

302GAA810-A (Ref. Drawing)

#### Order by Part Number and Description. Reference Numbers are for your convenience only.

Ref.		Model GAE Mechanical Se		al No.	Dual Splash Lube Size – 5H Size – 5M Size 5L		
١	No.	Description		Req'd	GAEH_R <u>∆</u> <u>∆= (E or G)</u>	GAEM_R $\triangle$ $\triangle$ = (E or G)	GAEL_R <u>∆</u> <u>∆= (E or G)</u>
	2	Dlug		10	64003	64AC3	64AC3
	2	Plug Gear Case			64AC3 304GAE602	304GAE602	304GAE602
	5					75P40	
	6	Screw			75P40 5L359	75P40 5L359	75P40
*	7	Breather					5L359
	9	Gasket			300GAE715	300GAE715	300GAE715
*	10	Gear Kit Screws		1 8	300GAE6008 75A33P	300GAE6008	300GAE6008
						75A33P	75A33P
*	12 13	Bearing Retainer			900883050501	900883050501	900883050501
*	14	Shim Set		-	900881052900	900881052900	900881052900 8500397
*	15	Ball Bearing Mechanical Seal		4	8500397 900871020005	8500397 900871020005	900871020005
	16	Screw		8	75P56	75P56	75P56
	17	Foot – Vert. & Horiz.				300GAE166	
	18	Bearing Housing Gear End			300GAE166 303GAE006	303GAE100 303GAE006	300GAE166 303GAE006
	19	Dowel Pin			62M48	62M48	62M48
	20			-	200GAA451	200GAA451	200GAA451
	21	Lifting Lug			75P55	75P55	75P55
	22	ScrewImpeller Case			900883051701	900883051801	900883051901
	23	Rotor Group		'	900003031701	900003031001	900003031901
	23	5" Standard Clearances		1	327GAE4028	326GAE4028	325GAE4028
		5" High Temperature Clearances			To be assigned	To be assigned	To be assigned
	24	Bearing Housing Drive End			304GAE006	304GAE006	304GAE006
	25	Key-Square			900639910305	900639910305	900639910305
*	28	Wavy Spring			900669170405	900669170405	900669170405
	29	Drive Cover			300GAE477	300GAE477	300GAE477
	30	Screw			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			76F92	76F92	76F92
**	45	Paint, Bulk, GDP188, Aluminum		0.125	28H284	28H284	28H284
	46	Plug			64AC2	64AC2	64AC2
**	54	Shim Case .0025/.0035"		1	200GAE732	200GAE732	200GAE732
**	55	Shim Case .010"			201GAE732	201GAE732	201GAE732
**	56	Shim Case .0015/.002"			202GAE732	202GAE732	202GAE732
	76	Compound, Loctite			25BC877	25BC877	25BC877
*	80	Bearing – Conrad			12BA254	12BA254	12BA254
	81	Dowel Pin			62M13	62M13	62M13
	82	Locking Assembly			22G43	22G43	22G43
	83	Slinger			300GAE173	300GAE173	300GAE173
	84	Screw			75LM14	75LM14	75LM14
	85	Bearing Retainer			300GAE205	300GAE205	300GAE205
**	86	Overhaul Kit 5" R VERS Mechanical Seal			75LM214	75LM214	75LM214
**	105 900	Group-Indent & Instruction Legend Series		1	303GAE6010	303GAE6010	303GAE6010
	900	Croup-macht & manachon Legena Selles	, o 1\	1	205GAE4011	205GAE4011	205GAE4011

<sup>\*</sup> INCLUDED IN OVERHAUL KIT.

<sup>\*\*</sup> NOT SHOWN ON ILLUSTRATION



#### 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.
- 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 a coordance 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 fimited 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 greese lubricated bare blowers, consisting of all parts within, are warranted for 1.8 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" blow or 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 s ervice 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 rieplacement 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 eigent, 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**

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# **NOTES**

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For additional information, contact your local representative or visit: www.contactgd.com/mobile

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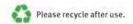












# **NOTES**


# MAINTENANCE DATA SHEET FOR POSITIVE DISPLACEMENT BLOWER

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#### 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\$

<sup>\*</sup> 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.

Conditions: CAD Dollar, net 30, taxes extra, price valid for 2017, minimum order of 75 \$, FOB Montreal, PQ.

<sup>\*\*</sup> Fill with new grease until old grease is flushed.

<sup>\*\*\*</sup> Overhaul kit consist of bearings, seals, gaskets, shims, taper pins and bearing retainer screws.

B-501/2	38094	VFD, Danfoss 15HP, 380- 480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBX CXXXXDX	0
P-701/2	38093	VFD, Danfoss 2HP, 380- 480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBX CXXXXDX	788

# **Operating Guide**

# **VLT® AQUA Drive FC 202**

0.25-90 kW







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#### VLT® AQUA Drive FC 202



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## 1

#### 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 <a href="https://www.vlt-drives.danfoss.com/Support/Technical-Documentation/">www.vlt-drives.danfoss.com/Support/Technical-Documentation/</a> 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	2.6x
reflect software version 2.6x. Edito		
	update.	

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 lowvoltage 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*.



#### 1.4.2 Features

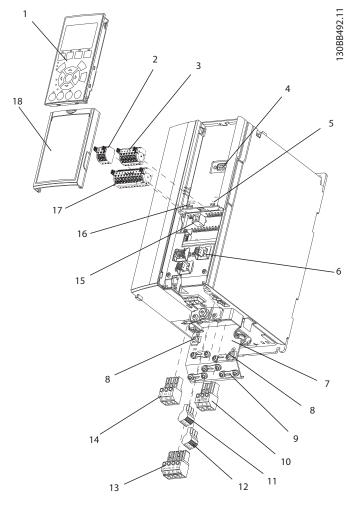
The VLT® AQUA Drive FC 202 is designed for water and wastewater applications. The range of standard and optional features includes:

- 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).



## 1.4.3 Exploded Views

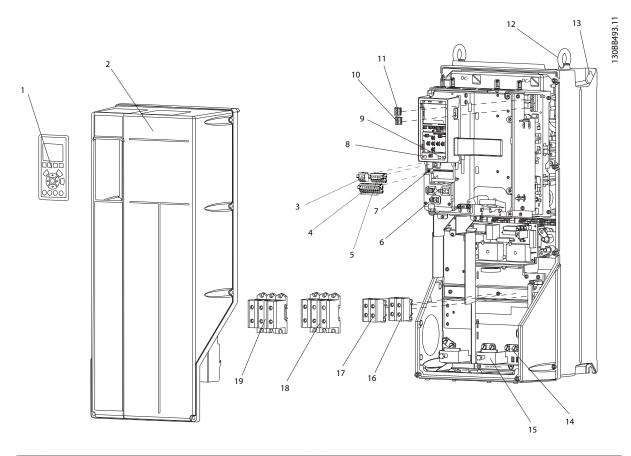


1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 fieldbus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains 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







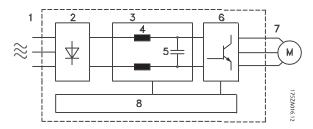
1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital I/O and 24 V supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable shield connector
6	Cable shield connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load 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.
		<ul> <li>Filter the intermediate DC circuit voltage.</li> <li>Prove mains transient protection.</li> </ul>
		Reduce RMS current.
4	DC reactors	Raise the power factor reflected back to the line.
		Reduce harmonics on the AC input.
5	Capacitor bank	<ul><li>Stores the DC power.</li><li>Provides ride-through protection for short power losses.</li></ul>
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	<ul> <li>Input power, internal processing, output, and motor current are monitored to provide efficient operation and control.</li> <li>User interface and external commands are monitored and performed.</li> </ul>
		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.





## 2 Safety

#### 2.1 Safety Symbols

The following symbols are used in this guide:

## **A**WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

## **A**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

## **A**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.

## **AWARNING**

#### **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.

## **A**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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Voltage [V]	Minimum waiting time (minutes)			
	4	7	15	
200-240	0.25-3.7 kW	-	5.5–45 kW	
	(0.34-5 hp)		(7.5-60 hp)	
380-480	0.37-7.5 kW	-	11–90 kW	
	(0.5-10 hp)		(15–121 hp)	
525-600	0.75-7.5 kW	-	11–90 kW	
	(1–10 hp)		(15–121 hp)	
525-690	-	1.1-7.5 kW	11–90 kW	
		(1.5-10 hp)	(15–121 hp)	

Table 2.1 Discharge Time

## **A**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.

## **AWARNING**

#### **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.

## **AWARNING**

## 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.

## **A**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.





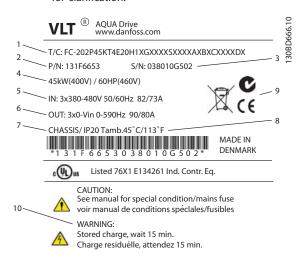
#### 3 Mechanical Installation

#### 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.



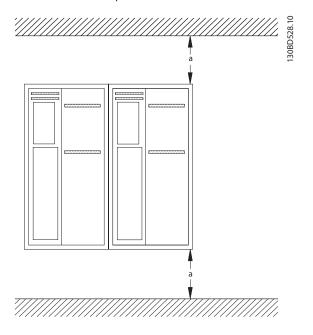
#### 3.3 Mounting

#### 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.
- Locate the unit as near to the motor as possible.Keep the motor cables as short as possible.
- 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

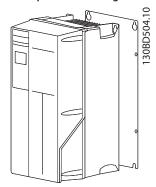


Illustration 3.3 Proper Mounting with Backplate

#### NOTICE

A backplate is required when mounted on railings.

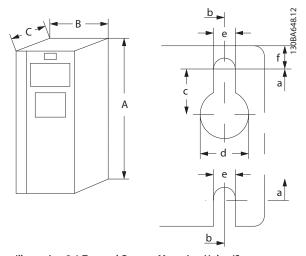


Illustration 3.4 Top and Bottom Mounting Holes (See chapter 8.9 Power Ratings, Weight, and Dimensions)



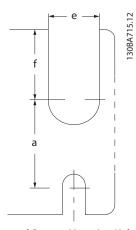


Illustration 3.5 Top and Bottom Mounting Holes (B4, C3, and C4)



#### 4 Electrical Installation

#### 4.1 Safety Instructions

See chapter 2 Safety for general safety instructions.

## **A**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.

## **A**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 factorysupplied, 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

## **AWARNING**

#### 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<sup>2</sup> (7 AWG).
   Separately terminate 2 ground wires, both complying with the dimension requirements.

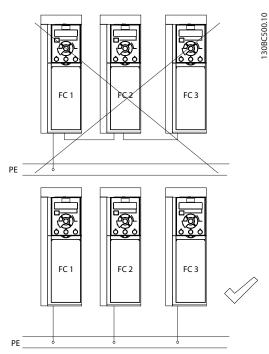


Illustration 4.1 Grounding Principle





#### 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<sup>2</sup> (6 AWG).



#### 4.4 Wiring Schematic

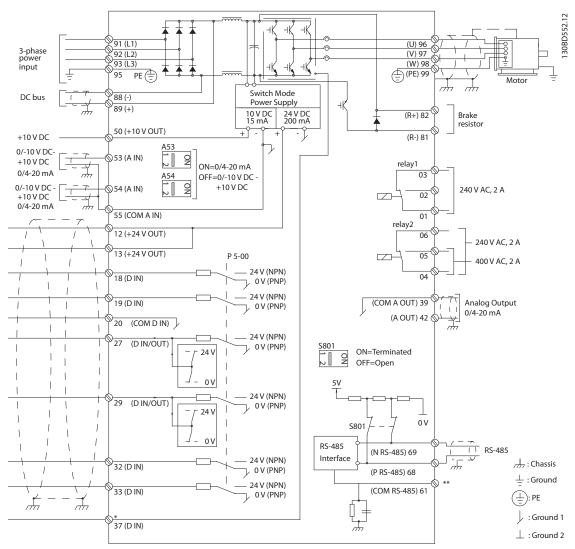


Illustration 4.2 Basic Wiring Schematic

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.

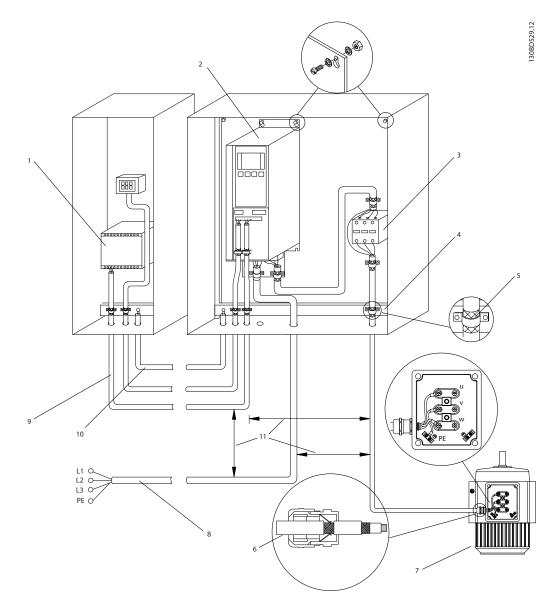
#### NOTICE

Actual configurations vary with unit types and optional equipment.



<sup>\*\*</sup>Do not connect cable shield.





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 <sup>2</sup> (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).



#### 4.5 Access

1. Remove the cover with a screwdriver (See *Illustration 4.4*) or by loosening the attaching screws (See *Illustration 4.5*).

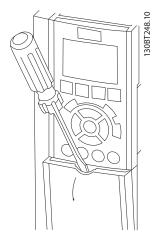


Illustration 4.4 Access to Wiring for IP20 and IP21 Enclosures

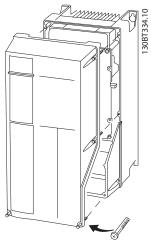


Illustration 4.5 Access to Wiring for IP55 and IP66 Enclosures

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

## **A**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.
- 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*.



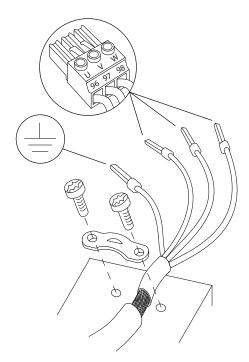


Illustration 4.6 Motor Connection

*Illustration 4.7* shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

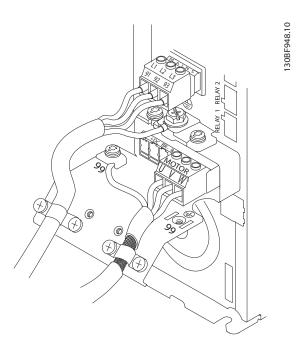


Illustration 4.7 Example of Motor, Mains, and Ground Wiring

#### 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*).
- Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
- 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*.

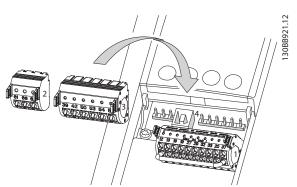
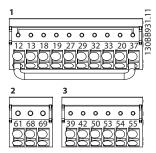


Illustration 4.8 Control Terminal Locations





**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			
		Default	
Terminal	Parameter	setting	Description
	Dig	ital Inputs/Outp	outs
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			
	Default			
Terminal	Parameter	setting	Description	
	Parameter 5			
	-10 Termina			
	l 18 Digital			
18	Input	[8] Start	-	
19	Parameter 5			
	-11 Termina			
	l 19 Digital	[0] No		
	Input	operation	Digital inputs.	
32	Parameter 5			
	-14 Termina			
	l 32 Digital	[0] No		
	Input	operation	_	
33	Parameter 5			
	-15 Termina	ra1.44		
	l 33 Digital	[0] No		
	Input	operation		
27	Parameter 5			
	-12 Termina			
	l 27 Digital	[2] Coast	For digital input or	
	Input	inverse	output. Default setting	
29	Parameter 5	[14] Jog	is input.	
	-13 Termina			
	l 29 Digital			
	Input			
20	_	_	Common for digital	
			inputs and 0 V	
			potential for 24 V	
27		C ( T	supply.	
37	_	Safe Torque	Safe input (optional).	
	Δna	Off (STO) log Inputs/Out	Used for STO.	
20	Ana	log inputs/Out		
39	_	_	Common for analog	
42	0	6 10	output	
42	Parameter 6	l <sup>-</sup>	Programmable analog	
	-50 Termina	mign Limit	output. 0–20 mA or 4–	
	1 42 Output		20 mA at a maximum	
F0		+10 V DC	of 500 Ω	
50	_	1+10 V DC	10 V DC analog supply	
			voltage for potenti-	
			ometer or thermistor.  15 mA maximum	
	Davarrete		mumixbin Am cı	
	Parameter			
	group 6-1*			
53	Analog Input 53	Reference		
			Analog input Far	
54	Parameter	Feedback	Analog input. For	
	group 6-2* Analog		voltage or current. Switches A53 and A54	
	Input 54		select mA or V.	
55	IIIput 54			
23	_	_	Common for analog input	
	Sor	ial Communica		
Serial Communication				



	Terminal description			
		Default		
Terminal	Parameter	setting	Description	
61	-	-	Integrated RC-Filter for	
			cable shield. ONLY for	
			connecting the shield if	
			EMC problems occur.	
	Parameter	-		
	group 8-3*			
	FC Port		RS485 Interface. A	
68 (+)	Settings		control card switch is	
69 (-)	Parameter	-	provided for	
	group 8-3*		termination resistance.	
	FC Port			
	Settings			
		Relays		
	Parameter 5			
	-40 Functio		Form C relay output.	
01, 02, 03	n Relay [0]	[9] Alarm	For AC or DC voltage	
04, 05, 06	Parameter 5	[5] Running	and resistive or	
	-40 Functio		inductive loads.	
	n Relay [1]			

**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.

 Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

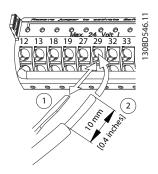


Illustration 4.10 Connecting Control Wires

- 2. Insert the bare control wire into the contact.
- Remove the screwdriver to fasten the control wire into the contact.
- 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.

30BD530.10



# 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*).
- Remove any optional equipment covering the switches.
- 3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

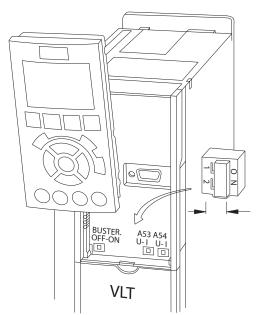


Illustration 4.11 Location of Terminal 53 and 54 Switches

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.

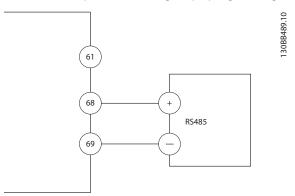


Illustration 4.12 Serial Communication Wiring Diagram

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.





#### 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	Ø
Auxiliary equipment	<ul> <li>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.</li> </ul>	
	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	Check for proper fusing or circuit breakers.	
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	Check for loose connections.	
power wiring	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

## **A**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.



### 5 Commissioning

#### 5.1 Safety Instructions

See chapter 2 Safety for general safety instructions.

## **A**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.
- 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.
- 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.
- Confirm continuity of the motor by measuring Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).
- Check for proper grounding of the frequency converter and the motor.
- Inspect the frequency converter for loose connections on the terminals.
- 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:

- 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.
- Ensure that any optional equipment wiring matches the installation application.

- Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.
- 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 <a href="https://www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm">www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm</a>.

#### 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.





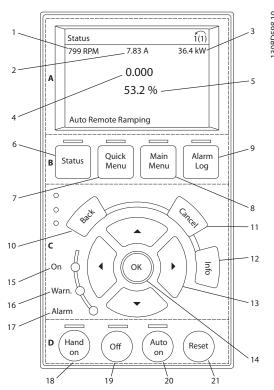


Illustration 5.1 GLCP

#### 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	[1617] Speed [RPM]
	Line 1.1 Small	
2	Parameter 0-21 Display	[1614] Motor Current
	Line 1.2 Small	
3	Parameter 0-22 Display	[1610] Power [kW]
	Line 1.3 Small	
4	Parameter 0-23 Display	[1613] Frequency
	Line 2 Large	
5	Parameter 0-24 Display	[1602] Reference %
	Line 3 Large	

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	Press the navigation keys to move between	
	Keys	items in the menu.	
14	ОК	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)

#### 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

- Press [Off] to stop the motor before uploading or downloading data.
- Press [Main Menu], select parameter 0-50 LCP Copy and press [OK].
- 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.

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.
- Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
- Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
- Press [▲] [▼] to change the value of a parameter setting.
- 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.





# Recommended initialization procedure via parameter 14-22 Operation Mode

- 1. Press [Main Menu] twice to access parameters.
- 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 startup 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].

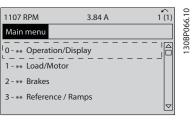


Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to *parameter* group 0-0\* Basic Settings and press [OK].

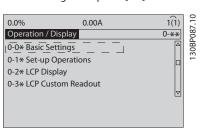


Illustration 5.3 Operation/Display



4. Press the navigation keys to scroll to parameter 0-03 Regional Settings and press [OK].

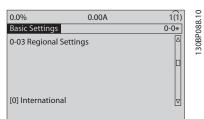


Illustration 5.4 Basic Settings

- 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
  - 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<sup>+</sup> 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

- 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.
- 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.
- Parameter 1-37 d-axis Inductance (Ld).
   Enter line to common direct axis inductance of the PM motor.







If only line-line data is available, divide the lineline 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

- 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	Parameter 1-17 Voltage filter time
$I_{Load}/I_{Motor} < 5$	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	Keep calculated values.
50>I <sub>Load</sub> /I <sub>Motor</sub> >5	
High inertia applications	Parameter 1-14 Damping Gain,
$I_{Load}/I_{Motor} > 50$	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	Parameter 1-17 Voltage filter time
<30% (rated speed)	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:

5

- 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<sup>+</sup> SynRM settings. *Table 5.8* provides application-specific recommendations:

ncrease <i>parameter 1-17 Voltage filter</i>
time const. by factor 5–10.
Reduce parameter 1-14 Damping
Gain.
Reduce parameter 1-66 Min. Current
at Low Speed (<100%).
Keep the default values.
ncrease parameter 1-14 Damping
Gain, parameter 1-15 Low Speed Filter
Time Const., and parameter 1-16 High
Speed Filter Time Const.
ncrease parameter 1-17 Voltage filter
time const.
ncrease 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.

Application	Settings
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	Avoid short ramp-down times.
kW (24 hp)	

**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.





- 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].
- 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.
- 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.
- Accelerate the frequency converter by pressing
   [A] 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.
- Adjust the speed reference throughout the speed range.
- 4. Remove the external run command.
- 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*.



## 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.

#### 6.1 Application Examples

#### 6.1.1 Feedback

			Parameters	
FC	1	10	Function	Setting
+24 V	120	_ 130BB675.10	Parameter 6-22 Terminal	4 mA*
+24 V	130	30BE	54 Low Current	
DIN	180	-	Parameter 6-23 Terminal	20
DIN	190		54 High Current	mA*
СОМ	200		Parameter 6-24 Terminal	0*
DIN	270		54 Low Ref./Feedb.	
DIN	290		Value	
DIN	320		Parameter 6-25 Terminal	50*
D IN	330		54 High Ref./Feedb.	
DIN	37		Value	
			* = Default value	
+10 V	500		Notes/comments:	
A IN	530	+	D IN 37 is an option.	
A IN	540			
COM	550	4-20 mA		
A OUT	420			
COM	390			
U - I				
A 54				

A 54	
Table 6.1 Analog Current Feedle	ack Transducer

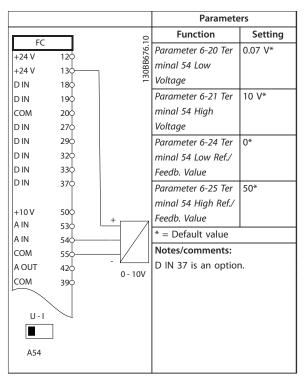


Table 6.2 Analog Voltage Feedback Transducer (3-wire)



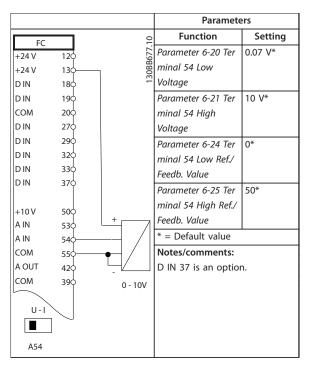


Table 6.3 Analog Voltage Feedback Transducer (4-wire)

#### 6.1.2 Speed

			Paramete	ers
FC		10	Function	Setting
+24 V	120	3088926.10	Parameter 6-10 Ter	0.07 V*
+24 V	130	088	minal 53 Low	
DIN	180	13	Voltage	
D IN	190		Parameter 6-11 Ter	10 V*
СОМ	200		minal 53 High	
DIN	270		Voltage	
D IN	290		Parameter 6-14 Ter	0 Hz
D IN	320		minal 53 Low Ref./	
D IN	330		Feedb. Value	
DIN	370		Parameter 6-15 Ter	50 Hz
			minal 53 High Ref./	
+10 V A IN	530	+	Feedb. Value	
A IN	540		* = Default value	
СОМ	550		Notes/comments:	
A OUT	420	- L	D IN 37 is an option	٦.
СОМ	390	-10 - +10V	·	
U-1				
A53				

Table 6.4 Analog Speed Reference (Voltage)

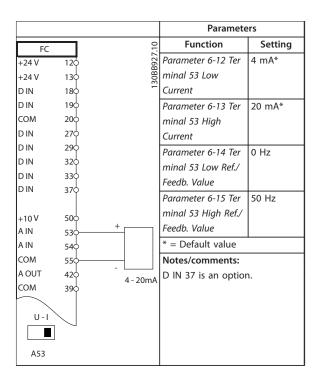


Table 6.5 Analog Speed Reference (Current)

			Paramete	ers
FC		01	Function	Setting
+24 V	120	130BB683.10	Parameter 6-10 Ter	0.07 V*
+24 V	130	0886	minal 53 Low	
D IN	180	13	Voltage	
D IN	190		Parameter 6-11 Ter	10 V*
СОМ	200		minal 53 High	
D IN	270		Voltage	
D IN	290		Parameter 6-14 Ter	0 Hz
D IN	320		minal 53 Low Ref./	
D IN	330		Feedb. Value	
D IN	370		Parameter 6-15 Ter	50 Hz
			minal 53 High Ref./	
+10 V A IN	500	_	Feedb. Value	
A IN	530— 540		* = Default value	
COM	550-		Notes/comments:	
A OUT	420		D IN 37 is an option	٦.
COM	390			
U-I `				
A53				

Table 6.6 Speed Reference (Using a Manual Potentiometer)

## 6.1.3 Run/Stop

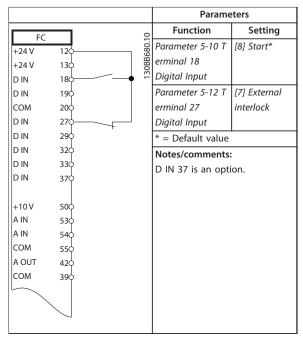


Table 6.7 Run/Stop Command with External Interlock

			Parame	eters
FC		10	Function	Setting
+24 V	120	30BB681.10	Parameter 5-10 T	[8] Start*
+24 V	130	0BB	erminal 18	
DIN	180	 13	Digital Input	
DIN	190		Parameter 5-12 T	[7] External
COM	200		erminal 27	interlock
DIN	270		Digital Input	
DIN	290		* = Default value	ļ.
DIN	320		Notes/comments	
DIN	330		If parameter 5-12	Terminal 27
DIN	370		Digital Input is set	
+10 V	500		operation, a jump	er wire to
A IN	530		terminal 27 is not	needed.
A IN	540		D IN 37 is an opti	ion.
СОМ	550			
A OUT	420			
COM	390			
R	- 010 - 020 - 030			
22	- 040 - 050 - 060			

Table 6.8 Run/Stop Command without External Interlock

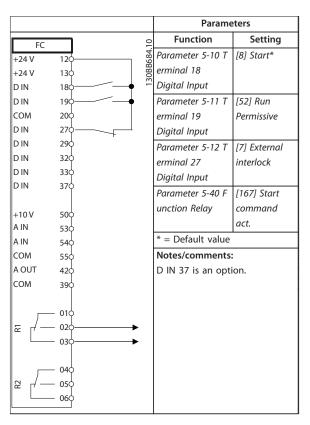


Table 6.9 Run Permissive

#### 6.1.4 External Alarm Reset

			Parameters	
FC	$\neg$	10	Function	Setting
+24 V	120-	 130BB682.10	Parameter 5-11 T	[1] Reset
+24 V	130	)BB6	erminal 19	
DIN	180	13	Digital Input	
DIN	190-		* = Default value	
СОМ	200		Notes/comments:	:
DIN	270		D IN 37 is an opti	on.
DIN	290			
DIN	320			
DIN	330			
DIN	370			
+10 V	500			
A IN	530			
A IN	540			
СОМ	550			
A OUT	420			
COM	390			
	7			

Table 6.10 External Alarm Reset



## 6.1.5 RS485

			Parameters		
FC	$\overline{}$	10	Function	Setting	
+24 V	120	30BB685.10	Parameter 8-30 P		
+24 V	130	088	rotocol	FC*	
D IN	180	13	Parameter 8-31 A	1*	
D IN	190		ddress		
СОМ	200		Parameter 8-32 B	9600*	
D IN	270		aud Rate		
D IN	290		* = Default value		
D IN	320		Notes/comments:	,	
D IN	330		Select protocol, a		
D IN	370		baud rate in the a		
101/			mentioned parameters.		
+10 V A IN	50¢ 53¢		D IN 37 is an opti		
AIN	540		D IN 37 IS all option.		
СОМ	550				
A OUT	420				
COM	390				
	010				
₽ //—	020				
	030				
	040				
₽ - -	050				
	060	RS-485			
	610				
	680	+			
	690	-			

Table 6.11 RS485 Network Connection

#### 6.1.6 Motor Thermistor

## **A**CAUTION

#### THERMISTOR INSULATION

Risk of personal injury or equipment damage.

 Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.

			Parameters	
10.7		Function	Setting	
+24 V	120		Parameter 1-90	[2] Thermistor
+24 V	130		Motor Thermal	trip
D IN	180		Protection	
DIN	190		Parameter 1-93 T	[1] Analog
COM	200		hermistor Source	input 53
DIN	270		* = Default value	
DIN	290			
DIN	320		Notes/comments:	:
DIN	330		If only a warning	is required,
D IN	370		set parameter 1-90	0 Motor
			Thermal Protection	n to [1]
+10 V	500		Thermistor warning	a.
A IN	530		D IN 37 is an opti	_
A IN	540		b iiv 37 is uii opti	.011.
COM	550			
A OUT	420			
COM	390			
U-I A53		130BB686.12		

Table 6.12 Motor Thermistor



## 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.

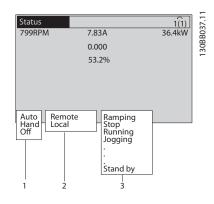
# **A**WARNING

#### **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 <i>Table 7.1</i> )
2	Reference site (see <i>Table 7.2</i> )
3	Operation status (see <i>Table 7.3</i> )

#### 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	rake [2] AC brake is selected in parameter 2-10 B	
	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. Genera		
	energy is absorbed by the brake resistor.	





	T	
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	<ul> <li>[1] Control Ramp-down was selected in parameter 14-10 Mains Failure.</li> <li>The mains voltage is below the value set in parameter 14-11 Mains Voltage at Mains Fault at mains fault.</li> <li>The frequency converter ramps down the motor using a controlled ramp down.</li> </ul>	
Current High	The frequency converter output current is above the limit set in <i>parameter 4-51 Warning Current High</i> .	
Current Low	The frequency converter output current is below the limit set in <i>parameter 4-52 Warning Speed Low</i> .	
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 <i>parameter 4-57 Warning Feedback High</i> .	
Feedback low	The sum of all active feedbacks is below the feedback limit set in <i>parameter 4-56 Warning Feedback Low</i> .	

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	A freeze output command was given, but the
request	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.
In an annual to	•
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
	<ul> <li>parameter 3-19 Jog Speed [RPM].</li> <li>[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.</li> <li>The jog function is activated via the serial</li> </ul>
	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.
	1



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 <i>parameter 4-55 Warning Reference High</i> .		
Ref. low	The sum of all active references is below the reference limit set in <i>parameter 4-54 Warning Reference Low</i> .		
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 <i>parameter 1-71 Start Delay</i> , 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

#### 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.

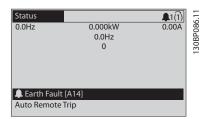
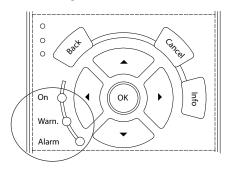


Illustration 7.2 Alarm Example

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  $\Omega$ .

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



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.





#### 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.



#### 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 (r		
	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.		





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	The state of the s	
	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		
	incorrect after the delay for power cards to	
	register.	
2327	Too many power card locations are registered a	
present.		
2330 Power size information between the power card		
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	
3123	control board hardware.	
5124		
5124	Option in slot B: Hardware incompatible with	
F125	control board hardware.	
5125	Option in slot C0: Hardware incompatible with	
F404	control board hardware.	
5126	Option in slot C1: Hardware incompatible with	
F274 455	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 Unom and Inom

The settings for motor voltage, motor current, and motor power are wrong. Check the settings in *parameters 1-20* to 1-25.



#### ALARM 52, AMA low Inom

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  $R_{\text{S}}$  and  $R_{\text{r}}$  are increased. Usually this is not critical.

#### 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:

- 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  $^{\circ}$ C (167  $^{\circ}$ 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.



#### 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.



## 7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
	Missing input power.	See Table 4.3.	Check the input power source.
	Missing or open fuses, or circuit	See Open fuses and tripped circuit breaker in	Follow the recommendations provided.
	breaker tripped.	this table for possible causes.	
	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	Check the 24 V control voltage supply for	Wire the terminals properly.
D: 1	(terminal 12 or 50) or at control	terminals 12/13 to 20-39 or 10 V supply for	
Display	terminals.	terminals 50-55.	
dark/No	Incompatible LCP (LCP from		Use only LCP 101 (P/N 130B1124) or LCP
function	VLT® 2800 or 5000/6000/8000/	-	102 (P/N 130B1107).
	FCD or FCM).		
	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		Contact supplier.
	SMPS is defective.	_	
	Overloaded supply (SMPS) due	To rule out a problem in the control wiring,	If the display stays lit, the problem is in
	to improper control wiring or a	disconnect all control wiring by removing	the control wiring. Check the wiring for
Intermittent	fault within the frequency	the terminal blocks.	short circuits or incorrect connections. If
display	converter.		the display continues to cut out, follow the
			procedure for display dark.
	Service switch is open or	Check if the motor is connected and the	Connect the motor and check the service
	missing motor connection.	connection is not interrupted (by a service	switch.
		switch or other device).	
	No mains power with 24 V DC	If the display is functioning but no output,	Apply mains power to run the unit.
	option card.	check that mains power is applied to the	
		frequency converter.	
	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	Apply a valid start signal to start the
		Input for correct setting for terminal 18 (use	motor.
Motor not		default setting).	
running	Motor coast signal active	Check parameter 5-12 Terminal 27 Digital	Apply 24 V on terminal 27 or program this
J	(Coasting).	Input for correct setting for terminal 27 (use	terminal to No operation.
		default setting).	
	Wrong reference signal source.	Check the following:	Program the correct settings. Check
		Reference signal: Local, remote, or bus	parameter 3-13 Reference Site. Set preset
		reference.	reference active in <i>parameter group 3-1*</i>
		Preset reference.	References.
		Terminal connection.	
		Scaling of terminals.	
		Reference signal availability.	
	Motor rotation limit.	Check that parameter 4-10 Motor Speed	Program the correct settings.
		Direction is programmed correctly.	
Motor running	Active reversing signal.	Check if a reversing command is	Deactivate reversing signal.
in wrong		programmed for the terminal in <i>parameter</i>	
direction		group 5-1* Digital inputs.	
	Wrong motor phase		See chapter 5.5 Checking Motor Rotation.



Symptom	Possible cause	Test	Solution
	Frequency limits are set	Check the output limits in	Program the correct limits.
	incorrectly.	parameter 4-13 Motor Speed High Limit	
		[RPM], parameter 4-14 Motor Speed High	
Motor is not		Limit [Hz] and parameter 4-19 Max Output	
reaching		Frequency.	
maximum	Reference input signal is not	Check the reference input signal scaling in	Program the correct settings.
speed	scaled correctly.	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.	
	Possible incorrect parameter	Check the settings of all motor parameters,	Check the settings in parameter group 1-6*
Motor speed	settings.	including all motor compensation settings.	Load Depen. Setting. For closed-loop
unstable		For closed-loop operation, check the PID	operation, check the settings in <i>parameter</i>
		settings.	group 20-0* Feedback.
Motor runs	Possible overmagnetization.	Check for incorrect motor settings in all	Check the motor settings in parameter
rough		motor parameters.	groups 1-2* Motor Data, 1-3* Adv Motor
Tough			Data, and 1-5* Load Indep. Setting.
Motor does	Possible incorrect settings in	Check the brake parameters. Check the	Check parameter groups 2-0* DC Brake and
not brake	the brake parameters. Possible	ramp time settings.	3-0* Reference Limits.
THOU BILINE	too short ramp-down times.		
	Phase-to-phase short circuit.	The motor or panel has a short phase-to-	Eliminate any short circuits detected.
		phase. Check the motor and panel phase	
		for short circuits.	
	Motor overload.	Motor is overloaded for the application.	Perform a start-up test and verify that the
Open power			motor current is within the specifications. If
fuses or circuit			the motor current exceeds the nameplate
breaker trip			full load current, the motor may run only
			with reduced load. Review the specifi-
			cations for the application.
	Loose connections.	Perform a pre-startup check for loose	Tighten any loose connections.
	Ducklam with the mains passes	Connections.	If impolanced law follows the wire it is a
	Problem with the mains power	Rotate input power leads into the	If imbalanced leg follows the wire, it is a
Mains current	(See <i>alarm 4, Mains phase loss</i> description).	frequency converter 1 position: A to B, B to C, C to A.	power problem. Check the mains supply.
imbalance	Problem with the frequency	Rotate input power leads into the	If imbalance leg stays on the same input
>3%	converter.	frequency converter 1 position: A to B, B to	terminal, it is a problem with the unit.
		C, C to A.	Contact the supplier.
	Problem with the motor or	Rotate output motor cables 1 position: U to	If imbalanced leg follows the wire, the
	motor wiring.	V, V to W, W to U.	problem is in the motor or motor wiring.
Motor current			Check the motor and motor wiring.
imbalance	Problem with the frequency	Rotate output motor cables 1 position: U to	If imbalance leg stays on same output
>3%	converter.	V, V to W, W to U.	terminal, it is a problem with the
			frequency converter. Contact the Danfoss
			supplier.
	Motor data was entered	If warnings or alarms occur, see	Increase the ramp-up time in
Frequency	incorrectly.	chapter 7.4 List of Warnings and Alarms.	parameter 3-41 Ramp 1 Ramp Up Time.
converter		Check that motor data is entered correctly.	Increase the current limit in
acceleration			parameter 4-18 Current Limit. Increase the
problems			torque limit in parameter 4-16 Torque Limit
			Motor Mode.
Frequency	Motor data was entered	If warnings or alarms occur, see	Increase the ramp-down time in
converter	incorrectly.	chapter 7.4 List of Warnings and Alarms.	parameter 3-42 Ramp 1 Ramp Down Time.
deceleration		Check that motor data is entered correctly.	Enable overvoltage control in
	1	I .	parameter 2-17 Over-voltage Control.



Symptom	Possible cause	Test	Solution
	Resonances.	Bypass critical frequencies by using	Check if noise and/or vibration have been
		parameters in parameter group 4-6* Speed	reduced to an acceptable limit.
		Bypass.	
		Turn off overmodulation in	
Acoustic noise		parameter 14-03 Overmodulation.	
or vibration		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



## 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)		0	2–4 (4–1	0)		10 (7)	35 (2)	50 (1/0)	95 (4/0)
[mm² (AWG)]		0.	2-4 (4-1	o)		10 (7)	33 (2)	30 (1/0)	93 (4/0)
Maximum cable cross-section for mains with	5.26	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	2 x 50 (2
disconnect switch [mm2 (AWG)]	(10)	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)	23 (3)	30 (1/0)	x 1/0) <sup>9) 10)</sup>
Maximum cable cross-section for mains without	5.26	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	95 (4/0)
disconnect switch [mm2 (AWG)]	(10)	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)	25 (5)	30 (1/0)	93 (4/0)
Cable insulation temperature rating [°C (°F)]	75	75	75	75	75	75 (167)	75 (167)	75 (167)	75 (167)
	(167)	(167)	(167)	(167)	(167)	73 (107)	73 (107)	73 (107)	73 (107)
Estimated power loss <sup>3)</sup> at rated maximum load [W] <sup>4)</sup>	44	30	44	60	74	110	150	300	440
Efficiency <sup>5)</sup>	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	PK	25	Pł	(37	PK	55	PK	75
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO
Typical shaft output [kW]	0	25	0.	.37	0.	55	0.	75
Typical shaft output at 208 V [hp]	0	0.34		0.5		75		1
Protection rating IP20/Chassis <sup>6)</sup>	Λ.	.2	,	\2	_	2		.2
Protection rating IP21/Type 1		12	'	12	A2			12
Protection rating IP55/Type 12	Λ.4.	/A5	Λ.	-/A5	Λ.4	/A5	Λ.4	/A5
Protection rating IP66/NEMA 4X	/\ <del>4</del> /	7.4.5		·/A3	A4,	77.5	A4,	7.4.5
Output current								
Continuous (3x200–240 V) [A]	1.	.8	2	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	2.2	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]	1	0	1	10	1	0	1	0
Additional specifications								
Maximum cable cross-section <sup>2)</sup> for mains, motor, brake,				4, 4, 4 (1)	2, 12, 12)			
and load sharing [mm <sup>2</sup> (AWG)]				(minimum	n 0.2 (24))			
Maximum cable cross-section <sup>2)</sup> for mains disconnect	ect ( 4.4/10.12.12)							
[mm² (AWG)]	6, 4, 4 (10, 12, 12)							
Estimated power loss <sup>3)</sup> at rated maximum load [W (hp)] <sup>4)</sup>	21 (	0.03)	29 (	29 (0.04) 42 (0.06)		0.06)	54 (0.07)	
Efficiency <sup>5)</sup>	0.9	94	0.	.94	0.95		0.95	

Table 8.2 Mains Supply 3x200-240 V AC, PK25-PK75

Type designation	P1	K1	P1	K5	P2	K2	P3	КО	P3	K7
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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	2	:	3	4	4	į	5
Protection rating IP20/Chassis <sup>6)</sup>	A	2	A	2		.2	۸	.3	۸	.3
Protection rating IP21/Type 1	_ ^		_ ^	2		12	_ ^	.5	_ ^	.5
Protection rating IP55/Type 12	A4/	/Δ5	A4/	/Δ5	Δ.4	/A5	Δ	.5	Δ	.5
Protection rating IP66/NEMA 4X	A4/	, A.J	A4/	A3	A4,	////				.5
Output current										
Continuous (3x200–240 V) [A]	6.	.6	7.	.5	10	).6	12	2.5	16	5.7
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]	2.3	38	2.7	70	3.	82	4.	50	6.00	
Maximum input current										
Continuous (3x200-240 V) [A]	5.	.9	6.	.8	9	.5	11	1.3	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]	2	0	2	0	2	20	3	2	3	2
Additional specifications										
Maximum cable cross-section <sup>2)</sup> for mains, motor,				4	, 4, 4 (12	, 12, 12)				
brake, and load sharing [mm <sup>2</sup> (AWG)]				(m	ninimum	0.2 (24)	)			
Maximum cable cross-section <sup>2)</sup> for mains disconnect				6	4 4 (10	12 12)				
[mm²] [(AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss <sup>3)</sup> at rated maximum load [W	63 (0.09) 82 (0.11) 116 (0.16) 155 (0.21)					185 /	(0.25)			
(hp)] <sup>4)</sup>	03 (0	J.U7)	02 ((	J. 1 1 <i>)</i>	1101	(0.10)	155 (	(U.Z I)	103 (	(0.23)
Efficiency <sup>5)</sup>	0.9	96	0.9	96	0.	96	0.9	96	0.9	96

Table 8.3 Mains Supply 3x200-240 V AC, P1K1-P3K7



Specifications



Type designation	P5	K5	P7	K5	P	11K	P1	5K
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	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 <sup>7)</sup>	В	3	В	3		B3	В	4
Protection rating IP21/Type 1								
Protection rating IP55/Type 12	B1		В	1		B1	В	2
Protection rating IP66/NEMA 4X								
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		6	3		63	8	0
Additional specifications	•		·				•	
IP20 maximum cable cross-section <sup>2)</sup> for mains, brake,	10 10	(8, 8, -)	10 10	(0, 0, )	10 10	- (8, 8, -)	35, -, -	(2 )
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 <sup>2)</sup>	16 10 1	(( 0 ()	16 10 1	(( 0 ()			6) 35, -, - (2, -,	
for mains, brake, and load sharing [mm <sup>2</sup> (AWG)]	16, 10, 10	5 (6, 8, 6)	16, 10, 10	5 (6, 8, 6)	16, 10, 1	6 (6, 8, 6)	35, -, -	(2, -, -)
Protection rating IP21 maximum cable cross-section <sup>2)</sup>								
for motor	10, 10, -	(8, 8, -)	10, 10, –	(8, 8, -)	10, 10,	- (8, 8, -)	35, 25, 2	5 (2, 4, 4)
[mm² (AWG)]								
Maximum cable cross-section <sup>2)</sup> for mains disconnect			16 10 10	(6 0 0)	•		25	(2)
[mm² (AWG)]			16, 10, 10	(6, 8, 8)	, 8)		35	(2)
Estimated power loss <sup>3)</sup> at rated maximum load [W	220 (0.22)	240 (0 (2)	239	310	371	514 (O T)	463	602
(hp)] <sup>4)</sup>	239 (0.33)	310 (0.42)	(0.33)	(0.42)	(0.51)	514 (0.7)	(0.63)	(0.82)
Efficiency <sup>5)</sup>	0.	96	0.	96	0.96		0.96	

Table 8.4 Mains Supply 3x200-240 V AC, P5K5-P15K



Type designation	P18K		P2	2K	P3	0K	P3	7K	P4	5K
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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 <sup>7)</sup>	В	4	C	C3		.3	C	4	C4	
Protection rating IP21/Type 1										
Protection rating IP55/Type 12	C1		c	1		1		.2	C2	
Protection rating IP66/NEMA 4X										
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]	1.	25	125		160		20	00	25	50
Additional specifications										
Protection rating IP20 maximum cable cross-										
section for mains, brake, motor, and load	35	(2)	50 (1)		50 (1)		150 (300 MCM)		150 (30	0 MCM)
sharing		(2)	50 (1)		30 (1)		130 (300 MCM)		150 (500 MCM)	
[mm² (AWG)]										
Protection ratings IP21, IP55, IP66 maximum										
cable cross-section for mains and motor	50	(1)	50	(1)	50	(1)	150 (30	0 MCM)	150 (30	0 MCM)
[mm² (AWG)]										
Protection ratings IP21, IP55, IP66 maximum										
cable cross-section for brake, and load	50	(1)	50	(1)	50	(1)	95 (	(3/0)	95 (	(3/0)
sharing [mm² (AWG)]										
Maximum cable cross-section <sup>2)</sup> for			50, 3	5, 35			95. 7	0, 70	1	50, 120
disconnect [mm² (AWG)]			(1, 2				(3/0, 2/0, 2		(350 MCM, 300 MCM, 4/0)	
Estimated power loss <sup>3)</sup> at rated maximum	624			845	874	1140	1143	1353		
load [W (hp)] <sup>4)</sup>	(0.85)	737 (1)	740 (1)	(1.2)	(1.2)	(1.6)	(1.6)	(1.8)	1400 (1.9)	1636 (2.2)
Efficiency <sup>5)</sup>	0.	96	0.9	 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





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 [mm²] (AWG)]	10 (7)	35 (2)	50 (1/0)	120 (4/0)
Estimated power loss <sup>3)</sup> at rated maximum load [W (hp)] <sup>4)</sup>	300 (0.41)	440 (0.6)	740 (1)	1480 (2)
Efficiency <sup>5)</sup>	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	PK	37	Pk	(55	PK	75	P1	P1K1 HO NO		K5
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	HO NO		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	1.0		1.5		.0
Protection rating IP20/Chassis <sup>6)</sup>	А	.2	P	12	А	12	Д	12	A2	
Protection rating IP55/Type 12 Protection rating IP66/NEMA 4X	A4,	A4/A5 A4/A5				/A5	A4.	/A5	A4,	/A5
Output current					•		•			
Continuous (3x380-440 V) [A]	1.	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]	1	0	1	0	1	0	10		1	0
Additional specifications			•		•					
Protection ratings IP20, IP21										
maximum cable cross-section <sup>2)</sup> for					4, 4, 4 (12	2, 12, 12)				
mains, motor, brake, and load					(minimum	0.2 (24))				
sharing [mm² (AWG)]										
Protection ratings IP55, IP66										
maximum cable cross-section <sup>2)</sup> for					4, 4, 4 (12	) 12 12\				
mains, motor, brake, and load					4, 4, 4 (12	2, 12, 12)				
sharing [mm² (AWG)]										
Maximum cable cross-section <sup>2)</sup> for	6, 4, 4 (10, 12, 12)									
disconnect [mm² (AWG)]		0, 4, 4 (10, 12, 12)								
Estimated power loss <sup>3)</sup>	25 //	) ()E)	42 /	0.06)	46 (0.06) 58 (0.08) 62				63.4	0.08)
at rated maximum load [W (hp)] <sup>4)</sup>	35 (	0.05)	42 (	0.06)	40 (	0.00)	38 (	0.00)	02 (	0.00)
Efficiency <sup>5)</sup>	0	93	_	95		96	_	96		97

Table 8.7 Mains Supply 3x380-480 V AC, PK37-P1K5

Q

Type designation	P2	K2	P3	K0	P4K0 P5K5 P				P7	K5
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	HO NO		НО	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.	4.0		5.3		7.5		0
Protection rating IP20/Chassis <sup>6)</sup>	А	2	А	2	A:	2	А	.3	А3	
Protection rating IP55/Type 12	A4/	٨٥	A4/	/	A4/	'ΛΕ	_	.5	А	_
Protection rating IP66/NEMA 4X	A4/	AS	A4/	AS	A4/	AS		.5	A	3
Output current										
Continuous (3x380-440 V) [A]	5.	6	7.	.2	10	0	1	3	10	б
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	1	1	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									<u>·</u>	
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]	2	)	2	0	20		3	0	3	0
Additional specifications										
Protection ratings IP20, IP21										
maximum cable cross-section <sup>2)</sup> for					4, 4, 4 (12	2, 12, 12)				
mains, motor, brake, and load					(minimum	0.2 (24))				
sharing [mm² (AWG)]										
Protection ratings IP55, IP66										
maximum cable cross-section <sup>2)</sup> for					4, 4, 4 (12	) 12 12)				
mains, motor, brake, and load					7, 7, 7 (12	2, 12, 12)				
sharing [mm² (AWG)]										
Maximum cable cross-section <sup>2)</sup> for	6, 4, 4 (10, 12, 12)									
disconnect [mm² (AWG)]	6, 4, 4 (10, 12, 12)									
Estimated power loss <sup>3)</sup>	88 (0.12) 116 (0.16) 124 (0.17) 187 (0.25) 225				225 (	0.31)				
at rated maximum load [W (hp)] <sup>4)</sup>	00 ((	.14)		0.10)	124 (	0.17)	107	(0.23)	223 (	0.51)
Efficiency <sup>5)</sup>	0.9	97	0.9	97	0.9	97	0.	97	0.9	97

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Table 8.8 Mains Supply 3x380-480 V AC, P2K2-P7K5





Type designation	P1	P11K P15K P18K P22K P.							P3	30K	
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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 <sup>7)</sup>	В	3	В	3	В	3	В	4		B4	
Protection rating IP21/Type 1	В	B1 B1 B2 B2							Е	B2	
Protection rating IP55/Type 12	_	1		1	_	1		2	,	12	
Protection rating IP66/NEMA 4X	В	1	В	1	В	1	В	2	"	B2	
Output current	•										
Continuous (3x380-440 V) [A]	-	24	24	32	32	37.5	37.5	44	44	61	
Intermittent (60 s overload)	_	26.4	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1	
(3x380-440 V) [A]	_	20.4	30.4	33.2	31.2	41.3	00	40.4	70.4	67.1	
Continuous (3x441-480 V) [A]	-	21	21	27	27	34	34	40	40	52	
Intermittent (60 s overload)	_	23.1	33.6	29.7	43.2	37.4	54.4	44	64	61.6	
(3x441-480 V) [A]		23.1	33.0	29.7	73.2	37.4	54.4	77	0-	01.0	
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)	_	24.2	35.2	31.9	46.4	37.4	54.4	44	64	60.5	
(3x380-440 V) [A]		27.2	33.2	31.9	70.7	37.4	54.4	77	04	00.5	
Continuous (3x441–480 V) [A]	-	19	19	25	25	31	31	36	36	47	
Intermittent (60 s overload)	_	20.9	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7	
(3x441-480 V) [A]		20.5	30.4	27.3	70	34.1	45.0	33.0	37.0	31.7	
Maximum pre-fuses [A]	-	63		63		63		63		80	
Additional specifications											
Protection ratings IP21, IP55, IP66											
maximum cable cross-section <sup>2)</sup> for			16, 10, 16	5 (6 8 6)				35 – –	(2, -, -)		
mains, brake, and load sharing			10, 10, 10	(0, 0, 0)				33, ,	(2, , )		
[mm² (AWG)]											
Protection ratings IP21, IP55, IP66											
maximum cable cross-section <sup>2)</sup> for			10, 10,–	(8, 8,-)				35, 25, 2	5 (2, 4, 4)		
motor [mm² (AWG)]											
Protection rating IP20 maximum											
cable cross-section <sup>2)</sup> for mains,		10, 10,- (8, 8,-)									
brake, motor, and load sharing		33, , (2, , ,									
[mm² (AWG)]											
Maximum cable cross-section <sup>2)</sup> for					16 10 10	(6 9 9)					
disconnect [mm² (AWG)]					16, 10, 10	(0, 8, 8)					
Estimated power loss <sup>3)</sup>	201 (2.1)	392	201 (2.1)	392	379	465	444	525	547	726 (1)	
at rated maximum load [W (hp)] <sup>4)</sup>	291 (0.4)	(0.53)	291 (0.4)	(0.53)	(0.52)	(0.63)	(0.61)	(0.72)	(0.75)	739 (1)	
Efficiency <sup>5)</sup>	0.9	98	0.9	98	0.9	98	0.9	98	0.	98	

Table 8.9 Mains Supply 3x380-480 V AC, P11K-P30K



Type designation	P3	7K	P4	5K	P5	5K	P7	′5K	P9	0K
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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 <sup>6)</sup>	В	4		.3	C	3	C	.4		4
Protection rating IP21/Type 1	C	:1		.1	С	:1		2		.2
Protection rating IP55/Type 12										-2
Protection rating IP66/NEMA 4X	C	.1		1	C	.1		2		.2
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			l	l			ı		l	
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]	1(	00	125		16	<u>.                                    </u>	2.	50	2:	50
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 (30	0 MCM)	) 150 (300 MCM)	
Protection ratings IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> (AWG)]	50	(1)	50 (1)		50	(1)	95 (	(3/0)	95 (	(3/0)
Maximum cable cross-section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> (AWG)]				35, 35 2, 2)				70, 70 /0, 2/0)	185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss <sup>3)</sup> at rated maximum load [W (hp)] <sup>4)</sup>	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 <sup>5)</sup>	0.9	98	0.	98	0.9	98	0.	98	0.	99
			-							

Table 8.10 Mains Supply 3x380-480 V AC, P37K-P90K



## 8.1.5 Mains Supply 3x525-600 V AC

Type designation	Pk	(75	P1	K1	P1	K5	P2	K2	
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	
Typical shaft output [kW]	0.	75	1.1		1	.5	2.2		
Typical shaft output [hp]		1	1	1.5		2	3		
Protection rating IP20/Chassis	,	١3		.3		١3	A3		
Protection rating IP21/Type 1	<i>'</i>	13		13		13	^	.5	
Protection rating IP55/Type 12	A	۸5	Α	.5	A	۸5	А	.5	
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		.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]	1	0	1	0	1	0	20		
Additional specifications									
Maximum cable cross-section <sup>2)</sup> for				444/	(10 10 10)				
mains, motor, brake, and load sharing					(12,12,12) ım 0.2 (24))				
[mm² (AWG)]				(111111111)	1111 0.2 (24))				
Maximum cable cross-section <sup>2)</sup> for					(10.12.12)				
mains disconnect [mm² (AWG)]				0,4,4 (	(10,12,12)				
Estimated power loss <sup>3)</sup>	25.	0.05)	F0 /	0.07)			62.4	2.12)	
at rated maximum load [W (hp)] <sup>4)</sup>	35 (	0.05)	50 (	0.07)	65 (	0.09)	92 (0.13)		
Efficiency <sup>5)</sup>	0.	97	0.	97	0.	97	0.97		

Table 8.11 Mains Supply 3x525-600 V AC, PK75-P2K2

g

# Danfoss

Type designation	P3	K0	P4	K0	P5	5K5	P7	K5	
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	
Typical shaft output [kW]	3.0		4.0		5	5.5	7.5		
Typical shaft output [hp]	4	1		5	7	'.5	1	10	
Protection rating IP20/Chassis	A2			2		12			
Protection rating IP21/Type 1	А	.2	<i>P</i>	.2	<i>'</i>	/3	A3		
IP55/Type 12	А	5	Д	15	A	<b>\</b> 5	A	5	
Output current					•		•		
Continuous (3x525-550 V) [A]	5.	.2	6	.4	ç	).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		ç	0.0	11.0		
Continuous kVA at 550 V [kVA]	4.	.9	6.1		ç	0.0	11.0		
Maximum input current			•				•		
Continuous (3x525-600 V) [A]	5.	.2	5	.8	8	3.6	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]	2	0	2	.0	3	32	32		
Additional specifications									
Maximum cable cross-section <sup>2)</sup> for				4447	12,12,12)				
mains, motor, brake, and load sharing				, , ,	m 0.2 (24))				
[mm² (AWG)]				(IIIIIIIIIIII	111 0.2 (24))				
Maximum cable cross-section <sup>2)</sup> for				C 4 4 (	10 12 12)				
mains disconnect [mm² (AWG)]				6,4,4 (	10,12,12)				
Estimated power loss <sup>3)</sup>	122 /	0.47)	1.45	(0.2)	105	(0.27)			
at rated maximum load [W (hp)] <sup>4)</sup>	122 (	U.17)	145	(0.2)	195	(0.27)	261 (	261 (0.36)	
Efficiency <sup>5)</sup>	0.9	97	0.	97	0.	.97	0.9	97	

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Table 8.12 Mains Supply 3x525-600 V AC, P3K0-P7K5



Type designation	P1	1K	P1	5K	P1	8K	P2	2K	P3	0K	P3	7K
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	NO	НО	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/								30	- 50			
Chassis	В	3	В	33	В	3	В	34	В	34	В	4
Protection rating IP21/												
Type 1												
Protection rating IP55/								12				
Type 12	B	1		31	В	1		32	8	32	'	1
Protection rating IP66/												
NEMA 4X												
Output current												
Continuous (3x525-550 V)	11.5	19	19	23	23	28	28	36	36	43	43	54
[A]	11.5	19	19	23	23	20	20	30	30	73	73	34
Intermittent (3x525–	18.4	21	30	25	37	31	45	40	58	47	65	59
550 V) [A]	10.1		30	23	3,	31	.5	10	30	.,	03	3,
Continuous (3x551-600 V)	11	18	18	22	22	27	27	34	34	41	41	52
[A]						,						
Intermittent (3x551– 600 V) [A]	17.6	20	29	24	35	30	43	37	54	45	62	57
Continuous kVA at 550 V	11	18.1	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
[kVA]	- ' '	10.1	10.1	21.9	21.9	20.7	20.7	34.3	34.3	41.0	41.0	31.4
Continuous kVA at 575 V	11	17.9	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
[kVA]		17.5	17.5	21.5	21.5	20.5	20.5	33.7	33.7	40.0	40.0	31.0
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]	4	0	4	10	5	0	6	50	8	80	10	00
Additional specifications												
Protection rating IP20,												
maximum cable cross-			10,	10,-					35,	-,-		
section <sup>2)</sup> for mains, brake,			(8,						(2,-			
motor, and load sharing			(-)	-, ,					(-/	, ,		
[mm² (AWG)]												
Protection ratings IP21,												
IP55, IP66 maximum cable			16, 1	0, 10					35,	-,-		
cross-section <sup>2)</sup> for mains,			(6, 8						(2,-			
brake, and load sharing												
[mm² (AWG)]												
Protection ratings IP21,												
IP55, IP66 maximum cable			10,							5, 25		
cross-section <sup>2)</sup> for motor			(8, 8	ŏ,−)					(2, 4	+, 4)		
[mm² (AWG)]											l	
Maximum cable cross-					16, 10	, 10					50, 3	5, 35
section <sup>2)</sup> for mains					(6, 8,						l	2, 2)
disconnect [mm² (AWG)]												
Estimated power loss <sup>3)</sup>	220	300	220	300	300	370	370	440	440	600	600	
at rated maximum load	(0.3)	(0.41)	(0.3)	(0.41)	(0.41)	(0.5)	(0.5)	(0.6)	(0.6)	(0.82)	(0.82)	740 (1)
[W (hp)] <sup>4)</sup>												
Efficiency <sup>5)</sup>	0.	98	0.	98	0.9	98	0.	98	0.	98	0.	98

Table 8.13 Mains supply 3x525-600 V AC, P11K-P37K



Type designation	P4	5K	P5	55K	P7	5K	P9	ОК		
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	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	C	3	(	C3 C4				C4		
Protection rating IP21/Type 1										
Protection rating IP55/Type 12	C	1		1	C	.2		2		
Protection rating IP66/NEMA 4X										
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					ı		ı	ı		
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]	1.	50	1	60	22	25	2:	50		
Additional specifications										
Protection rating IP20 maximum cable										
cross-section for mains and motor		50	(1)			150 (30	00 MCM)			
[mm² (AWG)]										
Protection rating IP20 maximum cable										
cross-section for brake and load		50	(1)			95	(4/0)			
sharing [mm² (AWG)]										
Protection ratings IP21, IP55, IP66										
maximum cable cross-section for		50	(1)			150 (2)	00 MCM)			
mains and motor		50	(1)			150 (50	00 MCM)			
[mm² (AWG)]										
Protection ratings IP21, IP55, IP66										
maximum cable cross-section for		50	(1)			95	(4/0)			
brake and load sharing [mm² (AWG)]										
Maximum cable cross-section <sup>2)</sup> for		50, 3	5 25		05 7	0, 70	185, 1	50, 120		
mains disconnect [mm² (AWG)]		(1, 2	•		l '	/0, 2/0)	(350 MCM,	(350 MCM, 300 MCM,		
		(1, 2	-, -,		(3/0, 2)	· · · · · · · · · · · · · · · · · · ·	4/	(0)		
Estimated power loss <sup>3)</sup>	740 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1500 (2)	1500 (2)	1800 (2.5)		
at rated maximum load [W (hp)] <sup>4)</sup>	/ <del>4</del> 0 (1)	900 (1.2)	900 (1.2)	1100 (1.5)	1100 (1.5)	1300 (2)	1300 (2)	1000 (2.3)		
Efficiency <sup>5)</sup>	0.	98	0.	98	0.	98	0.98			

Table 8.14 Mains supply 3x525-600 V AC, P45K-P90K



## 8.1.6 Mains Supply 3x525-690 V AC

Type designation	P1	K1	P1	K5	P2	K2	P3	K0	P4	K0	P5	K5	P7	K5
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	NO	НО	NO	НО	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	4	:	5	7	.5	1	0
IP20/Chassis	Α	١3	Α	١3	Α	١3	А	١3	Α	.3	А	.3	А	.3
Output current											•			
Continuous (3x525–550 V) [A]	2	.1	2	.7	3	.9	4	.9	6	.1	9	.0	11	1.0
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	0.0
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	0.0
Continuous kVA at 690 V [kVA]	1	.9	2	.6	3	.8	5	.4	6	.6	9	.0	12	2.0
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 <sup>2)</sup>							4, 4	4, 4						
for mains, motor, brake, and load							(12, 1	2, 12)						
sharing [mm² (AWG)]							(minim	um (24)						
Maximum cable cross-section <sup>2)</sup>							6	4, 4						
for mains disconnect							,	4, 4 2, 12)						
[mm² (AWG)]							(10, 1	2, 12)						
Estimated power loss <sup>3)</sup>														
at rated maximum load [W (hp)] <sup>4)</sup>	44 (	0.06)	60 (	0.08)	88 (	0.12)	120 (	(0.16)	160	(0.22)	220	(0.3)	300 (	(0.41)
Efficiency <sup>5)</sup>	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	P1	1K	P1	5K	P1	8K	P2	2K	P3	0K
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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	В	4	В	4	В	4	В	4	В	4
IP21/Type 1										
IP55/Type 12	В	32	В	2	В	2	В	2	В	2
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 <sup>2</sup> for mains,					35, 2	25, 25				
motor, brake, and load sharing [mm <sup>2</sup> (AWG)]					(2,	4, 4)				
Maximum cable cross–section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> (AWG)]					,	0,10 8, 8)				
Estimated power loss <sup>3)</sup>	150	220	150	220	220	300	300	370	370	440
at rated maximum load [W (hp)] <sup>4)</sup>	(0.2)	(0.3)	(0.2)	(0.3)	(0.3)	(0.41)	(0.41)	(0.5)	(0.5)	(0.6)
Efficiency <sup>5)</sup>	0.	98	0.	98	0.9	98	0.9	98	0.9	98

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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	P:	37K	P4	5K	P5	5K	P75K/	N75K <sup>8)</sup>	P90K/	N90K <sup>8)</sup>
High/normal overload <sup>1)</sup>	НО	NO	НО	NO	НО	NO	НО	NO	НО	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	-	34	C	3	C	3	D:	3h	D:	3h
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					150 (20)	) MCM)				
motor [mm² (AWG)]	150 (300 MCM)									
Maximum cable cross-section for brake and					95 (	2 /0)				
load sharing [mm² (AWG)]					95 (	3/0)				
Maximum cable cross-section <sup>2)</sup> for mains							185, 15	50, 120		
disconnect [mm² (AWG)]	95 (3/0)					(350 MCM, 300		_		
disconnect [IIIII (AWG)]							MCM	, 4/0)		
Estimated power loss <sup>3)</sup>	600	740 (1)	740 (1)	900	900	1100	1100	1500	1500	1800
at rated maximum load [W (hp)] <sup>4)</sup>	(0.82)	7 70 (1)	7 -10 (1)	(1.2)	(1.2)	(1.5)	(1.5)	(2)	(2)	(2.5)
Efficiency <sup>5)</sup>	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.



#### 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.

#### 8.3 Motor Output and Motor Data

Motor output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0-590 Hz <sup>1)</sup>
Switching on output	Unlimited
Ramp times	1–3600 s

<sup>1)</sup> Dependent on power size.

Torque characteristics, normal overload

Starting torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes <sup>2)</sup>
Overload torque (constant torque)	Maximum 110% for 1 minute, once in 10 minutes <sup>2)</sup>

Torque characteristics, high overload

Starting torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes <sup>2)</sup>
Overload torque (constant torque)	Maximum 150/160% for 1 minute, once in 10 minutes <sup>2)</sup>

<sup>2)</sup> Percentage relates to the nominal torque of the frequency converter, dependent on power size.



#### 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 a
Maximum relative humidity 5–95	% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated	(lass 3(2)
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 Condition	ions 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 de	sign guide.
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class <sup>1)</sup>	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 <sup>1)</sup>	
Maximum cross-section to control terminals, rigid wire	1.5 mm <sup>2</sup> or 2 x 0.75 mm <sup>2</sup> (16 AWG)
Maximum cross-section to control terminals, flexible cable	1 mm² (18 AWG)
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm <sup>2</sup> (20 AWG)
Minimum cross-section to control terminals	0.25 mm <sup>2</sup> (24 AWG)

<sup>1)</sup> 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<sup>2</sup> (8 AWG) or 2 rated mains wires terminated separately according to EN 50178. See alsochapter 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).



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 <sub>i</sub>	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/S202=On (I)
Current level	0/4-20 mA (scaleable)
Input resistance, R <sub>i</sub>	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.

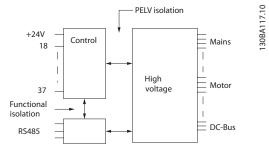


Illustration 8.1 PELV Isolation of Analog Inputs

Λ	l		
Ana	loq	output	

Thatog catput	
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 <sup>1)</sup> , 29 <sup>1)</sup> , 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 <sub>i</sub>	Approximately 4 k $\Omega$

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.



Maximum error 0.1% of full scale

12 bit

Specifications	Operating Guide	<i>0-</i>
Specifications	Operating Guide	
Digital output		
Programmable digital/pulse	outputs	2
Terminal number		27, 29 <sup>1)</sup>
Voltage level at digital/frequence	ency output	0-24 V
Maximum output current (sir		40 mA
Maximum load at frequency		1 kΩ
Maximum capacitive load at		10 nF
Minimum output frequency	at frequency output	0 Hz
Maximum output frequency	at frequency output	32 kHz

<sup>1)</sup> 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 <sub>i</sub>	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error 0.1% of full scale

#### Control card, 24 V DC output

Accuracy of frequency output

Resolution of frequency outputs

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

nearly surpus	
Programmable relay outputs	2
Relay 01 terminal number	1-3 (break), 1-2 (make)
Maximum terminal load (AC-1) <sup>1)</sup> on 1-3 (NC), 1-2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 1-2 (NO), 1-3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13) <sup>1)</sup> (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4-6 (break), 4-5 (make)
Maximum terminal load (AC-1) <sup>1)</sup> on 4-5 (NO) (resistive load) <sup>2) 3)</sup>	400 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> on 4-5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 4-5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13) <sup>1)</sup> on 4-5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1) <sup>1)</sup> on 4-6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> on 4-6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 4-6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13) <sup>1)</sup> 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

<sup>1)</sup> 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, To 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.

Contro				

Control card 10 V DC output

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 (fu	ıll speed)
USB plug USB type B "dev	vice" plug

#### 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)
А3	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)
В3	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) <sup>1)</sup>	14/24 (124/221) <sup>1)</sup>	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) <sup>1)</sup>	14/24 (124/221) <sup>1)</sup>	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 mm² (3 AWG) and y≥95 mm² (3 AWG).



#### 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  $A_{rms}$ .

### 8.8.1 CE Compliance

Enclosure	Power [kW (hp)]	Recommended	Recommended	Recommended circuit	Maximum trip level
		fuse size	maximum fuse	breaker	[A]
				Moeller	
A2	0.25-2.2	gG-10 (0.25-1.5)	gG-25	PKZM0-25	25
	(0.34–3)	gG-16 (2.2)			
A3	3.0-3.7	gG-16 (3)	gG-32	PKZM0-25	25
	(4–5)	gG-20 (3.7)			
A4	0.25-2.2	gG-10 (0.25-1.5)	gG-32	PKZM0-25	25
	(0.34–3)	gG-16 (2.2)			
A5	0.25-3.7	gG-10 (0.25-1.5)	gG-32	PKZM0-25	25
	(0.34–5)	gG-16 (2.2-3)			
		gG-20 (3.7)			
B1	5.5–11	gG-25 (5.5)	gG-80	PKZM4-63	63
	(7.5–15)	gG-32 (7.5)			
B2	15 (20)	gG-50	gG-100	NZMB1-A100	100
В3	5.5–11	gG-25	gG-63	PKZM4-50	50
	(7.5–15)				
B4	15–18	gG-32 (7.5)	gG-125	NZMB1-A100	100
	(20–24)	gG-50 (11)			
		gG-63 (15)			
C1	18.5–30	gG-63 (15)	gG-160 (15-18.5)	NZMB2-A200	160
	(25–40)	gG-80 (18.5)	aR-160 (22)		
		gG-100 (22)			
C2	37–45	aR-160 (30)	aR-200 (30)	NZMB2-A250	250
	(50–60)	aR-200 (37)	aR-250 (37)		
C3	22–30	gG-80 (18.5)	gG-150 (18.5)	NZMB2-A200	150
	(30–40)	aR-125 (22)	aR-160 (22)		
C4	37–45	aR-160 (30)	aR-200 (30)	NZMB2-A250	250
	(50–60)	aR-200 (37)	aR-250 (37)		

Table 8.19 200–240 V, Enclosure Sizes A, B, and C

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Enclosure	Power [kW (hp)]	Recommended	Recommended	Recommended circuit	Maximum trip level
		fuse size	maximum fuse	breaker	[A]
				Moeller	
A2	1.1-4.0	gG-10 (0.37-3)	gG-25	PKZM0-25	25
	(1.5–5)	gG-16 (4)			
A3	5.5-7.5	gG-16	gG-32	PKZM0-25	25
	(7.5–10)				
A4	1.1-4.0	gG-10 (0.37-3)	gG-32	PKZM0-25	25
	(1.5–5)	gG-16 (4)			
A5	1.1-7.5	gG-10 (0.37-3)	gG-32	PKZM0-25	25
	(1.5–10)	gG-16 (4-7.5)			
B1	11–18.5	gG-40	gG-80	PKZM4-63	63
	(15–25)				
B2	22–30	gG-50 (18.5)	gG-100	NZMB1-A100	100
	(30–40)	gG-63 (22)			
В3	11–18	gG-40	gG-63	PKZM4-50	50
	(15–24)				
B4	22–37	gG-50 (18.5)	gG-125	NZMB1-A100	100
	(30–50)	gG-63 (22)			
		gG-80 (30)			
C1	37–55	gG-80 (30)	gG-160	NZMB2-A200	160
	(50–75)	gG-100 (37)			
		gG-160 (45)			
C2	75–90	aR-200 (55)	aR-250	NZMB2-A250	250
	(100–125)	aR-250 (75)			
C3	45–55	gG-100 (37)	gG-150 (37)	NZMB2-A200	150
	(60–75)	gG-160 (45)	gG-160 (45)		
C4	75–90	aR-200 (55)	aR-250	NZMB2-A250	250
	(100–125)	aR-250 (75)			

Table 8.20 380-480 V, Enclosure Sizes A, B, and C



Enclosure	Power [kW (hp)]	Recommended	Recommended	Recommended circuit	Maximum trip level
		fuse size	maximum fuse	breaker	[A]
				Moeller	
A2	1.1-4.0	gG-10	gG-25	PKZM0-25	25
	(1.5–5)				
A3	5.5-7.5	gG-10 (5.5)	gG-32	PKZM0-25	25
	(7.5–10)	gG-16 (7.5)			
A5	1.1-7.5	gG-10 (0.75-5.5)	gG-32	PKZM0-25	25
	(1.5–10)	gG-16 (7.5)			
B1	11–18	gG-25 (11)	gG-80	PKZM4-63	63
	(15–24)	gG-32 (15)			
		gG-40 (18.5)			
B2	22-30	gG-50 (22)	gG-100	NZMB1-A100	100
	(30–40)	gG-63 (30)			
В3	11–18.5	gG-25 (11)	gG-63	PKZM4-50	50
	(15–25)	gG-32 (15)			
B4	22-37	gG-40 (18.5)	gG-125	NZMB1-A100	100
	(30–50)	gG-50 (22)			
		gG-63 (30)			
C1	37–55	gG-63 (37)	gG-160 (37-45)	NZMB2-A200	160
	(50–75)	gG-100 (45)	aR-250 (55)		
		aR-160 (55)			
C2	75–90	aR-200 (75)	aR-250	NZMB2-A250	250
	(100–125)				
C3	45–55	gG-63 (37)	gG-150	NZMB2-A200	150
	(60–75)	gG-100 (45)			
C4	75–90	aR-160 (55)	aR-250	NZMB2-A250	250
	(100–125)	aR-200 (75)			

Table 8.21 525-600 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended	Recommended circuit	Maximum trip
			maximum fuse	breaker	level [A]
				Danfoss	
	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
A3	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
	11 (15)	gG-25	gG-63	-	-
B2	15 (20)	gG-25	gG-63	-	-
DZ.	18 (24)	gG-32	-	-	-
	22 (30)	gG-32	-	-	-
	30 (40)	gG-40	-	-	-
	37 (50)	gG-63	gG-80	-	-
C2	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	Maxi-	Buss-	Buss-	Buss-	Buss-	Buss-	Buss-	Buss-	SIBA	Littelfu	Ferraz-	Ferraz-	Ferraz-
[kW	mum	mann	mann	mann	mann	mann	mann	mann	RK1	se	Shawmut	Shawmut	Shawmut
(hp)]	prefuse	JFHR2	RK1	J	Т	cc	cc	cc		RK1	CC	RK1	J
	size [A]												
1.1						FNQ-	KTK-	LP-	5017906-	KLN-			
(1.5)	15	FWX-15	KTN-R15	JKS-15	JJN-15	R-15	R-15	CC-15	016	R15	ATM-R15	A2K-15R	HSJ15
						FNQ-	KTK-	LP-	5017906-	KLN-			
1.5 (2)	20	FWX-20	KTN-R20	JKS-20	JJN-20	R-20	R-20	CC-20	020	R20	ATM-R20	A2K-20R	HSJ20
						FNQ-	KTK-	LP-	5012406-	KLN-			
2.2 (3)	30 <sup>1)</sup>	FWX-30	KTN-R30	JKS-30	JJN-30	R-30	R-30	CC-30	032	R30	ATM-R30	A2K-30R	HSJ30
										KLN-			
3.0 (4)	35	FWX-35	KTN-R35	JKS-35	JJN-35	-	-	-	-	R35	-	A2K-35R	HSJ35
									5014006-	KLN-			
3.7 (5)	50	FWX-50	KTN-R50	JKS-50	JJN-50	-	-	-	050	R50	-	A2K-50R	HSJ50
5.5									5014006-	KLN-			
(7.5)	60 <sup>2)</sup>	FWX-60	KTN-R60	JKS-60	JJN-60	1	-	_	063	R60	-	A2K-60R	HSJ60
7.5									5014006-	KLN-			
(10)	80	FWX-80	KTN-R80	JKS-80	JJN-80	-	_	-	080	R80	_	A2K-80R	HSJ80
15		FWX-	KTN-						2028220-	KLN-			
(20)	150	150	R150	JKS-150	JJN-150	-	-	-	150	R150	-	A2K-150R	HSJ150
22		FWX-	KTN-						2028220-	KLN-			
(30)	200	200	R200	JKS-200	JJN-200	-	-	_	200	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)]	Maxi- mum pre- fuse size	Buss- mann JFHR2	Buss- mann RK1	Buss- mann J	Buss- mann T	Buss- mann CC	Buss- mann CC	Buss- mann CC	SIBA RK1	Littelfus e RK1	Ferraz- Shawmut CC	Ferraz- Shawmut RK1	Ferraz- Shawmut J	
	[A]													
7.5									5014006-					
(10)	60	FWH-60	KTS-R60	JKS-60	JJS-60	-	-	_	063	KLS-R60	-	A6K-60R	HSJ60	
									2028220-					
11 (15)	80	FWH-80	KTS-R80	JKS-80	JJS-80	-	-	-	100	KLS-R80	-	A6K-80R	HSJ80	
		FWH-	KTS-						2028220-					
22 (30)	150	150	R150	JKS-150	JJS-150	-	_	-	160	KLS-R150	-	A6K-150R	HSJ150	
		FWH-	KTS-						2028220-					
37 (50)	200	200	R200	JKS-200	JJS-200	ı	_	-	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.





			Recommende	d maximum fuse		
Power [kW	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
(hp)]	Type RK1 1)	Type J	Type T	Type CC		Type CC
0.25-0.37	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
(0.34-0.5)						
0.55-1.1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
(0.75–1.5)						
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	KTN-R-50	JKS-50	JJN-50	-	-	-
(7.5–10)						
11 (15)	KTN-R-60	JKS-60	JJN-60	-	-	-
15 (20)	KTN-R-80	JKS-80	JJN-80	-	-	-
18.5–22	KTN-R-125	JKS-125	JJN-125	-	-	-
(25-30)						
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

			Re	commended ma	aximum fuse			
Power [kW	SIBA	Littelfuse	Ferraz-	Ferraz-	Bussmann	Littelfuse	Ferraz-	Ferraz-
(hp)]	Type RK1	Type RK1	Shawmut	Shawmut	Type JFHR23)	JFHR2	Shawmut	Shawmut
	·		Type CC	Type RK1 <sup>2)</sup>	''		JFHR2 <sup>4)</sup>	J
0.25-0.37	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	-	-	HSJ-6
(0.34-0.5)								
0.55-1.1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	_	-	HSJ-10
(0.75–1.5)								
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	5014006-050	KLN-R-50	-	A2K-50-R	FWX-50	_	-	HSJ-50
(7.5–10)								
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	2028220-125	KLN-R-125	-	A2K-125-R	FWX-125	_	-	HSJ-125
(25-30)								
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	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW (hp)]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
-	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.1-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
(1.5–3)						
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

			Re	ecommended ma	aximum fuse			
Power	SIBA	Littelfuse	Ferraz-	Ferraz-	Bussmann	Ferraz-	Ferraz-	Littelfuse
[kW (hp)]	Type RK1	Type RK1	Shawmut	Shawmut	JFHR2	Shawmut	Shawmut	JFHR2
			Type CC	Type RK1		J	JFHR2 <sup>1)</sup>	
-	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	-	-
1.1-2.2	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	-	-
(1.5–3)								
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.





					Recommend	led maximui	m fuse			
Power	Bussmann	Bussman	Bussmann	Bussmann	Bussman	Bussman	SIBA	Littelfuse	Ferraz-	Ferraz-
[kW	Type RK1	n	Type T	Type CC	n	n	Type RK1	Type RK1	Shawmut	Shawmut
(hp)]		Type J			Type CC	Type CC			Type RK1	J
0.75-	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
1.1										
(1–1.5)										
1.5-2.2	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
(2-3)										
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	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)										
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	KTS-R-35	JKS-35	JJS-35	-	-	-	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
(15–20)										
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	KTS-R-150	JKS-150	JJS-150	-	-	-	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
(100)										
90	KTS-R-175	JKS-175	JJS-175	-	-	-	2028220-200	KLS-R-175	A6K-175-R	HSJ-175
(125)										

Table 8.29 3x525-600 V, Enclosure Sizes A, B, and C

	Recommended maximum fuse							
Power	Maximum	Bussmann	Bussmann	Bussmann	SIBA	Littelfuse	Ferraz-	Ferraz-
[kW	pre-fuse	E52273	E4273	E4273	E180276	E81895	Shawmut	Shawmut
(hp)]	[A]	RK1/JDDZ	J/JDDZ	T/JDDZ	RK1/JDDZ	RK1/JDDZ	E163267/E2137	E2137
							RK1/JDDZ	J/HSJ
11–15	30	KTS-R-30	JKS-30	JJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
(15–20)								
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

a



### 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 (	) (0.5–5)	5.5-	-7.5	0.37-4.0	0.37-7.5 (0.5-
3,550 150 1	L	0.57 1.0	(0.5 5)	(7.5–10)		(0.5–5)	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		20	21	20	21	55/66	55/66
NEMA		Chassis	Type 1	Chassis	Type 1	Type 12/4X	Type 12/4X
Height [mm (in)]	•	•	,				
Height of backplate	A <sup>1)</sup>	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	А	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	В	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	В	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	-	242 (9.5)
Width of backplate with 2 C options	В	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 <sup>2)</sup> [mm (in)]	•	•	•		•		
Without option A/B	С	205 (8.1)	205 (8.1)	205 (8.1)	205 (8.1)	175 (6.9)	200 (7.9)
With option A/B	С	220 (8.7)	220 (8.7)	220 (8.7)	220 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]	•		•		•		
	С	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)
	е	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)

<sup>1)</sup> See Illustration 3.4 and Illustration 3.5 for top and bottom mounting holes.

Table 8.31 Power Ratings, Weight, and Dimensions, Enclosure Sizes A2-A5

<sup>2)</sup> Depth of enclosure varies with different options installed.



Enclosure size [kW (hp)]		B1	B2	В3	B4	C1	C2	C3	C4
3x525-690 V	T7	-	11–30 (15–40)	-	-	-	37–90 (50–125)	-	-
3x525-600 V	Т6	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)]			ı	1					
Height of backplate	A <sup>1)</sup>	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	А	-	-	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	В	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	В	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	В	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 <sup>2)</sup> [mm (in)]				•	•	•		•	•
Without option A/B	С	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	С	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)]									
	С	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)	-	-
	е	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)

<sup>1)</sup> See Illustration 3.4 and Illustration 3.5 for top and bottom mounting holes.

Table 8.32 Power Ratings, Weight, and Dimensions, Enclosure Sizes B1-B4, C1-C4

8

<sup>2)</sup> Depth of enclosure varies with different options installed.



## 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 <sub>M,N</sub>	Nominal motor frequency
FC	Frequency converter
linv	Rated inverter output current
Ішм	Current limit
lm,n	Nominal motor current
IVLT,MAX	Maximum output current
IVLT,N	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n <sub>s</sub>	Synchronous motor speed
P <sub>M,N</sub>	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 <sub>LIM</sub>	Torque limit
U <sub>M,N</sub>	Nominal motor voltage
5-	

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).





Appendix	Operating Guide
Terminal 29 Digital Output Term X30/6 Digi Out (MCB 101) Term X30/7 Digi Out (MCB 101) Relays On Delay, Relay Off Delay, Relay Off Delay, Relay Fure in put Term 79 I ow Frequency	Term. 29 High Frequency Term. 29 Low Ref/Freedb. Value Term. 29 Low Ref/Freedb. Value Term. 29 Low Ref/Freedb. Value Pulse Filter Time Constant #29 Term. 33 High Refyreedb. Value Term. 34 Low Refyreedb. Value Term. 35 High Refyreedb. Value Term. 36 Low Refyreedb. Value Term. 36 Low Refyreedb. Value Term. 37 High Refyreedb. Value Term. 37 High Refyreedb. Value Term. 38 High Refyreedb. Value Pulse Output Max Freq #79 Term. 39 Pulse Output Variable Pulse Output Max Freq #79 ANF Cap Reconnect Delay Bus Controlled Digital & Relay Bus Control Pulse Out #27 Timeout Preset Pulse Out #27 Timeout Preset Pulse Out #29 Bus Control Pulse Out #37 Timeout Preset Pulse Out #38 Timeout Preset Pulse Out #38 Timeout Preset Analog In/Out Analog In/Out Analog In/Out Analog In/Out Analog In/Out Terminal 53 Low Voltage Terminal 53 Low Current Terminal 53 Low Current Terminal 53 Low Current Terminal 53 Low Current Terminal 53 Low Voltage Terminal 54 Low Voltage Terminal 54 Low Voltage Terminal 54 High Current Terminal 54 Low Ref./Feedb. Value Terminal 54 Live Zero Analog In/Out Terminal 54 Live Zero Analog In/Out Terminal 54 Live Zero
5-31 5-32 5-32 5-40 5-40 5-41 5-42 5-55	5.53 5.54 5.55 5.55 5.55 5.56 6.00 6.01 6.01 6.02 6.03
Digital Pot.Meter Step Size Ramp Time Power Restore Maximum Limit Minimum Limit Ramp Delay Maror I imites	Motor Speed Direction Motor Speed Low Limit [RPM] Motor Speed Low Limit [Hz] Motor Speed High Limit [RPM] Motor Speed High Limit [RPM] Motor Speed High Limit [Hz] Motor Speed High Limit [Hz] Motor Speed High Limit [Hz] Motor Elimit Motor Mode Current Limit Max Output Frequency  Adj. Warnings  Adj. Warnings  Adj. Warnings  Adj. Warning Speed Low Warning Speed High Warning Reference Low Warning Speed High Warning Reference Low Warning Reference High Warning Reference Low Warning Reference Low Warning Reference Low Warning Reference Low Warning Reference High Warning Reference High Warning Reference High Warning Reference High Warning Reference Low Warning Reference High Warning Reference High Warning Reference High Warning Speed From [Hz] Bypass Speed From [Hz] Bypass Speed To [Hz] Speed Bypass Speed To [Hz] Speed Bypass Speed To [Hz] Speed Bypass Speed To [Hz] Bypass Sp
3-9* 3-90 3-91 3-92 3-94 3-95 4-*	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
Stop Adjustments Function at Stop Min Speed for Function at Stop [RPM] Min Speed for Function at Stop [Hz] Min Speed Low [RPM] Trip Speed Low [RPM] Trip Speed Low [Hz] Moor Temperature Moor Temperature Moor Temperature Moor Temperature Moor Temperature Moor Temperature	
1-79 1-88 1-80 1-82 1-85 1-87 1-90	
Torque Characteristics Overload Mode Overload Mode Ofockwise Direction Motor Selection Motor Construction VVC+ PM/SYN RM Damping Gain Low Speed Filter Time Const. High Snead Filter Time Const.	Motor Data Motor Power [kW] Motor Power [kW] Motor Power [kW] Motor Voltage Motor Current Motor Current Motor Manial Speed Motor Current Motor Manial Speed Motor Corn. Rated Torque Motor Retation Check Motor Resistance (RA) Motor Resistance (RA) Retor Resistance (RA) Main Reactance (XI) Retor Resistance (RA) Main Reactance (XI) Retor Leakage Reactance (XI) Retor Leakage Reactance (XI) Motor Massistance (RA) Main Reactance (LG) q-axis Inductance 5at. (LdSat) G-axis Inductance 5at. (LdSat) G-axis Inductance 5at. (LdSat) G-axis Inductance 5at. Point Load Indep. Setting Motor Magnetisation at Zero Speed Min Speed Normal Magnetising [HZ] W/f Characteristic - f Flying Start Test Pulses Frequency Load Depen. Setting Load Depen. Setting Load Depen. Setting Load Load Compensation High Speed Load Compensation Silp Compensation Silp Compensation Time Constant Min. Current at Low Speed Start Mode Start Mode Start Mode Start Loela Start Mode Start Loela Start Function Flying Start Compressor Start Max Speed [HZ]
1-03 1-04 1-10 1-14 1-15 1-15	1.52 1.15 1.15 1.15 1.15 1.15 1.15 1.15
*** Operation / Display  D** Basic Settings  D1 Language  Motor Speed Unit  Segional Settings  4 Operating State at Power-up  Local Mode Unit  Secup Operations  A Africe Security  A Africe Security	
0-03 0-03 0-03 0-04 0-05 0-13	0-1-10 0-1-12 0-1-13 0-13 0



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	-	
	-	

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	14-12 Hunchon at Mains Imbalance 14-12 Reset Functions 14-2 Reset Functions 14-2 Reset Functions 14-2 Auromatic Restar Time 14-2 Operation Mode 14-2 Trip Delay at Inverter Fault 14-2 Frip Delay at Torque Limit 14-3 Current Lim Ctr, Proportional Gain 14-3 Current Lim Ctr, Proportional Gain 14-3 Current Lim Ctr, Integration Time 14-3 Current Lim Ctr, Integration Time 14-3 Current Lim Ctr, Filter Time 14-4 VT Level 14-4 VT Level 14-5 Fauromment 14-5 Fauromment 14-5 Fauromment 14-5 Gapacitance Output Filter 14-5 Gapacitance Output Filter 14-5 Cuput Filter 14-5 Capacitance Output Filter 14-5 Fauromment 14-6 Faurom at Over Temperature 14-6 Faurom supplied by External 24/DC 14-9 Fault Level 14-9 Fault Level 15-0 Operating bours 15-0 Operating bours 15-0 Operating Hours 15-0 Over Temp's 15-0 Over Temp's 15-0 Reset Running Hours 15-0 Level Level 15-1 Logging Source
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View Datasheet Page 1 of 2

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
- □ Compressor-Screw
- Engines
- □ Medical
- □ Waste Water Aeration

- □ Blowers-Side Channel
- □ Construction\Contractor Industry
- □ Hydraulic Breathers fine filtration
- □ Pneumatic Conveying Systems
- □ Workshop

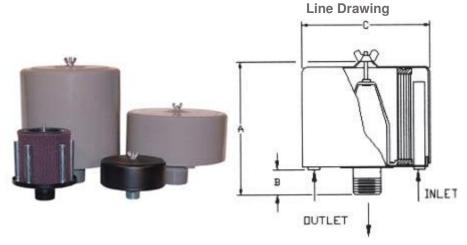
- □ Compressor-Piston
- □ Dental
- □ Industrial & Severe Duty
- □ Sparging

#### **FEATURES & SPECIFICATIONS**

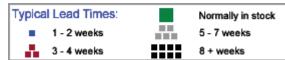
- □ ;99%+ removal efficiency std: Paper=2 micron, Polyester=5 micron
- □ Filter change out differential: 10"-15" in. H<sub>2</sub>O above initial delta P
- □ Interchangeable elements: Polyester, Paper, HEPA
- □ Pressure drop graphs available upon request
- Tubular silencing design tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with powder coated finish or galvanized steel
- Fully drawn weatherhood no welds to rust or vibrate apart
- □ Low pressure drop center bracket and outlet pipe design
- $\hfill\Box$  Temp (continuous): min -15  $^{\circ}$  F ( -26  $^{\circ}$  C) max 220  $^{\circ}$  F (104  $^{\circ}$  C)
- 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
- applications and machines these units are used on, a single insufficient. Please inquire for your specific requirement)

#### **OPTIONS**

- □ 1/8" tap holes for differential pressure gauges □ Available in Stainless Steel
- $\hfill\Box$  Hot dipped galvanized housings
- □ Special connections, BSPT/Metric
- Epoxy coated housings
- □ Various elements available



\*All measurements are shown in standards.



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 Ibs.	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

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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

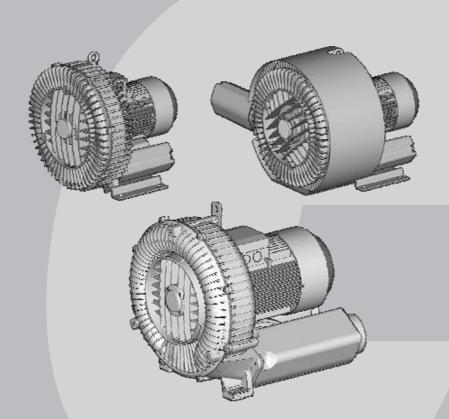
B601/2 - Blower, Elmo G200 2BH-1510-7HH56-Z

## **Operating instructions G-BH1, G-BH9**



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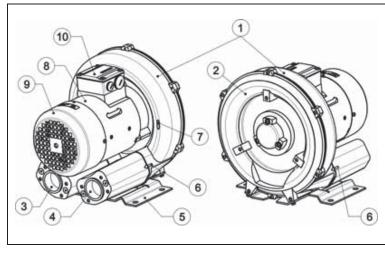


Fig. 1: Design of gas-ring vacuum pump/compressor

- 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

#### Safety

#### **Definitions**

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

#### Safety alert symbol 1.1.1

The **safety alert symbol**  $\triangle$  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.

#### 

#### Danger of injuries.

Indicates a potentially hazardous situation, that could result in death or serious injury if the corresponding measures are not taken.

#### 

#### 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!

<u>Start-up</u> and <u>operation</u> 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.

#### **⚠ 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 pumpmotor 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).

## 3 Technical Data

# 3.1 Mechanical data Weight

weight					
Single-impeller design	ı				
	Wei	ight			
Туре	[kg] approx.	[lbs] approx.			
2BH1100-70.	9	20			
2BH1200-70.	9	20			
2BH1300-70.	9	20			
2BH1300-71.	10	22			
2BH1300-72.	11	24			
2BH1330-70.	10	22			
2BH1330-71.	11	24			
2BH1330-72.	12	26			
2BH1400-70.	13	29			
2BH1400-71.	16	35			
2BH1400-72.	17	37			
2BH1430-70.	14	31			
2BH1430-71.	17	37			
2BH1430-72.	18	40			
2BH1500-70.	20	44			
2BH1500-71.	22	49			
2BH1500-72.	23	51			
2BH1500-73.	25	55			
2BH1530-70.	21	46			
2BH1530-71.	23	51			
2BH1530-72.	24	53			
2BH1530-73.	26	57			
2BH1600-70.	27	60			
2BH1600-71.	30	66			
2BH1600-72.	36	79			
2BH1600-73.	40	88			
2BH1600-76.	32	71			
2BH1600-77.	39	86			
2BH1630-70.	29	64			
2BH1630-71.	32	71			
2BH1630-72.	37	82			
2BH1630-73.	43	95			
2BH1630-76.	34	75			
2BH1630-77.	40	88			

Single-impeller design					
	Weight				
Туре	[kg] approx.	[lbs] approx.			
2BH18070.	117	258			
2BH18071.	126	278			
2BH18072.	132	291			
2BH18370.	120	265			
2BH18371.	129	284			
2BH18372.	135	298			
2BH19070.	179	395			
2BH19071.	198	437			
2BH19073.	210	463			
2BH19370.	179	395			
2BH19371.	198	437			
2BH19373.	209	463			
2BH923P	167	368			
2BH923Q	145	320			
2BH923H	151	333			

Two-impeller design				
	Weight			
Туре	[kg] approx.	[lbs] approx.		
2BH1310-72.	15	33		
2BH1410-73.	25	55		
2BH1410-74.	27	60		
2BH1510-74.	40	88		
2BH1510-75.	44	97		
2BH1610-71.	43	95		
2BH1610-72.	48	106		
2BH1610-73.	54	119		
2BH1610-74.	66	146		
2BH1610-75.	73	161		
2BH1610-77.	50	110		
2BH1610-78.	62	137		
2BH1640-73.	54	119		
2BH1640-74.	69	152		
2BH1640-75.	75	165		
2BH1640-78.	62	137		
2BH18171.	171	377		
2BH18172.	177	390		

Two-impeller design					
	Weight				
Туре	[kg] approx.	[lbs] approx.			
2BH18173.	203	448			
2BH18174.	215	474			
2BH18472.	177	390			
2BH18473.	203	448			
2BH19171.	274	604			
2BH19172.	288	635			
2BH19173.	299	659			
2BH19174.	309	681			
2BH1940-7B.2.	275	606			
2BH1940-7B.3.	314	692			
2BH1940-7B.4.	324	714			
2BH1943-72.	330	728			
2BH1943-73.	339	747			
2BH1943-74.	349	769			

#### Minimum distances

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

Туре	[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:

Туре	[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  $\pm 3$  dB (A).

Single-impeller design					
Туре	1-m measuring-surface sound pressure level L [dB (A)]				
	50 Hz approx.	60 Hz approx.			
2BH1100-70.	52	55			
2BH1200-70.	57	61			
2BH1300-70.	53	56			
2BH1300-71.	53	56			
2BH1300-72.	53	56			
2BH1330-70.	53	56			
2BH1330-71.	53	56			
2BH1330-72.	53	56			
2BH1400-70.	63	64			
2BH1400-71.	63	64			
2BH1400-72.	63	64			
2BH1430-70.	63	64			
2BH1430-71.	63	64			
2BH1430-72.	63	64			
2BH1500-70.	64	70			
2BH1500-71.	64	70			
2BH1500-72.	64	70			
2BH1500-73.	64	70			
2BH1530-70.	64	70			
2BH1530-71.	64	70			
2BH1530-72.	64	70			
2BH1530-73.	64	70			
2BH1600-70.	69	72			
2BH1600-71.	69	72			
2BH1600-72.	69	72			
2BH1600-73.	69	72			
2BH1600-76.	69	72			
2BH1600-77.	69	72			
2BH1630-70.	69	72			

Single-impeller design		
Туре	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1630-71.	69	72
2BH1630-72.	69	72
2BH1630-73.	69	72
2BH1630-76.	69	72
2BH1630-77.	69	72
2BH18070.	70	74
2BH18071.	70	74
2BH18072.	70	74
2BH18370.	70	74
2BH18371.	70	74
2BH18372.	70	74
2BH19070.	74	79
2BH19071.	74	79
2BH19073.	74	79
2BH19370.	75	80
2BH19371.	75	80
2BH19373.	75	80
2BH923	79	81

Two-impeller design		
Туре	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz approx.	60 Hz approx.
2BH1310-72.	55	61
2BH1410-73.	66	69
2BH1410-74.	66	69
2BH1510-74.	72	74
2BH1510-75.	72	74
2BH1610-71.	73	76
2BH1610-72.	73	76
2BH1610-73.	73	76
2BH1610-74.	73	76
2BH1610-75.	73	76
2BH1610-77.	73	76
2BH1610-78.	73	76
2BH1640-73.	74	78
2BH1640-74.	74	78
2BH1640-75.	74	78
2BH1640-78.	74	
2BH18171.	74	
2BH18172.	74	78
2BH18173.	74	78
2BH18174.	74	78
2BH18472.	74	78
2BH18473.	74	78
2BH19171.	74	84
2BH19172.	74	84
2BH19173.	74	84
2BH1940-7B.2.	75	84
2BH1940-7B.3.	75	84
2BH1940-7B.4.	75	84
2BH1943-72.	75	84
2BH1943-73.	75	84
2BH1943-74.	75	84

# Sound power level

Sound power level  $L_W$  as per EN ISO 3744, tolerance  $\pm 3$  dB (A).

Two-impeller design		
	Sound pow [dB	
Туре	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	0 - 12	0.8 - 0.00	

	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	3-7	3.09 - 3.10

# 3.2 Electrical data

See rating plate.

## 3.3 Operating conditions

## **Temperatures**

Temperature of pumped gases:	max. permissible temperature:		
pumped gases.	+40°C	[+104°F]	
	Nominal value:		
	+15°C	[+59°F]	
	Pump-motor units for higher fluid temperatures on request.		
Ambient	max. permissible temperature:		
temperature:	+40°C	[+104°F]	
	min. permissible temperature:		
	-15°C	[+5°F]	
	Nominal value:	minal 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

# 

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:

handling equipment!

# 

# 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 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...).

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.

# 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 pumpmotor 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

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 pumpmotor 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 pumpmotor 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 noiseconducting or noise-radiating parts (e.g. thin walls or sheet-metal plates).
- Provide pump-motor unit with soundinsulating 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 pumpmotor 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 second silencer (available as an accessory for the 2BH1):

  The second silencer (available as an accessory for the 2BH1):

  The second silencer (available as an accessory for the 2BH1):

  The second 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.

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  $U_N \le 690V$ ).
- 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  $U_N \le 690V$ ).

There may be no protruding wire ends!

### 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.

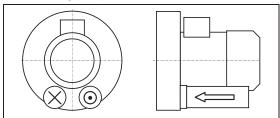


Fig. 2: 2BH1... (single-impeller pump-motor units), 2BH9 23

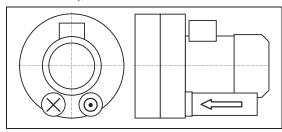


Fig. 3: 2BH1640 (two-impeller pump-motor unit with double-flow design)

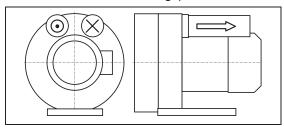


Fig. 4: 2BH1840-7G... (two-impeller pump-motor unit with double-flow design)

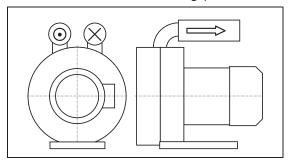


Fig. 5: 2BH1840-7J... (two-impeller pump-motor unit with double-flow design)

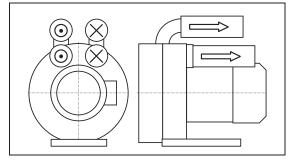


Fig. 6: 2BH1840-7L... (two-impeller pump-motor unit with double-flow design)

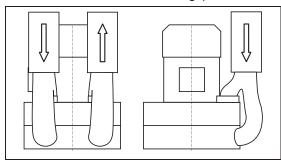


Fig. 7: 2BH1943 (two-impeller pump-motor unit with double-flow design)

On two-impeller pump-motor units with a twostage 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.

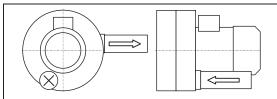


Fig. 8: 2BH1310 ... 2BH1610, 2BH1910 (two-impeller pump-motor units with a twostage design)

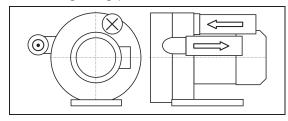


Fig. 9: 2BH1810 (two-impeller pump-motor unit with a two-stage design)

# **⚠ 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 <u>inlet connection</u> (see Chapter 5.3.1, Pg. 19) and discharged via the <u>discharge connection</u> (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

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.

# 6 Commissioning

# 

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  $\leq 1 \text{ k}\Omega$  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 drivemotor 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.

# 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 pumpmotor 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 pumpmotor 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<sub>eff</sub> ≤ 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  $\leq 1 \text{ k}\Omega$  per volt of nominal voltage, the winding is too dry.

# 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	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
noise	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	Winding short-circuit.	Have winding checked.	Electrician
switch trips when motor is	Motor overloaded.	Reduce throttling.	Service*)
switched on. Power consumption too	Throttling does not match specification on rating plate.	Clean filters, mufflers and connection pipes if necessary.	Service*)
high.	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	Leak in system.	Seal leak in the system.	Operator
does not generate any or generates	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
insufficient pressure difference.	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

<sup>\*)</sup> Only when the maintenance manual is at hand: rectification by the operator.

## 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** pumpmotor 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.
  - 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 Holger Krause documentation: 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)

\*) Only applicable for version with frequency converter 2FC

664.44434.40.000



# 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.

	<ul> <li>In the case of shipment to Germany, the statement is to be completed in German or English.</li> <li>The statement is to be attached to the outside of the packing on shipment.</li> <li>If necessary, the carrier is to be informed.</li> </ul>					
1.	Product designation (ty	pe):				
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. Contin	ue with "5. Information	on the contamination"		
5.	Information on the cont. The unit/system was used	amination If in the following application:	(if necessary prov	vide more information on an additional sheet)		
	and has come into contact	t with the following classifiable subs	tances or substances p	resenting a hazard to health/environment:		
	Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):		
	The unit/system has b	een emptied in accordance with the	operating instructions,	flushed and cleaned externally.		
	Safety data sheets in a	accordance with the applicable regu	lations are enclosed (	sheet).		
	_ ,	recautions are necessary for handlir	•	,		
	The following ealety p	recount of the mediculary for mariani	ig (o.g. poroonal protoo	avo oquipmont).		
^	Landly binding statemen					
ь.	Legally binding statemed herewith guarantee that so.		mplete and that I, as sig	gnatory, am in a position to judge that this is		
We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We a 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 employees tasked with repair/disposal.						
	Company/institute:					
	Name, position:		Phone:			
	Street:		Fax:			
	Post code, city:					
	Country:		Stomp:			
	Date, signature:					
© (	Gardner Denver Deutschland	GmbH		610.00250.40.905		

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Elmo Rietschle is a brand of Gardner Denver's Industrial Products Group and part of Blower Operations.



# cincinnati fan

<del>r o'</del>rm: 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

		DESITE	III OI LOII IOATIONO			
E	BLOWER SERIAL NUMBER: MFG. DATE:					
N	NOTE: The serial number above is a required reference for any assistance. It is stamped on the blower nameplate					
<u>E</u>	BLOWER SPECIFICA	TIONS:				
	Model:	Arrangement:	Rotation:	Discharge:		
	Nominal Inlet Size	<b>e:</b> (in Inches)	Wheel Size and Type:			
E	BLOWER PERFORM	ANCE 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: \	/oltage:	Phase:		
	Hz:	Frame Size:	Enclosure:	Efficiency:		
	IF Motor is EXP, Class(es) & Group(s) are:					
	Manufacturers Model Number:		c	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.

# 1

Hazardous voltage can cause electrical shock and death.



High speed rotating equipment can cause severe personal injury.

**DANGER** 

Lock out/Tag out to prevent personal injury <u>BEFORE</u> starting <u>ANY</u> 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. <a href="NEVER">NEVER</a> 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.

OMM-01-0509-page 2

#### 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.

<u>NEVER</u> 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 <u>immediately</u> turned off and locked out in accordance with OSHA regulations. Power to the blower should <u>NOT</u> 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 <u>BEFORE</u> OPENING <u>ANY</u> 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 <u>not</u> 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.

# 

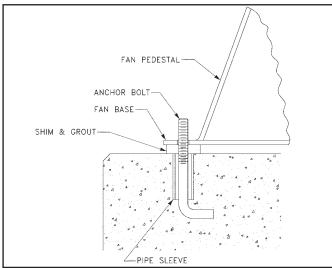
SHUT THE BLOWER DOWN IMMEDIATELY IF THERE IS ANY SUDDEN INCREASE IN VIBRATION.

# **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 <u>flexible</u> 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 <u>independently</u> supported. <u>DO NOT</u> 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 <u>must</u> 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	Required Torque	
Bushing Size	(Inch Pounds)	
Н	95	
В	192	
P	192	
Q	350	
R	350	

# **↑** CAUTION

Set screws should <u>NEVER</u> 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. <u>DO NOT</u> 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 <u>BEFORE</u> 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 <u>BEFORE</u> 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 <u>WAS NOT</u> DESIGNED TO OPERATE IN, AN EXPLOSION AND/OR FIRE <u>CAN</u> OCCUR.

## NOTICE:

- a. All EXP motors have <u>some</u> 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 <u>very</u> painful experience;
The <u>normal</u> 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 <u>extend</u> the motor manufacturers warranty, when used with a speed controlling device, if the motor has the words "**Inverter Duty**" marked on the <u>motor</u> name plate. If the motor does not have "**Inverter Duty**" marked on the motor name plate, <u>and</u> you have a motor failure, you will be required to contact the motor manufacturer for any service or warranty claims.

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.

	rtup & Post-Startup Checks: Pre-Startup Checks Complete	(Check blocks as each step i	s completed. Retain t	his for your records.) DATE:
		•		DATE:
	A2. 8 Hour, Post-Startup Che			DATE:
117		Checks Completed By:		
$\downarrow\downarrow\downarrow\downarrow$	MAKE SURE POWER TO THE MO	TOR IS LOCKED OUT <u>BEFORE</u> ST	ARTING PRE-STARTUP OI	R POST-STARTUP CHECKS.
1. 🗖 🗖 🗖	If possible, <i>CAREFULLY</i> spin heard.	the blower wheel by hand to en	sure it rotates freely ar	nd no rubbing or clicking noise is
2. 🗆 🗆 🗆		and duct work hardware to make	e sure it is tight.	
3.		rews to make sure they are tigh	_	5
		oushing, make sure the bolts ar		
5.	-	gn material in the blower or duc		. •
		ors in the duct work are securely		s a projectile.
6.		-	•	atria al accataca
7.	•	mponents are properly sized ar	id matched for your ele	ctrical system.
8. 🗆 🗆 🗆				
9. 🗆 🗆 🗆		opened and closed to make sur		
10.	•			is welded at all the joint connec-
		perly braced to prevent "side swa		
11. 🗆 🗆 🗆				perature construction. Never sub-
	ject a "cold" blower to a "hot" of	gas stream. If the blower will be	handling "hot gases" g	reater than 150°F (65°C) it is
	imperative that the blower be	subjected to a gradual rate of te	emperature increase, no	ot to exceed 15°F/minute
				periencing a drop in temperature
				reached an equilibrium tempera-
		should the power be turned off.		
12. 🗆 🗆 🗆		connections to the blower motor		
13. 🗆 🗆 🗆	Make sure the blower wheel is	s stationary prior to startup. <b>Sta</b>	rting a blower with a	wheel that is rotating back-
	wards can cause wheel dan	nage.		
14. 🗆 🗆 🗆	Apply power to the blower mo	tor momentarily (i.e. "bump star	rt") to check for proper h	blower wheel rotation. If the blow-
	er is rotating in the wrong dire	ection, reconnect the motor lead	Is per the motor manufa	acturers wiring schematic. Blower
	rotation is determined by vi	ewing the blower from the mo	otor side of the blower	r, NOT from the inlet side. After
	reconnecting the leads, repea	t this step. See Fig. 2 below.		
	Fig. 2			
	9-			
		( ) Motor		
		Clockwise	Counter-Clockwise	<b>;</b>
		(CW) Rotation	(CCW) Rotation	
45 000	A made a marriage to the a laborate management	tou and let it assess on to full one	and Trump off the manua	w. I. a.a.l., a.m.al. liakara fara a.m.,
15. ⊔⊔⊔				r. Look and listen for any unusual
		•		oticed, lock out the power, wait for
		complete stop, locate the caus	e and correct it.	
16. □□□ Unlock power and start the blower.				
17. ⊔⊔⊔	□□□ Measure, record and keep the following motor data for future reference and comparison:			son:
	(Single phase motors will only have L1 and L2 leads)			
		otor lead: L1 L2		
	(Running amps SHOULD NO	$oldsymbol{\Gamma}$ exceed the motor nameplate $oldsymbol{\mathfrak{c}}$	amps for the voltage be	ing operated on)
		ıds: L1 L2 L3		
	(Should be about the same in	put voltage on <u>all</u> 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:

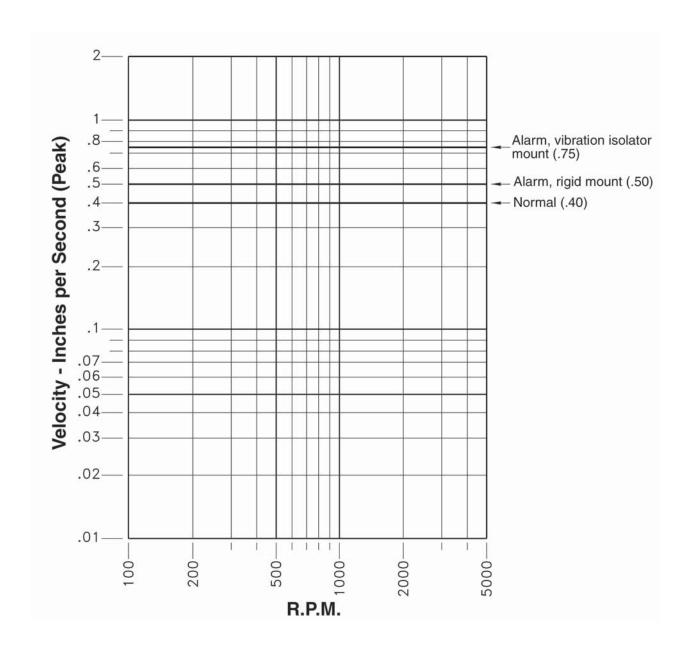
The blower SHOULD NOT be operated if the vibration velocity of the fan exceeds 0.50 inches per second, filter out, if the blower is rigidly mounted. If the blower is mounted on isolators or on an isolator base, it <a href="SHOULD">SHOULD</a> NOT be operated if the vibration velocity of the blower exceeds 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 <u>MUST</u> be removed and cleaned before it is put back into service. If any parts of the wheel have been eroded, the wheel <u>MUST</u> 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, <u>BUT</u> checking the vibration readings should <u>NEVER</u> exceed a 12 month period. For the AMCA/ANSI standard for vibration limits, see Fig. 4 on page 9.

Fig. 3	(1) $(2)$
VIBRATION METER PROBE POSITIONS	
For Arrangement 4 Blowers	<u> </u>
1 2 3 4 5	
A	5
B	3 4
<u> </u>	
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:



# **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 <u>always</u> 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:

Wheel unbalance.
 Poor blower inlet and/or discharge conditions.

Mechanical looseness.
 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 <u>MUST</u> 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 <u>complete</u> blower/motor <u>assembly</u>, 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 <u>MUST</u> 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	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.
		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 ( <b>rotation</b> ).
	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 ( <b>LM</b> 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.	
	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	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	Motor wired incorrectly.	
	2. Incorrect voltage supply.	
	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. <u>Each item must be checked monthly.</u>

# **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 SELL-ER'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 <u>manufacturer's</u> 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



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E-Mail: sales@cincinnatifan.com

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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



# 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		
Sensor Type		
	Range: 0 to 50 mg/L concentration	
	Accuracy: ±0.1 mg/L, 0 to 8 mg/L	
RDO PRO-X Probe	±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	
	Range: 0° to 50° C (32° to 122° F)	
Temperature sensor	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

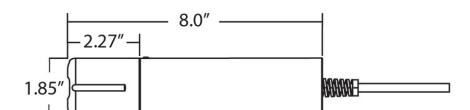
- 10-m standard length with stripped-and-tinned ends
- Customized lengths with titanium twist-lock connectors



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.



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.

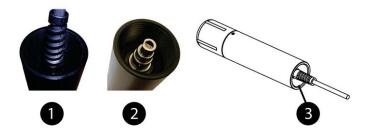
- 1. Set up the calibration procedure as previously described, and perform a watersaturated air calibration.
- 2. Remove the water-saturated sponge from the calibration chamber and fill the chamber to the fill line with approximately 60 mL of fresh sodium sulfite solution.



- 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 ( $1\frac{1}{4}$  -  $11\frac{1}{2}$  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.

- Use your finger to apply a very light layer of silicone-based lubricant around the Oring 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.

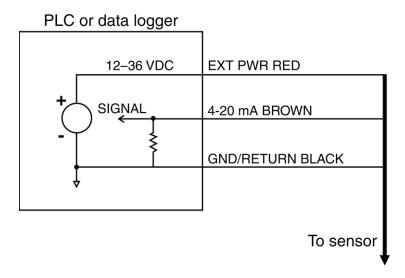
	Signal	Color
M2	Ground/Return	Black
M1 M3	External Power	Red
F6 F4	4-20 mA	Brown
	RS485 (-)	Green
F5	RS485 (+)	Blue
	SDI-12	White



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



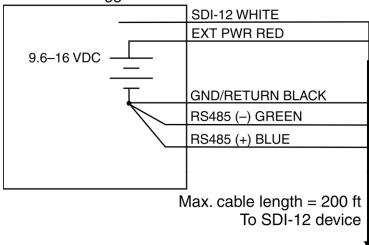


Cable length must not exceed 1219 m (4000 ft.) Analog signal must be enabled in Win-Situ 5 Software or the Comm Kit Software prior to use.

## **SDI-12 (3-wire)**

Signal	Color
Ground/Return	Black
External Power (9.6-16 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue
SDI-12	White

## Data logger



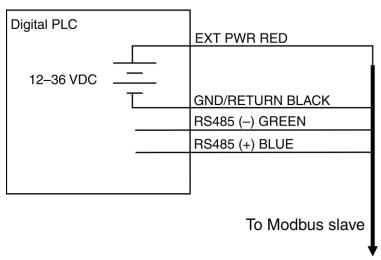


Cable length must not exceed 60.96 m (200 ft.)

## Modbus Master with Built-in RS485

Signal	Color
Ground/Return	Black
External Power (12-36 VDC)	Red
RS485 (-)	Green
RS485 (+)	Blue

# Modbus master with RS485 built-in



✓

Cable length must not exceed 1219 m (4000 ft.)