly to pressure changes. The transducer can be cleaned by gently swishing the transducer back and forth in a bucket of warm, soapy water until the residue softens and washes off. (See **Cleaning Your Transducer**, page 8.) ***Under no circumstances should any object or tool be used to remove residue from the sensing diaphragm or else permanent damage will be done.*** If cleaning the diaphragm does not solve the problem, the transducer should be returned to the factory for repair or replacement.

3. Symptom: ***Transducer develops a negative offset and gets worse over time (actual level exceeds specified level).***

Procedure: This may be a sign that moisture has entered the reference (vent) tube in the cable and is inside the transducer housing. This is usually the result of not maintaining the desiccant vent filter or of operating the transducer without a desiccant filter or aneroid bellows. If caught early enough, the transducer can be saved by coiling the cable and transducer in a pan and baking it in an oven at 50°C (122°F) for a minimum of 2 hours. *Be careful that the oven temperature does not exceed 50ºC (122°F)* or both the transducer and the cable can be damaged. **Alternatively**, suspend both the cable and transducer in a vertical position (with vent tube down), overnight to allow water to drain from the transducer and vent tube.

4. Symptom: ***Transducer suddenly fails during or just after a nearby lightning event.***

Procedure: This failure is usually caused by overvoltage due to ground transients resulting from a direct or indirect lightning event. These transients can travel

distances of a mile or more. The transducer may be returned to the factory for repair and optional retrofit of our ***lightning protection system.*** This system carries a lifetime warranty against transducer damage due to lightning.

5. Symptom: ***Transducer response to pressure/level input changes becomes sluggish.***

Procedure: This is usually a sign that the sensing end of the transducer has become fouled with residue. The transducer must be removed from service and the sensing diaphragm cleaned as described in Item 2, (warm, soapy water). If fouling persists, the transducer may be replaced with a Series 705 or Series 750 (non-fouling) transducer, which is specifically designed for trouble-free operation in a high residue environment.

6. Symptom: ***Output reading is within limits but "freezes" at one point.***

Procedure: In certain environments "crust" may form over the sensing diaphragm, preventing the sensor from identifying change in level. Removing the transducer from service and cleaning it (as described in Item 2) will generally solve the problem. To combat marine growth, you might try wrapping the transducer with copper wire similar to that found in wire scouring pads for cleaning dishes. Marine growth occurs on the copper and eventually erodes the copper and drops off or the copper is manually removed during routine maintenance. Alternatively, there are various companies that will impregnate/coat the 316 stainless steel with anti-fouling chemicals of coatings. Level transducers temporarily removed from the well or sump should not be stored dry, but should be stored in a bucket of fresh water in order to prevent "crust" formation.

7. Symptom: ***Readings increase very slowly over time***.

Procedure: Our cable is shipped coiled and consequently takes time to straighten when installed. Attaching a weight to the transducer (e.g., one of our sacrificial anodes) will help. To prevent cable stretch with lengths greater than 200 feet (60 m), secure the Kevlar fibers (just under the cable jacket) to your junction box or other secure object.

8. Symptom: ***No electrical output from your transducer.***

Procedure: Check all electrical connections to ensure they are correct and secure. Double check your power supply or use a battery (as described previously) to ensure the transducer is getting power. If all checks OK, the problem could be a circuit board or the sensor in your transducer. The unit must be returned to the factory for evaluation. The most probable cause of this type of failure is damage to the submersible cable jacket allowing water to leak down the cable and into the transducer housing or lightning damage.

9. Symptom: ***Formation of marine growth on a submersible transducer.***

Procedure: Certain transducer construction materials, for example, 316 stainless steel, attract marine life (snails) and algae. Clean the transducer diaphragm by

soaking it in a bucket of warm water with a non-aggressive cleaning solution. You can also coat the transducer with marine grease. This may be the most effective and inexpensive way to protect your transducer.

10. Symptom: ***Submersible transducer exhibits corrosion or pitting on body or diaphragm***

Procedure: Dissimilar metals (for example, your transducer housing and your pump housing) in an electrolytic environment (fluid in your well) can lead to *galvanic corrosion* of the metal that is nearer the anodic end of the galvanic series. Likewise, a voltage potential between the ground wire of the transducer and the ground of other equipment in the well can lead to *galvanic corrosion*. Installation of a P/N 820 or 825 sacrificial anode will help protect your transducer from *galvanic corrosion*. Our sacrificial anodes are made of a zinc alloy that, being nearer the anodic end of the galvanic series than the 316 stainless steel or titanium housing of the transducer, will corrode before the transducer.

11. Symptom: ***The transducer is buried in dirt or silt and the readings seem to be erroneous.***

Procedure: Use of a piezometer nosepiece in this application would help. This nosepiece can be easily installed in the field and features a very fine screen to keep dirt from fouling the diaphragm, but allows the diaphragm to sense moisture levels.

12. Symptom: ***Transducer has an offset error.***

Procedure: Our submersible transducers perform best when the sensing end is pointing in a downward manner. Keep in mind that you can experience offset error due to the position sensitivity or orientation change of the sensor. Offset errors are more prominent in low pressure applications with the sensing end of the transducer lying flat or pointing upward.

13. Symptom: ***I am testing a Series 700 4-20mA sensor for use with our data logger. On page A-2 of the KPSI Level and Pressure Transducers User's Manual, I see the standard 4-20mA configuration. Does the recording channel of my data logger become the mA meter?***

Procedure: Most data loggers cannot measure current (mA) directly. When this is the case a load resistor must be used to convert the current (mA) output into an appropriate voltage. If the User's Manual for your particular instrument does not illustrate a preferred method for recording current (mA) data then you should attach your transducer signal wires to your data logger in the following manner.

Transducer red wire - Data Logger Excitation Terminal
(The minimum excitation for a Series 700 Transducer is 9VDC)
Transducer black wire – Data Logger signal input (+) terminal

Attach a Load resistor between the Data Logger signal input (+) terminal and the Data Logger signal input (-) terminal.

Attach a separate piece of wire between the Data Logger signal input (-) and analog ground.

In this configuration you will turn your data logger into a milliammeter. The size of your load resistor can be calculated in the following manner.

D/0.02=R

Where:

Data logger input range = D
Full scale output of transducer = 0.02 A (20 mA)
Load Resistor Value = R

Pick an appropriate standard value

250 Ohms results in 1 to 5 VDC at 4 and 20 mADC
125 Ohms results in 0.5 to 2.5 VDC (500 to 2500 mVDC) at 4 and 20 mADC

At this point the discussion needs to address IR loss (voltage drop) in series circuits. Note that Series 700 transducers need a minimum of 9 VDC to operate correctly. When the transducer is operating correctly it will output a current which, when driven through a resistor, will generate some amount of voltage drop. If the resistor value is 250 Ohms then the voltage measured across that resistor will be 0.004 A * 250 Ohms = 1.000 VDC and 0.020 A * 250 Ohms = 5 VDC. Notice that, if the available voltage from the data logger is12 VDC then 12 VDC - 5 VDC = 7 VDC which is less than the voltage required by the transducer to operate. If this scenario were to occur the transducer would actually stop functioning correctly when its output reached 12 mADC (50% of transducer full scale range). In this case the appropriate choice for a load resistor value is 125 Ohms.

14. Symptom: ***I have a Series 700 4-20mA transducer rated for 7.5 PSIG attached to a pressure source that is outputting 7.5 PSIG. With 20VDC being supplied I am getting 19.94 mA. I can't find the upper range allowance for the sensor, but this seems low to me. Does this mA reading fall into the acceptable range for the transducer with the settings I've specified?***

Procedure: When evaluating a transducer it is sometimes convenient to make some broad generalizations in order to rapidly determine the condition of the unit. In general, transducers that output a 4-20 mADC signal have a 16 mADC span (4 - 20 = 16). If the transducers accuracy is reported as being some percentage of its full-scale range then the following table could be used in conjunction with the instructional notations to determine whether a more detailed analysis of data quality is required.

Model	Accuracy	Accuracy in mADC
700	1.00%FS	±0.16 ma
710	0.50%FS	±0.08 ma
720	0.25%FS	±0.05 ma
730	0.10%FS	±0.016 ma
735	0.05%FS	±0.008 ma

In order to approximately determine how many milliamps a transducer should output at a given depth.

1. Determine the depth (in feet) at which the transducer is sited.
2. Divide the depth value (from step 1) by the transducer full-scale range (in feet). - Record the value.
3. Multiply the value calculated in step 2 by 16 (the transducer span in milliamps).
4. Add 4 to the product of step 3. This is the approximate value in milliamps that should be output by the transducer at its current depth.

In order to approximately determine the depth of a transducer (in feet) using a given value of milliamps.

1. Divide the full-scale range of the transducer (in feet) by 16. Record this value.
2. Subtract 4 from the milliamp output of the transducer. Record this value
3. Multiply the result of step one by the result of step 2. This is the approximate depth at which the transducer is sited.

If the resulting numbers are reasonably close to some verified value for current water depth, then the unit is functioning. In order to determine the quality of measurement, additional steps need to be performed.

Appendix D

Calibration Calculations

Pressure Systems ships a calibration sheet with every KPSI™ Transducer. This sheet lists the actual values that were output by the transducer, when it was being manufactured, at several different pressures. In addition, two coefficients are provided that can be used to calculate the actual depth from any given mA output value. These coefficients are derived from a Least Squares Best Fit Straight Line (BFSL) calibration using the data listed on the datasheet. Our accuracy specification is referenced to the line described by the BFSL coefficients and so the transducer may not output exactly 4 mADC at zero pressure and 20 mADC at full-scale. As an example here is an example of data for a typical transducer.

Calibration Report

Test Date: 02/28/08
Test Time: 13:02:57
Model No: 320T14B0A008.670000.000B10030B
Serial No: 0802048
Pressure Range: 0.00 to 8.67 PSIG
Excitation: 9-28 VDC
Output: 4-20 mA

Test Temps: ROOM = 25.3 DegC

PCU Serial No: TRF048

Target Test Pressure	BFSL Rm Temp Outputs	Run #1 Rm Temp Outputs	Run #1 Error %FSO	Run #2 Rm Temp Outputs	Run #2 Error %FSO
0.00	4.0017	3.9995	-0.0134	3.9981	-0.0222
1.73	7.2050	7.2003	-0.0295	7.2066	0.0098
3.47	10.4096	10.4111	0.0091	10.4144	0.0297
5.20	13.6133	13.6182	0.0305	13.6207	0.0461
6.94	16.8176	16.8158	-0.0114	16.8174	-0.0014
8.67	20.0219	20.0173	-0.0290	20.0190	-0.0184
6.94	16.8171	16.8162	-0.0057	16.8172	0.0006
5.20	13.6127	13.6176	0.0305	13.6175	0.0299
3.47	10.4083	10.4131	0.0298	10.4110	0.0167
1.73	7.2049	7.2067	0.0115	7.2059	0.0065
0.00	4.0020	4.0001	-0.0118	4.0000	-0.0124

Maximum Static Error: 0.0523 %FSO
Maximum Non-repeatability: -0.0393 %FSO

Electrical termination: RED: +SUPPLY
BLACK: -SUPPLY
BLUE: SHIELD

Slope1:	0.5411	PSIG/mA
Zero Offset1:	0.0000	PSIG
Slope2:	1.8479	mA/PSIG
Zero Offset2:	4.0017	mA
Conversion Factor:	1.0000	

Notes:

Calculations:

Method 1: Calculate pressure in desired units, using sensor's output as independent variable.
PSIG = 0.5411(mA - 4.0017) + 0.0000

Method 2: Calculate predicted sensor output in desired units using pressure as the independent variable.
mA = 1.8479(PSIG - 0.0000) + 4.0017

In this case, even though the offset or 0 PSIG output was 4.0017 mADC and the full-scale point was 20.0219 mADC the unit actually performed better than its specified accuracy of ±0.25% of full-scale range as indicated in the Error % FS column.

The calculation for pressure is illustrated below:

PSIG = (Span*Output (in mA)) + Offset

And, to convert to feet of water

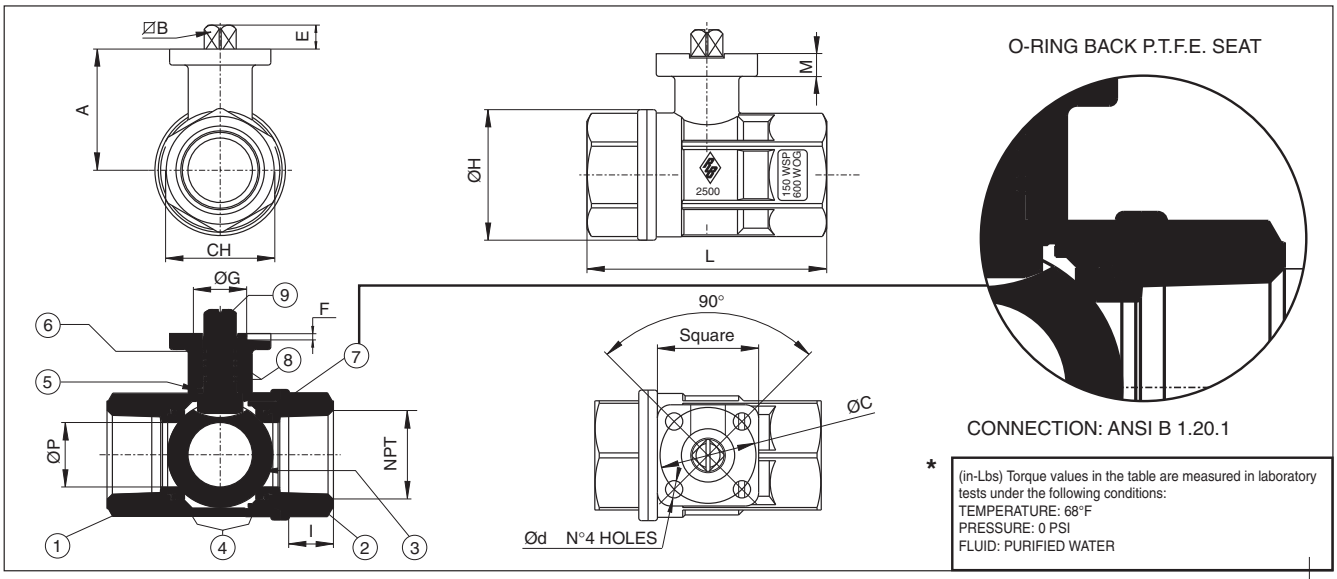
Feet H_2O = PSIG * 2.3073

measurement
SPECIALTIES
34 Research Drive, Hampton, VA 23666 USA
757-865-1243, Toll Free 800-328-3665
Fax 757-865-8744
E-mail sales@PressureSystems.com
www.PressureSystems.com
online orders www.LevelandPressure.com

SERIES 250N - 253N
DIRECT MOUNT 2 WAY BALL VALVE

Brass ball valve, female/female, with ISO 5211 pad for actuator.
- Full port from 1/4" to 4".
- Pressure rating 600 WOG - 150 WSP.
- Temperature to 366°F.
- Blow out proof stem, chrome plated brass ball.
- P.T.F.E. seats with O-RING backing for low operating torque.
- P.T.F.E. seats and double O-RING stem packing.
- 100% electronically tested in the open and closed position at 80 psi.

250N: WITH BRASS BALL AND STEM - size up to 4".
253N: WITH STAINLESS STEEL BALL AND STEM - size up to 2".



* (in-Lbs) Torque values in the table are measured in laboratory tests under the following conditions:
TEMPERATURE: 68°F
PRESSURE: 0 PSI
FLUID: PURIFIED WATER

1	BODY	BRASS CW 617N UNI EN 12165	1
2	END CONNECTION	BRASS CW 617N UNI EN 12165	1
3	BALL	BRASS CW 617N UNI EN 12165	1
4	BALL SEAT	P.T.F.E	2
5	THRUST WASHER	P.T.F.E	1
6	STEM SEAL	P.T.F.E	1
7	O-RING	FKM (Viton®)	2
8	O-RING	FKM (Viton®)	2
9	STEM	BRASS CW 614 NUNI EN 12164	1

1/4"	1.49	1.28	0.35	1.42 (ISO F03)	0.24	0.35	0.08	0.98	1.32	0.39	2.64	1.06	0.22	0.39	5.4	600	0.82	53.10
3/8"	1.49	1.28	0.35	1.42 (ISO F03)	0.24	0.35	0.08	0.98	1.32	0.40	2.64	1.06	0.22	0.39	6	600	0.79	53.10
1/2"	1.49	1.28	0.35	1.42 (ISO F03)	0.24	0.35	0.08	0.98	1.32	0.53	2.64	1.06	0.22	0.56	16.3	600	0.66	53.10
3/4"	1.49	1.36	0.35	1.42 (ISO F03)	0.24	0.35	0.08	0.98	1.57	0.55	3.00	1.26	0.22	0.75	29.5	600	0.91	53.10
1"	1.49	1.79	0.35	1.42 (ISO F03)	0.24	0.35	0.12	0.98	1.93	0.66	3.35	1.61	0.24	0.95	43	600	1.55	53.10
1"1/4	1.49	1.93	0.35	1.42 (ISO F03)	0.24	0.35	0.12	0.98	2.30	0.68	3.66	1.97	0.24	1.18	89	600	2.14	53.10
1"1/2	1.96	2.52	0.43	1.97 (ISO F05)	0.27	0.43	0.12	1.38	2.87	0.68	4.13	2.16	0.39	1.49	230	600	3.71	150.46
2"	1.96	2.88	0.43	1.97 (ISO F05)	0.27	0.43	0.12	1.38	3.60	0.70	4.80	2.75	0.31	1.97	265	600	5.52	150.46
2"1/2	2.75	3.48	0.55	2.76 (ISO F07)	0.35	0.59	0.12	2.16	4.51	0.93	6.10	3.54	0.35	2.52	540	600	8.83	274.37
3"	2.75	3.85	0.55	2.76 (ISO F07)	0.35	0.59	0.12	2.16	5.35	1.01	6.89	4.13	0.35	3.00	873	600	13.29	274.37
4"	2.75	4.59	0.67	2.76 (ISO F07)	0.35	0.69	0.12	2.16	6.53	1.09	8.03	5.12	0.33	3.74	1390	600	21.54	646.05

OM ELECTRIC ACTUATOR

OPERATION AND MAINTENANCE MANUAL

E-723

◆ PERFORMANCE

【12V / 24V】

Model No.	Torque (Nm)	Speed (90^0)	Motor Power	Motor Speed		12V DC/ AC			24V DC/ AC		
				12 V	24 V	Run	Start	Lock	Run	Start	Lock
OM-A	50	20 s	10 W	3600/min	3600/min	0.5A	3.0A	3.0A	0.7A	0.8A	1.4A
OM-1	35	15 s	10 W	3600/min	3600/min	0.5A	3.0A	3.0A	0.6A	0.8A	1.4A
OM-2	90	15 s	70 W	1800/min	1800/min	3.4A	5.0A	8.5A	3.0A	5.0A	13.0A
OM-3	150	22 s	70 W	1800/min	1800/min	3.4A	5.0A	8.5A	3.0A	5.0A	13.0A
OM-4	400	16 s	180W	1800/min	1800/min	12.0A	8.5A	30.0A	6.0A	8.0A	30.0A
OM-5	500	22 s	180W	1800/min	1800/min	13.0A	8.5A	30.0A	6.5A	8.0A	30.0A
OM-6	650	28 s	180W	1800/min	1800/min	14.0A	8.5A	30.0A	7.5A	8.0A	30.0A
OM-7									7.0A	8.0A	30.0A
OM-8									7.5A	8.0A	30.0A
OM-9									7.0A	8.0A	30.0A
OM-10									7.5A	8.0A	30.0A
OM-11									10.0A	10.0A	26.0A
OM-12									15.0A	15.0A	26.0A

【Single-Phase】

Model No.	Torque (Nm)	Speed (90^0)		Motor Power	Motor Speed		110V Current			220V-240V Current		
		60 Hz	50 Hz		60 Hz	50 Hz	Run	Start	Lock	Run	Start	Lock
BM-2	120	8 s	10 s	40W	1720/min	1450/min	1.3A	3.0A	1.8A	0.5A	1.5A	0.9A

M-A	50	20s	24s	10W	3600/min	3000/min	0.5A	1.5A	0.6A	0.3A	1.0A	0.5A
OM-1	35	12s	13s	10W	3600/min	3000/min	0.5A	1.5A	0.6A	0.3A	1.0A	0.5A
OM-2	90	15s	17s	40W	1720/min	1450/min	1.0A	3.0A	1.8A	0.5A	1.5A	0.9A
OM-3	150	22s	26s	40W	1720/min	1450/min	1.0A	3.0A	1.8A	0.5A	1.5A	0.9A
OM-4	400	16s	18s	120W	1720/min	1420/min	1.3A	3.1A	3.6A	0.6A	1.5A	1.8A
OM-5	500	22s	25s	120W	1720/min	1450/min	1.5A	3.0A	3.6A	0.7A	1.5A	1.8A
OM-6	650	28s	31s	120W	1720/min	1450/min	1.8A	3.0A	3.6A	0.8A	1.5A	1.8A
OM-7	1000	46s	55s	180W	1720/min	1450/min	3.2A	12.0A	10.0A	1.6A	4.0A	4.0A
OM-8	1500	46s	55s	220W	1720/min	1450/min	4.0A	14.0A	10.0A	2.0A	3.6A	5.0A
OM-9	2000	58s	70s	180W	1720/min	1450/min	3.2A	12.0A	6.0A	1.6A	5.0A	4.0A
OM-10	2500	58s	70s	220W	1720/min	1450/min	4.0A	12.0A	6.0A	2.0A	4.0A	3.0A
OM-11	3000	58s	70s	250W	1720/min	1450/min	3.0A	10.0A	5.0A	1.6A	4.0A	3.0A
OM-12	3500	58s	70s	300W	1720/min	1420/min	4.0A	14.0A	5.0A	2.0A	4.0A	3.0A

◆ PERFORMANCE

【Three-Phase】

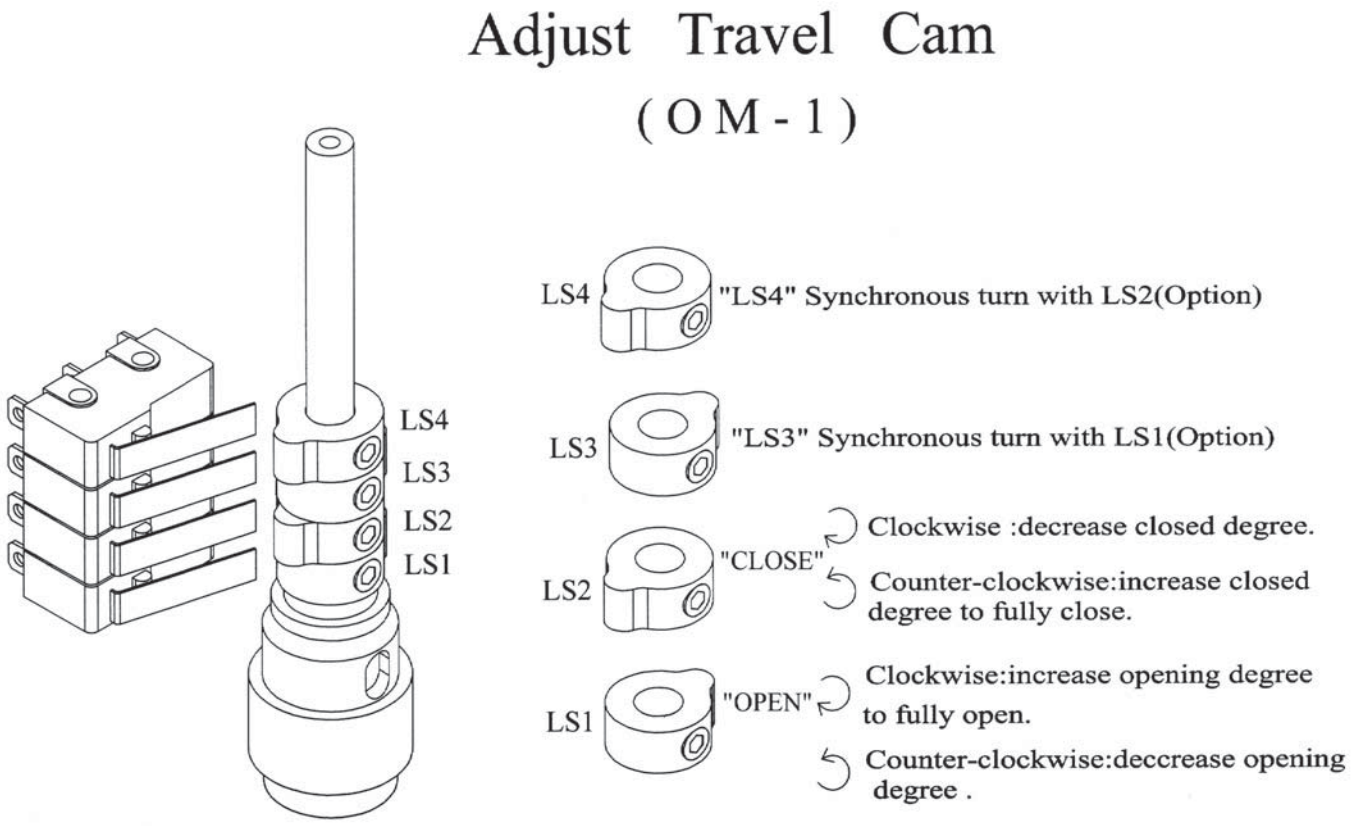
Model No.	Torque (Nm)	Speed (90°)		Motor Power	Motor Speed		220V Current			380V Current			440V Current		
		60Hz	50Hz		60Hz	50Hz	Run	Start	Lock	Run	Start	Lock	Run	Start	Lock
BM-2	120	8 s	10 s	40W	1720/min	1450/min	06A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
OM-2	90	15 s	17 s	40W	1720/min	1450/min	0.6A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
OM-3	150	22 s	26 s	40W	1720/min	1450/min	0.6A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
OM-4	400	16 s	18 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A
OM-5	500	22 s	25 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A
OM-6	650	28 s	31 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A
OM-7	1000	46 s	55 s	180W	1720/min	1450/min	0.6A	0.8A	1.8A	0.4A	0.6A	1.0A	0.4A	0.6A	1.0A
OM-8	1500	46 s	55 s	220W	1720/min	1450/min	0.8A	1.0A	2.8A	0.6A	0.8A	1.6A	0.6A	0.8A	1.2A
OM-9	2000	58 s	70 s	180W	1720/min	1450/min	0.4A	0.6A	2.0A	0.4A	0.6A	1.0A	0.4A	0.6A	1.0A
OM-10	2500	58 s	70 s	220W	1720/min	1450/min	0.8A	1.0A	1.5A	0.4A	0.6A	1.0A	0.4A	0.6A	1.0A
OM-11	3000	58 s	70 s	250W	1720/min	1450/min	1.2A	1.2A	3.0A	0.6A	0.8A	1.5A	0.6A	0.8A	1.5A
OM-12	3500	58 s	70 s	300W	1720/min	1450/min	1.2A	1.4A	2.5A	0.6A	0.8A	1.5A	0.6A	0.8A	1.5A

◆ TRAVEL CAM & LIMIT SWITCHES ADJUSTMENT

The travel cams are set to control the open and closed position of the valve. The position is set to stop the travel of the actuator when the travel cams activate the limit switch.

Standard is two limit switches, one for open, one for closed. The bottom limit switch is normally the open position (full CCW); the top limit switch is normally the closed position (full CW). 2-Auxiliary switches are available and are set independent of the two primary control limit switches.

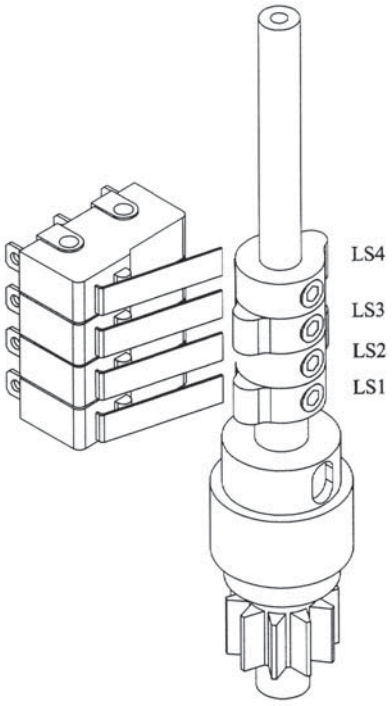
The travel cams can be adjusted by 2.5mm Hex. Spanner.



Clockwise = Closes
Counter Clockwise = Opens

TRAVEL CAM & LIMIT SWITCHES ADJUSTMENT

Adjust Travel Cam
(O M - A)



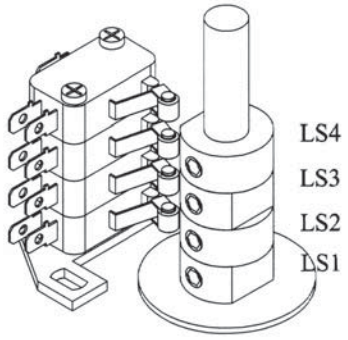
LS4 — "LS4" Synchronous turn with LS2(Option)

LS3 — "LS3" Synchronous turn with LS1(Option)

LS2 — "CLOSE"
- Clockwise :increase closed degree to fully close.
- Counter-clockwise:decrease closed degree.

LS1 — "OPEN"
- Clockwise:decrease opening degree.
- Counter-clockwise:increase opening degree to fully open.

Adjust Travel Cam
(BM-2) (OM-2~12)



LS4 — "LS4" Synchronous turn with LS2(Option)

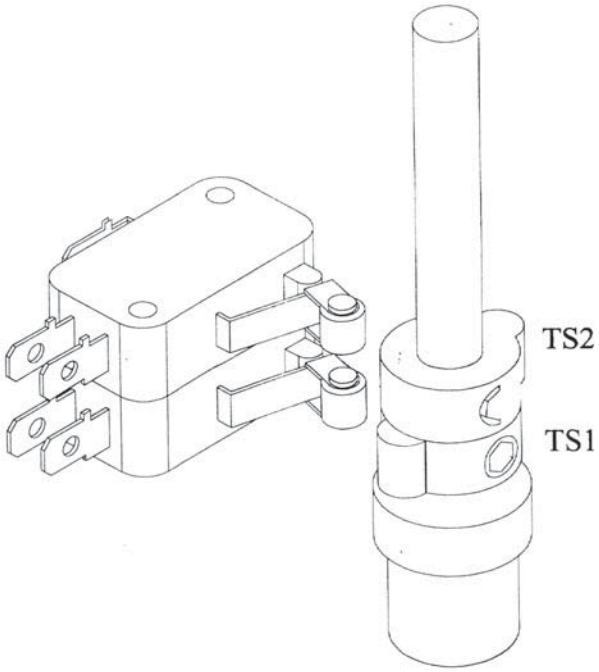
LS3 — "LS3" Synchronous turn with LS1(Option)

LS2 — "CLOSE"
- Clockwise:decrease closed degree.
- Counter-clockwise:increase closed degree to fully close.

LS1 — "OPEN"
- Clockwise:increase opening degree to fully open.
- Counter-clockwise:decrease opening degree.

◆ TRAVEL CAM & TORQUE SWITCHES ADJUSTMENT

Adjust Travel Cam
(OM-2~OM-8)



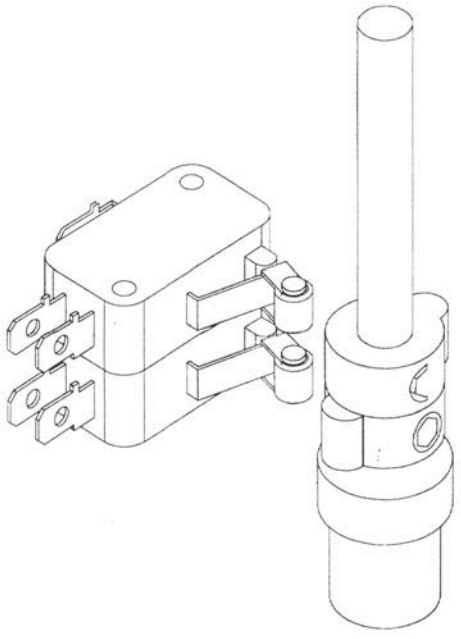
TS2 "CLOSE"

- Counter-clockwise:Decrease the degree of torque setting.
- Clockwise:Increase the degree of torque setting.

TS1 "OPEN"

- Counter-clockwise:Decrease the degree of torque setting.
- Clockwise:Increase the degree of torque setting.

Adjust Travel Cam
(OM-9~OM-12)



TS2 "CLOSE"

- Counter-clockwise:Increase the degree of torque setting.
- Clockwise:Decrease the degree of torque setting.

TS1 "OPEN"

- Clockwise:Increase the degree of torque setting.
- Counter-clockwise:Decrease the degree of torque setting.

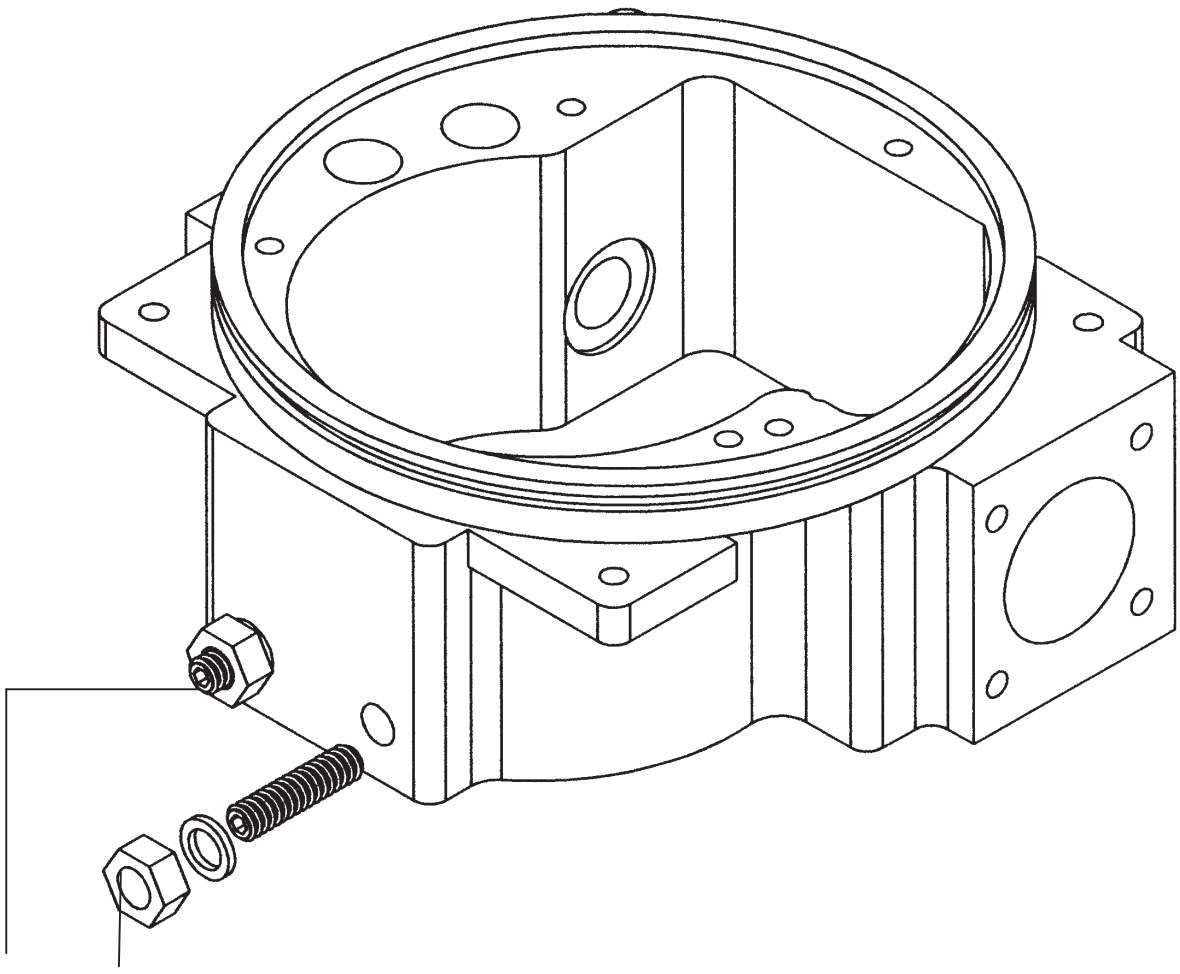
◆ MECHANICAL STOPS

(1) For Electric Operation

Please refer to " Travel Cam & Limit Switches Adjustment ".

(2) For Manual Operation

1. To loosen the screws.
2. To adjust limit switches & travel cams.
3. To adjust the screws.
4. To reverse one cycle.



OPEN】 【CLOSE】

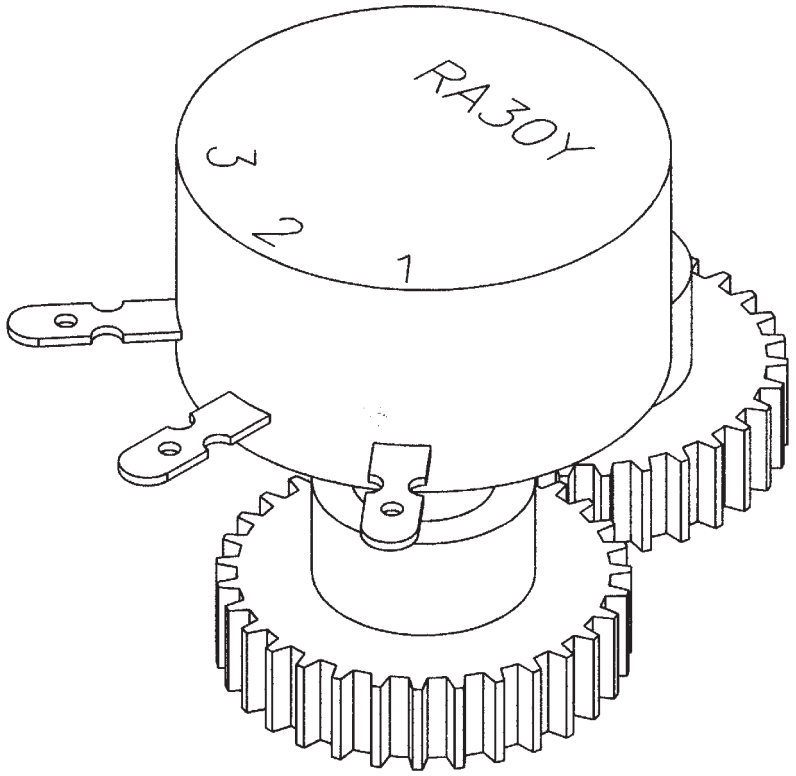
◆ POTENTIOMETER

Potentiometers turn with transmission shafts, and can provide a feedback signal for position indication.

Potentiometer points 1, 2, 3 are wired to terminal blocks 5, 6, 7.
When a valve is closed: 5, 6→ 1K Ohm.
6, 7 → 0K Ohm.
When a valve is opened: 5, 6 → 0K Ohm
6, 7 → 1K Ohm.

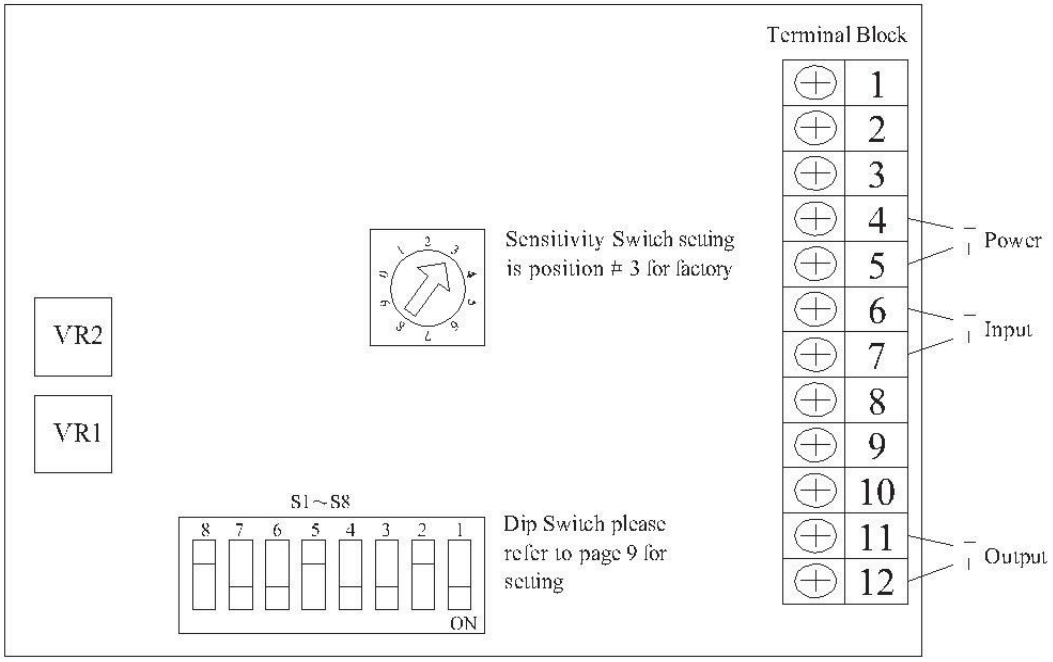
For modulating controllers, potentiometer points 1, 2, 3 are wired to terminal blocks 8, 9, 10.
When a valve is closed: 8, 9 → 5K Ohm.
9, 10 → 0K Ohm.
When a valve is opened: 8, 9 → 0K Ohm
9, 10 → 5K Ohm.

∗ Remark: OM-A is opposite. (i.e. 1,2,3 wired to 7,6,5; 1,2,3 wired to 10,9,8)

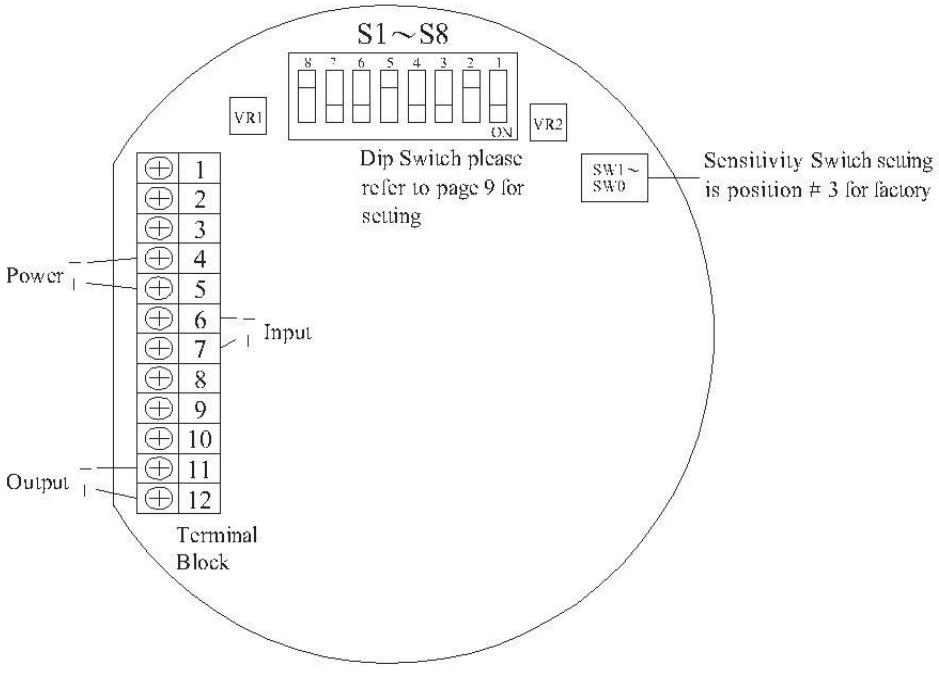


◆ MODULATING CONTROL BOARD：Interface

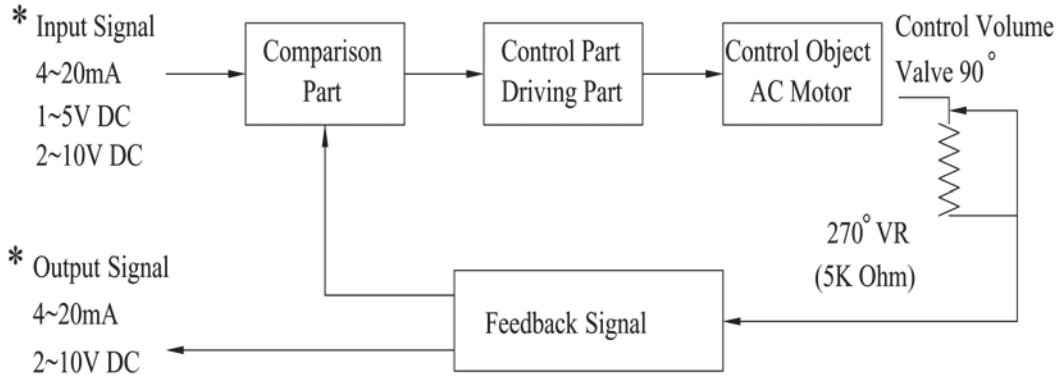
Modulating Control Board for OM2～12



Modulating Control Board for OM1,OMA



◆ MODULATING CONTROL BOARD



★Attention: TURN POWER OFF BEFORE CHANGING THE FOLLOWING SETTINGS:

S1,2: INPUT SIGNAL SELECT " 4~20mA " set 1-ON / 2-OFF.
" 1~5V " set 1-OFF / 2-OFF.
" 2~10V" set 1-OFF / 2-ON.

S3,4,5,: OUTPUT SIGNAL SELECT "2-10V" set 3-ON / 4-OFF / 5-ON.
"4-20mA" set 3-OFF / 4-ON / 5-OFF.

S6: Valve is fully-open when the input signal is 4mA, 2V or 1V and valve is fully-closed when the input signal is 20mA, 10V or 5V, set 6-ON.
S7,8: POSITION SELECT (When the feedback signal fails) "valve fully-closed" set 7-ON / 8-OFF；"valve fully-open" set 7-OFF / 8-ON；"valve stops" set 7-ON / 8-ON.

S6: Valve is fully-closed when the input signal is 4mA, 2V or 1V and valve is fully-open when the input signal is 20mA, 10V or 5V, set 6-OFF.
S7,8: POSITION SELECT (When the feedback signal fails) "valve fully-closed" set 7-OFF / 8-ON；"valve fully-open" set 7-ON / 8-OFF；"valve stops" set 7-ON / 8-ON.

SW1~0: Sensitivity switch:-
When switch to "1", the 0~90 degree can be divided up to around 80 times movement.
When switch to "0", the 0~90 degree can be divided up to around 17 times movement.
The sensitivity decreases 7 times movement by sectors from SW1 to SW2, SW2 to SW3, SW3 to SW4 and so on.

◆ LUBRICATION

The gearbox of the SUN YEH actuator is enclosed, and it has already been lubricated sufficiently with high temperature lubricant at the factory sufficient for use for up to two years.

◆ IMPORTANT NOTICES & MAINTENANCE

*** Notices**:

1. Make sure the voltage is correct before wiring.
2. Turn off before power for maintenance purposes.
3. Seal the casing and conduit entrance after wiring to prevent dusting or water contamination.
4. The angle of electric actuator installation must between 0~180 degree. Do not install upside down or below the horizontal.
5. Do not install when hazardous or explosive gases may be present.
6. The frequency of open and close is restricted to every 5 minutes. Avoid too high frequency.
7. When more than one electric actuator needs to operate simultaneously, please connect with the individual cables.
8. Please connect the ground wire to PE inside the electric actuator.
9. The warranty period of our product is for one year.

*** Storage**:

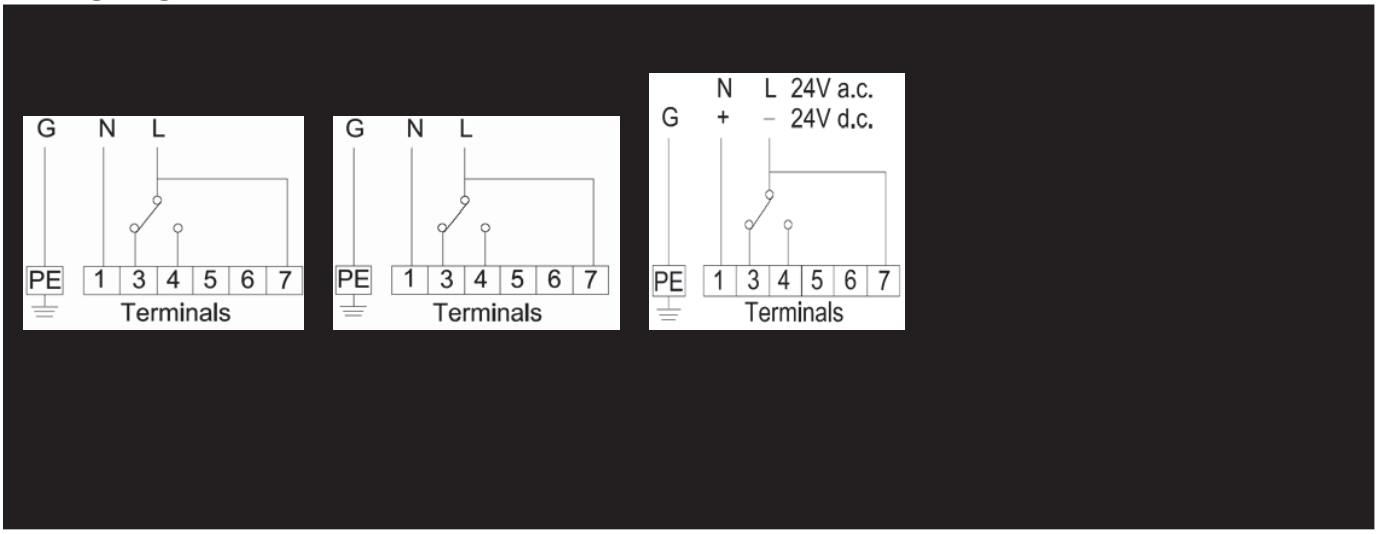
1. The actuator should be placed in a clean and dry place, and protected from the weather and extreme vibration.
2. If actuator needs be stored outside, it must be protected from excess moisture, dust, and weather.

◆ TROUBLE SHOOTING

Conditions	Possibilities	Solutions
Motor does not operate	1. Is the supplied power and voltage correct? 2. Any blisters on the capacitor? 3. Are the gear trains free?	1. Checking by meter. 2. If so replace. 3. Remove motor to check.
Motor stops running	1. Is power supply short circuited? 2. Any foreign objects in flow stream?	1. Check wiring. 2. Check for obstructions.
Unable to fully open/close	1. Loose/Misaligned cam? 2. Bent valve stem? 3. Mechanical stop adjustment incorrect?	1. Adjust/Tighten using spanner. 2. Replace valve stem. 3. Check position of stops.
Valve stops operating when motor is running.	1. Gear worn out? 2. Sleeve adapter worn out or broken? 3. Broken valve stem or actuator transmission shaft?	1. Replace gear. 2. Replace sleeve adapter. 3. Replace valve stem or actuator transmission shaft.
Abnormal control for operating two or more actuators simultaneously.	1. Controlling circuit connects in tandem or parallel?	1. Please refer to the wiring diagram.
Motor overheats.	1. Is the voltage correct? 2. Is valve too tight to operate? 3. High working frequency? 4. Is motor stem or bearing binding?	1. Checking by meter. 2. Replace valve. 3. Check duty cycle. 4. Replace the binding parts.
Abnormal on/off angle on 3-phase voltage.	1. Wrong phase wiring?	1. Change phase wiring.
Occasional on/off actuator failure.	1. Simultaneous input power on/off.	1. Check if the selection switch is normal.
Vibration when valve is closed.	1. Motor brake spring fatigued or Teflon worn?	1. Replace spring or Teflon.

OM-1 ~ OM-13, OM-A, OM-A-M, BM-2 110/220/24V Actuator (ON/OFF, 3 Point Control)

Wiring Diagram



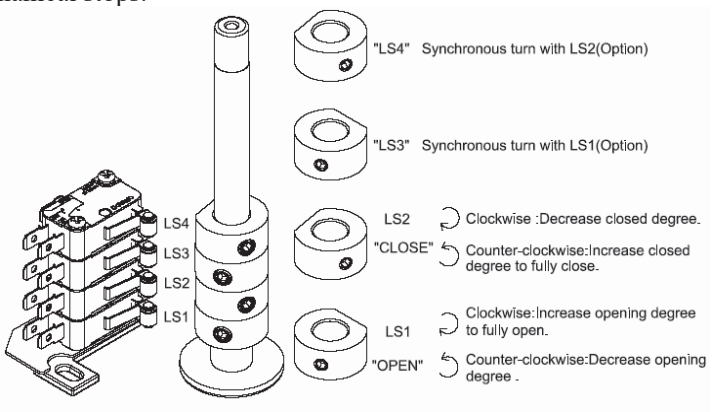
Travel switches adjustment for OM-2~OM-13

The quarter-turn actuator is provided with a limiting of manual rotation device to avoid over-travel with the hand-wheel. Before setting the limit switches, please adjust the mechanical stops.

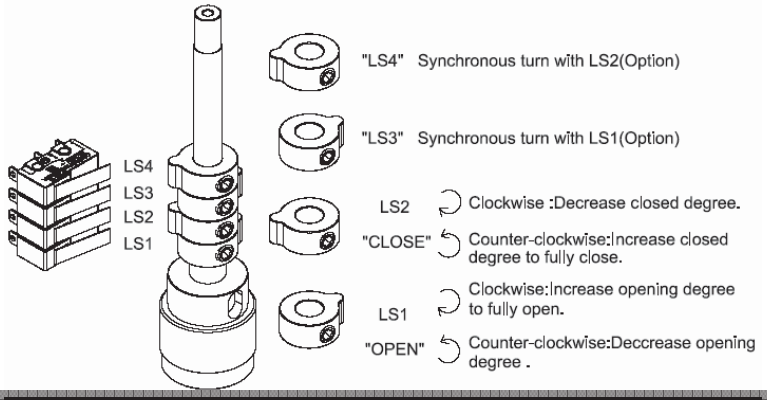
Mechanical Stops adjustment

【OPEN】【CLOSE】

1. To loosen the screws
2. To adjust limit switches & travel cams.
3. To adjust the screws
4. To reverse one cycle



Travel switches adjustment for OM-1 & OM-A, OM-A-M

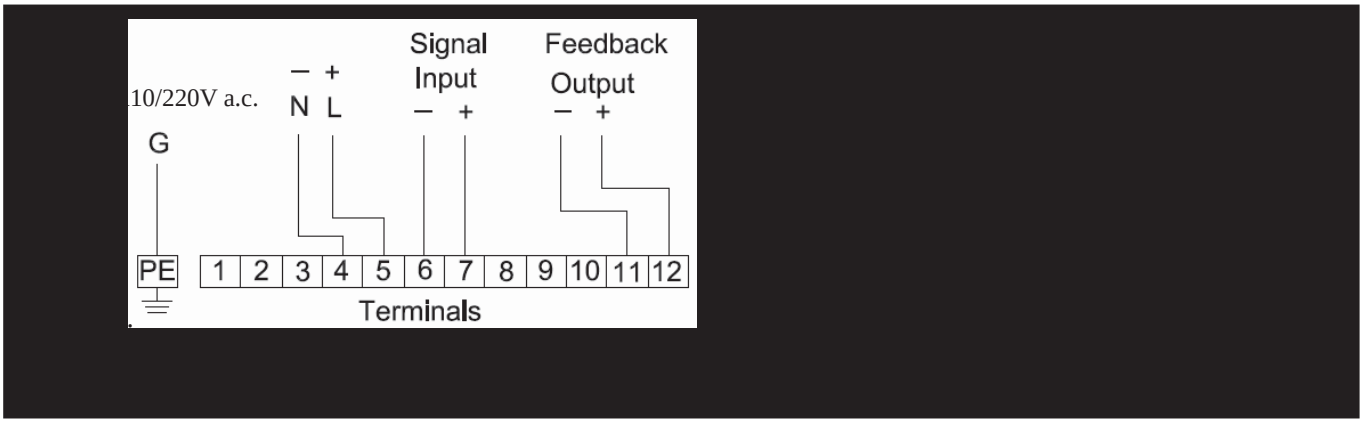


Important Notices & Maintenance

- Make sure if the voltage is correct before wiring.
- Power off before distribution or for maintenance purpose.
- Lock tight the casting and conduit entrance after power distribution to prevent from dusting or water spoiling.
- The angle of electric actuators must not be below the horizon or stands upside down.
- When electric actuators need two sets of unit for simultaneously, please connect with the individual cable.
- Don't install in complete vacuum space directly.
- Actuator should be placed at clean and dry place for storage, and protected with outer carton from being affected by great temperature difference or serious vibration.

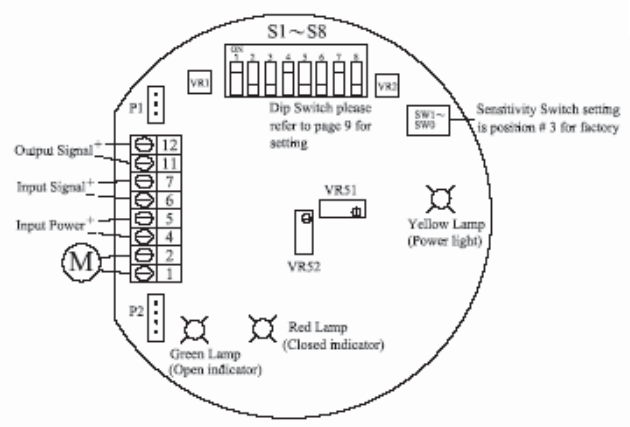
OM-1~ OM-13, OM-A, OM-A-M 110/220/24V Actuator (Modulating , 30% & 75% duty cycle)

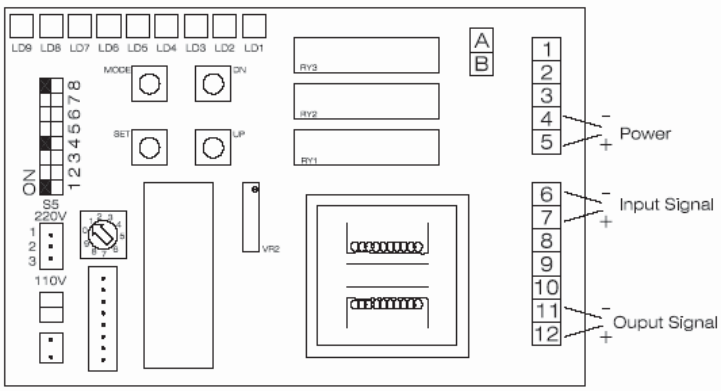
Wiring Diagram



Modulating Board Set Up

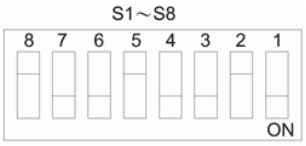
OM-1 & OM-A ,OM-A-M **OM-2 ~ OM-13**





▲ Disconnect power supply before changing the following settings.

Dip Switch setting



* S3, S4 &S5 for out put signal

Output Signal	S3	S4	S5
2-10V	ON	OFF	ON
4-20mA	OFF	ON	OFF

* S6 - Direction of travel in response to the control.

(Factory setting is OFF.)

S6	Symbol
OFF	90° Signal
ON	90° Signal

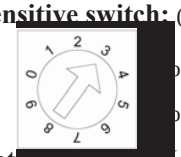
* S1, S2 for input signal

Input Signal	S1	S2
2-10V	OFF	ON
4-20mA	ON	OFF
1-5V	OFF	OFF

* S7 & S8-Actuator response to the loss of control signal.

When signal fails	S7	S8
Full closed	OFF	ON
Full open	ON	OFF
Stops	ON	ON

sensitive switch: (Factory setting is position “3”)



osition “0” : Lowest Sensitive, 0-90 divided into 17 steps.

osition “1” : Highest Sensitive, 0-90 divided into 70 steps.

Setting for OPEN and CLOSE

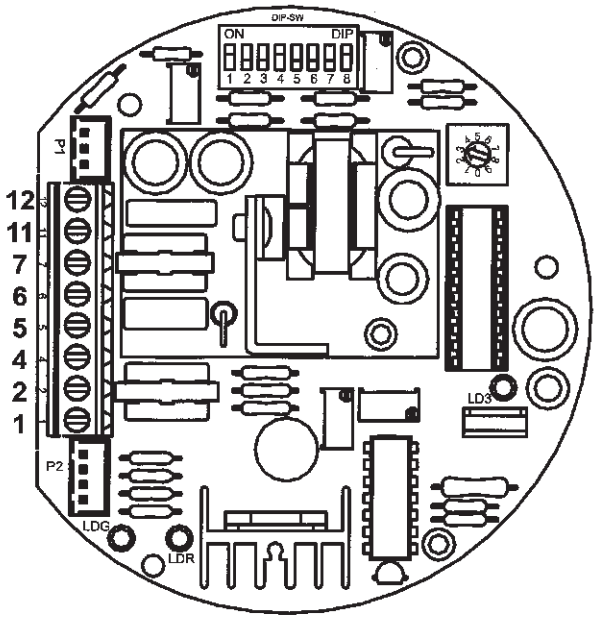
1. Keep pressing “SET” for 3 seconds, then LED9 comes on, it will enter the manual mode.
2. Keep pressing “UP” until LED2 comes on (fully-open), then supplies the input signal (5V or 10V or 20mA) and presses “MODE” once.
3. Keep pressing “Down” until LED1 comes on (fully-close), then supplies the input signal (1V or 2V or 4mA) and presses “MODE” once.
4. After finishing the above settings, press “SET” once.

To reset and return to the original status – Please power off and get troubleshooting, then power on.

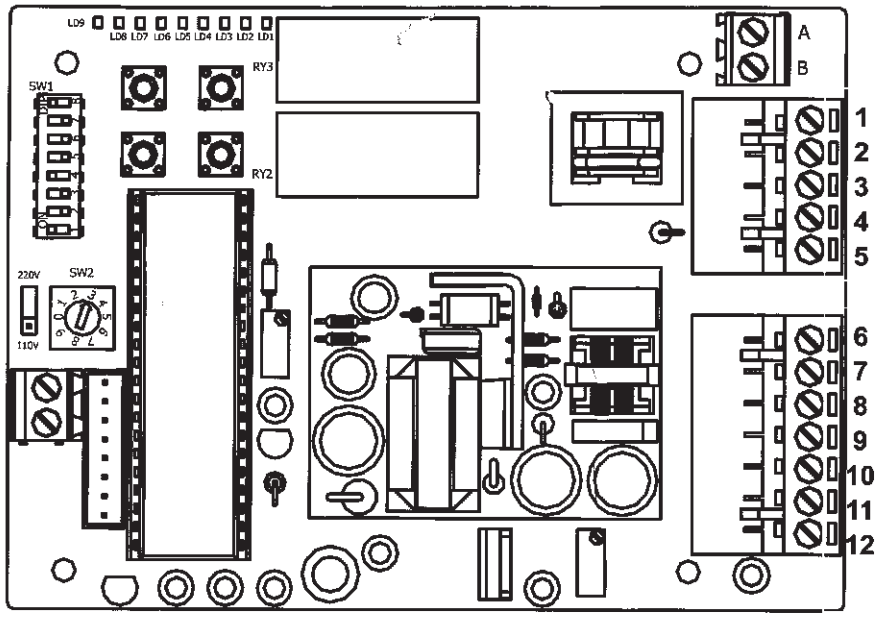
⚠ **To avoid functional failure caused by statics, do not touch any components on the PCB with metal tools or bare hands.**

Modulating Board Set Up

OM-1 & OM-A ,OM-A-M



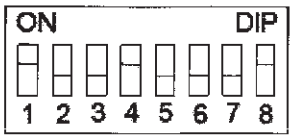
OM-2 ~ OM-13



▲To adjust the following settings, turn power off FIRST.

Dip Switch setting

Factory setting: 1,4,8 ON



* S1, S2 for input signal

Input Signal	S1	S2
2-10V	OFF	ON
4-20mA	ON	OFF
1-5V	OFF	OFF

* S3, S4 &S5 for output signal

Output Signal	S3	S4	S5
2-10V	ON	OFF	ON
4-20mA	OFF	ON	OFF

* S7 & S8-Actuator response to the loss of control signal.

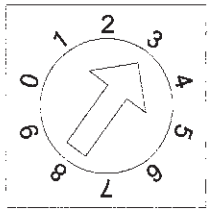
When signal fails	S7	S8
Fully closed	OFF	ON
Fully open	ON	OFF
Stops	ON	ON

* S6 - Direction of travel in response to the control.

S6	Symbol
OFF	90° Signal
ON	90° Signal

Sensitivity Switch Setting: (Factory setting is position "3")

SW2



When switch to "1" : The Highest Sensitive and the 0-90 degree can be divided up to around 50 times movement.

When switch to "0" : The Lowest Sensitive and the 0-90 degree can be divided up to around 10 times movement.

The sensitivity decreases 7 times movement by sectors from SW1 to SW2, SW2 to SW3, SW3 to SW4 and so on.

Settings for OPEN and CLOSE

Keep pressing "**SET**" for 2 seconds, then LD9 comes on, it will enter the manual mode.

OPEN setting

1. Keep pressing "**UP**" until actuator runs to fully-open position, LD2 comes on, then supplies the input signal. (5V or 10V or 20mA).
2. Press "**MODE**" once. The OPEN setting is completed.

CLOSE setting

1. Keep pressing "**DOWN**" until actuator runs to fully-closed position, LD1 comes on, then supplies the input signal. (1V or 2V or 4mA).
2. Press "**MODE**" once. The CLOSE setting is completed.

Press "**SET**" once and back to electric mode.

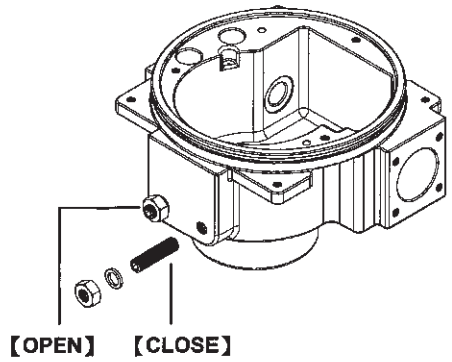
LD1 : Fully - closed	LD6 : Motor thermostat turn off
LD2 : Fully – open	LD7 : Output signal short circuit
LD3 : Power	LD8 : Motor current is excessive
LD4 : Abnormal voltage	LD9 : Manual mode
LD5 : Wrong Input signal	

Operating Instruction

The quarter-turn actuator is provided with a limiting of manual rotation device to avoid over-travel with the hand-wheel. Please follow below adjusting procedures carefully to avoid the damage of the mechanical stops.

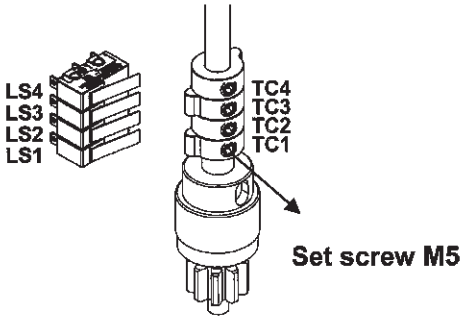
Mechanical Stops adjustment

1. Loosen mechanical stop screws.
2. For modulating type, loosen the set screw on the sector gear.
3. Follow below travel switches adjustment procedure for angle calibration.
4. For modulating type, rotate sector gear clockwise to the end. Then tighten the set screw.
5. Tighten the mechanical stop screw until it reaches the shaft, then reverse one cycle.



Travel switches adjustment

【OM-A & OM-A-M】



TC4 Synchronous turn with TC2 (optional)

TC3 Synchronous turn with TC1 (optional)

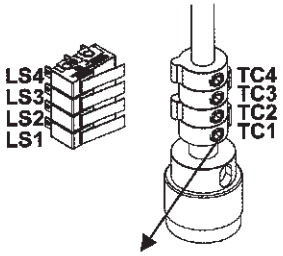
TC2 "CLOSE" ↻ Clockwise : increase closing degree to fully closed.

↺ Counter Clockwise : decrease closing degree.

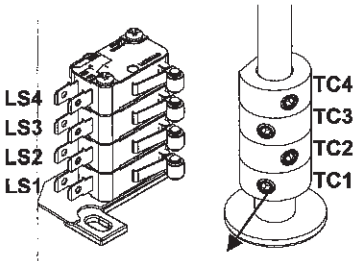
TC1 "OPEN" ↻ Clockwise : decrease opening degree.

↺ Counter Clockwise : increase opening degree to fully open.

【OM-1】



【BM-2, OM-2~13】



TC4 Synchronous turn with TC2 (optional)

TC3 Synchronous turn with TC1 (optional)

TC2 "CLOSE" ↻ Clockwise : decrease closing degree.

↺ Counter Clockwise : increase closing degree to fully closed.

TC1 "OPEN" ↻ Clockwise : increase opening degree to fully open.

↺ Counter Clockwise : decrease opening degree.

Important Notices & Maintenance

- Check for correct voltage prior to wiring.
- Turn power off before servicing or for maintenance purpose.
- Use sealant to seal conduit connections after wiring to prevent dusting or water contamination.
- The angle of electric actuator installation must be between 0~180 degree. Do not install upside down or below the horizontal.
- When more than one electric actuator needs to operate simultaneously, please connect with the individual cables.
- Please connect the ground wire to PE inside the electric actuator.
- Not intended for vacuum spaces and avoid installing near explosive atmospheres.
- The standard actuator is 30% duty cycle and optional for 75% duty cycle. Avoid too high frequency for the rated duty cycle.

PLC, TM251MESE

Modicon M251 Logic Controller

Hardware Guide

04/2014

EIO0000001486.00

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Schneider Electric

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 nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

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 serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book

At a Glance

Document Scope

Use this document to:

- Install and operate your M251 Logic Controller.
- Connect the M251 Logic Controller to a programming device equipped with SoMachine software.
- Interface the M251 Logic Controller with I/O expansion modules, HMI and other devices.
- Familiarize yourself with the M251 Logic Controller features.

NOTE: Read and understand this document and all related documents before installing, operating, or maintaining your controller.

Validity Note

This document has been updated with the release of SoMachine V4.1.

The technical characteristics of the devices described in this manual also appear online.

The characteristics that are presented in this manual should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the manual and online information, use the online information as your reference.

Related Documents

Title of Documentation	Reference Number
Modicon M251 Logic Controller - Programming Guide	EIO0000001462 (ENG), EIO0000001463 (FRE), EIO0000001464 (GER), EIO0000001465 (SPA), EIO0000001466 (ITA), EIO0000001467 (CHS)
Modicon TM3 Digital I/O Modules - Hardware Guide	EIO0000001408 (ENG), EIO0000001409 (FRE), EIO0000001410 (GER), EIO0000001411 (SPA), EIO0000001412 (ITA), EIO0000001413 (CHS), EIO0000001375 (TUR), EIO0000001374 (POR)

Title of Documentation	Reference Number
Modicon TM3 Expert I/O Modules - Hardware Guide	EIO0000001420 (ENG), EIO0000001421 (FRE), EIO0000001422 (GER), EIO0000001423 (SPA), EIO0000001424 (ITA), EIO0000001425 (CHS), EIO0000001381 (TUR), EIO0000001380 (POR)
Modicon TM3 Transmitter and Receiver Modules - Hardware Guide	EIO0000001426 (ENG), EIO0000001427 (FRE), EIO0000001428 (GER), EIO0000001429 (SPA), EIO0000001430 (ITA), EIO0000001431 (CHS), EIO0000001383 (TUR), EIO0000001382 (POR)
Modicon TM4 Expansion Modules - Hardware Guide	EIO0000001796 (ENG); EIO0000001797 (FRE); EIO0000001798 (GER); EIO0000001799 (SPA); EIO0000001800 (ITA); EIO0000001801 (CHS)
M251 Logic Controller - Instruction Sheet	HRB59604

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

Product Related Information

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of a hazardous atmosphere.

⚠ DANGER

POTENTIAL FOR EXPLOSION

Install and use this equipment in non-hazardous locations only.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Part I
Modicon M251 Logic Controller Introduction

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
1	M251 General Overview	13
2	M251 Features	35
3	M251 Installation	45

Chapter 1
M251 General Overview

Overview

This chapter provides general information about the M251 Logic Controller system architecture and its components.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
M251 Logic Controller Description	14
Maximum Hardware Configuration	16
TM4 Expansion Modules	19
TM3 Expansion Modules	20
TM2 Expansion Modules	28
Accessories	32

M251 Logic Controller Description

Overview

The M251 Logic Controller has various powerful features and can service a wide range of applications.

Software configuration, programming, and commissioning are achieved with the SoMachine software described in the SoMachine Programming Guide and in the M251 Logic Controller Programming Guide.

Programming Languages

The M251 Logic Controller is configured and programmed with the SoMachine software, which supports the following IEC 61131-3 programming languages:

- IL: Instruction list
- ST: Structured text
- FBD: Function block diagram
- SFC: Sequential function chart
- LD: Ladder diagram

SoMachine software can also be used to program this controller using CFC (continuous function chart) language.

Power Supply

The power supply of the M251 Logic Controller is 24 Vdc *(see page 68)*.

Real Time Clock

The M251 Logic Controller includes a Real Time Clock (RTC) system *(see page 36)*.

Run/Stop

The M251 Logic Controller can be operated externally by the following:

- a hardware Run/Stop switch *(see page 40)*
- a SoMachine software command

Memory

This table describes the different types of memory:

Memory Type	Size	Used
RAM	64 Mbytes, of which 8 Mbytes available for the application	To execute the application.
Flash	128 Mbytes	To save the program and data in case of a power interruption.

Removable Storage

M251 Logic Controllers include an embedded SD card slot *(see page 41)*.

The main uses of the SD card are:
- Initializing the controller with a new application
- Updating the controller firmware
- Applying post configuration files to the controller
- Applying recipes
- Receiving data logging files

Embedded Communication Features

The M251 Logic Controller native communication ports include (depending on the controller reference):
- CANopen Master *(see page 88)*
- Ethernet *(see page 90)*
- USB Mini-B *(see page 96)*
- Serial Line *(see page 97)*

M251 Logic Controllers

Reference	Digital Inputs	Digital Outputs	Communication Ports
TM251MESC	0	0	1 serial line port 1 USB mini-B programming port 1 dual port Ethernet switch 1 CANopen port
TM251MESE	0	0	1 serial line port 1 USB mini-B programming port 1 dual port Ethernet switch 1 Ethernet port for fieldbus

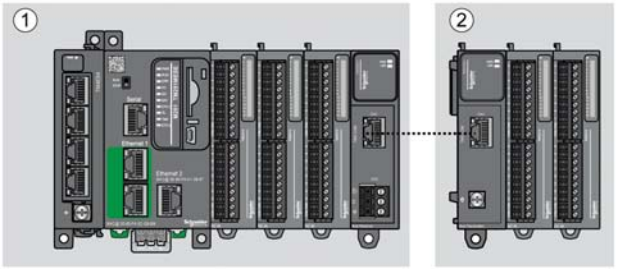
Maximum Hardware Configuration

Introduction

The M251 Logic Controller is a control system that offers an scalable solution with optimized configurations and an expandable architecture.

Local and Remote Configuration Principle

The following figure defines the local and remote configurations:



(1) Local configuration
(2) Remote configuration

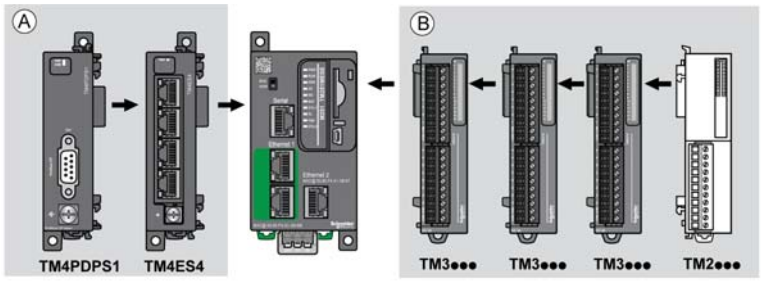
M251 Logic Controller Local Configuration Architecture

Optimized local configuration and flexibility are provided by the association of:

- TM4 expansion modules
- M251 Logic Controller
- TM3 expansion modules
- TM2 expansion modules

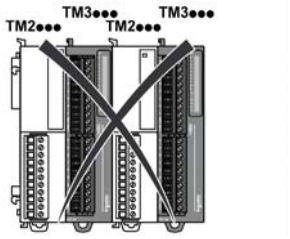
Application requirements determine the architecture of your M251 Logic Controller configuration.

The following figure represents the components of a local configuration:



(A) Expansion modules (3 maximum)
(B) Expansion modules (7 maximum)

NOTE: It is prohibited to mount a TM2 module before any TM3 module as indicated in the following figure:



M251 Logic Controller Remote Configuration Architecture

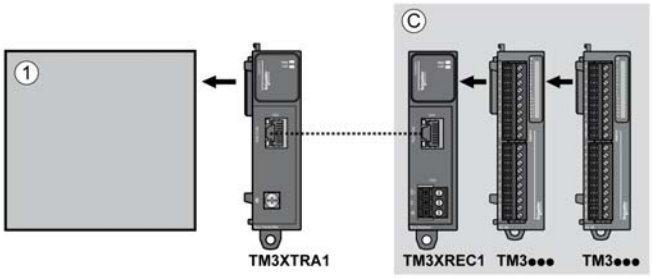
Optimized remote configuration and flexibility are provided by the association of:

- TM4 expansion modules
- M251 Logic Controller
- TM3 expansion modules
- TM3 transmitter and receiver modules

Application requirements determine the architecture of your M251 Logic Controller configuration.

NOTE: You cannot use TM2 modules in configurations that include the TM3 transmitter and receiver modules.

The following figure represents the components of a remote configuration:



(1) Logic controller and modules
(C) Expansion modules (7 maximum)

Maximum Number of Modules

The following table shows the maximum configuration supported:

References	Maximum	Type of Configuration
TM251••••	7 TM3 / TM2 expansion modules	Local
TM251••••	3 TM4 expansion modules	Local
TM3XREC1	7 TM3 expansion modules	Remote
NOTE: TM3 transmitter and receiver modules are not included in a count of the maximum number of expansion modules.		

NOTE: The configuration with its TM4, TM3, and TM2 expansion modules is validated by SoMachine software in the **Configuration** window.

NOTE: In some environments, the maximum configuration populated by high consummation modules, coupled with the maximum distance allowable between the TM3 transmitter and receiver modules, may present bus communication issues although the SoMachine software allows for the configuration. In such a case you will need to analyze the consummation of the modules chosen for your configuration, as well as the minimum cable distance required by your application, and possibly seek to optimize your choices.

TM4 Expansion Modules

Introduction

The range of TM4 expansion modules includes communication modules.

For more information, refer to the TM4 Expansion Modules Hardware Guide.

TM4 Expansion Modules

The following table shows the TM4 expansion module features:

Module reference	Type	Terminal type
TM4ES4	Ethernet communication	4 RJ45 connectors 1 screw for functional ground connection
TM4PDPS1	PROFIBUS DP slave communication	1 SUB-D 9 pins female connector 1 screw for functional ground connection
NOTE: If the controller has more than one embedded Ethernet port, the module works as a standalone Ethernet switch.		

TM3 Expansion Modules

Introduction

The range of TM3 expansion modules includes:

- Digital modules, classified as follows:
  - Input modules *(see page 20)*
  - Output modules *(see page 21)*
  - Mixed input/output modules *(see page 23)*
- Analog modules, classified as follows:
  - Input modules *(see page 24)*
  - Output modules *(see page 25)*
  - Mixed input/output modules *(see page 26)*
- Expert modules *(see page 27)*
- Transmitter and Receiver modules *(see page 27)*

For more information, refer to the following documents:

- TM3 Digital I/O Modules Hardware Guide
- TM3 Analog I/O Modules Hardware Guide
- TM3 Expert I/O Modules Hardware Guide
- TM3 Transmitter and Receiver Modules Hardware Guide

TM3 Digital Input Modules

The following table shows the TM3 digital input expansion modules, with corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DI8A	8	Regular inputs	120 Vac 7.5 mA	Removable screw terminal block / 5.08 mm
TM3DI8	8	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 5.08 mm
TM3DI8G	8	Regular inputs	24 Vdc 7 mA	Removable spring terminal block / 5.08 mm
TM3DI16	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal blocks / 3.81 mm
TM3DI16G	16	Regular inputs	24 Vdc 7 mA	Removable spring terminal blocks / 3.81 mm
TM3DI16K	16	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector
TM3DI32K	32	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector

TM3 Digital Output Modules

The following table shows the TM3 digital output expansion modules, with corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DQ8R	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8RG	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ8T	8	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8TG	8	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ8U	8	Regular transistor outputs (sink)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8UG	8	Regular transistor outputs (sink)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ16R	16	Relay outputs	24 Vdc / 240 Vac 8 A maximum per common line / 2 A maximum per output	Removable screw terminal blocks / 3.81 mm
TM3DQ16RG	16	Relay outputs	24 Vdc / 240 Vac 8 A maximum per common line / 2 A maximum per output	Removable spring terminal blocks / 3.81 mm
TM3DQ16T	16	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line / 0.5 A maximum per output	Removable screw terminal blocks / 3.81 mm

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DQ16TG	16	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line / 0.5 A maximum per output	Removable spring terminal blocks / 3.81 mm
TM3DQ16U	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.4 A maximum per output	Removable screw terminal blocks / 3.81 mm
TM3DQ16UG	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.4 A maximum per output	Removable spring terminal blocks / 3.81 mm
TM3DQ16TK	16	Regular transistor outputs (source)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector
TM3DQ16UK	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector
TM3DQ32TK	32	Regular transistor outputs (source)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connectors
TM3DQ32UK	32	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connectors

TM3 Digital Mixed Input/Output Modules

This following table shows the TM3 mixed I/O modules, with corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DM8R	4	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 5.08 mm
	4	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM8RG	4	Regular inputs	24 Vdc 7 mA	Removable spring terminal block /5.08 mm
	4	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM24R	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal blocks / 3.81 mm
	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM24RG	16	Regular inputs	24 Vdc 7 mA	Removable spring terminal blocks / 3.81 mm
	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	

TM3 Analog Input Modules

The following table shows the TM3 analog input expansion modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AI2H	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AI2HG	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm
TM3AI4	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 3.81 mm
TM3AI4G	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal blocks / 3.81 mm
TM3AI8	12 bit, or 11 bit + sign	8	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 3.81 mm
TM3AI8G	12 bit, or 11 bit + sign	8	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal blocks / 3.81 mm
TM3TI4	16 bit, or 15 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable screw terminal block / 3.81 mm
TM3TI4G	16 bit, or 15 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable spring terminal blocks / 3.81 mm

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3TI8T	16 bit, or 15 bit + sign	8	inputs	Thermocouple NTC/PTC	Removable screw terminal block / 3.81 mm
TM3TI8TG	16 bit, or 15 bit + sign	8	inputs	Thermocouple NTC/PTC	Removable spring terminal blocks / 3.81 mm

TM3 Analog Output Modules

The following table shows the TM3 analog output modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AQ2	12 bit, or 11 bit + sign	2	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AQ2G	12 bit, or 11 bit + sign	2	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm
TM3AQ4	12 bit, or 11 bit + sign	4	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AQ4G	12 bit, or 11 bit + sign	4	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm

TM3 Analog Mixed Input/Output Modules

This following table shows the TM3 analog mixed I/O modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AM6	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 3.81 mm
		2	outputs		
TM3AM6G	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 3.81 mm
		2	outputs		
TM3TM3	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable screw terminal block / 5.08 mm
	12 bit, or 11 bit + sign	1	output	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	
TM3TM3G	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable spring terminal block / 5.08 mm
	12 bit, or 11 bit + sign	1	output	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	

TM3 Expert Module

The following table shows the TM3 expert expansion module, with corresponding terminal type:

Reference	Description	Terminal Type / Pitch
TM3XTYS4	TeSys module	4 front connectors RJ-45 1 power supply connector / 5.08 mm

TM3 Transmitter and Receiver Modules

The following table shows the TM3 transmitter and receiver expansion modules:

Reference	Description	Terminal Type / Pitch
TM3XTRA1	Data transmitter module for remote I/O	1 front connector RJ-45 1 screw for functional ground connection
TM3XREC1	Data receiver module for remote I/O	1 front connector RJ-45 Power supply connector / 5.08 mm

TM2 Expansion Modules

Overview

You can expand the number of I/Os of your M251 Logic Controller by adding TM2 I/O expansion modules.

The following types of electronic modules are supported:
- TM2 digital I/O expansion modules
- TM2 analog I/O expansion modules

For more information, refer to the following documents:
- TM2 Digital I/O Expansion Modules Hardware Guide
- TM2 Analog I/O Expansion Modules Hardware Guide

NOTE: TM2 modules can only be used in the local configuration, and only if there is no TM3 transmitter and receiver modules present in the configuration.

NOTE: It is prohibited to mount a TM2 module before any TM3 module. The TM2 modules must be mounted and configured at the end of the local configuration.

TM2 Digital Input Expansion Modules

The following table shows the compatible TM2 digital input expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel Type	Voltage Current	Terminal Type
TM2DAI8DT	8	Regular inputs	120 Vac 7.5 mA	Removable screw terminal block
TM2DDI8DT	8	Regular inputs	24 Vdc 7 mA	Removable screw terminal block
TM2DDI16DT	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal block
TM2DDI16DK	16	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector
TM2DDI32DK	32	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector

TM2 Digital Output Expansion Modules

The following table shows the compatible TM2 digital output expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel type	Voltage Current	Terminal type
TM2DRA8RT	8	Relay outputs	30 Vdc / 230 Vac 2 A max	Removable screw terminal block
TM2DRA16RT	16	Relay outputs	30 Vdc / 230 Vac 2 A max	Removable screw terminal block
TM2DDO8UT	8	Regular transistor outputs (sink)	24 Vdc 0.3 A max per output	Removable screw terminal block
TM2DDO8TT	8	Regular transistor outputs (source)	24 Vdc 0.5 A max per output	Removable screw terminal block
TM2DDO16UK	16	Regular transistor outputs (sink)	24 Vdc 0.1 A max per output	HE10 (MIL 20) connector
TM2DDO16TK	16	Regular transistor outputs (source)	24 Vdc 0.4 A max per output	HE10 (MIL 20) connector
TM2DDO32UK	32	Regular transistor outputs (sink)	24 Vdc 0.1 A max per output	HE10 (MIL 20) connector
TM2DDO32TK	32	Regular transistor outputs (source)	24 Vdc 0.4 A max per output	HE10 (MIL 20) connector

TM2 Digital Mixed Input/Output Expansion Modules

The following table shows the compatible TM2 digital mixed I/O expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel type	Voltage Current	Terminal type
TM2DMM8DRT	4	Regular inputs	24 Vdc 7 mA	Removable screw terminal block
	4	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM2DMM24DRF	16	Regular inputs	24 Vdc 7 mA	Non-removable spring terminal block
	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	

TM2 Analog Input Expansion Modules

The following table shows the compatible TM2 analog input expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel type	Voltage Current	Terminal Type
TM2AMI2HT	2	High-level inputs	0...10 Vdc 4...20 mA	Removable screw terminal block
TM2AMI2LT	2	Low-level inputs	Thermocouple type J,K,T	Removable screw terminal block
TM2AMI4LT	4	Analog inputs	0...10 Vdc 0...20 mA PT100/1000 Ni100/1000	Removable screw terminal block
TM2AMI8HT	8	Analog inputs	0...20 mA 0...10 Vdc	Removable screw terminal block
TM2ARI8HT	8	Analog inputs	NTC / PTC	Removable screw terminal block
TM2ARI8LRJ	8	Analog inputs	PT100/1000	RJ11 connector
TM2ARI8LT	8	Analog inputs	PT100/1000	Removable screw terminal block

TM2 Analog Output Expansion Modules

The following table shows the compatible TM2 analog output expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel type	Voltage Current	Terminal Type
TM2AMO1HT	1	Analog outputs	0...10 Vdc 4...20 mA	Removable screw terminal block
TM2AVO2HT	2	Analog outputs	+/- 10 Vdc	Removable screw terminal block

TM2 Analog Mixed Input/Output Expansion Modules

The following table shows the compatible TM2 analog mixed I/O expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Channels	Channel type	Voltage Current	Terminal Type
TM2AMM3HT	2	Analog inputs	0...10 Vdc 4...20 mA	Removable screw terminal block
	1	Analog outputs	0...10 Vdc 4...20 mA	
TM2AMM6HT	4	Analog inputs	0...10 Vdc 4...20 mA	Removable screw terminal block
	2	Analog outputs	0...10 Vdc 4...20 mA	
TM2ALM3LT	2	Low-level inputs	Thermo J,K,T, PT100	Removable screw terminal block
	1	Analog outputs	0...10 Vdc 4...20 mA	

Accessories

Overview

This section describes the accessories and cables.

Accessories

Reference	Description	Use	Quantity
TMASD1	SD Card *(see page 41)*	Use to update the controller firmware, initialize a controller with a new application or clone a controller, manage user files.	1
TMAT2PSET	Set of 5 removable screw terminal block	Connects 24 Vdc power supply.	1
AB1AB8P35	End brackets	Help secure the logic controller or receiver module and their expansion modules on a top hat section rail (DIN rail).	1
TM2XMTGB	Grounding Bar	Connects the cable shield and the module to the functional ground.	1
TM200RSRCEMC	Shielding take-up clip	Mounts and connects the ground to the cable shielding.	25 pack

Cables

Reference	Description	Details	Length
TCSXCNAMUM3P	Terminal port/USB port cordset	From the USB mini-B port on the M251 Logic Controller to USB port on the PC terminal.	3 m (10 ft)
TCSMCN3M4F3C2	RS-232 serial link cordset 1 RJ45 connector and 1 SUB-D 9 connector	For DTE terminal (printer)	3 m (9.84 ft)
TCSMCN3M4M3S2	RS-232 serial link cordset 1 RJ45 connector and 1 SUB-D 9 connector	For DCE terminal (modem, converter)	3 m (9.84 ft)

Reference	Description	Details	Length
490NTW000••	Ethernet shielded cable for DTE connections	Standard cable, equipped with RJ45 connectors at each end for DTE. CE compliant	2,5,12,40, or 80 m (6.56,16.4, 39.37, 131.23, or 262.47 ft)
490NTW000••U		Standard cable, equipped with RJ45 connectors at each end for DTE. UL compliant	2,5,12,40, or 80 m (6.56,16.4, 39.37, 131.23, or 262.47 ft)
TCSECE3M3M••S4		Cable for harsh environment,, equipped with RJ45 connectors at each end. CE compliant	1, 2, 3, 5, or 10 m (3.28, 6.56, 9.84, 16.4, 32.81 ft)
TCSECU3M3M••S4		Cable for harsh environment, equipped with RJ45 connectors at each end. UL compliant	1, 2, 3, 5, or 10 m (3.28, 6.56, 9.84, 16.4, 32.81 ft)

Chapter 2
M251 Features

Overview

This chapter describes the Modicon M251 Logic Controller features.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Real Time Clock (RTC)	36
Run/Stop	40
SD Card	41

Real Time Clock (RTC)

Overview

The M251 Logic Controller includes an RTC to provide system date and time information, and to support related functions requiring a real-time clock. To continue keeping time when power is off, a non-rechargeable battery is required (see reference below). A battery LED on the front panel of the controller indicates if the battery is depleted or absent.

This table shows how RTC drift is managed:

RTC Characteristics	Description
RTC drift	Less than 60 seconds per month without any user calibration at 25 °C (77 °F)

Battery

The controller has one battery.

In the event of a power interruption, the backup battery maintains the RTC for the controller.

This table shows the characteristics of the battery:

Characteristics	Description
Use	In the event of a transient power outage, the battery powers the RTC and user data.
Backup life	At least 2 years at 25 °C max (77 °F). At higher temperatures, the time is reduced.
Battery monitoring	Yes
Replaceable	Yes
Controller battery type	Lithium carbon monofluoride, type Panasonic BR2032

Installing and Replacing the Battery

While lithium batteries are preferred due to their slow discharge and long life, they can present hazards to personnel, equipment and the environment and must be handled properly.

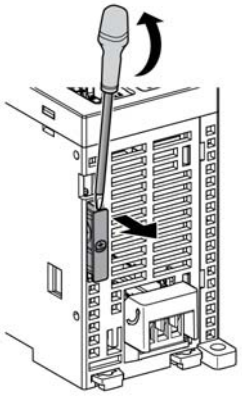
⚠ DANGER

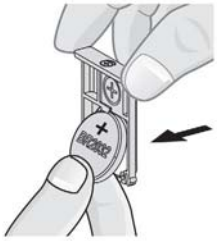
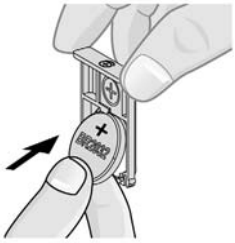
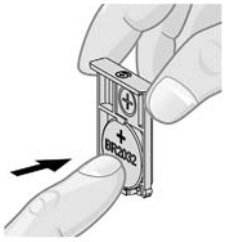
EXPLOSION, FIRE, OR CHEMICAL BURNS

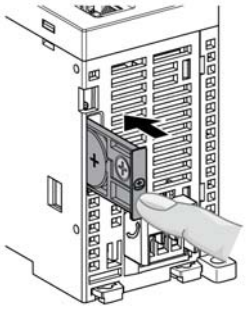
- Replace with identical battery type.
- Follow all battery manufacturer's instructions.
- Remove all replaceable batteries before discarding unit.
- Recycle or properly dispose of used batteries.
- Protect battery from any potential short-circuit.
- Do not recharge, disassemble, heat above 100 °C (212 °F), or incinerate.
- Use your hands or insulated tools to remove or replace the battery.
- Maintain proper polarity when inserting and connecting a new battery.

Failure to follow these instructions will result in death or serious injury.

To install or replace the battery, follow these steps:

Step	Action
1	Remove power from your controller.
2	Use an insulated screw-driver to pull out the battery holder. 
3	Side out the battery holder of the controller

Step	Action
4	Remove the battery from the battery holder. 
5	Insert the new battery into the battery holder in accordance with the polarity markings on the battery. 
6	Replace the battery holder on the controller and verify that the latch clicks into place. 

Step	Action
7	Slide in the battery holder of the controller. 
8	Power up your M251 Logic Controller.
9	Set the internal clock. For further details on the internal clock, refer to M251 Logic Controller Programming Guide *(see Modicon M251 Logic Controller, Programming Guide)*.

NOTE: Replacement of the battery in the controllers other than with the type specified in this documentation may present a risk of fire or explosion.

⚠ WARNING
IMPROPER BATTERY CAN PROVOKE FIRE OR EXPLOSION
Replace battery only with identical type: Panasonic Type BR2032.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

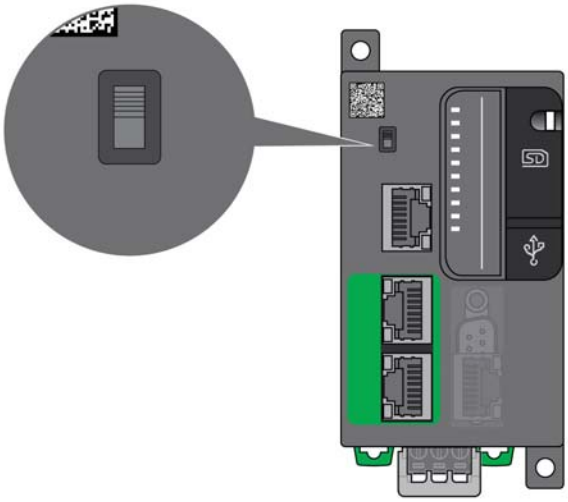
Run/Stop

Run/Stop

The M251 Logic Controller can be operated externally by the following:

- a hardware Run/Stop switch
- a SoMachine software command.

The M251 Logic Controller has a Run/Stop hardware switch, which puts the controller in a RUN or STOP state.



SD Card

Overview

When handling the SD card, follow the instructions below to help prevent internal data on the SD card from being corrupted or lost or a SD card malfunction from occurring:

NOTICE
LOSS OF APPLICATION DATA ● Do not store the SD card where there is static electricity or probable electromagnetic fields. ● Do not store the SD card in direct sunlight, near a heater, or other locations where high temperatures can occur. ● Do not bend the SD card. ● Do not drop or strike the SD card against another object. ● Keep the SD card dry. ● Do not touch the SD card connectors. ● Do not disassemble or modify the SD card. ● Use only SD cards formatted using FAT or FAT32. **Failure to follow these instructions can result in equipment damage.**

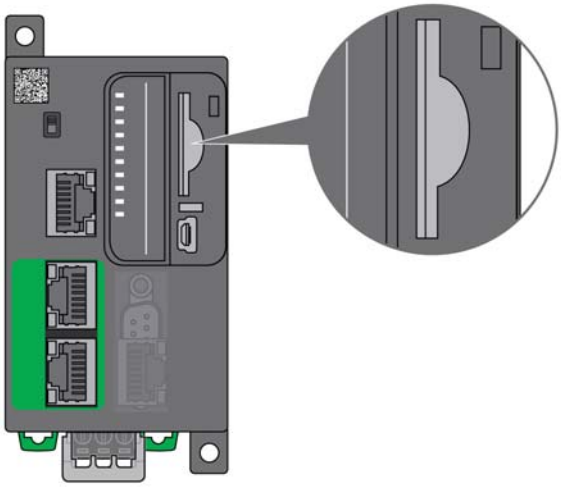
The M251 Logic Controller does not recognize NTFS formatted SD cards. Format the SD card on your computer using FAT or FAT32.

When using the M251 Logic Controller and a SD card, observe the following to avoid losing valuable data:

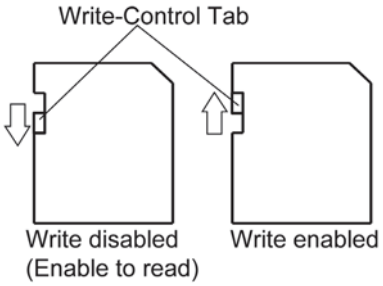
- Accidental data loss can occur at any time. Once data is lost it cannot be recovered.
- If you forcibly extract the SD card, data on the SD card may become corrupted.
- Removing an SD card that is being accessed could damage the SD card, or corrupt its data.
- If the SD card is not positioned correctly when inserted into the controller, the data on the card and the controller could become damaged.

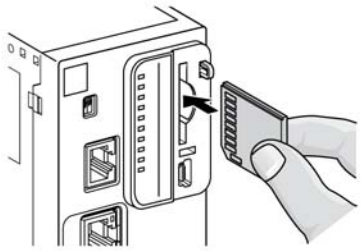
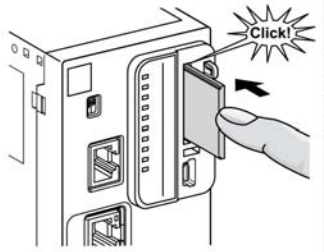
NOTICE
LOSS OF APPLICATION DATA ● Backup SD card data regularly. ● Do not remove power or reset the controller, and do not insert or remove the SD card while it is being accessed. ● Become familiar with the proper orientation of the SD card when inserting it into the controller. **Failure to follow these instructions can result in equipment damage.**

This figure shows the SD card slot:



It is possible to set the Write-Control Tab to prevent write operations to the SD card. Push the tab up, as shown in the example on the right-hand side, to release the lock and enable writing to the SD card. Before using an SD card, read the manufacturer’s instructions.



Step	Action
1	Insert the SD card into the SD card slot: 
2	Push until you hear it “click”: 

SD Card Slot Characteristics

Topic	Characteristics	Description
Supported type	Standard Capacity	SD (SDSC)
	High Capacity	SDHC
Global memory	Size	32 GB max.

TMASD1 Characteristics

Characteristics	Description
Card removal durability	Minimum 1000 times
File retention time	10 years @ 25 °C (77 °F)
Flash type	SLC NAND
Memory size	512 MB
Ambient operation temperature	–10 … +85° C (14...185 °F)
Storage temperature	–25 … +85° C (–13...185 °F)
Relative humidity	95% max. non-condensing
Write/Erase cycles	3,000,000 (approximately)

NOTE: The TMASD1 has been rigorously tested in association with the logic controller. For other commercially available cards, please consult your local sales representative.

NOTE: The SD card can be used directly on your PC.

Chapter 3
M251 Installation

Overview

This chapter provides installation safety guidelines, device dimensions, mounting instructions, and environmental specifications.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
3.1	M251 Logic Controller General Rules for Implementing	46
3.2	M251 Logic Controller Installation	51
3.3	M251 Electrical Requirements	64

Section 3.1
M251 Logic Controller General Rules for Implementing

What Is in This Section?

This section contains the following topics:

Topic	Page
Environmental Characteristics	47
Certifications and Standards	50

Environmental Characteristics

Enclosure Requirements

M251 Logic Controller system components are designed as Zone B, Class A industrial equipment according to IEC/CISPR Publication 11. If they are used in environments other than those described in the standard, or in environments that do not meet the specifications in this manual, the ability to meet electromagnetic compatibility requirements in the presence of conducted and/or radiated interference may be reduced.

All M251 Logic Controller system components meet European Community (CE) requirements for open equipment as defined by IEC/EN 61131-2. You must install them in an enclosure designed for the specific environmental conditions and to minimize the possibility of unintended contact with hazardous voltages. Use metal enclosures to improve the electromagnetic immunity of your M251 Logic Controller system. Use enclosures with a keyed locking mechanism to minimize unauthorized access.

Environmental Characteristics

All the M251 Logic Controller module components are electrically isolated between the internal electronic circuit and the input/output channels within the limits set forth and described by these environmental characteristics. For more information on electrical isolation, see the technical specifications of your particular controller found later in the current document. This equipment meets CE requirements as indicated in the table below. This equipment is intended for use in a Pollution Degree 2 industrial environment.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following table shows the general environmental characteristics:

Characteristic		Specification
Standard compliance	IEC/EN 61131-2 IEC/EN 61010-2-201	
Ambient operating temperature	Horizontal installation	–10...55 °C (14...131 °F)
	Vertical installation	–10...35 °C (14...95 °F)
Storage temperature		–25...70 °C (- 13...158 °F)

Characteristic		Specification
Relative humidity	Transport and storage	10...95 % (non-condensing)
	Operation	10...95 % (non-condensing)
Degree of pollution	IEC/EN 60664-1	2
Degree of protection	IEC/EN 61131-2	IP20 with protective covers in place
Machine Safety conformance	IEC/EN 61010-2-201	Yes
Corrosion immunity		Atmosphere free from corrosive gases
Operating altitude		0...2000 m (0...6560 ft)
Storage altitude		0...3000 m (0...9843 ft)
Vibration resistance	IEC/EN 61131-2 Panel mounting or mounted on a top hat section rail (DIN rail)	3.5 mm (0.13 in) fixed amplitude from 5...8.5 Hz 29.4 m/s^2 or 96.45 ft/s^2 (3 g_n) fixed acceleration from 8.7...150 Hz
Mechanical shock resistance		147 m/s^2 or 482.28 ft/s^2 (15 g_n) for a duration of 11 ms

Electromagnetic Susceptibility

The M251 Logic Controller system meets electromagnetic susceptibility specifications as indicated in the following table:

Characteristic	Designed to specification	Range	
Electrostatic discharge	IEC/EN 61000-4-2	8 kV (air discharge) 4 kV (contact discharge)	
Radiated electromagnetic field	IEC/EN 61000-4-3	10 V/m (80...1000 MHz) 3 V/m (1.4...2 GHz) 1 V/m (2...3 GHz)	
Magnetic field	IEC/EN 61000-4-8	30 A/m 50 Hz, 60 Hz	
Fast transients burst	IEC/EN 61000-4-4	–	CM[1] and DM[2]
		AC/DC Power lines	2 kV
		Relay Outputs	–
		24 Vdc I/Os	–
		Analog I/Os	–
		Communication line	1 kV

Characteristic	Designed to specification	Range		
Surge immunity	IEC/EN 61000-4-5 IEC/EN 61131-2	–	CM[1]	DM[2]
		DC Power lines	1 kV	0.5 kV
		AC Power lines	–	–
		Relay Outputs	–	–
		24 Vdc I/Os	–	–
		Shielded cable (between shield and ground)	1 kV	–
Induced electromagnetic field	IEC/EN 61000-4-6	10 Vrms (0.15...80 MHz)		
Conducted emission	IEC/EN 55011 (IEC/CISPR Publication 11)	AC power line: ● 0.15...0.5 MHz: 79 dBµV/m QP / 66 dBµV/m AV ● 0.5...300 MHz: 73 dBµV/m QP / 60 dBµV/m AV		
		AC/DC power line: ● 10...150 kHz: 120...69 dBµV/m QP ● 150...1500 kHz: 79...63 dBµV/m QP ● 1.5...30 MHz: 63 dBµV/m QP		
Radiated emission	IEC/EN 55011 (IEC/CISPR Publication 11)	Class A, 10 m distance: ● 30...230 MHz: 40 dBµV/m QP ● 230...1000 MHz: 47 dBµV/m QP		

1 Common Mode

2 Differential Mode

Certifications and Standards

Introduction

The M251 Logic Controllers are designed to conform to the main national and international standards concerning electronic industrial control devices:

- IEC/EN 61131-2
- UL 508
- CSA 22.2 n° 142
- CSA E61131-2

The M251 Logic Controllers have obtained, or in the process of obtaining, the following conformity marks:

- CE
- cULus pending
- CSA pending

The M251 Logic Controllers comply with the main national and international Directives and Regulations concerning electronic industrial control devices:

- Europe RoHS, exemption annex III 7(a)
- China RoHS regulations
- REACh v9

Section 3.2
M251 Logic Controller Installation

What Is in This Section?

This section contains the following topics:

Topic	Page
Installation and Maintenance Requirements	52
M251 Logic Controller Mounting Positions and Clearances	55
Top Hat Section Rail (DIN rail)	58
Installing and Removing the Controller with Expansions	61
Direct Mounting on a Panel Surface	63

Installation and Maintenance Requirements

Before Starting

Read and understand this chapter before beginning the installation of your system.

The use and application of the information contained herein require expertise in the design and programming of automated control systems. Only you, the user, machine builder or integrator, can be aware of all the conditions and factors present during installation and setup, operation, and maintenance of the machine or process, and can therefore determine the automation and associated equipment and the related safeties and interlocks which can be effectively and properly used. When selecting automation and control equipment, and any other related equipment or software, for a particular application, you must also consider any applicable local, regional or national standards and/or regulations.

Pay particular attention in conforming to any safety information, different electrical requirements, and normative standards that would apply to your machine or process in the use of this equipment.

Disconnecting Power

All options and modules should be assembled and installed before installing the control system on a mounting rail, onto a mounting plate or in a panel. Remove the control system from its mounting rail, mounting plate or panel before disassembling the equipment.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

Programming Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Operating Environment

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of a hazardous atmosphere.

⚠ DANGER

POTENTIAL FOR EXPLOSION

Install and use this equipment in non-hazardous locations only.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Install and operate this equipment according to the conditions described in the Environmental Characteristics.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Installation Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use appropriate safety interlocks where personnel and/or equipment hazards exist.
- Install and operate this equipment in an enclosure appropriately rated for its intended environment.
- Use the sensor and actuator power supplies only for supplying power to the sensors or actuators connected to the module.
- Power line and output circuits must be wired and fused in compliance with local and national regulatory requirements for the rated current and voltage of the particular equipment.
- Do not use this equipment in safety-critical machine functions.
- Do not disassemble, repair, or modify this equipment.
- Do not connect any wiring to reserved, unused connections, or to connections designated as No Connection (N.C.).

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: JDYX2 or JDYX8 fuse types are UL-recognized and CSA approved.

M251 Logic Controller Mounting Positions and Clearances

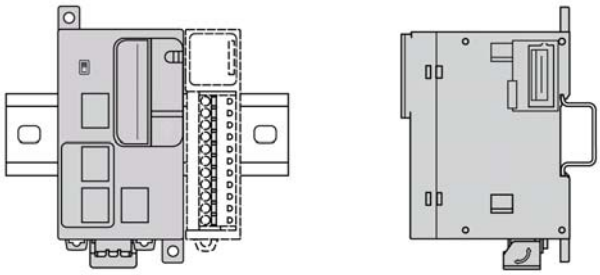
Introduction

This section describes the correct mounting positions for the M251 Logic Controller.

NOTE: Keep adequate spacing for proper ventilation and to maintain the operating temperature specified in the Environmental Characteristics *(see page 47)*.

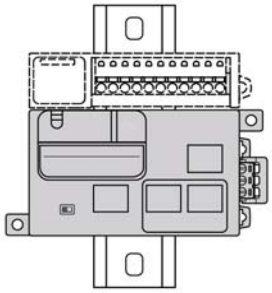
Correct Mounting Position

To obtain optimal operating characteristics, the M251 Logic Controller should be mounted horizontally on a vertical plane as shown in the figure below:



Acceptable Mounting Positions

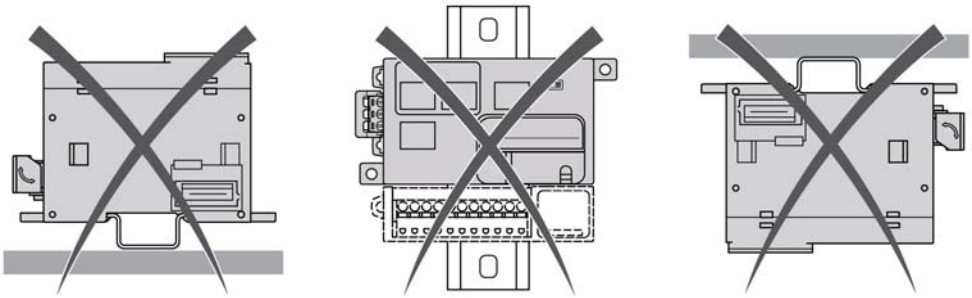
The M251 Logic Controller can also be mounted vertically on a vertical plane as shown below.



NOTE: Expansion modules must be mounted above the controller.

Incorrect Mounting Position

The M251 Logic Controller should only be positioned as shown in the Correct Mounting Position figure. The figures below show the incorrect mounting positions.



Minimum Clearances

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Place devices dissipating the most heat at the top of the cabinet and ensure adequate ventilation.
- Avoid placing this equipment next to or above devices that might cause overheating.
- Install the equipment in a location providing the minimum clearances from all adjacent structures and equipment as directed in this document.
- Install all equipment in accordance with the specifications in the related documentation.

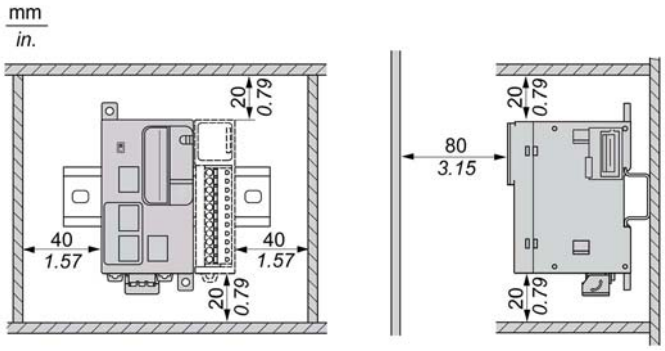
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The M251 Logic Controller has been designed as an IP20 product and must be installed in an enclosure. Clearances must be respected when installing the product.

There are 3 types of clearances to consider:

- The M251 Logic Controller and all sides of the cabinet (including the panel door).
- The M251 Logic Controller terminal blocks and the wiring ducts to help reduce potential electromagnetic interference between the controller and the duct wiring.
- The M251 Logic Controller and other heat generating devices installed in the same cabinet.

The following figure shows the minimum clearances that apply to all M251 Logic Controller references:



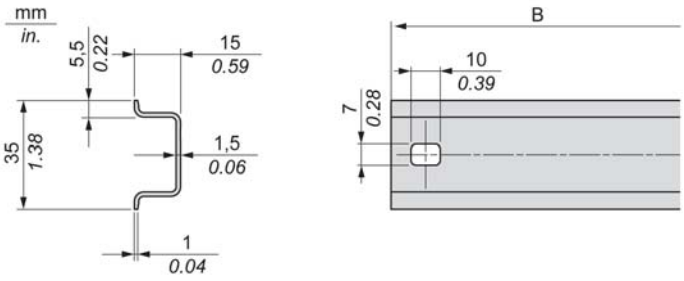
Top Hat Section Rail (DIN rail)

Dimensions of Top Hat Section Rail DIN Rail

You can mount the controller or receiver and its expansions on a 35 mm (1.38 in.) top hat section rail (DIN rail). It can be attached to a smooth mounting surface or suspended from a EIA rack or mounted in a NEMA cabinet.

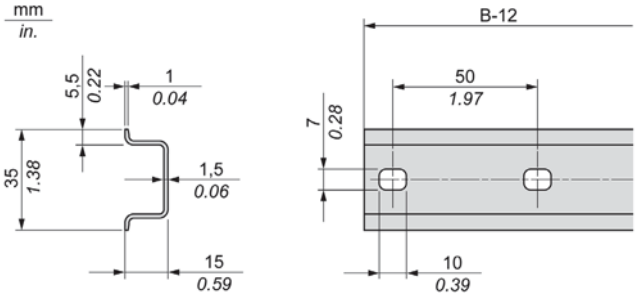
Symmetric Top Hat Section Rails (DIN Rail)

The following illustration and table show the references of the top hat section rails (DIN rail) for the wall-mounting range:



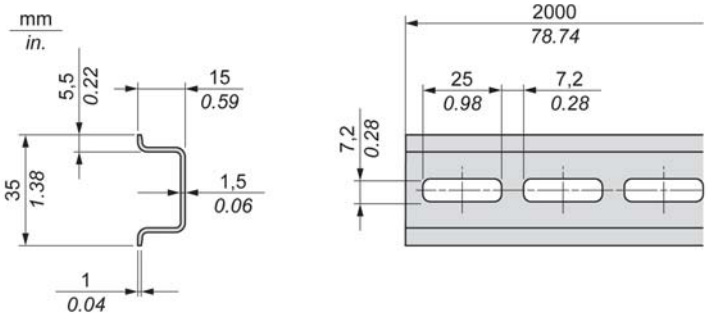
Reference	Type	Rail Length (B)
NSYSDR50A	A	450 mm (17.71 in.)
NSYSDR60A	A	550 mm (21.65 in.)
NSYSDR80A	A	750 mm (29.52 in.)
NSYSDR100A	A	950 mm (37.40 in.)

The following illustration and table show the references of the symmetric top hat section rails (DIN rail) for the metal enclosure range:



Reference	Type	Rail Length (B-12 mm)
NSYSDR60	A	588 mm (23.15 in.)
NSYSDR80	A	788 mm (31.02 in.)
NSYSDR100	A	988 mm (38.89 in.)
NSYSDR120	A	1188 mm (46.77 in.)

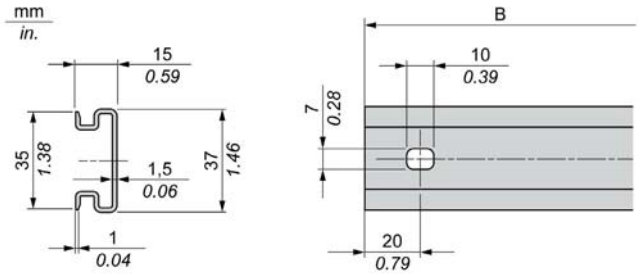
The following illustration and table shows the references of the symmetric top hat section rails (DIN rail) of 2000 mm (78.74 in.):



Reference	Type	Rail Length
NSYSDR200[1]	A	2000 mm (78.74 in.)
NSYSDR200D[2]	A	
1 Unperforated galvanized steel **2** Perforated galvanized steel		

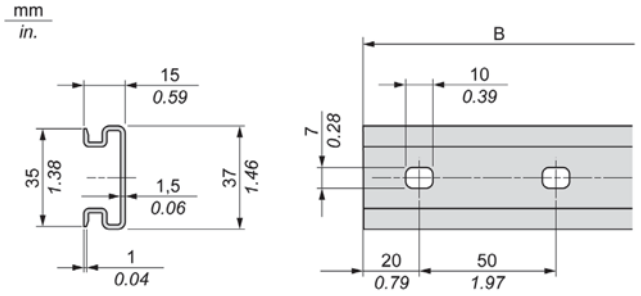
Double-Profile Top Hat Section Rails (DIN rail)

The following illustration and table show the references of the double-profile top hat section rails (DIN rails) for the wall-mounting range:



Reference	Type	Rail Length (B)
NSYDPR25	W	250 mm (9.84 in.)
NSYDPR35	W	350 mm (13.77 in.)
NSYDPR45	W	450 mm (17.71 in.)
NSYDPR55	W	550 mm (21.65 in.)
NSYDPR65	W	650 mm (25.60 in.)
NSYDPR75	W	750 mm (29.52 in.)

The following illustration and table show the references of the double-profile top hat section rails (DIN rail) for the floor-standing range:



Reference	Type	Rail Length (B)
NSYDPR60	F	588 mm (23.15 in.)
NSYDPR80	F	788 mm (31.02 in.)
NSYDPR100	F	988 mm (38.89 in.)
NSYDPR120	F	1188 mm (46.77 in.)

Installing and Removing the Controller with Expansions

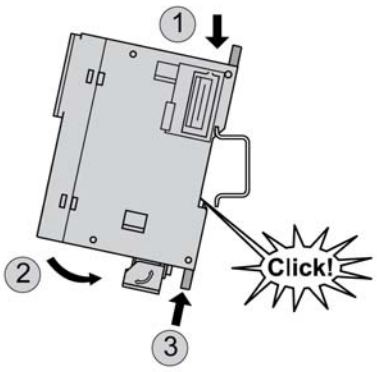
Overview

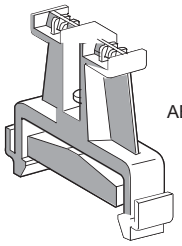
This section describes how to install and remove the controller with its expansion modules from a top hat section rail (DIN rail).

To assemble expansion modules to a controller or receiver module, or to other modules, refer to the respective expansion modules hardware guide(s).

Installing a Controller with its Expansions on a DIN Rail

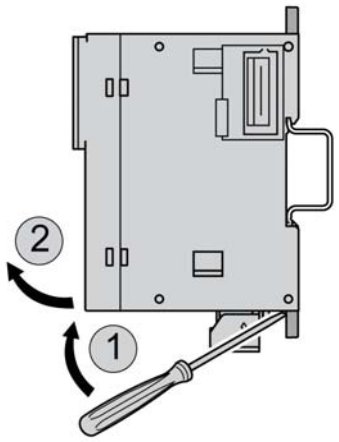
The following procedure describes how to install a controller with its expansion modules on a top hat section rail (DIN rail):

Step	Action
1	Fasten the top hat section rail (DIN rail) to a panel surface using screws.
2	Position the top groove of the controller and its expansion modules on the top edge of the DIN rail and press the assembly against the top hat section rail (DIN rail) until you hear the top hat section rail (DIN rail) clip snap into place. 

Step	Action
3	Place 2 terminal block end clamps on both sides of the controller and expansion module assembly.  AB1AB8P35 **NOTE:** Type ABB8P35 or equivalent terminal block end clamps help minimize sideways movement and improve the shock and vibration characteristics of the controller and expansion module assembly.

Removing a Controller with its Expansions from a Top Hat Section Rail (DIN Rail)

The following procedure describes how to remove a controller with its expansion modules from a top hat section rail (DIN rail):

Step	Action
1	Remove all power from your controller and expansion modules.
2	Insert a flat screwdriver into the slot of the top hat section rail (DIN rail) clip. 
3	Pull down the DIN rail clip.
4	Pull the controller and its expansion modules from the top hat section rail (DIN rail) from the bottom.

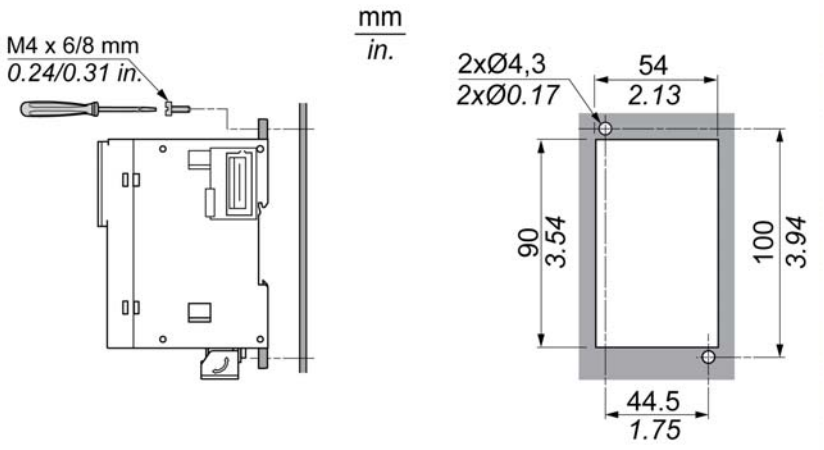
Direct Mounting on a Panel Surface

Overview

This section shows how to install M251 Logic Controller on a panel surface using the mounting holes.

Mounting Hole Layout

This diagram shows the mounting hole layout for M251 Logic Controller:



Section 3.3
M251 Electrical Requirements

What Is in This Section?

This section contains the following topics:

Topic	Page
Wiring Best Practices	65
DC Power Supply Characteristics and Wiring	68
Grounding the M251 System	72

Wiring Best Practices

Overview

This section describes the wiring guidelines and associated best practices to be respected when using the M251 Logic Controller system.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

Wiring Guidelines

This rules must be applied when wiring a M251 Logic Controller system:

- Communication wiring must be kept separate from the power wiring. Route these 2 types of wiring in separate cable ducting.
- Verify that the operating conditions and environment are within the specification values.
- Use proper wire sizes to meet voltage and current requirements.
- Use copper conductors (required).
- Use twisted pair, shielded cables for networks, and fieldbus.

Use shielded, properly grounded cables for all communication connections. If you do not use shielded cable for these connections, electromagnetic interference can cause signal degradation. Degraded signals can cause the controller or attached modules and equipment to perform in an unintended manner.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for all communication signals.
- Ground cable shields for all communication signals at a single point[1].
- Route communication separately from power cables.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1]Multipoint grounding is permissible if connections are made to an equipotential ground plane dimensioned to help avoid cable shield damage in the event of power system short-circuit currents.

For more details, refer to Grounding Shielded Cables *(see page 73)*.

NOTE: Surface temperatures may exceed 60° C. To conform to IEC 61010 standards, route primary wiring (wires connected to power mains) separately and apart from secondary wiring (extra low voltage wiring coming from intervening power sources). If that is not possible, double insulation is required such as conduit or cable gains.

Rules for Removable Screw Terminal Block

The following tables show the cable types and wire sizes for a **5.08 pitch** removable screw terminal block (power supply):

mm / in. 7 / 0.28								
mm^2	0.2…2.5	0.2…2.5	0.25…2.5	0.25…2.5	2 x 0.2…1	2 x 0.2…1.5	2 x 0.25…1	2 x 0.5…1.5
AWG	*24…14*	*24…14*	*23...14*	*23...14*	*2 x 24…17*	*2 x 24…16*	*2 x 23…17*	*2 x 20...16*

Ø 3,5 mm (*0.14 in.*)	C	N•m	0.5...0.6
		lb-in	*4.42...5.31*

The use of copper conductors is required.

⚠ DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

- Tighten connections in conformance with the torque specifications.
- Do not insert more than one wire per connector of the terminal block without the cable ends specified above.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

FIRE HAZARD

Use only the recommended wire sizes for the current capacity of the power supplies.

Failure to follow these instructions will result in death or serious injury.

DC Power Supply Characteristics and Wiring

Overview

This section provides the characteristics and the wiring diagrams of the DC power supply.

DC Power Supply Voltage Range

If the specified voltage range is not maintained, outputs may not switch as expected. Use appropriate safety interlocks and voltage monitoring circuits.

⚠ DANGER

FIRE HAZARD

- Use only the recommended wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm2 (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm2 (AWG 16) with a temperature rating of at least 80 °C (176 °F).

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

DC Power Supply Requirements

The M251 Logic Controller and associated I/O (TM2,TM3) require power supplies with a nominal voltage of 24 Vdc. The 24 Vdc power supplies must be rated Safety Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV) according to IEC 61140. These power supplies are isolated between the electrical input and output circuits of the power supply.

⚠ WARNING

POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment[1].

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1]For compliance to UL (Underwriters Laboratories) requirements, the power supply must also be of a type Class II with a maximum power output availability of less than 100 VA (approximately 4 A at nominal voltage). A Class II circuit requires dry indoor use only in non-hazardous locations, and must be grounded. You must separate Class II circuits from other circuits. If a non-Class II power source is used, either power supply or transformer, you must impose a current limiting device such as a fuse or a circuit breaker with a maximum rating of 4 A, but never exceeding the limits indicated in the electric characteristics and wiring diagrams for this equipment. If the indicated rating of the electrical characteristics or wiring diagrams are greater than 4 A, multiple Class II power supplies may be used.

Controller DC Characteristics

This table shows the characteristics of the DC power supply required for the controller:

Characteristic		Value	
Rated voltage		24 Vdc	
Power supply voltage range		19.2...28.8 Vdc	
Power interruption time		10 ms at 24 Vdc	
Maximum inrush current		50 A	
Continuous output power		typical 32.6 W	max. 40.4 W
Isolation	between DC power supply and internal logic	Not isolated	
	between DC power supply and protective earth ground (PE)	500 Vac	

Power Interruption

The duration of power interruptions where the M251 Logic Controller is able to continue normal operation varies depending upon the load to the power supply of the controller, but a minimum of 10 ms is maintained as specified by IEC standards.

When planning the management of the power supplied to the controller, you must consider the power interruption duration due to the fast cycle time of the controller.

There could potentially be many scans of the logic and consequential updates to the I/O image table during the power interruption, while there is no external power supplied to the inputs, the outputs or both depending on the power system architecture and power interruption circumstances.

⚠ WARNING

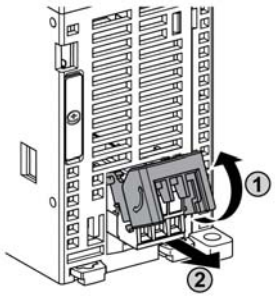
UNINTENDED EQUIPMENT OPERATION

- Individually monitor each source of power used in the controller system including input power supplies, output power supplies and the power supply to the controller to allow appropriate system shutdown during power system interruptions.
- The inputs monitoring each of the power supply sources must be unfiltered inputs.

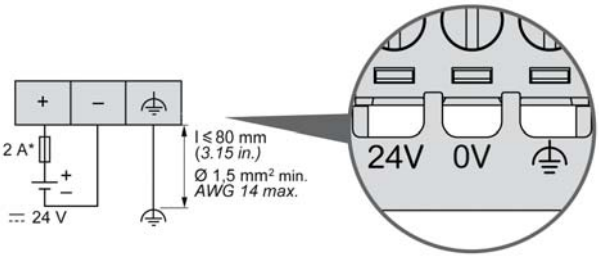
Failure to follow these instructions can result in death, serious injury, or equipment damage.

DC Power Supply Wiring Diagram

This figure shows the power supply terminal block removal procedure:



The following figure shows the wiring of the DC power supply:



* Type T fuse

For more information, refer to the 5.08 pitch Rules for Removable Screw Terminal block (*see page 67*).

Grounding the M251 System

Overview

To help minimize the effects of electromagnetic interference, cables carrying fieldbus communication signals must be shielded.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for communication signals.
- Ground cable shields for communication signals at a single point [1].
- Always comply with local wiring requirements regarding grounding of cable shields.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1]Multipoint grounding is permissible if connections are made to an equipotential ground plane dimensioned to help avoid cable shield damage in the event of power system short-circuit currents.

The use of shielded cables requires compliance with the following wiring rules:

- For protective ground connections (PE), metal conduit or ducting can be used for part of the shielding length, provided there is no break in the continuity of the ground connections. For functional ground (FE), the shielding is intended to attenuate electromagnetic interference and the shielding must be continuous for the length of the cable. If the purpose is both functional and protective, as is often the case for communication cables, the cable must have continuous shielding.
- Wherever possible, keep cables carrying one type of signal separate from the cables carrying other types of signals or power.

Protective Ground (PE) on the Backplane

The protective ground (PE) should be connected to the conductive backplane by a heavy-duty wire, usually a braided copper cable with the maximum allowable cable section.

Shielded Cables Connections

Cables carrying fieldbus communication signals must be shielded. The shielding must be securely connected to ground. The fieldbus communication cable shields must be connected to the protective ground (PE) with a connecting clamp secured to the conductive backplane of your installation.

⚠ WARNING

ACCIDENTAL DISCONNECTION FROM PROTECTIVE GROUND (PE)

- Do not use the TM2XMTGB Grounding Bar to provide a protective ground (PE).
- Use the TM2XMTGB Grounding Bar only to provide a functional ground (FE).

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The shielding of the Modbus cable must be connected to the protective ground (PE).

⚠ DANGER

HAZARD OF ELECTRIC SHOCK

- The grounding terminal connection (PE) must be used to provide a protective ground at all times.
- Make sure that an appropriate, braided ground cable is attached to the PE/PG ground terminal before connecting or disconnecting the network cable to the equipment.

Failure to follow these instructions will result in death or serious injury.

Part II
Modicon M251 Logic Controller

What Is in This Part?

This part contains the following chapters:

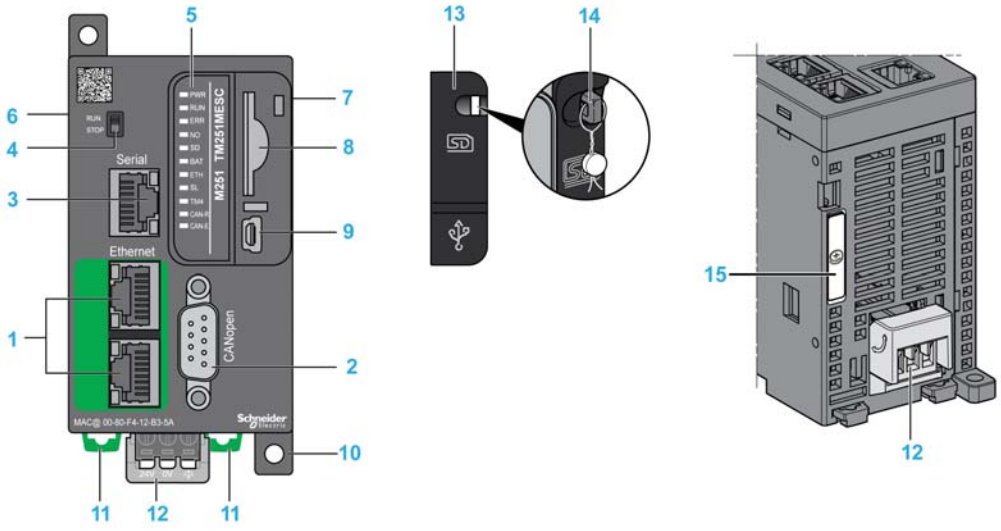
Chapter	Chapter Name	Page
4	TM251MESC	77
5	TM251MESE	81

Chapter 4
TM251MESC

TM251MESC Presentation

Description

This figure shows the different components of the TM251MESC logic controller:

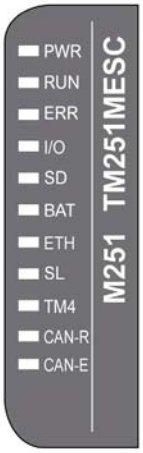


N°	Description	Refer to
1	Dual port Ethernet switch	Ethernet port *(see page 90)*
2	CANopen port	CANopen port *(see page 88)*
3	Serial line port / Type RJ45 (RS-232 or RS-485)	Serial Line *(see page 97)*
4	Run/Stop switch	Run/Stop *(see page 40)*
5	Status LEDs	–
6	TM4 bus connector	TM4 Expansion Modules *(see page 19)*
7	TM3/TM2 bus connector	TM3 Expansion Modules *(see page 20)*
8	SD card slot	SD Card *(see page 41)*
9	USB mini-B programming port / For terminal connection to a programming PC (SoMachine)	USB Mini-B Programming Port *(see page 96)*

N°	Description	Refer to
10	Surface mounting lugs	–
11	Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail)	Top Hat Section Rail *(see page 58)*
12	24 Vdc power supply	DC Power supply Characteristics and Wiring *(see page 68)*
13	Protective cover (SD card slot and USB mini-B programming port)	–
14	Locking hook (Hook not included)	–
15	Battery holder	Real Time Clock (RTC) *(see page 36)*

Status LEDs

This figure shows the status LEDs:



The following table describes the system status LEDs:

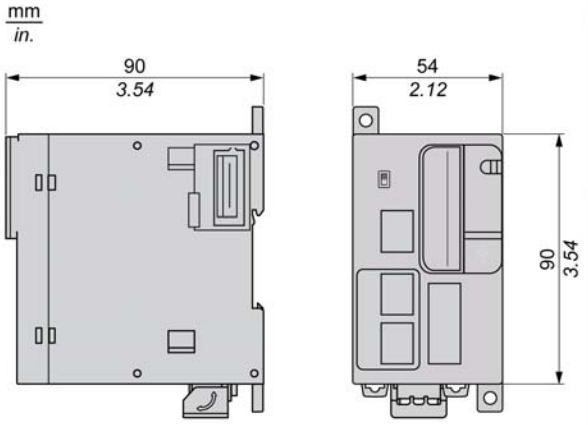
Label	Function Type	Color	Status	Description
PWR	Power	Green	On	Indicates that power is applied.
			Off	Indicates that power is removed.
RUN	Machine status	Green	On	Indicates that the controller is running a valid application.
			Flashing	Indicates that the controller has a valid application that is stopped.
			1 flash	Indicates that the controller has paused at BREAKPOINT.
			Off	Indicates that the controller is not programmed

Label	Function Type	Color	Status	Description
ERR	Internal Error	Red	On	Indicates that an operating system error has been detected
			Fast flashing	Indicates that the controller has detected an internal error
			Slow flashing	Indicates either that a minor error has been detected if **RUN** is ON or that no application has been detected
I/O	I/O error	Red	On	Indicates device errors on the serial line, SD card, TM4 bus, TM3 bus, Ethernet port(s) or CANopen port.
SD	SD card access	Green	On	Indicates that the SD card is being accessed
BAT	Battery	Red	On	Indicates that the battery needs to be replaced.
			Flashing	Indicates that the battery charge is low.
ETH	Ethernet port status	Green	On	Indicates that the ethernet port is connected and the IP address is defined.
			3 flashes	Indicates that the ethernet port is not connected.
			4 flashes	Indicates that the IP address is already in used.
			5 flashes	Indicates that the module is waiting for BOOTP or DHCP sequence.
			6 flashes	Indicates that the configured IP address is not valid.
SL	Serial line	Green	On	Indicates the status of serial line *(see page 99)*
			Off	Indicates no serial communication
TM4	Error on TM4 bus	Red	On	Indicates that an error has been detected on the TM4 bus
			Off	Indicates that no error has been detected on the TM4 bus
CAN-R	CANopen running status	Green	On	Indicates that the CANopen bus is operational.
			Off	Indicates that the CANopen master is configured.
			Flashing	Indicates that the CANopen bus is being initialized.
			1 flash per second	Indicates that the CANopen bus is stopped.
CAN-E	CANopen error	Red	On	Indicates that the CANopen bus is stopped (BUS OFF).
			Off	Indicates no CANopen detected error.
			Flashing	Indicates that the CANopen bus is not valid.
			1 flash per second	Indicates that the controller has detected that the maximum number of error frames has been reached or exceeded.
			2 flashes per second	Indicates that the controller has detected either a Node Guarding or a Heartbeat event.

NOTE: All the LEDs flash when the logic controller is being identified. For more details, refer to the SoMachine Programming Guide.

Dimensions

This figures shows the external dimensions of the logic controller:

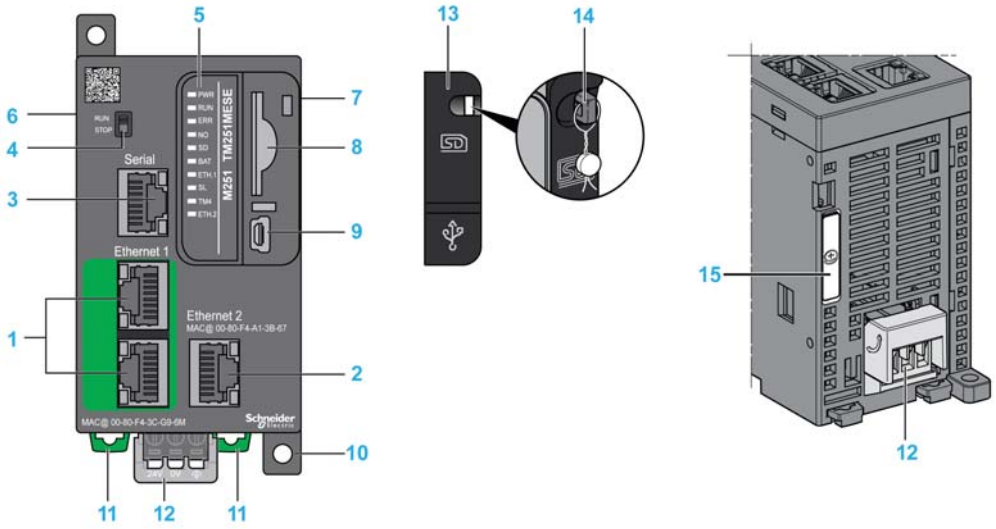


Chapter 5
TM251MESE

TM251MESE Presentation

Description

This figure shows the different components of the TM251MESE logic controller:

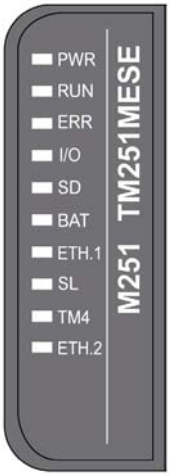


N°	Description	Refer to
1	Dual port Ethernet switch	Ethernet port *(see page 90)*
2	Ethernet port 2	Ethernet ports *(see page 93)*
3	Serial line port / Type RJ45 (RS-232 or RS-485)	Serial Line *(see page 97)*
4	Run/Stop switch	Run/Stop *(see page 40)*
5	Status LEDs	–
6	TM4 bus connector	TM4 Expansion Modules *(see page 19)*
7	TM3/TM2 bus connector	TM3 Expansion Modules *(see page 20)*
8	SD card slot	SD Card *(see page 41)*
9	USB mini-B programming port / For terminal connection to a programming PC (SoMachine)	USB Mini-B Programming Port *(see page 96)*

N°	Description	Refer to
10	Surface mounting lugs	–
11	Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail)	Top Hat Section Rail *(see page 58)*
12	24 Vdc power supply	DC Power supply Characteristics and Wiring *(see page 68)*
13	Protective cover (SD card slot and USB mini-B programming port)	–
14	Locking hook (Hook not included)	–
15	Battery holder	Real Time Clock (RTC) *(see page 36)*

Status LEDs

This figure shows the status LEDs:



The following table describes the system status LEDs:

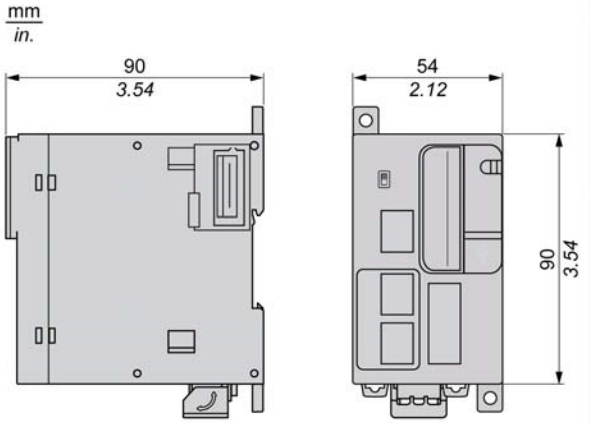
Label	Function Type	Color	Status	Description
PWR	Power	Green	On	Indicates that power is applied.
			Off	Indicates that power is removed.
RUN	Machine status	Green	On	Indicates that the controller is running a valid application.
			Flashing	Indicates that the controller has a valid application that is stopped.
			1 flash	Indicates that the controller has paused at BREAKPOINT.
			Off	Indicates that the controller is not programmed

Label	Function Type	Color	Status	Description
ERR	Internal Error	Red	On	Indicates that an operating system error has been detected
			Fast flashing	Indicates that the controller has detected an internal error
			Slow flashing	Indicates either that a minor error has been detected if **RUN** is ON or that no application has been detected
I/O	I/O error	Red	On	Indicates device errors on the serial line, SD card, TM4 bus, TM3 bus, Ethernet port(s) or CANopen port.
SD	SD card access	Green	On	Indicates that the SD card is being accessed
BAT	Battery	Red	On	Indicates that the battery needs to be replaced.
			Flashing	Indicates that the battery charge is low.
ETH.1 ETH.2	Ethernet port status	Green	On	Indicates that the ethernet port is connected and the IP address is defined.
			3 flashes	Indicates that the ethernet port is not connected.
			4 flashes	Indicates that the IP address is already in used.
			5 flashes	Indicates that the module is waiting for BOOTP or DHCP sequence.
			6 flashes	Indicates that the configured IP address is not valid.
SL	Serial line	Green	On	Indicates the status of serial line (*see page 99*)
			Off	Indicates no serial communication
TM4	Error on TM4 bus	Red	On	Indicates that an error has been detected on the TM4 bus
			Off	Indicates that no error has been detected on the TM4 bus

NOTE: All the LEDs flash when the logic controller is being identified. For more details, refer to the SoMachine Programming Guide.

Dimensions

This figure shows the external dimensions of the logic controller:



Part III
Modicon M251 Logic Controller Communication

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
6	Integrated Communication Ports	87
7	Connecting the M251 Logic Controller to a PC	101

Chapter 6
Integrated Communication Ports

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
CANopen Port	88
Ethernet Port	90
TM251MESE Specific Considerations	93
USB Mini-B Programming Port	96
Serial Line	97

CANopen Port

CANopen Capabilities

The Modicon M251 Logic Controller CANopen master has the following features:

Maximum number of slaves on the bus	63 CANopen slave devices
Maximum length of CANopen fieldbus cables	According to the CAN specification (see cable length and transmission speed).
Maximum number of PDO managed by the master	252 TPDOs + 252 RPDOs

For each additional CANopen slave,

- the application size increases by an average of 10 Kbytes which conceivably could result in exceeding memory limits.
- the configuration initialization time at the startup increases which conceivably could result in a watchdog timeout.

Although SoMachine does not restrict you from doing so, we recommend that you not exceed more than 63 CANopen slave modules (and/or 252 TPDOs and 252 RPDOs) in order to have a sufficient performance tolerance and to avoid any performance degradation.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect more than 63 CANopen slave devices to the controller to avoid system overload watchdog condition.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTICE

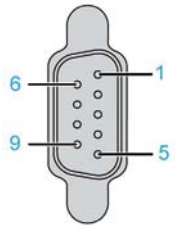
DEGRADATION OF PERFORMANCE

Do not exceed more than 252 TPDOs and 252 RPDOs for the Modicon M251 Logic Controller.

Failure to follow these instructions can result in equipment damage.

CANopen Wiring Diagram

The CANopen plug is a male sub-D9 terminal block:



Pin	Signal	Description
1	–	Reserved
2	CAN_L	CAN_L bus line
3	CAN_GND	CAN ground
4	–	Reserved
5	(CAN_SHLD)	Optional CAN shield
6	GND	Ground
7	CAN_H	CAN_H bus line
8	–	Reserved
9	(CAN_V+)	Optional CAN external positive supply

Cable Length

Transmission speed is limited by the bus length and the type of cable used.

This table describes the relationship between the maximum transmission speed and the bus length (on a single CAN segment without a repeater).

Maximum Transmission baud Rate	Bus Length
1000 Kbps	20 m (65 ft)
800 Kbps	40 m (131 ft)
500 Kbps	100 m (328 ft)
250 Kbps	250 m (820 ft)
125 Kbps	500 m (1,640 ft)
50 Kbps	1000 m (3280 ft)
20 Kbps	2500 m (16,400 ft)

Ethernet Port

Overview

The M251 Logic Controller is equipped with Ethernet communications ports:

Reference	Number of Ports	Port Name
TM251MESC	2 (one dual Ethernet port switch)	Ethernet
TM251MESE	2 (one dual Ethernet port switch)	Ethernet 1
	1	Ethernet 2

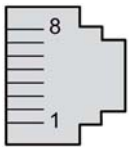
Characteristics

This table describes the different Ethernet characteristics:

Characteristic	Description
Function	Modbus TCP/IP, SoMachine protocol, EtherNet I/P
Connector type	RJ45
Auto negotiation	from 10 M half duplex to 100 M full duplex
Cable type	Shielded
Automatic cross-over detection	Yes

Pin Assignment

This figure shows the RJ45 Ethernet connector pin assignment:



This table describes the RJ45 Ethernet connector pins:

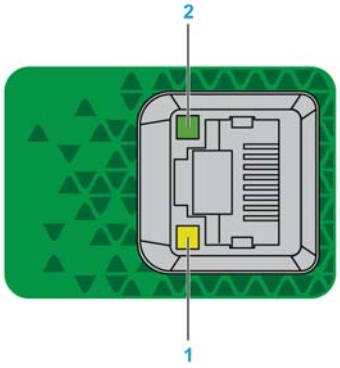
Pin N°	Signal
1	TD+
2	TD-
3	RD+
4	-
5	-
6	RD-
7	-
8	-

NOTE: The controller supports the MDI/MDIX auto-crossover cable function. It is not necessary to use special Ethernet crossover cables to connect devices directly to this port (connections without an Ethernet hub or switch).

NOTE: Ethernet cable disconnection is detected every second. In case of disconnection of a short duration (< 1 second), the network status may not indicate the disconnection.

Status LED

This figure shows RJ45 connectors status LED:



This table describes the Ethernet status LEDs:

Label	Description	LED		
		Color	Status	Description
1	Ethernet link	Green/Yellow	Off	No link
			Solid yellow	Link at 10 Mbit/s
			Solid green	Activity at 100 Mbit/s
2	Ethernet activity	Green	Off	No activity
			On	Transmitting or receiving data

TM251MESE Specific Considerations

Ethernet Ports

The TM251MESE has 2 different Ethernet networks. Each one get its own and unique IP and MAC address.

The 2 Ethernet networks are called Ethernet 1 and Ethernet 2:

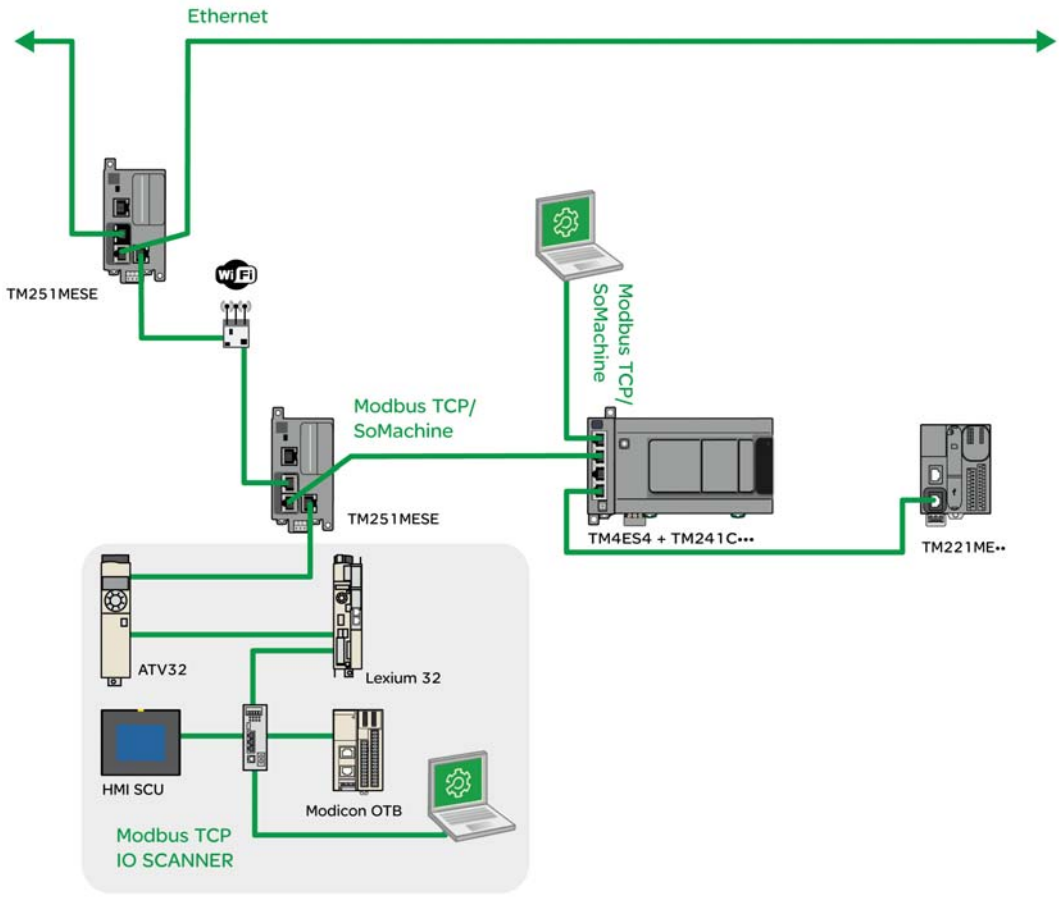
- Ethernet 1 is made of 2 switched Ethernet ports dedicated to communication between machines or with the factory network.
- Ethernet 2 is made of 1 Ethernet port dedicated to fieldbus device connections.

For example, you can:

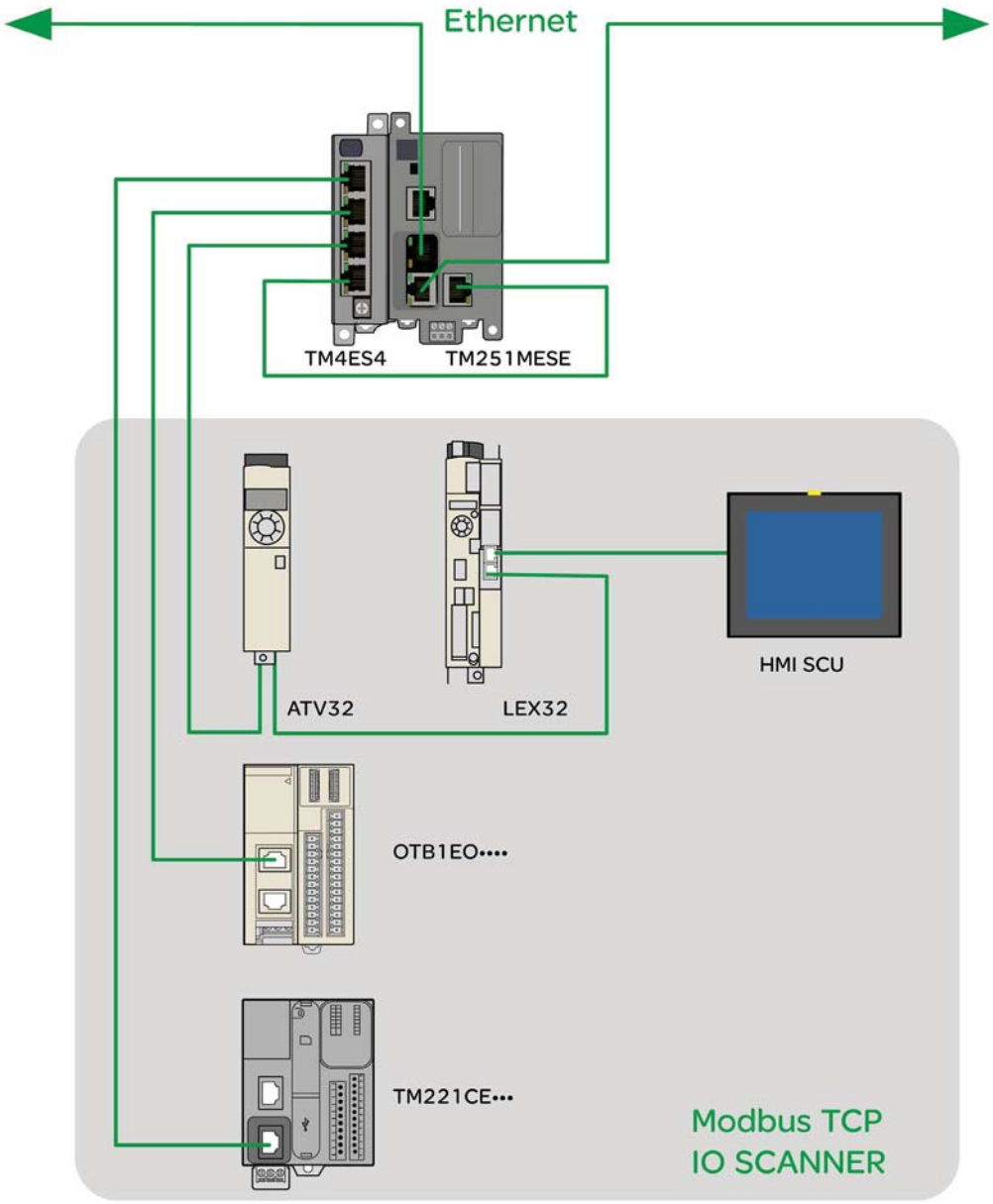
- Connect your PC to the Ethernet 1.
- Use a Modbus TCP I/O scanner with the Ethernet 2.

System Architecture

This figure is an example of an Ethernet architecture with 2 TM251MESE.



This figure is an example of an Ethernet architecture with TM251MESE and TM4ES4.



USB Mini-B Programming Port

Overview

The USB Mini-B Port is the programming port you can use to connect a PC with a USB host port using SoMachine software. Using a typical USB cable, this connection is suitable for quick updates of the program or short duration connections to perform maintenance and inspect data values. It is not suitable for long-term connections such as commissioning or monitoring without the use of specially adapted cables to help minimize electromagnetic interference.

⚠ WARNING

INOPERABLE EQUIPMENT OR UNINTENDED EQUIPMENT OPERATION

- You must use a shielded USB cable such as a BMX XCAUSBH0•• secured to the functional ground (FE) of the system for any long-term connection.
- Do not connect more than one controller at a time using USB connections.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Characteristics

This table describes the characteristics of the USB Mini-B programming port:

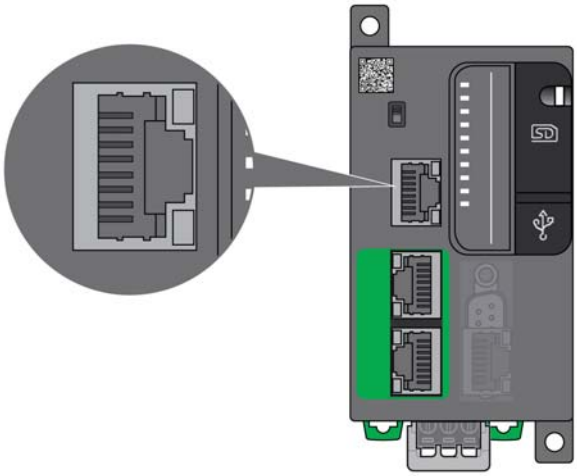
Parameter	USB Programming Port
Function	Compatible with USB 2.0
Connector type	Mini-B
Isolation	None
Cable type	Shielded

Serial Line

Overview

The serial line:

- Can be used to communicate with devices supporting the Modbus protocol as either master or slave, ASCII protocol (printer, modem...) and SoMachine Protocol (HMI,...).
- provides a 5 Vdc power distribution.



Characteristics

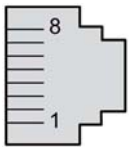
Characteristic		Description
Function		RS485 or RS232 software configured
Connector type		RJ45
Isolation		Non-isolated
Maximum baud rate		1200 up to 115 200 bps
Cable	Type	Shielded
	Maximum length	15 m (49 ft) for RS485 3 m (9.84 ft) for RS232
Polarization		Software configuration is used to connect when the node is configured as a master. 560 Ω resistors are optional.
5 Vdc power supply for RS485		Yes

NOTE: Some devices provide voltage on RS485 serial connections. It is necessary to avoid connection of these voltage lines to your controller as they may damage the controller serial port electronics and render the serial port inoperable.

NOTICE
INOPERABLE EQUIPMENT Use only the VW3A8306R•• serial cable to connect RS485 devices to your controller. **Failure to follow these instructions can result in equipment damage.**

Pin Assignment

The following figure shows the pins of the RJ45 connector:



This table describes the pin assignment of the RJ45 connector:

Pin	RS232	RS485
1	RxD	N.C.
2	TxD	N.C.
3	N.C.	N.C.
4	N.C.	D1 (A +)
5	N.C.	D0 (B –)
6	N.C.	N.C.
7	N.C. *	5 Vdc
8	Common	Common

*: 5 Vdc delivered by the controller, do not connect.

N.C.: No connection

RxD: Received data

TxD: Transmitted data

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Status LED

This table describes the serial line status LED:

Label	Description	LED		
		Color	Status	Description
SL	Serial line	Green	On	Indicates the activity of the serial line.
			Off	Indicates no serial communication.

Chapter 7
Connecting the M251 Logic Controller to a PC

Connecting the Controller to a PC

Overview

To transfer, run, and monitor the applications, connect the controller to a computer, that has SoMachine installed, using either a USB cable or an Ethernet connection (for those references that support an Ethernet port).

NOTICE
INOPERABLE EQUIPMENT
Always connect the communication cable to the PC before connecting it to the controller.
Failure to follow these instructions can result in equipment damage.

USB Powered Download

In order to execute limited operations, the M251 Logic Controller has the capability to be powered through the USB Mini-B port. A diode mechanism avoids having the logic controller both powered by USB and by the normal power supply, or to supply voltage on the USB port.

When powered only by USB, the logic controller executes the firmware and the boot project (if any) and the I/O board is not powered during boot (same duration as a normal boot). USB powered download initializes the internal flash memory with some firmware or some application and parameters when the controller is powered by USB. The preferred tool to connect to the controller is the **Controller Assistant**.

The controller packaging allows easy access to USB Mini-B port with minimum opening of the packaging. You can connect the controller to the PC with a USB cable. Long cables are not suitable for the USB powered download.

⚠ WARNING

INSUFFICENT POWER FOR USB DOWNLOAD

Do not use a USB cable longer than 3m (9.8 ft) for USB powered download.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: It is not intended that you use the USB Powered Download on an installed controller. Depending on the number of I/O expansion modules in the physical configuration of the installed controller, there may be insufficient power from your PC USB port to accomplish the download.

USB Mini-B Port Connection

TCSXCNAMUM3P: This USB cable is suitable for short duration connections such as quick updates or retrieving data values.

BMXXCAUSBH018: Grounded and shielded, this USB cable is suitable for long duration connections.

NOTE: You can only connect 1 controller or any other device associated with SoMachine and its component to the PC at any one time.

The USB Mini-B Port is the programming port you can use to connect a PC with a USB host port using SoMachine software. Using a typical USB cable, this connection is suitable for quick updates of the program or short duration connections to perform maintenance and inspect data values. It is not suitable for long-term connections such as commissioning or monitoring without the use of specially adapted cables to help minimize electromagnetic interference.

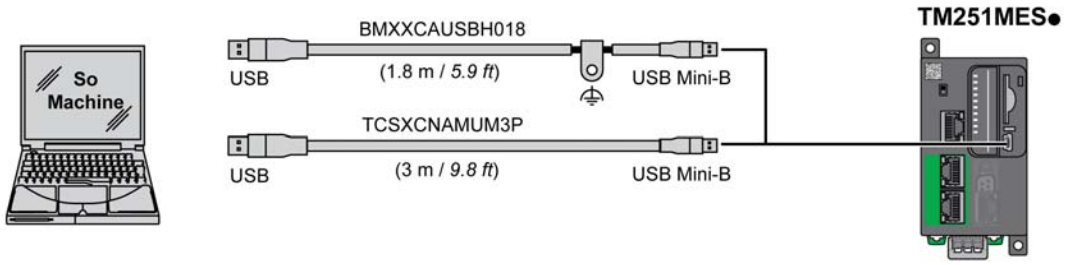
⚠ WARNING

INOPERABLE EQUIPMENT OR UNINTENDED EQUIPMENT OPERATION

- You must use a shielded USB cable such as a BMX XCAUSBH0•• secured to the functional ground (FE) of the system for any long-term connection.
- Do not connect more than one controller at a time using USB connections.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The communication cable should be connected to the PC first to minimize the possibility of electrostatic discharge affecting the controller.

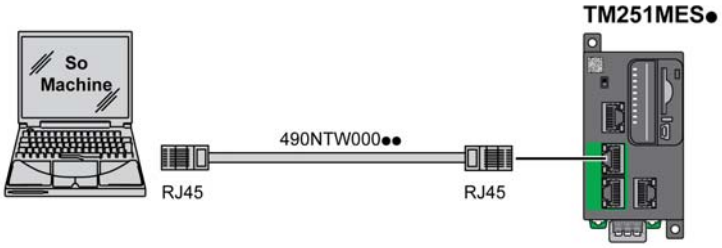


To connect the USB cable to your controller, follow the steps below:

Step	Action
1	**1a** If making a long-term connection using the cable BMXXCAUSBH018, or other cable with a ground shield connection, be sure to securely connect the shield connector to the functional ground (FE) or protective ground (PE) of your system before connecting the cable to your controller and your PC. **1b** If making a short-term connection using the cable TCSXCNAMUM3P or other non-grounded USB cable, proceed to step 2.
2	Connect your USB cable to the computer.
3	Open the hinged access cover.
4	Connect the Mini connector of your USB cable to the controller USB connector.

Ethernet Port Connection

You can also connect the controller to a PC using an Ethernet cable.



To connect the controller to the PC, do the following:

Step	Action
1	Connect your Ethernet cable to the PC.
2	Connect your Ethernet cable to the Ethernet port on the controller.

Glossary

A

ASCII

(*American standard code for Information Interchange*) A protocol for representing alphanumeric characters (letters, numbers, certain graphics, and control characters).

B

bps

(*bit per second*) A definition of transmission rate, also given in conjunction with multiplicator kilo (kbps) and mega (mbps).

C

CANopen

An open industry-standard communication protocol and device profile specification (EN 50325-4).

CFC

(*continuous function chart*) A graphical programming language (an extension of the IEC 61131-3 standard) based on the function block diagram language that works like a flowchart. However, no networks are used and free positioning of graphic elements is possible, which allows feedback loops. For each block, the inputs are on the left and the outputs on the right. You can link the block outputs to the inputs of other blocks to create complex expressions.

continuous function chart language

A graphical programming language (an extension of the IEC61131-3 standard) based on the function block diagram language that works like a flowchart. However, no networks are used and free positioning of graphic elements is possible, which allows feedback loops. For each block, the inputs are on the left and the outputs on the right. You can link the block outputs to inputs of other blocks to create complex expressions.

D

DIN

(*Deutsches Institut für Normung*) A German institution that sets engineering and dimensional standards.

E

EIA rack

(*electronic industries alliance rack*) A standardized (EIA 310-D, IEC 60297, and DIN 41494 SC48D) system for mounting various electronic modules in a stack or rack that is 19 inches (482.6 mm) wide.

EN

EN identifies 1 of many European standards maintained by CEN (*European Committee for Standardization*), CENELEC (*European Committee for Electrotechnical Standardization*), or ETSI (*European Telecommunications Standards Institute*).

F

FBD

(*function block diagram*) One of 5 languages for logic or control supported by the standard IEC 61131-3 for control systems. Function block diagram is a graphically oriented programming language. It works with a list of networks, where each network contains a graphical structure of boxes and connection lines, which represents either a logical or arithmetic expression, the call of a function block, a jump, or a return instruction.

FE

(functional Earth) A common grounding connection to enhance or otherwise allow normal operation of electrically sensitive equipment (also referred to as functional ground in North America).

In contrast to a protective Earth (protective ground), a functional earth connection serves a purpose other than shock protection, and may normally carry current. Examples of devices that use functional earth connections include surge suppressors and electromagnetic interference filters, certain antennas, and measurement instruments.

H

HE10

Rectangular connector for electrical signals with frequencies below 3 MHz, complying with IEC 60807-2.

I

IEC

(*international electrotechnical commission*) A non-profit and non-governmental international standards organization that prepares and publishes international standards for electrical, electronic, and related technologies.

IEC 61131-3

Part 3 of a 3-part IEC standard for industrial automation equipment. IEC 61131-3 is concerned with controller programming languages and defines 2 graphical and 2 textual programming language standards. The graphical programming languages are ladder diagram and function block diagram. The textual programming languages include structured text and instruction list.

IL

(*instruction list*) A program written in the language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (refer to IEC 61131-3).

instruction list language

A program written in the instruction list language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (see IEC 61131-3).

IP 20

(*ingress protection*) The protection classification according to IEC 60529 offered by an enclosure, shown by the letter IP and 2 digits. The first digit indicates 2 factors: helping protect persons and for equipment. The second digit indicates helping protect against water. IP 20 devices help protect against electric contact of objects larger than 12.5 mm, but not against water.

L

ladder diagram language

A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (see IEC 61131-3).

LD

(*ladder diagram*) A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (refer to IEC 61131-3).

M

master/slave

The single direction of control in a network that implements the master/slave mode.

Modbus

The protocol that allows communications between many devices connected to the same network.

N

NEMA

(*national electrical manufacturers association*) The standard for the performance of various classes of electrical enclosures. The NEMA standards cover corrosion resistance, ability to help protect from rain, submersion, and so on. For IEC member countries, the IEC 60529 standard classifies the ingress protection rating for enclosures.

P

PDO

(*process data object*) An unconfirmed broadcast message or sent from a producer device to a consumer device in a CAN-based network. The transmit PDO from the producer device has a specific identifier that corresponds to the receive PDO of the consumer devices.

PE

(*protective Earth*) A common grounding connection to help avoid the hazard of electric shock by keeping any exposed conductive surface of a device at earth potential. To avoid possible voltage drop, no current is allowed to flow in this conductor (also referred to as *protective ground* in North America or as an equipment grounding conductor in the US national electrical code).

R

RJ-45

A standard type of 8-pin connector for network cables defined for Ethernet.

RPDO

(*receive process data object* An unconfirmed broadcast message or sent from a producer device to a consumer device in a CAN-based network. The transmit PDO from the producer device has a specific identifier that corresponds to the receive PDO of the consumer devices.

RS-485

A standard type of serial communication bus, based on 2 wires (also known as EIA RS-485).

RxD

The line that receives data from one source to another.

S

SFC

(*sequential function chart*) A language that is composed of steps with associated actions, transitions with associated logic condition, and directed links between steps and transitions. (The SFC standard is defined in IEC 848. It is IEC 61131-3 compliant.)

ST

(*structured text*) A language that includes complex statements and nested instructions (such as iteration loops, conditional executions, or functions). ST is compliant with IEC 61131-3.

T

terminal block

(*terminal block*) The component that mounts in an electronic module and provides electrical connections between the controller and the field devices.

TPDO

(*transmit process data object*) An unconfirmed broadcast message or sent from a producer device to a consumer device in a CAN-based network. The transmit PDO from the producer device has a specific identifier that corresponds to the receive PDO of the consumer devices.

TxD

The line that sends data from one source to another.

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Installation Guide

IG 022 / Rev. 1.5

eWON COSY 131

This installation guide describes the hardware of the eWON COSY 131 and explains how to get started with the embedded web site.

support.ewon.biz

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1. Product Summary

1.1. Introduction

The present Installation Guide describes the hardware of the ***eWON COSY 131*** family.

The eWON Cosy 131 family is a set of 3 industrial gateways/routers.

The eWON Cosy 131 is fully compatible with the Talk2M cloud connectivity services (www.talk2M.com).

1.2. Concept of the eWON COSY 131 Family

The Cosy 131 is available in 3 different versions depending on their communication interface:

- Ethernet Switch **Cosy 131 Ethernet**
- WiFi & Ethernet Switch **Cosy 131 WiFi**
- 3G+ & Ethernet Switch **Cosy 131 Cellular 3G+**

1.3. General specification of the hardware platform

Characteristic	Value
Design	Industrial design (24 VDC power supply, DIN Rail mounting, extended temperature)
Processor	ARM9
Clock	Backed up real time clock (RTC) Backup battery lifetime has 10 years expectancy
Ethernet Interface	LAN Ethernet port 10/100 Mbps
Digital Input	2
Digital Output	1
Mounting	Latch for DIN rail EN50022-compliant

1.4. Typical applications

- Remote Access of Ethernet devices using Talk2M connection
- Industrial VPN router

1.5. Type and Part Numbers

The available part numbers are:

Part Number	Type	Description
EC61330_00MA	COSY 131	LAN/WAN – Ethernet Only Switch 4-Ports
EC6133C_00MA	COSY 131	LAN/WAN, WIFI – Ethernet Switch + WiFi
EC6133D_00MA	COSY 131	LAN/WAN -3G+ Penta - Ethernet Switch + 3G+

Table: List of the available part numbers

- Note -

The MA suffix means Multiple languages A (ENG, FR, DE, SP)

The part number syntax is explained in *3.1. Label*

2. Safety, Environmental & Regulatory Information

2.1. Scope

The present heading addresses Safety, Environmental & Regulatory Information for the eWON Cosy 131 family.

2.2. Power supply

The external power supply is a third party device that is not part of this certification.

The device shall be supplied by a LPS power supply certified according to IEC/UL60950-1 or Class 2 per NEC (See annex A.2. Specification of the External Power Supply for detailed information).

2.3. Applicable Directives, Standards and Compliance

The product described in the present Installation Guide complies with the CE, R&TTE directives and the FCC regulations related to the wireless modems.

The product described in the present Installation Guide belongs to class A Information Technology Equipment (ITE). In a domestic environment this product may cause radio interference in which case the user may be required to take appropriate measures.

2.3.1. Applicable European Directives

The product described in the present Installation Guide is in conformity with the following EC directives:

- RoHS Directive 2011/65/EU
- EMC Directive 2004/108/EC
- R&TTE Directive 1999/5/EC (for versions includind RF modems)
  The product conforms to the corresponding R&TTE articles:
  RF spectrum efficiency (Art 3.2); EMC (Art. 3.1b); Safety (Art. 3.1a)
- REACH Directive 2006/121/EC
- For COSY 131, Cellular 3G+ only: to comply with R&TTE directive
  - Antenna must be mounted on a grounded plate
  - RFI suppressors must be mounted on the power supply cable in the following order, starting at 3cm of the connector and going to the power supply:
    - Wurth Elecktronik 742-717-33
    - Wurth Elecktronik 742-716-22
    - Wurth Elecktronik 742-711-11

2.3.2. Applicable Safety Standards

The product described in the present Installation Guide is in conformity with the following safety standards:

- IEC/EN 60950-1
- UL 60950-1
- CSA-C22.2 No 60950-1-07

2.3.3. FCC Compliance

The product described in the present Installation Guide complies with Part 15 of the FCC Rules. Operating is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

2.3.4. Certifications

The product described in the present Installation Guide has been certified by authorized bodies:

- UL Certificate Of Compliance (CoC) for Ordinaty Locations # E350576 for a TMRA of 60°C
- CB certificate # DK-42240-UL

These certificates can be downloaded as PDF files on the eWON Support web site: http://support.ewon.biz/official-documents

2.4. Field implementation & environmental conditions

2.4.1. Ingress Protection

The eWON COSY 131 has an IP20 protection grade. Therefore, the eWON COSY is NOT suited for outdoor mounting. It has to be integrated in an electrical cabinet, protected from excessive heat, humidity and dust. Do not push any sharp object into the air vents or openings of the equipment.

2.4.2. Mounting Recommendations

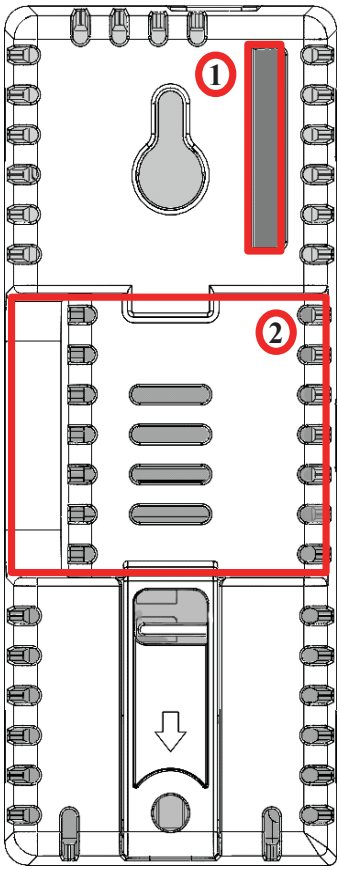
The normal mounting position of the eWON COSY is wall mounted on a horizontal Omega type DIN-rail (EN 50022).

- **Mounting the unit on DIN-rail**
  Pull the slide lock (located at the bottom of the unit's back-side) downwards and present the unit in front of the DIN rail. Tilt the eWON upwards in order to hang it on the upper edge of the DIN rail by its hook. Gently tilt the unit downwards until it finds its original position. Pull the slide lock upwards to fix and lock the unit on the DIN rail.

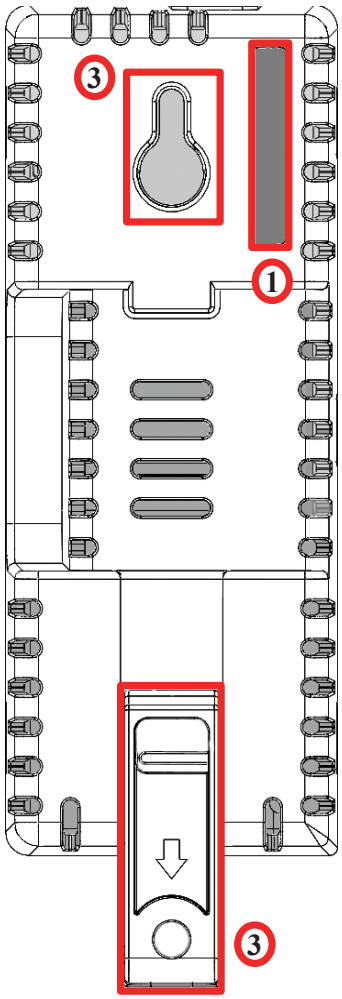
- **Removing the unit from DIN-rail**
  Release the unit by pulling the slide lock downwards while gently tilting the unit upwards. Free the unit by unhooking it from the upper rail edge. See 2.4.2 Mounting instructions

The product is intended to be mounted vertically, label on the right side

Installation on DIN-rai



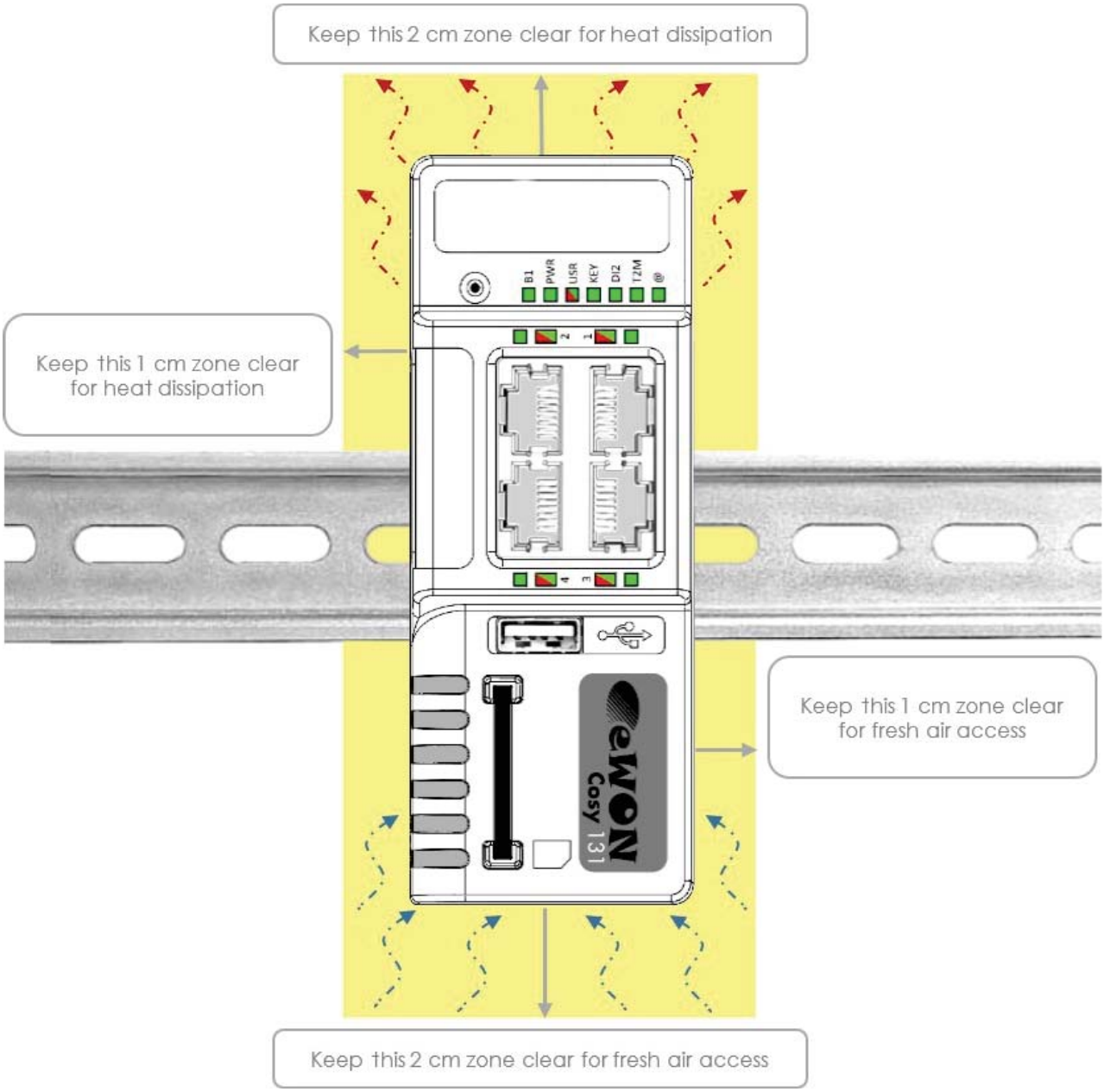
Wall mounting position



1	SIM card slot
2	DIN rail mounting braket
3	Screw holes intended to receive M4 screws with an 8mm diameter head

To ensure a proper ventilation of the equipment, a free gap of at least 2 cm must be respected in front of all upper & lower ventilation openings of the unit.

A free gap of at least 1 cm must be respected on each side of the unit.



- Caution -

In any other mounting position than the one explained here above, the specified temperature has to be derated to -25°C to +40°C.

2.4.3. Cabling rules

Shielded cables must be used for Ethernet and USB connectivity to comply with the EMC requirements.

USB cable must be

- shorter than 3m;
- USB 2.0 type
- Maximum current per contact : 0.5A (or better)
- "A" plug connected to the eWON

2.4.4. Environmental conditions

The equipment will operate properly within the following environmental limits if it has been correctly mounted according to the above mentioned recommendations:

Operating T°	-25°C to +70°C
Relative Humidity	10 to 95% non-condensing
Operating altitude	Up to maximum 2000m
Storage temperature	-40 to +70 °C
Storage Humidity	10 to 95% non-condensing
Storage altitude	Up to maximum 3000m

2.4.5. Earthing

Earthing the eWON is necessary to eliminate unwanted transients (lightning protection) and to conform to the EMC requirements. Therefore, a functional earth (FE) terminal is available on the main connector as shown in A.2. Specification of the External Power Supply, Connect this terminal directly to allow impedance ground. Shielded cables have to be used for Ethernet and USB to comply with the EMC requirements.

2.5. Battery

The COSY contains a CR2032 battery. This battery is used to maintain the real time clock up-to-date even when the unit is not powered.

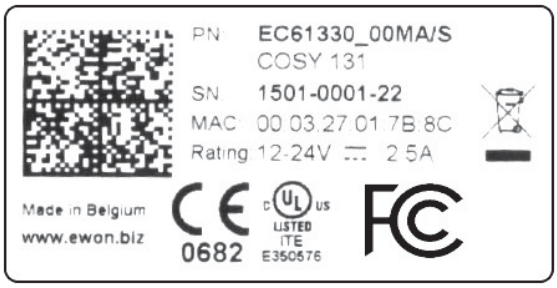
- Caution -

Risk of explosion if battery is replaced by an incorrect type.
The battery is not attended to be replaced on consumer's side. The product shall be returned to manufacture for replacement.

3. Hardware description

3.1. Label

The identification label of the eWON COSY 131 is placed on the right hand side of the housing. The different parts of the label are described below:

eWON COSY 131 Ethernet	Label	Description
	**PN**	Part Number (see syntax table below)
	SN	Serial number on the form **YYWW-SSSS-PP** **YY** = Year of production **WW** = Week of production **SSSS** = sequential mfg order **PP** = product type
	MAC	MAC address of the Ethernet adapter
	Rating	Power supply requirements
	Marks	CE, UL,... logos if applicable

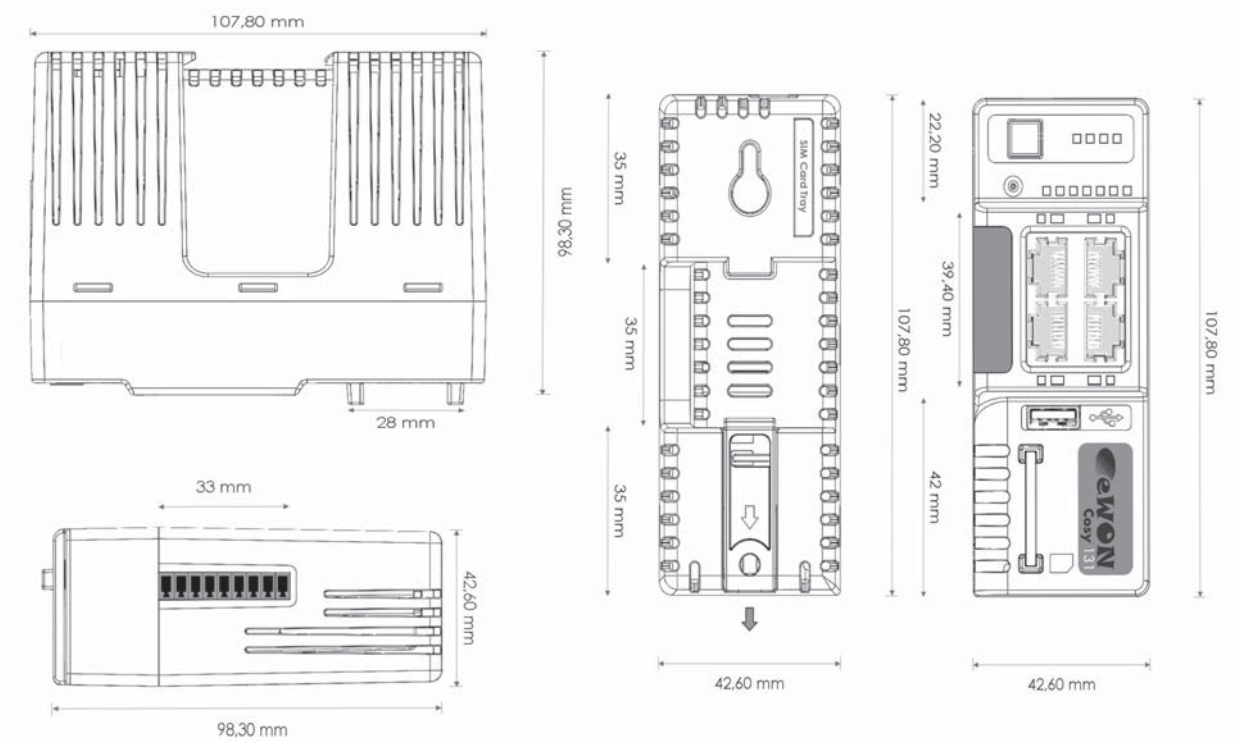
Marks	Description
CE	Conformité Européenne or European Conformity (**EC**)
0682	Notified Body Number, warrantor of the CE Mark validation
c UL us LISTED	**UL Listed** (*Underwriters Laboratories*)
FC	**FCC** *Federal Communications Commission*

Label can have variant marks depending of models	
eWON COSY 131 WiFi	**eWON COSY 131 – 3G Penta**

EC6133m_ccLL[suffix]

Position(s)	Description	Acceptable values	
EC	name of the family	EC for eWON COSY	
6	number corresponding to the HW platform.	6	for "Cosy 131" platform
1	is communication options 1.	1	One Ethernet
3	Is communication options 2.	3	Three Ethernet
3	field communication option.	3	USB
m	modem communication option.	0	No modem
		C	WiFi
		D	HSUPA Modem
cc	is one or more digits or letters that correspond to software options	00 = no software option	
LL	Defines the firmware language	MA	UK + FR + DE + SP
[suffix]	can have an optional "/" character Defines the compliances of the unit	S	compliance with the UL/IEC/EN 60950 standard

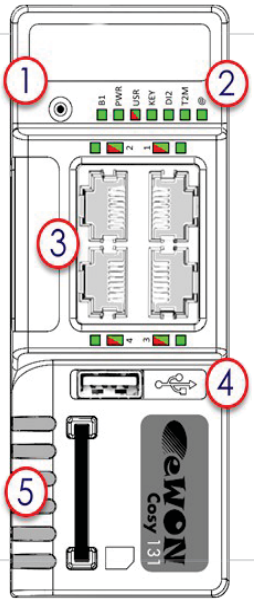
3.2. Mechanical dimensions



3.3. Overal description

3.3.1. Front

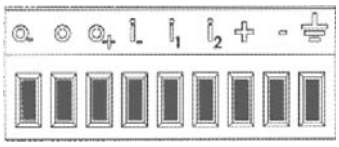
#	Description
1	Reset button
2	Status LEDs panel
3	LAN/WAN Ethernet ports and corresponding status LEDs (**Red**: WAN / **Green**: LAN)
4	USB slot
5	SD card slot *

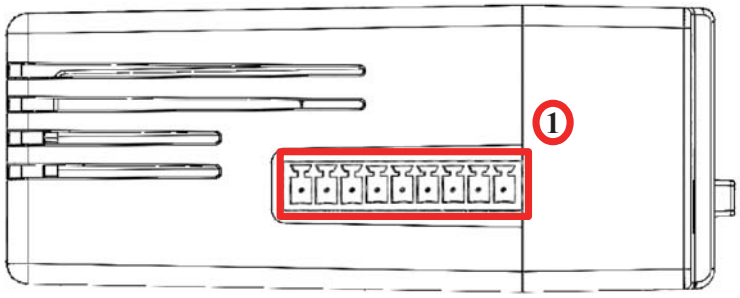


- SD Card is not supported for the moment

3.3.2. Upper side

Connector

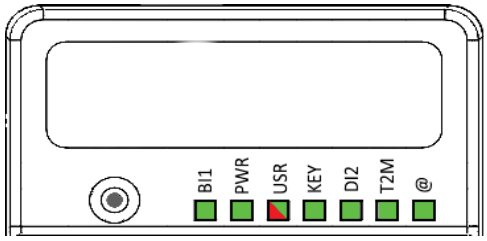




1	Main connector including power input terminal, 1DO and 2 DI

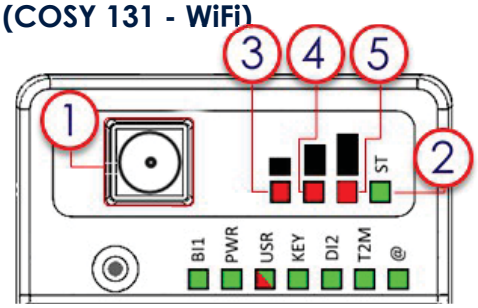
For more information about the connector see in A.1. Main Connector

3.3.2. Status LED panel (COSY 131 – All version):



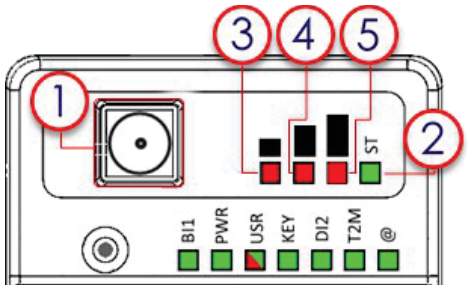
Label	Description
BI1	Button BI1 input Green ON = Reset being pressed
PWR	Power Green ON = Power is present
USR	User Green ON+OFF slowly = Unit is OK RED pattern = special attention required
KEY	Digital IN 1 – Green = ON: Signal on input 1 detected See. Digital Output & Digital Inputs
DI2	Digital IN 2 – Green = ON: Signal on input 2 detected See. Digital Output & Digital Inputs
T2M	Talk2M - Green ON = Talk2M VPN connection established See. Digital Output & Digital Inputs
@	Internet Green ON = Internet is configured on the eWON COSY

3.3.3.1. Status LED panel (COSY 131 - WiFi)



#	Mark	Description
1	/	SMA male connector for WIFI antenna
2	ST	Modem status Green ON = WiFi connected
3		Reception signal level Red ON = Poor signal
4		Reception signal level Red ON = Signal is OK
5		Reception signal level Red ON = Good signal

3.3.3.2. Status LED panel (COSY 131 - Cellular 3G+)



#	Mark	Description
1	/	SMA female connector for GSM antenna
2	ST	Modem status Green ON = Modem connected
3		Reception signal level Red ON = Poor signal
4		Reception signal level Red ON = Signal is OK
5		Reception signal level Red ON = Good signal

3.4. Radio communication models

- Warning -

This device is intended to be used in fixed or mobile applications only (not for portable applications). The antenna used for this transmitter has to be installed in a space providing a safe distance of at least 20 cm without encountering any person and must not be co-located or operating in conjunction with any other antenna or transmitter.

3.4.1. COSY 131 with internal WiFi modem

Cosy 131 – Wifi		
Item	**Value(s)**	
Protocols and Frequencies	IEEE802.11b/g/n, 2.4GHz - Channels: 1 to 11 (inclusive)	
Antenna Connector	Type RP-SMA	
Antenna (included in the delivery)	**Charact.**	**Value(s)**
	Impedance	50 Ohms
	Input Power	> 17 dBm, IEEE 802.11b > 15 dBm, IEEE 802.11g/n
	Tightening Torque	0.5 Nm. *In the absence of a torque wrench, a soft manual tightening is sufficient.*

Device conformity has been tested with the reference antenna: Pulse W1030.

- The product complies with the R&TTE directive, the FCC, the IC and Japan regulations related to the Wifi communications.
- Absolute maximum antenna gain as per FCC's rules and regulations, 47CFR:
  - Part 15C : 2.14dBi
- Modifications cannot be made by the user if it influences the normal behavior of the device.
- The user shall be informed about modem identification numbers according to their national authorities.
  This product contains part identified as follows by national authorities:
  – FCC ID: QOQWF111
  – IC ID: 5123A-BGTWF111
  – RRA ID: KCC-CRM-BGT-WF111
  – GITEKI (MIC) ID: 209-J00061

3.4.2. COSY 131 with internal 3G+ Penta modem

Cosy 131 – Cellular 3G+		
Item	**Value(s)**	
Protocols and Frequencies	GSM/GPRS/EDGE - 850, 900, 1800, 1900 MHz UMTS/HSUPA - 800/850, 900,AWS 1700,1900,2100 Mhz	
Class	5 bands GPRS/EDGE Class 33	
Antenna Connector	Type SMA	
Antenna (not included in the delivery*)	**Charact.**	**Value(s)**
	Impedance	50 Ohms
	VSWR	<= 5:1 Absolute max. to avoid permanent damage <= 2:1 Limit to fulfill all regulatory requirements
	Input Power	> 33 dBm (2W) peak power in GSM > 24 dBm average power in WCDMA
	Tightening Torque	0.5 Nm. *In the absence of a torque wrench, a soft manual tightening is sufficie*

Device conformity has been tested with the reference antenna: Taoglas TG.09.0113

As see in 2.4.1 Mounting instructions SIM Card Tray is at the rear of the COSY 131

(*) 3G antenna has to be purchased separately, 3G penta band antenna is available from eWON with FAC90501_0000 as reference

- The product complies with the R&TTE directive, the FCC, the IC and Japan regulations related to the GSM modems.
- Absolute maximum antenna gain as per FCC's rules and regulations, 47 CFR :
  - – Part 22H : 5.22dBi;
  - – Part 27 : 3.31dBi;
  - – Part 24E : 6.45dBi.
- Modifications cannot be made by the user if it influences the normal behavior of the device.
- The user shall be informed about modem identification numbers according to their national authorities:
  This product contains part identified as follows by national authorities:
  – FFC ID: RI7HE910
  – IC ID: 5131A-HE910
  – GITEKI (MIC) ID: 005-100269
  – JATE ID: AD12-0318001

3.5. LAN Switch Specifications

3.5.1. Boot process

During the (re)boot process, the eWON prevents the switch feature from working. This means that it might require little time starting from the power on (or the reboot request) to get the LAN switch to be fully operational.

When an eWON router is configured to operate a certain way, it is part of the strategy, if no other method worked, to reboot itself. This is the ultimate eWON strategy to try restoring the requested communication channels and be consistent with requested configuration.

4. COSY IP Address & Access to the Web Configuration

4.1. Factory Default IP settings

Characteristics	Value(s)
LAN IP Address	10.0.0.53
LAN Subnet Mask	255.255.255.0
Gateway	0.0.0.0

4.2. Powering ON

Power on the unit and wait approximately 25 sec. until the boot process is finished.

After a successful boot process the ***USR*** LED is flashing green ON & OFF slowly.

If the ***USR*** LED is flashing RED according to a given pattern, it indicates that the boot process was interrupted due to a problem. Most frequent problems include :

- a duplicate IP address was detected on the LAN Network
  USR LED flashing pattern is RED 1x short, 1x long

For the other LED patterns in case of error, please refer to the General Reference Guide RG-001.

4.3. Setting the eWON COSY LAN IP Address

You can easily establish your first communication with your eWON COSY by using our companion tool ***eBuddy*** which can be downloaded from http://support.ewon.biz/software

Connect one of the LAN-ports (by default, port No. 1 is always a LAN port) of your COSY with your PC point-to-point or through a network where there is no risk that the eWON's default IP-address (10.0.0.53) would conflict with another connected device.

Start the eBuddy application. This one scans the network through the Ethernet adapter and retrieves the connected eWON, including its IP address, Subnet Mask and serial number. The application also allows you to change the default IP address without being necessarily in the same network range.

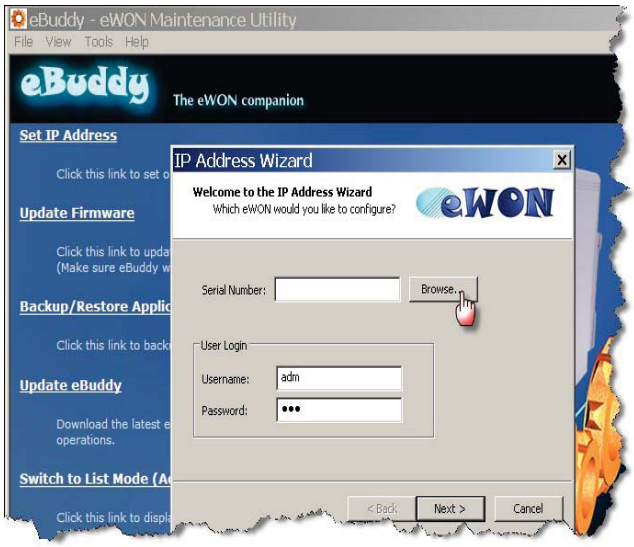
Start the ***eBuddy*** utility on your PC

In the home page,
select ***Set IP Address***

Fill in the Serial Number of your COSY or click on ***Browse*** and select it.

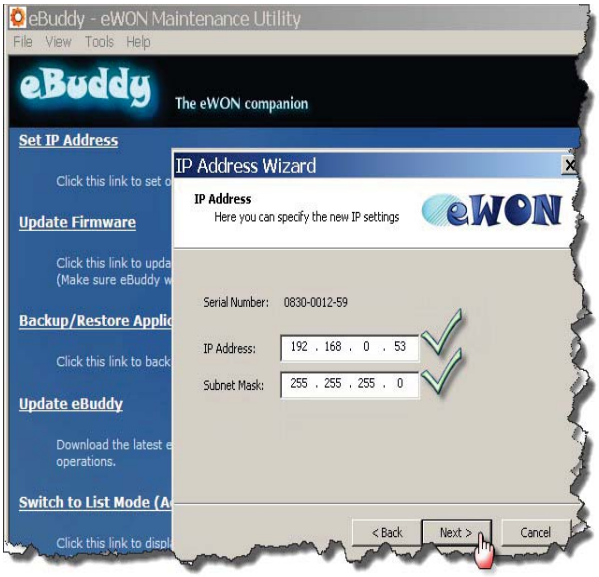
The Serial Number of the COSY is on its label, see in 3.1.Label

Click ***Next***



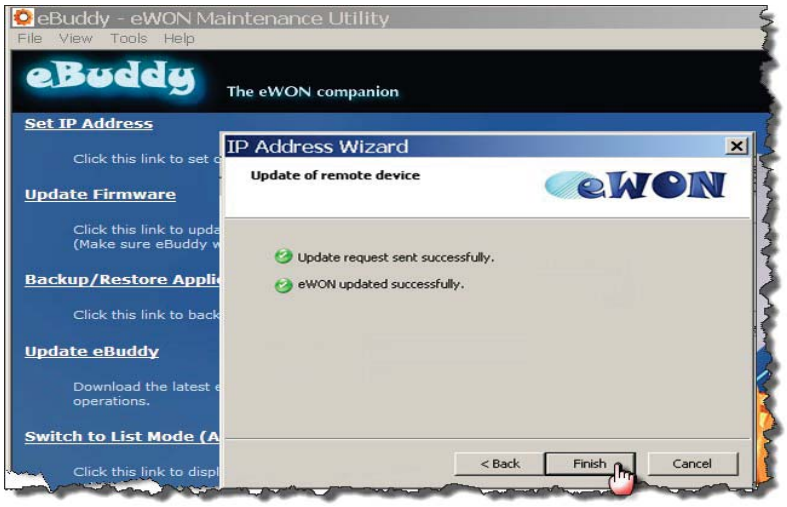
Enter a new LAN IP address and Subnet Mask.

Click ***Next***



Wait until the address is updated and the device has rebooted.

Click ***Finish***.



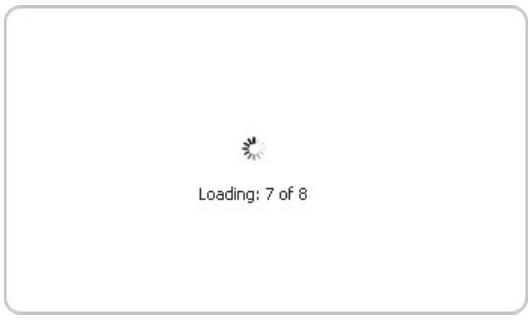
4.4. eWON COSY's Web Interface

To access the web pages of your eWON COSY proceed as follows:

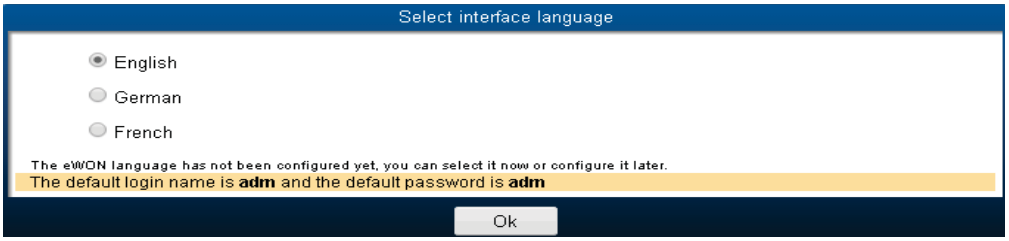
Connect the PC to one of the LAN port of the eWON COSY.

Open your Internet browser and access the eWON COSY internal Web page by entering the LAN IP address in the URL field (the default address is http://10.0.0.53).

You arrive on a loading page

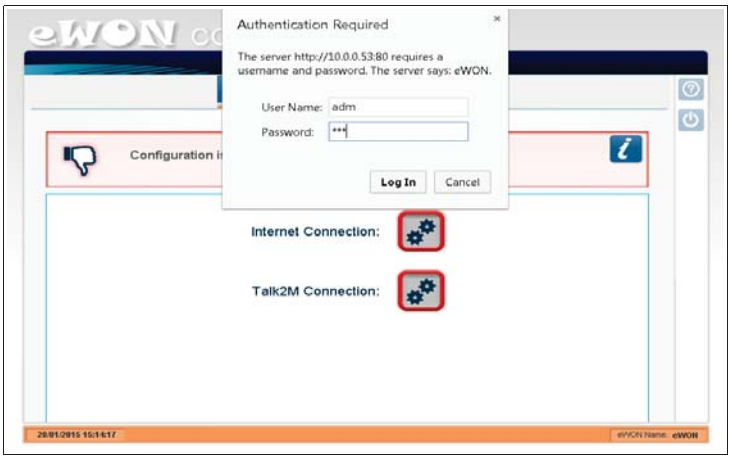


If this is the first boot of the eWON COSY (or after a level 2 reset), you will be asked for a default language.



Before configuring your eWON COSY, an authentication is required.

For a first boot, the default login & password are both "adm".



- Warning -

*For security reasons, changing the default password "**adm"** is absolutely required.*

You will be automatically redirected to the Quick Launch Wizard page:

You can follow the **Quick Start Guide** as an aid to configure your eWON COSY.

Can be downloaded on http://support.ewon.biz/cosy-131

To reconfigure your eWON COSY, you can easily rerun the wizard by clicking on the Settings button on top of the page.

5. Troubleshooting

5.1. Normal Boot Process

The normal boot process of the eWON COSY takes approximately 25 seconds to complete. During this process, all LEDs are shortly ON, except BI1 as long as the RESET button is not pressed. During this boot sequence, the ***USR*** LED is orange. As soon as the boot process is finished and the unit is ready to be used, the ***USR*** LED flashes GREEN slowly.

5.2. Resetting the eWON COSY 131

The reset button B1 is located on the front of the COSY unit (see in 3.3.1.Front). The reset function of this button is active only if pressed while powering on. The eWON COSY features two type of reset levels. A table follows with the impacted configuration zones per reset level.

5.3. First Level Reset (user reset)

The first level reset consists in formatting only the « ***user files*** » part of the non volatile memory. This type of reset does not modify the communication parameters of the eWON COSY.

How do I generate a first level reset?

- Power the unit OFF and ON again
- ***Immediately press and maintain*** the reset button. The LED labeled BI1 turns ON.
- Wait approximately 30 seconds until the ***USR*** LED flashes RED 1x per second.
- Immediately release the button (if you don't, you would reach the second level reset phase). The LED labeled BI1 turns OFF.
- Wait approximately 30 secs until the reset procedure is completed.
- The eWON restarts automatically and the unit is ready to be used, the ***USR*** LED flashes GREEN slowly.

5.4. Second Level Reset (factory reset)

This second level reset formats the entire non volatile memory and returns the eWON to its factory settings. This operation consists in 3 steps:

- Formats the entire non volatile memory, including all COM parameters and IP addresses
- Full hardware auto-test with result shown by the ***USR*** LED
- Return to ex-factory configuration (default config)

How do I generate a second level reset?

- Power the unit OFF and ON again
- ***Immediately press and maintain*** the reset button. The LED labeled BI1 turns ON.
- Wait approximately 35 seconds until the ***USR*** LED remains RED steady.
- When this state is reached, release the button. The LED labeled BI1 turns OFF.
- It takes no longer than 2 seconds to complete.
- Check if the auto test is successful, the ***USR*** LED flashes RED with a pattern of 200ms ON and 1,5 sec OFF[1]. The eWON COSY ***does NOT restart in normal mode*** by itself and remains running in this diagnostic mode.
- You have to power the eWON COSY OFF and ON again to reboot the unit in normal mode. As described before, the eWON returns to its default COM parameters and factory IP addresses (like LAN 10.0.0.53) after this level 2 reset is performed.

5.5. Reset Impact Matrix

	Erased or Reset	Preserved
Impact Reset Level 1 (user reset)		LAN IP address + mask
	adm password	Internet access
		Language settings
	eWON Identification	Modem/ Wifi settings
	User Web site	Talk2M config
		Proxy configuration

Impact Reset Level 2 (factory reset)	*adm* password	Nothing
	eWON Identification	
	User Web site	
	LAN IP address + mask	
	Internet access	
	Language settings	
	Modem/ Wifi settings	
	Talk2M config	
	Proxy configuration	

*1 Any other pattern reflects a problem. The pattern will start with 200ms ON (opening of the pattern) followed by OFF and a certain number of times of a 1 sec ON allowing to identify the nature of the detected problem. If you were to be confronted with an error pattern on the **USR** LED, please write down the pattern you observed and contact your distributor.*

Appendix A - Connector Pinout & Related Specifications

A.1 - Main Connector

As shown in the picture, the female mating connector is labeled with the appropriate symbols.

Characteristic	Value
Connector type	MINICONNEC MC model Type MC 1,5/9-ST-3,5 Pitch = 3.50 mm 9-pin female
Connector pinout	

PIN	ICON	ID	Description
1	O_-	DO_COM	Output signal (0V ground) connected to the emitter of the MOSFET transistor
2	O	DO	Output signal connected to the drain of the MOSFET transistor
3	O_+	DO_VDC	Common of the external predrive power supply (between +12 et +24 VDC)
4	i_-	DI_COM	Ground of the input (isolated)
5	i_1	DI1	Input signal 1
6	i_2	DI2	Input signal 2
7	+	Power in VDD +	between +12 et +24 VDC
8	-	Power in GND -	0V
9	⏚	Functional Earth	

A.2 - Specification of the External Power Supply

The eWON COSY must be powered by a safety Low Power Supply (LPS) in accordance with clause 2.5 of UL/IEC 60950-1 Ed2. Standard, 12-24Vdc, 30W min. Certified for 60°C and for altitudes up to 2000m. The safety LPS power supply is not part of the delivery.

Suggested power supply:

SIEMENS SITOP logo power 24V 2.5A 60W - Siemens order ref: 6EP1332-1SH43.

Equivalents are available on the market.

Power Supply	
Characteristic	**Value**
Power supply voltage	external 12-24 VDC +/- 19%
Max COSY input power	30W max.
Internal voltage protection	max 30V
Input protection	protected against polarity inversion

A.3 - Digital Output & Digital Inputs

Digital Inputs	
Characteristic	**Value**
Type of digital output[2]	Open drain MOSFET
Max. current (ext,source)	200 mA
Isolation (both DI & DO)	1,5 kV
DI voltage range	0 to 24 VDC
DI protection	33 VDC Max
DI OFF state input voltage range	0 to 5 VDC
DI ON state input voltage range	10 to 30 VDC
DI ON state current range	From 3,8 mA @ 12 VDC to 8,2 mA @ 24 VDC

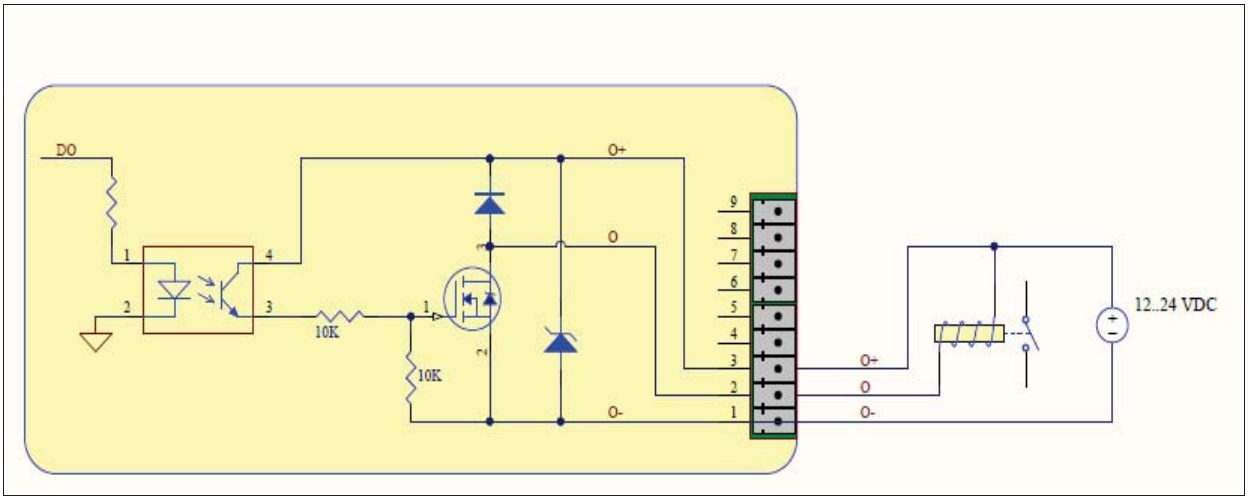
2 *When the eWON COSY reboots, a short phase of ON state is part of the starting process.*

The digital output is activated by an open drain MOSFET transistor driven by an optocoupler. The maximum current flow inside this transistor has a value above the one specified in the eWON, in order to cope with the switching power losses.

The transistor used is in an open drain type with predrive. This means the relay power supply has to be supplied from an external source to the predrive electronics. The diagram below shows the external wiring needed for proper operation of the digital output. A relay has been chosen for this sample application but any load within the specifications can be used instead.

- Note -

This is a sink only output to ground (the transistor acts like a switch ground).



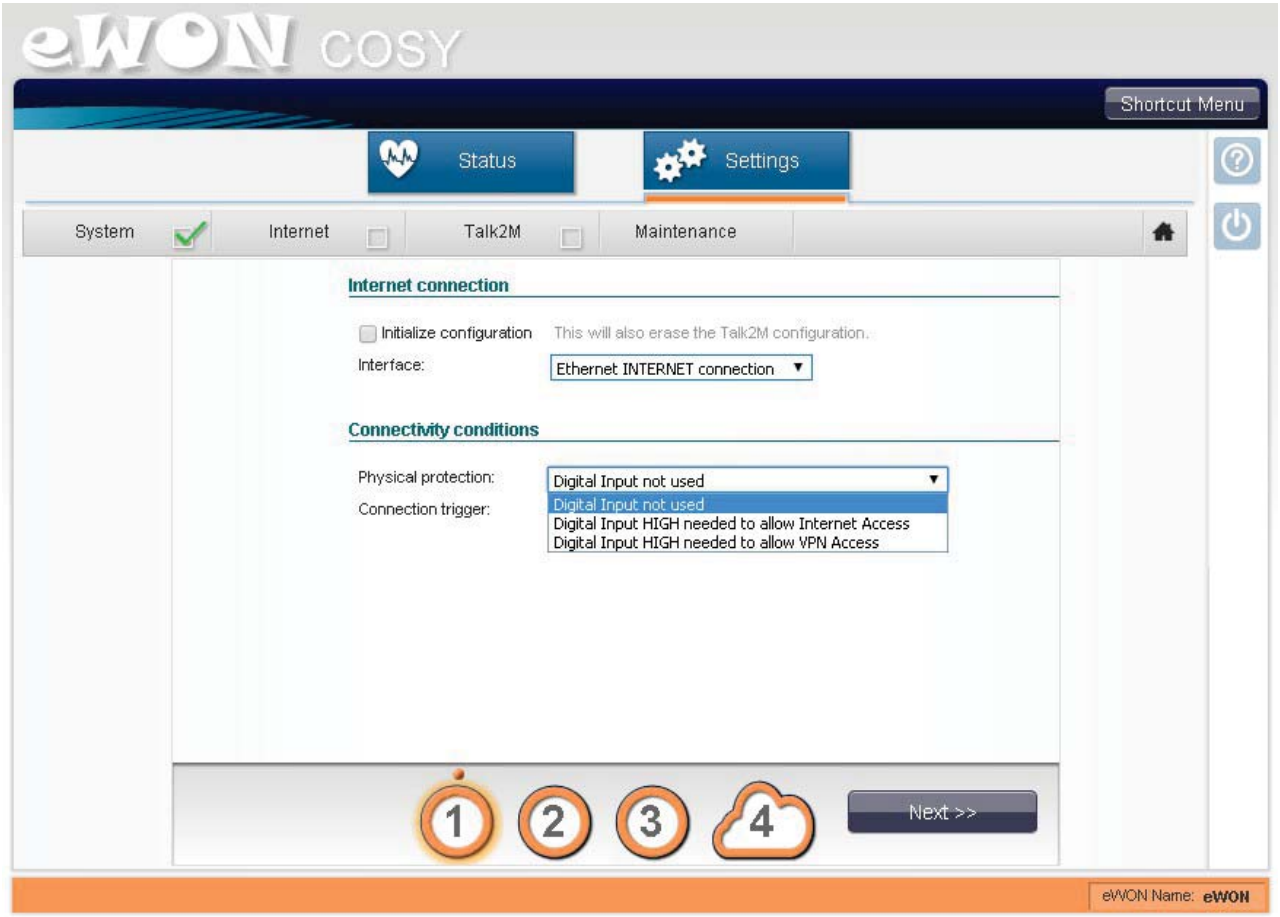
Possible features :

Digital Output & Inputs can be used on the COSY 131, some features can be externalized by wiring the main connector.

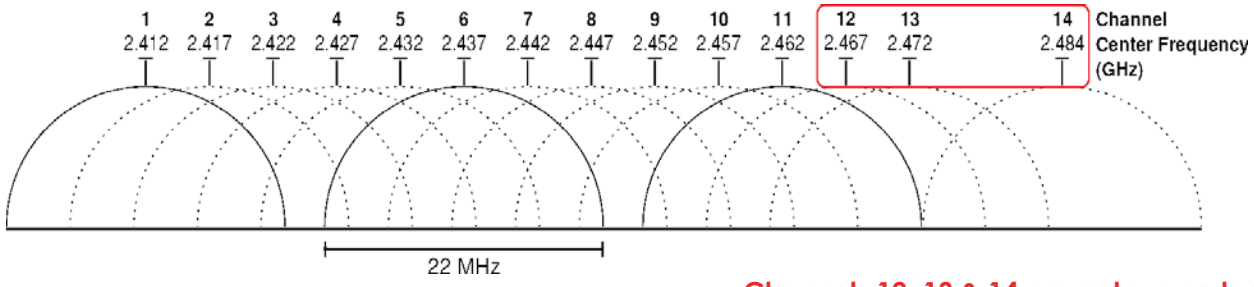
LED	Connector	Description
KEY	**DI1**	On a key switch to authorize or prevent the Internet connection.
		On a key switch to authorize or prevent the VPN connection.
DI2	**DI2**	Not supported.
T2M	**DO**	Can be wired to an external device to propagate the Talk2M status. If the VPN connection is active, the DO is set to 1.

Digital Input (DI1) can be used as a connectivity condition.

The configuration of this condition has to be done during the Internet Wizard where you define if the digital input is used or not and for which purpose.



A.4 - Used Wireless Frequencies



- **Channels 12, 13 & 14 are not supported**

Used channels and frequencies are between: Channel 1 - 2,412 Ghz and 11 - 2,462 Ghz

Revision

Revision History

Revision	Date	Description
1.0	22/01/2015	Original Document
1.1	04/02/2015	Pictures modifications
1.2	27/04/2015	WiFi & DI/DO Updates (3.4.1 A.3, A.4)
1.3	30/06/2015	Added Cabling rules (#2.4.3.Cabling rules)
1.4	17/11/2015	Added section 3.5: LAN Switch Specifications
1.5	11/01/2016	Modified DO Diagram

Document build number: 86

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eWON sa, Member of ACT'L Group

MicroClear®

MANUAL

FILTER MCXS2 and MCXL2
COMPACT FILTER HOUSING MA-/MB-SERIES

Directions for Installation, Operation and Maintenance

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MicroClear®

MANUAL

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1. Product Specification

1.1. Designated application

The wastewater treatment plant must be operated with specified wastewater only.

For membrane bioreactor applications the feed water may not contain any materials harmful for, or even kill, the micro-organisms in the biological treatment stage. Do not feed the plant with disinfectants or similar substances.

Only specified wastewater with specified capacity is permitted to be fed into the plant. It is not permitted to feed the plant with excessive amounts of:

- surface water,
- cooling water, or
- rain water

as this will lead to plant overloading and malfunction.

The unit is intended exclusively for the above specified use. Any additional use or re-building of the equipment without prior written approval by the manufacturer does not comply with the intended use. The manufacturer will not assume liability for consequential damage to the plant or the environment. The operator alone will bear the risk.

Do not start up the plant before it has been ensured that all safety devices are completely mounted and operable, and that the plant complies with the rules.

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1.2. General safety instructions

This **Installation, Operating and Maintenance Manual** has to be kept available at all times. Any person who has to perform work on the wastewater treatment plant must have access to this manual.

In addition to this manual, common legal instructions in the sense of the labour protection law and ordinance regulating the use of tools have to be available.

As this manual contains fundamental instructions to be observed when installing, operating and servicing the filter housing, the responsible staff must read the instructions prior to machine installation and start-up. Not only the general safety instructions contained in this chapter have to be observed but also the special safety instructions added under the main items.

1.2.1. Definition of safety, warning and instruction signs

General warning sign

This symbol will accompany all important instructions or warnings associated with risks of life or limb as well as severe damage to equipment. Follow these instructions and proceed carefully! At the same time, follow all applicable laws, general safety and accident prevention regulations.

Attention symbol

Special attention is required to ensure compliance with instructions concerning correct operating sequences to prevent damage to the plant or its function.

Notice symbol

This symbol is found where an action or a procedure is recommended to ensure the correct handling of equipment or units.

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Safety and instruction signs must be strictly followed and should be directly attached to the plant.

These signs should be kept in absolutely readable condition. Signs or labels that have become unreadable must be replaced immediately.

1.2.2. Obligation and duty for operational care

To achieve operational safety, it is necessary to obey the following procedures. It is the operator's obligation to plan these procedures and control their implementation.

The operator must especially ensure that

- Equipment is employed according to its intended use (see chapter "Product Specification"). Any use not in compliance with the plant's specified intended use will invalidate the warranty.
- Regular maintenance and the checkups are carried out according to the chapter "Maintenance". The operator is responsible for the effluent quality.
- The filter housing should be operated only in a perfect ready-to-operate condition.
- This operation and maintenance manual is permanently available on site in complete and legible condition.
- Only sufficiently qualified and authorized personnel are in charge of unit operation, maintenance and repair.
- Any safety or warning symbols attached to the plant remain there in a legible condition.
- All relevant data is recorded at least once per day, especially filtration pressure and effluent output.

1.2.3. Qualification of operating and maintenance staff

Only well-trained and briefed persons who know this manual and act according to this manual are authorized to operate the unit. The individual areas of responsibility of operating staff must be defined clearly.

The training of personnel must be held in the beginning under the supervision of an experienced person. Successfully completed training and briefing must be confirmed in writing.

Non-observance of this instruction will invalidate any warranty.

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Any person performing work on the wastewater treatment plant must read this installation, operation and maintenance manual and confirm by signature that the manual has been completely understood.

Maintenance personnel must be trained specifically for plant maintenance works, beyond the standard of knowledge that the operating staff has already, preferably well trained and experienced staff.

1.3. Safety instructions for installation, inspection and maintenance

The following points should be recalled and ensured by the operator during the installation, inspection or maintenance works:

- Switch off all current-carrying equipment before starting work.
- Sealed or closed rooms of the wastewater treatment plant which need to be entered for service and maintenance have to be aerated in order to prevent a dangerous explosive atmosphere, lack of oxygen and presence of harmful concentrations of gas or vapour.
- Follow the instructions from the plant manufacturer for the exact work procedure.

It is in the operator's own interest to clean the plant prior to working on it, this helps to prevent the danger of infections.

When cleaning the plant, avoid direct contact with wastewater, organic material, etc. Always wear protective clothing, e.g. waterproof protective gear, boots, gloves, to keep these materials from your body. If possible, also wear face protection.

Do not use a high pressure cleaner but only a soft water jet.

Before starting the machine again, check the items mentioned in chapter "Starting up". Reattach all equipment or components completely to their original place and assure that they are properly and completely reattached.

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2. Installation

2.1. Preparation of the installation

Observe once more the following instructions when installing the equipment to avoid any damage to the equipment and other physical damage.

- Only qualified persons are permitted to perform installation work, observing the safety instructions.
- Check the unit for transport damage prior to starting any installation work.
- Make sure only authorized persons have access to the working area and that installation work does not endanger any other persons.
- Read also the chapter "General Safety Instructions".

2.1.1. Acceptable environmental conditions

MicroClear® filters must be protected against frost. In operation, the optimum working temperature is between 15 and 35 °C. The use of filters at lower temperatures is possible, but results in less flux (please contact us for an exact estimation).

2.1.2. Requirements on the minimum dimensions of the tank

Following dimension details of the tank should be used as a design guideline.

Filter housing	No. of filters	Filter-area [m²]	Typical max. flow* [m³/day]	Size of the filter housing [L x W x H in cm]	Min. size of the filtration tank [L x W x H in cm]	Min. water depth [cm]
MA03-S	1 MCXS2	3.5	2.0	28.3 x 32 x 68.4	50 x 50 x 150	120
MA03-M	2 MCXS2	7	4.0	28.3 x 32 x 117.4	50 x 50 x 200	170
MA03-XL	1 MCXL2	8	5.0	43 x 35 x 64.5	70 x 50 x 150	120
MA03-XL2	2 MCXL2	16	10.0	43 x 35 x 113	70 x 50 x 200	170
MB2-S	4 MCXL2	32	20.0	59.8 x 49.6 x 135.5	100 x 100 x 200	170
MB2-M	6 MCXL2	48	30.0	80.8 x 49.6 x 135.5	120 x 100 x 200	170

* Values depend on the wastewater characteristics and regular chem. cleaning

It is important to maintain a minimum distance between filter housings and the tank's side wall to ensure a low pressure loss for the runoff of water that rises inside the filter housing.

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2.2. General instructions

Installation must be carried out in accordance with these instructions if installation is not part of the supply contract with newterra GmbH, or an authorized trader or maintenance company. If the installation is not performed according to this installation, operation and maintenance manual, newterra GmbH cannot accept responsibility for incorrect offloading or installation.

Installation should be performed by qualified and experienced personnel.

The following actions should be carried out in order to maintain optimal operation of the MicroClear®- filter cassettes and compact MA/MB- series:

- Completely read this manual. It contains important information how to prevent damage caused by lack of knowledge.
- Make sure that the tank is leak-proof and has a correct dimension according to the guidelines of newterra GmbH.
- The tank must be emptied and cleaned before beginning the installation work inside the tank.

2.3. Assembly

Be careful not to mix up any lines as air in the permeate line would destroy the module.

In some cases the membrane surface can stick together on new filters. Don´t pull the plates apart, otherwise the active layer will be damaged.

Sticking membranes are no quality issue, the membrane will come apart as soon as the surface ist wet.

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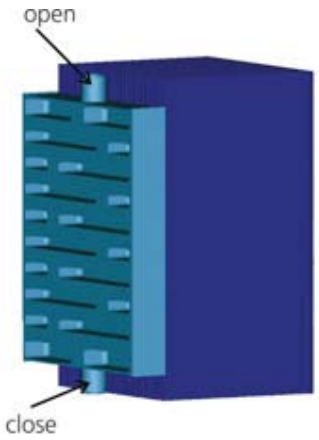
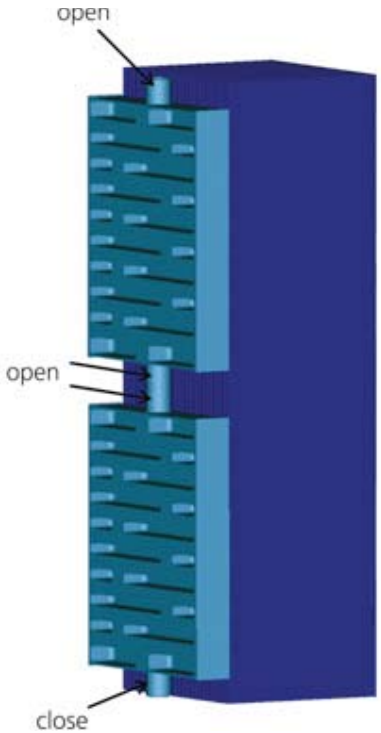
2.3.1. Arrangement of the filters

Individual filter (one layer)



- Check the permeate nozzles of the filter. The open nozzle must be used at the top side of the filter.
- Plug the lower nozzle according to the instructions below.
- Attach and fix a hose with inner diameter 25 mm to the open nozzle.
- Connect the other end of the hose with the permeate extraction unit.
- If required, use reduction.
- Operate the MicroClear cassettes only in original MicroClear® filter housings.

Arrangement of filters in multiple layers



- Check the open permeate nozzles of the filters.
- The filter to be used at the bottom of the stack must have only one open nozzle. Plug the lower nozzle according to the instructions below.
- Make sure that the filter to be used at the top of the stack has open nozzles on both sides.
- Arrange the filters as shown in the illustration.
- Connect and fix the open nozzle of the bottom filter with the open nozzle of the top filter by using a hose with inner diameter 25 mm. Alternatively use a 25 mm PVC connector, see below.
- Attach and fix a hose with inner diameter 25 mm to the open nozzle of the top filter and connect with the permeate extraction unit.
- If required, use reduction.
  Operate the MicroClear cassettes only in original MicroClear® filter housings.

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2.3.2. Installation of a plug

Notice

From the factory, the MicroClear® filter bottom nozzle is open.
To close, follow the instructions given below!
Needed parts are given with each single filter.

a. Install 2 o-rings (15,6 x 1,78, EPDM) into the two grooves of the plug.

b. Add lubricant certified for connecting systems in drinking water to the plug and the o-rings.

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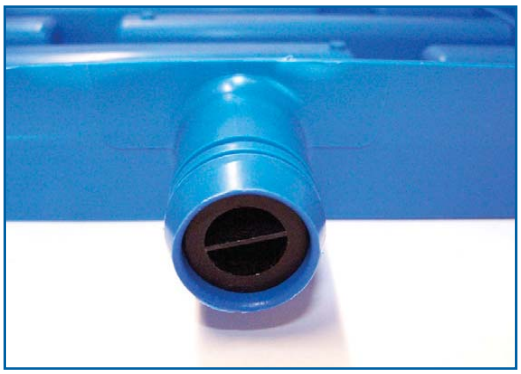
c. Insert the plug with the o-rings into the nozzle. Press gently and make sure, that the o-rings stay in the grooves and are not squeezed away.

d. Press the plug all the way into the nozzle until it cannot be moved any further. The friction holds the plug in place up to a tested back-flush pressure of 1,5 bar (max. allowable back-flush pressure is 0,1 bar). If necessary, the plug can be removed with pliers.



e. The MicroClear® MCXL is now ready for use.

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2.3.3. Connection of two MicroClear® using a PVC fitting and O-rings

MicroClear® filters can be connected with Standard PVC fittings nominal size 25 mm. The O-rings made of EPDM have a size of 21,95 x 1,78 mm and can be ordered with Art.-No. 30100360. It is mandatory to use a lubricant as shown above for the mounting of the O-ring and the fitting.

Permeate withdrawal is always from the top of the filter! Filters are mounted in upward direction into a closed frame. Aeration is from below.

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3. Starting Up

3.1. Procedure of starting up

3.1.1. Checks prior to operation

1. Check the horizontal alignment of filter housings.
2. Check that filter modules and filters are secured against buoyancy.

3.1.2. Clear water test

1. The filtration tank should be filled with clear water prior to starting the filtration unit.
2. Switch on the blower and check for an even distribution of air across the complete filter area.
3. Switch on permeate removal at a filtration pressure of 0.05 bar.

If all components function normally, empty the tank and fill with mixed liquor.

3.1.3. Prerequisites for operation with sewage

	Make sure that the biomass concentration of activated sludge is below 12 g/l at start-up.
	Screening the water with a 2 mm punchhole screen is essential to prevent the build-up of a blockage beneath the filters. This could result in an uneven distribution of air and damage filters. Industrial water and an unusual amount of fibres require special design for pre-treatment.
	No untreated wastewater should enter the membrane. Make sure water is completely biologically treated before it gets to the membrane.

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4. Operation and Control

4.1. Operating a new filter

When starting the system, the trans-membrane pressure (TMP) should be set to max 0.07 bar in order to prevent irreversible blockage of the membranes. After one to two days the suction pressure can be increased until the design output is reached. The run-in period, due to a so-called “dirt layer” that develops, is terminated when output of the unit will only decrease over a period of a couple of days.

4.2. Continuous operation

4.2.1. Filtration pressure

In continuous operation, filters are operated with a transmembrane pressure (TMP) of 0.1 to 0.15 bar. Exact regulation of suction pressure is essential for long-term operation. Fluctuating pressure should be avoided as it leads to an early blocking of membranes.

The filtration pressure, filtrate flow and air flow must be recorded daily and given to the manufacturer in the case of guarantee claims.

4.2.2. Temperature

The filter can be operated within a wide range of ambient temperature. However, the following maximum limit should be observed.

Maximum short term	50 °C
Maximum long term operation	40 °C
Standard operation	15 °C - 35 °C

Furthermore the filter may not be exposed to frost.

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4.2.3. Aeration

The air blower for scouring must always be in operation when the filtration process is running. A failure in blower operation will lead to severe blockage of the membranes.

The recommended value for the amount of air for scouring the membrane at operating pressure is given in the following table.

“At operating pressure” means, that the resistance of the water column (e.g. 2 m = 200 mbar) has to be added to the resistance of the diffuser (e.g. 80 mbar). For this example, the blower has to deliver the following amount of air at 280 mbar (see blower curve).

Filter module	Aeration rate (Nm³/h)		Flange connection [DN/NPS]
	Relax	Filtration	
MA03-S, MA03-M	6	3	19 / ¾”
MA03-XL, MA03-XL2	10	5	19 / ¾”
MB2-S	20	10	80 / 3”
MB2-M	30	15	80 / 3”

Exceeding these values will lead to abnormal wear or damage of the filters or of the diffusers.
The aeration must be switched off for 20 minutes per day to allow for a relaxation of the diffuser membrane.

The air blower for scouring must always be in operation when the filtration process is running. A failure in blower operation will lead to severe blockage of the membranes.

Exceeding these values can lead to abnormal wear of the filters or of the diffusers.

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5. Maintenance

Never expose the filter to frost, dust, rain or direct sunlight.

5.1. Cleaning of the MicroClear® Filter

If permeability has decreased below 50 l/m²hbar, a basic chemical cleaning of filters is necessary (depending on the application once or twice per year). The filter must be put into a cleaning tank, in which the cleaning chemicals are filled. In the case of an external filter setup, the filter tank must be emptied and filled with clear water.

Maintenance is only to be carried out by qualified and trained personnel! Chemicals can lead to serious injuries. Always wear protective glasses, clothing and, if possible, gloves. Obey the safety data sheet of the chemical manufacturer!

The following procedures are recommended for chemical cleaning of the ultrafiltration membrane. Keep the working temperature between 20 to 25 °C for all steps.

- Step 1: Immerse the filter inside a tank of NaOH solution, pH 11 for 3 hours.
- Step 2: Immerse the filter inside a tank of NaOCl 200 ppm (max. 500 ppm) (calculated as active chlorine) for 8 hours.
- Step 3: Rinse the filter with tap water.

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Web www.microclear.de

Rinse thoroughly with clear water to avoid the formation of chlorine gas!

- Step 4: Immerse the filter inside a tank of citric acid, pH 2 for 1 hour.
- Step 5: Finally, check permeability with tap water.

Normal permeability after cleaning: 150 to 300 l/m²hbar. If this value is not attained, repeat cleaning or use different detergents after contacting newterra GmbH.

5.2. Spare parts

Common spare parts such as permeate collector pipe, air diffuser, or filter module can be ordered directly from newterra GmbH or from a related partner of newterra GmbH.

Do not use any replacement parts other than those recommended by newterra GmbH. Use of third-party parts without informing or consulting with newterra GmbH will invalidate the warranty.

5.3. Persistence of the membrane

The raw water should comply with the attached compatibility chart. Furthermore, it must be:

Lipophilic substances average	< 25 mg/l
Lipophilic substances maximum	< 50 mg/l

Silicones and solvents must be avoided completely. Long molecules in general result in membrane blockage and should be avoided. This is especially true of flocculation aids based on polymers (polyelectrolyte) and antifoaming agents. Antifoaming agents based on silicone must be avoided completely as the can block membranes irreversibly.

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MicroClear® Compatibility chart

Group		SP-Type membrane
Chlorinated solvents	Methylene Chloride, Chloroform, Carbon Tetrachloride, Chlorobezene, Trichloroethane (< 1%)	--
Esters	Ethyl Acetate, Butyl Acetate, Butyl Acrylate (< 1%)	--
Ethers	Ethyl Ether, Polyethylene Oxide (< 1%)	--
H_2O_2	< 2000 ppm	++
Inorganic acids	HF, HCl, H_2SO_4	pH 0 - 14
Ketones	Acetone, Methyl Ethyl Ketone	--
NaOCl	< 500 ppm, 50.000 ppmxh	++
Organic acids	Sulfamic Acid, Formic Acid, Oleic Acid, Sulfonic Acid, Acetic Acid, Acrylic Acid, Lactic Acid	pH 0- 14
Phenols		--
Silicones		--
Alcohols	Ethanol, Butanol, Isopropranol (< 50%)	
Aldehydes	Formaldehyde (< 1%)	++
Alkali		pH 0- 14
	Dimethyl Formamide, Dimethyl, Acetamide, Dioxane, N-Methyl, Pyrrolidone, Tetramethyl Acetamide	--
Aprotic solvents	Benzene, Toluene, Xylene, Anthracene, Naphathalene, Gasoline	--
Aromatic hydrocarbon	Methoxyethanol, Ethoxyethanol, Buthoxyethanol	?

++ = very good
+ = good
- = fair
-- = not recommended

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6. Additional information

If any additional information is required, please contact newterra GmbH, contact see below.

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Installation, Operation & Maintenance

MANUAL

For:

T-Type Disc Diffusers

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M-CP005D-EN
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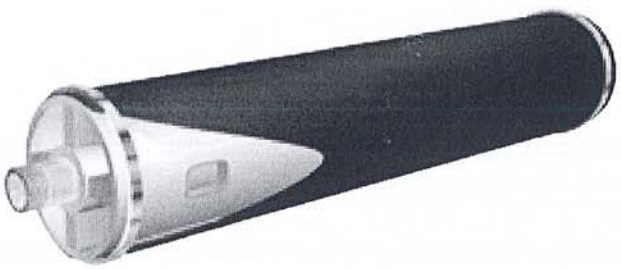
aeration for life

PRODUCT SPECIFICATIONS

FlexAir™ T-Series Tube Diffuser

Fine Bubble Flexible Membrane



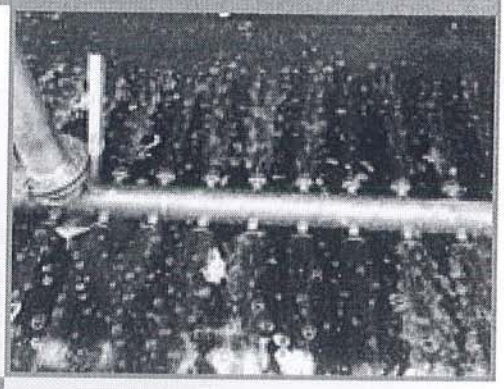
- 62 mm and 91 mm diameter tube diffusers with standard length options from 250 mm to 1000 mm
- Choice of PVC or CPVC material diffuser tubes available
- Stainless Steel ¾" male pipe thread or plastic ¾" female pipe thread connections available
- Premium quality membranes available in EPDM, PU, PTFE Matrix™ or PTFE-coated, silicone, or other materials
- Triple-check design minimizes entry of liquid/solids into air feed piping
- High-capacity membrane option available for maximum airflow and low operating pressure
- Non-buoyant flo-thru design for reduced uplift and stress on mounting connection

Model	Membrane Performance	Design Airflow (membrane)		Overall Length (membrane)		Active Surface Area (membrane)		Dry Weight (diffuser)		Net Operating Buoyancy (diffuser)	
		scfm	m^3_N/h	in	mm	ft^2	m^2	lb	kg	lb	kg
Magnum 91–1003	Micro	0–20	0–32	39.5	1003	2.64	0.245	5.4	2.4	1.7	0.76
	High-Cap	0–35	0–55	39.5	1003	2.64	0.245	5.4	2.4	1.7	0.76
Magnum 91–762	Micro	0–15	0–24	30.0	762	1.97	0.183	4.3	2.0	1.2	0.55
	High-Cap	0–26	0–41	30.0	762	1.97	0.183	4.3	2.0	1.2	0.55
Magnum 91–502	Micro	0–9	0–15	19.8	502	1.25	0.116	3.1	1.4	0.73	0.33
	High-Cap	0–17	0–26	19.8	502	1.25	0.116	3.1	1.4	0.73	0.33
Standard 62–1003	Micro	0–13	0–21	39.5	1003	1.71	0.159	3.9	1.8	1.9	0.85
	High-Cap	0–23	0–36	39.5	1003	1.71	0.159	3.9	1.8	1.9	0.85
Standard 62–762	Micro	0–10	0–15	30.0	762	1.27	0.118	3.4	1.5	1.1	0.50
	High-Cap	0–17	0–27	30.0	762	1.27	0.118	3.4	1.5	1.1	0.50
Standard 62–650	Micro	0–8.0	0–13	25.6	650	1.07	0.099	3.2	1.4	0.76	0.35
	High-Cap	0–14	0–22	25.6	650	1.07	0.099	3.2	1.4	0.76	0.35
Standard 62–610	Micro	0–7.6	0–12	24.0	610	1.00	0.092	3.1	1.4	0.63	0.29
	High-Cap	0–13	0–21	24.0	610	1.00	0.092	3.1	1.4	0.63	0.29

Environmental Dynamics International

FlexAir™ T-Series: Tube Membrane Diffuser

Processes:
Biological Aeration
Activated Sludge Processes
Oxidation Ditch
Sequence Batch Reactors (SBR)
Membrane Bio Reactors (MBR)
Moving Bed Bio Reactors (MBBR)
Sludge Stabilization/Digestion
Package Plants



Applications:
Municipal Wastewater
Industrial Wastewater
Fixed Grid Systems
Lift-Out Systems
Floating Systems
Tank Mixing
High Oxygen Transfer
Low Head Loss

Industries:
Food and Drink
Dairy and Cheese
Pulp and Paper
Oil and Gas
Animal Processing
Leachate
Energy and Power
Pharmaceutical

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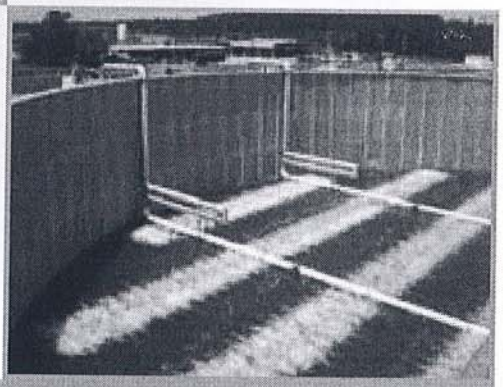

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Storage Instructions

Receiving Inspection

R.2015-06-17

(FOB EDI only)
Inspect shipments for damage upon receipt. The recipient/receiver is responsible for all damages. EDI offers to act on behalf of the recipient / receiver in filing a claim for damage incurred during shipment. To file a claim against the freight company, a damage report must be submitted to EDI within 24 hours of delivery.

(FOB Jobsite only)
Inspect shipments for damage upon receipt. Any damages observed upon receipt must be noted with the freight company at the time of delivery and reported to EDI within 24 hours of delivery. EDI will repair or replace damaged goods when notified within this notification period.

(Ex-Works only)
Inspect shipments for damage upon receipt. The recipient/receiver is responsible for all damages. To file a claim against the freight company, file a damage report directly with the shipping company.

Note
A full inventory of shipped components shall be completed within 14 days of the receipt of shipment. Any deficiencies in the shipment that are clearly deemed to be the result of EDI will be reconciled by EDI when notified within this time period.

Pre-Installation Storage Requirements

R.2015-06-17

Pipe sections are furnished with end caps to minimize the entry of foreign materials (dirt, debris, etc.) into the pipe. Any foreign materials that are allowed to contaminate the pipe will need to be removed from the system prior to installation and start-up.

Piping Storage Requirements:

- Store Piping on a flat surface.
- Accessories must be protected from excessive moisture and rain.
- Storage is acceptable provided the ambient air temperature is below 140°F (60°C).
- Avoid impact loads and moisture when storing below 32°F (0°C).

Note
Piping and components are to be shaded from sunlight if stored for longer than 6 months.

Diffuser Storage Requirements:

- Boxes must be protected from excessive moisture and rain.
- Storage is acceptable provided the ambient air temperature is below 100°F (40°C).
- Shade or move Components indoors if the Ambient air temperature exceeds 100°F (40°C).
- Indoor storage is acceptable if the ambient air temperature does not exceed 125°F (52°C).

Note
Storage of diffuser membrane components shall be limited to one year.

Post-Installation Storage Requirements for a Flexible Membrane System

R.2015-06-17

If the reactor is drained and the aeration system is exposed for a short period of time (less than 4 weeks), the system shall be protected from foreign objects including but not limited to paint or weld splatter, falling objects, etc.

A gray fabric tarp should be suspended above the aeration system approximately 6" (150 mm) if the ambient air temperature is above 100°F (40°C).

Warning ⚠
Do not use any form of plastic to cover the aeration components. Plastic can create a hotter environment and/or fuse to the surface of the equipment.

If the aeration system is idle for an extended period time (greater than 4 weeks), the system should be submerged in approximately 4 feet of clean water provided the ambient air temperature is greater than 32°F (0°C).
If the ambient air temperature is below 32°F (0°C), the water level may need to be increased so that the ice layer does not contact the aeration system.

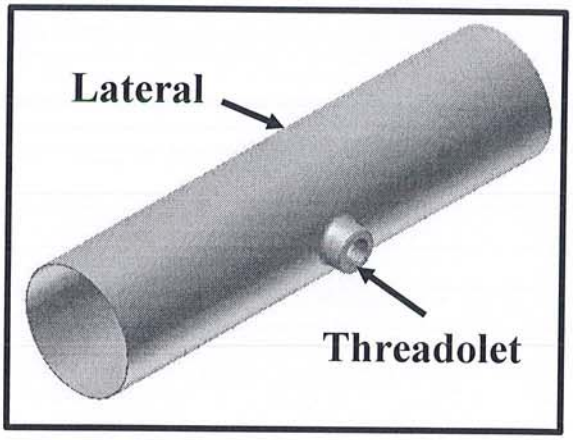
When reactivating a system where ice exists, operate the system at a minimum airflow to avoid movement of ice and maintain this airflow condition until the ice is no longer present. The water level should never be lowered if ice is present. The weight of the ice may damage the system

Installation Instructions

FlexAir T-Series Installation

R.2015-12-07

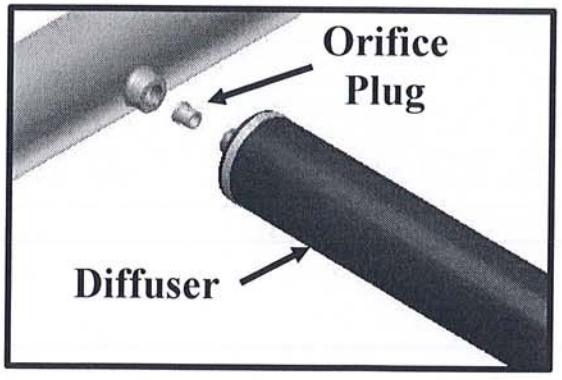
Inventory all parts to ensure no shortages and familiarize yourself with the layout drawings and installation details.



Note

PTFE thread sealant tape should be applied to all steel to steel threaded connections. EDI recommends Hercules Mega-Loc brand pipe dope on all plastic to plastic or plastic to steel threaded connections for lubricant and sealant (pipe dope containing PTFE is potentially damaging to plastic parts).

1) Apply thread sealant to the threads of the T-Series.
2) Insert the orifice plug into the T-series diffuser (if provided).



3) Thread diffuser into threadolet until hand-tight.

Note

The T-series diffuser should be oriented with the unperforated sections on top and bottom.

4) Repeat steps 1-3 for remaining diffusers.

Leveling of Diffusers

Air distribution through the aeration system is a function of the relative elevation of the individual aeration units and the leveling tolerance of the air supply piping. Excessive variation in pipe elevation (see Start-up Instructions) may result in poor air distribution during normal operation.

Start-Up Instructions

General Aeration/Mixing Systems Start-Up Instructions

R.2015-11-24

These instructions cover the general start-up requirements for the aeration system. Special start-up requirements outlined in the Engineer's specifications, contract documents, or instructions offered by EDI shall be supplementary to or take precedence over these general instructions.

General Air Piping Inspection

Contractor is to confirm the cleanliness of the air piping. If existing header piping is used, the air purge or water flush cleaning procedure is recommended prior to installation of diffuser units to remove any internal debris that may have accumulated in the header piping.

Inspect air piping and diffuser connections for loose fittings or damaged pipe. Damaged piping sections and connections should be repaired prior to commencing system operations.

Confirm that piping and diffusers are level by filling the basin with water until the diffusers are 1" to 2" under water. Diffuser elevation tolerance should be within the approved tolerance for the respective diffusers. Adjust supports as required to level the air supply piping (on which the diffusers are mounted) to within a tolerance of ±1/4".

Blower Components

See the blower installation and start-up instructions to assure all blower components are mounted properly and ready for operation. When EDI provides the blower assemblies, detailed installation and start-up instructions are provided in the blower submittal package.

Blower components should be fully installed and fully serviced prior to making final electrical connections and starting up the aeration system.

Precautions should be taken throughout system installation to minimize the discharge of airborne particles to the aeration system. As a minimum, an air inlet filter should be installed and operated during blower servicing procedures. EDI recommends a filter efficiency of 93% of 10-microns. Any solvents used to clean blower should be bypassed from the aeration piping. The discharge of airborne particulate matter or solvent into aeration piping may result in damage to diffuser membranes.

Upon completion of blower manufacturer's recommended service, the subsequent start-up procedures may be followed.

Initial System Start-Up

To start the system, completely open all valves in the air supply system, including blower shut-off valves, header valves and lateral isolation/throttling valves. This instruction assumes that uniform water level is present in all aerated basins served by a common blower. If varying water levels are present, basins with lower water levels will need to have the valve to that basin throttled back to avoid improper air distribution. Failure to completely open all valves may result in over-pressuring blower unit, release of pressure relief valve, motor overload, or poor air distribution in aeration system with the potential of exceeding airflow capacity to diffuser units and damaging the diffuser membranes.

Once valve positions have been confirmed, the blower unit may be started. EDI does not recommend starting multiple blower units at initial system start-up. Subsequent blowers should be brought on-line after the system has equalized and uniform diffuser activity is observed throughout the system.

Use the blower manufacturer's recommended start-up procedures. EDI recommends that initial pressure surge be reduced through PRV or blow-off valve.

Start-up procedures should follow the basic guidelines as listed below:

- When starting initial blower, the PRV or blow-off valve should be used to reduce the start-up pressure surge. This is accomplished by removing weights and the cap from the PRV or by opening the blow-off valve.
- When the basin has been filled, note the operating pressure at the blowers. The pressure relief valve should be adjusted to free-flow at approximately 1 psig above the normal operating pressure of the system.
- To confirm the PRV operates, partially close blower shut-off valve until PRV releases air. Reopen the shut-off valve to confirm that PRV will reseat. If required, readjust the PRV to the recommended setting per instructions in the Blower IOM manual.
- To properly assess the airflow distribution on the aeration system, the blower system must be operating at the design operating point. On dual blower systems, design airflow is typically achieved by operating one blower at 100%. On three-blower systems, design airflow is typically based on operating two blowers at 100%.
- Airflow distribution adjustment between aeration grids should not be conducted until the full operating depth is obtained and the blower system has been in operation for several days. Small adjustments may be made to the isolation/throttling valves on the laterals receiving the most air. System balancing should be completed on an incremental basis. Changes in airflow distribution may require 2-8 hours to fully

stabilize when fine-tuning a system. In addition, in situations where multiple basins are employed and varying water levels exist, adjustments of lateral valves will be required to maintain air distribution in the tanks.

EDI recommends that the system Operator contact EDI at 573-474-9456 prior to making any adjustments to the airflow distribution.

Active Aeration Inspection

With the blower system active, operate the aeration system at 50% design air capacity. At this setting, check piping and diffusers for obvious leaks, and repair as required. Open any manual purge valves to expel water that may be in the piping. Close the purge valves once all water has been expelled.

Check for minor leaks by completing the following steps:

- Turn the airflow down to very minimal release. If the system employs separate drop valves, each grid can be checked separately by throttling the valve one at a time. Again, take care not to exceed airflow capacities in neighboring aeration grids when reducing airflow by this method.
- The airflow will not be uniform at this low level. This is acceptable, as this test is only used to check for small leaks that are not visible with the design amount of airflow. Check for any observed leaks and repair as required.

Leaks commonly occur due to:

- Missing or misaligned O-ring
- Torn membranes
- Loose disc retainer ring

Optional Water Flush and Air Purge Cleaning of Piping

R.2015-06-17

These instructions cover the general procedure that may be used to clean the piping in a fine or medium bubble diffuser system prior to diffuser installation. Special pipe cleaning requirements outlined in the Engineer's specifications, contract documents, or instructions offered by EDI shall be supplementary to or take precedence over the general instructions outlined below.

If both water flush and air purge cleaning are used, the water flush procedure should be implemented first.

Water Flush Cleaning

To water-flush the system, connect a water supply to the air header or make individual connections to each lateral. If flush water is piped to the header, it is imperative that the header be valved or stubbed such that water does not flood the blowers.

Clean water must be used. It is not necessary to use potable water, but the flush water must be free of silt or debris.

Flush header assembly prior to water flushing the laterals. To flush the header, fill it with water and open the end lateral to create a flush velocity in the header of at least two feet per second.

The laterals are to be individually flushed at a recommended velocity of five to six feet per second. This is done by sequentially opening and closing the isolation valves on the individual laterals.

Opening one isolation valve will produce a significant flushing action in the lateral as water is pumped through the header. One or two drilled air outlet holes should be uncapped to allow water and debris to be flushed out of the piping.

As an alternative to using the main header/lateral flush procedure, the individual laterals may be cleaned independently of the main header. For this operation, the laterals are disconnected from the main header and cleaned individually.

Air Purge Cleaning

Remove weights and cap from the pressure relief valve during initial start-up of the system. This prevents potential damage to the blowers from blocked valves or obstructions in piping system. Cap and weights can be added back to the pressure relief valve as necessary to provide proper operating pressure capability.

Note

When a blow-off valve is provided for the blower system, it may be operated in lieu of using the pressure relief valve procedure listed above.

Open all lateral valves prior to start-up of the blowers. Provide an opening at the end of the air laterals to allow air and foreign materials to be discharged from the system. The opening may be made at the end of the air lateral by leaving the end cap off of the lateral or by removing two orifice/outlet plugs at the end of the lateral.

In order to increase the velocity of air through the header and air laterals, it may be desirable to operate at maximum blower capacity. In addition, it may be necessary to close some of the lateral throttling valves to achieve a high velocity through the balance of the laterals that are open to the atmosphere. A high velocity is required in order to blow out any accumulated foreign materials.

As laterals are consecutively cleaned, the isolation valves are operated in a manner that allows the remaining laterals to be cleaned by an air purge.

Upon completion of the air purge, the blowers are shut down and the laterals are capped. Diffuser units are installed on the laterals and all isolation valves are opened prior to filling the basin with water.

If only an air purge is used to clean the piping, the basins are now ready to be filled with water to check the operation of the diffuser units

Safety Considerations

General Safety Considerations

R.2015-06-17

The diffused aeration system supplied on this project has no moving parts and poses little to no risk of injury. However, routine maintenance may expose personnel to potential hazards. EDI has listed below potential hazards and recommended precautions when maintenance procedures are required for the aeration components.

Tank Hazards (at full liquid depth):

- *Turbulent liquid action.*

Precautions:

- *Provide access to emergency throw rope or life ring.*
- *Use buddy system and follow standard safety procedures.*

Tank Hazards (empty):

- *Falling into tank.*
- *Objects falling onto personnel in the tank.*
- *Slippery basin floor.*

Precautions:

- *Avoid access ways without railings.*
- *Provide emergency exit/access.*
- *Appropriate personal safety equipment*

Personal Protection Measures

Wastewater has a potential for health hazards because it may carry disease producing organisms and a variety of chemical wastes. It is important to employ good personal hygiene practices to prevent oral and skin contact with wastewater.

The following is a list of methods to prevent direct contact entry of pathogenic organisms:

- Wash hands frequently with soap and water after contacting wastewater, visiting restrooms, before eating, drinking, or smoking; and at the end of jobsite visit. When soap and water are not available use anti-bacterial hand wash specifically formulated for use when soap and water is not convenient.
- Promptly treat cuts and abrasions using appropriate first aid measures.
- Handle sharp items with extra care to prevent accidental injuries.
- Clean contaminated tools after use.
- Follow good common sense and exercise extra caution whenever there is contact with contaminated water or sludge.
- Never touch face, mouth, eyes, ears, or nose while working with wastewater or sludge.

Personal Protective Equipment

Wear heavy-duty gloves (or double gloving) and boots that are waterproof and puncture resistant. When practical, use thin disposable latex gloves for light work. Use reinforced rubber gloves for heavy activities.

Discard gloves that become torn and try not to submerge hand below top of glove during service activities. When it is not feasible to use gloves while installing or inspecting equipment, make sure to follow personal hygiene practice listed above.

Wear goggles in the presence of heavy aerosols, dust, or when splashing of wastewater might occur.

Wear protective clothing; if possible, shower and change clothes before leaving plant site. If work clothes are washed at home, separate from the family wash and use chlorine bleach.

Confined Space Hazard

Verify the designation of the tank before entering. Wastewater tanks or basins can be considered confined spaces and contain potential hazards. Flammable, explosive, toxic, or other hazardous substances or the absence of sufficient oxygen could cause injury, acute illness, disability, or death.

Particular care should be exercised to assure NO hydrogen sulfide, chlorine or other heavier than air gases have accumulated in the basins or tanks. DO NOT ENTER ANY CONFINED SPACE until your supervisor has verified that proper safety precautions have been met. Do not enter a confined space without someone else present on the outside and do not enter a confined space without proper rescue equipment outside the confined space. Every confined space entry has a unique set of hazards, but atmospheric monitoring and proper entrance procedures can minimize the hazards entry personnel typically encounter.

Operation Instructions

Description of the Aeration-Mixing System

R.2015-06-17

The aeration-mixing system employs a main air header and valved lateral piping system to distribute air throughout the basin. EDI normally designs the aeration system piping to provide uniform air distribution without adjustment to the isolation/throttling valves on the laterals. However, these valves are typically provided for direct control of airflow distribution on large aeration systems or for process control. If process demands dictate a revised airflow distribution pattern, contact EDI for guidance on modification to the system.

Normal Operation of the Aeration System

The following procedures should be followed on a regular basis to assure consistent and satisfactory performance of the aeration-mixing system.

The air rate to the system may be adjusted to maintain the desired dissolved oxygen levels in the basin. When adjusting the airflow rate, the diffusers should be operated within the normal operating range of the diffuser. Excessive airflow rates will result in high pressure drops across the diffuser and reduced oxygen transfer performance. Low airflow rates may result in incomplete utilization of the diffuser membrane and reduced air distribution.

The aeration-mixing system is designed to provide uniform aeration. Positive dissolved oxygen concentrations should be present throughout the entire system during normal operation.

A dissolved oxygen profile analysis may be used to confirm the performance of the aeration system. Typically, the dissolved oxygen levels are measured at the inlet, the outlet, and the midpoint locations of each basin to determine the aeration system performance. In regulating the system airflow to control dissolved oxygen levels, the diffuser units should be operated within their minimum and maximum airflow limits.

In applications where water level variations may exist between aeration basins supplied by a single blower, the isolation valves may need to be adjusted to maintain adequate airflow distribution. This normally requires valving back the air to the basin with the reduced water level.

Note

It is important to confirm the operating airflow range of the diffuser units before valving back any isolation valve. Damage could result to the aeration diffuser if airflow is above the recommendations noted in the Product Specification Sheet. Please consult EDI to confirm operating procedure before adjusting any aeration isolation/throttling valve.

Normal Operation of the Blower System

The Aeration-Mixing System normally utilizes a centrifugal or positive displacement (PD) blower system consisting of one or more blower units for normal operation plus one on-line spare unit. All blower units including the spare unit must be operated on a regular basis to maintain their proper working condition. EDI recommends that blower units be operated sequentially with idle blower units brought on-line weekly. EDI does not recommend the simultaneous operation of on-line and spare blowers for an extended period. This operating condition may deliver airflows exceeding the air capacity of the diffuser units.

All blower components should be serviced on a regular basis. For additional information concerning proper blower operation, service requirements or service intervals, reference the Blower Operation and Maintenance manual.

Shutdown Conditions

If air service is interrupted at any time, it should be restored as soon as possible. When restarting positive displacement blower units, the start-up pressure surge should be reduced by down-weighting the pressure relief valve (PRV) or operating the blow-off valve. Once the blower is operational, reset the PRV or slowly close the blow-off valve over a five- to ten-minute period. The PRV must be set properly to prevent overloading of the blower system. Operate manual water purge devices if provided. If the PRV releases air for an extended period of time, the relief setting should be checked.

Normal Operation of the Diffuser Unit

The diffuser unit has no moving parts and requires very little maintenance for long-term operation. EDI recommends that the air supply to the diffusers be maintained at all times for optimum performance. The airflow to the diffuser units must be kept within the ranges noted in the Product Specification Sheet to maintain the structural and operating characteristics of the diffuser membrane. Continuous application of high airflows, greater than denoted for normal operation, may result in physical damage to the diffuser membrane.

Note

Use caution when adjusting several lateral throttling valves in the same piping system. This procedure can result in elevated airflows in sections of the basin, exceeding the maximum allowable airflow to each diffuser unit.

Normal Operation of the Purge Assembly

Condensation will accumulate in the subheader and lateral piping due to the cooling of the air when it reaches the EDI aeration system. EDI has provided a purge assembly to remove this accumulation from the pipe while the system is in operation. If a manual purge assembly has been provided, open the ball valve at the top of the purge assembly on a monthly basis. Allow the water to exit through the valve until only air remains. Close the ball valve once the purging process has been completed.

Preventive Maintenance

Maintenance Schedule

R.2015-06-17

In order to be covered by the manufacturer's warranty the FlexAir aeration system must be maintained. EDI recommends to visually inspect the overall system and clean the membranes to remove any accumulated foulants on an annual basis. This activity is beneficial to the Owner, as a reduction in the uniformity of air release or an increase in backpressure will impact the power use. The FlexAir aeration system is designed to allow the system to be accessed by dropping the water level in the basin being serviced.

Note

To prevent solids from entering the system, it is important to keep the air flowing through the system until the water level has dropped below the lateral piping.

The air to the basin being serviced should be turned off after the water has dropped below the lateral piping and diffusers to prevent the possibility of excessive airflows to the units or damage to the blower unit.

The following items may be helpful in servicing the FlexAir aeration system during periodic inspections or maintenance procedures:

- Protective gloves and clothing
- Long-handled soft bristle brush for cleaning assembly for observation
- Spare FlexAir membranes

All system components should be inspected for general wear or damage. This includes but is not limited to:

- Pipe supports including anchor bolts, pipe straps and fasteners.
- Pipe connection including fasteners, shifts in alignment of pipes and joints.
- Diffuser assembly including position, membrane integrity, membrane clamps / retainer ring, etc.
- Purge assembly components including all connections, anchor points, and wear at any contact points.
- Any worn or damaged components need to be repaired or replaced. Please contact EDI for assistance in identifying a root cause and solution.

In Situ Cleaning of Membrane

Typically membrane diffuser units will require cleaning because of two common types of surface build-up; biological and inorganic scaling.

Biological build-up is a moss-like growth. The recommended cleaning procedure is to physically dislodge the growth either by gently brushing the substance off with a soft plastic bristle brush or by using low-pressure hosing. Care should be taken not to abrade the rubber membrane surface during the cleaning procedure.

In Situ Acid Cleaning

When standard cleaning methods do not produce desired results, inorganic scaling may be present and may require an alternate cleaning technique. Inorganic scaling is a granular mineral-like precipitate that can form on the membrane surface.

Warning ⚠

Read all applicable SDS (Safety Data Sheets) carefully and follow all instructions given therein. Always have new users familiarize themselves with the SDS before handling chemicals. Wear personal protective equipment (including, but not limited to, rubber gloves, safety goggles, and other protective clothing) as required.

The foulant adhered to a membrane can be tested with a solution of muriatic acid (20° Baume Hydrochloric Acid, 31.45% by weight HCl) for reactivity. This may indicate the nature of the foulant and its propensity for chemical cleaning. Ensure that the air supply has been turned off from the diffusers being serviced. Afterwards, place a small amount of acid on the surface of the membrane where fouling is most prevalent. If the foulant is reactive to acid, this is indicative of inorganic fouling, such as calcium deposits, and acid cleaning is recommended. Otherwise, the foulant is typically organic and acid cleaning may not prove effective.

If it is determined that the foulant does respond to acid, the membrane may be cleaned with acid in addition to manual cleaning. This technique involves applying Muriatic Acid directly to the membrane surface after the manual cleaning procedure followed by rinsing with a low-pressure hose. In the case of ceramic diffusers, the acid is typically applied both on the surface and pumped through the diffuser using air.

Note

EDI can provide an acid injection system, upon request, for cleaning aeration systems without process interruptions. Contact EDI for more information.

Membrane Protection

The diffuser membranes should be protected from chemicals that may be harmful to the material. If using a cleaning aid or other substance on or around the membranes, please contact EDI for chemical compatibility.

Corrective Maintenance

Troubleshooting

R.2015-06-17

The FlexAir aeration system requires very little maintenance for long-term operation. Periodic visual inspection of the system should allow the Operator to determine if the system is performing at optimum levels.

Operating airflows below the design condition will also reduce the uniformity of air distribution. If operating conditions warrant airflow rates below the design condition, contact EDI for additional operational guidelines.

Below are symptoms and procedures to follow if inspection of the aeration system reveals abnormal operating characteristics:

Large volume of air in localized area	
Possible Cause	**Procedure**
Air leak in aeration piping.	Access area in question. Inspect joints for evidence of breakage.
Diffuser membrane damaged or missing.	Inspect diffuser units for membrane damage. Repair as required.

Decreased diffuser activity and increased back pressure noted at blower	
Possible Cause	**Procedure**
Diffusers becoming fouled or deformed.	Access diffusers and inspect for external or internal fouling or deformation.
Reduced blower discharge air volume.	Confirm blower operating point and rpm reading.
Restriction in air header.	Confirm isolation valve position on header and drops.

Dissolved oxygen profile not satisfactory throughout basin	
Possible Cause	**Procedure**
Increased loading to system.	Confirm loading to system.
Reduced blower discharge air volume.	Confirm blower operations.
Improper distribution of air in system.	Inspect piping for leaks, both in-basin piping and out of basin piping leading from the blower system.
Air leak in system.	
Excessive foulant accumulated on diffuser.	Access diffusers and inspect for external fouling.

Replacing Diffuser Assembly

R.2015-12-15

If routine inspections reveal the need to replace a diffuser assembly, revert back to the installation instructions for the removal and reinstallation of components. Any parts damaged during removal should be replaced.

Questions regarding the aeration-mixing system operation, maintenance, etc. should be forwarded to Environmental Dynamics International, 5601 Paris Road, Columbia, Missouri 65202. +1(573)474-945

AerationWorks™

Global Maintenance & Installation Services

Customer Support Services

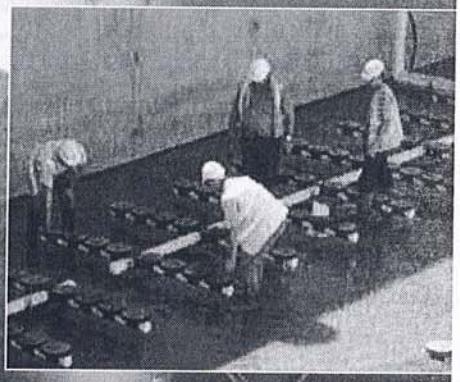
- **Install New Aeration Systems**
- **Maintain or Refurbish Existing Aeration Systems**
- **Develop and Implement Long-Term Maintenance Programs**
- **Service and Support for all Brands of Aeration Systems**

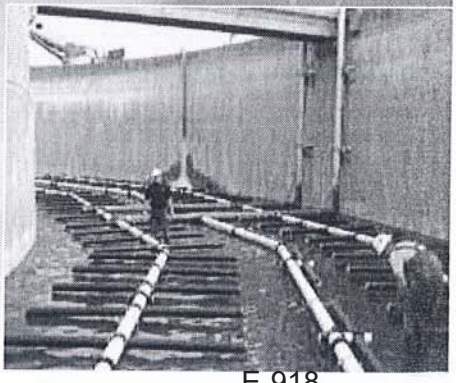
"The EDI Aeration Works division provides experts in the installation and maintenance of any aeration system, including supervision and/or the skilled labor pool to perform the actual service"

- Chuck Tharp, PE
Chairman • Environmental Dynamics Inc.

Aeration Works maintains special equipment, tools and skilled crews for installation and service on any aeration construction or maintenance project.

Contractors, owners and operating companies can better utilize their own personnel, equipment and resources by enlisting the support of the EDI Aeration Works Division.





EDI Aeration Works personnel have the experience and knowledge to handle unique systems and offers a cost effective alternative for installation and maintenance of your aeration system.

AerationWorks™

Global Maintenance & Installation Services

5601 Paris Road • Columbia, MO 65202 • USA

+1 877.EDI.AIR8 (334-2478)

info@aerationworks.com

Environmental Dynamics International

Service Department

Quality In-House & On-Site Customer Service

EDI provides Field & Customer Service directly from its worldwide headquarters located in Columbia, Missouri, while maintaining Authorized Field Service offices around the globe.

Services may include visits made by an Authorized EDI Service Representative to a project site and may provide any or all of the following:

Train on-site personnel in the proper installation and assembly of all EDI equipment.

Inspect installation to provide verification of general conformance to EDI specifications and requirements.

Provide startup services to ensure that the equipment is operating satisfactorily after installation.

Train plant Owners/Operators in long term operation and maintenance procedures for the EDI equipment that has been installed.

Provide troubleshooting investigation or inspection when requested by the customer, with regards to EDI equipment installation

MotorSaver®
THREE-PHASE ELECTRIC MOTOR PROTECTOR

INSTALLATION INSTRUCTIONS FOR SYMCOM'S MOTORSAVER®
MODEL 460

DANGER!

HAZARDOUS VOLTAGES MAY BE PRESENT DURING INSTALLATION.
Electrical shock can cause death or serious injury.
Installation should be done by qualified personnel following all national, state and local electrical codes.

BE SURE POWER IS DISCONNECTED PRIOR TO INSALLATION!
FOLLOW NATIONAL, STATE, AND LOCAL CODES!
READ THESE INSTRUCTIONS ENTIRELY BEFORE INSTALLATION!

! WARNING !

UNEXPECTED OUTPUT ACTUATION CAN OCCUR.
Use hard-wired safety interlocks where personnel and/or equipment hazards exist.
Failure to follow this instruction can result in death, injury or equipment damage.

The Model 460 MotorSaver® is an auto ranging voltage monitor designed to protect three-phase motors regardless of size. The MotorSaver® is used on 190-480 VAC, 50 to 60 Hz motors to protect from damage caused by single phasing, low voltage, high voltage, phase reversal, and voltage unbalance.

CONNECTIONS

1. Mount the MotorSaver® in a convenient location in or near the motor control panel. If the location is wet or dusty, the MotorSaver® should be mounted in a NEMA 4 or 12 enclosure. The MotorSaver® can be mounted to a back panel using two #6 or #8 x 5/8 screws or can be snapped onto a DIN rail.
2. Connect L1, L2 and L3 on the MotorSaver's terminal strip to the LINE SIDE of the motor starter. (See Figure No. 1).
3. Connect the output relay to the circuitry to be controlled. For motor control, connect the normally open contact in series with the magnetic coil of the motor starter as shown in Figure No. 1. For alarm operation, connect the normally closed contact in series with the control circuit as shown in Figure No. 2.

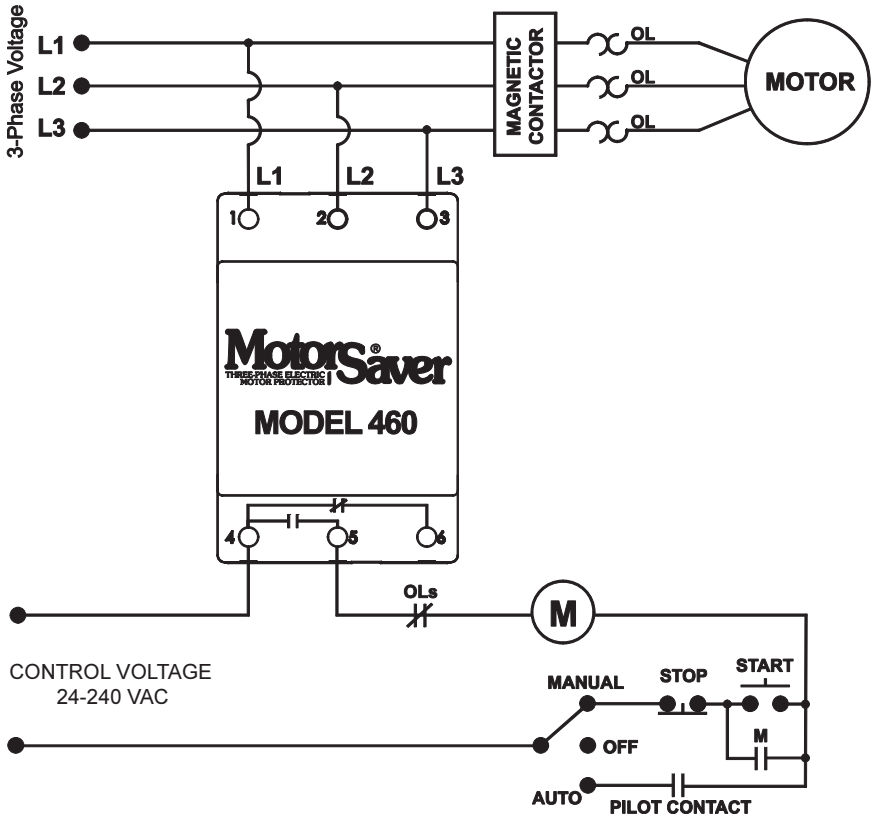


FIGURE NO. 1: CONTROL WIRING DIAGRAM

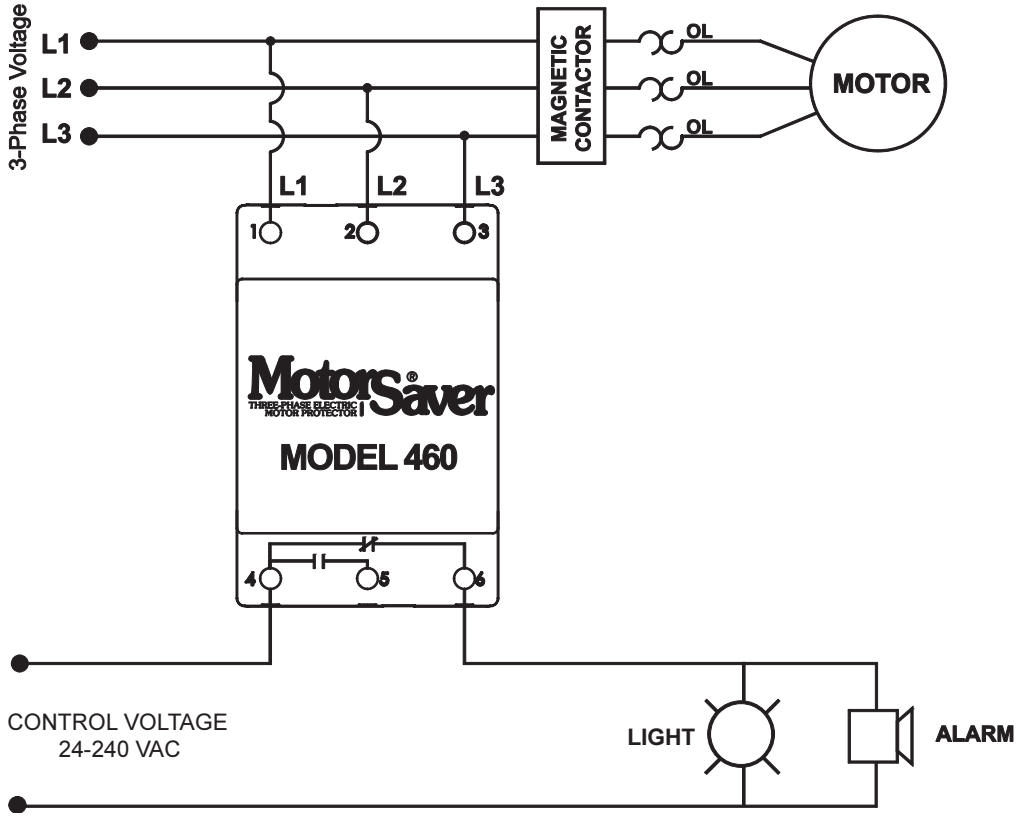
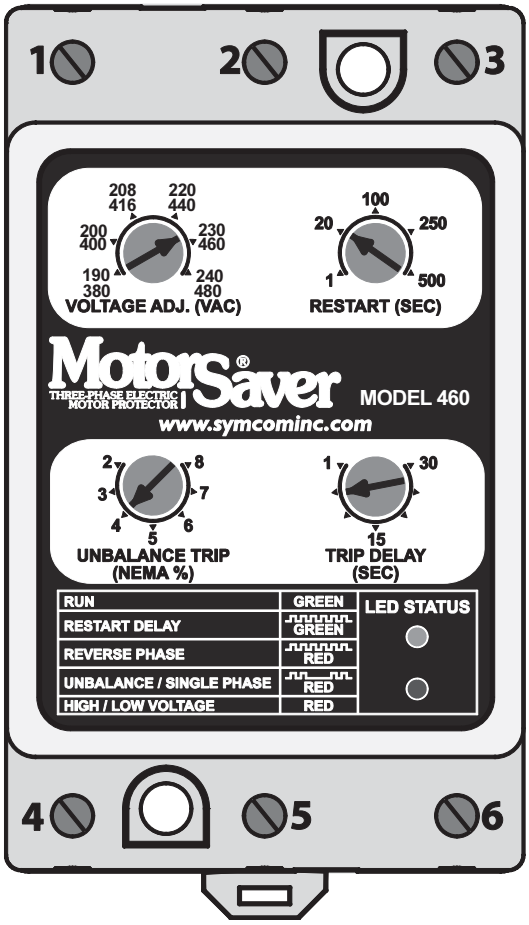


FIGURE NO. 2: ALARM WIRING DIAGRAM

SETTINGS



1. Line voltage adjustment: Rotate the **"VOLTAGE ADJ. (VAC)"** to the nominal three-phase line voltage feeding the motor to be protected.
2. Restart delay adjustment: Rotate the **"RESTART (SEC)"** adjustment to the desired position. The restart delay is the time between MotorSaver® seeing acceptable voltage and the MotorSaver® closing its output contacts. For compressor applications, the restart delay should be set for the approximate time it takes for the head pressure to bleed off of the compressor. For other applications, the restart delay is typically set between 2 and 10 seconds.
3. Trip delay adjustment: Rotate the **"TRIP DELAY (SEC)"** adjustment to the desired setting. This adjustment does not affect the trip delay on phasing faults. Typically, the trip delay adjustment is set between 1 and 5 seconds. In areas where voltage fluctuations are frequent, the trip delay adjustment may be set greater than 10 seconds.
4. Voltage unbalance adjustment: Rotate the **"UNBALANCE TRIP (NEMA%)"** adjustment to the desired unbalance trip level. The NEMA MG1 standard does not recommend operating a motor above 1% voltage unbalance without <u>derating</u> the motor. The NEMA MG1 standard also recommends against operating a motor above a 5% voltage unbalance under any circumstances. SymCom recommends consulting the motor manufacturer for specific tolerances.

$$\text{Percent Unbalance} = \frac{\text{Maximum Deviation from the Average}}{\text{Average}} \times 100$$

Example: The measured line-to-line voltages are 203, 210, and 212.

$$\text{Average} = \frac{203 + 210 + 212}{3} = 208.3$$

The maximum deviation from the average is the largest difference between the average voltage (208.3) and any one voltage reading.

208.3 - 203 = 5.3 210 - 208.3 = 1.7 212 - 208.3 = 3.7

The maximum deviation from the average is 5.3.

$$\frac{5.3}{208.3} \times 100 = 2.5\% \text{ Unbalance}$$

POWER-UP

Turn on the 3∅ power to the motor. The MotorSaver's green RUN light will blink during the RESTART delay. After the RESTART delay, the MotorSaver® will energize its output contacts and the green RUN light will illuminate. If the contacts do not energize and the RUN light does not illuminate, see the TROUBLESHOOTING section.

DIAGNOSTIC INDICATOR LIGHTS	
RUN	GREEN
RESTART DELAY	GREEN
REVERSE PHASE	RED
UNBALANCE / SINGLE PHASE	RED
HIGH / LOW VOLTAGE	RED

CONGRATULATIONS!!
YOU HAVE JUST INSTALLED THE FINEST MOTOR PROTECTION AVAILABLE!!

TROUBLESHOOTING

SYMPTOM	LIGHT PATTERN	SOLUTION
No lights are on. The unit seems completely dead.	N / A	Measure the three line-to-line voltages. If any of the voltages are below 150 VAC, the MotorSaver® does not have enough power to operate its internal electronics. This may occur on a single-phased system. If the voltages are correct, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Red light is blinking (on initial power up).	RED	Turn off the three-phase power. Swap any two leads powering the MotorSaver® (L1, L2, or L3). There is a 50-50 chance of connecting L1, L2, and L3 correctly the first time. Re-apply the three-phase power.
Red light is blinking (after the motor has been previously running).	RED	The incoming lines have been reverse phased. The MotorSaver® is preventing the motor from running backwards. Correct the phase sequence.
Red light is blinking in this pattern.	RED	The voltage is unbalanced or single-phased. Measure the incoming line voltages and calculate the % unbalance. If the voltage unbalance does not exceed the % unbalance reset value, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Red light is on steady.	RED	The voltage is out of tolerance. Measure the three line-to-line voltages. Calculate the average of the three voltages. If the average is 7% above or below the nominal voltage as selected by the LINE VOLTAGE ADJUST, the MotorSaver® is functioning properly. If the voltage is within ±7% of the selected line voltage, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Green light blinks and motor is not running.	GREEN	The MotorSaver® is in restart delay.
Green light is on steady, but motor does not start.	GREEN	The MotorSaver® is in run mode. Ensure other control devices are allowing the motor to start. Check control circuit for loose wires or malfunctioning switches.

Any questions or comments call SymCom at 1-800-843-8848 or 1-605-348-5580

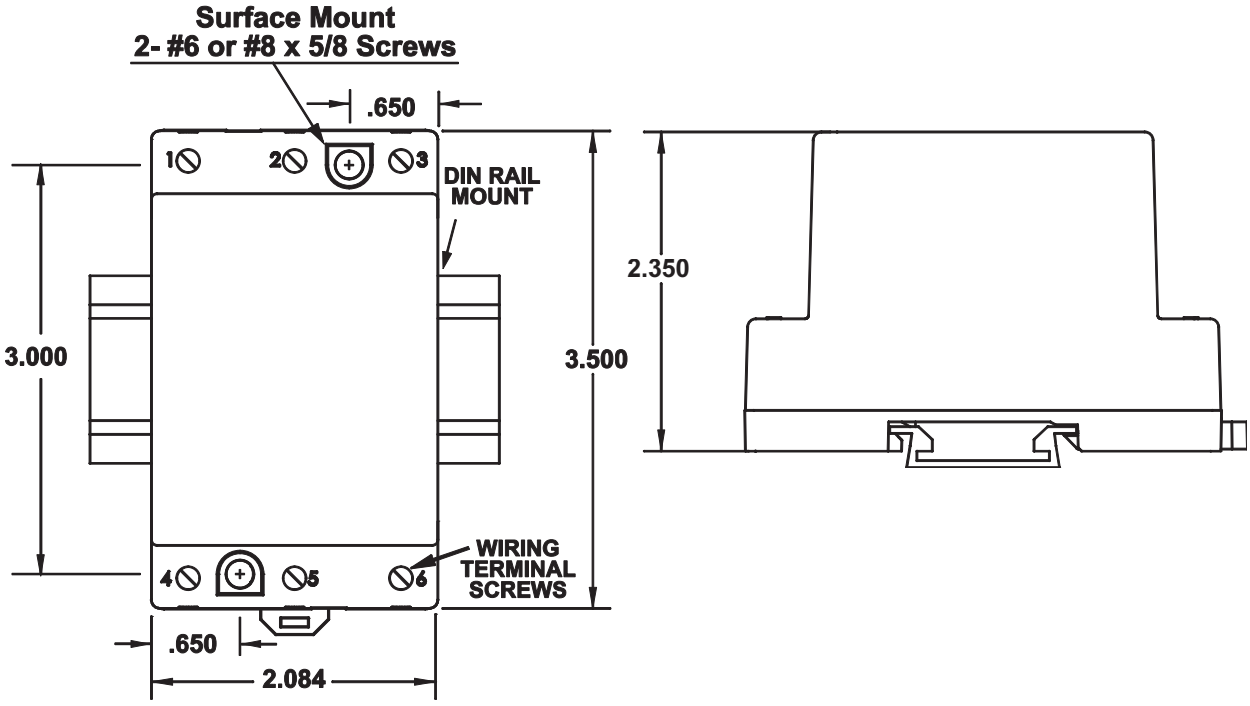
SPECIFICATIONS

3 - Phase Line Voltage	190 - 480 VAC
Frequency	50* - 60 Hz
Low Voltage (% of setpoint)	
Trip	90% ± 1%
Reset	93% ± 1%
High Voltage (% of setpoint)	
Trip	110% ±1%
Reset	107% ±1%
Voltage Unbalance (NEMA)	
Trip	2 - 8% Adjustable
Reset	Trip Setting minus 1% (5 - 8%)
	Trip Setting minus 0.5% (2 - 4%)
Trip Delay Time	
Low, High, and Unbalanced Voltage	1 - 30 Seconds Adjustable
Single-phasing faults (>25% UB)	1 Second Fixed
Restart Delay Time	
After a fault or complete power loss	1 - 500 Seconds Adjustable
Output Contact Rating - SPDT	
Pilot Duty	480 VA @ 240 VAC
General Purpose	10 A @ 240 VAC
Power Consumption	6 Watts (maximum)
Weight	14 oz
Enclosure	Polycarbonate
Terminal	
Torque	6 Inch-Pounds Max.
Wire AWG	12 - 20 AWG
Safety Marks	
UL	UL508 (File # E68520)
CE	IEC 60947-6-2
Standards Passed	
Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 3, 6 kv contact, 8 kv air
Radio Frequency Immunity, Radiated	159 MHz, 10 V/m
Fast Transient Burst	IEC 1000-4-4, Level 3, 3.5 kv input power and controls

*NOTE: 50 Hz will increase all delay timers by 20%

Surge	
IEC	IEC 1000-4-5, Level 3, 4kv line-to-line; Level 4, 4kv line-to-ground
ANSI / IEEE	C62.41 Surge and Ring Wave Compliance to a level of 6kv line-to-line
Hi-potential Test	Meets UL508 (2 x rated V +1000V for 1 minute)
Environmental	
Temperature Range	Ambient Operating: -20° - 70° C (-4° - 158°F) Ambient Storage: -40° - 80° C (-40° - 176°F)
Class of Protection	IP20, NEMA 1 (Finger Safe)
Relative Humidity	10-95%, non-condensing per IEC 68-2-3

DIMENSIONS



SymCom warrants its microcontroller based products against defects in material or workmanship for a period of five (5) years* from the date of manufacture. All other products manufactured by SymCom shall be warranted against defects in material and workmanship for a period of two (2) years from the date of manufacture. For complete information on warranty, liability, terms, and conditions, please refer to the SymCom Terms and Conditions of Sale document.

Visit our website at www.symcominc.com for our complete catalog and new product listings!

SymCom Inc
Motor Protection & Controls Since 1974

2880 North Plaza Drive, Rapid City, SD 57702
Phone: (800) 843-8848 or (605) 348-5580
FAX: (605) 348-5685

P-201/2 - Pump, Centrifugal, Price Pump 1hp 460V 3ph 3600RPMPN: RC200AI-300-26566-100-36-3X6

P-301/2 - Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPMPN: RC200AI-250-26566-75-36-3T7

P-401/2 - Pump, Centrifugal, Price, Misc"RC300AI-4.33-26566-500-36-3T7200GPM @ 60 FEET PRESSURE3600RPM 5HP TEFC 460v3P"

P-501/2 - Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPMPN: RC200AI-388-26566-200-36-3T6

P503 - Pump, Centrifugal, Price Pump 1/4hp 460V 3ph 1800RPMPN: RC200AI-388-26566-25-18-3T6

P-551/2 - Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPMPN: RC200AI-250-26566-75-36-3T7

P-553/4 - Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPMPN: RC200AI-388-26566-200-36-3T6

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

TYPE RC CENTRIFUGAL PUMPS

MODELS: RC 200/300

PLEASE FILL IN FROM PUMP NAMEPLATE

Pump Model_____

BOM. No._____

Serial No._____

RETAIN MANUAL FOR REFERENCE

Price® Pump Company
21775 8th. Street East
Sonoma, CA 95476
Tel: 707-938-8441
Fax 707-938-0764
Email: sales@pricepump.com

Congratulations

You are now the owner of a Price® Pump Co. Centrifugal Pump. This pump was carefully inspected and subjected to final performance tests before being released for shipment. In order to achieve maximum performance and reliability, please follow the simple instructions in this manual.

RECOMMENDED PRECAUTIONS

1. For satisfactory operation and safety, maximum system pressure must not exceed 350 psi* (24.6kg/sq cm).

2. For satisfactory operation and safety, maximum fluid temperature must not exceed 300°F* (121°C).

3. No modifications, additions or deletions should be made to the pump without prior approval of the factory.

4. Drain pump completely and flush with water before servicing a pump handling volatile or harmful liquids.

READ CAREFULLY THE CAUTION BELOW

The performance of your Price® Pump Co. Centrifugal Pump is based on clean, room temperature, water with suction conditions as shown on the performance curves. If used to pump liquids other than water, pump performance may differ from rated performance based on the different specific gravity, temperature, viscosity, etc. of the liquid being pumped. A standard pump, however, may not be safe for pumping all types of liquids, such as toxic, volatile or chemical liquids, or liquids under extreme temperatures or pressures.

Please consult Price® Pump Co. technical specifications as well as local codes and general references to determine the appropriate pump for your particular application. Since it is impossible for us to anticipate every application of a Price® Centrifugal pump, if you plan to use the pump for a non-water application, contact Price® Pump Co. beforehand to determine whether such application may be appropriate and safe under the operating conditions. Failure to do so could result in property damage or personal harm.

* Depends on seal materials and seal type

Visit our website for product information and technical support

www.pricepump.com

INSTALLATION / OPERATING INSTRUCTIONS
CENTRIFUGAL PUMPS

Warning

Before installing, repairing or performing maintenance on this pump, read these instructions completely.

Disconnect power to pump before servicing to avoid dangerous or fatal electrical shock.

Match supply voltage and frequency to motor nameplate values. Incorrect voltage can cause fire or serious motor damage and void warranty.

Ground motor before connection to electrical power supply! Failure to ground motor can cause severe or fatal electrical shock!

Do not ground to gas supply line!

Before disassembling pump, be certain all liquid has been removed. If pump was used to pump hazardous or toxic fluid, it must be decontaminated prior to disassembly.

Close Coupled Motor Pumps

It is suggested that these pumps be firmly bolted to a level surface. Adequate air movement around motor will help prevent overheating.

Do not over tighten inlet and outlet piping or volute may be damaged.

Power Frame Mounted Pumps

Power Frame mounted pumps must be mounted on a rigid base that will not warp or flex. Each pump must be mounted such that the pump shaft centerline is in-line with the driver shaft centerline. Pads and/or shims will be required on the pump, the driver or both to insure proper alignment. The two shafts should not touch each other (end to end) and the distance between them depends on the coupling used to connect them.

Misalignment will cause vibration, bearing failure and void warranty. Pumps are rough aligned at the factory but must be realigned after shipment and installation.

Pulley driven pump must have pulleys inline and proper belt tightness practices followed.

Direction of Rotation

Note: Motor shaft rotation is viewed from the suction end of pump. A rotational arrow is shown on the front of the pump volute casing. Incorrect rotation can cause pump damage, failure or reduced performance, voiding warranty. It is best to check rotation by momentarily energizing or jogging the motor prior to filling pump with liquid.

Warning! Do not operate pump without liquid as damage may result to the pump internal wear surfaces.

Plumbing

All piping needs to be supported independently of the pump. Piping connections should not exert any stress on the pump volute or fittings.

Suction Piping (Inlet)

(Horizontal Pumps)

Suction line must provide adequate suction pressure and even (Laminar) liquid flow for proper pump operation. Air, entrapped in the suction line due to leaks or improper piping design, may cause the pump to lose prime. Non-priming pumps must have their suction 'flooded' at start up (see datasheets for minimum NPSHR). Also, the suction line must provide sufficient pressure (NPSH) and even flow to pump inlet to prevent pump cavitation. The suction pipe entering the pump should be straight and a minimum length of 5 times and preferably 10 times the pump inlet diameter. Elbows, fittings or valves installed close to the pump inlet can disrupt liquid flow and cause cavitation. Suction lines must be at least the same diameter as the pump inlet or larger if possible.

Price Pump Company recommends against using foot valves in the suction line to maintain liquid in the pump when it's not operating. If foot valves are used, due to suction lift conditions, they must be properly maintained to avoid leaks resulting from wear or fouling. Suction piping must be designed to prevent vapor from being trapped in high spots in the piping. This condition may cause the pump to vapor lock.

Discharge Piping (Outlet)

To control flow and discharge head, it is advisable to install a valve (globe, ball, or other adjustable and non-leak type) in the discharge line adjacent to the pump. The valve may be closed during system repairs to prevent backflow. By installing a check valve in the discharge line, backflow can also be prevented during maintenance or during periods of pump stoppage.

Operation

All centrifugal pumps must be filled with liquid prior to start up. It is suggested that during initial start up the discharge valve be closed and then opened as the motor reaches full rpm's. If pump does not build up pressure as motor speed increases, shut down and make sure that liquid flow into pump is not restricted (see "Troubleshooting").

Note: A centrifugal pumps flow rate and head (pressure) will vary with the amount of resistance (pipe friction and flow restrictions) in the discharge line. As the valve on the discharge line opens, the flow rate and motor amperes draw will increase and head (pressure) will decrease. As the valve on the discharge line is closed, the flow rate and amperes draw will decrease and the head (pressure) will increase.

If resistance in the discharge line is not sufficient, the pump will operate at a condition of maximum flow, sometimes called "end of curve" performance. Maximum horse-power is required to operate at this point and motor overload may result. If excessive amperes draw and motor overload is occurring, reduce the system flow rate by installing a valve or orifice in the discharge line to control (restrict) the pumps flow rate. Alternatively, reduce pump head by trimming impeller to a smaller diameter.

Consult Price Pump or a local Price Pump distributor for assistance.

www.appsupport@pricepump.com

1. Pump fails to build head pressure:

Check for:

a. Pump not primed.

b. Incorrect pump rotation.

c. Driver speed too low.

d. Suction line restricted.

e. Driver failure.

f. Plugged or damaged impeller.

g. Pump or impeller undersized.

h. Pump cavitation.

i. Improper impeller clearance.

2. Pump fails to provide enough flow rate.

Check for:

a. System resistance too high.

b. Pump undersized.

c. Pump not primed.

d. Driver speed too low.

e. Poor suction conditions.

f. Improper impeller clearance.

3. Excessive noise or vibration during operation.

Check for:

a. Motor bearing failing.

b. Pump cavitation.

c. Improper impeller clearance.

4. Leaking mechanical seal.

Check for:

a. Improper assembly.

b. Worn or cracked seal faces.

c. Abrasive material in fluid.

d. Liquid flashing at seal faces (Fluid temperature too high).

e. Seal pressure rating too low for the service.

f. Chemical attack of seal components.

g. Seal operated dry or with a liquid having poor lubricating properties.

5. Pump gradually loses pressure and head.

Check for:

a. Increasing temperature causing cavitation or liquid vaporization.

b. Driver failure.

c. Suction lift too high.

d. Air entering suction line.

6. Motor overheating.

Check for:

a. Excessive flow and amp draw (Throttle discharge).

b. Low voltage or frequency.

c. Flow rate too low with resulting heat rise.

d. Bearing failure.

e. System temperature too high.

Before attempting any repairs under warranty, contact Price Pump to obtain factory authorization. Repairs carried out without authorization may void warranty. Many causes of pump failure are due to improper system design. Refer to the trouble shooting list in this manual before carrying out pump inspection or repair.

DISASSEMBLY

1. Disconnect power source to motor.

2. Disconnect electrical connections tagging wires carefully to preserve correct rotation. Loosen motor base.

3. Remove pump and motor assembly to repair area.

4. Remove volute from pump.

5. Unscrew and remove impeller lockdown bolt and lock washers. Slide impeller off shaft. (If 'keyed' shaft design, do not throw away the shaft key).

6. Remove seal head from the shaft. **Type 6A:** Remove seal head from bracket. **Type 21:** Slide seal head from the shaft. **Type 9:** Loosen set screws and slide seal head off shaft.

7. Remove four motor bolts and remove bracket from motor.

8. Remove seal seat from bracket. Use wooden or plastic dowel to remove the seat from the bracket.

REASSEMBLY

If PEO (pump end only) go assembling PEO.

1. Thoroughly clean the seat cavity of the bracket.

2. Thoroughly clean pump shaft. Assure that the shaft is not grooved and that there is no evidence of pitting or scoring. If the shaft is grooved, scored or worn, replace it.

3. Install the pump shaft onto the motor shaft, aligning set screws of the pump shaft with the keyway of the motor shaft. Install slinger between the pump shaft setscrews.

4. **Type 6A**

a. Place bracket on firm surface with seat cavity (pump end) up. Using a tool (1-19/64" ID x 1-5/8" OD x 1/2" deep), press seal into seal cavity with carbon face of seal (volute end up) up. Press until flange is seated in seal cavity of bracket. Press only on outer flange of seal. Avoid touching carbon surface.

b. Place bracket on motor (aligning the base if applicable). Secure bracket with four motor bolts.

c. Pull pump shaft forward until shoulder of pump shaft contacts back of bracket and slightly snug one setscrew to hold shaft in place.

d. Apply small amount of oil (vegetable or other light oil) on the pump shaft and I.D. of seat elastomer. Gently place seat on end of shaft with ceramic face down toward seal. After sliding impeller onto shaft, seat will be properly located.

e. Slide impeller onto shaft ensuring seat is pushed flush with shoulder of shaft and impeller hub.

f. Install shaft key (if applicable), impeller flat washer, lock washers and lockdown bolt. Tighten securely to 10ft.lbs. Caution: Serviceable Loctite (or equivalent) must be used on lockdown bolt. Lock washer pairs must be assembled 'cam face' to 'cam face'. See diagram.

g. Loosen pump shaft set screw.

h. Install new volute gasket or o-ring and mount volute to bracket. Secure with bolts and tighten evenly.

i. **Setting impeller clearance:**

Slide pump shaft forward until impeller touches volute. Slide shaft back .010-.015". Tighten pump shaft set screws. Turn shaft by hand to ensure impeller does not rub against volute. Proceed to step 9.

5. **For Type 21, 8, 9 seals:**

a. Place the bracket on a firm surface with the seat cavity (pump end) up.

b. Place a small amount of light oil on the seat cup or o-ring seat. Place the seat in the seat cavity with the polished face up toward the pump end.

c. Evenly push seat into cavity with fingers then gently tap seat into place with a wooden dowel or plastic rod (1-1/8" outside diameter). To help ensure the seat is not damaged place the cardboard disk supplied with the seal over the seat face.

6. Place bracket on motor (aligning the base if applicable). Secure bracket with four motor bolts.

7. Pull pump shaft forward until shoulder of pump shaft contacts back of bracket and slightly snug one setscrew to hold shaft in place

8. Install seal head assembly

For Type 21 Seals:

a. Lubricate shaft and seal elastomer with oil (vegetable or other light oil).

b. Install rotary seal head onto pump shaft and slide toward seat until carbon face contacts ceramic seat.

c. Install seal spring and retainer.

d. Installing impeller. Install key in pump shaft. Slide impeller onto shaft ensuring that the spring retainer does not slip between the shoulder of the shaft and the hub of the impeller. Install impeller flat washer, lock washers and lockdown. Tighten securely to 10 ft. lbs. **Caution:** Serviceable Loctite (or equivalent) must be used on lockdown bolt. Lock washer pairs must be assembled 'cam face' to 'cam face'. See diagram

e. Loosen pump shaft set screw.

f. Install new volute gasket/o-ring and mount volute to bracket. Secure with bolts and tighten evenly.

g. Slide pump shaft forward until impeller touches volute. Slide shaft back with a screwdriver **.010"-.015".** Tighten pump shaft set screws. Turn shaft by hand to ensure impeller does not rub against volute. Proceed to step 9.

For Type 8 & 9 Seals:

a. Install impeller. Install key in pump shaft. Slide impeller onto shaft and install impeller washer and lockdown bolt. Tighten securely.

b. Loosen pump shaft set screw.

c. Install new volute gasket/o-ring and mount volute to bracket. Tighten at least two bolts at this time.

d. Slide pump shaft forward until impeller touches volute. Slide shaft back **.010"-.015".** Tighten pump shaft set screws. Turn shaft by hand to ensure impeller does not rub against volute.

Remove volute and impeller.

e. Install seal head onto pump shaft sliding gently past shoulder of shaft. Slide seal head toward seat until carbon face contacts ceramic seat. Tighten seal head setscrews to pump shaft. **Remove clips in seal head and discard.**

j. Reinstall impeller, flat washer, lock washers and lockdown bolt. Tighten securely (10 ft. lbs.)

Caution: Serviceable Loctite (or equivalent) must be used on lockdown bolt. Lock washer pairs must be assembled 'cam face' to 'cam face'. See diagram

k. Install new volute gasket or o-ring and mount volute to bracket. Secure with bolts and tighten evenly.

l. Rotate pump shaft by hand to ensure impeller does not rub against volute.

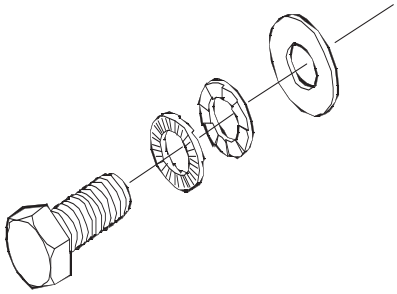
9. Return pump to installation, reconnect electric connections.

10. Start pump momentarily to observe shaft rotation. If rotation corresponds to the rotation arrow, pump may be put into service. If rotation is incorrect, switch any two leads on 3-phase motors. Check wiring diagram of motor for proper single phase rotation.

11. Remove top pipe plug (if applicable) from the front of volute and prime pump thoroughly, making sure all entrapped air is purged.

12. Start pump allowing adequate time to purge all air from system. Observe any gauges, flow meters, etc. to see of pump performs properly.

DIAGRAM OF
LOCKDOWN ASSEMBLY



INSTALLING A PEO (PUMP END ONLY)

a. Place the bracket on a firm surface, loosen stub shaft setscrews and carefully remove shipping plug.

b. Place motor in an upright position with motor shaft pointing upward. Make sure motor shaft and end bell flange are free of burrs and surfaces are clean.

c. Align PEO stub shaft setscrews with motor shaft keyway and carefully slid the PEO onto the motor shaft until it sits firmly onto the motor end bell flange.

d. Oriented the PEO's discharge port or base to preferred motor configuration while referencing the motors electrical box position.

e. Install flange bolts and tighten. (Install pump base if applicable)

f. Reposition pump back onto motor base.

g. Refer to pump Reassembly Instructions and proceed to **setting the impeller clearance**.

Type 21 C Face Style Double Seal Installation

(For Type CD, RC, LT & MS Series Pumps)

Double Seal pumps are generally used for one of these reasons:

1. To avoid seal damage when pumping abrasives.

2. To manage seal temperature when pumping hot liquids.

3. To prevent pump fluid from leaking to atmosphere when pumping toxic or other hazardous liquids.

A double seal must have pressure to the seal chamber at a minimum of 5 PSI preferable 10 PSI above pump pressure.

Flow rate through seal chamber will depend upon pump fluid temperature. Minimum flow should be 1 GPM for CD, RC, LT & MS Series Pumps. Flow rates may have to be increased with higher temperatures. Check the seal chamber discharge fluid temperature to be sure fluid is below boiling. We suggest a 140°F to 150°F temperature range. If seal cooling liquid flashes, seal may become damaged. Seal chamber fluid should enter at the bottom and discharge at the top to avoid entrapped air in the chamber. Be sure to prime the secondary pumping system properly as you would any other system.

CAUTION: Always Pressurize the Seal Chamber before starting the main pump!

In a pumping system that starts and stops automatically, insure that both pumps start at the same time.

REASSEMBLY:

1. Clean seat cavity of the bracket and seal plate thoroughly.

2. Thoroughly clean pump shaft. Assure that the shaft is not grooved and that there is no evidence of pitting or fretting. Polish the shaft with extra fine emery cloth and clean the keyway. If the shaft is grooved, fretted or worn, replace it.

3. Install the pump shaft onto the motor shaft, aligning set screws of the pump shaft with the keyway of the motor shaft. Ensure all debris and burrs are removed from the motor shaft and that the slinger is in place.

4. Place bracket on motor (aligning the base if applicable). Secure bracket with four motor bolts.

5. Pull out pump shaft as far as it will go toward volute end and slightly tighten one set screw to hold shaft in place

6. Place a small amount of vegetable oil (or equivalent) on the seat cup. Install seats into seat plate and bracket with polished faces up. Evenly push seat into seat cavity with fingers, then gently tap seat into place with a wooden dowel or plastic rod (1-1/8" outside diameter). To help ensure the seat is not damaged, place the cardboard disk supplied with the seal under the end of the dowel to prevent damaging the seat face.

7. Install seal head assembly:

For Type 21:

a. Lubricate shaft and elastomer with vegetable oil or equivalent.

b. Install first rotary seal head onto pump shaft and slide toward seat using a twisting motion until carbon face touches seal seat.

c. Install second rotary seal head onto shaft sleeve with carbon facing towards pump end.

8. Install seal plate onto pump end of bracket with new gasket and tighten cap screws evenly (note: use pipe sealant on bolts).

9. Install impeller:

a. Install key in pump shaft.

b. Slide impeller onto shaft.

c. Install impeller washer and lockdown. Tighten to 10 ft-lbs.

10. Loosen pump shaft set screw.

11. Install new volute gasket or o-ring and mount volute. Secure with bolts and tighten evenly.

12. Move shaft back with a screwdriver **.010"-.015"**. Tighten pump shaft set screws. Turn shaft by hand to ensure impeller does not rub against volute.

13. Return pump to installation, reconnect electric connections.

14. Start pump momentarily to observe shaft rotation. If rotation corresponds to the rotation arrow on the pump, it may be put into service. If rotation is incorrect, switch any two leads on 3-phase motors to change rotation. Check wiring diagram of motor for single phase rotation correction.

15. Remove top pipe plug (if applicable) from the front of volute and prime pump thoroughly, making sure all air is purged. Turn shaft one revolution and then refill. Replace the pipe plug.

16. Start pump allowing adequate time to purge all air from system. Observe any gauges, flow meters, etc., to see if pump performs properly.

Double Seal Flush Piping Installation

1. Piping of the double seal arrangement should be done in accordance with all governmental regulations and safety codes.

2. All double seals require a barrier flush between the seals for proper lubrication and cooling. The barrier liquid must be maintained at 10-15 PSIG above the discharge pressure of the pump and it must be chemically compatible with the pumped liquid, material construction of the pump, and seals (5/8" double seals have 18-8 parts).

3. The barrier flush shall have a minimum flow rate in accordance with the graph below. If water is used as a fluid, the inlet temperature should not exceed 140°F.

4. A positive pressure must be maintained to the barrier flush between the seal faces even when the pump is not running. To conserve the barrier liquid a solenoid valve (Item 1) may be installed and connected electrically in parallel with the motor so the barrier fluid flows only when the pump is running. Note: The maximum pressure of the barrier fluid at the inlet is 150 PSIG.

5. The inlet should be connected to the bottom and the outlet to the top of the seal cavity.

Procedures for Checking Double Seals for Internal Leakage

Option 1 - for use with 2 flow meters.

Install flow meters on the inlet and outlet lines. Normal operating conditions will be indicated by equal or near equal flow on both flow meters. If the inlet flow meter shows more flow than the outlet, this could indicate excessive leakage.

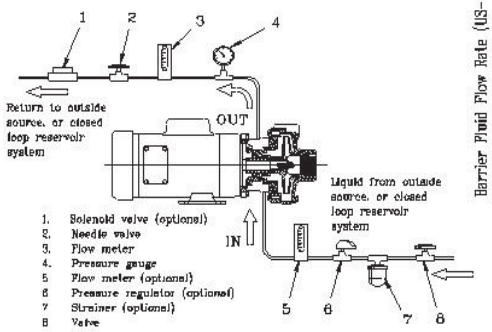
Option 2 - for use with 1 flow meter.

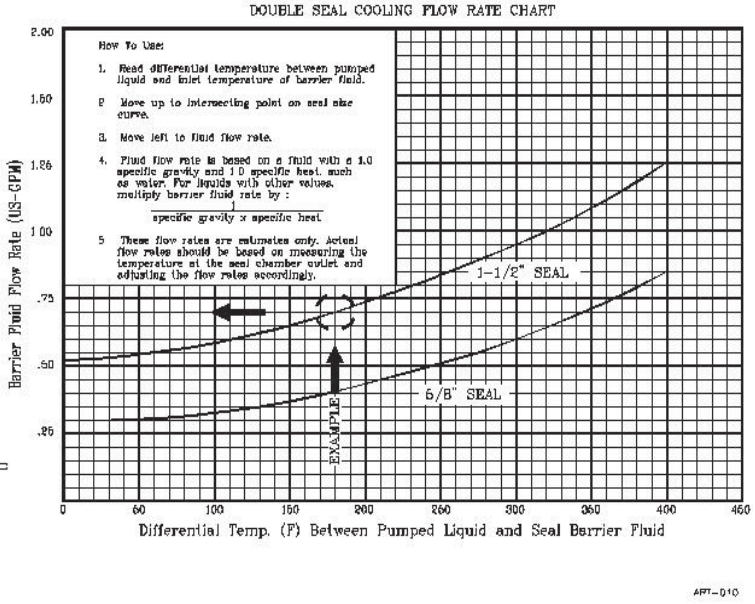
1. Shut off flow at outlet needle valve (Item 2).

2. Shut off inlet gate valve (Item 8) - for 15 seconds maximum.

3. If pressure in seal cavity drops rapidly rather than gradually while the gate valve is shut, the seal is leaking excessively.

4. To restart open gate valve first then reset valve on outlet.





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Key #	Description	Quantity	RC200 Part #	RC300 Part #
A.	Volute SS	1	3710-0	3712-0
B.	Pipe Plugs 1/8”	2	0559	0559
C.	Impeller Specify diameter **			
	SS (Hex bore)	1	3711- (specify dia.)	3713- (specify dia.)
D.	O-ring, Viton	1	3070	3070
E.	Bracket	1	0972	0972
F[1]	Mounting Base	1	0197	0197
F[2]	Volute Bolts	8	0917	0917
G[1]	Motor Bolts		0593	0593
	Base	2		
	No Base	4		
G[2]	Motor Bolts		0673	0673
	Base	2		
	No Base	0		
H.	Hex Shaft w/ setscrews 5/8” ID (56C motor)	1	3714-1	3714-1
H.	Hex Shaft w/ setscrews 7/8” ID (143TC, 145TC, 182C, 184C motor)	1	3715-1	3715-1
J.	Slinger (For 5/8” shaft pumps only)	1	0522	0522
	Seal with Seat			
K[1]	T.21 Fluorocarbon (std.)	1	0553	0553
K[2]	T.9 PTFE (optional)	1	1150	1150
K[3]	Double Seal/Seat (opt):			
	T.21 Fluorocarbon	2	0985	0985
	T.21 Neoprene	2	0984	0984
	T.21 EPR	2	1023	1023
	Double Seal Plate	1	0973	0973
	Plate Gasket, PTFE	1	0974	0974
	Seal Plate Cover Bolts	3	0256	0256
L.	T.21 Quench Opt (For 5/8” shaft pumps only) Fluorocarbon Lip Seal	1	0891	0891
M.	Impeller Lockdown Bolt	1	0596	0596
N.	Impeller Lockdown Washer	1	2423	2423
P.	Impeller Lock Washer	2	2344	2344
Q[1]	Motor, Electric (For 5HP 184C or other footed motors, only use bracket.)	1	Specify P/N	Specify P/N
Q[2]	Power Frames			
	For use with 5/8” ID Shaft	1	5478	5478
	For use with 7/8” ID Shaft	1	5501	5501
Q[3]	Air Motor	1	Specify P/N	Specify P/N
RC - Repair Parts Kit				
	For **56C 5/8” Hex** shaft	1	2207	--------
	For **56C 7/8” Hex** shaft	1	--------	2207-1

(Includes: Hexed Shaft w/ SS , Slinger (5/8” shaft only), Impeller Lockdown Bolt, 2ea. Impeller Lockdown Washers)

** Double seal pumps use double seal impellers, for example; P/N 3711DS - (specify dia.)

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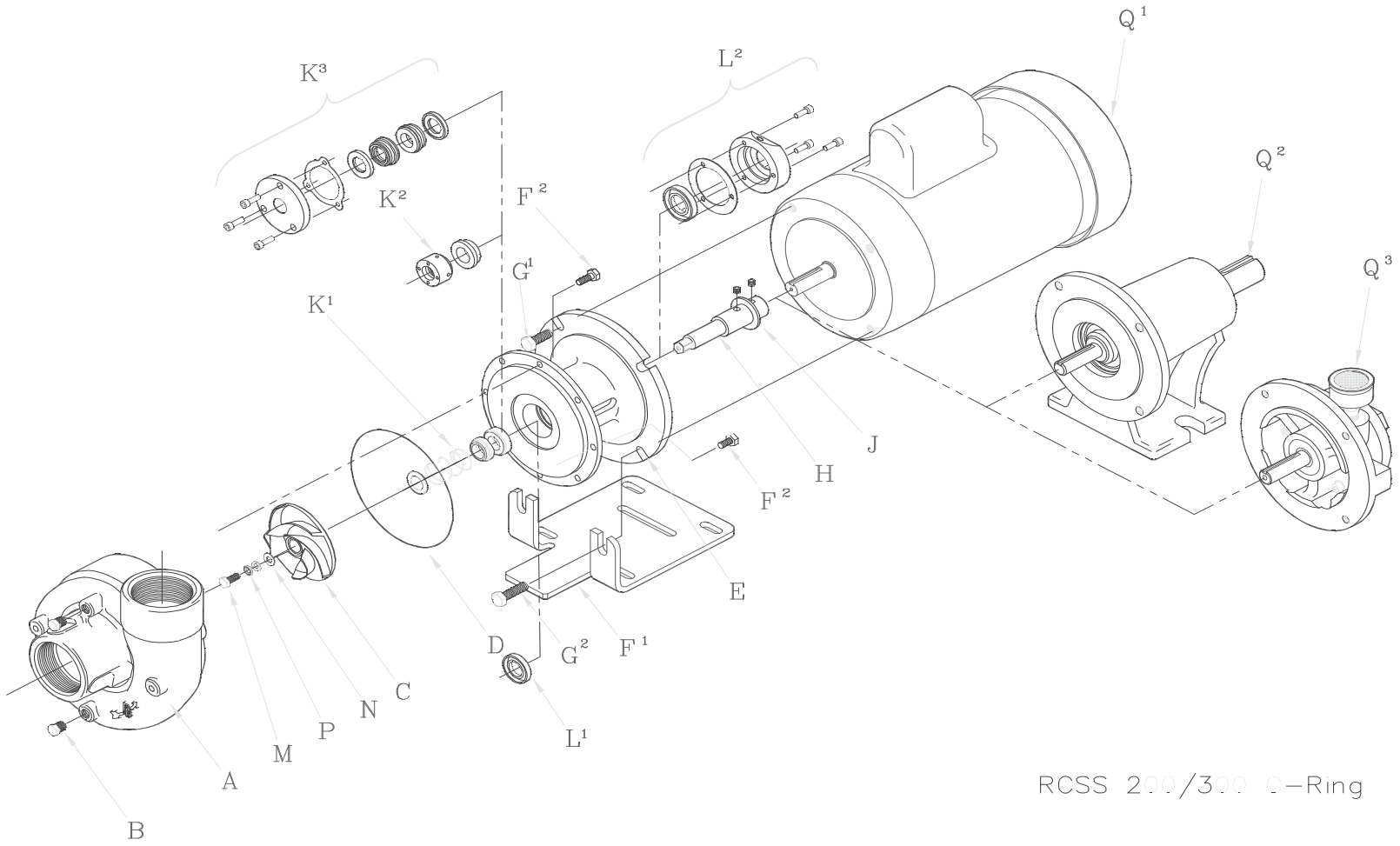

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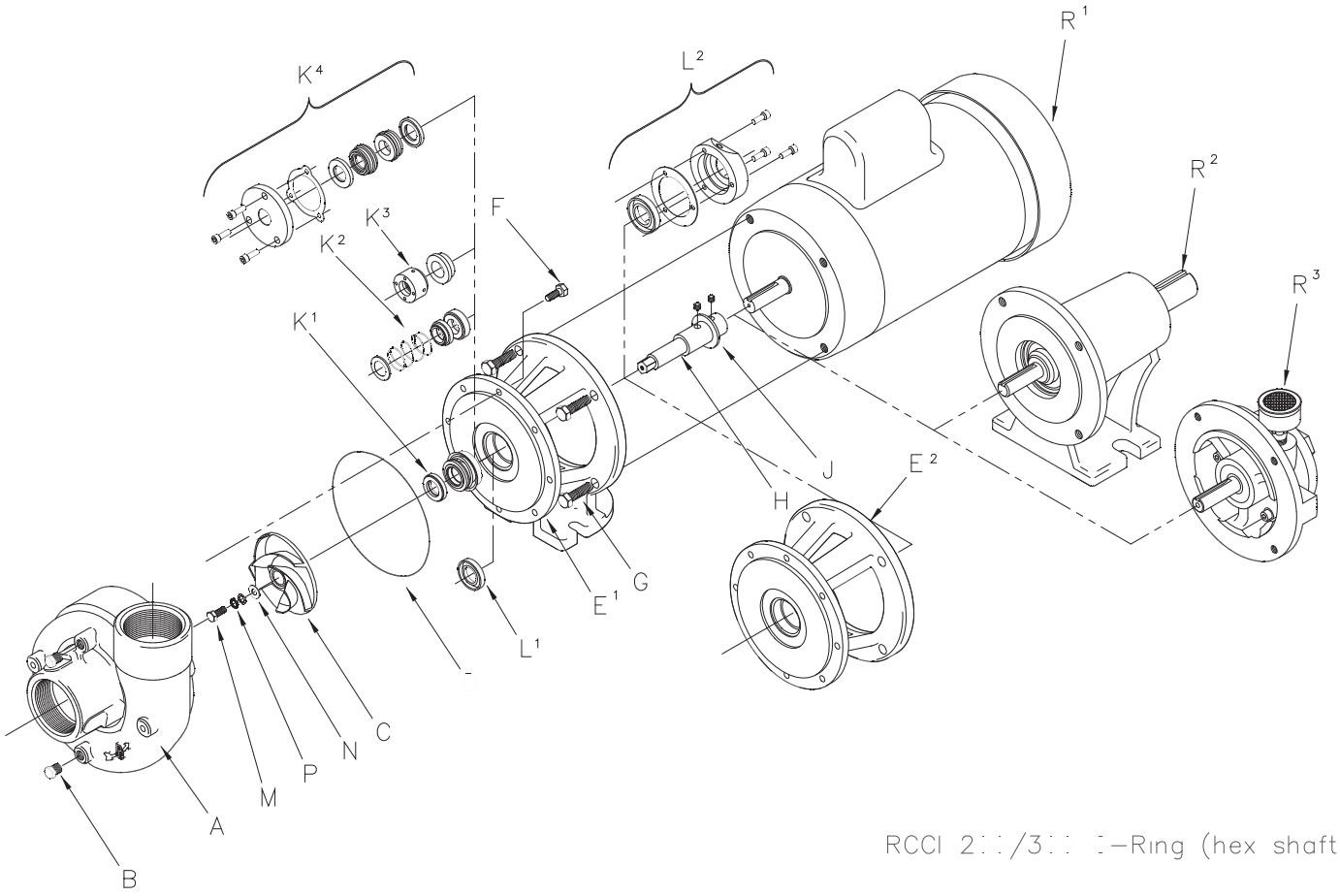
Key #	Description	Quantity	RC200 Part #	RC300 Part #
A.	Volute Cast Iron	1	0183-0	0120-0
A.	Volute Bronze	1	3716-0	3717-0
B.	Pipe Plugs 1/8"	2	0557	0557
C.	Impeller - Specify diameter **			
	Cast Iron (Hex Bore)	1	4185 - (specify dia.)	4186 - (specify dia.)
	Bronze (Hex Bore)	1	4115 - (specify dia.)	4116 - (specify dia.)
	Stainless Steel (Hex Bore)	1	3711- (specify dia.)	3713 - (specify dia.)
D.	O-ring (Buna std.)	1	3074	3074
E[1]	Bracket w/ Foot	1	2426	2426
E[2]	Bracket w/o Foot	1	2428	2428
F.	Volute Bolts	8	0573	0573
G.	Motor Bolts	4	0588	0588
H.	Shaft w/ setscrews 5/8" ID, Hex (56C motor)	1	3714-1	3714-1
H.	Shaft w/ setscrews 7/8" ID, Hex (143TC, 145TC, 182C, 184C motor)	1	3715-1	3715-1
J.	Slinger (For 5/8" shaft pumps only)	1	0522	0522
	Seal with Seat			
K[1]	T.6A Buna (std.)	1	0538	0538
K[2]	T.21 Fluorocarbon (optional)	1	0553	0553
K[3]	T.9 PTFE (optional)	1	1150	1150
K[4]	Double Seal/Seat (opt):			
	T.21 Fluorocarbon	2	0985	0985
	T.21 Neoprene	2	0984	0984
	T.21 EPR	2	1023	1023
	Double Seal Plate	1	0973	0973
	Plate Gasket, PTFE	1	0974	0974
	Seal Plate Cover Bolts	3	0256	0256
L[1]	T.6A Quench Lip Seal, Fluorocarbon	1	0899	0899
L[2]	T.21 Quench (5/8" shaft pumps only)			
	Quench Plate	1	0308	0308
	Plate Gasket, Syn. Fiber	1	0504	0504
	Seal Plate Cover Bolts	3	0267	0267
	Fluorocarbon Lip Seal	1	0891	0891
M.	Impeller Lockdown Bolt	1	0596	0596
N.	Impeller Lockdown Washer	1	2423	2423
P.	Impeller Lock Washer	2	2344	2344
R[1]	Motor, Electric (For 5HP 184C or other footed motors, use P/N 2428 bracket.)	1	Specify P/N	Specify P/N
R[2]	Power Frames			
	For use with 5/8" ID Shaft	1	5478	5478
	For use with 7/8" ID Shaft	1	5501	5501
R[3]	Air Motor	1	Specify P/N	Specify P/N
RC - Repair Parts Kit				
	For **56C 5/8" Hex** shaft	1	2207	--------
	For **56C 7/8" Hex** shaft	1	--------	2207-1

(Includes: Hex Shaft w/ SS Slinger (5/8" shaft only), Impeller Lockdown Bolt , Washer and Key)

** Double seal pumps use d ouble seal impellers, for example ; P/N 4185DS - (specify dia.)

PRICE® PUMP CO.

RCCI_P.dwg rev. C



RCCI 2::/3:: :-Ring (hex shaft)

Price® Pump C:.
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PRICE CENTRIFUGAL PUMP CAUTIONS & WARNINGS

- **CAUTION:** Price Pump centrifugal pumps must be operated above minimum flow rate to avoid damage.
- **CAUTION:** All Price Pump centrifugal pumps require the suction to be flooded.
- **CAUTION:** It is recommended that all piping connections to the pump be flexible.
- **WARNNING:** Verify chemical compatibility of the pump materials of construction with the fluid being pumped.
- **WARNNING:** Price centrifugal pumps are not designed for use in sanitary or food applications.
- **CAUTION:** Use only Price Pump original equipment factory replacement parts.
- **WARNNING:** Price pump fluid temperature limits must be observed. Maximum operating temperature is 300°F.
- **CAUTION:** The pump should be thoroughly flushed and drained before disassembly.
- **CAUTION:** For larger pump motor units, weight may exceed 65 1bs. (30 kg).

CAUTION: Maximum working pressure for seals:

- Type 6 Seal **75 PSI** (5.2 bar)
- Type 6A Seal **75 PSI** (5.2 bar)
- Type 8 Seal **325 PSI** (22.4 bar)
- Type 9 Seal **350 PSI** (24.1 bar)
- Type 21 Seal **150 PSI** (10.3 bar)
- Type 2106 Seal **150 PSI** (10.3 bar)

CAUTION: Maximum solid size by pump

- HP75 / MS50 **0.030"** (0.76mm)
- SP150 **0.060"** (1.50mm)
- LT25 **0.120"** (3.05mm)
- F50/75/95 **0.150"** (3.81mm)
- OH75 **0.150"** (3.81mm)
- CD100/150 **0.150"** (3.81mm)
- CL150 **0.150"** (3.81mm)
- RC200/300 **0.380"** (9.60mm)
- XJ-JB100 **0.120"** (3.05mm)
- XJ-JB150 **0.250"** (6.40mm)
- XJ-JB200 **0.440"** (11.2mm)
- XL-XT100 **0.120"** (3.05mm)
- XL-XT150 **0.250"** (6.40mm)
- XL-XT200 **0.440"** (11.2mm)

- HP75 / MS50 **0.5 GPM** (1.9 LPM)
- SP150 **10 GPM** (38 LPM)
- LT25 **0.5 GPM** (1.9 LPM)
- F50/75/95 **5.0 GPM** (19 LPM)
- OH75 **7.0 GPM** (26 LPM)
- CD100 **12 GPM** (45 LPM)
- CD150 **25 GPM** (94 LPM)
- CL150 **40 GPM** (150 LPM)
- RC200 **10 GPM** (38 LPM)
- RC300 **50 GPM** (189 LPM)
- XJ-JB150 **20 GPM** (75 LPM)
- XJ-JB150 **40 GPM** (150 LPM)
- XJ-JB200 **90 GPM** (340 LPM)
- XL-XT100 **10 GPM** (38 LPM)
- XL-XT150 **35 GPM** (132 LPM)
- XL-XT200 **50 GPM** (189 LPM)

GENERAL TERMS OF SALE FOR PRODUCTS

1. GENERAL

A. Seller's price is based on these sales terms and conditions. The agreement and inclusion of other or amended terms in this contract will result in a change (including increase) in Seller's pric e (as may be contained in any price books or quotations) to reflect such other or amended terms . This contract shall represent the final, complete and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained or waived by parole evidence, any Terms and Conditions contained in Buyer's purchase order or request for quotation, any course of dealings between the parties, Seller's performance or delivery, or in any other way. The Terms and Conditions of this contr act may only be modified or waived in a written document signed by an Officer of Seller. These terms are intended to cover all activity of Seller and Buyer hereunder, including sales and use of products, parts and work and all related matters (references t o products include parts and references to work include construction, installation and start -up). Any reference by Seller to Buyer's specifications and similar requirements are only to describe the products and work covered hereby and no warranties or oth er terms therein shall have any force of effect. Any information provided by Seller including, but not limited to, suggestions as to specific equipment does not imply any guarantee of specific suitability and/or material compatibility in a particular appl ication, since many factors outside the control of Seller may affect the suitability of products in a particular application. Catalogs, circulars, similar pamphlets and information contained on websites of the Seller are issued for general information pur poses only and shall not be deemed to modify the provisions hereof.

B. The agreement formed hereby and the language herein shall be construed and enforced under the Uniform Commercial Code as in effect in the State of California on the date hereof.

2. TAXES

Any sales, use or other similar type taxes imposed on this sale or on this transaction and/or any import or export duties or fees as may be assessed or imposed on or as a result of deliveries under this transaction are not included in the price . Such taxes shall be billed separately to the Buyer. Seller will accept a valid exemption certificate from the Buyer if applicable; however, if an exemption certificate previously accepted is not recognized by the governmental taxing authority involved and the Seller is required to pay the tax covered by such exemption certificate. Buyer agrees to promptly reimburse Seller for the taxes paid.

3. PERFORMANCE, INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after arrival at point of delivery. Where seller has responsibility for installation, construction or start -up all work shall be finally inspected and accepted with thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer, (including claims for shortages) except only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clauses, hereof, must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty - (30) day period for each partial performance. There shall be n o revocation of acceptance. Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for non -performance or for delays in performance occasioned by any causes beyond Seller's reasonable control, including, by way of example and not limitation, to labor difficulties, delays of vendors or carriers, fires, governmental act ions, or shortages of material, components, labor, or manufacturing facilities. Any delays so occasioned shall affect a corresponding extension of Seller's performance dates, which are, in any event, understood to be approximate. IN NO EVENT SHALL BUYER BE ENTITLED TO INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR LATE PERFORMANCE OR FOR A FAILURE TO PERFORM. Seller reserves the right to make partial shipments and to ship products, parts or work which may be completed prior to the scheduled performance date.

C. In the event that Seller has agreed to mount motors, turbines, gears, or other products which are not manufactured by Seller and which are not an integral part of Seller's manufactured product, and a delay in the delivery of such products to Seller occ urs that will cause a delay in Seller's performance date, Seller reserves the right to ship its product upon completion of manufacture and to refund an equitable portion of the amount originally included in the purchase price for mounting without incurring liability for non -performance.

D. Seller reserves to itself the right to change its specifications, drawings and standards if such changes will not impair the performance of its products, and parts, and further those products , and parts, will meet any of Buyer's specifications and other specific product requirements which are a part of this agreement. Seller is a global supplier of products and utilizes parts and products obtained worldwide, and Seller's products supplied under this contract shall be s ubject to Seller's sole determination as to all manufacturing, sourcing, assembly and supply unless otherwise specifically agreed in writing.

E. The manufacture and inspection of products and parts shall be to Seller's Engineering and Quality Assurance st andards, plus such other inspections or tests of documentation as are specifically agreed to by Seller. Requirements for any additional inspection, tests, documentation, or Buyer witness of manufacture, test, and/or inspection shall be subject to addition al charges.

4. TITLE AND RISK OF LOSS

Title and risk of loss shall pass to buyer upon delivery of products at the designated "Ex Works" as defined by Incoterms, unless other wise agreed by the parties.

5. EROSION AND CORROSION

It is specifically unde rstood that products and parts sold hereunder are not warranted for operation with erosive or corrosive fluids or for operation with any fluid or under any operating condition in variance with the specifications of this contract . No product or part shall b e deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore. No product shall be deemed defective by reason of any effect on Seller's products of the ac tion or results (such as vibration) of any goods or system (such as piping) not supplied by Seller.

6. BUYER'S RESPONSIBILITY

The design specifications of the equipment require the operation of the equipment within certain parameters and m ay call for the use of speed controls, safety devices, set points or other control devices to insure that the operation remains within design parameters. Buyer agrees and understands that the equipment must be operated and maintained within design specific ations and operated within the specifications of the contract, irrespective of whether controls or devices are otherwise required.

7. WARRANTY AND LIMITATION OF LIABILITY.

A. Seller warrants only that its product and parts, when shipped, will be free fr om defects in materials and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within two (2) years of shipment by seller and all claims for defective work must be made in writing immediately upon discovery. Defective items must be held for Seller's inspection and returned to the sellers' point of original shipment upon request.

ANY UNAUTHORIZED DISSASSEMBLY, ALTERATION OF OR TAMPERING WITH ANY PRODUCT OR COMPONENT MAY "VOID" THE WARRANTY, IN THAT SUCH ACTION WILL RESULT IN SELLER BEING RELEASED AND RELIEVED FROM ITS OBLIGATIONS UNDER THIS WARRANTY AND FOR ANY FURTHER COSTS OR ACTIONS UNDER CLAUSE 7.C, FOLLOWING, AND THE BUYER ASSUMING SOLE RESPONSIBILITY FOR THE COSTS AND RESULTS OF SUCH ACTION.

THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED, WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. ANY PRODUCT (S) SOLD HEREU NDER WHICH ARE NOT MANUFACTURED BY SELLER ARE NOT WARRANTED BY SELLER and shall be covered only by the express warranty, if any, of the manufacturer thereof. With respect to products and parts not manufactured by Seller, Seller's only obligation shall be to assign to Buyer, to the extent possible, whatever warranty Seller obtains from the manufacturer.

C. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace its product, part o r work at the original place of shipment, or (ii) refund an equitable portion of the purchase price.

D. THE FOREGOING IS SELLER'S ONLY OBLIGATION AND BUYER'S EXCLUSIVE REMEDY FOR BREACH OF WARRANTY AND, EXCEPT FOR THE REMEDIES PERMITTED UNDER THE PERFORMANCE, INSPECTION AND ACCEPTANCE AND THE PATENTS CLAUSES HEREOF, THE FOREGOING IS BUYER EXCLUSIVE REMEDY AGAINST SELLER FOR ALL CLAIMS ARISING HEREUNDER OR RELATING HERETO WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE OR S TRICT LIABILITY) , INDEMNITY OR OTHER THEORIES. BUYER'S FAILURE TO SUBMIT A CLAIM AS PROVIDED ABOVE SHALL SPECIFICALLY WAIVE ALL CLAIMS FOR DAMAGES OR OTHER RELIEF, INCLUDING BUT NOT LIMITED TO CLAIMS BASED ON LATENT DEFECTS. IN NO EVENT SHALL BUYER BE EN TITLED TO INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, NOR FOR DAMAGES FOR LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK OR PRODUCTION STOPPAGE, IMPAIRMENT OF OTHER GOODS, INCREASED EXPENSES OF OPERATION, OR THE COST OF PURCHASING REPLACEMENT POWER OR OTHER SERVICES BECAUSE OF SERVICE INTERRUPTIONS. FURTHERMORE, IN NO EVENT SHALL SELLER'S TOTAL LIABILITY FOR DAMAGES OF BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS OR PARTS MANUFACTURED BY SELLER AND UPON WHICH SUCH LIABIL ITY IS BASED. ANY ACTION ARISING HEREUNDER RELATED HERETO, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES, MUST BE COMMENCED WITHIN ONE (1) YEAR AFTER THE CAUSE OF ACTION ACCRUES OR IT SHALL BE BARRED.

8. PURCHASER'S R EPRESENTATIONS & WARRANTIES

Purchaser represents and warranties that the products(s) covered by this contract shall not be used in or in connection with a nuclear facility or application. The parties agree that this representation and warranty is material and is being relied on by seller. This provision may be modified in a separate writing signed by an officer of Price Pump Co.

9. PATENTS

Seller agrees to assume the defense of any suit for infringement of any patents brought against Buyer to the extent of such suit charges infringement of an apparatus or product claim by Seller's product in and of itself, provided (i) said product is built entirely to Seller's design, (ii) Buyer notifies Seller in writing of the filing of such suit within ten (10) days a fter the service of process thereof, and (iii) Seller is given complete control of the defense of such suit, including the right to defend, settle and make changes in the product for the purpose of avoiding infringement of any process or method claims. Pr ovided however, Seller will not defend any suit for infringement of a claimed patent where such alleged infringement is the result of following specific instruction furnished by Seller.

10. EXTENT OF SUPPLY

Only products as listed in Seller's proposal are included in this agreement. It must not be assumed that Seller has included anything beyond same.

11. MANUFACTURING SOURCES

To maintain delivery schedules, Seller reserves the right to have all or any part of the Buyer's order manufactured at an y of Sellers', sellers' licensees or sub contractors' plants, globally.

12. TERMS OF PAYMENT

Net 30 days from date of invoice .

13. ARBITRATION

In the event a dispute arises between the parties relating to or arising out of this agreement, the parties agree to attempt to have their senior management amicably settle the matter. In the event that the matter cannot be settled, the parties shall submit all disputes relating to this Agreement (whether contract, tort, products liability or otherwise) to bind ing Arbitration before a panel of arbitrators under the Commercial Dispute Resolution Procedures of the American Arbitration Association. Each party shall appoint an arbitrator and the third shall be selected in accordance with the rules of the American A rbitration Association. Judgment upon the award may be entered in any court having jurisdiction. The parties shall cooperate in providing reasonable disclosure of relevant documents. Each party shall bear its own expenses, and the costs and fees of the ar bitration shall be borne as allocated by the Arbitrator.

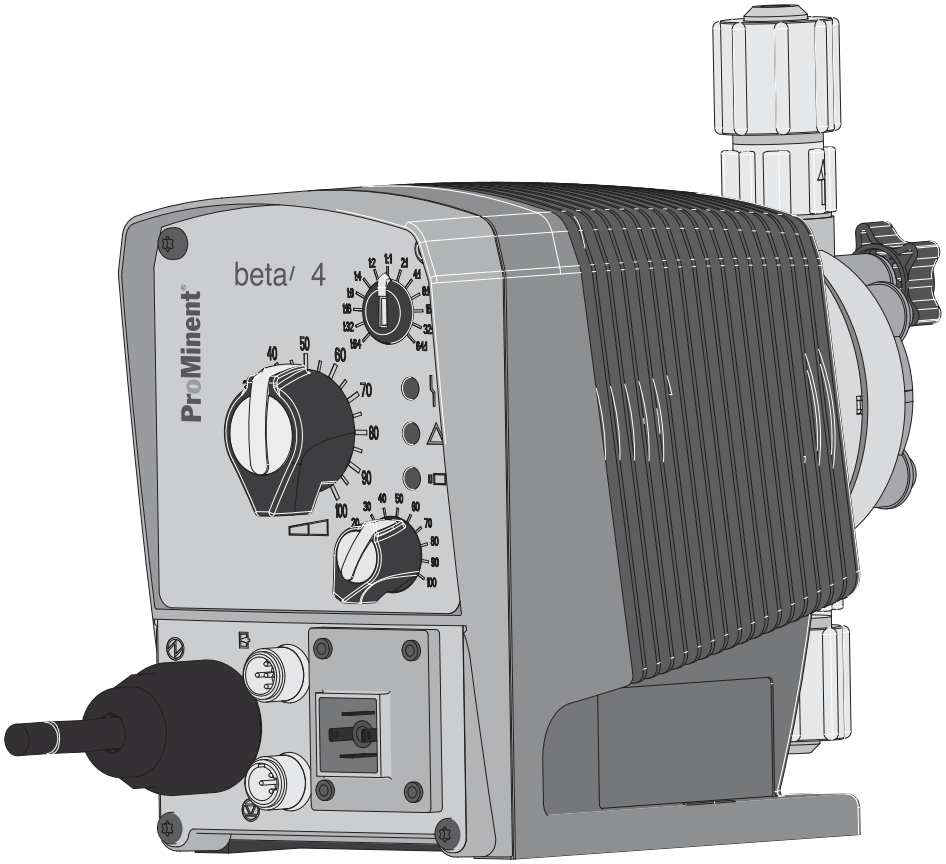
P-6101,2,3 - Beta - BT4b - BT4B0708PVT2000UD010A01Flow: 1.88GPH / 7.10L/HPressure: 102PSI / 07BAR"

Operating instructions

Solenoid Metering Pump

Beta® b BT4b and BT5b

EN



Please carefully read these operating instructions before use. · Do not discard.
The operator shall be liable for any damage caused by installation or operating errors.
The latest version of the operating instructions are available on our homepage.

Supplementary information

Fig. 1: Please read!

Read the following supplementary information in its entirety! You will benefit more from using the operating instructions should you already know this information.

The following are highlighted separately in the document:

- Enumerated lists

→ Instructions

⇨ Outcome of the instructions

↳ *'State the identity code and serial number' on page 2*: Links to points in this chapter

- refer to ... : References to points in this document or another document

[Keys]

Information

This provides important information relating to the correct operation of the unit or is intended to make your work easier.

Safety Information

Safety information is identified by pictograms - see Safety Chapter.

Validity

These operating instructions conform to current EU regulations applicable at the time of publication.

State the identity code and serial number

Please state identity code and serial number, which you can find on the nameplate when you contact us or order spare parts. This enables us to clearly identify the unit type and material versions.

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1 Identity code

Product range Beta b							
BT4b	Type	Capacity					
		bar	l/h				
	1000	10	0.74				
	1601	16	1.10				
	1602	16	2.20				
	1604	16	3.60				
	0708	7	7.10				
	0413	4	12.30				
	0220	2	19.00				
BT5b							
	2504	25	2.90				
	1008	10	6.80				
	0713	7	11.00				
	0420	4	17.10				
	0232	2	32.00				
		Material of dosing head/valves					
		PP	Polypropylene/PVDF. With the self-bleeding version (SEK): polypropylene/polypropylene				
		NP	Clear acrylic/PVDF. With the self-bleeding version (SEK): Clear acrylic/PVC				
		PV	PVDF/PVDF				
		TT	PTFE/PTFE				
		SS	Stainless steel 1.4404/1.4404				
			Material of seals/diaphragm				
			T	PTFE/PTFE coated			
			E	EPDM/PTFE coated, only for PP and NP self-bleeding (SEK)			
			B	FPM-B/PTFE coated, only for PP and NP self-bleeding (SEK)			
			W	Diaphragm additionally with FPM coating for media containing silicate			
				Dosing head design			
				0	without bleed valve, without valve spring only for NP, TT, SS and type 0232		
				1	without bleed valve, with valve spring only for NP, TT, SS and type 0232		
				2	with bleed valve, without valve spring only for PP, PV, NP not for type 0232		
				3	with bleed valve, with valve spring only for PP, PV, NP not for type 0232		
				4	version for higher-viscous media only for PVT, type 1604, 2504, 0708, 1008, 0413, 0713, 0220, 0420		
				7	self-bleeding (SER) only for PV/NP, not for types 1000, 1601 and 0232		
				9	self-bleeding (SEK) only for PP/NP, not for types 1000 and 0232		
					Hydraulic connector		
					0	Standard connection in line with technical data	
					5	Connector for 12/6 tube, discharge side only	
					9	Connector for 10/4 tube, discharge side only	

Product range Beta b																				
						Design														
						0	Standard													
							Logo													
							0	with ProMinent logo												
								Electrical connections												
								U	100 ... 230 V ± 10%, 50/60 Hz*											
									Cable and plug											
									A	2 m European										
									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 (NC) (change-over relay)									
										3	fault indicating relay (NO) (change-over relay)									
										4	as 1 + pacing relay, (ONE each)									
										5	as 3 + pacing relay, (ONE each)									
											Accessories									
											0	without accessories								
											1	with foot and injection valve, 2 m PVC suction line, 5 m PE metering line								
												Control type								
												0	no lock							
												1	with lock: manual operation locked when external cable plugged in							
												H	External without PCS stop							
													Control version							
													0	Standard						
													A	External analogue 0...20 mA / 4...20 mA						
														Options						
														00	no options					

2 About this pump

Properties of the device

This solenoid metering pump Beta b is equipped with all adjustment and activation functions for modern water treatment and the dosing of chemicals. It has pulse step-up and pulse step-down compared with the preceding model. This enables it to adapt more precisely to external signal generators. The result is the simpler and more precise adjustment of chemical consumption to the actual need. It also has a 10 percent increase in efficiency and energy efficiency over the preceding model. The Beta b can be simply adjusted during operation.

3 Safety Chapter

Identification of safety notes

The following signal words are used in these operating instructions to denote different severities of danger:

Signal word	Meaning
WARNING	Denotes a possibly dangerous situation. If this is disregarded, you are in a life-threatening situation and this can result in serious injuries.
CAUTION	Denotes a possibly dangerous situation. If this is disregarded, it could result in slight or minor injuries or material damage.

Warning signs denoting different types of danger

The following warning signs are used in these operating instructions to denote different types of danger:

Warning signs	Type of danger
	Warning – automatic start-up.
	Warning – high-voltage.
	Warning – danger zone.

Intended Use

- Only use the pump to meter liquid feed chemicals.
- Only use the pump after it has been correctly installed and started up in accordance with the technical data and specifications contained in the operating instructions.
- Observe the general limitations with regard to viscosity limits, chemical resistance and density - see also ProMinent resistance list in the Product Catalogue or at www.prominent.com!
- All other uses or modifications are prohibited.
- The pump is not intended for the metering of gaseous media and solids.
- The pump is not intended for the metering of flammable media without implementing suitable protective measures.
- The pump is not intended for the metering of explosive media.
- The pump is not intended for operation in areas at risk from explosion.
- The pump is not intended for exterior applications without the implementation of suitable protective measures.
- The pump should only be operated by trained and authorised personnel, see the following "Qualifications" table.
- You are obliged to observe the information contained in the operating instructions at the different phases of the unit's service life.

Safety Information

WARNING!

Warning about personal and material damage

The pump can start to pump, as soon as it is connected to the mains voltage.

– Install an emergency cut-off switch in the pump power supply line or integrate the pump in the emergency cut-off management of the system.

WARNING!

Danger of electric shock

A mains voltage may exist inside the pump housing.

– If the pump housing has been damaged, you must disconnect it from the mains immediately. It may only be returned to service after an authorised repair.

WARNING!

Warning of dangerous or unknown feed chemical

Should a dangerous or unknown feed chemical be used: It may escape from the hydraulic components when working on the pump.

– Take appropriate protective measures before working on the pump (e.g. safety glasses, safety gloves, ...). Observe the safety data sheet for the feed chemical.
– Drain and flush the liquid end before working on the pump.

WARNING!

Fire danger

When pumping inflammable media the operator must take suitable safety precautions.

WARNING!

Danger from hazardous substances!

Possible consequence: Fatal or very serious injuries.

Please ensure when handling hazardous substances that you have read the latest safety data sheets provided by the manufacture of the hazardous substance. The actions required are described in the safety data sheet. Check the safety data sheet regularly and replace, if necessary, as the hazard potential of a substance can be re-evaluated at any time based on new findings.

The system operator is responsible for ensuring that these safety data sheets are available and that they are kept up to date, as well as for producing an associated hazard assessment for the workstations affected.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

– Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
– Depressurise the system before commencing any work on hydraulic parts.

CAUTION!

Warning of feed chemical spraying around

The metering pump can generate a multiple of its rated pressure. Hydraulic parts can rupture if a discharge line is blocked.

– Correctly install a relief valve in the discharge line downstream of the metering pump.

CAUTION!

Warning of feed chemical spraying around

An unsuitable feed chemical can damage the wetted parts of the pump.

– Take into account the resistance of the wetted materials when selecting the feed chemical - see the ProMinent Product Catalogue or visit our homepage.

CAUTION!

Danger of injury to personnel and material damage

The use of untested third party components can result in injury to personnel and material damage.

– Only fit parts to metering pumps that have been tested and recommended by ProMinent.

CAUTION!

Danger from incorrectly operated or inadequately maintained pumps

Danger can arise from a poorly accessible pump due to incorrect operation and poor maintenance.

– Ensure that the pump is accessible at all times.
– Adhere to the maintenance intervals.

CAUTION!

Danger from incorrect metering

Should a different liquid end size be fitted, this will change the metering behaviour of the pump.

– Have the pump reprogrammed in the works.

CAUTION!

Warning against illegal operation

Observe the regulations that apply where the device is installed.

Fixed separating protective equipment

- Dosing head
- Housing
- Hood (houses the control elements)

The dosing head may only be removed by the customer in accordance with the "Repair" chapter.

The housing and the hood may only be removed by ProMinent customer service department.

Information in the event of an emergency

In an emergency, either pull out the mains plug, turn the multifunctional switch to "Stop" or press the Emergency Stop switch installed on the customer's side or disconnect the pump from the mains power supply in line with the emergency shut-down management guidelines for your system!

If feed chemical escapes, additionally ensure that the hydraulic system around the pump is at atmospheric pressure. Adhere to the safety data sheet for the feed chemical.

Qualification of personnel

Task	Qualification
Storage, transport, unpacking	Instructed person
Assembly	Technical personnel, service
Planning the hydraulic installation	Qualified personnel who have a thorough knowledge of metering pumps
Hydraulic installation	Technical personnel, service
Installation, electrical	Electrical technician
Operation	Instructed person
Maintenance, repair	Technical personnel, service
Decommissioning, disposal	Technical personnel, service
Troubleshooting	Technical personnel, electrical technician, instructed person, service

Explanation of the table:

Qualified personnel

A qualified employee is deemed to be a person who is able to assess the tasks assigned to him and recognise possible dangers based on his/her technical training, knowledge and experience, as well as knowledge of pertinent regulations.

Note:

A qualification of equal validity to a technical qualification can also be gained by several years of employment in the relevant field of work.

Electrical technician

An electrical technician is able to complete work on electrical systems and recognise and avoid possible dangers independently based on his/her technical training and experience, as well as knowledge of pertinent standards and regulations.

The electrical technician should be specifically trained for the working environment in which he is employed and know the relevant standards and regulations.

An electrical technician must comply with the provisions of the applicable statutory directives on accident prevention.

Instructed person

An instructed person is deemed to be a person who has been instructed and, if required, trained in the tasks assigned to him/her and possible dangers that could result from improper behaviour, as well as having been instructed in the required protective equipment and protective measures.

Service

The Service department refers to service technicians, who have received proven training and have been authorised by ProMinent to work on the system.

Sound pressure level

Sound pressure level LpA < 70 dB according to EN ISO 20361

at maximum stroke length, maximum stroke rate, maximum back pressure (water)

4 Storage, Transport and Unpacking

Safety Information

WARNING!

The transporting of pumps which have been used with radioactive feed chemicals is forbidden!

They will also not be accepted by ProMinent!

WARNING!

Only return metering pumps for repair in a cleaned state and with a flushed liquid end - refer to "Decommissioning!

Only return metering pumps with a completed Decontamination Declaration form. The Decontamination Declaration constitutes an integral part of an inspection / repair order. A unit can only be inspected or repaired when a Declaration of Decontamination Form is submitted that has been completed correctly and in full by an authorised and qualified person on behalf of the pump operator.

The "Decontamination Declaration Form" can be found on our homepage.

CAUTION!

Danger of material damage

The device can be damaged by incorrect or improper storage or transportation!

- The unit should only be stored or transported in a well packaged state - preferably in its original packaging.
- The packaged unit should also only be stored or transported in accordance with the stipulated storage conditions.
- The packaged unit should be protected from moisture and the ingress of chemicals.

Ambient conditions

Data	Value	Unit
Minimum storage and transport temperature	-20	°C
Maximum storage and transport temperature	+60	°C
Maximum air humidity *	95	% rel. humidity

* non-condensing

Scope of delivery

Compare the delivery note with the scope of delivery:

- Metering pump with mains cable
- Connector kit for hose/pipe connection (optional)
- Product-specific operating instructions with EC Declaration of Conformity
- Optional accessories

5 Overview of Equipment and Control Elements

5.1 Overview of Equipment

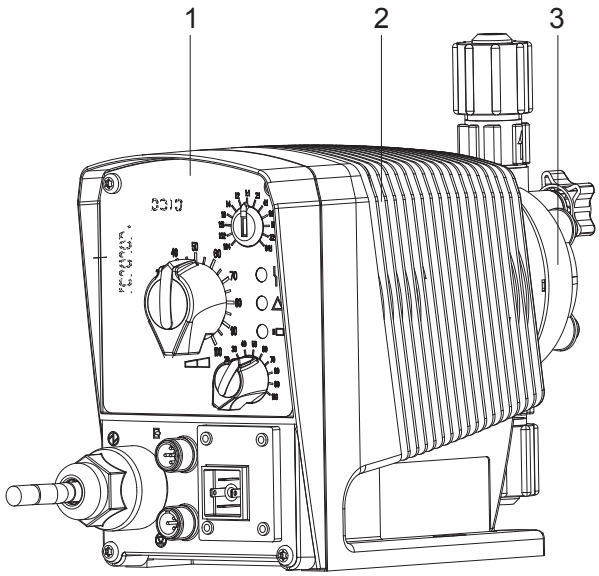


Fig. 2: Complete overview

1 Control unit
2 Drive unit
3 Liquid end

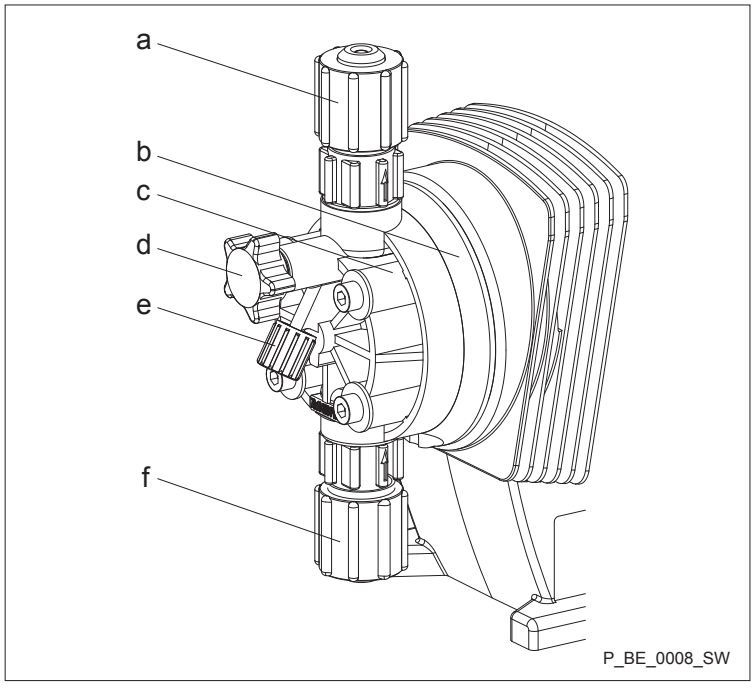
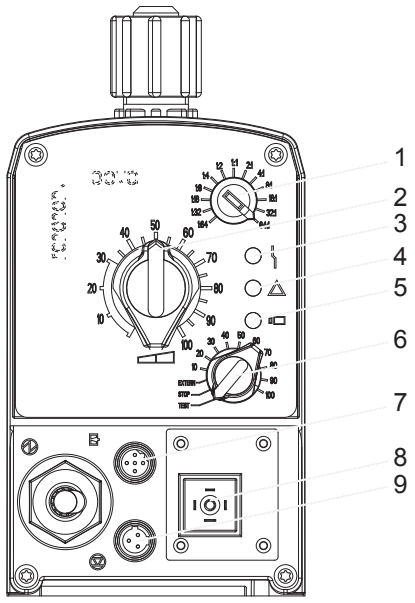


Fig. 3: Overview of liquid end (PV)

a Discharge valve
b Backplate
c Dosing head
d Bleed valve
e Bypass hose sleeve
f Suction valve

5.2 Control Elements



P_BE_0011_SW

Fig. 4

1 Pulse control switch
2 Stroke Length Adjustment Button
3 Fault indicator (red)
4 Warning indicator (yellow)
5 Operating indicator (green)
6 Multifunctional Switch
7 "External control" terminal
8 Relay connection (optional)
9 "Level switch" terminal

5.2.1 Pulse control switch

In **"External Contact" operating mode**, the pulse control switch either triggers a series of strokes or steps down an incoming series of contacts by a single contact (at the "external control" terminal).

In **"External Analogue" operating mode**, the stroke rate can be controlled by an mA signal via the pulse control switch. To do so, the multifunctional switch has to be turned to "Extern".

5.2.2 Stroke Length Adjustment Button

The stroke length adjustment button can be used to adjust the stroke length.

5.2.3 Multifunctional Switch

The multifunctional switch can be used to set the following functions, operating modes and stroke rate.

The operating modes that can be set are:

- Test (priming function)
- Stop (optionally missing)
- Extern (Contact)
- External (analogue, optional)
- Manual (setting stroke rate in 10% increments)

5.2.4 Functional and Fault Indicators

Fault indicator (red)

The fault indicator lights up if the fluid level in the dosing tank falls below the second switching point of the level switch (20 mm residual filling level in the dosing tank).

The fault indicator lights up if the current falls below 3.8 mA (only with 4...20 mA) or exceeds 23 mA in "External Analogue" operating mode.

This LED flashes in the event of an undefined operating status.

Warning indicator (yellow)

The warning indicator lights up if the fluid level in the dosing tank falls below the first switching point of the level switch.

Operating indicator (green)

The operating indicator lights up if the pump is ready for operation and there are no fault or warning alerts. It goes out quickly as soon as the pump has performed a stroke.

5.2.5 "External control" terminal

The "external control" terminal is a five-pole panel terminal.

It enables the following functions and operating modes to be used:

- Pause
- External contact
- External Analogue (optional)
- Auxiliary frequency (external frequency changer)

The two- and four-pole cables used to date can continue to be used. The "Auxiliary frequency" function can, however, only be used with a five-pole cable.

5.2.6 "Level switch" terminal

A 2-stage level switch with pre-warning and end switch-off can be connected.

6 Functional description

6.1 Liquid End

The dosing process is performed as follows: The diaphragm is pressed into the dosing head; the pressure in the dosing head closes the suction valve and the feed chemical flows through the discharge valve out of the dosing head. The diaphragm is now drawn out of the dosing head; the discharge valve closes due to the negative pressure in the dosing head and fresh feed chemical flows through the suction valve into the dosing head. One cycle is completed.

6.2 Drive Unit

The diaphragm is driven by an electromagnet, which is controlled by an electronic controller.

6.3 Capacity

The capacity is determined by the stroke length and the stroke rate.

The stroke length is adjusted by the stroke length adjustment knob within a range of 0 ... 100 %. A stroke length of between 30 ... 100 % (SEK type: 50 ... 100 %) is recommended to achieve the specified reproducibility!

Data	Value	Unit
Recommended stroke length, standard type	30 ... 100	%
Recommended stroke length, SEK type	50 ... 100	%

The stroke rate can be set within a range of 10 ... 100 % using the multifunctional switch.

6.4 Self-Bleeding

Self-bleeding liquid ends (SEK types) are capable of independent priming when a discharge line is connected and diverting existent air pockets via a bypass. During operation they are also capable of conveying away gases which are produced, independently of the operating pressure in the system. It is also possible to dose precisely in a depressurised state due to the integral back pressure valve.

6.5 Operating modes

The operating modes are selected by means of the multifunctional switch.

"Manual" operating mode

As soon as the stroke rate has been set by the multifunctional switch, the pump finds itself in "Manual" operating mode. 100% corresponds to 180 strokes/min.

"External contact" operating mode

The "External Contact" operating mode is described below in the "Operation" and "Installation, Electrical" chapters.

"External Analogue" operating mode

The "External Analogue" operating mode is described below in the "Operation" and "Installation, Electrical" chapters.

6.6 Functions

The functions are described below in the "Operation" chapter.

6.7 Relay

The pump has two connecting options.

Fault indicating relay option

The relay can switch a connected power circuit (e.g. for an alarm horn) in the event of warnings or fault messages (e.g. warning levels).

The relay can be retrofitted with the retrofit kit via a knock-out opening in the pump foot - refer to "Retrofitting relays".

Fault indicating and pacing relay option

This combined relay can generate a contact with each stroke via its pacing relay in addition to its function as a fault indicating relay.

The relay can be retrofitted with the retrofit kit via a knock-out opening in the pump foot - refer to "Retrofitting relays".

6.8 Hierarchy of Operating Modes, Functions and Fault Statuses

The different operating modes, functions and fault statuses have a different effect on if and how the pump reacts.

The following list shows the order:

1. - Test (priming)
2. - Fault, Stop, Pause
3. - Auxiliary frequency (external frequency changeover)
4. - Manual, Extern Contact

Comments:

re 1 - "Priming" can take place in any mode of the pump (providing it is functioning).

re 2 - "Fault", "Stop" und "Pause" stop everything apart from "Priming".

re 3 - The stroke rate of "Auxiliary frequency" always has priority over the stroke rate specified by an operating mode in 4.

7 Assembly

– *Compare the dimensions on the dimension sheet with those of the pump.*

WARNING!

Danger of electric shock

If water or other electrically conducting liquids penetrate into the drive housing, in any other manner than via the pump's suction connection, an electric shock may occur.

– Position the pump so that it cannot be flooded.

CAUTION!

Danger from incorrectly operated or inadequately maintained pumps

Danger can arise from a poorly accessible pump due to incorrect operation and poor maintenance.

– Ensure that the pump is accessible at all times.
– Adhere to the maintenance intervals.

Capacity too low

The liquid end valves can be disturbed by vibrations.

– *Secure the metering pump so that no vibrations can occur.*

Capacity too low

If the valves of the liquid end are not vertical, they cannot close correctly.

– *Suction and discharge valves must stand vertically upwards (for self-bleeding liquid end, the bleed valve).*

Mount the metering pump with the pump foot on a horizontal, level and load-bearing supporting surface.

8 Installation, hydraulic

Safety Information

CAUTION!

Warning of feed chemical spraying around

An unsuitable feed chemical can damage the wetted parts of the pump.

– Take into account the resistance of the wetted materials when selecting the feed chemical - see the ProMinent Product Catalogue or visit our homepage.

CAUTION!

Warning of feed chemical spraying around

Pumps which are not fully installed hydraulically can pump feed chemical from the outlet opening of the discharge valve as soon as they are connected to the mains power supply.

– First install the pump hydraulically, then electrically.
– In the event that you have failed to do so, turn the multi-functional switch to *[Stop]* (if fitted) or press an On / Off switch or Emergency Stop switch on site.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

– Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
– Depressurise the system before commencing any work on hydraulic parts.

CAUTION!

Danger from rupturing hydraulic components

Peak loads during the dosing stroke can cause the maximum permissible operating pressure of the system and pump to be exceeded.

– The discharge lines are to be properly designed.

CAUTION!

Danger of personnel injury and material damage

The use of untested third party parts can result in personnel injuries and material damage.

– Only fit parts to metering pumps, which have been tested and recommended by ProMinent.

8.1 Installing hose lines

8.1.1 Installation of Metering Pumps Without Bleed Valve

Safety Information

CAUTION!

Warning of feed chemical spraying around

The pipes can loosen or rupture if they are not installed correctly.

- Route all hose lines so they are free from mechanical stresses and kinks.
- Only use original hoses with the specified hose dimensions and wall thicknesses.
- Only use clamp rings and hose nozzles that are intended for the hose diameter in question to ensure the long service life of the connections.

CAUTION!

Danger from rupturing hydraulic components

Hydraulic components can rupture if the maximum permissible operating pressure is exceeded.

- Always adhere to the maximum permissible operating pressure of all hydraulic components - please refer to the product-specific operating instructions and system documentation.
- Never allow the metering pump to run against a closed shut-off device.
- Install a relief valve.

CAUTION!

Hazardous feed chemicals can escape

Hazardous or extremely aggressive feed chemicals can leak out when using conventional bleeding procedures with metering pumps.

- Install a bleed line with return line into the storage tank.

CAUTION!

Hazardous feed chemicals can escape

Hazardous or extremely aggressive feed chemicals can leak out in the event that the metering pump is removed from the installation.

- Install a shut-off valve on the metering pump's pressure and discharge sides.

CAUTION!

Uncontrolled flow of feed chemical

Feed chemical can press through a stopped metering pump if there is back pressure.

- Use an injection valve or a vacuum breaker.

CAUTION!

Uncontrolled flow of feed chemical

Feed chemicals can leak through the metering pump in an uncontrolled manner in the event of excessive priming pressure.

– Do not exceed the maximum permissible priming pressure for the metering pump.

Align the pipes so that the metering pump and the liquid end can be removed from the side if necessary.

Installing hose lines - PP, NP, PV, TT designs

1. Cut off the ends of the hoses at right angles.
2. Pull the union nut (2) and clamp ring (3) over the hose (1) - see figure Fig. 5.
3. Push the hose end (1) up to the stop over the nozzle (4) and widen, if necessary.

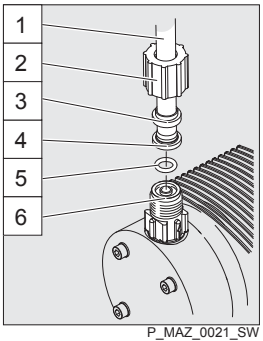
Ensure that the O-ring and flat seal (5) is properly fitted to the valve (6).

Never re-use used PTFE seals. An installation sealed in this way is not watertight.

This type of seal is permanently distorted when subjected to pressure.

In order to enable it to be distinguished from the EPDM flat seal, the FPM flat seal PV design has a dot.

4. Place the hose (1) with the nozzle (4) onto the valve (6).
5. Clamp the hose connector: Tighten the union nut (2) while simultaneously pressing on the hose (1).
6. Re-tighten the hose connector: Pull on the hose (1) briefly, which is fastened to the dosing head and then tighten the union nut (2) once more.

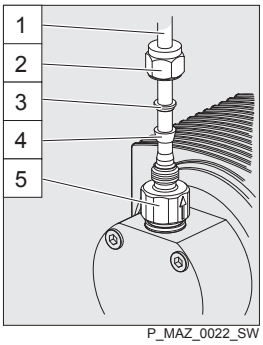


1 Hose
2 Union nut
3 Clamp ring
4 Nozzle
5 O-ring or flat seal
6 Valve

Fig. 5: PP, NP, PV and TT designs

Installing stainless steel pipe - SS design

1. Pull the union nut (2) and clamp rings (3, 4) over the pipe (1) with approx. 10 mm overhang - see *'Installing stainless steel pipe - SS design' on page 23*.
2. Insert the pipe (1) up to the stop in the valve (5).
3. Tighten the union nut (2).



1 pipe
2 Union nut
3 Rear clamp ring
4 Front clamp ring
5 Valve

Fig. 6: SS design

Installing hose lines - SS design

CAUTION!

Warning of feed chemical spraying around

Connections can come loose in the event that hose lines are installed incorrectly on stainless steel valves.

– Only use PE or PTFE hose lines.
– In addition, insert a stainless steel support insert into the hose line.

8.1.2 Installation of Metering Pumps With Bleed Valve

Safety Information

CAUTION!

– All the installation and safety notes for metering pumps without bleed valves also apply.

Installation of the return line

A return line is also connected in addition to the suction and discharge line.

1. Attach the hose line to the return hose nozzle or to the liquid end bleed valve. PVC hose, soft, 6x4 mm is recommended.
2. Feed the free end of the return line back to the storage tank.
3. Shorten the return line so that it is not immersed in the feed chemical in the storage tank.

8.1.3 Installation of Metering Pumps With Self-bleeding (SEK Type)

Safety Information

CAUTION!

- All of the installation and safety notes for metering pumps without self-bleeding also apply.
- Do not exceed the maximum values for priming lift, priming pressure and viscosity of the feed chemical.
- Do not allow the suction side line cross-section to exceed the line cross-section on the suction valve.

Information about priming pressure

- *Make sure that the priming pressure on the suction end is at least equal to the return line pressure.*
- *Priming pressure in the return line restricts the bleeding function.*
- *However, operation with priming pressure in the return line and the suction end at atmospheric pressure is possible.*

Installation of the return line

A return line is also connected in addition to the suction and discharge line.

- *The return line is connected to the vertical valve on the upper side of the liquid end. It is factory-labelled with a red sleeve - see ‘Installation of the return line’ on page 24.*
- *The discharge line is connected to the horizontal valve.*

1. Attach the hose line to the return hose nozzle or to the liquid end bleed valve. PVC hose, soft, 6x4 mm is recommended.
2. Feed the free end of the return line back to the storage tank.
3. SEK only: Insert the return line into the anti-kink device on the bleed valve and screw it in place until the anti-kink device engages.

The anti-kink device prevents the return line from kinking, avoiding the risk of self-bleeding failure.

4. Shorten the return line so that it is not immersed in the feed chemical in the storage tank.

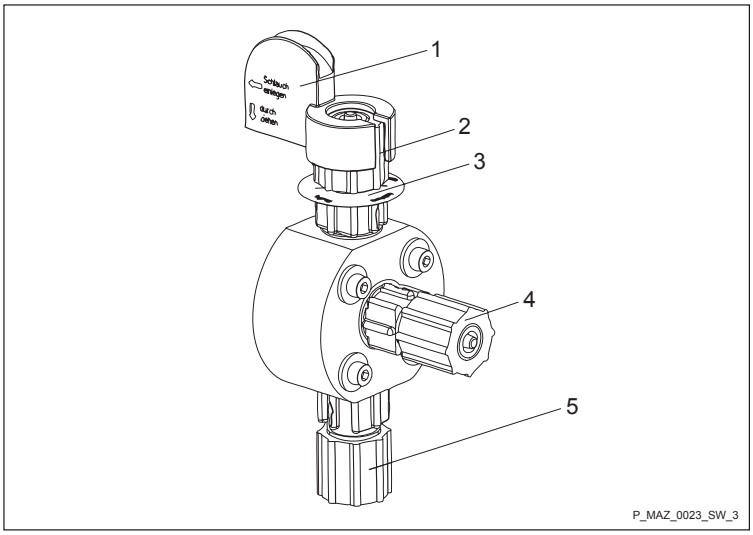


Fig. 7: SEK liquid end

1 Anti-kink device
2 Bleed valve for the return line into the storage tank, 6/4 mm
3 Red sleeve
4 Discharge valve for discharge line to the injection point, 6/4 - 12/9 mm
5 Suction valve for suction line in the storage tank, 6/4 - 12/9 mm

8.1.4 Basic installation notes

Safety notes

CAUTION!

Danger resulting from rupturing hydraulic components

Hydraulic components can rupture if the maximum permissible operating pressure is exceeded.

– Never allow the metering pump to run against a closed shut-off device.
– With metering pumps without integral relief valve: Install a relief valve in the discharge line.

CAUTION!

Hazardous feed chemicals can escape

With hazardous feed chemicals: Hazardous feed chemical can leak out when using conventional bleeding procedures with metering pumps.

– Install a bleed line with a return into the storage tank.

→ Shorten the return line so that it does not dip into the feed chemical in the storage tank.

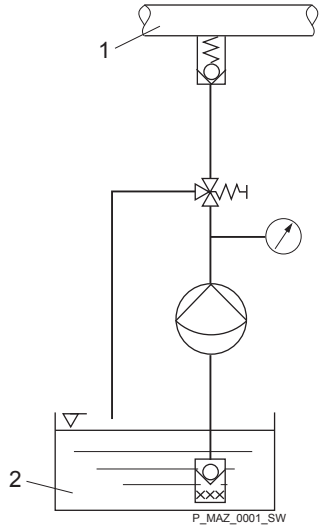


Fig. 8: Standard installation

1 Main line
2 Storage tank

Legend for hydraulic diagram

Symbol	Explanation	Symbol	Explanation
	Metering pump		Foot valve with filter meshes
	Injection valve		Level switch
	Multifunctional valve		Manometer

9 Electrical Installation

WARNING!

Danger of electric shock

A mains voltage may exist inside the device.

– Before any work, disconnect the device's mains cable from the mains.

WARNING!

Risk of electric shock

This pump is supplied with a grounding conductor and a grounding-type attachment plug.

– To reduce the risk of electric shock, ensure that it is connected only to a proper grounding-type receptacle.

WARNING!

Risk of electric shock

In the event of an electrical accident, the pump must be quickly disconnected from the mains.

– Install an emergency cut-off switch in the pump power supply line or
– Integrate the pump in the emergency cut-off management of the system and inform personnel of the isolating option.

WARNING!

Danger of electric shock

A mains voltage may exist inside the pump housing.

– If the pump housing has been damaged, you must disconnect it from the mains immediately. It may only be returned to service after an authorised repair.

CAUTION!

Material damage possible due to power surges

Should the pump be connected to the mains power supply in parallel to inductive consumers (such as solenoid valves, motors), inductive power surges can damage the controller when it is switched off.

– Provide the pump with its own contacts and supply with voltage via a contactor relay or relay.

Personnel: ■ Electrician

→ Install the pump in line with best working practice and in accordance with the operating instructions and applicable regulations.

9.1 Supply voltage connector

WARNING!

Unexpected startup is possible

As soon as the pump is connected to the mains, the pump may start pumping and consequently feed chemical may escape.

– Prevent dangerous feed chemicals from escaping.
– If you have not successfully prevented this, immediately press the *[STOP/START]* key or disconnect the pump from mains, e.g. via an emergency cu-off switch.

CAUTION!

If the pump is integrated into a system: Design the system so that potential hazardous situations are avoided by pumps starting up automatically subsequent to unintended power interruptions.

CAUTION!

Provide an option to disconnect the pump without Emergency Stop switch from the mains power supply.

9.1.1 Mains voltage

Parallel connection to inductive consumers

Should the pump be connected to the mains in parallel to inductive consumers (e.g. solenoid valves, motor), the pump must be electrically isolated when these consumers are switched off.

- Supply the pumps with voltage via a contactor relay or relay using separate contacts for the pump.
- If this is not possible then connect a varistor (part no. 710912) or an RC member, 0.22 µF / 220 Ω in parallel.

Interference suppression aids

Product	Part no.
Varistor:	710912
RC Gate, 0.22 µF / 220 Ω:	710802

9.2 Supply voltage connector - low voltage

WARNING!

Danger of electric shock

– For safety reasons, the low voltage pumps must be operated using only protective low voltage (SELV in accordance with EN 60335-1).

CAUTION!

Supply voltages that are too high destroy the pump.

– Do not connect the low voltage pump to voltages > 30 V.

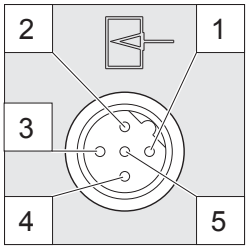
- *The pump will generate a fault ("switch-off threshold for supply") in the event that the supply voltage to the pump is insufficient to ensure reliable function. The pump will recommence operation as soon as the supply voltage is restored.*
- *The fault indicator flashes additionally if the supply voltage is interrupted during a stroke, ("threshold for stroke abort"). Aborted strokes are not counted by the stroke counter. In doing so, the pump's electronic controller periodically checks the supply voltage ("wait time after stroke abort": 10 min). The pump will recommence operation if the supply voltage is sufficient.*
- *The pump's electrical system will shut down completely in the event that the supply voltage undershoots another threshold. The pump will come out of standby mode and recommence operation as soon as sufficient supply voltage is restored.*
- *The programmed thresholds apply to standard lead-acid batteries. ProMinent can match these to customer requirements.*
- *Use short large-diameter power leads in order to minimise faults. Use batteries with low internal resistance.*
- *If the pump is connected with incorrect polarity, it will not run because the polarity protection does not allow any current to flow.*

9.3 Description of the Terminals

9.3.1 "External control" terminal

The "external control" socket is a five-pin panel socket. It is compatible with two- and four-pole cables.

The "Auxiliary rate" function can only be used with a five conductor cable.



P_BE_0014_SW

Fig. 9: Pump assignment

Electrical interface for pin 1 "Pause" - pin 2 "External contact" - pin 5 "Auxiliary frequency"

Data	Value	Unit
Voltage with open contacts	5	V
Input resistance	10	kΩ
Max. pulse frequency	25	pulse/s
Min. pulse duration	20	ms
Min. pause between pulses	3	ms

Control via:

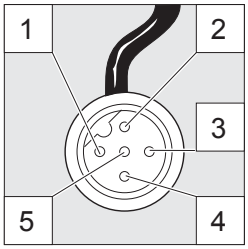
- potential-free contact (load: 0.5 mA at 5 V) or
- Semiconductor switch (residual voltage < 0.7 V)

Electrical interface for pin 3 "mA input" (with identity code characteristic "Control version": A - "External Analogue")

Data	Value	Unit
Input apparent ohmic resistance, approx.	120	Ω

Behaviour of the pump

At **approx. 0.1 mA (4.1 mA)** the metering pump makes its **first metering stroke**.
At **approx. 19.9 mA** the pump moves to continuous operation at **180 strokes / min** .
With current signals **above 23 mA**, the red fault indicator lights up, the pump stops and any fault indicating relay fitted switches (a **fault** is pending).
Only with 4...20 mA: With current signals **below 3.8 mA**, the red fault indicator lights up, the pump stops and any fault indicating relay fitted switches (**Fault** for example with a cable break).



P_BE_0015_SW

Fig. 10: Cable assignment

Pin	Function	5-wire cable	2-wire cable
1	Pause	brown	bridged at pin 4
2	External contact	white	brown
3	mA input*	blue	-
4	Earth GND	black	white
5	Auxiliary frequency	grey	-

* with identity code characteristic "Control version": A - "External Analogue"

Refer to the functional description for the hierarchy of functions and operating modes.

"Pause" function

The pump does not work if:

- the cable is connected and pin 1 and pin 4 are open.

The pump works if:

- the cable is connected and pin 1 and pin 4 are connected.
- no cable is connected.

"External contact" operating mode

The pump performs one or more strokes if:

- Pin 2 and pin 4 are connected to each other for at least 20 ms. At the same time, pin 1 and pin 4 must also be connected to each other.

"External Analogue" operating mode

- The metering pump makes its first metering stroke at approx. 0.1 mA (4.1 mA) and enters into continuous operation at approx. 19.9 mA.

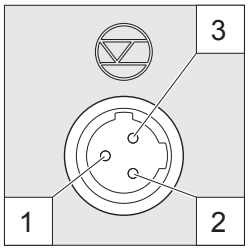
"Auxiliary frequency" operating mode

The pump works at a pre-set stroke rate if:

- Pin 5 and pin 4 are connected to each other. At the same time, pin 1 and pin 4 must also be connected to each other. The auxiliary frequency is factory-preset to the maximum stroke rate.

9.3.2 "Level switch" terminal

There is a connecting option for a 2-stage level switch with pre-warning and limit stop.



P_BE_0016_SW

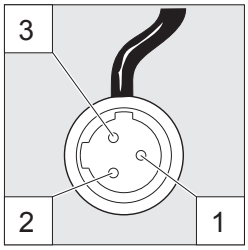
Fig. 11: Pump assignment

Electrical interface

Data	Value	Unit
Voltage with open contacts	5	V
Input resistance	10	kΩ

Control via:

- potential-free contact (load: 0.5 mA at 5 V) or
- Semiconductor switch (residual voltage < 0.7 V)



P_BE_0017_SW

Fig. 12: Cable assignment

Pin	Function	3-wire cable
1	Earth GND	black
2	Minimum pre-warning	blue
3	Minimum limit stop	brown

9.4 Relay

9.4.1 Relay functions

Beta b BT4b/BT5b

Identity code	Description	Type	Maximum voltage	Maximum current	Behaviour of relay type when retrofitting, as standard
0	no relay	-	-	-	-
1	Fault indicating relay	NC changeover contact	230 V	8 A	X
3	Fault indicating relay	NO changeover contact	230 V	8 A	-
4	Fault indicating relay	N/O	24 V	100 mA	X
	Pacing relay	N/O	24 V	100 mA	-
5	Fault indicating relay	N/O	24 V	100 mA	-
	Pacing relay	N/O	24 V	100 mA	-

Relay type switches in the event of...

Relay type	level Warning	level low	Calibrated stroke length Error	Processor Error
Fault indicating relay:	X	X	X	X

9.4.2 "Fault indicating relay" output (identity code 1 + 3)

A fault indicating relay can optionally be ordered. It is used to emit a signal when there is a fault with the pump and for the "Liquid level low, 1st stage" warning message and "Liquid level low 2nd stage" fault message.

A cut-off relay works when there are fault alerts from the pump and in the event of the "Liquid level low 2nd stage" alert.

The fault indicating relay can be retrofitted and is operational once attached to the relay board - refer to the "Operating Instructions for Retrofitting Relays for Beta b and delta".

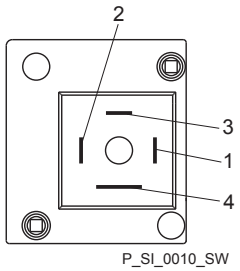


Fig. 13: Pump assignment

Electrical interface

Data	Value	Unit
Maximum contact load at 230 V and 50/60 Hz:	8	A
Minimum mechanical lifespan:	200,000	switching operations

Identity code 1 + 3

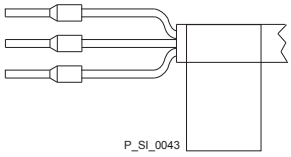


Fig. 14: Cable assignment

Pin assignment

To pin	VDE cable	Contact	CSA cable
1	white	NO (normally open)	white
2	green	NC (normally closed)	red
4	brown	C (common)	black

9.4.3 "Fault indicating relay" + "Pacing relay" output (identity code 4 + 5)

A fault indicating / pacing relay can optionally be ordered. The pacing output is electrically-isolated by means of an optocoupler with a semiconductor switch. The second switch is a relay.

The fault indicating /pacing relay can be retrofitted and is operational once attached to the relay board - refer to the "Operating Instructions for Retrofitting Relays for Beta b and delta".

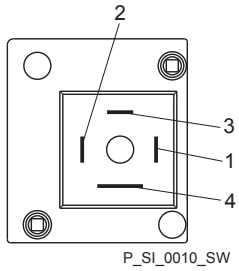


Fig. 15: Pump assignment

Electrical interface

for fault indicating relays:

Data	Value	Unit
Maximum contact load at 24 V and 50/60 Hz:	8	A
Minimum mechanical lifespan:	200,000	switching operations

for semiconductor switch pacing relay:

Data	Value	Unit
Residual voltage max. at I_c = 1 mA	0.4	V
Maximum current	100	mA
Maximum voltage	24	VDC
Pacing pulse duration, approx.	100	ms

Identity code 4 + 5

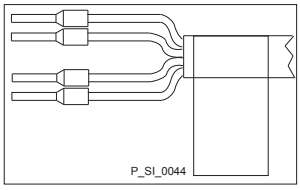


Fig. 16: Cable assignment

Pin assignment

To pin	VDE cable	Contact	Relay
1	yellow	NO (normally open)	Fault indicating relay
4	green	C (common)	Fault indicating relay
3	white	NO (normally open)	Pacing relay
2	brown	C (common)	Pacing relay

10 Start up

WARNING!

Dangerous reactions are possible due to contact of feed chemical with water

The feed chemical can mix and react in the liquid end with water remaining after testing in the factory.

- Read the safety data sheet on the feed chemical.
- Blast the liquid end with compressed air.
- Flush the liquid end with a suitable medium through the suction connector.

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

- During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

CAUTION!

Danger with dangerous feed chemicals

Contact with the feed chemical is possible provided the following handling instructions are adhered to.

- If the feed chemical is dangerous, take appropriate safety precautions when carrying out the following handling instructions.
- Adhere to the feed chemical safety data sheet.

CAUTION!

Warning of feed chemical spraying around

An unsuitable feed chemical can damage the parts of the pump that come into contact with the chemical.

- Take into account the resistance of the materials that will come into contact with the medium when selecting the feed chemical - refer to the ProMinent® Resistance List in the Product Catalogue or at www.prominent.com.

- *Reliable metering cannot be guaranteed after the metering pump has been idle for some time, as the feed chemical can crystallise in the valves and on the diaphragm. Regularly check the valves and diaphragm.*
- *Only adjust the stroke length when the pump is running.*
- *The metering pump should prime at 100% stroke length, as the priming lift depends on the stroke volume when the liquid end is empty. If the metering pump has to prime at a smaller stroke length and is not priming, reduce the priming lift (i.e. briefly lift up the storage tank with the feed chemical).*
- *SEK-type only: The suction lift corresponds to the priming lift, as some gas always remains in the liquid end with gaseous media.*

Starting up the metering pump

1. Fill the liquid end - *'Filling the liquid end' on page 35*.
2. Check the pump connectors and connections for leak-tightness.
3. Check the suction valve and discharge valve for leak-tightness and tighten if necessary.
4. Check the liquid end for leak-tightness and tighten the screws on the dosing head if necessary - see below for starting torque.
5. Only with bleed valve: Check whether the bleed valve is closed.
6. Start up the relief valve in the system in line with its operating instructions.
7. Start up the system.
8. After 24 hours of operation: Tighten the screws on the dosing head - see below for tightening torque.

Tightening torque

Data	Value	Unit
Tightening torque for screws:	4.5 ... 5.0	Nm

Draining the liquid end

With feed chemicals that should not come into contact with water.

1. Turn the pump so that the pressure connector is facing downwards.
2. Allow water to flow out of the liquid end.
3. Flush the suction connector from above with a suitable medium or blast with compressed air.

Filling the liquid end

With liquid ends without bleed valve:

1. Connect the suction line to the liquid end but not yet to the discharge line.
2. If fitted: Close the shut-off valve on the discharge side.
3. Connect a short, transparent section of hose to the discharge valve.
4. Switch on the metering pump and allow to work at maximum stroke length and stroke rate until some feed chemical becomes visible in the short section of hose.
   ⇨ The liquid end has been filled completely without bubbles.
5. Switch off the metering pump.
6. Connect the discharge line to the liquid end.
   ⇨ The metering pump is ready for operation.

With liquid ends with bleed valves (not SEK):

1. Connect the suction and discharge line to the liquid end.
2. Connect the return line.
3. Open the bleed valve by turning the star-shaped handle in a counter-clockwise direction.
   ⇨ You can now use the return line to bleed the pump.
4. Switch on the metering pump and allow to work at maximum stroke length and stroke rate until some feed chemical becomes visible in the return or discharge line.
   ⇨ The liquid end has been filled completely without bubbles.
5. Switch off the metering pump.
6. Close the bleed valve.
   ⇨ The metering pump is ready for operation.

With self-bleeding metering pumps (SEK type):

- *The return line is connected to the vertical valve on the top of the liquid end. It is labelled with a red sleeve ex-works.*
- *The discharge line is connected to the horizontal valve.*

1. Switch on the metering pump and allow to work at maximum stroke length and stroke rate until some feed chemical becomes visible in the return or discharge line.
   ⇨ The liquid end has been filled completely without bubbles.
2. Switch off the metering pump.
   ⇨ The metering pump is ready for operation.

Setting the precise dosage

Stroke length and stroke rate

- *Select as large a stroke length as possible with gaseous feed chemicals.*
- *Select as high a stroke rate as possible for good mixing.*
- *Do not set the stroke length to less than 30 % for precise metering using quantity-proportional metering.*

11 Operation

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

– During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

WARNING!

Danger of electric shock

Incompletely installed electrical options can allow moisture into the inside of the housing.

– Knock-out openings in the pump housing must be equipped with matching modules or be sealed in a leak-tight manner.

WARNING!

Danger of electric shock

A mains voltage may exist inside the pump housing.

– If the pump housing has been damaged, you must disconnect it from the mains immediately. It may only be returned to service after an authorised repair.

11.1 Manual

Personnel: ■ Instructed personnel

11.1.1 Capacity

The capacity is determined by the stroke length and the stroke rate.

The stroke length is adjusted by the stroke length adjustment knob within a range of 0 ... 100 %. A stroke length of between 30 ... 100 % (SEK type: 50 ... 100 %) is recommended to achieve the specified reproducibility!

Data	Value	Unit
Recommended stroke length, standard type	30 ... 100	%
Recommended stroke length, SEK type	50 ... 100	%

The stroke rate can be set within a range of 10 ... 100 % using the multi-functional switch.

11.1.2 Functions

The pump has the following functions:

"Pause" function

The pump can be remotely stopped via the "External Control" terminal. The "Pause" function only works via the "External Control" terminal.

"Stop" function (optional)

The pumps can be stopped by turning the multifunctional switch to "Stop" without disconnecting it from the mains power supply.

"Priming" function

Priming (transient conveyance at maximum frequency) can be provided by turning the multifunctional switch to "Test".

"Level switch" function

Information about the liquid/powder level in the feed chemical container is reported to the pump. To do so, a two-stage level switch must be fitted; it is connected to the "Level switch" terminal.

"Auxiliary rate" function

Enables switching of a stroke rate via the "External control" jack. This auxiliary rate has priority over the operating mode stroke rate settings . In the standard version, the "Auxiliary frequency" function is programmed to 100 % stroke rate.

11.1.3 External contact

"Extern" operating mode:

In the Extern Contact operating mode, either a series of strokes can be triggered or an inbound series of contacts can be stepped down via the pulse control switch by a single contact on the "External control" terminal. To do so, the multifunctional switch has to be turned to "Extern".

Explanation of the stepped-down values:

Settable values	Incoming contacts	Strokes performed
1:1	1	1
1:2	2	1
1:4	4	1
1:8	8	1
1:16	16	1
1:32	32	1
1:64	64	1

Explanation of stepped-up values:

Settable values	Incoming contacts	Strokes performed
1:1	1	1
2:1	1	2
4:1	1	4
8:1	1	8
16:1	1	16
32:1	1	32
64:1	1	64

11.1.4 External analog

"External Analogue" operating mode

In "External Analogue" operating mode, the stroke rate can be controlled by an mA signal via the pulse control switch. To do so, the multifunctional switch has to be turned to "Extern".

In the same way, a single contact via the pulse control switch at the "external control" terminal can either be used to trigger a series of strokes or to step down an incoming series of contacts. To do so, the multifunctional switch has to be turned to "Extern".

Explanation of the stepped-down values:

Settable values	Incoming contacts	Strokes performed
such as "External Analogue"	such as "External Analogue"	such as "External Analogue"
...	...	...
01:16	16	1
01:32	32	1
0-20 mA	-	corresponding to the mA signal

Explanation of stepped-up values:

Settable values	Incoming contacts	Strokes performed
such as "External Analogue"	such as "External Analogue"	such as "External Analogue"
...	...	...
16:1	1	16
32:1	1	32
4-20 mA	-	corresponding to the mA signal

11.2 Remote operation

There is an option to control the pump remotely via a signal cable - refer to your system documentation and to "Electrical Installation".

12 Maintenance

WARNING!

It is mandatory that you read the safety information and specifications in the "Storage, Transport and Unpacking" chapter prior to shipping the pump.

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

– During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

– Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
– Depressurise the system before commencing any work on hydraulic parts.

Third party spare parts for the pumps may lead to problems when pumping.

– *Use only original spare parts.*
– *Use the correct spare parts kits. In the event of doubt, refer to the exploded views and ordering information in the appendix.*

Standard liquid ends:

Interval	Maintenance work	Personnel
Quarterly*	■ Check the metering diaphragm for damage** - refer to "Repair". ■ Check that the hydraulic lines are fixed firmly to the liquid end. ■ Check that the suction valve and discharge valve are fitted tightly. ■ Check the tightness of the entire liquid end - particularly around the leakage hole - refer to *'Standard liquid ends:' on page 40*! ■ Check that the flow is correct: Allow the pump to prime briefly - turn the multifunctional switch briefly to "Test" ■ Check that the electrical connections are intact. ■ Check the integrity of the housing. ■ Check that the dosing head screws are tight.	Technical personnel

* Under normal loading (approx. 30 % of continuous operation)

Under heavy loading (e.g. continuous operation): Shorter intervals.

** Check the diaphragm frequently with feed chemicals that put particular pressure on the diaphragm, e.g. those containing abrasive additives.

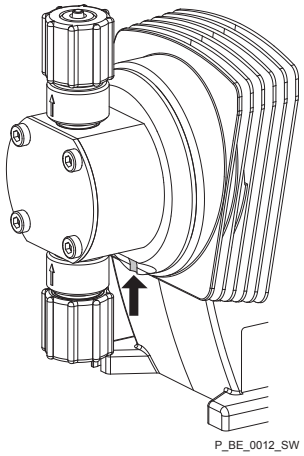


Fig. 17: Leakage hole

Liquid ends with bleed valve:

Interval	Maintenance work
Quarterly*	In addition: ■ Check that the bypass line is fixed firmly to the liquid end ■ Check that the bleed valve is tight. ■ Check the discharge and bypass line for kinks ■ Check that the bleed valve is operating correctly.

* Under normal loading (approx. 30 % of continuous operation)

Under heavy loading (e.g. continuous operation): Shorter intervals.

Tightening torque

Data	Value	Unit
Tightening torque for screws:	4.5 ... 5.0	Nm

13 Repairs

Safety Information

WARNING!

Danger of electric shock

Unauthorised repairs inside the pump can result in an electric shock.

For this reason, only allow a ProMinent branch or representative to perform repair inside the pump, in particular the following:

– Replacement of damaged mains connection lines
– Replacement of fuses
– Replacement of electronic control

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

– During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

WARNING!

It is mandatory that you read the safety information and specifications in the "Storage, Transport and Unpacking" chapter prior to shipping the pump.

WARNING!

Contact with the feed chemical

Parts that come into contact with the feed chemical are exposed and touched during repair work.

– Protect yourself against the feed chemical in case it is hazardous. Read the safety data sheet on the feed chemical.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

– Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
– Depressurise the system before commencing any work on hydraulic parts.

Repairs that may be carried out by qualified technical personnel, in accordance with the operating instructions:

- Cleaning valves
- Replacing the diaphragm

All other repairs: Contact the responsible ProMinent branch!

13.1 Cleaning valves

Warning of faulty operation

Refer to the exploded drawings in the appendix when working on the unit.

Cleaning a discharge valve or a suction valve on types (PP, PV, NP) 1000, 1601, 1602, 1604, 2504

Warning of faulty operation

- *Discharge and suction valves differ from each other! Only take them apart one after each other, so that you do not confuse the components!*
- *Only use new components which fit your valve - both in terms of shape and chemical resistance!*
- *Recalibrate the pump after replacing a valve!*
- *Using an Allen key or similar, insert it into the smaller hole of the discharge connector and push the valve inserts out of it.*

A suction valve is constructed in almost the same way as a discharge valve.

Please note, however, that:

- the two valve inserts are identical here
- There is an additional spacer between the valve inserts.
- There is a shaped seal in the dosing head instead of an O-ring.
- The flow direction of the suction connector is the opposite to that of the discharge connector.

Cleaning a discharge valve or a suction valve on types (PP, PV, NP) 0708, 1008, 0220, 0420, 0413, 0713, 0232

Warning of faulty operation

- *Discharge and suction valves differ from each other! Only take them apart one after each other, so that you do not confuse the components!*
- *Only use new components which fit your valve - both in terms of shape and chemical resistance!*
- *With the PVT material version, the ball seat is integrated in the dosing head and so has to be cleaned separately!*
- *On the PVT material version, the discharge valve is a double ball valve!*
- *Using an Allen key or similar, insert it into the smaller hole of the discharge connector and push the valve inserts out of it.*

A suction valve is constructed in almost the same way as a discharge valve.

Please note, however, that:

- The flow direction of the suction connector is the opposite to that of the discharge connector.

13.2 Replacing the diaphragm

WARNING!
A little feed chemical may have accumulated behind the diaphragm in the backplate following a leak - depending on the design!

– Take this feed chemical into consideration when you are planning a repair - especially if it is hazardous!

- If necessary take protective measures.
- Adhere to the material safety data sheet for the feed chemical.
- Ensure that the system is at atmospheric pressure.

1. Empty the liquid end (turn the liquid end upside down and allow the feed chemical to run out; flush out with a suitable medium; flush the liquid end thoroughly when using hazardous feed chemicals!)
2. Turn the stroke adjustment dial as far as 0% stroke length when the pump is running (the drive axle is then difficult to turn).
3. Switch off the pump.
4. Unscrew the hydraulic connectors on the discharge and suction side.
5. With PP types with bleed valve: Firstly remove the bleed valve (grip), then lift off the cover of the liquid end with a screw driver.
6. Remove the screws (1).
7. Loosen the dosing head (2) and the backplate (4) from the pump housing (6) - but only loosen!
8. Hold the pump housing (6) with one hand and clamp the diaphragm (3) with the other hand between the dosing head (2) and the backplate (4).
9. Loosen the diaphragm (3) from the drive axle with a gentle backwards turn of the dosing head (2), diaphragm (3) and backplate (4) in an anticlockwise direction.
10. Unscrew the diaphragm (3) completely from the drive axle.
11. Remove the backplate (4) from the pump housing (6).
12. Check the condition of the safety diaphragm (5) and replace if necessary.
13. Push the safety diaphragm (5) onto the drive axle only until it lies flush with the pump housing (6) and no further!
14. Tentatively screw the new diaphragm (3) onto the drive axle until it can go no further.

    ⇨ The diaphragm (3) is now sitting at the stop of the thread.
15. Should this not work, remove dirt or swarf from the threads and screw the diaphragm (3) onto the drive axle correctly this time.

Ensure that the diaphragm is screwed exactly onto the drive axle otherwise the pump will subsequently not meter accurately!

16. Unscrew the diaphragm (3) again.
17. Place the backplate (4) on the pump housing (6).

CAUTION!
Leakage may become apparent at a later stage.
– Make sure that the leakage hole points downwards when the pump is installed later - please refer to !
– Place the backplate (4) immediately into the correct position on the pump housing (6)! Do not twist the backplate on the pump housing to prevent the safety diaphragm (5) becoming warped!

18. Place the diaphragm (3) into the backplate (4).

CAUTION!
Leakage may become apparent at a later stage.
– Do not over-tighten the diaphragm (3) in the following step!
– Ensure that the backplate (4) remains in its position so that the safety diaphragm does not become warped!

19. Hold the backplate (4) firmly and screw the diaphragm (3) in a clockwise direction until it is sitting tightly (the twisting resistance of the return spring can be felt).

20. Set the stroke length to 100%.

21. Place the dosing head (2) with the screws (1) onto the diaphragm (3) and the backplate (4) - ensure that the suction connector points downwards when the pump is in its subsequent fitting position.

22. Gently tighten the screws (1) and then tighten them diagonally. See below for the tightening torque.

23. With PP types with bleed valve: Allow the cover of the liquid end to rest in the dosing head, then press the grip on the bleed valve into the dosing head.

CAUTION!
Leakage possible
– Check the tightening torque of the screws after 24 hours of operation!
– With PP and PV dosing heads, check the tightening torque again after three months!

Tightening torque

Data	Value	Unit
Tightening torque for screws:	4.5 ... 5.0	Nm

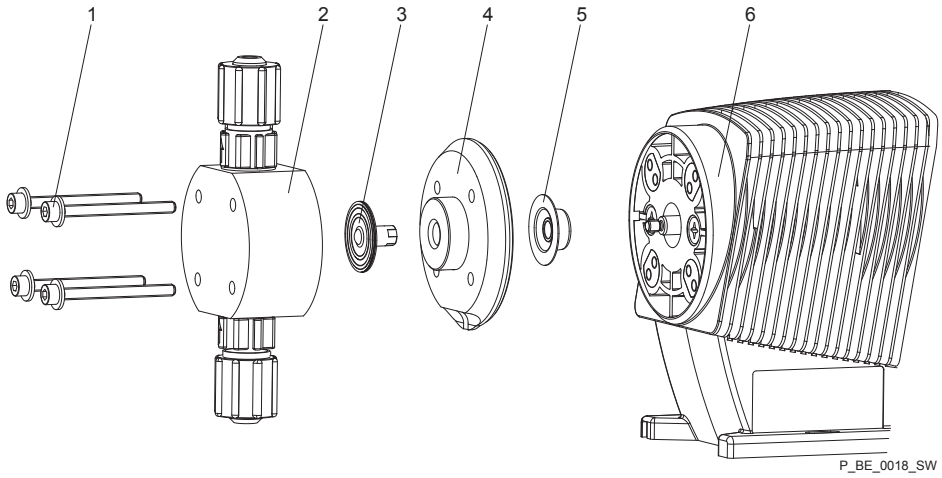


Fig. 18: Partially exploded view of liquid end

14 Troubleshooting

Safety Information

WARNING!

Warning of dangerous or unknown feed chemical

Should a dangerous or unknown feed chemical be used: It may escape from the hydraulic components when working on the pump.

– Take appropriate protective measures before working on the pump (e.g. safety glasses, safety gloves, ...). Observe the safety data sheet for the feed chemical.
– Drain and flush the liquid end before working on the pump.

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

– During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

– Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
– Depressurise the system before commencing any work on hydraulic parts.

14.1 Faults without a fault message

Fault description	Cause	Remedy	Personnel
Pump does not prime in spite of full stroke motion and bleeding.	Minor crystalline deposits on the ball seat due to the valves drying out.	Take the suction hose out of the storage tank and thoroughly flush out the liquid end.	Technical personnel
	Serious crystalline deposits on the ball seat due to the valves drying out.	Dismantle the valves and clean them - refer to "Repair"	Technical personnel
Fluid is escaping from the backplate.	The screws in the dosing head are too loose.	Tighten the screws in the dosing head crosswise - refer to "Repair" for tightening torque.	Instructed personnel
	The diaphragm is not leak-tight.	Replace the diaphragm - refer to "Repair".	Technical personnel
Green LED display (operating indicator) does not light up.	The wrong mains voltage or no mains voltage is connected.	Connect the pump correctly to the specified mains voltage - according to the specification on the nameplate	Electrician

14.2 Fault messages

Fault description	Cause	Remedy	Personnel
Red LED indicator (fault indicator) lights up and the pump stops	The fluid level in the storage tank has reached "Liquid level low 2nd stage".	Fill the storage tank.	Instructed personnel
	The pump is in "External Analogue" operating mode and the control current has risen above 23 mA (fault signal).	Clear the cause of the fault on the pump.	
	The pump is in "External Analogue" operating mode, set to "4-20 mA" and the control current has fallen below 4 mA.	Clear the cause of the low control current (e.g. cable break).	
	The multifunctional switch is not turned to "Extern" but an external cable is connected and the pump has the identity code feature "Control type" - "1" "with lock".	Either turn the multifunctional switch to "Extern" or remove the Extern cable from the pump	Technical personnel

14.3 Warning messages

Fault description	Cause	Remedy	Personnel
Yellow LED indicator (warning indicator) lights up	The fluid level in the storage tank has reached "Liquid level low 1st stage".	Fill the storage tank.	Instructed personnel

14.4 All Other Faults

Please contact the responsible ProMinent branch or representative!

15 Decommissioning

Decommissioning

WARNING!

Danger from chemical residues

There is normally chemical residue in the liquid end and on the housing after operation. This chemical residue could be hazardous to people.

- It is mandatory that the safety notes in the "Storage, Transport and Unpacking" chapter are read before shipping or transport.
- Thoroughly clean the liquid end and the housing of chemicals and dirt. Adhere to the material safety data sheet for the feed chemical.

WARNING!

Warning of dangerous or unknown feed chemical

Should a dangerous or unknown feed chemical be used: It may escape from the hydraulic components when working on the pump.

- Take appropriate protective measures before working on the pump (e.g. safety glasses, safety gloves, ...). Observe the safety data sheet for the feed chemical.
- Drain and flush the liquid end before working on the pump.

WARNING!

Fire hazard with flammable media

Only with combustible media: These may start to burn when combined with oxygen.

- During filling and draining of the liquid end, an expert must ensure that feed chemical does not come into contact with oxygen.

CAUTION!

Warning of feed chemical spraying around

Feed chemical can spray out of the hydraulic components if they are manipulated or opened due to pressure in the liquid end and adjacent parts of the system.

- Disconnect the pump from the mains power supply and ensure that it cannot be switched on again by unauthorised persons.
- Depressurise the system before commencing any work on hydraulic parts.

Danger of damage to the device

Take into account the information in the "Storage, Transport and Unpacking" chapter if the system is decommissioned for a temporary period.

1. Disconnect the pump from the mains/power supply.
2. Drain the liquid end by turning the pump upside down and allowing the feed chemical to run out.

3. Flush the liquid end with a suitable medium; flush the dosing head thoroughly when using hazardous feed chemicals!

Disposal

CAUTION!

Environmental hazard due to electronic waste

There are electronic components in the pump, which can have a toxic effect on the environment.

– Separate the electronic components from the remaining parts.
– Note the pertinent regulations currently applicable in your country!

16 Technical data

16.1 Performance data

Beta b operating at 180 strokes/minute and 100% stroke length

Type	Minimum pump capacity at maximum back pressure			Minimum pump capacity at medium back pressure			Connection size outside Ø x inside Ø	Suction lift*	Priming lift**	Maximum priming pressure on suction side
	bar	l/h	ml/stroke	bar	l/h	ml/stroke	mm	m WS	m WS	bar
Beta b										
1000	10	0.74	0.069	5.0	0.82	0.076	6x4	6.0	1.8	8
0700	7	0.8	0.074	3.5	0.88	0.074	6x4	6.0	1.8	8
0400	4	0.84	0.078	2.0	0.92	0.078	6x4	6.0	1.8	8
2001	20	0.96	0.089	10	1.5	0.13	6x3	6.0	2.0	8
1601	16	1.1	0.10	8.0	1.40	0.13	6x4	6.0	2.0	8
1001	10	1.3	0.12	5.0	1.5	0.14	6x4	6.0	2.0	8
0701	7	1.4	0.13	3.5	1.7	0.14	6x4	6.0	2.0	8
0401	4	1.5	0.14	2.0	2.0	0.18	6x4	6.0	2.0	8
2002	20	1.7	0.16	10	2.8	0.26	6x3	6.0	2.5	5.5
1602	16	2.2	0.20	8.0	2.5	0.24	6x4	6.0	2.5	5.5
1002	10	2.4	0.22	5.0	2.8	0.26	6x4	6.0	2.5	5.5
0702	7	2.6	0.24	3.5	3.1	0.29	6x4	6.0	2.5	5.5
0402	4	2.8	0.26	2.0	3.6	0.36	6x4	6.0	2.5	5.5
1604	16	3.6	0.33	8.0	4.3	0.40	6x4	5.0	3.0	3
1004	10	3.9	0.36	5.0	4.7	0.44	6x4	5.0	3.0	3
0704	7	4.2	0.39	3.5	5.1	0.47	6x4	5.0	3.0	3
0404	4	4.5	0.42	2.0	5.6	0.52	6x4	5.0	3.0	3
0708	7	7.1	0.66	3.5	8.4	0.78	8x5	4.0	2.0	2
0408	4	8.3	0.77	2	10.0	0.93	8x5	4.0	2.0	2
0413	4	12.3	1.14	2.0	14.2	1.31	8x5	3.0	2.5	1.5
0220	2	19.0	1.76	1.0	20.9	1.94	12x9	2.0	2.0	1
2504	25	2.9	0.27	12.5	3.7	0.34	8x4[1]	4.0	3.0	3
1605	16	4.1	0.38	8.0	4.9	0.45	8x5	4.0	3.0	3
1008	10	6.8	0.63	5.0	8.3	0.76	8x5	3.0	3.0	2
0713	7	11.0	1.02	3.5	13.1	1.21	8x5	3.0	3.0	1.5
0420	4	17.1	1.58	2.0	19.1	1.77	12x9	3.0	3.0	1
0232	2	32.0	2.96	1.0	36.2	3.35	12x9	2.0	2.0	0.8
Beta b Metering pumps with self-bleeding dosing head SEK* **										
1601	16	0.59	0.055	8.0	0.80	0.072	6x4	6.0	2.0	0.5
1001	10	0.72	0.067	5.0	0.60	0.08	6x4	6.0	2.0	0.5
0701	7	0.84	0.078	3.5	1.12	0.10	6x4	6.0	2.0	0.5

Type	Minimum pump capacity at maximum back pressure			Minimum pump capacity at medium back pressure			Connection size outside Ø x inside Ø	Suction lift*	Priming lift**	Maximum priming pressure on suction side
	bar	l/h	ml/ stroke	bar	l/h	ml/ stroke	mm	m WS	m WS	bar
0401	4	0.9	0.083	2.0	1.2	0.11	6x4	6.0	2.0	0.5
2002	20	0.78	0.07	10.0	1.8	0.17	6x4	6.0	2.5	0.5
1602	16	1.40	0.13	8.0	1.70	0.16	6x4	6.0	2.5	0.5
1002	10	1.7	0.16	5.0	2.0	0.18	6x4	6.0	2.5	0.5
0702	7	1.8	0.17	3.5	2.2	0.20	6x4	6.0	2.5	0.5
0402	4	2.1	0.19	2.0	2.5	0.23	6x4	6.0	2.5	0.5
1604	16	2.7	0.25	8.0	3.6	0.33	6x4	6.0	3.0	0.5
1004	10	3.3	0.30	5.0	3.9	0.36	6x4	6.0	3.0	0.5
0704	7	3.6	0.33	3.5	4.0	0.37	6x4	6.0	3.0	0.5
0404	4	3.9	0.36	2.0	4.2	0.39	6x4	6.0	3.0	0.5
0708	7	6.60	0.61	3.5	7.50	0.69	8x5	6.0	2.0	0.5
0408	4	7.5	0.64	2.0	8.1	0.77	8x5	6.0	2.0	0.5
0413	4	10.8	1.0	2.0	12.6	1.17	8x5	6.0	2.5	0.5
0220	2	16.2	1.5	1.0	18.0	1.67	12x9	6.0	2.0	0.5
1008	10	6.3	0.58	5.0	7.5	0.69	8x5	6.0	3.0	0.5
0713	7	10.5	0.97	3.5	12.3	1.14	8x5	6.0	2.5	0.5
0420	4	15.6	1.44	2.0	17.4	1.61	12x9	6.0	2.5	0.5
Beta b metering pumps with self-bleeding dosing head SER**										
1002	10	1.40	0.13	8.0	1.70	0.174	6x4	6.0	1.8	0.5
1004	10	2.7	0.25	8.0	3.6	0.33	6x4	6.0	1.8	0.5
0708	7	6.60	0.61	3.5	7.50	0.69	8x5	6.0	1.8	0.5
0413	4	10.8	1.0	2.0	12.6	1.17	8x5	6.0	1.8	0.5
0220	2	16.2	1.5	1.0	18.0	1.67	12x9	6.0	2.0	0.5
1008	10	6.3	0.58	5.0	7.5	0.69	8x5	6.0	1.8	0.5
0713	7	10.5	0.97	3.5	12.3	1.14	8x5	6.0	1.8	0.5
0420	4	15.6	1.44	2.0	17.4	1.61	12x9	6.0	1.8	0.5

* - Suction lift with a filled suction line and filled liquid end. With self-bleeding dosing head with air in the suction line.

** - Priming lift with clean and moist valves. Priming lift at 100% stroke length and free outlet or opened bleed valve.

*** - The given performance data constitutes guaranteed minimum values, calculated using water as the medium at room temperature. The bypass connection with a self-bleeding dosing head SEK is 6x4 mm.

*** - The given performance data constitutes guaranteed minimum values, calculated using water as the medium at room temperature.

[1] - The connector width is 6 mm on SST material versions.

Beta b Metering pumps with dosing heads for higher-viscosity media (HV) have a 10-20% lower capacity and are not self-priming. Connection G 3/4-DN 10 with hose nozzle d16-DN10.

16.2 Accuracy

16.2.1 Standard Liquid End

Data	Value	Unit
Capacity range of the series	-5 ... +10	% *
Reproducibility	±2	% **

* - at max. stroke length and max. operating pressure for all material versions

** - at constant conditions and min. 30 % stroke length

16.2.2 Self-Bleeding Liquid End

As the self-bleeding liquid end is used with outgassing media and when operating with air bubbles, no dosing accuracy or reproducibility can be provided.

The recommended minimum stroke length with self-bleeding dosing pumps is 50 %.

16.3 Viscosity

The liquid ends are suitable for the following viscosity ranges:

Version	Range	Unit
standard	0 ... 200	mPas
With valve springs	200 ... 500	mPas
Self-bleeding (SEK)	0 ... 50	mPas
HV (highly viscous)	500 ... 3000*	mPas

* Only when the installation is correctly adjusted

16.4 Material Data

Standard liquid ends

Version	Dosing head	Suction/Discharge connector	Seals	Valve balls
PPE	Polypropylene	Polypropylene	EPDM	Ceramic
PPB	Polypropylene	Polypropylene	FPM	Ceramic
PPT	Polypropylene	PVDF	PTFE	Ceramic
NPE	Acrylic glass	PVC	EPDM	Ceramic
NPB	Acrylic glass	PVC	FPM	Ceramic
NPT	Acrylic glass	PVDF	PTFE	Ceramic
PVT	PVDF	PVDF	PTFE	Ceramic
TTT	PTFE with carbon	PTFE with carbon	PTFE	Ceramic
SST	Stainless steel 1.4404	Stainless steel 1.4404	PTFE	Ceramic

Only the self-bleeding version in PPE, PPB, NPE and NPB material models with a valve spring made of hastealloy C and a valve insert made of PVDF. Diaphragm with a PTFE coating.

FPM = fluororubber

Pump

Housing parts: polyphenyl ether (PPE with fibreglass)

16.5 Electrical data

Version: 100 - 230 V ±10 %, 50/60 Hz, Beta b BT4b

Data	Value	Unit
Nominal power, approx.	6.4 ... 16.5	W
Current I eff	0.65 ... 0.1	A
Peak current	4.2 ...1.3	A
Switch on peak current, (within approx. 50 ms falling)	15	A
Fuse*	0.8	AT

Version: 100 - 230 V ±10 %, 50/60 Hz, Beta b BT5b

Data	Value	Unit
Nominal power, approx.	20 ... 25	W
Current I eff	0.9 ... 0.3	A
Peak current	5.9 ... 2.3	A
Switch on peak current, (within approx. 50 ms falling)	15	A
Fuse*	0.8	AT

* Fuses must have VDE, UL and CSA certification. E.G. type 19195 manufactured by Wickmann in compliance with IEC Publ. 127 - 2/3.

Power consumption

Type	Perform-ance	Type	Perform-ance	Type	Perform-ance
	W		W		W
1000	7.6	1602	12.2	0408	12.7
0700	6.4	1002	10.6	0413	16.5
0400	5.7	0702	9.3	0220	16.5
2001	10.5	0402	7.9	2504	21.2
1601	10.0	1604	16.5	1008	20.3
1001	8.3	1004	12.7	0713	21.2
0701	7.5	0704	11.1	0420	21.2
0401	6.9	0404	9.5	0232	24.9
2002	13.5	0708	16.5		

Design: 12 - 24 VDC# -8/+24 %, identity code M

Parameter	Beta b BT4b
Nominal power, approx.	17.4 W.
Nominal current (averaged at 180 H/min)	3.9 ... 1.9 A.
Peak current	15.6... 8.7 A.
closed current (no stroke)	32 ... 24 mA.
Fuse*	5 AT

SELV in accordance with EN 60335-1

* 5 AT, 5x20 mm, order no. 712028

The pump only works if the polarity is correct.

Design: 24 VDC# -15/+24 %, identity code N

Parameter	Beta b BT5b
Nominal power, approx.	24.4 W.
Nominal current (averaged at 180 H/min)	2.5 A.
Peak current	11.7 A.
Closed current (no stroke)	24 mA.
Fuse*	5 AT

SELV in accordance with EN 60335-1

* 5 AT, 5x20 mm, order no. 712028

The pump only works if the polarity is correct.

16.6 Temperatures

Pump, fully assembled

Data	Value	Unit
Storage and transport temperature:	-10 ... +50	°C
Ambient temperature in operation (power end/drive and control):	-10 ... +45	°C

Liquid end, long-term*

Maximum temperature, liquid end

Material version	Value	Unit
PP	50	°C
NP	40	°C
PV	50	°C
TT	50	°C
SS	50	°C

* long term at max. operating pressure, dependent on the ambient temperature and the feed chemical temperature

Minimum temperature, liquid end

Minimum temperature, liquid end

Material version	Value	Unit
All	-10	°C

Liquid end, short-term*

Maximum temperature, liquid end

Material version	Value	Unit
PPT	100	°C
NPT	60	°C
PVT	120	°C
TTT	120	°C
SST	120	°C

* Temp. max., for 15 min at max. 2 bar, dependent on the ambient and feed chemical temperatures

16.7 Climate

Data	Value	Unit
Maximum air humidity *:	95	% rel. humidity

* non-condensing

Exposure in a humid and alternating climate:

FW 24 according to DIN 50016

16.8 Degree of Protection and Safety Requirements

Degree of protection

Protection against accidental contact and humidity:

IP 65 according to DIN EN 60529

Safety requirements

Degree of protection:

1 - mains power connection with protective earth conductor

16.9 Compatibility

Some hydraulic parts of the Beta® b are identical to those of the Beta® a, gamma/ L and delta®.

There is most compatibility with pumps of the Beta® a, gamma/ L and delta® series with the following components and accessories:

- Signal cable gamma/Vario 2-, 4- and 5-wire for the "Extern" function
- Level switch 2-stage (gamma / Vario / Beta®)
- Dosing line cross-sections
- Standard gamma connector kit
- Chemical feed container
- Overall height (distance between the suction and discharge connector)
- Same use of accessories, such as back pressure valves, multifunctional valves, dosing monitor and flushing equipment

16.10 Sound pressure level

Sound pressure level

Sound pressure level LpA < 70 dB according to EN ISO 20361

at maximum stroke length, maximum stroke rate, maximum back pressure (water)

16.11 Shipping weight

Shipping weight of Beta b types - in kg

Material	BT4b						BT5b		
	1000, 0700, 0400	2001, 1601, 1001, 0701, 0401	2002, 1602, 1002, 0702, 0402	1604, 1004, 0704, 0404	0708, 0408, 0413	0220	2504, 1008, 0713	0420	0232
PP, NP, PV, TT	2.5	2.9	2.9	3.1	3.1	3.3	4.5	4.7	5.1
SS	3.0	3.6	3.6	3.9	3.9	4.4	5.3	5.8	6.6

17 Dimensional drawings

- *Compare the dimensions on the dimensional drawing and pump.*
- *All dimensions are in mm.*

Dimensional drawing Beta b, material version PP

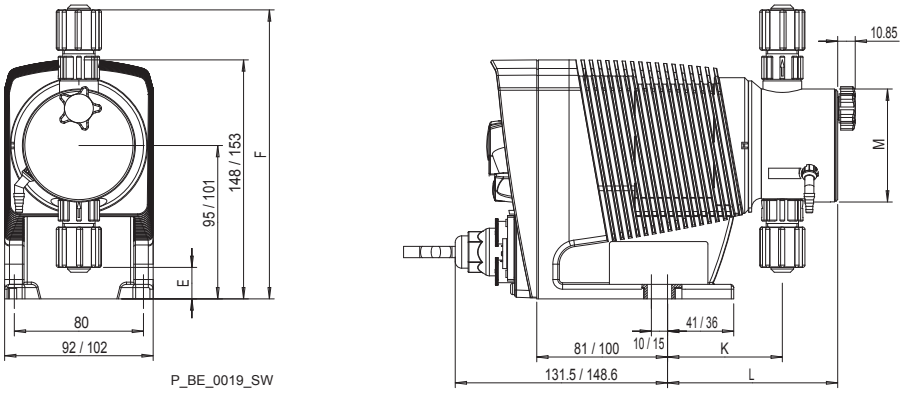


Fig. 19: Dimension drawing Beta b BT4b/BT5b, material version PP - dimensions in mm

	1000 - 1604	0708 - 0220	1008 - 0420	0232
E	19.5	7	14	1.5
F	179	186.5	191.5	200.5
K	71	77.5	74	77.5
L	105.5	111	107.5	94.5
M	Ø 70	Ø 90	Ø 90	Ø 110

Dimensional drawing Beta b, material version PP

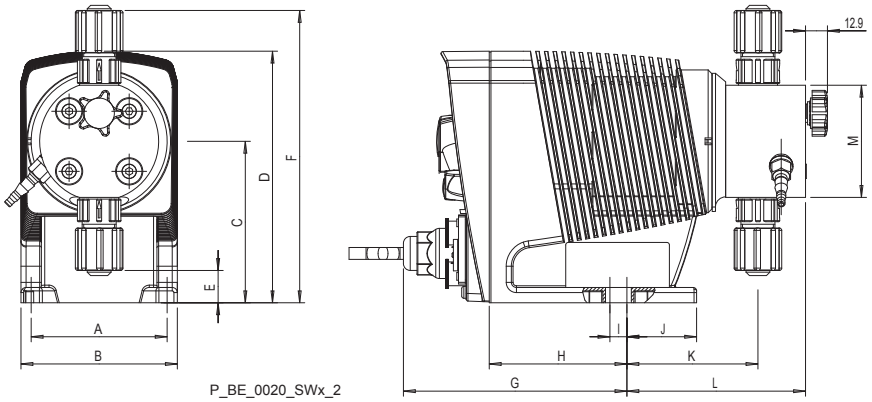


Fig. 20: Dimension drawing Beta b BT4b/BT5b, material version PP - dimensions in mm

	1000 - 1604	0708 - 0220	2504	1008 - 0420	0232
A	80	80	80	80	80
B	92	92	102	102	102
C	95	95	101	101	101
D	148	148	153	153	153
E	19	7.2	24.6	14	3.2
F	172	182.8	178.4	188	198.8
G	131.5	131.5	148.6	148.6	148.6
H	81	81	100	100	100
I	10	10	15	15	15
J	41	41	36	36	36
K	77	77.5	77.1	74.1	76
L	105	105.5	105.1	102.1	104.5
M	Ø 70	Ø 90	Ø 70	Ø 90	Ø 110

Dimensional drawing Beta b, material version PP and NP SEK

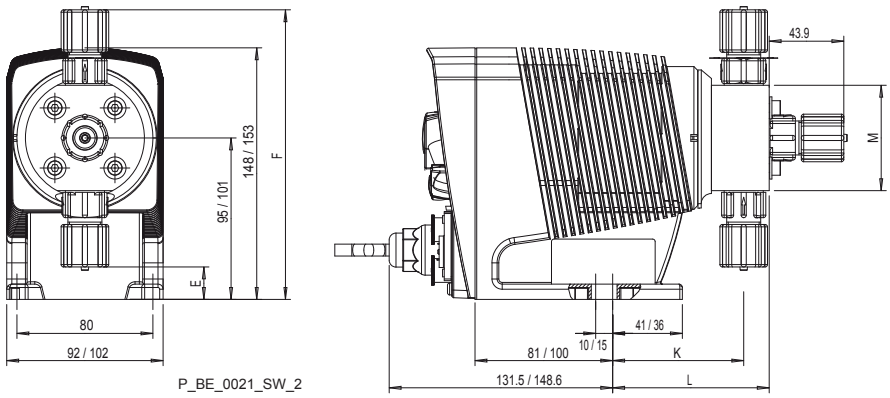


Fig. 21: Dimensional drawing Beta b BT4b/BT5b, material versions PP and NP with self-bleeding dosing head SEK - dimensions in mm

	1604	0708 - 0220	1008 - 0232
E	19	7.5	13.6
F	170.5	182.5	188.4
K	77	74	74
L	92	105.5	89
M	Ø 70	Ø 90	Ø 90

Dimensional drawing Beta b, material version PV

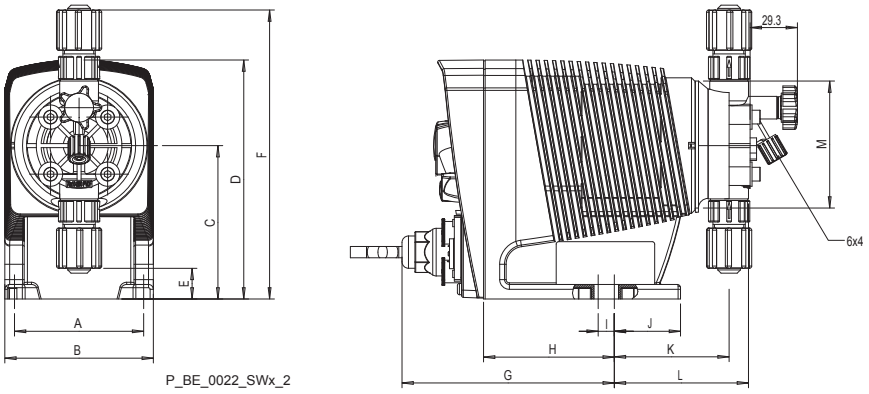


Fig. 22: Dimension drawing Beta b BT4b/BT5b, material version PV - dimensions in mm

	1604	0708 - 0220	1008 - 0420	0232
A	80	80	80	80
B	92	92	102	102
C	95	95	101	101
D	148	148	153	153
E	19	8.1	14.1	3.2
F	179	185.5	191.5	199
G	131.5	131.5	148.5	148.5
H	81	81	100	100
I	10	10	15	15
J	41	41	36	36
K	71	73	73	76
L	83	90	90	93
M	Ø 70	Ø 90	Ø 90	Ø 110

Dimensional drawing Beta b, material version PV HV

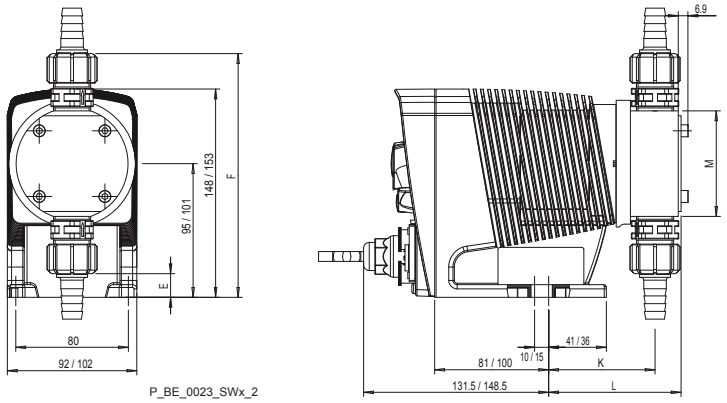


Fig. 23: Dimensional drawing Beta b BT4b/BT5b, material version PV for highly viscous feed chemicals - dimensions in mm

	1604	0708 - 0413	0220	1008 - 0713	0420
E	17	13	13	22.8	19
F	173	177	177	179.2	183
K	75.5	77	77	75.5	78.5
L	94	95	95	94	96.5
M	Ø 70	Ø 80	Ø 85	Ø 85	Ø 85

Dimensional drawing Beta b, material version TT

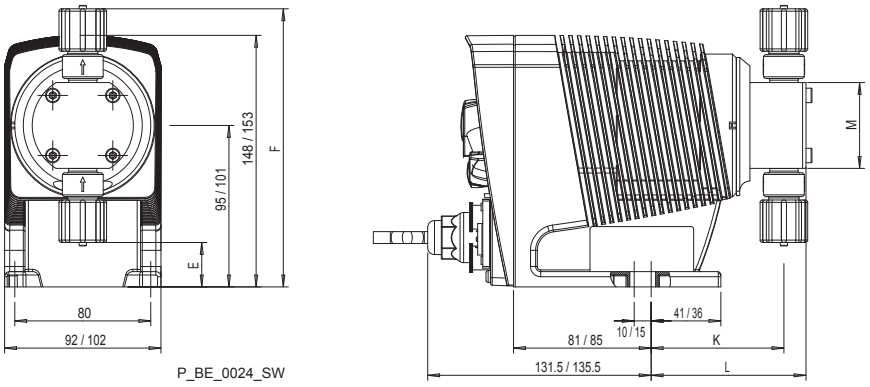


Fig. 24: Dimension drawing Beta b BT4b/BT5b, material version TT - dimensions in mm

	1000 - 1601	1602 - 1604	0708 - 0220	1008 - 0420	0232
E	26.2	21.3	-13.2	-7.2	-14.2
F	163.7	168.8	202.7	208.7	215.7
K	78	72	77	77.1	78
L	91	86	94	94	97
M	Ø 60	Ø 70	Ø 85	Ø 85	Ø 100

Dimensional drawing Beta b, material version SS

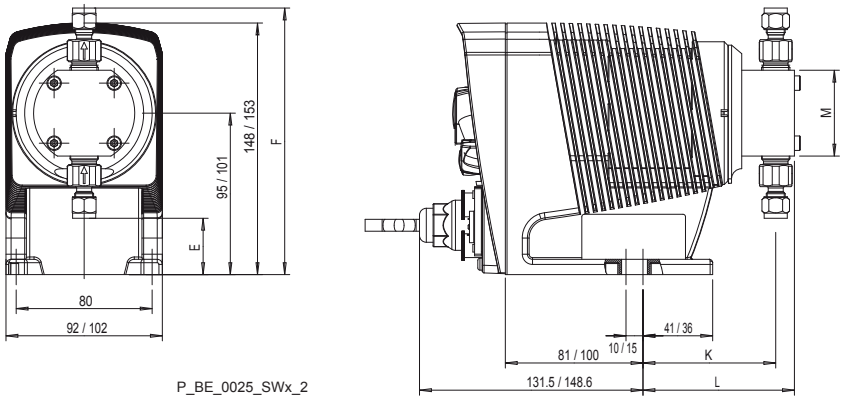


Fig. 25: Dimensional drawing Beta b BT4b/BT5b, material version SS - dimensions in mm

	1000 - 1601	1602 - 1604	0708 - 0220	2504	1008 - 0420	0232
E	33.2	24.4	-7.8	31.7	-1.8	-8
F	156.9	165.6	197.3	170.4	203.3	210
K	78	75	82	72	77	78
L	89	87	97	84	92	95
M	Ø 60	Ø 70	Ø 85	Ø 70	Ø 85	Ø 110

18 Diagrams for setting the metering capacity

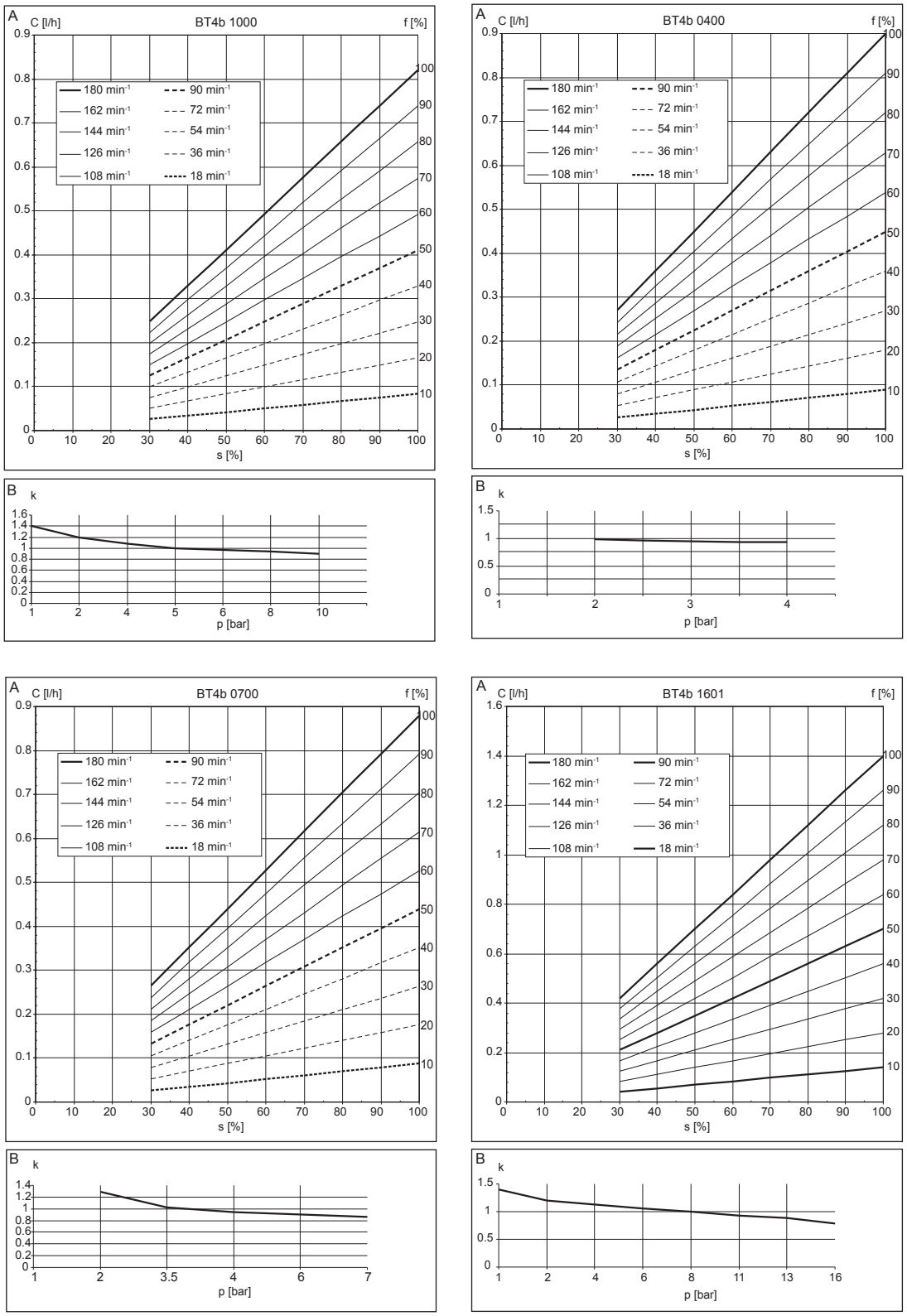


Fig. 26: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

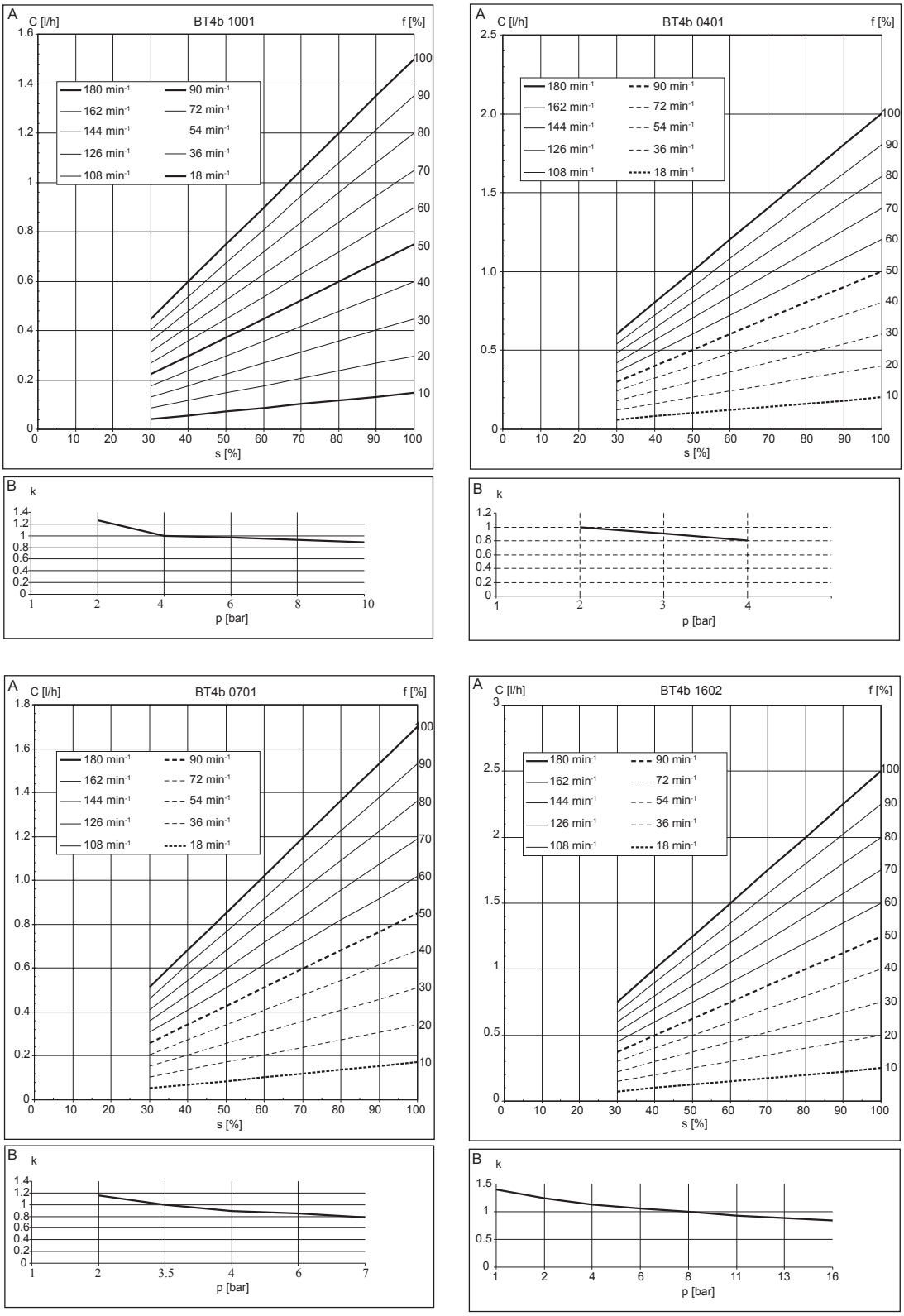


Fig. 27: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

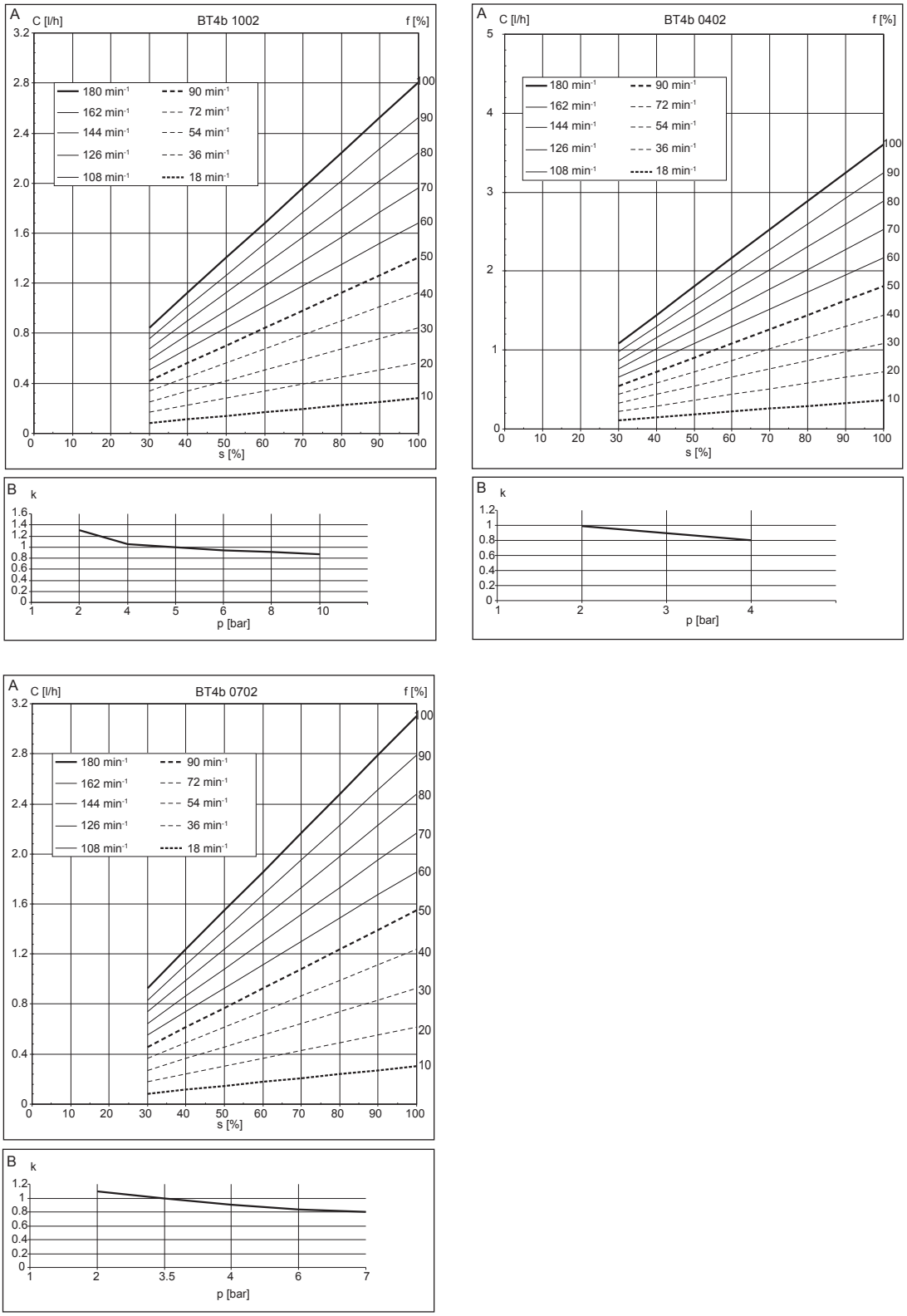


Fig. 28: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

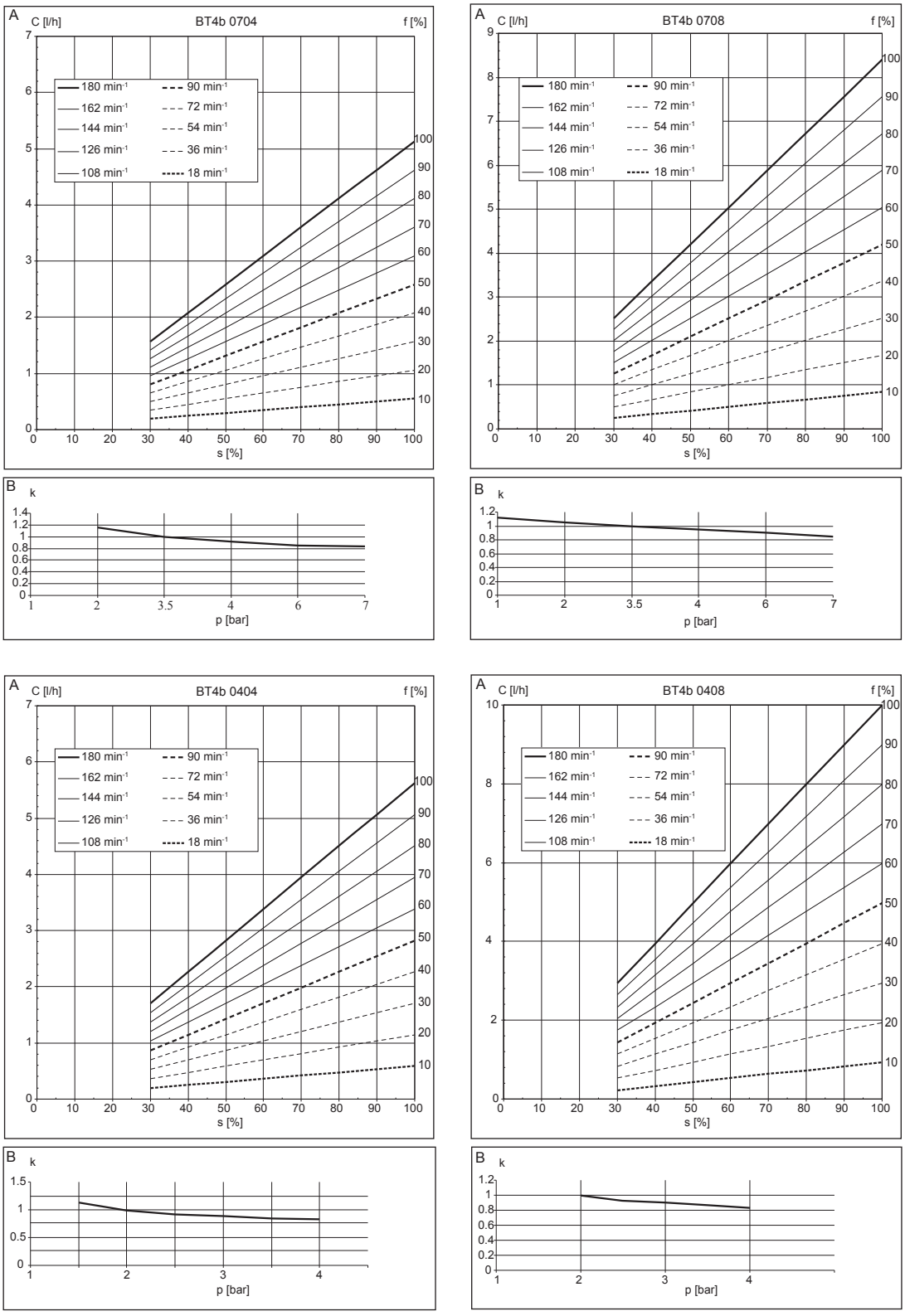


Fig. 29: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

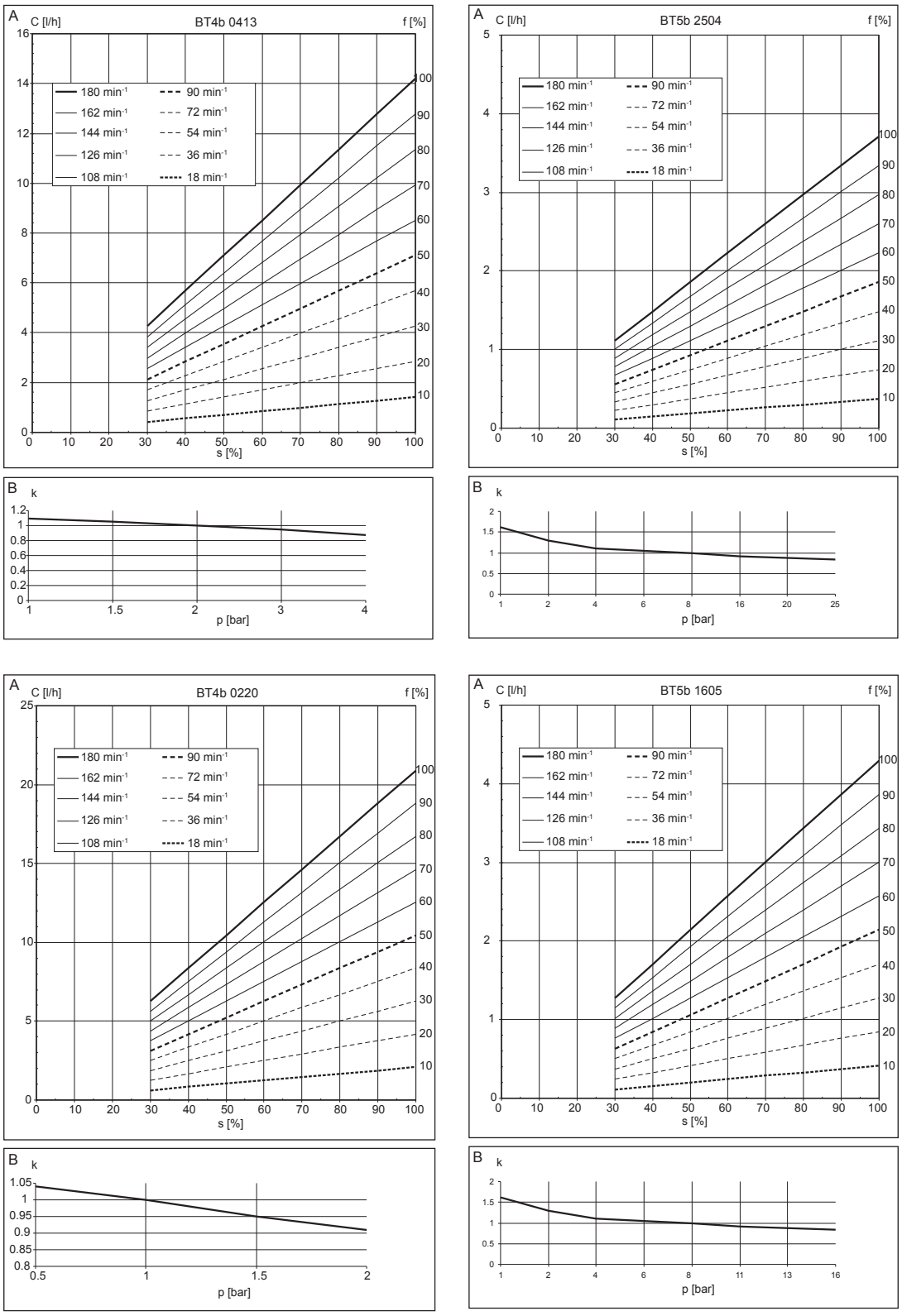


Fig. 30: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

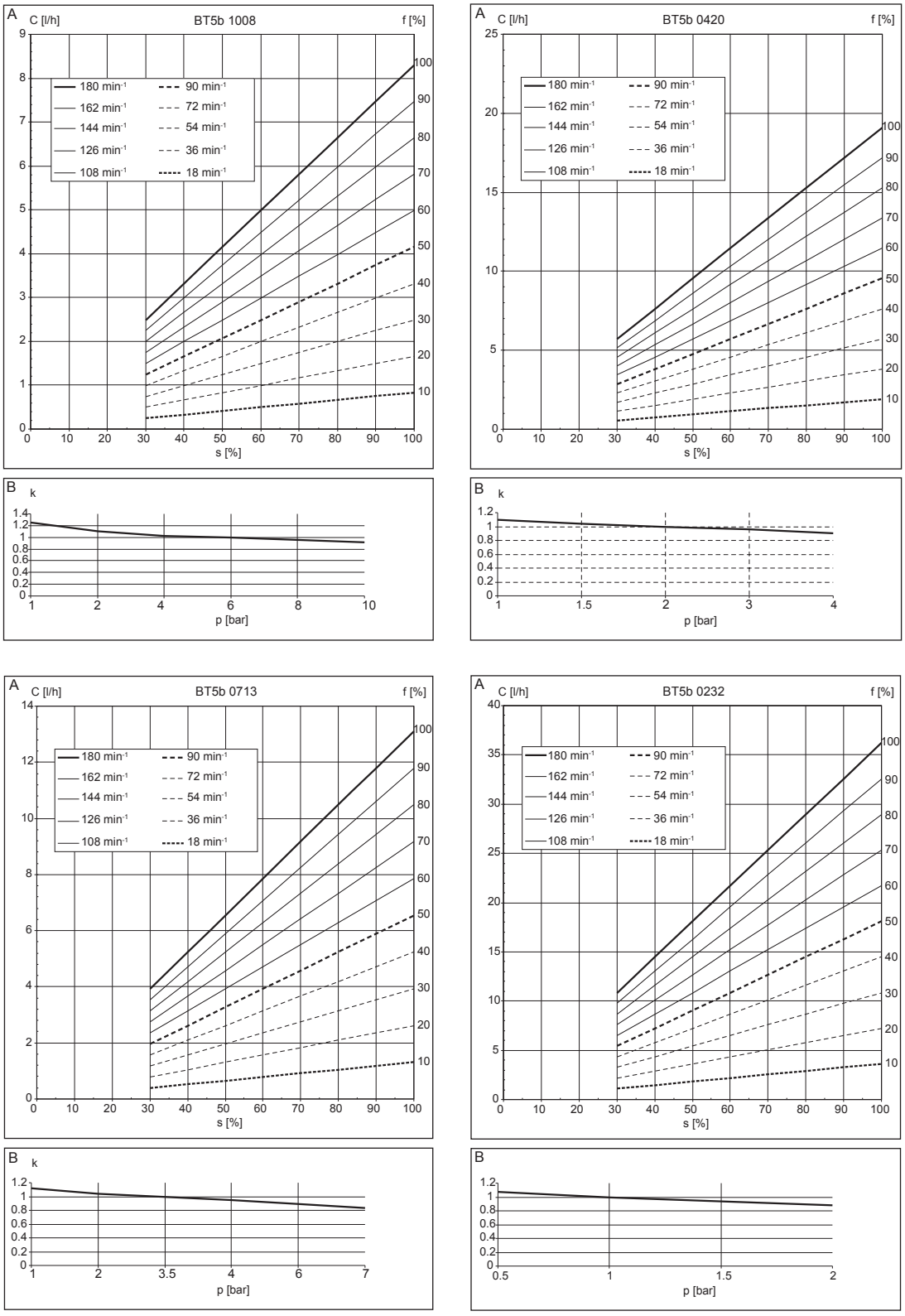


Fig. 31: A) Metering capacity C for medium back pressure dependent on the stroke length s for different stroke rates f. B) Corresponding correction factors k dependent on back pressure p.

19 Exploded Views of Liquid Ends

Liquid end Beta® 1000 - 1604 PP with bleed valve

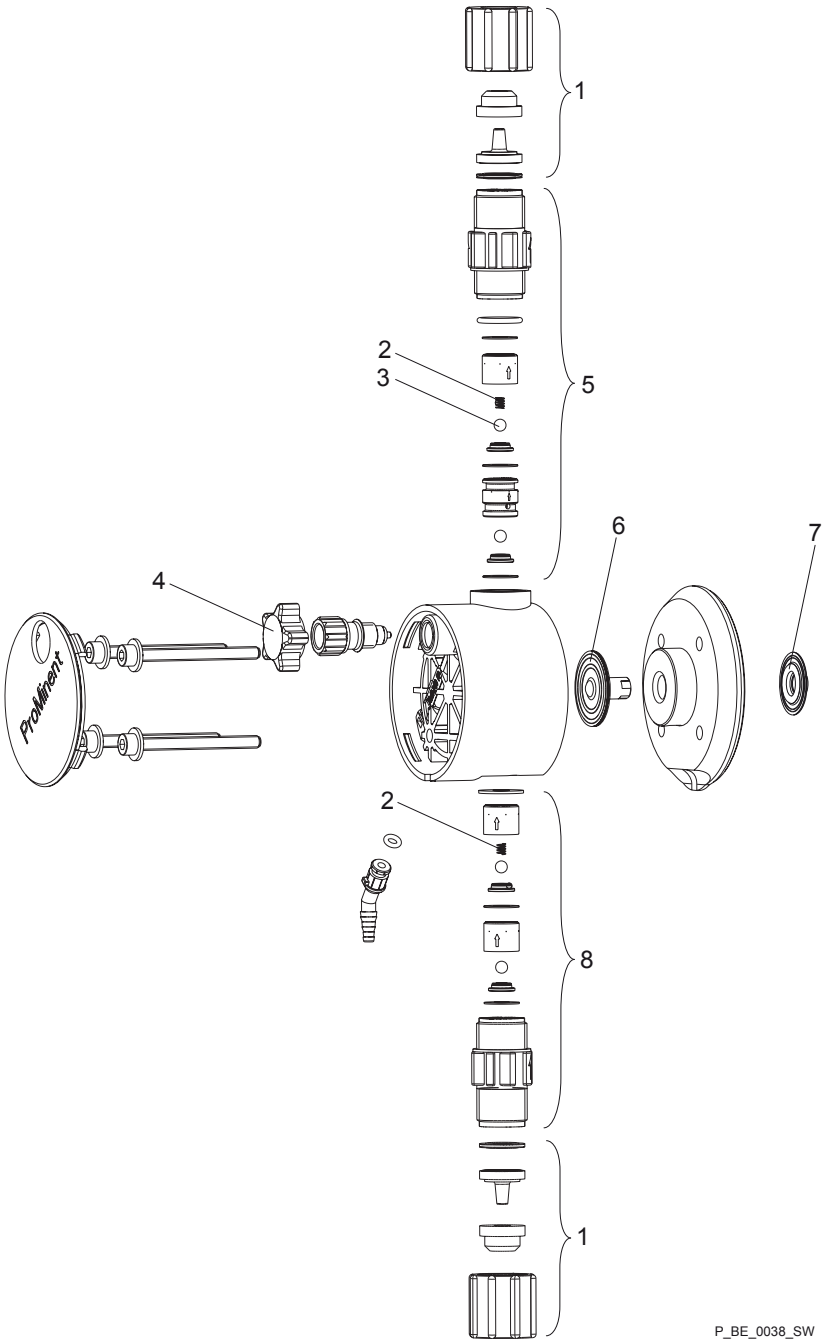


Fig. 32

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
1	Connector kit 6/4 PVT	1023246	1023246	1023246	1023246
3	4 Valve balls	404201	404201	404201	404201
4	Bleed valve	1021662	1021662	1021662	1021662

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
5	Discharge valve, compl. 4.7-2 PVT	1023127	1023127	1023127	1023127
6	Diaphragm	1000244	1000245	1000246	1034612
7	Safety diaphragm	1006061	1006061	1006061	1006061
8	Suction valve, compl. 4.7-2 PVT	1023128	1023128	1023128	1023128

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) PP with bleed valve

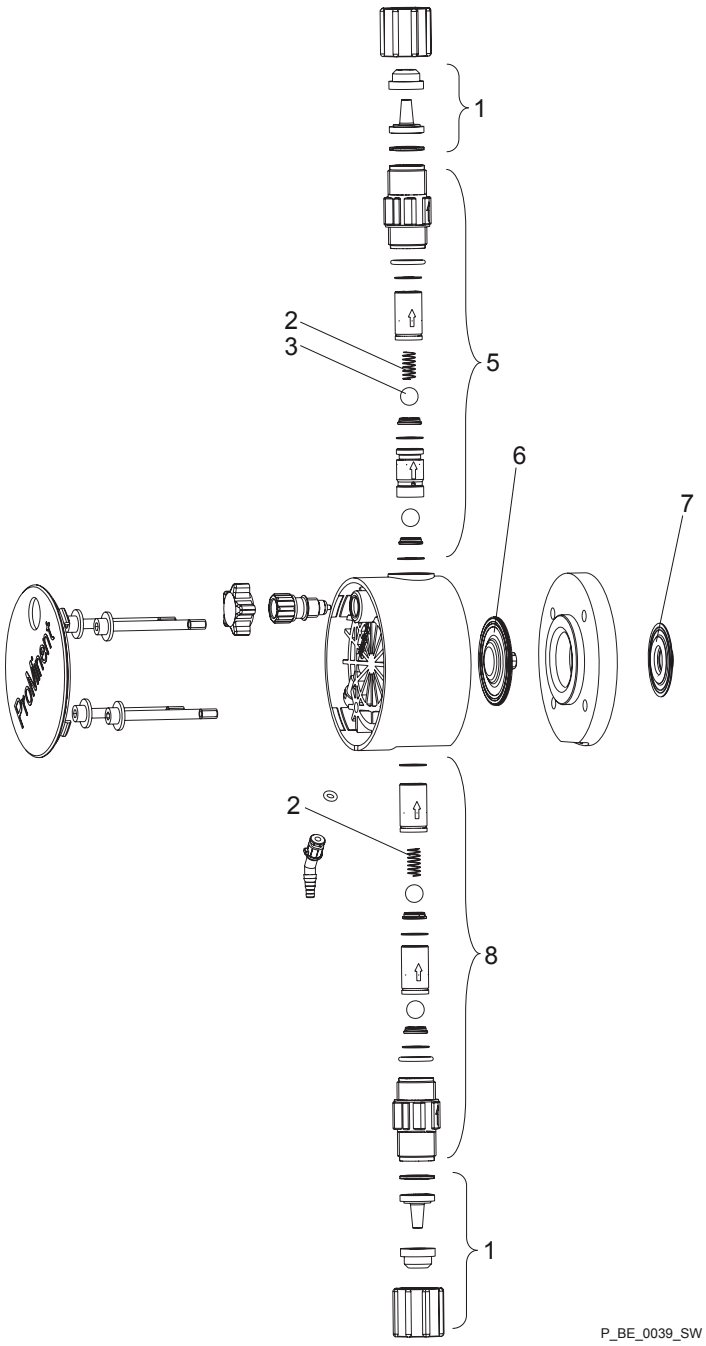


Fig. 33

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
1	Connector kit 8/5 PVT	1023247	1023247	1023247
3	4 Valve balls	404281	404281	404281
4	Bleed valve	1021662	1021662	1021662
5	Discharge valve, compl. 9.2-2 PVT	1023125	1023125	1023125

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
6	Diaphragm	1000248	1000249	1000250
7	Safety diaphragm	1006061	1006061	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126	1023126	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0232 PP without bleed valve

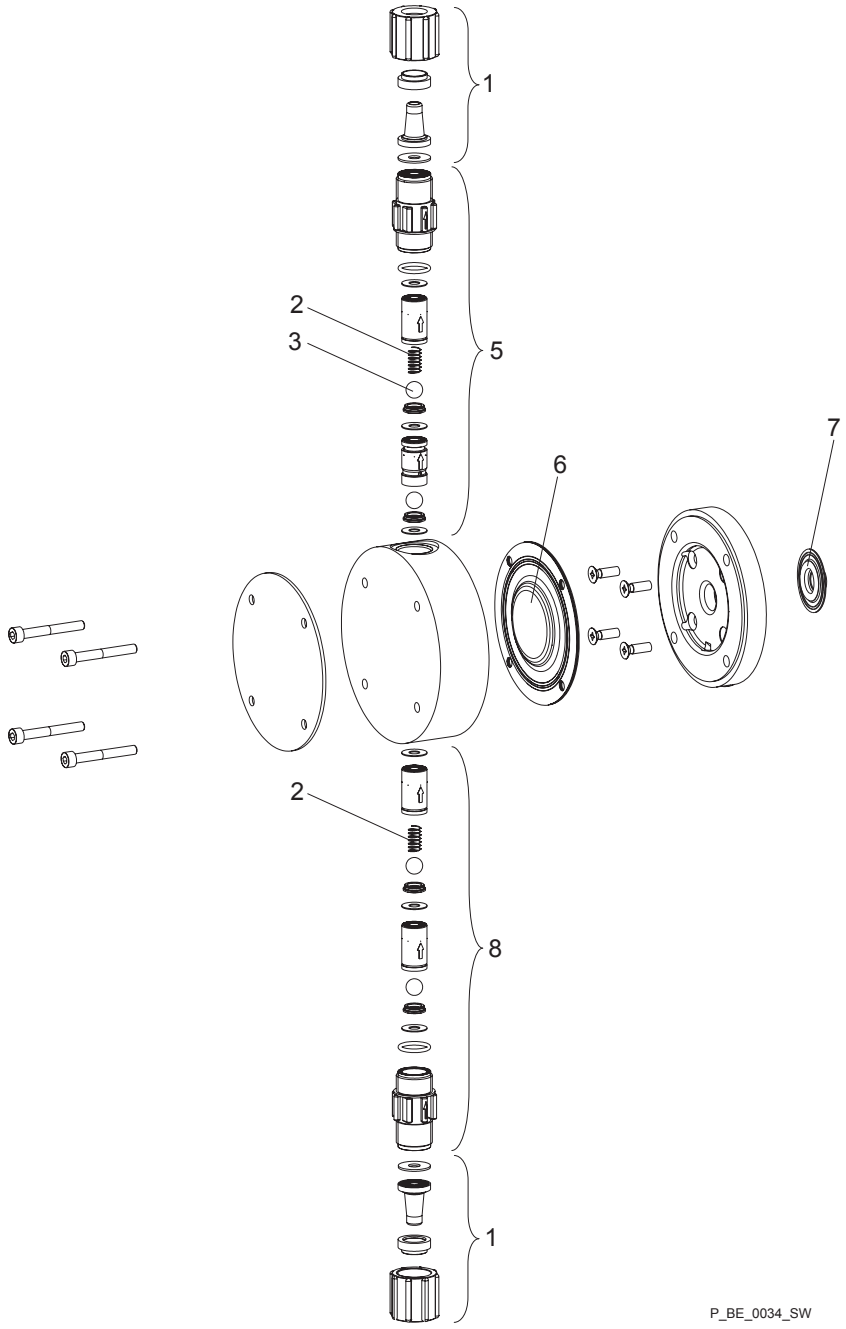


Fig. 34

Item	Description	Type 0232
1	Connector kit 12/9 PVT	1023248
3	4 Valve balls	404281
5	Discharge valve, compl. 9.2-2 PVT	1023125
6	Diaphragm	1000251

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0232
7	Safety diaphragm	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 1000 - 1604 NP with and without bleed valve

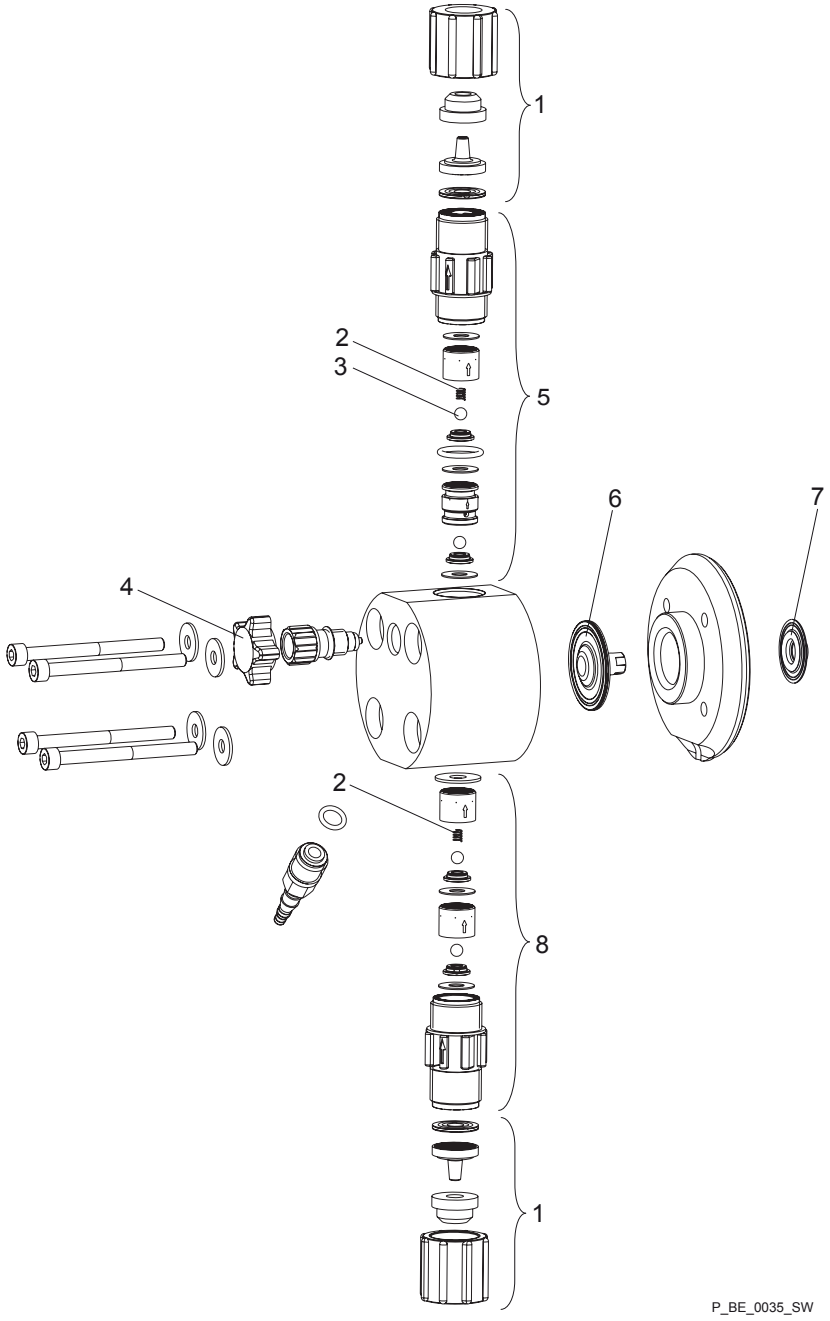


Fig. 35

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
1	Connector kit 6/4 PVT	1023246	1023246	1023246	1023246
3	4 Valve balls	404201	404201	404201	404201
4	Bleed valve	1021662	1021662	1021662	1021662
5	Discharge valve, compl. 4.7-2 PVT	1023127	1023127	1023127	1023127

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
6	Diaphragm	1000244	1000245	1000246	1034612
7	Safety diaphragm	1006061	1006061	1006061	1006061
8	Suction valve, compl. 4.7-2 PVT	1023128	1023128	1023128	1023128

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) NP with and without bleed valve

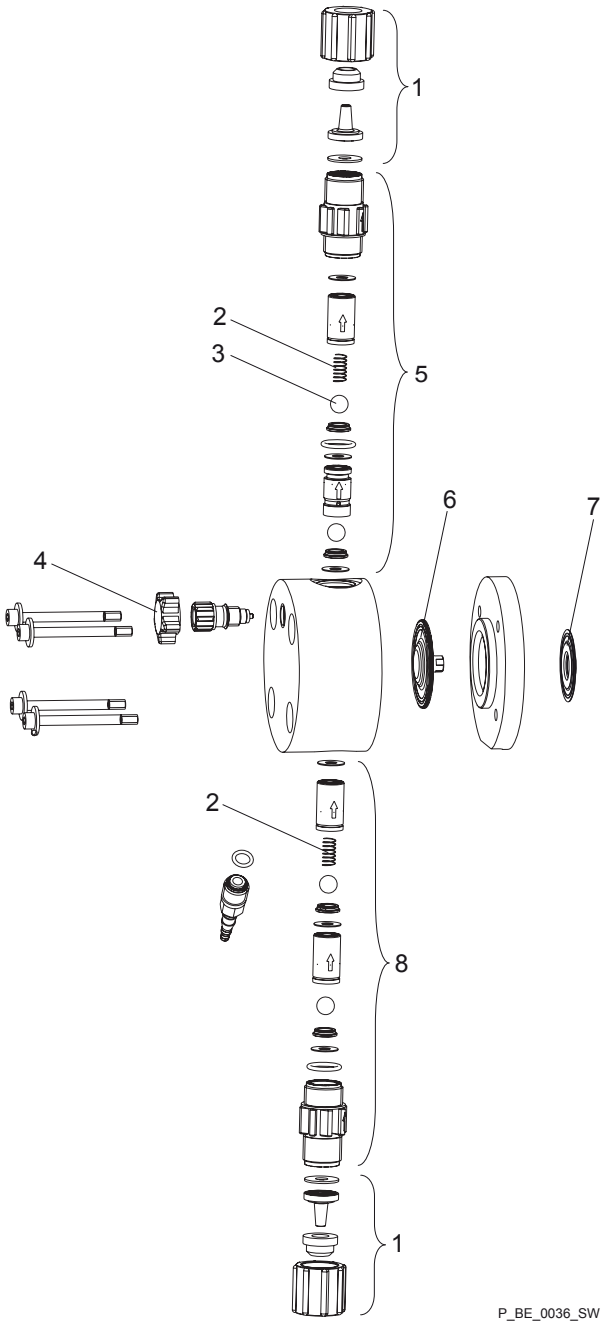


Fig. 36

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
1	Connector kit 8/5 PVT	1023247	1023247	1023247
3	4 Valve balls	404281	404281	404281
4	Bleed valve	1021662	1021662	1021662
5	Discharge valve, compl. 9.2-2 PVT	1023125	1023125	1023125

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
6	Diaphragm	1000248	1000249	1000250
7	Safety diaphragm	1006061	1006061	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126	1023126	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0232 NP with and without bleed valve

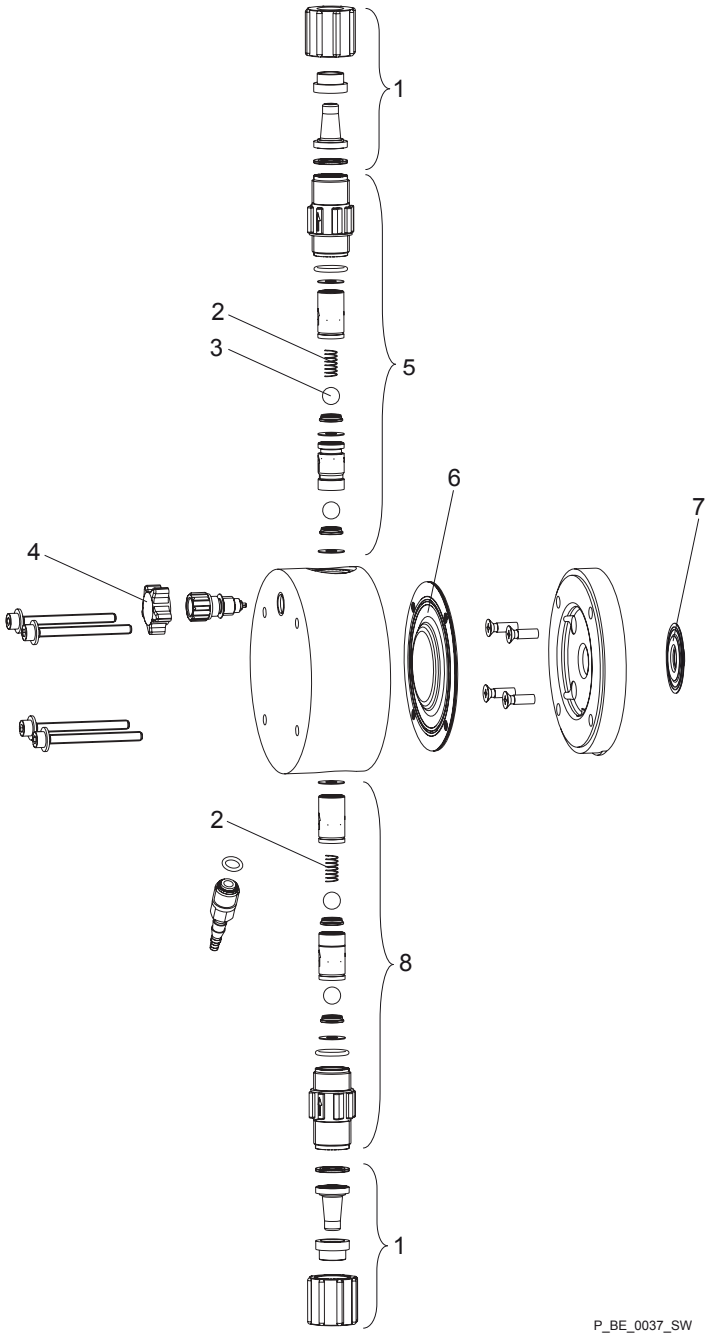


Fig. 37

Item	Description	Type 0232
1	Connector kit 12/9 PVT	1023248
3	4 Valve balls	404281
5	Discharge valve, compl. 9.2-2 PVT	1023125
6	Diaphragm	1000251

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0232
7	Safety diaphragm	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 1000 - 1604 PV with bleed valve

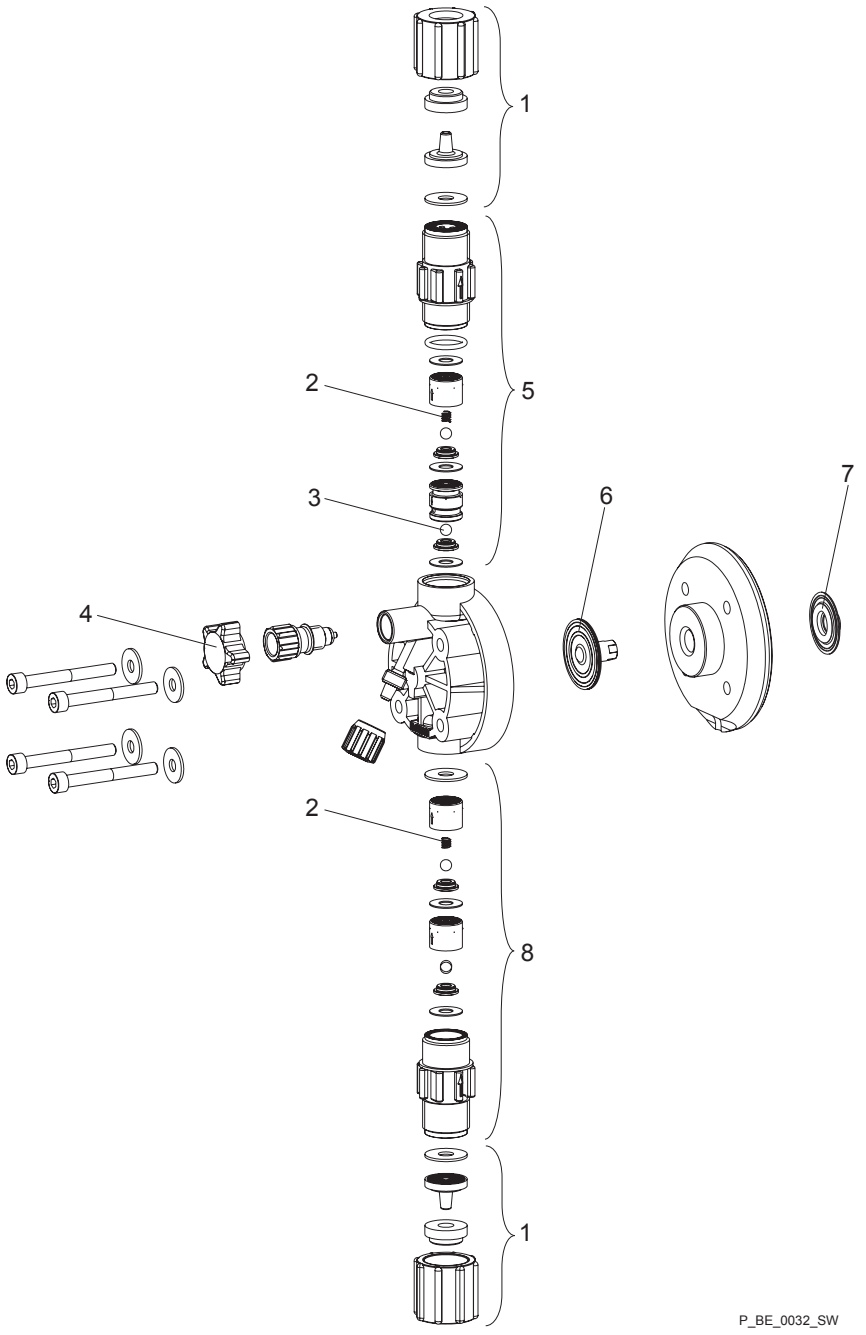


Fig. 38

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
1	Connector kit 6/4 PVT	1035660	1035660	1035660	1035660
3	4 Valve balls	404201	404201	404201	404201
4	Bleed valve	1021662	1021662	1021662	1021662
5	Discharge valve, compl. 4.7-2 PVT	1023127	1023127	1023127	1023127

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
6	Diaphragm	1000244	1000245	1000246	1034612
7	Safety diaphragm	1006061	1006061	1006061	1006061
8	Suction valve, compl. 4.7-2 PVT	1023128	1023128	1023128	1023128

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) PV with bleed valve

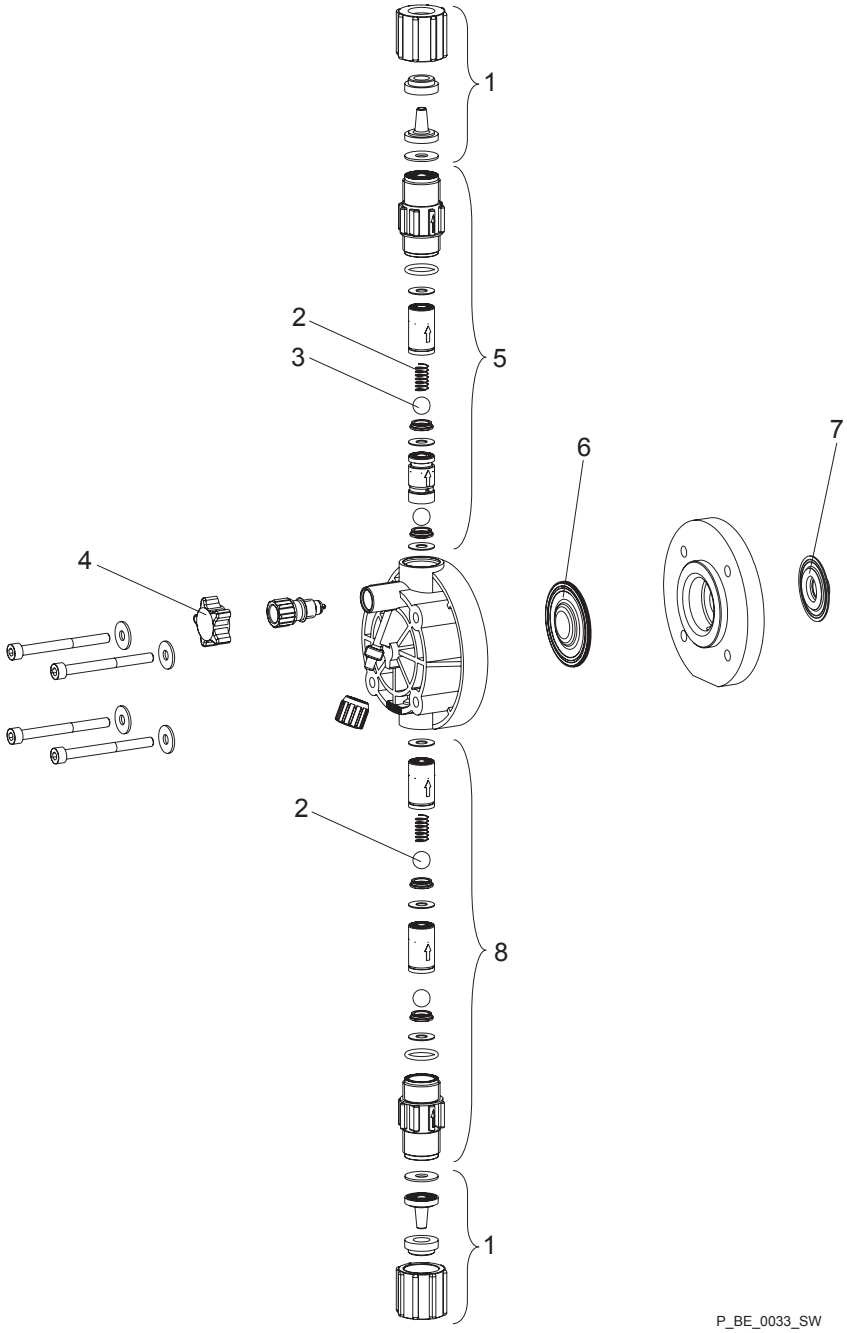


Fig. 39

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
1	Connector kit 8/5 PVT (0220/0420: 12/9)	1035661	1035661	1035659
3	4 Valve balls	404281	404281	404281
4	Bleed valve	1021662	1021662	1021662
5	Discharge valve, compl. 9.2-2 PVT	1023125	1023125	1023125

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
6	Diaphragm	1000248	1000249	1000250
7	Safety diaphragm	1006061	1006061	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126	1023126	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0232 PV without bleed valve

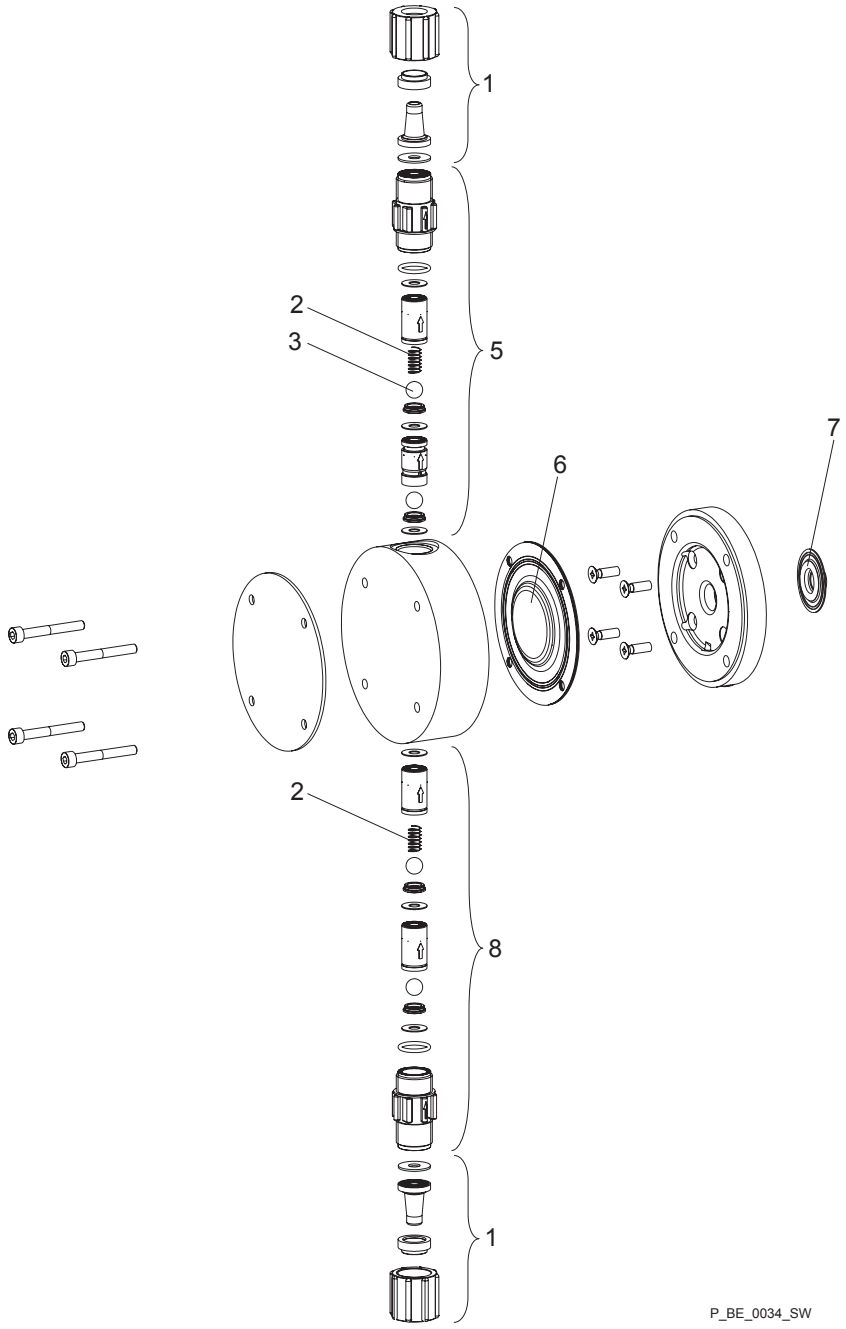


Fig. 40

Item	Description	Type 0232
1	Connector kit 12/9 FVD PVT	1035659
3	4 Valve balls	404281
5	Discharge valve, compl. 9.2-2 PVT	1023125
6	Diaphragm	1000251

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0232
7	Safety diaphragm	1006061
8	Suction valve, compl. 9.2-2 PVT	1023126

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 1604 - 0220 (0420) PV
HV, for highly viscous feed chemicals

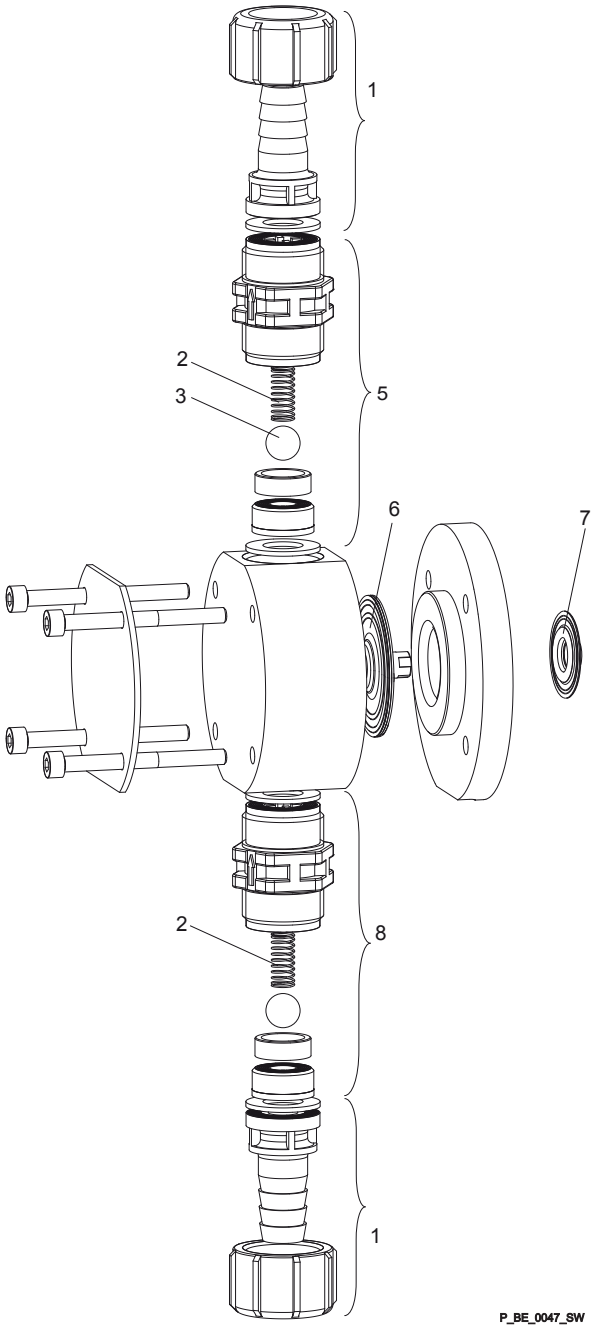


Fig. 41

Item	Description	Type 1604	Type 0708	Type 0413	Type 0220
1	Connector kit DN10 HV with PVT tube nozzle	1017405	1017405	1017405	1017405
3	4 Valve balls	404277	404277	404277	404277
6	Diaphragm	1006061	1006061	1006061	1006061
7	Safety diaphragm	1027414	1027414	1027414	1027414
The positions listed are included in the spare parts kit. Technical changes reserved.					

Liquid end Beta® 1000 - 1604 TT

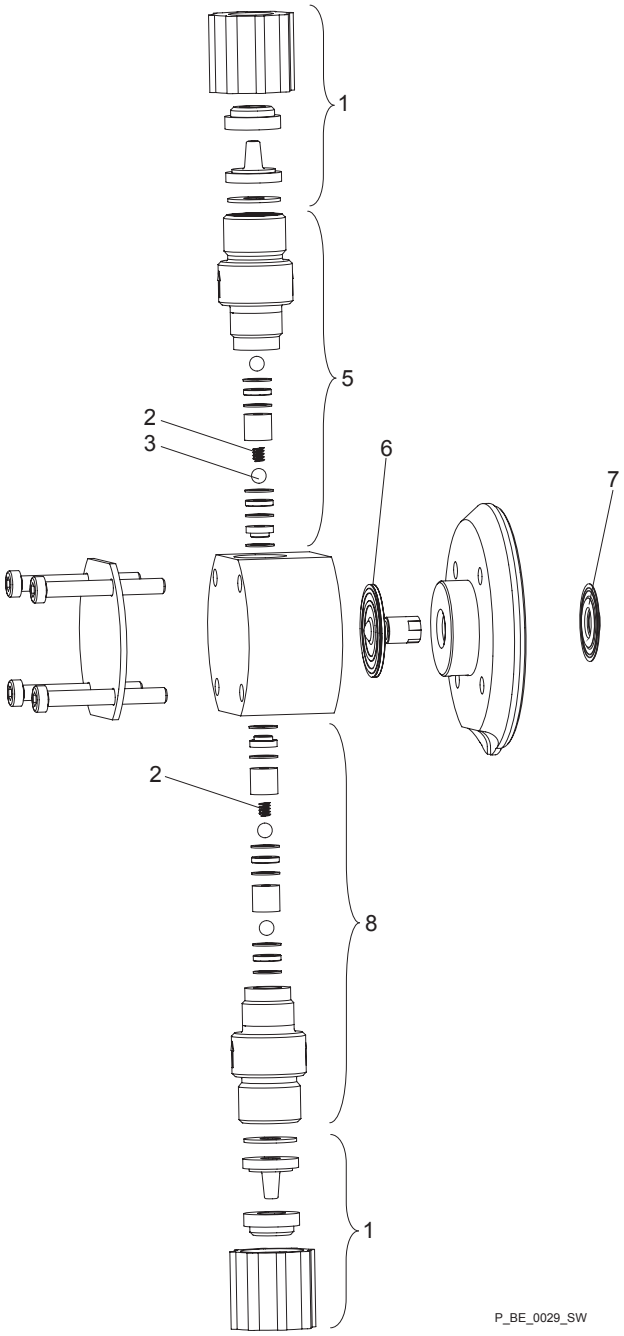


Fig. 42

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
1	Connector kit 6/4 TTT	817201	817201	817201	817201
3	4 Valve balls	404201	404201	404201	404201
5	Discharge valve, compl. 4.7-2 TTT	809406	809406	809406	809406
6	Diaphragm	1000244	1000245	1000246	1034612

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
7	Safety diaphragm	1006061	1006061	1006061	1006061
8	Suction valve, compl. 4.7-2 TTT	809407	809407	809407	809407

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) TT

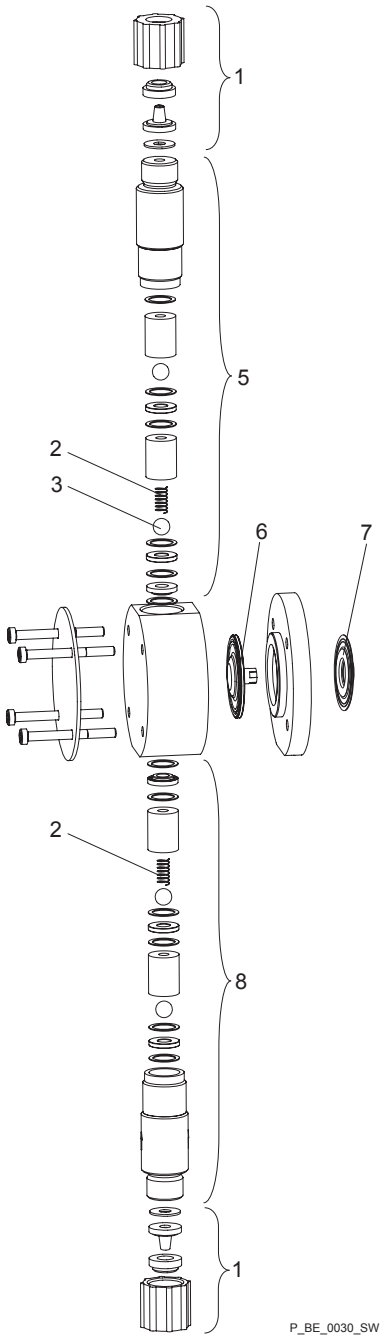


Fig. 43

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
1	Connector kit 8/5 TTT	817204	817204	817204
3	4 Valve balls	404281	404281	404281
5	Discharge valve, compl. 9.2-2 TTT	809444	809444	809444
6	Diaphragm	1000248	1000249	1000250

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
7	Safety diaphragm	1006061	1006061	1006061
8	Suction valve, compl. 9.2-2 TTT	809445	809445	809445

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0232 TT

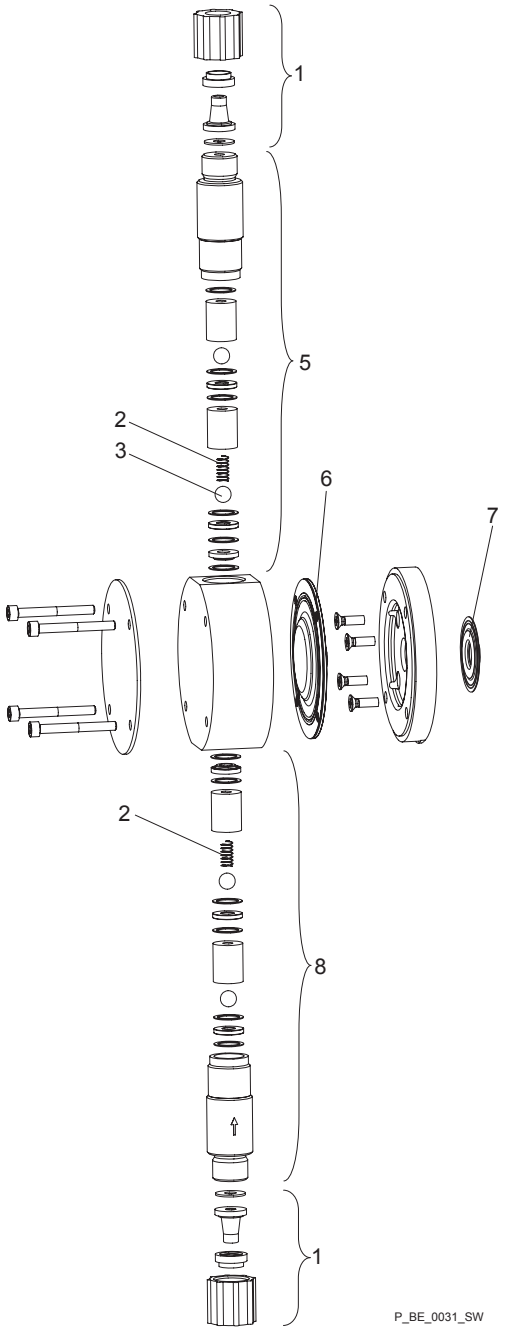


Fig. 44

Item	Description	Type 0232
1	Connector kit 12/9 TTT	817202
3	4 Valve balls	404281
5	Discharge valve compl. TTT	809444
6	Diaphragm	1000251

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0232
7	Safety diaphragm	1006061
8	Suction valve compl. TTT	809445

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 1000 - 1604 SS

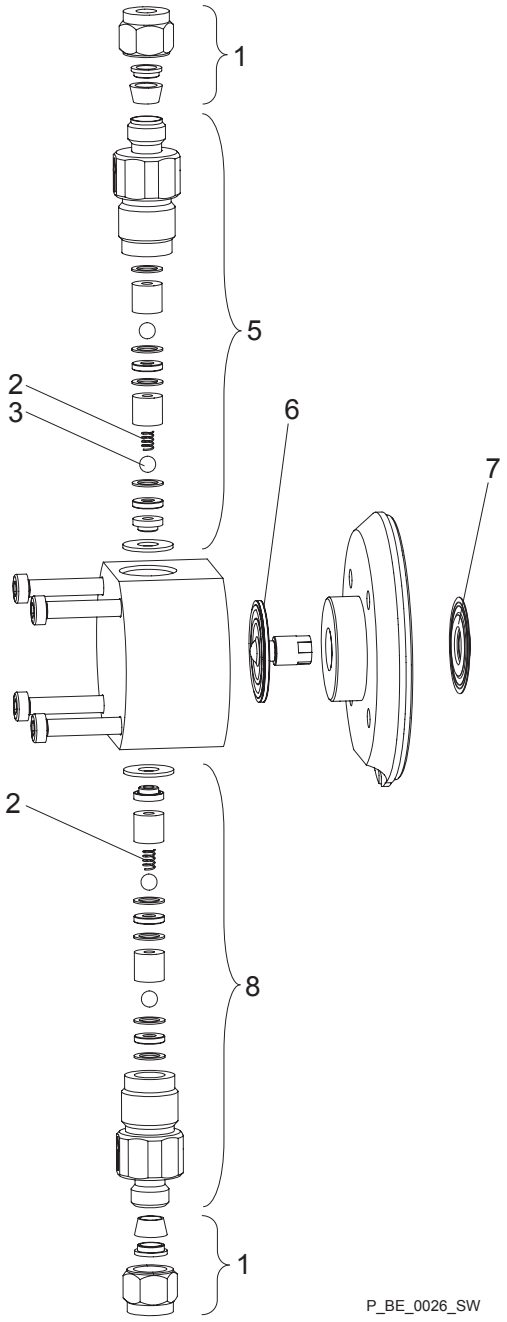


Fig. 45

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
1	Connector kit 6 mm SS	104233	104233	104233	104233
3	4 Valve balls	404201	404201	404201	404201
5	Discharge valve compl. 6 mm SST	809418	809418	809418	809418
6	Diaphragm	1000244	1000245	1000246	1034612

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 1000	Type 1601	Type 1602	Type 1604
7	Safety diaphragm	1006061	1006061	1006061	1006061
8	Suction valve compl. 6 mm SST	809419	809419	809419	809419

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) SS

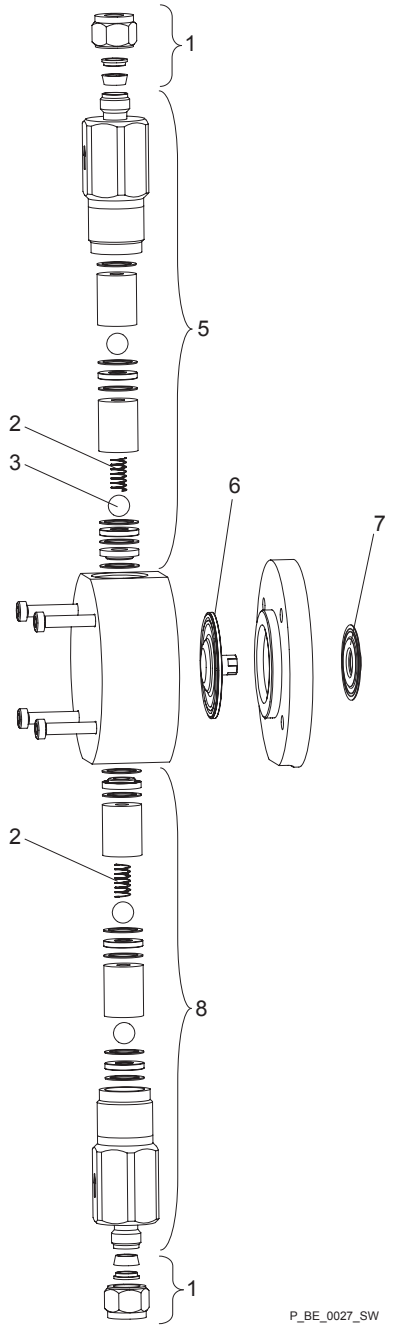


Fig. 46

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
1	Connector kit SS	104237	104237	104245
3	4 Valve balls	404281	404281	404281
5	Discharge valve compl. SST	809494	809494	809446
6	Diaphragm	1000248	1000248	1000250

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0708 (1008)	Type 0413 (0713)	Type 0220 (0420)
7	Safety diaphragm	1006061	1006061	1006061
8	Suction valve compl. SST	809495	809495	809447

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 0232 SS

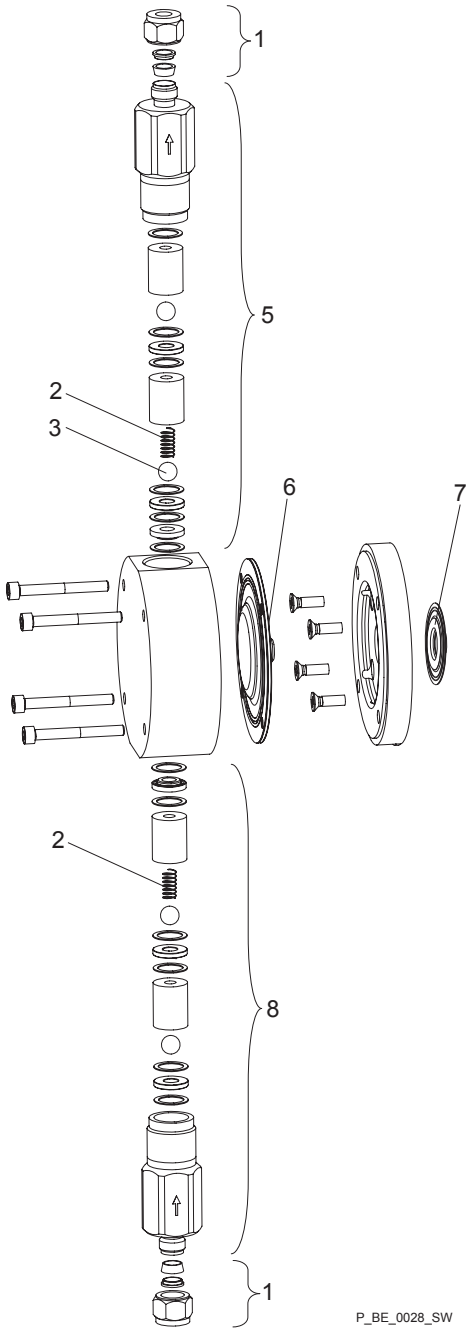


Fig. 47

Item	Description	Type 0232
1	Connector kit 12 mm SS	104245
3	4 Valve balls	404281
5	Discharge valve compl. 12 mm SST	809446
6	Diaphragm	1000251

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Item	Description	Type 0232
7	Safety diaphragm	1006061
8	Suction valve compl. 12 mm SST	809447

Spring (item 2) is a special accessory. The positions listed are included in the spare parts kit. Technical changes reserved.

Liquid end Beta® 1601 - 1604 PP SEK and 1601 - 1604 NP SEK, self-bleeding

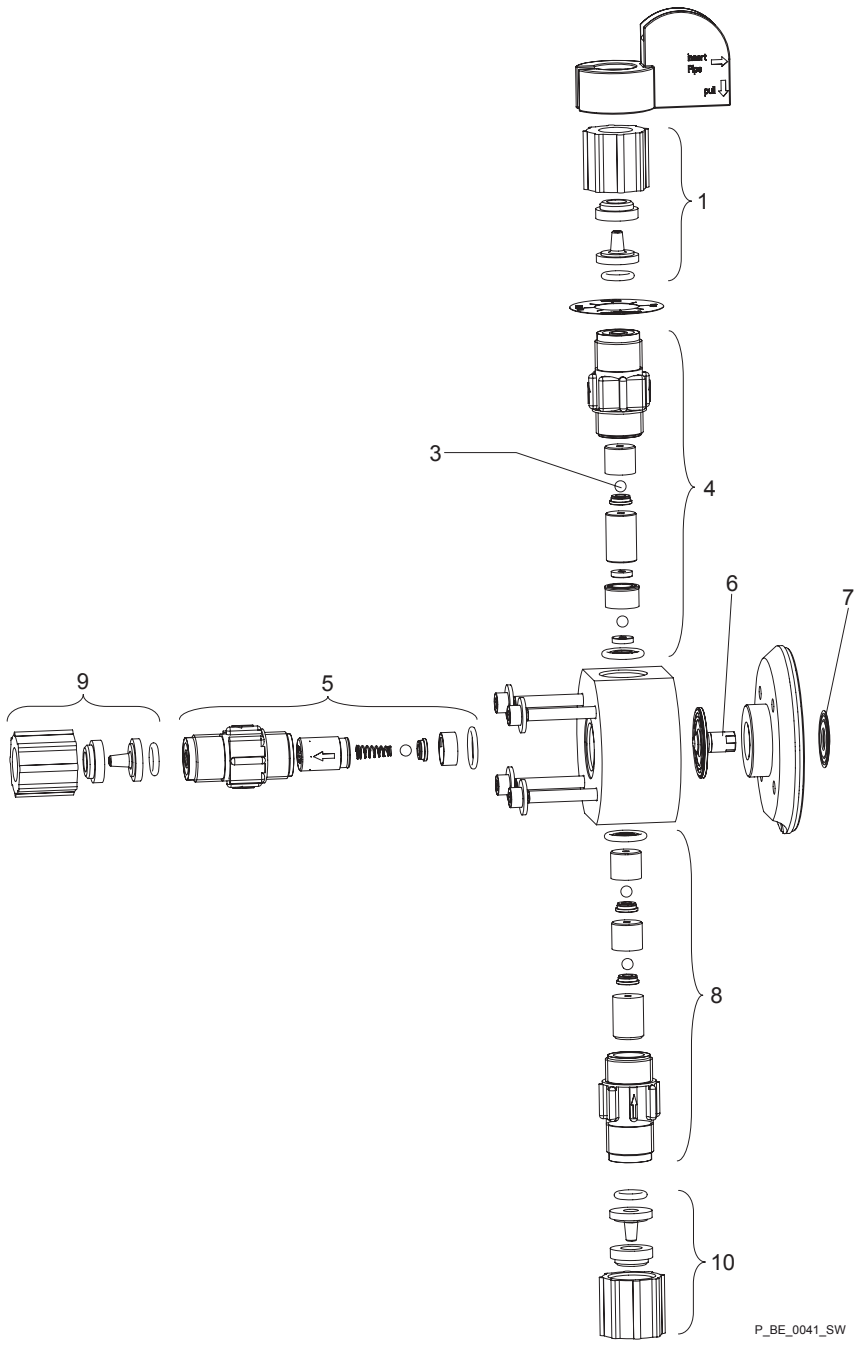


Fig. 48

Item	Part	Material version	Part no.
1, 9, 10	Connector kit 6/4	PPE	817160
1, 9, 10	Connector kit 6/4	PPB	817173
1, 9, 10	Connector kit 6/4	PCE	791161
1, 9, 10	Connector kit 6/4	PCB	817165
9, 10	Connector kit 8/5	PPE	817161
9, 10	Connector kit 8/5	PPB	817174

Item	Part	Material version	Part no.
9, 10	Connector kit 8/5	PCE	792058
9, 10	Connector kit 8/5	PCB	817066
9	With 2504: Connector kit 8/4	PCB	1035844
10	With 2504: Connector kit 6/4	PCE	791161
10	With 2504: Connector kit 6/4	PCB	817065
3	4 Valve balls		404201
4	Bleed valve	PPE	1001063
4	Bleed valve	PPB	1001062
4	Bleed valve	PCE	1001061
4	Bleed valve	PCB	1001060
5	Discharge valve compl.	PPE	1001067
5	Discharge valve compl.	PPB	1001066
5	Discharge valve compl.	PCE	1001065
5	Discharge valve compl.	PCB	1001064
6	Diaphragm 1601		1000245
6	Diaphragm 1602		1000246
6	Diaphragm 1604		1034612
7	Safety diaphragm		1006061
8	Suction valve compl.	PPE	792644
8	Suction valve compl.	PPB	792646
8	Suction valve compl.	PCE	792119
8	Suction valve compl.	PCB	792026

Spare parts kits for type:	Material version	Part no.
1601	PPE	1001756
1602	PPE	1001757
1604 with spring	PPE	1035335
1604 without spring	PPE	1035339
1601	PPB	1001762
1602	PPB	1001763
1604 with spring	PPB	1035336
1604 without spring	PPB	1035340
1601	NPE	1001660
1602	NPE	1001661

Spare parts kits for type:	Material version	Part no.
1604 without spring	NPE	1035337
1604 with spring	NPE	1035333
1601	NPB	1001666
1602	NPB	1001667
1604 without spring	NPB	1035338
1604 with spring	NPB	1035334

Sealing sets	Material	Part no.
1 Sealing set	EPDM	1001674
1 Sealing set	FPM	1001672

The positions listed are included in the spare parts kit.

Technical changes reserved.

Liquid end Beta® 0708 (1008) - 0220 (0420) PP / NP SEK, self-bleeding

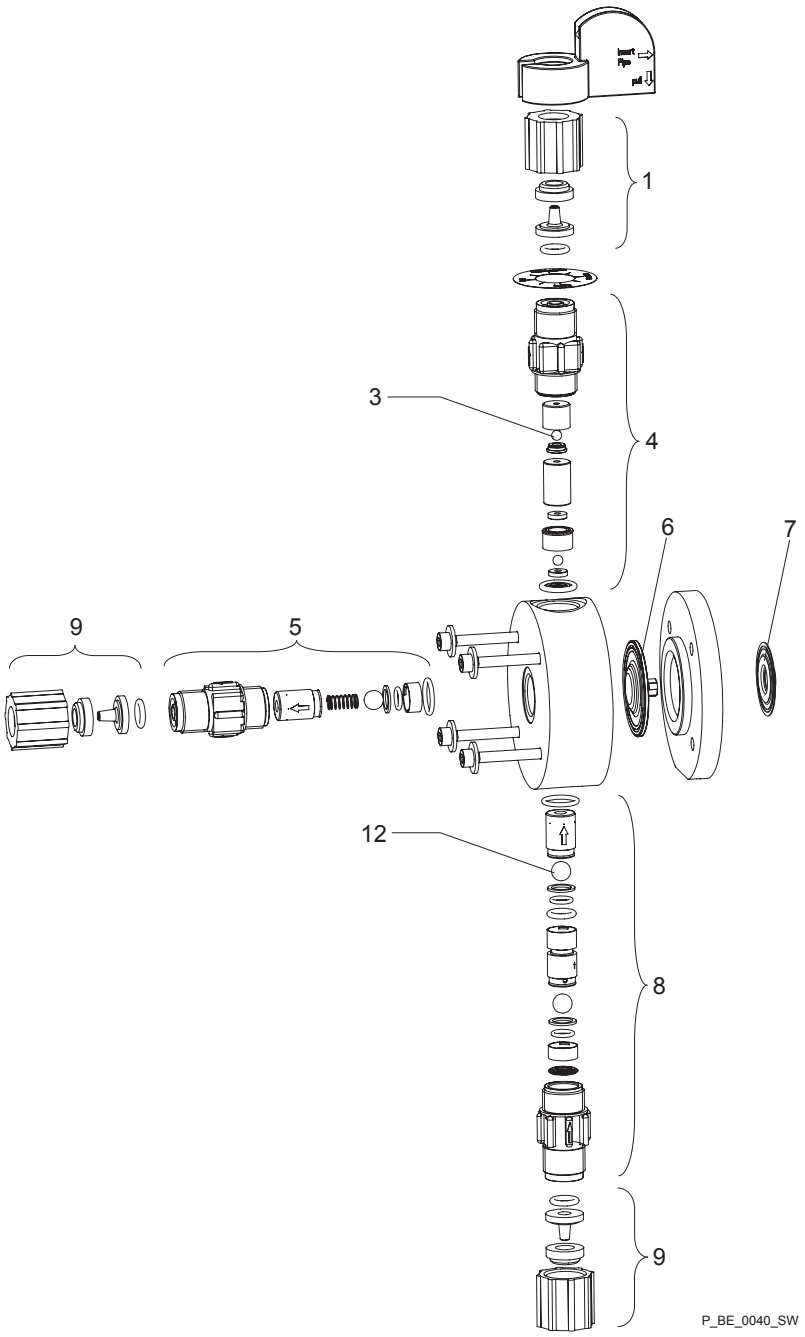


Fig. 49

Item	Part	Material version	Part no.
1	Connector kit 6/4	PPE	817160
1	Connector kit 6/4	PPB	817173
1	Connector kit 6/4	PCE	791161
1	Connector kit 6/4	PCB	817165
9	Connector kit 8/5	PPE	817161
9	Connector kit 8/5	PPB	817174

Item	Part	Material version	Part no.
9	Connector kit 8/5	PCE	792058
9	Connector kit 8/5	PCB	817066
9	Connector kit 12/9	PPE	817162
9	Connector kit 12/9	PPB	817175
9	Connector kit 12/9	PCE	790577
9	Connector kit 12/9	PCB	817067
3	4 Valve balls		404201
4	Bleed valve	PPE	1001063
4	Bleed valve	PPB	1001062
4	Bleed valve	PCE	1001061
4	Bleed valve	PCB	1001060
5	Discharge valve compl.	PPE	1001071
5	Discharge valve compl.	PPB	1001070
5	Discharge valve compl.	PCE	1001069
5	Discharge valve compl.	PCB	1001068
6	Diaphragm 0708		1000248
6	Diaphragm 0413		1000249
6	Diaphragm 0220		1000250
7	Safety diaphragm		1006061
8	Suction valve compl.	PPE	1001437
8	Suction valve compl.	PPB	1001436
8	Suction valve compl.	PCE	1001435
8	Suction valve compl.	PCB	1001434

Spare parts kits for type:	Material version	Part 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

Sealing sets	Material	Part no.
1 Sealing set	EPDM	1001674
1 Sealing set	FPM	1001672

The positions listed are included in the spare parts kit.

Technical changes reserved.

20 Further order information

Spare parts kits for SEK types

The information is given in the corresponding exploded views.

Spare parts kits for SER types

Type	NPT7 / PVT7
1602	1047830
1604	1047858
0708 (1008)	1047832
0413 (0713)	1047833
0220 (0420)	1047837

Spare parts kits for other types

Type	PP, NP, PV	TT	SS	HV types
1000	1023107	1001737	1001729	-
1601	1023108	1001738	1001730	-
1602	1023109	1001739	1001731	-
1604 (2504)	1035332	1035330	1035331	1035342
0708 (1008)	1023111	1001741	1001733	1019067
0413 (0713)	1023112	1001742	1001734	1019069
0220 (0420)	1023113	1001754	1001735	1019070
0232	1024124	1001755	1001736	-

Sealing sets for SEK types

The information is given in the corresponding exploded views.

Sealing sets for other types

Type	PP, NP	PV	TT, SS
1000, 1601, 1602, 1604	1023130	1023130	483907 *
0708 (1008) 0413 (0713) 0220 (0420)	1023129	1023129	483975
0232	1023129	1023129	483975
All HV types	-	1019364	-
* 11-part			

Relay retrofit kit for Beta® b

Name	Part no.
Fault indicating relay for Beta® b	1029309
Fault indicating and pacing relay for Beta® b	1029310

Interference suppression aids

Product	Part no.
Varistor:	710912
RC Gate, 0.22 µF / 220 Ω:	710802

Further sources of information

Further information on spare parts, accessories and options can be found in:

- the exploded drawings
- the identity code
- under www.prominent.com
- the ProMinent product catalogue

21 EC Declaration of Conformity for Machinery

In accordance with DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, Appendix I, BASIC HEALTH AND SAFETY REQUIREMENTS, section 1.7.4.2. C.

We,

- ProMinent GmbH
- Im Schuhmachergewann 5 - 11
- D - 69123 Heidelberg,

hereby declare that the product specified in the following, complies with the relevant basic health and safety requirements of the EC Directive, on the basis of its functional concept and design and in the version distributed by us. Any modification to the product not approved by us will invalidate this declaration.

Extract from the EC Declaration of Conformity

Designation of the product:	Metering pump, product range Beta/4 and Beta/5
Product type:	BT4b _ _ _ _ _ _ _ _ _ _ _ U BT5b _ _ _ _ _ _ _ _ _ _ _ U
Serial number:	see nameplate on the device
Relevant EC directives:	Machinery Directive (2006/42/EC) EMC Directive (2004/108/EC) Compliance with the protection targets of the Low Voltage Directive 2006/95/EC according to Appendix I, No. 1.5.1 of the Machinery Directive 2006/42/EC RoHS Directive (2011/65/EU)
Harmonised standards applied, in particular:	EN 809: 2010 EN ISO 12100: 2010 EN 61010-1: 2010 EN 61000-6-2: 2005 EN 61000-6-3: 2011 EN 50581: 2013
Place, Date:	Heidelberg, 22.07.2014

You will find the EC Declaration of Conformity to download on our homepage.

22 EC Declaration of Conformity for Machinery

In accordance with DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, Appendix I, BASIC HEALTH AND SAFETY REQUIREMENTS, section 1.7.4.2. C.

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Extract from the EC Declaration of Conformity

Designation of the product:	Metering pump, product range Beta/4 and Beta/5
Product type:	BT4b _ _ _ _ _ _ _ _ _ _ _ M BT4b _ _ _ _ _ _ _ _ _ _ _ N BT5b _ _ _ _ _ _ _ _ _ _ _ N
Serial number:	see nameplate on the device
Relevant EC directives:	EC Machinery Directive (2006/42/EC) EC EMC Directive (2004/108/EC) EU RoHS Directive (2011/65/EU)
Harmonised standards applied, in particular:	EN 809: 2010 EN ISO 12100: 2010 EN 61010-1: 2010 EN 61000-6-2: 2005 EN 61000-6-3: 2011 EN 50581: 2013
Place, Date:	Heidelberg, 22.07.2014

You will find the EC Declaration of Conformity on our homepage.

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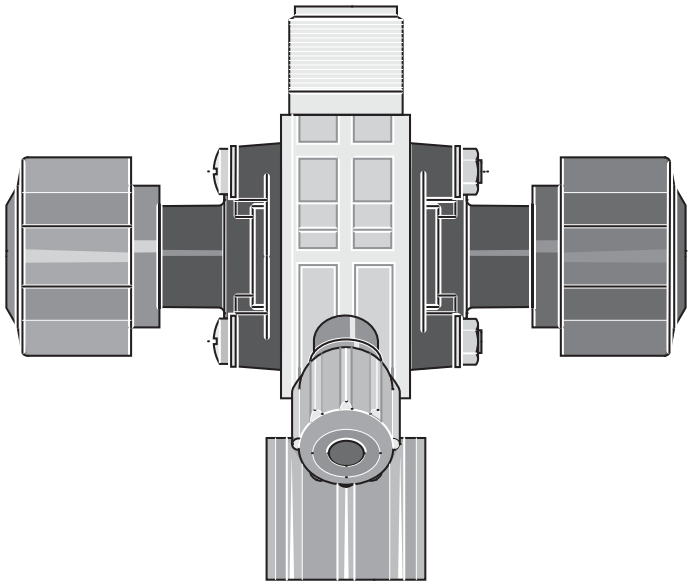
P-610x - Pump, Metering, Parts, Multi-function ValvePVDF, 87PSIG Size 2

Betriebsanleitung / Operating Instructions
Mode d'emploi / Instrucciones de servicio

ProMinent® Mehrfunktionsventil
ProMinent® Multi-Function Valve
Vanne multifonctions ProMinent®
Válvula multifuncional ProMinent®

D/GB/F/E



Teile Nr./Part No.: 987629 **ProMinent Dosiertechnik GmbH · 69123 Heidelberg · Germany** BA MAZ 623 10/04 G/GB/F/E

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from page 9 to page 14

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de página 21 hasta página 26

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Betriebsanleitung ProMinent® Mehrfunktionsventil
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Technische Änderungen vorbehalten.

Betriebsanleitung bitte zuerst vollständig durchlesen. Nicht wegwerfen! Bei Schäden durch Bedienungsfehler erlischt die Garantie!

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1 Aufbau

Die Funktionen des Mehrfunktionsventils werden durch je eine federbelastete Membran erzeugt. Es ist je ein Entlastungsmechanismus für die Druckhalte-Funktion und für die Überdruckfunktion vorgesehen.

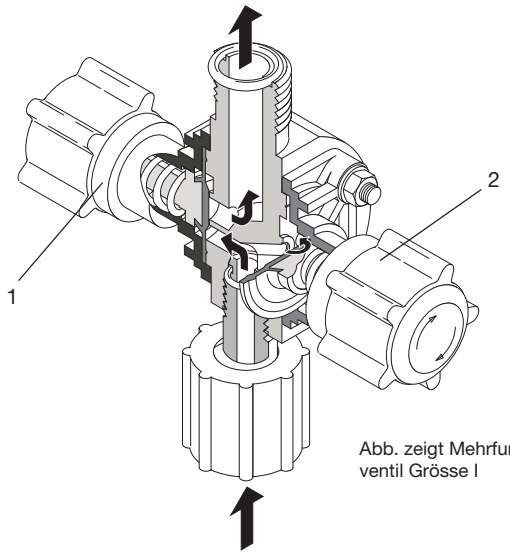


Abb. zeigt Mehrfunktionsventil Grösse I

2 Funktionsbeschreibung

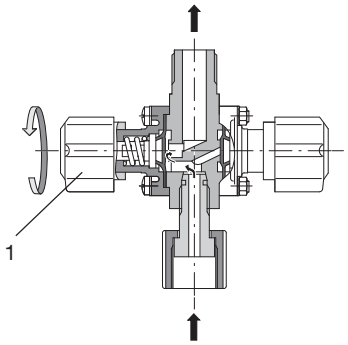
Funktionen

- Erzeugung eines definierten Gegendruckes bei Dosierung gegen freien Auslauf.
  Das Aufheben dieser Funktion erfolgt durch Drehen am schwarzen Drehknopf im Uhrzeigersinn (1).
- Verhindern von Durchhebern aus dem Vorratsgebinde bei Unterdruck an der Dosierstelle.
  Das Aufheben dieser Funktion erfolgt durch Drehen am schwarzen Drehknopf im Uhrzeigersinn (1).

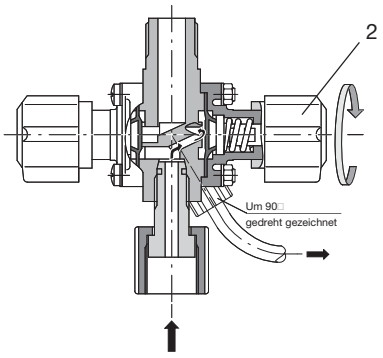
ACHTUNG

- **Multifunktionsventile sind keine absolut dicht schließende Absperrorgane.**

Wenn absolut kein Dosiermedium zur Dosierstelle gelangen darf, so ist ein zusätzliches Absperrorgan saugseitig der Pumpe vorzusehen.



- Ansaughilfe bei der Inbetriebnahme der Pumpe gegen Druck. Das Lösen der Druckleitung ist nicht erforderlich. Dies erfolgt durch Drehen am roten Drehknopf (2).



ACHTUNG

- **An der Dosierstelle muß ein Rückschlagventil installiert werden, da bei der Betätigung des Ventils der gesamte Inhalt der Anlage über den Bypass zurückfließen kann.**

- Entlastung der Dosierleitung bei Stillstand der Anlage (z.B. Reparatur). Dies erfolgt durch Drehen am roten Drehknopf (2).
- Überströmventil zum Schutz der Anlage gegen unzulässigen Überdruck, der von der Dosierpumpe verursacht wird. Rückführung über eine Bypassleitung. Diese Funktion erfolgt automatisch.

3 Bestimmungsgemäßer Gebrauch

Bestimmungsgemäßer Gebrauch

Schutz der Dosierleitung vor unzulässigem Überdruck, der durch die Dosierpumpe erzeugt wird, wenn ein in der Dosierleitung befindlicher Absperrhahn geschlossen wird.

- Das Multifunktionsventil darf nicht verwendet werden zum Schutz der Dosierleitung vor unzulässigem Überdruck, der andere Ursachen hat als der von der Dosierpumpe erzeugte Druck.
- Das Ventil darf **nicht** als Absperrorgan verwendet werden.

4 Montage / Installation

Sicherheitsanforderung, Sicherheitshinweise

ACHTUNG

- **Bei druckbeaufschlagten Systemen muss an der Dosierstelle ein Rückschlagventil installiert sein, da sonst bei Betätigung des Ventils der gesamte Inhalt der Anlage über den Bypass zurückfließen kann.**
- **Die Bypassleitung muß immer angeschlossen sein, da es beim Betrieb des Ventils nahe der Überdruckfunktion zu einem minimalen Überströmen in die Bypassleitung kommen kann.**
- **Multifunktionsventile sind keine absolut dicht schließenden Absperrorgane!**

Montagebeschreibung mechanisch/hydraulisch

Das Mehrfunktionsventil wird direkt auf den Druckanschluß der Pumpe aufgeschraubt. Das Ventil kann um 360□gedreht und ausgerichtet werden.

Abgangsseitig wird mittels Anschlußset bzw. GF-Verschraubung die Dosierleitung bzw. Dosierschlauch befestigt. Werkseitig ist in der O-Ringnut am Abgang ein EPDM O-Ring eingelegt. Für Anwendungen, bei denen EPDM nicht beständig ist, wird die Montage eines Viton® B O-Rings empfohlen. Dieser O-Ring (bräunlich) ist dem Ventil beigelegt.

Die Bypassleitung wird in den Vorratsbehälter zurückgeführt. Befestigung über Schlauchtülle und Überwurfmutter.

5 Betrieb / Bedienung

ACHTUNG

- **Die Bypassleitung muß immer angeschlossen sein, da es beim Betrieb des Ventils nahe der Überdruckfunktion zu einem minimalen Überströmen in die Bypassleitung kommen kann.**
- **Multifunktionsventile sind keine absolut dicht schließenden Absperrorgane!**

Bedienung und Einstellung Ansaughilfe

Durch Drehen des roten Drehknopfes (2) in Pfeilrichtung (Uhrzeigersinn) wird der Weg zum Bypass frei. Das Medium fließt in den Vorratsbehälter zurück.

HINWEIS

- **Dabei wird auch die Druckleitung teilweise entlastet und es kann Flüssigkeit am Bypass austreten.**

Die ProMinent Dosierpumpe ist jetzt auf „Ansaugen" zu stellen (s. hierzu auch Betriebsanleitung der Pumpe), bis Flüssigkeit in der Bypassleitung sichtbar wird.

Die Pumpe hat angesaugt und kann in Betrieb genommen werden. Nach dem Loslassen des roten Drehknopfes (2) geht dieser selbständig in die Ausgangsstellung zurück.

Entlastung der Druckleitung

Durch Herausdrehen des roten Drehknopfes (2) und des schwarzen Drehknopfes (1) im Uhrzeigersinn wird der Weg von der Druckleitung zum Bypass frei. Wird nur der rote Drehknopf (2) betätigt, so fällt der Druck in der Leitung auf ca. 1,5 bar ab.

Die beiden Knöpfe müssen solange herausgedreht bleiben, bis keine Flüssigkeit mehr an der Bypassöffnung austritt bzw. keine Flüssigkeit mehr in den Vorratsbehälter zurückfließt. Die Dosierleitung ist jetzt druckentlastet. Nach dem Loslassen der beiden Drehknöpfe, drehen sich beide wieder selbständig in ihre Ausgangsstellung zurück.

6 Technische Daten / Bestellhinweise

Mediumberührte Werkstoffe

Ventilkörper	PVDF
Membrane	PTFE-beschichtet
Dichtungen	Viton® oder EPDM
Adapter bei Größe III	PVC

Viton® ist ein eingetragenes Warenzeichen von DuPont Dow Elastomers.

Typ	Best. Nr.	Überström-Öffnungsdruck*	Anschluß-größe	Bypass-Anschluß
Größe I	792011.9	16 bar	6-12 mm	6/4 mm
Größe I	791715.6	10 bar	6-12 mm	6/4 mm
Größe I	1005745	6 bar	6-12 mm	6/4 mm
Größe II	792203.4	10 bar	6-12 mm	12/9 mm
Größe II	740427.0	6 bar	6-12 mm	12/9 mm
Größe III	792215.6	10 bar	DN 10	12/9 mm

* Der hier angegebene Überström-Öffnungsdruck ist der Druck, bei dem das Ventil zu öffnen beginnt. Je nach Pumpentyp kann der Druck bis zum vollständigen Öffnen des Ventils um bis zu 50 % höher liegen.

Einsatzbereich

Größe I	CONCEPT, Pneumados und Beta® 4: alle Typen gamma/ L: Typ 1000, 1601, 1602, 1005, 0708, 0413, 0220 und 1605
Größe II	alle Typen unter Größe I Beta® 5: Typ 1008, 0713, 0420 und 0232 gamma/ L: Typ 1008, 0713, 0420 und 0232
Größe III	Sigma/ 1 mit Anschlussgewinde DN 10

Technische Änderungen vorbehalten.

Please completely read through these operating instructions. Do not discard! The warranty shall be invalidated by damage caused by operating errors!

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2	Functional Description	10
3	Use for Intended Purpose	12
4	Mounting / Installation	12
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1 Design

Each of the functions of the multi-function valve is produced by a spring-loaded diaphragm. The valve features a pressure relief mechanism for both the pressure retaining function as well as for the pressure relief function.

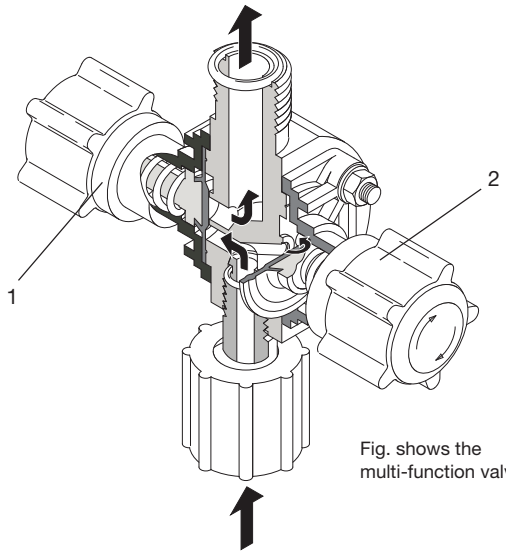


Fig. shows the multi-function valve, Size I

2 Functional Description

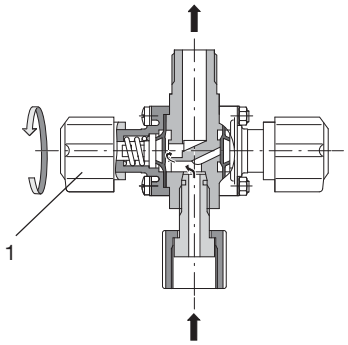
Functions

- Producing a defined backpressure for metering with respect to free outlet.
  Turn the black rotary knob clockwise (1) to disable this function.
- Prevents lift-through from the supply vessel in the case of vacuum at the metering point.
  Turn the black rotary knob clockwise (1) to disable this function.

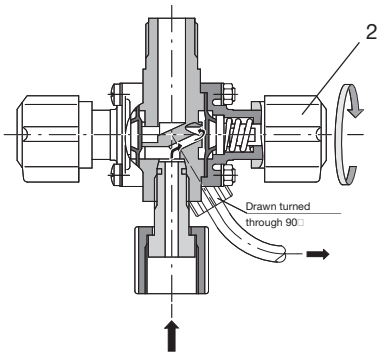
IMPORTANT

- **Multi-function valves are not intended to act as fully sealing stop taps.**

If it is imperative that no metering chemical reaches the metering point, fit an additional stop cock to the suction side of the pump.



- Intake aid to prevent pressure when starting up pumps. It is not necessary to release the delivery line.
  Turn the red rotary knob (2) for this purpose.



IMPORTANT

- **A non-return valve must be installed at the metering point since the entire content of the system can flow via the bypass when the valve is operated.**

- Depressurizing the metering line when the relevant system is at a standstill (e.g. repairs). Turn the red rotary knob (2) for this purpose.
- Overflow valve to protect the system from impermissible overpressure caused by the metering pump. Return flow via a bypass line. This function operates automatically.

3 Use for Intended Purpose

Use for Intended Purpose

To protect the metering line from impermissible overpressure caused by the metering pump when a stop cock valve is connected in the metering line.

- The multi-function valve may not be used to protect the discharge line from inadmissible excess pressure caused by anything other than the pressure generated by the metering pump.
- The valve must **not** be used as a shut-off.

4 Mounting / Installation

Safety Requirements, Notes on Safety

IMPORTANT

- **Pressurised systems must have a non-return valve fitted at the metering point because the entire contents of the system can flow back via the bypass when the valve is operated.**
- **The bypass line must always be connected since minimum overflow into the bypass line can occur during operation of the valve close to the pressure relief function.**
- **Multi-function valves are not intended to act as fully sealing stop taps!**

Mounting Description, Mechanical/Hydraulic

The multi-function valve is screwed directly on to the pressure connection of the pump. The valve can be turned and aligned through 360□.

The metering line or metering hose is secured on the outlet end by means of a connection set or GF screw fitting. An EPDM O-ring is fitted at the factory in the O-ring groove at the outlet. For applications in which EPDM is not suitable, it is advisable to fit a Viton B O-ring. This O-ring (brown) is supplied together with the valve.

The bypass line is routed into the supply vessel. It is secured by means of a hose grommet and union nut.

5 Operation

IMPORTANT

- **The bypass line must always be connected since minimum overflow into the bypass line can occur during operation of the valve close to the pressure relief function.**
- **Multi-function valves are not intended to act as fully sealing stop taps!**

Operation and Setting Intake Aid

Turn the red rotary knob (2) in the direction of the arrow (clockwise) to open the way to the bypass. The medium flows back into the supply tank.

NOTE

- **In this case, the delivery line is partly depressurized and liquid can flow out of the bypass.**

The ProMinent metering pump must now be set to “intake“ (refer to pump operating instructions) until liquid can be seen in the bypass line.

The pump is now primed and ready for use. After being released, the red rotary knob (2) reverts of its own accord back to its initial position.

Depressurizing the Delivery Line

The passage from the delivery line to the bypass is cleared by turning the red rotary knob (2) and the black rotary knob (1). The pressure drops in the line to approx. 1.5 bar if only the red rotary knob (2) is turned.

Both knobs must remain unscrewed until no more liquid flows out of the bypass line or no more liquid flows back into the supply tank. The metering line is now depressurized. Once released, both rotary knobs turn of their own accord back to their initial position.

6 Technical Data / Ordering Notes

Materials in Contact with Medium

Valve housing	PVDF
Diaphragm	PTFE-coated
Seals	Viton® or EPDM
Adapter for size III	PVC

Viton® is a registered trademark of DuPont Dow Elastomers.

Type	Order No.	Overflow opening pressure*	Connection size	Bypass connection
Size I	792011.9	16 bar	6-12 mm	6/4 mm
Size I	791715.6	10 bar	6-12 mm	6/4 mm
Size I	1005745	6 bar	6-12 mm	6/4 mm
Size II	792203.4	10 bar	6-12 mm	12/9 mm
Size II	740427.0	6 bar	6-12 mm	12/9 mm
Size III	792215.6	10 bar	DN 10	12/9 mm

* The overflow opening pressure stated here is the pressure at which the valve starts to open. Depending on the pump type, the pressure may be higher up to 50 % until complete opening of the valve.

Operating range

Size I	CONCEPT, Pneumados and Beta® 4: all types gamma/ L: type 1000, 1601, 1602, 1005, 0708, 0413, 0220 and 1605
Size II	all types below size I Beta® 5: type 1008, 0713, 0420 and 0232 gamma/ L: type 1008, 0713, 0420 and 0232
Size III	Sigma/ 1 with threaded connection DN 10

Subject to technical modifications.

Veuillez lire en premier lieu entièrement ce mode d'emploi. Ne surtout pas le jeter ! En cas de dommages occasionnés par des erreurs d'utilisation, il y a automatiquement perte du droit de garantie !

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5	Mise en service	19
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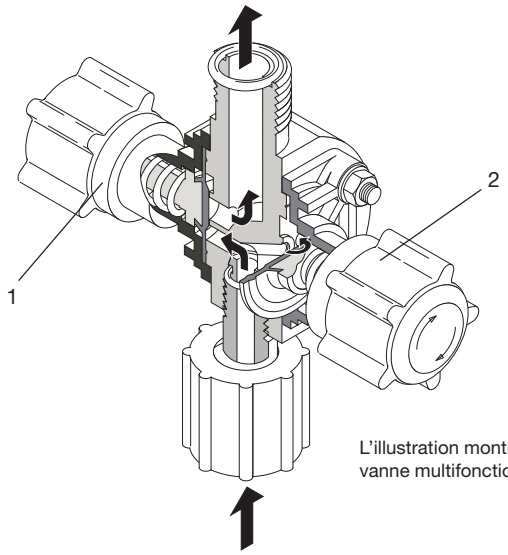
1 Structure

Les fonctionnalités de la vanne multifonctions sont générées à chaque fois par une membrane équipée d'un ressort. Un mécanisme de décharge est prévu pour la fonction de maintien en pression et pour la fonction de surpression.



L'illustration montre une vanne multifonctions taille I

2 Description fonctionnelle

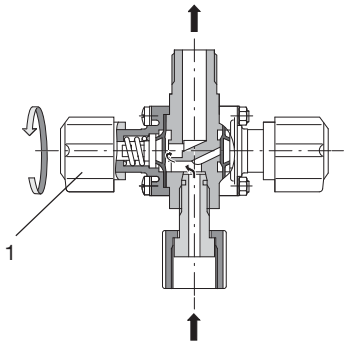
Fonctionnalités

- Génération d'une contre-pression définie pour un dosage contre une sortie libre.
  Cette fonction peut être arrêtée en tournant le bouton rotatif noir en sens horaire (1).
- Eviter les coups de siphon du réservoir en présence d'un vide au point de dosage.
  Cette fonction peut être arrêtée en tournant le bouton rotatif noir en sens horaire (1).

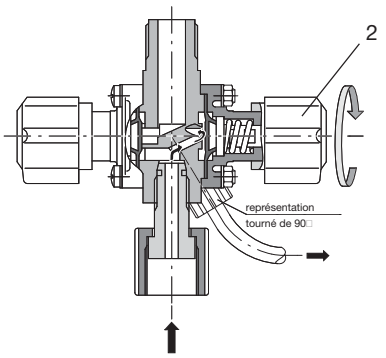
ATTENTION

- **Les vannes multifonctions ne sont pas des organes d'arrêt à fermeture absolument étanche.**

Si aucune quantité de fluide ne doit parvenir au point de dosage, il faut prévoir un organe d'arrêt supplémentaire côté aspiration de la pompe.



- Dispositif auxiliaire d'aspiration pour la mise en service de la pompe contre pression. Pas besoin de desserrer le tuyau de refoulement.
  Tourner à cet effet le bouton rotatif rouge (2).



ATTENTION

- **Un clapet anti-retour doit être installé au point de dosage étant donné qu'en actionnant la vanne, le contenu total de l'installation est susceptible de recouler via la dérivation.**

- Décharge de la conduite de dosage à l'arrêt de l'installation (réparation par exemple). Tourner à cet effet le bouton rotatif rouge (2).
- Soupape de décharge pour protéger l'installation contre une surpression inadmissible provoquée par la pompe doseuse. Retour via une conduite de dérivation (bypass). Cette fonction s'exécute automatiquement.

3 Utilisation conforme

Utilisation conforme

Protection de la conduite de dosage contre une surpression non autorisée, générée par la pompe doseuse après la fermeture d'un robinet d'arrêt monté dans la conduite de dosage.

- La vanne multifonctions ne doit pas être utilisée pour la protection de la conduite de dosage contre une surpression inadmissible ayant d'autres causes que la pression générée par la pompe doseuse.
- La vanne **ne doit pas** être utilisée en tant qu'organe d'arrêt.

4 Montage / Installation

Exigences concernant la sécurité, consignes de sécurité

ATTENTION

- **Lors d'injection dans un système sous pression, un clapet anti-retour doit être installé au point de dosage sinon un retour de flux est susceptible d'être refoulé via le bypass de la vanne multifonctions lorsque celle-ci est actionnée.**
- **La conduite de bypass doit toujours être raccordée. Lorsque la pression d'exploitation de la pompe est proche de la pression de décharge de la vanne, il se peut qu'un peu de produit s'écoule du raccord de bypass.**
- **Les vannes multifonctions ne sont pas des organes d'arrêt à fermeture absolument étanche.**

Description du montage de l'installation mécanique/hydraulique

La vanne multifonctions se visse directement sur le raccord de refoulement de la pompe. La vanne peut être tournée et alignée de 360□.

Côté sortie, il convient de fixer le tuyau ou resp. la conduite de dosage au moyen du lot de raccordement ou via un raccord vissé GF. Un joint torique en EPDM est posé départ usine dans la rainure du joint torique en sortie. En cas d'utilisations pour lesquelles l'EPDM ne serait pas résistant, nous recommandons le montage d'un joint torique en Viton B. Ce joint torique (brunâtre) est joint à la vanne.

La conduite de dérivation est ramenée dans le réservoir. Elle est fixée par un embout de tuyau flexible et un écrou-raccord.

5 Mise en service / Commande

ATTENTION

- **La conduite bypass doit toujours être raccordée étant donné qu'en cas d'exploitation de la vanne à proximité de la fonction de surpression, un débordement minimal est susceptible de se produire dans la conduite de dérivation.**
- **Les vannes multifonctions ne sont pas des organes d'arrêt à fermeture absolument étanche.**

Commande et réglage
Dispositif auxiliaire d'aspiration

Tourner le bouton rotatif rouge (2) dans le sens de la flèche (sens horaire) pour dégager la voie vers le (bypass). Le milieu s'écoule de nouveau dans le réservoir.

REMARQUE

- **Ce faisant, la conduite de refoulement est partiellement déchargée et du liquide peut sortir du bypass.**

Dès à présent, commuter la pompe doseuse ProMinent® sur „Amorçage" (voir à cet effet également le mode d'emploi de la pompe), jusqu'à ce que du liquide devienne visible dans la conduite de dérivation.

La pompe s'est amorcée et peut être mise en service. En laissant revenir le bouton rotatif rouge (2), celui-ci reprend automatiquement sa position d'origine.

Décharge de la conduite de refoulement

En sortant le bouton rotatif rouge (2) et le bouton rotatif noir (1) par rotation dans le sens des aiguilles d'une montre, le parcours allant de la conduite de refoulement vers le bypass est libéré. En actionnant uniquement le bouton rotatif rouge (2), la pression dans la conduite tombe à 1,5 bar environ.

Les deux boutons doivent demeurer tournés jusqu'à ce que plus aucun liquide ne sorte de l'ouverture du bypass ou que plus aucun liquide ne soit refoulé dans le réservoir. La conduite de dosage est maintenant hors pression. En relâchant les deux boutons rotatifs, ceux-ci se remettent à tourner automatiquement sur leur position d'origine.

6 Caractéristiques techniques / Remarques concernant la commande

Matériaux en contact avec le milieu

Corps de la vanne	PVDF
Membranes	revêtues de PTFE
Joints	Viton® ou EPDM
Adapteur taille III	PVC

Viton® est une marque déposée de DuPont Dow Elastomers.

Type	Nº de commande	Pression d'ouverture de décharge*	Grandeur de raccordement	Raccord bypass
taille I	792011.9	16 bar	6-12 mm	6/4 mm
taille I	791715.6	10 bar	6-12 mm	6/4 mm
taille I	1005745	6 bar	6-12 mm	6/4 mm
taille II	792203.4	10 bar	6-12 mm	12/9 mm
taille II	740427.0	6 bar	6-12 mm	12/9 mm
taille III	792215.6	10 bar	DN 10	12/9 mm

* La pression d'ouverture de décharge indiquée ici constitue la pression à laquelle la vanne commence à s'ouvrir. En fonction du type de pompe, la pression jusqu'à l'ouverture complète de la vanne peut être jusqu'à 50 % plus élevée.

Domaine d'utilisation

taille I	CONCEPT, Pneumados et Beta® 4: tous types gamma/ L: type 1000, 1601, 1602, 1005, 0708, 0413, 0220 et 1605
taille II	tous types inférieurs à la taille I Beta® 5: type 1008, 0713, 0420 et 0232 gamma/ L: type 1008, 0713, 0420 et 0232
taille III	Sigma/ 1 avec taraudage de raccordement DN 10

Sous réserve de modifications.

Le rogamos lea primeramente en su totalidad las instrucciones de servicio. No las tire. En caso de daños ocasionados por error en el manejo del equipo, desaparece la garantía.

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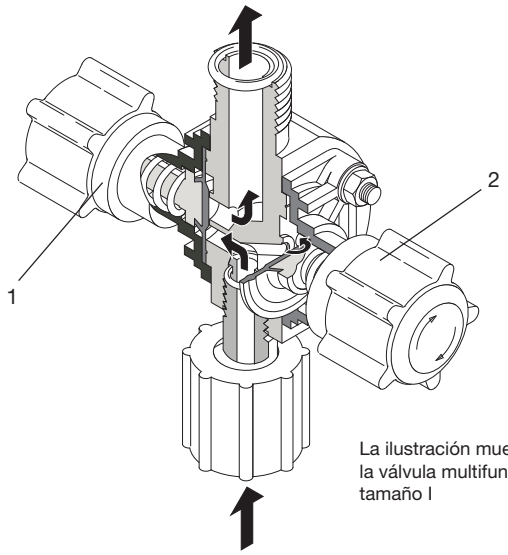
1 Principio de funcionamiento

Las funciones de la válvula multifuncional son generadas, en cada caso, por una membrana sometida a la presión de un muelle. Están previstos un mecanismo de descarga para la función de mantenimiento de la presión y otro para la de sobrepresión.



La ilustración muestra la válvula multifuncional tamaño I

2 Características funcionales

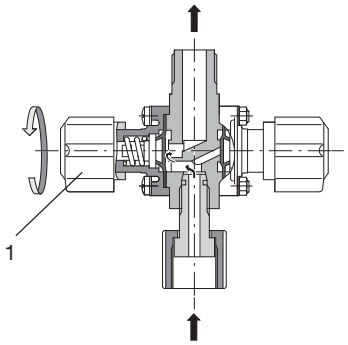
Funciones

- Generar una contrapresión definida en la dosificación a salida libre.
  La supresión de esta función se realiza girando el botón giratorio negro en sentido horario (1).
- Evitar el "efecto sifón" desde el depósito dosificador en caso de presión negativa en el punto de dosificación.
  La supresión de esta función se realiza girando el botón giratorio negro en sentido horario (1).

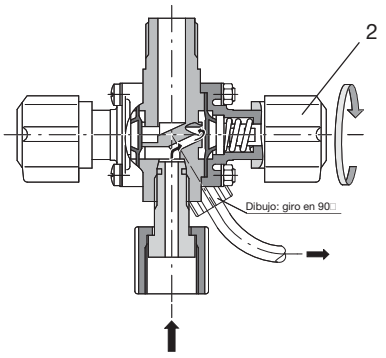
ATENCIÓN

- **Las valvulas multifuncionales no son órganos de cierre absolutamente herméticos.**

Si no debe llegar absolutamente ningún medio de dosificación al punto de dosificación debe instalarse un órgano de cierre adicional en el lado de aspiración de la bomba.



- Ayudar en la aspiración en la puesta en servicio de la bomba contra presión. No es necesario aflojar el tubo de presión. Esto se realiza girando el botón giratorio rojo (2).



ATENCIÓN

- **En el punto de dosificación se debe instalar una válvula de retención, ya que al operar la válvula, todo el contenido de la instalación puede refluir a través de la derivación.**

- Descargar el tubo de dosificación cuando la instalación esté parada (p.ej. por motivos de reparación). Esto se realiza girando el botón giratorio rojo (2).
- Válvula de seguridad para proteger la instalación contra sobrepresiones inadmisibles generadas por la bomba dosificadora. Retorno a través de un tubo de derivación. Esta función es automática.

3 Uso conforme a los fines previstos

Uso conforme a los fines previstos

Protección del tubo dosificador contra sobrepresiones inadmisibles generadas por la bomba dosificadora al cerrar una llave de retención ubicada en el tubo dosificador.

- La válvula multifuncional no debe utilizarse para protección de la tubería de dosificación contra sobrepresión indebida, que tiene otras causas que la presión generada por la bomba dosificadora.
- La válvula **no** debe ser empleada como órgano de cierre.

4 Montaje / Instalación

Requisitos e indicaciones de seguridad

ATENCIÓN

- **En sistemas presurizados debe estar instalada una válvula antirretorno en los puntos de dosificación, ya que de lo contrario, al operarse la válvula todo el contenido de la instalación puede refluir a través de la derivación.**
- **El tubo de derivación debe mantenerse siempre conectado, ya que al operar la válvula cerca de la función de sobre-presión es posible que rebase una pequeña cantidad de líquido hacia el tubo de derivación.**
- **Las válvulas multifuncionales no son órganos de cierre absolutamente herméticos.**

Descripción del montaje mecánico / hidráulico

La válvula multifuncional se enrosca directamente en la conexión de presión de la bomba. La válvula tiene un giro de 360□y puede orientarse según conveniencia.

En el lado de salida, se fija el tubo o conducto dosificador mediante un juego de conexiones o bien la unión roscada GF. En la ranura anular en O del lado de salida, viene colocada de fábrica una junta toroidal de EPDM. Para las aplicaciones en las que el EPDM no sea resistente a los líquidos utilizados, se recomienda el montaje de una junta toroidal de Viton B. Esta junta toroidal (de color marrón) viene adjunta a la válvula.

El tubo de derivación se lleva nuevamente al depósito dosificador. Fijarlo mediante boquilla portatubo y tuerca de racor.

5 Operación / Manejo

ATENCIÓN

- **El tubo de derivación debe mantenerse siempre conectado, ya que al operar la válvula cerca de la función de sobre-presión es posible que rebase una pequeña cantidad de líquido hacia el tubo de derivación.**
- **Las válvulas multifuncionales no son órganos de cierre absolutamente herméticos.**

Operación y puesta a punto
Ayuda en la aspiración

Mediante giro del botón giratorio rojo (2) en la dirección de la flecha (sentido horario) queda libre la vía al bypass. El líquido a dosificar retorna al depósito dosificador.

NOTA

- **Se produce una descarga parcial del tubo de presión, por lo que puede salir líquido en la derivación.**

La bomba dosificadora ProMinent debe ponerse entonces en "aspirar" (véase tambièn al respecto las instrucciones de servicio de la bomba), hasta que aparezca líquido en el tubo de derivación.

La bomba ha aspirado y puede ser puesta en marcha. Al soltar el botón giratorio rojo (2), éste retorna automáticamente a la posición inicial.

Descarga del tubo de presión

Girando hacia fuera el botón giratorio rojo (2) y el botón giratorio negro (1) en el sentido de las agujas del reloj, queda libre el recorrido de la tubería de impulsión hasta el bypass. Si sólo es accionado el botón giratorio rojo (2), la presión en la tubería bajará hasta 1,5 bar, aproximadamente.

Ambos mandos deben permanecer en esa posición hasta que ya no salga líquido por el orificio de derivación ni que retorne líquido al depósito dosificador. El tubo de dosificación está entonces descargado de presión. Al soltar los dos mandos giratorios, éstos retornan automáticamente a su posición inicial.

6 Características técnicas / Instrucciones para el pedido

Materiales empleados para los elementos en contacto con el líquido a dosificar

Cuerpo de válvula	PVDF
Membrana	revestida de Teflón
Juntas	Viton® o EPDM
Pieza de ajuste para tamaño III	PVC

Viton® es una marca registrada de DuPont Dow Elastomers.

Tipo	No. de ref.	Presión de apertura de rebose*	Tamaño de conexión	Conexión de derivación
Tamaño I	792011.9	16 bar	6-12 mm	6/4 mm
Tamaño I	791715.6	10 bar	6-12 mm	6/4 mm
Tamaño I	1005745	6 bar	6-12 mm	6/4 mm
Tamaño II	792203.4	10 bar	6-12 mm	12/9 mm
Tamaño II	740427.0	6 bar	6-12 mm	12/9 mm
Tamaño III	792215.6	10 bar	DN 10	12/9 mm

* La presión de apertura de rebose indicada aquí es la presión a la que empieza a abrirse la válvula. Según el tipo de bomba, la presión hasta la apertura total de la válvula puede ser hasta el 50 % mayor.

Aplicaciones

Tamaño I	CONCEPT, Pneumados y Beta® 4: todos los tipos gamma/ L: tipo 1000, 1601, 1602, 1005, 0708, 0413, 0220 y 1605
Tamaño II	todos los tipos bajo tamaño I Beta® 5: tipo 1008, 0713, 0420 y 0232 gamma/ L: tipo 1008, 0713, 0420 y 0232
Tamaño III	Sigma/ 1 con rosca de unión DN 10

Sujeto a modificaciones técnicas.

Anschriften- und Liefernachweise durch den Hersteller /
Addresses and delivery through manufacturer /
Adresses et liste des fournisseurs fournies par le constructeuer /
Para informarse de las direcciones de los distribuidores, dirigirse al fabricante:

ProMinent Dosiertechnik GmbH
Im Schuhmachergewann 5-11 · 69123 Heidelberg
Germany
Tel.: +49 6221 842-0
Fax: +49 6221 842-419
info@prominent.com · www.prominent.com

P-701/702	12026	Motor, Teco, 1hp, 1800rpm, 143T	208-230/460V, 3ph, CSA/UR

TECO Westinghouse

OPERATION & MAINTENANCE MANUAL FOR THREE PHASE INDUCTION MOTORS

TECO-Westinghouse Motor Company
5100 North IH-35
Round Rock, Tx. 78681

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1. INTRODUCTION

This and the following instruction address the more common situations encountered in motor installation, operation and maintenance. For the TWMC motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of live electrical parts and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transportation, assembly, operation, etc... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should be considered and checked.

- The technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- The general erection and safety regulations.
- The local and plant-specific specifications and requirements.
- The proper use of transport, lifting devices and tools.
- The use of personal protective equipment.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:

Warning of electric hazards for personnel.

Warning of dangers for personnel.

ATTENTION!
Warning of damage for the motor or installation.

2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION

Inspection upon receipt
Check to following points upon receipt:

- Are the nameplate ratings identical with what you ordered?
- Are dimensions and color in compliance with your specifications?
- Are the nameplate ratings for space heater, thermal protector, temperature detector, etc. identical with what you ordered?
- Is there any damage?
- Are all accessories and accompanying instruction manuals in good order?
- Please ensure that the arrow head indicator really indicates direction of rotation.
- If there are any specific requirements, please ensure they are in conformity with your specifications.

2.1 Storage
When motors are not in operation, the following precautionary measures should be undertaken to assure best performance.

2.2 Place
(a) High and dry, well ventilated without direct sun, dust or corrosive gas.
(b) Not located near to a boiler or freezer.
(c) Entirely free form vibration and easy for movements.
(d) Motors should be put on pallets to prevent moisture.

2.3 Moisture prevention
Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3ºC above the dew point temperature by providing either external or internal heat. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor. Incandescent light bulbs can be placed within the motor to provide heat. However, if used, they must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

2.4
Even during storage, the insulation resistance should be kept above the specified values.
(a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 3.1.2 “Measurement of insulation resistance”.
(b) Insulation resistance test should be performed once every three months.

2.5

If the motor is not in operation for a long period (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

(a) Protect the motor as measures stated in 2.2.3.
(b) Insulation resistance test should be performed as stated in 2.2.4.

2.6 Bearing protection

(a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor. It is very important that this brace be re-installed exactly as it was originally, before the motor is moved form storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.
(b) Motors equipped with sleeve bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil. To keep the bearing journals well oiled and to prevent rusting, the motor shaft should be rotated several revolutions about every month ensuring the shaft does not come to rest in its original position. While the shaft is rotating, it should be pushed to both extremes of the endplay.
(c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. The shaft should be rotated several revolutions about every month to maintain proper distribution of the grease within the bearings.
(d) Tilt-pad bearings are a type of sleeve bearing used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage internal, oil must be periodically manually introduced into the pads and housing to prevent the occurrence of oxidation of the precision machined components.
    (1) Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
    (2) Pour in approximately one cup of oil every month and rotate the shaft a few revolutions about every two (2) weeks.
    (3) For long periods of storage, the oil that accumulates in the housing should be removed.

ATTENTION!
Care should be taken to keep parts such as fitting surfaces, key, shaft extension and axial central hole from any collision with foreign matter. Grease should also be generously applied to prevent rusting.

2.7 Transportation

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. The vertical mounting type motors should be transported in the vertical position.

Do not use the hoisting hook/eyebolts to lift more that the motor itself. They are designed to support the motor only. Make sure the hoisting hook is correctly attached to the eyebolt(s)/lug(s) are fully screwed in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.
Do not twist the steel wires and make sure the eyebolts have been firmly screwed and the sling angle is correct.

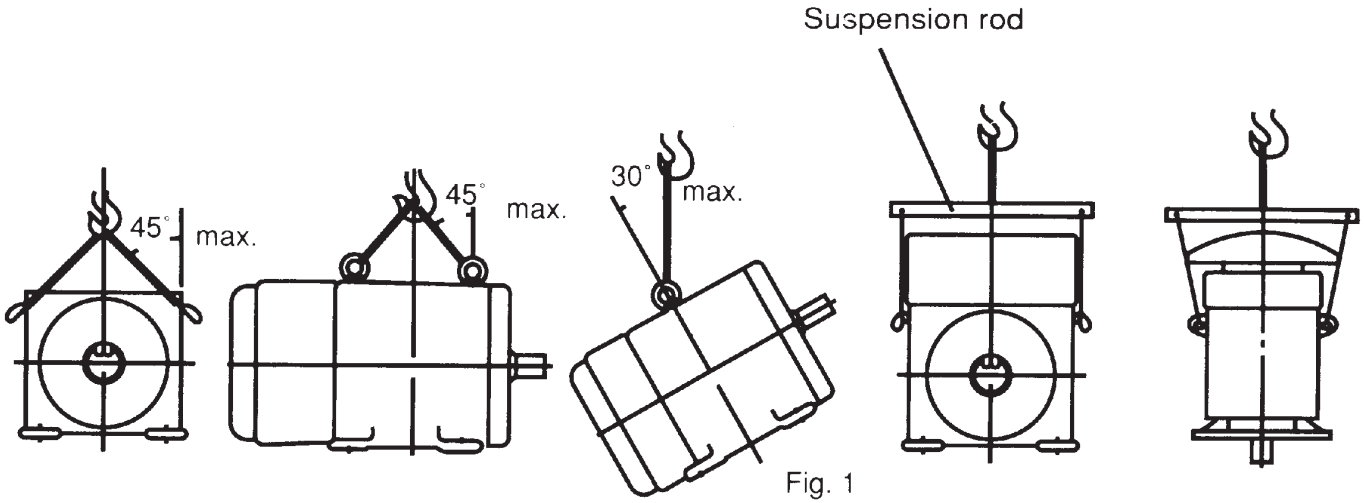


Fig. 1

3 INSTALLATION

Site and environment for motor installation

3.1.1

Standard environment and site conditions for the installation of motors are usually set as follows:

(a) Ambient temperature: -10~40ºC
(b) Humidity: Relative humidity below 90%RH for totally enclosed types, and below 80%RH for semi-enclosed types.
(c) Elevation: below 1000 meters or 3300 feet.
(d) Harmful gases, liquids, dusts, high moisture should be absent.
(e) Foundations should be strong and free of vibration.

If there are any special environmental conditions, please inform TWMC prior o ordering.

3.1.2 Ventilation and space

(a) Installation area should be well ventilated.
(b) The installation space should be large enough to facilitate heat dissipation and maintenance.

3.2 Foundation

3.2.1

Use rigid and solid sole plate or common bed as foundation.
For best motor performance, it is advisable to use a sole plate or common bed, particularly when using a shaft coupling.

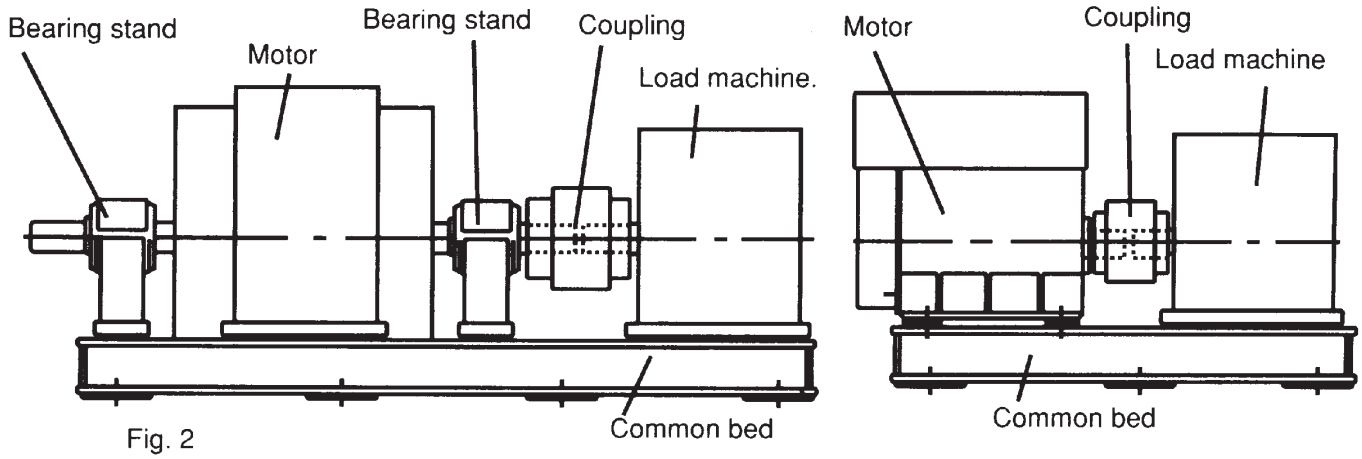


Fig. 2

3.2.2 Installation

(a) Select an appropriate foundation surface for the sole plate or common bed, which will be, considered the ultimate level.
(b) Align the position of the common bed with reference to that level.
(c) Align the level accuracy at least at four points such as bearing mounting, shaft extension etc. The accuracy should be within 0.04mm or .0015 inches
(d) Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig. 3. Stiff pads should also be installed beneath the wedges, which are welded together at various spots about 400-500mm (15.75-19.70 inches) apart etc., to enable the foundation to carry evenly the weight of the whole motor.
(e) The base should be sturdy and rigid to keep it flat and level.
(f) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(g) Accurately install shaft couplings, belt sheaves etc., then weld the wedges solid to prevent untoward change in position.

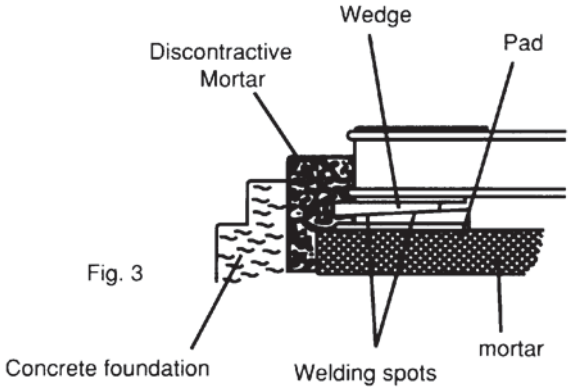


Fig. 3

3.2.3 The foundation of vertical induction motors: (Also the foundation of pump)

(a) Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
(b) A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig. 4.

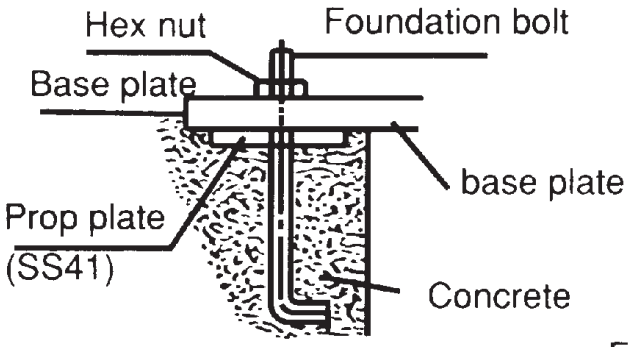


Fig. 4

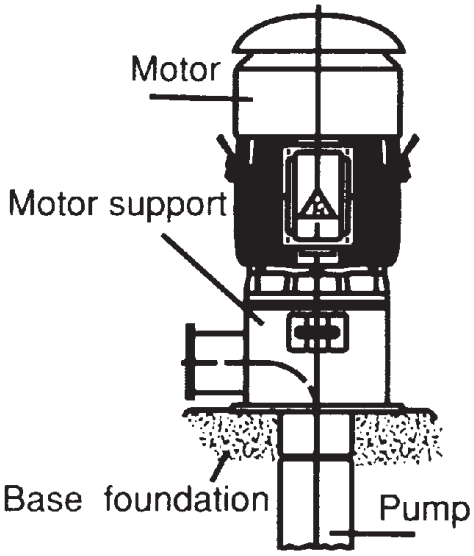


Fig. 5

3.2.4 Installation of vertical motors:

(a) All mounting surfaces must be clean and level.
(b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm (.0015 in.) flat and level.
(c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(d) Accurately install shaft couplings.

3.3 Installation of shaft coupling

ATTENTION!
Motors must always be accurately aligned, and this applies especially where they are directly coupled.
Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.

3.3.1

Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

ATTENTION!
Basically, the coupling should be heated and pushed onto the shaft extension with slight axial force. Do not hammer coupling to prevent bearing damage.

3.3.2

Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from load being transmitted to the motor bearings, which could cause bearing damage. The recommended limits of end float are as follows:

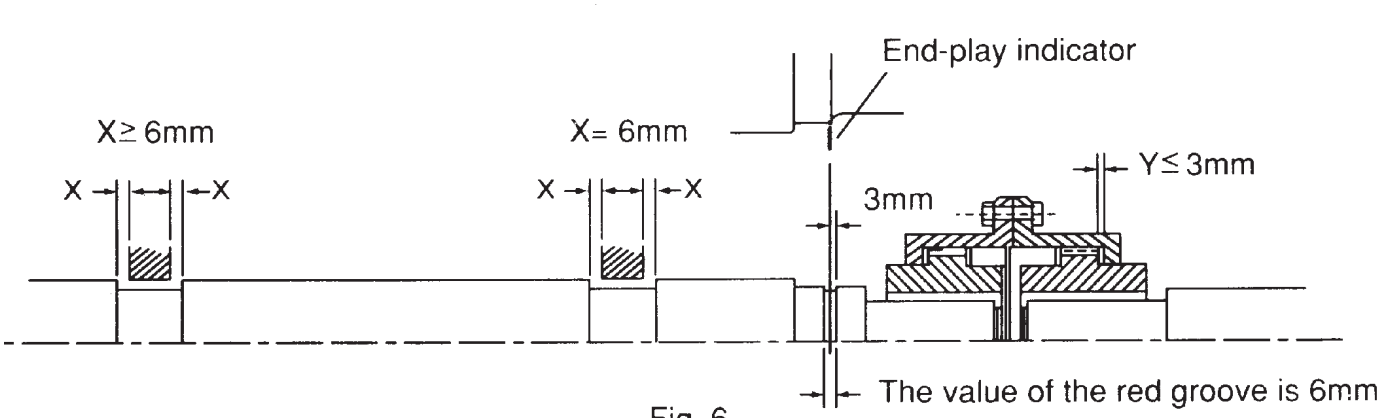


Fig. 6

(a) When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm (.236 in.) of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.

(b) Unless otherwise specified, the designed end-play value X of the groove for TWMC motors in general is within 6mm (.236 in.) as illustrated in Fig. 6. In essence, the endplay indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus X equals to 6±1mm or so, and the endplay value (Y) of the couplings should equal or be smaller than 3mm (.118 in.).

(c) If the desired value Y is grater than 3mmm (.118 in.) caused for instance by a thrust load and/or load machine with large end-play, please inform TWMC prior to entering an order.

3.3.3

In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the endplay indicator position but also to axial shaft expansion and increase in shaft centerline height due to thermal effects. In general, the axial shaft growth for motors can be disregarded since neither bearing is fixed and any shaft growth due to temperature increase will produce an elongation away from the coupling.

Shaft height growth (change in shaft centerline elevation) for TEFC machines can be calculated as follows:

$$\Delta=(0.0005\text{”}) \times (\text{motor foot to shaft £ dimension})$$

For non-TEFC machines, divide the number by 2.

3.3.4

It is desirable, in normal operation that the motor operates on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment:

Unit: mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.04	0.05
A	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.03	0.04

Angular misalignment is the amount by which the centerlines of driver and driven shafts are skewed. It can be measured using a dial indicator set up as shown in Fig. 7. The couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

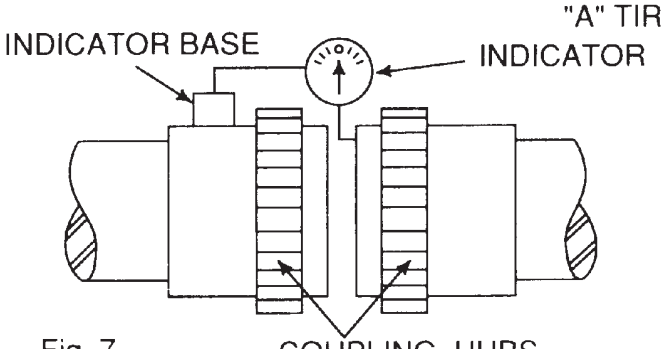


Fig. 7

TIR=Total indicator reading (by dial indicator)

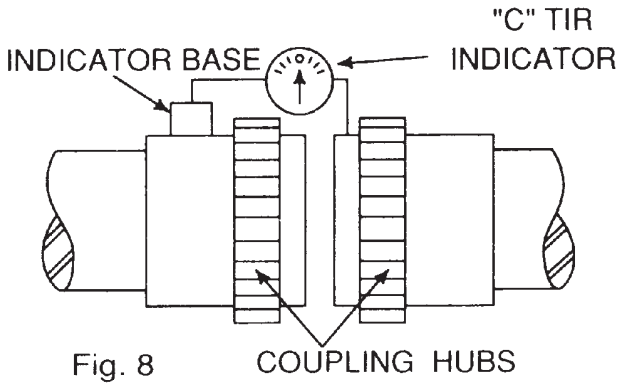


Fig. 8

Parallel misalignment is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig. 8. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

3.3.5

After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frames, at least two dowel pins should be installed in two diagonally opposite motor feet.

3.3.6 Installation of shaft coupling: (Vertical hollow shaft motor only)

Bolted Coupling as shown in Fig. 9

(a) Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
(b) The coupling is fastened with bolts.
(c) This coupling type is not auto-release type.

Note: Standard high thrust motors can absorb momentary up-thrust load up to 30% of the standard down thrust load. If the up-thrust is long in duration (over 10 Seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and standard motor is not suitable.

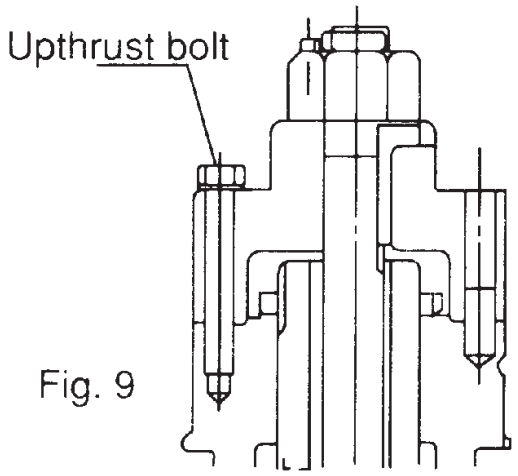


Fig. 9

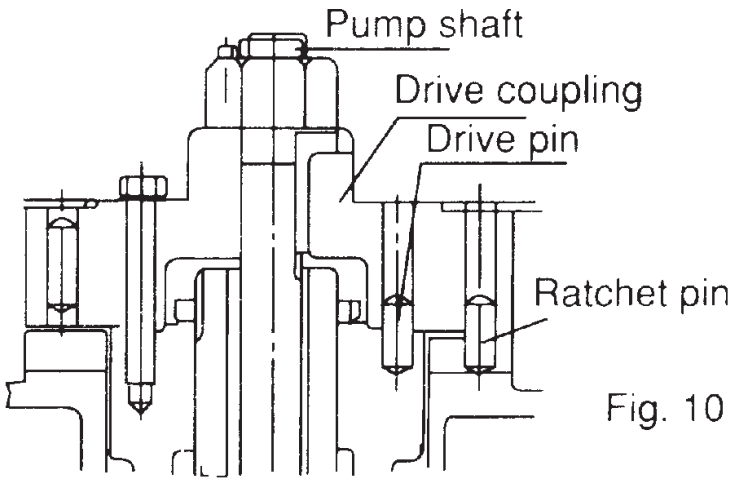


Fig. 10

3.3.7 Non-reverse ratchet/coupling, as Fig. 10 (If necessary)

The non-reverse coupling is also a bolted type and,

(a) It prevents the pump and motor from rotating in the reverse direction.
(b) It also prevents damage form over speeding and damage to pump shaft and bearings.
(c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
(d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
(e) When installing the non-reverse coupling, do not use lubricant. Lubricant will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
(f) As with the bolted coupling, the up-thrust capabilities are 30% of the standard high thrust rating for down thrust.

ATTENTION!
Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.

3.4 Installation for belt drive

In general, power transmission though direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

3.4.1

The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belts. It is also advisable to limit the belt velocity to under 35m/sec (115 ft/sec) to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform TWMC when you have decided the size of the sheaves and the length of the belts upon ordering.

ATTENTION!
Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig. 11 equal to 0) to reduce the bending moment and improve shaft life.

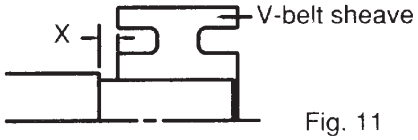


Fig. 11

3.4.2 Table of belt-sheave application for general electric motors

Output (KW/HP)			V-Belt Sheave							
			Conventional V-Belts				Narrow V-Belts			
4P	6P	8P	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)
11/15	-	-	B	4	160	82	3V	4	125	48
-	11/15	-	B	5	170	101	3V	5	140	59
-	-	11/15	B	5	190	101	3V	6	160	69
15/20	-	-	B	5	170	101	3V	6	125	69
-	15/20	-	B	5	224	101	3V	6	160	69
-	-	15/20	C	4	224	111	5V	3	180	60
18.5/25	-	-	B	5	200	101	3V	6	140	69
-	18.5/25	-	C	4	224	111	5V	3	180	60
-	-	18.5/25	C	5	224	136	5V	4	180	78
22/30	-	-	B	5	224	101	5V	6	160	69
-	22/30	-	C	5	224	136	3V	4	180	78
-	-	22/30	C	5	250	136	5V	4	200	78
30/40	-	-	C	5	224	136	5V	4	180	78
-	30/40	-	C	5	265	136	5V	4	224	78
-	-	30/40	C	6	265	162	5V	5	224	95
37/50	-	-	C	6	224	162	5V	4	200	78
-	37/50	-	C	6	265	162	5V	4	224	78
-	-	37/50	C	7	280	187	5V	5	250	95
45/60	-	-	C	6	265	162	5V	4	224	78
-	45/60	-	C	7	280	187	5V	5	224	95
-	-	45/60	C	7	315	187	5V	6	250	113
55/75	-	-	C	7	265	187	5V	5	224	95
-	55/75	-	C	8	300	213	5V	6	250	113
-	-	55/75	D	5	355	196	5V	6	280	113
75/100	-	-	C	8	315	213	5V	6	250	113
-	75/100	-	D	6	355	233	5V	6	315	113
-	-	75/100	D	6	400	233	5V	6	355	113
-	90/120	-	D	6	400	233	5V	6	355	113
-	-	90/120	D	6	425	233	8V	4	355	124
-	110/150	-	D	7	400	270	8V	4	355	124
-	132/175	110/150	D	7	450	270	8V	4	400	124
-	160/200	132/175	D	9	450	344	8V	4	450	124

3.5 Conveyance with chain or gear

3.5.1

Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (overhung) of chain and gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.

3.5.2
Pay close attention to ensure the parallelism of shafts.

3.5.3
The teeth of couplings should be correctly and precisely matched; the force conveyance centers should lie on the same line.

3.5.4
There should be no skip, jumping, vibration or unusual noises.

ATTENTION!
Do not hammer the conveyance devices such as couplings, belt sheaves, chain wheels, gears etc. onto the shaft. Those shaft fitments should be fitted and removed only by means of suitable devices. Heat shrinking may be a better alternative to avoid damaging bearings and components.

The exposed rotating parts should be covered to prevent accidents.

3.6 Electrical connections
All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations. Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams attached to the motor.

3.6.1 Power
The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at rated conditions:

±10% of rated voltage
±5% of rated frequency
±10% combined voltage and frequency variation so long as frequency variation is no more than ±5% of rated.

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage to or failure of the motor.

3.6.2
The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.

The bolted joints between the motor lead and the power cables must be made and insulated in a workman-like manner following the best trade practices.

3.6.3
Either fabricated motors or fan cooled cast frame, motors are all provided with grounding pads or bolts.

The motor must be grounded by proper connection to the electrical system ground.

3.6.4

The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner: While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

3.6.5 Auxiliary devices

Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.

If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.

Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.

4. OPERATION

4.1 Examination before start

4.1.1

When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted:

(a) Make sure all wiring is correct.
(b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
(c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
(d) Ensure the capacity of fuses, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
(e) Make sure the frame and terminal box are grounded.
(f) Make sure that the starting method is correct.
(g) Make sure switches and starters are set at their right positions.
(h) Motor heaters must be switched off when the motor is running.

4.1.2 Measurement of insulation resistance

During and immediately after measuring, the terminals must not be touched as they may carry residual dangerous voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.

(a) For rated voltage below 1000V, measured with a 500VDC megger.
(b) For rated voltage above 1000V, measured with a 1000VDC megger.
(c) In accordance with IEEE 43, clause 9.3, the following formula should be applied:

$$R \geq \left(\frac{\text{Rated voltage (v)}}{1000} + 1 \right) \times 10(M\Omega)$$

(d) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to the winding:
   (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
   (2) Direct current (as from a welder) can be passed through the winding. The total current should not exceed approximately 50% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the fully applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.

Ensure there is adequate guarding so live parts cannot be touched.

   (3) Heated air can either blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

ATTENTION!
Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40ºC for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will approximately halve for each 10ºC increase in insulation temperature above the dew point temperature.

(e) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

4.1.3 Power Source

(a) Ensure the capacity of the power source is sufficient.
(b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
(c) Voltage variation should be confined to within ±10% of the rated value and the phase to phase voltages should be balanced.

4.1.4 Bearing lubrication

(a) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibited, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.

(b) Motors, which are supplied with provision for flood lubrication, have an inlet orifice to meter the oil flow to the bearing. Refer to the outline drawing for these values. If the supply pressure does not match that stated on the outline, the orifice size must be adjusted to produce the specified flow rate. The drain adapter (also provided) has a weir plate fixed to the inside of the pipe to permit the establishment of the proper oil level. This weir plate must be located at the bottom of the pipe and must be parallel to the plane of the motor feet. To ensure optimum flow, the drain line should be vented to the atmosphere.

Oil inlet temperature:	Normal below 50ºC
	Alarm 60ºC
	Trip 65ºC

(c) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.

(d) Motors that have been designed with anti-friction bearings for use with an oil mist lubrication system have been packed at the factory with a small amount of grease for short test runs. Continuous running should not be considered unless the oil mist system is installed and operating.

(e) Grease lubricant type

(1) The bearings have been well greased at the factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage

(2) All motors with ZZ bearings will have SHELL Alvania R3 (*Lithium base grease*). All motors with open bearings will have Polyrex EM (polyurea base grease).

4.1.5 Cooling water for the cooler on water-cooled motors

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water: General tower water or industrial water.	
Volume: Please see outline drawing	
Inlet temperature:	Normal below 30ºC
	Alarm 35ºC
	Trip 40ºC

ATTENTION!
Make sure all locks, which fasten the movable parts of the motors during transportation, are dismantled and the shaft can rotate freely.

ATTENTION!
Ensure there is no foreign matter or tools inside the motors before starting motors.

4.1.6
Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.

The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to avoid flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.

4.1.7
Make sure the items above are examined. Test the motor running with or without load. Record and check according to "Maintenance" at 15-minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If all goes well the motor can be classified as "in good order".

4.2 Starting operation

4.2.1 Starting load
Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load, which is then gradually increased, proportional to the square of the speed and at last reaches 100% load at full load speed.

4.2.2 Starting
Too frequent starts can be harmful to the motors. The following restrictions should be observed:

(a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
(b) Motor can be started only once when it is at normal running temperature.
(c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted:
    (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
    (2) Let the motor cool down for 30 minutes before restarting, unloaded.
    (3) Two inching starts can be regarded as one normal start.

ATTENTION!
If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately.
Investigate thoroughly and take corrective action before attempting a restart.

Possible reasons for not starting are:
(1) Too low a voltage at the motor terminals.
(2) The load is too much for the rotor to accelerate.
(3) The load is frozen up mechanically.
(4) All electrical connections have not been made.
(5) Single-phase power has been applied.
(6) Any combination of the above.

4.2.3 Rotating direction

(a) Most TWMC motors are bi-directional. However, when some special types, such as high speed 2-Pole, certain large capacity motors, those with a non-reversing ratchet etc., should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.

(b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.

4.2.4 Power source, Voltage, Current

(a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.

(b) Voltage variation should be confined to within ±10% of the rating and the three phase voltages should be in full balance

(c) Ensure the motor phase currents, when without load, are within ±5% of the average values.

4.2.5

Frequency variation should be confined to within ±5% of the rating. The aggregate variation of voltage and frequency should be confined to within ±10% of the absolute value of the ratings.

Starting time and unusual noises

ATTENTION!
Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and refer to TWMC Service representative.

4.2.6 Sleeve bearing oil rings (sleeve bearing types only)

As the oil ring is used to carry lubricant to sleeve bearings, frequently check to ensure the oil ring is in motion.

4.2.7 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rate of rise in bearing temperature is more indicative of impending trouble than is the actual temperature.

ATTENTION!
If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature stabilizes.

Recommended limits on bearing temperature are as follows:

Sleeve Bearings	**Total measured temperature**
● By permanently installed detector	90ºC
● By temporary detector on top of the bearing sleeve near the oil ring	85ºC

Anti-Friction Bearings	Total measured temperature
● By permanently installed detector	100ºC
● By temporary detector measuring the outside of the bearing housing	95ºC

ATTENTION! (For sleeve bearing)

(1) It must be noted that when operating flood lubricated sleeve bearings without outside lubrication supplied, the bearing temperature must not be allowed to exceed 85ºC total temperature

(2) Under normal condition, for the self-lube bearing, the rate of temperature rise should be from 11 to 14ºC for the first ten (10) minutes after starting up and approximately 22ºC at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.

(3) When the rate of bearing temperature rise is less than 1ºC per half-hour, the bearing temperature is considered to be stabilized.

(4) If the total bearing temperature exceeds 95ºC, the motor should be shut down immediately.

Noise and Vibration

ATTENTION!
Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

5. MAINTENANCE

5.1 Major points in regular inspections and maintenance.

For safety, maintenance and repairs must only be carried out by properly trained personnel.

Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supplie(s).

Routine inspection and maintenance are usually performed by looking, listening, smelling and simple meters.

High temperature may arise under operating conditions on the motor surfaces, so that touching should be prevented or avoided. Keep away from moving and live parts. Unless deemed necessary, do not remove guards whilst assessing the motor.

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine inspection and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

Owing to the varied time and circumstances, motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically according to factory maintenance program. Generally, the inspection scope determined by the following factors:

(a) Ambient temperature.
(b) Starting and stopping frequency.
(c) Troublesome parts usually affecting motor functions.
(d) Easily abraded parts.
(e) The important position of motor in the operational system of a factory should be duly recognized. Therefore, its health and wellbeing should be fully protected especially when it is operating in severe conditions.

5.2 Motor windings:

(a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 3.1.2 “Measurement of insulation resistance”.
(b) Inspection of coil-ends:
  (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
  (2) Moisture must not accumulate. Keep coils warm when motor is not in use if moisture can be seen.
  (3) Discoloring. This is mainly caused by overheating.
(c) Ensure no untoward change of wedges from original position.
(d) Ensure the binding at the coil end is in its normal position.

5.3 Clean the interior of the motor:

(a) After a motor is in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.
(b) Points to note during cleaning:
  (1) If using compressed air or blower:
    (a) Compressed air should be free of moisture.
    (b) Maintain air pressure at 4 kg/cm², since high pressure can cause damage to coils.
  (2) Vacuum
    Vacuum cleaning can be used, both before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tools should be non-metallic to avoid any damage to thee winding insulation
  (3) Wiping
    Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent. In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.

ATTENTION!
Solvents of nay type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.

Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an airline respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.

(4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning

5.4 Clean the exterior of the motor:

(a) On open ventilated motors, screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air movement.

ATTENTION!
Screens and louvers should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.

(b) If the motor is equipped with air filters, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. It is better to replace or recondition filters too often than not often enough.

(c) Totally enclosed air to air cooled and totally enclosed fan cooled motors require special cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fiber bristles (not wire of any type).

5.5 Maintenance of anti-friction bearings

5.5.1 Frequency of re-lubrication:

The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc. It is, therefore, impossible to be precise about replenishment intervals. However, for normal direct coupling transmission, the periods shown as Table 1 may be used as a guide.

Remarks:

(a) The periods shown in Table 1 should be halved where bearings are used for belt drive and/or in dirty or high ambient temperature or high humidity environments.

(b) Please refer to the lubrication nameplate, if attached to the motor.

(c) For bearing numbers outside the range of Table 1, please contact TWMC

(d) If the periods referred to in Table 1 for drive-end bearing and opposite drive-end are different, for the convenience of maintenance operation, please take the shorter one the required grease replenishment period of these bearings.

5.5.1 Kinds of grease:

All motors with ZZ bearings will have SHELL Alvania R3 (lithium base grease). All motors with open bearings will have Polyrex EM (polyurea base grease).
Certain T-frame models will utilize special grease and will be noted on the lubrication nameplate. Please us identical grease or its equivalents when maintaining lubrication schedule.

ATTENTION!
Do not mix different kinds of grease.
Mixing grease with different type of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.

5.5.2 Grease quantity

The amount of grease per replenishment depends on the type, size and construction of the bearings. The maximum amount of one replenishment for each bearing is shown in Table 2.

5.5.3 Re-greasing

If re-lubrication is to be performed when the motor is running, stay clear of rotating parts.

It is advisable to re-grease when the motor is running to allow the new grease to be evenly distributed inside the bearing.
Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet of grease drainage should be opened to allow the proper venting of old grease.

Use a grease gun to pump grease through grease nipple into the bearings. After re-greasing, operate the motor for 10-30 minutes to allow any excess grease to vent out.

TABLE 1.

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
62XX 63XX 72XX 73XX	6210										
	12									2000 Hrs.	
	13										
	14									1000 Hrs.	
	15										
	16									720 Hrs.	
	17							2000 Hrs.			
	18			3000 Hrs.							
	20										
	22										
	24							1500 Hrs.			
	26										
	28					2000 Hrs.		1000 Hrs.			
	30										
	32							500 Hrs.			
	34					1500 Hrs.					
	36										
	38			2000 Hrs.		1000 Hrs.					

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
NU2XX NU3XX	NU214								
	15							2000 Hrs.	
	16								
	17								
	18			3000 Hrs.				1500 Hrs.	
	20								
	22							1000 Hrs.	
	24								
	26					2000 Hrs.			
	28							500 Hrs.	
	30								
	32								
	34			2000 Hrs.		1000 Hrs.			
	36								
	38	2000 Hrs.							
	40								
	44			1000 Hrs.					
	48	1000 Hrs.							

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
222XX 223XX	22220							300 Hrs.	
	22								
	24		1000 Hrs.			500 Hrs.			
	26								
	28								
	30					300 Hrs.			
	32			500 Hrs.					
	34								
	36								
	38	500 Hrs.							
	40			300 Hrs.					
	44								
	48	300 Hrs.							

TABLE 2.

Bearing No.		Amount of replenishment
62XX 72XX NU2XX 2222XX	6210	30 g
	6212	40
	6213	50
	6214	50
	6215	60
	6216	60
	6217	80
	6218	80
	6220	100
	6222	120
	6224	120
	6226	140
	6228	160
	6230	180
	6232	200
	6234	250
	6236	300
	6238	350
	6240	400
	6244	450
	6248	500

Bearing No.		Amount of replenishment
63XX 73XX NU223XX 223XX	6310	40 g
	6312	60
	6313	80
	6314	80
	6315	100
	6316	100
	6317	120
	6318	120
	6320	160
	6322	220
	6324	270
	6326	300
	6328	400
	6330	450
	6332	500
	6334	600
	6336	700
	6338	800
	6340	900
	6344	900
	6348	900

*Fill new grease until it overflows and the old grease is entirely replaced.

5.5.4 Oil re-lubrication (For oil lubrication types only)

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing form clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gauge, drain enough oil to bring the level back within the recommended operating range. **Do not permit the operating level to fall below the minimum shown on the gauge.**

ATTENTION!
Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.

Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil.

Use only good grade, oxidation-corrosion-inhibited turbine oils produced by reputable oil companies.

The viscosity of the oil to be used depends upon the type and size of the bearings, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used)). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 3. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil. Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil-metering hole is clear, and then dry the housing thoroughly before re-assembly, and ensure all traces of cleaning solvent have been removed.

TABLE 3 Oil Viscosity**

Bearing function and location	Bearing Type	Oil Viscosity - SSU	
		@ 100°F	@ 200°F
Thrust Bearing	72XX, 73XX Angular contact ball And/or (62XX, 63XX)	150	45
	Spherical roller	300	53
	Plate (Kingsbury Type)	300	53

**Remark: When a lubrication nameplate attached to the motor, use lubrication oil it stipulates.

5.5.5 Cleaning and installation of bearings

(a) Apply the proper amount of grease to the disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.

(b) Bearing installation

ATTENTION!
Before installing the bearings, make sure that the shaft mounted parts inside the bearings are in place before installation.

Since the bearing is a high precision component, it is important to avoid ingression of dust and foreign matter, and hammering during cleaning and installation. Use extreme care and insure clean conditions during installation and assembly.

ATTENTION!
The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be avoided absolutely.

The bearing should be heated in a bath of clean oil at a temperature of approximately 80°C. After warming, slide the bearings in place quickly and nimbly so that it has not shrunk before being fully in position.
Grease the bearing after the temperature returns to normal, and then reassemble the motor.

5.6 Maintenance of sleeve bearings

5.6.1 Daily inspections

(a) Ensure the volume and quality of lubrication oil are in compliance with specifications.

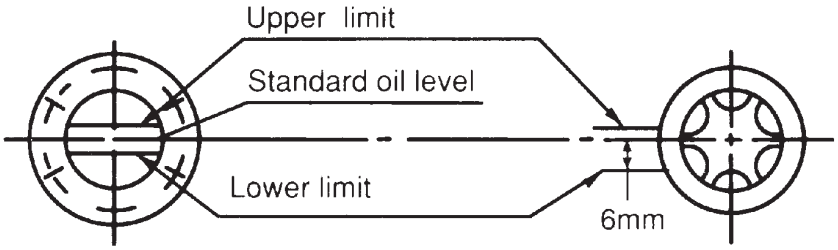


Fig. 12

(b) Ensure there is motion of the oil ring and it is not clamped.

(c) The indicator of the shaft endplay should be restricted within the specified range of the red groove of the shaft or the ±3mm (.118 in.) range of the drive-end shaft shoulder, or the bearing may be damaged.

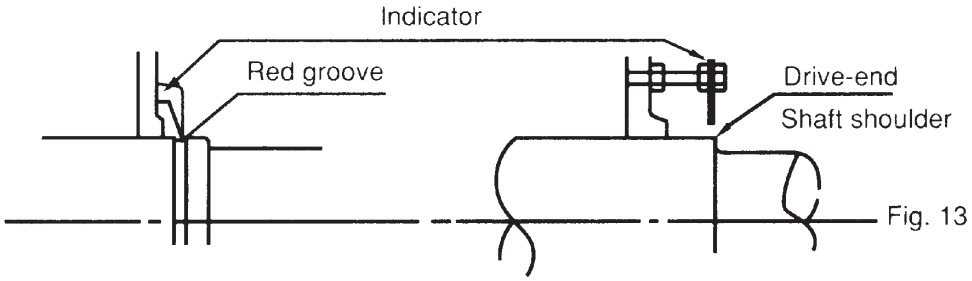


Fig. 13

5.6.2 Regular examination

(a) Periodical change of oil

The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high speed (3600 rpm) motors or if severe oil discoloration or contamination occurs. In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.

Refill the reservoir to the center of oil sight glass with a rust and oxidation inhibited turbine grade oil. Refer to the outline and lubrication nameplate for the correct viscosity.

(b) Quantity of lubrication oil

Please refer to the lubrication nameplate for oil quantity.

(c) Oil viscosity

(d)

ISO	Equivalents	Viscosity (SUS/100°F)
VG32	Esso Teresso 32	150
VG46	Esso Teresso 46	200
VG68	Esso Teresso 68	300

5.6.3 Disassembly

Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated for larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

ATTENTION!
Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.

The following is the recommended procedure for removing the bearing sleeve:

(a) Remove the oil drain plug in the housing bottom and drain the oil sump.

(b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc..

(c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.

(d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive n the top bearing half.

(e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up I parts or damage to the surfaces at the partings.

(f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.

(g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive, jacing or lifting can be done using bolts threaded into the tapped holes provided in the shaft end.

(h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eyebolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.

Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and rotated back to its bottom position. Serious personal injury could result.

(i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.

5.6.4 Re-assembly

Bearing re-assembly is basically a reverse of the disassembly procedures outlined above, with the following suggestions:

(a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.

(b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.

(c) All parts should be carefully inspected for nicks, scratches, etc., in any contract surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filling, etc., followed by thorough cleaning.

(d) Before installing the floating labyrinth seal halves, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its side face. These must be place at the bottom toward the inside of the bearing so that accumulating oil may drain back into the housing.

(e) Put a bead of Curil-T around the seal half O.D.'s on both sides adjacent to the garter spring groove. This will prevent oil by-passing the seal around its outside.

(f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Curil-T around the O.D's on both sides adjacent to the garter spring groove on this half also.

(g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance.

(h) Some of the pipe plugs in the housing are metric thread type. These are identified as those, which have a copper, lead, or similar material washer. If these plugs are removed,

be careful not to lose the washers. Before re-assembly, inspect the washers and replace them as required.

(i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The "tab" must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

ATTENTION!
(1) Curil-T is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.
(2) During the re-assembly of the bearing parts, a thin layer of Curil-T should be applied to all gaskets and machined interface surfaces. This suggestion does not apply to the machined surfaces of the bearing liner halves.
(3) When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure that the splinted surface of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of he shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.

5.7 Maintenance of slip ring (For Wound Rotor Motors only)

Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.

5.7.1 Adjustment of carbon brush

(a) Brush pressure for normal operation:
- Electro-graphite brush…..0.2~0.25 kg/cm²

When frequent vibrations are evident or the brush is small (area below 0.5 cm²), the pressure should be greater than as shown.

(b) Adjustment of brush pressure:
The brush pressure should be adjusted to keep normal operation as it wears.
- The brush pressure may be reduced after use, so it is necessary to re-adjust. For adjustment, please turn adjusting screw, pressure adjusting pin or pressure adjusting plate as shown in Fig. 14 to obtain the correct tension (=0.23 x brush cross sectional area in cm²) ±10% kg.

(c) Brush pressure need not be adjusted if constant force spring is used as shown in Fig. 15 and Fig. 16.

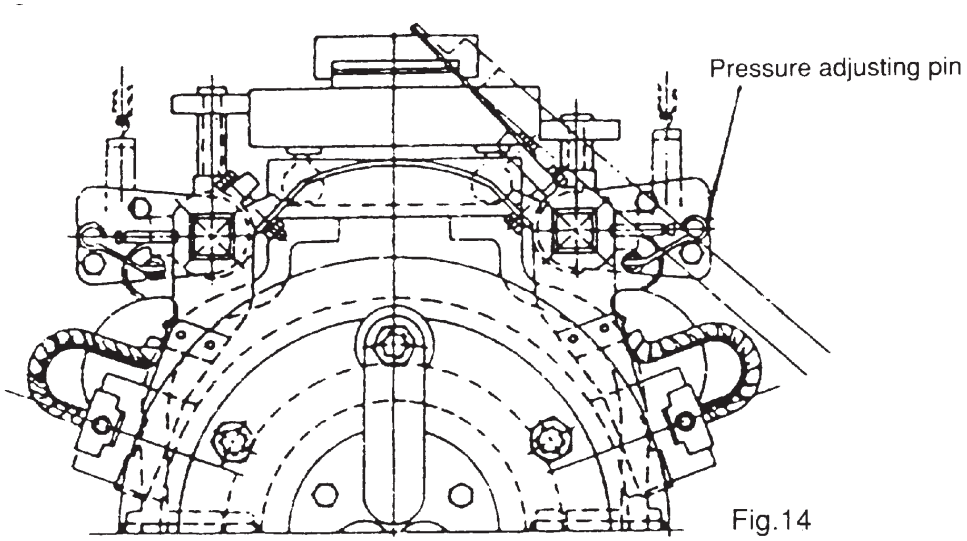


Fig.14

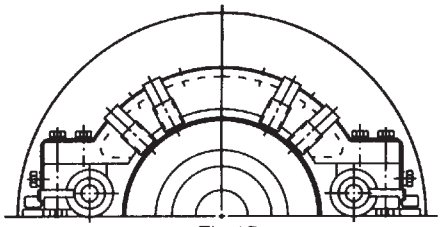


Fig.15

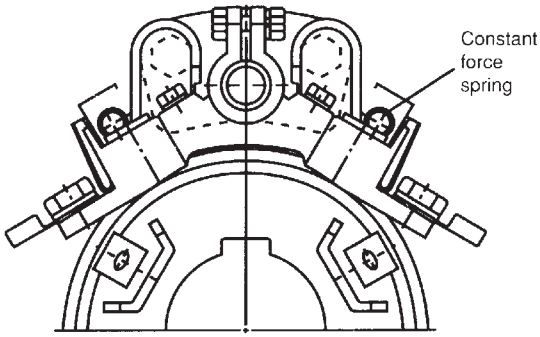


Fig.16

5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to ½ ~ ¾ of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TWMC, and are listed on the nameplate of the motor. It is important to know this when you replace the brush, so a recommended type is used.

(b) Dimensions

Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

ATTENTION!
The gap between a brush and it holder is important for good performance and safety of the motor.

(c) Adjustment of new brushes (Shown in Fig. 17)

(1) Polish the new brush with a file until is assumes the appropriate contour of the slip ring which it touches.

(2) Place sand-paper (JIS R6252 No. 40…50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
(3) Repeat item 2 with fine sand –paper (JIS R6252 No. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
(4) Finally, clean the contaminated slip ring and brush with clean cloth or compressed air.

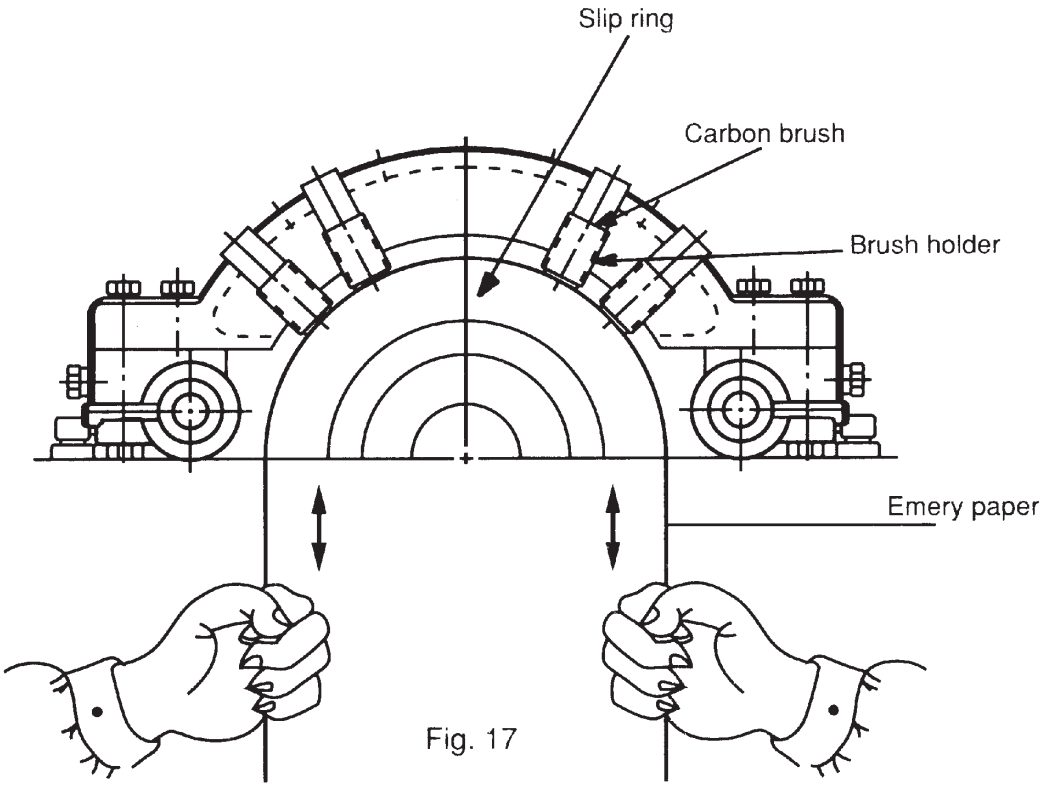


Fig. 17

5.8 Maintenance of non-reverse ratchet mechanism (For Vertical high Thrust Motor only)

5.8.1

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive backpressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TWMC vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of the N.R.R. mechanism is shown as Fig 18 below.

The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over-speeding and damage to water-lubricated pump shaft bearings

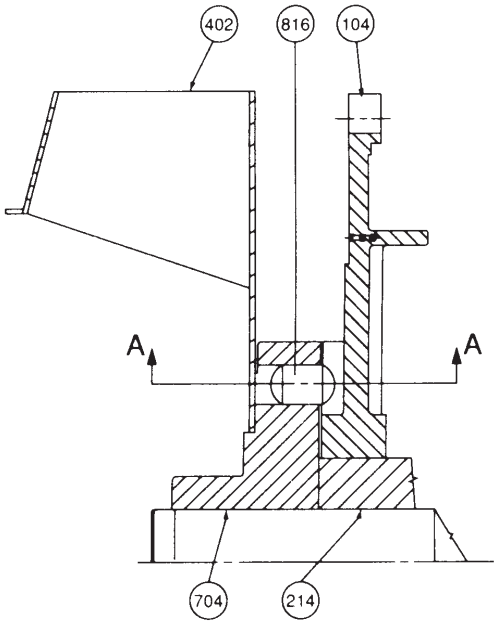
when, on shutdown, the falling water column tends to drive the pump in the reverse direction. In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

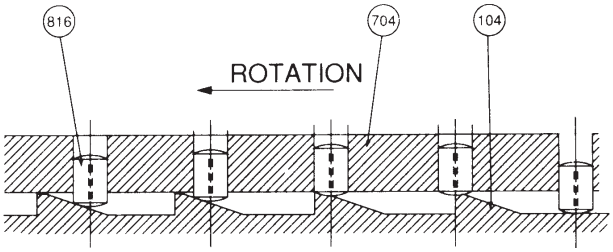
5.8.2

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stopping while in service. Provided that the pins are deformed due to this reverse shock load, then the up and down motion of the ratchet pins could be sluggish or jammed and that unusual noises shall arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period should be halved.

ATTENTION!
The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.





SECTION A-A

ITEM	NAME
104	RATCHET
214	BEARING SEAT
402	EXTERNAL FAN
704	RATCHET PIN CARRIER
816	RATCHET PIN

Fig. 18

6. FAULT FINDING AND RECOGNITION

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Fail to start without load	Motionless and soundless	Power-off	Consult power company
		Switch-off	Switch-on
		No fuse	Install fuse
		Broken wiring	Check wiring and repair
		Broken lead	Check wiring and repair
		Broken windings	Check windings and repair
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)	Short circuit of circuit switches	Check circuit switches and replace
		Incorrect wiring	Check wiring according to nameplate
		Poor contact at terminal	Lock tightly
		Windings grounded	Factory repair
		Broken windings	Factory repair
		Poor contact of circuit switches	Check and repair
		Broken wiring	Check and repair
		Poor contact of starting switches	Check and repair
		Short circuit of starting switches	Check and repair
		Incorrect connections of starting switches	Connect according to nameplate
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits
		Overload	Lighten load
		High load at low voltage	Check circuit capacity and reduce load
	Overheating motor	Overload or intermittent overload	Lighten load
		Under-voltage	Check circuit capacity and power source
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the duct
		Ambient temperature exceeds 40°C	Correct insulation class to B or F, or lower ambient temperature
		Friction between rotor and stator	Factory repair
		Fuse blown (Single-phase rotating)	Install the specified fuse
		Poor contact of circuit switches	Check and repair
		Poor contact of circuit starting switches	Check and repair
		Unbalance three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and powers source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheat	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing over-heating	High belt tension	Adjust belt tension
		Slack belt tension	Adjust belt tension
		Misalignment between motor and machine shafts	Re-align
		Over speed of bearing outer-ring	Adjust bracket
		High bearing noise	Replace the damaged bearing
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings should be repaired at the factory
	Bearing noise	Noise of low shishi or Thru-Thru	May be normal
		Kala-Kala as a result of poor lubrication	Grease
		Kulo-Kulo as a result of poor lubrication	Clean bearing and grease
		Sa-Sa or larger noise	Replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingression of foreign matter	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
		Induced by conveyance machine	Repair machine
Vibration	Electromagnetic vibration	Short circuit of winding	Factory repair
		Open circuit of rotor	Factory repair
	Mechanical vibration	Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetric centers between belt sheaves	Align central points
		Central points of couplings do not lie on the same level	Adjust the central points of couplings to the same level
		Improper mounting installation	Lock the mounting screws
		Motor mounting bed is not strong enough	Reinforce mounting bed

Remarks:

(1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switches etc.

(2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controller's etc.

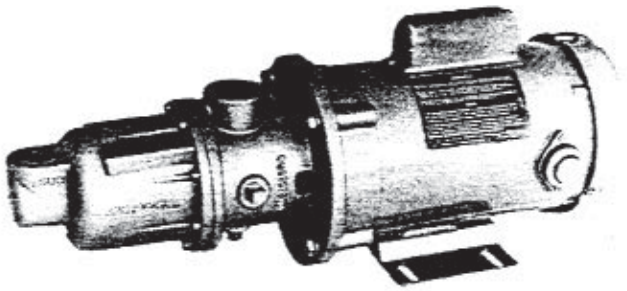
MOYNO

Always the Right Solution™

SERVICE MANUAL
MOYNO® 500 PUMPS
300 SERIES MOTORIZED
331, 332, 333, AND 344 MODELS

DESIGN FEATURES

Housing:	Cast iron/316 SS
Pump Rotor:	Chrome plated AISI 416 stainless steel/Chrome plated 316 stainless steel
Pump Stator:	NBR (Nitrile)
Seal:	Mechanical (carbon/ceramic)
Motor Shaft:	AISI 416 stainless steel/ANSI 316 stainless steel
Motor:	1/2 HP, 60 Hertz, 1725 rpm, totally enclosed, fan cooled (TEFC) C-Faced, 1 phase 115/230V or 3 phase 230/460V (other motor options available; consult sales representative)



Note: Alternate elastomers available. Refer to Repair/Conversion kit numbers pages 3 and 4.

INSTALLATION

Mounting Position. Pump may be mounted in any position. When mounting vertically, it is necessary to keep bearings above seals to prevent possible seal leakage into bearings.

Pre-Wetting. Prior to connecting pump, wet pump elements and mechanical seal by adding fluid to be pumped into suction and discharge ports. Turn pump over several times in a clockwise direction to work fluid into pump elements.

Piping. Piping to pump should be self-supporting to avoid excessive strain on pump housings. See Table 1 for suction and discharge port sizes of each pump model. Use pipe "dope" or tape to facilitate disassembly and to provide seal on pipe connections.

Electrical. Follow the wiring diagram on the motor nameplate or inside the terminal box for the proper connections. The wiring should be direct and conform to local electrical codes. Check power connections for proper voltage. Voltage variations must not exceed ±10% of nameplate voltage. Motor is provided with internal automatic overload protection.

To prevent damage to pump, pump rotation must be clockwise when facing pump from motor end.

OPERATION

Self-Priming. With wetted pumping elements, the pump is capable of 25 feet of suction lift with pipe size equal to port size. Be sure suction lines are air tight or pump will not self prime. Self-priming capabilities will vary due to fluid viscosity.

DO NOT RUN DRY. Unit depends on liquid pumped for lubrication. For proper lubrication, flow rate should be at least 10% of rated capacity.

Pressure and Temperature Limits. See Table 1 for maximum discharge pressure of each model. Unit is suitable for service at temperatures shown in Table 2.

Storage. Always drain pump for extended storage periods by removing bottom drain plug in pump body.

Caution: Suction pressure should never be greater than discharge pressure.

Table 1. Pump Data

Pump Model	Suction Port (NPT)	Discharge Port (NPT)	Voltage Rating (VAC)	Discharge Pressure (psig)
331	3/4	3/4	See Motor Name Plate For Voltage Ratings	150
332	3/4	3/4	See Motor Name Plate For Voltage Ratings	100
333	3/4	3/4	See Motor Name Plate For Voltage Ratings	50
344	3/4	3/4	See Motor Name Plate For Voltage Ratings	†30

†With 3/4 HP motor, pressure is 40 psig.

Table 2. Temperature Limits

Elastomer	Temperature Limits
*NBR	10°-160°F
*EPDM	10°-210°F
*FPM	10°-240°F

*NBR = Nitrile
EPDM = Ethylene-Propylene-Diene Terpolymer
FPM = Fluoroelastomer

TROUBLESHOOTING

WARNING: Before making adjustments, disconnect power source and thoroughly bleed pressure from system prior to disassembly. Failure to do so could lead to electric shock or serious bodily harm.

Failure To Pump.

1. Motor will not start: Check power supply. Voltage must be ± 10% of nameplate rating when motor is in locked rotor condition. Check for faulty capacitor on 1 phase Models.
2. Motor runs and thermally kicks out: Check for excessive discharge pressure. Check for defective centrifugal switch on 1 phase Models. Increase ventilation to motor. Do not use less than #14 wire size.
3. Stator torn; possible excessive pressure: Replace stator, check pressure at discharge port.
4. Flexible joint broken; possible excessive pressure:

   Replace joint, check pressure at discharge port.
5. Wrong rotation (3 phase only): Rotation must be clockwise when facing pump from motor end. Reverse the connections of any two line leads to the motor.
6. Excessive suction lift or vacuum.

Pump Overloads.

1. Excessive discharge pressure: Check pressure at discharge port for maximum ratings given in Table 1.
2. Fluid viscosity too high: Limit fluid viscosity to 100 CP or 500 SSU.

Noisy Operation.

1. Excessive suction lift or vacuum: Maximum suction lift is 25 feet for water.
2. Suction line too small: Check pipe size. Be sure lines are free from obstructions.
3. Pump Cavitates: Pump speed is 1725 rpm. Viscosity of fluid should not exceed 100 CP or 500 SSU.
4. Flexible joint worn: Replace joint. Check pressure at discharge port.
5. Insufficient mounting: Mount to be secure to a firm base. Vibration induced noise can be reduced by using mount pads and short sections of hose on suction and discharge ports.

Seal Leakage.

1. Leakage at startup: If leakage is slight, allow pump to run several hours to let faces run in.
2. Persistent seal leakage: Faces may be cracked from freezing or thermal shock. Replace seal.

Pump Will Not Prime.

1. Air leak on suction side: Check pipe connections.

PUMP DISASSEMBLY

WARNING: Before disassembling pump, disconnect power source and thoroughly bleed pressure from system. Failure to do so could result in electric shock or serious bodily harm.

1. Remove suction and discharge piping. Drain pump body by removing drain plug (261B).
2. Remove screws (112) holding suction housing (2) to discharge housing (1). Remove suction housing (2) and stator (21).
3. Remove rotor (22) from flexible joint (24) by turning counterclockwise (RH thread). On pinned, 3 phase models, remove rotor pin (45) with suitable punch.
4. Flexible joint (24) can be removed from motor shaft by using a 3/16 allen wrench in end of joint and turning counterclockwise. On 3 phase motors, remove motor pin (46) with suitable punch, then remove joint:
5. Slide mechanical seal (69) off motor shaft.
6. Remove discharge housing (1) from adaptor flange (12) by removing screws (1 12B).
7. Carefully pry seal seat out of discharge housing (1). If any parts of mechanical seal are worn or broken, the complete seal assembly should be replaced. Seal components are matched parts and are not interchangeable.
8. Remove adapter flange (12) from motor (70) by removing screws (112A).
9. Remove slinger ring (77).

PUMP ASSEMBLY

1. Install slinger ring (77).
2. Attach adaptor flange (12) to motor housing using screws (112A).
3. Attach discharge housing (1) to adaptor flange (12) using screws (1128). Be sure to center seal bore on shaft.
4. Install mechanical seal (69) in discharge housing (1) using the following procedure:
   a. Clean and oil sealing faces using clean oil (not grease).

Caution: Do not use oil on EPDM parts. Substitute glycerin or soap and water.

   b. Oil outer surfaces of the seal seat, and push assembly over the motor shaft and into the discharge housing (1) seating it firmly and squarely.
   c. After cleaning and oiling the shaft, slide the seal body along the motor shaft until it meets the seal seat.
   d. Install seal spring and spring retainer on shaft.
5. Thread flexible joint (24) into motor shaft in a clockwise direction (RH thread). Tighten with 3/16 allen wrench. On 3 phase models, install motor pin (46).
6. Thread rotor (22) onto flexible joint (24) in a clockwise direction (RH thread). On 3 phase models, install rotor pin (45).
7. Slide stator (21) on rotor (22). On 331 & 332 models, insert rounded end of stator ring (135) into end of stator prior to installing stator on rotor.
8. Secure stator (21) and suction housing (2) to discharge housing (1) using screws (112).
9. Lubricate rotor and stator by filling Suction housing and discharge housing with fluid to be pumped.
10. Connect Suction and discharge piping and power source.

PARTS LIST

To determine part numbers for all parts except standard motors, enter table with item number from pump illustration. Then locate part number under applicable model number (first three digits). Parts listed down the center are applicable to all pump models. To determine part numbers for standard motor (item 70), enter table at item 70 with the last two digits of model number: motor description and part number are on that line.

Item No.	Description	Pump Model Numbers			
		331	332	333	344
1	Discharge Housing	Cast Iron 350-1016-000/Stainless Steel 350-1016-007			
2	Suction Housing	Cast Iron 330-1064-002/Stainless Steel 330-1911-002			
*21	Stator	340-3501-120	340-3502-120	340-3503-120	340-3504-120
*22	Rotor (Threaded) 416 S5	320-2729-000	330-0906-000	320-1394-000	320-1841-000
*22	Rotor (Pinned) 416 SS	320-2729-004	320-4559-004	320-1584-002	320-1569-002
24	Flexible Joint (Threaded)	Carbon Steel 320-1511-000/Stainless Steel 320-3759-000			
240	Flexible Joint (Pinned)	Carbon Steel 320-1612-000/Stainless Steel 320-4415-000			
*45	Shaft Pin (2 req.)	320-4069-002			
*69	Mechanical Seal	320-2424-000			
70	Standard Motor				
	-59 1PH TEFC 1750 RPM	330-4529-000			
	-60 3PH TEFC 1750 RPM, Pin	330-4528-100			
	-52 1PH TEFC 1750 RPM	330-4529-1 00			
	-50 3PH TEFC 1750 RPM	330-4528-003			
77	Slinger Ring	320-6382-000			
112	Screw, Cap (8 req.)	Carbon Steel 619-1430-103 (10-24 x 5/8)/Stainless Steel 619-1432-120 (10-24 x 3/4)			
112A	Screw, Hex Hd (4 req.)	Carbon Steel 619-1530-161 (3/8-16 x 1)/Stainless Steel 320-6715-005 (3/8-16 x 1)			
135	Stator Ring	Carbon Steel 320-7812-000 /Stainless Steel 362-1774-000			
215	Lock Washer (8 req.)	320-6464-000			
215A	Lock Washer (4 req.)	Carbon Steel 623-0010-411/Stainless Steel 320-6717-002			
261	Pipe Plug, 1/4 NPT	Carbon Steel 610-0120-021/Stainless Steel 610-0420-020			
	Rotor (Threaded) 316 SS	320-2933-000	320-2942-000	320-2936-000	320-2934-000
	Rotor (Pinned) 316 SS	320-2933-002			

*Recommended spare parts.
Used on 3 phase models.

REPAIR/CONVERSION KIT NUMBERS

Item No.	Description	All 331 Models (Threaded Only)			All 332 Models (Threaded Only)		
		NBR	EPDM	FPM	NBR	EPDM	FPM
—	Kit No.	311-9026-000	311-9025-000	311-9054-000	311-9027-000	311-9038-000	311-9055-000
21	• Stator	340-3501-120	340-3501-320	340-3501-520	340-3502-120	340-3502-320	340-3502-520
24	• Joint	*320-1511-000	320-6367-000	320-4670-000	*320-1511-000	320-6367-000	320-4670-000
69	• Seal	320-2424-000	320-6379-000	320-6501-000	320-2424-000	320-6379-000	320-6501-000
		All 333 Models (Threaded Only)			All 344 Models (Threaded Only)		
Item No.	Description	NBR	EPDM	FPM	NBR	EPDM	FPM
—	Kit No.	311-9029-000	311-9028-000	311-9056-000	311-9031-000	311-9030-000	311-9057-000
21	• Stator	340-3503-120	340-3503-320	340-3503-520	340-3504-120	340-3504-320	340-3504-520
24	• Joint	*320-1511-000	320-6367-000	320-4670-000	*320-1511-000	320-6367-000	320-4670-000
69	• Seal	320-2424-000	320-6379-000	320-6501-000	320-2424-000	320-6379-000	320-6501-000

NBR = Nitrile
EPDM = Ethylene-Propylene-Diene Terpolymer
FPM = Fluoroelastomer
*Carbon steel joint, for 316 SS joint use 320-3759-000.

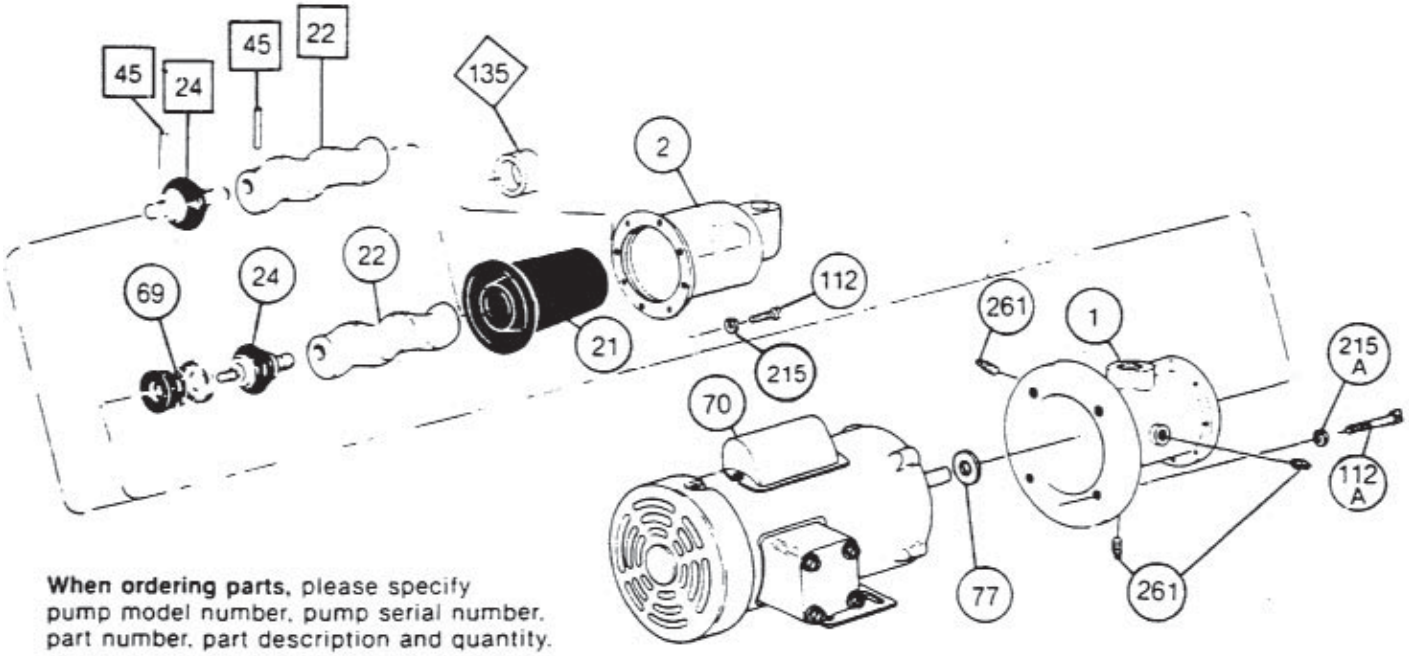
REPAIR/CONVERSION KIT NUMBERS (CONT.)

		All 331 Models (Pinned Only)			All 332 Models (Pinned Only)		
Item No.	**Description**	**NBR**	**EPDM**	**FPM**	**NBR**	**EPDM**	**FPM**
–	Kit No.	311-9104-000	311-9108-000	311-9112-000	311-9105-000	311-9109-000	311-9113-000
21	• Stator	340-3501-120	340-3501-320	340-3501-520	340-3502-120	340-3502-320	340-3502-520
24	• Joint	*320-1612-000	320-6973-000	320-6984-000	*320-1612-000	320-6973-000	320-6984-000
69	• Seal	320-2424.000	320-6379-000	320-6501-000	320-2424-000	320-6379-000	320-6501-000
45	• Pin (2 req.)	320-4069-002			320-4069-002		
		All 333 Models (Pinned Only)			**All 344 Models (Pinned Only)**		
Item No.	**Description**	**NBR**	**EPDM**	**FPM**	**NBR**	**EPDM**	**FPM**
–	• Kit No.	311-9106-000	311-9110-000	311-9114-000	311-9107-000	311-9111~000	311-9115-000
21	• Stator	340-3503-120	340-3503-320	340-3503-520	340-3504-120	340-3504-320	340-3504-520
24	• Joint	*320-1612-000	320-6973-000	320-6984-000	*320-1612-000	320-6973-000	320-6984-000
69	• Seal	320-2424-000	320-6379-000	320-6501-000	320-2424-000	320-6379-000	320-6501-000
45	Pin (2 req.)	320-4069-002			320-4069-002		

ABRASION RESISTANT SEALS

Elastomer	All 331 – 334 Models
NBR	320-6460-000
EPDM	320-6502-000
FPM	320-6503-000

NBR = Nitrile
EPDM = Ethylene-Propylene-Diene Terpolymer
FPM = Fluoroelastomer
*Carbon steel joint, for 316 SS joint use 320-4415-000.



When ordering parts, please specify pump model number, pump serial number, part number, part description and quantity.

◇ Used only on 331 & 332 Models.

□ Used on 3 Phase Models

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Product information presented here reflects conditions at time of publication. Consult factory regarding discrepancies or inconsistencies.

ZOELLER® PUMP COMPANY

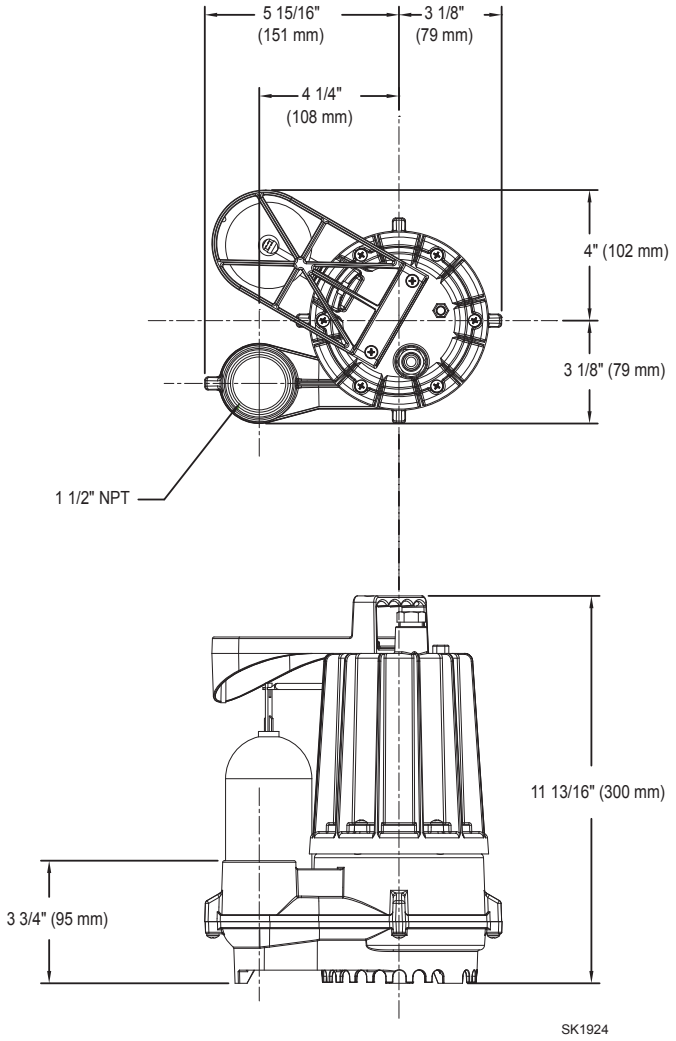
Zoeller Family of Water Solutions™

SECTION: 2.15.030
FM2780
0315
Supersedes
0114

TECHNICAL DATA SHEET
AQUA-MATE SERIES
Model 72 Submersible Dewatering Pump

PRODUCT SPECIFICATIONS

MOTOR	Horse Power	3/10
	Voltage	115
	Phase	1 Ph
	Hertz	60 Hz
	RPM	3400
	Type	Permanent split capacitor
	Insulation	Class B
	Amps	3.1
PUMP	Operation	Automatic or nonautomatic
	Auto On/Off Points	7-3/8" (18.7 cm) / 3-5/8" (9.2 cm)
	Discharge Size	1-1/2" NPT
	Solids Handling	3/8" (9 mm) spherical solids
	Cord Length	9' (3 m) standard
	Cord Type	UL listed, 3-wire, grounded plug
	Max. Head	18' (5.5 m)
	Max. Flow Rate	38 GPM (144 LPM)
	Max. Operating Temp.	110° F (43° C)
	Cooling	Oil free
	Motor Protection	Auto reset thermal overload
MATERIALS	Motor Housing	Engineered plastic
	Pump Housing	Engineered plastic
	Base	Engineered plastic
	Upper Bearing	Ball bearing
	Lower Bearing	Ball bearing
	Mechanical Seals	Carbon and ceramic
	Impeller Type	Non-clogging vortex
	Impeller	Engineered plastic
	Hardware	Stainless steel
	Motor Shaft	410 stainless steel
	Gasket	Buna-N o-ring



NOTE: See model comparison chart for specific details.

Certified to CSA Standard 227875

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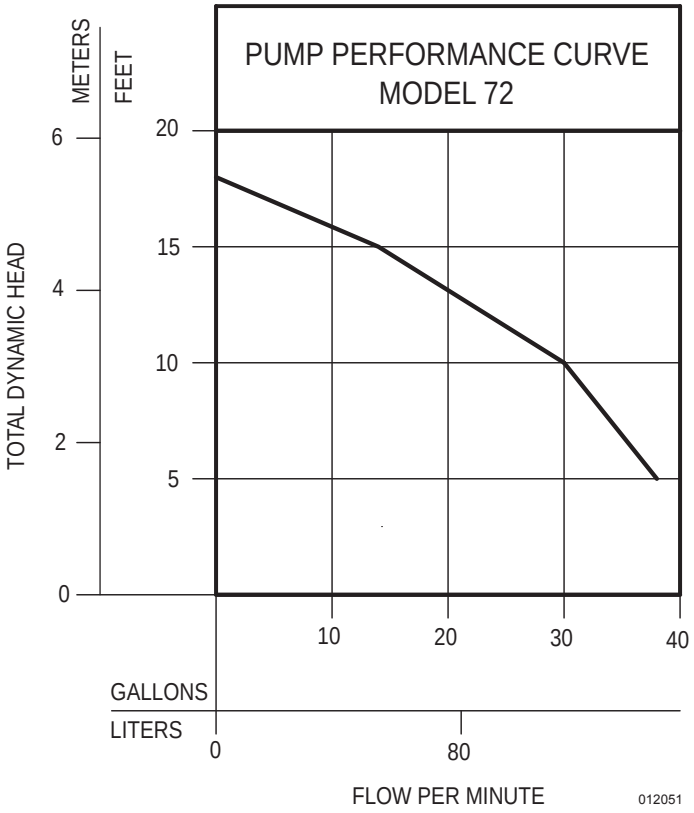
TOTAL DYNAMIC HEAD FLOW PER MINUTE

MODEL		72	
Feet	Meters	Gal.	Liters
5	1.5	38	144
10	3.0	30	114
15	4.6	14	53
Shut-off Head:		18 ft. (5.5 m)	



Model	MODEL COMPARISON										
	Seal	Mode	Volts	Ph	Amps	HP	Hz	Lbs	Kg	Simplex	Duplex
M72	Single	Auto	115	1	3.1	3/10	60	9.5	4.3	1	3
N72	Single	Non	115	1	3.1	3/10	60	9.5	4.3	2	2 & 3
BN72	Single	Non	115	1	3.1	3/10	60	9.5	4.3	*	---

* Single piggyback switch included.

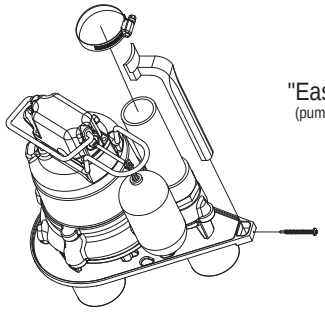
SELECTION GUIDE

1. Integral float-operated mechanical switch, no external control required.
2. Single piggyback variable level float switch or double piggyback variable level float switch. Refer to FM0477.
3. See FM0477 for a residential alternator system.

OPTIONAL PUMP STAND P/N 10-2421

- Reduces potential clogging by debris
- Replaces rocks or bricks under the pump
- Made of durable, noncorrosive ABS
- Raises pump 2" (5 cm) off bottom of basin
- Provides the ability to raise intake by adding sections of 1½" or 2" (DN40 or DN50) PVC piping
- Attaches securely to pump
- Accommodates sump, dewatering and effluent applications

NOTE: Make sure float is free from obstruction.



"Easy assembly"
(pump & discharge pipe not included.)

⚠ CAUTION All installation of controls, protection devices and wiring should be done by a qualified licensed electrician. All electrical and safety codes should be followed including the most recent National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).

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Notice to installing contractor: Instructions must remain with installation.

Your Peace of Mind is Our Top Priority®

SECTION: 6.10.002
FM2676
1011
Supersedes
New

Product information presented here reflects conditions at time of publication. Consult factory regarding discrepancies or inconsistencies.

Zoeller Family of Water Solutions™

MAIL TO: P.O. BOX 16347 • Louisville, KY 40256-0347
SHIP TO: 3649 Cane Run Road • Louisville, KY 40211-1961
(502) 778-2731 • 1 (800) 928-PUMP • FAX (502) 774-3624

visit our web site: www.zoeller.com

NOTICE: VENT HOLE FOR CHECK VALVE SEE #3 IN CAUTION SECTION BELOW AND #4 ON PAGE 3

INSTALLATION INSTRUCTIONS
RECOMMENDED MODELS

DATE INSTALLED:
MODEL NUMBER:

P/N 151797

EFFLUENT*/SUMP/DEWATERING	SEWAGE
49 / 53 / 57 Series, 98 Series	264 Series
137 Series, 151 / 152 / 153 Series	266 / 267 / 268 Series

PREINSTALLATION CHECKLIST - ALL INSTALLATIONS

1. Inspect your pump. Occasionally, products are damaged during shipment. If the unit is damaged, contact your dealer before using. DO NOT remove the test plugs in the cover nor the motor housing.
2. Carefully read the literature provided to familiarize yourself with specific details regarding installation and use. These materials should be retained for future reference.

▲ WARNING — SEE BELOW FOR LIST OF WARNINGS

1. Make certain that the receptacle is within the reach of the pump's power supply cord. DO NOT USE AN EXTENSION CORD. Extension cords that are too long or too light do not deliver sufficient voltage to the pump motor. But, more important, they could present a safety hazard if the insulation were to become damaged or the connection end were to fall into the sump.
2. Make sure the pump electrical supply circuit is equipped with fuses or circuit breakers of proper capacity. A separate branch circuit is recommended, sized according to the "National Electrical Code" for the current shown on the pump nameplate.
3. Testing for ground. As a safety measure, each electrical outlet should be checked for ground using an Underwriters Laboratory Listed circuit analyzer which will indicate if the power, neutral and ground wires are correctly connected to your outlet. If they are not, call a qualified licensed electrician.
4. For Added Safety. Pumping and other equipment with a 3-prong grounded plug must be connected to a 3-prong grounded receptacle. For added safety the receptacle may be protected with a ground-fault circuit interrupter. When a pump needs to be connected in a watertight junction box, the plug can be removed and spliced to the supply cable with proper grounding. For added safety this circuit may be protected by a ground-fault circuit interrupter. The complete installation must comply with the National Electrical Code and all applicable local codes and ordinances.
5. FOR YOUR PROTECTION, ALWAYS DISCONNECT PUMP FROM ITS POWER SOURCE BEFORE HANDLING. Single phase pumps are supplied with a 3-prong grounded plug to help protect you against the possibility of electrical shock. DO NOT UNDER ANY CIRCUMSTANCES REMOVE THE GROUND PIN. The 3-prong plug must be inserted into a mating 3-prong grounded receptacle. If the installation does not have such a receptacle, it must be changed to the proper type, wired and grounded in accordance with the National Electrical Code and all applicable local codes and ordinances. Three phase pumps require motor starting devices with motor overload protection. See FM0486 for duplex installations.
6. The tank is to be vented in accordance with local plumbing code. Pumps must be installed in accordance with the National Electrical Code and all applicable local codes and ordinances. Pumps are not to be installed in locations classified as hazardous in accordance with National Electrical Code, ANSI/NFPA 70.
7. "Risk of electrical shock" Do not remove power supply cord and strain relief or connect conduit directly to the pump.
8. Installation and servicing of electrical circuits and hardware should be performed by a qualified licensed electrician.
9. Pump installation and servicing should be performed by a qualified person.
10. Risk of electric shock - These pumps have not been investigated for use in swimming pool and marine areas.
11. According to the state of California (Prop 65), this product contains chemicals known to the state of California to cause cancer and birth defects or other reproductive harm.

▲ CAUTION — SEE BELOW FOR LIST OF CAUTIONS

1. Check to be sure your power source is capable of handling the voltage requirements of the motor, as indicated on the pump name plate.
2. The installation of automatic pumps with variable level float switches or nonautomatic pumps using auxiliary variable level float switches is the responsibility of the installing party and care should be taken that the tethered float switch will not hang up on the pump apparatus or pit peculiarities and is secured so that the pump will shut off. It is recommended to use rigid piping and fittings and the pit be 18" or larger in diameter.
3. Information - vent hole purpose. It is necessary that all submersible sump, effluent, and sewage pumps capable of handling various sizes of solid waste be of the bottom intake design to reduce clogging and seal failures. If a check valve is incorporated in the installation, a vent hole (approx. 3/16") must be drilled in the discharge pipe below the check valve and pit cover to purge the unit of trapped air. Trapped air is caused by agitation and/or a dry basin. Vent hole should be checked periodically for clogging. The 53 / 57, and 98 Series pumps have a vent located in the pump housing opposite the float, adjacent to a housing lug, but an additional vent hole is recommended. The vent hole on a High Head application may cause too much turbulence. You may not want to drill one. If you choose not to drill a vent hole, be sure the pump case and impeller is covered with liquid before connecting the pipe to the check valve and no inlet carries air to the pump intake. NOTE: THE HOLE MUST ALSO BE BELOW THE BASIN COVER AND CLEANED PERIODICALLY. Water stream will be visible from this hole during pump run periods.
4. Pump should be checked frequently for debris and/or build up which may interfere with the float "on" or "off" position. Repair and service should be performed by Zoeller Pump Company Authorized Service Station only.
5. Dewatering and effluent sump pumps are not designed for use in pits handling raw sewage.
6. Maximum operating temperature for standard model pumps must not exceed 130°F (54°C).
7. Pump models 266, 267, 268, and 137 must be operated in an upright position. Do not attempt to start pump when tilted or laying on its side.
8. Do not operate a pump in an application where the Total Dynamic Head is less than the minimum Total Dynamic Head listed on the Pump Performance Curves.

NOTE: Pumps with the "UL" mark and pumps with the "US" mark are tested to UL Standard UL778. CSA Certified pumps are certified to CSA Standard C22.2 No. 108.

REFER TO WARRANTY ON PAGE 2.

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E-1131

Limited Warranty

Manufacturer warrants, to the purchaser and subsequent owner during the warranty period, every new product to be free from defects in material and workmanship under normal use and service, when properly used and maintained, for a period of three years from the date of original manufacture. Parts that fail within the warranty period, that inspections determine to be defective in material or workmanship, will be repaired, replaced or remanufactured at Manufacturer's option, provided however, that by so doing we will not be obligated to replace an entire assembly, the entire mechanism or the complete unit. No allowance will be made for shipping charges, damages, labor or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to and there shall be no warranty for any material or product that has been disassembled without prior approval of Manufacturer, subjected to misuse, misapplication, neglect, alteration, accident or act of God; that has not been installed, operated or maintained in accordance with Manufacturer's installation instructions; that has been exposed to outside substances including but not limited to the following: sand, gravel, cement, mud, tar, hydrocarbons, hydrocarbon derivatives (oil, gasoline, solvents, etc.), or other abrasive or corrosive substances, wash towels or feminine sanitary products, etc. in all pumping applications. The warranty set out in the paragraph above is in lieu of all other warranties expressed or implied; and we do not authorize any representative or other person to assume for us any other liability in connection with our products.

Contact Manufacturer at, 3649 Cane Run Road, Louisville, Kentucky 40211, Attention: Customer Service Department to obtain any needed repair or replacement of part(s) or additional information pertaining to our warranty.

MANUFACTURER EXPRESSLY DISCLAIMS LIABILITY FOR SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES OR BREACH OF EXPRESSED OR IMPLIED WARRANTY; AND ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND OF MERCHANTABILITY SHALL BE LIMITED TO THE DURATION OF THE EXPRESSED WARRANTY.

Some states do not allow limitations on the duration of an implied warranty, so the above limitation may not apply to you. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

EASY DO'S & DON'T'S FOR INSTALLING A SUMP PUMP

1. DO read thoroughly all installation material provided with the pump.
2. DO inspect pump for any visible damage caused by shipping. Contact dealer if pump appears to be damaged.
3. DO clean all debris from the sump. Be sure that the pump will have a hard, flat surface beneath it. DO NOT install on sand, gravel or dirt.
4. DO be sure that the sump is large enough to allow proper clearance for the level control switch(es) to operate properly.
5. DO Always Disconnect Pump From Power Source Before Handling.
   DO always connect to a separately protected and properly grounded circuit.
   DO NOT ever cut, splice, or damage power cord (Only splice in a watertight junction box).
   DO NOT carry or lift pump by its power cord.
   DO NOT use an extension cord with a sump pump.
6. DO install a check valve and a union in the discharge line.
   DO NOT use a discharge pipe smaller than the pump discharge.
7. DO NOT use a sump pump as a trench or excavation pump, or for pumping sewage, gasoline, or other hazardous liquids.
8. DO test pump immediately after installation to be sure that the system is working properly.
9. DO cover sump with an adequate sump cover.
10. DO review all applicable local and national codes and verify that the installation conforms to each of them.
11. DO consult manufacturer for clarifications or questions.
12. DO consider a two pump system with an alarm where an installation may become overloaded or primary pump failure would result in property damages.
13. DO consider a D.C. Backup System where a sump or dewatering pump is necessary for the prevention of property damages from flooding due to A.C. power disruptions, mechanical or electrical problems or system overloading.
14. DO inspect and test system for proper operations at least every three months.

SERVICE CHECKLIST

▲ WARNING ELECTRICAL PRECAUTIONS- Before servicing a pump, always shut off the main power breaker and then unplug the pump - making sure you are wearing insulated protective sole shoes and not standing in water. Under flooded conditions, contact your local electric company or a qualified licensed electrician for disconnecting electrical service prior to pump removal.

▲ WARNING Submersible pumps contain oils which becomes pressurized and hot under operating conditions - allow 2½ hours after disconnecting before attempting service.

CONDITION	COMMON CAUSES
A. Pump will not start or run.	Check fuse, low voltage, overload open, open or incorrect wiring, open switch, impeller or seal bound mechanically, defective capacitor or relay when used, motor or wiring shorted. Float assembly held down. Switch defective, damaged, or out of adjustment.
B. Motor overheats and trips overload or blows fuse.	Incorrect voltage, negative head (discharge open lower than normal) impeller or seal bound mechanically, defective capacitor or relay, motor shorted.
C. Pump starts and stops too often.	Float tight on rod, check valve stuck or none installed in long distance line, overload open, level switch(s) defective, sump pit too small.
D. Pump will not shut off.	Debris under float assembly, float or float rod bound by pit sides or other, switch defective, damaged or out of adjustment.
E. Pump operates but delivers little or no water.	Check strainer housing, discharge pipe, or if check valve is used vent hole must be clear. Discharge head exceeds pump capacity. Low or incorrect voltage. Incorrect motor rotation. Capacitor defective. Incoming water containing air or causing air to enter pumping chamber.
F. Drop in head and/or capacity after a period of use.	Increased pipe friction, clogged line or check valve. Abrasive material and adverse chemicals could possibly deteriorate impeller and pump housing. Check line. Remove base and inspect.

If the above checklist does not uncover the problem, consult the factory - Do not attempt to service or otherwise disassemble pump. Service must be performed by Zoeller Authorized Service Stations. Go to www.zoellerpumps.com/servicestations **to find the Authorized Service Station in your area.**

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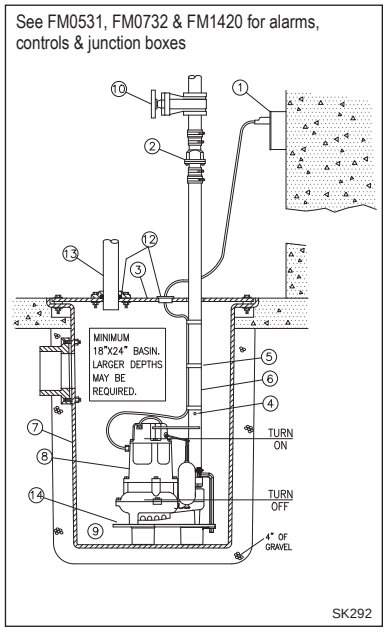
RECOMMENDED INSTALLATION FOR ALL APPLICATIONS

(1) Electrical wiring and protection must be in accordance with National Electrical Code and any other applicable state and local electrical requirements.
(2) Install proper Zoeller unicheck (combination union and check valve), preferably just above the basin to allow easy removal of the pump for cleaning or repair. On sewage, effluent or dewatering, if high head or below cover installation is required use 30-0164 on 1½" pipe, 30-0152 on 2" pipe and 30-0160 on 3" pipe. See (4) below.
(3) All installations require a basin cover to prevent debris from falling into the basin and to prevent accidental injury.
(4) When a Unicheck is installed, drill a 3/16" dia. hole in the discharge pipe even with the top of the pump. *NOTE: THE HOLE MUST ALSO BE BELOW THE BASIN COVER AND CLEANED PERIODICALLY.* (High Head unit see #3 under "Caution" on front page). Water stream will be visible from this hole during pump run periods.
(5) Securely tape or clamp power cord to discharge pipe, clear of the float mechanism(s).
(6) Use full-size discharge pipe.
(7) Basin must be in accordance with applicable codes and specifications.
(8) Pump must be level and float mechanism(s) clear of sides of basin before starting pump.
(9) Basin must be clean and free of debris after installation.
(10) Gate Valve or Ball Valve to be supplied by installer and installed according to any and all codes.
(11) Locate float switches as shown in sketches. The best place for the "off" point is above the motor housing and positioned 180° from the inlet. Never put "off" point below discharge on pump (Sewage & Effluent only). *NOTE: FOR AUTOMATIC PUMPS, USE DEWATERING INSTALLATION SKETCH.*
(12) Gas tight seals required to contain gases and odors.
(13) Vent gases and odors to the atmosphere through vent pipe (Sewage & Dewatering only).
(14) Install Zoeller Pump Stand (Model 10-2421) under pump to provide a settling basin. (Effluent & Dewatering only.)

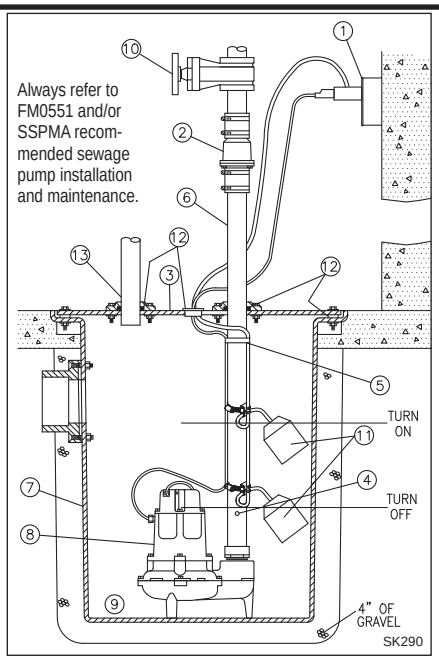
For Effluent Only:

(15) Wire pump to power through a Zoeller watertight junction box or watertight splice. ***NOTE: Watertight enclosure is a must in damp areas. See No. 8 on front page of FM0732.***
(16) Refer to SSPMA Effluent Sizing Manual for determining "on" - "off" switches.
(17) Septic tank risers must be used for easy pump and filter access.

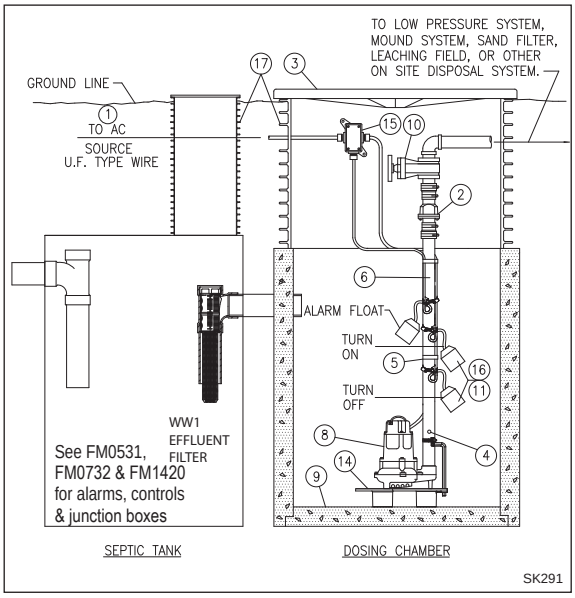
NOTE: Double seal pumps offer extra protection from damage caused by seal failure.



TYPICAL DEWATERING INSTALLATION



TYPICAL SEWAGE INSTALLATION



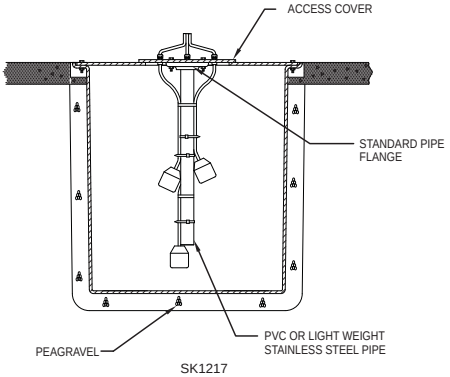
TYPICAL EFFLUENT INSTALLATION

All installations must comply with all applicable electrical and plumbing codes, including, but not limited to, National Electrical Code, local, regional, and/or state plumbing codes, etc. Not intended for use in hazardous locations.

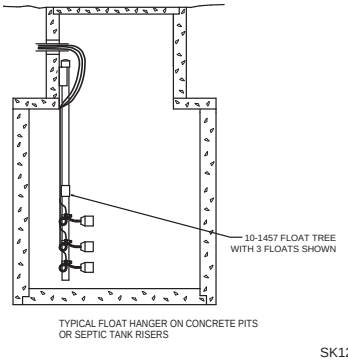
SUGGESTED METHODS OF FLOAT INSTALLATION

On some installations it may be desirable to install an independent hanger for the level control switches to avoid possible hang ups on the pumps, piping, valves, etc. Float hangers are available from Zoeller Company on Catalog Sheet FM0526 or can be fabricated from standard pipe and fittings.

TYPICAL FLOAT HANGER ON STEEL COVER PITS



TYPICAL FLOAT HANGER ON CONCRETE PITS OR SEPTIC TANK RISERS



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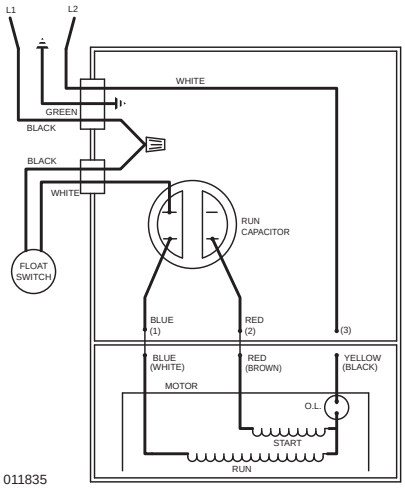
WD & WH MODEL INSTALLATION



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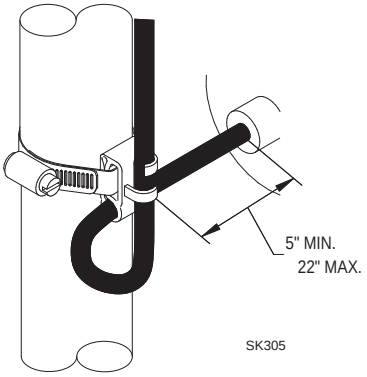
WIRING DIAGRAM FOR MODELS
WD - 230V, 1 Ph, 60 Hz.
WH - 200/208V, 1 Ph, 60 Hz.

Determining Pumping Range in Inches (1 inch - 2.5 cm)

Tether Length	5 min.	10	15	20	22 max.
Pumping Range	9	13.5	18	22	24

Use only as a guide. Due to weight of cable, pumping range above horizontal is not equal to pumping range below horizontal. Ranges are based on testing in nonturbulent conditions. Range may vary due to water temperature and cord shape. As tether length increases, so does the variance of the pumping range.

Models WD & WH are fully automatic. A float switch is included and factory wired in the pump circuit to provide automatic operation once the float switch is secured properly to the outlet pipe. Use the diagram above to secure the float switch properly and obtain the proper tether to customize the on-off cycle to each application.



20 AMP SWITCH (WD & WH MODELS)

Note: Failure to keep within proper tether limits may prevent reliable switch operation.

Note: Cable must be mounted in horizontal position.

SINGLE PHASE WIRING INSTRUCTIONS

▲ WARNING FOR YOUR PROTECTION, ALWAYS DISCONNECT PUMP FROM ITS POWER SOURCE BEFORE HANDLING. Single phase pumps are supplied with a 3-prong grounded plug to help protect you against the possibility of electrical shock. DO NOT UNDER ANY CIRCUMSTANCES REMOVE THE GROUND PIN. The 3-prong plug must be inserted into a mating 3-prong grounded receptacle. If the installation does not have such a receptacle, it must be changed to the proper type, wired and grounded in accordance with the National Electrical Code and all applicable local codes and ordinances.

▲ WARNING "Risk of electrical shock" Do not remove power supply cord and strain relief or connect conduit directly to the pump.

▲ WARNING Installation and checking of electrical circuits and hardware should be performed by a qualified licensed electrician.

▲ WARNING Units supplied without a plug (single and three phase) and single phase nonautomatic units with a 20 amp plug must have a motor control and liquid level control provided at time of installation. The control device should have suitable voltage, ampere, frequency, grounding and horsepower rating for the pump to which it is connected.

THREE PHASE WIRING INSTRUCTIONS

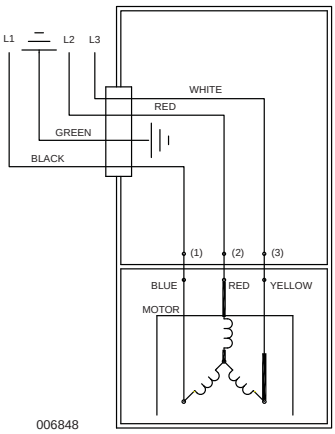
▲ WARNING FOR YOUR PROTECTION, ALWAYS DISCONNECT PUMP FROM ITS POWER SOURCE BEFORE HANDLING.

To automatically operate a nonautomatic three phase pump, a control panel is required. Follow the instructions provided with the panel to wire the system. For automatic three phase pumps see automatic 3 phase wiring diagram located to the far right.

Before installing a pump, check the pump rotation to ensure that wiring has been connected properly to power source, and that the green lead of power cord (See wiring diagram), is connected to a valid ground. Momentarily energize the pump, observing the directions of kick back due to starting torque. Rotation is correct if kick back is in the opposite direction of rotation arrow on the pump casing. If rotation is not correct, switching of any two power leads other than ground, should provide the proper rotation.

All three phase pumps require motor starting devices with motor overload protection. See FM0486 for duplex installations. Pumps must be installed in accordance with the National Electrical Code and all applicable local codes and ordinances. Pumps are not to be installed in locations classified as hazardous in accordance with National Electrical Code, ANSI/NFPA 70.

NONAUTOMATIC 3 PHASE



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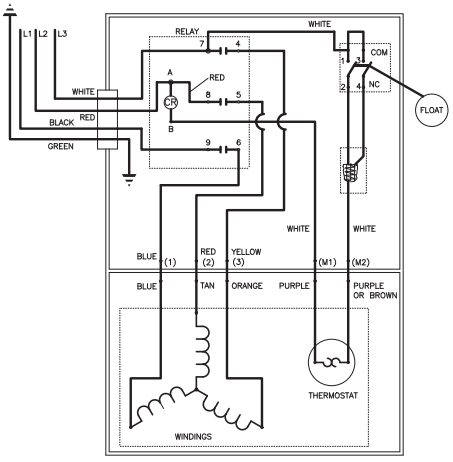
AUTOMATIC 3 PHASE



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IMPORTANT NOTICE: Some insurance policies, both commercial and residential, extend coverage for damages incurred by product failure. You will need to have possession of the product to support your claim in most cases. Zoeller Pump Co. will exchange the unit or refund the original purchase price once the claim is settled with the insurer in the case where you need to retain possession of the product to support a damage claim you submit to your insurance company.

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Aviso al contratista instalador: Las instrucciones deberán permanecer con la instalación.

FM2676S

Su Tranquilidad es Nuestra Prioridad®

La siguiente información sobre este producto refleja las condiciones existentes en la fecha de publicación. Se debe consultar a la fábrica cualquier discrepancia o inconsistencia que existiera.

Zoeller Family of Water Solutions™

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FECHA DE INSTALACIÓN:
NÚMERO DE MODELO:

INSTRUCCIONES DE INSTALACIÓN
MODELOS RECOMENDADOS

AVISO: AGUJERO DE VENTILACIÓN PARA LA VÁLVULA DE RETENCIÓN, VEA EL NRO. 3 EN LA SECCIÓN DE PRECAUCIONES A CONTINUACIÓN Y EL NRO. 4 EN LA PÁGINA 3.

EFLUENTES*/SUMIDERO/ACHIQUE	AGUAS CLOACALES
49 / 53 / 57 Series, 98 Series	264 Series
137 Series, 151 / 152 / 153 Series	266 / 267 / 268 Series

LISTA DE VERIFICACIÓN DE PRE-INSTALACIÓN - TODAS LAS INSTALACIONES

1. Inspeccione su bomba. Ocasionalmente, los productos se dañan durante el envío. Si la unidad está dañada, comuníquese con su vendedor antes de usarla. NO quite los tapones de prueba de la cubierta ni del cárter del motor.
2. Lea cuidadosamente toda la literatura provista para familiarizarse con los detalles específicos relacionados con la instalación y uso. Estos materiales deberán guardarse para referencia futura.

▲ ADVERTENCIA

VER ABAJO LA LISTA DE ADVERTENCIAS

1. Asegúrese de que el tomacorriente esté al alcance del cable de alimentación eléctrica de la bomba. NO USE UN CABLE DE EXTENSIÓN. Los cables de extensión que son demasiado largos o livianos no suministran voltaje suficiente al motor de la bomba. Más importante aún, presentan un peligro a la seguridad si el aislante se daña o el extremo de conexión cae dentro del sumidero.
2. Asegúrese de que el circuito de alimentación eléctrica de la bomba esté equipado con fusibles o interruptores de circuito de capacidad adecuada. Se recomienda un circuito auxiliar, del tamaño de acuerdo al "Código Eléctrico Nacional" para la corriente que se muestra en la etiqueta de nombre de la bomba.
3. Prueba de puesta a tierra. Como medida de seguridad, cada tomacorriente debe verificarse para puesta a tierra usando un analizador de circuitos aprobado por el Underwriters Laboratory, el cual indicará si los alambres de energía, neutrales y de puesta a tierra están conectados correctamente a su tomacorriente. Si no lo están, llame a un técnico electricista calificado.
4. Para mayor seguridad. El equipo de bombeo y otro equipo eléctrico con enchufes de 3 patillas deben conectarse a un tomacorriente para 3 patillas con puesta a tierra. Para mayor seguridad, el tomacorriente puede estar protegido con un interruptor de circuito de falla a tierra. Cuando una bomba necesita ser conectada a una caja de conexión hermética, el enchufe puede ser retirado y empalmado al cable de alimentación eléctrica propiamente conectado a tierra. Para mayor seguridad, este circuito puede ser protegido mediante un interruptor de circuito de falla a tierra. La instalación completa deberá cumplir con el Código Eléctrico Nacional y todas las ordenanzas y códigos locales aplicables.
5. PARA SU PROTECCIÓN, SIEMPRE DESCONECTE LA BOMBA DE LA FUENTE DE ALIMENTACIÓN ELÉCTRICA ANTES DE MANIPULARLA. Las bombas monofásicas se suministran con enchufes de 3 patillas con puesta a tierra para ayudar a protegerle contra la posibilidad de choque eléctrico. NO RETIRE BAJO NINGUNA CIRCUNSTANCIA LA CLAVIJA DE PUESTA A TIERRA. Los enchufes de 3 patillas se deben introducir en un tomacorriente para 3 patillas apropiado. Si la instalación no posee un tomacorriente de este tipo, se debe cambiar por uno apropiado, cableado y con puesta a tierra de acuerdo al Código Eléctrico Nacional y a todas las ordenanzas y códigos locales aplicables. Las bombas trifásicas requieren dispositivos de arranque del motor con protección contra sobrecarga. Vea FM0486 para instalaciones duplex.
6. El tanque se debe ventilar conforme a los códigos de plomería locales. Las bombas se deben instalar conforme al Código Eléctrico Nacional y a todos los códigos y ordenanzas locales que correspondan. Las bombas no se deben instalar en sitios peligrosos conforme a la clasificación del Código Eléctrico Nacional, ANSI/NFPA 70.
7. "Riesgo de choque eléctrico". No quite el cable de alimentación eléctrica ni el dispositivo de alivio de tensión y no conecte un conductor directamente a la bomba.
8. La instalación y verificación de los circuitos eléctricos y del equipo deberán llevarse a cabo por un técnico electricista calificado.
9. La instalación y verificación de la bomba deberá llevarse a cabo por una persona calificada.
10. Riesgo de choque eléctrico – No se ha investigado el uso de estas bombas en áreas marinas y en piscinas.
11. Este producto contiene sustancias químicas que de acuerdo al estado de California pueden causar cáncer y defectos congénitos u otros daños a la salud reproductiva.

REFIÉRASE A LA GARANTÍA EN LA PÁGINA 2.

▲ PRECAUCIÓN

VER ABAJO LA LISTA DE PRECAUCIONES

1. Asegúrese de que la fuente de energía eléctrica sea capaz de manejar los requisitos de voltaje del motor, según se indica en la etiqueta de nombre de la bomba.
2. La instalación de bombas automáticas con interruptores de flotador de nivel variable o las bombas no automáticas que usan interruptores de flotador de nivel variable auxiliares es responsabilidad del instalador y deberá verificarse que el interruptor de flotador atado no se enganchará en el aparato de la bomba ni en las peculiaridades del foso y que está fijado de manera que permita la parada de la bomba. Se recomienda usar tubería y empalmes rígidos y que el foso tenga 45 cm (18 pulg.) o más de diámetro.
3. Información - Objetivo del agujero de ventilación. Es necesario que todas las bombas sumer-gibles de sumidero, efluentes y de aguas cloacales capaces de manejar residuos sólidos de varios tamaños tengan la entrada en la parte inferior para reducir el atascamiento y las fallas del sello. Si se incorpora a la instalación una válvula de retención, deberá perforarse un agujero de ventilación [de aprox. 5 mm (3/16 pulg.)] en la tubería de descarga debajo de la válvula de retención y de la tapa del foso a fin de purgar la unidad del aire atrapado. La causa de aire atrapado puede ser agitación y/o un estanque seco. Deberá revisarse periódicamente el agujero de ventilación para verificar que no esté atascado. Las bombas de las series 53, 57 ó 98 poseen una ventilación ubicada en la caja de la bomba del lado opuesto al flotador, junto a una aleta de la caja. Sin embargo, se recomienda un agujero de ventilación adicional. Un agujero de ventilación en una aplicación de carga elevada podría causar demasiada turbulencia. Es posible que usted prefiera no perforar uno. Si decide no perforar un agujero de ventilación, asegúrese de que la caja de la bomba y el impulsor estén cubiertos de líquido antes de conectar la tubería a la válvula de retención y que no haya ningún tipo de entrada de aire en la vía de entrada de la bomba. NOTA: EL AGUJERO TAMBIÉN DEBERÁ ESTAR POR DEBAJO DE LA TAPA DEL SUMIDERO Y SE DEBERÁ LIMPIARLO PERIÓDICAMENTE. Se verá un chorro de agua saliendo del agujero durante los períodos de bombeo.
4. Se debe revisar la bomba frecuentemente para asegurarse de que no hay escombros y/o acumulación que pueda interferir con la posición "on" (encendido) o "off" (apagado) del flotador. La reparación y servicio deberá hacerse solamente por personal de una Estación de servicio autorizada por Zoeller Pump Company.
5. Las bombas de achique y de efluentes no se diseñan para uso en fosos con aguas cloacales crudas.
6. La temperatura de funcionamiento máxima para bombas de modelo estándar no debe superar 54°C (130°F).
7. Las bombas modelos 266, 267, 268, y 137 se deben operar en posición vertical. No intente encender la bomba cuando esté inclinada o apoyada sobre uno de sus lados.
8. No opere la bomba en una aplicación donde la carga dinámica total sea menor que la carga dinámica total mínima que se indica en la Curva de rendimiento de la bomba.

AVISO: Las bombas con la marca "UL" y "US" han sido probadas de acuerdo al estándar UL778. Las bombas "aprobadas por CSA" están certificadas de acuerdo al estándar CSA C22.2 No. 108.

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