

ENGINEERING  
TOMORROW



Operating Guide

# VLT® AQUA Drive FC 202

110-800 kW, D9h-D10h and E5h-E6h Enclosed Drives





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# 1 Introduction

## 1.1 Purpose of this Operating Guide

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

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

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

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

## 1.2 Additional Resources

Other resources are available to understand advanced drive functions and programming.

- The Programming Guide provides detailed information on the LCP, menu system, parameters, and troubleshooting with alarms and warnings.
- The Design Guide provides detailed information about capabilities and functionality to design motor control systems.
- The Safe Torque Off Operating Guide provides detailed specifications, requirements, and installation instructions for the Safe Torque Off function.
- Supplementary publications and manuals are available from Danfoss, see [www.danfoss.com](http://www.danfoss.com).

## 1.3 Manual Version

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

The original language of this manual is English.

Table 1: Manual and Software Version

Version	Remarks	Software version
AQ262141056213 - 0201	Updated illustrations and power loss tables.	3.40
MG80H1xx	First version	3.31

## 1.4 Approvals and Certifications

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

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

### Thermal memory retention requirement

The enclosed drive is UL listed per UL508A and CSA 14 standards. The drive module in the enclosed drive system complies with UL 508C or UL 61800-5-1 thermal memory retention requirements. For more information on UL 508C thermal memory retention requirements, refer to the *Motor Thermal Protection* section in the product-specific Design Guide.

## NOTICE

### OUTPUT FREQUENCY LIMIT

Due to export control regulations, the output frequency of the enclosed drive (with no output filters) is limited to 590 Hz. For demands exceeding 590 Hz, contact Danfoss. For enclosed drives with output filters, the maximum output frequency is limited to 60 Hz without derating and to 100/120 Hz with derating.

### ADN-compliance

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

## 1.5 Finding the Declaration of Conformity Certificate

1. Open a web browser and enter <https://www.danfoss.com/en/service-and-support/documentation/>.
2. Click *Certificates & declarations*.
3. Use the *Search* field to search for PLV\*.

The system provides a list of the search results.

4. Filter the search results by entering the following criteria.
  - a. *Business unit* = Drives
  - b. *Documents/Document types* = Certificate
5. Scroll down until you find the PLV XXX titled certificate for the specific product segment, such as *PLV 202 EU Declaration*. Double click the link to open the certificate. For an example, see [1.6 Declaration of Conformity Certificate](#).

## 1.6 Declaration of Conformity Certificate

ENGINEERING  
TOMORROW**Danfoss A/S**6430 Nordborg  
Denmark  
CVR nr.: 20 16 57 15Telephone: +45 7488 2222  
Fax: +45 7449 0949**EU DECLARATION OF CONFORMITY****Danfoss A/S****Danfoss Drives**

declares under our sole responsibility that the

**Product category:** Frequency Converter**Type designation(s):** FC-202XYZZ\*\*\*\*\*

Character X: N or P

Character YYY: K25, K37, K55, 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: S2, S4, 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

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: 2021.05.25 Place of issue:	Issued by	Date: 2021.05.25 Place of issue:	Approved by
Graasten, DK	Signature:  Name: <b>Martin Skov Holm</b> Title: <b>Head of PM - EU</b>	Graasten, DK	Signature:  Name: <b>Michael Quitzau</b> Title: <b>Head of PM&amp;D, Denmark</b>

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**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

(MTTFd=14000 years, DC=90%, Category 3)

EN/IEC 61508-1:2011, EN/IEC 61508-2:2011

(Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h  
for specific variants, PFD = 1E-10, 1E-4 for specific  
variants, SFF>99%, HFT=0))

EN/IEC 62061:2005 + A1:2013 + A2:2015

(Safe Stop function, SILCL 2)

EN/IEC 60204-1:2006 + A1:2009

(Stop Category 0)

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  
Safety of machinery - Functional safety of safety-  
related electrical, electronic and programmable  
electronic control systems

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

Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX  
3009.

The assembly covered by the certificate PTB 14 ATEX 3009 have been evaluated  
internally at Danfoss to be in compliance with 2014/34 EU.



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CVR nr.: 20 16 57 15Telephone: +45 7488 2222  
Fax: +45 7449 0949**EU DECLARATION OF CONFORMITY****Danfoss A/S****Danfoss Drives**

declares under our sole responsibility that the VLT® Enclosed Power and Harmonic options with VLT® AQUA Drive included,

**Product category:** Frequency converter

**Type designation(s):** PLV202xx\*xxx\*\*xx\*\*\*\*\*x\*\*\*\*

Character 7-8: T4, P4, H4, L4, U4, T7, P7, H7, L7 or U7.

Character 10-12: 90, 110, 132, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710 or 800.

Character 16-17: MX, M1, M2, M3, M4, MA or MB.

Character 18: X, D, S, C, 1 or 2.

Character 36: 2 or 4.

\* may be any character indicating drive options which do not impact this DoC

Total Characters: 40

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**

EN 61800-5-1:2007 + A1:2017

Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy

**EMC Directive 2014/30/EU**

EN 61800-3:2004+A1:2011

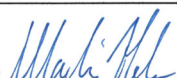

Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods.

Class C2 for N4 Version; Class C3 for N2 Version.

**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: 2021.05.25 Place of issue:	Issued by	Date: 2021.05.25 Place of issue:	Approved by
Graasten, DK	 <b>Signature:</b> <b>Name: Martin Skov Holm</b> <b>Title: Head of PM - EU</b>	Graasten, DK	 <b>Signature:</b> <b>Name: Michael Quitzau</b> <b>Title: Head of PM&amp;D, Denmark</b>

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**Machinery Directive 2006/42/EC**

EN61800-5:2:2007

Adjustable speed electrical power drive systems -

(Safe stop function conforms with STO – Part 5-2: Safety requirements - Functional

Safe torque off, SIL 2 Capability

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## 2 Safety

### 2.1 Safety Symbols

The following symbols are used in this manual:

#### ⚠ D A N G E R ⚠

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

#### ⚠ W A R N I N G ⚠

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

#### ⚠ C A U T I O N ⚠

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

#### N O T I C E

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

### 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, plant, 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 manuals provided with the unit, especially the instructions given in the Operating Guide.
- Have good knowledge of the generic and specialist standards applicable to the specific application.

## 2.3 Safety Precautions

### ⚠ WARNING ⚠

#### LACK OF SAFETY AWARENESS

This document gives important information on how to prevent injury and damage to the equipment or the system. Ignoring them can lead to death, serious injury, or severe damage to the equipment.

- Make sure to fully understand the dangers and safety measures incurred in the application.

### ⚠ WARNING ⚠

#### DISCHARGE TIME

The drive contains DC-link capacitors and, if input filter options are present, extra capacitors and inductors. These components can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

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

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

Table 2: Discharge Time

Drive model	Minimum waiting time
D9h/D10h	20 minutes
E5h/E6h	40 minutes

### ⚠ WARNING ⚠

#### HIGH VOLTAGE

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

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

### ⚠ WARNING ⚠

#### UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

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

**⚠ W A R N I N G ⚠****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.

**⚠ W A R N I N G ⚠****ROTATING SHAFTS**

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.
- Ensure that electrical work conforms to national and local electrical codes.
- Follow the procedures in this guide.

**⚠ C A U T I O N ⚠****INTERNAL FAILURE HAZARD**

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

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

## 3 Product Overview

### 3.1 Intended Use

#### NOTICE

##### OUTPUT FREQUENCY LIMIT

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

The enclosed drive is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. Depending on the configuration, the drive can be used in standalone applications or form part of a larger system or installation. The enclosed drive is designed to:

- Regulate motor speed in response to system feedback or remote commands from external controllers.
- Provide motor overload protection.
- Monitor system and motor status.
- Reduce harmonics and increase the power factor using the optional passive harmonic filter or line reactor.
- Reduce motor acoustic noise and protect motor insulation with the optional output filters.
- Reduce bearing current and shaft voltage with the optional common-mode filter.
- Reduce high-frequency, electromagnetic noise in the motor cables with the optional dU/dt filter.
- Provide sinusoidal output with optional sine-wave filter.

The enclosed drive is designed for residential, industrial, and commercial environments in accordance with local laws and standards. Do not use this drive in applications that are non-compliant with specified operating conditions and environments.

#### NOTICE

##### RADIO INTERFERENCE

In a residential environment, this product can cause radio interference.

- Take supplementary mitigation measures.

### 3.2 What is an Enclosed Drive?

The enclosed drive is an IP21/54 (NEMA 1/12) enclosure surrounding an IP20 (Protected Chassis) drive to form the basis of the system. There are 4 enclosed drive models with varying power ratings.

- D9h model: 110–160 kW (125–250 hp)
- D10h model: 200–400 kW (250–450 hp)
- E5h model: 355–630 kW (450–650 hp)
- E6h model: 500–800 kW (650–950 hp)

The enclosed drive is available with various power options and input and output filters to create a factory-built, custom drive. Some options and filters result in extra cabinets attached to the left or right side of the drive cabinet. These optional cabinets are shown with dotted lines, while the drive cabinet is shaded.

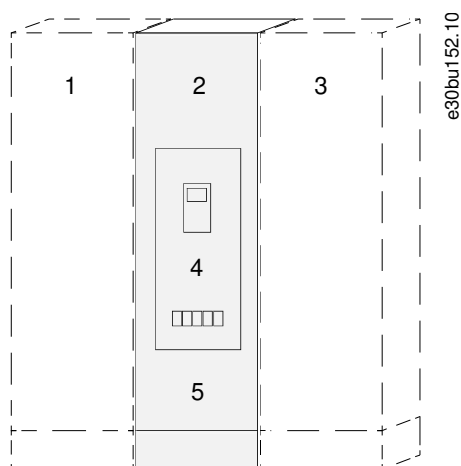


Illustration 1: Possible Configurations for a D9h Enclosed Drive

1	Input filter cabinet (passive harmonic filter or line reactor)	4	Control compartment
2	Drives cabinet	5	Input power options <sup>(1)</sup>
3	Sine-wave cabinet		

<sup>1</sup> The D9h enclosure does not require an input power options cabinet – the input power options are placed in the drive cabinet.

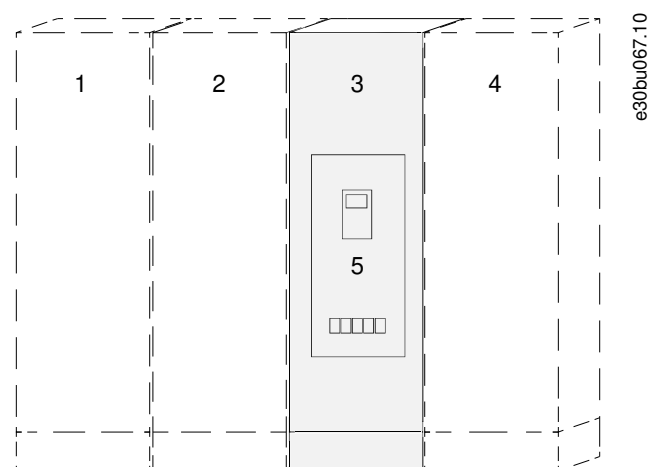
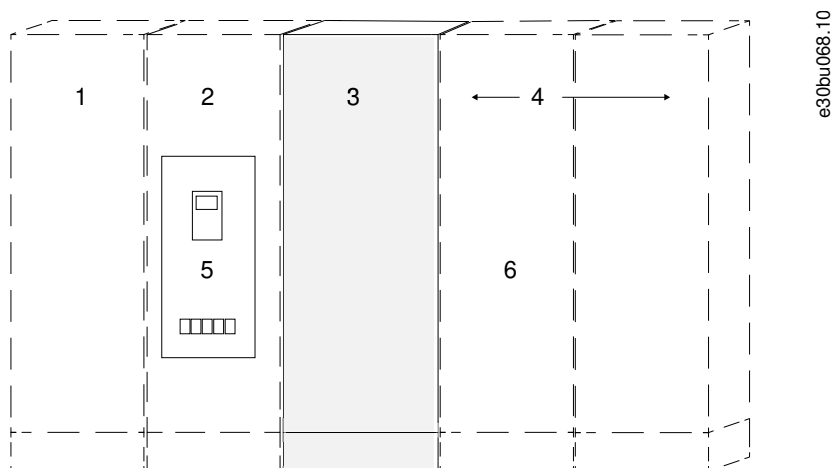


Illustration 2: Possible Configurations for a D10h Enclosed Drive

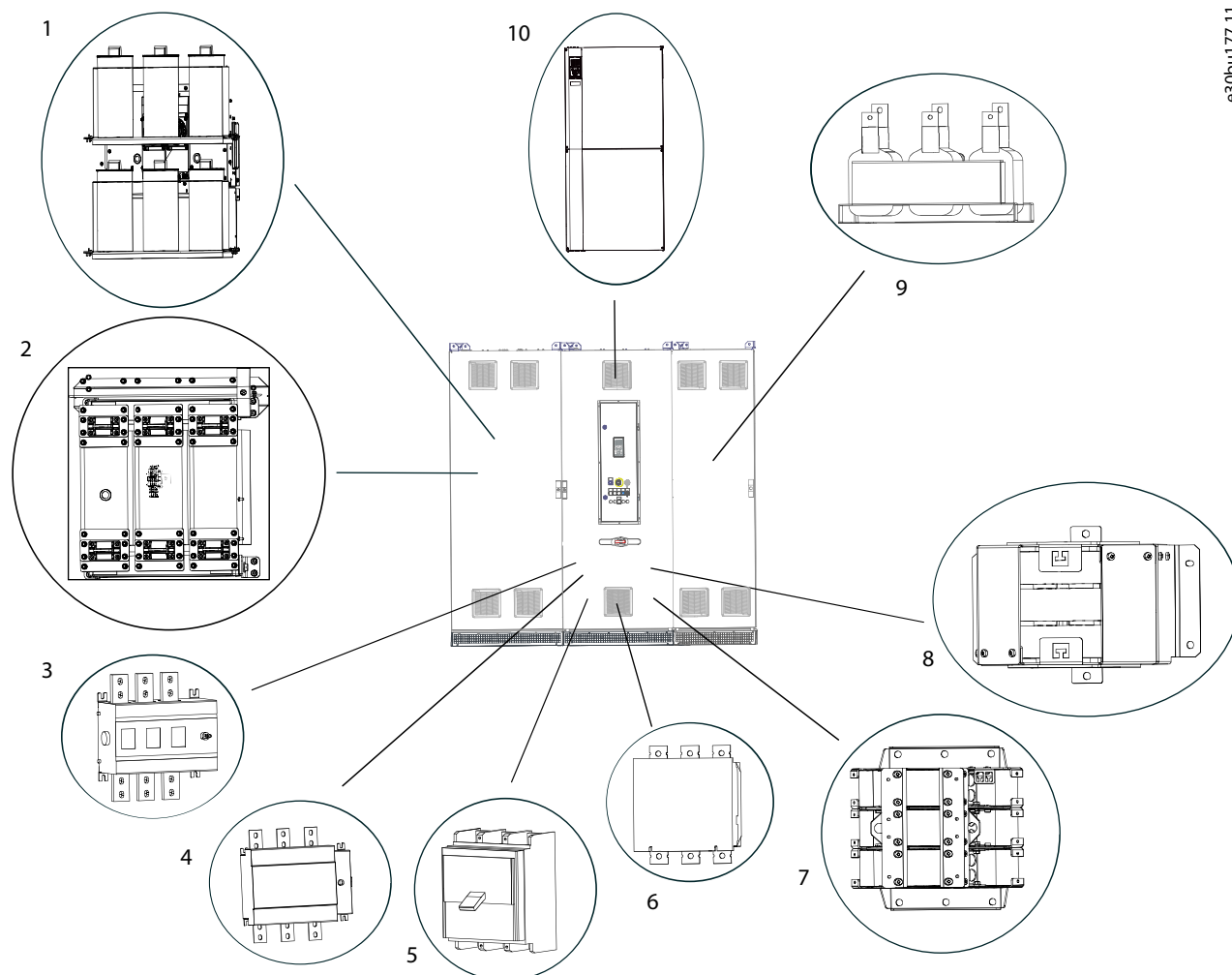
1	Input filter cabinet (passive harmonic filter or line reactor)	4	Sine-wave filter cabinet
2	Input power options cabinet <sup>(1)</sup>	5	Control compartment
3	Drive cabinet		

<sup>1</sup> If more than 1 input power option is ordered, the D10h enclosed drive requires an input power options cabinet. Otherwise the single input power option is placed below the control compartment in the drive cabinet.

**Illustration 3: Possible Configurations for an E5h or E6h Enclosed Drive**

1	Input filter cabinet (passive harmonic filter or line reactor)	4	Sine-wave filter cabinet
2	Input power options cabinet	5	Control compartment
3	Drive cabinet	6	dU/dt filter cabinet

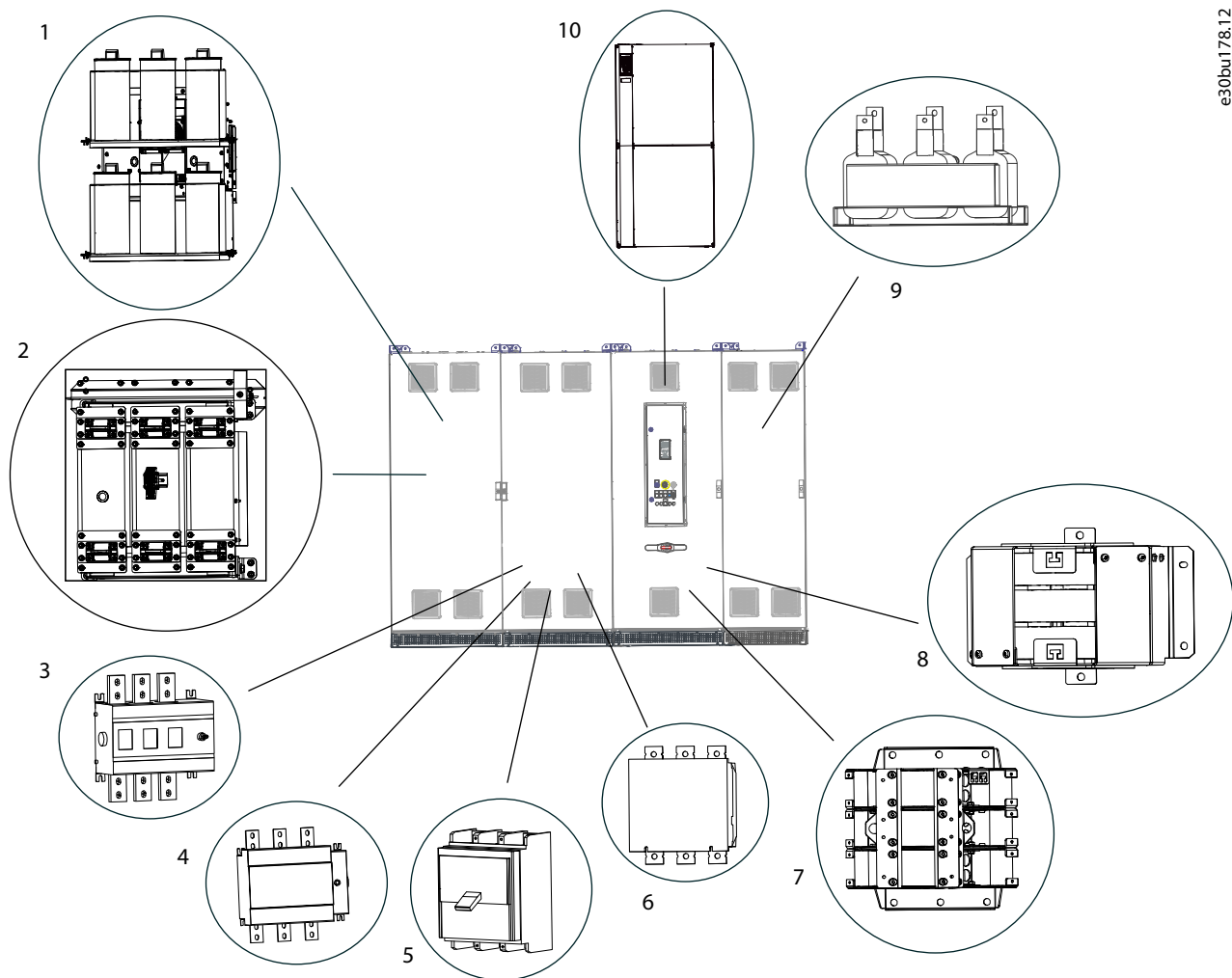
### 3.3 Location of Options within an Enclosed Drive



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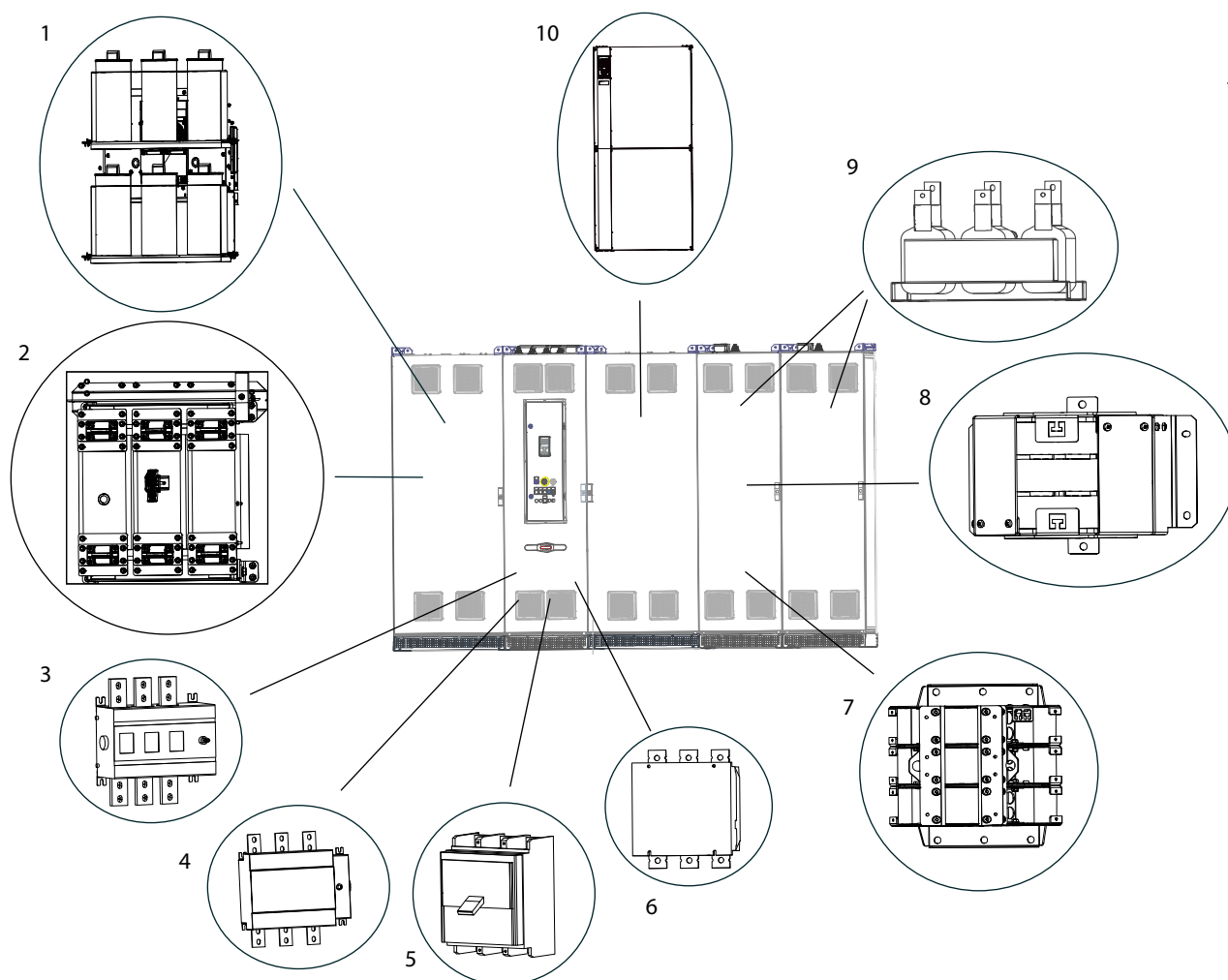
**Illustration 4: Visual Representation of a D9h Enclosure and the Locations of Available Options**

1	Passive harmonic filter (PHF)	6	Mains contactor
2	Line reactor	7	dU/dt filter
3	Non-fusible disconnect	8	Common-mode filter
4	Fusible disconnect	9	Sine-wave filter
5	Molded-case circuit breaker (MCCB)	10	Drive module (varies in power rating)



**Illustration 5: Visual Representation of a D10h Enclosure and the Locations of Available Options**

1	Passive harmonic filter (PHF)	6	Mains contactor
2	Line reactor	7	dU/dt filter
3	Non-fusible disconnect	8	Common-mode filter
4	Fusible disconnect	9	Sine-wave filter
5	Molded-case circuit breaker (MCCB)	10	Drive module (varies in power rating)



**Illustration 6: Visual Representation of a E5h/E6h Enclosure and the Locations of Available Options**

1	Passive harmonic filter (PHF)	6	Mains contactor
2	Line reactor	7	dU/dt filter
3	Non-fusible disconnect	8	Common-mode filter
4	Fusible disconnect	9	Sine-wave filter
5	Molded-case circuit breaker (MCCB)	10	Drive module (varies in power rating)

### 3.4 Drive Identification

#### 3.4.1 Identifying the Drive and Its Options

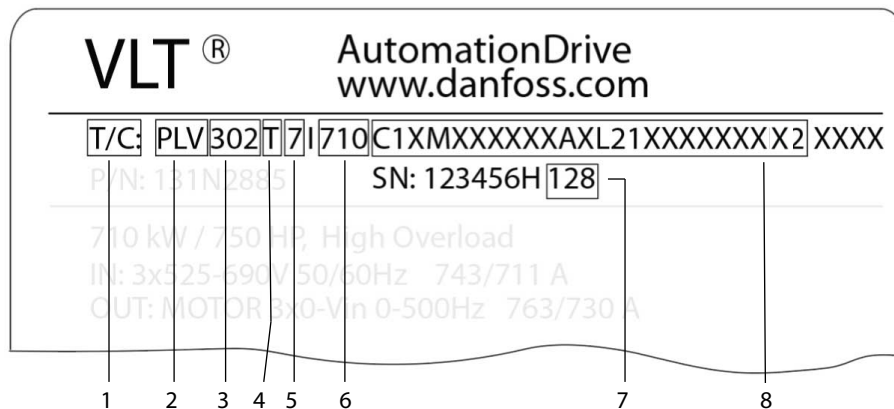
Enclosure size and specific options are used throughout this guide whenever procedures or components differ based on the drive and its options. Use the following steps to identify the enclosed drive:

**Procedure**

1. Locate the type code (T/C) on the nameplate. The nameplate is found on the exterior of the drive by the bottom grill and on the control compartment door.
2. Determine the type of enclosure by obtaining the following information from the type code:
  - a. Product group and drive series (characters 1–6).
  - b. Voltage rating (character 8).
  - c. Model/power rating (characters 10–12).
3. Go to [Table 3](#) and use the model number and voltage rating to find the enclosure size.

4. Using the type code, refer to [3.4.3 Type Code Identification](#) to identify the installed options.

#### Example



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Illustration 7: Using the Nameplate to Find the Enclosure Size and Installed Options

1	Type code	5	Mains voltage
2	Product group (PLV = enclosed drive)	• 4 = 380–480 V	
3	Drive series	• 5 = 380–500 V	
	• 102 = VLT® HVAC Drive	• 7 = 525–690 V	
	• 103 = VLT® Refrigeration Drive		
	• 202 = VLT® AQUA Drive	6	Model/power rating
	• 302 = VLT® AutomationDrive	7	Build date (wwy, where ww = the week and y = the last digit of the year)
4	Low harmonic filter option (if any)	8	Option codes

### 3.4.2 Enclosure Size Identification

Table 3: Model by Drive Voltage

Model	Enclosure size (380–480 V)	Enclosure size (525–690 V)
N110	D9h	D9h
N132	D9h	D9h
N160	D9h	D9h
N200	D10h	D10h
N250	D10h	D10h
N315	D10h	D10h
N355	E5h	–
N400	E5h	D10h
N450	E5h	E5h
N500	E6h	E5h
N560	E6h	E5h

Model	Enclosure size (380–480 V)	Enclosure size (525–690 V)
N630	–	E5h
N710	–	E6h
N800	–	E6h

### 3.4.3 Type Code Identification

Table 4: Product Group Code

Character position	Code	Description
1–3	PLV	VLT® Enclosed Drives

Table 5: Drive Series Codes

Character position	Code	Description
4–6	102	VLT® HVAC Drive FC 102
	103	VLT® Refrigeration Drive FC 103
	202	VLT® AQUA Drive FC 202
	302	VLT® AutomationDrive FC 302

Table 6: Low-harmonic Filter Codes

Character position	Code	Description
7	T	None
	P	Passive filter, THDi=5%, 50 Hz
	H	Passive filter, THDi=8%, 50 Hz
	L	Passive filter, THDi=5%, 60 Hz
	U	Passive filter, THDi=8%, 60 Hz

Table 7: Mains Voltage Codes

Character position	Code	Description
8	4	380–480 V
	5	380–500 V
	7	525–690 V (525–600 V for UL)

Table 8: Norms and Standards Codes

Character position	Code	Description
9	I	IEC
	U	UL

Table 9: Power Rating Codes

Character position	Code	Description
10–12	90K	(N90K) 90 kW/125 hp
	110	(N110) 110 kW/150 hp
	132	(N132) 132 kW/200 hp
	160	(N160) 160 kW/250 hp
	200	(N200) 200 kW/300 hp
	250	(N250) 250 kW/350 hp
	315	(N315) 315 kW/450 hp
	355	(N355) 355 kW/500 hp
	400	(N400) 400 kW/550 hp
	450	(N450) 450 kW/600 hp
	500	(N500) 500 kW/650 hp
	560	(N560) 560 kW/750 hp
	630	(N639) 630 kW/900 hp
	710	(N710) 710 kW/1000 hp
	800	(N800) 800 kW/1200 hp

Table 10: Drive Module PCB Coating Codes

Character position	Code	Description
13	C	Coated PCB
	R	Coated PCB + ruggedized

Table 11: Plinth (Pedestal) Codes

Character position	Code	Description
14	1	100 mm high pedestal
	2	200 mm high pedestal
	4	400 mm high pedestal
	5	Marine pedestal

Table 12: Drive Module Braking and Safety Codes

Character position	Code	Description
15	X	No brake IGBT
	B	Brake IGBT
	T	Safe Torque Off
	U	Brake IGBT + Safe Torque Off

Table 13: Mains Option Codes

Character position	Code	Description
16–17	MX	None
	M1	Fusible disconnect
	M2	Non-fusible disconnect
	M3	Circuit breaker (MCCB)
	M4	Mains contactor
	M5	AC reactor
	M6	Fuses
	MA	Fusible disconnect + mains contactor
	MB	Non-fusible disconnect + mains contactor
	MC	AC reactor + fusible disconnect
	MD	AC reactor + fusible disconnect + mains contactor
	ME	AC reactor + non-fusible disconnect
	MF	AC reactor + circuit breaker (MCCB)
	MG	AC reactor + mains contactor
	MH	AC reactor + non-fusible disconnect + mains contactor

Table 14: Output Filter Codes

Character position	Code	Description
18	X	None
	D	dU/dt filter
	S	Sine-wave filter
	C	Common-mode filter
	1	Common-mode + dU/dt filters
	2	Common-mode + sine-wave filters

Table 15: Reserved Code

Character position	Code	Description
19	X	None

Table 16: Cable Infeed Codes

Character position	Code	Description
20	X	Bottom
	T	Top
	L	Mains top, motor bottom
	M	Mains bottom, motor top

Table 17: Auxiliary Power Supply Codes

Character position	Code	Description
21	1	230 V AC external
	2	230 V AC internal
	4	230 V AC internal + 24 V DC internal
	5	230 V AC external + 24 V DC internal
	6	120 V AC external
	7	120 V AC internal
	8	120 V AC internal + 24 V DC internal
	9	120 V AC external + 24 V DC internal

Table 18: Back-channel Cooling Codes

Character position	Code	Description
22	X	Bottom in, top out
	1	Back in, back out
	C	Back in, top out
	D	Bottom in, back out
	N	None

Table 19: Auxiliary Function Codes

Character position	Code	Description
23–24	AX	No auxiliary options
	A1	AC socket+cabinet light
	A2	Extended I/O terminals
	A3	Cabinet heater
	A4	Motor heater control
	A5	Insulation monitor
	AA	AC socket + cabinet light + extended I/O terminals
	AB	AC socket + cabinet light + cabinet heater

Character position	Code	Description
	AC	AC socket + cabinet light + motor heater control
	AD	AC socket + cabinet light + insulation monitor
	AE	AC socket + cabinet light + extended I/O terminals + cabinet heater
	AF	AC socket + cabinet light + extended I/O terminals + motor heater control
	AG	AC socket + cabinet light + extended I/O terminals + insulation monitor
	AH	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control
	AI	AC socket + cabinet light + extended I/O terminals + cabinet heater + insulation monitor
	AJ	AC socket + cabinet light + extended I/O terminals + motor heater control + insulation monitor
	AK	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AL	AC socket + cabinet light + cabinet heater + motor heater control
	AM	AC socket + cabinet light + cabinet heater + insulation monitor
	AN	AC socket + cabinet light + cabinet heater + motor heater control + insulation monitor
	AO	AC socket + cabinet light + motor heater control + insulation monitor
	AP	Extended I/O terminals + cabinet heater
	AQ	Extended I/O terminals + motor heater control
	AR	Extended I/O terminals + insulation monitor
	AS	Extended I/O terminals + cabinet heater + motor heater control
	AT	Extended I/O terminals + cabinet heater + insulation monitor
	AU	Extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AV	Extended I/O terminals + motor heater control + insulation monitor
	AW	Cabinet heater + motor heater control
	A8	Cabinet heater + insulation monitor
	AY	Cabinet heater + motor heater control + insulation monitor
	AZ	Motor heater control + insulation monitor

Table 20: LCP Mounting Codes

Character position	Code	Description
25	L	LCP in the door
	N	No LCP in the door

Table 21: Protection Rating Codes

Character position	Code	Description
26–27	21	IP21
	54	IP54

Table 22: Door-mounted Codes

Character position	Code	Description
28–29	XX	None
	D1	Signal lights and reset button
	D2	Emergency switch off + emergency push-button
	D3	STO with emergency push-button (basic functional safety)
	D4	STO/SS1 with emergency push-button + safely limited speed (TTL encoder)
	D5	STO/SS1 with emergency push-button + safely limited speed (HTL encoder)
	DA	Indicator lights and reset button + emergency switch off and emergency push-button
	DB	Indicator lights and reset button + STO with emergency push-button (basic functional safety)
	DC	Indicator lights and reset button + STO/SS1 with emergency push-button + safely limited speed (TTL encoder)
	DE	Indicator lights and reset button + STO/SS1 with emergency push-button + safely limited speed (HTL encoder)

Table 23: A Option Codes

Character position	Code	Description
30	X	No A option
	0	VLT® PROFIBUS DP-V1 MCA 101
	4	VLT® DeviceNet MCA 104 (FC 102/FC 202/FC 302 only)
	6	VLT® CANopen MCA 105 (FC 302 only)
	8	VLT® EtherCAT MCA 124 (FC 302 only)
	G	VLT® LonWorks MCA 108 (FC 102 only)
	J	VLT® BACnet MCA 109 (FC 102 only)
	K	VLT® BACnet/IP MCA 125 (FC 102 only)
	L	VLT® PROFINET MCA 120
	N	VLT® EtherNet/IP MCA 121 (FC 102/FC 202/FC 302 only)
	Q	VLT® Modbus TCP MCA 122 (FC 102/FC 202/FC 302 only)
	T	VLT® PROFIBUS Converter VLT 3000 MCA 113 (FC 302 only)
	U	VLT® PROFIBUS Converter VLT 5000 MCA 114 (FC 302 only)

Character position	Code	Description
	Y	VLT® POWERLINK MCA 123 (FC 302 only)
	W	VLT® DeviceNet Converter MCA 194 (FC 302 only)
	Z	VLT® AK-LonWorks MCA 107 (FC 103 only)

Table 24: B Option Codes

Character position	Code	Description
31	X	No B option
	0	VLT® Analog I/O MCB 109 (FC 102/FC 103/FC 202 only)
	2	VLT® PTC Thermistor Card MCB 112 (FC 102/FC 202/FC 302 only)
	4	VLT® Sensor Input MCB 114 (FC 102/FC 202/FC 302 only)
	K	VLT® General Purpose I/O Option MCB 101
	P	VLT® Relay Option MCB 105
	Y	VLT® Extended Cascade Controller MCO 101 (FC 202 only)
	R	VLT® Encoder Option MCB 102 (FC 302 only)
	U	VLT® Resolver Option MCB 103 (FC 302 only)
	Z	VLT® Safety PLC Interface MCB 108 (FC 302 only)
	5	VLT® Programmable I/O MCB 115
	6	VLT® Safe Option TTL MCB 150 (FC 302 only)
	7	VLT® Safe Option HTL MCB 151 (FC 302 only)
	8	VLT® Safety Option MCB 152 (FC 302 only)

Table 25: C0 Option MCO Codes

Character position	Code	Description
32	X	No C option software
	4	VLT® Motion Control MCO 305 (FC 302 only)

Table 26: C1 Option Codes

Character position	Code	Description
33	X	No C1 option
	5	VLT® Advanced Cascade Controller MCO 102 (FC 202/FC 302 only)
	7	VLT® Sensorless Safety MCB 159 (FC 302 only)
	R	VLT® Extended Relay Card MCB 113 (FC 302 only)

Table 27: C Option Software Codes

Character position	Code	Description
34	X	No software option
	0	VLT® Synchronizing Controller MCO 350 (FC 302 only)
	1	VLT® Positioning Controller MCO 351 (FC 302 only)

Table 28: D Option Codes

Character position	Code	Description
35	X	No D option
	0	VLT® 24 V DC Supply MCB 107
	1	VLT® Real time clock option MCB 117

Table 29: EMC Filter Codes

Character position	Code	Description
36	2	(H2) RFI class A2 (C3)
	4	(H4) RFI class A1 (C2)

Table 30: Reserved Code

Character position	Code	Description
37–39	X	None

Table 31: Documentation Language Codes

Character position	Code	Description
40	X	English, no 2 <sup>nd</sup> language
	G	English + German
	F	English + French

### 3.5 Power Ratings, Weight, and Dimensions

Table 32: Power Ratings and Dimensions for D9h–D10h and E5h–E6h Enclosures (Standard Configurations)

Enclosed drive	D9h	D10h	E5h	E6h
Rated power at 380–480 V [kW (hp)]	110–160 (150–250)	200–315 (300–450)	355–450 (500–600)	500–560 (650–750)
Rated power at 525–690 V [kW (hp)]	110–160 (125–200)	200–400 (250–400)	450–630 (450–650)	710–800 (750–950)
Protection rating	IP21 (NEMA 1)/ IP54 (NEMA 12)	IP21 (NEMA 1)/IP54 (NEMA 12)	IP21 (NEMA 1)/IP54 (NEMA 12)	IP21 (NEMA 1)/IP54 (NEMA 12)
Drive cabinet	D9h	D10h	E5h	E6h
Height [mm (in)] <sup>(1)</sup>	2100 (82.7)	2100 (82.7)	2100 (82.7)	2100 (82.7)
Width [mm (in)] <sup>(2)</sup>	400 (15.8)	600 (23.6)	600 (23.6)	800 (31.5)

Enclosed drive	D9h	D10h	E5h	E6h
Depth [mm (in)]	600 (23.6)	600 (23.6)	600 (23.6)	600 (23.6)
Weight [kg (lb)] <sup>(2)</sup>	280 (617)	355 (783)	400 (882)	431 (950)
<b>Input filter cabinet</b>	<b>D9h</b>	<b>D10h</b>	<b>E5h</b>	<b>E6h</b>
Height [mm (in)] <sup>(1)</sup>	2100 (82.7)	2100 (82.7)	2100 (82.7)	2100 (82.7)
Width [mm (in)]	400 (15.8)/600 (23.6)	400 (15.8)/600 (23.6)	600 (23.6)/800 (31.5)	600 (23.6)/800 (31.5)
Depth [mm (in)]	600 (23.6)	600 (23.6)	600 (23.6)	600 (23.6)
Weight [kg (lb)]	410 (904)	410 (904)/530 (1168)	530 (1168)	530 (1168)/955 (2105)
<b>Input power options cabinet</b>	<b>D9h</b>	<b>D10h</b>	<b>E5h</b>	<b>E6h</b>
Height [mm (in)] <sup>(1)</sup>	–	2100 (82.7)	2100 (82.7)	2100 (82.7)
Width [mm (in)]	–	600 (23.6)	600 (23.6)	600 (23.6)
Depth [mm (in)]	–	600 (23.6)	600 (23.6)	600 (23.6)
Weight [kg (lb)]	–	380 (838)	380 (838)	380 (838)
<b>Sine-wave filter cabinet</b>	<b>D9h</b>	<b>D10h</b>	<b>E5h</b>	<b>E6h</b>
Height [mm (in)] <sup>(1)</sup>	2100 (82.7)	2100 (82.7)	2100 (82.7)	2100 (82.7)
Width [mm (in)]	600 (23.6)	600 (23.6)	1200 (47.2)	1200 (47.2)
Depth [mm (in)]	600 (23.6)	600 (23.6)	600 (23.6)	600 (23.6)
Weight [kg (lb)]	384 (847)	384 (847)	768 (1693)	768 (1693)
<b>dU/dt filter cabinet</b>	<b>D9h</b>	<b>D10h</b>	<b>E5h</b>	<b>E6h</b>
Height [mm (in)] <sup>(1)</sup>	–	–	2100 (82.7)	2100 (82.7)
Width [mm (in)] <sup>(3)</sup>	–	–	400 (15.8)	400 (15.8)
Depth [mm (in)]	–	–	600 (23.6)	600 (23.6)
Weight [kg (lb)]	–	–	240 (529)	240 (529)
<b>Top entry/exit cabinet</b>	<b>D9h</b>	<b>D10h</b>	<b>E5h</b>	<b>E6h</b>
Height [mm (in)] <sup>(1)</sup>	2100 (82.7)	2100 (82.7)	2100 (82.7)	2100 (82.7)
Width [mm (in)] <sup>(3)</sup>	400 (15.8)	400 (15.8)	400 (15.8)	400 (15.8)
Depth [mm (in)]	600 (23.6)	600 (23.6)	600 (23.6)	600 (23.6)
Weight [kg (lb)]	164 (362)	164 (362)	164 (362)	164 (362)

<sup>1</sup> Cabinet height includes standard 100 mm (3.9 in) pedestal. A 200 mm (7.9 in) or 400 mm (15.8 in) pedestal is optional.

<sup>2</sup> Without options.

<sup>3</sup> The E5h and E6h enclosures contain 2 sine-wave cabinets. The provided width is the total of both cabinets.

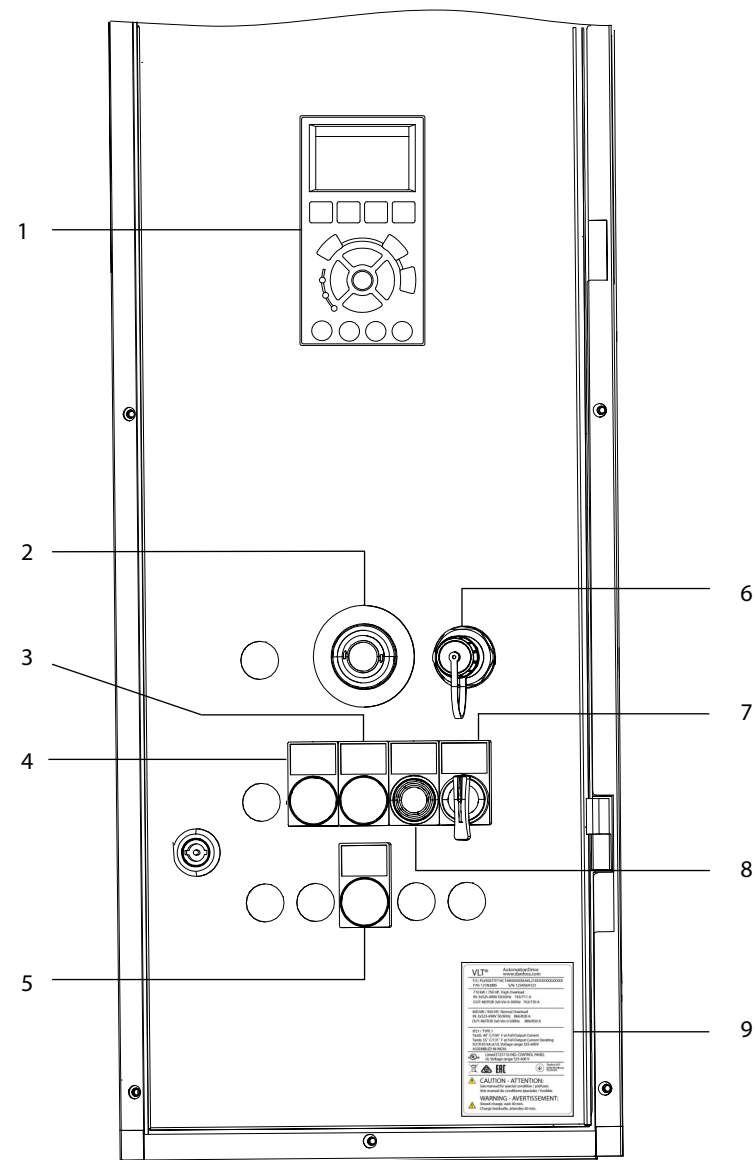
## 3.6 Control Compartment and Local Control Panel

### 3.6.1 Control Compartment Overview

The control compartment is a self-contained space that can be accessed without opening the drive enclosure. The control compartment contains the following:

- Control terminals.
- Relay terminals.
- Terminals for option cards.
- Optional components:
  - Auxiliary supply terminals.
  - Auxiliary voltage transformer connections.
  - +24 V DC external supply.
  - AC customer socket.
  - Extended I/O terminals.
  - Cabinet heater connections.
  - Motor heater control connections.
  - Thermal trip indicator relays.
  - Insulation monitor.
  - Magnetic cabinet light.
- Buttons and indicator lights (on the exterior door).
- Local control panel (LCP).
- Product nameplate.

3.6.2 Control Compartment Door

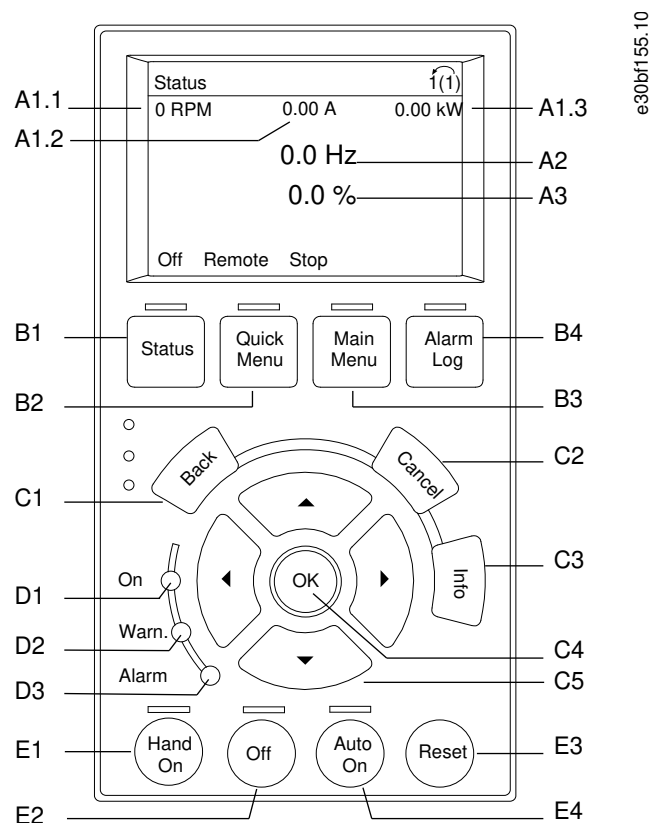


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Illustration 8: Exterior Door of Control Compartment (Shown with All Options)

1	Local control panel (LCP)	6	USB slot
2	Emergency push-button	7	0–1 Start switch
3	Fault indicator light	8	Reset button
4	Run indicator light	9	Nameplate
5	Insulation fault indicator light		

### 3.6.3 Local Control Panel (LCP)



**Illustration 9: 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 33: LCP Display Area**

Callout	Parameter	Default setting
A1.1	<i>Parameter 0-20 Display Line 1.1 Small</i>	Reference [Unit]
A1.2	<i>Parameter 0-21 Display Line 1.2 Small</i>	Analog input 53 [V]
A1.3	<i>Parameter 0-22 Display Line 1.3 Small</i>	Motor current [A]
A2	<i>Parameter 0-23 Display Line 2 Large</i>	Frequency [Hz]
A3	<i>Parameter 0-24 Display Line 3 Large</i>	Feedback [Unit]

#### 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 34: LCP Menu Keys

Callout	Key	Function
B1	Status	Shows operational information.
B2	Quick Menu	Allows access to parameters for initial set-up instructions. Also provides detailed application steps. Refer to <i>Quick Menu mode</i> in the <i>LCP Menu</i> section.
B3	Main Menu	Allows access to all parameters. Refer to <i>Main Menu mode</i> in the <i>LCP Menu</i> 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. The navigation keys also provide speed control in local (hand) operation. The display brightness can be adjusted by pressing [Status] and [▲]/[▼] keys.

Table 35: 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 36: LCP Indicator Lights

Callout	Indicator	LED	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 keys are found toward the bottom of the local control panel.

Table 37: 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.

### 3.6.4 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 Menu] key. The resulting readout appears on the LCP display.

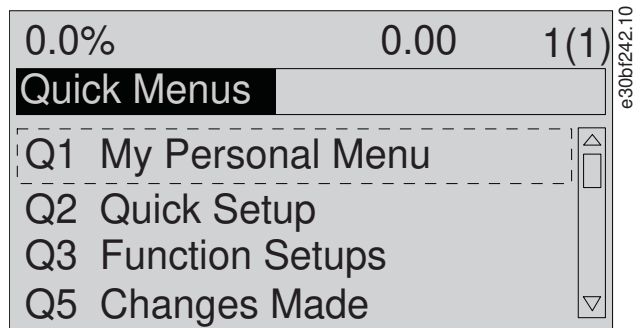


Illustration 10: Quick Menu View

#### Q1 My Personal Menu

The Personal Menu is used to determine what is shown in the display area. Refer to [3.6.3 Local Control Panel \(LCP\)](#). 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 [7.2.4 Entering System Information](#) for the set-up 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 multizone applications.

#### Q4 Smart Setup

Q4 Smart Setup guides the user through typical parameter settings used to configure 1 of the following 4 applications:

- Single pump/motor.
- Motor alternation.
- Master/follower.
- Basic cascade.

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

#### Q5 Changes Made

Select Q5 Changes Made for information about:

- The 10 most recent changes.
- Changes made from 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 38: Logging Parameter Examples

Q6 Loggings	
<i>Parameter 0-20 Display Line 1.1 Small</i>	Reference [Unit]
<i>Parameter 0-21 Display Line 1.2 Small</i>	Analog input 53 [V]
<i>Parameter 0-22 Display Line 1.3 Small</i>	Motor current [A]
<i>Parameter 0-23 Display Line 2 Large</i>	Frequency [Hz]
<i>Parameter 0-24 Display Line 3 Large</i>	Feedback [Unit]

## Q7 Water and Pumps

The parameters found in the Q7 Water and Pumps contain basic data that is necessary for configuring water pump applications.

### Main Menu

The *Main Menu* mode is used to:

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

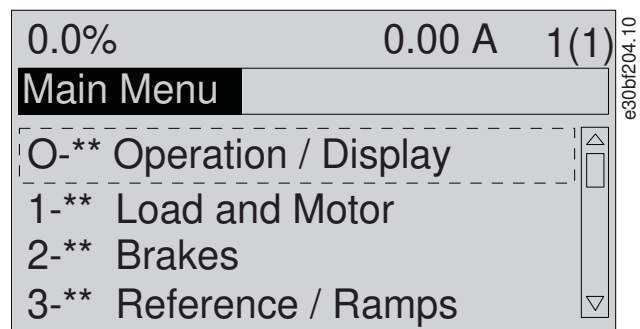


Illustration 11: Main Menu View

## 4 Mechanical Installation

### 4.1 Items Supplied

Items supplied can vary according to product configuration.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- 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 clarification.

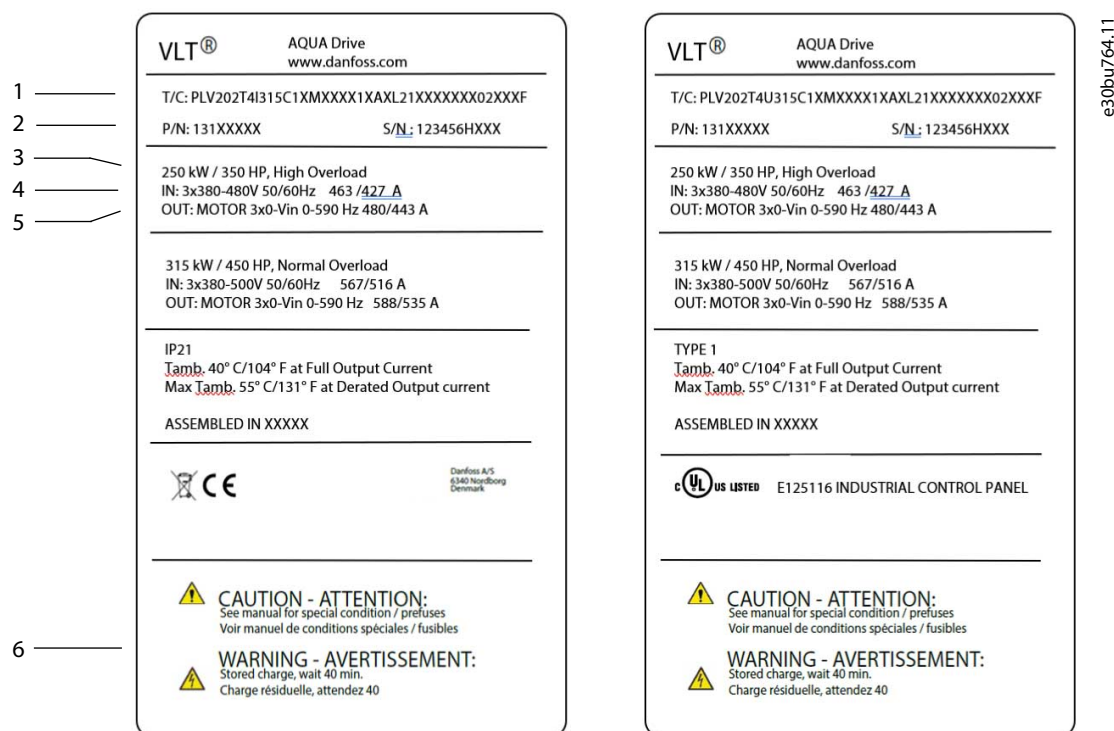


Illustration 12: Example of a Product Nameplate for E6h Enclosure (IEC Version on Left, UL Version on Right)

1	Type code	4	Input voltage, frequency, and current (at low/high voltages)
2	Part number and serial number	5	Output voltage, frequency, and current (at low/high voltages)
3	Power rating	6	Discharge time

## NOTICE

### WARRANTY

Removing the nameplate from the drive results in loss of warranty.

### 4.2 Split Shipment

Depending on what options are ordered with an enclosed drive, the drive can consist of 5 cabinets and measure 3400 mm (134 in) in width, which can be difficult to transport and handle. In cases where an enclosed drive exceeds 1800 mm (71 in) in width, the cabinets are separated and shipped in multiple boxes. All necessary fasteners needed for reassembly are provided in the delivery. To reassemble a split shipment, refer to [4.10 Combining Multiple Cabinets from a Split Shipment](#) and [5.6.1 Connecting Wiring Harnesses](#).

### 4.3 Tools Needed

- I-beam and hooks rated to lift the weight of the drive.
- Crane or other lifting aid to place the unit into position.
- Drill with a 12 mm (1/2 in) drill bit.
- Tape measurer.
- Phillips and flat-bladed screwdrivers.
- Wrench with 7–17 mm metric sockets.
- Wrench extensions.
- T25 and T50 Torx drives.
- Sheet metal punch and/or pliers for cable entry plate.

### 4.4 Storing the Drive

Store the drive in a dry location. Keep the equipment sealed in its packaging until installation. Refer to the *Ambient Conditions* section for recommended ambient temperature.

Periodic forming (capacitor charging) is not necessary during storage unless storage exceeds 12 months.

### 4.5 Operating Environment

#### 4.5.1 Overview

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/NEMA protection rating of the equipment matches the installation environment. Refer to the *Ambient Conditions* section.

#### N O T I C E

##### CONDENSATION

Moisture can condense on the electronic components and cause short circuits.

- Avoid installation in areas subject to frost.
- Install an optional space heater when the unit is colder than the ambient air.
- Operating in standby mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

#### N O T I C E

##### EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

- Do not operate in environments where the ambient temperature exceeds 50 °C (122 °F) for units rated at 400–500 V and 45 °C (113 °F) for units rated at 525–690 V unless the drive is derated. Refer to the *Derating* section in the design guide.
- The unit 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. Also, temperature feedback is not shown when temperatures are below 0 °C (32 °F).
- Provide extra air conditioning for the cabinet or installation site when the temperature exceeds ambient temperature limits.

#### 4.5.2 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.

#### 4.5.3 Dust

When installing the unit in a dusty environment, keep the following free from dust buildup:

- Electronic components.
- Heat sink.
- Fans.

Keep the heat sink and fans free from dust buildup. 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. Dust can also accumulate on fan blades, causing an imbalance which prevents the fan from properly cooling the unit. Dust buildup can also damage fan bearings and cause premature fan failure.

For more information, refer to the *Maintenance and Service* section.

#### 4.5.4 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.

#### 4.6 Installation Requirements

### NOTICE

#### OVERHEATING

Improper mounting can result in overheating and reduced performance.

- Install the drive according to the installation and cooling requirements.

- Locate the unit as near to the motor as possible. For the maximum motor cable length, see [10.5 Motor and Control Cables](#).
- Ensure unit stability by mounting the unit to a solid surface.
- Ensure that the strength of the mounting location supports the unit weight.
- Ensure that there is enough space around the unit for proper cooling. Refer to [10.10 Enclosure Airflow](#).
- Ensure enough access to open the door.
- Ensure cable entry from the bottom.

## 4.7 Cooling Requirements

### NOTICE

#### OVERHEATING

Improper mounting can result in overheating and reduced performance.

- Install the drive following the installation and cooling requirements.

- Ensure that top and bottom clearance for air cooling is provided. Clearance requirement: 225 mm (9 in).
- Provide sufficient airflow flow rate. See [4.8 Airflow Rates](#).
- Consider derating for temperatures starting between 45 °C (113 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level.

The enclosed drive, excluding the input power options cabinet, utilizes a back-channel cooling concept that removes the air used to cool the heat sink. The heat sink cooling air carries approximately 90% of the heat out of the back channel of the drive. Different back-channel cooling kits are available to redirect the airflow based on individual needs.

## 4.8 Airflow Rates

Table 39: Airflow Rates for D9h Enclosure

Cabinet	Back-channel fan [m <sup>3</sup> /hr (cfm)]	Drive module top fan [m <sup>3</sup> /hr (cfm)]	Cabinet door fan [m <sup>3</sup> /hr (cfm)]
PHF/line reactor	450 (265)	–	–
Drive	420 (250)	102 (60)	150 (90)
dU/dt	–	–	–
Sine-wave	900 (530)	–	–
Top entry/top exit	–	–	–

Table 40: Airflow Rates for D10h Enclosure

Cabinet	Back-channel fan [m <sup>3</sup> /hr (cfm)]	Drive module top fan [m <sup>3</sup> /hr (cfm)]	Cabinet door fan [m <sup>3</sup> /hr (cfm)]
PHF/line reactor	515 (303)	–	–
Input options	–	–	510 (310)
Drive	840 (500)	204 (120)	315 (185)
dU/dt	–	–	–
Sine-wave	900 (530)	–	–
Top entry/top exit	–	–	–

Table 41: Airflow Rates for E5h Enclosure

Cabinet	Back-channel fan [m <sup>3</sup> /hr (cfm)]	Drive module top fan [m <sup>3</sup> /hr (cfm)]	Cabinet door fan [m <sup>3</sup> /hr (cfm)]
PHF/line reactor	765 (450)	–	–
Input options	–	–	510 (310)
Drive	994 (585)	595 (350)	335 (200)

Cabinet	Back-channel fan [m <sup>3</sup> /hr (cfm)]	Drive module top fan [m <sup>3</sup> /hr (cfm)]	Cabinet door fan [m <sup>3</sup> /hr (cfm)]
dU/dt	665 (392)	–	–
Sine-wave	2x900 (530)	–	–
Top entry/top exit	–	–	–

Table 42: Airflow Rates for E6h Enclosure

Cabinet	Back-channel fan [m <sup>3</sup> /hr (cfm)]	Drive module top fan [m <sup>3</sup> /hr (cfm)]	Cabinet door fan [m <sup>3</sup> /hr (cfm)]
PHF/line reactor	1285 (755)	–	–
Input options	–	–	510 (310)
Drive	1053–1206 (620–710)	629 (370)	430 (255)
dU/dt	665 (392)	–	–
Sine-wave	2x900 (530)	–	–
Top entry/top exit	–	–	–

## 4.9 Lifting the Drive

### ⚠ WARNING ⚠

#### HEAVY WEIGHT

The drive is heavy. 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.
- Ensure that the angle from the top of the drive to the lifting cable is 65° or greater.
- Test lift the drive approximately 610 mm (24 in) to verify the proper center of gravity lift point. Reposition the lifting point if the unit is not level.
- Never walk under suspended loads.

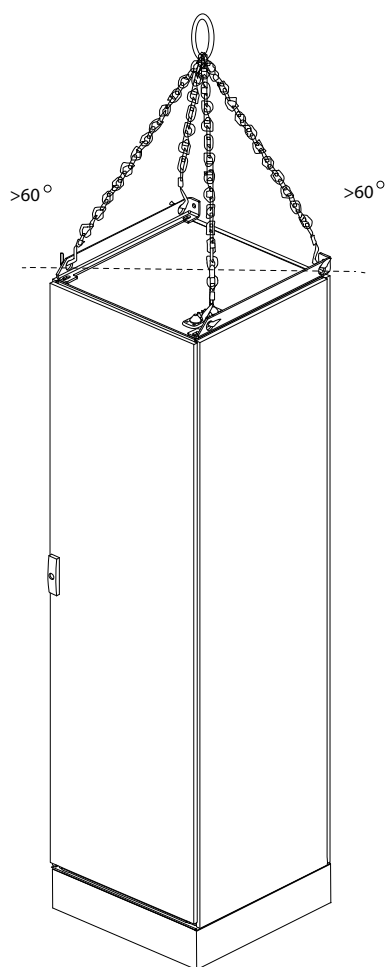


Illustration 13: Recommended Lifting Method

## 4.10 Combining Multiple Cabinets from a Split Shipment

### Procedure

1. Make sure the cabinets are in the right order and place them side by side. For the proper order, refer to [3.2 What is an Enclosed Drive?](#).
2. Attach the cabinets to one another:
  - a. Remove the Rittal back cover from each cabinet.
  - b. Secure the back side of the cabinets to one another using the back brackets. See [Illustration 14](#).
  -

- c. Secure the front side of the cabinets to one another using the front brackets. See [Illustration 14](#).
- d. Secure the lifting eyelets to the top of the cabinets. See [Illustration 15](#).
- e. Join the grounding bars using the connector piece (see the shaded piece in [Illustration 16](#)).

### Example

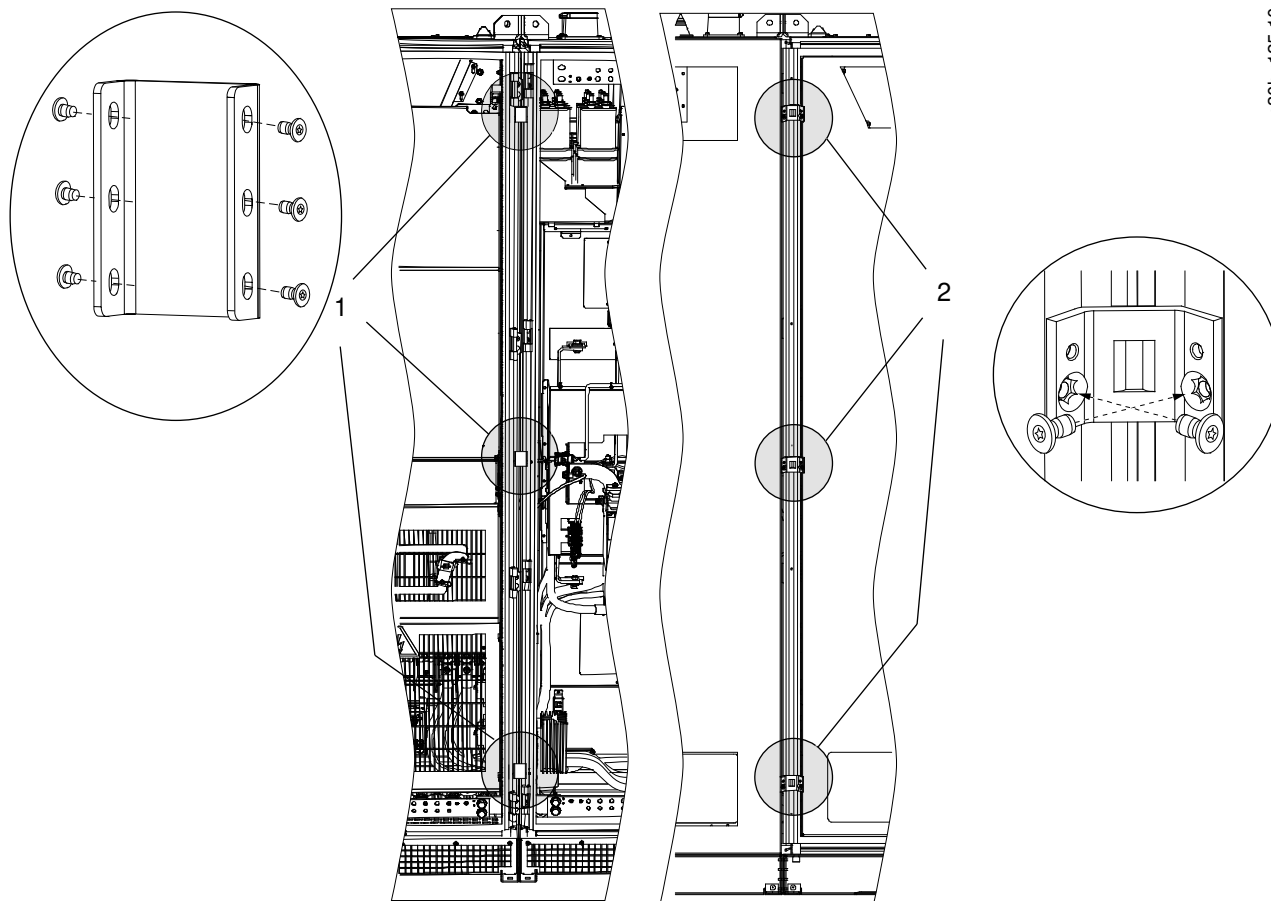


Illustration 14: Bracket Mounting Points for Cabinets

- |   |                |
|---|----------------|
| 1 | Front brackets |
| 2 | Back brackets  |

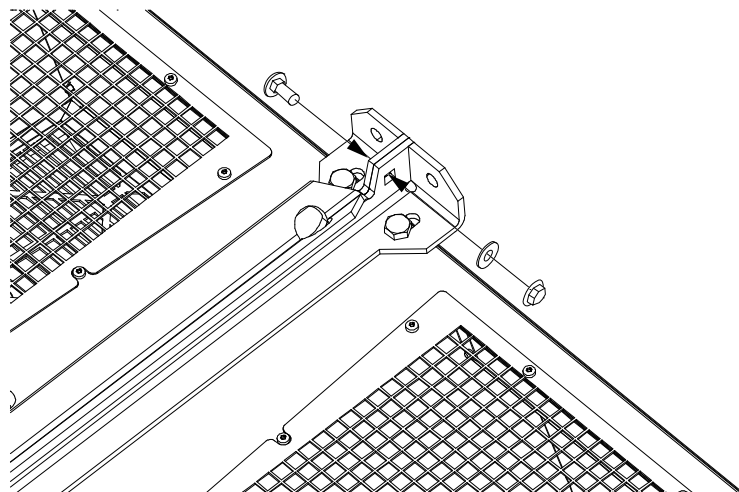
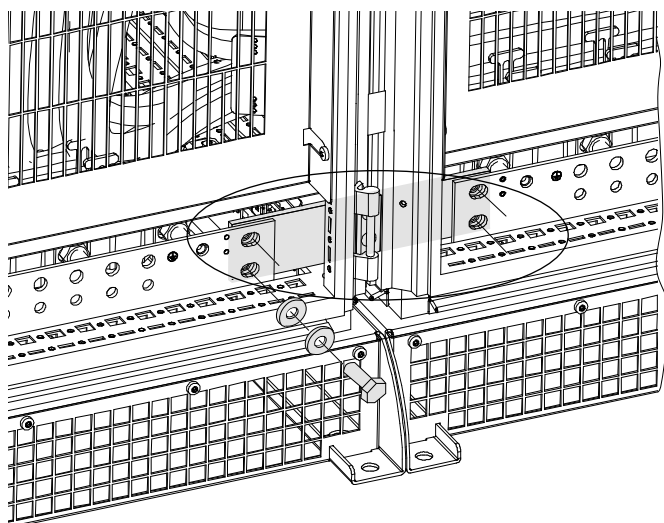


Illustration 15: Connecting the Lifting Eyelet Between Cabinets



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Illustration 16: Connecting the Grounding Bar Between Cabinets

## 4.11 Installing the Enclosed Drive

### 4.11.1 Creating an Entry for Cables

#### Procedure

1. Locate the cabinets that contain the motor and mains terminals.
2. Open the cabinet doors and remove any protective covers placed over the terminals.
3. Cut or drill openings in the cable entry plate and fit with appropriate Type-rated IEC/UL conduits, according to the mains and motor cable sizes.
4. Terminate the shields properly.

### 4.11.2 Installing the Drive with Back-channel Cooling Option

#### Procedure

1. Select an area in which to install the enclosure. Do not install the enclosure in an airtight space. The drive receives approximately 5–10% of intake air from the front of the cabinet.
2. Measure the duct openings in the back of the cabinets and create corresponding openings in the wall where the enclosure will be located.
3. If the enclosed drive is configured with a cabinet heater, connect the cabinet heater supply cable to the correct terminals in the control compartment. Refer to [5.7.2 Control Compartment Interior View](#).
4. Move the enclosure near the wall, lining up the enclosure ducts with the openings in the wall.

5. Make sure to provide an airtight seal for between the duct and wall opening.

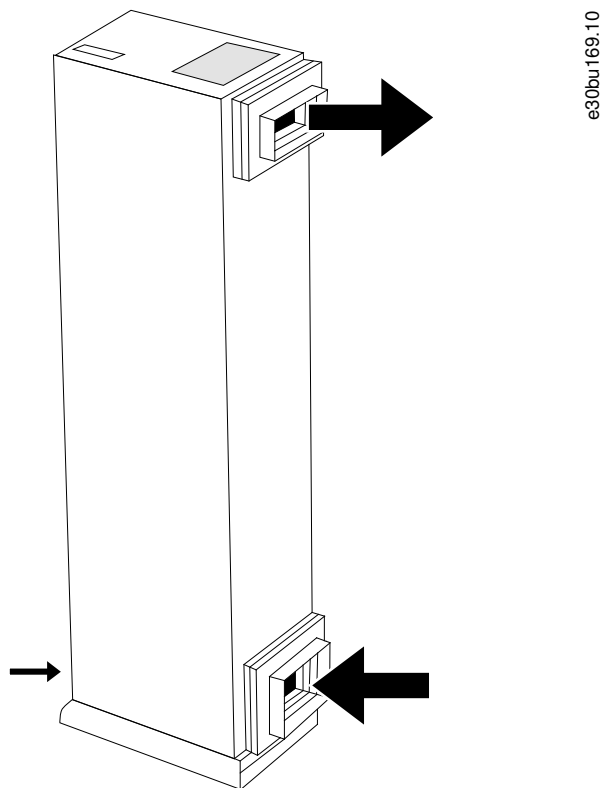
**Example**

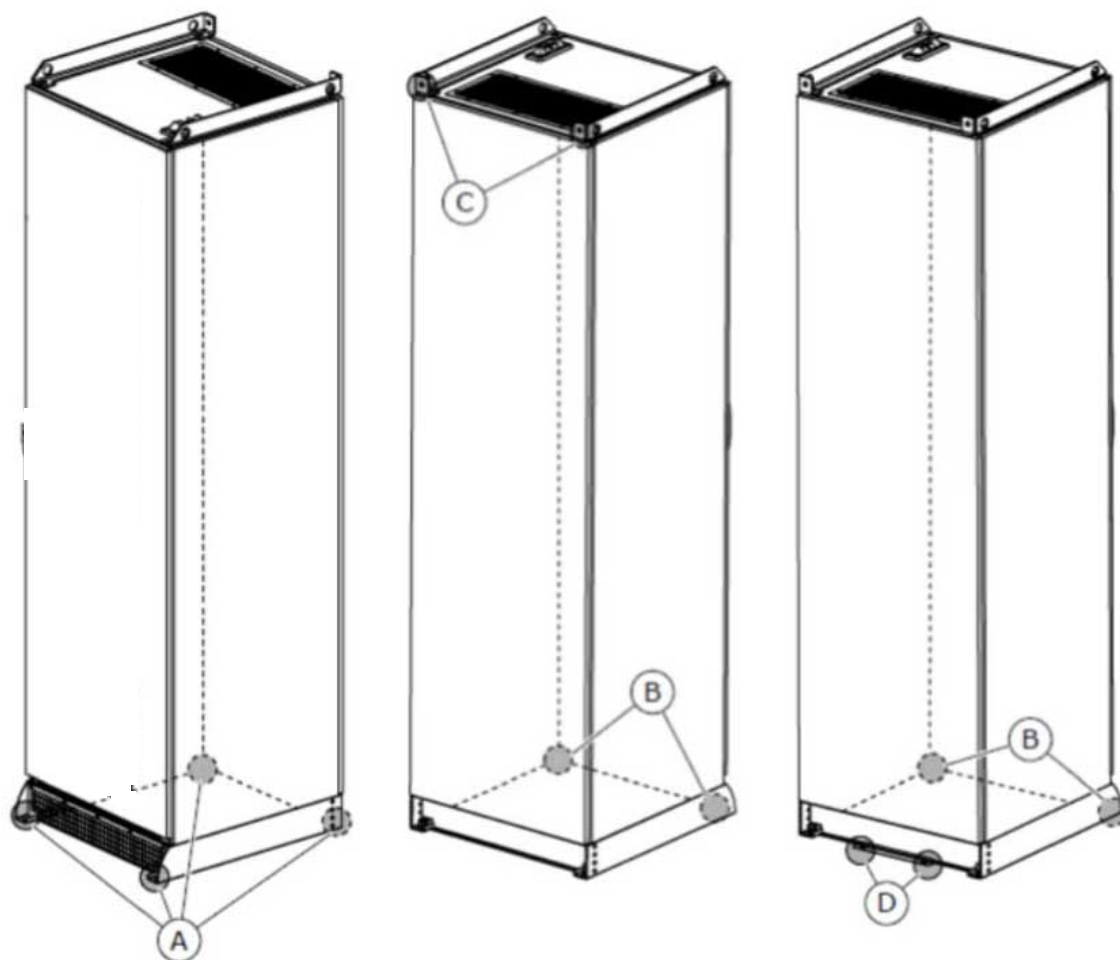
Illustration 17: Cabinet Airflow with the Back-channel Option (Duct Adapter Flanges not Provided with Option)

#### 4.11.3 Securing the Cabinet(s) to the Floor

There are 3 methods to secure the cabinet to the floor:

- Use the 4 mounting points at the base of the pedestal.
- Use the 2 mounting points at the front base of the pedestal and the 2 mounting points at the upper back of the cabinet.
- Use the 2 mounting points in the mounting bracket and the 2 mounting points at the front base of the pedestal.  
To use the mounting bracket, first attach it to the floor by sliding the edge of the cabinet pedestal under the mounting bracket. Then secure the 2 mounting holes to the front base of the pedestal.

## Example



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Illustration 18: Cabinet Mounting Points

A	The 4 mounting points at the base of the pedestal	C	The 2 mounting points at the upper back of the cabinet
B	The 2 mounting points at the front base of the pedestal	D	The 2 mounting points in the mounting bracket

## 5 Electrical Installation

### 5.1 Safety Instructions

See the *Safety Precautions* section for general safety warnings.

#### 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.

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

#### NOTICE

##### WIRE TYPE AND RATINGS

All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements. For power connections, minimum 75 °C (167 °F) rated copper wire is recommended. Refer to the *Specifications* chapter.

#### ⚠ WARNING ⚠

##### INDUCED VOLTAGE

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

- Run output motor cables separately or use shielded cables.
- Simultaneously lock out all the drives.

#### ⚠ WARNING ⚠

##### SHOCK HAZARD

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

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

#### NOTICE

##### PROPERTY DAMAGE

Protection against motor overload is not included in the default setting. For the North American market, the ETR function provides class 20 motor overload protection in accordance with NEC. Failure to set the ETR function means that motor overload protection is not provided and property damage can occur if the motor overheats.

- Enable the ETR function by setting *parameter 1-90 Motor Thermal Protection* to [ETR trip] or [ETR warning].

### 5.2 EMC-compliant Installation

To obtain an EMC-compliant installation, be sure to follow all electrical installation instructions.

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 by securely fastening 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 rated protective extra low voltage (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.
- Provide a minimum 200 mm (7.9 in) separation between mains input, motor cables, and control cables.

## NOTICE

### **INSTALLATION AT HIGH ALTITUDE**

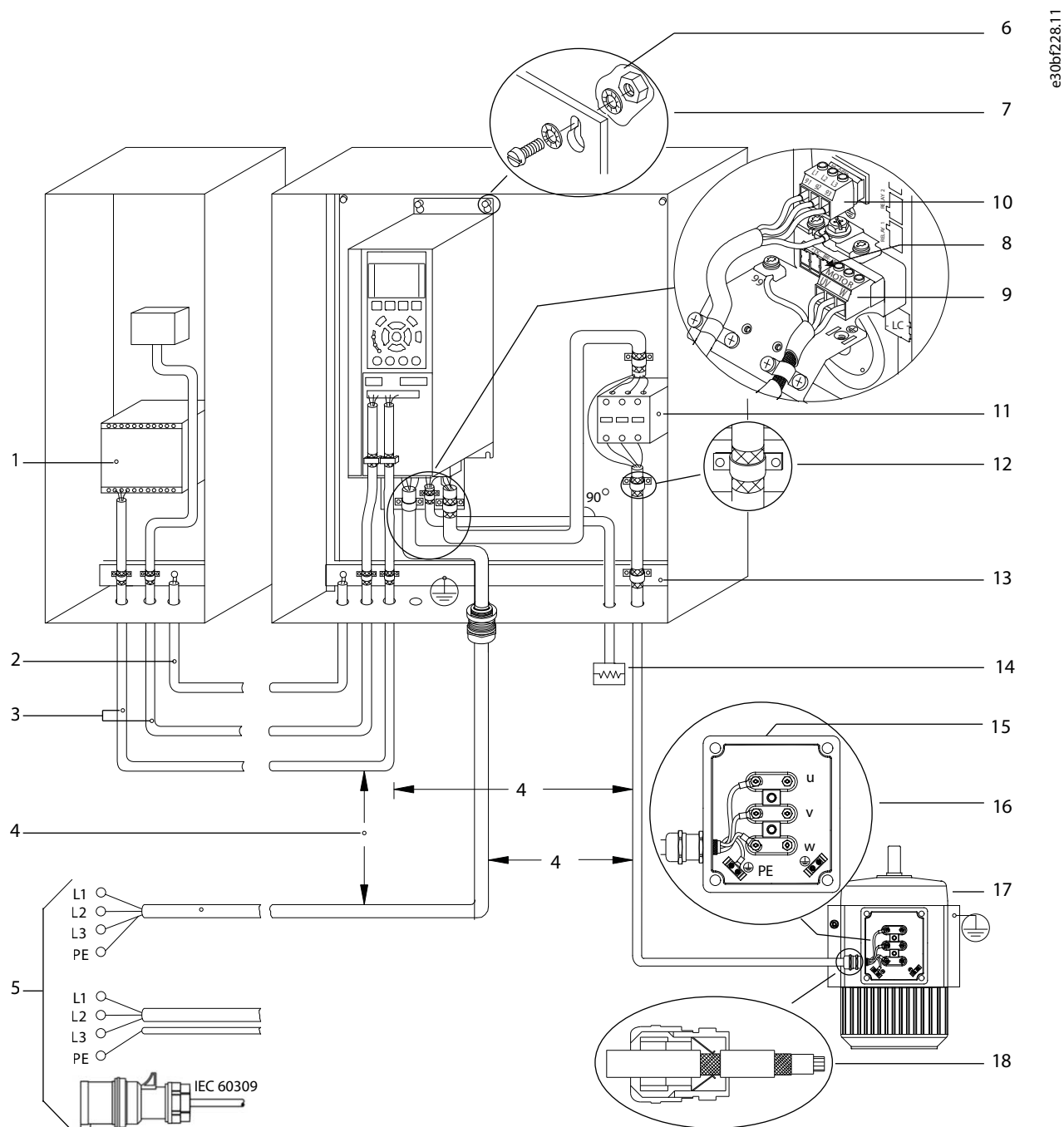
There is a risk for overvoltage. Isolation between components and critical parts could be insufficient and may not comply with PELV requirements.

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

## NOTICE

### **PROTECTIVE EXTRA LOW VOLTAGE (PELV) COMPLIANCE**

Prevent electric shock by using PELV electrical supply and complying with local and national PELV regulations.



### Illustration 19: Example of Proper EMC Installation

1	Programmable logic controller (PLC)	10	Mains cable (unshielded)
2	Minimum 16 mm <sup>2</sup> (6 AWG) equalizing cable	11	Output contactor, and so on
3	Control cables	12	Cable insulation stripped
4	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables	13	Common ground busbar. Follow local and national requirements for cabinet grounding
5	Mains supply options, see IEC/EN 61800-5-1	14	Brake resistor
6	Bare (unpainted) surface	15	Terminal box
7	Star washers	16	Connection to motor
8	Brake cable (shielded) – not shown, but same grounding principle applies as for motor cable	17	Motor
9	Motor cable (shielded)	18	EMC cable gland

## N O T I C E

### EMC INTERFERENCE

Use shielded cables for motor and control wiring, and separate cables for input power, motor wiring, and control wiring. Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance. Minimum 200 mm (7.9 in) clearance is required between power, motor, and control cables.

## 5.3 Wiring Overview for D9h and D10h Enclosed Drives

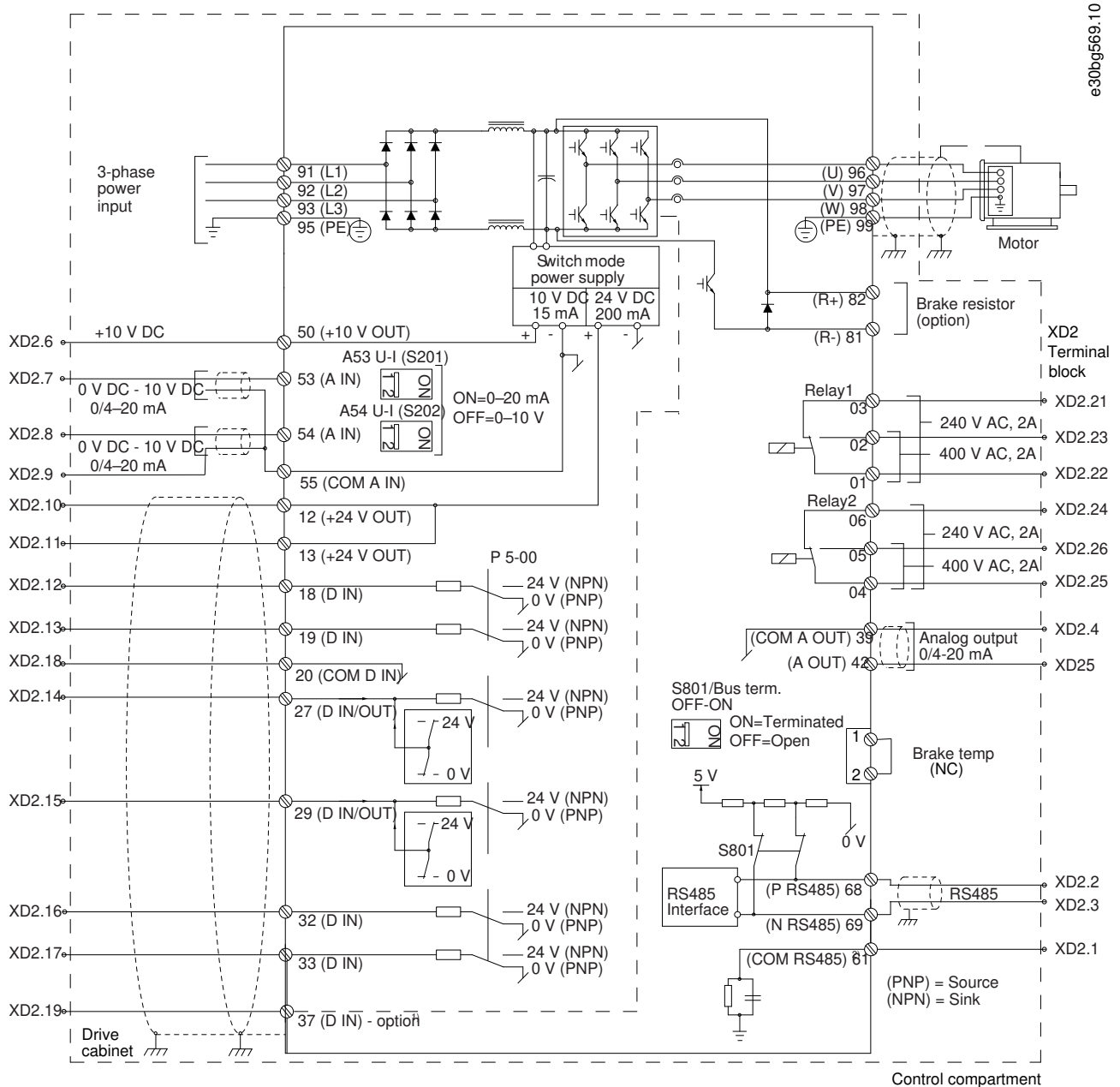


Illustration 20: Basic Wiring Overview for Enclosures D9h and D10h

1

Terminal 37 (optional) is used for Safe Torque Off. Refer to the VLT® FC Series - Safe Torque Off Operating Guide for installation instructions.

## 5.4 Wiring Overview for E5h and E6h Enclosed Drives

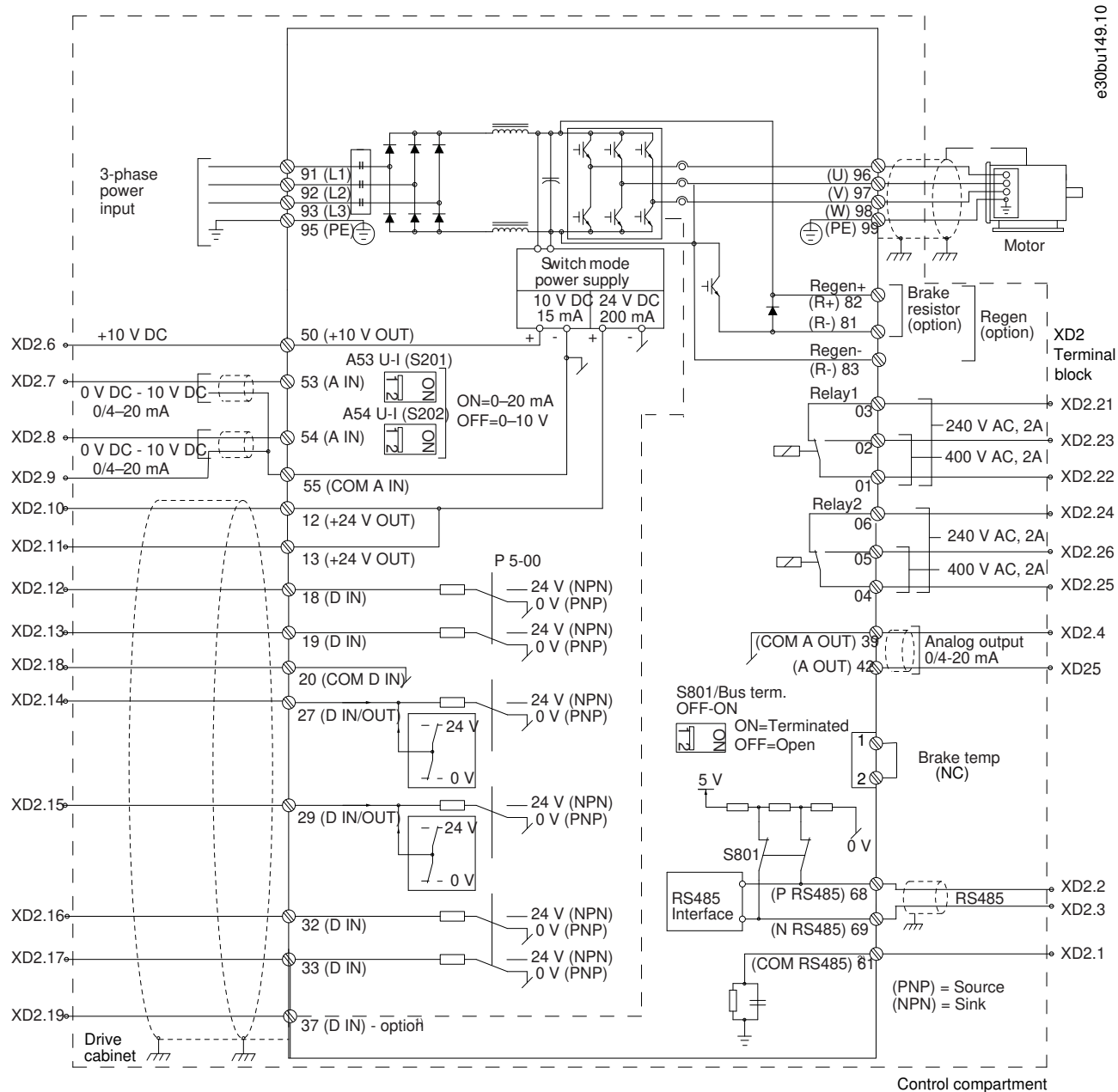


Illustration 21: Basic Wiring Overview for Enclosures E5h and E6h

- 1 Terminal 37 (optional) is used for Safe Torque Off. Refer to the VLT® pFC Series - Safe Torque Off Operating Guide for installation instructions.

## 5.5 Control Terminal Wiring Diagram Cross-reference

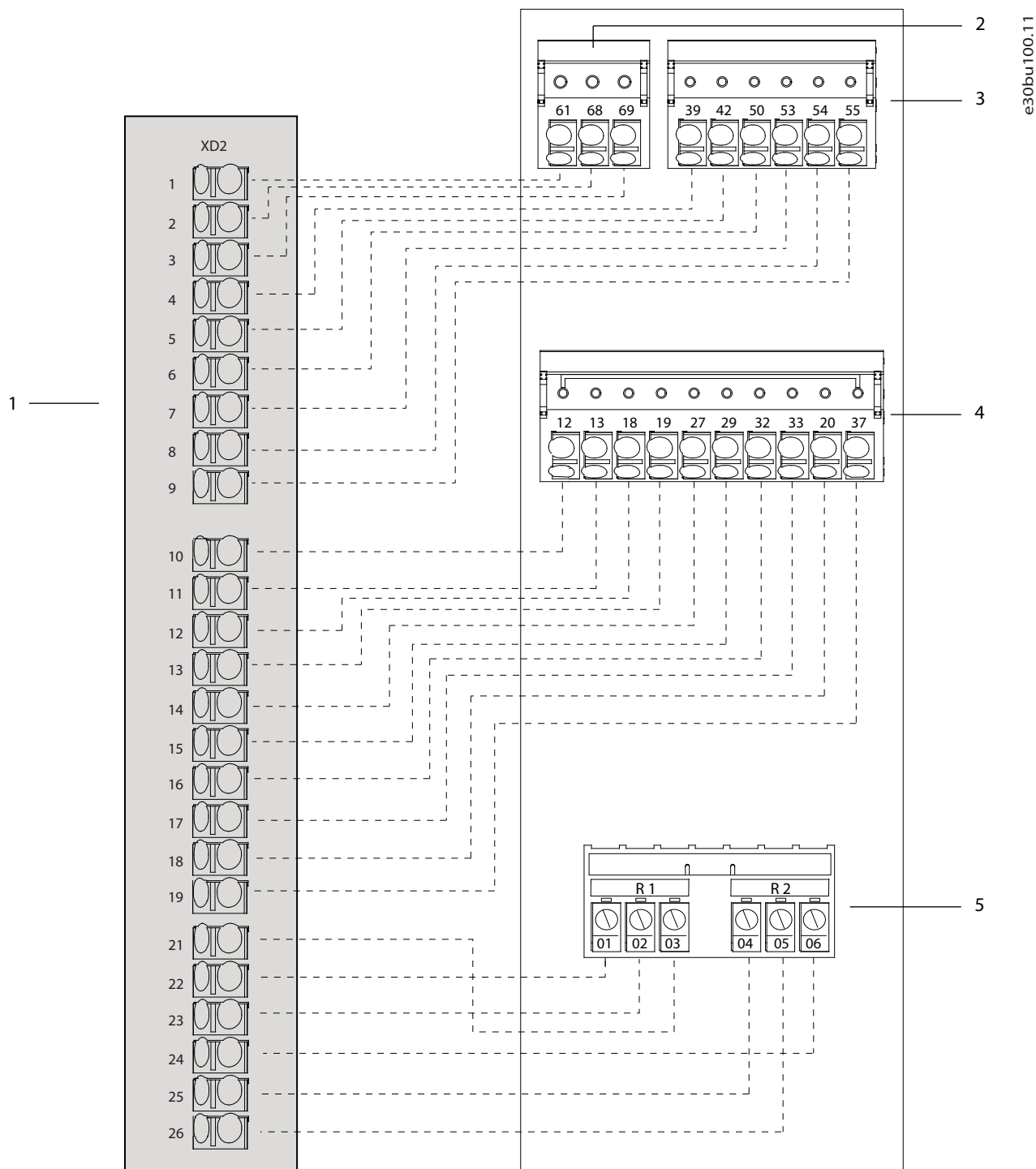


Illustration 22: Serial Communication, Digital Input/Output, Analog Input/Output, and Relay Terminals Cross-reference

1	User-accessible terminals (control compartment)	4	Digital input/output terminals (drive module)
2	Serial communication terminals (drive module)	5	Relay terminals (drive module)
3	Analog input/output terminals (drive module)		

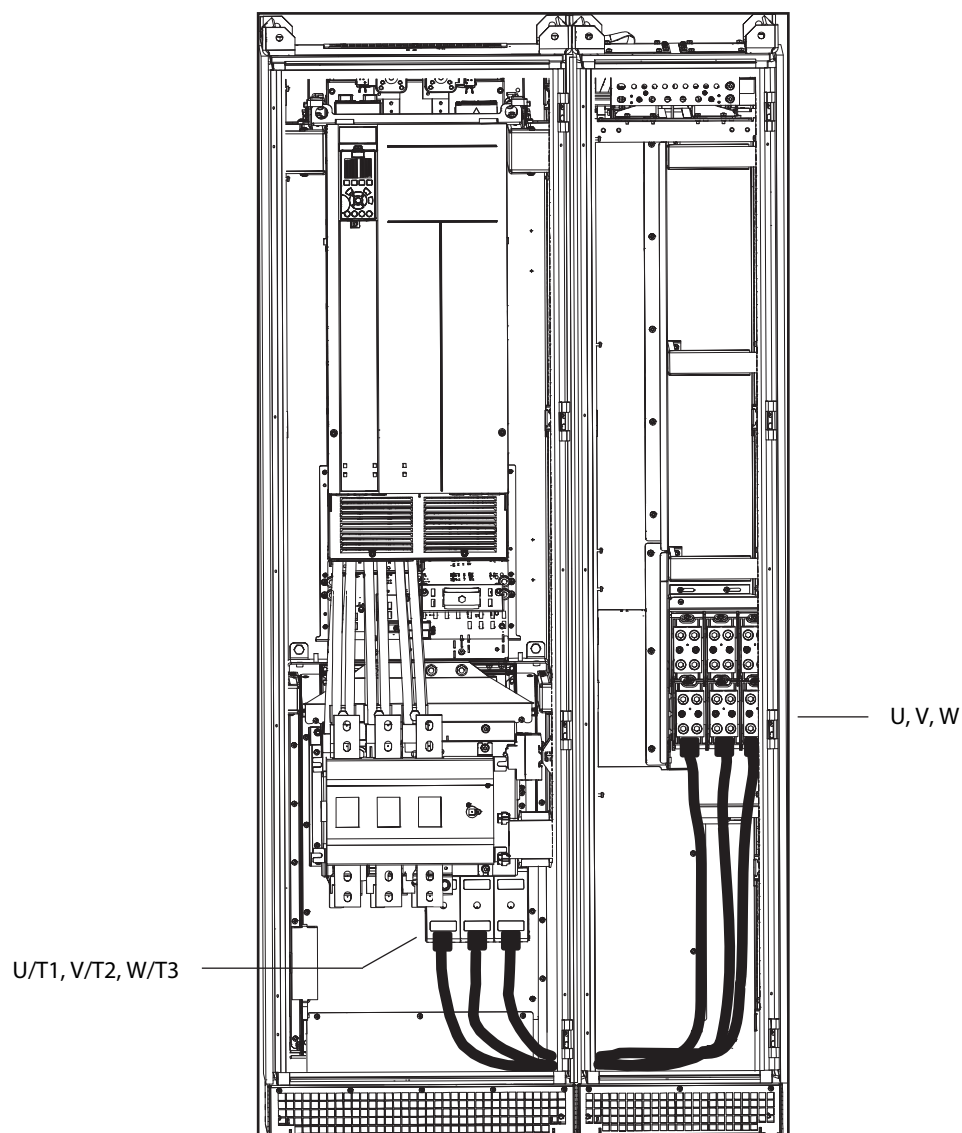
## 5.6 Split Shipment Wiring Harnesses

### 5.6.1 Connecting Wiring Harnesses

#### Procedure

1. Follow the recommended cable routing between cabinets, if applicable. See the *Cable Routing* section.
2. Connect the wiring harnesses according to how the enclosed drive is split. Each wiring harness in the enclosed drive is labeled. Refer to the illustrations in the appropriate wiring harness sections.
  - a. Connect the fan supply wiring harness.
  - b. Connect the thermal protection harness.
  - c. If applicable, connect the PHF contactor harnesses.
  - d. If applicable, connect the cabinet heater harness.
3. Connect the output filter cables. Refer to the illustrations in the appropriate wiring harness sections.
  - For the sine-wave filter option, there is 1 set of cables for each sine-wave filter. One end of each cable is already connected to the filter, the other end is bundled in the sine-wave filter cabinet. Connect the unattached sine-wave cable ends to the motor terminals inside the drive cabinet.
  - For the dU/dt filter option, the unattached filter cables are bundled inside the dU/dt filter cabinet. Connect the unattached cable ends to the motor terminals within the drive cabinet.
4. Connect the input filter cables. Refer to the illustrations in the appropriate wiring harness sections.
  - For the passive harmonic filter (PHF) option, the filter cables are bundled inside the input filter cabinet. First connect the unattached PHF cable ends (R/S/T) to the corresponding terminals in the input power options cabinet. Then connect the unattached PHF cable ends (L1R/L2S/L3T) to the R/S/T terminals in the drive cabinet.
  - For the line reactor option, the line reactor cables are bundled inside the input filter cabinet. First connect the unattached line reactor cable ends (R/S/T) to the corresponding terminals in the input power options cabinet. Then connect the unattached line reactor cable ends (L1R/L2S/L3T) to the R/S/T terminals in the drive cabinet.

## 5.6.2 Cable Routing



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Illustration 23: Cable Routing for Top Exit Cabinet to Drive Cabinet

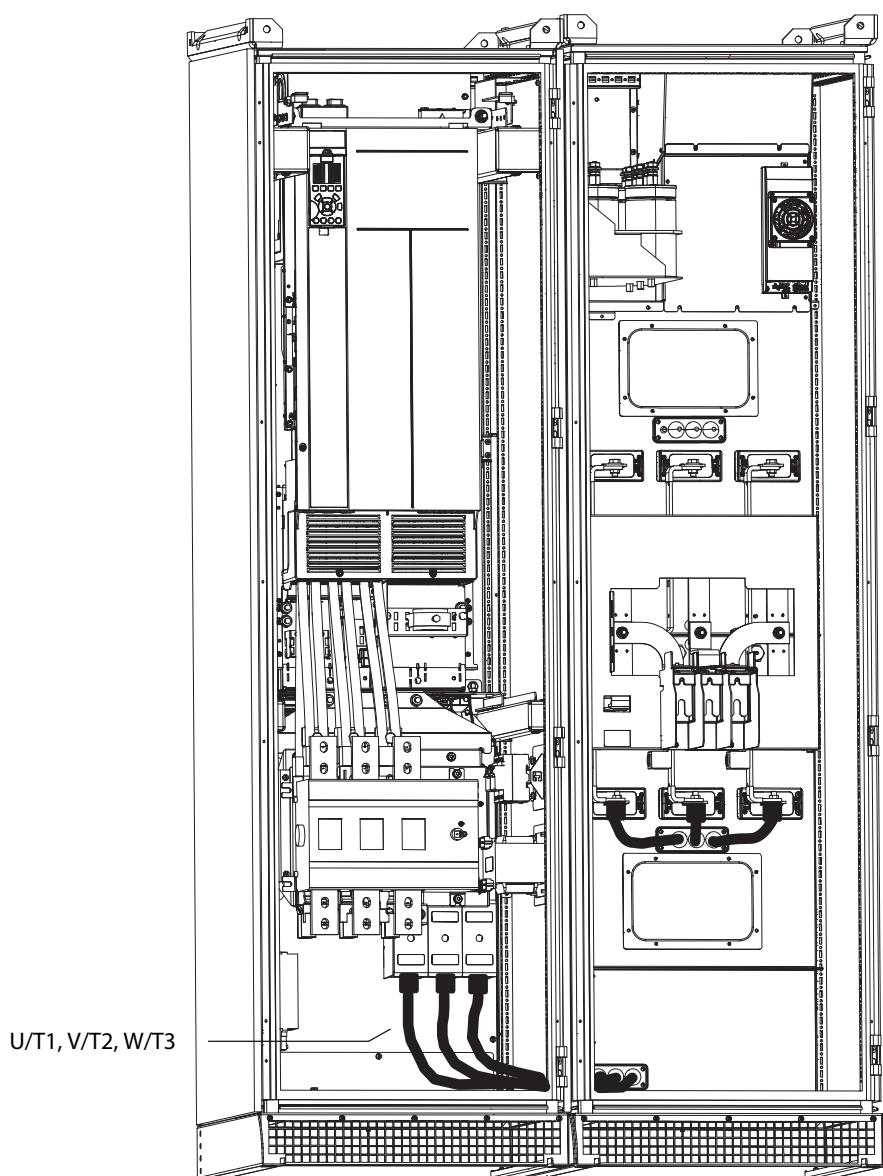
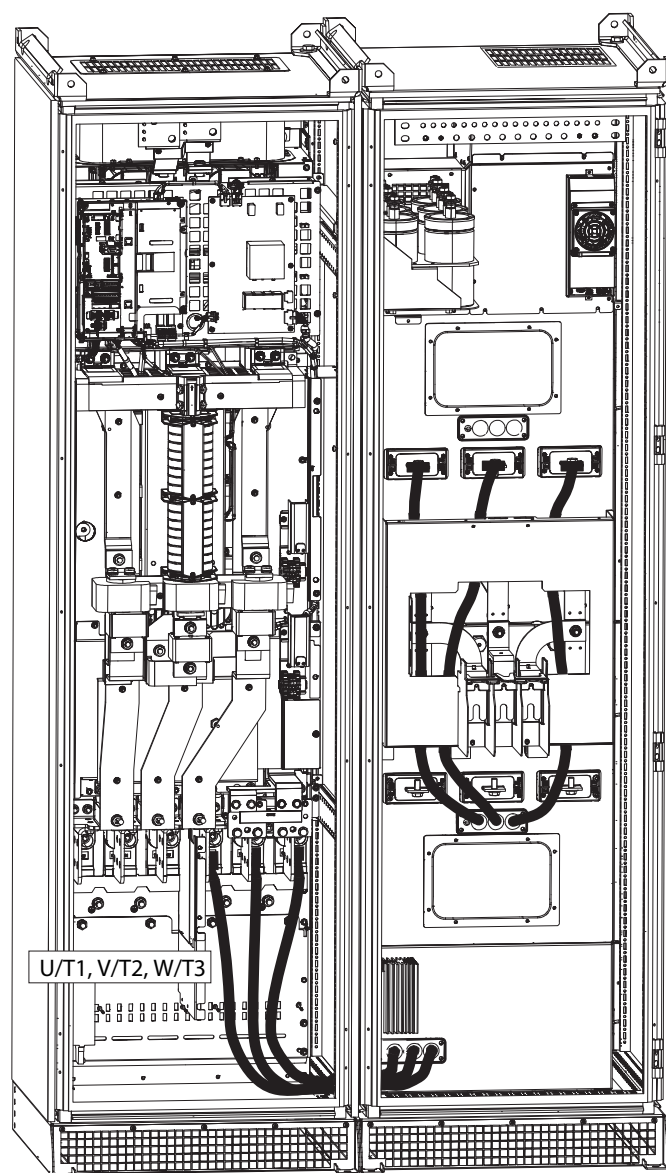
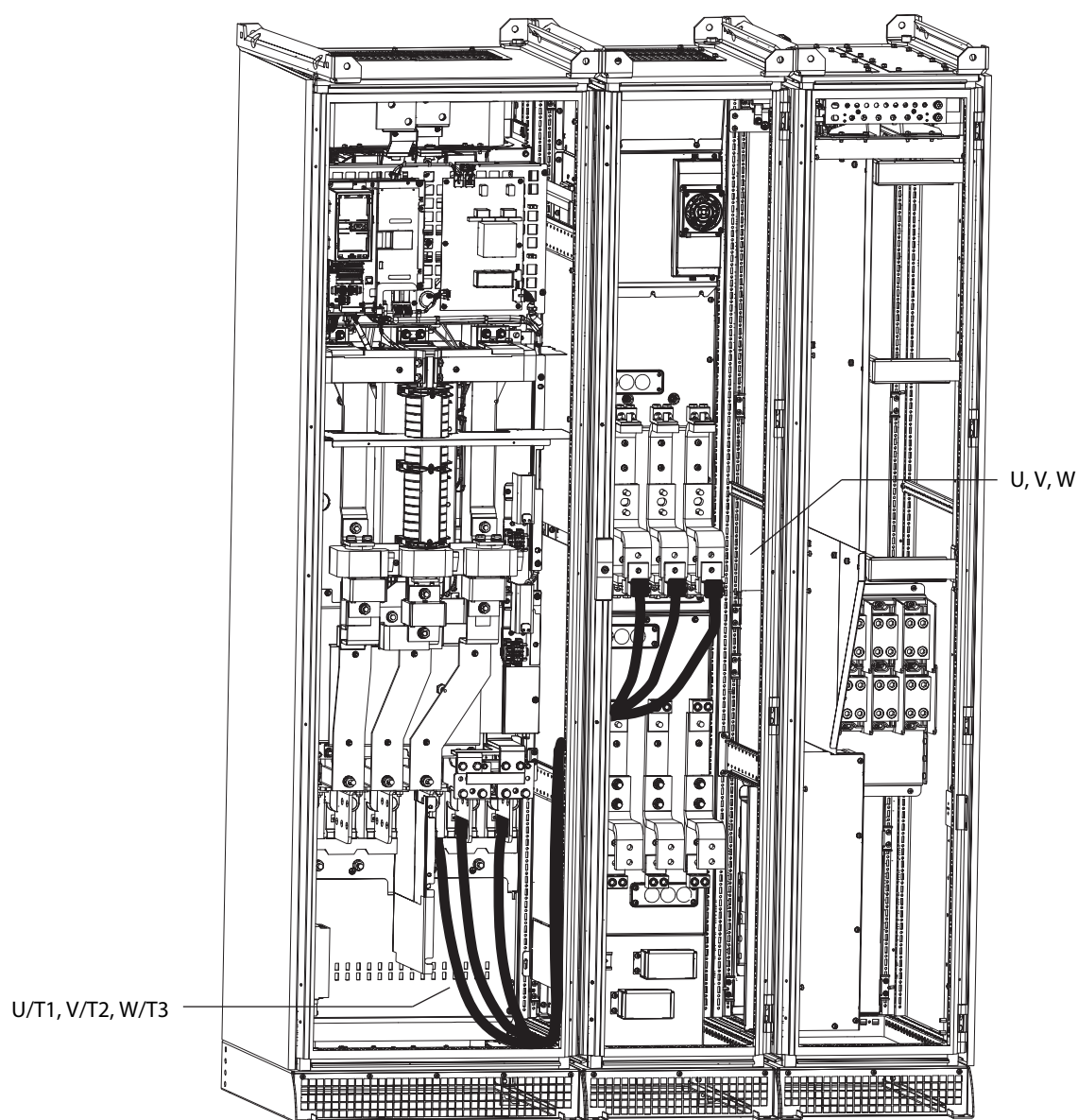


Illustration 24: Cable Routing for Sine-wave Cabinet to D10h Drive Cabinet



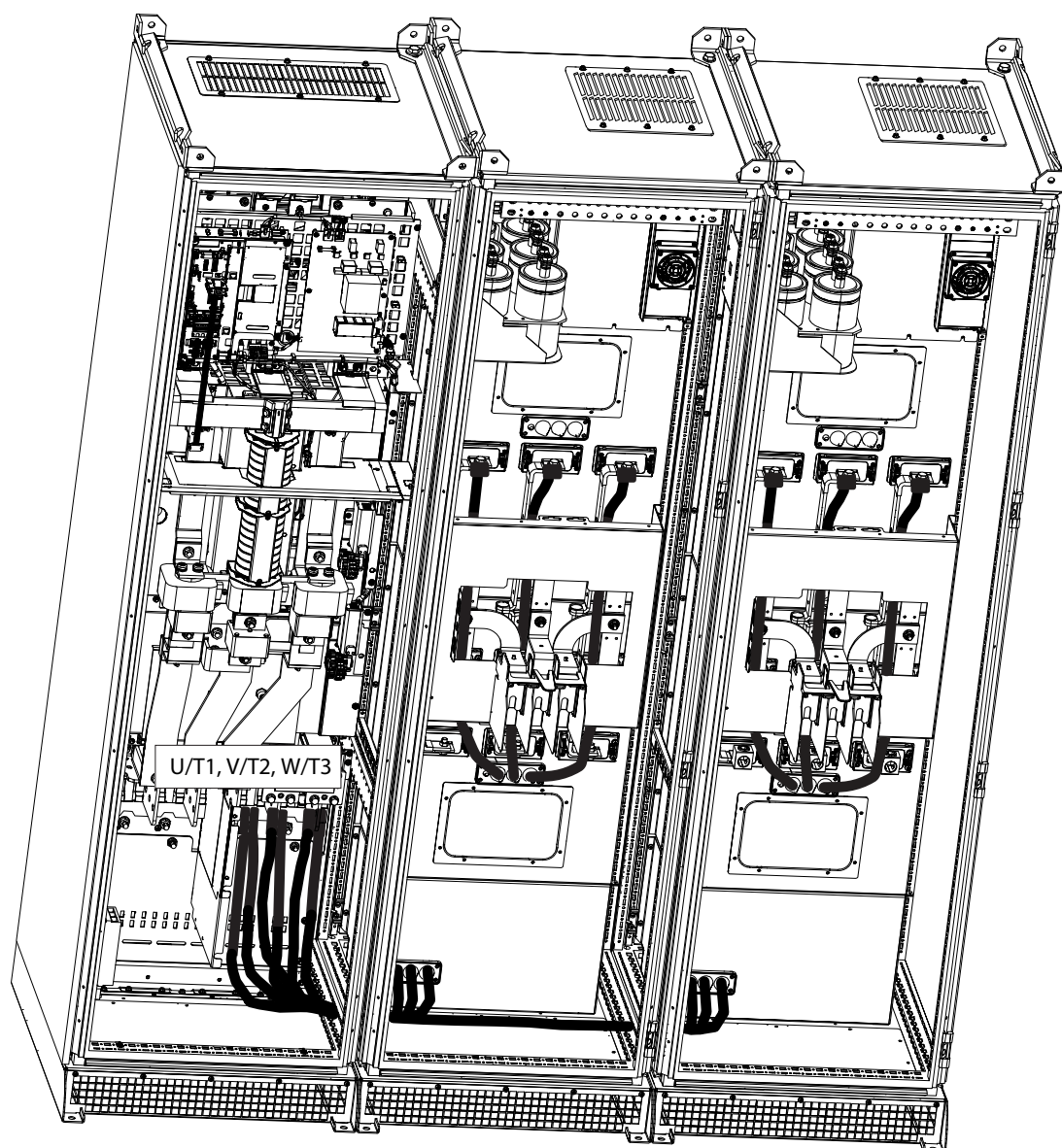
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Illustration 25: Cable Routing for Sine-wave Cabinet to E5h or E6h Drive Cabinet



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Illustration 26: Cable Routing for dU/dt Cabinet with Top Exit to E5h or E6h Drive Cabinet



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Illustration 27: Cable Routing for 2 Sine-wave Cabinets to E5h or E6h Drive Cabinet

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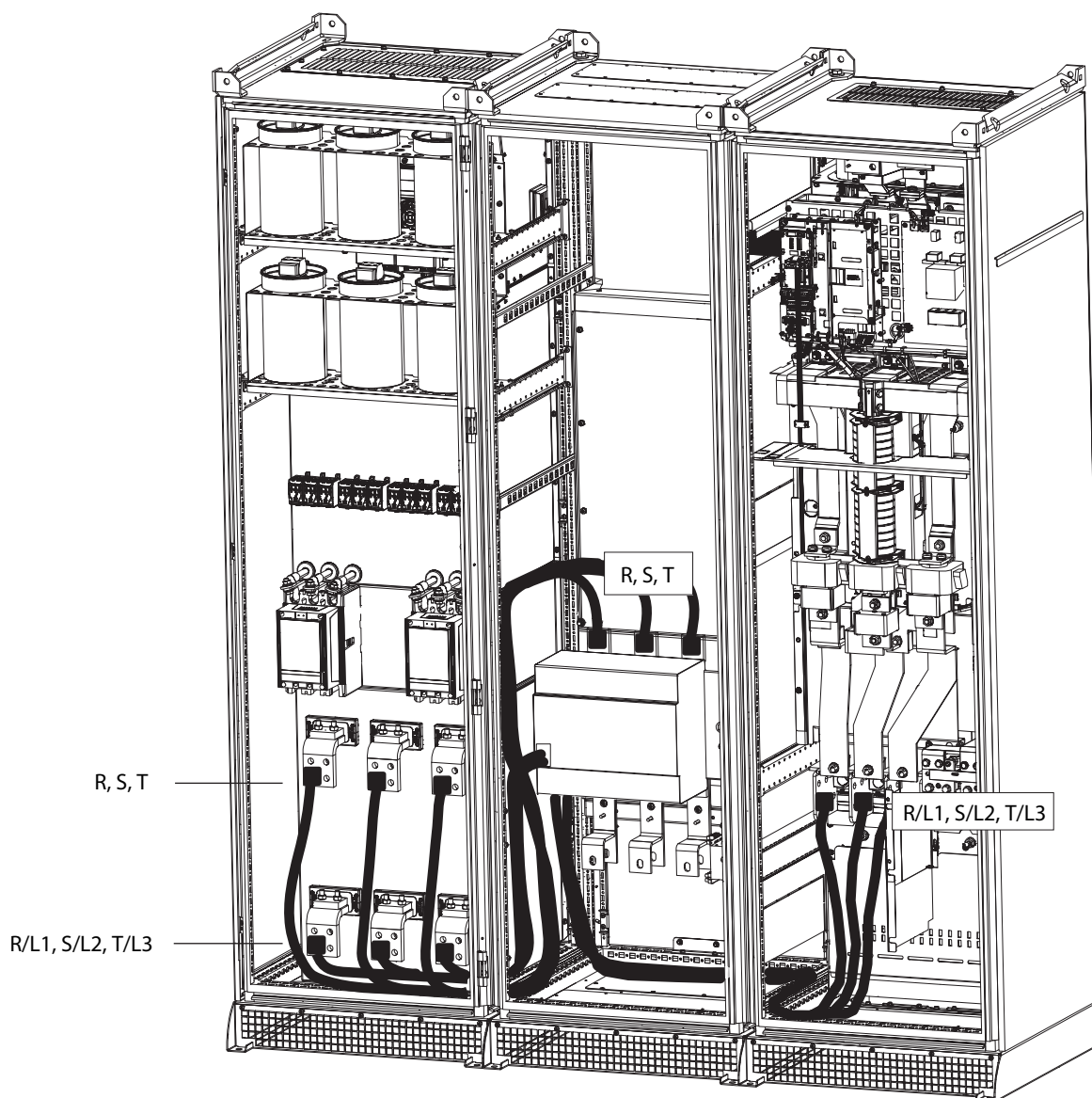
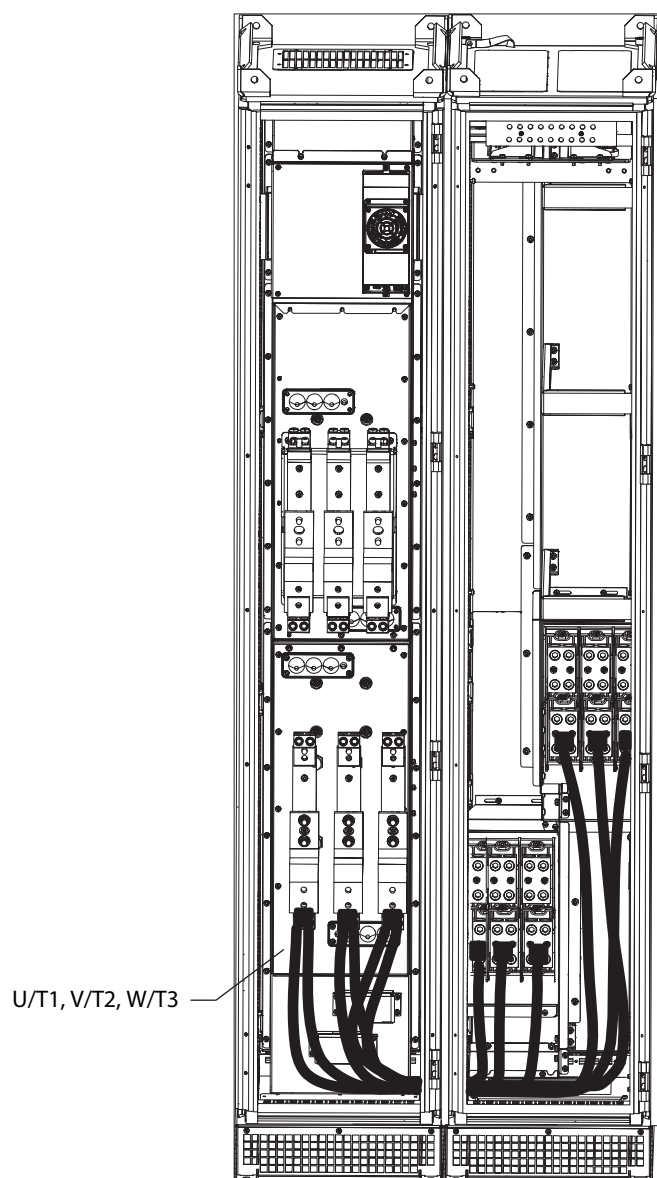
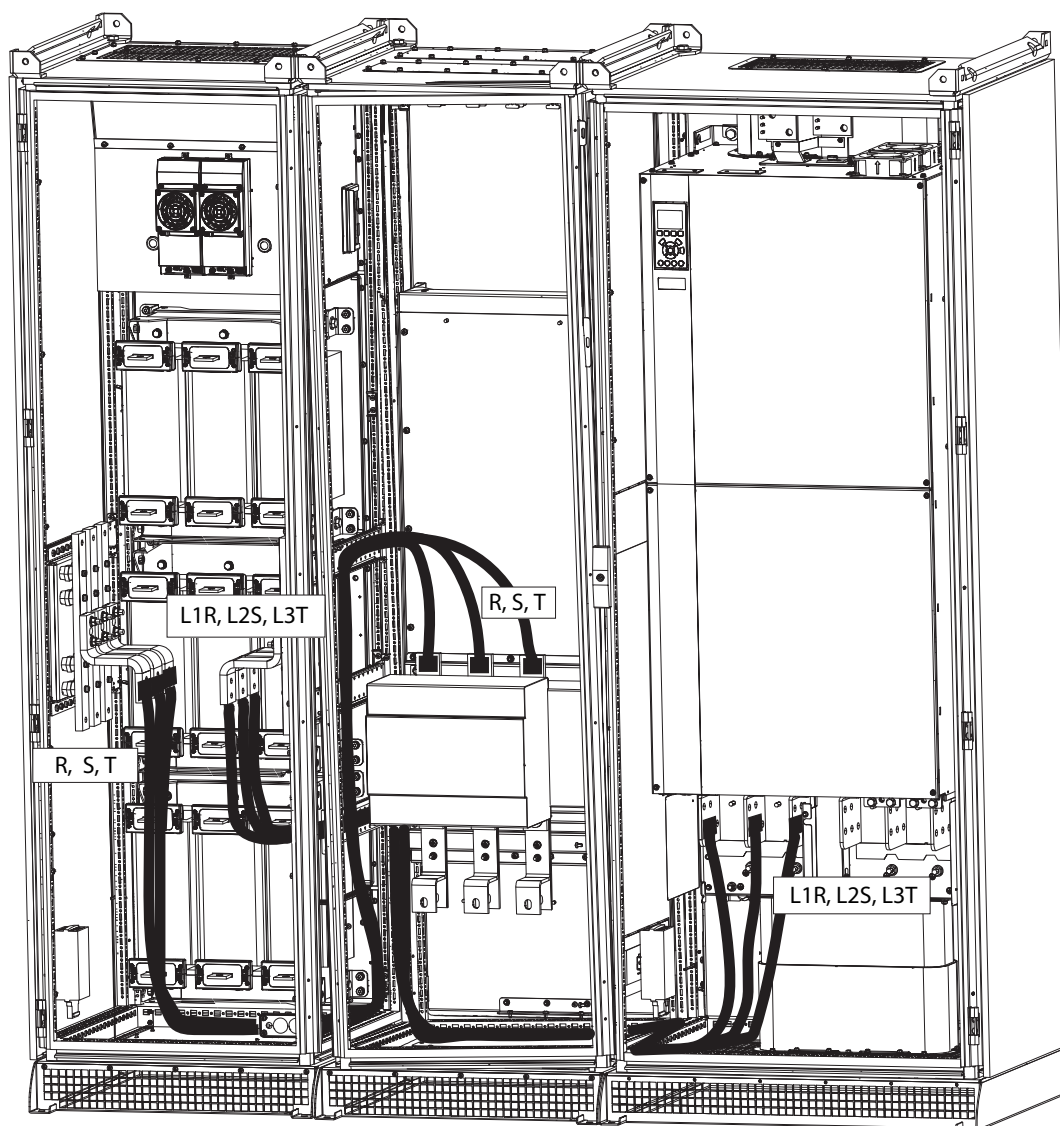


Illustration 28: Cable Routing for PHF Cabinet to E5h or E6h Drive Cabinet



e30bu863.10

Illustration 29: Cable Routing for dU/dt Cabinet to Top Exit Cabinet for E5h or E6h



e30bu873.10

Illustration 30: Cable Routing for Line Reactor Cabinet to Input Power Options Cabinet and E6h Drive Cabinet (Internal Wiring Connection Between Inductors in the Line Reactor Cabinet Is Not Shown)

## 5.6.3 D10h Wiring Harness

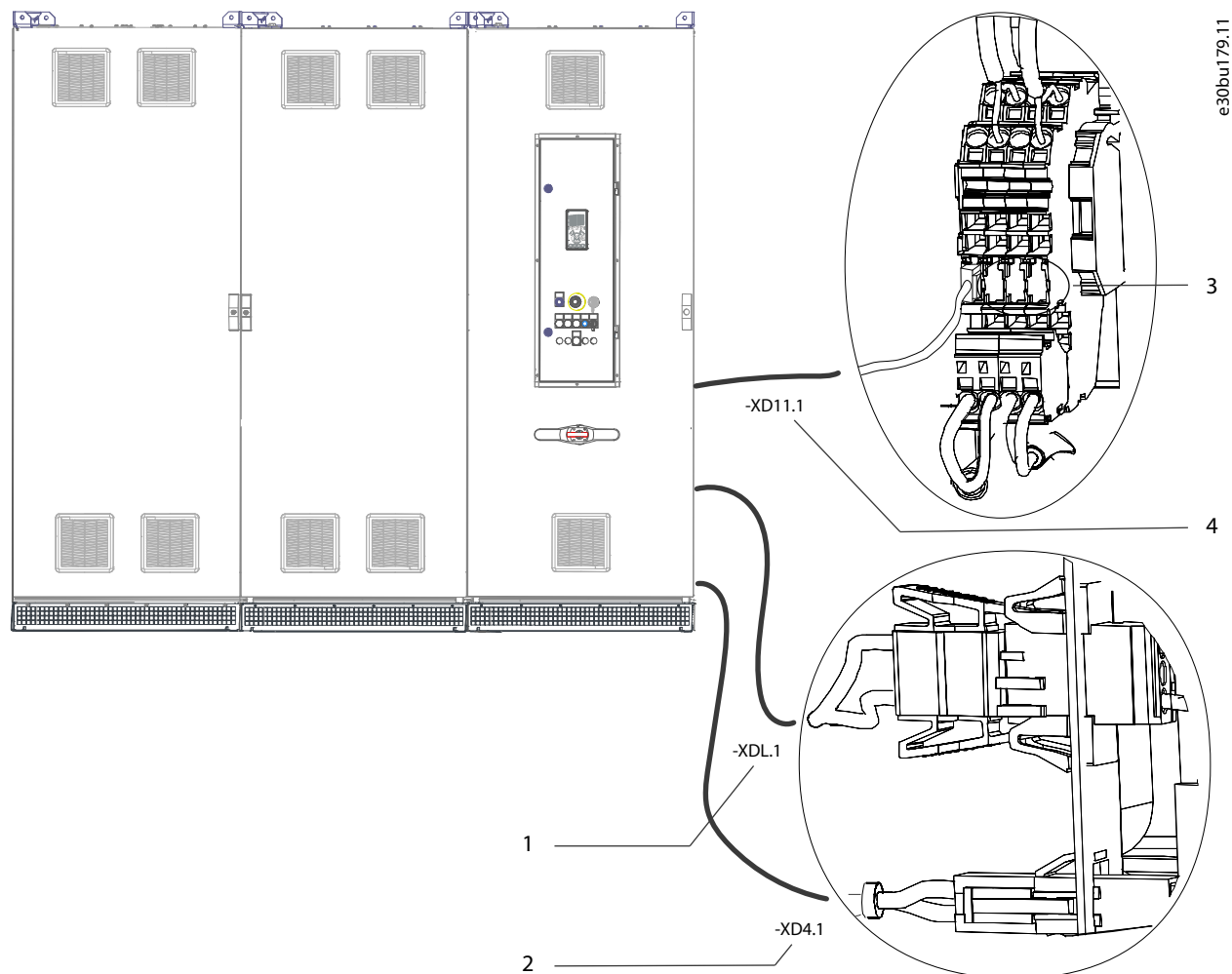
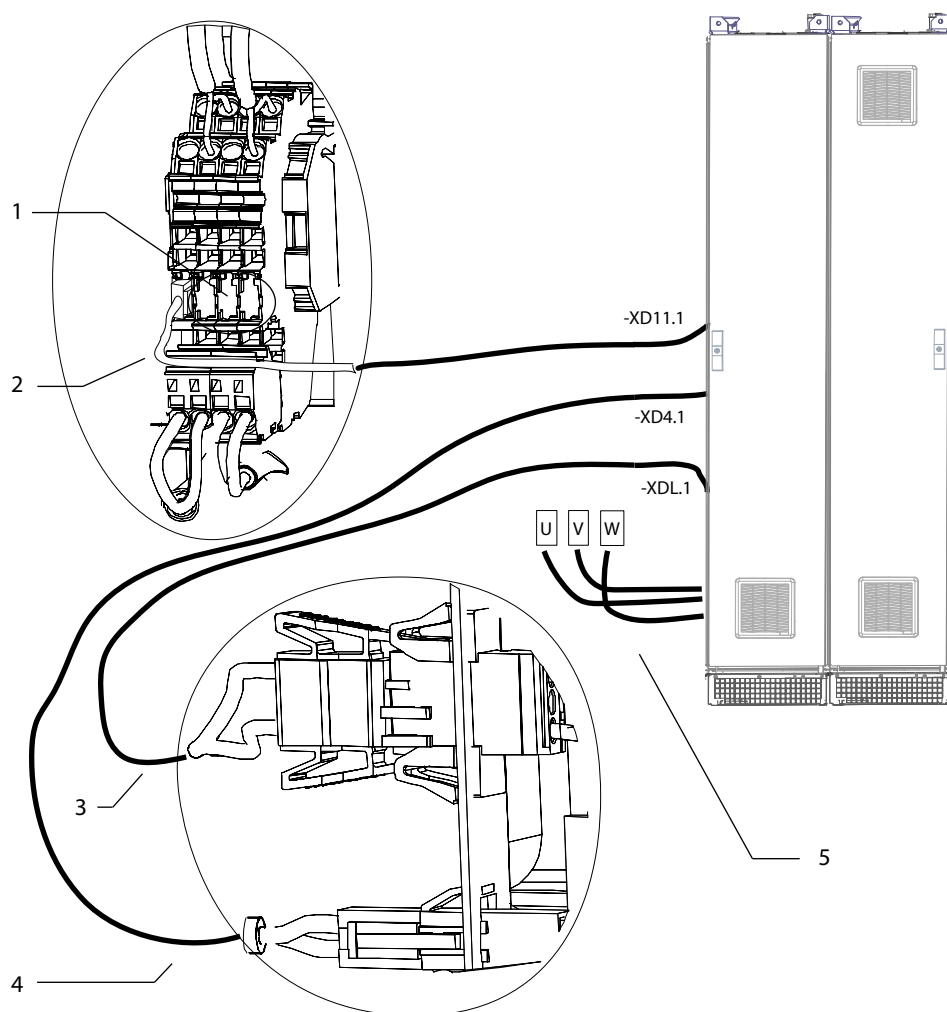


Illustration 31: Split Shipment Electrical Connections (Input Filter Cabinet + Input Power Options Cabinet + D10h Drive Cabinet)

1	DC-link harness to fan supply in output filter cabinet	3	Additional terminal connections
2	Cabinet heater supply harness to output filter cabinet	4	Thermal protection wiring harness to output filter cabinet



e30bu181.12

**Illustration 32: Split Shipment Electrical Connections (dU/dt Cabinet + Top Exit Cabinet)**

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan supply in drive cabinet		

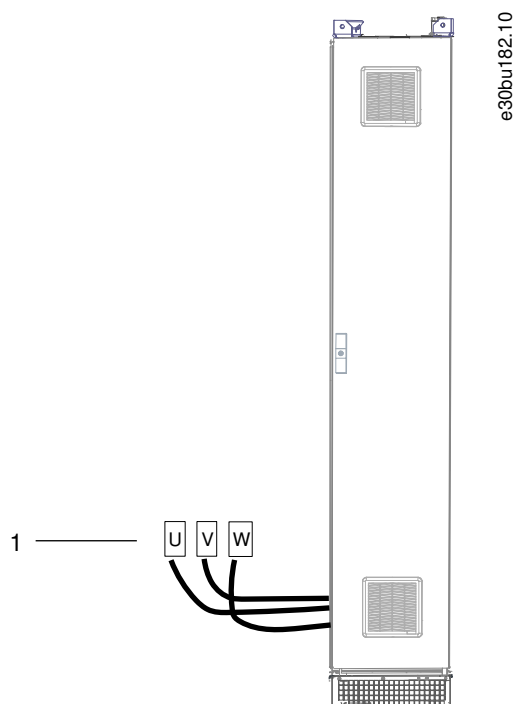


Illustration 33: Split Shipment Electrical Connections (Top Exit Cabinet)

1	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
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e30bu183.12

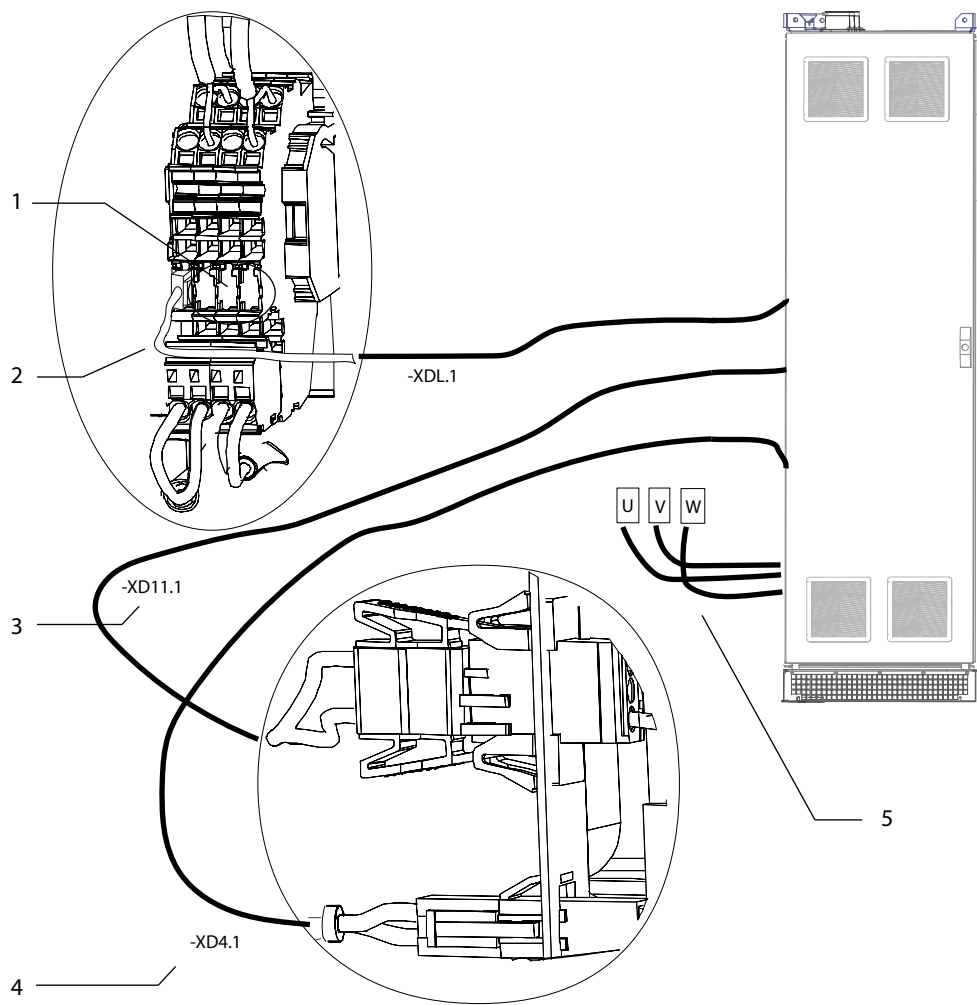


Illustration 34: Split Shipment Electrical Connections (D10h Sine-wave Cabinet)

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan supply in drive cabinet		

## 5.6.4 E5h Wiring Harness

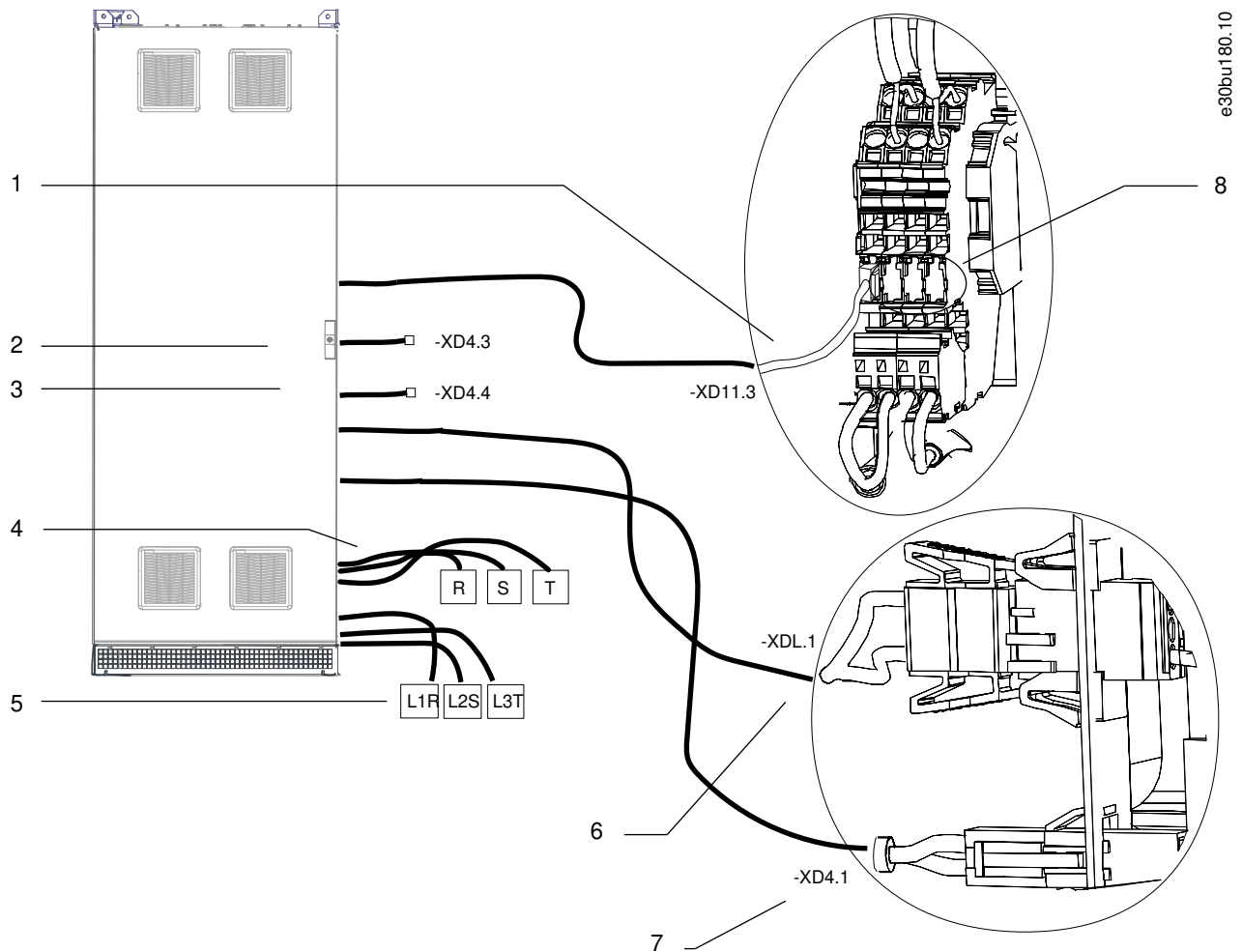
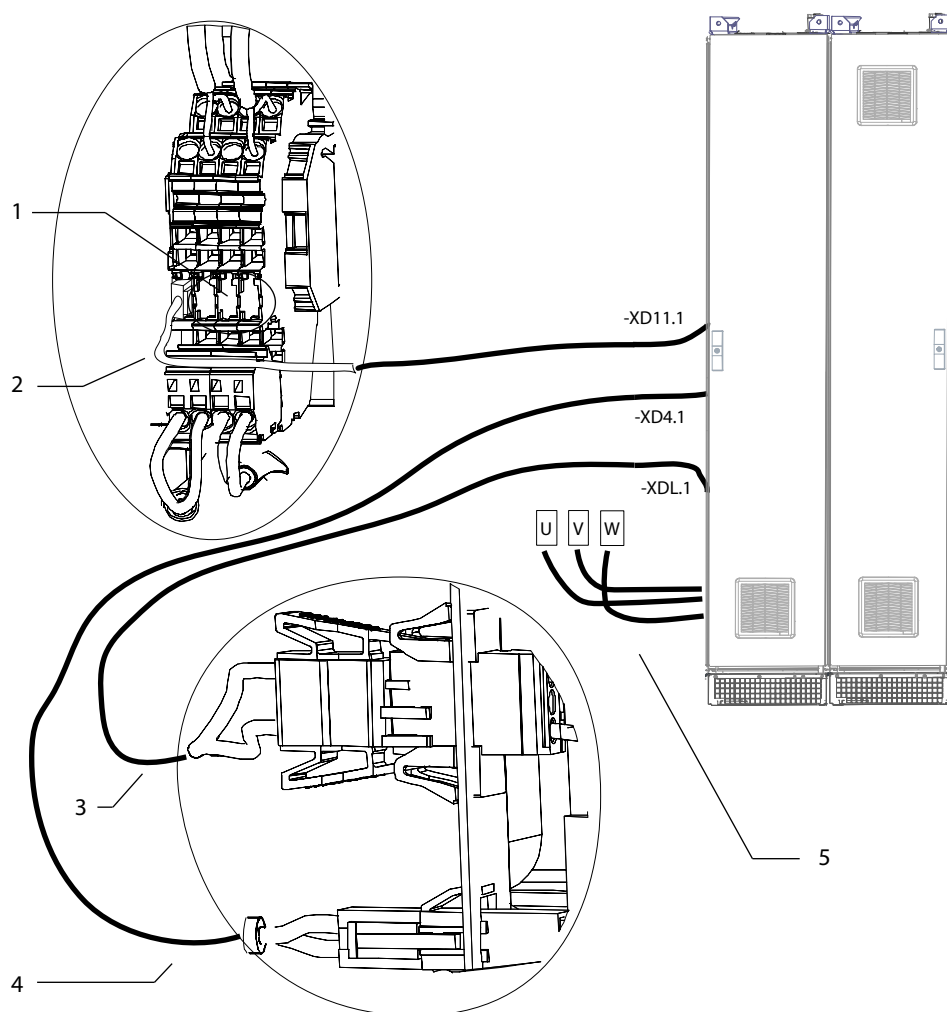


Illustration 35: Split Shipment Electrical Connections (Input Filter Cabinet)

1	Thermal protection wiring harness to input power options cabinet	5	Output terminal cables (L1R/L2S/L3T) to mains terminals (R/S/T) in the drives cabinet
2	PHF contactor 1 supply harness to input power options cabinet (only with PHF option)	6	DC-link harness to fan supply in the input power options cabinet
3	PHF contactor 2 supply harness to input power options cabinet (only with PHF option)	7	Cabinet heater supply harness to input power options cabinet
4	Input terminal cables (R/S/T) to mains terminals (R/S/T) in the input power options cabinet	8	Additional terminal connections



e30bu181.12

**Illustration 36: Split Shipment Electrical Connections (dU/dt Cabinet + Top Exit Cabinet)**

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan supply in drive cabinet		

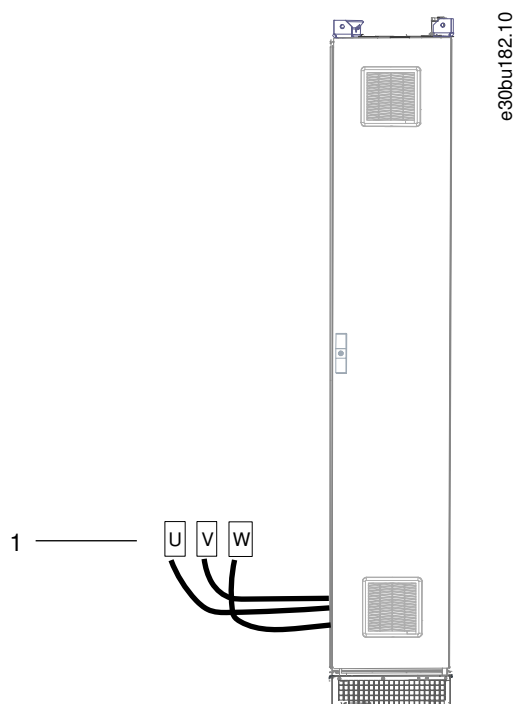
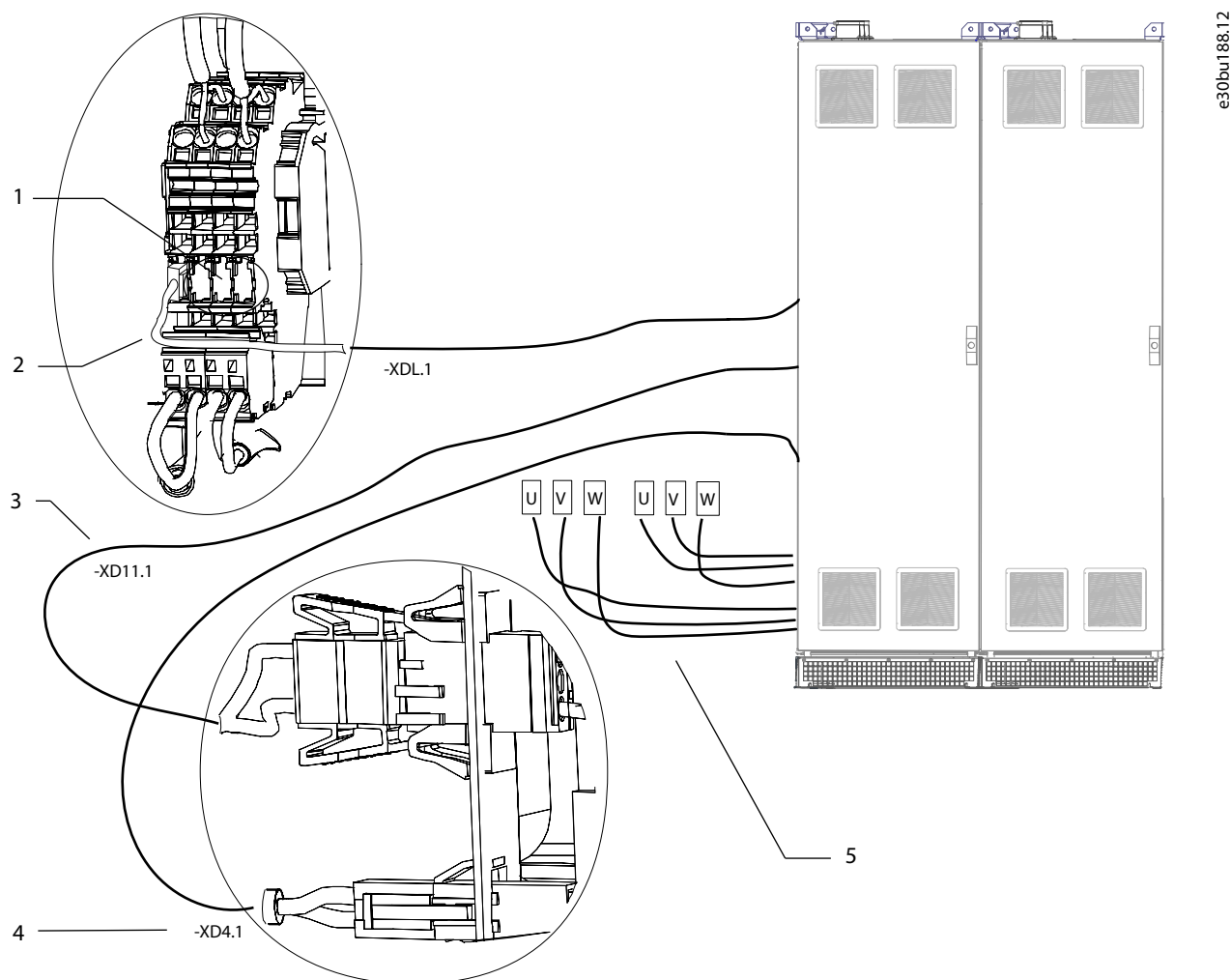


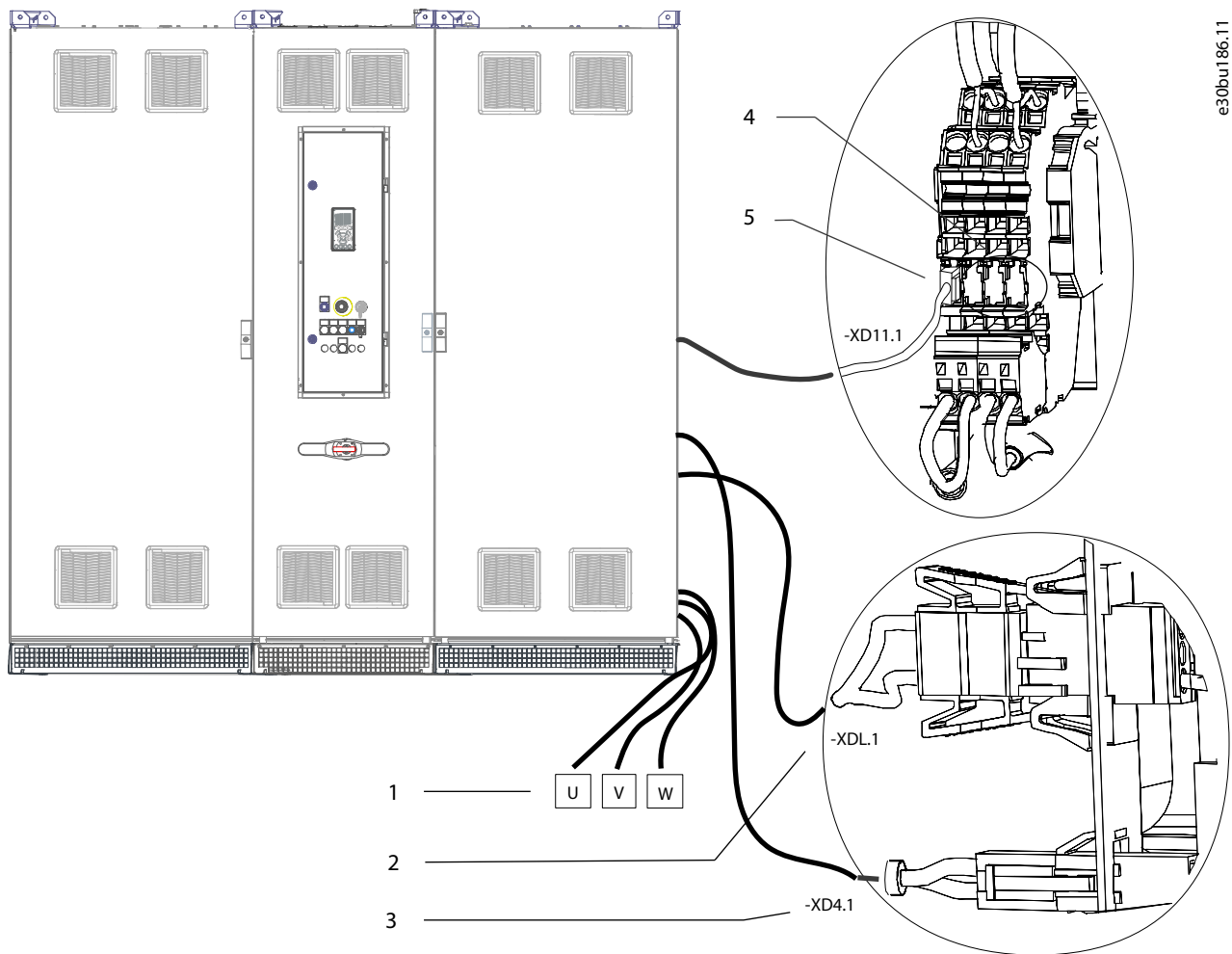
Illustration 37: Split Shipment Electrical Connections (Top Exit Cabinet)

1	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
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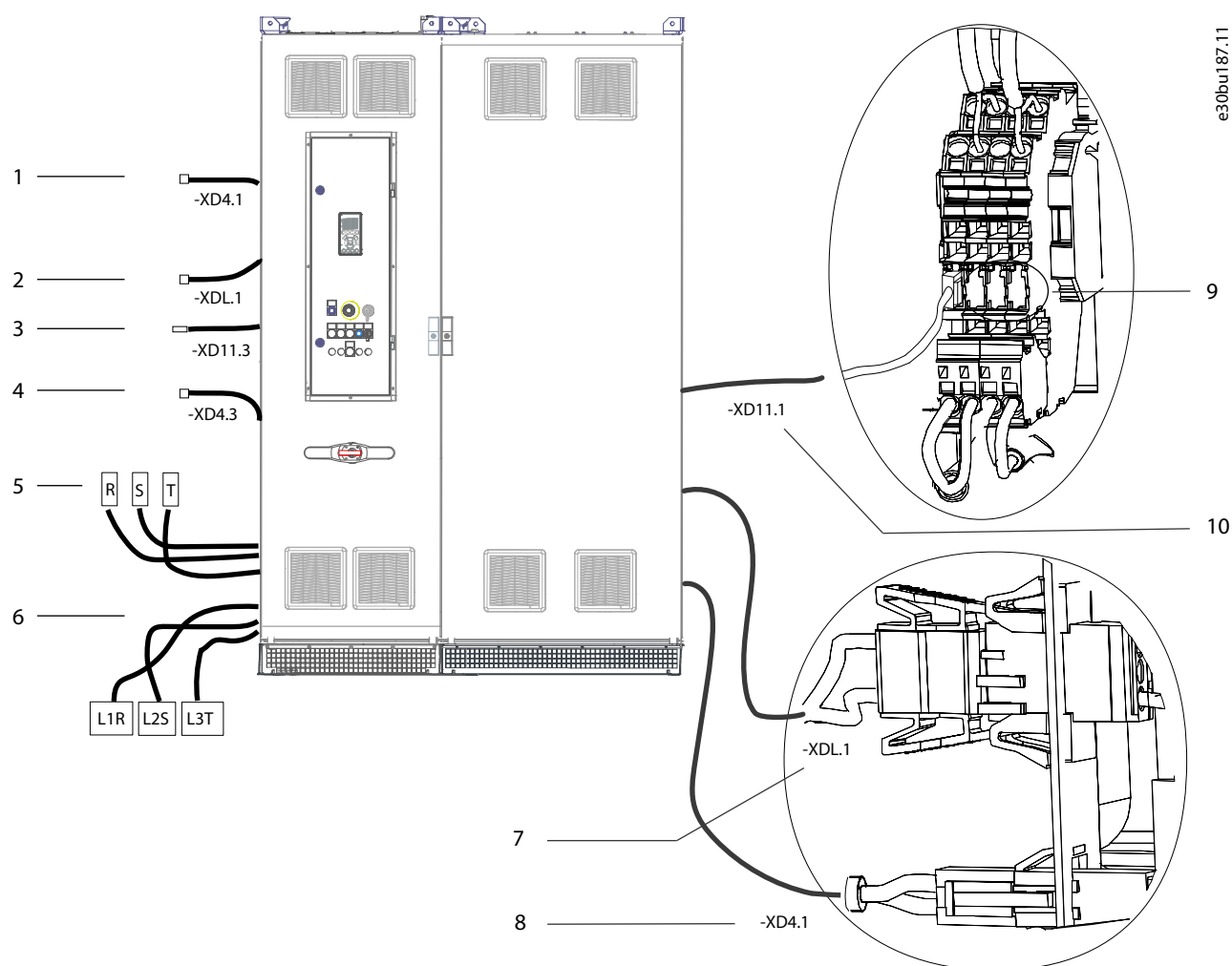
**Illustration 38: Split Shipment Electrical Connections (E5h/E6h Sine-wave Cabinets)**

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan supply in drive cabinet		



**Illustration 39: Split Shipment Electrical Connections (Input Filter Cabinet + Input Power Options Cabinet + E5h Drive Cabinet)**

1	Motor cables (U/V/W) to motor terminals (U/V/W) in output filter cabinet	4	Additional terminal connections
2	DC-link harness to fan supply in output filter cabinet	5	Thermal protection wiring harness to output filter cabinet
3	Cabinet heater supply harness to output filter cabinet		



**Illustration 40: Split Shipment Electrical Connections (Input Power Options Cabinet + E5h Drive Cabinet)**

1	Cabinet heater supply harness to input filter cabinet	6	Mains cables (L1R/L2S/L3T) to output terminals (L1R/L2S/L3T) in the input filter cabinet
2	DC-link harness to fan supply in input filter cabinet	7	DC-link harness to fan supply to output filter cabinet
3	Thermal protection harness to input filter cabinet	8	Cabinet heater supply harness to output filter cabinet
4	PHF contactor 1 supply harness to input filter cabinet (only with PHF option)	9	Available terminal connections
5	Mains cables (R/S/T) to input terminals (R/S/T) in the input filter cabinet	10	Thermal protection wiring harness to output filter cabinet

## 5.6.5 E6h Wiring Harness

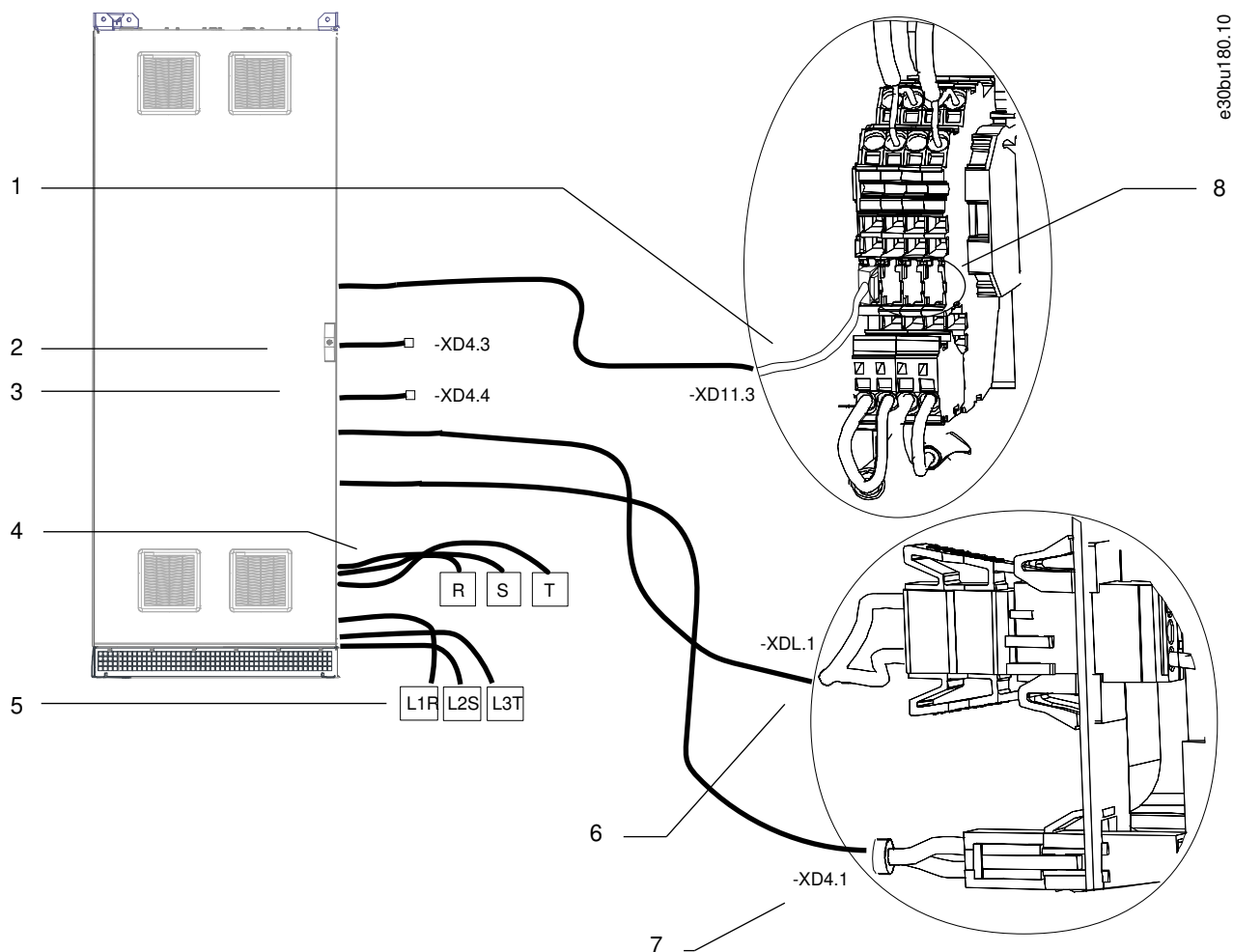
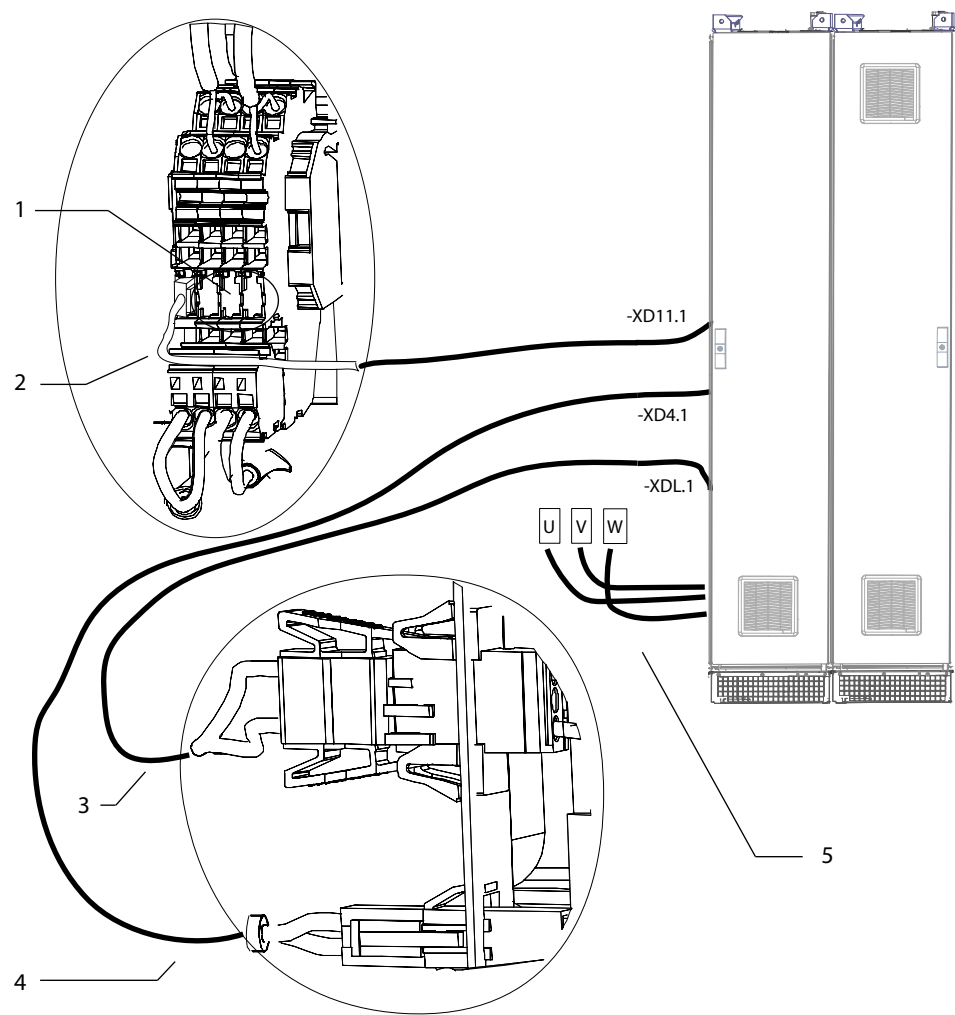


Illustration 41: Split Shipment Electrical Connections (Input Filter Cabinet)

1	Thermal protection wiring harness to input power options cabinet	5	Output terminal cables (L1R/L2S/L3T) to mains terminals (R/S/T) in the drives cabinet
2	PHF contactor 1 supply harness to input power options cabinet (only with PHF option)	6	DC-link harness to fan supply in the input power options cabinet
3	PHF contactor 2 supply harness to input power options cabinet (only with PHF option)	7	Cabinet heater supply harness to input power options cabinet
4	Input terminal cables (R/S/T) to mains terminals (R/S/T) in the input power options cabinet	8	Additional terminal connections



e30bu181.12

Illustration 42: Split Shipment Electrical Connections (dU/dt Cabinet + Top Exit Cabinet)

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan supply in drive cabinet		

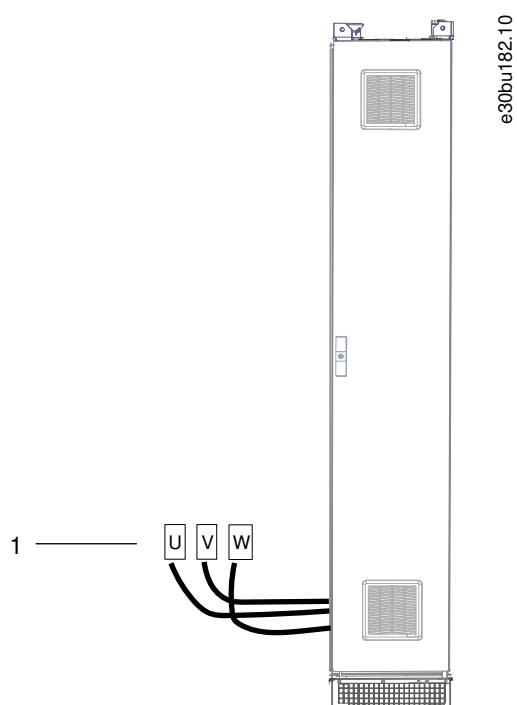
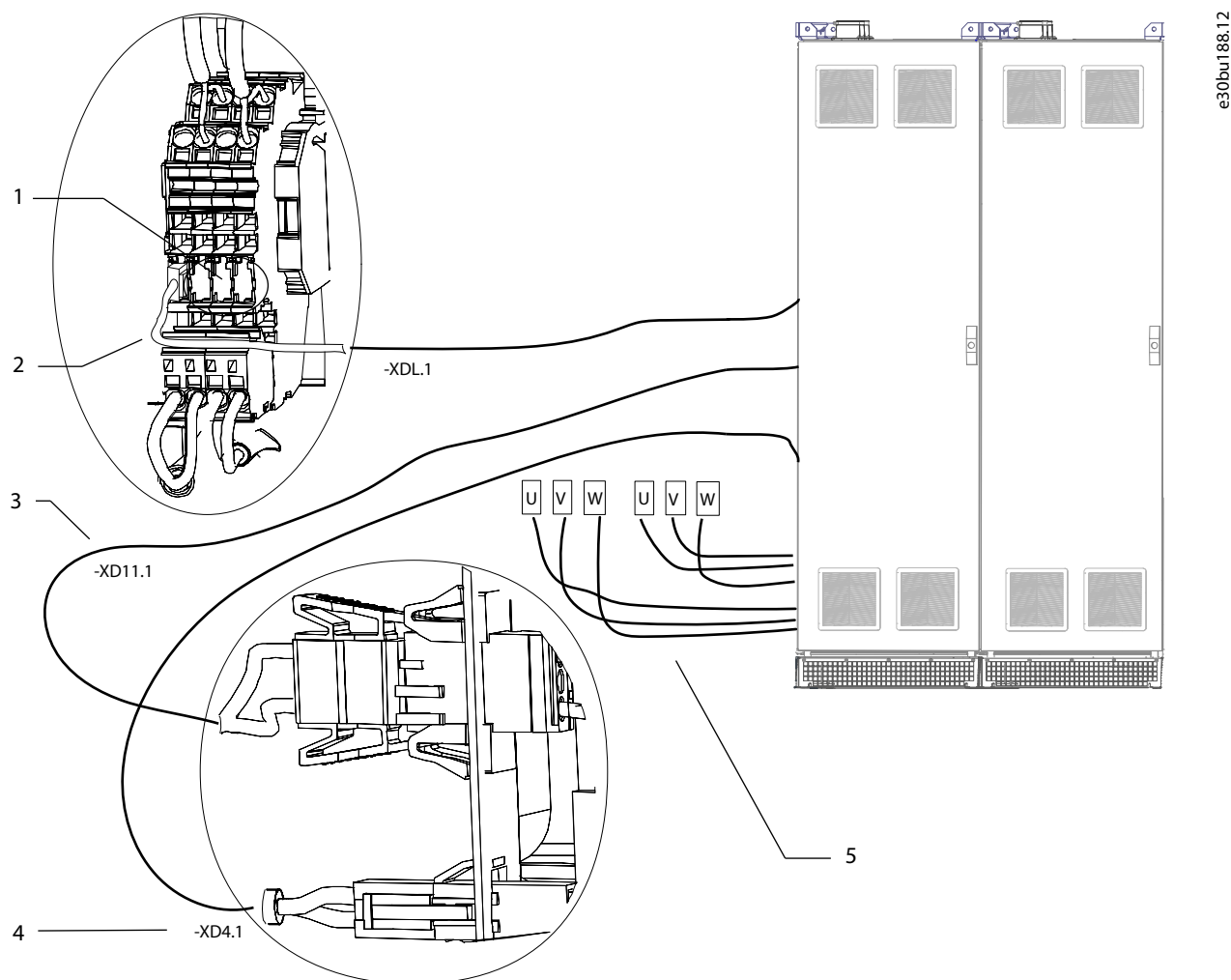


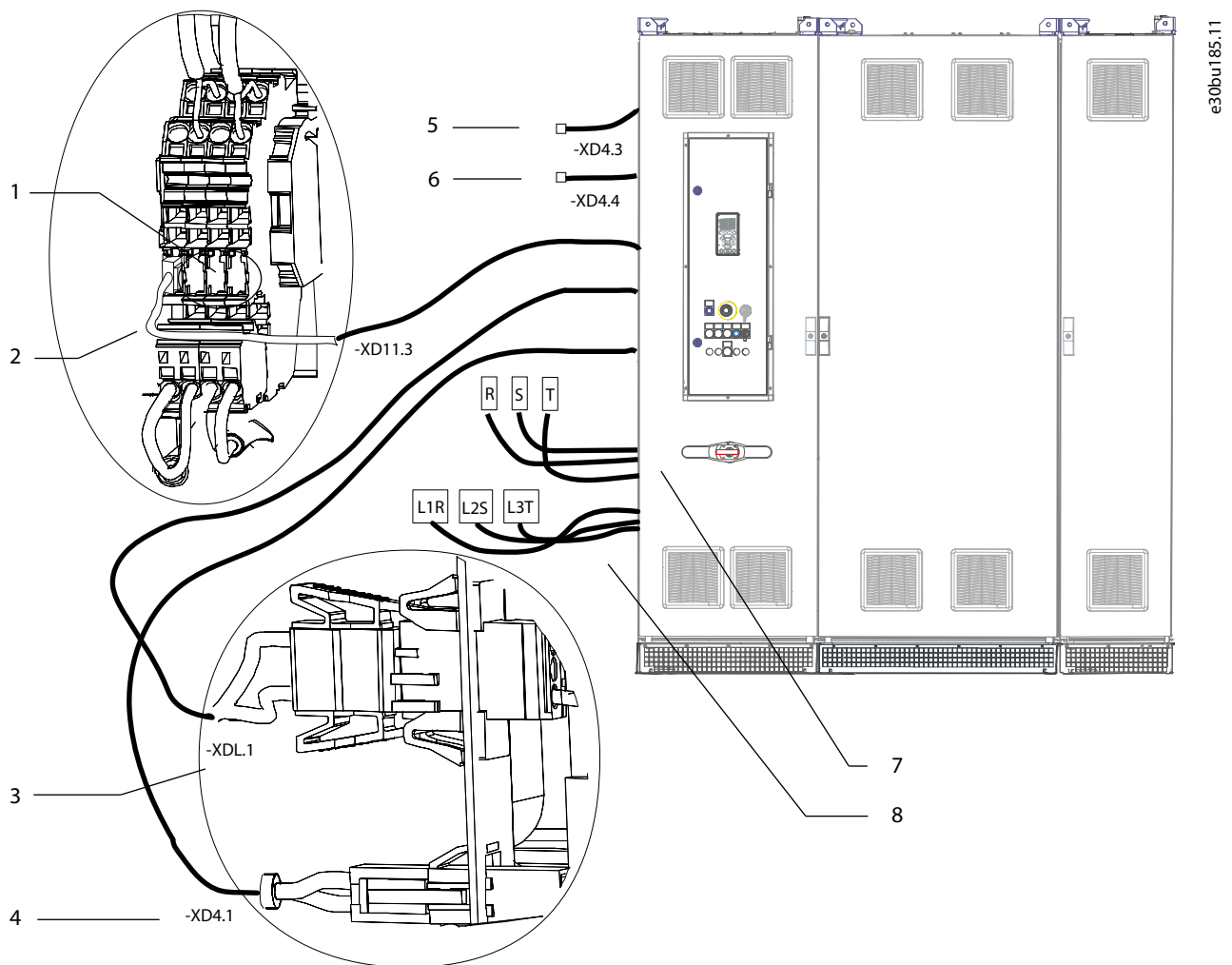
Illustration 43: Split Shipment Electrical Connections (Top Exit Cabinet)

1	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
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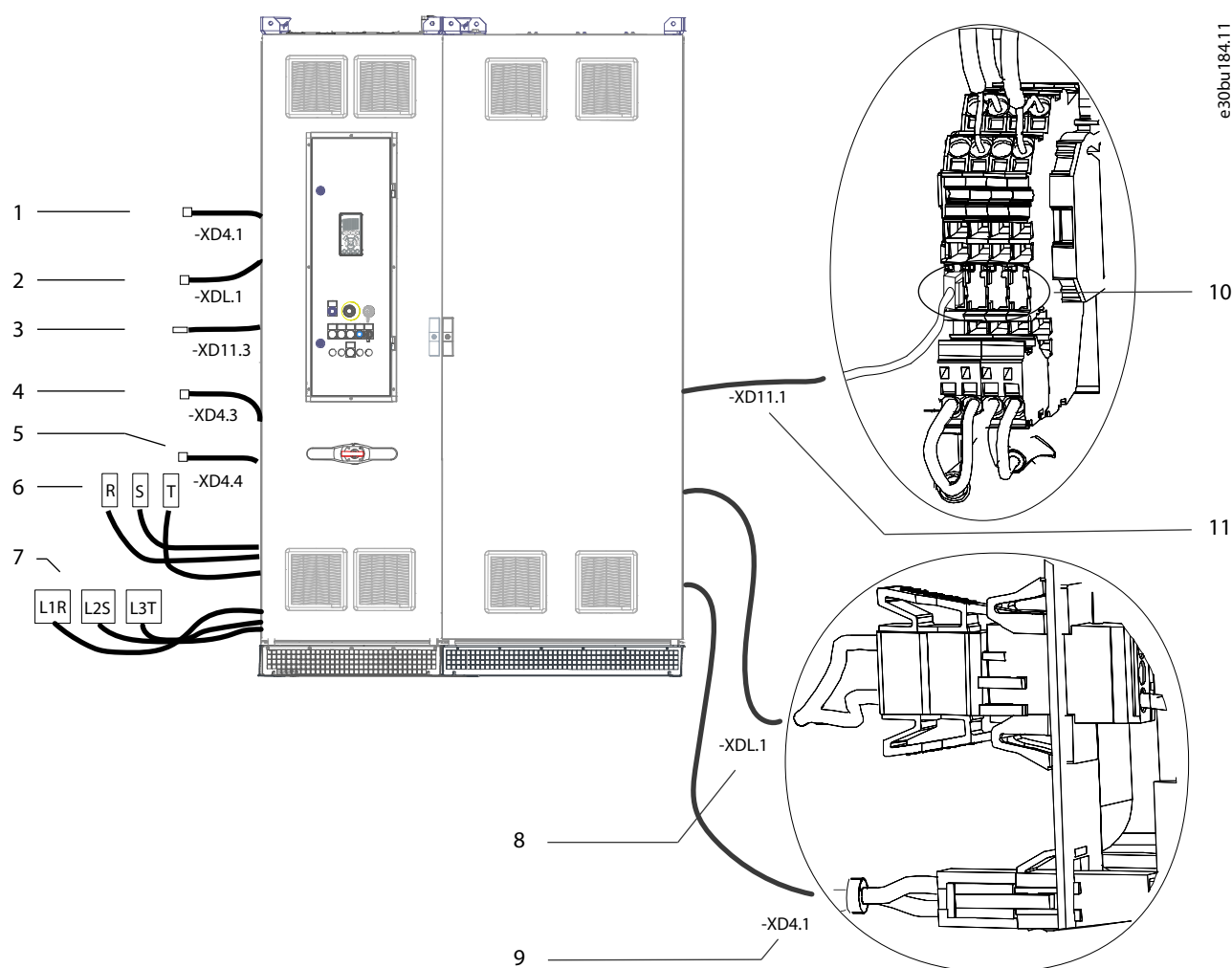
**Illustration 44: Split Shipment Electrical Connections (E5h/E6h Sine-wave Cabinets)**

1	Additional terminal connections	4	Cabinet heater supply harness to drive cabinet
2	Thermal protection wiring harness to drive cabinet	5	Motor cables (U/V/W) to motor terminals (U/V/W) in drive cabinet
3	DC-link harness to fan power supply in drive cabinet		



**Illustration 45: Split Shipment Electrical Connections (Input Power Options Cabinet + E6h Drive Cabinet + Top Exit Cabinet)**

1	Additional terminal connections	5	PHF contactor 1 supply harness to input filter cabinet (only with PHF option)
2	Thermal protection wiring harness to input filter cabinet	6	PHF contactor 2 supply harness to input filter cabinet (only with PHF option)
3	DC-link harness to fan supply in the input filter cabinet	7	Mains cables (R/S/T) to input terminals (R/S/T) in the input filter cabinet
4	Cabinet heater supply harness to input filter cabinet	8	Mains cables (L1R/L2S/L3T) to output terminals (L1R/L2S/L3T) in the input filter cabinet


**Illustration 46: Split Shipment Electrical Connections (Input Power Options Cabinet + E6h Drive Cabinet)**

1	Cabinet heater supply harness to input filter cabinet	7	Mains cables (L1R/L2S/L3T) to output terminals (L1R/L2S/L3T) in the input filter cabinet
2	DC-link harness to fan supply to input filter cabinet	8	DC-link harness to fan supply in output filter cabinet
3	Thermal protection wiring harness in the input filter cabinet	9	Cabinet heater supply harness to output filter cabinet
4	PHF contactor 1 supply harness to PHF cabinet (only with PHF option)	10	Available terminal connections
5	PHF contactor 2 supply harness to PHF cabinet (only with PHF option)	11	Thermal protection wiring harness to output filter cabinet
6	Mains cables R, S, T to input terminals (R/S/T) in the input filter cabinet		

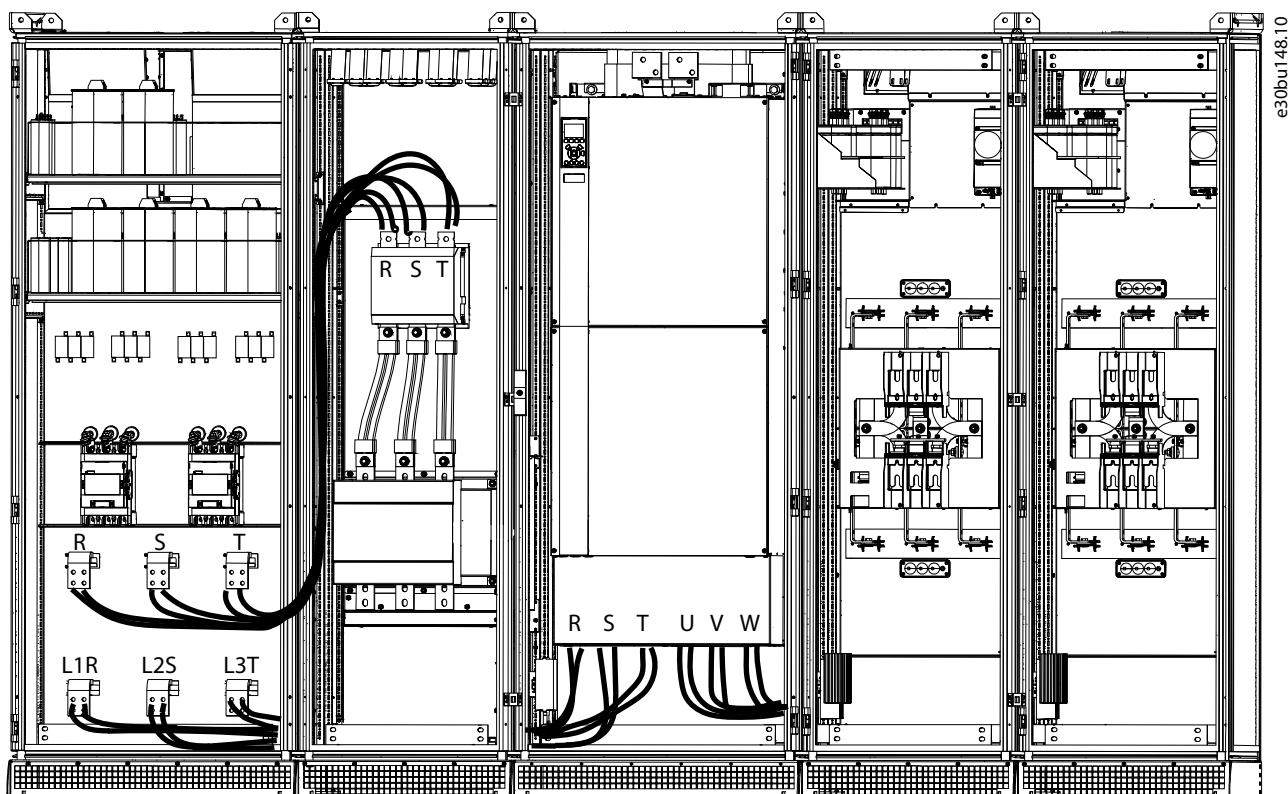


Illustration 47: Connecting Motor and Mains Cables (Example Shows a PHF Cabinet + Input Power Options Cabinet + E6h Drive Cabinet + Sine-wave Cabinets)

## 5.7 Control Compartment Wiring

### 5.7.1 Safety Precautions

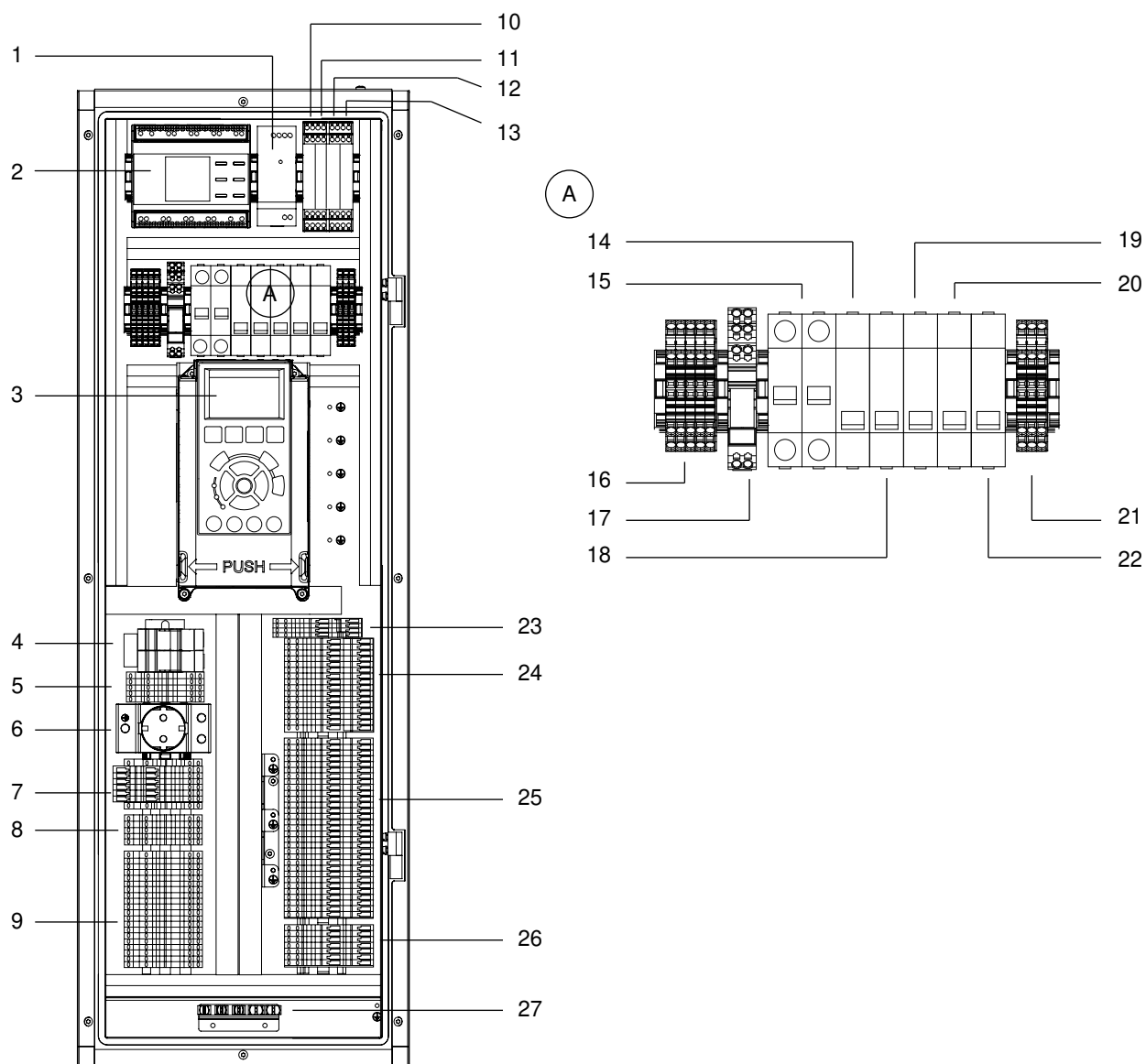
#### ⚠ WARNING ⚠

##### HIGH VOLTAGE

The mains disconnect switch does not disconnect the external voltage supply. Failure to disconnect the external voltage supply before touching any components in the control compartment can result in death or serious injury.

- Only qualified personnel must install, start up, and maintain the drive.
- Disconnect the external voltage supply.

## 5.7.2 Control Compartment Interior View



e30bu140.10

Illustration 48: Layout of Control Compartment Interior with All Options

1	24 V DC supply (-TB7)	15	AC circuit protection MCB (-FC6)
2	Insulation monitor (-BE1)	16	AC distribution circuit terminal block (-XD1)
3	Local control panel (LCP)	17	Auxiliary relay for heater (-QAM)
4	RJ45 terminal blocks 1 and 2 (-RJ45_1 and RJ45_2)	18	Contactor control circuit protection MCB (-FC10)
5	Protection terminal block set (-XD11)	19	Cabinet light/socket outlet protection MCB (-FCC)
6	Socket outlet (-XD10)	20	Cabinet heater(s) circuit protection MCB (-FCE)
7	Contactor control circuit terminal block (-XD0)	21	DC distribution circuit terminal block (-XD3)
8	Cabinet heater terminal block (-XD4)	22	Motor heater circuit protection MCB (-FCN)
9	Customer terminal block/option C0 terminal block (-XDW)	23	AC fan supply terminal block set (-XDY)
10	Thermal trip indicator relay, input power options cabinet (-KFJ.1)	24	Option C2 terminal block set (-XDF)
11	Thermal trip indicator relay, output filter cabinet (-KFJ.2)	25	Basic I/O terminal block and option A, B, D card terminal block set (-XD2)
12	Thermal trip indicator relay, input filter cabinet (-KFJ.3)	26	Door components terminal block set (-XDJ)
13	PHF capacitor connect/disconnect contactor relay (-QAF)	27	Grounding clamp for the shield termination of wires
14	+24 DC supply protection MCB (-FC7)		

### 5.7.3 Control Terminals

Table 43: Serial Communication Terminals

XD2 terminal	Parameter	Default Setting	Description
1	–	–	Integrated RC-filter for cable shield. Used only for connecting the shield in case of EMC problems.
2	<i>Parameter group 8-3* FC Port Settings</i>	–	RS485 interface. A switch (BUS TER.) is provided on the control card for bus termination resistance. See <i>Illustration 5.22</i> .
3	<i>Parameter group 8-3* FC Port Settings</i>	–	

Table 44: Digital Input/Output Terminal Descriptions

XD2 terminal	Parameter	Default setting	Description
10, 11	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.
12	<i>Parameter 5-10 Terminal 18 Digital Input</i>	<i>[8] Start</i>	Digital inputs.
13	<i>Parameter 5-11 Terminal 19 Digital Input</i>	<i>[10] Reversing</i>	
16	<i>Parameter 5-14 Terminal 32 Digital Input</i>	<i>[0] No operation</i>	

XD2 terminal	Parameter	Default setting	Description
17	<i>Parameter 5-15 Terminal 33 Digital Input</i>	<i>[0] No operation</i>	For digital input or output. Default setting is input.
14	<i>Parameter 5-12 Terminal 27 Digital Input</i>	<i>[2] Coast inverse</i>	
15	<i>Parameter 5-13 Terminal 29 Digital Input</i>	<i>[14] JOG</i>	
18	–	–	Common for digital inputs and 0 V potential for 24 V supply.
19	–	STO	When not using the optional STO feature, a jumper wire is required between terminal XD2.10 (or XD2.11) and terminal XD2.19. This set-up allows the drive to operate with factory default programming values.

Table 45: Analog Input/Output Terminal Descriptions

XD2 terminal	Parameter	Default setting	Description
4	–	–	Common for analog output.
5	<i>Parameter 6-50 Terminal 42 Output</i>	<i>[0] No operation</i>	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
6	–	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.
7	<i>Parameter group 6-1* Analog Input 1</i>	Reference	Analog input. For voltage (V) or current (mA).
8	<i>Parameter group 6-2* Analog Input 2</i>	Feedback	
9	–	–	Common for analog input.

### 5.7.4 Relay Terminals

Table 46: Relay Terminal Descriptions

XD2 terminal	Parameter	Default setting	Description
21, 22, 23	<i>Parameter 5-40 Function Relay [0]</i>	<i>[0] No operation</i>	Form C relay outputs. For AC or DC voltage.
24, 25, 26	<i>Parameter 5-40 Function Relay [1]</i>	<i>[0] No operation</i>	

### 5.7.5 Option Card Terminals

The option cards extend the functionality of drives and provide a high variety of interfaces to automation systems. When the option cards are specified in the type code, they are mounted in slots A, B, C, and D of the control card within the drive module. The option card wiring is routed to a terminal block within the control compartment. For more details, refer to the Installation/Operating Guide for the respective option card.

## NOTICE

### OPTION CARD INSTALLATION

If the option card is ordered along with the drive using the type code, the factory installs the option card and its wiring. If the option is ordered separately, the customer is responsible for installing the option card and the wiring extensions to the control compartment.

Table 47: Option A Terminal Connections for VLT® DeviceNet MCA 104, VLT® CANopen MCA 105, VLT® DeviceNet Converter MCA 194

Option card terminal	Corresponding terminal within the control compartment
1	XD2.40
2	XD2.41
3	XD2.42
4	XD2.43
5	XD2.44

Table 48: Option A Terminal Connections for VLT® PROFIBUS DP-V1 MCA 101, VLT® PROFIBUS Converter VLT 300 MCA 113, VLT® PROFIBUS Converter VLT 5000 MCA 114

Option card terminal	Corresponding terminal within the control compartment
67	XD2.40
66	XD2.41
63	XD2.42
62	XD2.43
CS	XD2.44

Table 49: Option A Terminal Connections for VLT® EtherNet/IP MCA 121, VLT® Modbus TCP MCA 122, VLT® POWERLINK MCA 123, VLT® Ether-CAT MCA 124

Option card terminal	Corresponding terminal within the control compartment
Port 1	RJ45_1
Port 2	RJ45_2

Table 50: Option B Terminal Connections

Option card terminal	Corresponding terminal within the control compartment
1	XD2.46
2	XD2.47
3	XD2.48
4	XD2.49
5	XD2.50
6	XD2.51
7	XD2.52
8	XD2.53
9	XD2.54
10	XD2.55
11	XD2.56
12	XD2.57

Table 51: Option C1 Terminal Connections for VLT® Extended Relay Card MCB 113

Option card terminal	Corresponding terminal within the control compartment
X45.1	XDF.17
X45.2	XDF.18
X45.3	XDF.19
X45.4	XDF.20
X46.1	XDF.1
X46.2	XDF.2
X46.3	XDF.3
X46.4	XDF.4
X46.5	XDF.5
X46.6	XDF.6
X46.7	XDF.7
X46.8	XDF.8
X46.9	XDF.9
X46.10	XDF.10
X46.11	XDF.11
X46.12	XDF.12
X46.13	XDF.13
X46.14	XDF.14
X47.1	XDF.21
X47.2	XDF.22
X47.3	XDF.23
X47.4	XDF.24
X47.5	XDF.25
X47.6	XDF.26
X47.7	XDF.27
X47.8	XDF.28
X47.9	XDF.29
X47.10	XDF.30
X47.11	XDF.31
X47.12	XDF.32
X58.1	XDF.15
X58.2	XDF.16

Table 52: Option C1 Terminal Connections for VLT® Advanced Cascade Controller MCO 102

Option card terminal	Corresponding terminal within the control compartment
X67.1	XDF.21
X67.2	XDF.22
X67.3	XDF.23
X67.4	XDF.24
X67.5	XDF.25
X67.6	XDF.26
X67.7	XDF.27
X67.8	XDF.28
X67.9	XDF.29
X67.10	XDF.30
X67.11	XDF.31
X67.12	XDF.32
X66.1	XDF.1
X66.2	XDF.2
X66.3	XDF.3
X66.4	XDF.4
X66.5	XDF.5
X66.6	XDF.6
X66.7	XDF.7
X66.8	XDF.8
X66.9	XDF.9
X66.10	XDF.10
X66.11	XDF.11
X66.12	XDF.12
X66.13	XDF.13
X66.14	XDF.14
X58.1	XDF.15
X58.2	XDF.16

Table 53: Option D Terminal Connections

Option card terminal	Corresponding terminal within the control compartment
35	XD2.28
36	XD2.29

## 5.7.6 Control Compartment Options

### 5.7.6.1 Auxiliary Supply Terminals

Table 54: Auxiliary Supply Type Codes

Character position	Code	Description
21	1	230 V AC external
	5	230 V AC external + 24 V DC internal
	6	120 V AC external
	9	120 V AC external + 24 V DC internal

The auxiliary supply terminal option provides an external voltage supply to the -XD1.1 terminal. The external supply must be short-circuit protected. The power of the external supply depends on other selected cabinet options.



Illustration 49: Auxiliary AC Supply Terminals

## ! W A R N I N G !

### HIGH VOLTAGE

The mains disconnect switch does not disconnect the external voltage supply. Failure to disconnect the external voltage supply before touching any components in the control compartment can result in death or serious injury.

- Disconnect the external voltage supply.
- Only qualified personnel must install, start up, and maintain the drive.

### 5.7.6.2 Auxiliary Voltage Transformer

Table 55: Auxiliary Supply Type Codes for Auxiliary Voltage Transformer

Character position	Code	Description
21	2	230 V AC internal
	4	230 V AC internal + 24 V DC internal
	7	120 V AC internal
	8	120 V AC internal + 24 V DC internal

The auxiliary voltage transformer is an option fitted internally that allows for the supply to be tapped from the mains. For example, if the enclosed drive is specified with a fused disconnect, the supply for the auxiliary voltage transformer is taken from between the drive and the fused disconnect. This configuration allows the control voltage to be disconnected with the main switch.

The transformer has multiple tapings on the primary side for the standard range of voltages on which the drive operates. The factory default wiring connects to the highest voltage tapping on the primary side, and the trip settings for the -FC4 terminal is set

accordingly. The customer can change the tapping provided the correct voltage is applied and the thermal magnetic circuit breaker is set accordingly.

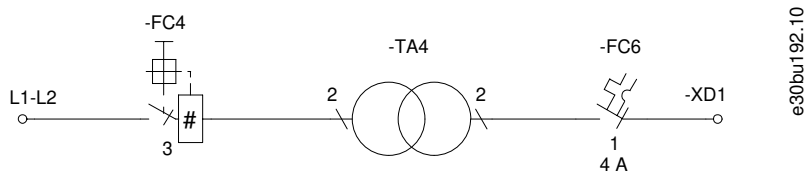


Illustration 50: Auxiliary Voltage Transformer Terminals

## NOTICE

### AUXILIARY COMPONENT FAILURE

Incorrect voltage or incorrect tapping installation will cause other auxiliary components in the control compartment to fail.

- When tapping the transformer, make sure to apply the correct voltage for the drive.
- Use the correct tapping and trip settings.

## 5.7.6.3 +24 V DC External Supply

Table 56: Auxiliary Supply Type Codes

Character position	Code	Description
21	4	230 V AC internal+24 V DC internal
	5	230 V AC external+24 V DC internal
	8	120 V AC internal+24 V DC internal
	9	120 V AC external+24 V DC internal

The 24 V DC external supply option enables other auxiliary options to be connected to a 24 V DC supply within the control compartment.

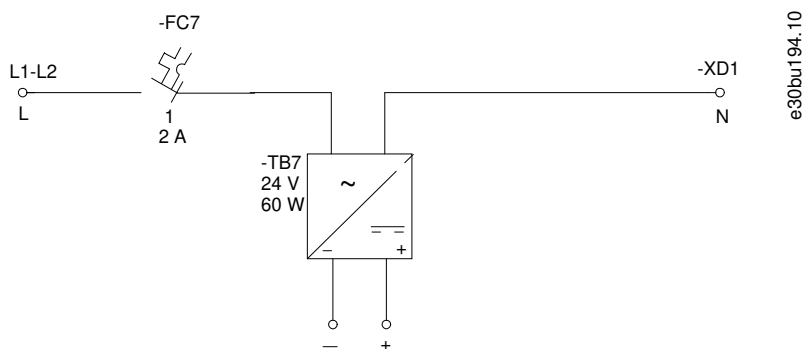


Illustration 51: 24 V DC External Supply Terminals

## 5.7.6.4 AC Customer Socket

Table 57: Auxiliary Function Type Codes

Character position	Code	Description
23–24	A1	AC socket + cabinet light
	AA	AC socket + cabinet light + extended I/O terminals
	AB	AC socket + cabinet light + cabinet heater

Character position	Code	Description
	AC	AC socket + cabinet light + motor heater control
	AD	AC socket + cabinet light + insulation monitor
	AE	AC socket + cabinet light + extended I/O terminals + cabinet heater
	AF	AC socket + cabinet light + extended I/O terminals + motor heater control
	AG	AC socket + cabinet light + extended I/O terminals + insulation monitor
	AH	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control
	AI	AC socket + cabinet light + extended I/O terminals + cabinet heater + insulation monitor
	AJ	AC socket + cabinet light + extended I/O terminals + motor heater control + insulation monitor
	AK	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AL	AC socket + cabinet light + cabinet heater + motor heater control
	AM	AC socket + cabinet light + cabinet heater + insulation monitor
	AN	AC socket + cabinet light + cabinet heater + motor heater control + insulation monitor
	AO	AC socket + cabinet light + motor heater control + insulation monitor

The customer socket provides a supply for measurement tools, equipment, or a computer. The socket type is CEE 7/3 ("Schuko", Type F) or NEMA 5-15 grounded (Type B). The default voltage is 230 V AC (IEC variant) and 115 V AC (UL variant). When using an external supply, the maximum output power is 450 VA (IEC variant) and 230 VA (UL variant). When using a transformer supply, the maximum output power is 200 VA for both variants.

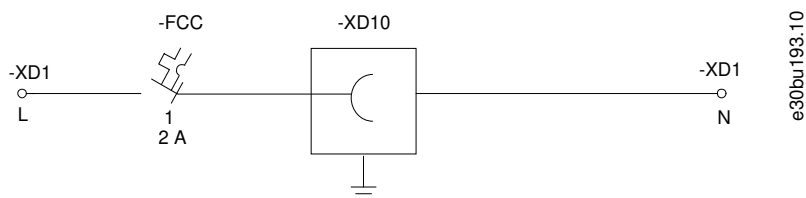


Illustration 52: AC Customer Socket Terminals

### 5.7.6.5 Extended I/O Terminals

Table 58: Auxiliary Function Type Codes

Character position	Code	Description
23–24	A2	Extended I/O terminals
	AA	AC socket+cabinet light + extended I/O terminals
	AE	AC socket+cabinet light + extended I/O terminals + cabinet heater
	AF	AC socket+cabinet light + extended I/O terminals + motor heater control
	AG	AC socket+cabinet light + extended I/O terminals + insulation monitor
	AH	AC socket+cabinet light + extended I/O terminals + cabinet heater + motor heater control
	AI	AC socket+cabinet light + extended I/O terminals + cabinet heater + insulation monitor

Character position	Code	Description
	AJ	AC socket+cabinet light + extended I/O terminals + motor heater control + insulation monitor
	AK	AC socket+cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AP	Extended I/O terminals + cabinet heater
	AQ	Extended I/O terminals + motor heater control
	AR	Extended I/O terminals + insulation monitor
	AS	Extended I/O terminals + cabinet heater + motor heater control
	AT	Extended I/O terminals + cabinet heater + insulation monitor
	AU	Extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AV	Extended I/O terminals + motor heater control + insulation monitor

The extended I/O terminal option includes 25 control terminals (-XDW) in the control compartment for use by the customer. If the enclosed drive is configured with any option C1 card, the -XDW terminal block is used for the option C1 card wiring.

### 5.7.6.6 Cabinet Heater

Table 59: Auxiliary Function Type Codes

Character position	Code	Description
23–24	A3	Cabinet heater
	AB	AC socket + cabinet light + cabinet heater
	AE	AC socket + cabinet light + extended I/O terminals + cabinet heater
	AH	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control
	AI	AC socket + cabinet light + extended I/O terminals + cabinet heater + insulation monitor
	AK	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AL	AC socket + cabinet light + cabinet heater + motor heater control
	AM	AC socket + cabinet light + cabinet heater + insulation monitor
	AN	AC socket + cabinet light + cabinet heater + motor heater control + insulation monitor
	AP	Extended I/O terminals + cabinet heater
	AS	Extended I/O terminals + cabinet heater + motor heater control
	AT	Extended I/O terminals + cabinet heater + insulation monitor
	AU	Extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AW	Cabinet heater + motor heater control
	A8	Cabinet heater + insulation monitor
	AY	Cabinet heater + motor heater control + insulation monitor

The cabinet heater option increases the inside temperature of the cabinet above the ambient temperature, preventing condensation in the cabinet. Each cabinet has 1 cabinet heater. The heater element is self regulating. The external supply is connected to terminal -XD1.1. When the drive is not in run state, the control relay -QAM changes the supply to the output terminals (-XD4). When the drive is in run state, the control relay disconnects the supply to the cabinet heater. The function is disabled when MCB -FCE is open.

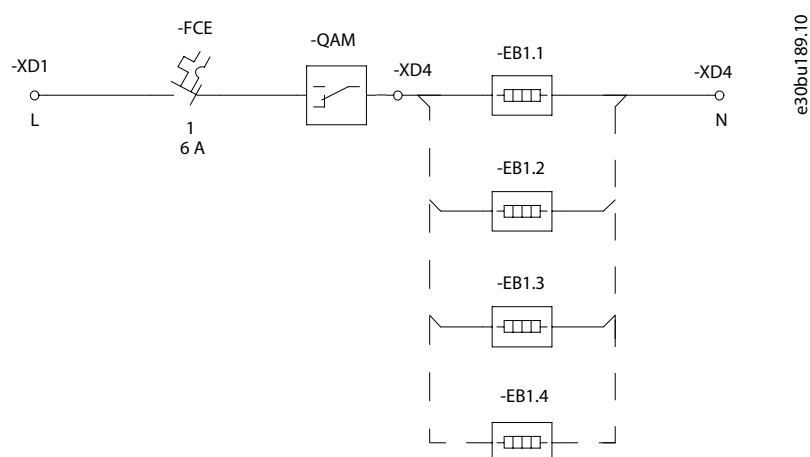


Illustration 53: Cabinet Heater Terminals

### 5.7.6.7 Motor Heater Control

Table 60: Auxiliary Function Type Codes

Character position	Code	Description
23–24	A4	Motor heater control
	AC	AC socket + cabinet light + motor heater control
	AF	AC socket + cabinet light + extended I/O terminals + motor heater control
	AH	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control
	AJ	AC socket + cabinet light + extended I/O terminals + motor heater control + insulation monitor
	AK	AC socket + cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AL	AC socket + cabinet light + cabinet heater + motor heater control
	AN	AC socket + cabinet light + cabinet heater + motor heater control + insulation monitor
	AO	AC socket + cabinet light + motor heater control + insulation monitor
	AQ	Extended I/O terminals + motor heater control
	AS	Extended I/O terminals + cabinet heater + motor heater control
	AU	Extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AV	Extended I/O terminals + motor heater control + insulation monitor
	AW	Cabinet heater + motor heater control
	AY	Cabinet heater + motor heater control + insulation monitor
	AZ	Motor heater control + insulation monitor

The motor heater option provides the ability to control the supply for the motor anti-condensation heater. The 24 V DC external supply is connected to terminal -XD1.1 in the lower part of the cabinet. When the drive is not in run state, the control relay -QAM changes the external supply to the -XDM output terminals. When the drive is in run state, the control relay disconnects the external supply to the motor heater. The function is disabled when MCB -FCN is open.

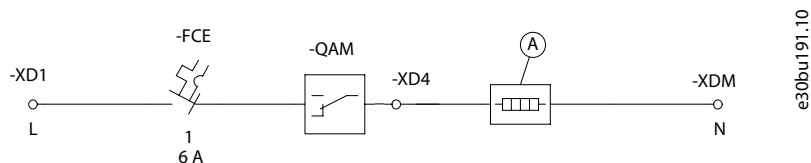


Illustration 54: Motor Heater Control (A = Heater element, not included)

### 5.7.6.8 Insulation Monitor

Table 61: Auxiliary Function Type Codes

Character position	Code	Description
23–24	A5	Insulation monitor
	AD	AC socket+cabinet light + insulation monitor
	AG	AC socket+cabinet light + extended I/O terminals + insulation monitor
	AI	AC socket+cabinet light + extended I/O terminals + cabinet heater + insulation monitor
	AJ	AC socket+cabinet light + extended I/O terminals + motor heater control + insulation monitor
	AK	AC socket+cabinet light + extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AM	AC socket+cabinet light + cabinet heater + insulation monitor
	AN	AC socket+cabinet light + cabinet heater + motor heater control + insulation monitor
	AO	AC socket+cabinet light + motor heater control + insulation monitor
	AR	Extended I/O terminals + insulation monitor
	AT	Extended I/O terminals + cabinet heater + insulation monitor
	AU	Extended I/O terminals + cabinet heater + motor heater control + insulation monitor
	AV	Extended I/O terminals + motor heater control + insulation monitor
	A8	Cabinet heater + insulation monitor
	AY	Cabinet heater + motor heater control + insulation monitor
	AZ	Motor heater control + insulation monitor

The insulation monitor option monitors the supply and insulation faults within the insulation level in an IT supply network with an insulation monitor in the control compartment.

### 5.7.6.9 Signal Lights and Reset Buttons

Table 62: Door-mounted Option Type Codes

Character position	Code	Description
28–29	D1	Signal lights and reset button
	DA	Signal lights and reset button + emergency switch off and emergency push-button
	DB	Signal lights and reset button + STO with emergency push-button (no functional safety)
	DC	Signal lights and reset button + STO/SS1 with emergency push-button + safely limited speed (TTL encoder)
	DE	Signal lights and reset button + STO/SS1 with emergency push-button + safely limited speed (HTL encoder)

The signal light and reset button option includes signal lights on the control compartment door for run and fault states of the AC drive. The door also has a button for the reset function of the drive.

### 5.7.6.10 Emergency Switch Off

Table 63: Door-mounted Option Type Codes

Character position	Code	Description
28–29	D2	Emergency switch off + emergency push-button
	DA	Signal lights and reset button + emergency switch off and emergency push-button

The emergency switch off option uses an input contactor to disconnect the drive from mains. Pushing the emergency stop push-button on the control compartment door opens the control circuit of the input contactor.

### 5.7.6.11 STO with Emergency Push-button on Door

Table 64: Door-mounted Option Type Codes

Character position	Code	Description
28–29	D3	STO with emergency push-button (no functional safety)
	DB	Signal lights and reset button + STO with emergency push-button (no functional safety)

This option provides the STO (Safe Torque Off) function via an emergency push-button mounted on the door of the control compartment. The control terminals of the control card are extended from inside the drive module and routed out to the terminal block set -XD2 in the control compartment. The emergency push-button is wired between terminals -XD2.10 and -XD2.19.

Activating the emergency push-button prevents the unit from generating the voltage required to rotate the motor. The option provides:

- Safe Torque Off (STO), as defined by EN IEC 61800-5-2.
- Stop Category 0, as defined in EN 60204-1.

### 5.7.6.12 STO/SS1 with Emergency Push-button + Safely Limited Speed (TTL Encoder) on Door

Table 65: Door-mounted Option Type Codes

Character position	Code	Description
28–29	D4	STO/SS1 with emergency push-button+safely limited speed (TTL encoder)
	DC	Indicator lights and reset button + STO/SS1 with emergency push-button+safely limited speed (TTL encoder)

This option provides the SS1 (Safe Stop 1) function with the VLT® Safety Option MCB 150 along with STO function using an emergency stop push-button on the control compartment door. The emergency stop push-button activates the motor deceleration and makes the motor stop in the set deceleration ramp time. Basic wiring for the S37 terminal of the option card to terminal 37 of control card and the emergency push-button wiring are provided.

MCB 150 is used when the standstill or the motor speed is measured using a TTL encoder. For detailed instructions, refer to the VLT® Safety Option MCB 150/151 Installation Guide. MCB 150 can be programmed using the VLT® Motion Control Tool MCT 10 software to take advantage of the following functional safety features:

- **Safe Torque Off (STO).**  
No power is being fed to the motor which can generate a rotation. Stop category 0 to EN IEC 60204-1.
- **Safe Stop 1 (SS1).**  
The motor decelerates. Monitoring of deceleration ramp and STO following zero speed, or STO at the end of a deceleration time. Stop category 1 to EN IEC 60204-1.
- **Safely limited speed (SLS).**  
This function prevents exceeding a defined speed value. See the OPT-B option board and safety relay user manuals for the regulations and the certified safety.

### 5.7.6.13 STO/SS1 with Emergency Push-button + Safely Limited Speed (HTL Encoder) on Door

Table 66: Door-mounted Option Type Codes

Character position	Code	Description
28–29	D5	STO/SS1 with emergency push-button + safely limited speed (HTL encoder)
	DE	Signal lights and reset button + STO/SS1 with emergency push-button + safely limited speed (HTL encoder)

This option provides the SS1 (Safe Stop 1) function with the VLT® Safety Option MCB 151 along with STO function using an emergency stop push-button on the control compartment door. The option is compatible with HTL encoders or PNP proximity switches. The emergency stop-push button activates the motor deceleration and makes the motor stop in the set deceleration ramp time. Basic wiring for the S37 terminal of the option card to terminal 37 of control card and the emergency push-button wiring are provided.

MCB 151 is used when the standstill or the motor speed is measured using a TTL encoder. For detailed instructions, refer to the VLT® Safety Option MCB 150/151 Installation, Guide. MCB 151 can be programmed using VLT® Motion Control Tool MCT 10 software to take advantage of the following functional safety features:

- **Safe Torque Off (STO).**  
No power is being fed to the motor which can generate a rotation. Stop category 0 to EN IEC 60204-1.
- **Safe Stop 1 (SS1).**  
The motor decelerates. Monitoring of deceleration ramp and STO following zero speed, or STO at the end of a deceleration time. Stop category 1 to EN IEC 60204-1.
- **Safely limited speed (SLS).**  
This function prevents exceeding a defined speed value. See the OPT-B option board and safety relay user manuals for the regulations and the certified safety.

## 5.8 Connecting Motor, Mains, and Ground Cables

### 5.8.1 Power Cabling and Grounding Considerations

#### Motor and mains connections

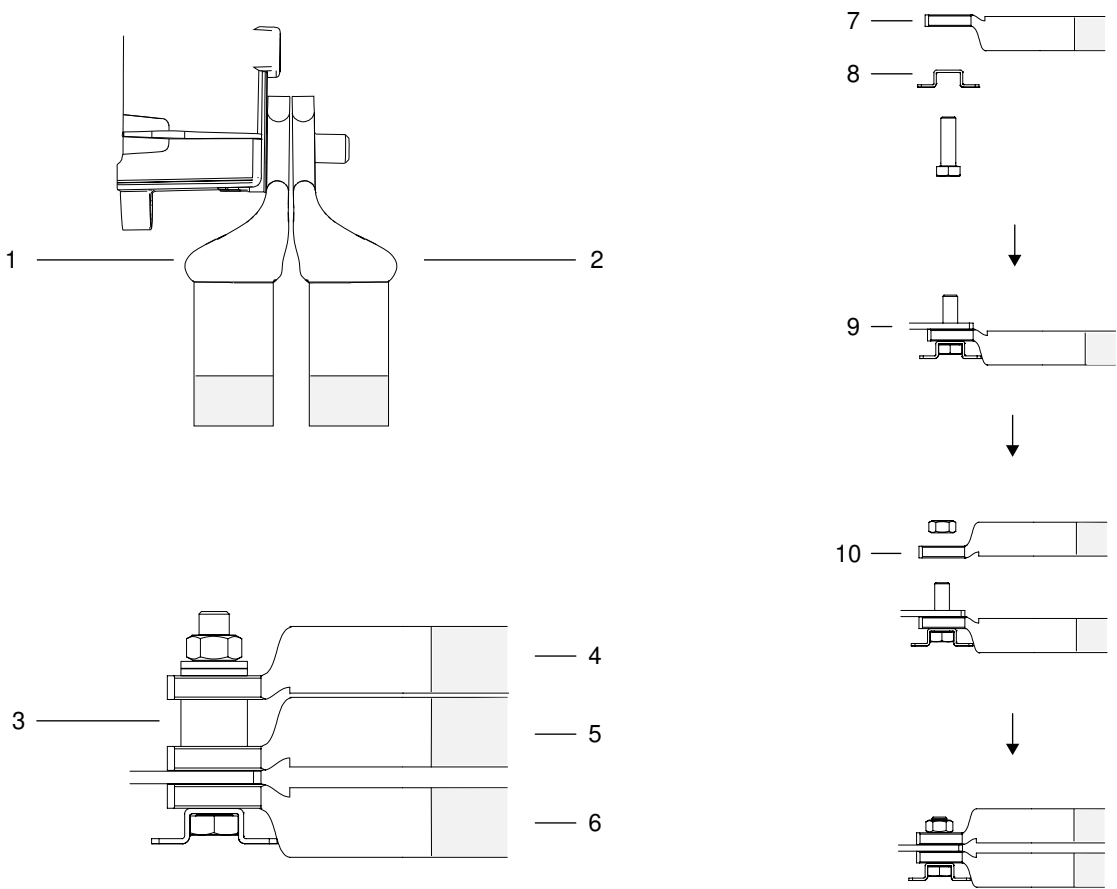
- Size the wiring according to the input current of the drive. For maximum wire sizes, see the *Electrical Data* section.
- Use cables rated for 75 °C (167 °F) of insulation for UL installations.
- Comply with local and national electrical codes for cable sizes.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided on the pedestal of IP21/IP54 (NEMA 1/NEMA 12) units.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring induction motor) between the drive and the motor.

Ground connection

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm<sup>2</sup> (6 AWG) (or 2 rated ground wires terminated separately).
- Tighten the terminals in accordance with the information provided in [10.11 Fastener Torque Ratings](#).

EMC-compliant Installation

Refer to the *EMC-compliant Installation* section.



e30bu151.10

Illustration 55: Different Ways of Connecting Multiple Cables to 1 Terminal

1	Cable 1	6	Cable 3
2	Cable 2	7	Cable 1 lug
3	Connection bushing	8	Bolt holder on the connector
4	Cable 1	9	Terminal connector
5	Cable 2	10	Cable 2 lug

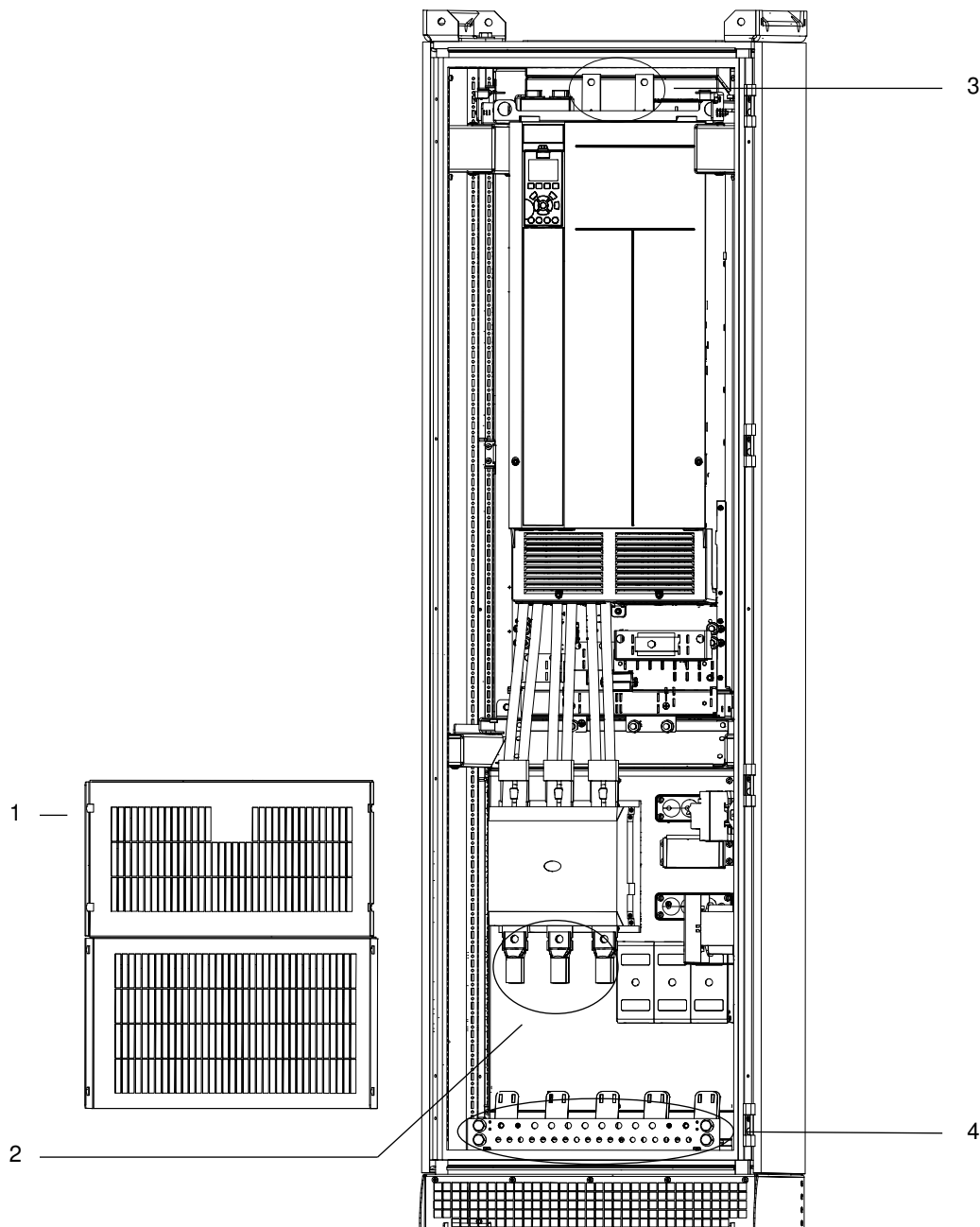
5.8.2 Connecting to the Mains

If the enclosed drive is not configured with an input filter or input power option, connect the mains to the drive module. Otherwise, connect the mains to the input power option.

Procedure

1. Strip a section of the outer cable insulation.
2. Fasten a connector/cable lug to the end of the stripped cable.
3. Create an electrical connection between the cable shield and ground by securing the stripped wire under the cable clamp.
4. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in [5.8.6 Connecting to Ground](#).
5. Connect the 3-phase AC input power cables to terminals R (L1), S (L2), and T (L3).
6. 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.
7. Tighten the terminals in accordance with the specifications shown in [10.11 Fastener Torque Ratings](#).

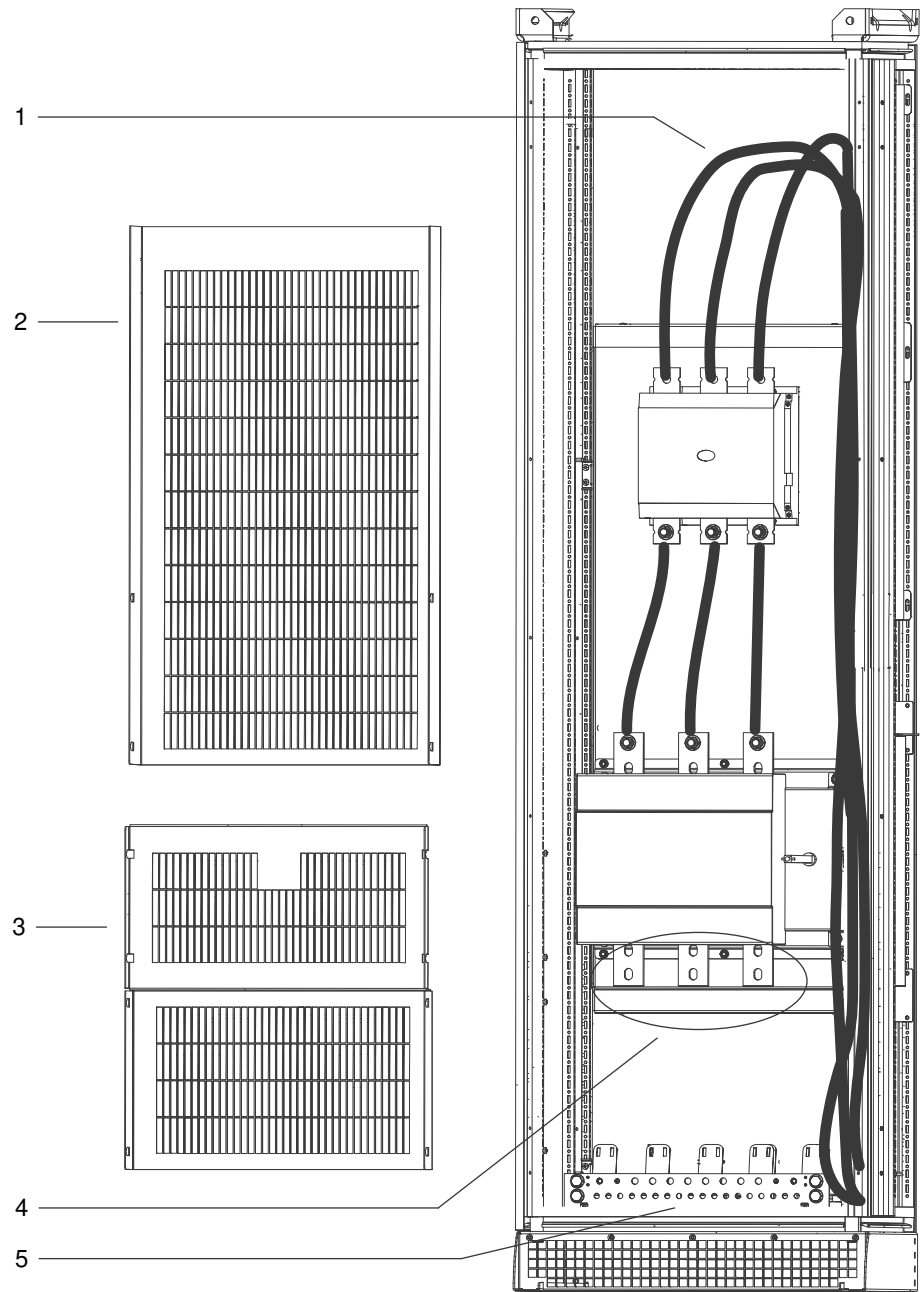
## Example



e30bu172.10

Illustration 56: Connection Points for Mains to Input Power Option (Enclosed Drive Configured Without Power Options Cabinet)

1	Lower cover	3	DC terminals
2	Input power terminals (contactor option is shown)	4	Grounding bar



e30bu173.10

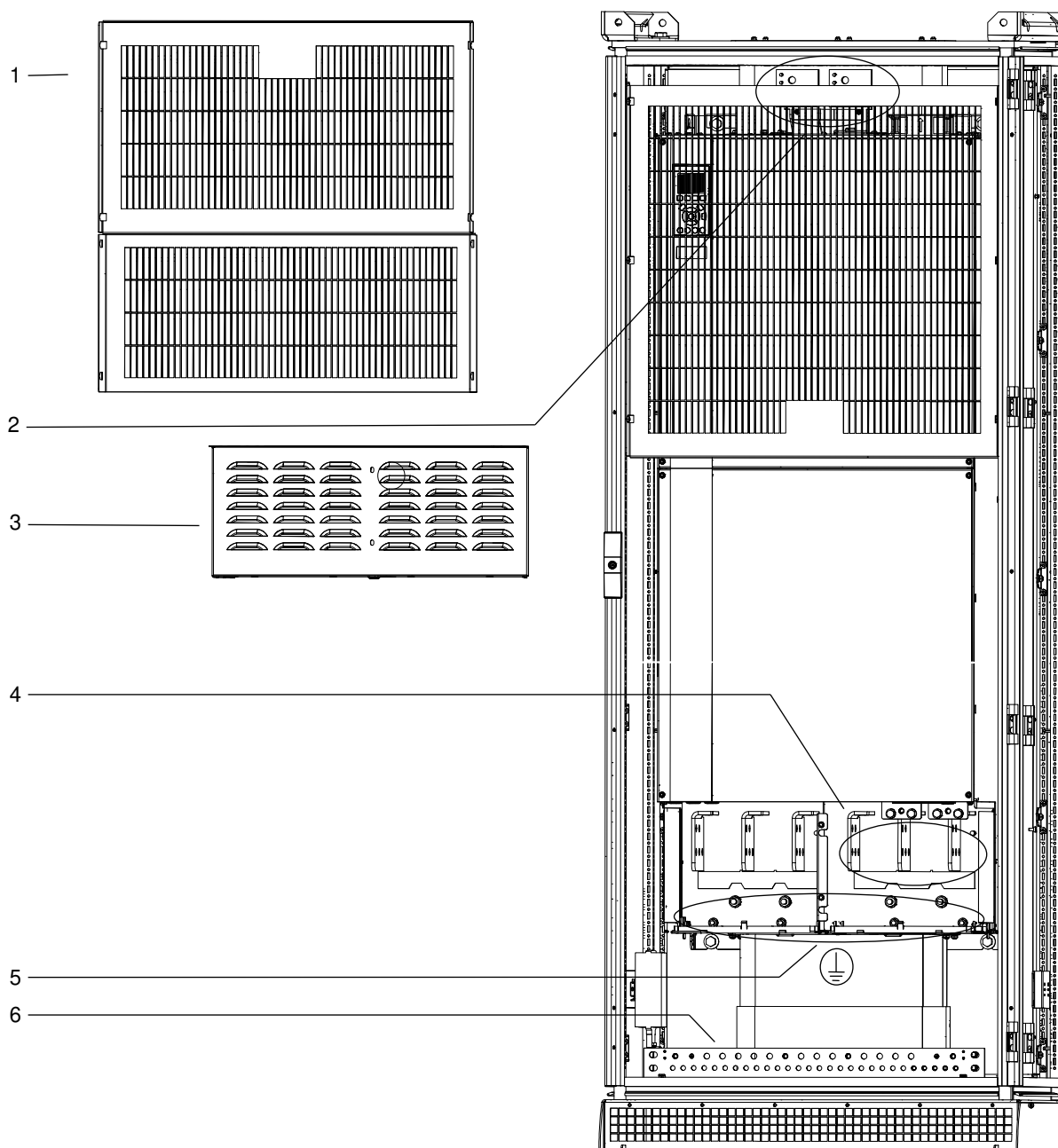
Illustration 57: Connection Points for Mains to Input Power Option (Enclosed Drive Configured With Power Options Cabinet)

1	Factory cables connecting contactor to drive input terminals	4	Input power terminals (disconnect option is shown)
2	Upper cover	5	Grounding bar
3	Lower cover		

### 5.8.3 Connecting the Drive Module to the Motor Procedure

1. Strip a section of the outer cable insulation.
2. Fasten a connector/cable lug to the end of the stripped cable.
3. Create an electrical connection between the cable shield and ground by securing the stripped wire under the cable clamp.
4. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in [5.8.6 Connecting to Ground](#).
5. Connect the 3-phase AC motor cables to terminals U (T1), V (T2), and W (T3).
6. Tighten the terminals in accordance with the specifications shown in [10.11 Fastener Torque Ratings](#).

## Example



e30bu171.10

Illustration 58: Connection Points for Drive Module to Motor (E6h Model Shown)

1	Lower cover	4	Motor terminals
2	DC terminals	5	Ground terminals on drive module
3	Terminal cover	6	Grounding bar

## 5.8.4 Connecting the Sine-wave Filter to the Motor

### Procedure

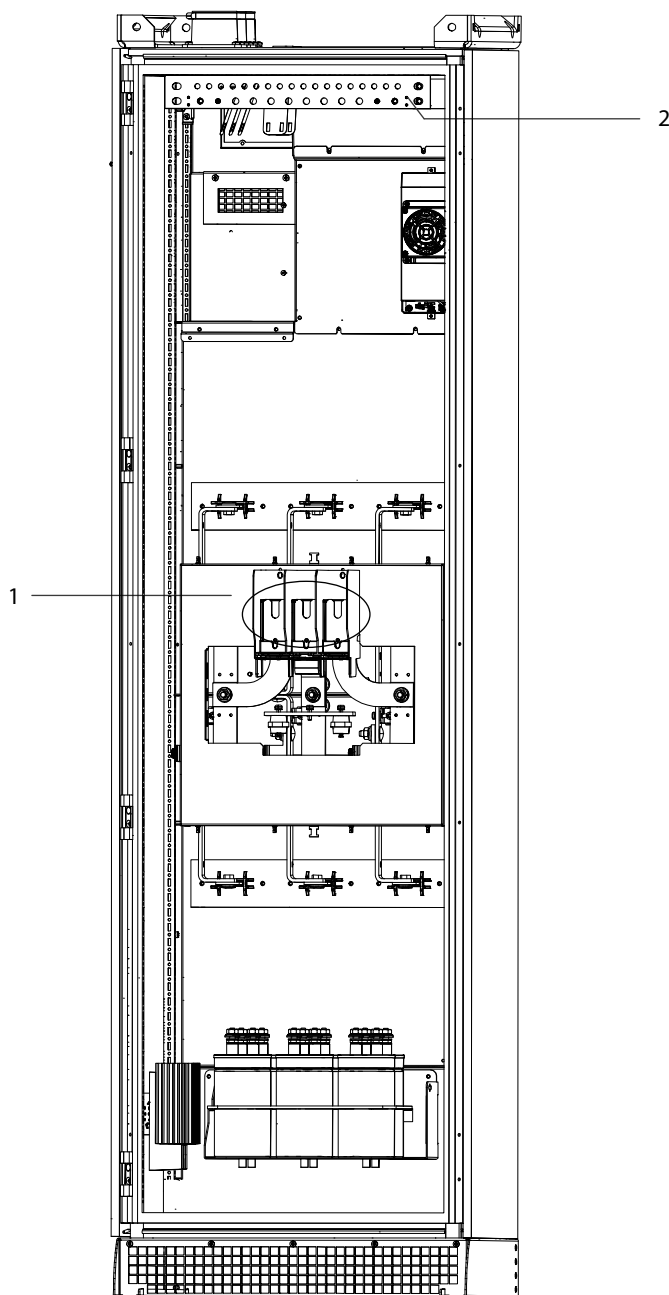
1. Strip a section of the outer cable insulation.
2. Fasten a connector/cable lug to the end of the stripped cable.
3. Create an electrical connection between the cable shield and ground by securing the stripped wire under the cable clamp.
4. Connect the ground cable to the nearest grounding terminal in accordance with the grounding instructions provided in [5.8.6 Connecting to Ground](#).
5. Connect the 3-phase AC motor cable to the sine-wave terminals U, V, and W.
  - If the enclosed drive has 1 sine-wave filter cabinet, run 1 set of motor cables to the cabinet.
  - If the enclosed drive has 2 sine-wave filter cabinets, run 2 sets of motor cables, 1 set to each sine-wave filter cabinet.

### NOTICE

- Each sine-wave cabinet must have the same number of motor phase cables and they must be in quantities of 2 (for example, 2, 4, 6, or 8). 1 cable is not allowed. The cables are required to be equal length.

6. Tighten the terminals in accordance with the specifications shown in [10.11 Fastener Torque Ratings](#).

#### Example



e30bu176.12

Illustration 59: Connection Points for the Sine-wave Filter to Motor (Top-exit Configuration Shown)

- |   |                 |
|---|-----------------|
| 1 | Motor terminals |
| 2 | Grounding bar   |

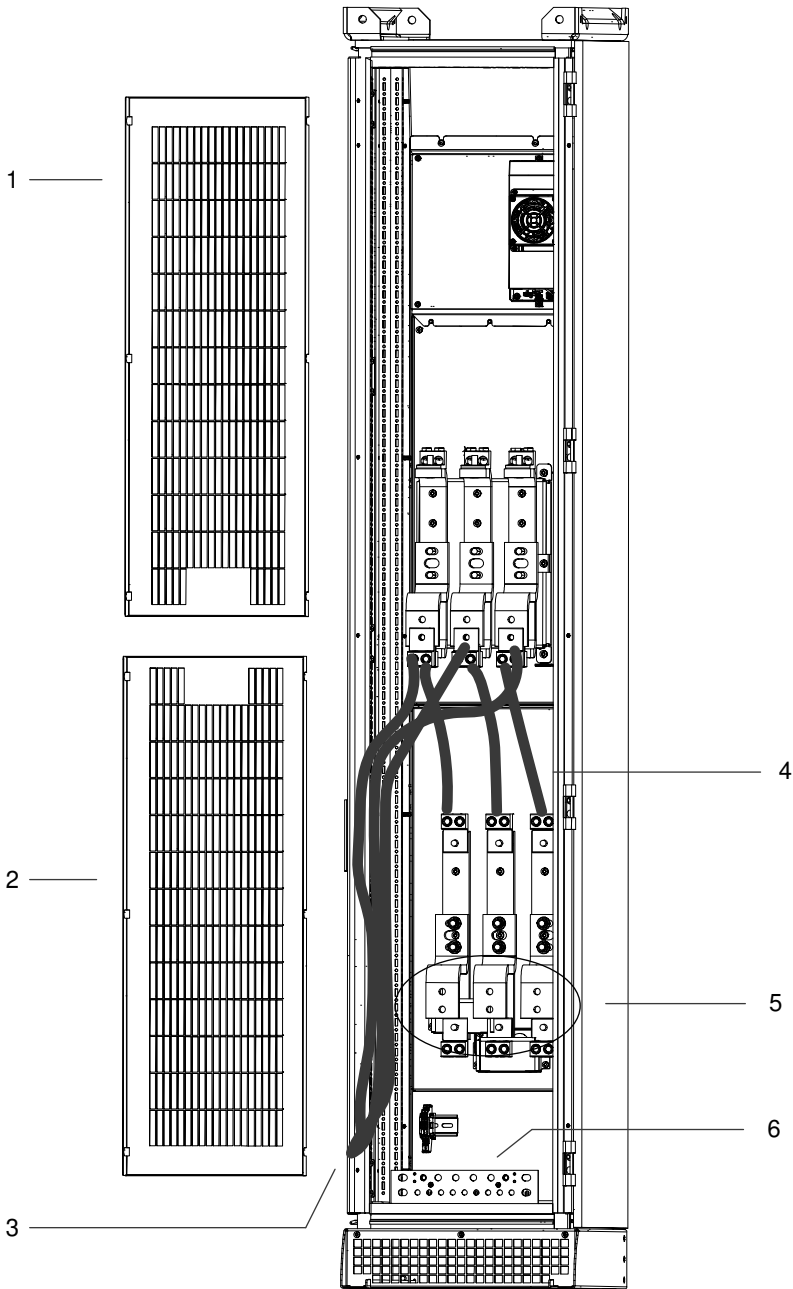
### 5.8.5 Connecting the dU/dt Filter to the Motor

#### Procedure

1. Strip a section of the outer cable insulation.
2. Fasten a connector/cable lug to the end of the stripped cable.
3. Create an electrical connection between the cable shield and ground by securing the stripped wire under the cable clamp.
4. Connect the ground cable to the nearest grounding terminal in accordance with the grounding instructions provided in [5.8.6 Connecting to Ground](#).

5. Connect the 3-phase AC motor wiring to the dU/dt terminals U (T1), V (T2), and W (T3).
6. Tighten the terminals in accordance with the specifications shown in [10.11 Fastener Torque Ratings](#).

Example



e30bu175.10

Illustration 60: Connection Points for the dU/dt Filter to Motor

1	Upper cover	4	Factory-installed cables
2	Lower cover	5	Motor terminals
3	Factory-installed power cables from the drive module	6	Grounding bar

5.8.6 Connecting to Ground

**⚠ 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.

**NOTICE**

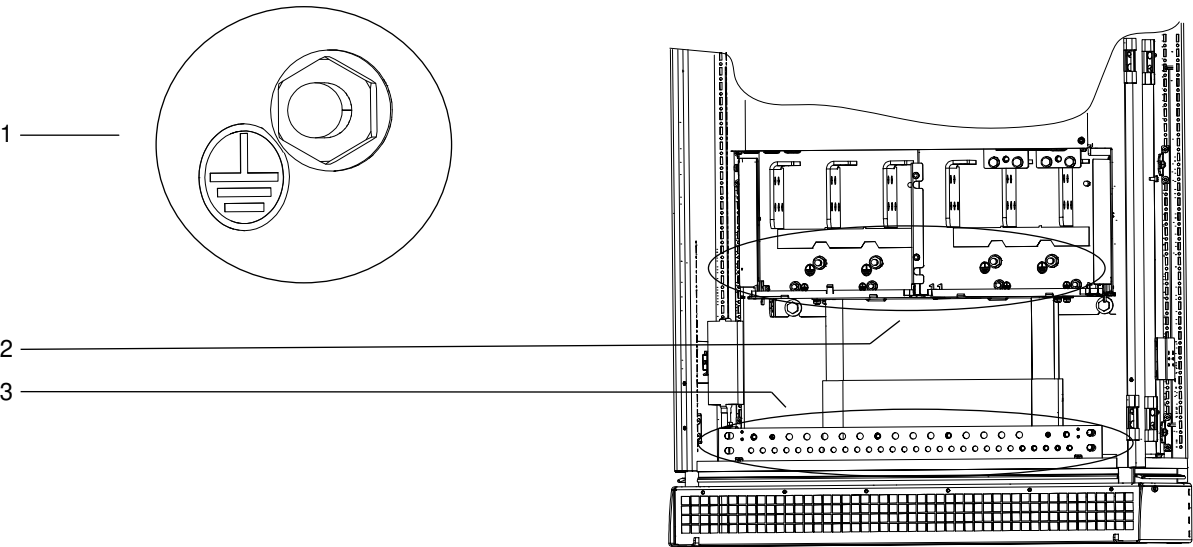
**POTENTIAL EQUALIZATION**

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<sup>2</sup> (5 AWG).

1. Strip a section of the outer cable insulation.
2. Fasten a connector/cable lug to the end of the stripped cable.
3. Connect the ground cable to the nearest grounding terminal.
4. Tighten the terminals in accordance with the specifications shown in [10.11 Fastener Torque Ratings](#).

Example



e30bu174.10

Illustration 61: Connection Grounding Points

1	Symbol indicating grounding terminals	3	Grounding bar (provided in every cabinet)
2	Grounding points on drive module		

## 5.9 Installing Upstream Fuses

### 5.9.1 Upstream Fuse Considerations

Factory fuse options like a fusible disconnect or MCCB protect the busbars and circuits within the drive. To protect the cables, an installer should use separate F1 fuses for upstream protection.

- Danfoss recommends the fuse type gG (IEC 60269-1) for the mains fuses. Use only fuses with a sufficient voltage rating according to the mains voltage. Do not use larger fuses than what is recommended. These fuses are selected for short-circuit protection only.
- Operation time of the fuse must be less than 0.4 s. The operation time must also agree with the fuse type and the impedance of the supply circuit.
- The recommended mains cable and fuse sizes are valid up to a cable length of 100 m (328 ft), with mains having a short-circuit current of 20 kA. Recommended cable sizes are shown in the *Electrical Data* section.
- Danfoss recommends the use of FC1 fuses to meet short-circuit protection for any enclosed drives supplied with only the non-fusible disconnect, a non-fusible disconnect and contactor, or a contactor only option.

### 5.9.2 Recommended Fuse Ratings for IEC Installation

Table 67: Recommended Fuse Ratings for IEC Installation, 380–480 V

Model	Fuse P/N	Fuse size	Rated current [A]	Minimum prospective SC current of the grid [kA]	Maximum fuse rating F1 [A]	Minimum voltage rating [V]	Type F1
N110K	Mersen NH1GG50V250	1	250	6.8	250	500	gG/gL
N132	Mersen NH2GG50V315	2	315	7	315	500	gG/gL
N160	Mersen NH2GG50V355	2	355	8.5	355	500	gG/gL
N200	Mersen NH3GG50V425	3	425	10	425	500	gG/gL
N250	Mersen NH3AGG50V630	3	630	13	630	500	gG/gL
N315	Mersen NH3AGG50V630	3	630	13	630	500	gG/gL
N355	Mersen NH4GG50V800	4	800	18	800	500	gG/gL
N400	Mersen NH4GG50V1000	4	1000	25	1000	500	gG/gL
N450	Mersen NH4GG50V1000	4	1000	25	1000	500	gG/gL
N500	Mersen NH4GG50V1000	4	1000	25	1000	500	gG/gL
N560	Mersen NH4GG50V1250	4	1250	33	1250	500	gG/gL

Table 68: Recommended Fuse Ratings for IEC Installation, 525–690 V

Model	Fuse P/N	Fuse size	Rated current [A]	Minimum prospective SC current of the grid [kA]	Maximum fuse rating F1 [A]	Minimum voltage rating [V]	Type F1
N110	Mersen NH2GG69V250	2	250	6.5	250	690	gG/gL
N132	Mersen NH2GG69V250	2	250	6.5	250	690	gG/gL
N160K	Mersen NH2GG69V250	2	250	6.5	250	690	gG/gL
N200	Mersen NH2GG69V315	2	315	7.5	315	690	gG/gL
N250	Mersen NH3GG69V355	3	355	8.5	355	690	gG/gL

Model	Fuse P/N	Fuse size	Rated current [A]	Minimum prospective SC current of the grid [kA]	Maximum fuse rating F1 [A]	Minimum voltage rating [V]	Type F1
N315	Mersen NH3GG69V425	3	425	9.5	425	690	gG/gL
N400	Mersen NH3GG69V500	3	500	12	500	690	gG/gL
N450	Mersen NH3GG69V500	3	500	12	500	690	gG/gL
N500	Mersen NH4GG69V630	4	630	14	630	690	gG/gL
N560	Mersen NH4GG69V800	4	800	19	800	690	gG/gL
N630	Mersen NH4GG69V800	4	800	19	800	690	gG/gL
N710	ABB OFAA4AM1000	4	1000	25	1000	690	aM
N800	ABB OFAA4AM1000	4	1000	25	1000	690	aM

### 5.9.3 Recommended Fuse Ratings for UL Installation

The fuses and MCCBs contained in the enclosed drive are suitable for both short circuit and branch circuit protection. Use only these fuses.

UL Approval is valid for maximum input voltage of 600 V. Per UL508A, the short-circuit current rating (SCCR) is as follows:

- Enclosed drives with a fusible disconnect or fusible disconnect and contactor option have 65 kA SCCR at the rated voltage.
- Enclosed drives with single switchgear (mains contactor only or non-fusible disconnect only option) have a 5 kA SCCR, but can reach 65 kA if the recommended Class fuses are used upstream.
- Enclosed drives with the MCCB option have a 65 kA interrupting rating for 380–480 V. For 525–690 V, the interrupting rating is 30 kA for the N355 model and 50 kA for the others.

The table values are calculated using correction factors for a 40 °C (104 °F) ambient operating condition and using cables with a minimum insulation rating of 90 °C (194 °F).

**Table 69: Recommended Fuse Ratings for UL Installation, 380–480 V**

Model	Fuse P/N (Mersen)	Fuse P/N (Danfoss)	Maximum current [A]	Maximum fuse rating F1 [A]	Minimum voltage rating [V]	Class F1
N110	A4J300	70CPE10965	300	300	500	Class J
N132	A4J350	70CPE10966	350	350	500	Class J
N160	A4J400	70CPE10522	400	400	500	Class J
N200	A4J500	70CPE10968	500	500	500	Class J
N250	A4J600	70CPE10523	600	600	500	Class J
N315	A4BY750	70CPE10969	750	750	500	Class L
N355	A4BY800	70CPE10974	800	800	500	Class L
N400	A4BY1000	70CPE10975	1000	1000	500	Class L
N450	A4BY1000	70CPE10975	1000	1000	500	Class L
N500	A4BY1100	70CPE10976	1100	1100	500	Class L
N560	A4BY1200	70CPE10977	1200	1200	500	Class L

Table 70: Recommended Fuse Ratings for UL Installation, 525–600 V

Model	Fuse P/N (Mersen)	Fuse P/N (Danfoss)	Maximum current [A]	Maximum fuse rating F1 [A]	Minimum voltage rating [V]	Class F1
N110	A4J175	70CPE10971	175	175	600	Class J
N132	A4J200	70CPE10521	200	200	600	Class J
N160	A4J250	70CPE10972	250	250	600	Class J
N200	A4J350	70CPE10966	350	350	600	Class J
N250	A4J400	70CPE10522	400	400	600	Class J
N315	A4J500	70CPE10968	500	500	600	Class J
N400	A4J600	70CPE10523	600	600	600	Class J
N450	A4J600	70CPE10523	600	600	600	Class J
N500	A4BY650	70CPE110003	650	650	600	Class L
N560	A4BY750	70CPE10969	750	750	600	Class L
N630	A4BY800	70CPE10974	800	800	600	Class L
N710	A4BY1000	70CPE10975	1000	1000	600	Class L
N800	A4BY1100	70CPE10976	1100	1100	600	Class L

## 5.10 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 from terminal XD2.14 in the control compartment. Digital input terminal XD2.14 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 XD2.14. If the drive does not run, refer to the documentation for the optional equipment that is wired into terminal XD2.14.

#### Procedure

1. When no interlock device is used, use a push-in type jumper (WAGO 2002-433) between terminal XD2.11 and XD2.14 in the control compartment. This wire provides an internal 24 V signal on terminal XD2.14. The drive is ready for operation.

## 5.11 Selecting the Voltage/Current Input Signal

The analog input terminals XD2.7 and XD2.8 in the control compartment allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

- Terminal XD2.7: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal XD2.8: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

#### Procedure

1. Disconnect power to the drive.
2. Remove the LCP (local control panel).
3. Remove any optional equipment covering the switches.

4. Set switches A53 and A54 to select the signal type (U = voltage, I = current).

#### Example

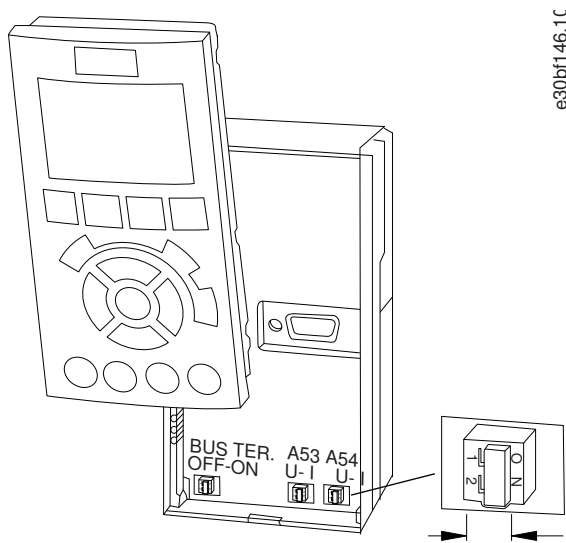


Illustration 62: Location of Switches A53 and A54

## 5.12 Setting Up RS485 Serial Communication

### 5.12.1 RS485 Features

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

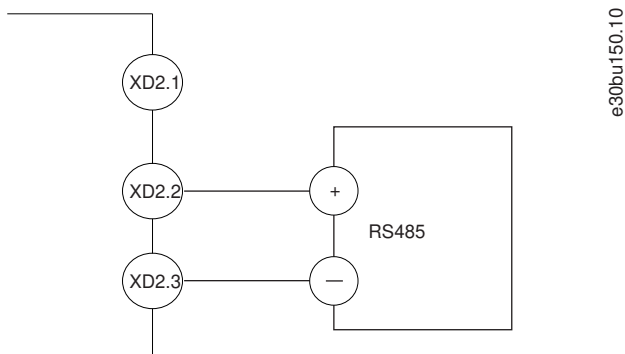
- Ability to select from the following communication protocols:
  - FC, FC MC, FC option
  - Modbus RTU
  - Metasys N2
  - FLN
  - BACnet
- Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-\*\* Communications and Options*.
- Selecting a specific 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.

### 5.12.2 Configuring RS485 Serial Communication

#### Procedure

1. Connect RS485 serial communication wiring to terminals (+) XD2.2 and (-) XD2.3.
  - - Use shielded serial communication cable.
  - - Properly ground the wiring. Refer to [5.8.6 Connecting to Ground](#).
2. Select the protocol type in *parameter 8-30 Protocol*.
3. Select the drive address in *parameter 8-31 Address*.

4. Select the baud rate in *parameter 8-32 Baud Rate*.

**Example****Illustration 63: RS485 Wiring Connection**

### 5.13 Configuring the Passive Harmonic Filter (PHF)

#### NOTICE

**EQUIPMENT DAMAGE**

Failure to use the correct settings can result in the AC drive overheating, resulting in damage to the AC drive and its surroundings.

**Procedure**

1. Set *parameter 5-02 Terminal 29 Mode* to [1] Output.
2. Set *parameter 5-31 Terminal 29 to [188] AHF Capacitor Connect*.
3. Set *parameter 14-51 DC-link Compensation* to [0] Off.

### 5.14 Configuring the dU/dt Filter

#### NOTICE

**EQUIPMENT DAMAGE**

Failure to use the correct settings for the D9h and D10h enclosures can result in the AC drive overheating, resulting in damage to the AC drive and its surroundings. E5h and E6h enclosures are not required to use a specific setting.

**Procedure**

1. Set *parameter 14-52 Output Filter* to [3] 100%.

### 5.15 Configuring the Sine-wave Filter

#### NOTICE

**EQUIPMENT DAMAGE**

Failure to use the correct settings can result in the AC drive overheating, resulting in damage to the AC drive and its surroundings.

**Procedure**

1. Set *parameter 14-55 Output Filter* to [1] Sine-wave.

### 5.16 MCCB Configuration

The molded-case circuit breaker (MCCB) offers the following trip settings:

- **Protection against overload (L).** The drive trips when there is an overload with inverse long-time delay trip according to the IEC 60947-2 Standard ( $I_2t=k$ ).
- **Protection against short circuit with time delay (S).** The drive trips when there is a short circuit with long inverse time-delay trip ( $I_2t=k$  ON), or a constant trip time ( $I_2t=k$  OFF).
- **Instant protection against short circuit (I).** The drive trips immediately if there is a short circuit. The trip function (L) is always available and either (S) or (I) can be selected by the DIP switch[S/I] on the trip unit of the MCCB.

Factory default settings are provided for functions L and I.

- Overcurrent setting (L) is done at 100% of the 1.5 times high overload FLA ( $I_1$ ).
- Time delay ( $t_1$ ) is selected as 12 s for 6 times of  $I_1$ .
- Short circuit instant trip setting (I) is followed. Short circuit trip with time delay (S) is ignored with the factory settings.
- Short circuit instant trip setting (I) is targeted at 300% of the 100% normal overload FLA ( $I_3$ ) of the drive.
- Neutral setting (N) is 100%.
- Frequency of operation is set at 50 Hz from the factory.

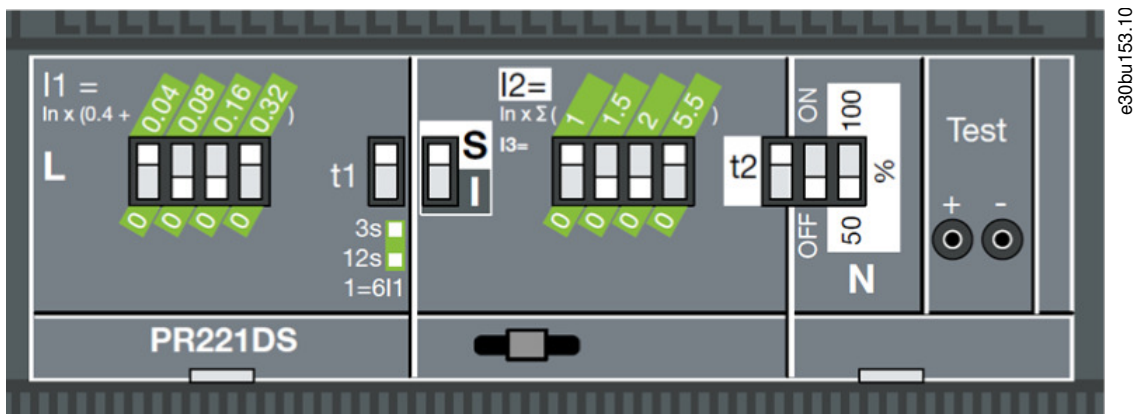


Illustration 64: MCCB Factory Default Settings

### 5.17 Safe Torque Off (STO) Wiring

The Safe Torque Off (STO) function is a component in a safety control system. STO 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 *VLT® FC Series - Safe Torque Off Operating Guide*.

## 6 Pre-start Check

### 6.1 Pre-start Check List

Motor
<ul style="list-style-type: none"> <li>Confirm continuity of the motor by measuring ohm values on U–V (96–97), V–W (97–98), and W–U (98–96).</li> <li>Confirm that the supply voltage matches the voltage of the drive and the motor.</li> </ul>
Switches
<ul style="list-style-type: none"> <li>Ensure that all switch and disconnect settings are in the proper positions.</li> </ul>
Auxiliary equipment
<ul style="list-style-type: none"> <li>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.</li> <li>Check function and installation of any sensors used for feedback to the drive.</li> <li>Remove any power factor correction caps on the motor.</li> <li>Adjust any power factor correction caps on the mains side and ensure that they are dampened.</li> </ul>
Cable/wire routing
<ul style="list-style-type: none"> <li>Ensure that motor wiring, brake wiring (if equipped), and control wiring are separated, shielded, or in 3 separate metallic conduits for high-frequency interference isolation.</li> </ul>
Control wiring
<ul style="list-style-type: none"> <li>Check for broken or damaged wires and loose connections.</li> <li>Check that control wiring is isolated from high-power wiring for noise immunity.</li> <li>Check the voltage source of the signals, if necessary.</li> <li>Use shielded or twisted pair cable.</li> <li>Ensure that the shield is terminated correctly.</li> </ul>
Input and output power wiring
<ul style="list-style-type: none"> <li>Check for loose connections.</li> <li>Check that motor and mains are in separate conduit or separated shielded cables.</li> </ul>
Grounding
<ul style="list-style-type: none"> <li>Make sure that a proper ground is used. Grounding to conduit or mounting the back panel to a metal surface is not a suitable grounding.</li> <li>Check for good ground connections that are tight and free of oxidation.</li> </ul>
Fuses and circuit breakers
<ul style="list-style-type: none"> <li>Check for proper fusing or circuit breakers.</li> <li>Check that all fuses are inserted firmly and are in operational condition.</li> <li>Check that all circuit breakers (if used) are in the open position.</li> </ul>
Cooling clearance

- Look for any obstructions in the airflow path.
- Measure top and bottom clearance of the drive to verify that there is at least 225 mm (9 in) of clearance for adequate airflow.

#### Ambient conditions

- Check that requirements for ambient conditions are met. See the *Ambient Conditions* section.

#### Interior of 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 enclosures with an IP20/Chassis protection rating, ensure that the unit is mounted to an unpainted metal surface.

#### Vibration

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

## 7 Commissioning

### 7.1 Applying Power to the Drive

Before applying power to the drive, verify that the drive and all associated equipment are ready for operation. Refer to the *Pre-start Check* section.

#### ⚠ WARNING ⚠

##### UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment, or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

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

#### NOTICE

##### MISSING SIGNAL

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING, or if *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 [5.10 Enabling Motor Operation](#) for details.

#### Procedure

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.

### 7.2 Programming the Drive

#### 7.2.1 Parameter Overview

Parameters contain various settings that are used to configure and operate the drive and motor. These parameter settings are programmed into the LCP through the different menus. For more detail on parameters, see the Programming Guide.

Parameter settings are assigned a default value at the factory, but can be configured for their unique application. Each parameter has a name and number that remain the same regardless of the programming mode.

In the *Main Menu* mode, the parameters are divided into groups. The 1<sup>st</sup> digit of the parameter number (from the left) indicates the parameter group number. The parameter group is then broken down into subgroups, if necessary. For example:

Table 71: Example of Parameter Group Hierarchy

Example	Description
0-** Operation/Display	Parameter group
0-0* Basic Settings	Parameter subgroup

Example	Description
<i>Parameter 0-01 Language</i>	Parameter
<i>Parameter 0-02 Motor Speed Unit</i>	Parameter
<i>Parameter 0-03 Regional Settings</i>	Parameter

## 7.2.2 Parameter Navigation

Use the following LCP keys to navigate through the parameters.

- Press [▲] [▼] to scroll up or down.
- Press [◀] [▶] to shift a space to the left or right of a decimal point while editing a decimal parameter value.
- Press [OK] to accept the change.
- Press [Cancel] to disregard the change and exit edit mode.
- Press [Back] twice to show the status view.
- Press [Main Menu] once to go back to the main menu.

## 7.2.3 Programming Example for an Open-loop Application

This procedure, which is used to configure a typical open-loop application, programs the drive to receive a 0–10 V DC analog control signal on input terminal 53. The drive responds by providing 20–50 Hz output to the motor proportional to the input signal (0–10 V DC=20–50 Hz). The wiring connections used to enable the external device set-up are shown in [Illustration 65](#).

### Procedure

1. Press [Quick Menu].
2. Select Q3 Function Setups and press [OK].
3. Select Parameter Data Set and press [OK].
4. Select Q3-2 Open Loop Settings and press [OK].
5. Select Q3-21 Analog Reference and press [OK].
6. Select *parameter 3-02 Minimum Reference*. Set the minimum internal drive reference to 0 Hz and press [OK].
7. Select *parameter 3-03 Maximum Reference*. Set the maximum internal drive reference to 60 Hz and press [OK].
8. Select *parameter 6-10 Terminal 53 Low Voltage*. Set the minimum external voltage reference on terminal 53 at 0 V and press [OK].
9. Select *parameter 6-11 Terminal 53 High Voltage*. Set maximum external voltage reference on terminal 53 at 10 V and press [OK].
10. Select *parameter 6-14 Terminal 53 Low Ref./Feedb. Value*. Set minimum speed reference on terminal 53 at 20 Hz and press [OK].
11. Select *parameter 6-15 Terminal 53 High Ref./Feedb. Value*. Set maximum speed reference on terminal 53 at 50 Hz and press [OK].



With an external device providing a 0–10 V control signal connected to drive terminal 53, the system is now ready for operation.

## NOTICE

### SETUP STATUS

When the scroll bar on the right of the display is at the bottom, the procedure is complete.

## Example

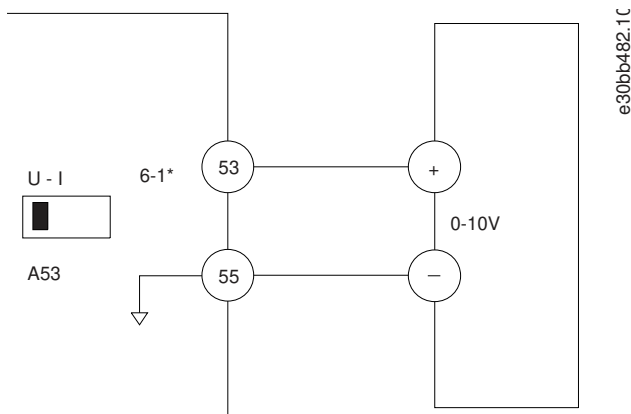


Illustration 65: Wiring Example for External Device Providing 0–10 V Control Signal

## 7.2.4 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.

## N O T I C E

## SOFTWARE DOWNLOAD

For commissioning via a PC, install VLT® Motion Control Tool MCT 10 set-up software. A basic version, which is sufficient for most applications, is available for download. An advanced version, which can commission multiple drives at once, can be ordered.

- See [https://www.danfoss.com/en/service-and-support/downloads/?sort=title\\_asc&filter=download-type%3Dtools](https://www.danfoss.com/en/service-and-support/downloads/?sort=title_asc&filter=download-type%3Dtools).

## Procedure

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* (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* (Off)

## 7.2.5 Configuring Automatic Energy Optimization

Automatic energy optimization (AEO) is a procedure that minimizes voltage to the motor, reducing energy consumption, heat, and noise.

### Procedure

1. Press [Main Menu].
2. Select *1-\*\* Load and Motor* and press [OK].
3. Select *1-0\* General Settings* and press [OK].
4. Select *parameter 1-03 Torque Characteristics* and press [OK].
5. Select either *[2] Auto Energy Optim CT* or *[3] Auto Energy Optim VT* and press [OK].

## 7.2.6 Configuring Automatic Motor Adaptation

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

The drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in *parameters 1-20 to 1-25*.

### NOTICE

**SOME MOTORS ARE UNABLE TO RUN THE COMPLETE VERSION OF THE TEST AND WILL TRIGGER AN ALARM.**

- In that case, or if an output filter is connected to the motor, select *[2] Enable reduced AMA*.

### Procedure

1. Press [Main Menu].
2. Select *1-\*\* Load and Motor* and press [OK].
3. Select *1-2\* Motor Data* and press [OK].
4. Select *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Press [Hand On] and then [OK].

The test runs automatically and indicates when it is complete.

## 7.3 Testing Before System Start-up

### 7.3.1 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.

### Procedure

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*.

### 7.3.2 Testing Encoder Rotation

Use this procedure if encoder feedback is used. For more information on the encoder option, refer to the option manual.

### Procedure

1. Select *[0] Open Loop* in *parameter 1-00 Configuration Mode*.
2. Select *[1] 24 V encoder* in *parameter 7-00 Speed PID Feedback Source*.
3. Press [Hand On].

4. Press [▶] for positive speed reference (*parameter 1-06 Clockwise Direction at [0] Normal*).
5. Check feedback in *parameter 16-57 Feedback [RPM]*.
  - If feedback is positive, the test was successful.
  - If feedback is negative, the encoder connection is wrong. Use either *parameter 5-71 Term 32/33 Encoder Direction* or *parameter 17-60 Feedback Direction* to inverse the direction, or reverse the encoder cables. *Parameter 17-60 Feedback Direction* is only available with the VLT® Encoder Input MCB 102 option.

## 7.4 Starting Up the Drive for the First Time

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

### ⚠ WARNING ⚠

#### MOTOR START

Starting the drive can cause the motor to 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, button, 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.

## 7.5 Parameter Settings

### 7.5.1 Parameter Setting Overview

Parameters are operational settings accessed through the LCP that are used to configure and operate the drive and motor for specific applications.

Some parameters have different default settings for international or North America. For a list of the different default values, see the *International/North American Default Parameter Settings* section.

Parameter settings are stored internally in the drive, allowing the following advantages:

- Parameter settings can be uploaded into the LCP memory and stored as a back-up.
- Multiple units can be programmed quickly by connecting the LCP to the unit and downloading the stored parameter settings.
- Settings that are stored in the LCP are not changed when restoring factory default settings.
- Changes made to default settings and parameter variables are stored and available for viewing in the quick menu. See the *LCP Menu* section.

### 7.5.2 Uploading and Downloading Parameter Settings

The drive operates using parameters stored on the control card, which is located within the drive. The upload and download functions move the parameters between the control card and the LCP.

#### Procedure

1. Press [Off].
2. Go to *parameter 0-50 LCP Copy* and press [OK].
3. Select 1 of the following:
  - - To upload data from the control card to the LCP, select [1] *All to LCP*.
  - - To download data from the LCP to the control card, select [2] *All from LCP*.

4. Press [OK].

A progress bar shows the uploading or downloading process.

5. Press [Hand On] or [Auto On].

### 7.5.3 Restoring Factory Default Settings Using the Recommended Initialization

#### NOTICE

##### LOSS OF DATA

Restoring default settings results in a loss of programming, motor data, localization, and monitoring records.

- To create a back-up, upload data to the LCP before initialization. See [7.5.2 Uploading and Downloading Parameter Settings](#).

1. Press [Main Menu] twice to access parameters.
2. Go to *parameter 14-22 Operation Mode* and press [OK].

*Parameter 14-22 Operation Mode* does not reset the following settings:

- Running hours.
- Serial communication options.
- Personal menu settings.
- Fault log, alarm log, and other monitoring functions.

3. Scroll to *Initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit. Default parameter settings are restored during start-up. Start-up takes slightly longer than normal.
6. After *alarm 80, Drive initialized* appears, press [Reset].

### 7.5.4 Restoring Factory Default Settings Using Manual Initialization

#### NOTICE

##### LOSS OF DATA

Restoring default settings results in a loss of programming, motor data, localization, and monitoring records.

- To create a back-up, upload data to the LCP before initialization. See [7.5.2 Uploading and Downloading Parameter Settings](#).

#### Procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] simultaneously while applying power to the unit (approximately 5 s or until an audible click sounds and the fan starts).

Manually initializing does not reset the following parameter settings:

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

Start-up takes slightly longer than normal.

#### NOTICE

A manual initialization also resets serial communication, RFI filter settings, and fault log settings.

## 8 Wiring Configuration Examples

### 8.1 Application Examples

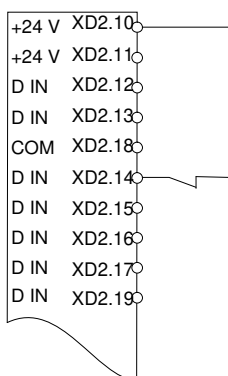
The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values selected in *parameter 0-03 Regional Settings*, unless otherwise indicated.
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

#### 8.1.1 Wiring Configuration for Automatic Motor Adaptation (AMA)

Table 72: Wiring Configuration for AMA with T27 Connected

Parameters	
Function	Setting
Parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
Parameter 5-12 Terminal 27 Digital Input	[2]* Coast inverse
*=Default value	
<b>Notes/comments:</b> Set <i>parameter group 1-2* Motor Data</i> according to motor nameplate. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	

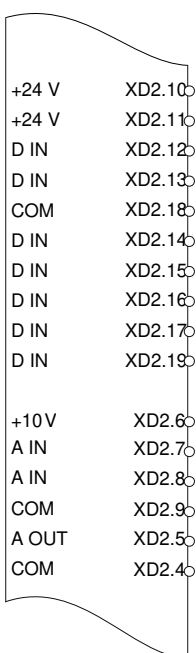


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#### 8.1.2 Wiring Configuration for Automatic Motor Adaptation (AMA) without T27

Table 73: Wiring Configuration for AMA without T27 Connected

Parameters	
Function	Setting
Parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
Parameter 5-12 Terminal 27 Digital Input	[0] No operation
*=Default value	
<b>Notes/comments:</b> Set <i>parameter group 1-2* Motor Data</i> according to motor nameplate. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	



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## 8.1.3 Wiring Configuration: Speed

Table 74: Wiring Configuration for Analog Speed Reference (Voltage)

Parameters	
Function	Setting
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 53 in the parameter title corresponds to terminal XD2.7 in the control compartment.	

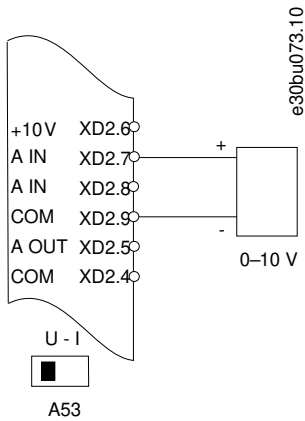


Table 75: Wiring Configuration for Analog Speed Reference (Current)

Parameters	
Function	Setting
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 53 in the parameter title corresponds to terminal XD2.7 in the control compartment.	

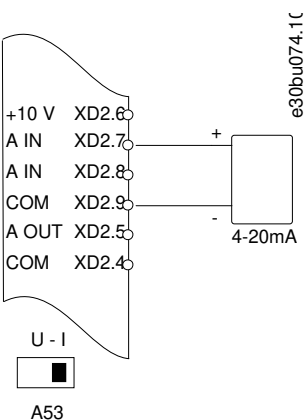


Table 76: Wiring Configuration for Speed Reference (Using a Manual Potentiometer)

Parameters	
Function	Setting
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 53 in the parameter title corresponds to terminal XD2.7 in the control compartment.	

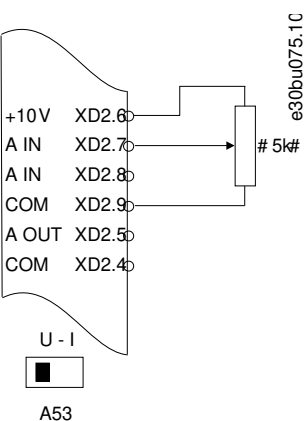


Table 77: Wiring Configuration for Speed Up/Down

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[19] Freeze Reference
Parameter 5-13 Terminal 29 Digital Input	[21] Speed Up
Parameter 5-14 Terminal 32 Digital Input	[22] Speed Down
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment. Terminal 29 in the parameter title corresponds to terminal XD2.15 in the control compartment. Terminal 32 in the parameter title corresponds to terminal XD2.16 in the control compartment.	

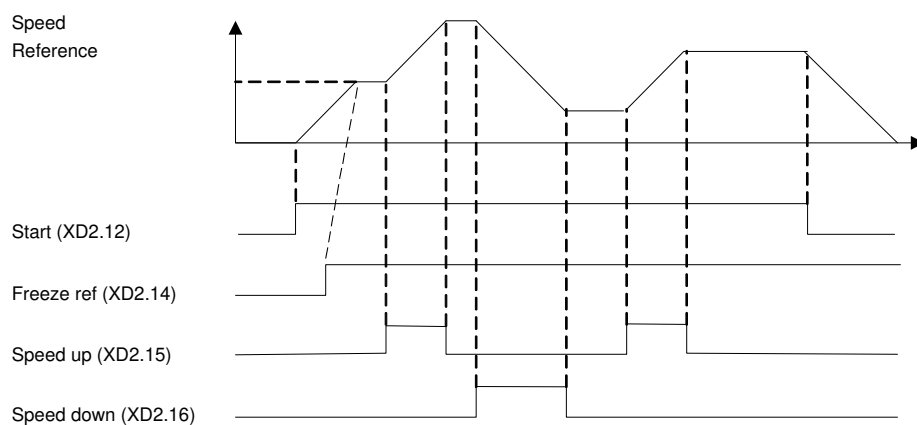


Illustration 66: Speed Up/Down

### 8.1.4 Wiring Configuration: Feedback

**Table 78: Wiring Configuration for Analog Current Feedback Transducer (2-wire)**

U - I  
A54

**Parameters**

Function	Setting
Parameter 6-22 Terminal 54 Low Current	4 mA*
Parameter 6-23 Terminal 54 High Current	20 mA*
Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*

\*=Default value

**Notes/comments:**

D IN 37 is an option.

Terminal 54 in the parameter title corresponds to terminal XD2.8 in the control compartment.

**Table 79: Wiring Configuration for Analog Voltage Feedback Transducer (3-wire)**

The figure consists of two parts: a wiring diagram on the left and a parameter table on the right.

**Wiring Diagram:**

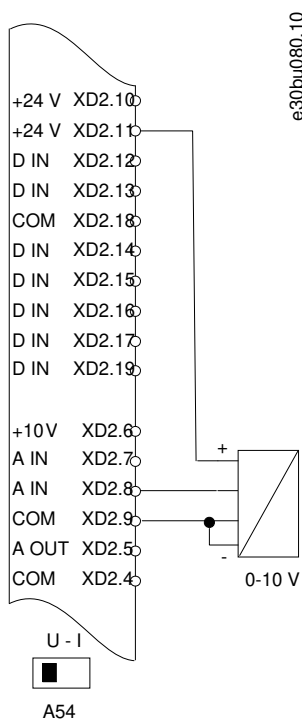
- Terminal Block (Left):**
  - Top section: +24 V XD2.10, +24 V XD2.11, D IN XD2.12, D IN XD2.13, COM XD2.18, D IN XD2.14, D IN XD2.15, D IN XD2.16, D IN XD2.17, D IN XD2.19.
  - Bottom section: +10 V XD2.6, A IN XD2.7, A IN XD2.8, COM XD2.9, A OUT XD2.5, COM XD2.4.
- Power Supply (Right):** A transformer labeled "0-10 V".
- Connections:**
  - The primary of the transformer is connected to the +24 V lines (XD2.10, XD2.11) and the D IN lines (XD2.12, XD2.13, XD2.14, XD2.15, XD2.16, XD2.17, XD2.19).
  - The secondary of the transformer is connected to the +10 V line (XD2.6) and the A IN lines (XD2.7, XD2.8).
  - The common terminal of the secondary is connected to the COM line (XD2.9).
- Legend:** A box with a black square is labeled "U - I" and "A54".

**Parameter Table:**

Parameters	
Function	Setting
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 54 in the parameter title corresponds to terminal XD2.8 in the control compartment.	

Table 80: Wiring Configuration for Analog Voltage Feedback Transducer (4-wire)

Parameters	
Function	Setting
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 54 in the parameter title corresponds to terminal XD2.8 in the control compartment.	



### 8.1.5 Wiring Configuration: Run/Stop

Table 81: Wiring Configuration for Run/Stop Command with External Interlock

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	

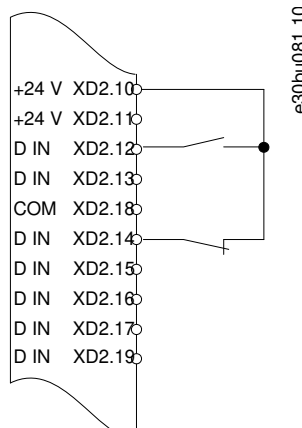


Table 82: Wiring Configuration for Run/Stop Command without External Interlock

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
*=Default value	
<b>Notes/comments:</b> If parameter 5-12 Terminal 27 Digital Inputs is set to [0] No operation, a jumper wire to terminal XD2.14 is not needed. D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	

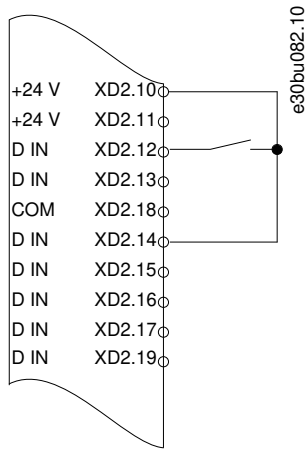
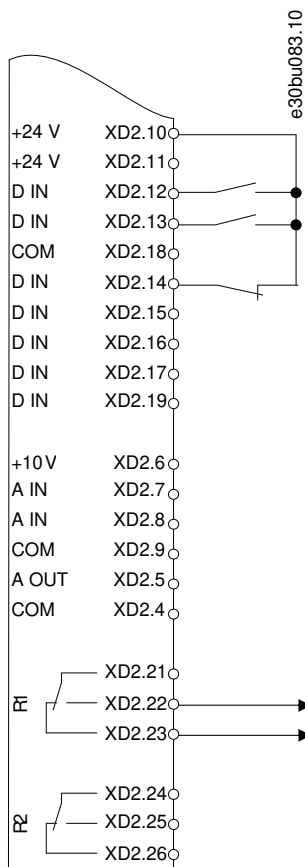


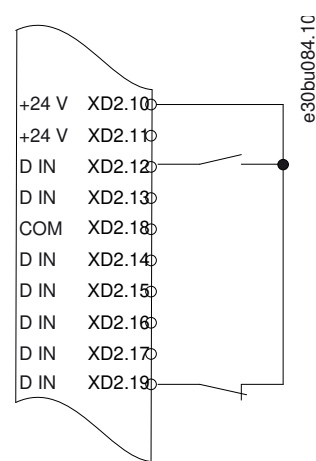
Table 83: Wiring Configuration for Run Permissive

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-11 Terminal 19 Digital Input	[52] Run permissive
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
Parameter 5-40 Function Relay	[167] Start command act.
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 19 in the parameter title corresponds to terminal XD2.13 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	



## 8.1.6 Wiring Configuration: Start/Stop

Table 84: Wiring Configuration for Start/Stop Command with Safe Torque Off Option

	Parameters	
	Function	Setting
	Parameter 5-10 Terminal 18 Digital Input	[Start]*
	Parameter 5-12 Terminal 27 Digital Input	[0] No operation
	Parameter 5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
	*=Default value	
<b>Notes/comments:</b> If <i>parameter 5-12 Terminal 27 Digital Input</i> is set to <i>[0] No operation</i> , a jumper wire to terminal XD2.14 is not needed. D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment. Terminal 37 in the parameter title corresponds to terminal XD2.19 in the control compartment.		

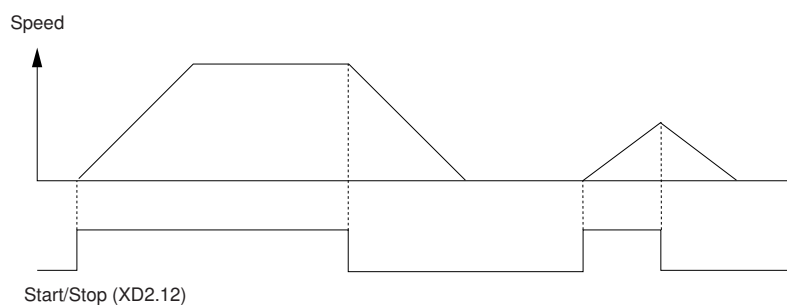
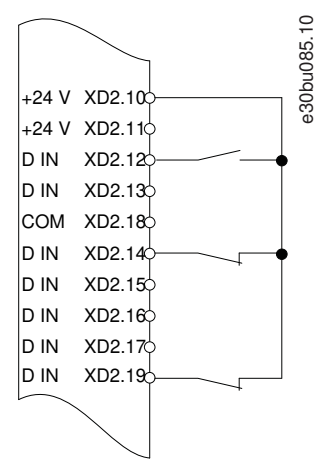
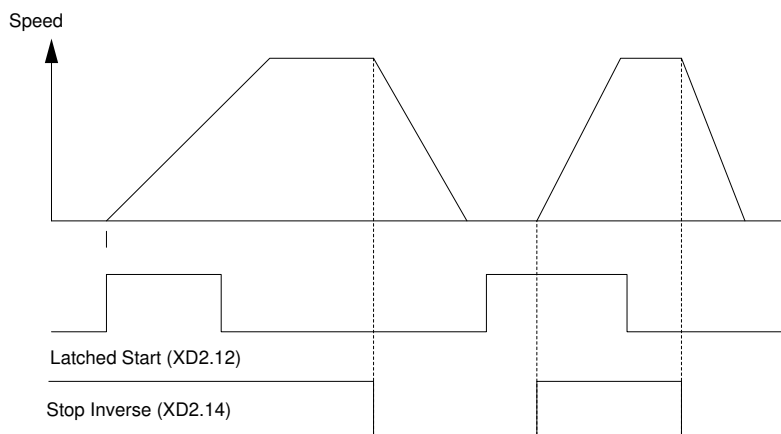


Illustration 67: Wiring Configuration for Start/Stop Command with Safe Torque Off

Table 85: Wiring Configuration for Pulse Start/Stop

	Parameters	
	Function	Setting
	Parameter 5-10 Terminal 18 Digital Input	[9] Latched Start
	Parameter 5-12 Terminal 27 Digital Input	[6] Stop Inverse
	*=Default value	
	<b>Notes/comments:</b> If parameter 5-12 Terminal 27 Digital Input is set [0] No operation, a jumper wire to terminal XD2.14 is not needed. D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment.	

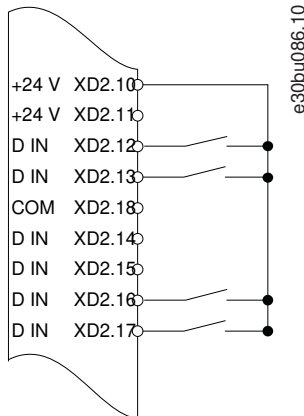


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Illustration 68: Latched Start/Stop Inverse

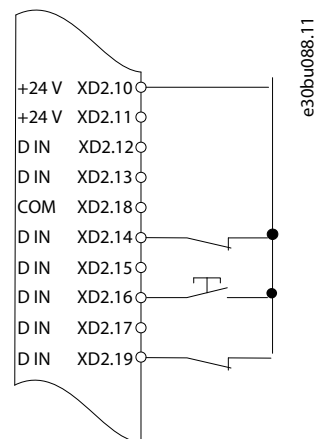
Table 86: Wiring Configuration for Start/Stop with Reversing and 4 Preset Speeds

Parameters	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start
Parameter 5-11 Terminal 19 Digital Input	[10] Reversing*
Parameter 5-12 Terminal 27 Digital Input	[0] No operation
Parameter 5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
Parameter 5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
Parameter 3-10 Preset Reference	<ul style="list-style-type: none"> <li>Preset ref. 0 = 25%</li> <li>Preset ref. 1 = 50%</li> <li>Preset ref. 2 = 75%</li> <li>Preset ref. 3 = 100%</li> </ul>
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option. Terminal 18 in the parameter title corresponds to terminal XD2.12 in the control compartment. Terminal 19 in the parameter title corresponds to terminal XD2.13 in the control compartment. Terminal 27 in the parameter title corresponds to terminal XD2.14 in the control compartment. Terminal 32 in the parameter title corresponds to terminal XD2.16 in the control compartment. Terminal 33 in the parameter title corresponds to terminal XD2.17 in the control compartment.	



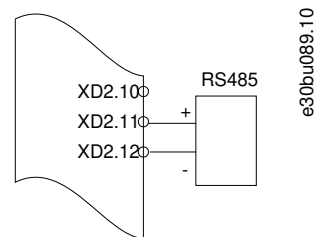
### 8.1.7 Wiring Configuration: External Alarm Reset

Table 87: Wiring Configuration for External Alarm Reset

	Parameter	
	Function	Setting
	Parameter 5-14 Terminal 32 Digital Input	[1] Reset
	*=Default value	
	<b>Notes/comments:</b> D IN 37 is an option. Terminal 32 in the parameter title corresponds to terminal XD2.16 in the control compartment.	

### 8.1.8 Wiring Configuration: RS485

Table 88: Wiring Configuration for RS485 Network Connection

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

## 8.1.9 Wiring Configuration: Motor Thermistor

### ⚠ CAUTION ⚠

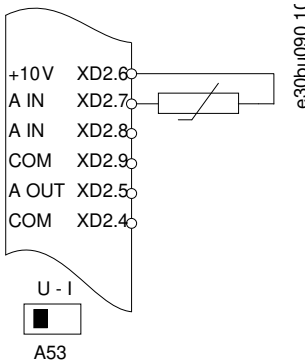
**THERMISTOR INSULATION**

Risk of personal injury or equipment damage.

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

Table 89: Wiring Configuration for Motor Thermistor

Parameters	
Function	Setting
Parameter 1-90 Motor Thermal Protection	[2] Thermistor trip
Parameter 1-93 Thermistor Source	[1] Analog input 53
* = Default value	
<p>If only a warning is required, set <i>parameter 1-90 Motor Thermal Protection</i> to [1] Thermistor warning.</p> <p>D IN 37 is an option.</p> <p>Input 53 in the parameter corresponds to terminal XD2.7 in the control compartment.</p>	

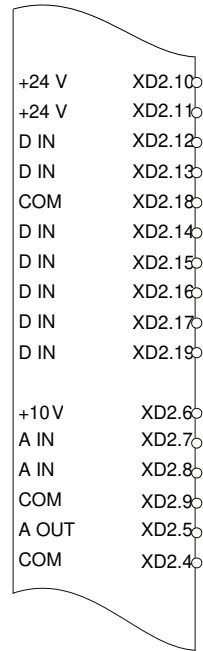


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## 8.1.10 Wiring for Regeneration

Table 90: Wiring Configuration for Regeneration

Parameter	
Function	Setting
Parameter 1-90 Motor Thermal Protection	100%*
* = Default value	
<p>To disable regeneration, decrease <i>parameter 1-90 Motor Thermal Protection</i> to 0%. However, if the application uses motor brake power and regeneration is not enabled, the drive will trip.</p>	

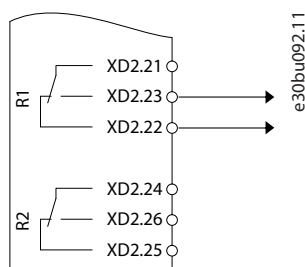


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### 8.1.11 Wiring Configuration for a Relay Set-up with Smart Logic Control

Table 91: Wiring Configuration for a Relay with Smart Logic Control

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



### 8.1.12 Wiring Configuration for a Submersible Pump

The system consists of a submersible pump controlled by a Danfoss VLT® AQUA Drive and a pressure transmitter. The transmitter gives a 4–20 mA feedback signal to the drive, which keeps a constant pressure by controlling the speed of the pump. To design a drive for a submersible pump application, there are a few important issues to consider. Select the drive according to motor current.

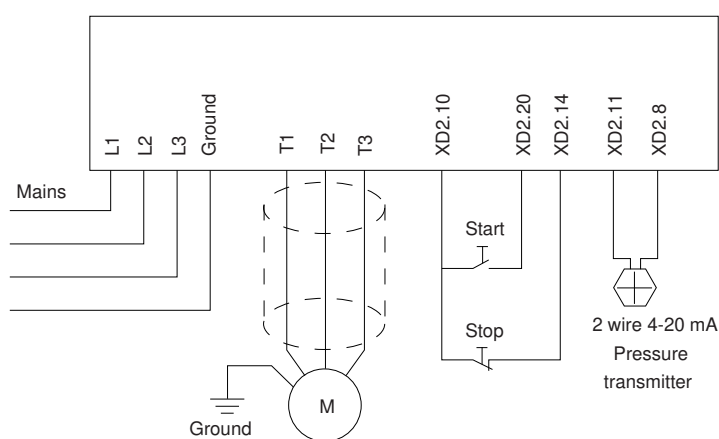
- The CAN motor is a motor with a stainless steel can between the rotor and stator that contains a larger and a more magnetic resistant air-gap than on a normal motor. This weaker field results in the motors being designed with a higher rated current than a normal motor with similar rated power. The special CAN motor is used because of the wet installation conditions. Design the system according to output current to be able to run the motor at nominal power.
- The pump contains thrust bearings that are damaged when running below minimum speed, which is normally 30 Hz.
- The motor reactance is nonlinear in submersible pump motors and, therefore, automatic motor adaption (AMA) may not be possible. Normally, submersible pumps are operated with long motor cables that might eliminate the nonlinear motor reactance and enable the drive to perform AMA. If AMA fails, the motor data can be set from *parameter group 1-3\* Adv. Motor Data* (see the motor datasheet). If AMA has succeeded, the drive compensates for the voltage drop in the long motor cables. If the advanced motor data are set manually, consider the length of the motor cable to optimize system performance.

- It is important that the system is operated with a minimum of wear and tear on the pump and motor. A Danfoss sine-wave filter can lower the motor insulation stress and increase lifetime (check actual motor insulation and the drive dU/dt specification). Most manufacturers of submersible pumps require the use of output filters.
- EMC performance can be difficult to achieve because the special pump cable, which is able to withstand the wet conditions in the well, is normally unshielded. A solution could be to use a shielded cable above the well and attach the shield to the well pipe, if it is made of steel. A sine-wave filter also reduces the EMI from unshielded motor cables.

To prevent damage to the thrust bearings of the pump, and to ensure sufficient motor cooling as quickly as possible, it is important to ramp the pump from stop to minimum speed as quickly as possible. Most submersible pump manufacturers recommend that the pump ramps to minimum speed (30 Hz) in maximum 2–3 s. The VLT® AQUA Drive FC 202 is designed with initial and final ramp for these applications. The initial and final ramps are 2 individual ramps, where initial ramp, if enabled, ramps the motor from stop to minimum speed and automatically switches to normal ramp, when minimum speed is reached. Final ramp does the opposite from minimum speed to stop in a stop situation. Consider also enabling advanced minimum speed monitoring.

To achieve extra pump protection, use the dry-run detection function. For more information, see the Programming Guide.

Pipe-fill mode can be enabled to prevent water hammering. The Danfoss drive can fill the vertical pipes using the PID controller to ramp up the pressure slowly with a user-specified rate (units/second). If enabled, the drive enters pipe-fill mode when it reaches minimum speed after start-up. The pressure is slowly ramped up until it reaches a user-specified filled setpoint, where the drive automatically disables pipe fill mode and continues in normal closed-loop operation.



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Illustration 69: Wiring for Submersible Pump Application

## NOTICE

Set the analog input 2, (terminal XD2.8) format to mA (switch 202).

### Parameter settings

Table 92: Relevant Parameters for Submersible Pump Application

Parameters
Parameter 1-20 Motor Power [kW]/parameter 1-21 Motor Power [HP]
Parameter 1-22 Motor Voltage
Parameter 1-24 Motor Current
Parameter 1-28 Motor Rotation Check
Parameter 1-29 Automatic Motor Adaptation (AMA) = [2] Enable Reduced AMA

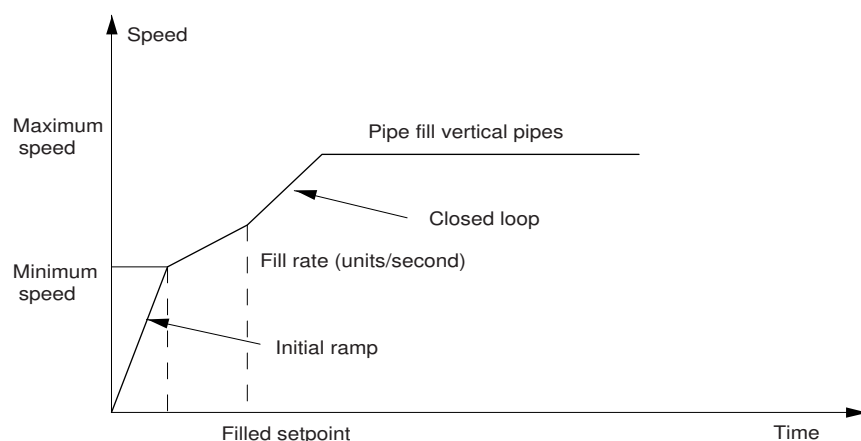
Table 93: Example of Settings for Submersible Pump

Parameters	Setting
Parameter 3-02 Minimum Reference	The minimum reference unit matches the unit in <i>parameter 20-12 Reference/ Feedback Unit</i>
Parameter 3-03 Maximum Reference	The maximum reference unit matches the unit in <i>parameter 20-12 Reference/ Feedback Unit</i>
Parameter 3-84 Initial Ramp Time	(2 s)
Parameter 3-88 Final Ramp Time	(2 s)
Parameter 3-41 Ramp 1 Ramp Up Time	(8 s depending on size)
Parameter 3-42 Ramp 1 Ramp Down Time	(8 s depending on size)
Parameter 4-11 Motor Speed Low Limit [RPM]	(30 Hz)
Parameter 4-13 Motor Speed High Limit [RPM]	(50/60 Hz)
To set up the feedback settings in the PID controller, use the Closed-loop wizard under Quick Menu, Function Set-up.	

Table 94: Example of Settings for Pipe-Fill Mode

Parameters	Setting
Parameter 29-00 Pipe Fill Enable	Disabled
Parameter 29-04 Pipe Fill Rate	(Feedback units)
Parameter 29-05 Filled Setpoint	(Feedback units)

## Performance



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Illustration 70: Performance Curve for Pipe Fill Mode

### 8.1.13 Wiring Configuration for a Cascade Controller

See [Illustration 71](#) for an example of a built-in basic cascade controller with 1 variable-speed pump (lead) and 2 fixed-speed pumps, a 4–20 mA transmitter, and system safety interlock.

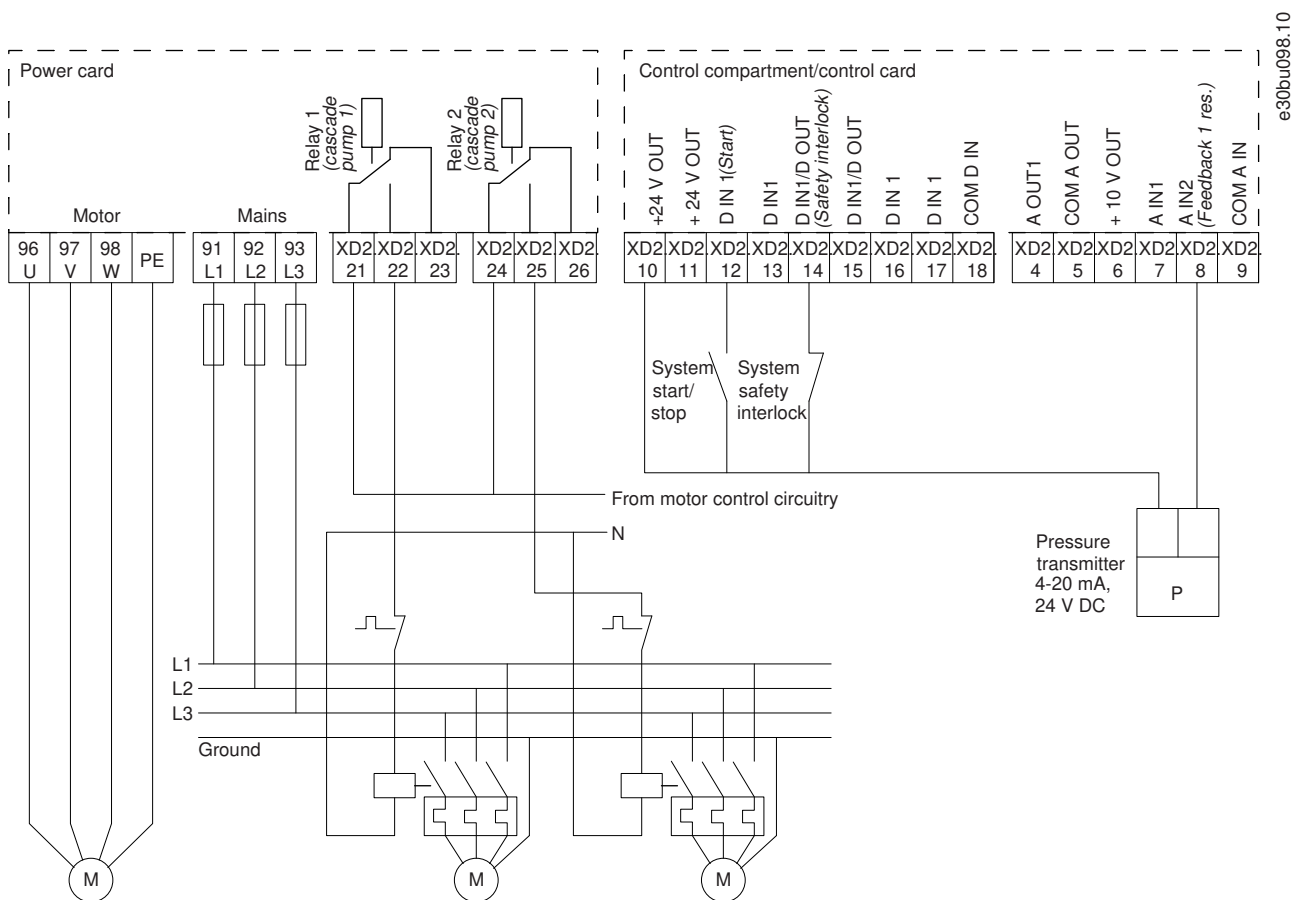


Illustration 71: Cascade Controller Wiring Diagram

## 8.1.14 Wiring Configuration for a Fixed Variable Speed Pump

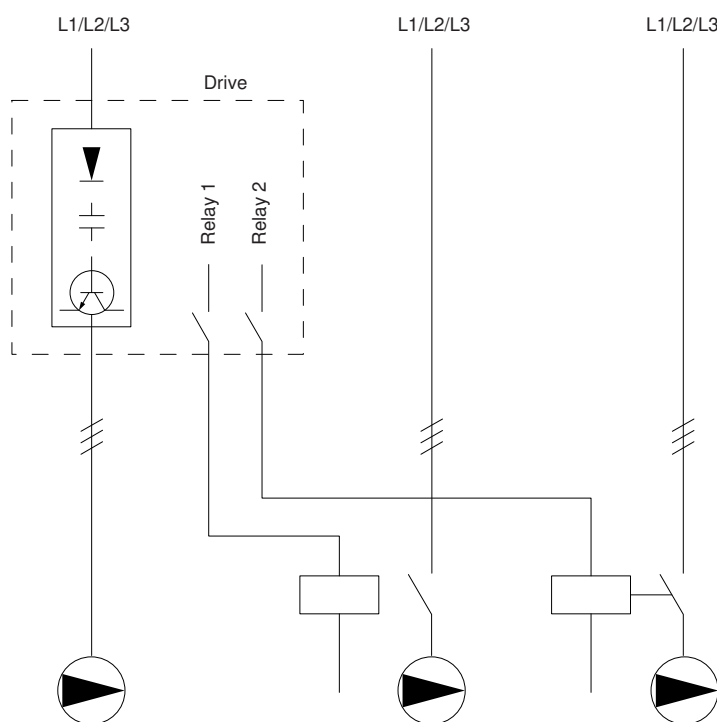
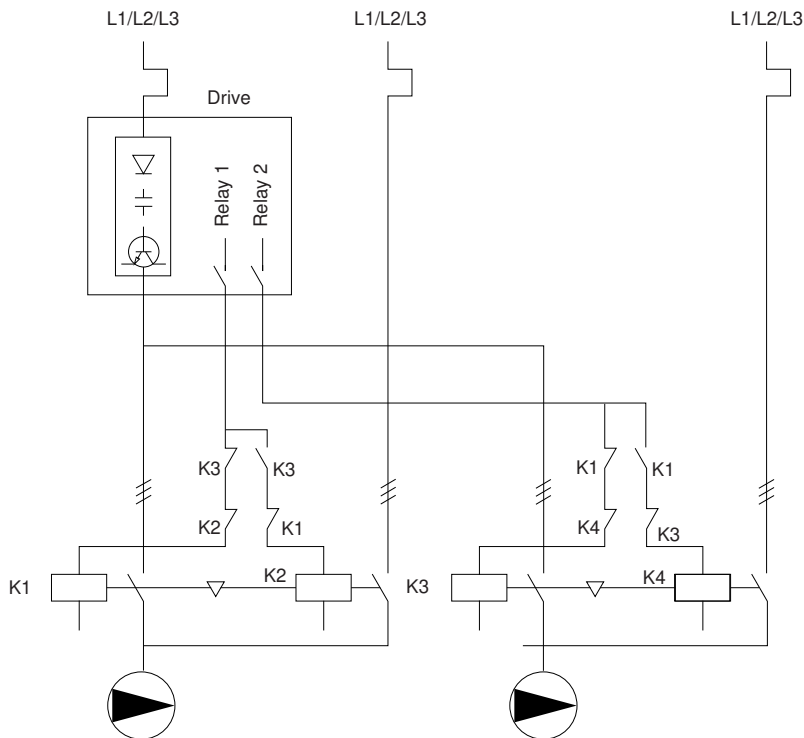


Illustration 72: Fixed Variable Speed Pump Wiring Diagram

### 8.1.15 Wiring Configuration for Lead Pump Alternation



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**Illustration 73: Lead Pump Alternation Wiring Diagram**

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

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

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

## 9 Maintenance, Diagnostics, and Troubleshooting

### 9.1 Maintenance and Service

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

#### ⚠ WARNING ⚠

##### UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

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

### 9.2 Disposal

Do not dispose of equipment containing electrical components together with domestic waste. Collect it separately in accordance with applicable local regulations.

### 9.3 Status Messages

#### 9.3.1 Status Message Overview

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

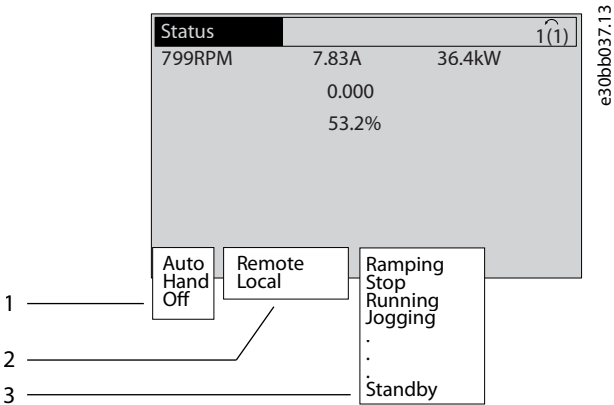


Illustration 74: Status Display

1	See <a href="#">9.3.2 Status Messages - Operating Mode</a> .	3	See <a href="#">9.3.4 Status Messages - Operation Status</a> .
2	See <a href="#">9.3.3 Status Messages - Reference Site</a> .		

### 9.3.2 Status Messages - Operating Mode

Table 95: 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.

### 9.3.3 Status Messages - Reference Site

Table 96: Reference Site

Reference site	Description
Remote	The speed reference is given from: <ul style="list-style-type: none"> <li>• External signals.</li> <li>• Serial communication.</li> <li>• Internal preset references.</li> </ul>
Local	The drive uses reference values from the LCP.

### 9.3.4 Status Messages - Operation Status

Table 97: Operation Status

Operation status	Description
AC brake	AC brake was selected in <i>parameter 2-10 Brake Function</i> . 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 <i>parameter 2-12 Brake Power Limit (kW)</i> has been reached.
Coast	<ul style="list-style-type: none"> <li>• [2] <i>Coast inverse</i> was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not connected.</li> <li>• Coast activated by serial communication.</li> <li>• No output from the drive to the motor.</li> </ul>
Ctrl. ramp-down	<p>[1] <i>Ctrl. ramp-down</i> was selected in <i>parameter 14-10 Mains Failure</i>.</p> <ul style="list-style-type: none"> <li>• The mains voltage is below the value set in <i>parameter 14-11 Mains Voltage at Mains Fault</i>.</li> <li>• The drive ramps down the motor in a controlled manner.</li> </ul>

Operation status	Description
Current high	The drive output current is above the limit set in <i>parameter 4-51 Warning Current High</i> .
Current low	The drive output current is below the limit set in <i>parameter 4-52 Warning Speed Low</i> .
DC hold	DC hold is selected in <i>parameter 1-80 Function at Stop</i> and a stop command is active. The motor is held by a DC current set in <i>parameter 2-00 DC Hold Current</i> .
DC stop	<p>The motor is held with a DC current (<i>parameter 2-01 DC Brake Current</i>) for a specified time (<i>parameter 2-02 DC Braking Time</i>).</p> <ul style="list-style-type: none"> <li>DC brake is activated in <i>parameter 2-03 DC Brake Cut In Speed [RPM]</i> and a stop command is active.</li> <li>DC brake (inverse) is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active.</li> <li>The DC brake is activated via serial communication.</li> </ul>
Feedback high	The sum of all active feedback is above the feedback limit set in <i>parameter 4-57 Warning Feedback High</i> .
Feedback low	The sum of all active feedback is below the feedback limit set in <i>parameter 4-56 Warning Feedback Low</i> .
Freeze output	<p>The remote reference is active, which holds the present speed.</p> <ul style="list-style-type: none"> <li>[20] Freeze Output was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and speed down.</li> <li>Hold ramp is activated via serial communication.</li> </ul>
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 ( <i>parameter group 5-1* Digital Inputs</i> ). 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	<p>The motor is running as programmed in <i>parameter 3-19 Jog Speed [RPM]</i>.</p> <ul style="list-style-type: none"> <li>[14] Jog was selected as function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal (for example, terminal 29) is active.</li> <li>The jog function is activated via the serial communication.</li> <li>The jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.</li> </ul>
Motor check	In <i>parameter 1-80 Function at Stop</i> , [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 <i>parameter 2-17 Over-voltage Control</i> . 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.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage).

## Operating Guide

Operation status	Description
	<ul style="list-style-type: none"> <li>To avoid tripping, the switching frequency is reduced to 1.5 kHz if <i>parameter 14-55 Output Filter</i> is set to [2] <i>Sine-Wave Filter Fixed</i>. Otherwise, the switching frequency is reduced to 1.0 kHz.</li> <li>If possible, protection mode ends after approximately 10 s.</li> <li>Protection mode can be restricted in <i>parameter 14-26 Trip Delay at Inverter Fault</i>.</li> </ul>
Qstop	<p>The motor is decelerating using <i>parameter 3-81 Quick Stop Ramp Time</i>.</p> <ul style="list-style-type: none"> <li>[4] <i>Quick stop inverse</i> was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active.</li> <li>The quick stop function was activated via serial communication.</li> </ul>
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in <i>parameter 4-55 Warning Reference High</i> .
Ref. low	The sum of all active references is below the reference limit set in <i>parameter 4-54 Warning Reference Low</i> .
Run on ref.	The 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 <i>parameter 4-53 Warning Speed High</i> .
Speed low	The motor speed is below the value set in <i>parameter 4-52 Warning Speed Low</i> .
Standby	In auto-on mode, the drive starts the motor with a start signal from a digital input or serial communication.
Start delay	In <i>parameter 1-71 Start Delay</i> , a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	[12] <i>Enable Start Forward</i> and [13] <i>Enable Start Reverse</i> were selected as functions for 2 different digital inputs ( <i>parameter group 5-1* Digital Inputs</i> ). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	<p>The drive has received a stop command from 1 of the following:</p> <ul style="list-style-type: none"> <li>LCP.</li> <li>Digital input.</li> <li>Serial communication.</li> </ul>
Trip/Trip lock	<p>An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, reset the drive using 1 of the following:</p> <ul style="list-style-type: none"> <li>Pressing [Reset].</li> <li>Remotely by control terminals.</li> <li>Via serial communication.</li> </ul>

## 9.4 Warnings and Alarms

### 9.4.1 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 prevent 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.

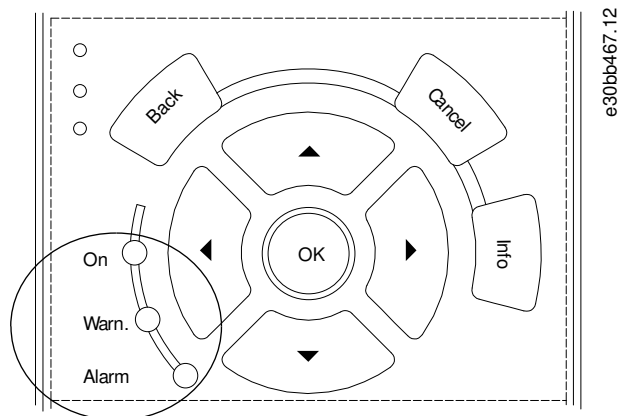


Illustration 75: Status Indicator Lights

Table 98: Fault Types

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

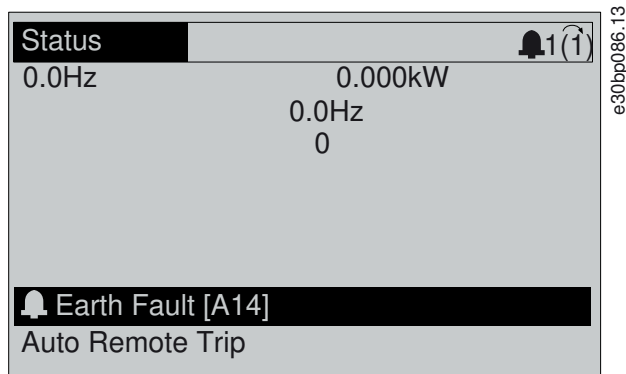


Illustration 76: Alarm Example

### 9.4.2 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  $\Omega$ .

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.

### 9.4.3 WARNING/ALARM 2, Live Zero Error

#### Cause

This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

#### Troubleshooting

- Check connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - VLT® Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

### 9.4.4 WARNING/ALARM 3, No Motor

#### Cause

No motor is connected to the output of the drive.

### 9.4.5 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.

### 9.4.6 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.

### 9.4.7 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.

### 9.4.8 WARNING/ALARM 7, DC Overvoltage

#### Cause

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

#### Troubleshooting

- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.
- If the alarm/warning occurs during a power sag, use kinetic back-up (*parameter 14-10 Mains Failure*).
- Connect a brake resistor.

### 9.4.9 WARNING/ALARM 8, DC Undervoltage

#### Cause

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

#### Troubleshooting

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

### 9.4.10 WARNING/ALARM 9, Inverter Overload

#### Cause

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

#### Troubleshooting

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

### 9.4.11 WARNING/ALARM 10, Motor Overload Temperature

#### Cause

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

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

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

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

#### Troubleshooting

- Check for motor overheating.
- Check whether the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20 to 1-25* is set correctly.

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- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Run AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)*. This tunes the drive to the motor more accurately and reduces thermal loading.

## 9.4.12 WARNING/ALARM 11, Motor Thermistor Overtemp

## Cause

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

## Troubleshooting

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

## 9.4.13 WARNING/ALARM 12, Torque Limit

## Cause

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

## Troubleshooting

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

## 9.4.14 WARNING/ALARM 13, Overcurrent

## Cause

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up. 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*.

## 9.4.15 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

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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.

### 9.4.16 ALARM 15, Hardware Mismatch

#### Cause

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

#### Troubleshooting

Record the value of the following parameters and contact Danfoss.

- *Parameter 15-40 FC Type.*
- *Parameter 15-41 Power Section.*
- *Parameter 15-42 Voltage.*
- *Parameter 15-43 Software Version.*
- *Parameter 15-45 Actual Typecode String.*
- *Parameter 15-49 SW ID Control Card.*
- *Parameter 15-50 SW ID Power Card.*
- *Parameter 15-60 Option Mounted.*
- *Parameter 15-61 Option SW Version* (for each option slot).

### 9.4.17 ALARM 16, Short Circuit

#### Cause

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

#### Troubleshooting

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

### 9.4.18 WARNING/ALARM 17, Control Word Timeout

#### Cause

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

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

#### Troubleshooting

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

### 9.4.19 WARNING/ALARM 20, Temp. Input Error

#### Cause

The temperature sensor is not connected.

#### 9.4.20 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.

#### 9.4.21 WARNING 23, Internal Fan Fault

##### Cause

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

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

##### Troubleshooting

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

#### 9.4.22 WARNING 24, External Fan Fault

##### Cause

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

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

##### Troubleshooting

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

#### 9.4.23 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*).

#### 9.4.24 WARNING/ALARM 26, Brake Resistor Power Limit

##### Cause

The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in *parameter 2-16 AC Brake Max. Current*. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option [2] Trip is selected in *parameter 2-13 Brake Power Monitoring*, the drive trips when the dissipated braking power reaches 100%.

#### 9.4.25 WARNING/ALARM 27, Brake Chopper Fault

##### Cause

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

##### Troubleshooting

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

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**9.4.26 WARNING/ALARM 28, Brake Check Failed****Cause**

The brake resistor is not connected or not working.

**Troubleshooting**

- Check *parameter 2-15 Brake Check*.

**9.4.27 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.

**9.4.28 ALARM 30, Motor Phase U Missing****Cause**

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

**Troubleshooting**

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

**9.4.29 ALARM 31, Motor Phase V Missing****Cause**

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

**Troubleshooting**

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

**9.4.30 ALARM 32, Motor Phase W Missing****Cause**

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

**Troubleshooting**

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

**9.4.31 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.

**9.4.32 WARNING/ALARM 34, Fieldbus Communication Fault****Cause**

The fieldbus on the communication option card is not working.

### 9.4.33 WARNING/ALARM 35, Option Fault

#### Cause

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

### 9.4.34 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.

### 9.4.35 ALARM 37, Phase Imbalance

#### Cause

There is a current imbalance between the power units.

### 9.4.36 ALARM 38, Internal Fault

#### Cause

When an internal fault occurs, a code number defined in [Table 99](#) is shown.

#### Troubleshooting

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

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

**Table 99: Internal Fault Codes**

Number	Text
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 minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
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. This situation can occur due to poor EMC protection or improper grounding.

Number	Text
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.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376–6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

#### 9.4.37 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.

#### 9.4.38 WARNING 40, Overload of Digital Output Terminal 27

##### Troubleshooting

- Check the load connected to terminal 27 or remove the short-circuit connection.
- Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

#### 9.4.39 WARNING 41, Overload of Digital Output Terminal 29

##### Troubleshooting

- Check the load connected to terminal 29 or remove the short-circuit connection.
- Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

#### 9.4.40 WARNING 42, Ovrlld X30/6-7

##### Troubleshooting

For terminal X30/6:

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

For terminal X30/7:

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

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### 9.4.41 ALARM 43, Ext. Supply

**Cause**

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

**Troubleshooting**

Choose 1 of the following:

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

### 9.4.42 ALARM 45, Earth Fault 2

**Cause**

Ground fault.

**Troubleshooting**

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

### 9.4.43 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.
- $\pm 18$  V.

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

**Troubleshooting**

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

### 9.4.44 WARNING 47, 24 V Supply Low

**Cause**

The supply on the power card is out of range.

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

- 24 V
- 5 V
- $\pm 18$  V

**Troubleshooting**

- Check for a defective power card.

### 9.4.45 WARNING 48, 1.8 V Supply Low

**Cause**

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

**Troubleshooting**

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

#### 9.4.46 WARNING 49, Speed Limit

##### Cause

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

#### 9.4.47 ALARM 50, AMA Calibration Failed

##### Cause

A calibration error has occurred.

##### Troubleshooting

- Contact the Danfoss supplier or Danfoss service department.

#### 9.4.48 ALARM 51, AMA Check Unom and Inom

##### Cause

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

##### Troubleshooting

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

#### 9.4.49 ALARM 52, AMA Low Inom

##### Cause

The motor current is too low.

##### Troubleshooting

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

#### 9.4.50 ALARM 53, AMA Motor Too Big

##### Cause

The motor is too big for the AMA to operate.

##### Troubleshooting

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

#### 9.4.51 ALARM 54, AMA Motor Too Small

##### Cause

The motor is too small for the AMA to operate.

##### Troubleshooting

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

#### 9.4.52 ALARM 55, AMA Parameter Out of Range

##### Cause

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

##### Troubleshooting

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

#### 9.4.53 ALARM 56, AMA Interrupted by User

##### Cause

The AMA is manually interrupted.

##### Troubleshooting

- Re-run the AMA calibration.

#### 9.4.54 ALARM 57, AMA Internal Fault

##### Cause

Internal fault.

##### Troubleshooting

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

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### 9.4.55 ALARM 58, AMA Internal Fault

**Cause**

Internal fault.

**Troubleshooting**

Contact the Danfoss supplier.

### 9.4.56 WARNING 59, Current Limit

**Cause**

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

**Troubleshooting**

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

### 9.4.57 ALARM 60, External Interlock

**Cause**

A digital input signal indicates a fault condition external to the drive. Within the control compartment, the following 3 relay contacts are connected in series to 1 digital input that is used as a thermal overload relay:

- KFJ.1 monitors the heat within the input power options cabinet.
- KFJ.2 monitors the heat within the output filter cabinet.
- KFJ.3 monitors the heat within the input filter cabinet.

When the thermal switches in any of these cabinets open due to overtemperature, the drive trips on External Interlock [A60].

**Troubleshooting**

- Open the control compartment and check for any lights in relays KFJ.1, KFJ.2, and KFJ.3. If no lights are present, check for other external interlocks.
- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the drive.

### 9.4.58 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*.

### 9.4.59 WARNING 62, Output Frequency at Maximum Limit

**Cause**

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

**Troubleshooting**

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

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

### 9.4.60 WARNING 64, Voltage Limit

**Cause**

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

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**9.4.61 WARNING/ALARM 65, Control Card Overtemperature****Cause**

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

**Troubleshooting**

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

**9.4.62 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*.

**9.4.63 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.

**9.4.64 ALARM 68, Safe Stop Activated****Cause**

Safe Torque Off (STO) has been activated.

**Troubleshooting**

- To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

**9.4.65 ALARM 70, Illegal FC Configuration****Cause**

The control card and power card are incompatible.

**Troubleshooting**

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

**9.4.66 ALARM 71, PTC 1 Safe Stop****Cause**

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

**Troubleshooting**

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

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**9.4.67 ALARM 72, Dangerous Failure****Cause**

Safe Torque Off (STO) with trip lock.

**Troubleshooting**

An unexpected combination of STO commands has occurred:

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

**9.4.68 WARNING 73, Safe Stop Auto Restart****Cause**

STO activated.

**Troubleshooting**

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

**9.4.69 ALARM 74, PTC Thermistor****Cause**

The PTC is not working. Alarm is related to VLT® PTC Thermistor Card MCB 112.

**9.4.70 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*.

**9.4.71 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 part number.

**9.4.72 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.

**9.4.73 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 4-34 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*.

**9.4.74 ALARM 79, Illegal Power Section Configuration****Cause**

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

#### 9.4.75 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.

#### 9.4.76 ALARM 81, CSIV Corrupt

##### Cause

The CSIV file has syntax errors.

#### 9.4.77 ALARM 82, CSIV Parameter Error

##### Cause

CSIV failed to initialize a parameter.

#### 9.4.78 ALARM 83, Illegal Option Combination

##### Cause

The mounted options are incompatible.

#### 9.4.79 ALARM 84, No Safety Option

##### Cause

The safety option was removed without applying a general reset.

##### Troubleshooting

- Reconnect the safety option.

#### 9.4.80 ALARM 85, Dang Fail PB

##### Cause

PROFIBUS/PROFIsafe error.

#### 9.4.81 ALARM 88, Option Detection

##### Cause

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

##### Troubleshooting

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

#### 9.4.82 ALARM 90, Feedback Monitor

##### Troubleshooting

- Check the connection to the encoder/resolver option and, if necessary, replace the VLT® Encoder Input MCB 102 or VLT® Resolver Input MCB 103.

#### 9.4.83 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.

#### 9.4.84 ALARM 99, Locked Rotor

##### Cause

The rotor is blocked.

##### Troubleshooting

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

#### 9.4.85 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.

#### 9.4.86 WARNING/ALARM 122, Mot. Rotat. Unexp.

##### Cause

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

#### 9.4.87 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.

#### 9.4.88 ALARM 164, ATEX ETR Cur.Lim.Alarm

##### Cause

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

#### 9.4.89 WARNING 165, ATEX ETR Freq.Lim.Warning

##### Cause

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

#### 9.4.90 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 (*parameter 1-98 ATEX ETR Interpol. Points. Freq.*).

#### 9.4.91 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, Heat Sink Temp.*

##### Troubleshooting

Check for the following:

- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above or below the AC drive.
- Blocked airflow around the unit.
- Damaged heat sink fan.
- Dirty heat sink.

#### 9.4.92 WARNING 251, New Typecode

##### Cause

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

#### 9.4.93 ALARM 421, Temperature Fault

##### Cause

A fault caused by the on-board temperature sensor is detected on the fan power card.

##### Troubleshooting

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

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## 9.4.94 ALARM 423, FPC Updating

## Cause

The alarm is generated when the fan power card reports 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*.

## 9.4.95 ALARM 424, FPC Update Successful

## Cause

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

## Troubleshooting

- Press [Reset] to stop the alarm.

## 9.4.96 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 fan power card.
- Contact supplier.

## 9.4.97 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 fan power card.

## 9.4.98 ALARM 427, FPC Supply

## Cause

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

## Troubleshooting

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

## 9.5 Troubleshooting

Table 100: 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 <i>Open power fuses</i> 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.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM).	–	Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N. 130B1107).

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Symptom	Possible cause	Test	Solution
	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 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 <i>Display dark\No function</i> .
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] <i>No operation</i> .
	Wrong reference signal source.	Check reference signal: <ul style="list-style-type: none"> <li>• Local</li> <li>• Remote or bus reference?</li> <li>• Preset reference active?</li> <li>• Terminal connection correct?</li> <li>• Scaling of terminals correct?</li> <li>• Reference signal available?</li> </ul>	Program correct settings. Check <i>parameter 3-13 Reference Site</i> . Set preset reference active in <i>parameter group 3-1* References</i> . Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that <i>parameter 4-10 Motor Speed Direction</i> is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in <i>parameter group 5-1* Digital inputs</i> .	Deactivate reversing signal.
	Wrong motor phase connection.	–	Correct motor phase connection, or set <i>parameter 1-06 Clockwise Direction</i> to [1] <i>Inverse</i> .
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> , <i>parameter 4-14 Motor Speed High Limit [Hz]</i> , and <i>parameter 4-19 Max Output Frequency</i> .	Program correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in <i>parameter group 6-0* Analog</i>	Program correct settings.

Symptom	Possible cause	Test	Solution
		<i>I/O mode and parameter group 3-1* References.</i>	
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 <i>parameter group 1-6* Load Depen. Setting</i> . For closed-loop operation, check settings in <i>parameter group 20-0* Feedback</i> .
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in <i>parameter groups 1-2* Motor data, 1-3* Adv Motor Data, and 1-5* Load Indep. Setting</i> .
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 <i>parameter groups 2-0* DC Brake and 3-0* Reference Limits</i> .
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 start-up test and verify that 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 <i>Alarm 4, Mains phase loss</i> description).	Rotate input power leads into the AC drive 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 <i>Warnings and Alarms</i> section. Check that motor data are entered correctly.	Increase the ramp-up time in <i>parameter 3-41 Ramp 1 Ramp Up Time</i> . Increase current limit in <i>parameter 4-18 Current Limit</i> . Increase torque limit in <i>parameter 4-16 Torque Limit Motor Mode</i> .
AC drive deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, refer to the <i>Warnings and Alarms</i> section. Check that motor data are entered correctly.	Increase the ramp-down time in <i>parameter 3-42 Ramp 1 Ramp Down Time</i> . Enable overvoltage control in <i>parameter 2-17 Over-voltage Control</i> .

## 10 Specifications

### 10.1 Electrical Data

#### 10.1.1 Electrical Data, 380–480 V AC

Table 101: Electrical Data, Mains Supply 3x380–480 V AC

FC 202	N110		N132		N160	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO
Typical shaft output at 400 V [kW]	90	110	110	132	132	160
Typical shaft output at 460 V [hp]	125	150	150	200	200	250
Typical shaft output at 480 V [kW]	110	132	132	160	160	200
<b>Enclosure size</b>	D9h		D9h		D9h	
<b>Output current (3-phase)</b>						
Continuous (at 400 V) [A]	177	212	212	260	260	315
Intermittent (60 s overload) (at 400 V) [A]	266	233	318	286	390	347
Continuous (at 460/480 V) [A]	160	190	190	240	240	302
Intermittent (60 s overload) (at 460/480 V) [A]	240	209	285	264	264	332
Continuous kVA (at 400 V) [kVA]	123	147	147	180	180	218
Continuous kVA (at 460 V) [kVA]	127	151	151	191	191	241
Continuous kVA (at 480 V) [kVA]	139	165	165	208	208	262
<b>Maximum input current</b>						
Continuous (at 400 V) [A]	171	204	204	251	251	304
Continuous (at 460/480 V) [A]	154	183	183	231	231	291
<b>Maximum number and size of cables per phase</b>						
- Mains [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)	
Drive module power loss at 400 V [W] <sup>(1)(2)(3)</sup>	2031	2559	2289	2954	2923	3770
Drive module power loss at 460 V [W] <sup>(1)(2)(3)</sup>	1828	2261	2051	2724	2089	3628
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	

FC 202	N110	N132	N160
Control card overtemperature trip [°C (°F)]	75 (167)	75 (167)	75 (167)
PHF overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)
Line reactor overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)
dU/dt filter overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)

<sup>1</sup> Typical power loss is at normal conditions and expected to be within  $\pm 15\%$  (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 102: Electrical Data, Mains Supply 3x380–480 V AC**

FC 202	N200		N250		N315	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO
Typical shaft output at 400 V [kW]	160	200	200	250	250	315
Typical shaft output at 460 V [hp]	250	300	300	350	350	450
Typical shaft output at 480 V [kW]	200	250	250	315	315	355
Enclosure size	D10h		D10h		D10h	
Output current (3-phase)						
Continuous (at 400 V) [A]	315	395	395	480	480	588
Intermittent (60 s overload) (at 400 V) [A]	473	435	593	528	720	647
Continuous (at 460/480 V) [A]	302	361	361	443	443	535
Intermittent (60 s overload) (at 460/480 V) [A]	453	397	542	487	665	589
Continuous kVA (at 400 V) [kVA]	218	274	274	333	333	407
Continuous kVA (at 460 V) [kVA]	241	288	288	353	353	426
Continuous kVA (at 480 V) [kVA]	262	313	313	384	384	463
Maximum input current						
Continuous (at 400 V) [A]	304	381	381	463	463	567
Continuous (at 460/480 V) [A]	291	348	348	427	427	516
Maximum number and size of cables per phase						
- Mains [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	

FC 202	N200		N250		N315	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
Drive module power loss at 400 V [W] <sup>(1)(2)(3)</sup>	3093	4116	4039	5137	5005	6674
Drive module power loss at 460 V [W] <sup>(1)(2)(3)</sup>	2872	3569	3575	4566	4458	5714
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Line reactor overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
dU/dt filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	

<sup>1</sup> Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 103: Electrical Data, Mains Supply 3x380–480 V AC**

FC 202	N355		N400		N450	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO
Typical shaft output at 400 V [kW]	315	355	355	400	400	450
Typical shaft output at 460 V [hp]	450	500	500	600	550	600
Typical shaft output at 480 V [kW]	355	400	400	500	500	530
Enclosure size	E5h		E5h		E5h	
Output current (3-phase)						
Continuous (at 400 V) [A]	600	658	658	745	695	800
Intermittent (60 s overload) (at 400 V) [A]	900	724	987	820	1043	880
Continuous (at 460/480 V) [A]	540	590	590	678	678	730

FC 202	N355		N400		N450	
Intermittent (60 s overload) (at 460/480 V) [A]	810	649	885	746	1017	803
Continuous kVA (at 400 V) [kVA]	416	456	456	516	482	554
Continuous kVA (at 460 V) [kVA]	430	470	470	540	540	582
Continuous kVA (at 480 V) [kVA]	468	511	511	587	587	632
<b>Maximum input current</b>						
Continuous (at 400 V) [A]	578	634	634	718	670	771
Continuous (at 460/480 V) [A]	520	569	569	653	653	704
<b>Maximum number and size of cables per phase</b>						
- Mains [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
Drive module power loss at 400 V [W] <sup>(1)(2)(3)</sup>	6178	6928	6851	8036	7297	8783
Drive module power loss at 460 V [W] <sup>(1)(2)(3)</sup>	5322	5910	5846	6933	7240	7969
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Line reactor overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
dU/dt filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	

<sup>1</sup> Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 104: Electrical Data, Mains Supply 3x380–480 V AC**

FC 202	N500		N560	
High/normal overload	HO	NO	HO	NO

FC 202	N500		N560	
High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.				
Typical shaft output at 400 V [kW]	450	500	500	560
Typical shaft output at 460 V [hp]	600	650	650	750
Typical shaft output at 480 V [kW]	530	560	560	630
Enclosure size	E6h		E6h	
Output current (3-phase)				
Continuous (at 400 V) [A]	800	880	880	990
Intermittent (60 s overload) (at 400 V) [A]	1200	968	1320	1089
Continuous (at 460/480 V) [A]	730	780	780	890
Intermittent (60 s overload) (at 460/480 V) [A]	1095	858	1170	979
Continuous kVA (at 400 V) [kVA]	554	610	610	686
Continuous kVA (at 460 V) [kVA]	582	621	621	709
Continuous kVA (at 480 V) [kVA]	632	675	675	771
Maximum input current				
Continuous (at 400 V) [A]	771	848	848	954
Continuous (at 460/480 V) [A]	704	752	752	858
Maximum number and size of cables per phase				
- Mains [mm <sup>2</sup> (AWG)]	4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	4x185 (4x350 mcm)		4x185 (4x350 mcm)	
Drive module power loss at 400 V [W] <sup>(1)(2)(3)</sup>	8352	9473	9449	11102
Estimated power loss at 460 V [W] <sup>(1)(2)(3)</sup>	7182	7809	7771	9236
Drive efficiency <sup>(2)</sup>	0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		100 (212)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)	

FC 202	N500	N560
Line reactor overtemperature trip [°C (°F)]	150 (302)	150 (302)
dU/dt filter overtemperature trip [°C (°F)]	150 (302)	150 (302)
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)	150 (302)

<sup>1</sup> Typical power loss is at normal conditions and expected to be within  $\pm 15\%$  (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

## 10.1.2 Electrical Data, 525–690 V AC

Table 105: Electrical Data, Mains Supply 3x525–690 V AC

FC 202	N110		N132		N160		N200	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	75	90	90	110	110	132	132	160
Typical shaft output at 575 V [hp]	100	125	125	150	150	200	200	250
Typical shaft output at 690 V [kW]	90	110	110	132	132	160	160	200
<b>Enclosure size</b>	D9h		D9h		D9h		D10h	
<b>Output current (3-phase)</b>								
Continuous (at 550 V) [A]	113	137	137	162	162	201	201	253
Intermittent (60 s overload) (at 550 V) [A]	170	151	206	178	243	221	301	278
Continuous (at 575/690 V) [A]	108	131	131	155	155	192	192	242
Intermittent (60 s overload) (at 575/690 V) [A]	162	144	197	171	233	211	288	266
Continuous kVA (at 550 V) [kVA]	103	125	125	147	147	183	183	230
Continuous kVA (at 575 V) [kVA]	108	131	131	154	154	191	191	241
Continuous kVA (at 690 V) [kVA]	129	157	157	185	185	230	229	289
<b>Maximum input current</b>								
Continuous (at 525 V) [A]	109	132	132	156	156	193	193	244
Continuous (at 575/690 V) [A]	104	126	126	149	149	185	185	233
<b>Maximum number and size of cables per phase</b>								
- Mains [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x185 (2x350 mcm)	

FC 202	N110		N132		N160		N200	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x185 (2x350 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x185 (2x350 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x185 (2x350 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x95 (2x3/0 mcm)		2x185 (2x350 mcm)	
Drive module power loss at 600 V [W] <sup>(1)(2)(3)</sup>	1430	1740	1742	2101	2080	2649	2361	3074
Drive module power loss at 690 V [W] <sup>(1)(2)(3)</sup>	1480	1798	1800	2167	2159	2740	2446	3175
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590		0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	75 (167)		75 (167)		75 (167)		75 (167)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)		150 (302)	
Line reactor overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)		150 (302)	
dU/dt filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)		150 (302)	
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)		150 (302)	

<sup>1</sup> Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 106: Electrical Data, Mains Supply 3x525–690 V AC**

FC 202	N250		N315		N400	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	160	200	200	250	250	315
Typical shaft output at 575 V [hp]	250	300	300	350	350	400
Typical shaft output at 690 V [kW]	200	250	250	315	315	400
<b>Enclosure size</b>	D10h		D10h		D10h	
<b>Output current (3-phase)</b>						
Continuous (at 550 V) [A]	253	303	303	360	360	418
Intermittent (60 s overload) (at 550 V) [A]	380	333	455	396	540	460
Continuous (at 575/690 V) [A]	242	290	290	344	344	400

FC 202	N250		N315		N400	
Intermittent (60 s overload) (at 575/690 V) [A]	363	319	435	378	516	440
Continuous kVA (at 550 V) [kVA]	230	276	276	327	327	380
Continuous kVA (at 575 V) [kVA]	241	289	289	343	343	398
Continuous kVA (at 690 V) [kVA]	289	347	347	411	411	478
<b>Maximum input current</b>						
Continuous (at 525 V) [A]	244	292	292	347	347	403
Continuous (at 575/690 V) [A]	233	279	279	332	332	385
<b>Maximum number and size of cables per phase</b>						
- Mains [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	2x185 (2x350 mcm)		2x185 (2x350 mcm)		2x185 (2x350 mcm)	
Drive module power loss at 600 V [W] <sup>(1)(2)(3)</sup>	3012	3723	3642	4465	4146	5028
Drive module power loss at 690 V [W] <sup>(1)(2)(3)</sup>	3123	3851	3771	4614	4258	5155
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–590		0–590		0–590	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Line reactor overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
dU/dt filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	

<sup>1</sup> Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 107: Electrical Data, Mains Supply 3x525–690 V AC**

FC 202	N450		N500		N560	
High/normal overload	HO	NO	HO	NO	HO	NO

FC 202	N450		N500		N560	
High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.						
Typical shaft output at 550 V [kW]	315	355	355	400	400	450
Typical shaft output at 575 V [hp]	400	450	400	500	500	600
Typical shaft output at 690 V [kW]	355	450	400	500	500	560
Enclosure size	E5h		E5h		E5h	
Output current (3-phase)						
Continuous (at 550 V) [A]	395	470	429	523	523	596
Intermittent (60 s overload) (at 550 V) [A]	593	517	644	575	785	656
Continuous (at 575/690 V) [A]	380	450	410	500	500	570
Intermittent (60 s overload) (at 575/690 V) [A]	570	495	615	550	750	627
Continuous kVA (at 550 V) [kVA]	376	448	409	498	498	568
Continuous kVA (at 575 V) [kVA]	378	448	408	498	498	568
Continuous kVA (at 690 V) [kVA]	454	538	490	598	598	681
Maximum input current						
Continuous (at 525 V) [A]	381	453	413	504	504	574
Continuous (at 575/690 V) [A]	366	434	395	482	482	549
Maximum number and size of cables per phase						
- Mains [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x127 (4x250 mcm)		4x127 (4x250 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x127 (4x250)		4x127 (4x250)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x127 (4x250)		4x127 (4x250)	
- Mains with contactor [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x127 (4x250)		4x127 (4x250)	
- Motor [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x127 (4x250)		4x127 (4x250)	
Drive module power loss at 600 V [W] <sup>(1)(2)(3)</sup>	4989	6062	5419	6879	6833	8076
Drive module power loss at 690 V [W] <sup>(1)(2)(3)</sup>	4920	5939	5332	6715	6678	7852
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–500		0–500		0–500	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	

FC 202	N450	N500	N560
Line reactor overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)
dU/dt filter overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)	150 (302)	150 (302)

<sup>1</sup> Typical power loss is at normal conditions and expected to be within  $\pm 15\%$  (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

**Table 108: Electrical Data, Mains Supply 3x525–690 V AC**

FC 202	N630		N710		N800	
<b>High/normal overload</b> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	450	500	500	560	560	670
Typical shaft output at 575 V [hp]	600	650	650	750	750	950
Typical shaft output at 690 V [kW]	560	630	630	710	710	800
<b>Enclosure size</b>	E5h		E6h		E6h	
<b>Output current (3-phase)</b>						
Continuous (at 550 V) [A]	596	630	659	763	763	889
Intermittent (60 s overload) (at 550 V) [A]	894	693	989	839	1145	978
Continuous (at 575/690 V) [A]	570	630	630	730	730	850
Intermittent (60 s overload) (at 575/690 V) [A]	855	693	945	803	1095	935
Continuous kVA (at 550 V) [kVA]	568	600	628	727	727	847
Continuous kVA (at 575 V) [kVA]	568	627	627	727	727	847
Continuous kVA (at 690 V) [kVA]	681	753	753	872	872	1016
<b>Maximum input current</b>						
Continuous (at 550 V) [A]	574	607	635	735	735	857
Continuous (at 575/690 V) [A]	549	607	607	704	704	819
<b>Maximum number and size of cables per phase</b>						
- Mains [mm <sup>2</sup> (AWG)]	4x127 (4x250 mcm)		4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Mains with disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Mains with fusible disconnect [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x185 (4x350 mcm)		4x185 (4x350 mcm)	

FC 202	N630		N710		N800	
- Mains with contactor [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x185 (4x350 mcm)		4x185 (4x350 mcm)	
- Motor [mm <sup>2</sup> (AWG)]	4x127 (4x250)		4x185 (4x350 mcm)		4x185 (4x350 mcm)	
Drive module power loss at 600 V [W] <sup>(1)(2)(3)</sup>	8069	9208	8543	10346	10319	12723
Drive module power loss at 690 V [W] <sup>(1)(2)(3)</sup>	7848	8921	8363	10066	10060	12321
Drive efficiency <sup>(2)</sup>	0.98		0.98		0.98	
Output frequency [Hz] <sup>(4)</sup>	0–500		0–500		0–500	
Heat sink overtemperature trip [°C (°F)]	110 (230)		110 (230)		110 (230)	
Control card overtemperature trip [°C (°F)]	80 (176)		80 (176)		80 (176)	
PHF overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Line reactor overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
dU/dt filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	
Sine-wave filter overtemperature trip [°C (°F)]	150 (302)		150 (302)		150 (302)	

<sup>1</sup> Typical power loss is at normal conditions and expected to be within  $\pm 15\%$  (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/). Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.

<sup>2</sup> Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see the *Ambient Conditions* section. For part load losses, see [drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/](https://drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/).

<sup>3</sup> See also *Input Power Option Losses* section.

<sup>4</sup> If using an output filter, the output frequency is limited further. See the *Motor Output (U, V, W)* section.

## 10.2 Mains Supply

The unit is suitable for use on a circuit capable of delivering not more than 65 kA short circuit current rating (SCCR) at 480/600 V.

Supply terminals	L1, L2, L3
Supply voltage <sup>(1)</sup>	380–480/500 V $\pm 10\%$ , 525–690 V $\pm 10\%$
Supply frequency	50/60 Hz $\pm 5\%$
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage <sup>(2)</sup>
True power factor ( $\lambda$ )	$\geq 0.9$ nominal at rated load
Displacement power factor ( $\cos \Phi$ )	Near unity ( $> 0.98$ )
Switching on the input supply L1, L2, and L3 (power-ups)	Maximum 1 time/2 minutes
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

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

<sup>2</sup> Calculations based on UL/IEC 61800-3.

## 10.3 Motor Output and Motor Data

### 10.3.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
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Output frequency (without sine-wave filter)	0–590 Hz <sup>(1)</sup>
Output frequency (with sine-wave filter and no derating)	0–60 Hz without derating
Output frequency (with sine-wave filter and derating)	0–100 Hz
Output frequency in flux mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

<sup>1</sup> Dependent on voltage and power.

### 10.3.2 Torque Characteristics

Starting torque (constant torque)	Maximum 150% for 60 s once in 10 minutes <sup>(1)</sup>
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s once in 10 minutes <sup>(1)</sup>
Torque rise time in flux (for 5 kHz $f_{sw}$ )	1 ms
Torque rise time in VVC <sup>+</sup> (independent of $f_{sw}$ )	10 ms

<sup>1</sup> Percentage relates to the nominal torque.

### 10.4 Ambient Conditions

Enclosure	IP21/NEMA 1, IP54/NEMA 12
Vibration test	1.0 g
Maximum THDv	10%
Maximum relative humidity	5–93 (IEC 721-3-3); Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H <sub>2</sub> S test	Class Kd
Ambient temperature	Maximum 50° C (122 °F) (24-hour average maximum 45 °C (113 °F)) <sup>(1)</sup>
Minimum ambient temperature during full-scale operation	0 °C (32 °F) <sup>(1)</sup>
Minimum ambient temperature at reduced speed performance	-10 °C (14 °F) <sup>(1)</sup>
Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating	1000 m (3280 ft)
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class <sup>(2)</sup>	IE2

<sup>1</sup> For more information on derating, refer to the product-specific Design Guide.

<sup>2</sup> Determined according to IEC 61800-9-2 at:

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

### 10.5 Motor and Control Cables

Maximum motor cable length, shielded	150 m (492 ft)
Maximum motor cable length, unshielded	300 m (984 ft)
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm <sup>2</sup> /16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm <sup>2</sup> /18 AWG

Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm <sup>2</sup> /20 AWG
Minimum cross-section to control terminals	0.25 mm <sup>2</sup> /24 AWG

For power cables, see the *Electrical Data* section.

## 10.6 Control Input/Output and Control Data

### 10.6.1 Control Card, USB Serial Communication

USB standard	1.1 (full speed)
USB plug <sup>(1)</sup>	USB type B plug

<sup>1</sup> 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; however, the USB ground connection is not galvanically isolated from ground. Use only an isolated laptop as PC connection to the USB connector on the drive.

### 10.6.2 STO Terminal XD2.19 (Terminal XD2.19 is Fixed PNP Logic)

STO Terminal XD2.19 <sup>(1)(2)</sup>	
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

<sup>1</sup> For more information about Terminal XD2.19 (Terminal 37 on the drive module) and Safe Torque Off, see the VLT® FC Series - Safe Torque Off Operating Guide.

<sup>2</sup> When using a contactor with a DC coil inside with STO, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

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

### 10.6.3 Control Card, 24 V DC Output

Terminal number	XD2.10, XD2.11
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.

### 10.6.4 Control Card, 10 V DC Output

Terminal number	XD2.6
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.

## 10.6.5 Digital Outputs

Programmable digital/pulse outputs	2
Terminal number <sup>(1)</sup>	XD2.14, XD2.15
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

<sup>1</sup> Can also be programmed as input.

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

## 10.6.6 Digital Inputs

Programmable digital inputs	4 (6)
Terminal number <sup>(1)</sup>	XD2.12, XD2.13, XD2.14, XD2.15, XD2.16, XD2.17
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN <sup>(2)</sup>	>19 V DC
Voltage level, logic 1 NPN <sup>(2)</sup>	<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

<sup>1</sup> Terminals XD2.14 and XD2.15 can also be programmed as output.

<sup>2</sup> Except STO input terminal XD2.19.

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

## 10.6.7 Pulse/Encoder Inputs

Programmable pulse/encoder inputs	2/1
Terminal number (pulse inputs)	XD2.17
Terminal number (encoder inputs) <sup>(1)</sup>	XD2.16, XD2.17
Maximum frequency at terminals XD2.15, XD2.16, XD2.17 (push-pull driven)	110 kHz
Maximum frequency at terminals XD2.15, XD2.16, XD2.17 (open collector)	5 kHz
Maximum frequency at terminals XD2.15, XD2.16, XD2.17	4 kHz
Voltage level	See Control Input/Output and Control Data.
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
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<sup>1</sup> Encoder inputs: XD2.16=A, XD2.17=B.

The pulse and encoder inputs (terminals XD2.15, XD2.16, XD2.17) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

## 10.6.8 Control Characteristics

Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals XD2.12, XD2.13)	≤±0.1 ms
System response time (terminals XD2.12, XD2.13, XD2.14, XD2.15, XD2.16, XD2.17)	≤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.

## 10.6.9 Relay Outputs

Programmable relay outputs	2
Relay 01 terminal number <sup>(1)</sup>	21–23 (break), 21–22 (make)
Maximum terminal load (AC-1) on 21–23 (NC), 21–22 (NO) (resistive load) <sup>(2)(3)</sup>	240 V AC, 2 A
Maximum terminal load (AC-15) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) on 21–22 (NO), 21–23 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13) (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number <sup>(1)</sup>	24–26 (break), 24–25 (make)
Maximum terminal load (AC-1) on 24–25 (NO) (resistive load) <sup>(2)(3)</sup>	400 V AC, 2 A
Maximum terminal load (AC-15) on 24–25 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) on 24–25 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13) on 24–25 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1) on 24–26 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) on 24–26 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) on 24–26 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13) on 24–26 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 21–23 (NC), 21–22 (NO), 24–26 (NC), 24–25 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

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

<sup>2</sup> Overvoltage category II.

<sup>3</sup> UL applications 300 V AC 2 A.

### 10.6.10 Analog Output

Number of programmable outputs	1
Terminal number	XD2.5
Current range at analog output	0/4 to 20 mA
Maximum load GND - analog output less than	500 $\Omega$
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.

### 10.6.11 Analog Inputs

Number of analog inputs	2
Terminal number	XD2.7, XD2.8
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 k $\Omega$
Maximum voltage	$\pm 20$ V
Current mode	Switch S201/S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, $R_i$	Approximately 200 $\Omega$
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

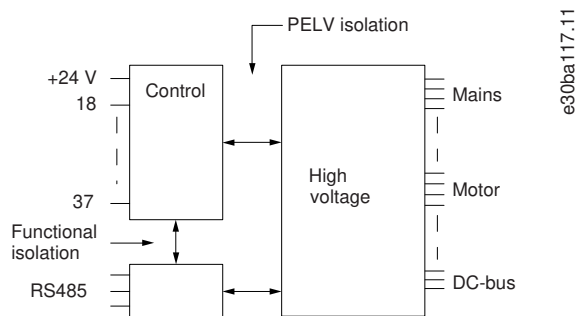


Illustration 77: PELV Isolation

### 10.6.12 Control Card, RS485 Serial Communication

Terminal number	XD2.2 (P,TX+, RX+), XD2.3 (N,TX-, RX-)
Terminal number XD2.1	Common for terminals XD2.2 and XD2.3

The RS485 serial communication circuit is galvanically isolated from the supply voltage (PELV).

### 10.6.13 Control Card Performance

Scan interval	1 ms
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## 10.7 Filter Specifications

### 10.7.1 Passive Harmonic Filter Specifications

Phase imbalance	Maximum of 3%
Voltage variation	+10%–15%
Nominal frequency	-2%, +2% (of 50 Hz or 60 Hz) when PHF is installed
Overload capability	150% for 60 s in a period of 10 minutes
Maximum inrush current, drive side	Maximum $5xI_{nom\ drive}$
Maximum inrush current, PHF input side	Maximum $2xI_{nom\ drive}$
Power derating	Same as drive

Table 109: Displacement Power Factor (Cos Phi)

Load [%]	Automatic capacitor control [p.u.] <sup>(1)(2)</sup>	Capacitor always connected [p.u.] <sup>(1)</sup>	Capacitor always open [p.u.] <sup>(1)</sup>
10	1.000	-0.790	1.000
25	-0.830	-0.830	0.990
50	-0.996	-0.996	0.950
75	0.997	0.997	0.930
100	0.986	0.986	0.920
160	0.980	0.980	0.910

<sup>1</sup> Positive numbers indicate lagging reactive currents. Negative numbers indicate leading currents.

<sup>2</sup> The capacitor connecting contactor switches at 20% load.

### 10.7.2 Line Reactor Specifications

All line reactors are equipped with thermal switches and are looped to the enclosed drive for overtemperature protection. For more details, refer to the *Control Compartment* section. The line reactor configuration varies depending on the enclosure and voltage required.

Table 110: Line Reactor Configuration for D9h–D10h and E5h–E6h Enclosures, 380–480 V

Enclosure	Model	Impedance [%]
D9h	N110	2.70
D9h	N132	3.22
D9h	N160	2.87
D10h	N200	3.47
D10h	N250	3.01
D10h	N315	3.65
E5h	N355	3.30
E5h	N400	3.62
E5h	N450	3.83
E6h	N500	2.94
E6h	N560	3.23

Table 111: Line Reactor Configuration for D9h–D10h and E5h–E6h Enclosures, 525–690 V

Enclosure	Model	Impedance [%]
D9h	N110	2.30
D9h	N132	2.78
D9h	N160	3.29
D10h	N200	2.92
D10h	N250	3.67
D10h	N315	3.08
D10h	N355	3.67
E5h	N400	2.89
E5h	N500	3.11
E5h	N560	3.55
E5h	N630	4.04
E6h	N710	3.19
E6h	N800	3.70

### 10.7.3 dU/dt Filter Specifications

Voltage rating	3x380–690 V
Motor frequency derating, 50 Hz	Nominal
Motor frequency derating, 60 Hz	Nominal
Motor frequency derating, 100 Hz	0.75 x nominal
Minimum switching frequency	No limit
Maximum switching frequency	Nominal switching frequency
Overload capacity	150% for 60 s, every 10 minutes

### 10.7.4 Sine-wave Filter Specifications

Voltage rating	3x380–480 V and 525–690 V AC
Nominal current @ 50 Hz	212 A and 315 A for 380–480 V, 137 A and 222 A for 525–690 V <sup>(1)</sup>
Motor frequency with derating <sup>(1)</sup>	Up to 150 Hz
Motor frequency without derating	0–60 Hz
Minimum switching frequency	2 kHz for 380–480 V, 1.5 kHz for 525–690 V
Maximum switching frequency	Nominal switching frequency
Overvoltage category	OVC III as defined in IEC61800-5-1
Overload capacity	150% for 60 s every 10 minutes
Ambient temperature [°C (°F)] <sup>(2)</sup>	-15 (5) to +60 (140)
Storage temperature [°C (°F)]	-40 (-40) to +70 (158)
Transport temperature [°C (°F)]	-40 (-40) to +70 (158)
Altitude during operation	100% current (no derating) up to 1000 m (3280 ft) 1% current derating for each 100 m (328 ft) above 1000 m (3280 ft)

Maximum 4000 m (13123 ft) with 500 V AC

Maximum 2000 m (6561 ft) with 690 V AC

Noise level

&lt; 80 dB(A)

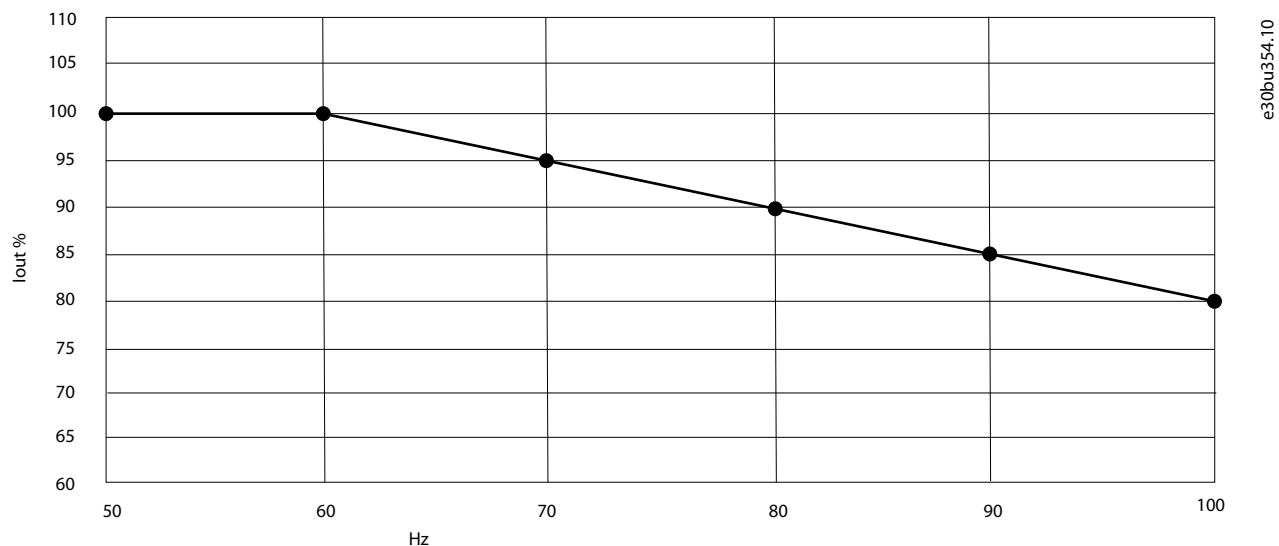
<sup>1</sup> The current ratings for the E5h and E6h enclosures are achieved by filter paralleling.<sup>2</sup> See [Illustration 79](#).

Illustration 78: Derating for Output Frequency While Using a Sine-wave Filter

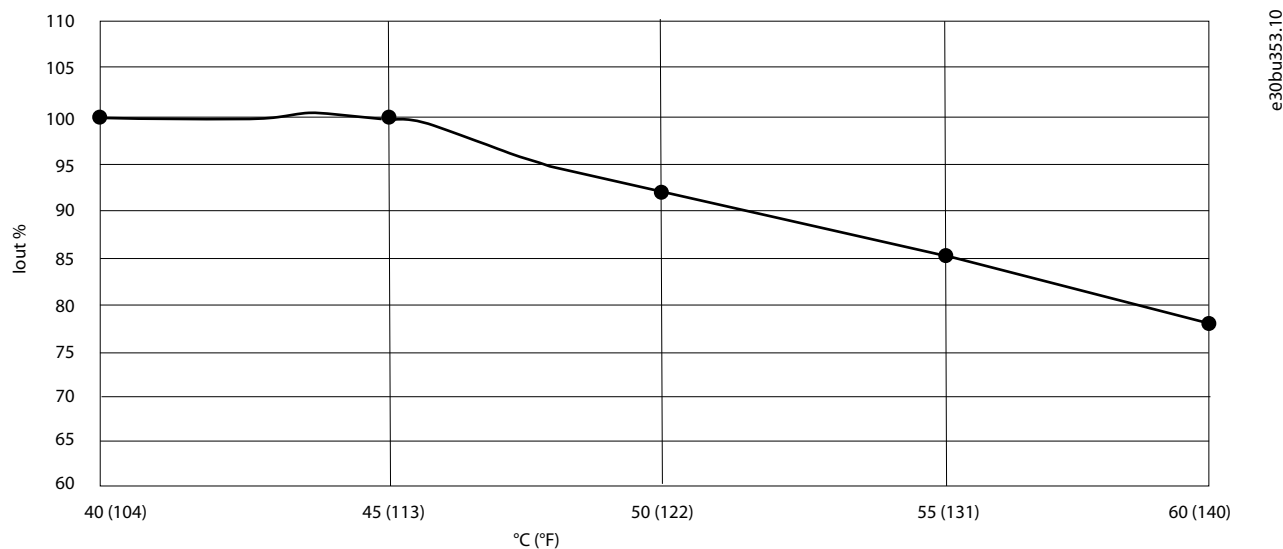


Illustration 79: Derating for Ambient Temperature While Using a Sine-wave Filter

## 10.8 Fuses, Circuit Breakers, and Switches

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

### NOTICE

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

Danfoss provides the following mains options for the enclosed drive:

- Panel fuses
- Fusible disconnect
- Non-fusible disconnect
- Contactor
- Molded-case circuit breaker (MCCB)

### 10.8.1 Panel Fuses

Panel fuses are an option for upstream protection, and are included only if the fusible disconnect option is selected. The panel fuses can be ordered as either a UL class fuse for UL variant or a gG fuse for IEC variant.

**Table 112: Panel Fuses for N110K–N315 Models, 380–480 V**

	N110	N132	N160	N200	N250	N315
<b>IEC (Type gG)</b>	250 A/500 V	315 A/500 V	355 A/500 V	425 A/500 V	630 A/500 V	630 A/500 V
Mersen P/N	NH1GG50V250	NH2GG50V315	NH2GG50V355	NH3GG50V425	NH3AGG50V630	NH3AGG50V630
<b>UL (Class J/L/T)</b>	300 A/600 V	350 A/600 V	400 A/600 V	500 A/600 V	600 A/600 V	750 A/600 V
Mersen P/N	A4J300	A4J350	A4J400	A4J500	A4J600	A4BY750

**Table 113: Panel Fuses for N355–N560 Models, 380–480 V**

	N355	N400	N450	N500	N560
<b>IEC (Type gG)</b>	800 A/500 V	1000 A/500 V	1000 A/500 V	1000 A/500 V	1250 A/500 V
Mersen P/N	NH4GG50V800	NH4GG50V1000	NH4GG50V1000	NH4GG50V1000	NH4GG50V1250
<b>UL (Class J/L/T)</b>	800 A/600 V	1000 A/600 V	1000 A/600 V	1100 A/600 V	1200 A/600 V
Mersen P/N	A4BY800	A4BY1000	A4BY1000	A4BY1100	A4BY1200

**Table 114: Panel Fuses for N110–N315 Models, 525–690 V**

	N110	N132	N160	N200	N250	N315
<b>IEC (Type gG)</b>	250 A/690 V	250 A/690 V	250 A/690 V	315 A/690 V	355 A/690 V	425 A/690 V
Mersen P/N	NH2GG69V250	NH2GG69V250	NH2GG69V250	NH2GG69V315	NH3GG69V355	NH3GG69V425
<b>UL (Class J/L/T)</b>	175 A/600 V	200 A/600 V	250 A/600 V	350 A/600 V	400 A/600 V	500 A/600 V
Mersen P/N	A4J175	A4J200	A4J250	A4J350	A4J400	A4J500

**Table 115: Panel Fuses for N400–N630 Models, 525–690 V**

	N400	N450	N500	N560	N630
<b>IEC (Type gG)</b>	500 A/690 V	500 A/500 V	630 A/500 V	800 A/500 V	800 A/500 V
Mersen P/N	NH3GG69V500	NH3GG69V500	NH4GG69V630	NH4GG69V800	NH4GG69V800
<b>UL (Class J/L/T)</b>	600 A/600 V	600 A/600 V	650 A/600 V	750 A/600 V	800 A/600 V
Mersen P/N	A4J600	A4J600	A4BY650	A4BY750	A4BY800

Table 116: Panel Fuses for N710–N800 Models, 525–690 V

	N710	N800
IEC (Type gG)	1000 A/690 V	1000 A/690 V
ABB P/N	OFAA4AM1000	OFAA4AM1000
UL (Class J/L/T)	1000 A/600 V	1100 A/600 V
Mersen P/N	A4BY1000	A4BY1100

## 10.8.2 Contactor Switches

The mains contactor is an option. All units ordered and supplied with a factory-installed contactor require a Class L/J branch circuit fusing to meet the 65 kA SCCR for the drive system.

This option makes it possible to connect or disconnect the drive from the mains by using a control switch on the control compartment door or an external switch. The external switch must be wired to terminals XD0. See [5.3 Wiring Overview for D9h and D10h Enclosed Drives](#) and [5.4 Wiring Overview for E5h and E6h Enclosed Drives](#). The mains contactor is supplied with 2 sets of auxiliary switches (1 normally open and 1 normally closed). These switches are on the sides of the contactor. By default, the NO auxiliary switch is wired at the factory and used by the system.

Rated operation current @ 230 V	6 A
Rated operation current @ 380 V	4 A
Rated operation current @ 480 V	1.5 A
Conventional thermal current, I <sub>th</sub>	10 A
Rated voltage	500 V AC
Rated impulse withstand voltage	600 V AC

Table 117: Mains Contactor Switches for N110–N315 Models, 380–480 V

	N110	N132	N160	N200	N250	N315
IEC	185 A/1000 V	185 A/1000 V	185 A/1000 V	400 A/1000 V	580 A/1000 V	500 A/1000 V
Eaton P/N	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE500M22A
UL	185 A/1000 V	185 A/1000 V	185 A/1000 V	400 A/1000 V	400 A/1000 V	580 A/1000 V
Eaton P/N	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE580N22A	XTCE580N22A

Table 118: Mains Contactor Switches for N355–N560 Models, 380–480 V

	N355	N400	N450	N500	N560
IEC	580 A/1000 V	580 A/1000 V	580 A/1000 V	820 A/1000 V	820 A/1000 V
Eaton P/N	XTCE580N22A	XTCE580N22A	XTCE580N22A	XTCE820N22A	XTCE820N22A
UL	820 A/1000 V	820 A/1000 V	820 A/1000 V	1000 A/1000 V	1000 A/1000 V
Eaton P/N	XTCE820N22A	XTCE820N22A	XTCE820N22A	XTCEC10N22A	XTCEC10N22A

Table 119: Mains Contactor Switches for N110–N315 Models, 525–690 V

	N110	N132	N160	N200	N250	N315
IEC	185 A/1000 V	185 A/1000 V	185 A/1000 V	400 A/1000 V	400 A/1000 V	400 A/1000 V
Eaton P/N	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A
UL	185 A/1000 V	185 A/1000 V	185 A/1000 V	400 A/1000 V	400 A/1000 V	400 A/1000 V
Eaton P/N	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A	XTCE400M22A

Table 120: Mains Contactor Switches for N400–N630 Models, 525–690 V

	N400	N450	N500	N560	N630
IEC	400 A/1000 V	580 A/1000 V	580 A/1000 V	580 A/1000 V	580 A/1000 V
Eaton P/N	XTCE400M22A	XTCE580N22A	XTCE580N22A	XTCE580N22A	XTCE580N22A
UL	400 A/1000 V	580 A/1000 V	580 A/1000 V	580 A/1000 V	580 A/1000 V
Eaton P/N	XTCE400M22A	XTCE580N22A	XTCE580N22A	XTCE580N22A	XTCE580N22A

Table 121: Mains Contactor Switches for N710–N800 Models, 525–690 V

	N710	N800
IEC	580 A/1000 V	820 A/1000 V
Eaton P/N	XTCE580N22A	XTCE820N22A
UL	820 A/1000 V	1000 A/1000 V
Eaton P/N	XTCE820N22A	XTCEC10N22A

### 10.8.3 Fusible Disconnect Switches

The fusible disconnect switch is an option that safely isolates the drive from the mains with a fuse switch mounted below the drive module. All units ordered and supplied with a factory-installed fusible disconnect switch have a fuse built in to the switch. The fuse has been sized to meet 65kA SCCR for the system. The input voltage and power rating of the drive determines the specific class or gG fuse. The input voltage and power rating are found on the product nameplate.

Table 122: Fusible Disconnect Switches for N110–N315 Models, 380–480 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	630 A/690 V	630 A/690 V	630 A/690 V
ABB P/N	OS400D30P	OS400D30P	OS400D30P	OS630D30P	OS630D30P	OS630D30P
UL	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V	600 A/600 V	800 A/600 V
ABB P/N	OS400J30	OS400J30	OS400J30	OS600J30	OS600J30	OS800L30

Table 123: Fusible Disconnect Switches for N355–N560 Models, 380–480 V

	N355	N400	N450	N500	N560
IEC	1250 A/690 V	1250 A/690 V	1250 A/690 V	1250 A/690 V	1250 A/690 V
ABB P/N	OS1250D30P	OS1250D30P	OS1250D30P	OS1250D30P	OS1250D30P
UL	800 A/600 V	1200 A/600 V	1200 A/600 V	1200 A/600 V	1200 A/600 V
ABB P/N	OS800L30	OS1200L30	OS1200L30	OS1200L30	OS1200L30

Table 124: Fusible Disconnect Switches for N110–N315 Models, 525–690 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	630 A/690 V	630 A/690 V	630 A/690 V
ABB P/N	OS400D30P	OS400D30P	OS400D30P	OS630D30P	OS630D30P	OS630D30P
UL	400 A/600 V	400 A/600 V	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V
ABB P/N	OS400J30	OS400J30	OS400J30	OS400J30	OS400J30	OS600J30

Table 125: Fusible Disconnect Switches for N400–N630 Models, 525–690 V

	N400	N450	N500	N560	N630
IEC	630 A/690 V	630 A/690 V	1250 A/690 V	1250 A/690 V	1250 A/690 V
ABB P/N	OS630D30P	OS630D30P	OS1250D30P	OS1250D30P	OS1250D30P
UL	600 A/600 V	600 A/600 V	800 A/600 V	800 A/600 V	800 A/600 V
ABB P/N	OS600J30	OS600J30	OS800L30	OS800L30	OS800L30

Table 126: Fusible Disconnect Switches for N710–N800 Models, 525–690 V

	N710	N800
IEC	1250 A/690 V	1250 A/690 V
ABB P/N	OS1250D30P	OS1250D30P
UL	1200 A/600 V	1200 A/600 V
ABB P/N	OS1200L30	OS1200L30

### 10.8.4 Non-fusible Disconnect Switches

The non-fusible disconnect switch is an option. All units ordered and supplied with a factory-installed, non-fusible disconnect switch require a UL Class fuse to meet 65kA SCCR for the drive system.

Table 127: Non-fusible Disconnect Switches for N110–N315 Models, 380–480 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	630 A/690 V	630 A/690 V	630 A/690 V
ABB P/N	OT400E30	OT400E30	OT400E30	OT630E30	OT630E30	OT630E30
UL	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V	600 A/600 V	800 A/600 V
ABB P/N	OT400U30	OT400U30	OT400U30	OT600U30	OT600U30	OT800U30

Table 128: Non-fusible Disconnect Switches for N355–N560 Models, 380–480 V

	N355	N400	N450	N500	N560
IEC	1000 A/690 V	1000 A/690 V	1250 A/690 V	1250 A/690 V	1250 A/690 V
ABB P/N	OT1000E30	OT1000E30	OT1250E30	OT1250E30	OT1250E30
UL	800 A/600 V	1200 A/600 V	1200 A/600 V	1200 A/600 V	1200 A/600 V
ABB P/N	OT800U30	OT1200U30	OT1200U30	OT1200U30	OT1200U30

Table 129: Non-fusible Disconnect Switches for N110–N315 Models, 525–690 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	630 A/690 V	630 A/690 V	630 A/690 V
ABB P/N	OT400E30	OT400E30	OT400E30	OT630E30	OT630E30	OT630E30
UL	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V	600 A/600 V	600 A/600 V
ABB P/N	OT400U30	OT400U30	OT400U30	OT600U30	OT600U30	OT600U30

Table 130: Non-fusible Disconnect Switches for N400–N630 Models, 525–690 V

	N400	N450	N500	N560	N630
IEC	630 A/690 V	630 A/690 V	630 A/690 V	1000 A/690 V	1000 A/690 V
ABB P/N	OT630E30	OT630E30	OT630E30	OT1000E30	OT1000E30
UL	600 A/600 V	600 A/600 V	600 A/600 V	800 A/600 V	800 A/600 V
ABB P/N	OT600U30	OT600U30	OT600U30	OT800U30	OT800U30

Table 131: Non-fusible Disconnect Switches for N710–N800 Models, 525–690 V

	N710	N800
IEC	1250 A/690 V	1250 A/690 V
ABB P/N	OT1250E30	OT1250E30
UL	1200 A/600 V	1200 A/600 V
ABB P/N	OT1200U30	OT1200U30

### 10.8.5 Molded-case Circuit Breakers

The molded-case circuit breaker (MCCB) is an option that combines a temperature-sensitive device with a current sensitive-electro-magnetic device to protect the drive.

Table 132: MCCB Part Numbers for N110–N315 Models, 380–480 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	800 A/690 V	800 A/690 V	800 A/690 V
ABB P/N	T5L400	T5L400	T5L400	T6L800	T6L800	T6L800
UL	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V	600 A/600 V	800 A/600 V
ABB P/N	T5L400BW	T5L400BW	T5LQ400BW	T6L600BW	T6LQ600BW	T6LQ800BW

Table 133: MCCB Part Numbers for N355K–N560 Models, 380–480 V

	N355	N400	N450	N500	N560
IEC	1000 A/690 V	1250 A/690 V	1250 A/690 V	1250 A/690 V	1600 A/690 V
ABB P/N	T71000LSR231 DS-LS	T71250LSR231 DS-LS	T71250LSR231 DS-LS	T71250LSR231 DS-LS	T71600LSR231 DS-LS
UL	1200 A/600 V	1200 A/600 V	1200 A/600 V	1600 A/600 V	1600 A/600 V
ABB P/N	T7L1200PR231/P	T7L1200PR231/P	T7LQ1200PR231/P	T8V1600PR232/P	T8V1600PR232/P

Table 134: MCCB Part Numbers for N110–N315 Models, 525–690 V

	N110	N132	N160	N200	N250	N315
IEC	400 A/690 V	400 A/690 V	400 A/690 V	630 A/690 V	630 A/690 V	630 A/690 V
ABB P/N	T5L400T	T5L400T	T5L400T	T6L630T	T6L630T	T6L630T
UL	400 A/600 V	400 A/600 V	400 A/600 V	600 A/600 V	600 A/600 V	600 A/600 V
ABB P/N	T5L400TW	T5L400TW	T5L400TW	T6L600TW	T6L600TW	T6L600TW

Table 135: MCCB Part Numbers for N400–N630 Models, 525–690 V

	N400	N450	N500	N560	N630
IEC	600 A/690 V	1000 A/690 V	1000 A/690 V	1000 A/690 V	1000 A/690 V
ABB P/N	T6L630T	T7L1000LSPR23 1 DS-LS	T7L1000LSPR23 1 DS-LS	T7L1000LSPR23 1 DS-LS	T7L1000LSPR23 1 DS-LS
UL	600 A/600 V	1000 A/600 V	1000 A/600 V	1200 A/600 V	1200 A/600 V
ABB P/N	T6LQ600TW	T7L1000PR231/P	T7L1000PR231/P	T7LQ1200PR231/P	T7LQ1200PR231/P

Table 136: MCCB Part Numbers for N710–N800 Models, 525–690 V

	N710	N800
IEC	1250 A/690 V	1250 A/690 V
ABB P/N	T7L1250LSPR23 1 DS-LS	T7L1250LSPR23 1 DS-LS
UL	1200 A/600 V	1200 A/600 V
ABB P/N	T7L1200PR231/ P	T7L1200PR231/ P

## 10.9 Enclosure Dimensions

### 10.9.1 Pedestal Dimensions

The pedestal, on which the enclosure sits, is available in 3 different heights:

- 100 mm (3.9 in)
- 200 mm (7.9 in)
- 400 mm (15.8 in)

### 10.9.2 D9h Enclosed Drive Exterior Dimensions

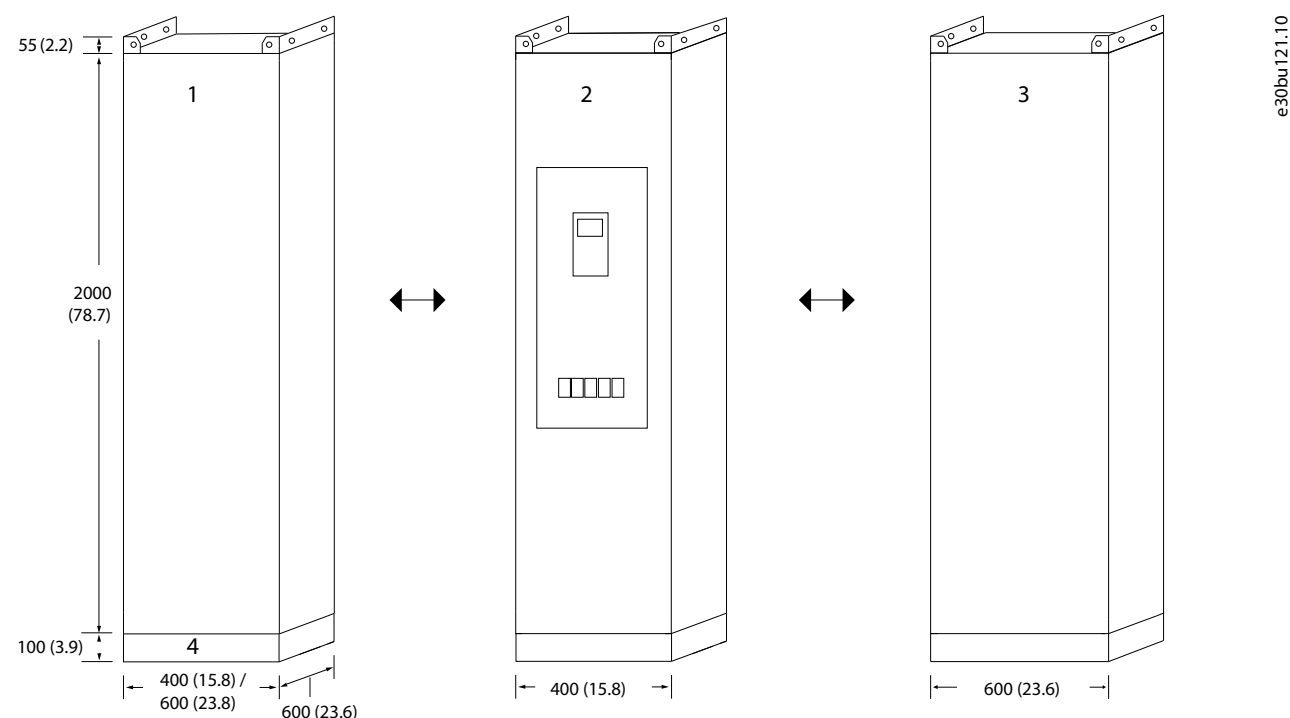


Illustration 80: Dimensions for D9h Enclosure with Standard Pedestal

1	Passive harmonic filter/line reactor cabinet	3	Sine-wave cabinet
2	D9h drive cabinet	4	Standard pedestal

### 10.9.3 D10h Enclosed Drive Exterior Dimensions

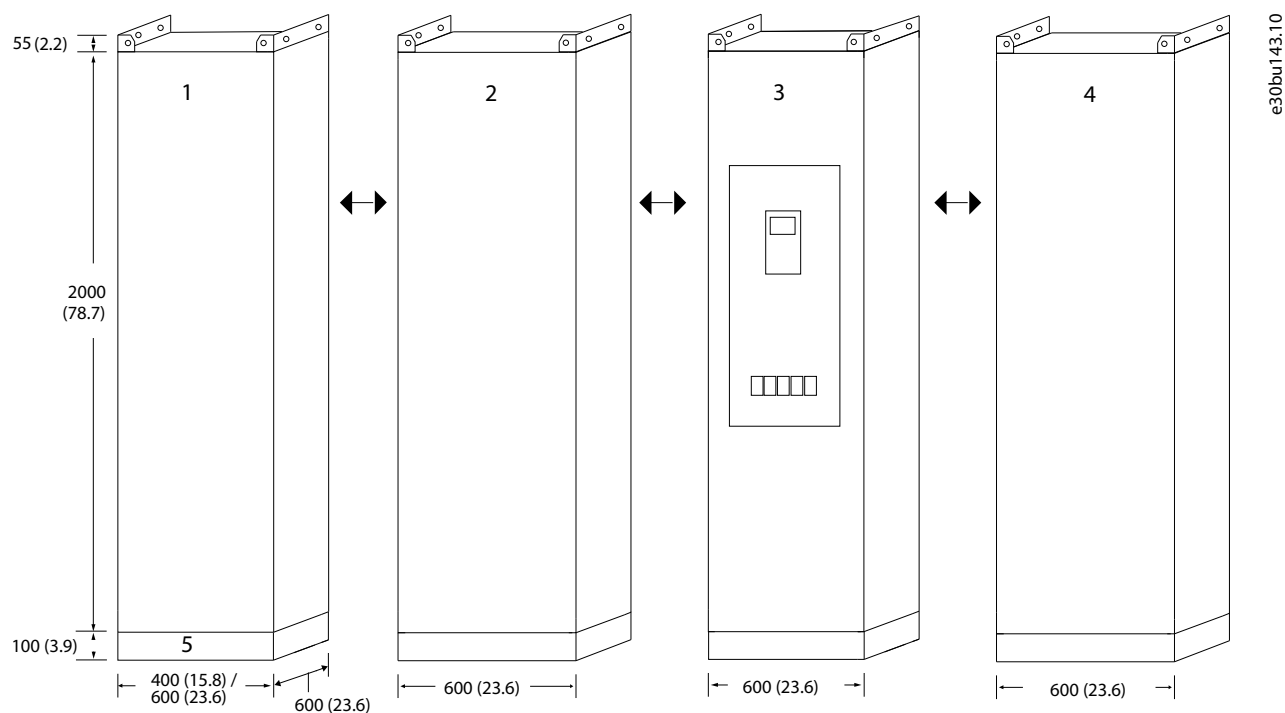


Illustration 81: Dimensions for D10h Enclosure with Standard Pedestal

1	Passive harmonic filter/line reactor cabinet	4	Sine-wave cabinet
2	Options cabinet (provided when more than 1 input option is ordered)	5	Standard pedestal
3	D10h drive cabinet		

## 10.9.4 E5h Enclosed Drive Exterior Dimensions

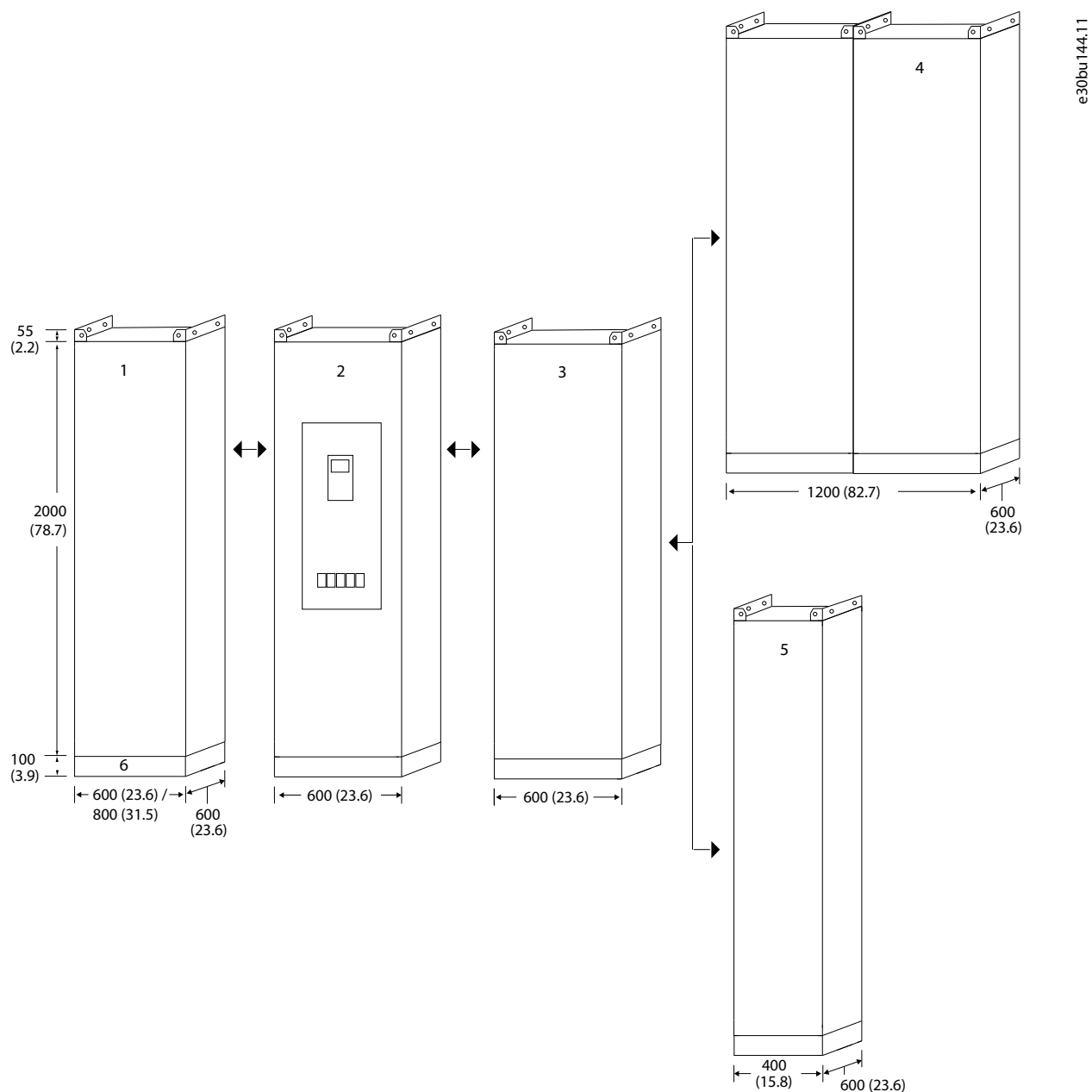


Illustration 82: Dimensions for E5h Enclosure with Standard Pedestal

1	Passive harmonic filter/line reactor cabinet	4	Sine-wave cabinet
2	Options cabinet	5	dU/dt cabinet
3	E5h drive cabinet	6	Standard pedestal

## 10.9.5 E6h Enclosed Drive Exterior Dimensions

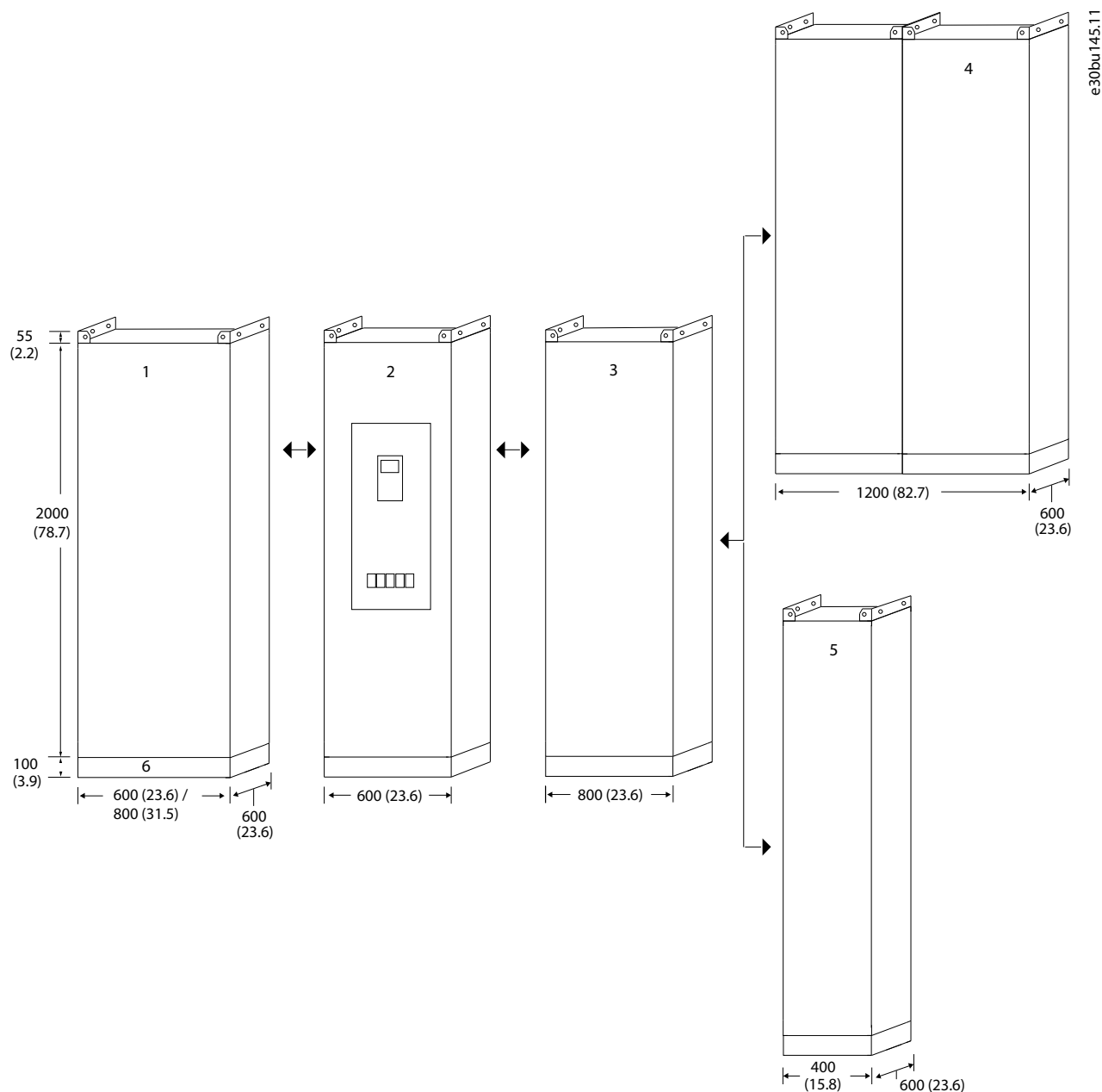
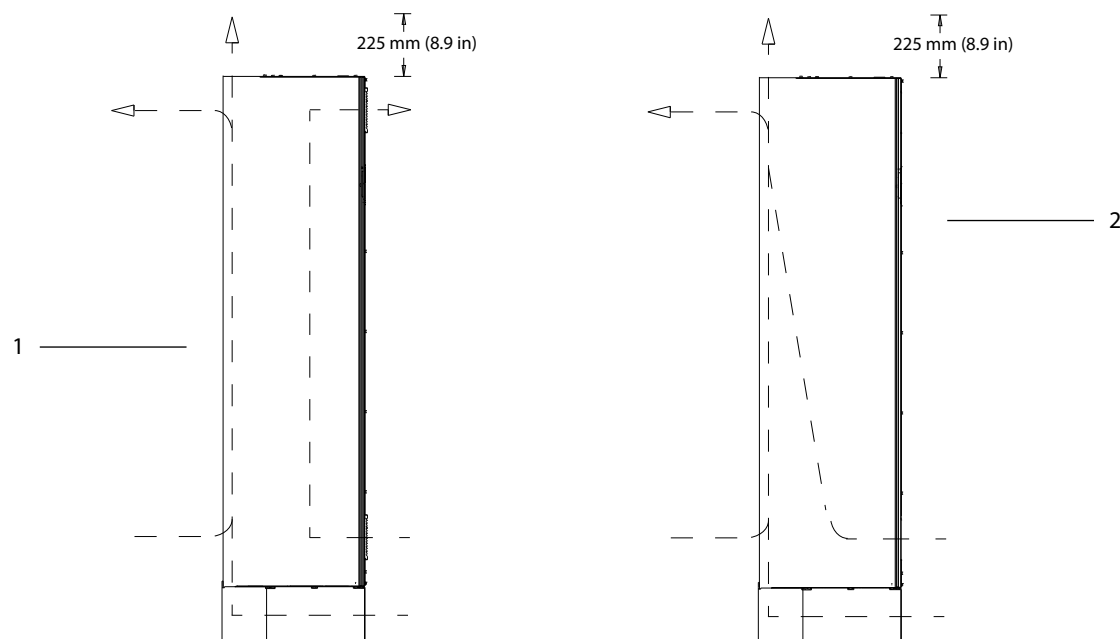


Illustration 83: Dimensions for E6h Enclosure with Standard Pedestal

1	Passive harmonic filter/line reactor cabinet	4	Sine-wave cabinet
2	Options cabinet	5	dU/dt cabinet
3	E6h drive cabinet	6	Standard pedestal

## 10.10 Enclosure Airflow



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**Illustration 84: Enclosure Airflow in Sine-wave Filter, Passive Harmonic Filter, and Drive Cabinets (Side View)**

- |   |                            |
|---|----------------------------|
| 1 | Drive module cabinet       |
| 2 | PHF and sine-wave cabinets |

## 10.11 Fastener Torque Ratings

Apply the correct torque when tightening fasteners in the locations that are listed in the table. 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.

**Table 137: Fastener Torque Ratings**

Location	Bolt size	Torque [Nm (in-lb)]
Mains terminals	M10/M12	19 (168)/37 (335)
Motor terminals	M10/M12	19 (168)/37 (335)
Ground terminals	M8/M10	9.6 (84)/19.1 (169)
Brake terminals	M8	9.6 (84)
Relay terminals	–	0.5 (4)
Ground busbars between cabinets	M8	10 (88.5)
Brackets between cabinets	M6	8 (71)
Door/panel cover	M5	2.3 (20)
Cable entry plate	M5	2.3 (20)
Serial communication cover	M5	2.3 (20)

## 11 Appendix

### 11.1 Conventions

- Numbered lists indicate procedures.
- Bullet lists indicate other information and description of illustrations.
- Italicized text indicates:
  - Cross reference.
  - Link.
  - Footnote.
  - Parameter name.
  - Parameter group name.
  - Parameter option.
- All dimensions are in mm (inch).

### 11.2 Abbreviations

Table 138: Abbreviations, Acronyms, and Symbols

Term	Definition
°C	Degrees Celsius
°F	Degrees Fahrenheit
Ω	Ohm
AC	Alternating current
AEO	Automatic energy optimization
ACP	Application control processor
AMA	Automatic motor adaptation
AWG	American wire gauge
CPU	Central processing unit
CSIV	Customer-specific initialization values
CT	Current transformer
DC	Direct current
DVM	Digital voltmeter
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FPC	Fan power card
HF	High frequency

Term	Definition
HVAC	Heating, ventilation, and air conditioning
Hz	Hertz
$I_{LIM}$	Current limit
$I_{INV}$	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IEC	International Electrotechnical Commission
IGBT	Insulated-gate bipolar transistor
I/O	Input/output
IP	Ingress protection
kHz	Kilohertz
kW	Kilowatt
$L_d$	Motor d-axis inductance
$L_q$	Motor q-axis inductance
LC	Inductor-capacitor
LCP	Local control panel
LED	Light-emitting diode
LOP	Local operation pad
mA	Milliamp
MCB	Miniature circuit breakers
MCCB	Molded-case circuit breaker
MCO	Motion control option
MCP	Motor control processor
MCT	Motion control tool
MDCIC	Multi-drive control interface card
mV	Millivolts
NEMA	National Electrical Manufacturers Association
NTC	Negative temperature coefficient
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth

Term	Definition
PELV	Protective extra low voltage
PHF	Passive harmonic filter
PID	Proportional integral derivative
PLC	Programmable logic controller
P/N	Part number
PROM	Programmable read-only memory
PS	Power section
PTC	Positive temperature coefficient
PWM	Pulse width modulation
$R_s$	Stator resistance
RAM	Random-access memory
RCD	Residual current device
Regen	Regenerative terminals
RFI	Radio frequency interference
RMS	Root means square (cyclically alternating electric current)
RPM	Revolutions per minute
SCR	Silicon-controlled rectifier
SMPS	Switch mode power supply
S/N	Serial number
STO	Safe Torque Off
$T_{LIM}$	Torque limit
$U_{M,N}$	Nominal motor voltage
V	Volt
VVC	Voltage vector control
$X_h$	Motor main reactance

### 11.3 International/North American Default Parameter Settings

Setting *parameter 0-03 Regional Settings* to [0] International or [1] North America changes the default settings for some parameters.

Table 139: VLT® FC Series International/North American Default Parameter Settings

Parameter	International default value	North American default value
<i>Parameter 0-03 Regional Settings</i>	International	North America
<i>Parameter 0-71 Date Format</i>	DD-MM-YYYY	MM/DD/YYYY
<i>Parameter 0-72 Time Format</i>	24 h	12 h

Parameter	International default value	North American default value
Parameter 1-23 Motor Frequency	50 Hz	60 Hz
Parameter 1-25 Motor Nominal Speed	1400 RPM	1680 RPM
Parameter 1-53 Model Shift Frequency	16.7	20.0
Parameter 1-56 U/f Characteristic	50 Hz	60 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM	1800 RPM
Parameter 14-37 Fieldweakening Speed	1400 RPM	1680 RPM

## 11.4 Required Parameter Settings for Drive Options

On performing a factory reset on the drive, all drive parameters revert to their factory default value. Several drive options have parameter settings that must be configured differently from the factory default values in order for the options to perform properly.

Table 140: Parameter Settings for the Passive Filter Option (Typecode Character 7 = P/H/L/U)

Parameter	Change value to
Parameter 5-02 Terminal 29 Mode	[1] Output
Parameter 5-10 Terminal 18 Digital Input	[7] External Interlock
Parameter 5-31 Terminal 29 Digital Output	[188] AHF Capacitor Connect
Parameter 14-51 DC-link Compensation	[0] Off

Table 141: Parameter Settings for the dU/dt Filter Option (Typecode Character 18 = D/1)

Parameter	Change value to
Parameter 5-10 Terminal 18 Digital Input	[7] External Interlock
Parameter 14-52 Fan Control	[3] On 100% <sup>(1)</sup>

<sup>1</sup> This fan setting applies only to D9h and D10h models.

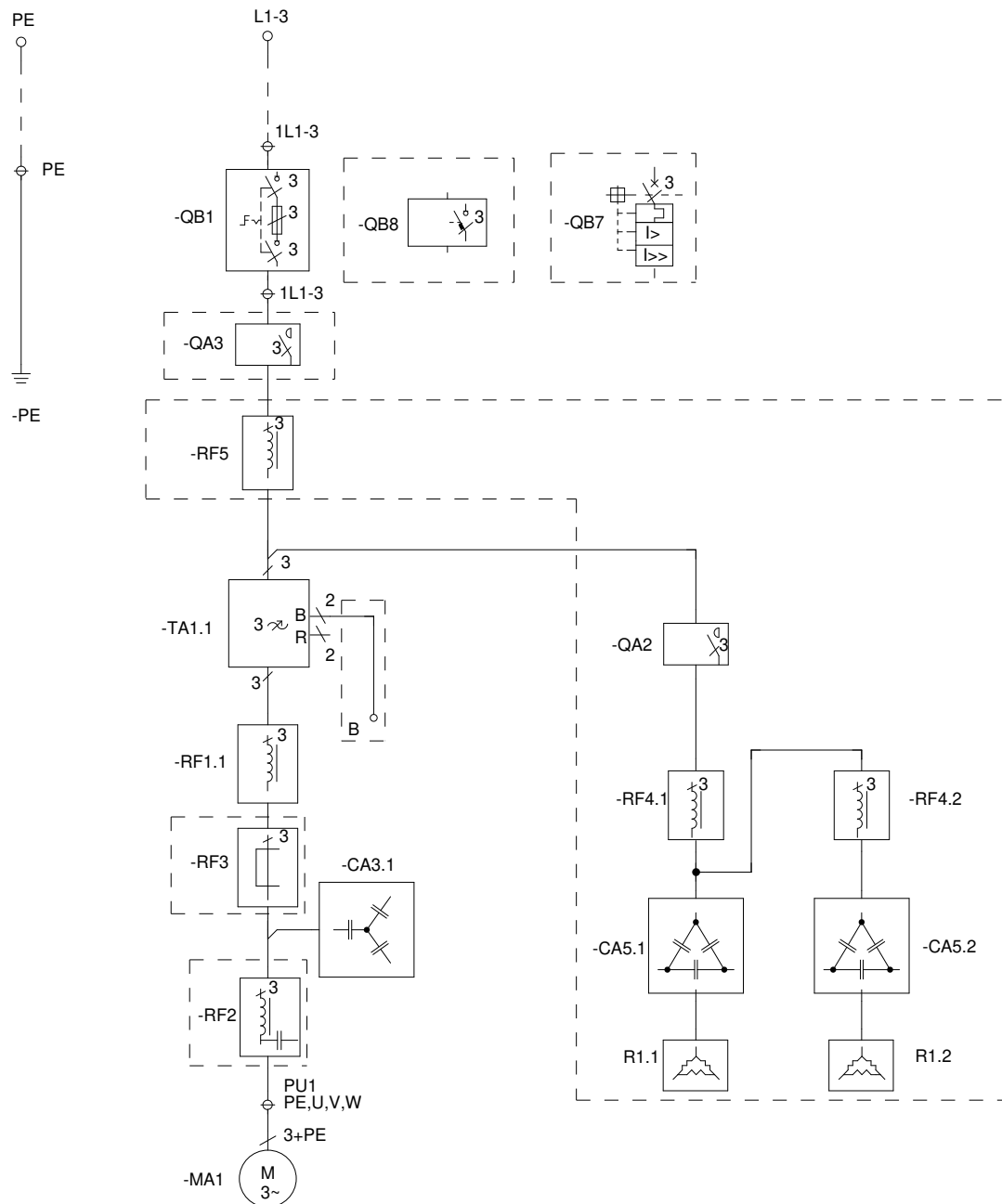
Table 142: Parameter Settings for the Sine-wave Filter Option (Typecode Character 18 = S/2)

Parameter	Change value to
Parameter 5-10 Terminal 18 Digital Input	[7] External Interlock
Parameter 14-55 Output Filter	[2] Sine-Wave Filter Fixed

Table 143: Parameter Settings for the Indicator Light + Reset Button Option (Typecode Character 28–29 = D1/DA/DB/DC/DD/DE)

Parameter	Change value to
Parameter 5-40 Function Relay [1]	[5] Running
Parameter 5-40 Function Relay [2]	[9] Alarm
Parameter 5-14 Terminal 32 Digital Input	[1] Reset

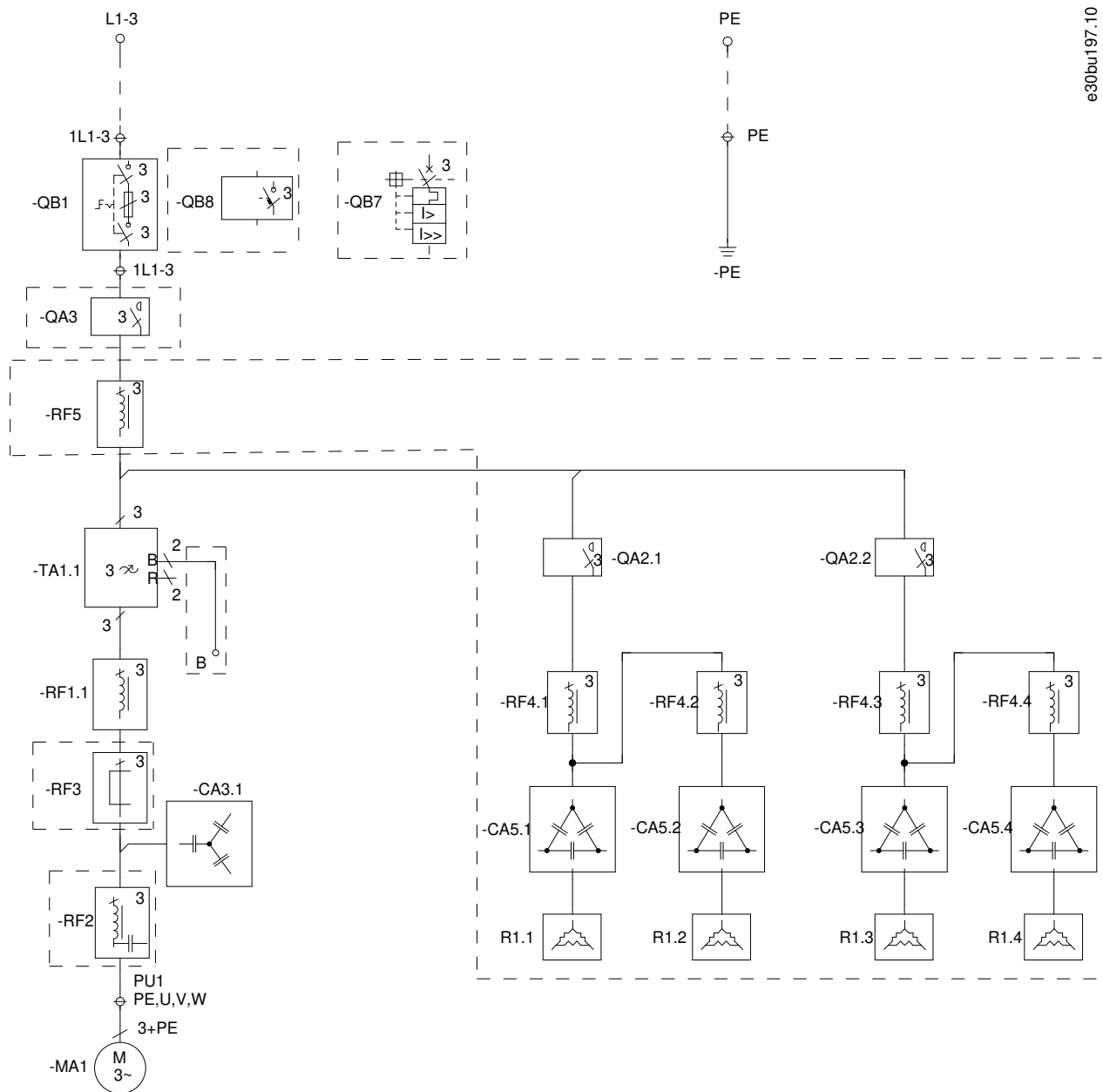
## 11.5 Block Diagrams



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Illustration 85: Electrical Power Flow for D9h/D10h Enclosures

-RFI	Radio frequency interference (RFI) filter	-QB8	Mains disconnect
R1	Resistor	-MA7	dU/dt and sine-wave filter fans
-RF5	Passive harmonic filter (PHF) L0	-MA8	PHF fans
-RF4	PHF inductors	-RF2	Sine-wave filter inductor
-CA5	PHF capacitors	-CA4	Sine-wave filter capacitor
-QA2	PHF contactor	-RF1	dU/dt filter inductor
-RFL	Line reactor	-CA3	dU/dt filter capacitor
-QAF	PHF relay	-RF3	Common-mode filter
-QB7	Molded-case circuit breaker (MCCB)	-MA1	Motor (customer side)
-QA3	Mains contactor	-TA1	Drive module
-QB2	Mains fused disconnect	LCP	Local control panel



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Illustration 86: Electrical Power Flow for E5h/E6h Enclosures

-RFI	Radio frequency interference (RFI) filter	-QB8	Mains disconnect
R1	Resistor	-MA7	dU/dt and sine-wave filter fans
-RF5	Passive harmonic filter (PHF) L0	-MA8	PHF fans
-RF4	PHF inductors	-RF2	Sine-wave filter inductor
-CA5	PHF capacitors	-CA4	Sine-wave filter capacitor
-QA2	PHF contactor	-RF1	dU/dt filter inductor
-RFL	Line reactor	-CA3	dU/dt filter capacitor
-QAF	PHF relay	-RF3	Common-mode filter
-QB7	Molded-case circuit breaker (MCCB)	-MA1	Motor (customer side)
-QA3	Mains contactor	-TA1	Drive module
-QB2	Mains fused disconnect	LCP	Local control panel

## 11.6 Input Power Option Losses

The loss values shown in this section are typical of the worst case operating conditions. For normal conditions, typical power loss is expected to be within  $\pm 15\%$ . The tolerance relates to differences in voltage and cable conditions. These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors increase power loss in the drive and filters, which affect the dimensioning of the drive and filter cooling. If the switching frequency is higher than the default setting, the power losses can increase.

For output filters, an increase in motor frequency will increase the losses. In this situation, follow the derating guidelines specified in the product-specific Design Guide.

### 11.6.1 Contactor Losses

Table 144: Power Losses for Contactor Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	16	11	13	9
N132	25	16	21	13
N160	36	25	33	21
N200	57	36	47	33
N250	42	28	36	24
N315	63	42	52	36
N355	62	51	50	42
N400	79	62	66	50
N450	91	69	76	66
N500	74	61	58	51
N560	94	74	76	58

Table 145: Power Losses for Contactor Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	7	5	6	4
N132	10	7	9	6
N160	15	10	13	9
N200	23	15	21	13
N250	33	23	30	21
N315	47	33	43	30
N355	63	47	58	43
N400	40	28	37	26
N500	50	33	45	30
N560	64	50	59	45
N630	72	64	72	59
N710	83	62	76	57
N800	76	56	69	51

## 11.6.2 Fusible Disconnect Losses

Table 146: Power Losses for Fusible Disconnect Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	71	49	57	40
N132	89	59	76	48
N160	131	90	121	76
N200	142	91	119	83
N250	155	105	132	88
N315	233	155	193	132
N355	188	156	151	127
N400	202	158	168	127
N450	233	176	194	168
N500	282	233	222	194
N560	305	241	246	189

Table 147: Power Losses for Fusible Disconnect Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	29	20	27	18
N132	41	29	37	27
N160	63	41	57	37
N200	71	45	65	41
N250	101	70	92	64
N315	118	84	108	77
N355	151	112	138	102
N400	191	135	175	125
N500	134	90	123	83
N560	154	119	141	109
N630	173	154	173	141
N710	208	155	190	142
N800	282	208	258	190

### 11.6.3 Non-fusible Disconnect Losses

Table 148: Power Losses for Non-fusible Disconnect Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	8	6	7	5
N132	13	8	11	7
N160	19	13	17	11
N200	29	19	25	17
N250	44	29	37	25
N315	65	44	54	37
N355	25	21	20	17
N400	32	25	26	20
N450	36	27	30	26
N500	43	36	34	30
N560	55	43	44	34

Table 149: Power Losses for Non-fusible Disconnect Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	4	2	3	2
N132	5	4	5	3
N160	8	5	7	5
N200	12	8	11	7
N250	17	12	16	11
N315	24	17	22	16
N355	33	24	30	22
N400	42	29	38	27
N500	52	35	47	32
N560	20	16	19	14
N630	23	20	23	19
N710	32	24	30	22
N800	44	32	40	30

### 11.6.4 Molded-case Circuit Breaker (MCCB) Losses

Table 150: Power Losses for MCCB Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	25	18	20	14
N132	38	25	32	20
N160	56	38	51	32
N200	54	35	45	32
N250	80	54	68	45
N315	120	80	100	68
N355	62	52	50	42
N400	80	62	66	50
N450	92	70	77	66
N500	112	92	88	77
N560	92	73	74	57

Table 151: Power Losses for MCCB Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	11	7	10	7
N132	15	11	14	10
N160	23	15	21	14
N200	22	14	20	13
N250	32	22	29	20
N315	45	32	41	29
N355	61	45	56	41
N400	43	30	39	28
N500	53	36	49	33
N560	69	53	63	49
N630	77	69	77	63
N710	84	63	77	57
N800	114	84	104	77

### 11.6.5 Passive Harmonic Filter Losses

Table 152: Power Losses for Passive Harmonic Filter Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	1083	841	1083	841
N132	1284	1083	1284	1083
N160	1511	1284	1511	1284
N200	1704	1511	1704	1511
N250	1814	1704	1814	1704
N315	2242	1814	1980	1814
N355	2302	2242	2242	1980
N400	2498	2302	2302	2242
N450	2613	2498	2498	2302
N500	2838	2613	2613	2498
N560	3160	2838	2838	2613

Table 153: Power Losses for Passive Harmonic Filter Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	3406	2689	2689	2151
N132	4302	3406	3406	2689
N160	5199	4302	4302	3406
N200	6454	5199	5199	4302
N250	8246	6454	6454	5199
N315	10308	8246	8246	6454
N355	10308	10308	10308	8246
N400	7768	6872	6872	5498
N500	10995	6872	7768	6872
N560	9919	9919	8605	7768
N630	10995	9919	9919	8605
N710	13744	10995	10995	9919
N800	13744	13744	13744	10995

## 11.6.6 Line Reactor Losses

Table 154: Power Losses for Line Reactor Option, 380–500 V

Model	380–440 V [W]		441–500 V [W]	
	NO	HO	NO	HO
–				
N110	406	306	327	231
N132	615	406	521	327
N160	537	366	492	310
N200	844	537	704	492
N250	1046	708	890	591
N315	1569	1046	1299	890
N355	1168	971	941	786
N400	1498	1168	1239	941
N450	1728	1305	1441	1239
N500	1393	1152	1096	960
N560	1764	1393	1426	1096

Table 155: Power Losses for Line Reactor Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	395	270	360	245
N132	552	395	504	360
N160	845	552	776	504
N200	817	511	745	470
N250	1170	817	1069	745
N315	1366	967	1250	883
N355	1842	1366	1681	1250
N400	1409	996	1293	919
N500	1744	1171	1595	1071
N560	2491	1921	2279	1757
N630	2786	2491	2786	2279
N710	2472	1845	2268	1686
N800	3361	2472	3069	2268

### 11.6.7 dU/dt Filter Losses

Table 156: Power Losses for dU/dt Filter Option, 380–480 V

Model	380–440 V [W]		441–480 V [W]	
	NO	HO	NO	HO
–				
N110	350	244	281	199
N132	526	350	448	281
N160	327	223	300	190
N200	514	327	429	300
N250	834	565	710	472
N315	1251	834	1036	710
N355	713	593	573	480
N400	914	713	757	573
N450	1054	795	878	757
N500	1402	1158	1101	964
N560	1774	1402	1434	1101

Table 157: Power Losses for dU/dt Filter Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	453	308	414	281
N132	204	146	187	134
N160	314	204	287	187
N200	498	314	456	287
N250	302	211	277	193
N315	427	302	390	277
N355	575	427	527	390
N400	800	565	733	523
N500	989	666	905	608
N560	585	450	535	412
N630	654	585	654	535
N710	959	715	878	654
N800	1430	1054	1308	964

### 11.6.8 Sine-wave Filter Losses

Table 158: Power Losses for Sine-wave Filter Option, 380–500 V

Model	380–440 V [W]		441–500 V [W]	
	NO	HO	NO	HO
–				
N110	1050	732	843	598
N132	770	512	656	411
N160	1130	770	1039	656
N200	1823	1159	1522	1065
N250	1312	888	1117	742
N315	1969	1312	1630	1117
N355	2529	2103	2033	1703
N40	3242	2529	2685	2033
N450	3738	2821	3112	2685
N500	2205	1822	1732	1517
N560	2790	2205	2255	1732

Table 159: Power Losses for Sine-wave Filter Option, 525–690 V

Model	525–550 V [W]		551–690 V [W]	
	NO	HO	NO	HO
–				
N110	1210	823	1106	752
N132	735	526	673	481
N160	1131	735	1032	673
N200	2063	1302	1888	1188
N250	1285	896	1177	820
N315	1814	1285	1657	1177
N355	2446	1814	2240	1657
N400	3560	2515	3264	2327
N500	4408	2966	4029	2709
N560	2487	1913	2274	1750
N630	2778	2486	2778	2274
N710	4075	3040	3730	2778
N800	5532	4075	5058	3730



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