ENGINEERING
TOMORROW

Operating Guide

VLT® HVAC Drive FC 102

1.1–90 kW, Enclosure Sizes A–C

drives.danfoss.com | VLT®

Contents

5 Electrical Installation

6 Controls and Options Installation

7 Operating the Drive

1 Introduction

1.1 Purpose of this Operating Guide

This operating guide provides information for safe installation and commissioning of the product. It is intended for use by qualified personnel. To use the drive safely and professionally, read and follow the instructions. Pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the product.

1.2 Trademarks

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

1.3 Additional Resources

Various resources are available to understand advanced drive operation, programming, and directives compliance.

- The design guide provides all technical information about the drive including options and accessories.
- The programming guide provides greater detail on how to work with parameters. It also contains application examples.
- The *VLT® Safe Torque Off Operating Guide* describes how to use Danfoss VLT® drives in functional safety applications. This guide is supplied with the drive when the Safe Torque Off option is present.
- The *VLT® Brake Resistor MCE 101 Design Guide* describes how to select the optimal brake resistor.
- The *VLT® Advanced Harmonic Filters AHF 005/AHF 010 Design Guide* describes harmonics, various mitigation methods, and the operation principle of the advanced harmonic filter. This guide also describes how to select the correct advanced harmonics filter for a particular application.
- The *Output Filters Design Guide* explains why it is necessary to use output filters for certain applications and how to select the optimal dU/dt or sine-wave filter.
- Supplemental publications and guides are available at https://www.danfoss.com/en/products/dds/low-voltage-drives/#tab-vlt-drives.

Optional equipment is available that may change some of the information described in these publications. Be sure to follow the instructions supplied with the options for specific requirements.

Contact a Danfoss supplier or visit http://www.danfoss.com for more information.

1.4 Version History

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

Table 1: Version History

Edition	Remarks	Software version
AQ267037536117, version 22	Updated UL61800-5-1 fuse content.	7.61

1.5 Approvals and Certifications

The specific approvals and certification that apply to this drive are listed on the product label. For more information, contact the local office or partner.

1.6 CE Declaration

Declaration of Conformity – VLT® HVAC Drive FC 102 Frequency Converters

e30bm415.10

ENGINEERING TOMORROW

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EU DECLARATION OF CONFORMITY

Danfoss A/S

Danfoss Drives

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), regulation(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+A11:2021	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.

EN IEC63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date: 2023.07.12 Place of issue:	Issued by	Date: 2023.07.12 Place of issue:	Approved by
Graasten, DK	Signature: Peder Spek Name: Peder Schmidt Spek Title: Produkt Manager	Graasten, DK	Signature: Chintan Kharche Name: Chintan Kharche Title: Head of BU Product Mgm. HVAC/R

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

ID No: 00730213
This doc. is managed by 500B0577
Revision No: A, 7
Page 1 of 4

Commission Regulation (EU) 2019/1781 under the Ecodesign Directive 2009/125/EC including amendment in Commission Regulation (EU) 2021/341

EN61800-9-2:2017	Adjustable speed electrical power drive systems - Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Energy efficiency indicators for power drive systems and motor starters.

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: **X, B or R at character 18 of the typecode.** The following directives apply:

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)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
	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 62061:2021 (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)

EN50495: 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
Notified Body no. (PQAN) : 0539
Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX 3009.

FC 102/202/302 with MCB 112 PTC Motor protection inside PTB 14 ATEX 3009
CAUTION: See manual for additional instruction
II (2) G[Ex e] [Ex d] [Ex n]
II (2) D[Ex tb] [Ex tc]
Label above must be placed visible on the drive

ID No: 00730213
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Revision No: A, 7
Page 2 of 4

2 Safety

2.1 Safety Symbols

The following symbols are used in documentation.

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).

The guide also includes ISO symbols for general warnings, warnings related to hot surfaces and burn hazard, high voltage and electric shock, and referring to the instructions.

	ISO warning symbol for general warnings
	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electric shock
	ISO action symbol for referring to the instructions

2.2 Qualified Personnel

To allow trouble-free and safe operation of the unit, only qualified personnel with proven skills are allowed to transport, store, assemble, install, program, commission, maintain, and decommission this equipment.

Persons with proven skills:

- Are qualified electrical engineers or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plants, and machinery in accordance with pertinent laws and regulations.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in all guides provided with the unit, especially the instructions given in the operating guide of the drive.

- Have good knowledge of the generic and specialist standards applicable to the specific application.

2.3 Safety Precautions

⚠ WARNING

LACK OF SAFETY AWARENESS

Before starting installation, read all safety guidelines and precautions in this installation guide. Additional documentation such as the product-specific operating guide, design guide, and programming guide, as well as the functional safety guides can be accessed by scanning the QR code on the front cover. PC tools and MyDrive® Energy can be downloaded at www.danfoss.com.

This guide gives important information on preventing injury and damage to the equipment or the system. Ignoring this information can lead to death, serious injury, or severe damage to the equipment.

- Make sure to fully understand the dangers and safety measures present in the application.
- Before performing any electrical work on the drive, lock out and tag out all power sources to the drive.

⚠ WARNING

LIFTING HEAVY LOAD

The drive is heavy. Lifting heavy objects incorrectly can result in death, injury, or property damage.

- Follow local safety regulations on lifting.
- Check the weight of the drive. The weight is provided on the outside of the shipping box.
- If lifting equipment is used, ensure that it is in proper working condition and can safely lift the weight of the drive.
- Test lift the drive to verify the proper center of gravity. Reposition the lifting point if not level.

⚠ WARNING

HAZARDOUS VOLTAGE

Drives contain hazardous voltage when connected to AC or DC supply. Failure to perform installation, startup, and maintenance by qualified personnel can result in death or serious injury.

- Only qualified personnel must perform installation, startup, and maintenance.

⚠ WARNING

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 can result in death or serious injury.

- Stop the motor
- Disconnect all power sources, including permanent magnet type motors.
- Wait for capacitors to discharge fully. The discharge time is specified on the drive product label.
- Verify full discharge by measuring the input AC and DC bus voltage levels.

⚠ WARNING

UNINTENDED START

When the drive is connected to the AC mains or connected on the DC terminals, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage.

- Stop the drive and motor before configuring parameters.
- Make sure that the drive cannot be started by external switch, a fieldbus command, an input reference signal from the control panel, or after a cleared fault condition.
- Disconnect the drive from the mains whenever safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

⚠ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD

The drive can cause a DC current in the ground conductor on a floating/ungrounded power grid when 1 phase becomes grounded. Failure to use a Type B residual current-operated protective device (RCD) can result in an electrical shock or fire.

- Use a Type B residual current-operated device (RCD) on the supply side.

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together or near other power cables can charge the equipment capacitors, even with the main power turned off and locked out. Failure to run the output motor cables separately, or to use shielded cables, could result in death or serious injury.

- Install output motor cables in separate conduits or use shielded cables.
- Simultaneously lock out/tag out all the drives.

⚠ WARNING

ELECTRICAL SHOCK HAZARD

Due to the stray capacitance of the shielded motor cable, the leakage currents exceed 3.5 mA. Failure to properly ground the drive can result in death or serious injury.

- Ensure that minimum size of the ground conductor complies with the local safety regulations for high touch current equipment.
- Use a reinforced ground conductor according to IEC 60364-5-54 cl. 543.7 or local safety regulations for equipment with leakage current >3.5 mA.
- For reinforced grounding:

  Use a ground conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al, or an extra ground conductor of the same cross-sectional area as the original ground conductor as specified by IEC 60364-5-54, with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) mechanically protected or 4 mm^2 (12 AWG) not mechanically protected.

  Use a ground conductor inside an enclosure or otherwise protected throughout its length against mechanical damage.

  Use a ground conductor that is part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) that is permanently connected or plugged in by an industrial connector. The multi-conductor power cable must be installed with an appropriate strain relief.

⚠ WARNING

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.

⚠ CAUTION

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

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

NOTICE

EXCESSIVE HEAT AND PROPERTY DAMAGE

Overcurrent can generate excessive heat within the drive. Failure to provide overcurrent protection can result in risk of fire and property damage.

- Use additional protective devices such as fusing, motor overloads, or a motor circuit protector (MCP) between the drive and the motor for applications with multiple motors.
- Input fusing is required to provide short-circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. Refer to the prodict-specific documentation for fuse specifications.

NOTICE

MOTOR DAMAGE

Protection against motor overload is not active by default. Failure to set the ETR function means that motor overload protection is not provided and motor damage can occur if the motor overheats.

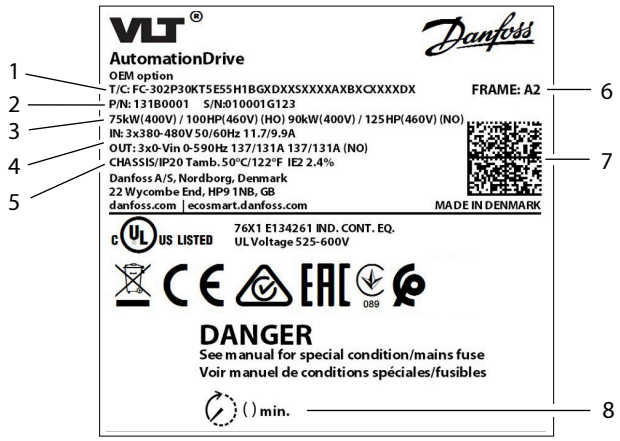
- To provide class 20 motor overload protection, enable the ETR function. See the programming guide for more information.

3 Receiving the Drive

3.1 Verifying the Shipment and the Contents

Verify the items supplied and the information on the product label match the order. The product label is on the exterior of the drive.

Visually check the packaging and the drive for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for verification. The drive is shipped with a selection of loose components packed in plastic bags. The amount of these components depend on the enclosure size and product configuration.



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1	Type code	**2**	Code number (P/N) and serial number (S/N)
3	Power rating	**4**	Input/output voltage, frequency, and current
5	Enclosure protection rating	**6**	Enclosure size
7	2D code – accessible by using a Datamatrix ECC 200 compatible barcode reader – containing the model code, code number, serial number, and manufacture date	**8**	Discharge time

NOTICE

LOSS OF WARRANTY

- Removing the product label from the drive can result in the loss of warranty.

3.2 Lifting the Drive

⚠ WARNING

LIFTING HEAVY LOAD

The weight of the drive is heavy and failure to follow local safety regulations for lifting heavy weights may cause death, personal injury, or property damage.

- Ensure that the lifting equipment is in proper working condition.
- Check the weight of the drive and verify that the lifting equipment can safely lift the weight.
- Always lift the drive using a lifting bar inserted into the lifting eyes. Maximum diameter for the lifting bar: 20 mm (0.8 in). The angle from the top of the drive to the lifting cable: 60° or greater.
- Test lift the unit approximately 610 mm (24 in) to verify the proper center of gravity lift point. Reposition the lifting point if the unit is not level.

3.3 Power Ratings, Weight, and Dimensions

Table 2: 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)	–	–	–
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)

Table 2: Power Ratings, Weight, and Dimensions, Enclosure Size A - (continued)

Enclosure size		A2		A3		A4	A5
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 Figure 1 and Figure 2.

Table 3: 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)**
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)

Table 3: Power Ratings, Weight, and Dimensions, Enclosure Size B - (continued)

Enclosure size		B1	B2	B3	B4
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 Figure 1 and Figure 2.

Table 4: 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)**	–
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)

Table 4: Power Ratings, Weight, and Dimensions, Enclosure Size C - (continued)

Enclosure size		C1	C2	C3	C4
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 Figure 1 and Figure 2.

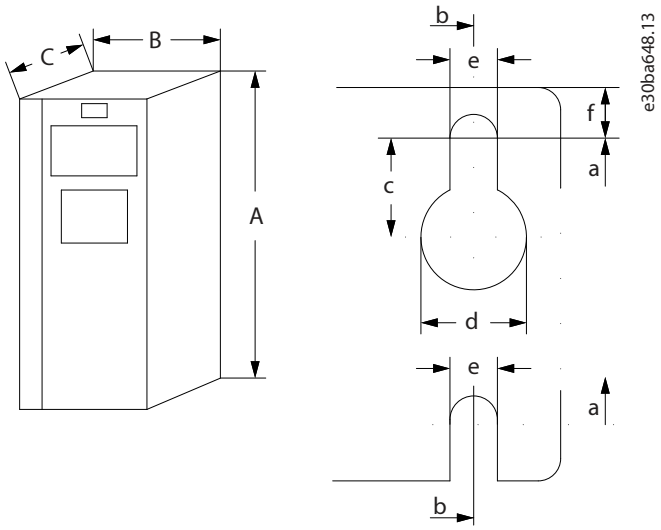


Figure 1: Top and Bottom Mounting Holes

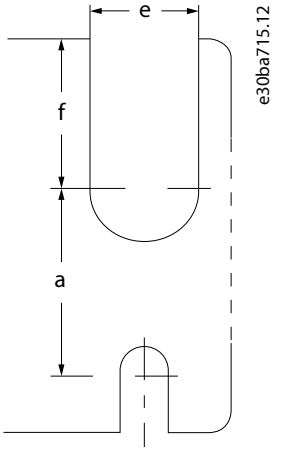


Figure 2: Top and Bottom Mounting Holes, Enclosure Sizes B4, C3, and C4

4 Mechanical Installation

4.1 Fastener Torque Ratings

Apply the correct torque when tightening fasteners in the locations that are listed. For electrical connections, refer to 5.7 Connecting the Mains and Motor Terminals. Too low or too high torque when fastening an electrical connection results in a bad electrical connection. To ensure correct torque, use a torque wrench.

⚠ WARNING

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.

Table 5: Fastener Torque Ratings

Location	Bolt size	Torque [Nm (in-lb)]
Door/panel cover	M5	2.3 (20)
Cable entry plate	M5	2.3 (20)
Serial communication cover	M5	2.3 (20)
LCP cover	–	2 (18)

4.2 Required Tools

- Lifting aid
- Tape measure
- Drill with assorted bits
- Screwdrivers (Torx, Phillips, slotted)
- Wrench with 7–17 mm sockets
- Socket extensions
- Sheet metal punch and/or pliers
- Wire crimper

4.3 Operating Environment

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment. For environment specifications, see the *Ambient Conditions* section.

NOTICE

CONDENSATION

Moisture can condense on the electronic components and cause short circuits. Operating in standby mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

- Avoid installation in areas subject to frost. Install an optional space heater when the drive is colder than the ambient air.

NOTICE

EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

- Do not operate in environments where the ambient temperature exceeds 55 °C (131 °F).
- The drive can operate at temperatures down to -10 °C (14 °F). However, proper operation at rated load is only guaranteed at 0 °C (32 °F) or higher.
- If the temperature exceeds ambient temperature limits, extra air conditioning is required for the cabinet or installation site.

4.4 Gases

Aggressive gases, such as hydrogen sulphide, chlorine, or ammonia can damage the electrical and mechanical components. The unit uses conformal-coated circuit boards to reduce the effects of aggressive gases. For conformal coating class specifications and ratings, see the *Ambient Conditions* section.

4.5 Dust

When installing the drive in dusty environments, pay attention to the following:

Periodic maintenance

When dust accumulates on electronic components, it acts as a layer of insulation. This layer reduces the cooling capacity of the components, and the components become warmer. The hotter environment decreases the life of the electronic components. Keep the heat sink and fans free from dust build-up.

Cooling fans

Fans provide airflow to cool the drive. When fans are exposed to dusty environments, the dust can damage the fan bearings and cause premature fan failure. Also, dust can accumulate on fan blades causing an imbalance which prevents the fans from properly cooling the unit.

4.6 Potentially Explosive Atmospheres

⚠ WARNING

EXPLOSIVE ATMOSPHERE

Installing the drive in a potentially explosive atmosphere can lead to death, personal injury, or property damage.

- Install the unit in a cabinet outside of the potentially explosive area.
- Use a motor with an appropriate ATEX protection class.
- Install a PTC temperature sensor to monitor the motor temperature.
- Install short motor cables.
- Use sine-wave output filters when shielded motor cables are not used.

As required by the EU Directive 2014/34/EU, any electrical or electronic device intended for use in an environment with a potentially explosive mixture of air, flammable gas, or dust must be ATEX-certified. Systems operated in this environment must fulfill the following special conditions to comply with the ATEX protection class:

- Class d specifies that if a spark occurs, it is contained in a protected area.

- Class e prohibits any occurrence of a spark.

Motors with class d protection

Does not require approval. Special wiring and containment are required.

Motors with class e or class n protection

When combined with an ATEX-approved PTC monitoring device like the VLT® PTC Thermistor Card MCB 112, installation does not need an individual approval from an approbated organization.

Motors with class d/e protection

The motor itself has an e ignition protection class, while the motor cabling and connection environment are in compliance with the d classification. To attenuate the high peak voltage, use a sine-wave filter at the drive output.

NOTICE

MOTOR THERMISTOR SENSOR MONITORING

Units with the VLT® PTC Thermistor Card MCB 112 option are PTB-certified for potentially explosive atmospheres.

4.7 Installation Requirements

- Place the unit as near to the motor as possible. See the *Cabling Guidelines* section for the maximum motor cable length.
- Ensure drive stability by mounting the drive to a solid surface. Verify that the strength of the mounting location supports the drive weight.
- Ensure enough room for cable entry at the bottom of the drive.
- Ensure enough clearance to open the door/panel.
- If the unit has the heat sink access panel option, ensure that there is enough clearance in the back of the drive to remove the panel.

4.8 Cooling Requirements

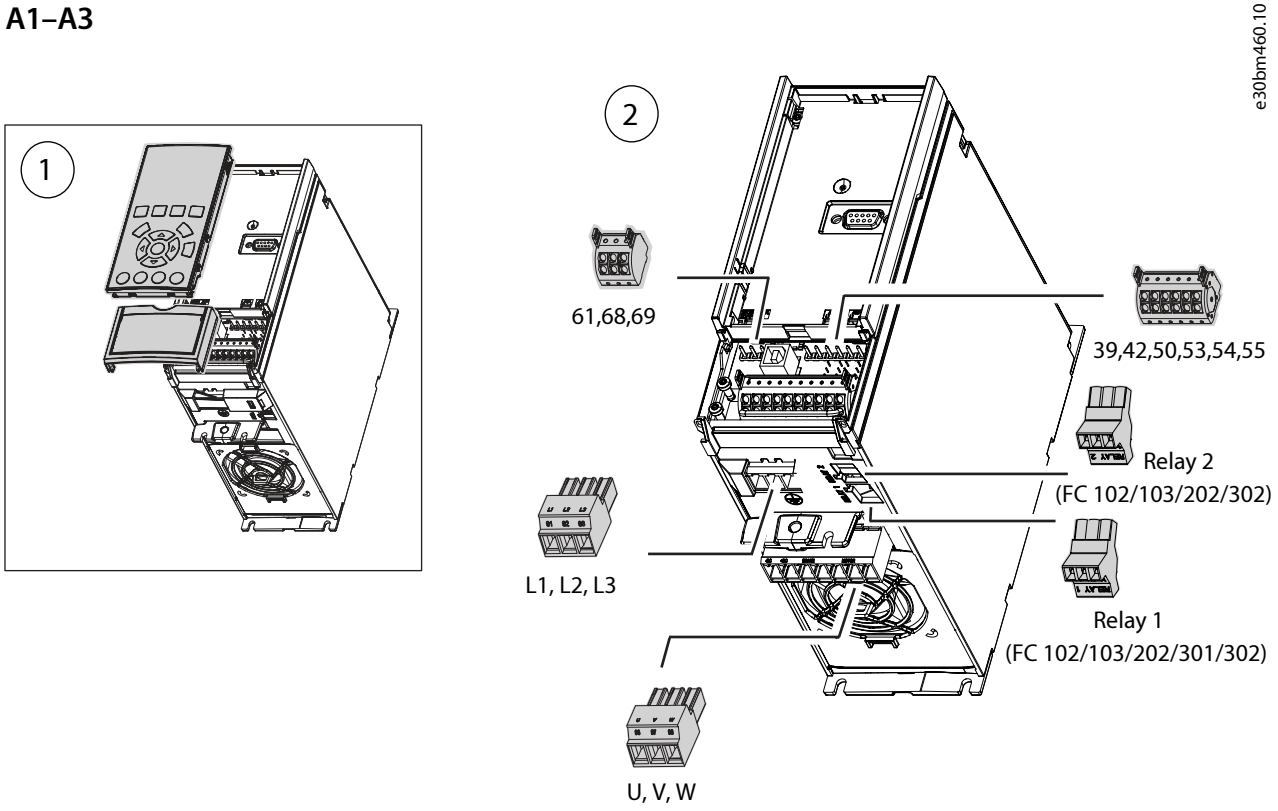
- To avoid overheating of the drive, pay attention to the required top and bottom cooling clearance for the various drive sizes. See Table 6.
- Consider derating for temperatures starting between 45 °C (113 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level. See the product-specific design guide for detailed information.

Table 6: Top and Bottom Cooling Clearances for the A–C Drives

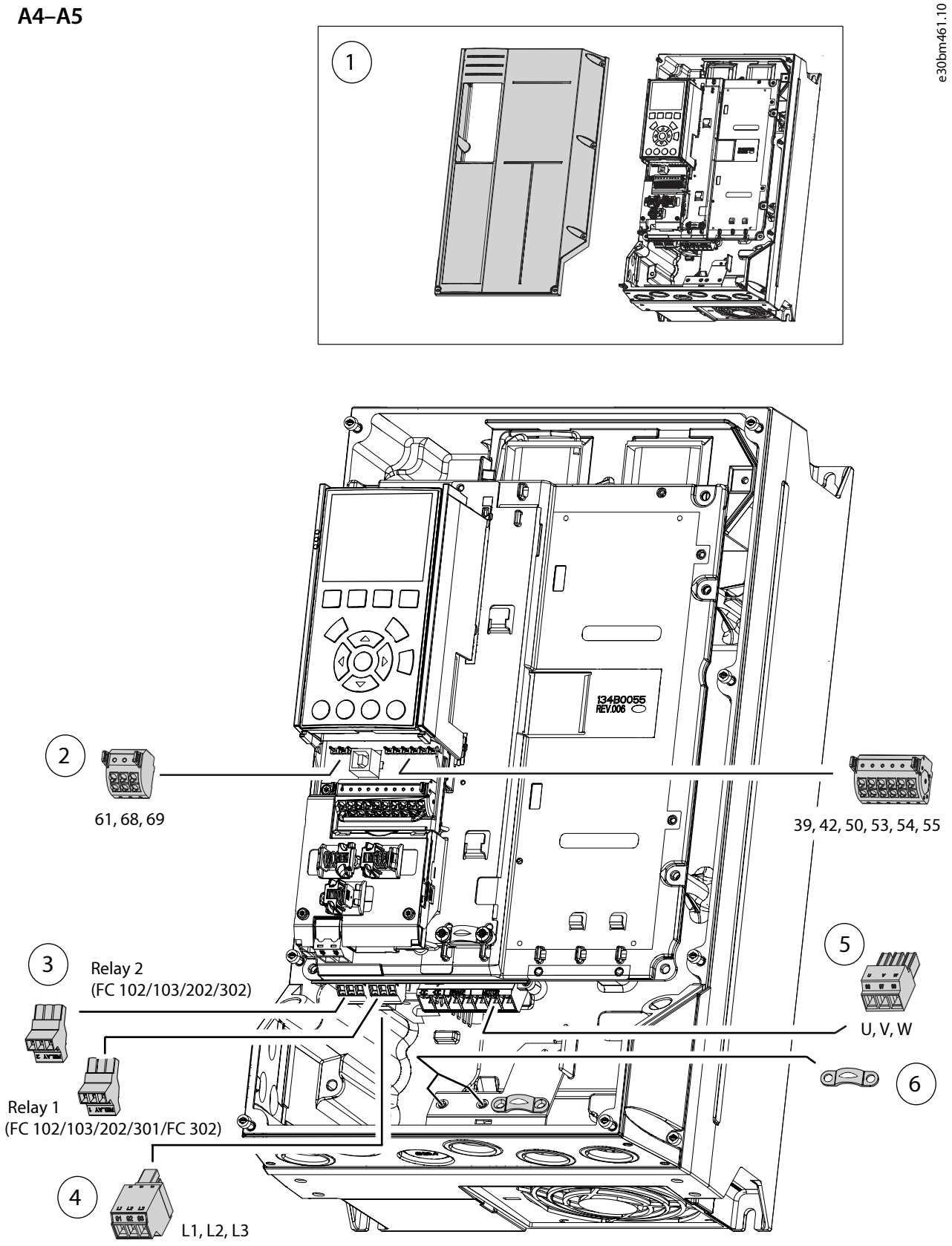
A2–A5	B1–B4	C1/C3	C2/C4
100 mm (3.9 in)	200 mm (7.9 in)	200 mm (7.9 in)	225 mm (8.9 in)

4.9 Installing the Accessory Bag Components

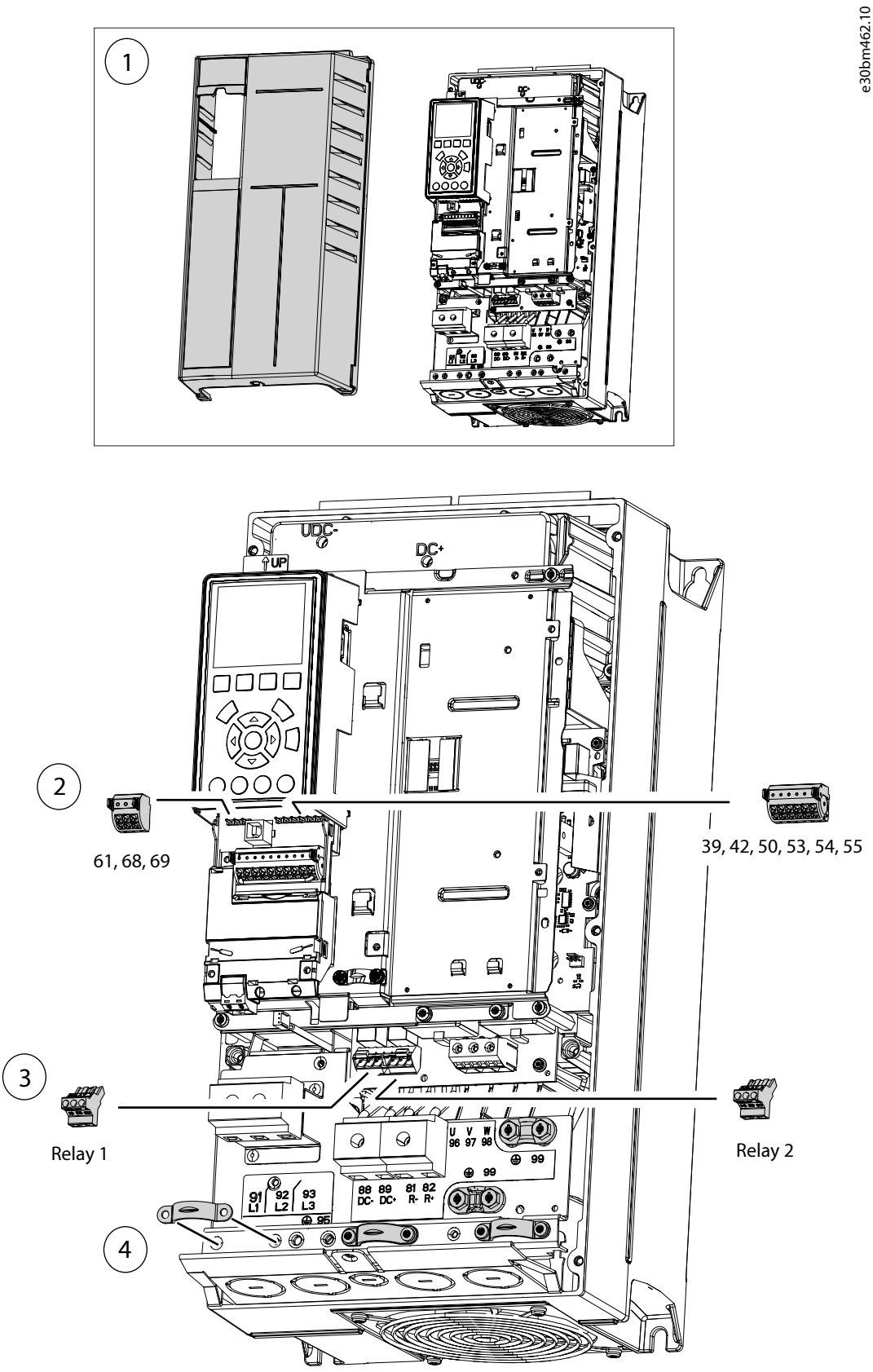
A1–A3



A4–A5

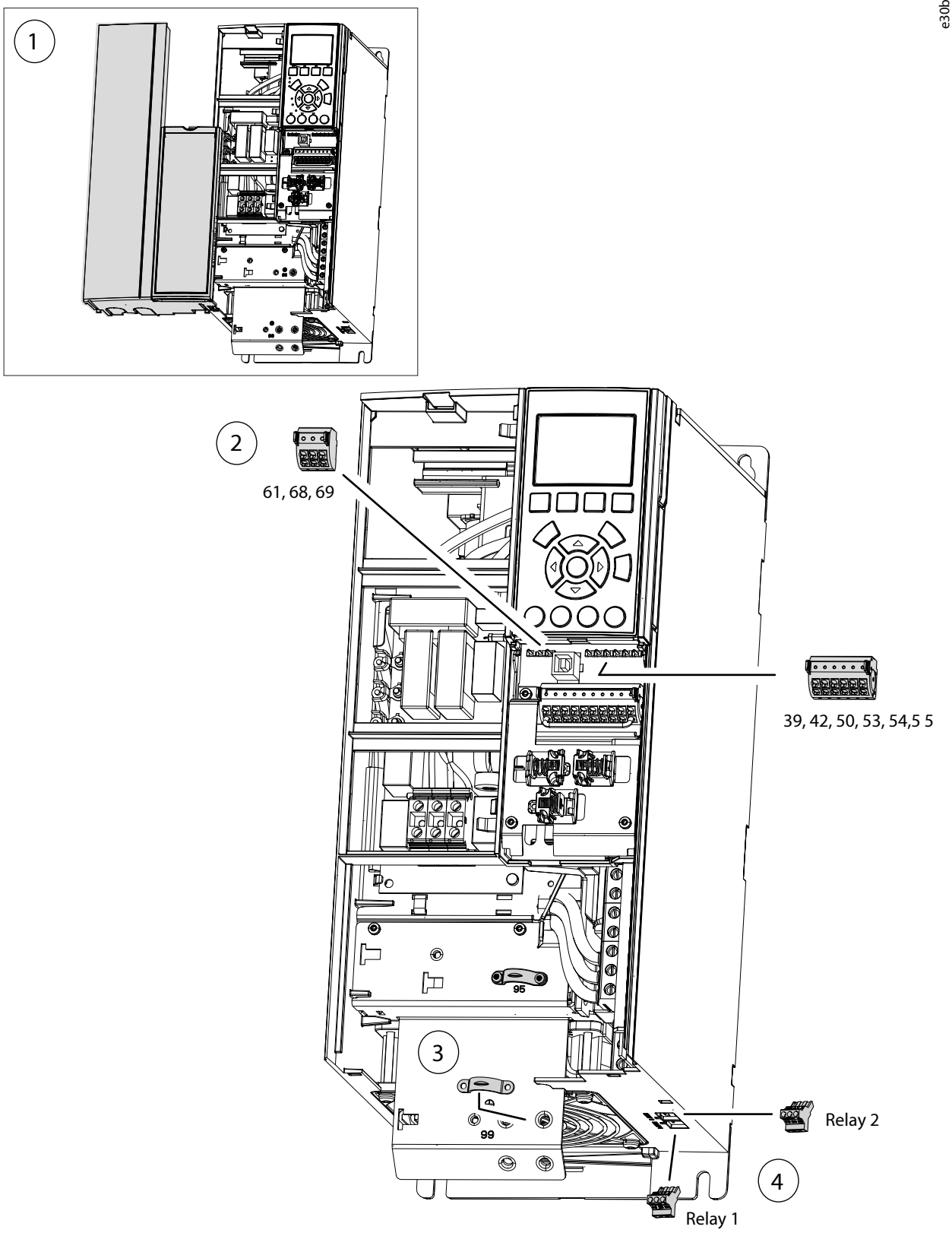

e30bm461.10
1
13480055
REV.006
2
61, 68, 69
39, 42, 50, 53, 54, 55
3
Relay 2
(FC 102/103/202/302)
5
U, V, W
6
Relay 1
(FC 102/103/202/301/FC 302)
4
L1, L2, L3

B1–B2

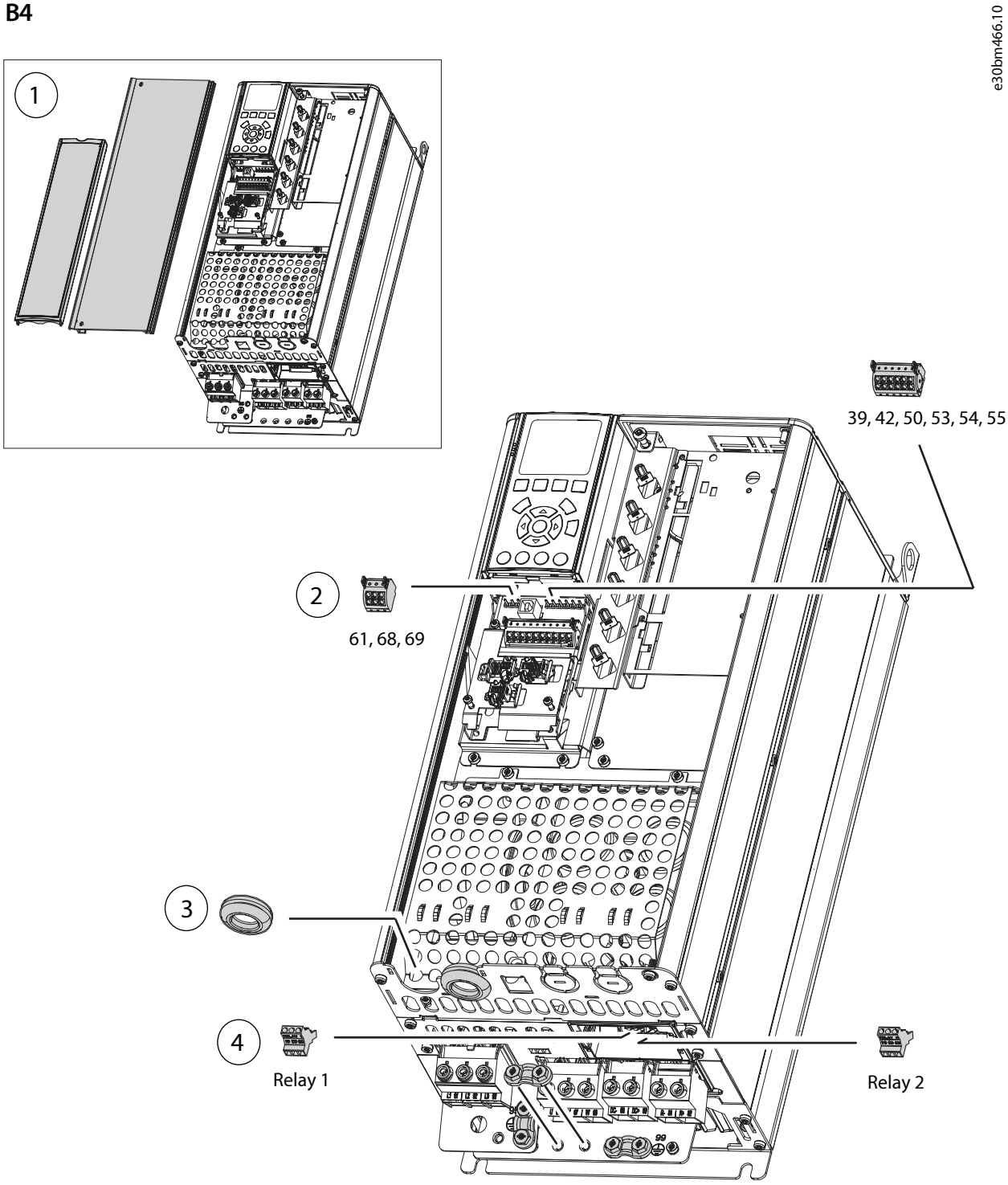

e30bm462.10
1
UDC-
DC+
UP
2
61, 68, 69
39, 42, 50, 53, 54, 55
3
Relay 1
Relay 2
4
91 L1
92 L2
93 L3
95
88 DC-
89 DC+
81 R-
82 R+
U 96
V 97
W 98
99
99

B3

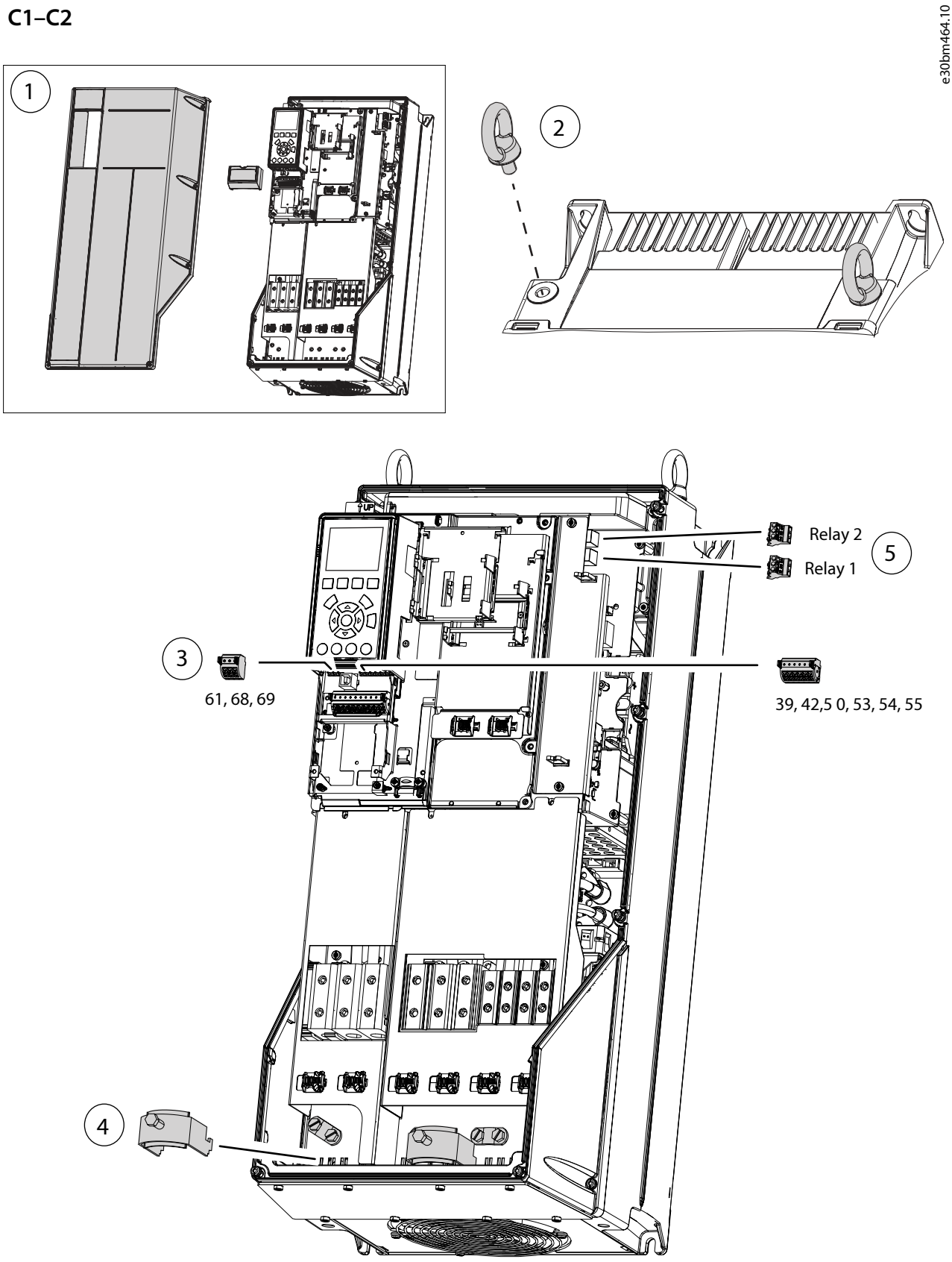
e30bm463.10



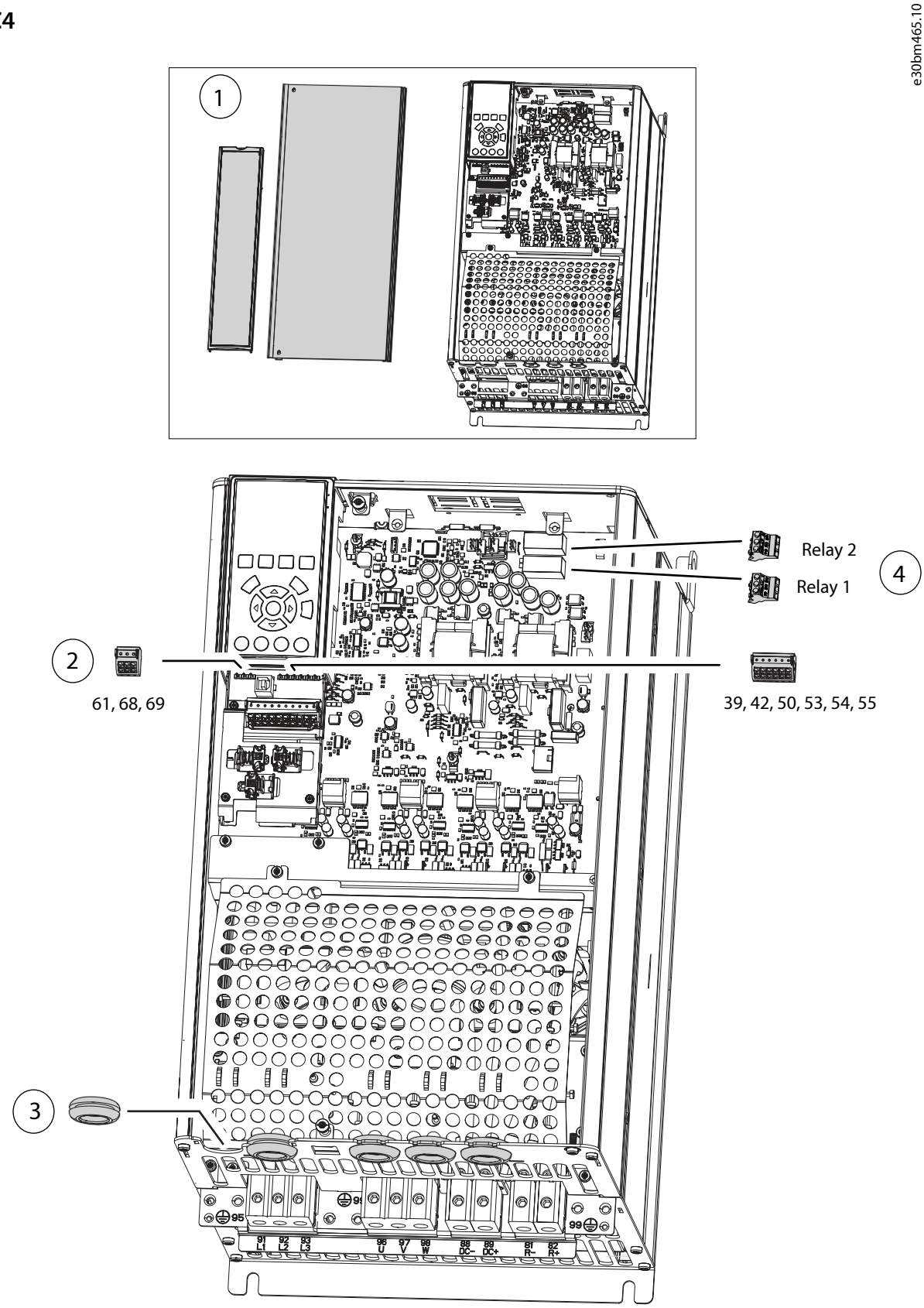
B4



C1–C2



C3–C4


e30bm465.10
1
Relay 2
Relay 1
4
2
61, 68, 69
39, 42, 50, 53, 54, 55
3
91 L1
92 L2
93 L3
96 U
97 V
98 W
88 DC-
89 DC+
81 R-
82 R+
95
99

4.10 Mounting the Drive

1. Make sure that the operating environment and electrical installation meet the following requirements.
   a. Indoor unconditioned/pollution degree 2.
   b. Overvoltage category 3.
2. Mount the drive on or against a solid, non-combustible mounting surface such as concrete or metal.

   When mounting on railings, a mounting plate is required.
3. Ensure proper cooling by providing minimum clearance above and below the drive.

   All enclosures can be installed side by side. However, if an IP21 conversion kit is used, the minimum side by side clearance is 50 mm (1.97 in).

	A	B	C	
A1	190 (7.5)	60 (2.4)	100 (3.9)	4 x M5
A2	257 (10.1)	70 (2.8)	100 (3.9)	4 x M5
A3	257 (10.1)	110 (4.3)	10 (3.9)	4 x M5
A4	398 (15.7)	171 (6.7)	10 (3.9)	4 x M5
A5	402 (15.8)	215 (8.4)	100 (3.9)	4 x M5
B1	454 (17.8)	210 (8.3)	100 (3.9)	4 x M6
B2	624 (24.6)	210 (8.3)	200 (7.9)	4 x M6

	A	B	C	
B3	380 (14.9)	140 (5.5)	200 (7.9)	4 x M5
B4	495 (19.5)	200 (7.9)	200 (7.9)	4 x M5
C1	648 (25.5)	272 (10.7)	200 (7.9)	4 x M5
C2	727 (28.6)	339 (13.3)	225 (8.9)	4 x M5
C3	521 (20.5)	270 (10.6)	200 (7.9)	4 x M5
C4	631 (24.8)	330 (13.0)	225 (8.9)	4 x M6

[mm (in)]

e30bm457.10

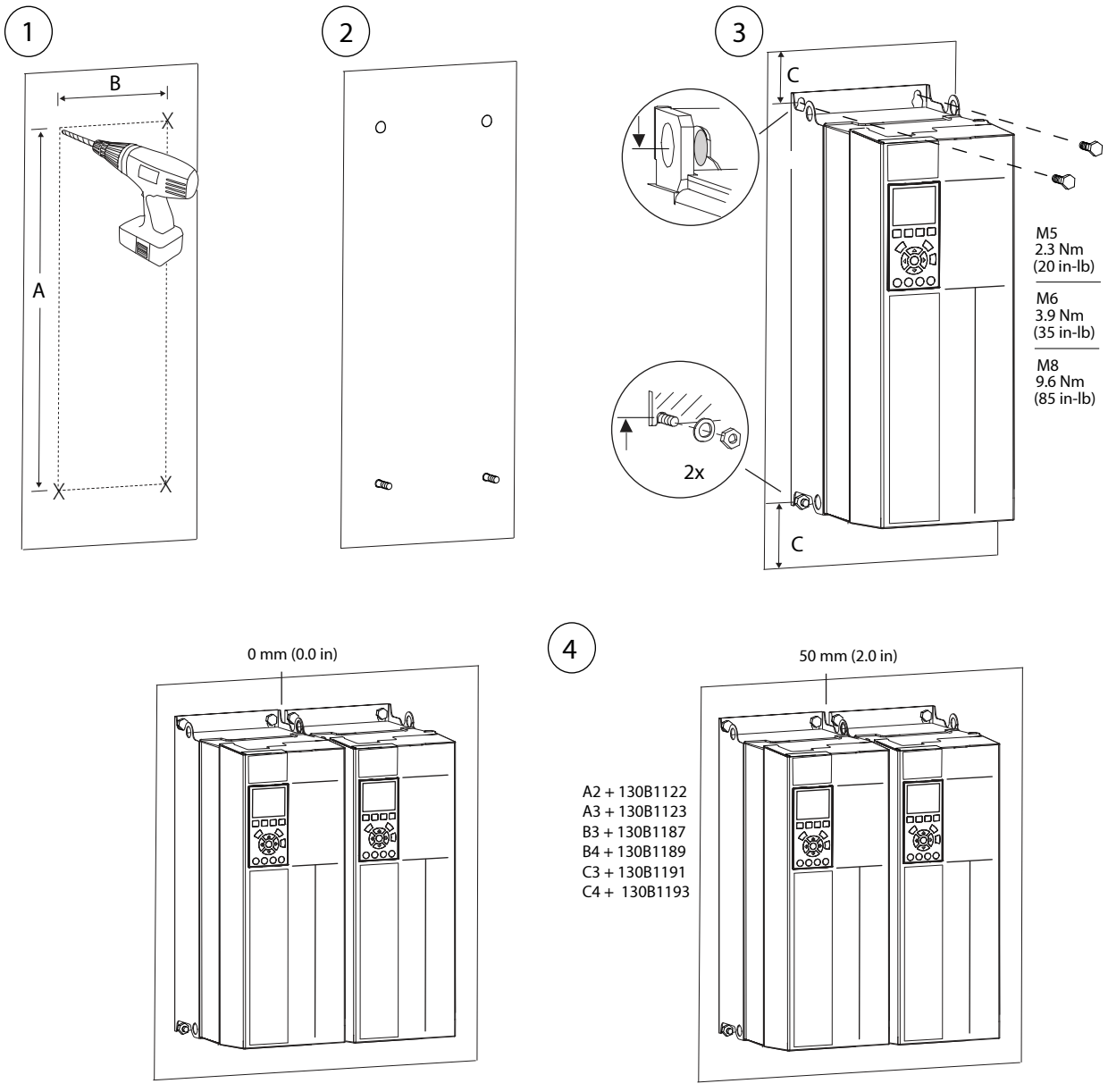
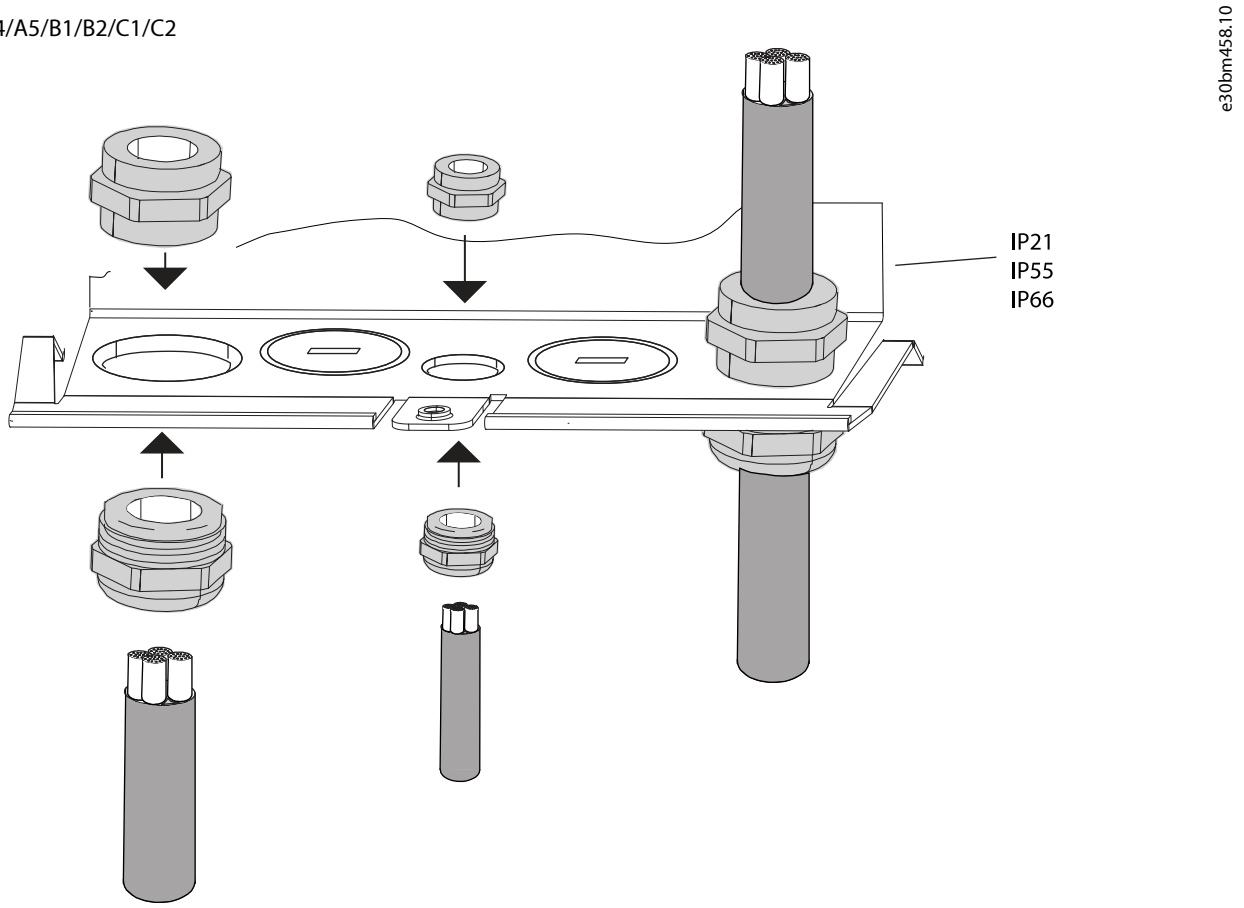


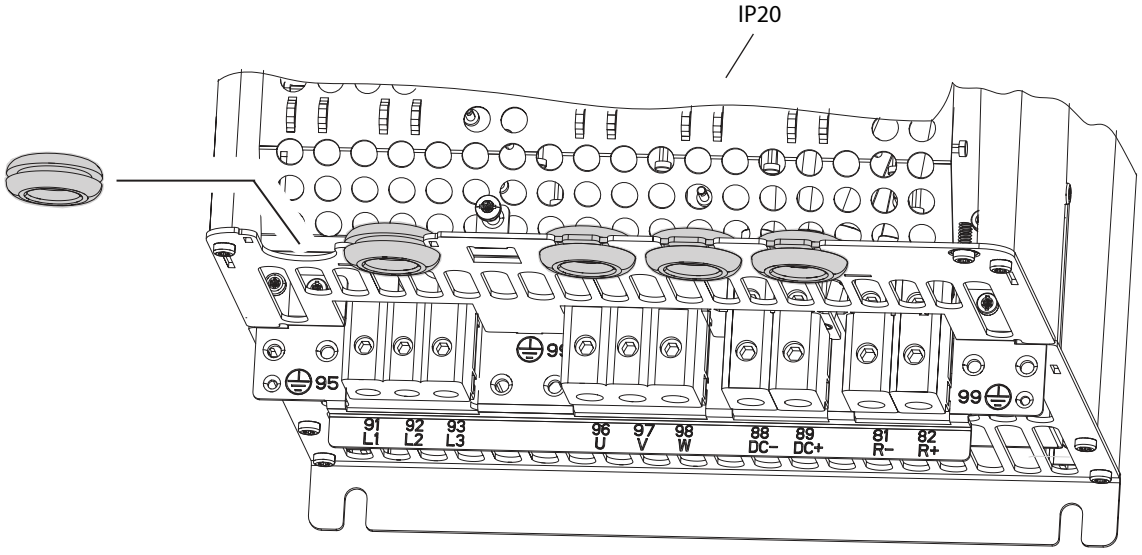
Figure 3: Wall-mount Installation

4.11 **Creating the Cable Entry Opening**

A4/A5/B1/B2/C1/C2

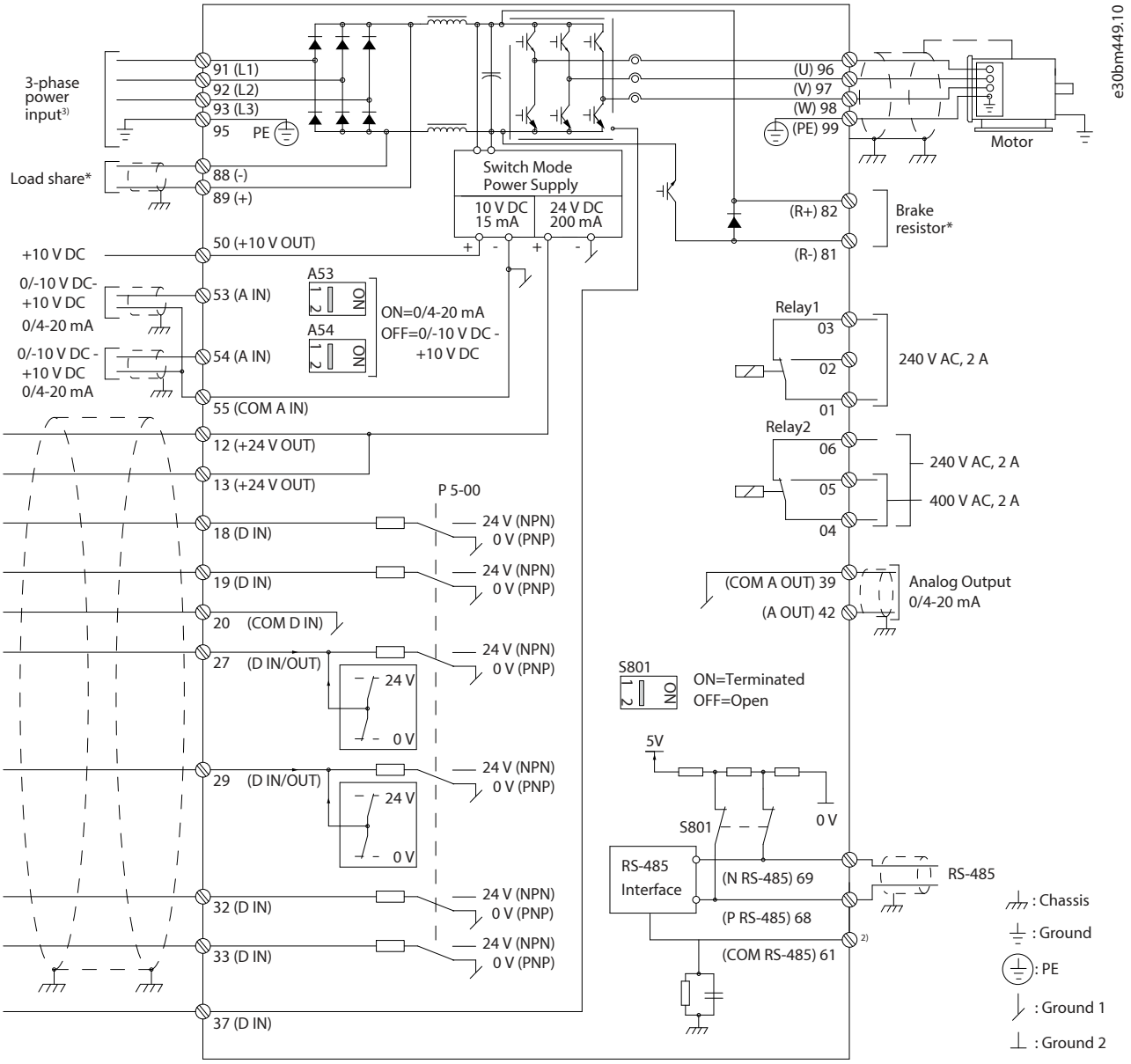


B3/B4/C3/C4



5 Electrical Installation

5.1 Wiring Diagram



*Optional.

5.2 EMC-compliant Installation

To obtain an EMC-compliant installation, refer to the wiring diagram/schematics and follow the instructions provided for:

- Connecting the motor.
- Connecting the AC mains.

- Connecting to ground.
- Control wiring.

Also, remember to practice the following:

- When using relays, control cables, a signal interface, fieldbus, or brake, connect the shield to the enclosure at both ends. If the ground path has high impedance, is noisy, or is carrying current, break the shield connection on 1 end to avoid ground current loops.
- Convey the currents back to the unit using a metal mounting plate. Ensure good electrical contact from the mounting plate through the mounting screws to the drive chassis.
- Use shielded cables for motor output cables. An alternative is unshielded motor cables within metal conduit.
- Ensure that motor and brake cables are as short as possible to reduce the interference level from the entire system.
- Avoid placing cables with a sensitive signal level alongside motor and brake cables.
- For communication and command/control lines, follow the particular communication protocol standards. For example, USB must use shielded cables, but RS485/Ethernet can use shielded UTP or unshielded UTP cables.
- Ensure that all control terminal connections are PELV.

NOTICE

TWISTED SHIELD ENDS (PIGTAILS)

Twisted shield ends increase the shield impedance at higher frequencies, which reduces the shield effect and increases the leakage current.

- Use integrated shield clamps instead of twisted shield ends.

NOTICE

SHIELDED CABLES

If shielded cables or metal conduits are not used, the unit and the installation do not meet regulatory limits on radio frequency (RF) emission levels.

NOTICE

EMC INTERFERENCE

Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance.

- Use shielded cables for motor and control wiring.
- Use separate cables for mains input, motor, and control wiring.
- Provide a minimum 200 mm (7.9 in) separation between mains input cables, motor cables, and control cables.

NOTICE

INSTALLATION AT HIGH ALTITUDE

There is a risk for overvoltage. Isolation between components and critical parts could be insufficient, and may not comply with PELV requirements.

- Use external protective devices or galvanic isolation. For installations above 2000 m (6500 ft) altitude, contact regarding PELV compliance.

NOTICE

PELV COMPLIANCE

- Prevent electric shock by using protective extra low voltage (PELV) electrical supply and complying with local and national PELV regulations.

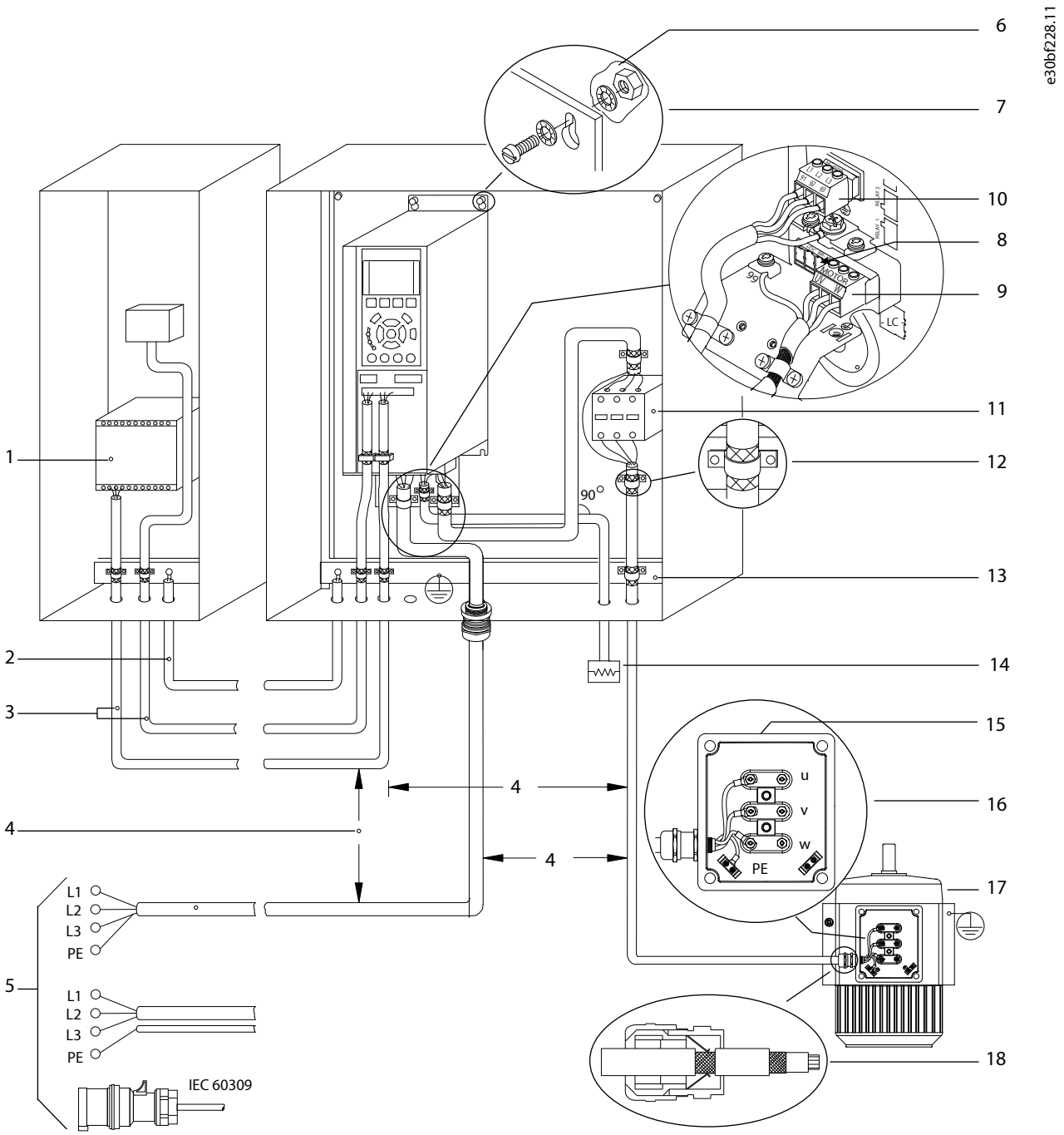


Figure 4: Example of Proper EMC Installation

1	Controller	**2**	Minimum 16 mm^2 (6 AWG) equalizing cable
3	Control cables	**4**	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables.
5	Mains supply	**6**	Bare (unpainted) surface
7	Star washers	**8**	Brake cable (shielded)
9	Motor cable (shielded)	**10**	Mains cable (unshielded)
11	Output contactor, and so on	**12**	Cable insulation stripped

13	Common ground busbar. Follow local and national requirements for cabinet grounding.	**14**	Brake resistor
15	Metal box	**16**	Connection to motor
17	Motor	**18**	EMC cable gland

5.3 Cabling Guidelines

- Before starting, make sure that none of the components of the AC drive are energized. Read thoroughly the *Safety* section.
- Make sure that the motor cables are sufficiently far from other cables.
- The motor cables must go across other cables at an angle of 90°.
- If it is possible, do not put the motor cables in long parallel lines with other cables.
- If the motor cables are parallel with other cables, follow the minimum distances.
- The distances are also valid between the motor cables and the signal cables of other systems.
- The maximum length of unshielded motor cables is 150 m (492 ft) and shielded motor cables is 300 m (984 ft).
- Only use symmetrical and shielded motor cables.

Table 7: Minimum Distances Between Cables

Distance between cables [m (ft)]	Length of shielded cable [m (ft)]
0.3 (1.0)	≤ 50 (164)
0.3 (1.0)	≤ 300 (984)

5.4 Grounding Guidelines

⚠ WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the drive properly can result in death or serious injury.

- Ensure the correct grounding of the equipment by a certified electrical installer.

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 cabling.
- Do not ground 1 drive to another in a daisy-chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (6 AWG) (or 2 rated ground wires terminated separately).
- Tighten the terminals in accordance with the information provided in the *Fastener Torque Rating* section.

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.
- Reduce burst transient by using high-strand wire.
- Do not use twisted shield ends (pigtails).

NOTICE

POTENTIAL EQUALIZATION

There is a 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).

5.5 Fuses and Circuit Breakers

5.5.1 Fuse Recommendations

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Fuses ensure that possible damage to the drive is limited to damage inside the unit. Danfoss recommends the following fuse types and/or circuit breakers on the supply side as protection.

- 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 this section 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.

To achieve the SCCR rating and the specific safety standards for which the drive has been certified, use the type code to identify the specific fuse standard to use, based on application requirements (CE, UL 61800-5-1, or UL 508C). See Figure 5.

Figure 5: Identifying the Fuse Certification Standard

5.5.2 CE Compliance

Table 8: 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		
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 9: 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 10: 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]
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)	gG-10	gG-32	PKZM0-25	25
	7.5 (10)	gG-16			

Table 10: 525–600 V, Enclosure Sizes A, B, and C - (continued)

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
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 11: 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		

Table 11: 525–690 V, Enclosure Sizes A, B, and C - (continued)

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			
	30 (40)	gG-63	gG-80		
B4/C2	37 (50)	gG-63	gG-100	–	–
C2/C3	45 (60)	gG-80	gG-125	–	–
	55 (75)	gG-100	gG-160		
C2	75 (100)	gG-125	gG-160	–	–
	90 (125)				

5.5.3 UL Compliance (61800-5-1)

Table 12: Recommended Fuse, 200–240 V and 115Y/200–139Y/240, Enclosure Sizes A, B, C1, and C2

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 13: Recommended Fuse, 380–480 V and 220Y/380–277Y/480, Enclosure Sizes A, B, C1, and C2

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 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
75 (100)	J/T	200 A	250 A
90 (125)	J/T	250 A	250 A

Table 14: Recommended Fuse, 200–240 V and 115Y/200–139Y/240, Enclosure Sizes C3, and C4

Power [kW (hp)]	Class	Recommended	Verified with	Tested enclosure (HxWxD)[1] [mm(in)]
22 (10)	T/J	125 A	150 A	800 (31.5) X 600 (23.6) X 400 (15.7)
30 (40)	T/J	150 A	150 A	800 (31.5) X 600 (23.6) X 400 (15.7)
37 (50)	T/J	200 A	250 A	1200 (47.2) X 600 (23.6) X 500 (19.7)
45 (60)	T/J	250 A	250 A	1200 (47.2) X 600 (23.6) X 500 (19.7)

1) C3 and C4 drives meet UL 61800-5-1 certification based on the drive being mounted within a larger enclosure (approximately 1.5x the drive) and being centered on the back panel of the larger enclosure. See Allowed Ventilation Openings for C3 and C4 Enclosures for dimensions and allowed vent openings and cable entry points for the tested units. To maintain UL 61800-5-1 certification and to provide the required shielding for vented enclosures, ensure that the spatial relationship between the drive and the vent openings in the larger enclosure is maintained, at a minimum. Larger enclosures can use greater distances to openings. For more information, contact Danfoss support.

Table 15: Recommended Fuse, 380–480 V and 220Y/380–277Y/480, Enclosure Sizes C3 and C4

Power [kW (hp)]	Class	Recommended	Verified with	Tested enclosure (HxWxD)[1] [mm(in)]
45 (60)	T/J	125 A	150 A	800 (31.5) X 600 (23.6) X 400 (15.7)
55 (75)	T/J	150 A	150 A	800 (31.5) X 600 (23.6) X 400 (15.7)
75 (100)	T/J	200 A	250 A	1200 (47.2) X 600 (23.6) X 500 (19.7)
90 (125)	T/J	250 A	250 A	1200 (47.2) X 600 (23.6) X 500 (19.7)

1) C3 and C4 drives meet UL 61800-5-1 certification based on the drive being mounted within a larger enclosure (approximately 1.5x the drive) and being centered on the back panel of the larger enclosure. See Allowed Ventilation Openings for C3 and C4 Enclosures for dimensions and allowed vent openings and cable entry points for the tested units. To maintain UL 61800-5-1 certification and to provide the required shielding for vented enclosures, ensure that the spatial relationship between the drive and the vent openings in the larger enclosure is maintained, at a minimum. Larger enclosures can use greater distances to openings. For more information, contact Danfoss support.

Allowed Ventilation Openings for C3 and C4 Enclosures

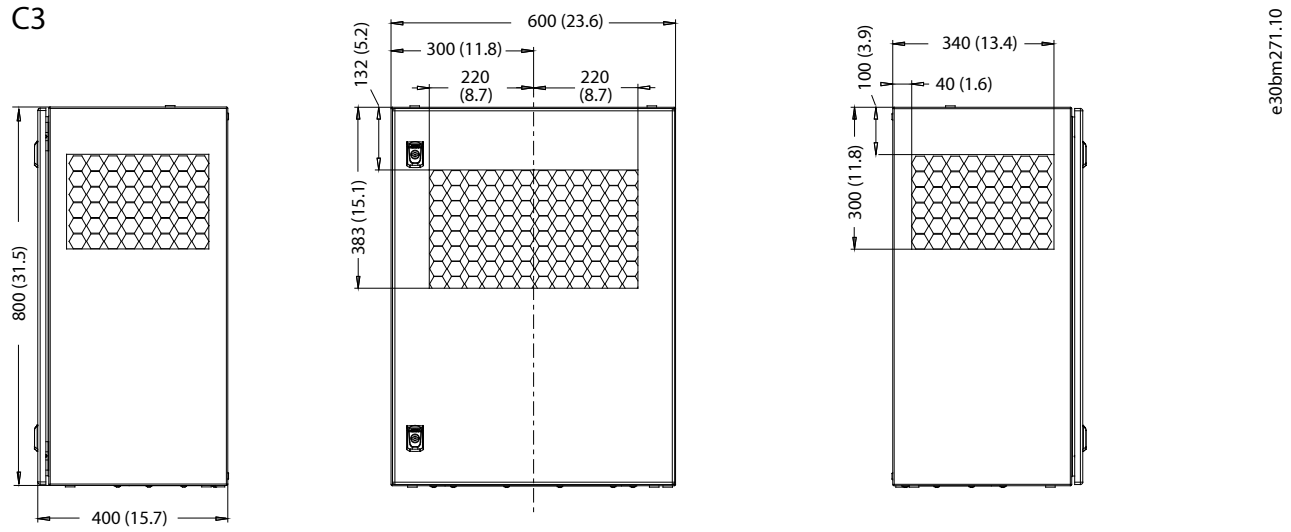


Figure 6: Allowed Ventilation Openings for C3 Enclosures as Tested for UL61800-5-1 Compliance

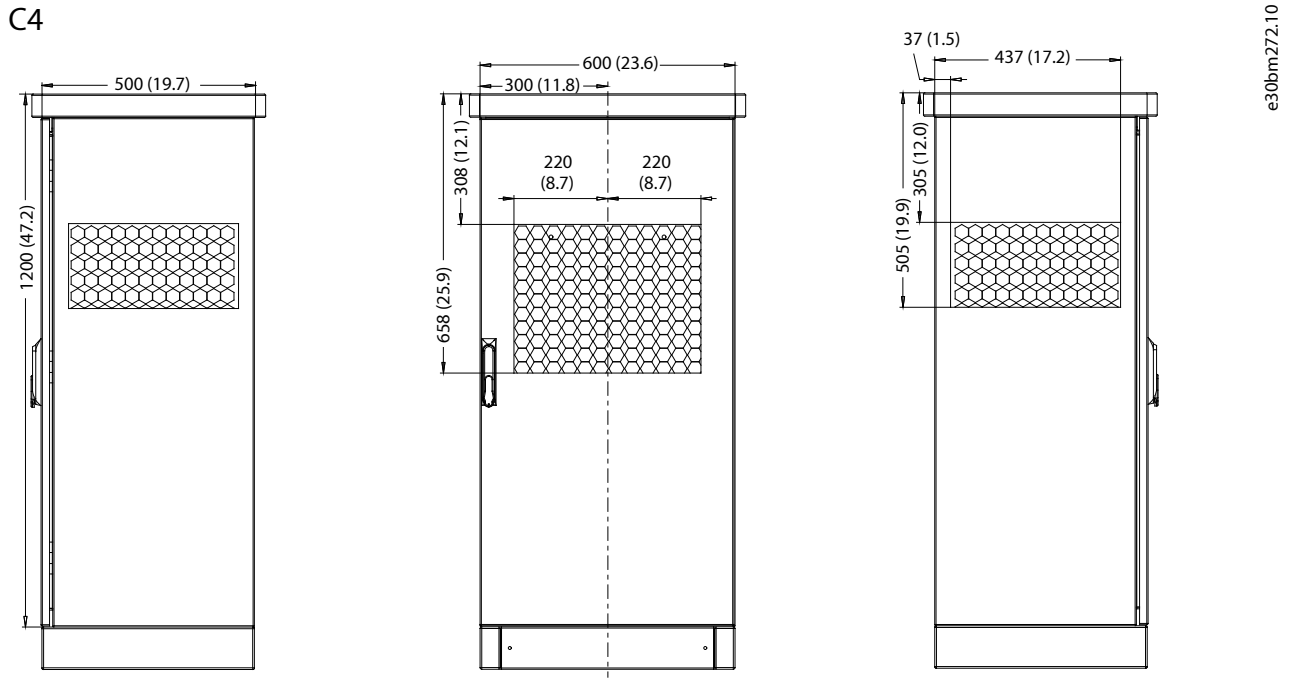


Figure 7: Allowed Ventilation Openings for C4 Enclosures as Tested for UL61800-5-1 Compliance

5.5.4 UL Compliance (508C)

Table 16: 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

Table 16: Recommended Maximum Fuse, 200–240 V, Enclosure Sizes A, B, and C - (continued)

Power [kW (hp)]	Bussmann Type RK1[1]	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
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 17: 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 18: 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	–	–	–
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 19: 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	–	–

Table 19: Recommended Maximum Fuse, 380–480 V, Enclosure Sizes A, B, and C - (continued)

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
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 20: 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	501790 6-005	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	501790 6-010	KLS-R-010	A6K-10-R	HSJ-10
3.0 (4.0)	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	501790 6-016	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	501790 6-020	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	501790 6-025	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	501790 6-030	KLS-R-030	A6K-30-R	HSJ-30
11–15 (15–20)	KTS-R-35	JKS-35	JJS-35	–	–	–	501400 6-040	KLS-R-035	A6K-35-R	HSJ-35
18.5 (25)	KTS-R-45	JKS-45	JJS-45	–	–	–	501400 6-050	KLS-R-045	A6K-45-R	HSJ-45
22 (30)	KTS-R-50	JKS-50	JJS-50	–	–	–	501400 6-050	KLS-R-050	A6K-50-R	HSJ-50
30 (40)	KTS-R-60	JKS-60	JJS-60	–	–	–	501400 6-063	KLS-R-060	A6K-60-R	HSJ-60
37 (50)	KTS-R-80	JKS-80	JJS-80	–	–	–	501400 6-080	KLS-R-075	A6K-80-R	HSJ-80
45 (60)	KTS-R-100	JKS-100	JJS-100	–	–	–	501400 6-100	KLS-R-100	A6K-100-R	HSJ-100
55 (75)	KTS-R-125	JKS-125	JJS-125	–	–	–	202822 0-125	KLS-R-125	A6K-125-R	HSJ-125

Table 20: Recommended Maximum Fuse, 525–600 V, Enclosure Sizes A, B, and C - (continued)

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
75 (100)	KTS-R-150	JKS-150	JJS-150	–	–	–	202822 0-150	KLS-R-150	A6K-150-R	HSJ-150
90 (125)	KTS-R-175	JKS-175	JJS-175	–	–	–	202822 0-200	KLS-R-175	A6K-175-R	HSJ-175

5.6 Disconnects and Contactors

The mains switch is on the left side of enclosure sizes B1, B2, C1, and C2. The mains switch on A5 enclosures is on the right side.

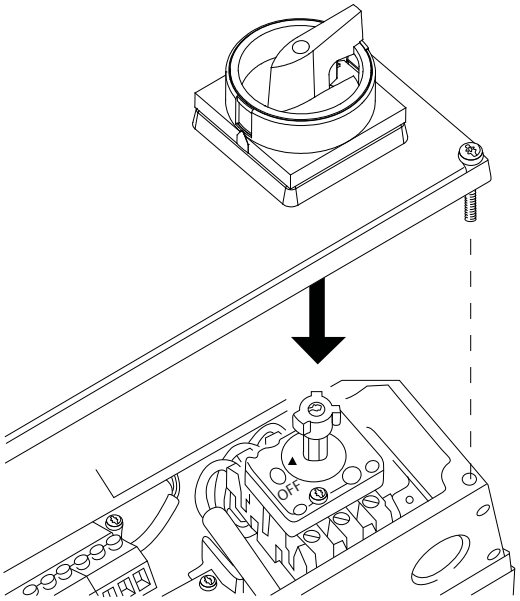


Figure 8: Location of Mains Switch (Enclosure Size A5)

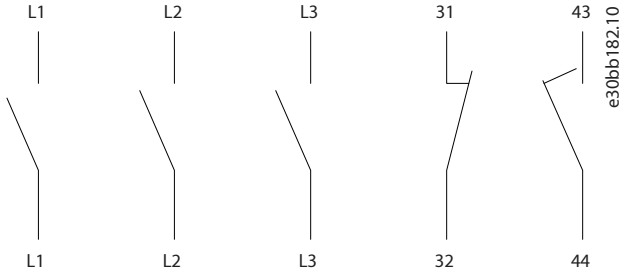


Figure 9: Terminal Connections for A5, B1, and B2

Enclosure size	Type
A5	Kraus&Naimer KG20A T303
B1/B2	Kraus&Naimer KG64 T303

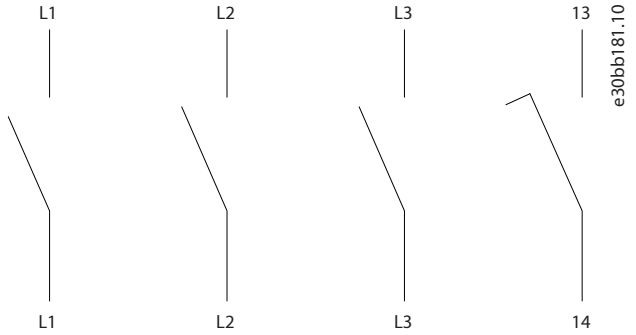


Figure 10: Terminal Connections for C1 and C2

Enclosure size	Type
C1, 37 kW (50 hp)	Kraus&Naimer KG100 T303
C1, 45–55 kW (60–75 hp)	Kraus&Naimer KG105 T303
C2, 75 kW (100 hp)	Kraus&Naimer KG160 T303
C2, 90 kW (125 hp)	Kraus&Naimer KG250 T303

5.7 Connecting the Mains and Motor Terminals

Prerequisite:

- Comply with local and national electrical codes for cable sizes. Refer to the *Cable Specifications* section.
- Size the power cabling based on the input current of the drive. The input current is listed on the drive product label.
- If using more than 1 cable per phase, make sure that the following applies:
  - All cables are the same type.
  - All cables have the same cross-section.
  - All cable lengths are within 10% of one another.
- Follow motor manufacturer wiring requirements.
- Use the cable entry plates provided with the drives to maintain proper protection ratings.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring induction motor) between the drive and the motor.

⚠ WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together or near other power cables can charge the equipment capacitors, even with the main power turned off and locked out. Failure to run the output motor cables separately, or to use shielded cables, could result in death or serious injury.

- Install output motor cables in separate conduits or use shielded cables.
- Simultaneously lock out/tag out all the drives.

NOTICE

OUTPUT CONTACTOR

- does not recommend using an output contactor on 525–690 V drives that are connected to an IT mains network.

NOTICE

IT MAINS/FLOATING DELTA/GROUNDED DELTA

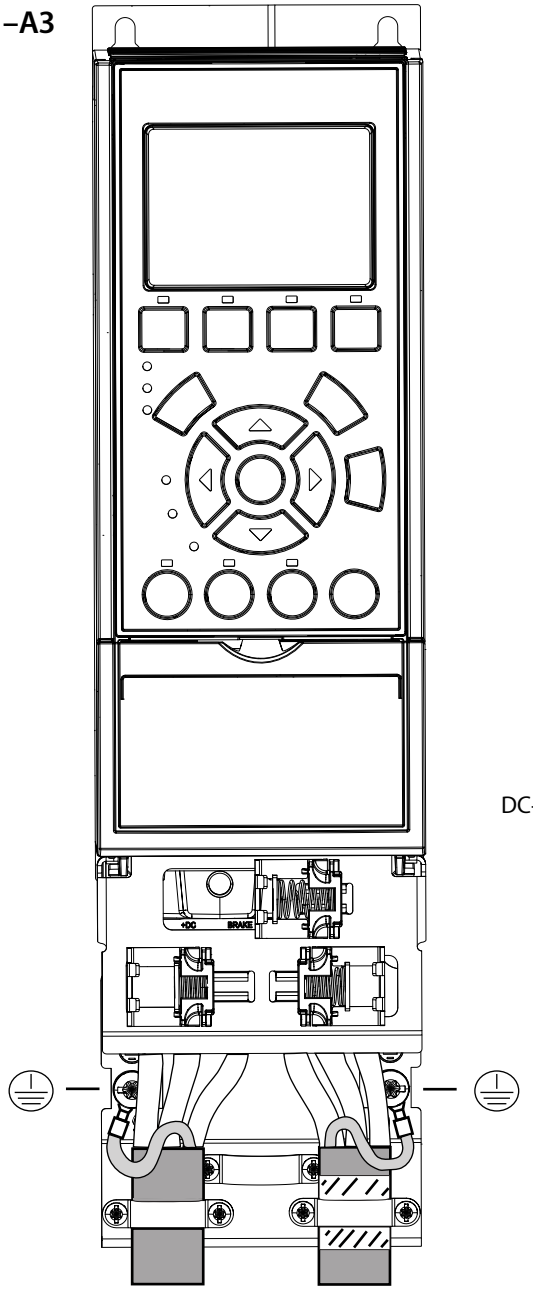
If using an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ground capacity currents can be reduced and damage can occur to the DC link if parameter ***14-50 RFI Filter*** is not turned off.

- Ensure that parameter ***14-50 RFI Filter*** is set to ***[0] Off***.

1. Strip a section of the outer cable insulation.
2. Secure the stripped end of the cable to a crimp lug or box lug.
3. Connect the ground wire to the holes in the busbar that correspond with the nearest grounding terminal. Refer to 5.4 Grounding Guidelines.
4. Secure the power connections.
   a. For motor connections, connect the 3-phase motor wiring to the holes in the busbar that correspond with terminals 96 (U), 97 (V), and 98 (W). Tighten the terminals in accordance with the specifications shown in the following illustrations.
   b. For connection of mains, connect the 3-phase AC input power wiring to the holes in the busbar that correspond with terminals 91 (R), 92 (S), and 93 (T). Tighten the terminals in accordance with the specifications shown in the following illustrations.

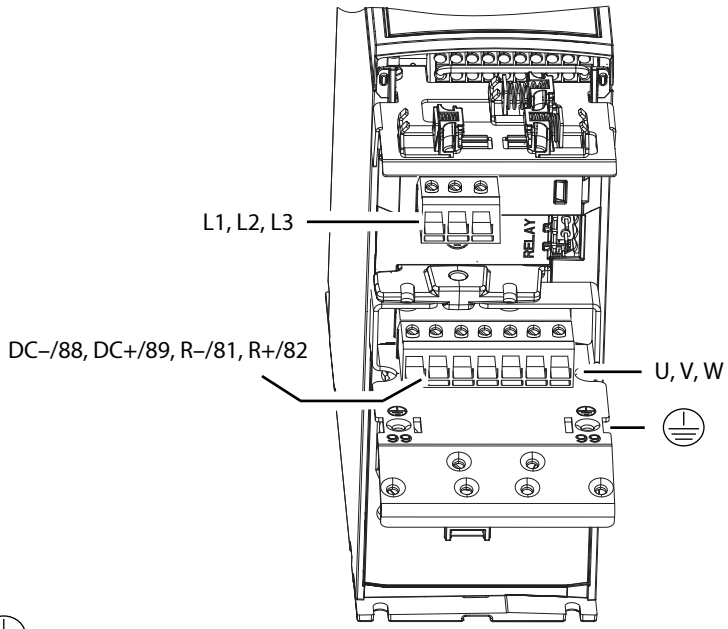
When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that parameter ***14-50 RFI Filter*** is set to ***[0] Off*** to avoid damage to the DC link and to reduce ground capacity currents.

A1–A3

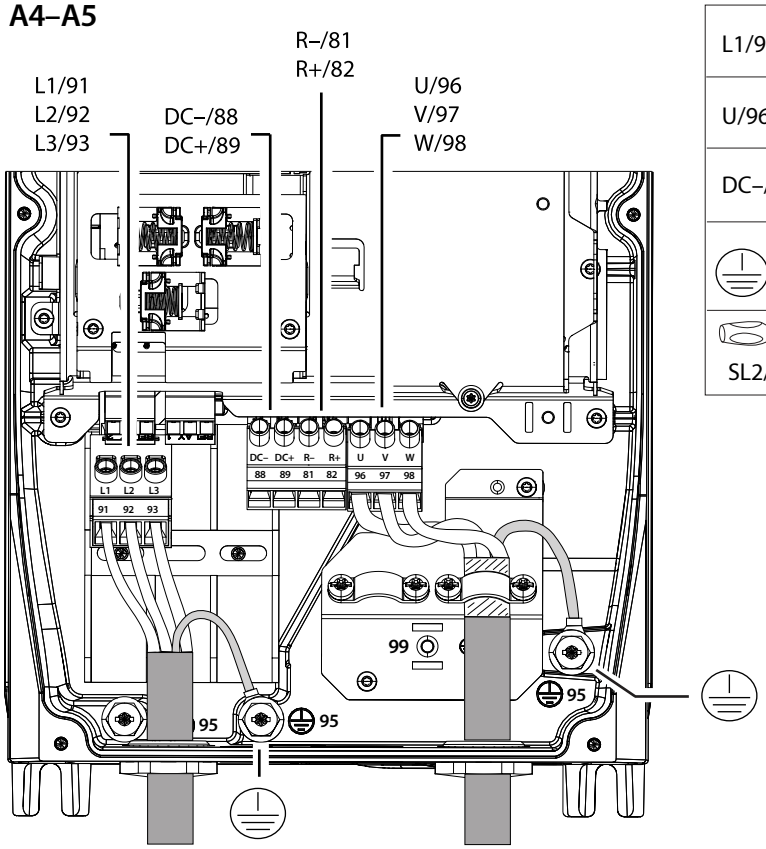


L1/91, L2/92, L3/93	1.2–1.5 Nm (11–13 in-lb)
U/96, V/97, W/98	2 Nm (17 in-lb)
DC–/88, DC+/89, R–/81, R+/82	2 Nm (17 in-lb)
	3 Nm (26 in-lb)
SL2/T20	

e30bm451.10



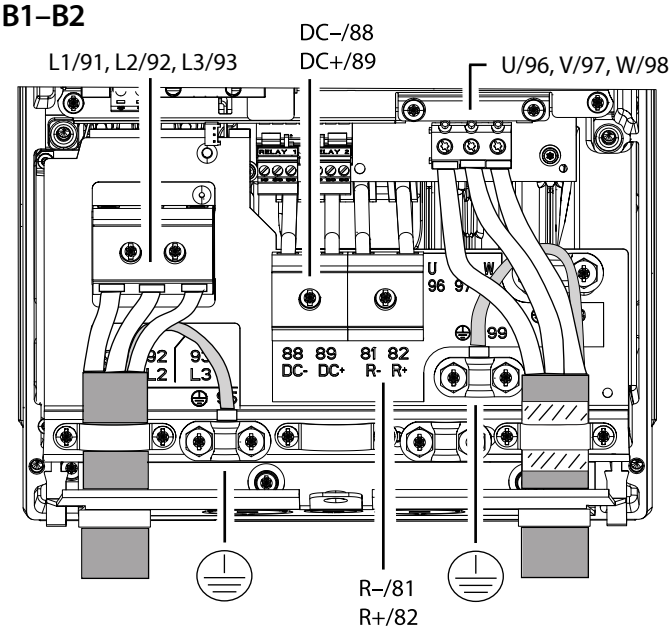
A4–A5



L1/91, L2/92, L3/93	1.2–1.5 Nm (11–13 in-lb)
U/96, V/97, W/98	2 Nm (17 in-lb)
DC–/88, DC+/89, R–/81, R+/82	2 Nm (17 in-lb)
	3 Nm (26 in-lb)
SL2/T20	

e30bm452.10

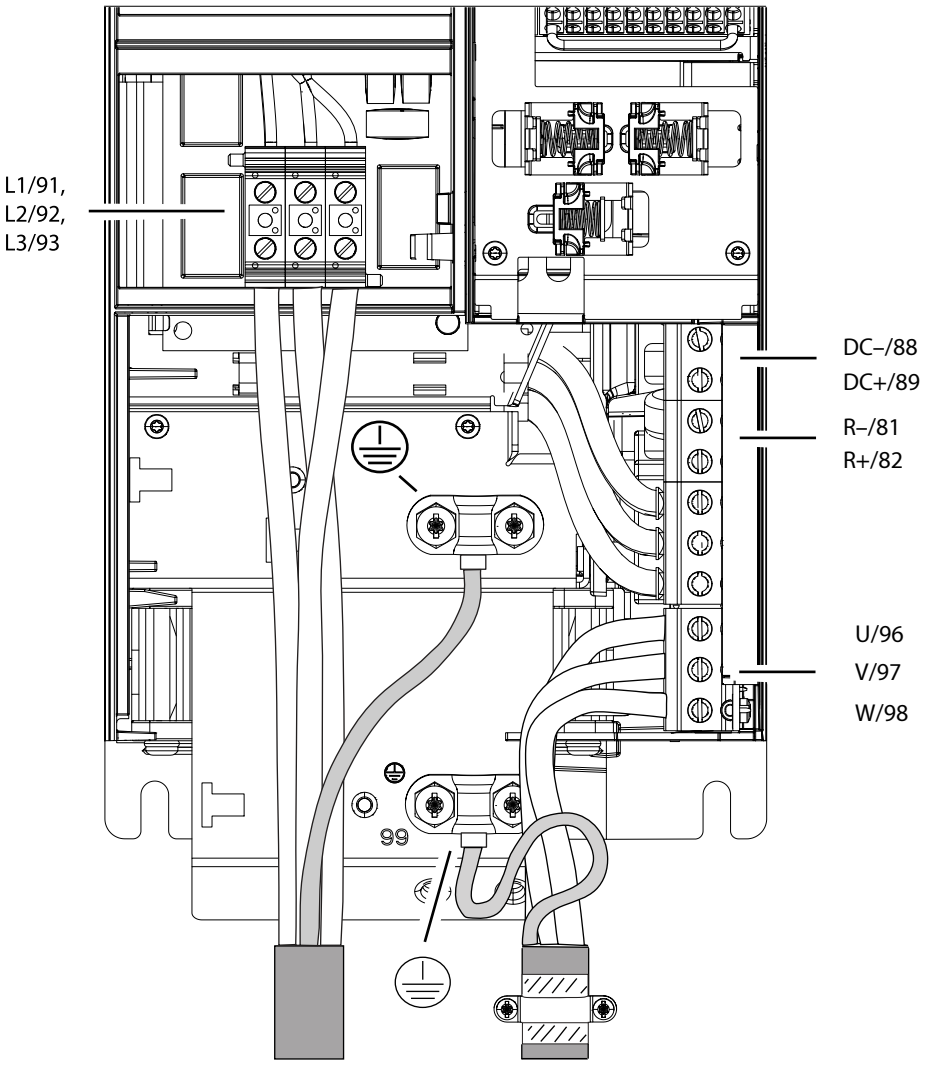
B1–B2



e30bm453.10

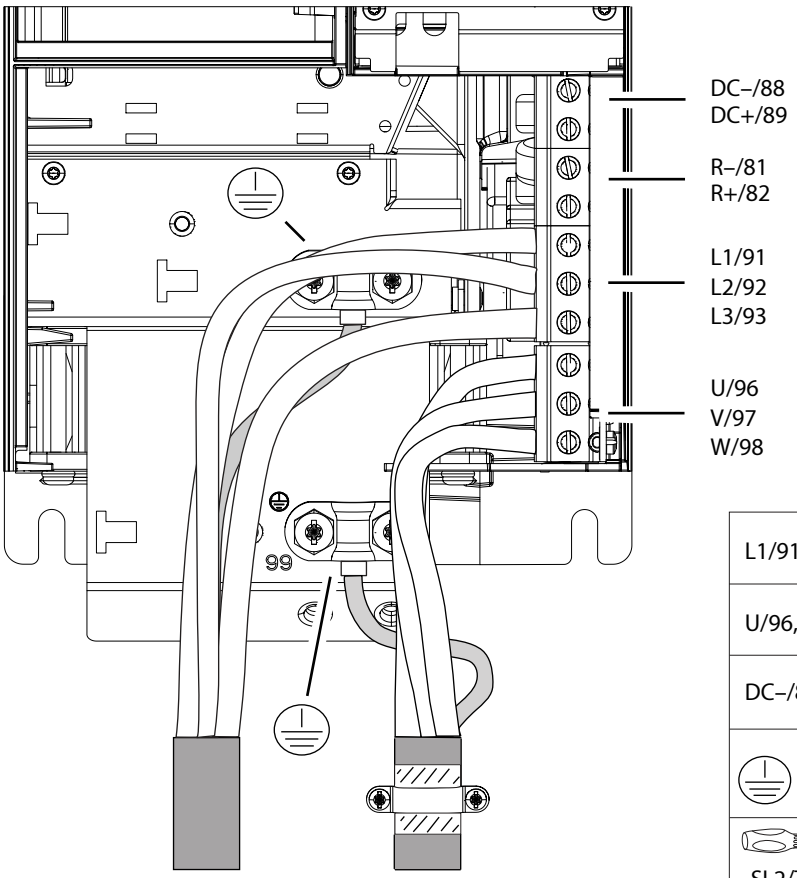
L1/91, L2/92, L3/93	1.2–1.5 Nm (11–13 in-lb)
U/96, V/97, W/98	2 Nm (17 in-lb)
DC–/88, DC+/89, R–/81, R+/82	2 Nm (17 in-lb)
	3 Nm (26 in-lb)
SL2/T20	

B3 (RFI)



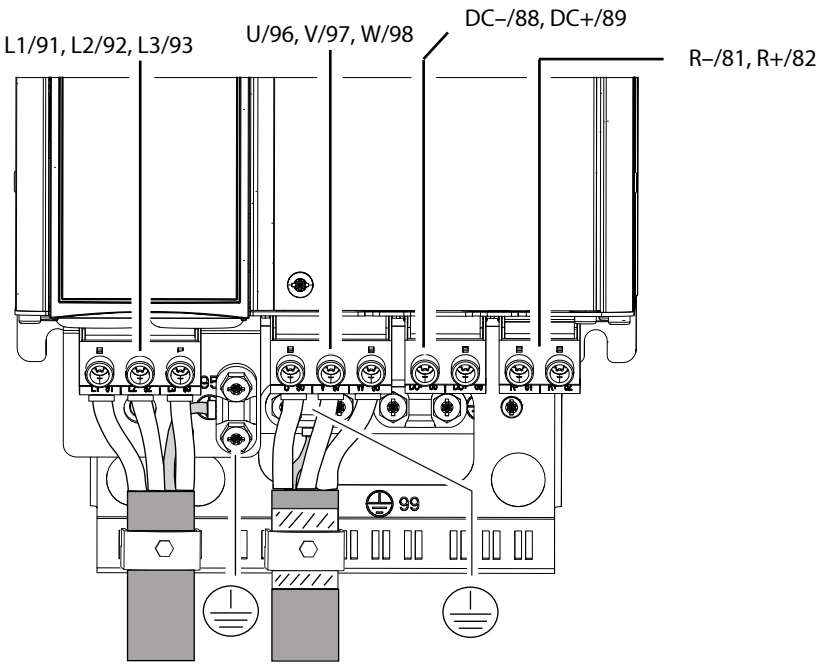
B3 (No RFI)

e30bm454.10

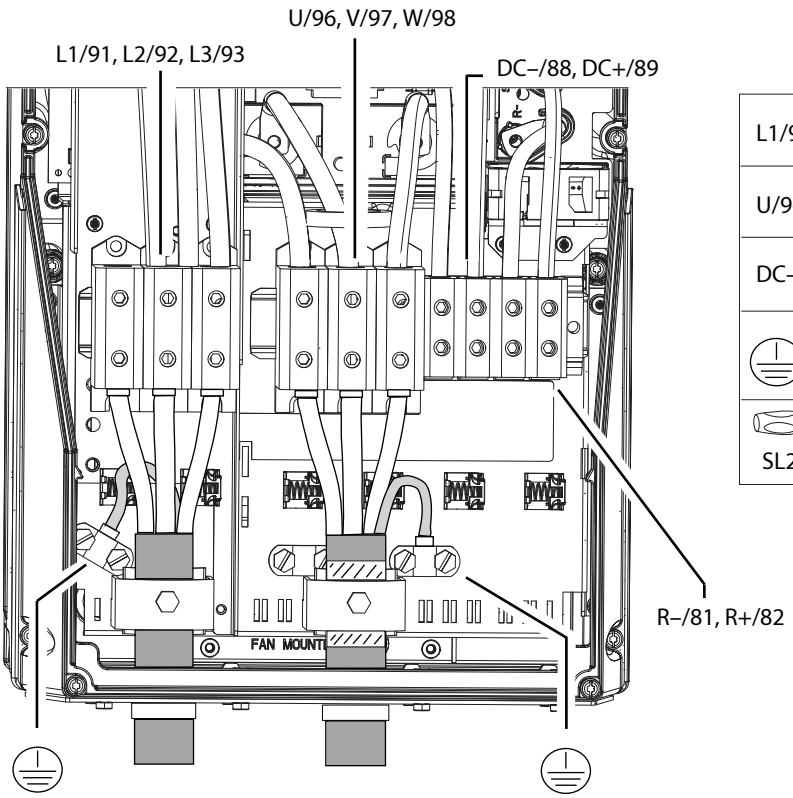


L1/91, L2/92, L3/93	1.2–1.5 Nm (11–13 in-lb)
U/96, V/97, W/98	2 Nm (17 in-lb)
DC–/88, DC+/89, R–/81, R+/82	2 Nm (17 in-lb)
	3 Nm (26 in-lb)
SL2/T20	

B4

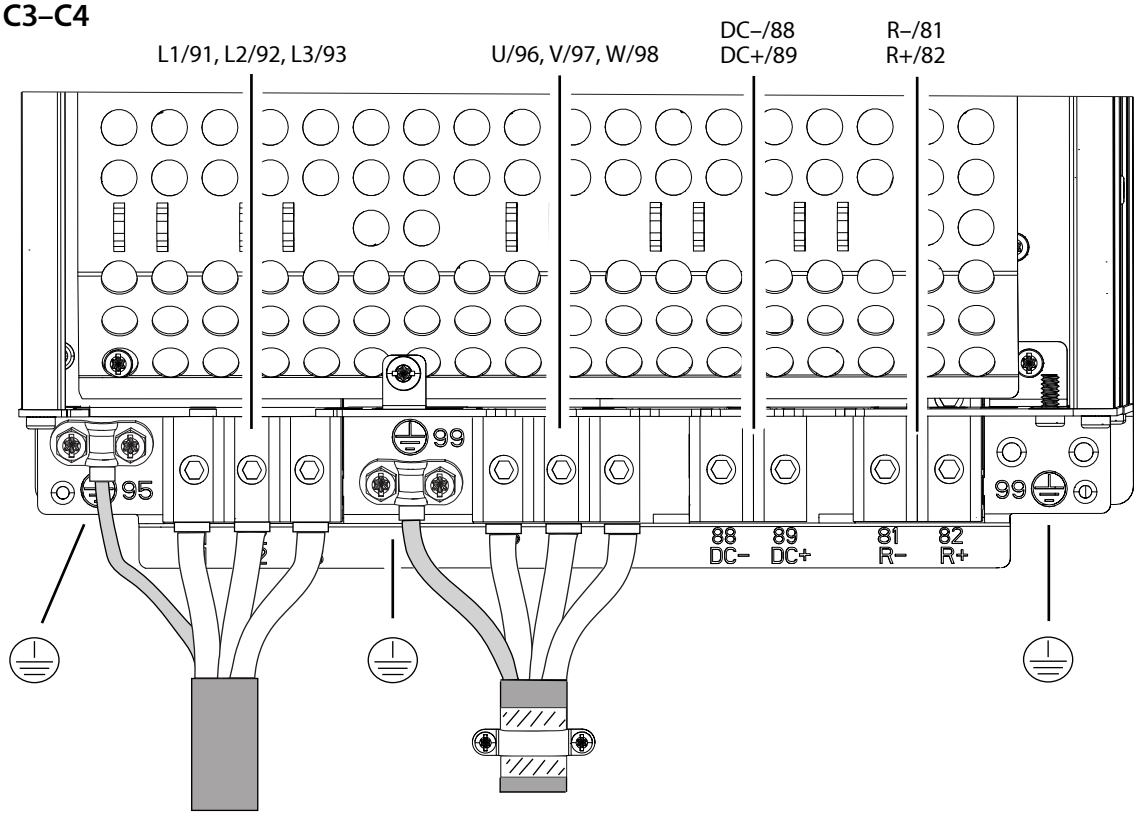


C1–C2



L1/91, L2/92, L3/93	14 Nm (124 in-lb)
U/96, V/97, W/98	14 Nm (124 in-lb)
DC–/88, DC+/89, R–/81, R+/82	14 Nm (124 in-lb)
	2 Nm (18 in-lb)
SL2/T20	

C3–C4



5.8 Grounding with a Category C1 Filter

Verify the filter category using the type code on the product label.

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.
4. Run the 3-phase motor wiring through the ferrite.
5. Connect the ground wire to the nearest grounding terminal.
6. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
7. Position the ferrite as shown in the illustration.
8. Squeeze the plastic clamps together. The teeth lock to fasten the ferrite to the wires.

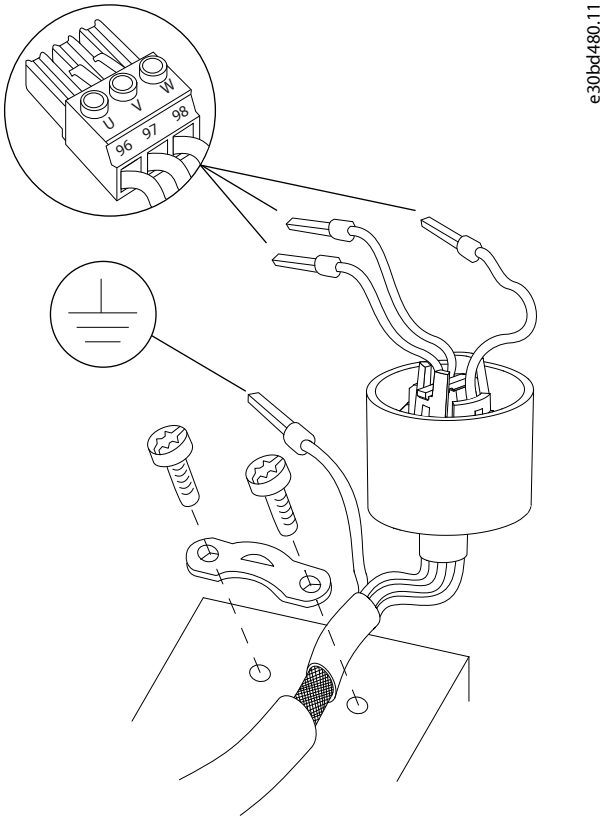


Figure 11: Installing a Category C1 Filter

6 Controls and Options Installation

6.1 Location of the Control Terminals

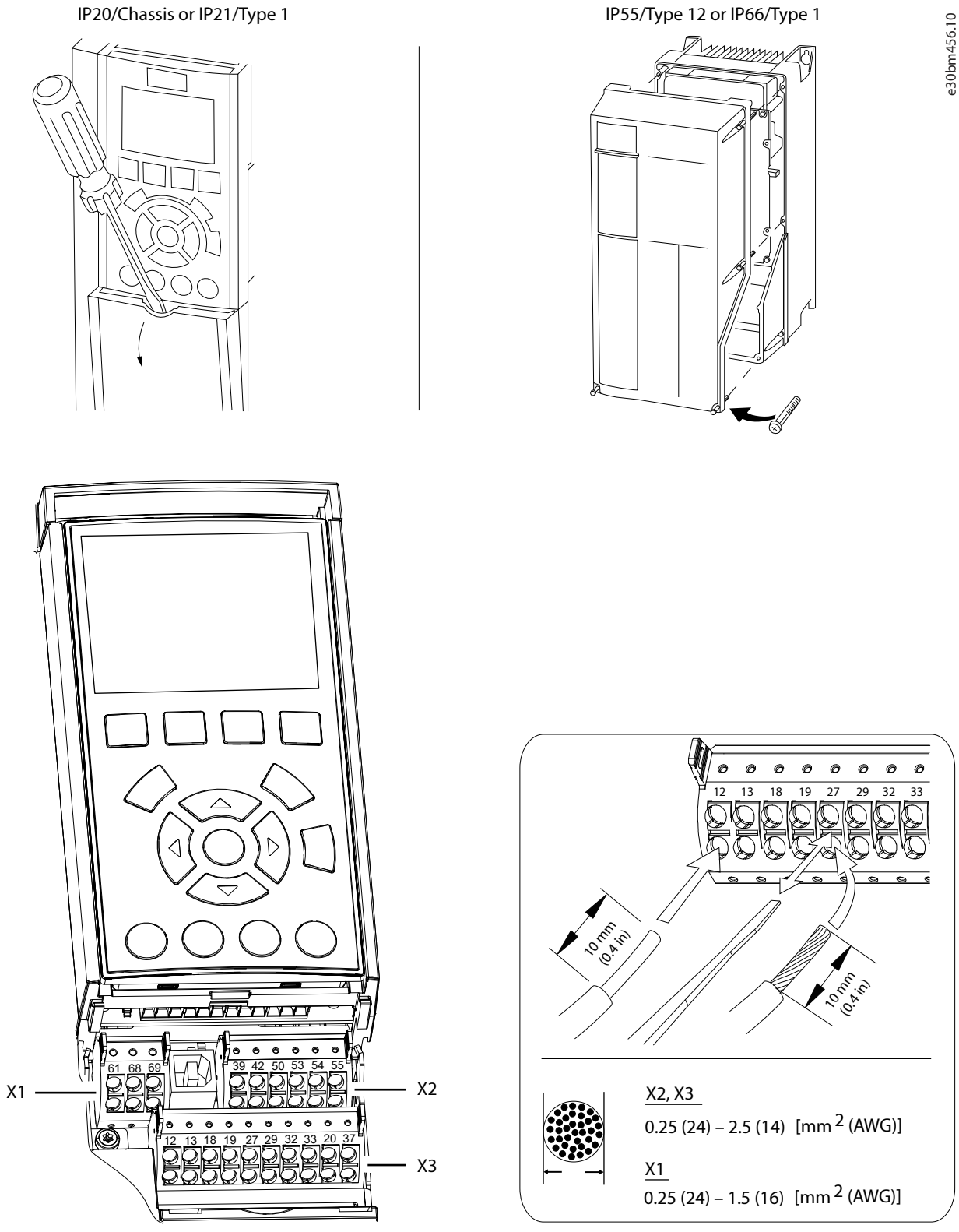


Figure 12: Accessing the Control Terminals

6.2 Routing Control Cables

1. Tie down and route all control cables down the left side of the enclosure except for the B3. For B3 drives, route the control cables to the right side of the enclosure.
2. Isolate control cables from high-power cables in the drive.
3. Connect the shields in a proper way to ensure optimum electrical immunity.
4. When the drive is connected to a thermistor, ensure that the thermistor control cable is shielded and reinforced/double insulated. A 24 V DC supply is recommended.
5. Connect the control cables to the relevant options on the control card. For more detail, see the relevant option/fieldbus instructions.
6. Tie down the fieldbus cable and route alongside the other control cables.

6.3 Control Terminals

Table 21: RS485 Serial Communication Terminals

Terminal	Parameter	Default setting	Description
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield if EMC problems exist.
68	Parameter group ***8-3* FC Port Settings***	–	RS485 interface. A switch (BUS TER.) is provided on the control card for bus termination resistance. See 6.10 Selecting the Voltage/Current Input Signal.
69	Parameter group ***8-3* FC Port Settings***	–	

Table 22: Digital Input/Output Terminal Descriptions

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	***5-10 Terminal 18 Digital Input***	***[8] Start***	Digital inputs.
19	***5-11 Terminal 19 Digital Input***	***[10] Reversing***	
32	***5-14 Terminal 32 Digital Input***	***[0] No operation***	
33	***5-15 Terminal 33 Digital Input***	***[0] No operation***	
27	***5-12 Terminal 27 Digital Input***	***[2] Coast inverse***	For digital input or output. Default setting is input.
29	***5-13 Terminal 29 Digital Input***	***[14] JOG***	

Table 22: Digital Input/Output Terminal Descriptions - (continued)

Terminal	Parameter	Default setting	Description
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	STO	(Optional feature) When not using the STO feature, a jumper wire is required between terminal 12 (or 13) and terminal 37. This setup allows the drive to operate with factory default programming values.

Table 23: Analog Input/Output Terminal Descriptions

Terminal	Parameter	Default setting	Description
39	–	–	Common for analog output.
42	***6-50 Terminal 42 Output***	***[0] No operation***	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	–	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.
53	Parameter group ***6-1* Analog Input 1***	Reference	Analog input. For voltage (V) or current (mA).
54	Parameter group ***6-2* Analog Input 2***	Feedback	
55	–	–	Common for analog input.

6.4 Relay Terminals

Relays 1 and 2 are standard relay terminals included on all drives. For relay terminal location, see 4.9 Installing the Accessory Bag Components.

Table 24: Relay 1 Terminal Descriptions

Terminal	Parameter	Default setting	Description
01: common	***5-40 Function Relay [0]***	***[0] No operation***	Form C relay output. For AC or DC voltage and resistive or inductive loads.
02: normally open			
03: normally closed			

Table 25: Relay 2 Terminal Descriptions

Terminal	Parameter	Default setting	Description
04: common	***5-40 Function Relay [1]***	***[0] No operation***	Form C relay output. For AC or DC voltage and resistive or inductive loads.
05: normally open			
06: normally closed			

6.5 Connecting the Control Cable to the Control Terminals

The control terminals are located near the LCP, as shown in 6.1 Location of the Control Terminals. The control terminal connectors can be unplugged from the drive for convenience when wiring. Either solid or flexible wire can be connected to the control terminals. For minimum and maximum control cable cross-section, refer to the *Cable Specifications* section.

NOTICE

ELECTRICAL INTERFERENCE

Minimize interference by keeping control wires as short as possible and separate from high-power cables.

1. Strip 10 mm (0.4 in) of the outer plastic layer from the end of the wire.
2. Insert the control wire into the terminal.
   - For a solid wire, push the bare wire into the contact.
   - For a flexible wire, open the contact by inserting a small screwdriver into the slot between the terminal holes and push the screwdriver inward. Then insert the stripped wire into the contact, and remove the screwdriver.
3. Pull gently on the wire to ensure that the contact is firmly established.

   Loose control cable can cause equipment faults or reduced performance.

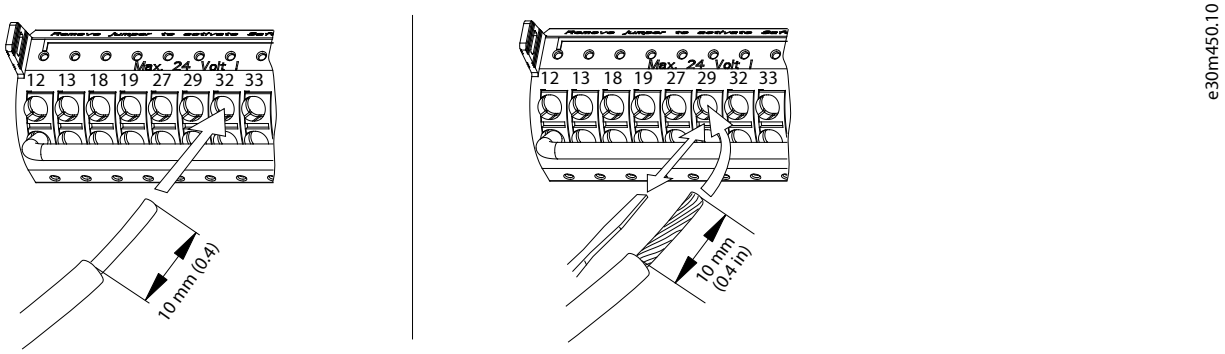


Figure 13: Connecting a Solid Control Cable (left) and a Flexible Control Cable (right) to a Terminal Block

6.6 Disconnecting the Control Cable from the Control Terminals

1. To open the contact, insert a small screwdriver into the slot between the terminal holes and push the screwdriver inward.
2. Pull gently on the wire to free it from the control terminal contact.

6.7 Enabling Motor Operation

If the status line at the bottom of the LCP reads ***AUTO REMOTE COAST***, the unit is ready to operate, but is missing an input signal on terminal 27. Digital input terminal 27 is designed to receive a 24 V DC external interlock command that allows the drive to operate when using factory default programming values.

NOTICE

FACTORY-INSTALLED OPTIONAL EQUIPMENT

Do not remove factory-installed wiring to terminal 27. If the drive does not run, refer to the documentation for the optional equipment that is wired into terminal 27.

1. When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27.

   This wire provides an internal 24 V signal on terminal 27. The drive is ready for operation.

6.8 RS485 Serial Communication

6.8.1 RS485 Features

RS485 is a 2-wire bus interface compatible with multi-drop network topology. This interface contains the following features:

- Ability to select from the following communication protocols:
  - FC, FC MC, FC option
  - Modbus RTU
  - Metasys N2
  - FLN
  - BACnet
- Functions can be programmed remotely using the protocol software and RS485 connection or in parameter group ***8-** Communications and Options***.
- Selecting a specific communication protocol changes various default parameter settings to match the specifications of the protocol, making more protocol-specific parameters available.
- Option cards for the drive are available to provide more communication protocols. See the option card documentation for installation and operation instructions.
- A switch (BUS TER) is provided on the control card for bus termination resistance.

6.8.2 Configuring RS485 Serial Communication

1. Connect RS485 serial communication wiring to terminals (+) 68 and (-) 69.
   a. Use shielded serial communication cable (recommended).
   b. See 5.4 Grounding Guidelines for proper grounding.
2. Select the following parameter settings:
   a. Protocol type in parameter ***8-30 Protocol***.
   b. Drive address in parameter ***8-31 Address***.
   c. Baud rate in parameter ***8-32 Baud Rate***.

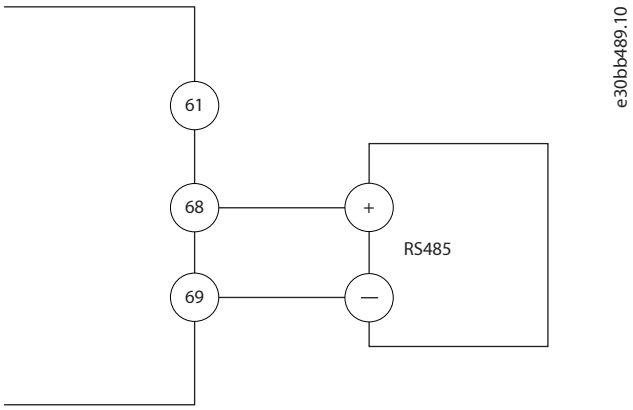


Figure 14: Serial Communication Wiring Diagram

6.9 Safe Torque Off (STO) Wiring

The Safe Torque Off (STO) function is a component in a safety control system. STO is an optional feature that, if needed, should be selected when ordering the drive. This feature prevents the unit from generating the voltage required to rotate the motor. To run the STO function, more wiring for the drive is required. Refer to the *Safe Torque Off Operating Guide*.

6.10 Selecting the Voltage/Current Input Signal

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

- Parameter ***16-61 Terminal 53 Switch Setting*** shows the setting for A53.
- Parameter ***16-63 Terminal 54 Switch Setting*** shows the setting for A54.

1. Disconnect power to the drive.
2. Remove the LCP (local control panel) by grasping the panel and gently pulling it forward.
3. Remove any optional equipment covering the switches.
4. Set switches A53 and A54 to select the signal type (U = voltage, I = current). See Figure 15.

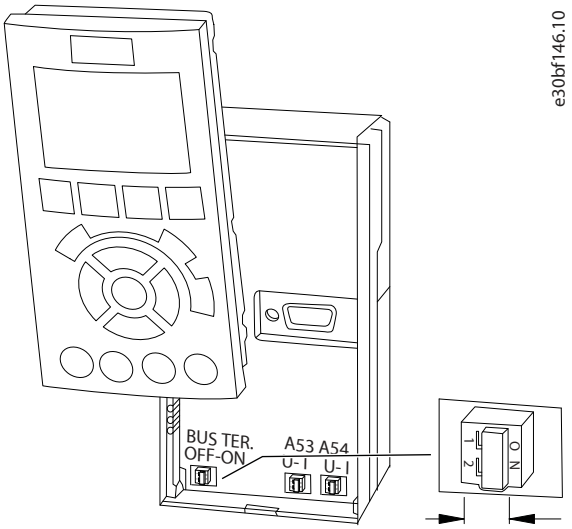


Figure 15: Location of Switches A53 and A54

7 Operating the Drive

7.1 Pre-start Check List

Table 26: Pre-start Check List

Inspect	✓	Check for
Motor		Confirm continuity of the motor by measuring ohm values on U–V (96–97), V–W (97–98), and W–U (98–96).
		Confirm that the supply voltage matches the voltage of the drive and the motor.
Switches		Ensure that all switch and disconnect settings are in the proper positions.
Auxiliary equipment		Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that reside 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 installed between the drive and the motor.
		Adjust any power factor correction capacitors on the mains side and ensure that they are dampened.
Cable routing		Check that all cable glands are firmly tightened.
		Ensure that motor wiring, brake wiring (if equipped), and control wiring are separated or shielded, or in 3 separate metallic conduits for high-frequency interference isolation.
Control cables		Check for broken or damaged wires and loose connections.
		Check that control wiring is isolated from high-power wiring for noise immunity.
		Check the voltage source of the signals, if necessary.
		Use a shielded cable or twisted pair and ensure that the shield is terminated correctly.
Input/output cables		Check for loose connections.
		Check that motor and mains are in separate conduit or separated shielded cables.
Grounding		Check for good ground connections that are tight and free of oxidation.
		Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.
Fuses 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 (if used) are in the open position.
Cooling		Look for any obstructions in the airflow path.
		Measure top and bottom clearance of the drive to verify adequate airflow for cooling, see the *Cooling Requirements* section.
Ambient conditions		Check that requirements for ambient conditions are met. See the *Ambient Conditions* section.
Interior of the drive		Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion.
		Verify that all installation tools have been removed from unit interior.
		For IP20/Type 1 enclosures, ensure that the unit is mounted on an unpainted, metal surface.

Table 26: Pre-start Check List - (continued)

Inspect	✓	Check for
Vibration		Check that the unit is mounted solidly, or that shock mounts are used, if necessary.
		Check for an unusual amount of vibration.

7.2 Applying Power to the Drive

Before applying power to the drive, verify that the drive and any associated equipment is ready for operation. Refer to 7.1 Pre-start Check List. For detailed commissioning and programming information, refer to the programming guide.

⚠ WARNING

UNINTENDED START

When the drive is connected to AC mains, DC supply, or load sharing, the motor may start at any time. 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. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage.

- Disconnect the drive from the mains.
- Press *[Off/Reset]* on the LCP before programming parameters.
- Ensure that the drive is fully wired and assembled when it is connected to AC mains, DC supply, or load sharing.

IMPORTANT: 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 6.7 Enabling Motor Operation for details.

1. Confirm that the input voltage is balanced within 3%. If not balanced, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation requirements.
3. Ensure that all operator devices are in the OFF position.
4. Close and securely fasten all covers and doors on the drive.
5. Apply power to the unit, but do not start the drive. For units with a disconnect switch, turn the switch to the ON position to apply power to the drive.
6. Power up the LCP.
7. Follow the prompts on the LCP to perform the initial setup. For more information on the LCP functions or the initial setup, refer to the programming guide.

7.3 Local Control Panel

7.3.1 Overview

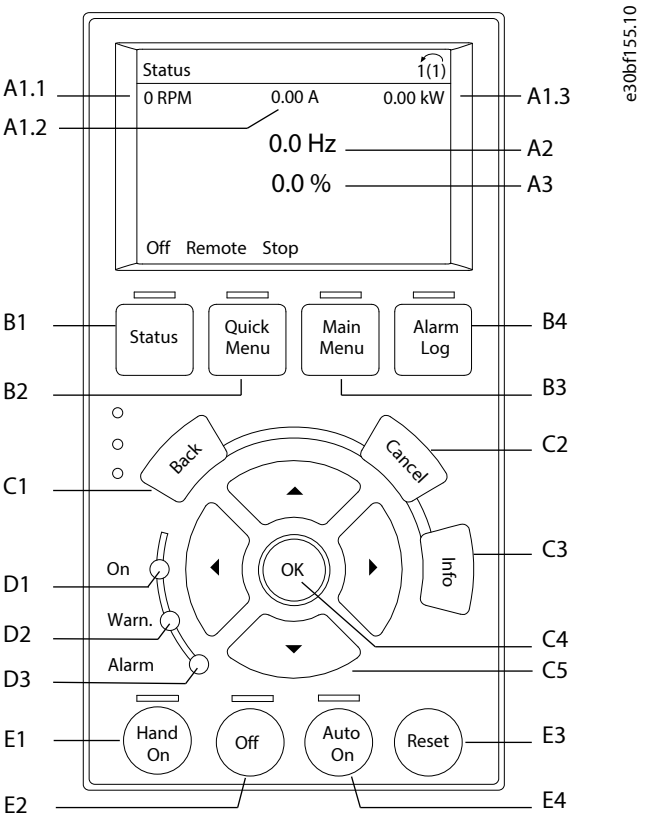


Figure 16: Graphical Local Control Panel (LCP)

The local control panel (LCP) is the combined display and keypad on the front of the drive. The LCP is used to:

- Control the drive and motor.
- Access drive parameters and program the drive.
- Show operational data, drive status, and warnings.

A numeric local control panel (NLCP) is available as an option. The NLCP operates in a manner similar to the LCP, but there are differences. For details on how to use the NLCP, see the product-specific programming guide.

A. Display area

Each display readout has a parameter associated with it. The information shown on the LCP can be customized for specific applications. Refer to *My Personal Menu* in the *LCP Menu* section.

Table 27: LCP Display Area

Callout	Parameter	Default setting
A1.1	Parameter ***0-20 Display Line 1.1 Small***	Reference Speed [%]
A1.2	Parameter ***0-21 Display Line 1.2 Small***	Motor current [A]
A1.3	Parameter ***0-22 Display Line 1.3 Small***	Power [kW]
A2	Parameter ***0-23 Display Line 2 Large***	Frequency [Hz]
A3	Parameter ***0-24 Display Line 3 Large***	kWh counter

B. Menu keys

Menu keys are used to access the menu for setting up parameters, toggling through status display modes during normal operation, and viewing fault log data.

Table 28: LCP Menu Keys

Callout	Key	Function
B1	*[Status]*	Shows operational information.
B2	*[Quick Menu]*	Allows access to parameters for initial setup instructions, and also provides detailed application steps. Refer to *Quick Menu mode* in the *LCP Menu* section.
B3	*[Main Menu]*	Allows access to all parameters. Refer to *Main Menu mode* in the *LCP Menu* section.
B4	*[Alarm Log]*	Shows a list of current warnings and the last 10 alarms.

C. Navigation keys

Navigation keys are used for programming functions and moving the display cursor. These keys also provide speed control in local (hand) operation. The display brightness can be adjusted by pressing the *[Status]* and [▲]/[▼] keys.

Table 29: LCP Navigation Keys

Callout	Key	Function
C1	*[Back]*	Reverts to the previous step or list in the menu structure.
C2	*[Cancel]*	Cancels the last change or command as long as the display mode has not changed.
C3	*[Info]*	Shows a definition of the function being shown.
C4	*[OK]*	Accesses parameter groups or enables an option.
C5	[▲][▼] [◄] [►]	Moves between items in the menu.

D. Indicator lights

Indicator lights identify the drive status and provide a visual notification of warning or fault conditions.

Table 30: LCP Indicator Lights

Callout	Indicator	Color	Function
D1	On	Green	Activates when the drive receives power from the mains voltage or a 24 V external supply.
D2	Warn.	Yellow	Activates when warning conditions are active. Text appears in the display area identifying the problem.
D3	Alarm	Red	Activates during a fault condition. Text appears in the display area identifying the problem.

E. Operation keys and reset

The operation buttons are found toward the bottom of the local control panel.

Table 31: LCP Operation Keys and Reset

Callout	Key	Function
E1	*[Hand On]*	Starts the drive in local control. An external stop signal by control input or serial communication overrides the local *[Hand On]*.
E2	*[Off]*	Stops the motor but does not remove power to the drive.
E3	*[Reset]*	Resets the drive manually after a fault has been cleared.
E4	*[Auto On]*	Puts the system in remote operational mode so it can respond to an external start command by control terminals or serial communication.

7.3.2 LCP Menu

Quick Menus

The *Quick Menus* mode provides a list of menus used to configure and operate the drive. Select the *Quick Menus* mode by pressing the *[Quick Menus]* key. The resulting readout appears on the LCP display.

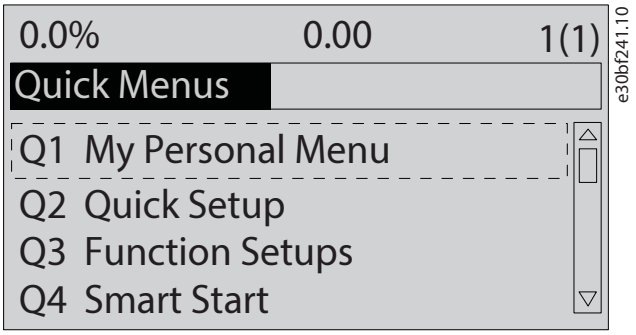


Figure 17: Quick Menu View

Q1 My Personal Menu

Q1 My Personal Menu is used to determine what is shown in the display area. Refer to 7.3.1 Overview. This menu can also show up to 50 pre-programmed parameters. These 50 parameters are manually entered using parameter ***0-25 My Personal Menu***.

Q2 Quick Setup

The parameters found in the *Q2 Quick Setup* contain basic system and motor data that are always necessary for configuring the drive. See 7.4 Entering System Information for the setup procedures.

Q3 Function Setups

The parameters found in the *Q3 Function Setups* contain data for fan, compressor, and pump functions. This menu also includes parameters for LCP display, digital preset speeds, scaling of analog references, closed-loop single zone, and multi-zone applications.

Q4 Smart Start

Q4 Smart Start guides the user through typical parameter settings used to configure 1 of the following 3 applications:

- Mechanical brake.
- Conveyor.
- Pump/fan.

The *[Info]* key can be used to see help information for various selections, settings, and messages.

Q5 Changes Made

Select *Q5 Changes Mode* for information about:

- The 10 most recent changes.
- Changes made from the default setting.

Q6 Loggings

Use *Q6 Loggings* for fault finding. To get information about the display line readout, select Loggings. The information is shown as graphs. Only parameters selected in parameter ***0-20 Display Line 1.1 Small*** through parameter ***0-24 Display Line 3 Large*** can be viewed. It is possible to store up to 120 samples in the memory for later reference.

Table 32: Logging Parameter Examples

Q6 Loggings	
Parameter ***0-20 Display Line 1.1 Small***	Reference [%]
Parameter ***0-21 Display Line 1.2 Small***	Motor Current [A]
Parameter ***0-22 Display Line 1.3 Small***	Power [kW]
Parameter ***0-23 Display Line 2 Large***	Frequency
Parameter ***0-24 Display Line 3 Large***	kWh Counter

Main Menu

The *Main Menu* mode is used to:

- List the parameter groups available to the drive and drive options.
- Change parameter values.

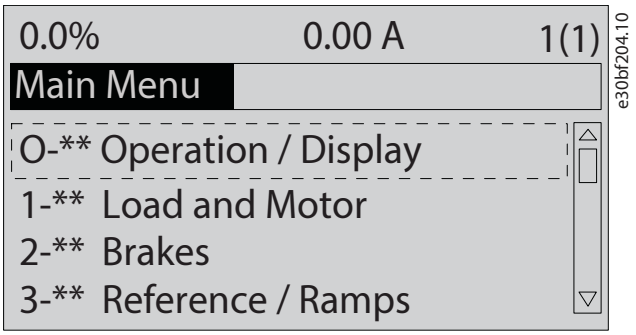


Figure 18: Main Menu View

7.4 Entering System Information

The following steps are used to enter basic system information into the drive. Recommended parameter settings are intended for start-up and checkout purposes. Application settings vary.

Although these steps assume that an induction motor is used, a permanent magnet motor can also be used. For more information on specific motor types, see the product-specific programming guide.

NOTE:

For commissioning via a PC, install the VLT® Motion Control Tool MCT 10 setup software. A basic version, which is sufficient for most applications, is available for download.

1. Press [Main Menu] on the LCP.
2. Select ***0–** Operation/Display*** and press *[OK]*.
3. Select ***0–0* Basic Settings***and press *[OK]*.
4. Select parameter ***0-03 Regional Settings*** and press *[OK]*.
5. Select ***[0] International***or ***[1] North America*** as appropriate and press *[OK]*. (This action changes the default settings for some basic parameters).
6. Press *[Quick Menus]* on the LCP and then select ***02 Quick Setup***.
7. If needed, change the following parameter settings. Motor data is found on the motor nameplate.
   a. Parameter ***0-01 Language*** (English)
   b. Parameter ***1-20 Motor Power [kW]*** (4.00 kW)
   c. Parameter ***1-22 Motor Voltage*** (400 V)
   d. Parameter ***1-23 Motor Frequency*** (50 Hz)
   e. Parameter ***1-24 Motor Current*** (9.00 A)
   f. Parameter ***1-25 Motor Nominal Speed*** (1420 RPM)
   g. Parameter ***5-12 Terminal 27 Digital Input*** (Coast Inverse)
   h. Parameter ***3-02 Minimum Reference*** (0.000 RPM)
   i. Parameter ***3-03 Maximum Reference*** (1500.000 RPM)
   j. Parameter ***3-41 Ramp 1 Ramp up Time*** (3.00 s)
   k. Parameter ***3-42 Ramp 1 Ramp Down Time*** (3.00 s)

l. Parameter ***3-13 Reference Site*** (Linked to Hand/Auto)

m. Parameter ***1-29 Automatic Motor Adaptation (AMA)*** (Off)

7.5 Testing Before System Start-up

⚠ CAUTION

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage.

- Ensure that equipment is safe to operate under any condition.
- Ensure that the motor, system, and any attached equipment are ready for start.

7.6 Testing Motor Rotation

NOTICE

INCORRECT MOTOR ROTATION

If the motor runs in the wrong direction, it can damage equipment.

- Before running the unit, check the motor rotation by briefly running the motor.

1. Press *[Hand On]*.
2. Move the left cursor to the left of the decimal point by using the left arrow key.
3. Enter an RPM that slowly rotates the motor and press *[OK]*.

   The motor runs briefly at either 5 Hz or the minimum frequency set in parameter ***4-12 Motor Speed Low Limit [Hz]***.

4. If the motor rotation is wrong, set parameter ***1-06 Clockwise Direction*** to ***[1] Inverse***.

7.7 Fire/Emergency Mode

When running in fire/emergency mode, the frequency converter can be programmed to sacrifice itself so the applications (for example, ventilation or water pumps) continue to operate as long as possible.

Before activating the fire/emergency mode, ensure that all relevant parameters for the motor and application are configured correctly. Danfoss recommends running the application from minimum to maximum speed and then bringing the application to a complete stop to verify that it functions correctly without triggering any warnings or alarms on the local control panel. Failure to complete this step before enabling the fire/emergency mode can result in loss of warranty. For more instructions on configuring the fire/emergency mode, see parameter group ***24-** Application Functions 2*** in the product-specific programming guide, or contact the local Danfoss office.

7.8 Starting Up the Drive for the First Time

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

NOTICE

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage.

- Ensure that equipment is safe to operate under any condition.
- Ensure that the motor, system, and any attached equipment are ready for start.

1. Press *[Auto On]*.

   If warnings or alarms occur, see the *Warnings and Alarms* section.

2. Apply an external run command.

   Examples of external run commands are a switch, key, or programmable logic controller (PLC).

3. Adjust the speed reference throughout the speed range.
4. Ensure that the system is working as intended by checking the sound and vibration levels of the motor.
5. Remove the external run command.

7.9 Status Messages

7.9.1 Overview

When the drive is in status mode, status messages automatically appear in the bottom line of the LCP display.

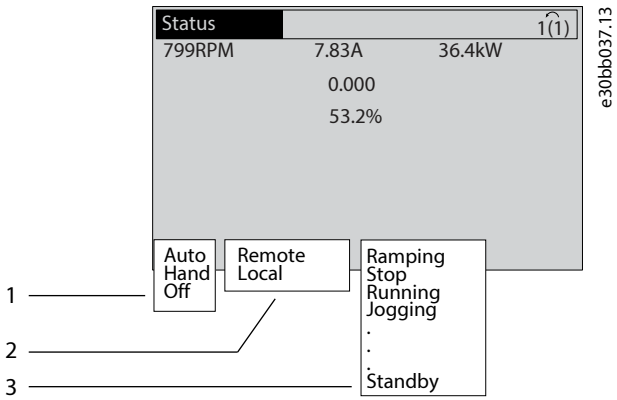


Figure 19: Status Display

1	See 7.9.2 Operating Mode.	2	See 7.9.3 Reference Site.
3	See 7.9.4 Operation Status.		

7.9.2 Operating Mode

Table 33: Operating Mode

Operating mode	Description
Auto	The drive requires external commands to execute functions. The start/stop commands are sent via the control terminals and/or the serial communication.
Hand	The navigation keys on the LCP can be used to control the drive. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.
Off	The drive does not react to any control signal until *[Auto On]* or *[Hand On]* is pressed.

7.9.3 Reference Site

Table 34: Reference Site

Reference site	Description
Remote	The speed reference is given from: • External signals. • Serial communication. • Internal preset references.
Local	The drive uses reference values from the LCP.

7.9.4 Operation Status

Table 35: Operation Status

Operation status	Description
AC brake	AC brake was selected in parameter ***2-10 Brake Function***. The AC brake overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. To start, press *[Hand On]*.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. The brake resistor absorbs the generative energy.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in parameter ***2-12 Brake Power Limit (kW)*** has been reached.
Coast	• ***[2] Coast inverse*** was selected as a function for a digital input (parameter group ***5–1* Digital Inputs***). The corresponding terminal is not connected. • Coast activated by serial communication. • No output from the drive to the motor.
Ctrl. ramp-down	***[1] Ctrl. 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 in a controlled manner.
Current high	The drive output current is above the limit set in parameter ***4-51 Warning Current High***.

Table 35: Operation Status - (continued)

Operation status	Description
Current low	The drive output current is below the limit set in parameter ***4-52 Warning Speed Low***.
DC hold	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 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***). • DC brake is activated in parameter ***2-03 DC Brake Cut In Speed [RPM]*** and a stop command is active. • 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 feedback is above the feedback limit set in parameter ***4-57 Warning Feedback High***.
Feedback low	The sum of all active feedback 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*** was 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 functions speed up and speed down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	***[19] Freeze Reference*** was 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 functions speed up and speed down.
Jog request	A jog command has been given, but the motor is 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 was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.
Motor check	In parameter ***1-80 Function at Stop***, ***[2] Motor Check*** was 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 was activated by ***[2] Enabled*** in parameter ***2-17 Over-voltage Control***. The connected motor is supplying 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.
Power unit off	(For drives with a 24 V external supply installed only.) Mains supply to the drive is removed, but the control card is supplied by the external 24 V.

Table 35: Operation Status - (continued)

Operation status	Description
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, the switching frequency is reduced to 1.5 kHz if parameter ***14-55 Output Filter*** is set to ***[2] Sine-Wave Filter Fixed***. Otherwise, the switching frequency is reduced to 1.0 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*** was selected as a function for a digital input (parameter group ***5–1* Digital Inputs***). The corresponding terminal is not active. • The quick stop function was 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 has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The drive is driving the motor.
Sleep mode	The energy-saving function is enabled. This function being enabled means that now the motor has stopped, but that it restarts automatically when required.
Speed high	The motor speed is above the value set in parameter ***4-53 Warning Speed High***.
Speed low	The 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*** were selected as functions for 2 different digital inputs (parameter group ***5–1* Digital Inputs***). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	The drive has received a stop command from 1 of the following: • LCP. • Digital input. • Serial communication.
Trip/Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, reset the drive using 1 of the following: • Pressing *[Reset]*. • Remotely by control terminals. • Via serial communication.

7.10 Warnings and Alarms

7.10.1 Warning and Alarm Types

Alarm

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or trip lock. Reset the drive after an alarm using 1 of the following methods:

- Press*[Reset]*/*[Off/Reset]*.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Warning

A state entered in fault situations, for example, if the drive is subject to an overtemperature or when the drive is protecting the motor, process, or mechanism. The drive prevents a restart until the cause of the fault has disappeared. To cancel the trip state, restart the drive. Do not use the trip state for personal safety.

Trip

When tripping, the drive suspends operation to avoid damage to the drive and other equipment. When a trip occurs, 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 is ready for a reset.

Trip lock

The drive enters this state in fault situations to protect itself. The drive requires physical intervention, for example, when there is a short circuit on the output. A trip lock can only be canceled by disconnecting mains, removing the cause of the fault, and reconnecting the drive. Restart is prevented until the trip state is canceled by activating reset or, sometimes, by being programmed to reset automatically. Do not use the trip lock state for personal safety.

LCP notification

When a fault is triggered, the LCP indicates the type of fault (alarm, warning, or trip lock) and shows the alarm or warning number in the display.

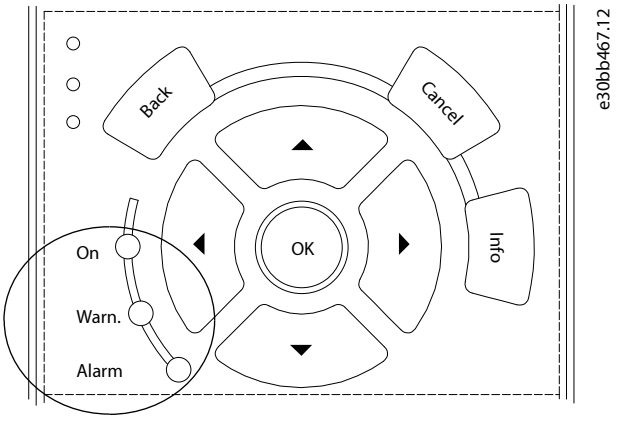


Figure 20: Status Indicator Lights

Table 36: Fault Types

Type of fault	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

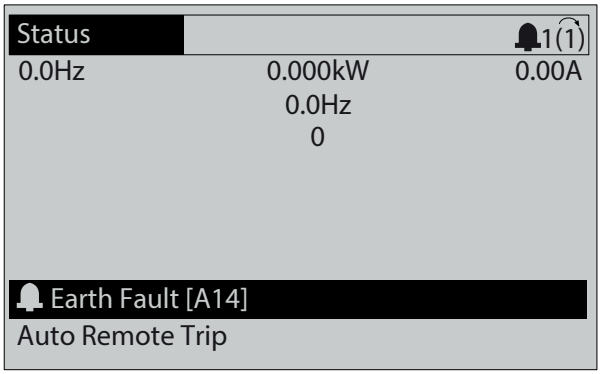


Figure 21: Alarm Example

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.

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 faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all the analog input terminals.
  - **a.** Control card terminals 53 and 54 for signals, terminal 55 common.
  - **b.** VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - **c.** 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 the input terminal signal test.

WARNING/ALARM 3, No Motor

Cause

No motor is connected to the output of the drive.

Troubleshooting

- Check the cable connection between the drive and the motor.

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.

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.

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.

WARNING/ALARM 7, DC Overvoltage

Cause

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

Troubleshooting

- Extend the ramp time.
- Change the ramp type.

WARNING/ALARM 8, DC Under Voltage

Cause

If the DC-link voltage (DC-link) drops below the undervoltage limit, 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 the input voltage test.

- Perform the soft charge circuit test.

WARNING/ALARM 9, Inverter Overload

Cause

The drive is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection issues a warning at 90% and trips at 100%, while giving an alarm. The drive cannot be reset until the counter is below 90%.

The fault occurs when the drive has run with more than 100% overload for too long.

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.

WARNING/ALARM 10, Motor ETR Overtemperature

Cause

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the drive issues a warning or an alarm when the counter reaches 100% in parameter ***1-90 Motor Thermal Protection***. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in parameter ***1-24 Motor Current*** is correct.
- Ensure that the motor data in parameter ***1-20*** to parameter ***1-25*** is set correctly.
- Running AMA in parameter ***1-29 Automatic Motor Adaptation (AMA)*** tunes the drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor Thermistor Overtemp

Cause

Check whether the thermistor is disconnected. Select whether the drive issues a warning or an alarm in ***parameter 1-90 Motor Thermal Protection***.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Ensure that the thermistor is connected correctly.
- If using a thermal switch or thermistor, ensure that the programming of ***parameter 1-93 Thermistor Source*** matches sensor wiring.

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, 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.

WARNING/ALARM 13, Overcurrent

Cause

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 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***.

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.

Alarm 15, Hardware Mismatch

Cause

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

Troubleshooting

- Record the values of the following parameters and contact .
  - **a.** Parameter ***15-40 FC Type***
  - **b.** Parameter ***15-41 Power Section***
  - **c.** Parameter ***15-42 Voltage***
  - **d.** Parameter ***15-43 Software Version***
  - **e.** Parameter ***15-45 Actual Typecode String***
  - **f.** Parameter ***15-49 SW ID Control Card***
  - **g.** Parameter ***15-50 SW ID Power Card***
  - **h.** Parameter ***15-60 Option Mounted***
  - **i.** Parameter ***15-61 Option SW Version*** (for each option slot).

ALARM 16, Short Circuit

Cause

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

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 to the drive and repair the short circuit.

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. The drive then ramps down to stop and issues 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 the installation adheres to the EMC requirements.

ALARM 18, Start Failed

Cause

The speed cannot exceed the value set in parameter ***1-78 Compressor Start Max Speed [Hz]*** during start within the allowed time, which is set in parameter ***1-79 Compressor Start Max Time to Trip***. The alarm may be caused by a blocked motor.

Troubleshooting

- Check if the motor is blocked.
- Check if the start maximum speed is set higher than the working speed after ramp up.
- Check if the start maximum time to trip is set shorter than the normal ramp up time.

WARNING/ALARM 20, Temp. Input Error

Cause

The temperature detected by VLT® Sensor Input Option MCB 114 exceeds the limit.

This warning/alarm is only active when ***[5] Stop and trip*** is selected in parameter ***35-06 Temperature Sensor Alarm Function***.

Troubleshooting

- Check the settings of the following parameters:
  - **a.** Parameter group *35-1* Temp. Input X48/4*
  - **b.** Parameter group *35-2* Temp. Input X48/7*
  - **c.** Parameter group *35-3* Temp. Input X48/10*
- Check the feedback temperature from the following parameters:
  - **a.** Parameter ***18-37 Temp. Input X48/4***
  - **b.** Parameter ***18-38 Temp. Input X48/7***
  - **c.** Parameter ***18-39 Temp. Input X48/10***

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.

Warning/Alarm 22, Hoist Mechanical Brake

Cause

The value of this warning/alarm shows the type of warning/alarm.

- 0 = The torque reference was not reached before timeout (parameter ***2-27 Torque Ramp Up Time***.

- 1 = Expected brake feedback was not received before timeout (parameter ***2-23 Activate Brake Delay***, parameter ***2-25 Brake Release Time***.

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*** by selecting ***[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

- Cycle 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.

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*** by selecting ***[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.

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***).

WARNING/ALARM 26, Brake Resistor Power Limit

Cause

The power transmitted to the brake resistor is calculated as an average 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 Brake Max. Current***. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If ***[2] Trip*** is selected in parameter ***2-13 Brake Power Monitoring***, the drive trips when the dissipated braking power reaches 100%.

Troubleshooting

- Decrease brake energy via lower speed or longer ramp time.

WARNING/ALARM 27, Brake Chopper Fault

Cause

The brake transistor is monitored during operation. 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.

WARNING/ALARM 28, Brake Check Failed

Cause

The brake resistor is not connected or not working.

Troubleshooting

- Check parameter ***2-15 Brake Check***.

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.

ALARM 30, Motor Phase U Missing

Cause

⚠ 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.

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

Troubleshooting

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

ALARM 31, Motor Phase V Missing

Cause

⚠ 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.

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

Troubleshooting

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

ALARM 32, Motor Phase W Missing

Cause

⚠ 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.

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

Troubleshooting

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

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.

WARNING/ALARM 34, Fieldbus Fault

Cause

The fieldbus on the communication option card is not working.

Troubleshooting

- Check the fieldbus communication option card.

ALARM 35, Option Fault

Cause

Fieldbus or option B detects internal faults.

Troubleshooting

- Contact the local supplier.

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.

ALARM 37, Phase Imbalance

Cause

There is a current imbalance between the power units.

ALARM 38, Internal Fault

Cause

When an internal fault occurs, a code number is shown.

Table 37: Internal Fault List

Fault number	Cause	Solution
0	The serial port cannot be initialized.	Contact the Danfoss supplier or Danfoss 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 Danfoss service department.
783	Parameter value outside of the minimum/maximum limits.	Adjust the parameter value to match the limits.
1024–1284	Internal fault.	Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.	Upgrade the software in the drive to the latest version.
1300	The option software in slot B is too old.	Upgrade the software in the drive to the latest version.
1302	The option software in slot C1 is too old.	Upgrade the software in the drive to the latest version.
1315	The option software in slot A is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1316	The option software in slot B is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1318	The option software in slot C1 is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1379–2819	Internal fault.	Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.	
1793	Motor-derived parameters not transferred correctly to the digital signal processor.	
1794	Power data not transferred correctly at power-up to the digital signal processor.	
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive also uses this fault code if the MCO does not power up correctly.	Check for poor EMC protection and improper grounding.
1796	RAM copy error.	
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.	Adjust the parameter value to match the limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.

Table 37: Internal Fault List - (continued)

Fault number	Cause	Solution
5125	Option in slot C0: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5376–6231	Internal fault.	Contact the Danfoss supplier or Danfoss service department.

Troubleshooting

- See the above table for the causes and solutions for different internal faults. If the fault persists, contact the supplier or service department for assistance.

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.

WARNING 40, Overload T27

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***.

WARNING 41, Overload T29

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***.

WARNING 42, Ovrld X30/6-7

Troubleshooting, 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).

Troubleshooting, 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).

WARNING 43, Ext. Supply

Cause

VLT® Extended Relay Option MCB 113 is mounted without 24 V DC. Select 1 of the options in the troubleshooting list.

Troubleshooting

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

ALARM 45, Earth (Ground) Fault 2

Cause

A ground fault has occurred.

Troubleshooting

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

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

WARNING/ALARM 47, 24 V Supply Low

Cause

The 24 V DC is measured on the control card.

Troubleshooting

- Check for a defective control card.

ALARM 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 is installed, check for overvoltage.

WARNING 49, Speed Limit

Cause

The warning is shown when the speed is outside of the specified range in parameter ***4-12 Motor Speed Low Limit [Hz]*** and parameter ***4-14 Motor Speed High Limit [Hz]***.

Troubleshooting

- Check if the system ran outside of the speed range.
- Check if parameter ***4-12 Motor Speed Low Limit [Hz]*** and parameter ***4-14 Motor Speed High Limit [Hz]*** are set correctly.

ALARM 50, AMA Calibration

Cause

A calibration error has occurred.

Troubleshooting

- Contact a supplier or the service department.

ALARM 51, AMA check U_{nom} and I_{nom}

Cause

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

Troubleshooting

- Check the settings in parameter ***1-20*** to parameter ***1-25***.

ALARM 52, AMA Low I_{nom}

Cause

The motor current is too low.

Troubleshooting

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

ALARM 53, AMA Big Motor

Cause

The power size of the motor is too large for the AMA to operate.

Troubleshooting

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

ALARM 54, AMA Small Motor

Cause

The power size of the motor is too small for the AMA to operate.

Troubleshooting

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

ALARM 55, AMA Parameter Range

Cause

The parameter values of the motor are outside of the acceptable range. The AMA does not run.

Troubleshooting

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

ALARM 56, AMA Interrupted

Cause

The AMA is manually interrupted.

Troubleshooting

- Re-run the AMA calibration.

ALARM 57, AMA Internal Fault

Cause

Internal fault.

Troubleshooting

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

ALARM 58, AMA Internal Fault

Cause

An AMA internal fault occurs.

Troubleshooting

- Contact a local supplier.

WARNING/ALARM 59, Current Limit

Cause

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

Troubleshooting

- Ensure that the motor data in parameter ***1-20*** to parameter ***1-25*** is set correctly.
- Possibly increase the current limit.
- Be sure that the system can operate safely at a higher limit.

ALARM 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.

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***.

WARNING/ALARM 62, Output Frequency Limit

Cause for Flux Mode

If the output frequency reaches the value set in parameter ***4-19 Max Output Frequency***, the drive issues a warning. The warning ceases when the output drops below the maximum limit. If the drive is unable to limit the frequency, it trips and issues an alarm. The latter may happen in the Flux mode if the drive loses control of the motor.

Troubleshooting for Flux Mode

- Check the application for possible causes. The load torque could be too significant to drag the motor run to a high speed.
- Increase the output frequency limit. Ensure that the system can operate safely at a higher output frequency.

Cause for VVC TCL Mode

The output speed limit is reached, and the torque reference is derated. If the system is designed to reduce the speed by speed limit function, the warning only means that the speed limit is active.

Troubleshooting for VVC TCL Mode

- The system speed exceeds the speed limit, in this case, adjust the system speed or adjust the speed limit.
- If the speed limit function is used to control system speed, the warning can be ignored.

ALARM 63, Mechanical Brake Low

Cause

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

WARNING 64, Voltage Limit

Cause

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

Troubleshooting

- Check if the mains input is not high enough.
- Check if the output frequency is too high above motor nominal frequency.

WARNING/ALARM 65, Control Card Over Temperature

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 the fan operation.
- Check the control card.

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***.

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.

ALARM 68, Safe Stop Activated

Cause

The 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]*.

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.

ALARM 70, Illegal FC Configuration

Cause

The control card and power card are incompatible.

Troubleshooting

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

ALARM 71, PTC 1 Safe Stop

Cause

Because the motor is too warm, the VLT® PTC Thermistor Card MCB 112 activated 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].

ALARM 72, Dangerous Failure

Cause

Safe Torque Off (STO) with trip lock. An unexpected combination of STO commands has occurred.

Troubleshooting

- VLT® PTC Thermistor Card MCB 112 enables X44/10, but STO is not enabled.

- MCB 112 is the only device using STO (specified via ***[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.

WARNING 73, Safe Stop Auto Restart

Cause

STO is activated.

Troubleshooting

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

ALARM 75, Illegal Profile Sel.

Cause

There was an attempt to write the parameter value while the motor was running.

Troubleshooting

- Stop the motor before writing the MCO profile to parameter ***8-10 Control Word Profile***.

WARNING 76, Power Unit Setup

Cause

The required number of power units does not match the detected number of active power units.

Troubleshooting

- When replacing a drive module, this warning can occur if the power-specific data in the module power card does not match the rest of the drive. Confirm that the spare part and its power card are the correct code number.

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.

ALARM 78, Tracking Error

Cause

The difference between setpoint value and actual value exceeds the value in parameter ***4-35 Tracking Error***.

Troubleshooting

- Disable the function or select an alarm/warning in parameter ***4-35 Tracking Error Function***.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to drive.
- Select motor feedback function in parameter ***4-30 Motor Feedback Loss Function***.
- Adjust the tracking error band in parameter ***4-35 Tracking Error*** and parameter ***4-37 Tracking Error Ramping***.

ALARM 79, Illegal Power Section Configuration

Cause

Internal fault.

Troubleshooting

- Contact the local supplier.

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.

ALARM 81, CSIV Corrupt

Cause

The CSIV file has syntax errors.

ALARM 82, CSIV Parameter Error

Cause

CSIV failed to initialize a parameter.

ALARM 83, Illegal Option Combination

Cause

The mounted options are incompatible.

ALARM 84, No Safety Option

Cause

The safety option was removed without applying a general reset.

Troubleshooting

- Reconnect the safety option.

ALARM 88, Option Detection

Cause

A new option configuration has been detected.

Troubleshooting

- Set parameter ***14-89 Option Detection*** to ***[1] Enable Option Change***, and power cycle the drive to accept the new configuration.

WARNING/ALARM 90, Feedback Monitor

Cause

A feedback fault is detected by option B.

Troubleshooting

- Contact the local supplier.

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.

WARNING/ALARM 92, No Flow

Cause

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

Troubleshooting

- Troubleshoot the system and reset the drive after the fault has been cleared.

WARNING/ALARM 93, Dry Pump

Cause

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 warning or alarm.

Troubleshooting

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

WARNING/ALARM 94, End of Curve

Cause

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

Troubleshooting

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

WARNING/ALARM 95, Broken Belt

Cause

Torque is below the torque level set for no load, indicating a broken belt. Parameter ***22-60 Broken Belt Function*** is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the drive after clearing the fault.

WARNING 96, Start Delayed

Cause

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

Troubleshooting

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

WARNING 97, Stop Delayed

Cause

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.

WARNING 98, Clock Fault

Cause

Time is not set or the RTC clock has failed.

Troubleshooting

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

ALARM 99, Locked Rotor

Cause

The rotor is blocked. It is only enabled for PM motor control.

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]***.

WARNING/ALARM 104, Mixing Fan Fault

Cause

The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing fan fault can be configured as a warning or an alarm in parameter ***14-53 Fan Monitor***.

Troubleshooting

- Cycle power to the drive to determine if the warning/alarm returns.

WARNING/ALARM 122, Mot. Rotat. Unexp.

Cause

The drive performs a function that requires the motor to be at a standstill, for example, DC hold for PM motors.

ALARM 144, Inrush Supply

Cause

A supply voltage on the inrush card is out of range.

Troubleshooting

- See the bit field result report value for more details.
  - **a.** Bit 2: Vcc high
  - **b.** Bit 3: Vcc low
  - **c.** Bit 4: Vdd high
  - **d.** Bit 5: Vdd low

ALARM 145, External SCR Disable

Cause

The alarm indicates a series DC-link capacitor voltage imbalance.

WARNING/ALARM 146, Mains Voltage

Cause

Mains voltage is outside valid operating range.

Troubleshooting

- See the following report values for details.
  - **a.** Voltage too low: 0=R-S, 1=S-T, 2=T-R
  - **b.** Voltage too high: 3=R-S, 4=S-T, 5=T-R

WARNING/ALARM 147, Mains Frequency

Cause

Mains frequency is outside valid operating range.

Troubleshooting

- The following report values provide more information:
  - **a.** 0: frequency too low
  - **b.** 1: frequency too high

WARNING/ALARM 148, System Temp

Cause

One or more of the system temperature measurements is too high.

WARNING/ALARM 154, D.out Overload

Cause

A digital output is overloaded.

WARNING 163, ATEX ETR Cur.Lim.Warning

Cause

The drive has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 65% of the allowed thermal overload.

Alarm 164, ATEX ETR Cur.Lim.Alarm

Cause

Running above the characteristic curve for more than 60 s within a period of 600 s activated the alarm, and the drive trips.

WARNING 165, ATEX ETR Freq.Lim.Warning

Cause

The drive has run for more than 50 s below the allowed minimum frequency as set in parameter ***1-98 ATEX ETR Interpol. Points.Freq.).***

ALARM 166, ATEX ETR Freq.Lim.Alarm

Cause

The drive has run for more than 60 s in a period of 600 s below the allowed minimum frequency as set in parameter ***1-98 ATEX ETR Interpol. Points. Freq.***).

WARNING 200, Fire Mode

Fire mode has been activated.

Troubleshooting

- The warning clears when fire mode is removed.
- See the fire mode data in the alarm log.

WARNING 201, Fire Mode was Active

Troubleshooting

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

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 this warning. See the fire mode data in the alarm log.

WARNING 203, Missing Motor

Cause

A multi-motor underload situation is detected. This warning indicates that a motor is missing.

Troubleshooting

- Inspect the system for proper operation.

WARNING 204, Locked Rotor

Cause

An overload condition is detected for a drive operating multi-motors. This warning indicates that there is a locked rotor.

Troubleshooting

- Inspect that the motor operates properly.

WARNING 220, Configuration File Version not Supported

Cause

The drive does not support the current configuration file version. Customization is aborted.

ALARM 243, Brake IGBT

Cause

This alarm is only for multi-drive systems. It is equivalent to *Alarm 27, Brake chopper fault*. The report value in thie alarm log indicates which drive module generated the alarm. This IGBT fault can be caused by any of the following:

- The DC fuse is blown.
- The brake jumper is not in position.
- The Klixon switch opened due to an overtemperature condition in the brake resistor.

Indication of the drive module generating the alarm:

- 1 = Left drive module.
- 2 = Second drive module from left.
- 3 = Third drive module from left (in 4-module systems).
- 4 = Fourth drive module from left (in 4-module systems).

ALARM 244, Heat Sink Temperature

Cause

The maximum temperature of the heat sink has been exceeded. The temperature fault cannot reset until the temperature drops below the defined heat sink temperature. The trip and reset points are different, based on the power size. This alarm is equivalent to *Alarm 29, Power module temp*.

Troubleshooting

- Check for the following:
  - **a.** Ambient temperature too high.
  - **b.** Motor cables too long.
  - **c.** Incorrect airflow clearance above or below the AC drive.
  - **d.** Blocked airflow around the unit.
  - **e.** Damaged heat sink fan.
  - **f.** Dirty heat sink.

ALARM 245, Heat Sink Sensor

Cause

There is no feedback from the heat sink temperature sensor. This signal form the IGBT thermal sensor is not available on the power card. This alarm is equivalent to *Alarm 39, Heat sink sensor*.

The report value in the alarm log indicates which drive module generated the alarm:

- 1 = Left drive module.
- 2 = Second drive module from the left.
- 3 = Third drive module from the left (in 4-module systems).
- 4 = Fourth drive module from the left (in 4-module systems).

Troubleshooting

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

ALARM 246, Power Card Supply

Cause

The supply on the power card is out of range. This alarm is only for multi-drive systems. It is equivalent to *Alarm 46, Power card supply*.

The report value in the alarm log indicates which drive module generated the alarm:

- 1 = Left drive module.
- 2 = Second drive module from left.
- 3 = Third drive module from left (in 4-module systems).

- 4 = Fourth drive module from left (in 4-module systems).

ALARM 247, Power Card Temperature

Cause

This alarm is only for multi-drive systems. It is equivalent to *Alarm 69, Power card temperature*.

The report value in the alarm log indicates which drive module generated the alarm:

- 1 = Left drive module.
- 2 = Second drive module from left.
- 3 = Third drive module from left (in 4-module systems).
- 4 = Fourth drive module from left (in 4-module systems).

ALARM 248, Illegal Power Section Configuration

Cause

This alarm is only for multi-drive systems. It is equivalent to *Alarm 79, Illegal power section configuration*.

The report value in the alarm log indicates which drive module generated the alarm:

- 1 = Left drive module.
- 2 = Second drive module from left.
- 3 = Third drive module from left (in 4-module systems).
- 4 = Fourth drive module from left (in 4-module systems).

Troubleshooting

- Check the current scaling cards on the MDCIC.

WARNING 249, Rect. Low Temperature

Cause

The temperature of the rectifier heat sink is too low, which indicates that the temperature sensor may be detect.

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.

WARNING 251, New Typecode

Cause

The power card or other components have been replaced, and the type code has changed.

Troubleshooting

- Reset the drive for normal operation.

ALARM 421, FPC Temp

Cause

A fault caused by the on-board temperature sensor is detected on the fan power card. The report values identify which fan power card detected the fault.

Troubleshooting

- Check the wiring.
- Check the on-board temperature sensor.
- Replace the fan power card.

ALARM 423, FPC Updating

Cause

The alarm is generated when the fan power card reports that it has an invalid PUD. The control card attempts to update the PUD. A subsequent alarm can result depending on the update. See *Alarm 424, FPC Update Successful* and *Alarm 425, FPC Update Failure*.

ALARM 424, FPC Update Successful

Cause

This alarm is generated when the control card has updated the fan power card PUD successfully.

Troubleshooting

- Press *[Reset]* to stop the alarm.

ALARM 425, FPC Update Failure

Cause

This alarm is generated after the control card failed to update the fan power card PUD.

Troubleshooting

- Check the fan power card wiring.
- Replace the fan power card.
- Contact supplier.

ALARM 426, FPC Config

Cause

The number of found fan power cards does not match the number of configured fan power cards. See parameter group ***15-6* Option Ident*** for the number of configured fan power cards.

Troubleshooting

- Check fan power card wiring.

- Replace the fan power card.

ALARM 427, FPC Supply

Cause

Supply voltage faults (5 V, 24 V, or 48 V) on the fan power card is detected.

Troubleshooting

- Check fan power card wiring.
- Replace the fan power card.

ALARM 432, Inrush Mode Error

Cause

An active inrush card reported the wrong mode. The report value indicates which inrush card reported the alarm.

Troubleshooting

- Check inrush card wiring.
- Replace the inrush card.

Warning 500, Motor Stator Winding Warning 2

Cause

The stator winding reached condition orange. A severe fault might occur soon in the motor.

Troubleshooting

- Check the stator windings.

Warning 501, Load Envelope Warning 2

Cause

Application load has reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased motor load.

Warning 502, Vibration Monitoring Warning 2

Cause

A significant increase in motor vibration is detected. The vibration levels have reached condition orange.

Troubleshooting

- Investigate the root cause for severe vibration.

Warning 506, Load Envelope Low Warning 2

The application load has reached condition orange low limit.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application

ALARM 510, Motor Stator Winding Alarm

Cause

Stator winding has reached condition red. A severe fault is detected in the motor.

Troubleshooting

- Check motor stator winding.

WARNING 510, Motor Stator Winding Warning 1

Cause

Stator winding reached condition yellow. An early fault is detected in the motor.

Troubleshooting

- Check the motor stator winding.

ALARM 511, Load Envelope Alarm

Cause

Application load has reached condition red.

Troubleshooting

- Check root cause for excessive overload or underload.

WARNING 511, Load Envelope Warning 1

Cause

Application load has reached condition yellow.

Troubleshooting

- Check root cause for high motor load.

Alarm 512, Sensor 1 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 1. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 512, Sensor 1 Monitoring Warning 1

Cause

An increase in the Sensor 1 value is detected. The value levels in Sensor 1 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 513, Sensor 2 Monitoring Warning 1

Cause

There is an excessive amount of motor vibration on sensor 2. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 513, Sensor 2 Monitoring Warning 1

Cause

An increase in the Sensor 2 value is detected. The value levels in Sensor 2 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 514, Sensor 3 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 3. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 514, Sensor 3 Monitoring Warning 1

Cause

An increase in the Sensor 3 value is detected. The value levels in Sensor 3 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 515, Sensor 4 Monitoring Alarm

Cause

There is an excessive amount of motor vibration on sensor 4. The vibration levels have reached condition red.

Troubleshooting

- Investigate the root cause for the excessive vibration. Before commissioning of condition-based monitoring, ensure to comply with the ISO10816 standard for machinery.

Warning 515, Sensor 4 Monitoring Warning 1

Cause

An increase in the Sensor 4 value is detected. The value levels in Sensor 4 have reached condition yellow.

Troubleshooting

- Investigate the root cause for the increased values.

Alarm 516, Load Envelope Low Alarm

The application load has reached low-level condition red.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application.

Warning 516, Load Envelope Low Warning 1

The application load has reached low-level condition yellow.

Troubleshooting

- Investigate the root cause for the decrease in motor load and then check the load specified for the application.

Warning 520, Stator Thld At Max/Min

Cause

The stator in the condition-based monitoring is either at its minimum or maximum limit.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-2* Stator*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 521, Load Thld At Max/Min

Cause

The load threshold in the condition-based monitoring is either at its minimum or maximum.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-3* Load*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 522, Sensor 1 Thld At Max/Min

Cause

The sensor 1 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 1 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-4* Sensor 1*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 523, Sensor 2 Thld At Max/Min

Cause

The sensor 2 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 2 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-5* Sensor 2*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 524, Sensor 3 Thld At Max/Min

Cause

The sensor 3 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 3 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-6* Sensor 3*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Warning 525, Sensor 4 Thld At Max/Min

Cause

The sensor 4 threshold in the condition-based monitoring is at its minimum or maximum value of the Sensor 4 function.

Troubleshooting

- Check the threshold values at maximum or minimum in parameter group ***46-** CBM Adv Thresholds*** to parameter group ***46-7* Sensor 4*** and adjust the values if needed.
- Acknowledge the generation by setting parameter ***45-46 Threshold Limit*** to ***[0] Limit OK***.

Alarm 550, Sensor 1 Low Monitoring Alarm

The value measured on Sensor 1 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 550, Sensor 1 Low Monitoring Warning 1

The value measured on Sensor 1 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 551, Sensor 2 Low Monitoring Alarm

The value measured on Sensor 2 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 551, Sensor 2 Low Monitoring Warning 1

The value measured on Sensor 2 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 552, Sensor 3 Low Monitoring Alarm

The value measured on Sensor 3 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 552, Sensor 3 Low Monitoring Warning 1

The value measured on Sensor 3 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Alarm 553, Sensor 4 Low Monitoring Alarm

The value measured on Sensor 4 is very low and has reached condition red low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

Warning 553, Sensor 4 Low Monitoring Warning 1

The value measured on Sensor 4 is very low and has reached condition yellow low.

Troubleshooting

- Investigate the root cause for the value reaching the red low level. For example, lost connection to analog inputs or no proper data communication on fieldbus sensors.

7.11 Troubleshooting

Table 38: Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	Check for loose connections.	Check the input power source.
	Missing or open fuses.	See *Open power fuses* 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.
	Short circuit on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminal 12/13 to 20–39, or 10 V supply for terminals 50–55.	Wire the terminals properly.
	Wrong contrast setting.	–	To adjust the contrast, press *[Status]* + [▲]/[▼].
	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 the supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the AC 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 shorts or incorrect connections. If the display continues to cut out, follow the procedure for *Display dark\No function*.

Table 38: Troubleshooting - (continued)

Symptom	Possible cause	Test	Solution
Motor not running	Service switch open or missing motor connection.	–	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	–	Apply mains power.
	LCP stop.	–	Depending on the operating mode, press *[Auto On]*or *[Hand On]*.
	Missing start signal (Standby).	–	Apply a valid start signal.
	Motor coast signal active (Coasting).	–	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 the parameter ***3-13 Reference Site***. Set a preset reference active in parameter group ***3-1* References***. Check for correct wiring. Check scaling of terminals. Check the reference signal.
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 the reversing signal.
	Wrong motor phase connection.	–	Correct motor phase connection, or set parameter ***1-06 Clockwise Direction*** to ***[1] Inverse***.
Motor is not reaching maximum speed	Frequency limits 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 reference input signal scaling in parameter group ***6-0* Analog I/O mode*** and parameter group ***3-1* References***.	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 Depen. Setting***. For closed-loop operation, check the settings in parameter group ***20-0* Feedback***.
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups ***1-2* Motor data***, ***1-3* Adv Motor Data***, and ***1-5* Load Indep. Setting***.

Table 38: Troubleshooting - (continued)

Symptom	Possible cause	Test	Solution
Motor does not brake	Possible incorrect settings in the brake parameters. Ramp-down times may be too short.	Check brake parameters. Check ramp time settings.	Check parameter groups ***2-0* DC Brake*** and ***3-0* Reference Limits***.
Open power fuses	Phase-to-phase short.	Motor or panel has a short phase-to-phase. Check motor and panel phases for shorts.	Eliminate any shorts detected.
	Motor overload.	Motor is overloaded for the application.	Perform a start-up test and verify that the motor current is within specifications. If motor current is exceeding the nameplate full load current, the motor can run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform pre-start-up check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (see ***Alarm 4, Mains phase loss*** description).	Rotate input power leads into the 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the AC drive.	Rotate input power leads into the AC drive 1 position: A to B, B to C, C to A.	If the imbalanced leg stays on same input terminal, it is a problem with the AC drive. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If the imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with AC drive.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If the imbalanced leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
AC drive acceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, refer to the *Warnings and Alarms* section. Check that motor data are entered correctly.	Increase the ramp-up time in parameter ***3-41 Ramp 1 Ramp Up Time***. Increase the current limit in parameter ***4-18 Current Limit***. Increase torque limit in parameter ***4-16 Torque Limit Motor Mode***.
AC drive deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, refer to the *Warnings and Alarms* section. Check that motor data are entered correctly.	Increase the ramp-down time in parameter ***3-42 Ramp 1 Ramp Down Time***. Enable overvoltage control in parameter ***2-17 Over-voltage Control***.

8 Specifications

8.1 Mains Supply

Supply terminals	L1, L2, L3
Supply voltage[1][2][3][4]	200–240 V ±10%
Supply voltage[1][2][3][5]	380–480 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 (10 hp)	Maximum 2 times per minute
Switching on input supply L1, L2, L3 (power-ups) 11–90 kW (1.5–125 hp)	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 a 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 on drive power and voltage rating.

3) UL 61800-5-1 is not valid for IT and delta grounded grids.

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

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

8.2 Motor Output and Motor Data

8.2.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency, 1.1–90 kW (1.5–125 hp)	0–590 Hz[1]
Switching on output	Unlimited
Ramp times	1–3600 s

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

8.2.2 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.

8.3 Ambient Conditions

Enclosure size A	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure sizes B1/B2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure sizes B3/B4	IP20/Chassis
Enclosure sizes C1/C2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure sizes C3/C4	IP20/Chassis
Enclosure kit available ≤ enclosure size A	IP21/TYPE 1/IP4X top
Vibration test enclosure A/B/C	1.0 g
Maximum relative humidity	5–95% (IEC 721-3-3); Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43), uncoated	Class 3C2
Aggressive environment (IEC 60068-2-43), coated	Class 3C3
Test method according to IEC 60068-2-43	H2S (10 days)
Ambient temperature (at SFAVM switching mode)	
- with derating	Maximum 55 °C (131 °F)[1]
- with full output power of typical EFF2 motors (up to 90% output current)	Maximum 50 °C (122 °F)[1]
- at full continuous FC output current	Maximum 50 °C (122 °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)
Maximum altitude above sea level with derating	3000 m (9843 ft)
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[2]	IE2

1) For more information, see the Derating section in the design guide.

2) Determined according to 61800-9-2 at:

- Rated load.
- 90% rated frequency.
- Switching frequency factory setting.
- Switching pattern factory setting.
- MyDrive® ecoSmart™ provides efficiency and part loss data for the drive according to 61800-3.

8.4 Cable Specifications

8.4.1 Motor Cable Length

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

8.4.2 Power Cable Cross-sections

Table 39: Maximum Cable Cross-section [mm² (AWG)]

Enclosure	Mains	Motor	Brake	Load share	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(6)	10(7)	10(7)	10(6)
B2	35(2)	35(2)	35(2)	35(2)	10(6)
B3	10(7)	10(7)	10(7)	10(7)	–
B4	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)	–
C4	95(4/0)	95(4/0)	95(4/0)	95(4/0)	–

8.4.3 Control Cable Cross-sections

Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm²/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm²/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm²/20 AWG

Minimum cross-section to control terminals	0.25 mm^2/24 AWG

8.5 Control Input/Output and Control Data

8.5.1 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.

8.5.2 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 the *Safe Torque Off Operating Guide* 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 return path 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.

8.5.3 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 mA 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.

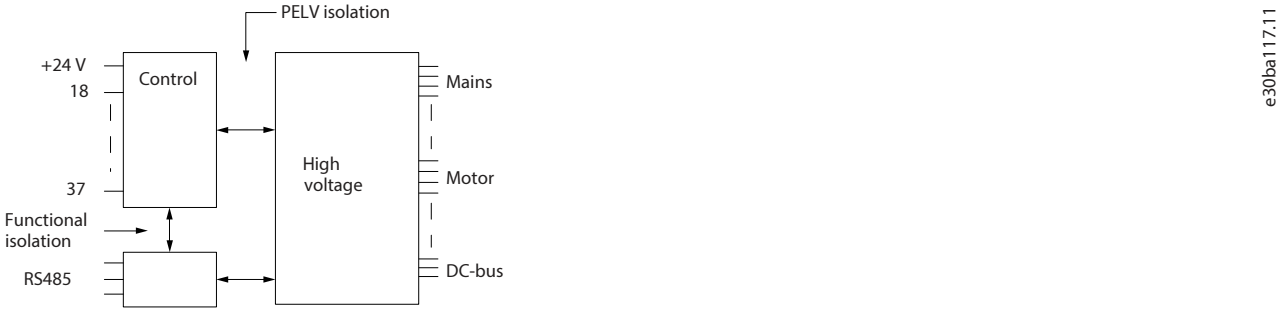


Figure 22: PELV Isolation

8.5.4 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 8.5.1 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.

8.5.5 Digital Outputs

Programmable digital/pulse outputs	2
Terminal number	27, 29
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.

8.5.6 Analog Output

Number of programmable outputs	1
Terminal number	42
Current range at analog output	0/4 mA 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.

8.5.7 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.

8.5.8 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.

8.5.9 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).

8.5.10 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.

8.5.11 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.

8.5.12 Control Card Performance

Scan interval	1 ms

8.5.13 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.

9 Maintenance

9.1 Preventive Maintenance Recommendations

Generally, all technical equipment, including AC drives, need a minimum level of preventive maintenance. To ensure trouble-free operation and long life of the drive, regular maintenance is recommended. It is also recommended as a good service practice to record a maintenance log with counter values, date, and time describing the maintenance and service actions.

recommends the following inspections and service intervals for air-cooled drives/systems.

NOTICE

The service schedule for part replacements can vary depending on operating conditions. Under specific conditions, the combination of stressful operation and environmental conditions work together to reduce the lifetime of the components significantly. These conditions can include, for example, extreme temperature, dust, high humidity, hours of use, corrosive environment, and loading.

For operation in stressful conditions, offers the DrivePro® Preventive Maintenance service. DrivePro® services extend the lifetime and increase the performance of the product with scheduled maintenance including customized part replacements. DrivePro® services are tailored to the specific application and operating conditions.

Table 40: Maintenance Schedule for Air-cooled Drives

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Installation			
Visual inspection	1 year	–	Check for the unusual, for example, for signs of overheating, aging, corrosion, and for dusty and damaged components.
Auxiliary equipment	1 year	According to manufacturer recommendations	Inspect equipment, switchgear, relays, disconnects, or fuses/circuit breakers. Examine the operation and condition for possible causes of operational faults or defects. The continuity check on fuses must be performed by trained service personnel.
EMC consideration	1 year	–	Inspect the wiring regarding the electromagnetic capability and the separation distance between control wiring and power cables.
Cable routing	1 year	–	Check for parallel routing of motor cables, mains wiring, and signal wiring. Avoid parallel routing. Avoid routing cables through free air without support. Check for aging and wearing of the cable insulation.
Control wiring	1 year	–	Check for tightness, damaged or crimped wires, or ribbon wires. Terminate the connections correctly with solid crimped ends. The use of shielded cables and grounded EMC plate, or a twisted pair is recommended.
Clearances	1 year	–	Check that the external clearances for proper airflow for cooling follow the requirements for the frame and product type. For clearances, refer to the local design regulations.
Sealing	1 year	–	Check that the sealing of the enclosure, the covers, and the cabinet doors are in good condition.

Table 40: Maintenance Schedule for Air-cooled Drives - (continued)

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Corrosive environments	1 year	–	Conductive dust and aggressive gases, such as sulphide, chloride, and salt mist, can damage the electrical and mechanical components. Air filters do not remove airborne corrosive chemicals. Act based on the findings.
Drive			
Programming	1 year	–	Check that the AC drive parameter settings are correct according to the motor, drive application, and I/O configuration. Only trained service personnel are allowed to perform this action.
Control panel	1 year	–	Check that the display pixels are intact. Check the event log for warnings and faults. Repetitive events are a sign of potential issues. If necessary, contact a local service center.
Drive cooling capacity	1 year	–	Check for blockages or constrictions in the air passages of the cooling channel. The heat sinks must be free of dust and condensation.
Cleaning and filters	1 year	–	Clean the interior of the enclosure annually, and more frequently if necessary. The amount of dust in the filter or inside the enclosure is an indicator for when the next cleaning or filter replacement is required.
Fans	1 year	3–10 years	Inspect the condition and operational status of all cooling fans. With the power off, the fan axis should feel tight, and spinning the fan with a finger, the rotation should be almost silent and not have abnormal rotation resistance. When in RUN mode, fan vibration, excessive or strange noise is a sign of the bearings wearing, and the fan must be replaced.
Grounding	1 year	–	The drive system requires a dedicated ground wire connecting the drive, the output filter, and the motor to the building ground. Check that the ground connections are tight and free of paint or oxidation. Daisy-chain connections are not allowed. If applicable, braided straps are recommended.
Power cables and wiring	1 year	–	Check for loose connections, aging, insulation condition, and proper torque to the drive connections. Check for proper rating of fuses and continuity check. Observe if there are any signs of operation in a demanding environment. For example, discoloration of the fuse housing can be a sign of condensation or high temperatures.
Vibration	1 year	–	Check for abnormal vibration or noise coming from the drive to ensure that the environment is stable for electronic components.
Spare parts			
Spare parts	1 year	2 years	Stock spares in their original boxes in a dry and clean environment. Avoid hot storage areas. Electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.
Exchange units and units stored for long periods before commissioning	1 year	2 years	Visually inspect for signs of damage, water, high humidity, corrosion, and dust within the visual field of view without disassembly. The exchange units with mounted electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.

1) Defined as the time after the commissioning/startup or the time from the previous inspection.

2) Defined as the time after the commissioning/startup or the time from the previous service schedule actions.

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