ENGINEERING
TOMORROW

Operating Guide

VLT HVAC Drive FC 102

1.1–90 kW

vlt-drives.danfoss.com

Contents

1 Introduction

1.1 Purpose of this Operating Guide

This operating guide provides information for safe installation and commissioning of the AC drive. It is intended for use by qualified personnel.

Read and follow the instructions to use the drive safely and professionally.

Pay particular attention to the safety instructions and general warnings. Always keep this operating guide with the drive.

VLT® is a registered trademark for Danfoss A/S.

1.2 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1: Manual and Software Version

Edition	Remarks	Software version
AQ267037536117-0101	Added UL61800-5-1 updates to Electrical Data and Fuse sections.	7.3x

1.3 Product Overview

1.3.1 Intended Use

The drive 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 AC drive, the motor, and equipment driven by the motor.
- System and motor status surveillance.

The drive can also be used for motor overload protection.

Depending on the configuration, the drive can be used in standalone applications or form part of a larger appliance or installation.

The drive is allowed for use in residential, industrial, and commercial environments in accordance with local laws and standards.

NOTICE

In a residential environment, this product can cause radio interference, in which case supplementary mitigation measures can be required.

Foreseeable misuse

Do not use the drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *Ambient Conditions*.

NOTICE

OUTPUT FREQUENCY LIMIT

Due to export control regulations, the output frequency of the drive is limited to 590 Hz. For demands exceeding 590 Hz, contact Danfoss.

1.3.2 Exploded Views

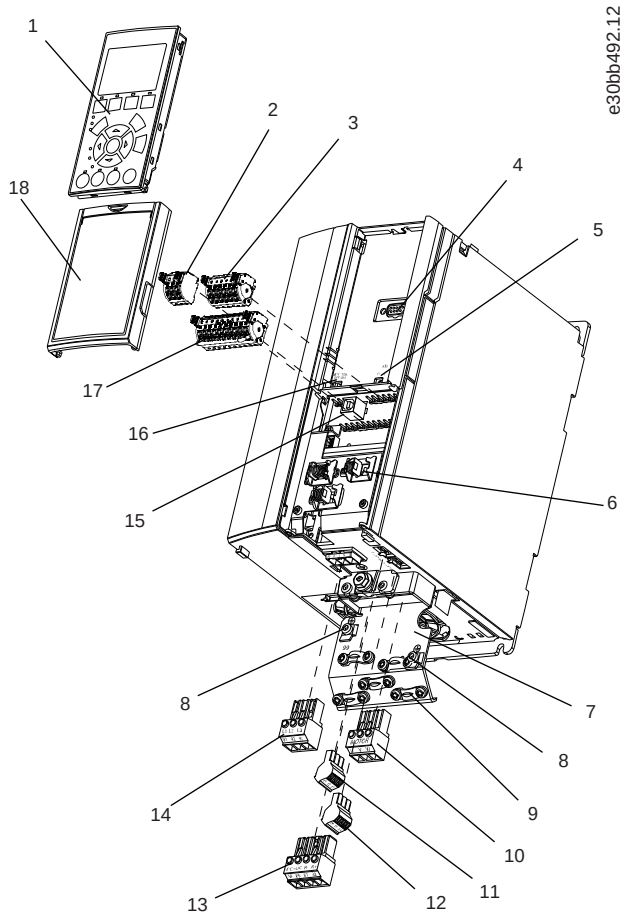

Illustration 1: Exploded View Enclosure Type A, IP20

1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 serial bus 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	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Shielded cable grounding clamp and strain relief	18	Cover

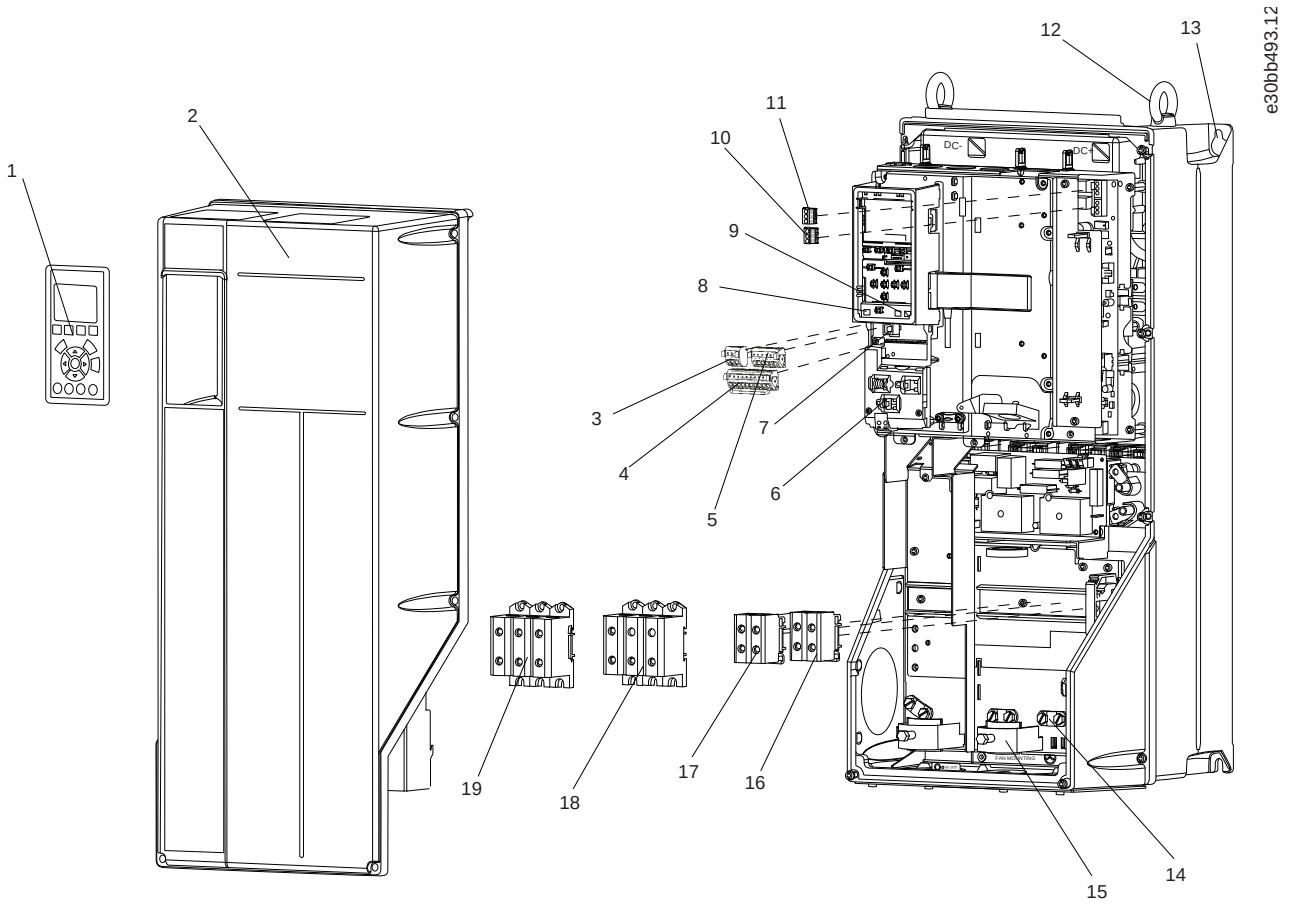

Illustration 2: Exploded View Enclosure Types B and C, IP55 and IP66

1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 serial bus connector	13	Mounting slot
4	Digital I/O and 24 V power 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	Serial bus 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), (L3)
10	Relay 1 (01, 02, 03)		

1.3.3 Block Diagram of the Drive

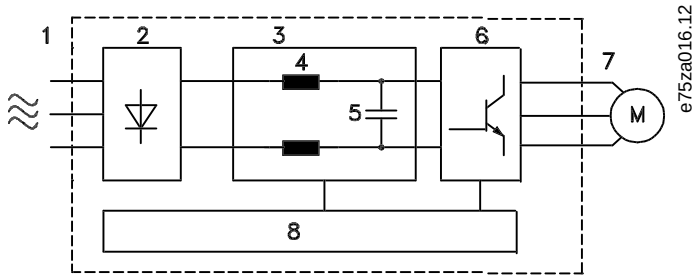

Illustration 3: Block Diagram

1 Mains input
- 3-phase AC mains power supply to the drive.

2 Rectifier
- The rectifier bridge converts the AC input to DC current to supply inverter power.

3 DC bus
- Intermediate DC-bus circuit handles the DC current.

4 DC reactors
- Filter the intermediate DC circuit voltage.
- Prove line transient protection.
- Reduce RMS current.
- Raise the power factor reflected back to the line.
- Reduce harmonics on the AC input.

5 Capacitor bank
- Stores the DC power.
- Proves ride-through protection for short power losses.

6 Inverter
- Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.

7 Output to motor
- Regulated 3-phase output power to the motor.

8 Control circuitry
- Input power, internal processing, output, and motor current are monitored to provide efficient operation and control.
- User interface and external commands are monitored and performed.
- Status output and control can be provided.

1.4 Type Approvals and Certifications

The following list is a selection of possible type approvals and certifications for Danfoss drives:

NOTICE

Drives of enclosure size T7 (525–690 V) are not UL listed.

Table 2: Type Approvals and Certifications

CE	ErP READY		DNV·GL
c UL us	EAC	089	OSHPD

			
			
			

N O T I C E

The specific approvals and certification for the drive are on the nameplate of the drive. For more information, contact the local Danfoss office or partner.

For more information on UL 508C thermal memory retention requirements, refer to the section *Motor Thermal Protection* in the product-specific Design Guide.

For more information on compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to the section ADN-compliant Installation in the product-specific Design Guide.

1.5 CE Declaration

ENGINEERING TOMORROW

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EU DECLARATION OF CONFORMITY

Danfoss A/S

Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter
Type designation(s): FC-102XYYYZZ**********

Character X: N or P
Character YYY: K37, K75, 1K1, 1K5, 2K2, 3K0, 3K7, 4K0, 5K5, 7K5, 11K, 15K, 18K, 22K, 30K, 37K, 45K, 55K, 75K, 90K, 110, 132, 150, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1M0, 1M2, 1M4
Character ZZ: T2, T4, T6, T7
* may be any number or letter indicating drive options which do not impact this DoC.
The meaning of the 39 characters in the type code string can be found in appendix 00729776.

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EN61800-5-1:2007 + A1:2017	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

EMC Directive 2014/30/EU

EN61800-3:2004 + A1:2012	Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods.

RoHS Directive 2011/65/EU including amendment 2015/863.

EN63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date: 2020.09.02 Place of issue:	Issued by	Date: 2020.09.02 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Gert Kjær** **Title: Senior Director, GDE**	Graasten, DK	**Signature:** **Name: Michael Termansen** **Title: VP, PD Center Denmark**

Danfoss only vouches for the correctness of the English version of this declaration. In the event of the declaration being translated into any other language, the translator concerned shall be liable for the correctness of the translation

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Classified as Business

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: **T or U at character 18 of the typecode.**

Machine Directive 2006/42/EC

EN/IEC 61800-5-2:2007 (Safe Stop function conforms with STO – Safe Torque Off, SIL 2 Capability)	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional

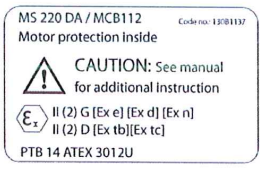
Other standards considered:

EN ISO 13849-1:2015 (Safe Stop function, PL d (MTTFd=14000 years, DC=90%, Category 3)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN/IEC 61508-1:2011, EN/IEC 61508-2:2011 (Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h for specific variants, PFD = 1E-10, 1E-4 for specific variants, SFF>99%, HFT=0))	Functional safety of electrical/electronic/ programmable electronic safety-related systems Part 1: General requirements Part 2: Requirements for electrical/ electronic / programmable electronic safety-related systems
EN/IEC 62061:2005 + A1:2013 (Safe Stop function, SILCL 2)	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN/IEC 60204-1:2006 + A1:2009 (Stop Category 0)	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

For products including ATEX option, it requires STO function in the products. The products can have the VLT PTC Thermistor Card MCB112 installed from factory **(2 at character 32 in the typecode)**, or it can be separately installed as an additional part.

2014/34/EU - Equipment for explosive atmospheres (ATEX)

Based on EU harmonized standard:	
EN 50495: 2010	Safety devices required for safe functioning of equipment with respect to explosion risks.



Notified Body:
PTB Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig,
has assessed the conformity of the "ATEX certified motor thermal protection systems" of Danfoss FC VLT Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX 3009.

2 Safety

2.1 Safety Symbols

The following symbols are used in this guide:

⚠ DANGER ⚠

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING ⚠

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION ⚠

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the drive. Only qualified personnel are allowed to install and operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this manual.

2.3 Safety Precautions

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel must perform installation, start-up, and maintenance.

⚠ WARNING ⚠

UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of 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.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

⚠ W A R N I N G ⚠

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.
- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully. The minimum waiting time is specified in the table *Discharge time* and is also visible on the nameplate on top of the drive.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Table 3: Discharge Time

Voltage [V]	Minimum waiting time (minutes)		
	4	**7**	**15**
200–240	1.1–3.7 kW (1.5–5 hp)	–	5.5–45 kW (7.5–60 hp)
380–480	1.1–7.5 kW (1.5–10 hp)	–	11–90 kW (15–125 hp)
525–600	1.1–7.5 kW (1.5–10 hp)	–	11–90 kW (15–125 hp)
525–690	–	1.1–7.5 kW (1.5–10 hp)	11–90 kW (15–125 hp)

⚠ W A R N I N G ⚠

ELECTRICAL SHOCK HAZARD - LEAKAGE CURRENT HAZARD >3.5 MA

Leakage currents exceed 3.5 mA. Failure to connect the drive properly to protective earth (PE) can result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the drive can be done with:
- a PE conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al.
- an extra PE conductor of the same cross-sectional area as the original PE conductor as specified by IEC 60364-5-54 with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) (mechanical protected) or 4 mm^2 (12 AWG) (not mechanical protected).
- a PE conductor completely enclosed with an enclosure or otherwise protected throughout its length against mechanical damage.
- a PE conductor part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) (permanently connected or pluggable by an industrial connector. The multi-conductor power cable shall be installed with an appropriate strain relief).
- NOTE: In IEC/EN 60364-5-54 cl. 543.7 and some application standards (for example IEC/EN 60204-1), the limit for requiring reinforced protective earthing conductor is 10 mA leakage current.

⚠ W A R N I N G ⚠

ROTATING SHAFTS

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.

⚠ W A R N I N G ⚠

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.

⚠ C A U T I O N ⚠

INTERNAL FAILURE HAZARD

An internal failure in the drive can result in serious injury when the drive 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 that the items supplied and the information on the product label correspond to the order confirmation.
- Check the packaging and the drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

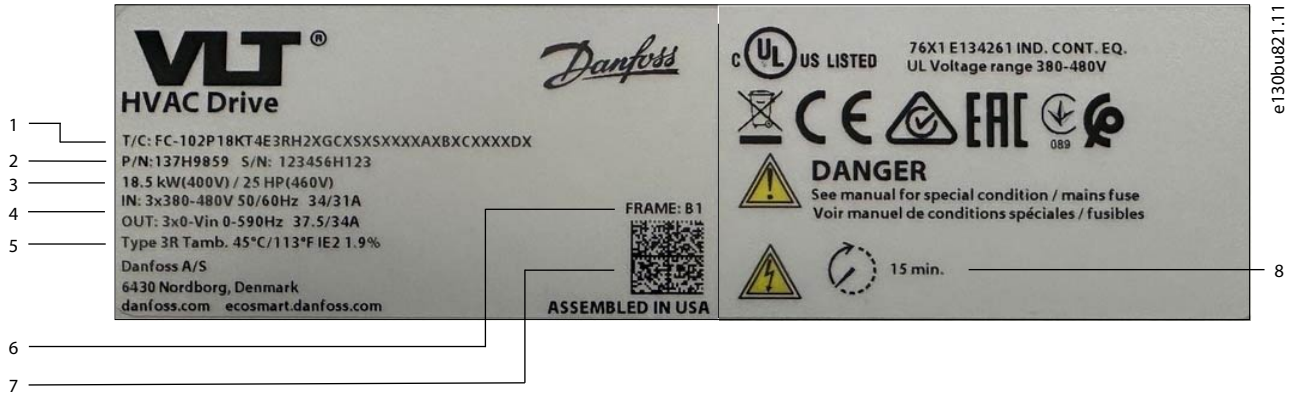


Illustration 4: Product Label (Example)

1	Type code	5	Enclosure type and IP rating along with maximum ambient temperature
2	Ordering number and serial number	6	Enclosure frame size
3	Power rating	7	QR code for additional documentation
4	Voltage, frequency, and current (at low/high voltages)	8	Discharge time (warning)

N O T I C E

LOSS OF WARRANTY

Do not remove the product label from the drive.

3.1.2 Storage

Ensure that the requirements for storage are fulfilled, see the *Ambient Conditions section*.

3.2 Installation Environment

N O T I C E

REDUCED LIFETIME

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 lifetime of the drive.

– Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock

The drive 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, refer to the *Ambient Conditions section*.

3.3 Mounting

3.3.1 Cooling

- Ensure that top and bottom clearance for air cooling is provided. See Table 4 for clearance requirements.

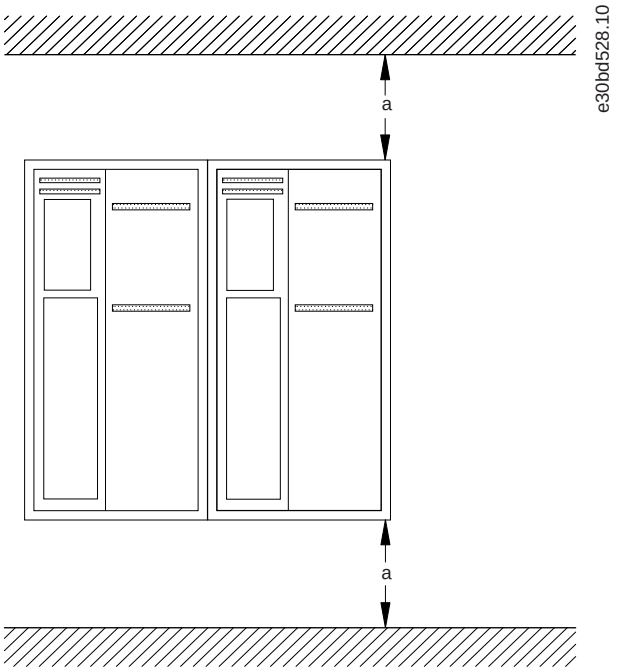


Illustration 5: Top and Bottom Cooling Clearance

Table 4: Minimum Airflow Clearance Requirements

Enclosure	A2–A5	B1–B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.8)	200 (7.8)	225 (8.9)

3.3.2 Lifting

- To determine a safe lifting method, check the weight of the unit, see 8.12 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 hoist rings on the unit, when provided.

3.3.3 Mounting

Procedure

1. Ensure that the strength of the mounting location supports the unit weight.

   The drive allows side-by-side installation.

2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

3.3.3.1 Mounting with Mounting Plate and Railings

A mounting plate is required when mounted on railings.

All A, B, and C enclosures allow side-by-side installation. Exception: If an IP21 kit is used, there has to be a clearance between the enclosures:

- For enclosures A2, A3, A4, B3, B4, and C3, the minimum clearance is 50 mm (1.97 in).
- For enclosure C4, the minimum clearance is 75 mm (2.95 in).

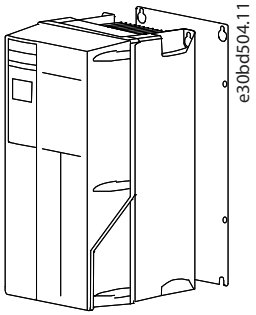


Illustration 6: Proper Mounting with Mounting Plate

4 Electrical Installation

4.1 Safety Instructions

See 2.3 Safety Precautions for general safety instructions.

⚠ 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.
- Simultaneously lock out all the drives.

⚠ WARNING ⚠

SHOCK HAZARD

The unit can cause a DC current in the PE conductor. Failure to use a Type B residual current-operated protective device (RCD) may lead to the RCD not providing the intended protection and therefore may result in death or serious injury.

- When an RCD is used for protection against electrical shock, only a Type B device is allowed on the supply side.

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between drive and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in the *Fuses and Circuit Breakers section*.

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 8.1 Electrical Data, 200–240 V and 3x115Y/200–139Y/240 Vto 8.4 Electrical Data, 525–690 V and 8.8.3 Control Cable Cross-sections for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in 4.3 Grounding, 4.4 Wiring Schematic, 4.6 Connecting the Motor, and 4.8.1 Control Wiring.

NOTICE

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

4.3 Grounding

⚠ W A R N I N G ⚠

ELECTRICAL SHOCK HAZARD - LEAKAGE CURRENT HAZARD >3.5 MA

Leakage currents exceed 3.5 mA. Failure to connect the drive properly to protective earth (PE) can result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the drive can be done with:
- a PE conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al.
- an extra PE conductor of the same cross-sectional area as the original PE conductor as specified by IEC 60364-5-54 with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) (mechanical protected) or 4 mm^2 (12 AWG) (not mechanical protected).
- a PE conductor completely enclosed with an enclosure or otherwise protected throughout its length against mechanical damage.
- a PE conductor part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) (permanently connected or pluggable by an industrial connector. The multi-conductor power cable shall be installed with an appropriate strain relief).
- NOTE: In IEC/EN 60364-5-54 cl. 543.7 and some application standards (for example IEC/EN 60204-1), the limit for requiring reinforced protective earthing conductor is 10 mA leakage current.

For electrical safety

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy chain fashion (see Illustration 7).
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section for the ground wires: 10 mm^2 (7 AWG).
- Separately terminate individual ground wires, both complying with the dimension requirements.

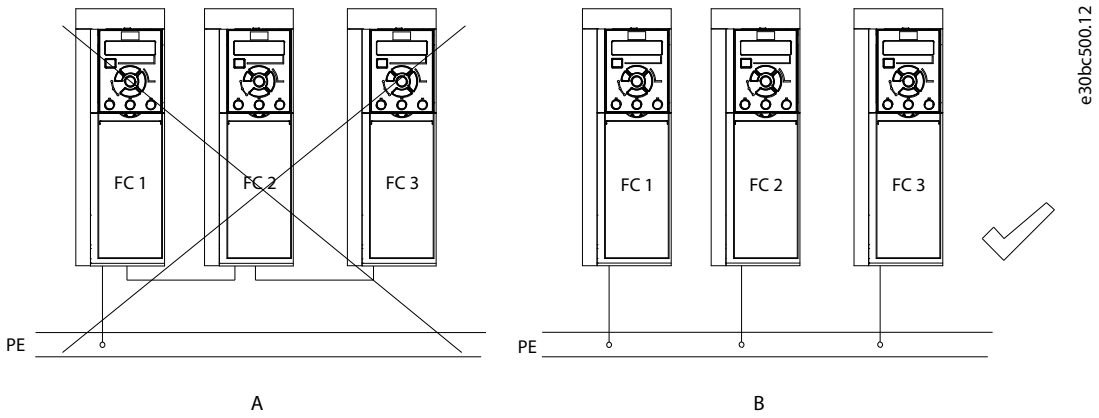


Illustration 7: Grounding Principle

For EMC-compliant installation

- Establish electrical contact between the cable shield and the drive enclosure by using metal cable glands or by using the clamps provided on the equipment.
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

N O T I C E

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

4.4 Wiring Schematic

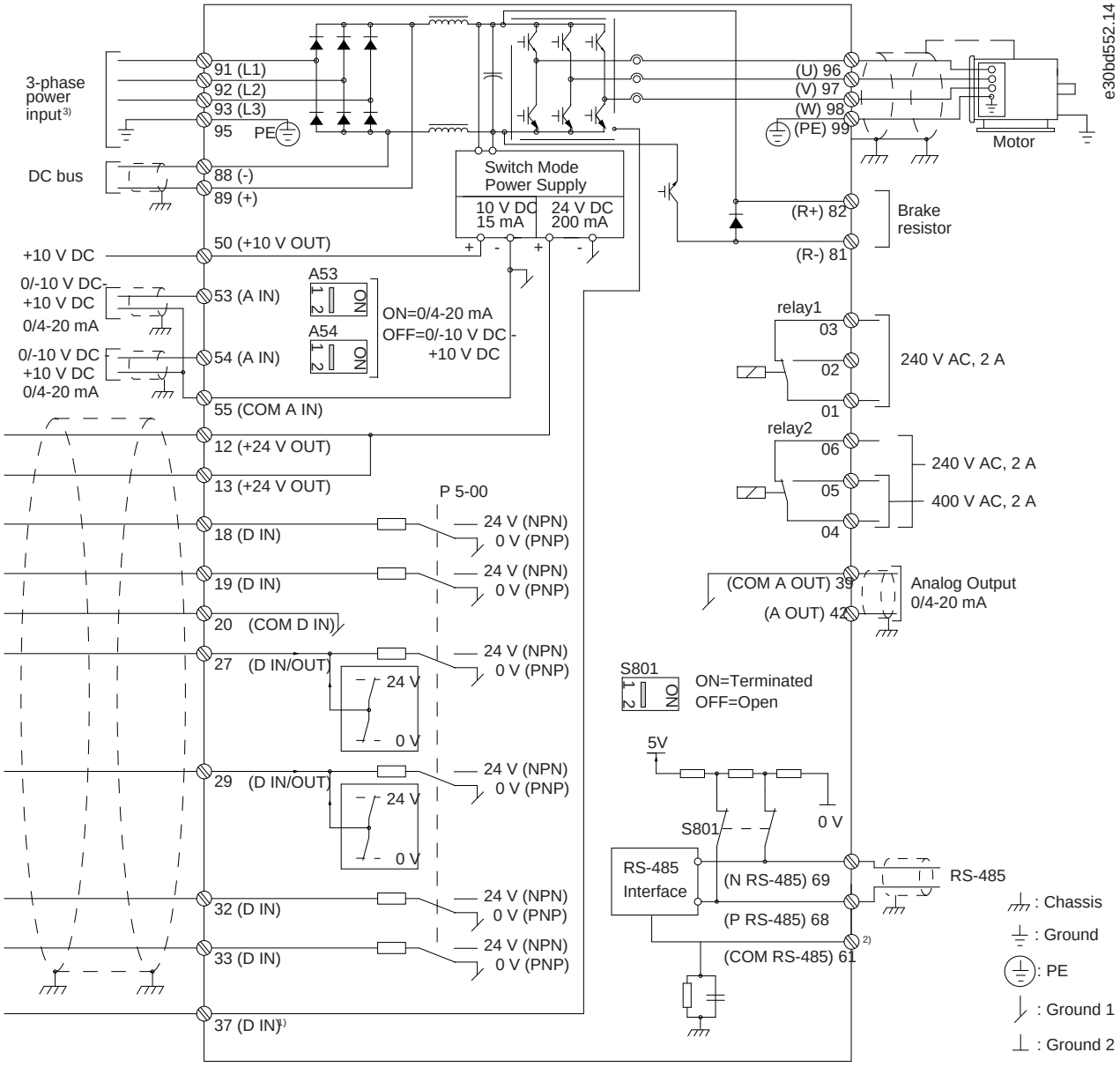


Illustration 8: Basic Wiring Schematic

A	Analog.	2	Do not connect cable shield.
D	Digital.	3	For 1-phase power input, wire to L1 and L2.
1	Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the Safe Torque Off Operating Guide for Danfoss VLT® Frequency Converters.		

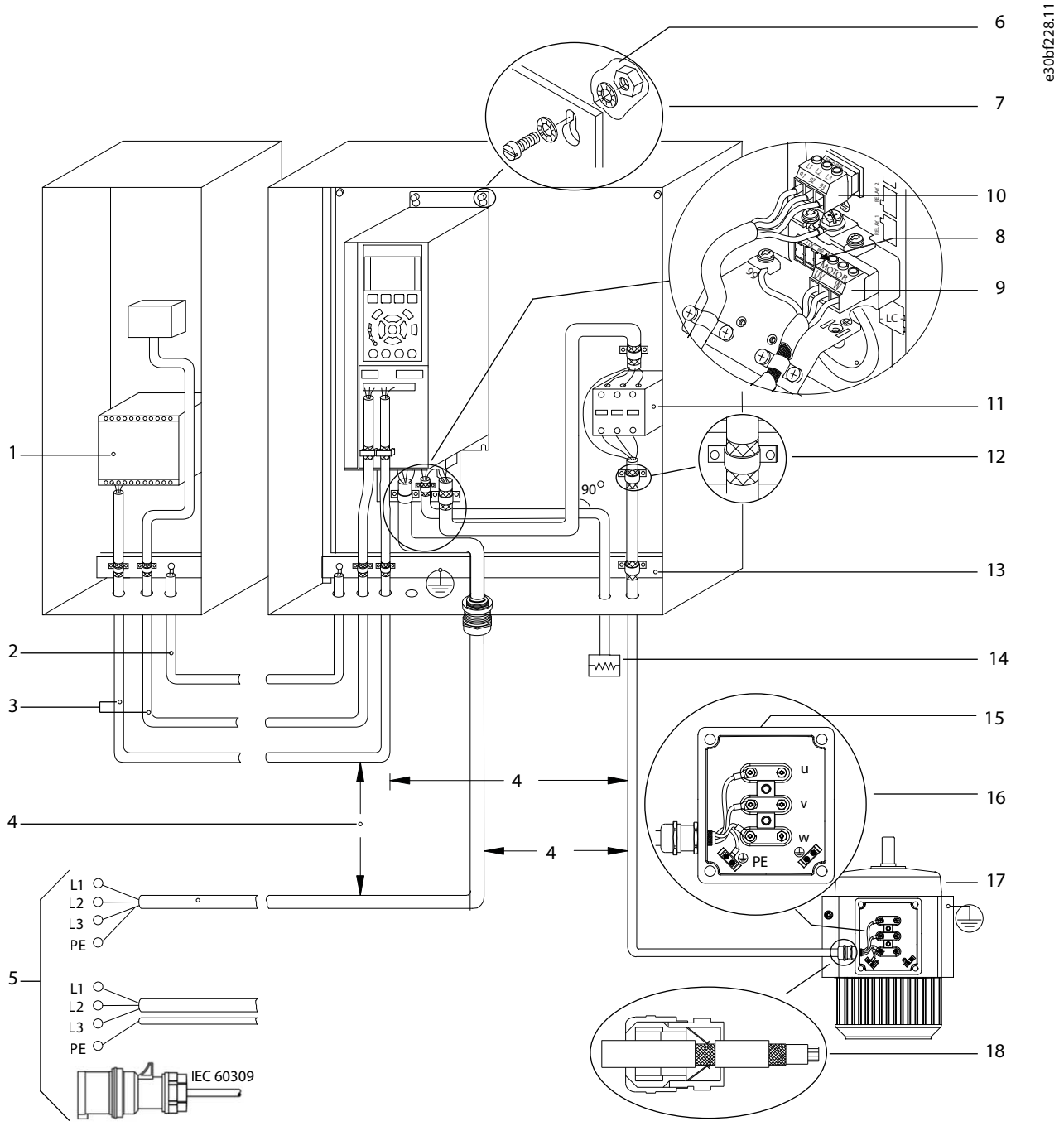


Illustration 9: EMC-compliant Electrical Connection

1	PLC.	10	Mains cable (unshielded).
2	Equalizing minimum 16 mm^2 (6 AWG).	11	Output contactor, and more.
3	Control cables.	12	Cable insulation stripped.
4	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables.	13	Common ground busbar. Follow local and national requirements for cabinet grounding.
5	Mains supply.	14	Brake resistor.
6	Bare (unpainted) surface.	15	Metal box.
7	Star washers.	16	Connection to motor.
8	Brake cable (shielded).	17	Motor.
9	Motor cable (shielded).	18	EMC cable gland.

N O T I C E

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 200 mm (7.9 in) clearance is required between power, motor, and control cables.

4.5 Access

- Remove the cover with a screwdriver (see Illustration 10) or by loosening the attaching screws (see Illustration 11).

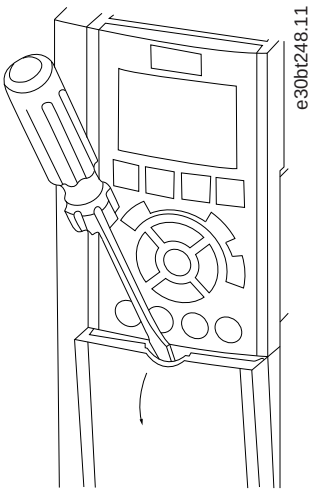


Illustration 10: Access to Wiring for IP20 and IP21 Enclosures

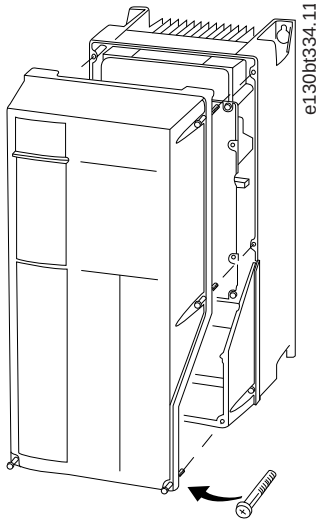


Illustration 11: Access to Wiring for IP55 and IP66 Enclosures

Before tightening the screws, refer to Table 5.

Table 5: Tightening Torques for Covers

Enclosure[1]	IP55 [Nm (in-lbs)]	IP66 [Nm (in-lbs)]
A4/A5	2 (18)	2 (18)
B1/B2	2.2 (19)	2.2 (19)
C1/C2	2.2 (19)	2.2 (19)

[1] No screws to tighten for A2/A3/B3/B4/C3/C4.

4.6 Connecting the Motor

⚠ W A R N I N G ⚠

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out/tagged 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.
- Simultaneously lock out/tag out all the drives.

- Run output separately or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see 8.1 Electrical Data, 200–240 V and 3x115Y/200–139Y/240 V to 8.4 Electrical Data, 525–690 V.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA 1/12) and higher units.
- Do not wire a starting or pole-changing device (for example a Dahlander motor or slip ring asynchronous motor) between the drive and the motor.

4.6.1 Grounding the Cable Shield

Procedure

1. Strip a section of the outer cable insulation.

2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between cable shield and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with grounding instructions provided in 4.3 Grounding.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).

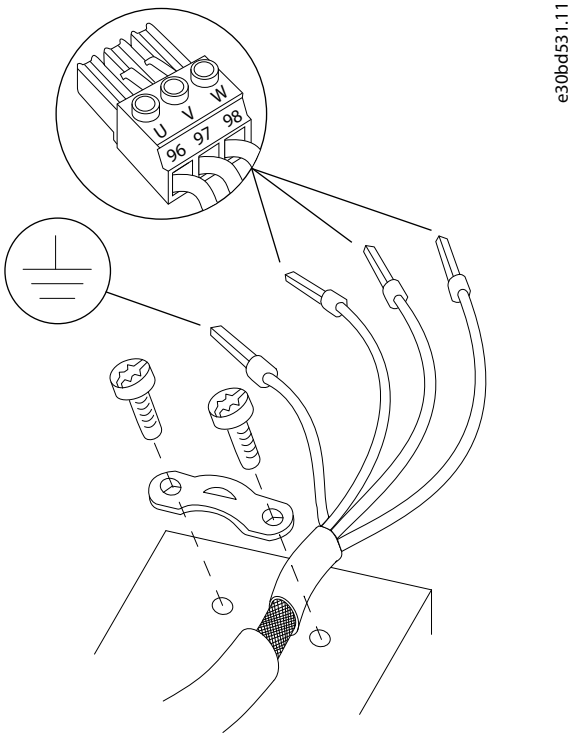


Illustration 12: Motor Connection

5. Tighten terminals in accordance with the information provided in 8.11 Connection Tightening Torques.

4.6.2 Grounding with Category C1 Filter

Check the filter category in the typecode on the nameplate.

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between cable shield and ground.
3. Run the 3-phase motor wiring through the rubber part, see Illustration 13.
4. Run the 3-phase motor wiring through the ferrite, see Illustration 13.
5. Connect ground wire to the nearest grounding terminal in accordance with grounding instructions.
6. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see Illustration 13.
7. Position the ferrite as shown in Illustration 13.
8. Squeeze the plastic clamps together. Use the teeth lock to fasten the ferrite to the wires.

9. Tighten terminals in accordance with the information provided in 8.11 Connection Tightening Torques.

Example

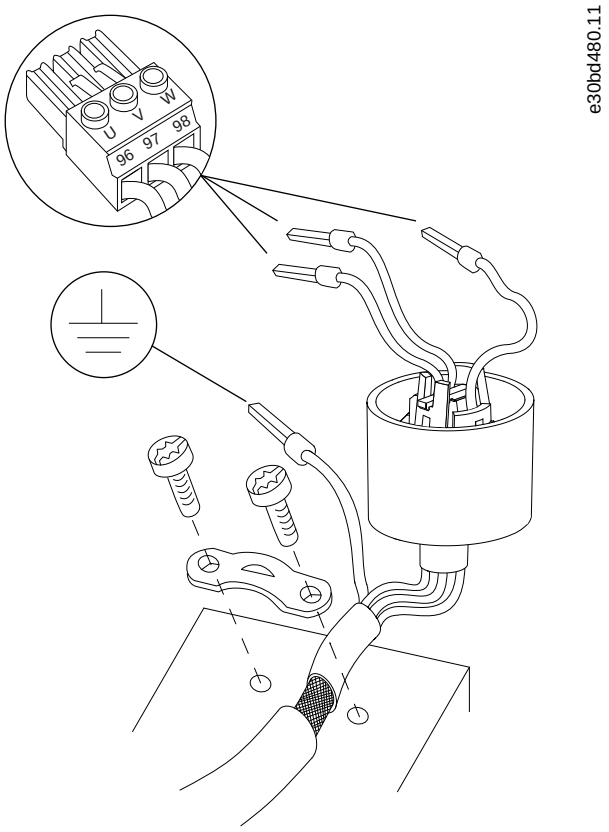


Illustration 13: Motor Connection for Drive with Category C1 Filter

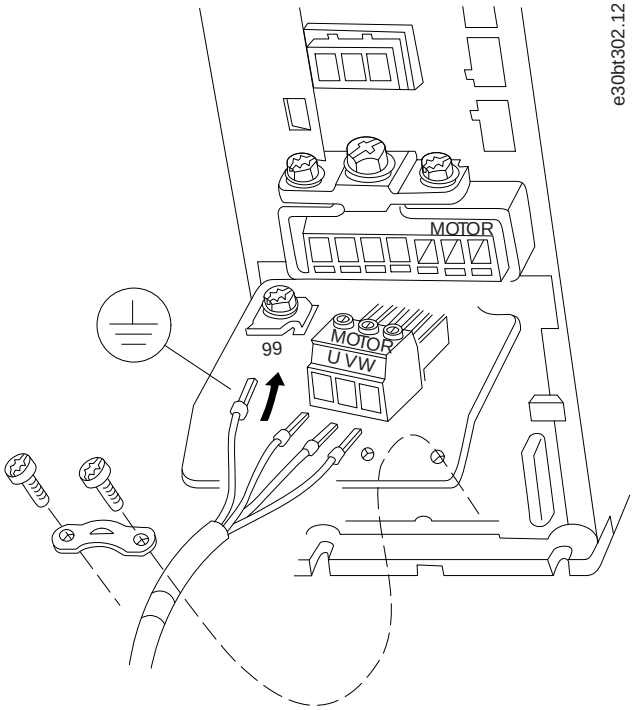


Illustration 14: Motor Connection for Enclosure Types A2 and A3

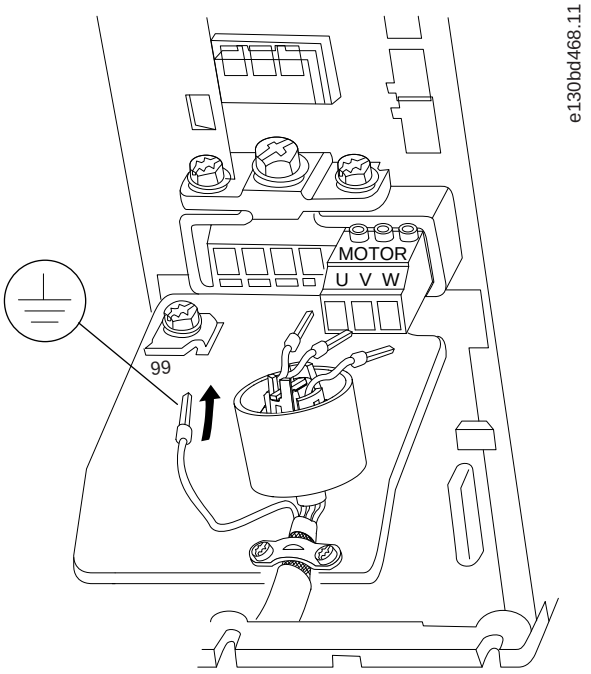


Illustration 15: Motor Connection with Category C1 Filter for Enclosure Types A2 and A3

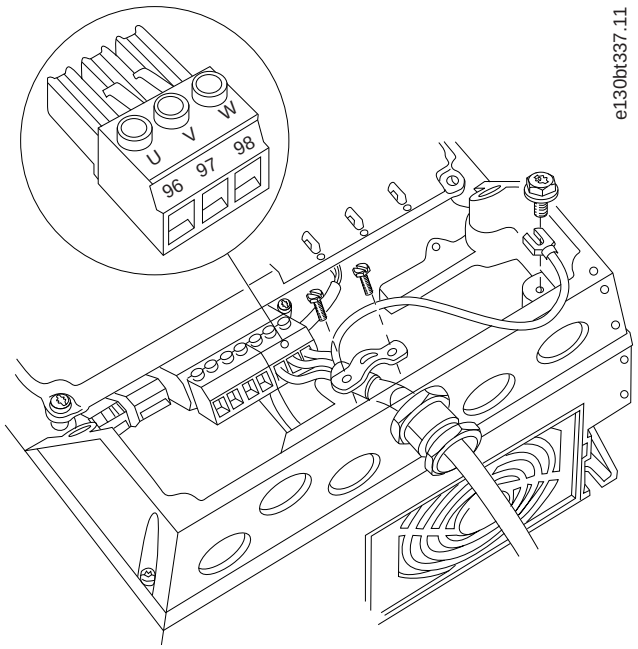


Illustration 16: Motor Connection for Enclosure Types A4 and A5 (IP55/66/NEMA Type 12)

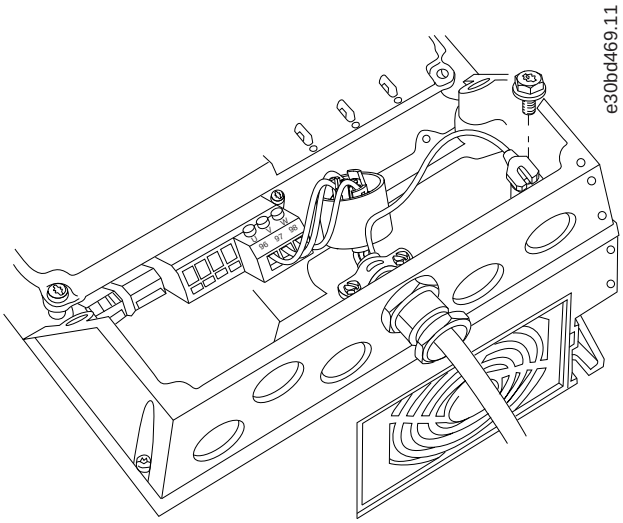


Illustration 17: Motor Connection with Category C1 filter for Enclosure Types A4 and A5 (IP55/66/NEMA Type 12)

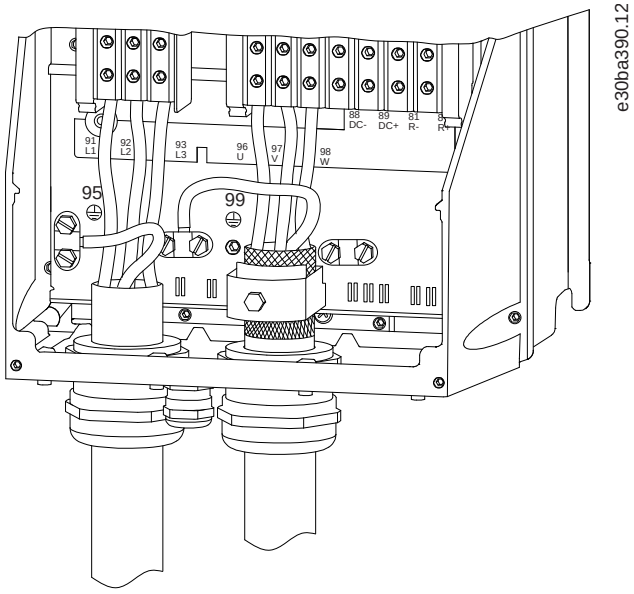


Illustration 18: Motor, Mains, and Ground Wiring for Enclosure Types B and C Using Shielded Cable

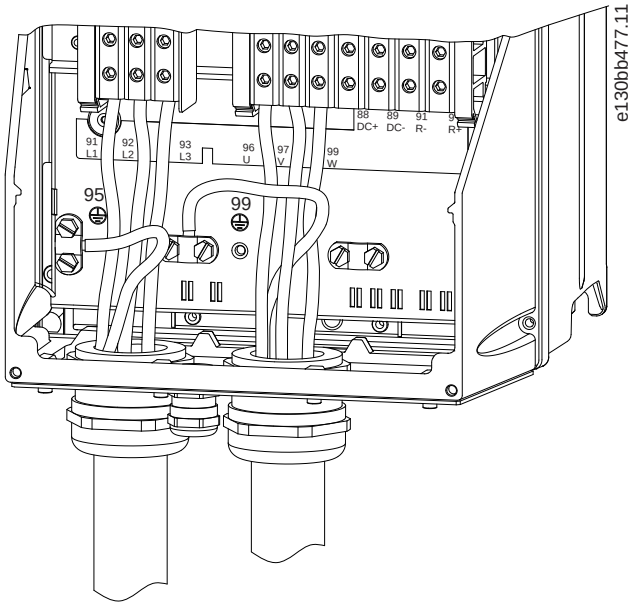


Illustration 19: Motor, Mains, and Ground Wiring for Enclosure Types B and C Using Conduit

4.7 Connecting AC Mains

- Size the wiring based on the input current of the drive. For maximum wire sizes, see 8.1 Electrical Data, 200–240 V and 3x115Y/200–139Y/240 V to 8.4 Electrical Data, 525–690 V.
- Comply with local and national electrical codes for cable sizes.

4.7.1 Connecting the Drive to Mains

Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3.
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions, see 4.3 Grounding and 4.6.1 Grounding the Cable Shield.
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*. This setting prevents damage to the DC link and reduces ground capacity currents in accordance with IEC 61800-3.

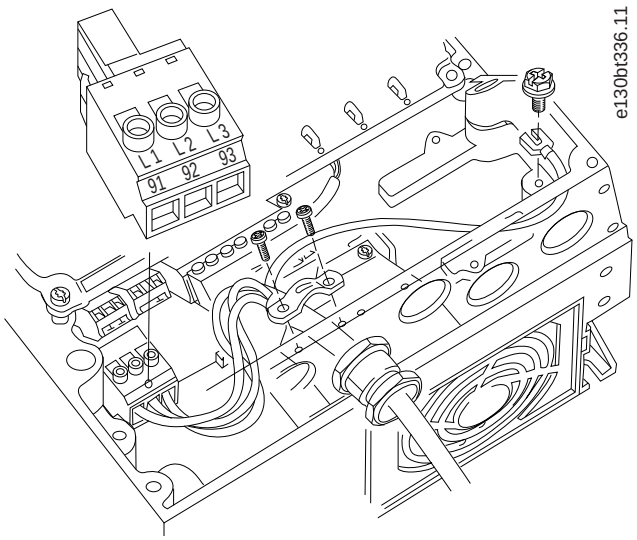


Illustration 20: Connecting to AC Mains

4.8 Control Terminals

4.8.1 Control Wiring

- Isolate control wiring from high power components in the drive.
- When the drive 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.

4.8.2 Control Terminal Types

Find the location of the removable drive connectors in Illustration 21 and Illustration 22. Terminal functions and default settings are summarized in 4.8.3 Terminal Descriptions.

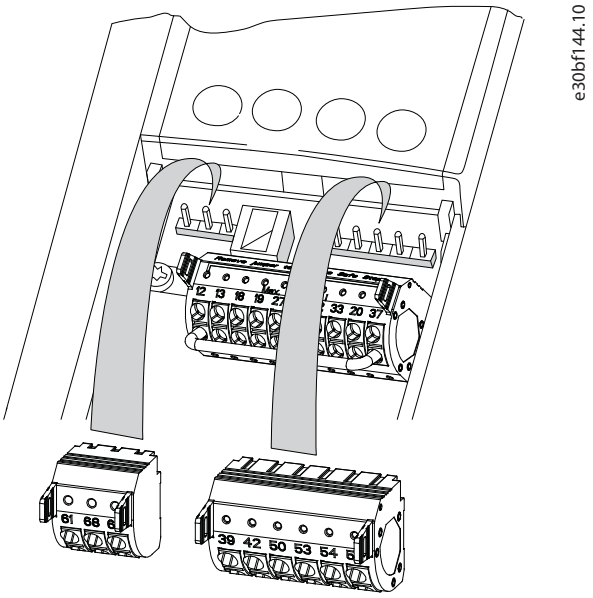


Illustration 21: Control Terminal Locations

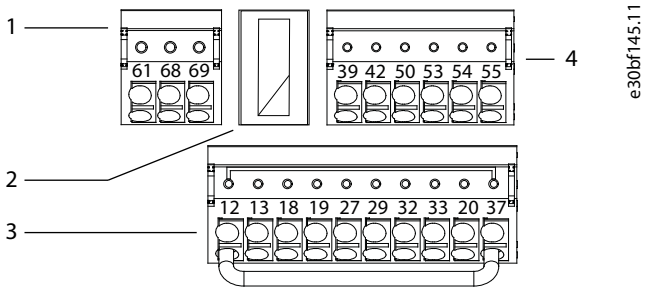


Illustration 22: Terminal Numbers on the Connectors

1	Serial communication connector	3	Digital input/output connector
2	USB port	4	Analog input/output connector

- Serial communication connector provides 2 terminals (+)68 and (-)69 for an RS485 serial communication.
- USB port available for use with the MCT 10 Set-up Software.
- Digital input/output connector provides:

- 4 programmable digital input terminals.
- 2 additional digital terminals programmable as either input or output.
- A 24 V DC terminal supply voltage.
- A common for optional customer-supplied 24 V DC voltage.

• Analog input/output connector provides:
- 2 analog inputs.
- 1 analog output.
- 10 V DC supply voltage.
- Commons for the inputs and output.

4.8.3 Terminal Descriptions

Table 6: Digital Inputs/Outputs

Terminal	Parameter	Default setting	Description
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.
18	*Parameter 5-10 Terminal 18 Digital Inputs*	*[8] Start*	Digital inputs
19	*Parameter 5-11 Terminal 19 Digital Inputs*	*[0] No operation*	
32	*Parameter 5-14 Terminal 32 Digital Input*	*[0] No operation*	
33	*Parameter 5-15 Terminal 33 Digital Input*	*[0] No operation*	
27	*Parameter 5-12 Terminal 27 Digital Input*	*[2] Coast inverse*	For digital input or output. Default setting is input.
29	*Parameter Terminal 29 Digital Input*	*[14] Jog*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	Safe Torque Off (STO)	Safe input (optional). Used for STO.

Table 7: Analog Inputs/Outputs

Terminal	Parameter	Default setting	Description
39	–	–	Common for analog output.
42	*Parameter 6-50 Terminal 42 Output*	Speed 0–high limit	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	–	+10 V DC	10 V DC analog supply voltage potentiometer or thermistor. 15 mA maximum.
53	*Parameter group 6-1* Analog Input 1*	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	*Parameter group 6-1* Analog Input 2*	Feedback	
55	–	–	Common for analog input.

Table 8: Serial Communication

Terminal	Parameter	Default setting	Description
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield if EMC problems occur.
68 (+)	*Parameter group 8-3* FC Port Settings*	–	RS485 interface. A control card switch is provided for termination resistance.
69 (-)	*Parameter group 8-3* FC Port Settings*	–	

Table 9: Relays

Terminal	Parameter	Default setting	Description
01, 02, 03	*Parameter 5-40 Function Relay [0]*	*[9] Alarm*	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	*Parameter 5-40 Function Relay [1]*	*[5] Running*	

Table 10: Additional Terminals

Terminal	Location
1 form C relay outputs	The location of the outputs depend on the drive configuration.
Terminals on built-in optional equipment	See the manual provided with the equipment option.

4.8.4 Wiring to Control Terminals

Control terminal connectors can be unplugged from the drive for ease of installation as shown in the next drawing.

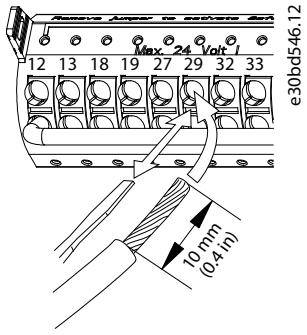
N O T I C E

Keep control wires as short as possible and separate from high power cables to minimize interference.

See 8.8.3 Control Cable Cross-sections and 6.1 Application Examples for typical control wiring connections.

Procedure

1. Open the contact by inserting a flathead screwdriver (maximum head width 4 mm/no. 1) into the slot above the contact and push the screwdriver slightly upwards.



2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.

4. Ensure that the contact is firmly established and not loose. Loose control wiring can cause equipment faults or less than optimum operation.

4.8.4.1 Removing a Control Wire

Procedure

1. Open the contact by inserting a flathead screwdriver (maximum head 4 mm/no. 1) into the slot in the middle between the 2 contacts and push the screwdriver slightly upwards.
2. Remove the control wire from the contact.
3. Remove the screwdriver.

4.8.5 Enabling Motor Operation (Terminal 27)

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the drive to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive a 24 V DC external interlock command. In many applications, wire an external interlock device to terminal 27.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads AUTO REMOTE COAST, this 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.
  - Do not add a jumper between terminals 12 and 27.
  - Do not disable input 27.

N O T I C E

The drive cannot operate without a signal on terminal 27 unless terminal 27 is re-programmed to *[0] No operation*.

4.8.6 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signals to voltage (0–10 V) or current (0/4–20 mA).

Default parameter settings:

- 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 Settings*).

⚠ W A R N I N G ⚠

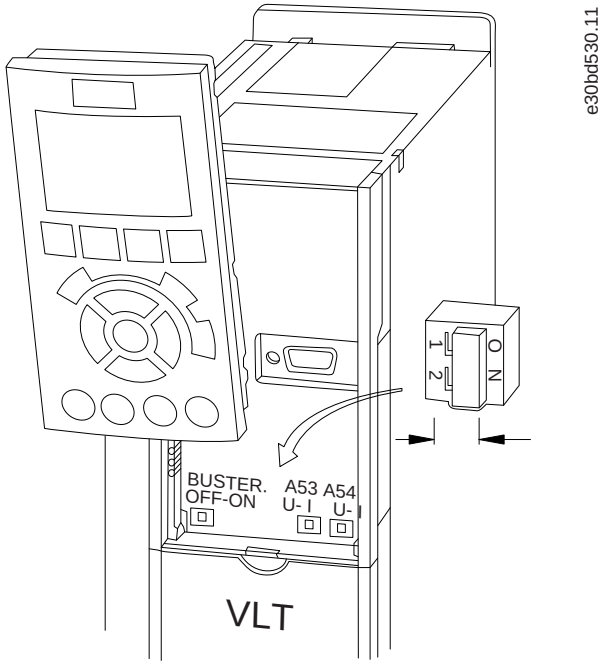
SHOCK HAZARD

AC drives contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to disconnect power to the drive before changing switch positions may result in death or serious injury.

– Always disconnect power to the drive before changing switch positions.

Procedure

1. Remove the LCP.



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

4.8.7 Safe Torque Off (STO)

To run STO, additional wiring for the drive is required.

Refer to the VLT® Frequency Converters Safe Torque Off Operating Guide for further information.

4.8.8 RS485 Serial Communication

Up to 32 nodes can be connected as a bus or via drop cables from a common trunk line to 1 network segment. Repeaters can divide network segments. Each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address across all segments.

- Connect RS485 serial communication wiring to terminals (+) 68 and (-) 69.
- Terminate each segment at both ends, using either the termination switch (bus term on/off, see 4.8.6 Voltage/Current Input Selection (Switches)) on the drive, or as biased termination resistor network.
- Connect a large surface of the shield to the ground, for example with a cable clamp or a conductive cable gland.
- Apply potential-equalizing cables to maintain the same ground potential throughout the network.
- Use the same type of cable throughout the entire network to prevent impedance mismatch.

Cable	Shielded twisted pair (STP)
Impedance	120 Ω
Maximum cable length [m (ft)]	1200 (3937) (including drop lines) 500 (1640) station-to-station

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in the following table. Check and mark the items when completed.

Table 11: Installation Check List

Inspect for	Description	√
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers residing on the input power side of the drive, or output side to the motor. Ensure that they are ready for full-speed operation. • Check the function and installation of any sensors used for feedback to the drive. • Remove any power factor correction capacitors on the motor. • Adjust any power factor correction capacitors 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 3.3.1 Cooling.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that the motor and mains cables are in separate conduit or separated shielded cables.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

⚠ C A U T I O N ⚠

INTERNAL FAILURE HAZARD

An internal failure in the drive can result in serious injury when the drive is not properly closed.

– Ensure that all safety covers are in place and securely fastened before applying power.

5 Commissioning

5.1 Applying Power

⚠ WARNING ⚠

UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of 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.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

NOTICE

MISSING SIGNAL

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING, or *alarm 60, External interlock* is shown, it indicates that the unit is ready to operate but is missing an input signal on, for example, terminal 27.

- See 4.8.5 Enabling Motor Operation (Terminal 27) for details.

Procedure

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.
4. Apply power to the unit. Do not start the drive now. For units with a disconnect switch, turn it to the ON position to apply power to the drive.

5.2 Local Control Panel Operation

5.2.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit.

LCP functions

- Control drive speed in hand-on mode.
- Start, stop, and control speed when in local control.
- Show operational data, status, warnings, and cautions.
- Program drive functions.
- Manually reset the drive after a fault when auto reset is inactive.

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the product-relevant Programming Guide for details on use of the NLCP.

NOTICE

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, code number 130B1000). For more information and downloads, see www.danfoss.com.

5.2.2 LCP Layout

The LCP is divided into 4 functional groups:

- A: Display area
- B: Display menus and keys
- C: Navigation keys and indicator lights (LEDs)
- D: Operation keys and reset

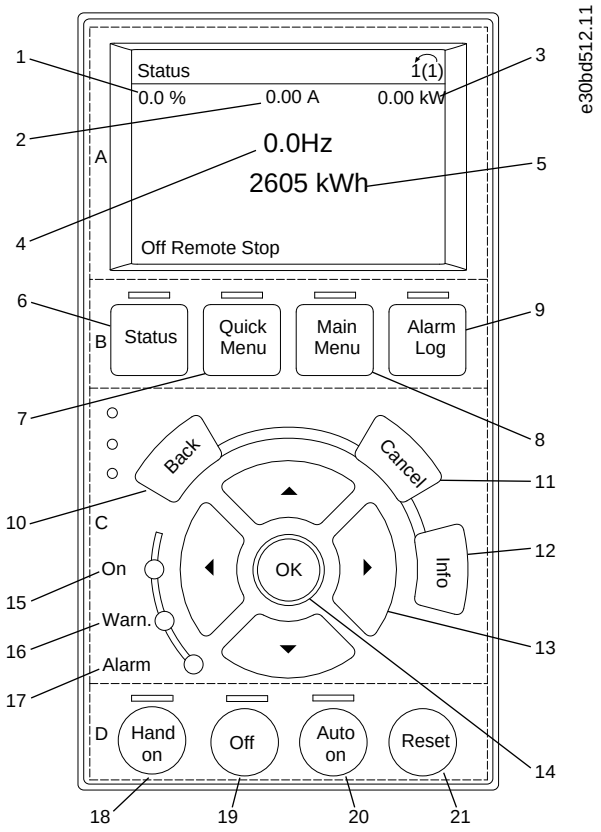


Illustration 23: Local Control Panel (LCP)

Area A: Display area

The display area is activated when the drive receives power from mains voltage, a DC bus terminal, or a 24 V DC external supply.

The information shown on the LCP can be customized for user application. Select options in the Quick Menu *Q3-13 Display Settings*.

Table 12: Legend to Area A, Display Area

Callout	Parameter	Default setting
1	*Parameter 0-20 Display Line 1.1 Small*	*[1602] Reference [%]*
2	*Parameter 0-21 Display Line 1.2 Small*	*[1614] Motor Current*
3	*Parameter 0-22 Display Line 1.3 Small*	*[1610] Power [kW]*
4	*Parameter 0-23 Display Line 2 Large*	*[1613] Frequency*
5	*Parameter 0-24 Display Line 3 Large*	*[1502] kWh Counter*

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.

Table 13: Legend to Area B, Display Menu Keys

Callout	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial setup 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.

Area 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 (hand) operation. There are also 3 drive status indicator lights in this area.

Table 14: Legend to Area C, Navigation Keys

Callout	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 has not changed.
12	Info	Press for a definition of the function being shown.
13	Navigation keys	Press to move between items in the menu.
14	OK	Press to access parameter groups or to enable a choice.

Table 15: Legend to Area C, Indicator Lights (LEDs)

Callout	Indicator	Light	Function
15	ON	Green	The ON LED activates when the drive receives power from mains voltage, a DC bus terminal, or a 24 V DC external supply.
16	WARN	Yellow	When warning conditions are met, the yellow WARN LED 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.

Area D: Operation keys and reset

Operation keys are at the bottom of the LCP.

Table 16: Legend to Area D, Operation Keys and Reset

Callout	Key	Function
18	[Hand On]	Starts the drive in local control. • An external stop signal by control input or serial communication overrides the local control.
19	[Off]	Stops the motor but does not remove power to the drive.
20	[Auto On]	Puts the system in remote control. • Responds to an external start command by control terminals or serial communication.
21	[Reset]	Resets the drive manually after a fault has been cleared.

NOTICE

The display contrast can be adjusted by pressing [Status] and[▲]/[▼] keys.

5.2.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters.

Programming data are stored internally in the drive.

- For backup, upload data into the LCP memory.
- To download data to another drive, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

5.2.4 Uploading/Downloading Data to/from the LCP

Procedure

1. Press [Off] to stop the motor before uploading or downloading data.
2. Press [Main Menu].
3. Go to *parameter 0-50 LCP Copy* and press [OK].
4. Select *[1] All to LCP* to upload data to the LCP, or select *[2] All from LCP* to download data from the LCP.
5. Press [OK].

   A progress bar shows the uploading or downloading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

5.2.5 Changing Parameter Settings

Parameter settings can be accessed and changed via the [Quick Menu] or [Main Menu] keys. The *Quick Menu* only gives access to a limited number of parameters.

Procedure

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲]/[▼] to browse through the parameter groups, press [OK] to select a parameter group.
3. Press [▲]/[▼] to browse through the parameters, press [OK] to select a parameter.
4. Press [▲]/[▼] to change the value of a parameter setting.
5. Press [◀]/[▶] to shift digit when a decimal parameter is in the editing state.
6. Press [OK] to accept the change.
7. Press either [Back] twice to enter *Status*, or press [Main Menu] once to enter *Main Menu*.

5.2.5.1 View Changes

Quick Menu Q5 lists all parameters changed from default settings.

- The list shows only parameters which have been changed in the current edit setup.
- Parameters that have been reset to default values are not listed.
- The message *Empty* indicates that no parameters have been changed.

5.2.6 Restoring Default Settings

N O T I C E

RISK OF LOSING DATA

When restoring default settings, there is a risk of losing programming, motor data, localization, and monitoring records.

– Provide a backup by uploading data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the drive. Initialization is carried out via *parameter 14-22 Operation Mode* (recommended) or manually.

- Initialization via *parameter 14-22 Operation Mode* does not reset the drive 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.

5.2.6.1 Recommended Initialization

Procedure

1. Press [Main Menu] twice to access parameter.
2. Scroll to *parameter 14-22 Operation Mode* and press [OK].
3. Scroll to *[2] Initialisation* 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. This may take slightly longer than normal.
6. *Alarm 80, Drive initialised* is shown.
7. Press [Reset] to return to operating mode.

5.2.6.2 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 a click is heard and the fan starts).

   Factory default parameter settings are restored during start-up. This might take slightly longer than normal.

Manual initialization resets parameter settings except for the settings in:

- *Parameter 15-00 Operating Hours*.
- *Parameter 15-03 Power Up's*.
- *Parameter 15-04 Over Temp's*.
- *Parameter 15-05 Over Volt's*.

5.3 Basic Programming

5.3.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

NOTICE

Motor data is required for the SmartStart setup. The required data are normally available on the motor nameplate.

- At 1st power-up or after initialization of the drive, SmartStart starts automatically.
- Follow the on-screen instructions to complete commissioning of the drive. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without using the SmartStart wizard, refer to 5.3.2 Commissioning via [Main Menu] or the *Programming Guide*.

5.3.2 Commissioning via [Main Menu]

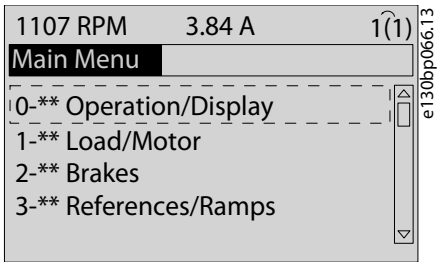
Recommended parameter settings are intended for start-up and checkout purposes. Application settings may vary.

Enter data with power ON, but before operating the drive.

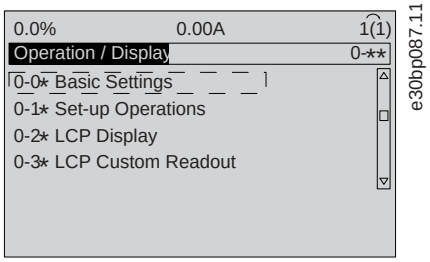
Procedure

1. Press [Main Menu] on the LCP.

2. Press the navigation keys to scroll to *parameter group 0-** Operation/Display* and press [OK].



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



5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK].

Default settings for a number of parameters are changed.

6. Press [Main Menu] on the LCP.
7. Press the navigation keys to scroll to *parameter 0-01 Language*.
8. Select 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:
    - **a.** *Parameter 3-02 Minimum Reference*.
    - **b.** *Parameter 3-03 Maximum Reference*.
    - **c.** *Parameter 3-41 Ramp 1 Ramp Up Time*.
    - **d.** *Parameter 3-42 Ramp 1 Ramp Down Time*.
    - **e.** *Parameter 3-13 Reference Site*. Linked to Hand/Auto Local/Remote.

5.3.3 Asynchronous Motor Setup

Procedure

When running in flux control principle, or 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.

1. Enter the motor data in *parameter 1-20 Motor Power [kW]* or *parameter 1-21 Motor Power [HP]* to *parameter 1-25 Motor Nominal Speed*. Enter the data in the following order:
    - **a.** *Parameter 1-20 Motor Power [kW]* or *Parameter 1-21 Motor Power [HP]*.
    - **b.** *Parameter 1-22 Motor Voltage*.
    - **c.** *Parameter 1-23 Motor Frequency*.
    - **d.** *Parameter 1-24 Motor Current*.
    - **e.** *Parameter 1-25 Motor Nominal Speed*.

Motor data information is on the motor nameplate.

2. Enter parameters for flux control/VVC+ mode:
    - **a.** *Parameter 1-30 Stator Resistance (Rs)*.
    -

b. *Parameter 1-31 Rotor Resistance (Rr)*.

- **c.** *Parameter 1-33 Stator Leakage Reactance (X1)*.
- **d.** *Parameter 1-34 Rotor Leakage Reactance (X2)*.
- **e.** *Parameter 1-35 Main Reactance (Xh)*.
- **f.** *Parameter 1-36 Iron Loss Resistance (Rfe)*.

5.3.3.1 Application-specific Adjustment when Running VVC+

VVC+ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

5.3.3.2 Application-specific Adjustment when Running Flux

Flux control principle is the preferred control principle for optimum shaft performance in dynamic applications. Perform an AMA since this control mode requires precise motor data. Depending on the application, further adjustments may be required.

Table 17: Recommendations for Flux Applications

Application	Settings
Low-inertia applications	Keep calculated values.
High-inertia applications	*Parameter 1-66 Min. Current at Low Speed* • Increase current to a value between default and maximum depending on the application. • Set ramp times matching the application. Too fast ramp up causes an overcurrent or overtorque. Too fast ramp down causes an overvoltage trip.
High load at low speed	*Parameter 1-66 Min. Current at Low Speed*. Increase current to a value between default and maximum depending on the application.
No-load application	Adjust *parameter 1-18 Min. Current at No Load* to achieve smoother motor operation by reducing torque ripple and vibration.
Flux sensorless control principle only	Adjust *Parameter 1-53 Model Shift Frequency*. • Example 1: If the motor oscillates at 5 Hz, and dynamics performance is required at 15 Hz, set *parameter 1-53 Model Shift Frequency* to 10 Hz. • Example 2: If the application involves dynamic load changes at low speed, reduce *parameter 1-53 Model Shift Frequency*. Observe the motor behavior to make sure that the model shift frequency is not reduced too much. Symptoms of inappropriate model shift frequency are motor oscillations or drive tripping.

5.3.4 Permanent Magnet Motor Set-up

N O T I C E

Only use permanent magnet (PM) motors in fan and pumps applications.

5.3.4.1 Initial Programming

Procedure

1. Activate PM motor operation in *parameter 1-10 Motor Construction*.
2. Select *[1] PM, non-salient SPM*.
3. Set *parameter 0-02 Motor Speed Unit* to *[0] RPM*.

5.3.4.2 Programming Motor Data

After selecting *[1] PM, Non-salient* 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* Adv. Motor Data* are active. The necessary data are on the motor nameplate and in the motor data sheet. Program the following parameters in the listed order.

Procedure

1. Program in the following order:
   - **a.** *Parameter 1-24 Motor Current*.
   - **b.** *Parameter 1-26 Motor Cont. Rated Torque*.
   - **c.** *Parameter 1-25 Motor Nominal Speed*.
   - **d.** *Parameter 1-39 Motor Poles*.
   - **e.** *Parameter 1-30 Stator Resistance*

     Enter line-to-common stator winding resistance (R_s). If only line-line data is available, divide the line-line value with 2 to achieve the line-to-common (starpoint value). It is also possible to measure the value with an ohmmeter, which takes the resistance of the cable into account. Divide the measured value by 2 and enter the result.
   - **f.** *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 line-line value with 2 to achieve the line-to-common (starpoint) value. It is also possible to measure the value with an inductancemeter, which takes the inductance of the cable into account. Divide the measeured value by 2 and enter the result.
   - **g.** *Parameter 1-40 Back EMF at 1000 RPM*.

     Enter line-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 drive 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)x1000 = (320/1800)x1000 = 178. This is the value that must be programmed for *parameter 1-40 Back EMF at 1000 RPM*.

5.3.4.3 Test Motor Operation

Procedure

1. Start the motor at low speed (100–200 RPM). If the motor does not turn, check installation, general programming, and motor data.
2. Check if the start function in *parameter 1-70 PM Start Mode* fits the application requirements.

5.3.4.4 Rotor Detection

This function is the recommended choice for applications where the motor starts from standstill, for example pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

5.3.4.5 Parking

This function is the recommended selection for applictions where the motor rotates 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.

Table 18: Recommendations for Various Applications

Application	Setting
Low inertia applications, $I_{Load}/I_{Motor}<5$	Increase *parameter 1-17 Voltage Filter Time Const.* by factor 5–10. Reduce *parameter 1-14 Damping Gain*.

Application	Setting
	Reduce *parameter 1-66 Min. Current at Low Speed* (<100%).
High inertia applications 50>I_{Load}/I_{Motor}>5	Keep calculated values.
High inertia applications I_{Load}/I_{Motor}>50	Increase *parameter 1-14 Damping Gain*, *parameter 1-15 Low Speed Filter Time Const.*, and *parameter 1-16 High Speed Filter Time Const.* (>100% for a prolonged time can overhet the motor).
High load at low speed <30% (rated speed)	Increase *parameter 1-17 Voltage Filter Time Const*. Increase *parameter 1-66 Min. Current at Low Speed* (>100% for a prolonged time can overheat the motor).

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.

Starting torque can be adjusted in *parameter 1-66 Min. Current at Low Speed*. 100% provides nominal toque as starting torque.

5.3.5 Automatic Energy Optimization (AEO)

N O T I C E

AEO is not relevant for permanent magnet motors.

Automatic energy optimization (AEO) is a procedure that minimizes voltage to the motor, 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*.

5.3.6 Automatic Motor Adaptation (AMA)

N O T I C E

AMA is not relevant for permanent magnet motors.

Automatic motor adaptation (AMA) is a procedure that optimizes compatibility between the drive and the motor.

- The drive 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 data entered in *parameters 1-20* to *1-25*.
- The motor shaft does not turn and no harm is done to the motor while running 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 7.6 List of Warnings and Alarms.
- Run this procedure on a cold motor for best results.

5.3.6.1 Running AMA

Enter the advanced motor data in *parameter group 1-3* Adv. Motor Data*.

Procedure

1. Press [Main Menu] to access parameters.
2. Scroll to *parameter group 1-** Load and Motor* and press [OK].
3. Scroll to *parameter group 1-2* Motor Data* and press [OK].
4. Scroll to *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Follow on-screen instructions.

The test runs automatically and indicates when it is complete.

5.3.7 Checking Motor Rotation

NOTICE

RISK OF DAMAGE

Risk of damage to pumps/compressors caused by motor running in the wrong direction.

- Before running the drive, 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]*.

Procedure

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.

5.3.7.1 Changing Direction of Rotation

Procedure

1. Remove power to the drive.
2. Wait for power to discharge.
3. Reverse the connection of any 2 of the 3 motor wires on the motor or drive side of the connection.

5.3.8 Local-control Test

If acceleration or deceleration problems occur, see 7.7 Troubleshooting.

To reset the drive after a trip, see 7.4 Warning and Alarm Types.

Procedure

1. Press [Hand On] to provide a local start command to the drive.
2. Accelerate the drive by pressing [▵] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off] and note any deceleration problems.

5.3.9 System Start-up

The procedure in this section requires wiring and application programming to be completed. The following procedure is recommended after application setup is completed.

If warnings or alarms occur, see 7.4 Warning and Alarm Types and 7.6 List of Warnings and Alarms.

1. Press [Auto on].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check the sound and vibration levels of the motor to ensure that the system is working as intended.

6 Basic I/O Configuration

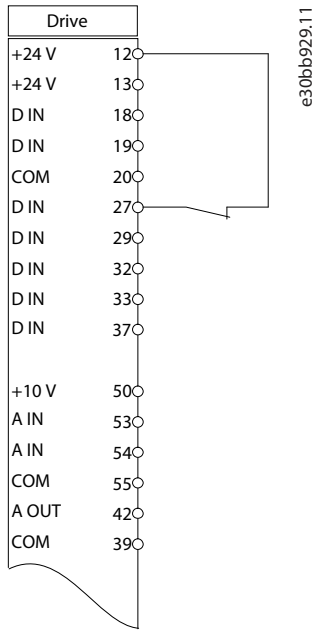
6.1 Application Examples

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.

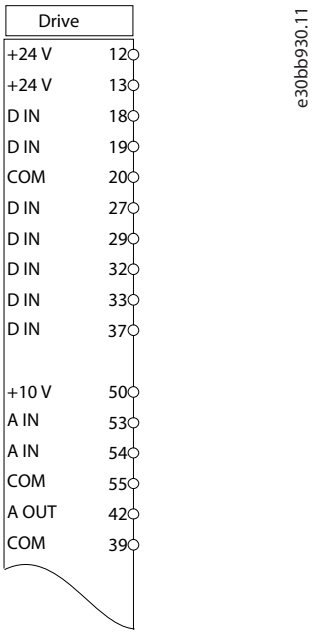
6.1.1 Wiring Configuration for Automatic Motor Adaptation (AMA)

Table 19: Wiring Configuration for AMA with T27 Connected

<table>
<tr><th></th><th colspan="2">Parameters</th></tr>
<tr><td rowspan="5"> 
</td><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 1-29 Automatic Motor Adaptation (AMA)</td><td>[1] Enable complete AMA</td></tr>
<tr><td>Parameter 5-12 Terminal 27 Digital Input</td><td>[2]* Coast inverse</td></tr>
<tr><td colspan="2">*=Default value</td></tr>
<tr><td colspan="2">Notes/comments:
Set parameter group 1-2* Motor Data according to motor nameplate.</td></tr>
</table>

6.1.2 Wiring Configuration for Automatic Motor Adaptation without T27

Table 20: AMA without T27 Connected

	Parameters	
	**Function**	**Setting**
	Parameter 1-29 Automatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	*=Default value	
	Notes/comments: *Parameter group 1-2* Motor Data* must be set according to motor.	

6.1.3 Wiring Configuration: Speed

Table 21: Analog Speed Reference (Voltage)

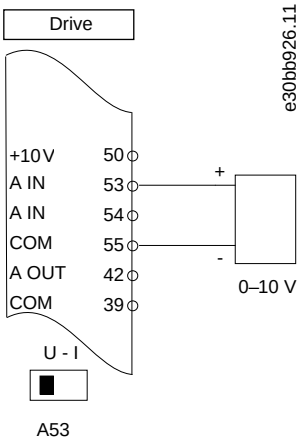
	Parameters	
	**Function**	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 22: Analog Speed Reference (Current)

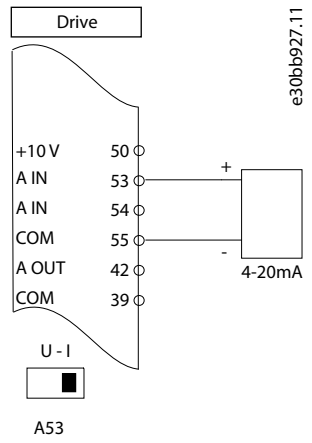
	Parameters	
	**Function**	**Setting**
	Parameter 6-12 Terminal 53 Low Current	4 mA*
	Parameter 6-13 Terminal 53 High Current	20 mA*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 23: Speed Reference (Using a Manual Potentiometer)

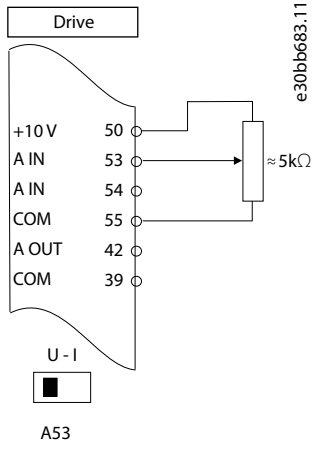
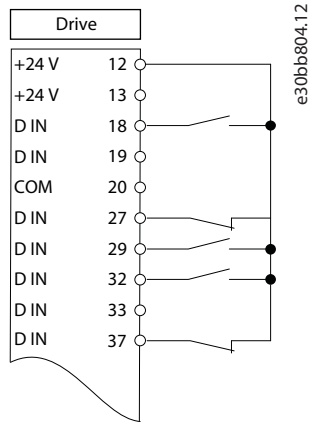
	Parameters	
	**Function**	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 24: Speed Up/Down

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[19] Freeze Reference*
	Parameter 5-13 Terminal 29 Digital Input	*[21] Speed Up*
	Parameter 5-14 Terminal 32 Digital Input	*[22] Speed Down*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

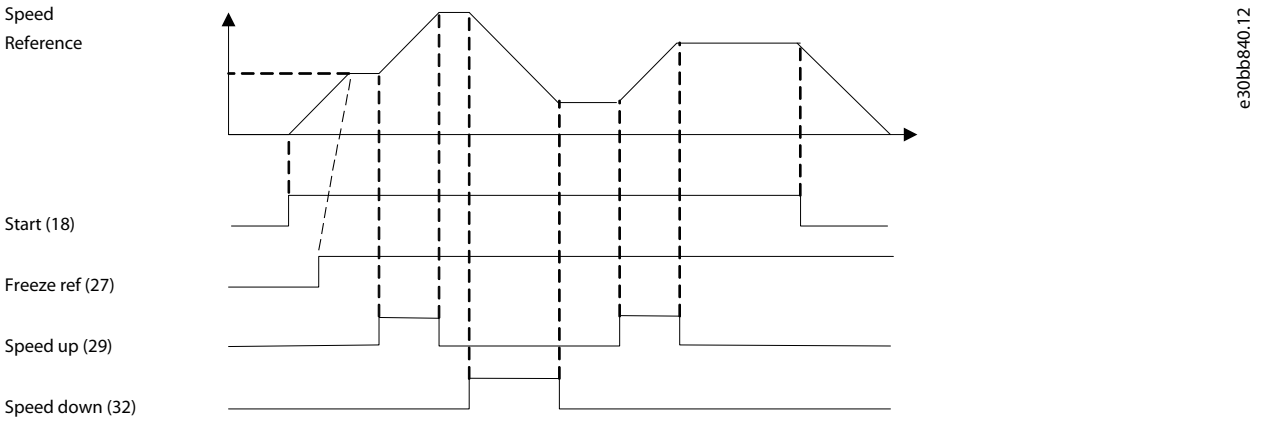


Illustration 24: Speed Up/Down

6.1.4 Wiring Configuration: Feedback

Table 25: Analog Current Feedback Transducer (2-wire)

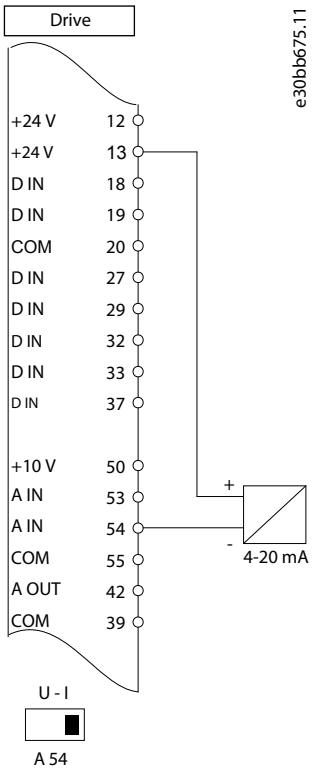
	Parameters	
	**Function**	**Setting**
	Parameter 6-22 Terminal 54 Low Current	4 mA*
	Parameter 6-23 Terminal 54 High Current	20 mA*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 26: Analog Voltage Feedback Transducer (3-wire)

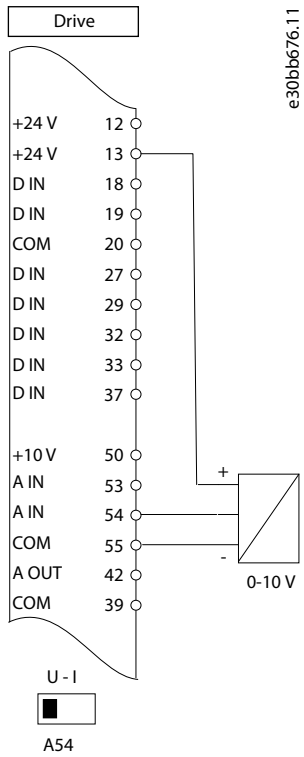
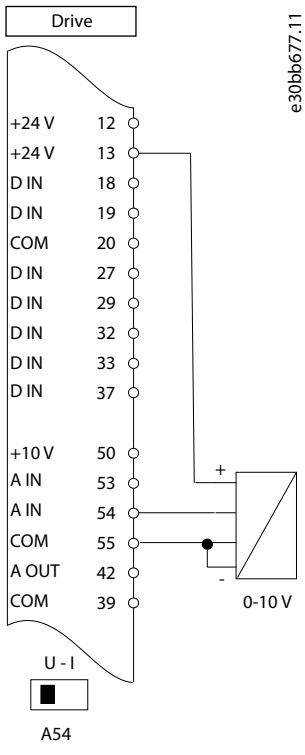
	Parameters	
	**Function**	**Setting**
	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
	Parameter 6-21 Terminal 54 High Voltage	10 V*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 27: Analog Voltage Feedback Transducer (4-wire)

	Parameters	
	**Function**	**Setting**
	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
	Parameter 6-21 Terminal 54 High Voltage	10 V*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.5 Wiring Configuration: Run/Stop

Table 28: Run/Stop Command with External Interlock

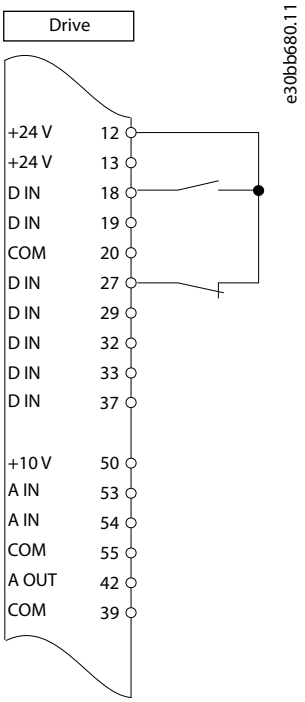
	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 29: Run/Stop Command without External Interlock

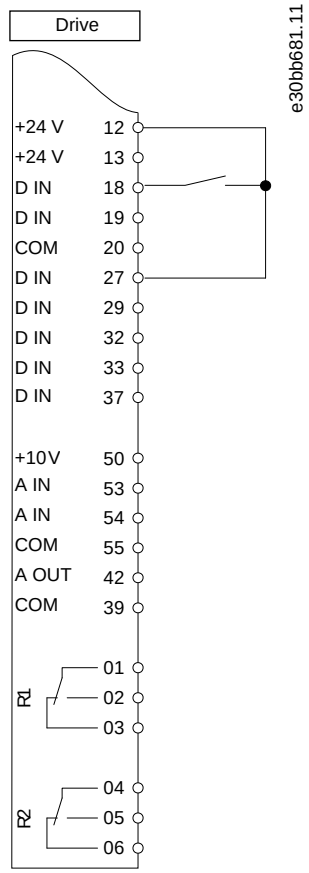
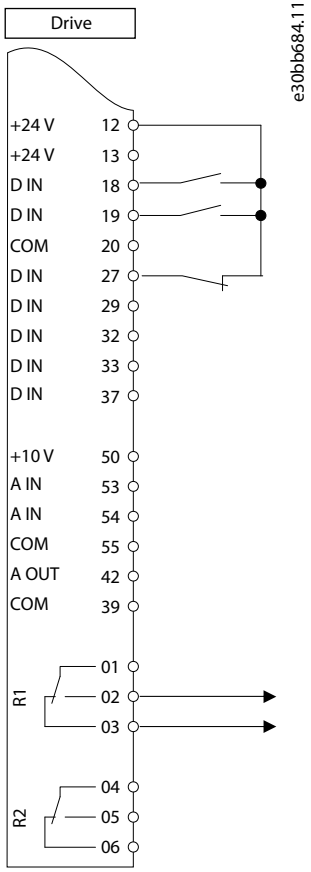
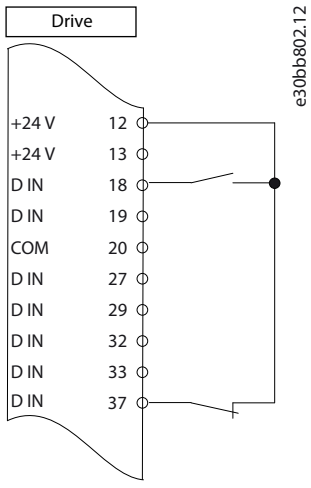
	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Inputs* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 30: Run Permissive

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-11 Terminal 19 Digital Input	*[52] Run permissive*
	Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
	Parameter 5-40 Function Relay	*[167] Start command act.*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.6 Wiring Configuration: Start/Stop

Table 31: Start/Stop Command with Safe Torque Off Option

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[Start]**
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-19 Terminal 37 Safe Stop	*[1] Safe Stop Alarm*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

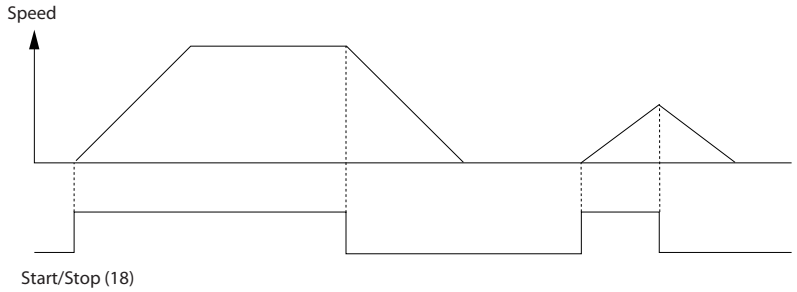
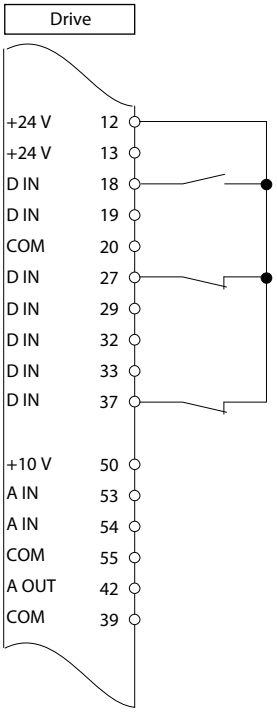


Illustration 25: Start/Stop Command with Safe Torque Off

Table 32: Pulse Start/Stop

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[9] Latched Start*
	Parameter 5-12 Terminal 27 Digital Input	*[6] Stop Inverse*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

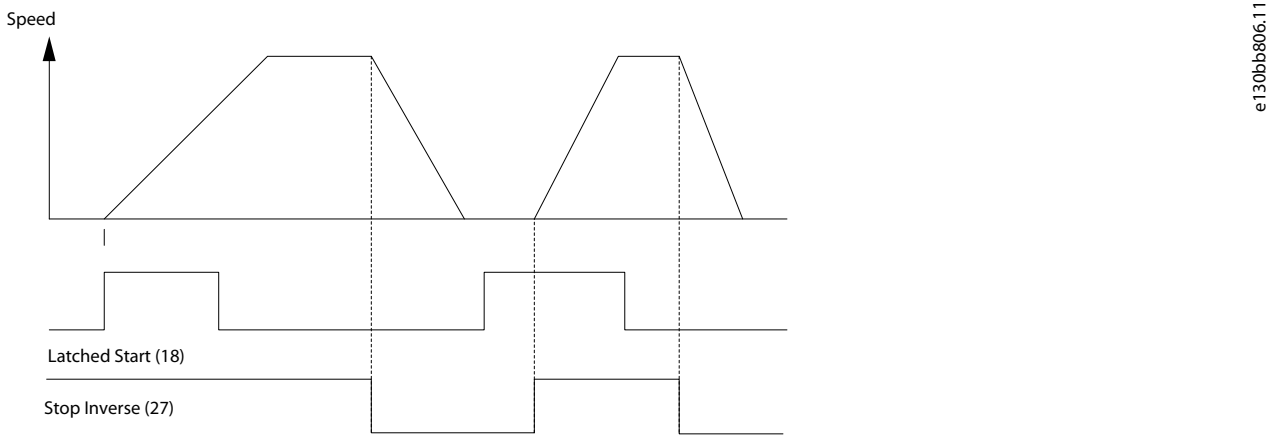
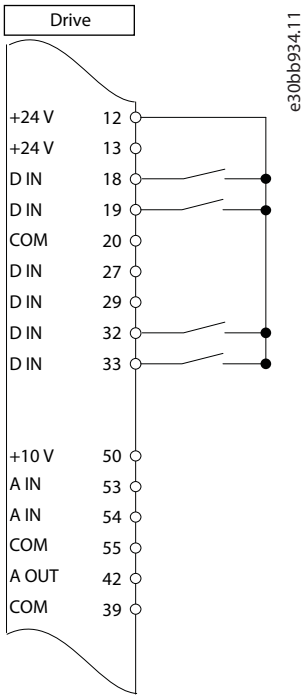


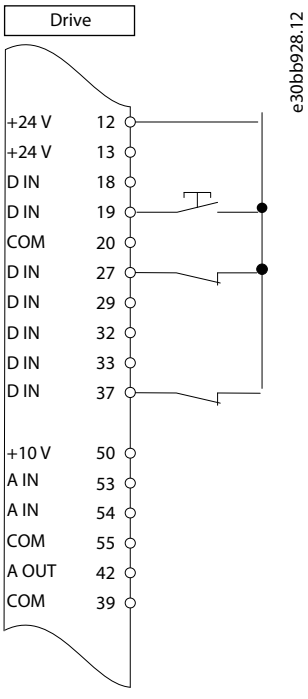
Illustration 26: Latched Start/Stop Inverse

Table 33: Start/Stop with Reversing and 4 Preset Speeds

	Parameters	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-11 Terminal 19 Digital Input	*[10] Reversing**
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-14 Terminal 32 Digital Input	*[16] Preset ref bit 0*
	Parameter 5-15 Terminal 33 Digital Input	*[17] Preset ref bit 1*
	Parameter 3-10 Preset Reference Preset ref. 0 Preset ref. 1 Preset ref. 2 Preset ref. 3	25% 50% 75% 100%
	*=Default value	
	Notes/comments: D IN 37 is an option.	

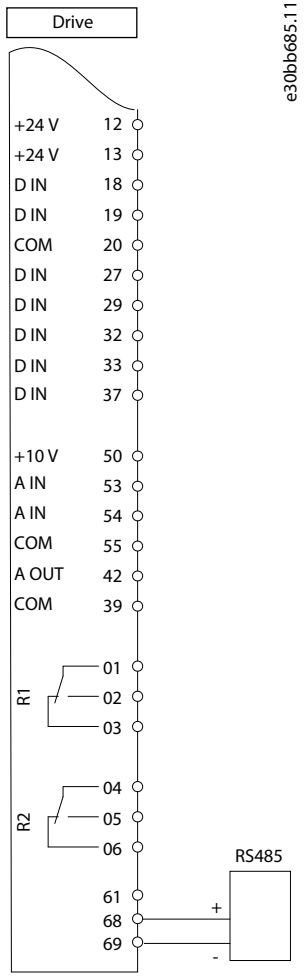
6.1.7 Wiring Configuration: External Alarm Reset

Table 34: External Alarm Reset

	Parameter	
	**Function**	**Setting**
	Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.8 Wiring Configuration: RS485

Table 35: Wiring Configuration for RS485 Network Connection

<table>
<tr><th colspan="2"></th><th colspan="2">Parameter</th></tr>
<tr><td colspan="2" rowspan="6"> 
</td><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 8-30 Protocol</td><td>FC*</td></tr>
<tr><td>Parameter 8-31 Address</td><td>1*</td></tr>
<tr><td>Parameter 8-32 Baud Rate</td><td>9600*</td></tr>
<tr><td colspan="2">*=Default value</td></tr>
<tr><td colspan="2">Notes/comments:
Select protocol, address, and baud rate in the above-mentioned parameters.
D IN 37 is an option.</td></tr>
</table>

6.1.9 Wiring Configuration: Motor Thermistor

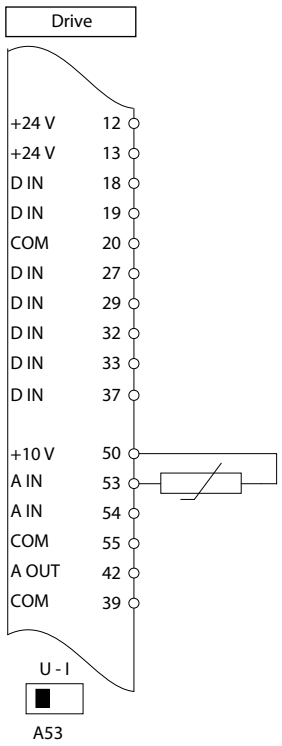
⚠ C A U T I O N ⚠

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

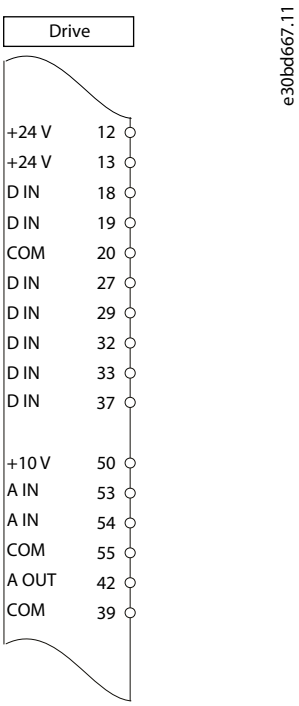
- To meet PELV insulation requirements, use only thermistors with reinforced or double insulation.

Table 36: Wiring Configuration for Motor Thermistor

<table>
<tr><td rowspan="5"> 
</td><td colspan="2">Parameters</td></tr>
<tr><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 1-90 Motor Thermal Protection</td><td>[2] Thermistor trip</td></tr>
<tr><td>Parameter 1-93 Thermistor Source</td><td>[1] Analog input 53</td></tr>
<tr><td colspan="2">* = Default value</td></tr>
<tr><td colspan="3">If only a warning is required, set parameter 1-90 Motor Thermal Protection to [1] Thermistor warning.
D IN 37 is an option.</td></tr>
</table>

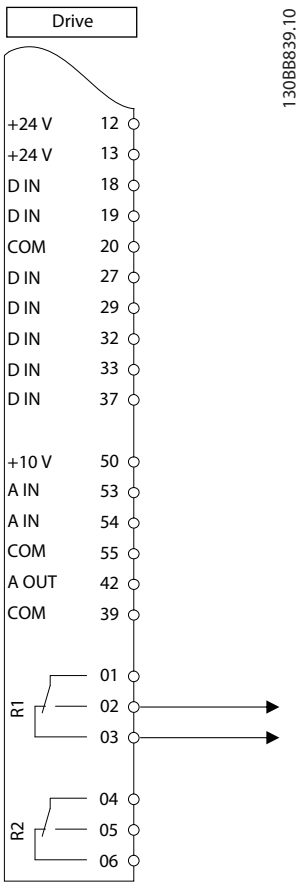
6.1.10 Wiring for Regen

Table 37: Regen

	Parameters	
	**Function**	**Setting**
	Parameter 1-90 Motor Thermal Protection	100%*
	* = Default value	
	To disable regen, decrease *parameter 1-90 Motor Thermal Protection* to 0%. If the application uses motor brake power and regen is not enabled, the unit trips.	

6.1.11 Wiring Configuration for a Relay Setup with Smart Logic Control

Table 38: Wiring Configuration for a Relay Setup with Smart Logic Control



Parameters	
Function	**Setting**
Parameter 4-30 Motor Feedback Loss Function	*[1] Warning*
Parameter 4-31 Motor Feedback Speed Error	100 RPM
Parameter 4-32 Motor Feedback Loss Timeout	5 s
Parameter 7-00 Speed PID Feedback Source	*[2] MCB 102*
Parameter 17-11 Resolution (PPR)	1024*
Parameter 13-00 SL Controller Mode	*[1] On*
Parameter 13-01 Start Event	*[19] Warning*
Parameter 13-02 Stop Event	*[44] Reset key*
Parameter 13-10 Comparator Operand	*[21] Warning no.*
Parameter 13-11 Comparator Operator	*[1] ≈ (equal)**
Parameter 13-12 Comparator Value	90
Parameter 13-51 SL Controller Event	*[22] Comparator 0*
Parameter 13-52 SL Controller Action	*[32] Set digital out A low*
Parameter 5-40 Function Relay	*[80] SL digital output A*
*=Default value	
Notes/comments: If the limit in the feedback monitor is exceeded, *warning 90, Feedback Mon.* is issued. The SLC monitors *warning 90, Feedback Mon.* and if the warning becomes true, relay 1 is triggered. External equipment may require service. If the feedback error goes below the limit again within 5 s, the drive continues and the warning disappears. Reset relay 1 by pressing [Reset] on the LCP.	

6.1.12 Wiring Configuration for a Cascade Controller

Refer to Illustration 27 for an example with the built-in basic cascade controller with 1 variable-speed pump (lead) and 2 fixed-speed pumps, a 4–20 mA transmitter, and system safety interlock.

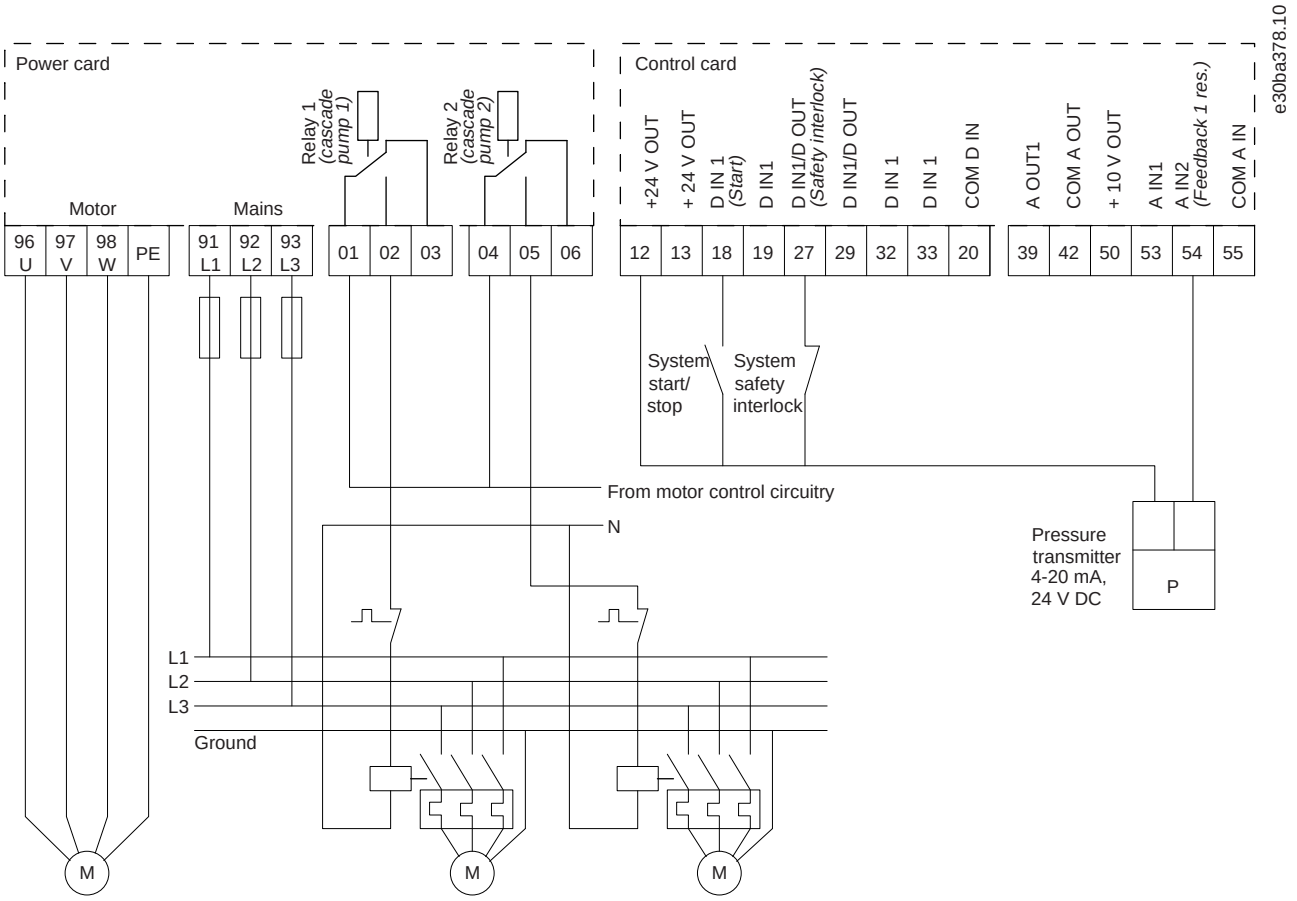


Illustration 27: Cascade Controller Wiring Diagram

6.1.13 Wiring Configuration for a Fixed Variable Speed Pump

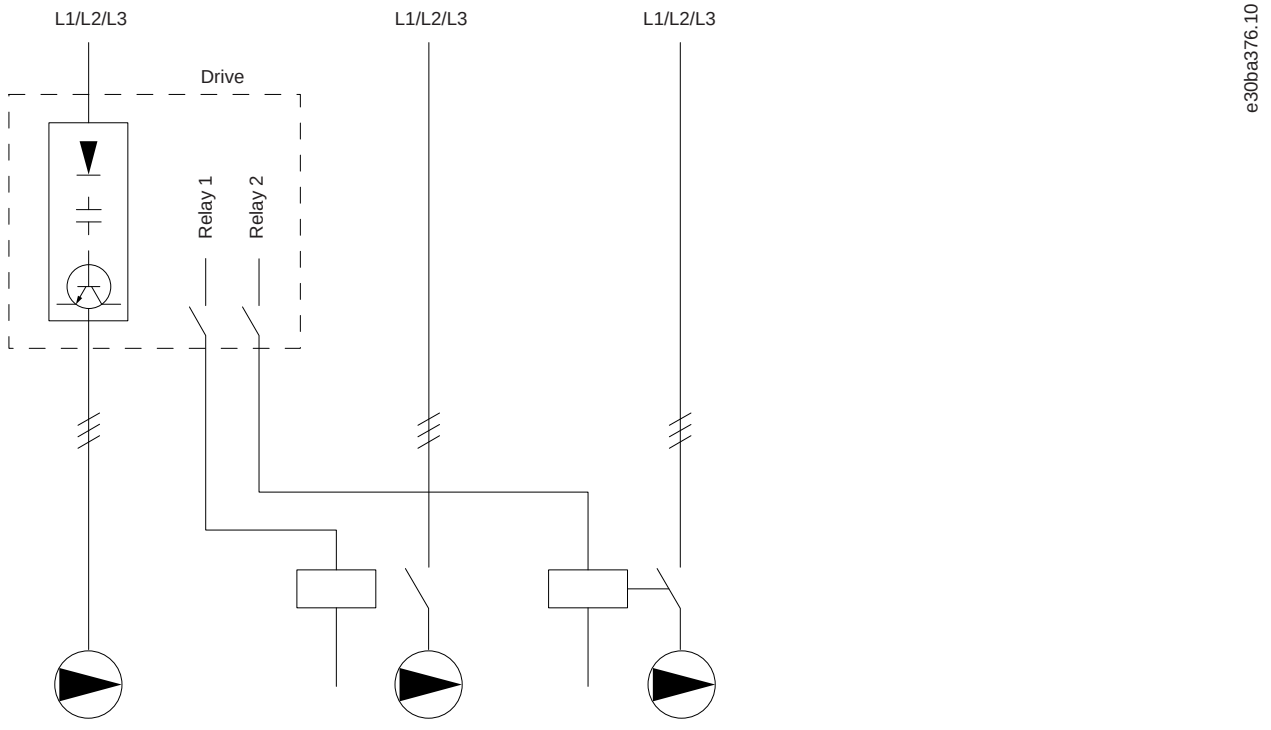


Illustration 28: Fixed Variable Speed Pump Wiring Diagram

6.1.14 Wiring Configuration for Lead Pump Alternation

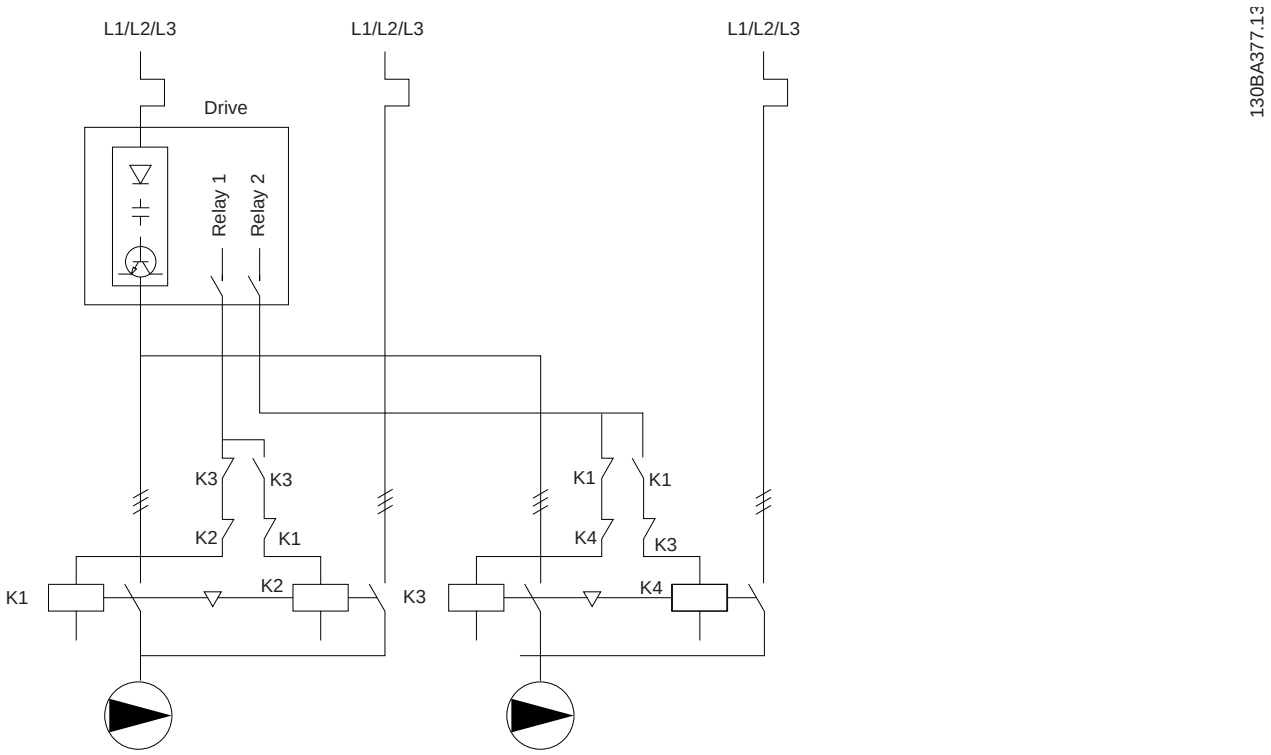


Illustration 29: Lead Pump Alternation Wiring Diagram

Every pump must be connected to 2 contactors (K1/K2 and K3/K4) with a mechanical interlock. Apply thermal relays or other motor overload protection devices according to local regulation and/or individual demands.

- Relay 1 (R1) and relay 2 (R2) are the built-in relays in the drive.
- When all relays are de-energized, the 1st built-in relay that is energized cuts in the contactor corresponding to the pump controlled by the relay. For example, relay 1 cuts in contactor K1, which becomes the lead pump.
- K1 blocks for K2 via the mechanical interlock, preventing mains from being connected to the output of the drive (via K1).
- Auxiliary break contact on K1 prevents K3 from cutting in.
- Relay 2 controls contactor K4 for on/off control of the fixed-speed pump.
- At alternation, both relays de-energize and now relay 2 is energized as the 1st relay.

For a detailed description of commissioning for mixed pump and master/slave applications, refer to *VLT® Extended/Advanced Cascade Controllers MCO 101/MCO 102 Operating Guide*.

7 Diagnostics and Troubleshooting

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the drive for loose terminal connections, excessive dust buildup, and so on, at regular intervals. Replace worn or damaged parts with Danfoss authorized parts. For service and support, contact the local Danfoss supplier.

⚠ W A R N I N G ⚠

UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of 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.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

7.2 Status Display

When the drive is in Status mode, status messages are generated automatically and appear in the bottom line of the display, see Illustration 30.

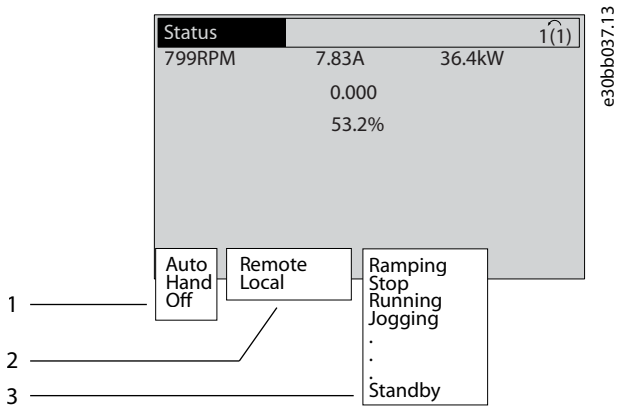


Illustration 30: Status Display

1	Operating mode (see Table 39)	3	Operation status (see Table 41)
2	Reference site (see Table 40)		

7.3 Status Message Definitions

See Table 39 to Table 41 for definitions of the status messages.

Table 39: Operating Mode

Off	The drive does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The drive is controlled from the control terminals and/or the serial communication.
Hand On	The drive is controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 40: Reference Site

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The drive uses [Hand On] control or reference values from the LCP.

Table 41: Operation Status

AC Brake	*[2] AC brake* is selected in *parameter 2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	AMA was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
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	• Coast inverse was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	*[1] Control Ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault*. • The drive ramps down the motor using a controlled ramp down.
Current High	The drive output current is above the limit set in *parameter 4-51 Warning Current High*.
Current Low	The drive output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC Hold	*[1] DC hold* is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold/Preheat Current*.
DC Stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • The DC brake cut in speed is reached in *parameter 2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • *[5] DC-brake inverse* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed.

	• *[20] Freeze output* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal options *[21] Speed up* and *[22] Speed down*. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	*[19] Freeze reference* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is active. The drive saves the actual reference. Changing the reference is now only possible via terminal options *[21] Speed up* and *[22] Speed down*.
Jog request	A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *parameter 3-19 Jog Speed [RPM]*. • *[14] Jog* was selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function is selected as a reaction for a monitoring function (for example, for the no signal function). The monitoring function is active.
Motor check	In *parameter 1-80 Function at Stop*, *[2] Motor Check* is selected. A stop command is active. To ensure that a motor is connected to the drive, 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 drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the drive from tripping.
PowerUnit Off	(Only drives with a 24 V external supply installed). Mains supply to the drive was removed, and the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.
QStop	The motor is decelerating using *parameter 3-81 Quick Stop Ramp Time*. • *[4] Quick stop inverse* is selected as a function for a digital input (*parameter group 5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function is activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The drive 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 drive 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 drive starts the motor with a start signal from a digital input or serial communication.
Start delay	In *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated, and the motor starts after the start delay time expires.
Start fwd/rev	*[12] Enable start forward* and *[13] Enable start reverse* are selected as options for 2 different digital inputs (*parameter group 5-1* Digital Inputs*). The motor starts in forward or reverse direction depending on which terminal is activated.
Stop	The drive 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 drive 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 drive. The drive can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication.

N O T I C E

In auto/remote mode, the drive requires external commands to execute functions.

7.4 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 drive 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 drive is tripped, meaning that the drive suspends operation to prevent damage to the drive or system. The motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive can be reset. It is then ready to start operation again.

Trip lock

Input power is cycled. The motor coasts to a stop. The drive continues to monitor the drive status. Remove input power to the drive, correct the cause of the fault, and reset the drive.

Resetting the drive after a 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.

7.5 Warning and Alarm Displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

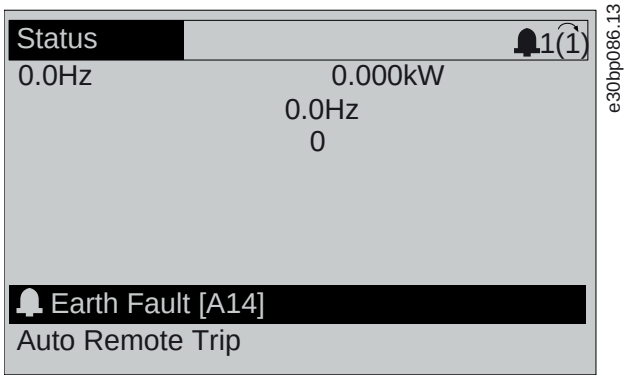


Illustration 31: Alarm Example

In addition to the text and alarm code in the LCP there are 3 status indicator lights.

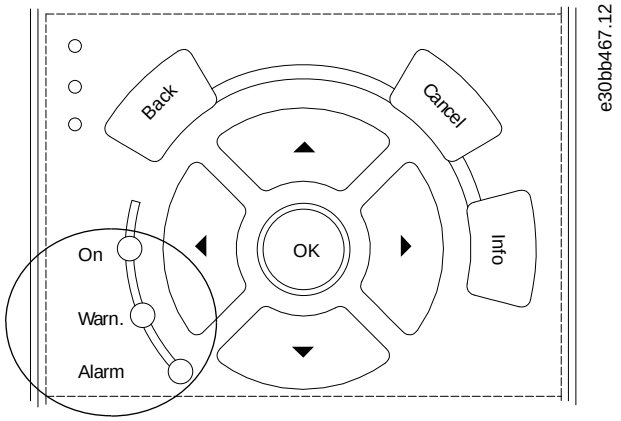


Illustration 32: Status Indicator Lights

	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

7.6 List of Warnings and Alarms

The following warning and alarm information defines each warning or alarm condition, provides the probable cause for the condition, and entails a remedy or troubleshooting procedure.

7.6.1 WARNING 1, 10 Volts Low

Cause

The control card voltage is less than 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

Troubleshooting

Remove the wiring from terminal 50.

- If the warning clears, the problem is with the wiring.
- If the warning does not clear, replace the control card.

7.6.2 WARNING/ALARM 2, Live Zero Error

Cause

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 a faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all analog mains 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, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

7.6.3 WARNING/ALARM 4, Mains Phase Loss

Cause

A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the drive.

7.6.4 WARNING 5, DC Link Voltage High

Cause

The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

7.6.5 WARNING 6, DC Link Voltage Low

Cause

The DC-link voltage (DC) is lower than the low-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

7.6.6 WARNING/ALARM 7, DC Overvoltage

Cause

If the DC-link voltage exceeds the limit, the drive trips after a certain time.

Troubleshooting

- 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*.
- If the alarm/warning occurs during a power sag, use kinetic backup (*parameter 14-10 Mains Failure*).
- Connect a brake resistor.

7.6.7 WARNING/ALARM 8, DC Undervoltage

Cause

If the DC-link voltage drops below the undervoltage limit, the drive checks for 24 V DC backup supply. If no 24 V DC backup supply is connected, the drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the drive voltage.
- Perform an input voltage test.
- Perform a soft-charge circuit test.

7.6.8 WARNING/ALARM 9, Inverter Overload

Cause

The drive has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100% with an alarm. The drive cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the drive rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Show the thermal drive load on the LCP and monitor the value.
  - When running above the drive continuous current rating, the counter increases.
  - When running below the drive continuous current rating, the counter decreases.

7.6.9 WARNING/ALARM 10, Motor Overload Temperature

Cause

According to the electronic thermal protection (ETR), the motor is too hot.

This warning/alarm is controlled by *parameter 1-90 Motor Thermal Protection*:

- If the parameter is set to warning options, the drive issues a warning or an alarm when the counter is >90%.
- If the parameter is set to trip options, the drive trips when the counter reaches 100%.

The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check whether the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20* to *1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Run AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)*. This tunes the drive to the motor more accurately and reduces thermal loading.

7.6.10 WARNING/ALARM 11, Motor Thermistor Overtemp

Cause

The motor thermistor indicates that the motor temperature is too high.

Troubleshooting

- Check for motor overheating.
- Check that the thermistor is securely connected.
- Check whether the motor is mechanically overloaded.
- When using terminal 53 or 54:
  - Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply).
  - Check that the terminal switch for 53 and 54 is set for voltage.
  - Check that *parameter 1-93 Thermistor Resource* selects 53 or 54.
- When using terminal 18, 19, 31, 32, or 33 (digital inputs):
  - Check that the thermistor is connected correctly between the digital input terminal used (digital input PNP only) and terminal 50.
  - Select the terminal to use in *parameter 1-93 Thermistor Resource*.

7.6.11 WARNING/ALARM 12, Torque Limit

Cause

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 warning 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 time, extend the ramp-down time.
- If torque limit occurs while running, increase the torque limit. Make sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

7.6.12 WARNING/ALARM 13, Overcurrent

Cause

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic backup. If extended mechanical brake control is selected, a trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Check that the motor size matches the drive.
- Check that the motor data is correct in *parameters 1-20* to *1-25*.

7.6.13 ALARM 14, Earth (Ground) Fault

Cause

There is current from the output phase to ground, either in the cable between the drive and the motor, or in the motor itself. The current sensors detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

Troubleshooting

- Remove power to the drive 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.
- Reset any potential individual offset in the 3 current sensors in the drive. Perform a manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

7.6.14 ALARM 15, Hardware Mismatch

Cause

A fitted option is not operational with the present control card hardware or software.

Troubleshooting

Record the value of the following parameters and contact Danfoss.

- *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).

7.6.15 ALARM 16, Short Circuit

Cause

There is short-circuiting in the motor or motor wiring.

Troubleshooting

⚠ W A R N I N G ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. 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.

- Disconnect power before proceeding.
- Remove the power to the drive and repair the short circuit.

7.6.16 WARNING/ALARM 17, Control Word Timeout

Cause

There is no communication to the drive. The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to *[0] Off*.

If *parameter 8-04 Control Word Timeout Function* is set to *[5] Stop and trip*, a warning appears, and the drive ramps down to a stop and shows an alarm.

Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.
- Verify that proper EMC installation was performed.

7.6.17 ALARM 18, Start Failed

The speed has not been able to exceed *parameter 1-77 Compressor Start Max Speed [RPM]* during start within the allowed time (set in *parameter 1-79 Compressor Max Time to Trip*).

Troubleshooting

- Check if the motor is blocked.

7.6.18 WARNING/ALARM 20, Temp. Input Error

Cause

The temperature sensor is not connected.

7.6.19 WARNING/ALARM 21, Parameter Error

Cause

The parameter is out of range. The parameter number is shown in the display.

Troubleshooting

- Set the affected parameter to a valid value.

7.6.20 WARNING 23, Internal Fan Fault

Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

For drives with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this warning appears. For drives with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the control card.

7.6.21 WARNING 24, External Fan Fault

Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

For drives with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this warning appears. For drives with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink.

7.6.22 WARNING 25, Brake Resistor Short Circuit

Cause

The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The drive is still operational, but without the brake function.

Troubleshooting

- Remove the power to the drive and replace the brake resistor (refer to *parameter 2-15 Brake Check*).

7.6.23 WARNING/ALARM 26, Brake Resistor Power Limit

Cause

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 resistor value set in *parameter 2-16 AC Brake Max. Current*. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option *[2] Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the drive trips when the dissipated braking power reaches 100%.

7.6.24 WARNING/ALARM 27, Brake Chopper Fault

Cause

The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The drive is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Troubleshooting

- Remove the power to the drive and remove the brake resistor.

7.6.25 WARNING/ALARM 28, Brake Check Failed

Cause

The brake resistor is not connected or not working.

Troubleshooting

- Check *parameter 2-15 Brake Check*.

7.6.26 ALARM 29, Heat Sink Temp

Cause

The maximum temperature of the heat sink is exceeded. The temperature fault is not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the drive power size.

Troubleshooting

Check for the following conditions:

- The ambient temperature is too high.
- The motor cables are too long.
- Incorrect airflow clearance above and below the drive.
- Blocked airflow around the drive.
- Damaged heat sink fan.
- Dirty heat sink.

7.6.27 ALARM 30, Motor Phase U Missing

Cause

Motor phase U between the drive and the motor is missing.

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. 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.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase U.

7.6.28 ALARM 31, Motor Phase V Missing

Cause

Motor phase V between the drive and the motor is missing.

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. 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.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase V.

7.6.29 ALARM 32, Motor Phase W Missing

Cause

Motor phase W between the drive and the motor is missing.

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. 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.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase W.

7.6.30 ALARM 33, Inrush Fault

Cause

Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.
- Check potential DC-link fault to ground.

7.6.31 WARNING/ALARM 34, Fieldbus Communication Fault

Cause

The fieldbus on the communication option card is not working.

7.6.32 WARNING/ALARM 35, Option Fault

Cause

An option alarm is received. The alarm is option-specific. The most likely cause is a power-up or a communication fault.

7.6.33 WARNING/ALARM 36, Mains Failure

Cause

This warning/alarm is only active if the supply voltage to the drive is lost and *parameter 14-10 Mains Failure* is not set to *[0] No Function*.

Troubleshooting

- Check the fuses to the drive and mains supply to the unit.

7.6.34 ALARM 38, Internal Fault

When an internal fault occurs, a code number defined in Internal Fault Codes is shown.

Troubleshooting

- Cycle power.
- Check that the option is properly installed.
- Check for loose or missing wiring.

It may be necessary to contact the Danfoss supplier or service department. Note the code number for further troubleshooting directions.

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact Danfoss supplier or service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/allowed.
1318	The option software in slot C is not supported/allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or service department.
2561	Replace the control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5376–6231	Internal fault. Contact the Danfoss supplier or service department.

7.6.35 ALARM 39, Heat Sink Sensor

Cause

There is no feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card.

Troubleshooting

- Check the ribbon cable between the power card and the gate drive card.
- Check for a defective power card.
- Check for a defective gate drive card.

7.6.36 WARNING 40, Overload of Digital Output Terminal 27

Troubleshooting

- 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*.

7.6.37 WARNING 41, Overload of Digital Output Terminal 29

Troubleshooting

- 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*.

7.6.38 WARNING 42, Ovrld X30/6-7

Troubleshooting

For terminal X30/6:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-32 Term X30/6 Digi out (MCB 101)* (VLT® General Purpose I/O MCB 101).

For terminal X30/7:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

7.6.39 ALARM 43, Ext. Supply

Cause

VLT® Extended Relay Option MCB 113 is mounted without 24 V DC.

Troubleshooting

Choose 1 of the following:

- Connect a 24 V DC external supply.
- Specify that no external supply is used via *parameter 14-80 Option Supplied by External 24VDC*, *[0] No*. A change in *parameter 14-80 Option Supplied by External 24VDC* requires a power cycle.

7.6.40 ALARM 45, Earth Fault 2

Cause

Ground fault.

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

7.6.41 ALARM 46, Power Card Supply

Cause

The supply on the power card is out of range. Another reason can be a defective heat sink fan.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

When powered with VLT® 24 V DC Supply MCB 107, only 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

Troubleshooting

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24 V DC supply is used, verify proper supply power.
- Check for a defective heat sink fan.

7.6.42 WARNING 47, 24 V Supply Low

Cause

The supply on the power card is out of range.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

Troubleshooting

- Check for a defective power card.

7.6.43 WARNING 48, 1.8 V Supply Low

Cause

The 1.8 V DC supply used on the control card is outside of the allowed limits. The supply is measured on the control card.

Troubleshooting

- Check for a defective control card.
- If an option card is present, check for overvoltage.

7.6.44 WARNING 49, Speed Limit

Cause

The warning is shown when the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the drive trips.

7.6.45 ALARM 50, AMA Calibration Failed

Cause

A calibration error has occurred.

Troubleshooting

- Contact the Danfoss supplier or Danfoss service department.

7.6.46 ALARM 51, AMA Check Unom and Inom

Cause

The settings for motor voltage, motor current, and motor power are wrong.

Troubleshooting

- Check settings in *parameters 1-20* to *1-25*.

7.6.47 ALARM 52, AMA Low Inom

Cause

The motor current is too low.

Troubleshooting

- Check the settings in *parameter 1-24 Motor Current*.

7.6.48 ALARM 53, AMA Motor Too Big

Cause
The motor is too big for the AMA to operate.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.6.49 ALARM 54, AMA Motor Too Small

Cause
The motor is too small for the AMA to operate.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.6.50 ALARM 55, AMA Parameter Out of Range

Cause
The AMA cannot run because the paramenter values of the motor are out of the acceptable range.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.6.51 ALARM 56, AMA Interrupted by User

Cause
The AMA is manually interrupted.

Troubleshooting

- Re-run the AMA calibration.

7.6.52 ALARM 57, AMA Internal Fault

Cause
Internal fault.

Troubleshooting
Try to restart the AMA. Repeated restarts can overheat the motor.

7.6.53 ALARM 58, AMA Internal Fault

Cause
Internal fault.

Troubleshooting
Contact the Danfoss supplier.

7.6.54 WARNING 59, Current Limit

Cause
The current is higher than the value in *parameter 4-18 Current Limit*.

Troubleshooting

- Ensure that the motor data in *parameters 1-20* to *1-25* is set correctly.
- Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

7.6.55 WARNING 60, External Interlock

Cause
A digital input signal indicates a fault condition external to the drive. An external interlock has commanded the drive to trip.

Troubleshooting

- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the drive.

7.6.56 WARNING/ALARM 61, Feedback Error

Cause

An error between calculated speed and speed measurement from feedback device.

Troubleshooting

- Check the settings for warning/alarm/disabling in *parameter 4-30 Motor Feedback Loss Function*.
- Set the tolerable error in *parameter 4-31 Motor Feedback Speed Error*.
- Set the tolerable feedback loss time in *parameter 4-32 Motor Feedback Loss Timeout*.

7.6.57 WARNING 62, Output Frequency at Maximum Limit

Cause

The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*.

Troubleshooting

- Check the application for possible causes.
- Increase the output frequency limit. Be sure that the system can operate safely at a higher output frequency.

The warning clears when the output drops below the maximum limit.

7.6.58 ALARM 63, Mechanical Brake Low

Cause

The actual motor current has not exceeded the release brake current within the start delay time window.

7.6.59 WARNING 64, Voltage Limit

Cause

The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

7.6.60 WARNING/ALARM 65, Control Card Overtemperature

Cause

The cutout temperature of the control card has exceeded the upper limit.

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check fan operation.
- Check the control card.

7.6.61 WARNING 66, Heat Sink Temperature Low

Cause

The drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

Troubleshooting

- Increase the ambient temperature of the unit.
- Supply a trickle amount of current to the drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* to 5% and *parameter 1-80 Function at Stop*.

7.6.62 ALARM 67, Option Module Configuration has Changed

Cause

One or more options have either been added or removed since the last power-down.

Troubleshooting

- Check that the configuration change is intentional and reset the unit.

7.6.63 ALARM 68, Safe Stop Activated

Cause

Safe Torque Off (STO) has been 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]).

7.6.64 ALARM 69, Power Card Temperature

Cause
The internal temperature has exceeded the allowed operating limits.

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check fan operation.
- Check the power card.

7.6.65 ALARM 70, Illegal FC Configuration

Cause
The control card and power card are incompatible.

Troubleshooting

- To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers on the cards.

7.6.66 ALARM 71, PTC 1 Safe Stop

Cause
Because the motor is too warm, the VLT® PTC Thermistor Card MCB 112 activated the Safe Torque Off (STO).

Troubleshooting

- Once the motor temperature reaches an acceptable level and the digital input from MCB 112 is deactivated, perform 1 of the following:
  - Send a reset signal via bus or digital I/O.
  - Press [Reset].

7.6.67 ALARM 72, Dangerous Failure

Cause
Safe Torque Off (STO) with trip lock.

Troubleshooting
An unexpected combination of STO commands has occurred:

- VLT® PTC Thermistor Card MCB 112 enables X44/10, but STO is not enabled.
- MCB 112 is the only device using STO (specified through selection *[4] PTC 1 alarm* or *[5] PTC 12 warning* in *parameter 5-19 Terminal 37 Safe Stop*). STO is activated, but X44/10 is not activated.

7.6.68 WARNING 73, Safe Stop Auto Restart

Cause
STO activated.

Troubleshooting

- With automatic restart enabled, the motor can start when the fault is cleared.

7.6.69 WARNING 77, Reduced Power Mode

Cause
The drive is operating in reduced power mode (less than allowed number of inverter sections). The warning is generated on power cycle when the drive is set to run with fewer inverters and remains on.

7.6.70 ALARM 79, Illegal Power Section Configuration

Cause
The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

7.6.71 ALARM 80, Drive Initialized to Default Value

Cause
Parameter settings are initialized to default settings after a manual reset.

Troubleshooting

- To clear the alarm, reset the unit.

7.6.72 ALARM 81, CSIV Corrupt

Cause

The CSIV file has syntax errors.

7.6.73 ALARM 82, CSIV Parameter Error

Cause

CSIV failed to initialize a parameter.

7.6.74 ALARM 88, Option Detection

Cause

A change in the option layout is detected. *Parameter 14-89 Option Detection* is set to *[0] Frozen configuration* and the option layout has been changed.

Troubleshooting

- To apply the change, enable option layout changes in *parameter 14-89 Option Detection*.
- Alternatively, restore the correct option configuration.

7.6.75 ALARM 91, Analog Input 54 Wrong Settings

Troubleshooting

- Set switch S202 in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

7.6.76 ALARM 92, No Flow

A no-flow condition has been detected in the system. *Parameter 22-23 No-flow Function* is set for alarm.

Troubleshooting

- Troubleshoot the system.
- Reset the drive when the fault is cleared.

7.6.77 ALARM 93, Dry Pump

A no-flow condition in the system with the drive operating at high speed may indicate a dry pump. *Parameter 22-26 Dry Pump Function* is set for alarm.

Troubleshooting

- Troubleshoot the system.
- Reset the drive when the fault is cleared.

7.6.78 ALARM 94, End of Curve

Feedback is lower than the set point. This may indicate a leakage in the system. *Parameter 22-50 End of Curve Function* is set for alarm.

Troubleshooting

- Troubleshoot the system.
- Reset the drive when the fault is cleared.

7.6.79 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.
- Reset the drive after the fault is cleared.

7.6.80 ALARM 96, Start Delayed

Motor start has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting

- Troubleshoot the system.
- Reset the drive when the fault is cleared.

7.6.81 WARNING 97, Stop Delayed

Stopping the motor has been delayed due to short-cycle protection. *Parameter 22-76 Interval between Starts* is enabled.

Troubleshooting

- Troubleshoot the system.
- Reset the drive when the fault is cleared.

7.6.82 WARNING 98, Clock Fault

Time is not set or the RTC clock has failed.

Troubleshooting

- Reset the clock in *parameter 0-70 Date and Time*.

7.6.83 ALARM 99, Locked Rotor

Cause

The rotor is blocked.

Troubleshooting

- Check if the motor shaft is locked.
- Check if the start current triggers the current limit set in *parameter 4-18 Current Limit*.
- Check if it increases the value in *parameter 30-23 Locked Rotor Detection Time [s]*.

7.6.84 WARNING 200, Fire Mode

This warning indicates that the drive operates in fire mode. The warning clears when fire mode is removed. See the fire mode data in the alarm log.

7.6.85 WARNING 201, Fire Mode was Active

- Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

7.6.86 WARNING 202, Fire Mode Limits Exceeded

While operating in fire mode, 1 or more alarm conditions have been ignored, which would normally trip the unit. Operating in this condition voids the warranty of the unit.

Troubleshooting

- Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

7.6.87 WARNING 203, Missing Motor

A multi-motor underload situation is detected. This warning could indicate that there is a missing motor.

Troubleshooting

- Inspect the system for proper operation.

7.6.88 WARNING 204, Locked Rotor

An overload condition is detected for a drive operating multi-motors. This could indicate a locked rotor.

Troubleshooting

- Inspect the motor proper operation.

7.6.89 WARNING 250, New Spare Part

Cause

A component in the drive system has been replaced.

Troubleshooting

- Enter the serial number and type code for canceling the Trip Lock status after a power cycle.

7.6.90 WARNING 251, New Typecode

Cause
The power card or other components have been replaced, and the typecode has changed.

Troubleshooting
Reset the drive for normal operation.

7.7 Troubleshooting

Table 42: Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See 4.9 Installation Check List.	Check the input power source.
	Missing or open fuses or circuit breaker tripped.	See *Open fuses and tripped circuit breaker* in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminals 12/13 to 20-19 or 10 V supply for terminals 50 to 55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/FCD or FCM).		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting.		Press [Status] + [▵] [▿] to adjust the contrast.
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.		Contact supplier.
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the drive.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch open or missing motor connection.	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and the service switch.
	No mains power with 24 V DC option card.	If the display is but no output, check that mains power is applied to the drive.	Apply mains power to run the unit.
	LCP Stop	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor.
	Missing start signal (Standby)	Check *parameter 5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.

Symptom	Possible cause	Test	Solution
	Motor coast signal active (Coasting)	Check *parameter 5-12 Coast Inv.* for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *[0] No operation*.
	Wrong reference signal source.	Check the reference signal: Local, remote, or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *parameter 3-13 Reference Site*. Set preset reference active in *parameter group 3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
	AIC not running	Check the following for current: • *Parameter 2-70 AIC L1 Current* • *Parameter 2-71 AIC L2 Current* • *Parameter 2-72 AIC L3 Current*	Troubleshoot the AIC (Active In-Converter).
Motor running in wrong direction.	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in *parameter group 5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.		See 5.3.7 Checking Motor Rotation
Motor does not reach maximum speed.	Frequency limits are set wrong.	Check output limits in *parameter 4-13 Motor Speed High Limit [RPM]*, *parameter 4-14 Motor Speed High Limit [Hz]*, and *parameter 4-19 Max Output Frequency*.	Program correct limits.
	Reference input signal not scaled correctly.	Check the reference input signal scaling in *parameter group 6-0* Analog I/O Mode* and *parameter group 3-1* References*. Reference limits in *parameter group 3-0* Reference Limits*.	Program correct settings.
Motor speed unstable.	Possible incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in *parameter group 1-6* Load Depend. Setting*. For closed-loop operation, check settings in *parameter group 20-0* Feedback*.
Motor runs rough.	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in *parameter groups 1-2* Motor Data*, *1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*.
Motor does not brake.	Possible incorrect settings in the brake parameters. Possible too short ramp-down times.	Check the brake parameters.	Check *parameter groups 2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase-to-phase short.	Motor or panel has a short phase. Check motor and panel phase for shorts.	Eliminate any short circuits detected.

Symptom	Possible cause	Test	Solution
	Motor overload	Motor is overloaded for the application.	Perform start-up test and verify that motor current is within the specifications. If motor current exceeds nameplate full load current, the motor may run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform a pre-start-up check to check for loose connections.	Tighten loose connections.
Mains current imbalance >3%.	Problem with mains power (see *alarm 4, Mains phase loss* description.	Rotate input power leads into the drive by 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check mains power supply.
	Problem with the drive.	Rotate input power leads in to drive by 1 position: A to B, B to C, C to A.	If imbalanced leg stays on the same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance >3%	Problem with motor or motor wiring.	Rotate output motor leads by 1 position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check the motor and motor wiring.
	Problem with the drive.	Rotate output motor leads by 1 position: U to V, V to W, W to U.	If imbalanced leg stays on the same output terminal, it is a problem with the unit. Contact the supplier.
Drive acceleration problems.	Motor data is entered incorrectly.	If warnings or alarms occur, see 7.6 List of Warnings and Alarms. Check that motor data is entered correctly.	Increase the ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. Increase current limit in *parameter 4-18 Current Limi*. Increase torque limit in *parameter4-16 Torque Limit Motor Mode*.
Drive deceleration problems.	Motor data is entered incorrectly.	If warnings or alarms occur, see 7.6 List of Warnings and Alarms. Check that motor data is entered correctly.	Increase ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *parameter 2-17 Over-voltage Control*.
Acoustic noise or vibration (for example, a fan blade is making noise or vibrations at certain frequencies).	Resonance, for example in the motor/fan system.	Bypass critical frequencies by using parameters in *parameter group 4-6* Speed Bypass*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in *parameter 14-03 Overmodulation*.	
		Change switching pattern and frequency *parameter group 14-0* Inverter Switching*.	
		Increase resonance dampening in *parameter 1-64 Resonance Dampening*.	

8 Specifications

8.1 Electrical Data, 200–240 V and 3x115Y/200–139Y/240 V

Table 43: Mains Supply 3x200–240 V AC and 3x115Y/200–139Y/240 V AC, Normal Overload 110% for 1 minute, P1K1–P3K7

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7
Typical shaft output at 208 V [hp]	1.5	2.0	2.9	4.0	4.9
IP20/UL Open Type[1]	A2	A2	A2	A3	A3
IP55/UL Type 12	A4/A5	A4/A5	A4/A5	A5	A5
IP66/UL Type 4X	A4/A5	A4/A5	A4/A5	A5	A5
Output current					
Continuous (3x200–240 V) [A]	6.6	7.5	10.6	12.5	16.7
Intermittent (3x200–240 V) [A]	7.3	8.3	11.7	13.8	18.4
Continuous kVA (208 V AC) [kVA]	2.38	2.70	3.82	4.50	6.0
Maximum input current					
Continuous (3x200–240 V) [A]	5.9	6.8	9.5	11.3	15
Intermittent (3x200–240 V) [A]	6.5	7.5	10.5	12.4	16.5
SCCR					
A2/A3 with mains disconnect [kA_{rms}]	50 kA	50 kA	50 kA	50 kA	50 kA
A4/A5 with mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA
Power losses and efficiency					
Estimated power loss at rated maximum load [W][2]	63	82	116	155	185
Efficiency[3]	0.96	0.96	0.96	0.96	0.96

[1] A2+A3 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 44: Mains Supply 3x200–240 V AC and 3x115Y/200–139Y/240 V AC, Normal Overload 110% for 1 minute, P5K5–P15K

Type designation	P5K5	P7K5	P11K	P15K
Typical shaft output [kW]	5.5	7.5	11	15
Typical shaft output at 208 V [hp]	7.5	10	15	20
IP20/UL Open Type[1]	B3	B3	B3	B4
IP21/UL Type 1	B1	B1	B1	B2

Type designation	P5K5	P7K5	P11K	P15K
IP55/UL Type 12	B1	B1	B1	B2
IP66/UL Type 4X	B1	B1	B1	B2
Output current				
Continuous (3x200–240 V) [A]	24.2	30.8	46.2	59.4
Intermittent (3x200–240 V) [A]	26.6	33.9	50.8	65.3
Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4
Maximum input current				
Continuous (3x200–240 V) [A]	22	28	42	54
Intermittent (3x200–240 V) [A]	24.2	30.8	46.2	59.4
SCCR				
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	10 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA
Power losses and efficiency				
Estimated power loss at rated maximum load [W](2)	269	310	447	602
Efficiency(3)	0.96	0.96	0.96	0.96

[1] B3+4 and C3+4 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 45: Mains Supply 3x200–240 V AC and 3x115Y/200–139Y/240 V AC, Normal Overload 110% for 1 minute, P18K–P45K

Type designation	P18K	P22K	P30K	P37K	P45K
Typical shaft output [kW]	18.5	22	30	37	45
Typical shaft output at 208 V [hp]	25	30	40	50	60
IP20/UL Open Type(1)	B4	C3	C3	C4	C4
IP21/UL Type 1	C1	C1	C1	C2	C2
IP55/UL Type 12	C1	C1	C1	C2	C2
IP66/UL Type 4X	C1	C1	C1	C2	C2
Output current					
Continuous (3x200–240 V) [A]	74.8	88	115	143	170
Intermittent (3x200–240 V) [A]	82.3	96.8	127	157	187
Continuous kVA (208 V AC) [kVA]	26.9	31.7	41.4	51.5	61.2
Maximum input current					

Type designation	P18K	P22K	P30K	P37K	P45K
Continuous (3x200–240 V) [A]	68	80	104	130	154
Intermittent (3x200–240 V) [A]	74.8	88	114	143	169
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	10 kA	10 kA	10 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA
Power losses and efficiency					
Estimated power loss at rated maximum load [W][2]	737	845	1140	1353	1636
Efficiency[3]	0.96	0.97	0.97	0.97	0.97

[1] B3+4 and C3+4 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

8.2 Electrical Data, 380–480 V and 3x220Y/380–277Y/480 V

Table 46: Mains Supply 3x380–480 V AC and 3x220Y/380–277Y/480 V AC, Normal Overload 110% for 1 minute, P1K1–P7K5

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P5K5
Typical shaft output [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Typical shaft output at 460 V [hp]	1.5	2.0	2.9	4.0	5.0	7.5	10
IP20/UL Open Type[1]	A2	A2	A2	A2	A2	A3	A3
IP55/UL Type 12	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
IP66/UL Type 4X	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current							
Continuous (3x380–440 V) [A]	3	4.1	5.6	7.2	10	13	16
Intermittent (3x380–440 V) [A]	3.3	4.5	6.2	7.9	11	14.3	17.6
Continuous (3x441–480 V) [A]	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (3x441–480 V) [A]	3.0	3.7	5.3	6.9	9.0	12.1	15.4
Continuous kVA (400 V AC) [kVA]	2.1	2.8	3.9	5.0	6.9	9.0	11
Continuous kVA (460 V AC) [kVA]	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Maximum input current							
Continuous (3x380–440 V) [A]	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (3x380–440 V) [A]	3.0	4.1	5.5	7.2	9.9	12.9	15.8
Continuous (3x441–480 V) [A]	2.7	3.1	4.3	5.7	7.4	9.9	13
Intermittent (3x441–480 V) [A]	3.0	3.4	4.7	6.3	8.1	10.9	14.3

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P5K5
SCCR							
A2/A3 with mains disconnect [kA_{rms}]	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA
A4/A5 with mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA
Power losses and efficiency							
Estimated power loss at rated maximum load [W](2)	58	62	88	116	124	187	255
Efficiency(3)	0.96	0.97	0.97	0.97	0.97	0.97	0.97

[1] A2+A3 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and vice versa. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully-loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 47: Mains Supply 3x380–480 V AC and 3x220Y/380–277Y/480 V AC, Normal Overload 110% for 1 minute, P11K–P30K

Type designation	P11K	P15K	P18K	P22K	P30K
Typical shaft output [kW]	11	15	18.5	22	30
Typical shaft output at 460 V [hp]	15	20	25	30	40
IP20/UL Open Type(1)	B3	B3	B3	B4	B4
IP21/UL Type 1	B1	B1	B1	B2	B2
IP55/UL Type 12	B1	B1	B1	B2	B2
IP66/UL Type 4X	B1	B1	B1	B2	B2
Output current					
Continuous (3x380–439 V) [A]	24	32	37.5	44	61
Intermittent (3x380–439 V) [A]	26.4	35.2	41.3	48.4	67.1
Continuous (3x440–480 V) [A]	21	27	34	40	52
Intermittent (3x440–480 V) [A]	23.1	29.7	37.4	44	61.6
Continuous kVA (400 V AC) [kVA]	16.6	22.2	26	30.5	42.3
Continuous kVA (460 V AC) [kVA]	16.7	21.5	27.1	31.9	41.4
Maximum input current					
Continuous (3x380–439 V) [A]	22	29	34	40	55
Intermittent (3x380–439 V) [A]	24.2	31.9	37.4	44	60.5
Continuous (3x440–480 V) [A]	19	25	31	36	47
Intermittent (3x440–480 V) [A]	20.9	27.5	34.1	39.6	51.7
SCCR					

Type designation	P11K	P15K	P18K	P22K	P30K
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	10 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA
Power losses and efficiency					
Estimated power loss at rated maximum load [W][2]	278	392	465	525	698
Efficiency[3]	0.98	0.98	0.98	0.98	0.98

[1] B3+4 and C3+4 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and vice versa. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully-loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 48: Mains Supply 3x380–480 V AC and 3x220Y/380–277Y/480 V AC, Normal Overload 110% for 1 minute, P37K–P90K

Type designation	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	37	45	55	75	90
Typical shaft output at 460 V [hp]	50	60	75	100	125
IP20/UL Open Type[1]	B4	C3	C3	C4	C4
IP21/UL Type 1	C1	C1	C1	C2	C2
IP55/UL Type 12	C1	C1	C1	C2	C2
IP66/UL Type 4X	C1	C1	C1	C2	C2
Output current					
Continuous (3x380–439 V) [A]	73	90	106	147	177
Intermittent (3x380–439 V) [A]	80.3	99	117	162	195
Continuous (3x440–480 V) [A]	65	80	105	130	160
Intermittent (3x440–480 V) [A]	71.5	88	116	143	176
Continuous kVA (400 V AC) [kVA]	50.6	62.4	73.4	102	123
Continuous kVA (460 V AC) [kVA]	51.8	63.7	83.7	104	128
Maximum input current					
Continuous (3x380–439 V) [A]	66	82	96	133	161
Intermittent (3x380–439 V) [A]	72.6	90.2	106	146	177
Continuous (3x440–480 V) [A]	59	73	95	118	145
Intermittent (3x440–480 V) [A]	64.9	80.3	105	130	160
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	10 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P37K	P45K	P55K	P75K	P90K
Power losses and efficiency					
Estimated power loss at rated maximum load [W][2]	739	843	1083	1384	1474
Efficiency[3]	0.98	0.98	0.98	0.98	0.99

[1] B3+4 and C3+4 may be converted to IP21 using a conversion kit.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and vice versa. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully-loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[3] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

8.3 Electrical Data, 525–600 V

Table 49: Mains Supply 3x525–600 V AC - Normal Overload 110% for 1 Minute, P1K1–P7K5

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7	4.0	5.5	7.5
IP20/UL Open Type	A3	A3	A3	A3	A2	A3	A3	A3
IP21/UL Type 1	A3	A3	A3	A3	A2	A3	A3	A3
IP55/UL Type 12	A5	A5	A5	A5	A5	A5	A5	A5
IP66/UL Type 4X	A5	A5	A5	A5	A5	A5	A5	A5
Output current								
Continuous (3x525–550 V) [A]	2.6	2.9	4.1	5.2	–	6.4	9.5	11.5
Intermittent (3x525–550 V) [A]	2.9	3.2	4.5	5.7	–	7.0	10.5	12.7
Continuous (3x525–600 V) [A]	2.4	2.7	3.9	4.9	–	6.1	9.0	11
Intermittent (3x525–600 V) [A]	2.6	3.0	4.3	5.4	–	6.7	9.9	12.1
Continuous kVA (525 V AC) [kVA]	2.5	2.8	3.9	5.0	–	6.1	9.0	11
Continuous kVA (575 V AC) [kVA]	2.4	2.7	3.9	4.9	–	6.1	9.0	11
Maximum input current								
Continuous (3x525–600 V) [A]	2.4	2.7	4.1	5.2	–	5.8	8.6	10.4
Intermittent (3x525–600 V) [A]	2.7	3.0	4.5	5.7	–	6.4	9.5	11.5
SCCR								
A2/A3 with mains disconnect [kA_{rms}]	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA
A4/A5 with mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5
Power losses and efficiency								
Estimated power loss at rated maximum load [W](1)	50	65	92	122	–	145	195	261
Efficiency(2)	0.97	0.97	0.97	0.97	–	0.97	0.97	0.97

[1] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[2] Measured using 5m (16.4 ft) shielded motor cables at rated load and rated frequency

Table 50: Mains Supply 3x525–600 V AC - Normal Overload 110% for 1 Minute, P11K–P30K

Type designation	P11K	P15K	P18K	P22K	P30K
Typical shaft output [kW]	11	15	18.5	22	30
IP20/UL Open Type	B3	B3	B3	B4	B4
IP21/UL Type 1	B1	B1	B1	B2	B2
IP55/UL Type 12	B1	B1	B1	B2	B2
IP66/UL Type 4X	B1	B1	B1	B2	B2
Output current					
Continuous (3x525–550 V) [A]	19	23	28	36	43
Intermittent (3x525–550 V) [A]	21	25	31	40	47
Continuous (3x525–600 V) [A]	18	22	27	34	41
Intermittent (3x525–600 V) [A]	20	24	30	37	45
Continuous kVA (525 V AC) [kVA]	18.1	21.9	26.7	34.3	41
Continuous kVA (575 V AC) [kVA]	17.9	21.9	26.9	33.9	40.8
Maximum input current					
Continuous (3x525–600 V) [A]	17.2	20.9	25.4	32.7	39
Intermittent (3x525–600 V) [A]	19	23	28	36	43
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P11K	P15K	P18K	P22K	P30K
Power losses and efficiency					
Estimated power loss at rated maximum load [W](1)	300	400	475	525	700
Efficiency(2)	0.97	0.97	0.97	0.97	0.97

1 The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

2 Measured using 5m (16.4 ft) shielded motor cables at rated load and rated frequency

Table 51: Mains Supply 3x525–600 V AC - Normal Overload 110% for 1 Minute, P37K–P90K

Type designation	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	37	45	55	75	90
IP20/UL Open Type	B4	C3	C3	C4	C4
IP21/UL Type 1	C1	C1	C1	C2	C2
IP55/UL Type 12	C1	C1	C1	C2	C2
IP66/UL Type 4X	C1	C1	C1	C2	C2
Output current					
Continuous (3x525–550 V) [A]	54	65	87	105	137
Intermittent (3x525–550 V) [A]	59	72	96	116	151
Continuous (3x525–600 V) [A]	52	62	83	100	131
Intermittent (3x525–600 V) [A]	57	68	91	110	144
Continuous kVA (525 V AC) [kVA]	51.4	61.9	82.9	100	130.5
Continuous kVA (575 V AC) [kVA]	51.8	61.7	82.7	99.6	130.5
Maximum input current					
Continuous (3x525–600 V) [A]	49	59	78.9	95.3	124.3
Intermittent (3x525–600 V) [A]	54	65	87	105	137
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P37K	P45K	P55K	P75K	P90K
Power losses and efficiency					
Estimated power loss at rated maximum load [W](1)	750	850	1100	1400	1500
Efficiency(2)	0.98	0.98	0.98	0.98	0.98

[1] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[2] Measured using 5m (16.4 ft) shielded motor cables at rated load and rated frequency

8.4 Electrical Data, 525–690 V

Table 52: Mains Supply 3x525–690 V AC, Normal Overload 110% for 1 Minute, P1K1–P7K5

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Enclosure IP20/(UL Open Type	A3	A3	A3	A3	A3	A3	A3
Output current							
Continuous (3x525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11
Intermittent (3x525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous (3x551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10
Intermittent (3x551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12	16
Continuous kVA 525 V AC [kVA]	1.9	2.5	3.5	4.5	5.5	8.2	10
Continuous kVA 690 V AC [kVA]	1.9	2.6	3.8	5.4	6.6	9.0	12
Maximum input current							
Continuous (3x525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.0	10
Intermittent (3x52–550 V) [A]	3.0	3.9	5.6	7.1	8.8	13	16
Continuous (3x551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent (3x551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
SCCR							
A2/A3 with mains disconnect [kA_{rms}]	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA
A4/A5 with mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Power losses and efficiency							
Estimated power loss at rated maximum load [W](1)	44	60	88	120	160	220	300
Efficiency(2)	0.98	0.98	0.98	0.98	0.98	0.98	0.98

1 The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

2 Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 53: Mains Supply 3x525–690 V AC, Normal Overload 110% for 1 Minute, P11K–P30K

Type designation	P11K	P15K	P18K	P22K	P30K
High/normal load	NO	NO	NO	NO	NO
Typical shaft output at 550 V [kW]	7.5	11	15	18.5	22
Typical shaft output at 690 V [kW]	11	15	18.5	22	30
IP20/UL Open Type	B4	B4	B4	B4	B4
IP21/UL Type 1	B2	B2	B2	B2	B2
IP55/UL Type 12	B2	B2	B2	B2	B2
Output current					
Continuous (3x525–550 V) [A]	14	19	23	28	36
Intermittent (60 s overload) (3x525–550 V) [A]	22.4	20.9	25.3	30.8	39.6
Continuous (3x551–690 V) [A]	13	18	22	27	34
Intermittent (60 s overload) (3x551–690 V) [A]	20.8	19.8	24.2	29.7	37.4
Continuous kVA (550 V AC) [kVA]	13.3	18.1	21.9	26.7	34.3
Continuous kVA (690 V AC) [kVA]	15.5	21.5	26.3	32.3	40.6
Maximum input current					
Continuous (at 550 V) [A]	15	19.5	24	29	36
Intermittent (60 s overload) (at 550 V) [A]	23.2	21.5	26.4	31.9	39.6
Continuous (at 690 V) [A]	14.5	19.5	24	29	36
Intermittent (60 s overload) (at 690 V) [A]	23.2	21.5	26.4	31.9	39.6
Maximum pre-fuses(1) [A]					
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P11K	P15K	P18K	P22K	P30K
Power losses and efficiency					
Estimated power loss at rated maximum load [W][1]	150	220	300	370	440
Efficiency[2]	0.98	0.98	0.98	0.98	0.98

[1] For type of fuse see 8.10.2 CE Compliance and the *Fuses and Circuit Breakers section*.

The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

[2] Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

Table 54: Mains Supply 3x525–690 V AC, Normal Overload 110% for 1 Minute, P37K–P90K

Type designation	P37K	P45K	P55K	P75K	P90K
High/normal load	NO	NO	NO	NO	NO
Typical shaft output at 550 V [kW]	30	37	45	55	75
Typical shaft output at 690 V [kW]	37	45	55	75	90
IP20/UL Open Type	B4	C3	C3	D3h	D3h
IP21/UL Type 1	C2	C2	C2	C2	C2
IP55/UL Type 12	C2	C2	C2	C2	C2
Output current					
Continuous (3x525–550 V) [A]	43	54	65	87	105
Intermittent (60 s overload) (3x525–550 V) [A]	47.3	59.4	71.5	95.7	115.5
Continuous (3x551-690 V) [A]	41	52	62	83	100
Intermittent (60 s overload) (3x551–690 V) [A]	45.1	57.2	68.2	91.3	110
Continuous kVA (550 V AC) [kVA]	41	51.4	61.9	82.9	100
Continuous kVA (690 V AC) [kVA]	49	62.1	74.1	99.2	119.5
Maximum input current					
Continuous (at 550 V) [A]	49	59	71	87	99
Intermittent (60 s overload) (at 550 V) [A]	53.9	64.9	78.1	95.7	108.9
Continuous (at 690 V) [A]	48	58	70	86	94.3
Intermittent (60 s overload) (at 690 V) [A]	52.8	63.8	77	94.6	112.7
Maximum pre-fuses[1] [A]	125	160	160	–	
SCCR					
With mains disconnect [kA_{rms}]	65 kA	65 kA	65 kA	65 kA	65 kA
Without mains disconnect [kA_{rms}]	100 kA	100 kA	100 kA	100 kA	100 kA

Type designation	P37K	P45K	P55K	P75K	P90K
Power losses and efficiency					
Estimated power loss at rated maximum load [W][2]	740	900	1100	1500	1800
Efficiency[2]	0.98	0.98	0.98	0.98	0.98

[1] For type of fuse see 8.10.2 CE Compliance and the *Fuses and Circuit Breakers section*.

[2] The typical power loss is at normal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Lower efficiency motors also add to the power loss in the drive and conversely. If the switching frequency is raised from nominal, the power losses may rise significantly. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each). Although measurements are made with state-of-the-art equipment, some measurement inaccuracy must be allowed for (±5%).

8.5 Mains Supply

Supply terminals	L1, L2, L3
Supply voltage[1][2][3]	200–240 V ±10%
Supply voltage[1][2][4]	380–480 V/500–600 V ±10%
Supply voltage[1][2]	525–600 V ±10%
Supply frequency	47.5–63 Hz
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 (cos Φ)	Near unity (>0.98)
Switching on the input supply L1, L2, L3 (power-ups) ≤7.5 kW	Maximum 2 times per minute
Switching on input supply L1, L2, L3 (power-ups) 11–90 kW	Maximum 1 time per minute
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

[1] Mains voltage low/mains dropout: During low mains voltage or a mains dropout, the drive continues until the DC-link voltage drops below the minimum stop level, which corresponds typically to 15% below the drive's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the drive's lowest rated supply voltage.

[2] The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/500/600/690 V maximum, depending upon drive power and voltage rating.

[3] If type code position 23 = 6: UL 61800-5-1, the supply voltage is 3x115Y/200–139Y/240 V.

[4] If type code position 23 = 6: UL 61800-5-1, the supply voltage is 3x220Y/380–277Y/480 V.

8.6 Motor Output and Motor Data

8.6.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency (1.1–90 kW)	0–590 Hz[1]
Switching on output	Unlimited
Ramp times	1–3600 s

[1] From software version 3.92 the output frequency of the frequency converter is limited to 590 Hz. Contact local Danfoss partner for further information.

8.6.2 Torque Characteristics

Starting torque (constant torque)	Maximum 110% for 60 s[1]
Starting torque	Maximum 135% up to 0.5 s[1]
Overload torque (constant torque)	Maximum 110% for 60 s[1]
Starting torque (variable torque)	Maximum 110% for 60 s[1]
Overload torque (variable torque)	Maximum 110% for 60 s

Torque rise time in VVC$^+$ (independent of f_{sw})	10 ms[2]

[1] Percentage relates to the nominal torque.

[2] The torque response time depends on application and load but as a rule, the torque step from 0 to reference is 4-5 x torque rise time.

8.7 Ambient Conditions

Enclosure	IP20/Chassis, IP20/Chassis, IP21/Type 1, IP54/Type 12, IP55/Type 12, IP66/Type 4X
Vibration test	1.0 g
Maximum relative humidity	5–93 (IEC 721-3-3); Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Ambient temperature	Maximum 50 °C (122 °F) (24-hour average maximum 45 °C (113 °F))[1]
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced speed 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 (3280 ft)
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class	IE2[2]

[1] See the *Derating chapter* in the design guide for:

- Derating for high ambient temperature.
- Derating for high altitude.

[2] Determined according to EN 50598-2 at:

- Rated load.
- 90% rated frequency.
- Switching frequency factory setting.
- Switching pattern factory setting.

8.8 Cable Specifications

8.8.1 Motor Cable Length

Maximum motor cable length, shielded	150 m (492 ft)
Maximum motor cable length, unshielded	300 m (984 ft)

8.8.2 Power Cable Cross-sections

Table 55: Maximum Cable Cross-section [mm^2 (AWG)]

Enclosure	Mains	Motor	Brake	Loadshare	Disconnect
A1	4(12)	4(12)	4(12)	4(12)	4(12)
A2	4(12)	4(12)	4(12)	4(12)	4(12)
A3	4(12)	4(12)	4(12)	4(12)	4(12)
A4	4(12)	4(12)	4(12)	4(12)	4(12)
A5	4(12)	4(12)	4(12)	4(12)	4(12)
B1	10(7)	10(7)	10(7)	10(7)	10(7)

Enclosure	Mains	Motor	Brake	Loadshare	Disconnect
B2	35(2)	35(2)	35(2)	35(2)	35(2)
B3	10(7)	10(7)	10(7)	10(7)	10(7)
B4	35(2)	35(2)	35(2)	35(2)	35(2)
C1	50(1/0)	50(1/0)	50(1/0)	50(1/0)	50(1/0)
C2	95(4/0)	95(4/0)	95(4/0)	95(4/0)	95(4/0)
C3	50(1/0)	50(1/0)	50(1/0)	50(1/0)	50(1/0)
C4	95(4/0)	95(4/0)	95(4/0)	95(4/0)	95(4/0)

8.8.3 Control Cable Cross-sections

Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

8.9 Control Input/Output and Control Data

8.9.1 Digital Inputs

Programmable digital inputs[1]	4 (6)
Terminal number	18, 19, 27, 29, 32, 33
Voltage level	0–24 V
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
Pulse frequency range	0–110 kHz
(Duty cycle) Minimum pulse width	4.5 ms
Input resistance, R_i	Approximately 4 kΩ

[1] The digital input is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

8.9.2 STO Terminal 37 (Terminal 37 is Fixed PNP Logic)

Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<4 V DC
Voltage level, logic 1 PNP	>20 V DC
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA rms
Typical input current at 20 V	60 mA rms
Input capacitance	400 nF

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
See 4.8.7 Safe Torque Off (STO) for further information about terminal 37 and Safe Torque Off.

When using a contactor with a DC coil inside in combination with STO, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

8.9.3 Analog Inputs

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 V to +10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	20 Hz/100 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

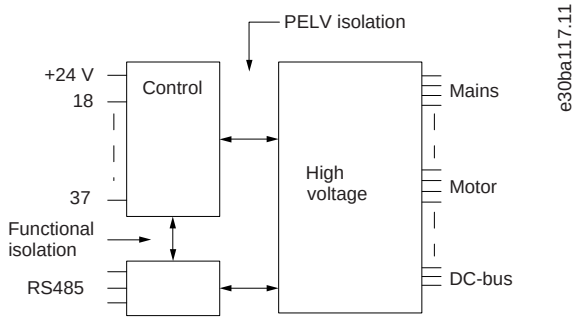


Illustration 33: PELV Isolation

8.9.4 Pulse/Encoder Inputs

Programmable pulse	2/1
Terminal number pulse	29, 33/33[1]
Maximum frequency at terminals 29, 33	110 kHz (Push-pull driven)
Maximum frequency at terminals 29, 33	5 kHz (Open collector)
Maximum frequency at terminals 29, 33	4 Hz
Voltage level	See 8.9.1 Digital Inputs.
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

[1] Pulse inputs are 29 and 33.

The pulse and encoder inputs (terminals 29 and 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

8.9.5 Digital Outputs

Programmable digital/pulse outputs	2
Terminal number	27, 29[1]
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error: 0.1% of full scale
Resolution of frequency outputs	12 bit

[1] Terminals 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.

8.9.6 Analog Output

Number of programmable outputs	1
Terminal number	42
Current range at analog output	0/4 to 20 mA
Maximum load GND - analog output less than	500 Ω
Accuracy on analog output	Maximum error: 0.5% of full scale
Resolution of analog output	12 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

8.9.7 Control Card, 24 V DC Output

Terminal number	12, 13
Output voltage	24 V +1, -3 V
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.

8.9.8 Control Card, +10 V DC Output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	15 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

8.9.9 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 galvanically isolated from the supply voltage (PELV).

8.9.10 Control Card, USB Serial Communication

USB standard	1.1 (full speed)
USB plug	USB type B plug

Connection to the 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 ground connection is not galvanically isolated from protective earth. Use only an isolated laptop as PC connection to the USB connector on the drive.

8.9.11 Relay Outputs

Programmable relay outputs	2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1] on 4–5 (NO) (resistive load)[2][3]	400 V AC, 2 A
Maximum terminal load (AC-15) on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 1 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[1] IEC 60947 parts 4 and 5. The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV)

[2] Overvoltage Category II

[3] UL applications 300 V AC 2 A.

8.9.12 Control Card Performance

Scan interval	1 ms

8.9.13 Control Characteristics

Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: Error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: Error ±0.15 RPM
Torque control accuracy (speed feedback)	Maximum error ±5% of rated torque

All control characteristics are based on a 4-pole asynchronous motor.

8.10 Fuses and Circuit Breakers

8.10.1 Fuse Recommendations

Fuses ensure that possible damage to the drive is limited to damage inside the unit. Danfoss recommends fuses and/or circuit breakers on the supply side as protection. For further information, see *Application Note Fuses and Circuit Breakers*.

N O T I C E

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 drive is equal to or lower than the energy provided by Moeller types.

For further information, see *Application Note Fuses and Circuit Breakers*.

The recommended fuses in 8.10.2 CE Compliance, 8.10.3 UL Compliance (61800-5-1), and 8.10.4 UL Compliance (508C) are suitable for use on a circuit capable of 100000 A_{rms} (symmetrical), depending on the drive power and voltage rating. See the *Electrical Data* section for the short-circuit current rating (SCCR) based on the specific power and voltage rating of the drive.

8.10.2 CE Compliance

Table 56: 200–240 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–1.5 (1.5–2.0)	gG-10	gG-25	PKZM0-25	25
	2.2 (3.0)	gG-16			
A3	3.0 (4.0)	gG-16	gG-32	PKZM0-25	25
	3.7 (5.0)	gG-20			
A4	1.1–1.5 (1.5–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2 (3.0)	gG-16			
A5	1.1–1.5 (1.5–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2–3.0 (3.0–4.0)	gG-16			
	3.7 (5.0)	gG-20			
B1	5.5 (7.5)	gG-25	gG-80	PKZM4-63	63
	7.5–11 (10–15)	gG-32			
B2	15 (20)	gG-50	gG-100	NZMB1-A100	100
B3	5.5–7.5 (7.5–10)	gG-25	gG-63	PKZM4-50	50
	11 (15)	gG-32			
B4	15 (20)	gG-50	gG-125	NZMB1-A100	100
	18 (24)	gG-63			
C1	18 (24)	gG-63	gG-160	NZMB2-A200	160
	22 (30)	gG-80			
	30 (40)	gG-100	aR-160		

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
C2	37 (50)	aR-160	aR-200	NZMB2-A250	250
	45 (60)	aR-200	aR-250		
C3	22 (30)	gG-80	gG-150	NZMB2-A200	150
	30 (40)	aR-125	aR-160		
C4	37 (50)	aR-160	aR-200	NZMB2-A250	250
	45 (60)	aR-200	aR-250		

Table 57: 380–480 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	1.1–3.0 (1.5–4.0)	gG-10	gG-25	PKZM0-25	25
	4.0 (5.0)	gG-16			
A3	5.5–7.5 (7.5–10.0)	gG-16	gG-32	PKZM0-25	25
A4	1.1–3.0 (1.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0 (5.0)	gG-16			
A5	1.1–3.0 (1.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0–7.5 (5.0–10.0)	gG-16			
B1	11–18 (15–24)	gG-40	gG-80	PKZM4-63	63
B2	22 (30)	gG-50	gG-100	NZMB1-A100	100
	30 (40)	gG-63			
B3	11–18 (15–24)	gG-40	gG-63	PKZM4-50	50
B4	22 (30)	gG-50	gG-125	NZMB1-A100	100
	30 (40)	gG-63			
	37 (50)	gG-80			
C1	37 (50)	gG-80	gG-160	NZMB2-A200	160
	45 (60)	gG-100			
	55 (75)	gG-160			
C2	75 (100)	aR-200	aR-250	NZMB2-A250	250
	90 (125)	aR-250			
C3	45 (60)	gG-100	gG-150	NZMB2-A200	150
	55 (75)	gG-160	gG-160		
C4	75 (100)	aR-200	aR-250	NZMB2-A250	250
	90 (125)	aR-250			

Table 58: 525–600 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A3	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10)	gG-16			
A5	1.1 (1.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10)	gG-16			
B1	11 (15)	gG-25	gG-80	PKZM4-63	63
	15 (20)	gG-32			
	18.5 (25)	gG-40			
B2	22 (30)	gG-50	gG-100	NZMB1-A100	100
	30 (40)	gG-63			
B3	11 (15)	gG-25	gG-63	PKZM4-50	50
	15–18.5 (20–25)	gG-32			
B4	22 (30)	gG-40	gG-125	NZMB1-A100	100
	30 (40)	gG-50			
	37 (50)	gG-63			
C1	37 (50)	gG-63	gG-160	NZMB2-A200	160
	45 (60)	gG-100			
	55 (60)	aR-160	aR-250		
C2	75–90 (100–125)	aR-200	aR-250	NZMB2-A250	250
C3	45 (60)	gG-63	gG-150	NZMB2-A200	150
	55 (75)	gG-100			
C4	75 (100)	aR-160	aR-250	NZMB2-A250	250
	90 (125)	aR-200			

Table 59: 525–690 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A3	1.1 (1.5)	gG-6	gG-25	PKZM0-16	16
	1.5 (2.0)	gG-6	gG-25		
	2.2 (3.0)	gG-6	gG-25		
	3.0 (4.0)	gG-10	gG-25		
	4.0 (5.0)	gG-10	gG-25		
	5.5 (7.5)	gG-16	gG-25		
	7.5 (10)	gG-16	gG-25		

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
B2/B4	11 (15)	gG-25	gG-63	–	–
	15 (20)	gG-32			
	18 (24)	gG-32			
	22 (30)	gG-40			
B4/C2	30 (40)	gG-63	gG-80	–	–
C2/C3	37 (50)	gG-63	gG-100	–	–
	45 (60)	gG-80	gG-125		
C2	55 (75)	gG-100	gG-160	–	–
	75 (100)	gG-125			

8.10.3 UL Compliance (61800-5-1)

Table 60: Recommended Fuse, 200–240 V and 115Y/200–139Y/240, Enclosure Sizes A2, A3, A5, B1, B2, and C1

Power [kW (hp)]	Class	Recommended	Verified with
1.1 (1.5)	J/T/CC	10 A	A2: class J, 20 A A5: class J, 30 A
1.5 (2.0)	J/T/CC	15 A	A2: class J, 20 A A5: class J, 30 A
2.2 (3.0)	J/T/CC	20 A	A2: class J, 20 A A5: class J, 30 A
3.0 (4.0)	J/T/CC	25 A	A3: class J, 30 A A5: class J, 30 A
3.7 (5.0)	J/T/CC	30 A	A3: class J, 30 A A5: class J, 30 A
5.5–7.5 (7.5–10)	J/T/CC	50 A	B1: class J, 60 A
11 (15)	J/T/CC	60 A	B1: class J, 60 A
15 (20)	J/T	80 A	B2: class J, 80 A
18.5–22 (25–30)	J/T	125 A	C1: class J, 150 A
30 (40)	J/T	150 A	C1: class J, 150 A

Table 61: Recommended Fuse, 380–480 V and 220Y/380–277Y/480, Enclosure Sizes A2, A3, A5, B1, B2, and C1

Power [kW (hp)]	Class	Recommended	Verified with
1.1 (1.5)	J/T/CC	6 A	A2: class J, 10 A A5: class J, 30 A
1.5–2.2 (2.0–3.0)	J/T/CC	10 A	A2: class J, 20 A

Power [kW (hp)]	Class	Recommended	Verified with
			A5: class J, 30 A
3.0 (4.0)	J/T/CC	15 A	A2: class J, 20 A A5: class J, 30 A
4.0 (5.0)	J/T/CC	20 A	A2: class J, 20 A A5: class J, 30 A
5.5 (7.5)	J/T/CC	25 A	A3: class J, 30 A A5: class J, 30 A
7.5 (10)	J/T/CC	30 A	A3: class J, 30 A A5: class J, 30 A
11–15 (15–20)	J/T/CC	40 A	B2: class J, 50 A
18.5 (25)	J/T/CC	50 A	B1: class J, 50 A
22 (30)	J/T/CC	60 A	B2: class J, 80 A
30 (40)	J/T	80 A	B2: class J, 80 A
37 (50)	J/T	100 A	C1: class J, 150 A
45 (60)	J/T	125 A	C1: class J, 150 A
55 (75)	J/T	150 A	C1: class J, 150 A

8.10.4 UL Compliance (508C)

Table 62: Recommended Maximum Fuse, 200–240 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Bussmann Type RK1[1]	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
1.1 (1.5)	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5 (2.0)	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2 (3.0)	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0 (4.0)	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7 (5.0)	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5–7.5 (7.5–10)	KTN-R-50	KS-50	JJN-50	–	–	–
11 (15)	KTN-R-60	JKS-60	JJN-60	–	–	–
15 (20)	KTN-R-80	JKS-80	JJN-80	–	–	–
18.5–22 (25–30)	KTN-R-125	JKS-125	JJN-125	–	–	–
30 (40)	KTN-R-150	JKS-150	JJN-150	–	–	–
37 (50)	KTN-R-200	JKS-200	JJN-200	–	–	–
45 (60)	KTN-R-250	JKS-250	JJN-250	–	–	–

[1] KTS-fuses from Bussmann may substitute KTN for 240 V drives.

Table 63: Recommended Maximum Fuse, 200–240 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type CC	Ferraz Shawmut Type RK1[1]	Bussmann Type JFHR2[2]	Littelfuse JFHR2	Ferraz Shawmut JFHR2[3]	Ferraz Shawmut J
1.1 (1.5)	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	–	–	HSJ-10
1.5 (2.0)	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	–	–	HSJ-15
2.2 (3.0)	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	–	–	HSJ-20
3.0 (4.0)	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	–	–	HSJ-25
3.7 (5.0)	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	–	–	HSJ-30
5.5–7.5 (7.5–10)	5014006-050	KLN-R-50	–	A2K-50-R	FWX-50	–	–	HSJ-50
11 (15)	5014006-063	KLN-R-60	–	A2K-60-R	FWX-60	–	–	HSJ-60
15 (20)	5014006-080	KLN-R-80	–	A2K-80-R	FWX-80	–	–	HSJ-80
18.5–22 (25–30)	2028220-125	KLN-R-125	–	A2K-125-R	FWX-125	–	–	HSJ-125
30 (40)	2028220-150	KLN-R-150	–	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
37 (50)	2028220-200	KLN-R-200	–	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
45 (60)	2028220-250	KLN-R-250	–	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

[1] A6KR-fuses from Ferraz Shawmut may substitute A2KR for 240 V drives.

[2] FWH-fuses from Bussmann may substitute FWX for 240 V drives.

[3] A50X-fuses from Ferraz Shawmut may substitute A25X for 240 V drives.

Table 64: Recommended Maximum Fuse, 380–480 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
1.1 (1.5)	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5–2.2 (2.0–3.0)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.0 (4.0)	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4.0 (5.0)	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 (15–20)	KTS-R-40	JKS-40	JJS-40	–	–	–
18.5 (25)	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	–	–	–

Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
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 65: Recommended Maximum Fuse, 380–480 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type CC	Ferraz Shawmut Type RK1	Bussmann JFHR2	Ferraz Shawmut J	Ferraz Shawmut JFHR2[1]	Littelfuse JFHR2
1.1 (1.5)	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	–	–
1.5–2.2 (2.0–3.0)	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	–	–
3.0 (4.0)	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	–	–
4.0 (5.0)	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 (15–20)	5014006-040	KLS-R-40	–	A6K-40-R	FWH-40	HSJ-40	–	–
18.5 (25)	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

[1] Ferraz Shawmut A50QS fuses may substitute for A50P fuses.

Table 66: Recommended Maximum Fuse, 525–600 V, Enclosure Sizes A, B, and C

Power [kW (hp)	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type RK1	Ferraz Shawmut J
1.1 (1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2 (2.0–3.0)	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

Power [kW (hp)	Buss-mann Type RK1	Buss-mann Type J	Buss-mann Type T	Buss-mann Type CC	Buss-mann Type CC	Buss-mann Type CC	SIBA Type RK1	Littel-fuse Type RK1	Ferraz Shawmut Type RK1	Ferraz Shaw-mut J
3.0 (4.0)	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
4.0 (5.0)	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5 (7.5)	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5 (10.0)	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11–15 (15–20)	KTS-R-35	JKS-35	JJS-35	–	–	–	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
18.5 (25)	KTS-R-45	JKS-45	JJS-45	–	–	–	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
22 (30)	KTS-R-50	JKS-50	JJS-50	–	–	–	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
30 (40)	KTS-R-60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
37 (50)	KTS-R-80	JKS-80	JJS-80	–	–	–	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
45 (60)	KTS-R-100	JKS-100	JJS-100	–	–	–	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
55 (75)	KTS-R-125	JKS-125	JJS-125	–	–	–	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
75 (100)	KTS-R-150	JKS-150	JJS-150	–	–	–	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
90 (125)	KTS-R-175	JKS-175	JJS-175	–	–	–	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 67: Recommended Maximum Fuse, 525–690 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
1.1 (1.5)	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5–2.2 (2.0–3.0)	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.0 (4.0)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4.0 (5.0)	KTS-R20	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 (15–20)	KTS-R-35	JKS-35	JJS-35	–	–	–
18.5 (25)	KTS-R-45	JKS-45	JJS-45	–	–	–

Power [kW (hp)]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
22 (30)	KTS-R-50	JKS-50	JJS-50	–	–	–
30 (40)	KTS-R-60	JKS-60	JJS-60	–	–	–
37 (50)	KTS-R-80	JKS-80	JJS-80	–	–	–
45 (60)	KTS-R-100	JKS-100	JJS-100	–	–	–
55 (75)	KTS-R-125	JKS-125	JJS-125	–	–	–
75 (100)	KTS-R-150	JKS-150	JJS-150	–	–	–
90 (125)	KTS-R-175	JKS-175	JJS-175	–	–	–

Table 68: Recommended Maximum Fuse, 525–690 V, Enclosure Sizes B, and C

Power [kW (hp)]	Maximum prefuse [A]	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	Littelfuse E81895 RK1/JDDZ	Ferraz Shawmut E163267/E2137 RK1/JDDZ	Ferraz Shawmut E2137 J/HSJ
11–15 (15–20)	30	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
18.5 (25.0)	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

8.11 Connection Tightening Torques

Table 69: Tightening Torque for Cables

Enclosure size	200–240 V [kW (hp)]	380–480/500 V [kW (hp)]	525–600 V [kW(hp)]	525–690 V [kW (hp)]	Mains [Nm (in-lb)]	Motor [Nm (in-lb)]	DC connection [Nm (in-lb)]	Brake [Nm (in-lb)]	Ground [Nm (in-lb)]	Relay [Nm (in-lb)]
A2	1.1–2.2 (1.5–3.0)	1.1–4.0 (1.5–5.0)	–	–	0.6	0.6	0.6	1.8	3.0	0.6
A3	3.0–3.7 (4.0– 5.0)	5.5–7.5 (7.5–10)	1.1–7.5 (1.5–10)	1.1–7.5 (1.5–10.0)	0.6	0.6	0.6	1.8	3.0	0.6
A4	1.1–2.2 (1.5–3.0)	1.1–4.0 (0.5–5.0)	–	–	0.6	0.6	0.6	1.8	3.0	0.6
A5	1.1–3.7 (1.5– 5.0)	1.1–7.5 (1.5–10)	1.1–7.5 (1.5–10.0)	–	0.6	0.6	0.6	1.8	3.0	0.6

Enclosure size	200–240 V [kW (hp)]	380–480/500 V [kW (hp)]	525–600 V [kW(hp)]	525–690 V [kW (hp)]	Mains [Nm (in-lb)]	Motor [Nm (in-lb)]	DC connection [Nm (in-lb)]	Brake [Nm (in-lb)]	Ground [Nm (in-lb)]	Relay [Nm (in-lb)]
B1	5.5–11 (7.5–15)	11–18 (15-24)	11–18 (15-24)	–	1.8	1.8 (15.9)	1.5	1.5	3.0	0.6
B2	15 (20)	22–30 (30–40)	22–30 (30–40)	11–30 (15– 40)	4.5 (39.8)	4.5 (39.8)	3.7	3.7	3.0	0.6
B3	5.5–11 (7.5–15)	11–18 (15-24)	11–18 (15-24)	–	1.8 (15.9)	1.8 (15.9)	1.8 (15.9)	1.8 (15.9)	3.0	0.6
B4	15–18 (20-24)	22–37 (30–50)	22–37 (30–50)	11–37 (15-50)	4.5 (39.8)	4.5 (39.8)	4.5 (39.8)	4.5 (39.8)	3.0	0.6
C1	18–30 (24– 40)	37–55 (50–75)	37–55 (50–75)	–	10 (89)	10 (89)	10 (89)	10 (89)	3.0	0.6
C2	37–45 (50– 60)	75–90 (100–125)	75–90 (100– 125)	37–90 (50–125)	14/24 (124/212)[1]	14/24 (124/212)[1]	14 (124)	14 (124)	3.0	0.6
C3	22–30 (30–40)	45–55 (60–75)	45–55 (60–75)	45–55 (60–75)	10 (89)	10 (89)	10 (89)	10 (89)	3.0	0.6
C4	37–45 (50– 60)	75–90 (100–125)	75–90 (100– 125)	–	14/24 (124/212)[1]	14/24 (124/212)[1]	14	14	3.0	0.6

[1] For different cable dimensions x/y, where x ≤95 mm^2 (3 AWG) and y ≥95 mm^2 (3 AWG).

8.12 Power Ratings, Weight, and Dimensions

Table 70: Power Ratings, Weight, and Dimensions, Enclosure Size A

Enclosure size		A2		A3		A4	A5
Rated power [kW (hp)]	200–240 V	1.1–2.2 (1.5–3.0)		3.0–3.7 (4.0–5.0)		1.1–2.2 (1.5–3.0)	1.1–3.7 (1.5–5.0)
	380-480/500 V	1.1–4.0 (1.5–5.0)		5.5–7.5 (7.5–10)		1.1–4.0 (1.5–5.0)	1.1–7.5 (1.5–10)
	525–600 V	–		1.1–7.5 (1.5–10)		–	1.1–7.5 (1.5–10)
	525–690 V	–		1.1–7.5 (1.5–10)	–	–	–
Protection rating	–	IP20(UL Open Type)	IP21(UL Type 1)	IP20(UL Open Type)	IP21(UL Type 1)	IP55/66(UL Type 12/4X)	IP55/66(UL Type 12/4X)
Height [mm (in)]							
Height of mounting plate	A[1]	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with ground termination plate for fieldbus cables	A	374 (14.7)	–	374 (14.7)	–	–	–

Enclosure size		A2		A3		A4	A5
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 mounting plate	B	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of mounting plate with 1 C option	B	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of mounting plate with 2 C options	B	150 (5.9)	150 (5.9)	190 (7.5)	190 (7.5)	–	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 [mm (in)]							
Depth without option A/B	C	205 (8.1)	207 (8.1)	205 (8.1)	207 (8.1)	175 (6.9)	200 (7.9)
With option A/B	C	220 (8.7)	222 (8.7)	220 (8.7)	222 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]							
	c	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.25 (0.32)
	d	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø12 (ø0.47)	ø12 (ø0.47)
	e	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø6.5 (ø0.26)	ø6.5 (ø0.26)
	f	9 (0.35)	9 (0.35)	6.5 (0.26)	6.5 (0.26)	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)	13.5/14.2 (30/31)
Front cover tightening torque [Nm (in-lb)]							
Plastic cover (low IP)		Click		Click		–	–
Metal cover (IP55/66)		–		–		1.5 (13.3)	1.5 (13.3)

[1] See Illustration 34 and Illustration 35.

Table 71: Power Ratings, Weight, and Dimensions, Enclosure Size B

Enclosure size		B1	B2	B3	B4
Rated power [kW (hp)]	**200–240 V**	**5.5–11 (7.5–15)**	**15 (20)**	**5.5–11 (7.5–15)**	**15–18 (20–24)**
	380-480/500 V	**11–18 (15–24)**	**22–30 (30–40)**	**11–18 (15–24)**	**22–37 (30–50)**
	525–600 V	**11–18 (15–24)**	**22–30 (30–40)**	**11–18 (15–24)**	**22–37 (30–50)**
	525–690 V	–	**11–30 (15–40)**	–	**11–37 (15–50)**
Protection rating	–	**IP21/55/66(UL Type 1/12/4X)**	**IP21/55/66(UL Type 1/12/4X)**	**IP20(UL Open Type)**	**IP20(UL Open Type)**

Enclosure size		B1	B2	B3	B4
Height [mm (in)]					
Height of mounting plate	A[1]	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)
Height with ground termination plate for fieldbus cables	A	–	–	420 (16.5)	595 (23.4)
Distance between mounting holes	a	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)
Width [mm (in)]					
Width of mounting plate	B	242 (9.5)	242 (9.5)	165 (6.5)	230 (9.1)
Width of mounting plate with 1 C option	B	242 (9.5)	242 (9.5)	205 (8.1)	230 (9.1)
Width of mounting plate with 2 C options	B	242 (9.5)	242 (9.5)	225 (8.9)	230 (9.1
Distance between mounting holes	b	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)
Depth [mm (in)]					
Depth without option A/B	C	260 (10.2)	260 (10.2)	249 (9.8)	242 (9.5)
With option A/B	C	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)
Screw holes [mm (in)]					
	c	12 (0.47)	12 (0.47)	8 (0.31)	–
	d	ø19 (ø0.75)	ø19 (ø0.75)	12 (0.47)	–
	e	ø9 (ø0.35)	ø9 (ø0.35)	6.8 (0.27)	8.5 (0.33)
	f	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)
Maximum weight [kg (lb)]		23 (51)	27 (60)	12 (26.5)	23.5 (52)
Front cover tightening torque [Nm (in-lb)]					
Plastic cover (low IP)		Click	Click	Click	Click
Metal cover (IP55/66)		2.2 (19.5)	2.2 (19.5)	–	–

[1] See Illustration 34 and Illustration 35.

Table 72: Power Ratings, Weight, and Dimensions, Enclosure Size C

Enclosure size		C1	C2	C3	C4
Rated power [kW (hp)]	**200–240 V**	**18–30 (24–40)**	**37–45 (50–60)**	**22–30 (30–40)**	**37–45 (50–60)**
	380-480/500 V	**37–55 (50–75)**	**75–90 (100–125)**	**45–55 (60–75)**	**75–90 (100–125)**
	525–600 V	**37–55 (50–75)**	**75–90 (100–125)**	**45–55 (60–75)**	**75–90 (100–125)**
	525–690 V	**–**	**37–90 (50–125)**	**45–55 (60–75)**	**–**

Enclosure size		C1	C2	C3	C4
Protection rating	–	**IP21/55/66(UL Type 1/12/4X)**	**IP21/55/66(UL Type 1/12/4X)**	**IP20(UL Open Type)**	**IP20(UL Open Type)**
Height [mm (in)]					
Height of mounting plate	A[1]	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)
Height with ground termination plate for fieldbus cables	A	–	–	630 (24.8)	800 (31.5)
Distance between mounting holes	a	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)
Width [mm (in)]					
Width of mounting plate	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of mounting plate with 1 C option	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Width of mounting plate with 2 C options	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)
Distance between mounting holes	b	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)
Depth [mm (in)]					
Depth without option A/B	C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
With option A/B	C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)
Screw holes [mm (in)]					
	c	12.5 (0.49)	12.5 (0.49)	–	–
	d	ø19 (ø0.75)	ø19 (ø0.75)	–	–
	e	ø9 (ø0.35)	ø9 (ø0.35)	8.5 (0.33)	8.5 (0.33)
	f	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)
Maximum weight [kg (lb)]		45 (99)	65 (143)	35 (77)	50 (110)
Front cover tightening torque [Nm (in-lb)]					
Plastic cover (low IP)		Click	Click	2 (17.7)	2 (17.7)
Metal cover (IP55/66)		2.2 (19.5)	2.2 (19.5)	2 (17.7)	2 (17.7)

[1] See Illustration 34 and Illustration 35.

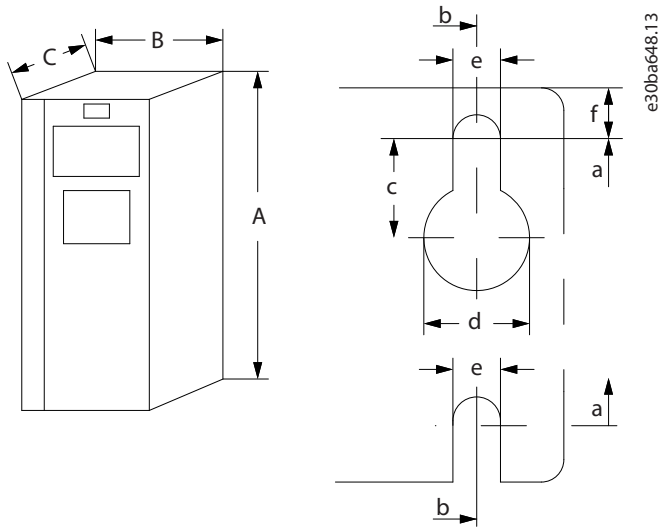


Illustration 34: Top and Bottom Mounting Holes

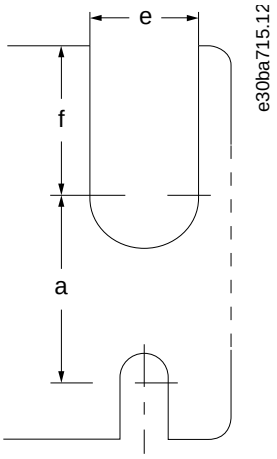


Illustration 35: Top and Bottom Mounting Holes, Enclosure Sizes B4, C3, and C4

9 Appendix

9.1 Symbols and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM motor	Permanent magnet motor
PWM	Pulse width motor
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

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