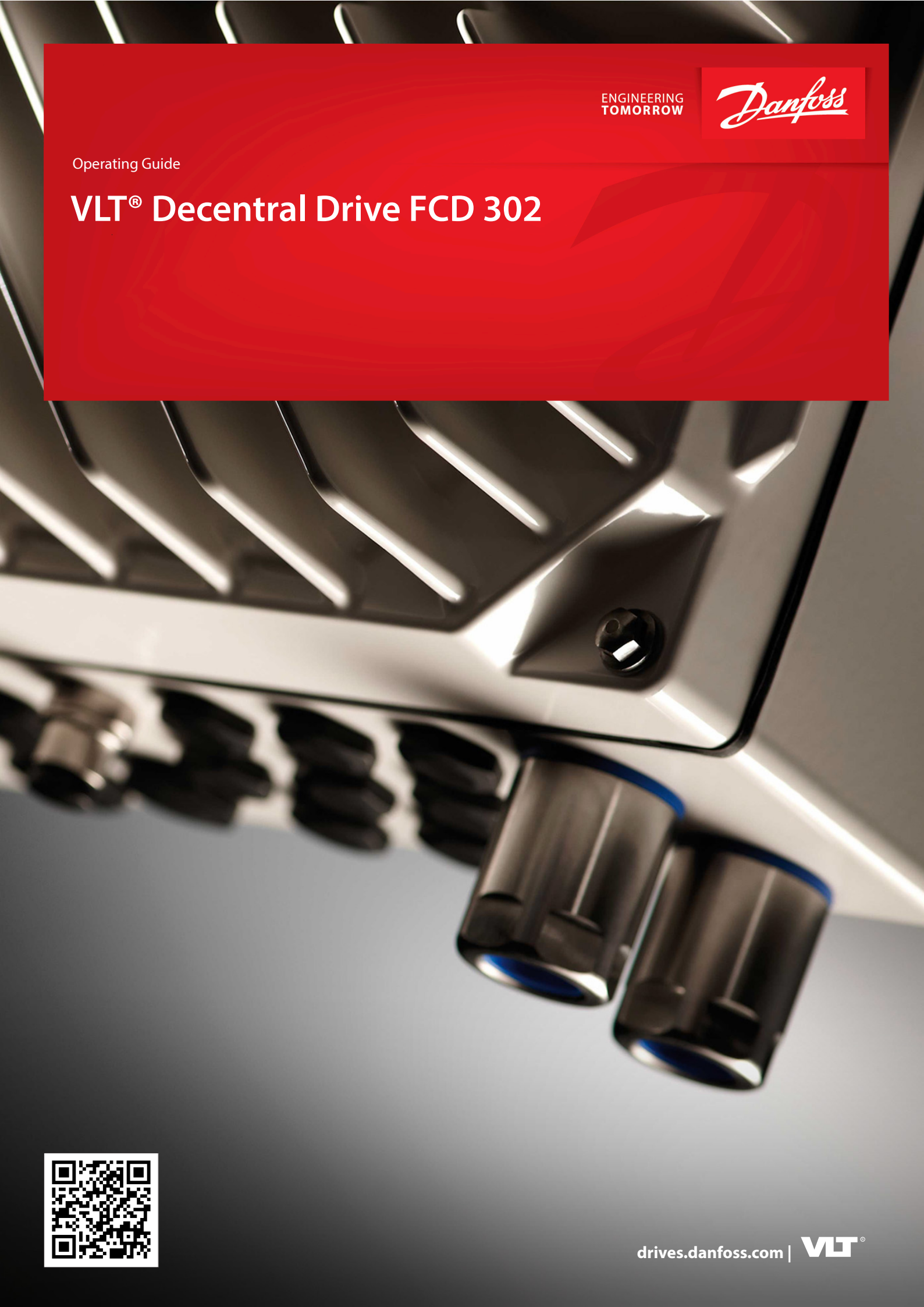
ENGINEERING
TOMORROW

Operating Guide

VLT® Decentral Drive FCD 302



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Contents

1 Introduction and Safety

1.1 Purpose of this Operating Guide

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

1.2 Additional Resources

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

- The *VLT® Decentral Drive FCD 302 Design Guide* provides detailed information about the capabilities and functionality to design motor control systems.
- The *VLT® AutomationDrive FC 301/302 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® PROFIBUS DP-V1 MCA 101 Programming Guide* provides greater detail on programming the VLT® drive using the PROFIBUS® DP communication protocol.
- The *VLT® Frequency Converters Safe Torque Off Operating Guide* provides greater detailed information about the Safe Torque Off (STO) function, the related installation, and commissioning.
- Instructions for operation with optional equipment.

Supplementary publications and guides are available at www.danfoss.com.

1.3 Trademarks

- VLT® is a registered trademark of Danfoss A/S
- DrivePro® is a registered trademark of Danfoss A/S.
- PROFIBUS® and PROFINET® are registered trademarks of PROFIBUS and PROFINET International (PI).

1.4 Document and Software Version

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

The original language of this guide is English.

Table 1: Document and Software Version

Edition	Remarks	Software version
AQ267036816112, version 0301	New document structure. Editorial update.	9.X.X

1.5 Approvals

1.5.1 Type Approvals and Certifications

Table 2 shows examples of possible type approvals and certifications for Danfoss drives.

Table 2: Type Approvals and Certifications

CE	ErP READY		DNV·GL
cULus	EAC	089	OSHPD
BUREAU VERITAS	LR		RINA 1861
ClassNK	RMRS		
ABS			

NOTICE

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

1.5.2 Declaration of Conformity

ENGINEERING TOMORROW

Danfoss A/S
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CVR nr.: 20 16 57 15

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EU DECLARATION OF CONFORMITY

Danfoss A/S
Danfoss Drives

declares under our sole responsibility that the

Product category: Frequency Converter

Type designation(s): FCD302PXXXT4**********

Character XXX: K37, K55, K75, 1K1, 1K5, 2K2, 3K0
* 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 IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

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.

Date: 2021.11.12 Place of issue:	Issued by	Date: 2020.11.12 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Martin Skov Holm** **Title: Head of PM - EU**	Graasten, DK	**Signature:** **Name: Michael Quitzau** **Title: Head of PM&D, Denmark**

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

ID No: 00729677 **Revision No:** A,6
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Figure 1: EU Declaration of Conformity for VLT® Decentral Drive FCD 302 page 1

Machine Directive 2006/42/EC

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

Other standards considered:

EN ISO 13849-1:2015 (Safe Stop function, PL d (MTTFd=14000 years, DC=90%, Category 3)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN/IEC 61508-1:2010, EN/IEC 61508-2:2010 (Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h for specific variants, PFD = 1E-10, 1E-4 for specific variants, SFF>99%, HFT=0))	Functional safety of electrical/electronic/ programmable electronic safety-related systems Part 1: General requirements Part 2: Requirements for electrical/ electronic / programmable electronic safety-related systems
EN/IEC 62061:2005 + A1:2013 (Safe Stop function, SILCL 2)	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

Further information can be found in manufacturers declarations:
EU Declaration of conformity 00730213 A.1, 00730215 A.1 and 00730217 A.1 or newer / Manufacturers declaration 00596226 A.9 or newer.

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Figure 2: EU Declaration of Conformity for VLT® Decentral Drive FCD 302 page 2

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Danfoss A/S
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UK DECLARATION OF CONFORMITY

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Product category: Frequency Converter

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Electrical Equipment (Safety) Regulations 2016

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

Electromagnetic Compatibility Regulations 2016

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

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 as amended

BS EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

Date: 2021.11.12 Place of issue:	Issued by	Date: 2020.11.12 Place of issue:	Approved by
Graasten, DK	**Signature:** **Name: Martin Skov Holm** **Title: Head of PM - EU**	Graasten, DK	**Signature:** **Name: Michael Quitzau** **Title: Head of PM&D, Denmark**

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Figure 3: UK Declaration of Conformity for VLT® Decentral Drive FCD 302 page 3

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

BS 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.

Supply of Machinery (Safety) Regulations 2008

BS 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:

BS EN ISO 13849-1:2015 (Safe Stop function, PL d (MTTFd=14000 years, DC=90%, Category 3)	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
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Figure 4: UK Declaration of Conformity for VLT® Decentral Drive FCD 302 page 4

1.6 Safety Symbols

The following symbols are used in Danfoss documentation.

DANGER

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

WARNING

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

CAUTION

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

NOTICE

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

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

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

1.7 Qualified Personnel

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

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

1.8 General Safety Precautions

WARNING

HAZARDOUS VOLTAGE

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

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

⚠ WARNING

INDUCED VOLTAGE

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

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

⚠ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD – RCD COMPLIANCE

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

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

⚠ WARNING

UNINTENDED START

When the drive is connected to the AC mains, 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, or an input reference signal from the LCP or LOP. The motor may also start via remote operation using MCT 10 setup 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.

⚠ WARNING

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.
- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery backups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully. The time for full discharge of the capacitors is minimum 4 minutes for VLT® Decentral Drive FCD 302, 400 V AC, 0.37–3.0 kW (0.5–4.0 hp).
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

⚠ WARNING

INTERNAL FAILURE HAZARD

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

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

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between drive and motor, is required for applications with multiple motors.
- Input fusing is required to provide short-circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in 4.9.2 Recommended Maximum Pre-fuse Size 25 A.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C (167 °F) rated copper wire. See 7.1 Electrical Data for recommended wire sizes and types.

1.9 Disposal

Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

2 Receiving the Drive

2.1 Verifying the Shipment and the Contents

The packaging contains:

- Accessories bag, supplied only with order of installation box.

  The accessories bag contains:

  - 2 cable clamps.
  - Bracket for motor/loads cables.
  - Elevation bracket for cable clamp.
  - Screw 4 mm, 20 mm.
  - Thread forming 3.5 mm, 8 mm.
- Operating Guide.
- Drive.

Based on the installed options, the box includes either 1 or 2 bags and 1 or more booklets.

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

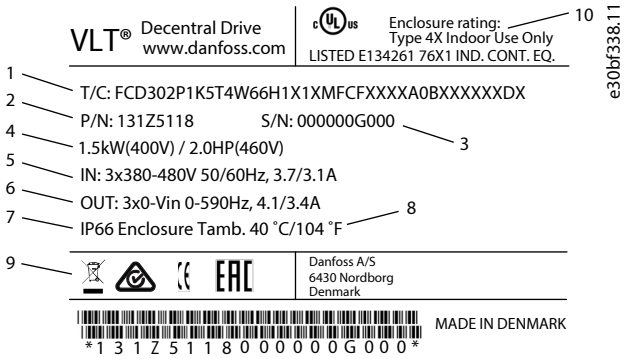

Figure 5: Example of the Model Code on the Product Nameplate

1	Type code	**2**	Ordering number
3	Serial number	**4**	Power rating
5	Input voltage, frequency, and current (at low/high voltages)	**6**	Output voltage, frequency, and current (at low/high voltages)
7	Enclosure type and protection rating (IP)	**8**	Maximum ambient temperature
9	Certifications	**10**	Enclosure rating

NOTICE

WARRENTY

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

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

2.2 Weight and Dimensions

Table 3: Weight Table

Drive	Weight [kg(lb)]
FCD 302 small unit	9.8 (21.6)
FCD 302 large unit	13.9 (30.6)

Dimensions

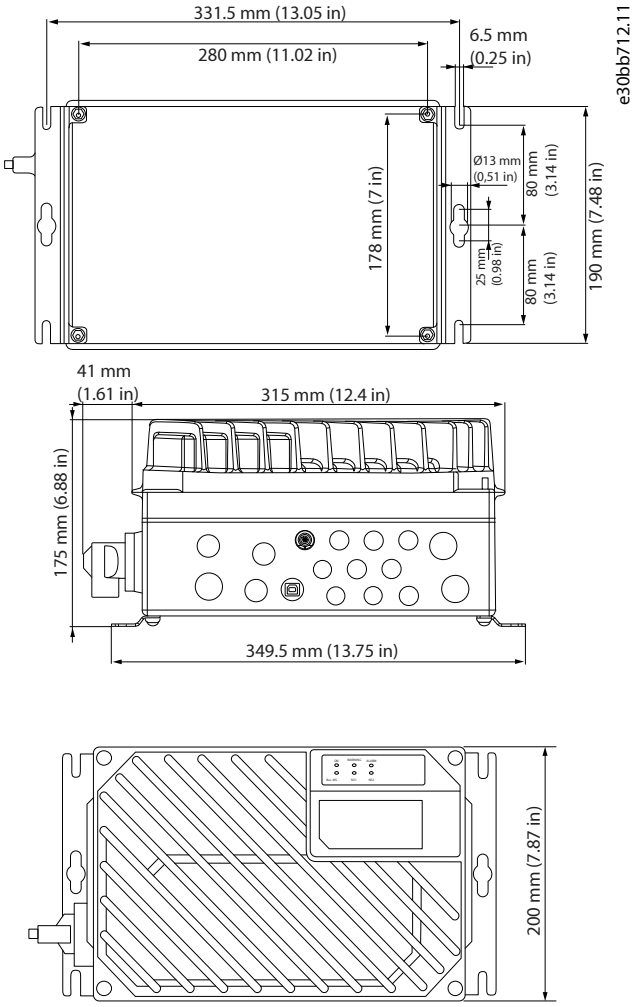

Figure 6: Dimensions VLT® Decentral Drive FCD 302 Small Unit

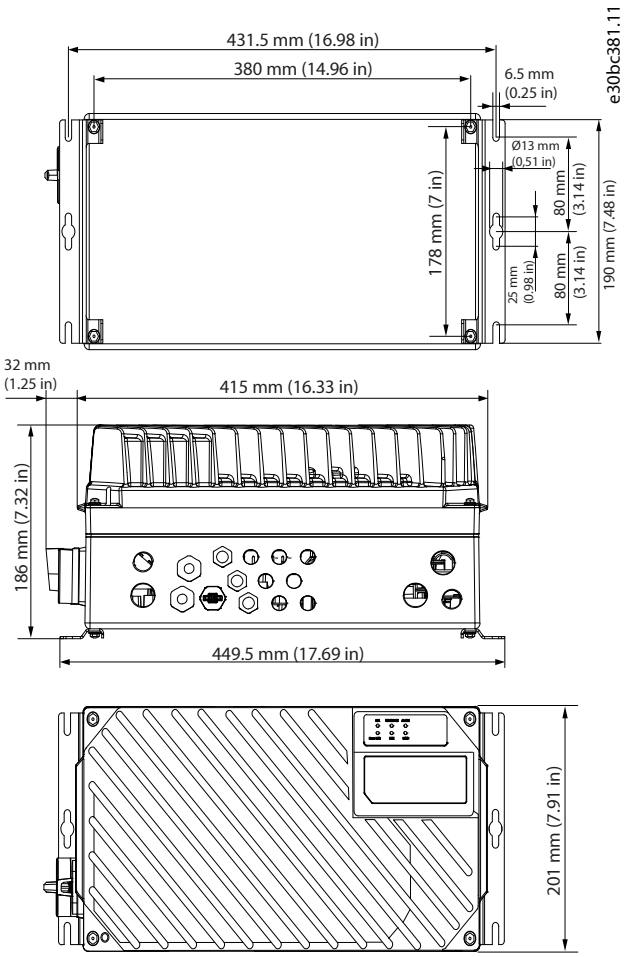

Figure 7: Dimensions VLT® Decentral Drive FCD 302 Large Unit

2.3 Storage

Ensure that the requirements for storage are fulfilled. See 7.4 Ambient Conditions for further information of temperature during storage/ transport.

3 Mechanical Installation

3.1 Recommended Tools and Equipment

Table 4: Tools and Equipment

Equipment	Size	Description
Screwdrivers	–	–
Socket (Hex)	8 mm	For fastening inverter screws/mounting of brackets
Slotted	0.4x2.5 mm	For spring loaded power and control terminals
Slotted/torx	1.0x5.5 mm/TX20	For cable clamps inside the installation box
Spanner	19, 24, 28 mm	For blind-plugs
LCP[1]	–	Local control panel
LCP cable[2]	–	Connection cable for local control panel

1) Code number 130B1078.

2) Code number 130B5776.

3.2 Installation Environment

NOTICE

REDUCED LIFETIME

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the drive.

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

Vibration and shock

The drive complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors. For detailed ambient conditions, refer to 7.4 Ambient Conditions.

3.3 Cooling Requirements

NOTICE

OVERHEATING

Improper mounting can result in overheating and reduced performance.

- Install the drive following the installation and cooling requirements.

The VLT® Decentral Drive FCD 302 has no forced cooling. It relies only on natural convection for cooling using the cooling fins.

- Provide a minimum of 100 mm (4 in) top and bottom air cooling clearance during installation, as shown in Figure 8.
- Derating starts above 40 °C (104 °F) and 1000 m (3280 ft) elevation above sea level. See the *VLT® Decentral Drive FCD 302 Design Guide* for detailed information.

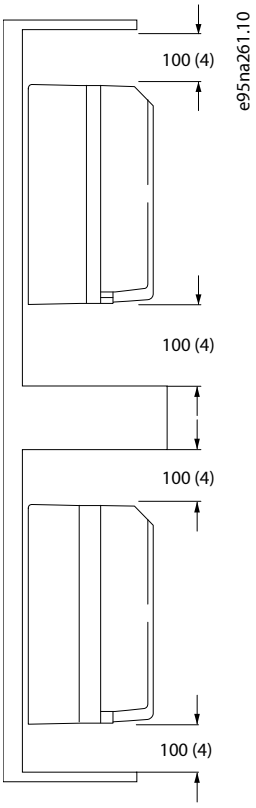

Figure 8: Top and Bottom Cooling Clearance

3.4 Mounting the Drive

3.4.1 Installation Requirements for the Drive

The VLT® Decentral Drive FCD 302 consists of 2 parts.

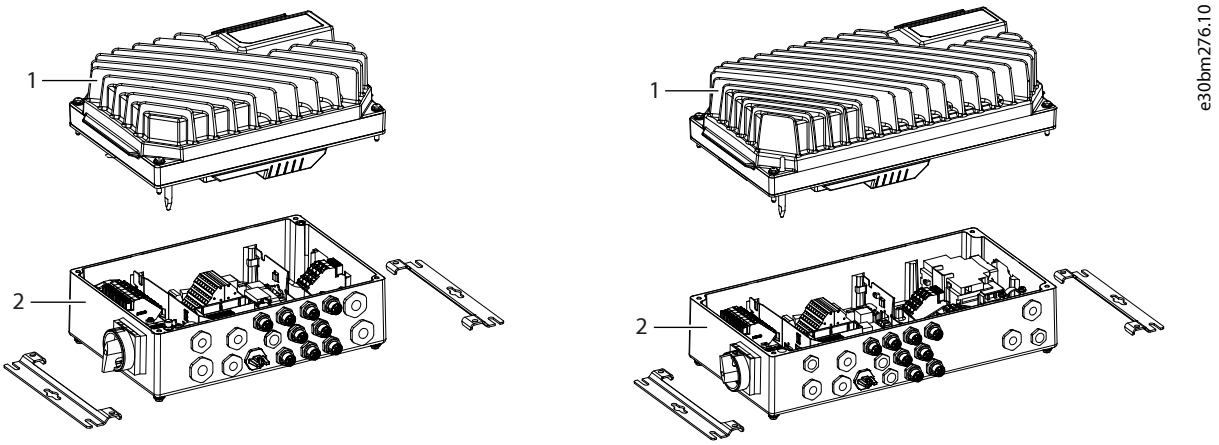

Figure 9: VLT® Decentral Drive FCD 302 Small/Large Unit

1	Inverter part	**2**	Installation box

Install the installation box and inverter part according to the allowed mounting positions:

- For standard applications, see Figure 10.
- For hygienic applications, see Figure 11.

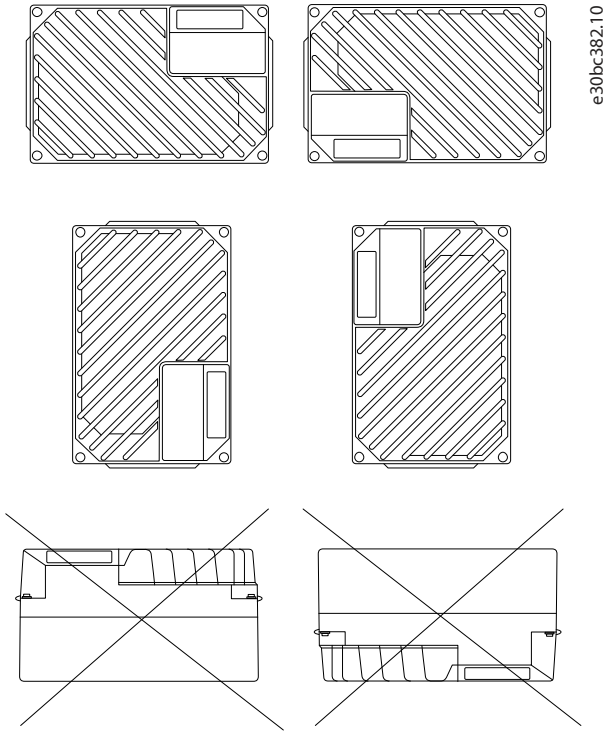

Figure 10: Allowed Mounting Positions - Standard Applications

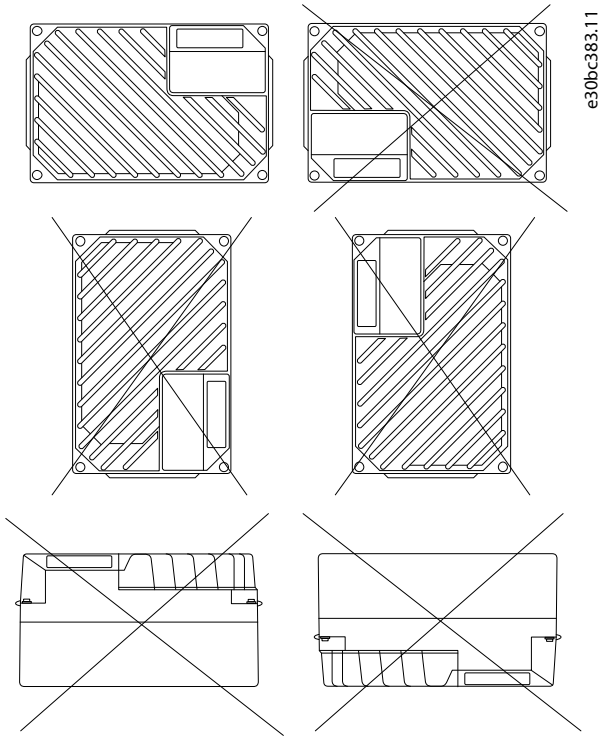

Figure 11: Allowed Mounting Positions - Hygienic Applications

3.4.2 Installing the Inverter Part

Procedure for compressing the gasket between the 2 parts.

1. Tighten the 4 connection screws to torque 2.8–3.0 Nm (24–26 in-lb).
2. Tighten the 4 screws in diagonally opposite order.

3. Tighten the 2 grounding spears to torque 3.0 (26 in-lb).

3.4.3 Mounting the Installation Box

1. Determine proper placement of the unit, concerning operating conditions and cable access.

2. Mount the VLT® Decentral Drive FCD 302 vertically on a wall or machine frame. For hygienic applications, ensure that liquids drain off the enclosure and orient the unit so the cable glands are located at the base.

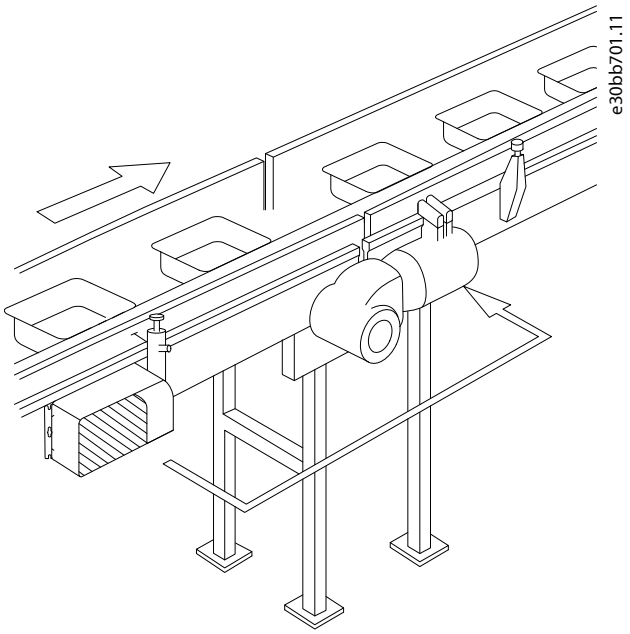

Figure 12: FCD 302 Standalone Mounted with Mounting Brackets (Example)

4 Electrical Installation

4.1 Wiring Diagram

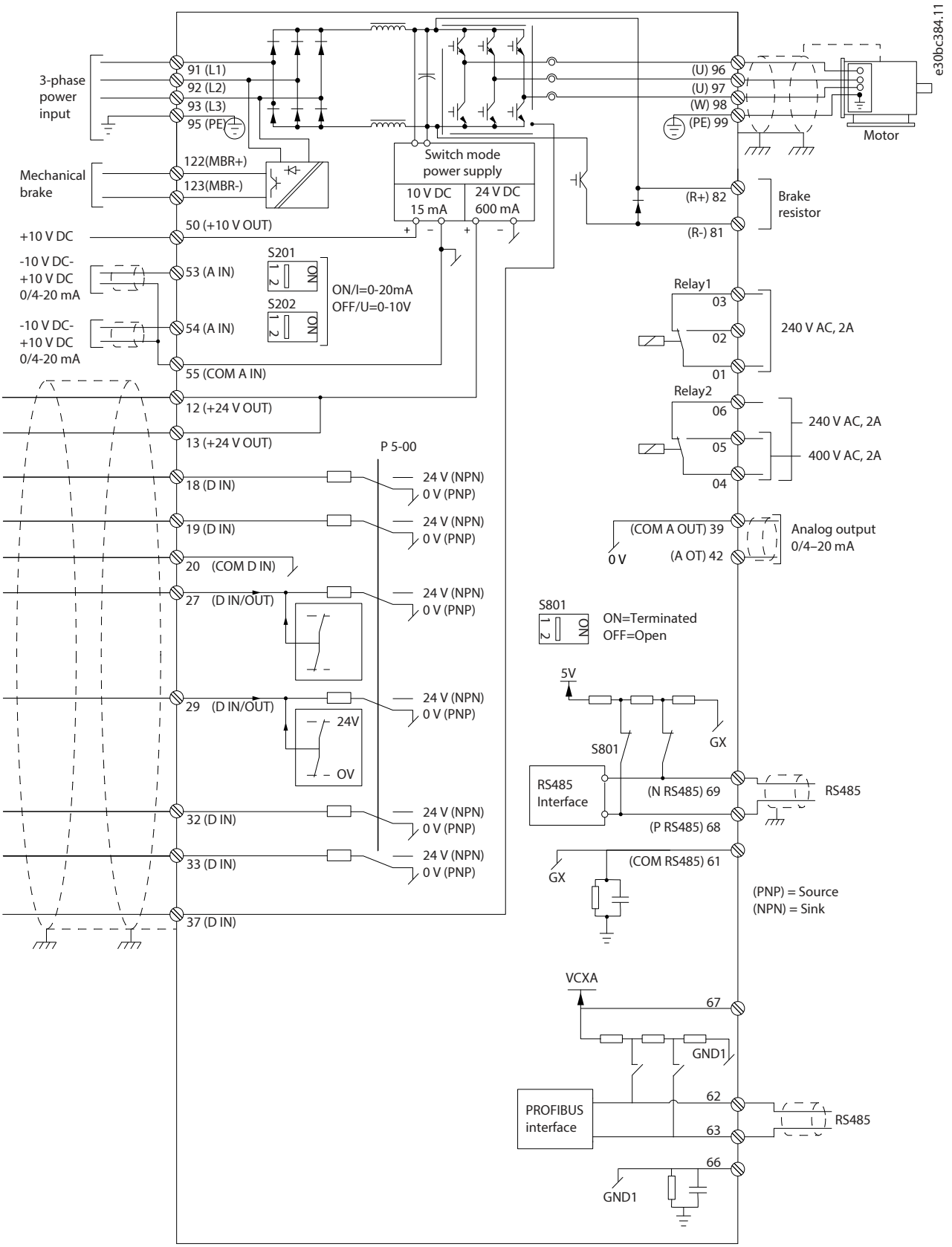

Figure 13: Basic Wiring Diagram

Circuit breaker and service switch

The following illustrations Figure 14 and Figure 15 are for FCD 302 large unit only.

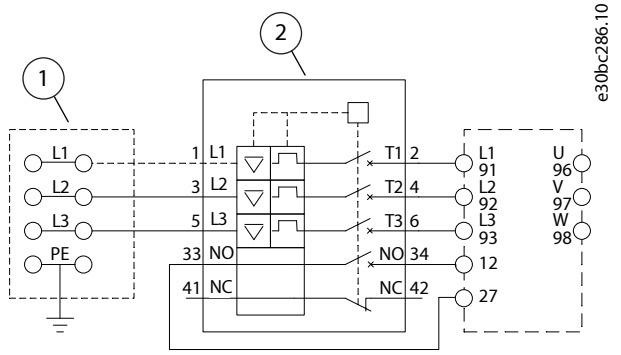

Figure 14: Circuit Breaker and Mains Disconnect

1	Looping terminals	**2**	Circuit breaker

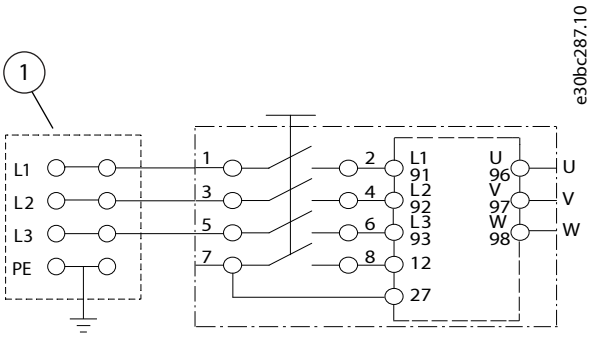

Figure 15: Service Switch at Mains with Looping Terminals

1	Looping terminals

4.2 Block Diagram of the Drive

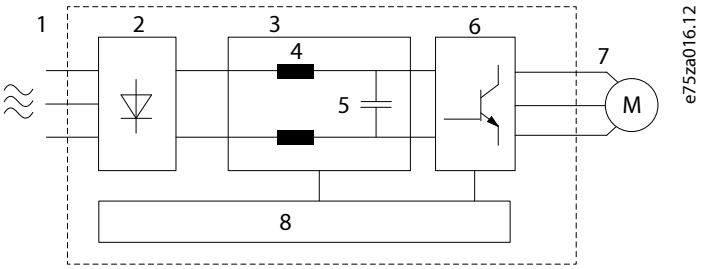

Figure 16: Block Diagram

1	Mains input	**2**	Rectifier
3	DC bus	**4**	DC reactors
5	Capacitor bank	**6**	Inverter
7	Output to motor	**8**	Control circuitry

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

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

3. DC bus: Intermediate DC bus circuit handles the DC current.
4. DC reactors: Filtering the intermediate DC circuit voltage, prove mains transient protection, reducing RMS current, raising the power factor reflected back to the line, and reducing harmonics on the AC input.
5. Capacitor bank: Store the DC power and proves ride-through protection for short power losses.
6. Inverter: Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7. Output to motor: Regulated 3-phase output power to the motor.
8. Control circuitry: Monitoring input power, internal processing, output, and motor current, along with user interface and external commands. Status output and control can be provided.

4.3 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in:

- 4.1 Wiring Diagram.
- 4.4 Grounding.
- 4.6.1 Connecting the Motor.
- 5.1 Control Wiring.

NOTICE

POTENTIAL EQUALIZATION

There is a risk of burst transient when the ground potential between the drive and the control system is different.

- Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

4.4 Grounding

For electrical safety

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy-chain fashion.
- Keep the ground wire connections as short as possible.
- Follow the motor manufacturers wiring requirements.
- Minimum cable cross-section: 10 mm^2 (7 AWG) (or 2 rated ground wires terminated separately).

For EMC-compliant installation

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

⚠ CAUTION

PE CONNECTION

The metal pins in the corners of the electronic part and the holes on the corner of the installation box are essential for the protective ground connection.

- Make sure that they are not loosened, removed, or violated in any way. Tightening torque is 3 Nm (26.6 in-lb).

NOTICE

POTENTIAL EQUALIZATION

There is a risk of burst transient when the ground potential between the drive and the control system is different.

- Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

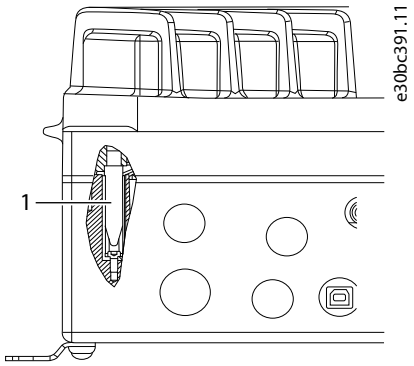

Figure 17: PE Connection

1	PE connection between installation box/inverter part

The external grounding terminal is available as an accessory (code number 130B5833).

4.5 Terminals Overview

4.5.1 Terminal Locations

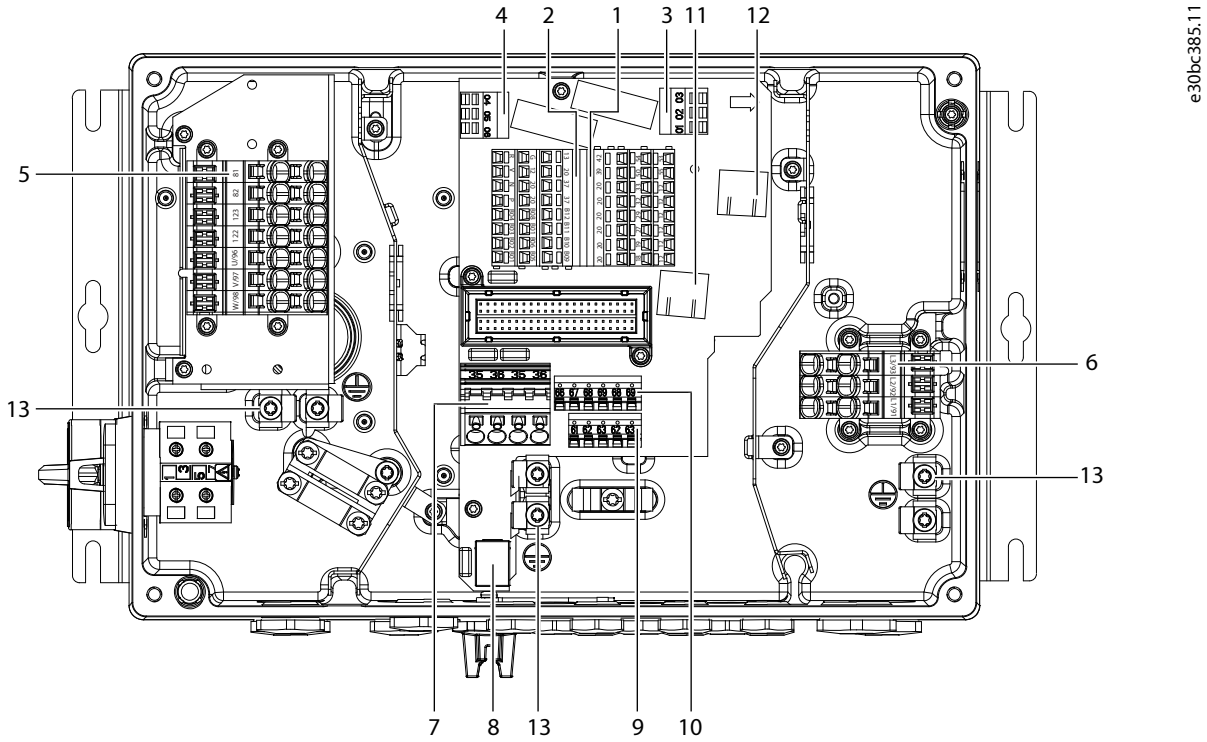

Figure 18: Terminal Location (Small Unit)

1	Digital and analog inputs/outputs	**2**	Safe Torque Off (STO), LCP connection, B-option
3	Relay 1	**4**	Relay 12
5	Motor, mechanical brake, brake resistor	**6**	Mains
7	24 V DC back-up input	**8**	USB port
9	Standard bus/RS485	**10**	PROFIBUS®
11	Ethernet port	**12**	Ethernet port
13	Protective Earth (PE)		

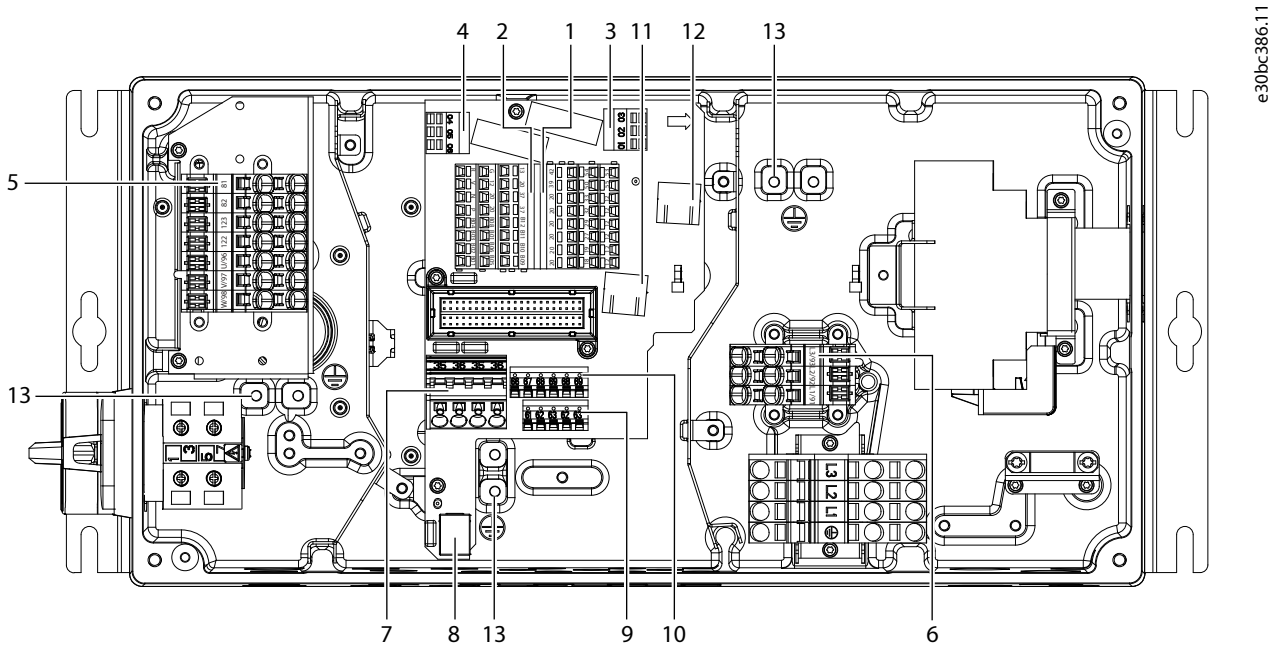

Figure 19: Terminal Location (Large Unit)

1	Digital and analog inputs/outputs	**2**	Safe Torque Off (STO), LCP connection, B-option
3	Relay 1	**4**	Relay 12
5	Motor, mechanical brake, brake resistor	**6**	Mains
7	24 V DC back-up input	**8**	USB port
9	Standard bus/RS485	**10**	PROFIBUS®
11	Ethernet port	**12**	Ethernet port
13	Protective Earth (PE)		

For both small and large units, the service switch is optional. The switch is shown mounted on the motor side. Alternatively, the switch can be on the mains side or omitted. For the large unit, the circuit breaker is optional. The large unit can be configured with either service switch or circuit breaker, not both. The illustration shown is not configurable in practice, but shows the respective positions of components only.

4.5.2 Terminal Types

Motor, control, and mains terminals are spring loaded (type, cage clamp).

1. Open the contact by inserting a small screwdriver into the slot above the contact, see Figure 20.
2. Insert the stripped wire into the contact.

3. Pull out the screwdriver.

   This release the spring-loaded terminal and fasten the wire to the contact.

4. Ensure that the contact is firmly established.

   Loose wiring can result in equipment faults or injury.

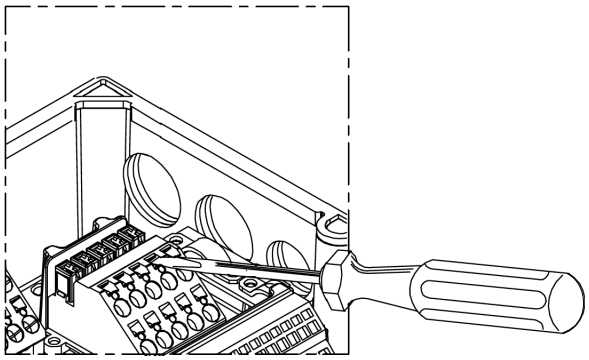

Figure 20: Opening the Terminals

4.6 Electrical Connections for Motors

4.6.1 Connecting the Motor

⚠ WARNING

INDUCED VOLTAGE

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

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

NOTICE

MOTOR PROTECTION

Protection against motor overload is not included in the factory setting. If this function is required, set parameter ***1–90 Motor Thermal Protection*** to trip or warning.

Refer to the *VLT® AutomationDrive FC 301/FC 302 programming guide* for further information.

- For correct dimensioning of cable cross-section, see 7.1 Electrical Data.

Table 5: Terminals 96, 97, 98

Terminal			Description
96	97	98	Motor voltage 0–100% of mains voltage
U	V	W	3 wires out of the motor
U1	V1	W1	6 wires out of the motor
W2	U2	V2	6 wires out of the motor

Table 5: Terminals 96, 97, 98 - (continued)

Terminal			Description
U1	V1	W1	6 wires out of the motor, star connected. Connect U2, V2, W2 separately (optional terminal block)
PE	–	–	Ground connection

NOTICE

DRIVE AND MOTOR CONNECTIONS

Do not install power factor correction capacitors between the drive and the motor. Do not wire a starting or pole-changing device between the drive and the motor.

1. Connect the motor to terminals 96, 97, 98.
2. Connect ground to PE terminal.
3. Ensure proper grounding of the motor cable shield at both the motor and drive ends.

4.6.2 Grounding Shielded Cable

Grounding clamps are provided for motor and control wiring.

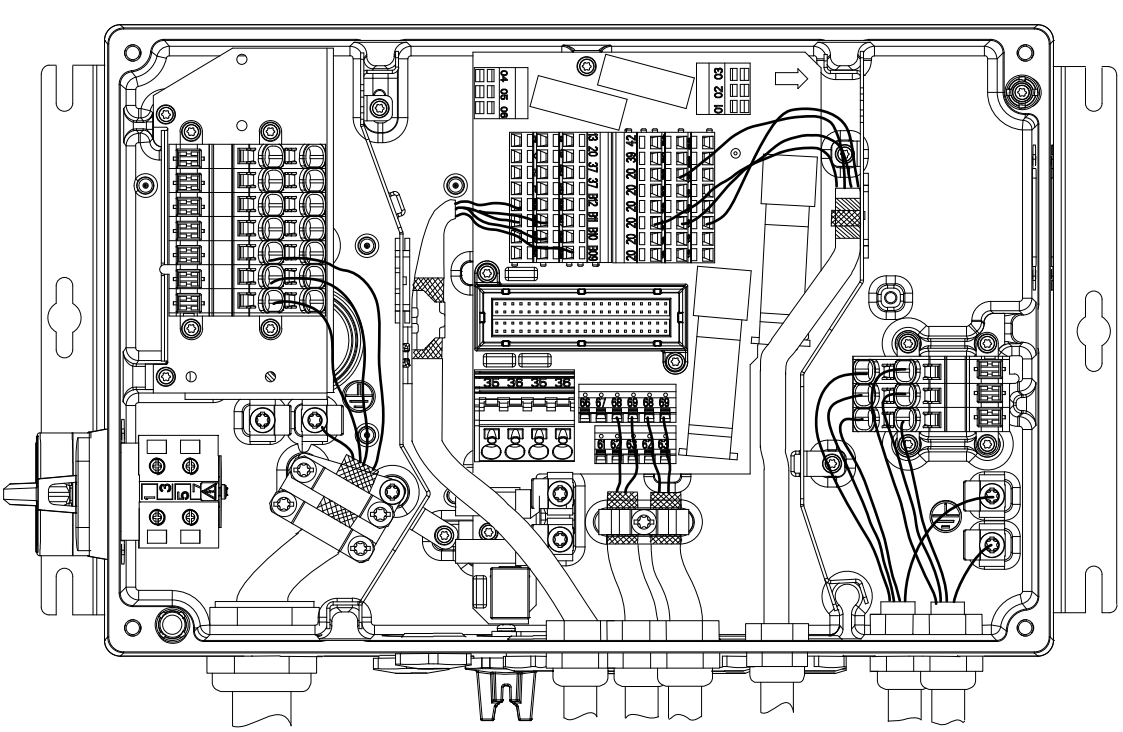

Figure 21: Grounding Clamp for Motor and Control Wiring (Small Unit)

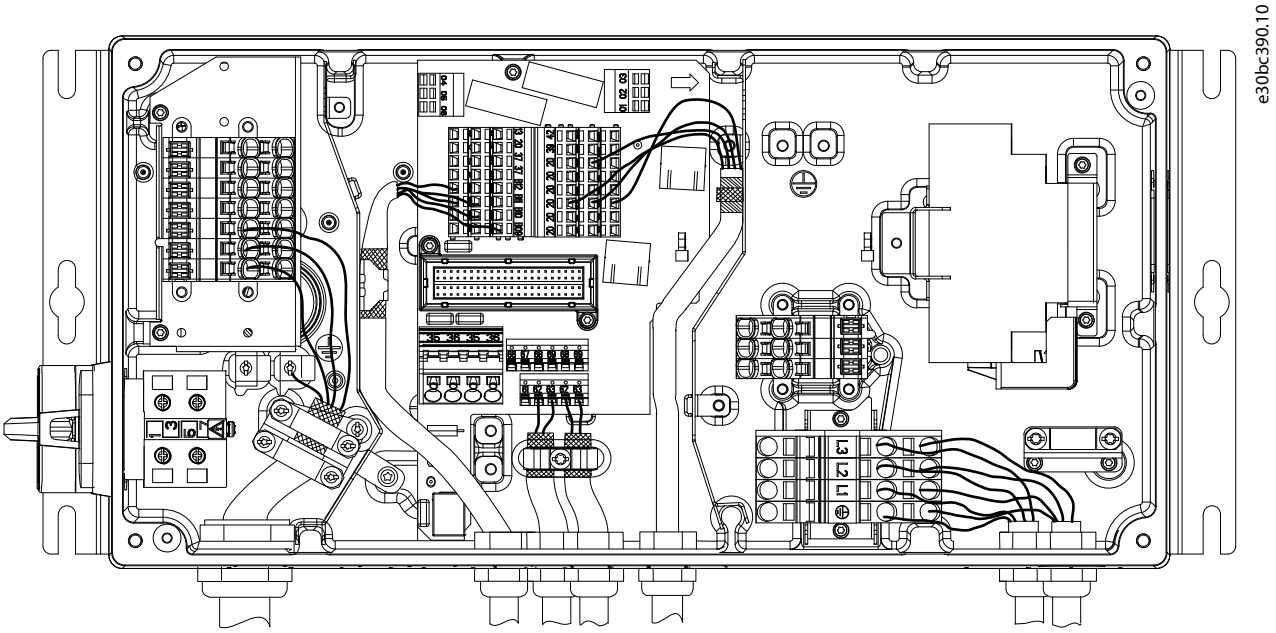

Figure 22: Grounding Clamp for Motor and Control Wiring (Large Unit)

1. Use a wire stripper to remove the insulation for proper grounding.
2. Secure the grounding clamp to the stripped portion of the wire with the screws provided.
3. Secure the grounding wire to the grounding clamp provided.

4.6.3 Connecting Several Motors

The drive can control several parallel-connected motors. The total current consumption of motors must not exceed the rated output current $I_{M,N}$ for the drive.

Installations with cables connected in a common joint are only recommended for short cable lengths (maximum 10 m (38.2 ft)). When motors are connected in parallel, parameter ***1–29 Automatic Motor Adaption (AMA)*** cannot be used.

NOTICE

LIMITATIONS IN PARRALLEL MOTOR SYSTEMS

The electronic thermal relay (ETR) of the drive cannot be used as motor protection for the individual motor in systems with parallel-connected motors.

- Provide further motor protection by thermistors in each motor or individual thermal relays. Circuit breakers are not suitable as protection.

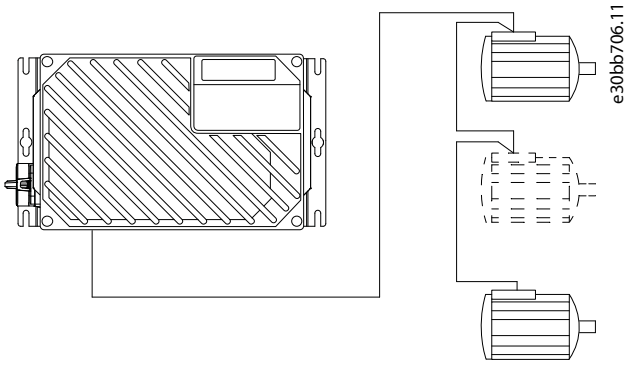

Figure 23: Parallel Connection of Motors

Problems can occur at start-up and at low RPM values when motor sizes differ widely. Motors of low-rated motor power have a relatively high ohmic resistance in the stator. This high resistance calls for a higher voltage at start and at low RPM values.

To resolve the problem:

- Reduce the load during start-up on the motor of lowest rated motor power.
- Configure parallel connections only between motors of comparable rated motor power.

4.7 Mains and Drive Power Connections

4.7.1 Connecting AC Mains

- Size the wiring based on the input current of the drive. For maximum wire sizes, see 7.1 Electrical Data.
- Comply with local and national electrical codes for cable sizes.

4.7.2 Connecting the Drive to Mains

Table 6: Terminals 91, 92, and 93

Terminals			Description
91	92	93	Mains voltage 3x380–480 V
L1	L2	L3	
PE	–	–	Ground connection

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3.
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions, see 4.4 Grounding, and 4.6.2 Grounding Shielded Cable.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that parameter ***14–50 RFI Filter*** is set to [***0***] ***Off***.

   This setting prevents damage to the DC link and reduces ground capacity currents in accordance with IEC 61800-3.

4.8 Motor and Mains Connection with Service Switch

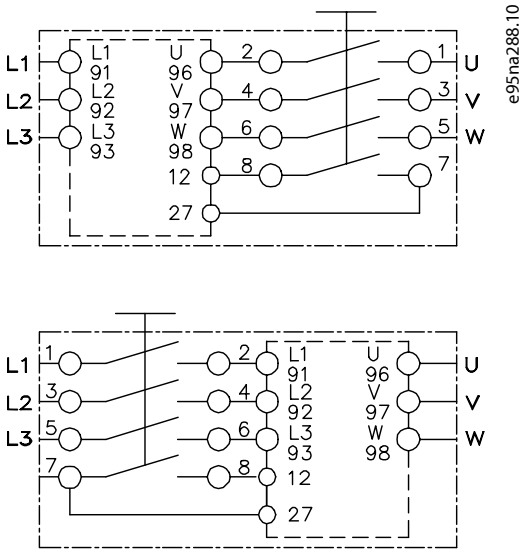

Figure 24: Motor and Mains Connection with Service Switch

4.9 Fuses and Circuit Breakers

4.9.1 Recommendations

- American Wire Gauge. Maximum cable cross-section is the largest cable cross-section that can be attached to the terminals. Always observe national and local regulations.
- Use type gG pre-fuses. To maintain UL/cUL, use pre-fuses of these types, see Table 7.
- Measured using a 10 m (32.8 ft) shielded/armored motor cable with a rated load and rated frequency.

Fuses

The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 500 V maximum.

Circuit breaker

The unit is suitable for use on a circuit capable of delivering not more than 10000 RMS symmetrical Amperes, 500 V maximum.

4.9.2 Recommended Maximum Pre-fuse Size 25 A

Table 7: FCD 302 Pre-fuses Meeting UL/cUL Requirements

Brand	Fuse type[1]	UL file number	UL category (CCN code)[2]
Bussmann	FWH-	E91958	JFHR2
Bussmann	KTS-R	E4273	RK1/JDDZ
Bussmann	JKS-	E4273	J/JDDZ
Bussmann	JJS-	E4273	T/JDDZ
Bussmann	FNQ-R-	E4273	CC/JDDZ
Bussmann	KTK-R-	E4273	CC/JDDZ
Bussmann	LP-CC-	E4273	CC/JDDZ
SIBA	5017906-	E180276	RK1/JDDZ
Littelfuse	KLS-R	E81895	RK1/JDDZ
Ferraz Shawmut	ATM-R	E2137	CC/JDDZ

Table 7: FCD 302 Pre-fuses Meeting UL/cUL Requirements - (continued)

Brand	Fuse type[1]	UL file number	UL category (CCN code)[2]
Ferraz Shawmut	A6K-R	E2137	RK1/JDDZ
Ferraz Shawmut	HSJ	E2137	J/HSJ

1) 5 A (0.37 kW (0.5 hp)), 7 A (0.55 kW (0.75 hp)), 9 A (0.75 kW (1.0 hp)), 12 A (1.1 kW (1.5 hp)), 15 A (1.5 kW (2.0 hp)), 20 A (2.2 kW (3.0 hp)), 25 A (3 kW (4.0 hp)).

2) The fuse types listed are the preferred and tested fuses. However, other suppliers or fuse types can be used as long as the UL category is equal to the fuse types listed in this table.

4.9.3 DC Voltage Levels

Table 8: FCD 302 DC Voltage Level

DC voltage level	380–480 V units (V DC)
Inverter undervoltage disable	373
Undervoltage warning	410
Inverter undervoltage re-enables (warning reset)	398
Overvoltage warning (without brake)	778
Dynamic brake turn-on	778
Inverter overvoltage re-enables (warning reset)	795
Overvoltage warning (with brake)	810
Overvoltage trip	820

5 Controls and Options Installation

5.1 Control Wiring

⚠ 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 setup 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.

- It is recommended that control wiring is rated for 600 V.
- Isolate control wiring from high-power components in the drive.
- If the drive is connected to a thermistor, for PELV isolation, ensure that control wiring is reinforced/double insulated.

5.2 Terminal Functions

Table 9: Terminal Functions

Terminal number	Functions
01, 02, 03	Relay 1 output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	Relay 2 output. Usable for AC or DC voltage and resistive or inductive loads.
12, 13	24 V DC digital supply voltage. Useable for digital inputs and external transducers. To use the 24 V DC for digital input common, program parameter ***5-00 Digital I/O Mode*** for PNP operation.
18, 19, 32, 33	Digital inputs. Selectable for NPN or PNP function in parameter ***5-00 Digital I/O Mode***. The default is PNP.
27, 29	Digital inputs or outputs. Program parameter ***5-01 Terminal 27 Mode*** for terminal 27 and parameter ***5-02 Terminal 29 Mode*** for terminal 29 for selecting the input/output functions. Default setting is input.
35	Common (-) for external 24 V control backup supply. Optional.
36	External +24 V control backup supply. Optional.
37	Safe Stop.
20	Common for digital inputs. To use for digital input common program parameter ***5-00 Digital I/O Mode*** for NPN operation.
39	Common for analog output.
42	Analog output. Programmable for various functions in parameter group ***6-5* Analog Output 1***. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	10 V DC analog supply voltage. 15 mA maximum commonly used for a potentiometer or thermistor.
53, 54	Analog input. Selectable for voltage (0 to ±10 V) or current (0 or 4 to ± 20 mA). Closed is for current and open is for voltage. Switches are located on the drive control card. See 5.6 DIP Switches.
55	Common for analog inputs.
61	Common for serial communication (RS485 interface). See 4.4 Grounding.

Table 9: Terminal Functions - (continued)

Terminal number	Functions
68 (+), 69 (-)	RS485 interface. When the drive is connected to an RS485 serial communication bus, a switch on the control card is provided for termination resistance. Set the switch to *ON* for termination and *OFF* for no termination.
62	RxD/TxD –P (red cable) for PROFIBUS®. See dedicated literature for VLT® PROFIBUS® DP-V1 MCA 101) for details.
63	RxD/TxD –N (green cable) for PROFIBUS®.
66	0 V for PROFIBUS®.
67	+5 V for PROFIBUS®.
B01-B12	B-option. See the dedicated literature for details.
G, R, V, N, P	Connection of LCP.

5.3 Brake Resistor

Table 10: Brake Resistor Terminals

Terminal	Function	Description
81 (optional function)	R- (Brake resistor -)	Connection for brake resistor (-) terminal
82 (optional function)	R+ (Brake resistor +)	Connection for brake resistor (+) terminal

- The brake resistor connection cable requires shielding/armoring. Connect the shield to the metal cabinet of the drive and to the metal cabinet of the brake resistor with cable clamps.
- Dimension the cross-section of the brake cable to match the brake torque.

5.4 Mechanical Brake

Table 11: Mechanical Brake Terminals

Terminals	Function	Description
122 (optional function)	MBR+ (Mechanical Brake +)	Connection for mechanical brake (+) terminal(1)
123 (optional function)	MBR- (Mechanical Brake -)	Connection for mechanical brake (-) terminal(1)

1) UDC = 0.45 x RMS mains voltage. Maximum current = 0.8 A.

In hoisting/lowering applications, control of an electro-mechanical brake is required:

- The brake is controlled using the special mechanical brake control/supply terminals 122 and 123.
- Select ***[32] Mechanical brake control*** in parameter group ***5-4* Relays, [1] Array, Relay 2*** for applications with an electro-mechanical brake.
- The brake is released when the motor current exceeds the preset value in parameter ***2–20 Release Brake Current***.
- The brake is engaged when the output frequency is less than the frequency set in parameter ***2–21 Activate Brake Speed [RPM]*** or parameter ***2–22 Activate Brake Speed [Hz]***. The brake engages only when the drive performs a stop command.

When the drive enters alarm mode or is exposed to an overvoltage situation, the mechanical brake immediately cuts in. For more detailed information, refer to the *VLT® AutomationDrive FC 301/FC 302 programming guide*.

NOTICE

When the mechanical brake control/supply terminals 122 and 123 are set through parameter group ***5–4* Relays, [1] Array, Relay 2***, only 1 relay output (Relay 1) is available for free programming.

5.5 Connection of Sensors/Actuators on M12 Sockets

Table 12: Connection Input (4 x M12)

Pin	Wire color	Terminal	Function
1	Brown	12	+24 V
3	Blue	20	0 V
4	Black	18, 19, 32, 33	Digital input

Table 13: Connection Output (2 x M12)

Pin	Wire color	Terminal	Function
1	Brown	Reserved[1]	Reserved
3	Blue	20	0 V
4	Black	02, 05	N.O. (24 V)

1) When reserved wires for option are used. If not used, they can be cut off.

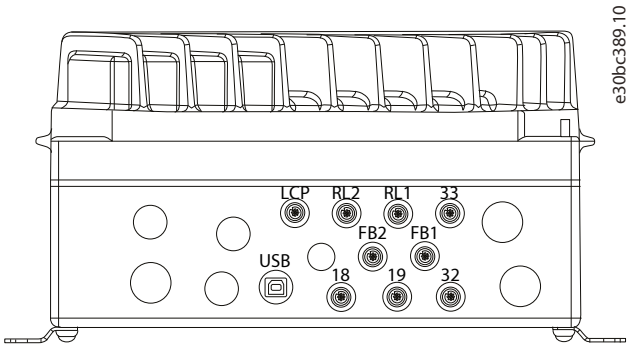

Figure 25: Connection of Sensors/Actuators on M12 Sockets

5.6 DIP Switches

- Analog input terminals 53 and 54 can select either voltage (0–10 V) or current (0–20 mA) input signals.
- Set switch S201 terminal 53 to select the signal type: *ON*=current, *OFF*=voltage.
- Set switch S202 terminal 54 to select the signal type: *ON*=current, *OFF*=voltage.
- Terminal 53 (default) is for a speed reference in an open loop.
- Terminal 54 (default) is for a feedback signal in a closed loop.

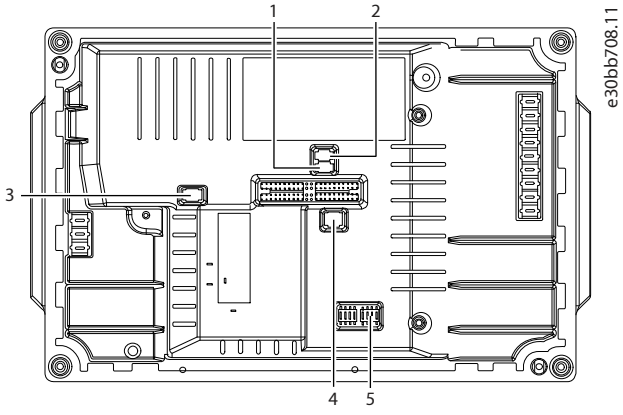

Figure 26: Location of DIP Switches

1	S201 - terminal 53	**2**	S202 - terminal 54
3	S801 - standard bus termination	**4**	PROFIBUS® termination
5	Fieldbus address		

Switches 4 and 5 are only valid for units fitted with fieldbus options.

Refer to *VLT® PROFIBUS® DP-V1 MCA 101 Programming Guide* for further information.

5.7 Serial Communication

5.7.1 Introduction to RS485 Serial Communication

- Use a shielded serial communication cable.
- See 4.4 Grounding for proper grounding.
- 2 communication protocols are internal to the drive:
  - Danfoss FC.
  - Modbus RTU.
- Functions can be programmed remotely using the protocol software and RS485 connection or in parameter group ***8-** Communications and Options***.
- Selecting a specific communication protocol changes various default parameter settings to match the specifications of that protocol, and makes more protocol-specific parameters available.
- Option cards for the drive are available to provide extra communication protocols. See the option card documentation for installation and operating guides.

5.7.2 Connecting and Setting Up RS485

Connect RS485 serial communication wiring to terminals (+)68 and (-)69.

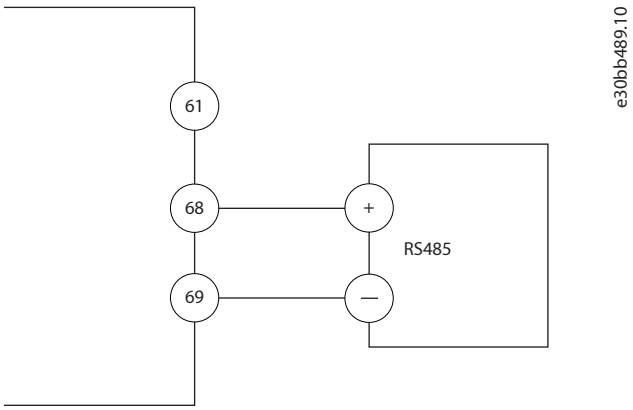

Figure 27: Serial Communication Wiring Diagram

Select the following for basic serial communication setup:

- Protocol type in parameter ***8–30 Protocol***.
- Drive address in parameter ***8–31 Address***.
- Baud rate in parameter ***8–32 Baud Rate***.

5.8 Safe Torque Off (STO)

Additional wiring for the drive is required to run safe torque off (STO).

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

6 Operating the Drive

6.1 Pre-start Checklist

Refer to 1.8 General Safety Precautions before operating the drive.

Before completing installation of the unit, inspect the entire installation as detailed in Table 14. Check and mark the items when completed.

Table 14: Pre-start Checklist

Inspect	Description	☑
Isolate the energy sources	• Verify that the input power to the unit is switched off and locked out. Do not rely on the drive disconnect switches for input power isolation. • Verify that there is no voltage on mains terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground. • Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground. • Confirm continuity of the motor by measuring Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).	
Input and output power wiring	• Check for loose connections. • Check for proper fusing or circuit breakers.	
Cable routing	Ensure that input power, motor wiring, and control wiring are separated or in 3 separate metallic conduits for high frequency noise isolation.	
Control wiring	• Check for broken or damaged wires and connections. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly at both ends.	
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers on the input power side of the drive, or the output side to the motor. Examine their operational readiness and ensure that they are ready in all respects for operation at full speed. • Check the function and installation of any sensors used for feedback to the drive. • Remove power factor correction caps on motor/motors, if present.	
EMC considerations	Check for proper installation regarding electromagnetic compatibility.	
Environmental considerations	See the equipment label for the maximum ambient operating temperature limits. Temperature is not to exceed 40 °C (104 °F). Humidity levels must be 5–95% non-condensing.	
Cooling clearance	Units require top and bottom clearance adequate to ensure proper airflow for cooling.	
Fusing and circuit breakers	Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position. Check for proper fusing or circuit breakers.	
Switches	Ensure that all switch and disconnect settings are in the proper position.	
Grounding	The equipment requires a dedicated ground wire from its chassis to the plant ground. Check for good ground connections that are tight and free of oxidation.	
Installation box and electronics part	Ensure the installation box and the electronics part is properly closed. Check that all 4 fastening screws are tightened with the right torque.	
Cable glands and blind plugs	Ensure that the cable glands and blind plugs are properly tightened to guarantee that the right enclosure protection degree is achieved. Liquids and/or excessive dust ingress in the drive can cause suboptimal performance or damage.	

Table 14: Pre-start Checklist - (continued)

Inspect	Description	☑
Vibration	Ensure that the equipment is not exposed to a high level of vibration. Mount the panel solidly or use shock mounts as necessary.	
Supply voltage	Verify that the supply voltage matches the voltage of the drive and the motor.	

6.2 Applying Power to the Drive

Before applying power to the drive, verify that the drive and any associated equipment is ready for operation. Refer to the 6.1 Pre-start Checklist. For detailed commissioning and programming information, refer to the *VLT® AutomationDrive FC 301/302 Programming Guide*.

⚠ 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 setup 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.

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.
3. Ensure that all operator devices are in the [*OFF*] position.
4. Ensure that panel doors are closed and covers securely fastened.
5. Apply power to the drive.

   Do not start the drive now. For units with a disconnect switch, turn the switch to [*ON*] to apply power to the drive.

6.3 Front Indicator Lights

The actual status can be read via 6 indicator lights, which signal the actual status of the unit. Front indicator lights on the drive, see Figure 28.

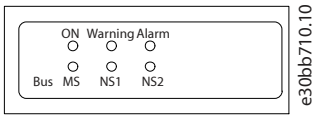

Figure 28: Front Indicator Lights

Table 15: Description of Front Indicator Lights

Indicator name	Color	Status	Description
ON	Green	On	The drive receives power from mains voltage or 24 V external supply.
–	–	Off	No power from mains voltage or 24 V external supply.
Warning	Yellow	On	Warning situation is present.

Table 15: Description of Front Indicator Lights - (continued)

Indicator name	Color	Status	Description
–	–	Off	No warning is present.
Alarm	Red	Flashing	Alarm is present.
–	–	Off	No alarm is present.
Bus MS[1]	–	–	Bus module status.
Bus NS1[1]	–	–	Bus network status 1.
Bus NS2[1]	–	–	Bus network status 2.

1) Only relevant if an optional fieldbus is present. See fieldbus-dedicated guides for specific information.

6.4 Local Control Panel Operation

6.4.1 Overview of the LCP

Easily program the drive via the local control panel (LCP).

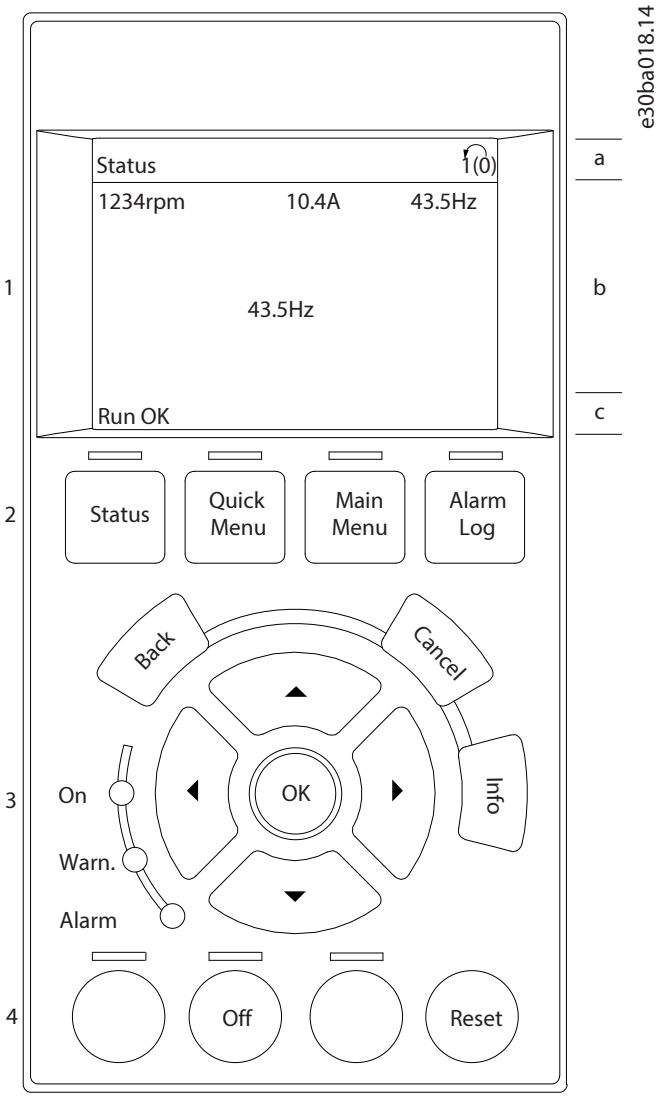

Figure 29: The LCP

1	Graphical display with status lines.	**2**	Menu keys and indicator lights - changing parameters and switching between display functions.
3	Navigation keys and indicator lights.	**4**	Operation keys and indicator lights.
a	Status line: Status message showing icons and graphics.	**b**	Line 1–2: Operator data lines showing data defined or selected. Add up to 1 extra line by pressing [Status].
c	Status line: Status messages showing text.		

The LCP display can show up to 5 items of operating data while showing *Status*.

NOTICE

If start-up is delayed, the LCP shows the INITIALIZING message until it is ready. Adding or removing options can delay the start-up.

6.4.2 Uploading and Downloading Data with the LCP

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

   A progress bar shows the status of the data upload or download process.
6. To return to normal operation, press [*Hand On*] or [*Auto On*].

6.4.3 Changing Parameter Settings

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

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

6.4.4 Restoring Default Settings

NOTICE

RISK OF DATA LOSS

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

- Provide a back-up by uploading data to the LCP before initialization.

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

- Initialization via parameter ***14-22 Operation Mode*** does not reset the drive settings such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.

- Manual initialization erases all motor programming, localization, and monitoring data, and restores factory settings.

6.4.5 Initialization

6.4.5.1 Recommended Initialization

1. Press [*Main Menu*] twice to access the parameter.
2. Scroll to parameter ***14–22 Operation Mode*** and press [*OK*].
3. Scroll to ***initialization*** and press [*OK*].
4. Remove power to the unit and wait for the display to turn off.

   Default parameter settings are restored during start-up. This may take slightly longer than normal.
5. ***Alarm 80, Drive initialized*** is shown.
6. To return to operating mode, press [*Reset*].

6.4.5.2 Manual Initialization

Manual initialization resets parameter settings except for the settings in:

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

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 for approximately 5 s or until hearing a click and the fan starts.

   Factory default parameter settings are restored during start-up. The start-up process takes slightly longer than normal after the manual initialization.

6.5 Basic Operational Programming

Drives require basic operational programming before running for the best performance. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. Enter the data in accordance with the following procedure. Enter the data with power ON, but before operating the drive.

1. Press [*Quick Menu*] on the LCP.
2. Use the navigation keys to scroll to ***Q2 Quick Setup*** and press [*OK*].

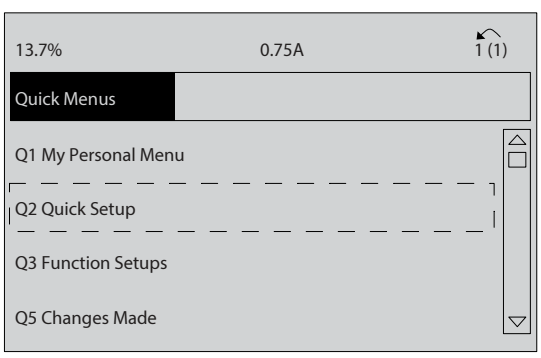

Figure 30: Quick Menus

3. Select language and press [*OK*].

4. Enter the motor data in parameter ***1–20 Motor Power*** [kW]/parameter ***1–21 Motor Power*** [hp] through parameter ***1–25 Motor Nominal Speed***. The information can be found on the motor nameplate. The entire quick menu is shown in International/North American default parameter settings.

   - Parameter ***1–20 Motor Power*** [kW].
   - Parameter ***1–21 Motor Power*** [hp].
   - Parameter ***1–22 Motor Voltage***.
   - Parameter ***1–23 Motor Frequency***.
   - Parameter ***1–24 Motor Current***.
   - Parameter ***1–25 Motor Nominal Speed***.

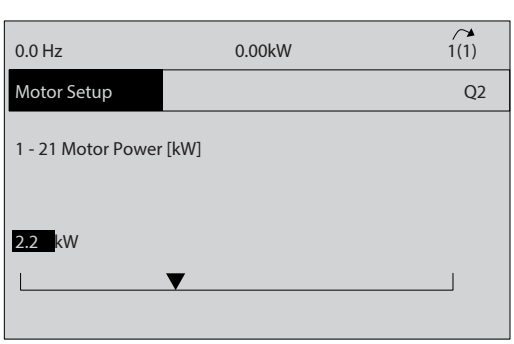

Figure 31: Motor Setup

5. Continue setup of Quick Menu parameters:

   a. Parameter ***5–12 Terminal 27 Digital Input***. If the terminal default is ***[2] Coast inverse***, it is possible to change the setting to ***[0] No operation***.

   b. Parameter ***1–29 Automatic Motor Adaptation (AMA)***. Set the desired AMA function, enable the complete AMA is recommended.

   c. Parameter ***3-02 Minimum Reference***. Set the minimum speed of the motor shaft.

   d. Parameter ***3-03 Maximum Reference***. Set the maximum speed of the motor shaft.

   e. Parameter ***3–41 Ramp 1 Ramp Up Time***. Set the ramping up time regarding synchronous motor speed, ns.

   f. Parameter ***3–42 Ramp 1 Ramp Down Time***. Set the ramping down time regarding synchronous motor speed, ns.

   g. Parameter ***3–13 Reference Site***. Set the site from where the reference must work.

6.6 Automatic Motor Adaptation (AMA)

6.6.1 Introduction to AMA

NOTICE

Automatic motor adaptation (AMA) is not relevant for permanent magnet motors.

Automatic motor adaptation 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 Motor Power*** [kW], ***1–21 Motor Power*** [hp], ***1–22 Motor Voltage***, ***1–23 Motor Frequency***, ***1–24 Motor Current***, and ***1–25 Motor Nominal Speed***.
- The motor shaft does not turn and no harm is done to the motor while running AMA.
- Some motors may be unable to run the complete version of the test. In that case, select ***[2] Enable reduced AMA***.

- If an output filter is connected to the motor, select ***[2] Enable reduced AMA***.
- Refer to 6.9.1 Introduction to Warnings and Alarms or *VLT® AutomationDrive FC 301/302 Programming Guide* if warnings or alarms occur.
- Run this procedure on a cold motor for best results.

6.6.2 Running AMA

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

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

The test runs automatically and indicates when it is complete.

6.7 Local Control Test

To reset the drive after a trip, see 6.9.1 Introduction to Warnings and Alarms.

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

6.8 System Start-up

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

If warnings or alarms occur, see 6.9.1 Introduction to Warnings and Alarms.

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

6.9 Warnings and Alarms

6.9.1 Introduction to Warnings and Alarms

A warning or an alarm is signaled by the relevant front indicator lights of the drive and indicated by a code on the display. The 6 front indicator lights show the actual status of the drive. For a status description of the 6 front indicator lights, refer to 6.3 Front Indicator Lights.

A comprehensive list of all warnings and alarms for the VLT® Decentral Drive FCD 302 is found in the *VLT® AutomationDrive FC 301/302 Programming Guide*. The following list highlights a selection of the most frequently occurring alarms and warnings encountered during drive operation.

A warning remains active until its cause is no longer present. Under certain circumstances, operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

If an alarm occurs, the drive trips. To resume operation, reset the alarm after the cause is rectified.

Resetting options:

- Press [*Reset*].
- Via a digital input with the reset function.
- Via serial communication/optional fieldbus.

After a manual reset pressing [*Reset*], press [*Auto On*] to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is in status trip lock.

Alarms that are in status trip lock offer extra protection, meaning that the mains supply must be switched off before the alarm can be reset. After being switched back on, the drive is no longer blocked and can be reset once the cause has been rectified.

Alarms that are not in status trip lock can also be reset using the automatic reset function in parameter ***14–20 Reset Mode*** (Warning: Automatic wake-up is possible.)

If a warning or alarm is marked against a code in the alarm/warning code list, this means that either a warning occurs before an alarm. Alternatively, it is possible to specify whether a warning or an alarm is shown for a given fault.

This is possible, for instance, in parameter ***1–90 Motor Thermal Protection***. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash. Once the problem has been rectified, only the alarm continues flashing until the drive is reset.

NOTICE

No missing motor phase detection (numbers 30–32) and no stall detection are active when parameter ***1–10 Motor Construction*** is set to ***[1] PM non-salient SPM***.

6.9.2 Warning and Alarm Codes

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 Response to Mains Imbalance***.

Troubleshooting

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

Warning 5, DC Link Voltage High

Cause

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

Warning 6, DC Link Voltage Low

Cause

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

WARNING/ALARM 9, Inverter Overload

Cause

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

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

Troubleshooting

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

WARNING/ALARM 10, Motor ETR Overtemperature

Cause

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

Troubleshooting

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

WARNING/ALARM 11, Motor Thermistor Overtemperature

Cause

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

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- 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). Also check that the terminal switch for 53 or 54 is set for voltage. Check that parameter ***1-93 Thermistor Resource*** selects terminal 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***.

WARNING/ALARM 12, Torque Limit

Cause

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

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.

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

WARNING/ALARM 13, Overcurrent

Cause

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

Troubleshooting

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

ALARM 14, Earth (Ground) Fault

Cause

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

Troubleshooting

- Remove power to the drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Reset any potential individual offset in the 3 current sensors in the drive. Perform a manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

Alarm 15, Hardware Mismatch

Cause

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

Troubleshooting

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

ALARM 16, Short Circuit

Cause

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

Troubleshooting

⚠ WARNING

HAZARDOUS VOLTAGE

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

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

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

WARNING/ALARM 17, Control Word Timeout

Cause

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

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

Troubleshooting

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

Warning/Alarm 22, Hoist Mechanical Brake

Cause

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

- 0 = The torque reference was not reached before timeout (parameter ***2-27 Torque Ramp Up Time***.
- 1 = Expected brake feedback was not received before timeout (parameter ***2-23 Activate Brake Delay***, parameter ***2-25 Brake Release Time***.

Warning 23, Internal Fan Fault

Cause

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

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

Troubleshooting

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

WARNING 25, Brake Resistor Short Circuit

Cause

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

Troubleshooting

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

WARNING/ALARM 26, Brake Resistor Power Limit

Cause

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

Troubleshooting

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

WARNING/ALARM 27, Brake Chopper Fault

Cause

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

Troubleshooting

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

WARNING/ALARM 28, Brake Check Failed

Cause

The brake resistor is not connected or not working.

Troubleshooting

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

ALARM 29, Heat Sink Temp

Cause

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

Troubleshooting

Check for the following conditions:

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

ALARM 30, Motor Phase U Missing

Cause

⚠ WARNING

HAZARDOUS VOLTAGE

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

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

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

Troubleshooting

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

ALARM 31, Motor Phase V Missing

Cause

⚠ WARNING

HAZARDOUS VOLTAGE

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

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

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

Troubleshooting

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

ALARM 32, Motor Phase W Missing

Cause

⚠ WARNING

HAZARDOUS VOLTAGE

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

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

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

Troubleshooting

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

ALARM 33, Inrush Fault

Cause

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

Troubleshooting

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

WARNING/ALARM 34, Fieldbus Fault

Cause

The fieldbus on the communication option card is not working.

Troubleshooting

- Check the fieldbus communication option card.

WARNING/ALARM 36, Mains Failure

Cause

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

Troubleshooting

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

ALARM 37, Phase Imbalance

Cause

There is a current imbalance between the power units.

ALARM 38, Internal Fault

Cause

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

Table 16: Internal Fault List

Fault number	Cause	Solution
0	The serial port cannot be initialized.	Contact the supplier or service department.
256–258	The power EEPROM data is defective or too old.	Replace the power card.
512–519	Internal fault.	Contact the supplier or service department.
783	Parameter value outside of the minimum/maximum limits.	Adjust the parameter value to match the limits.
1024–1284	Internal fault.	Contact the supplier or service department.
1299	The option software in slot A is too old.	Upgrade the software in the drive to the latest version.
1300	The option software in slot B is too old.	Upgrade the software in the drive to the latest version.
1302	The option software in slot C1 is too old.	Upgrade the software in the drive to the latest version.
1315	The option software in slot A is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1316	The option software in slot B is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1318	The option software in slot C1 is not supported/allowed.	The software version of the option or the fieldbus variant is not compatible with the drive software.
1379–2819	Internal fault.	Contact the supplier or service department.
1792	Hardware reset of digital signal processor.	

Table 16: Internal Fault List - (continued)

Fault number	Cause	Solution
1793	Motor-derived parameters not transferred correctly to the digital signal processor.	
1794	Power data not transferred correctly at power-up to the digital signal processor.	
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive also uses this fault code if the MCO does not power up correctly.	Check for poor EMC protection and improper grounding.
1796	RAM copy error.	
2561		Replace the control card.
2820	LCP stack overflow.	
2821	Serial port overflow.	
2822	USB port overflow	
3072–5122	Parameter value is outside its limits.	Adjust the parameter value to match the limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.	Change either the fieldbus hardware or the control board hardware.
5376–6231	Internal fault.	Contact the supplier or service department.

Troubleshooting

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

WARNING 40, Overload T27

Troubleshooting

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

WARNING 41, Overload T29

Troubleshooting

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

WARNING 42, Ovrld X30/6-7

Troubleshooting, X30/6

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

Troubleshooting, X30/7

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

WARNING 43, Ext. Supply

Cause

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

Troubleshooting

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

ALARM 45, Earth (Ground) Fault 2

Cause

A ground fault has occurred.

Troubleshooting

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

ALARM 46, Power Card Supply

Cause

The supply on the power card is out of range. Another reason can be a defective heat sink fan. There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

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

Troubleshooting

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

WARNING/ALARM 47, 24 V Supply Low

Cause

The 24 V DC is measured on the control card.

Troubleshooting

- Check for a defective control card.

ALARM 48, 1.8 V Supply Low

Cause

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

Troubleshooting

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

WARNING 49, SPEED LIMIT

Cause

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

Troubleshooting

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

ALARM 50, AMA Calibration

Cause

A calibration error has occurred.

Troubleshooting

- Contact a Danfoss supplier or the Danfoss service department.

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

Cause

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

Troubleshooting

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

ALARM 52, AMA Low I_{nom}

Cause

The motor current is too low.

Troubleshooting

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

ALARM 53, AMA Big Motor

Cause

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

Troubleshooting

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

ALARM 54, AMA Small Motor

Cause

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

Troubleshooting

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

ALARM 55, AMA Parameter Range

Cause

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

Troubleshooting

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

ALARM 56, AMA Interrupted

Cause

The AMA is manually interrupted.

Troubleshooting

- Re-run the AMA calibration.

ALARM 57, AMA Internal Fault

Cause

Troubleshooting

Troubleshooting

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

ALARM 58, AMA Internal Fault

Cause

An AMA internal fault occurs.

Troubleshooting

- Contact a local Danfoss supplier.

WARNING/ALARM 59, Current Limit

Cause

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

Troubleshooting

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

ALARM 60, External Interlock

Cause

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

Troubleshooting

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

- Reset the drive.

WARNING/ALARM 61, Feedback Error

Cause

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

Troubleshooting

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

WARNING/ALARM 62, Output Frequency Limit

Cause for Flux Mode

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

Troubleshooting for Flux Mode

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

Cause for VVC TCL Mode

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

Troubleshooting for VVC TCL Mode

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

ALARM 63, Mechanical Brake Low

Cause

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

WARNING 64, VOLTAGE LIMIT

Cause

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

Troubleshooting

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

WARNING/ALARM 65, Control Card Over Temperature

Cause

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

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check the fan operation.

- Check the control card.

Warning 66, Heat Sink Temperature Low

Cause

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

Troubleshooting

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

ALARM 67, Option Module Configuration Has Changed

Cause

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

Troubleshooting

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

ALARM 68, Safe Stop Activated

Cause

The Safe Torque Off (STO) has been activated.

Troubleshooting

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

ALARM 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.

ALARM 71, PTC 1 Safe Stop

Cause

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

Troubleshooting

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

ALARM 72, Dangerous Failure

Cause

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

Troubleshooting

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

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

WARNING 73, Safe Stop Auto Restart

Cause

STO is activated.

Troubleshooting

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

ALARM 74, PTC Thermistor

Cause

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

ALARM 75, Illegal Profile Sel.

Cause

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

Troubleshooting

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

WARNING 77, Reduced Power Mode

Cause

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

ALARM 78, Tracking Error

Cause

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

Troubleshooting

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

ALARM 79, Illegal Power Section Configuration

Cause

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

ALARM 80, Drive Initialized to Default Value

Cause

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

Troubleshooting

- To clear the alarm, reset the unit.

ALARM 81, CSIV Corrupt

Cause

The CSIV file has syntax errors.

ALARM 82, CSIV Parameter Error

Cause

CSIV failed to initialize a parameter.

ALARM 83, Illegal Option Combination

Cause

The mounted options are incompatible.

ALARM 84, No Safety Option

Cause

The safety option was removed without applying a general reset.

Troubleshooting

- Reconnect the safety option.

ALARM 88, Option Detection

Cause

A new option configuration has been detected.

Troubleshooting

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

WARNING 89, HOIST BRAKE SLIDING

Cause

This warning occurs when the motor speed feedback is bigger than 10 RPM during torque building time before the brake is open (parameter ***2-27 Torque Ramp Up Time***).

Troubleshooting

- Check if the mechanical brake is broken or opened before start.
- Check that the feedback is not zero before opening the brake.

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.

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.

ALARM 99, Locked Rotor

Cause

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

Troubleshooting

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

WARNING/ALARM 104, Mixing Fan Fault

Cause

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

Troubleshooting

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

WARNING/ALARM 122, Mot. Rotat. Unexp.

Cause

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

WARNING 163, ATEX ETR Cur.Lim.Warning

Cause

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

Alarm 164, ATEX ETR Cur.Lim.Alarm

Cause

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

WARNING 165, ATEX ETR Freq.Lim.Warning

Cause

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

ALARM 166, ATEX ETR Freq.Lim.Alarm

Cause

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

WARNING 251, New Typecode

Cause

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

Troubleshooting

- Reset the drive for normal operation.

7 Specifications

7.1 Electrical Data

Table 17: Shaft Output, Output Current, and Input Current

Mains supply 3x380–480 V AC							
Drive	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0
Rated shaft output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3.0
Rated shaft output [hp]	0.5	0.75	1.0	1.5	2.0	3.0	4.0
Maximum input current							
Continuous (3x380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5
Intermittent (3x380–440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4
Continuous (3x441–480 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7
Intermittent (3x441–480 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1
Recommended maximum fuse size (non-UL)	gG-25						
Built-in circuit breaker (large unit)	CTI-25M Code number: 047B3151						
Recommended circuit breaker Danfoss CTI-25M (small and large unit) Code number:							
0.37, 0.55 kW	Code number: 047B3148						
0.75, 1.1 kW	Code number: 047B3149						
1.5, 2.2, 3 kW	Code number: 047B3151						
Recommended circuit breaker Danfoss CTI-45MB (small unit) Code number:(1)							
0.55, 0.75 kW	Code number: 047B3160						
1.1 kW	Code number: 047B3161						
1.5 kW	Code number: 047B3162						
2.2 kW	Code number: 047B3163						
Power loss at maximum load [W](2)	35	42	46	58	62	88	116
Efficiency(3)	0.93	0.95	0.96	0.96	0.97	0.97	0.97
Output current							
Continuous (3x380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.2	7.2
Intermittent (3x380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	8.3	11.5
Continuous (3x441–480 V) [A]	1.2	1.6	2.1	3.0	3.4	4.8	6.3
Intermittent (3x441–480 V) [A]	1.9	2.6	3.4	4.8	5.4	7.7	10.1
Continuous kVA (400 V AC) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0
Continuous kVA (460 V AC) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0
Maximum cable size: Mains, motor, brake. [mm2/(AWG)]	Solid cable: 6/(10)						
Maximum cable size: Mains, motor, brake. [mm2/(AWG)]	Flexible cable: 4/(12)						

1) Type CTI-45MB circuit breakers are not available for 3 kW (4 hp) units.

2) Applies to the dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumption are included. For power loss data according to EN 50598-2, refer to ecosmart.mydrive.danfoss.com.

3) Efficiency is measured at nominal current. For energy efficiency class, see 7.4 Ambient Conditions. For part load losses, refer to ecosmart.mydrive.danfoss.com.

7.2 Mains Supply (L1, L2, L3)

Supply voltage[1), 2)]	380–480 V/500–600 V ±10%
Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cos Φ)	Near unity (>0.98)
Switching on the input supply L1, L2, L3 (power-ups)	Maximum 2 times per minute

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

2) The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/500/600/690 V maximum.

7.3 Motor Output and Motor Data

7.3.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1)]
Output frequency in flux mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

1) Dependent on voltage and power.

7.3.2 Torque Characteristics

Starting torque (constant torque)	Maximum 160% for 60 s[1)]
Starting torque	Maximum 180% up to 0.5 s[1)]
Overload torque (constant torque)	Maximum 160% for 60 s[1)]
Starting torque (variable torque)	Maximum 110% for 60 s[1)]
Overload torque (variable torque)	Maximum 110% for 60 s[1)]

1) Percentage relates to the nominal torque of the drive, dependent on power size.

7.4 Ambient Conditions

Protection rating	IP66/Type 4X
Vibration test for units without circuit breaker	1.7 g RMS
Mount unit with integrated circuit breaker on a level, vibration proof, and torsionally rigid support structure	
Maximum relative humidity	5–95% (IEC 721-3-3); Class 3K3 (non-condensing) during operation
Ambient temperature[1)]	Maximum 40 °C (75 °F) (24-hour average maximum 35 °C (95 °F))
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced speed performance	-10 °C (14 °F)
Temperature during storage/transport	-25...65/70 °C (-13...149/158 °F)
Maximum altitude above sea level	1000 m (3280 ft)

Energy efficiency class[2]	IE2

1) For more information, see the Derating section in the VLT® Decentral Drive FCD 302 Design Guide.

2) Determined according to EN 50598-2 at: Rated load, 90% rated frequency, switching frequency factory setting and, switching pattern factory setting.

7.5 Cable Lengths and Cross-sections

Maximum motor cable length (shielded)	10 m (32.8 ft)
Maximum motor cable length, unshielded, without fulfilling emission specification	10 m (32.8 ft)
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	1.5 mm^2/16 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG
Maximum cross-section to mains and motor, stranded/rigid wire	6 mm^2/10 AWG
Maximum cross-section to mains and motor, flexible wire	4 mm^2/12 AWG
Maximum cross-section to mains and motor, flexible with/without plastic sleeve	4 mm^2/12 AWG
Maximum cross-section to mains and motor, flexible with TWIN ferrule	1 mm^2/17 AWG
Minimum cross-section to mains and motor, flexible/rigid/ stranded	0.5 mm^2/20 AWG
Nominal/rated current	25 A (up to 50 A with optional looping terminals)

See electrical data tables in 7.1 Electrical Data for more information.

It is mandatory to ground the mains connection properly using T95 (PE) of the drive. The ground connection cable cross-section must be at least 10 mm^2 (8 AWG) or 2 rated mains wires terminated separately according to EN 50178. Use unshielded cable. See also 4.4 Grounding for further information.

7.6 Cable Entries

Table 18: Specification of Cable Entries

Section	Gland specification
Motor side	1xM20, 1xM25
Control side	2xM20, 9xM16[1]
Mains side	2xM25

1) Also used for 4xM12/6xM12 sensor/actuator sockets.

7.7 Control Input/Output and Control Data

7.7.1 Digital Inputs

Programmable digital inputs	4 (6)[1]
Terminal number	18, 19, 27[1], 29[1], 32, 33

Logic	PNP or NPN
Voltage level	0–24 V
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) Minimum pulse width	4.5 ms
Input resistance, R_i	Approximately 4 kΩ

1) Terminals 27 and 29 can also be programmed as output.

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

7.7.2 STO Terminal 37

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

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

For further information about terminal 37 and Safe Torque Off, see the *Safe Torque Off Operating Guide*.

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. The return way can be created 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.

7.7.3 Analog Inputs

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/S202 = OFF (U)
Voltage level	0 V to +10 V (scalable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/S202 = ON (I)
Current level	0/4 mA to 20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω

Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	200 Hz

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

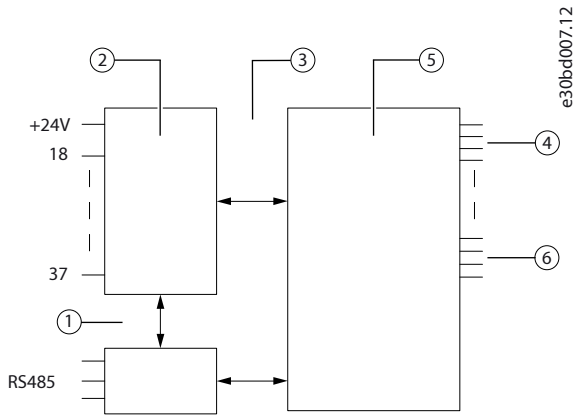

Figure 32: Analog Inputs

1	Functional isolation	**2**	Control
3	PELV isolation	**4**	Mains
5	High voltage	**6**	Motor

7.7.4 Pulse/Encoder Inputs

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33[(1)]/32[(2)], 33[(2)]
Maximum frequency at terminals 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminals 29, 32, 33	5 kHz (Open collector)
Maximum frequency at terminals 29, 32, 33	4 Hz
Voltage level	See *Digital Inputs*.
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

1) Pulse inputs are 29 and 33.

2) Encoder inputs: 32=A, 33=B.

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

7.7.5 Digital Outputs

Programmable digital/pulse outputs	2
Terminal number	27, 29[(1)]

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

1) Terminals 27 and 29 can also be programmed as input.

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

7.7.6 Analog Output

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

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

7.7.7 Control Card 24 V DC Output

Terminal number	12, 13
Output voltage	24 V +1, -3 V
Maximum load	600 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.

7.7.8 Control Card +10 V DC Output

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

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

7.7.9 Control Card RS485 Serial Communication

Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

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

7.7.10 Control Card USB Serial Communication

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

Connection to the PC is carried out via a standard host/device USB cable.

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

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

7.7.11 Relay Outputs

Programmable relay outputs	2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO), 1–3 (NC) (resistive load)	48 V DC, 1 A
Maximum terminal load (DC-13)[1] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1] on 4–5 (NO) (resistive load)[2], [3]	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (resistive load)	48 V DC, 1 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

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

2) Overvoltage Category II.

3) UL applications 300 V AC 2 A.

7.7.12 Control Card Performance

Scan interval	1 ms

7.7.13 Control Characteristics

Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms

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

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

8 Maintenance

8.1 Preventive Maintenance Recommendations

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

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

NOTICE

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

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

Table 19: Maintenance Schedule for Air-cooled Drives

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Installation			
Visual inspection	1 year	–	Check for the unusual, for example, for signs of overheating, aging, corrosion, and for dusty and damaged components.
Auxiliary equipment	1 year	According to manufacturer recommendations	Inspect equipment, switchgear, relays, disconnects, or fuses/circuit breakers. Examine the operation and condition for possible causes of operational faults or defects. The continuity check on fuses must be performed by trained service personnel.
EMC consideration	1 year	–	Inspect the wiring regarding the electromagnetic capability and the separation distance between control wiring and power cables.
Cable routing	1 year	–	Check for parallel routing of motor cables, mains wiring, and signal wiring. Avoid parallel routing. Avoid routing cables through free air without support. Check for aging and wearing of the cable insulation.
Control wiring	1 year	–	Check for tightness, damaged or crimped wires, or ribbon wires. Terminate the connections correctly with solid crimped ends. The use of shielded cables and grounded EMC plate, or a twisted pair is recommended.
Clearances	1 year	–	Check that the external clearances for proper airflow for cooling follow the requirements for the frame and product type. For clearances, refer to the local design regulations.
Sealing	1 year	–	Check that the sealing of the enclosure, the covers, and the cabinet doors are in good condition.
Corrosive environments	1 year	–	Conductive dust and aggressive gases, such as sulphide, chloride, and salt mist, can damage the electrical and mechanical components. Air filters do not remove airborne corrosive chemicals. Act based on the findings.
Drive			

Table 19: Maintenance Schedule for Air-cooled Drives - (continued)

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Programming	1 year	–	Check that the AC drive parameter settings are correct according to the motor, drive application, and I/O configuration. Only trained service personnel are allowed to perform this action.
Control panel	1 year	–	Check that the display pixels are intact. Check the event log for warnings and faults. Repetitive events are a sign of potential issues. If necessary, contact a local service center.
Drive cooling capacity	1 year	–	Check for blockages or constrictions in the air passages of the cooling channel. The heat sinks must be free of dust and condensation.
Capacitors, DC link	1 year	8–15+ years	The expected lifetime of the capacitors depends on the loading profile of the application and the ambient temperature. For applications with heavy loads in demanding environments or high ripple currents, replace electrolytic capacitors every 8 years and plastic foil capacitors every 12 years. If within the specifications of the drive type, replace every 10–15+ years. Only trained service personnel are allowed to perform this action.
Grounding	1 year	–	The drive system requires a dedicated ground wire connecting the drive, the output filter, and the motor to the building ground. Check that the ground connections are tight and free of paint or oxidation. Daisy-chain connections are not allowed. If applicable, braided straps are recommended.
PCB	1 year	10–12 years	Visually inspect the printed circuit boards for signs of damage or degrading due to aging, corrosive environments, dust, or environments with high temperatures. Only trained service personnel are allowed to perform the inspection and service action.
Power cables and wiring	1 year	–	Check for loose connections, aging, insulation condition, and proper torque to the drive connections. Check for proper rating of fuses and continuity check. Observe if there are any signs of operation in a demanding environment. For example, discoloration of the fuse housing can be a sign of condensation or high temperatures.
Vibration	1 year	–	Check for abnormal vibration or noise coming from the drive to ensure that the environment is stable for electronic components.
Insulator gaskets	1 year	10–15 years	Inspect the insulators for signs of degradation due to high temperature and aging. Replacement is based on findings or done at the same time as DC capacitor replacement. Only trained service personnel are allowed to perform this action.
Batteries	1 year	7–10 years	Replace the batteries according to the manufacturer recommendation. Replace the real-time clock battery in the control unit every 7–10 years.
Spare parts			
Spare parts	1 year	2 years	Stock spares in their original boxes in a dry and clean environment. Avoid hot storage areas. Electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.
Exchange units and units stored for long periods before commissioning	1 year	2 years	Visually inspect for signs of damage, water, high humidity, corrosion, and dust within the visual field of view without disassembly. The exchange units with mounted electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.

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

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

8.2 Cleaning

The enclosure (IP66/NEMA type 4x indoor) provides protection against dirt and water ingress. The enclosure is suitable for cleaning methods and solvents used in food and beverage plants. Use the solvent concentration recommended by the manufacturer. Avoid high-pressure hot water cleaning at close proximity or of long duration, because this method of cleaning can damage gaskets and labels.

9 Appendix

9.1 Abbreviations

Table 20: Abbreviations, Acronyms, and Symbols

Term	Definition
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electromagnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IP	Ingress protection
LCP	Local control panel
LOP	Local operation pad
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM motor	Permanent magnet motor
PWM	Pulse width motor
RMS	Root mean square
RPM	Revolutions per minute
Regen	Regenerative terminals
STO	Safe torque off
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

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