ENGINEERING
TOMORROW

Operating Guide

VLT Ea4 Parallel Drive Modules

Contents

1 Introduction and Safety

1.1 Purpose of this Manual

This manual provides requirements for mechanical and electrical installation of the VLT® Ea4 Parallel Drive Modules basic kit.

This guide includes information on:

- Wiring of mains and motor connections.
- Wiring of control and serial communications.
- Control terminal functions.
- Detailed tests that must be performed before start-up.
- Initial programming to verify proper functioning of the drive system.

This operating guide is intended for use by qualified personnel. To install the drive modules and paralleling kit safely and professionally, read and follow the operating guide. Pay particular attention to the safety instructions and general warnings. Always keep this guide with the panel containing the VLT® Parallel Drive Modules components.

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

1.2 Disclaimer

Danfoss shall have no obligation regarding any product that

- is not installed according to the standard configuration as specified in the installation guide.
- is improperly repaired or altered.
- is subjected to misuse, negligence, and improper installation where the guidelines were not followed.
- is used in a contradictory manner to the instructions provided.
- is a result of normal wear and tear.

NOTICE

OUTPUT FREQUENCY LIMIT

The output frequency of the drive is limited to 590 Hz due to export control regulations.

1.3 Safety and Installation Awareness

Before starting installation, read all safety guidelines and precautions in this operating guide. PC tools and MyDrive® ecoSmart™ can be downloaded at www.danfoss.com.

1.4 Qualified Personnel

Only qualified personnel are allowed to install, commission, and maintain Danfoss drives. Qualified personnel are trained individuals who are familiar with and authorized to mount and wire the drive in accordance with pertinent laws and regulations. Also, qualified personnel must be familiar with the instructions and safety measures described in this installation guide.

1.5 Safety Symbols

The following symbols are used in this guide:

⚠ DANGER ⚠

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

⚠ WARNING ⚠

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

⚠ CAUTION ⚠

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

NOTICE

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

1.6 Safety Precautions

⚠ WARNING ⚠

LACK OF SAFETY AWARENESS

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

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

⚠ WARNING ⚠

LIFTING HEAVY LOAD

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

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

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

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

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

⚠ WARNING ⚠

DISCHARGE TIME

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

- Stop the motor.
- Disconnect all power sources, including permanent magnet type motors.
- Wait for capacitors to discharge fully. The discharge time is shown on the nameplate. See Illustration 1 and Illustration 2.
- Verify full discharge by measuring the voltage level.

⚠ CAUTION ⚠

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.

⚠ WARNING ⚠

ELECTRICAL SHOCK AND FIRE HAZARD

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

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

⚠ 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 HAZARD

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

- Ensure that minimum size of the ground conductor complies with the local safety regulations for high touch current equipment.
- Use a reinforced ground conductor according to IEC 60364-5-54 cl. 543.7 or local safety regulations for equipment with leakage current >3.5 mA.
- For reinforced grounding:
  Use a ground conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al, or an extra ground conductor of the same cross-sectional area as the original ground conductor as specified by IEC 60364-5-54, with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) mechanically protected or 4 mm^2 (12 AWG) not mechanically protected.
  Use a ground conductor inside an enclosure or otherwise protected throughout its length against mechanical damage.
  Use a ground conductor that is part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) that is permanently connected or plugged in by an industrial connector. The multi-conductor power cable must be installed with an appropriate strain relief.

⚠ CAUTION ⚠

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

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

NOTICE

EXCESSIVE HEAT AND PROPERTY DAMAGE

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

- Use additional protective devices such as short-circuit protection or motor thermal protection between the drive and the motor for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them.

N O T I C E

PROPERTY DAMAGE

Protection against motor overload is not active by default. The ETR function provides class 20 motor overload protection. Failure to set the ETR function means that motor overload protection is not provided and property damage can occur if the motor overheats.

- Enable the ETR function. See the application guide for more information.

1.7 Disposal

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

2 Receiving the Drive

2.1 Verifying the Shipment and the Contents

Items supplied can vary according to product configuration.

- Make sure that the items supplied and the information on the nameplates correspond to the order confirmation.
- Visually check the packaging and the drive modules for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

N O T I C E

Removing the nameplates can result in loss of warranty.

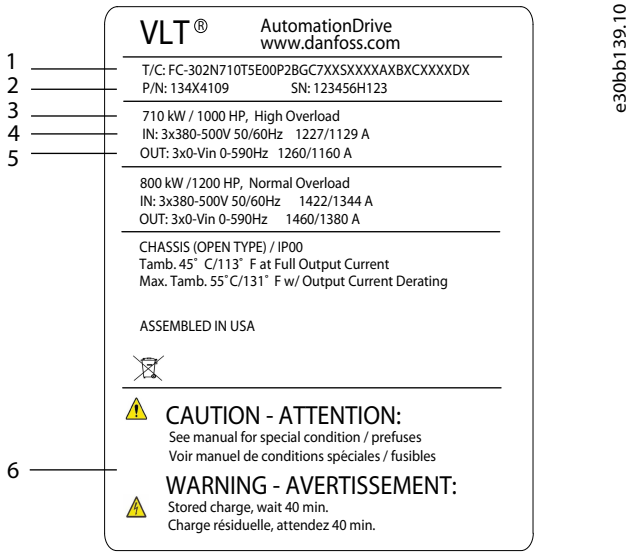

Illustration 1: Example of the Top-level Drive System Nameplate Found on Drive Module Exterior

1	Typecode	4	Input voltage, frequency, and current
2	Part number and serial number	5	Output voltage, frequency, and current
3	Power rating	6	Discharge time

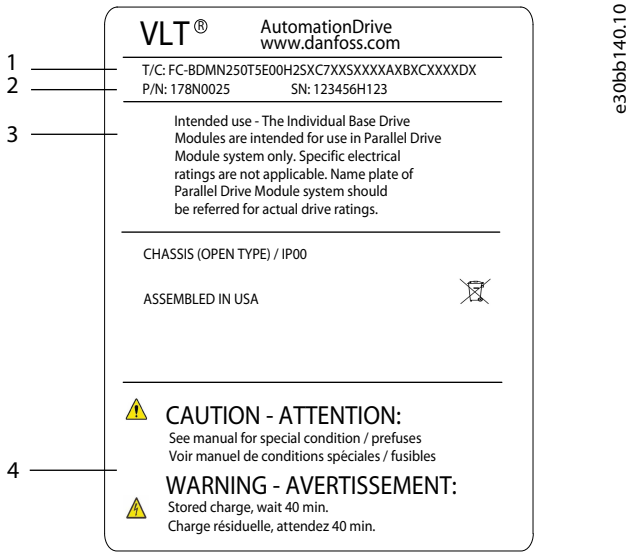

Illustration 2: Example of the Drive Module Nameplate in the Interior Beneath the Local Control Panel

1	Typecode	3	Intended use disclaimer
2	Part number and serial number	4	Discharge time

2.2 Lifting the Drive Module

⚠ W A R N I N G ⚠

The drive modules are heavy and failure to follow local safety regulations for lifting heavy weights may cause death, personal injury, or property damage.

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

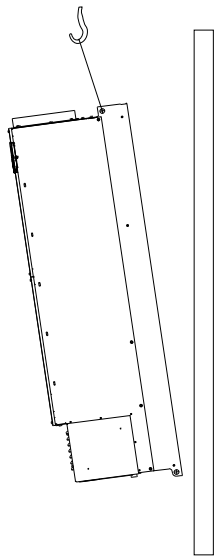

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Illustration 3: Drive Module Lifting Technique

2.3 Storage

Store the kit in a dry location. Keep the equipment sealed in its packaging until installation. Refer to 7.5 Ambient Conditions for Drive Modules for recommended ambient conditions during storage and use.

3 Product Overview

3.1 VLT® Ea4 Parallel Drive Modules Basic Kit

The VLT® Ea4 Parallel Drive Modules basic kit is used to create a drive system consisting of 4 drive modules. This kit provides a greater power range in a smaller enclosure, while allowing system integrators design flexibility and the potential to fabricate custom components for the system.

The basic kit contains the following components:

- Drive modules
- Control shelf
- Wire harnesses
- DC fuses with microswitch connectors

3.2 Drive Modules

The VLT® Ea4 Parallel Drive Modules basic kit contains 4 drive modules which are used to convert AC mains input into a variable AC waveform output.

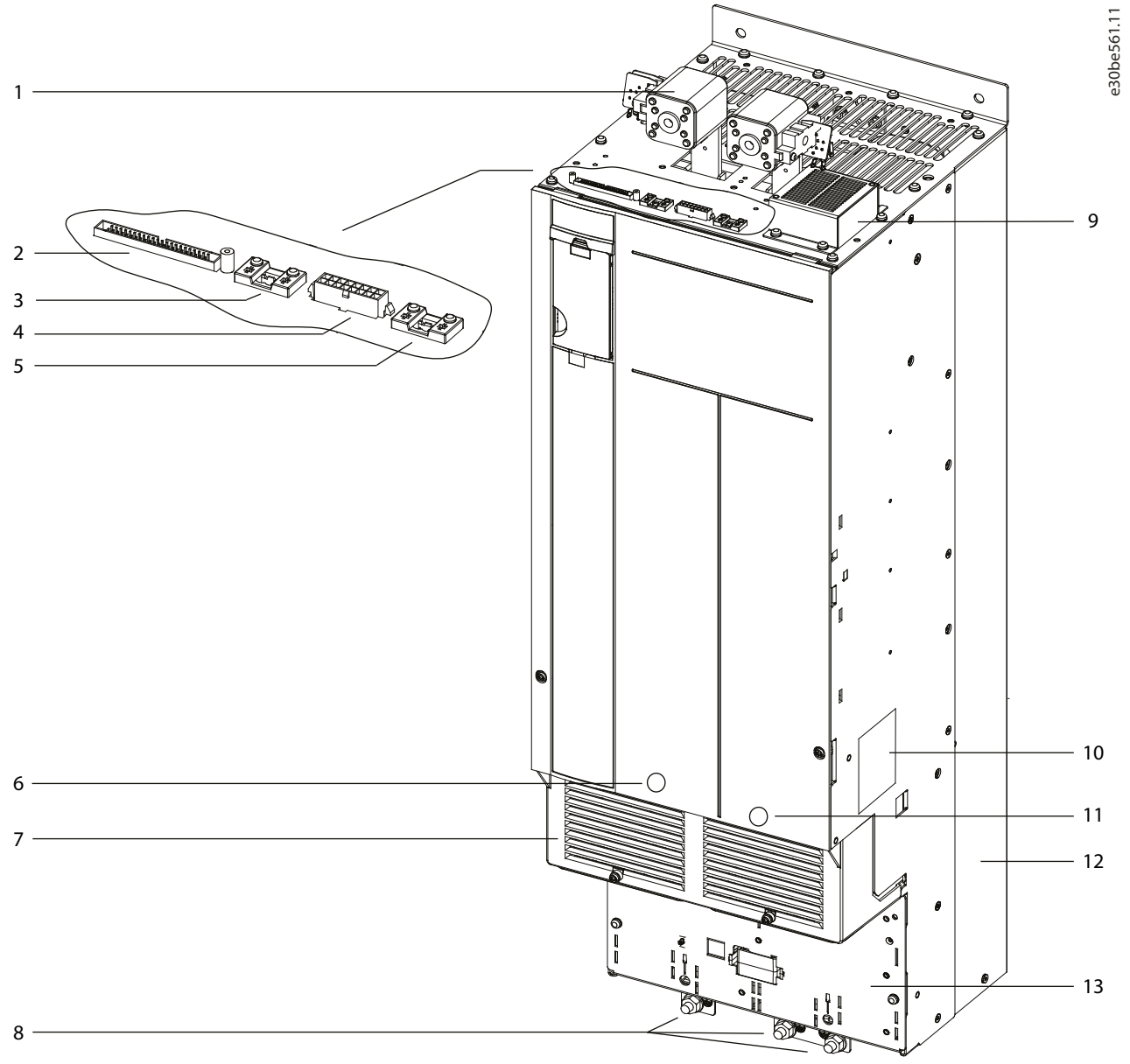


Illustration 4: Drive Module Overview

1	DC-link terminal and DC fuse	8	Ground terminals
2	MDCIC plug	9	Top fan
3	Microswitch connector to DC fuse	10	Drive module nameplate. See Illustration 2.
4	Relays 1 and 2	11	Motor output terminals (inside the unit)
5	Brake fault jumper and connector	12	Back-channel cooling
6	Mains input terminals (inside the unit)	13	Ground plate
7	Terminal cover	–	–

3.3 Control Shelf

The control shelf contains the local control panel (LCP), MDCIC, and control card. The LCP provides access to the system parameters. The MDCIC is connected to each of the drive modules via a ribbon cable and communicates to the control card. The control card controls the operation of the drive modules.

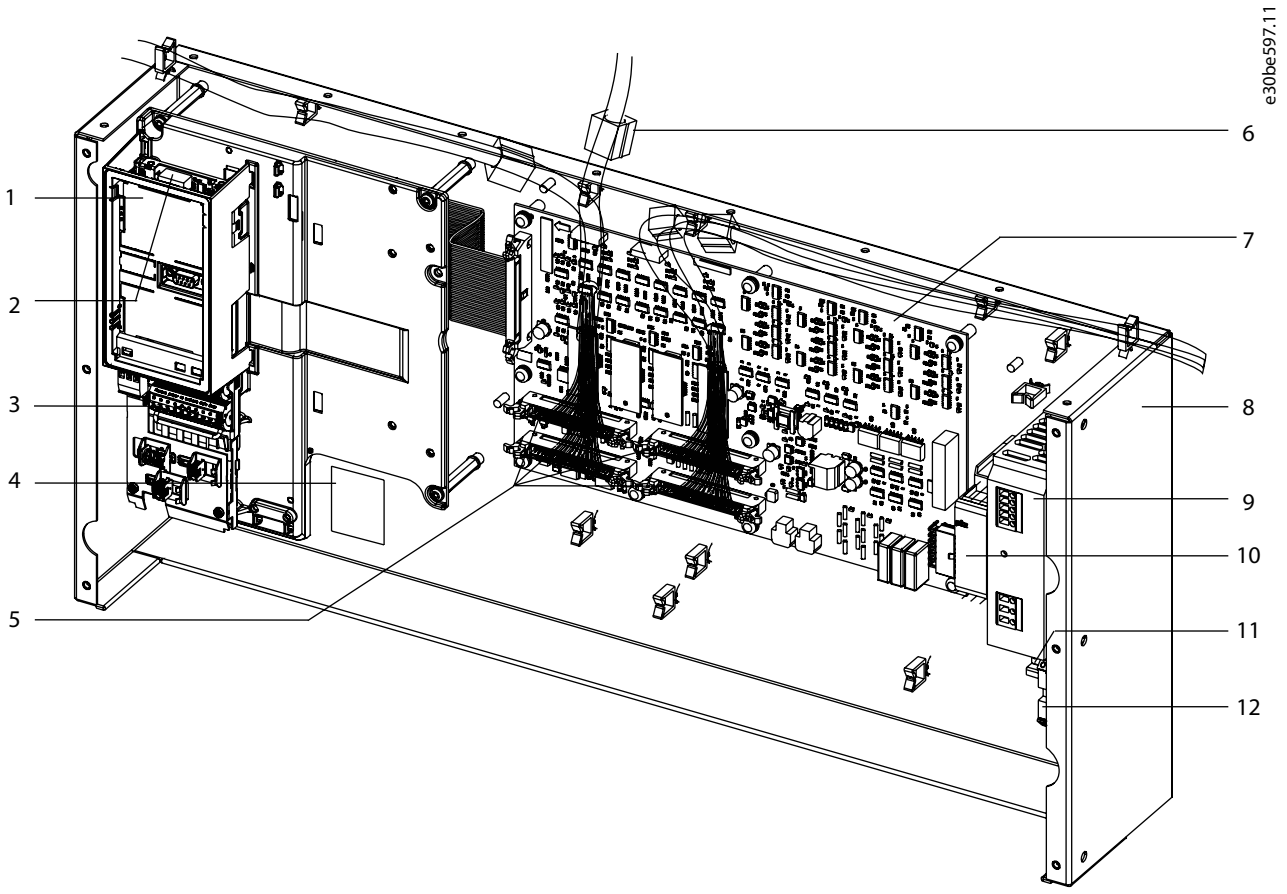


Illustration 5: Control shelf components

1	LCP cradle	7	MDCIC card
2	Control card (underneath cover)	8	Control shelf
3	Control terminal blocks	9	Switch mode power supply (SMPS). An external 230 V supply is needed to power the SMPS.
4	Top-level drive system nameplate. See Illustration 1.	10	Pilz relay
5	44-pin cables from MDCIC board to drive modules	11	DIN rail
6	Ferrite core	12	Terminal block mounted on DIN rail

3.4 Wire Harnesses

The VLT® Ea4 Parallel Drive Modules basic kit contains 3 wiring harnesses:

- Ribbon cable with 44-pin connector (on both ends of the cable)
- Relay cable with 16-pin connector (on 1 end of the cable)
- DC fuse microswitch cable with 2-pin connectors (on 1 end of the cable)

3.5 AC Fuses

Fuses installed on the supply side ensure that if a component breaks down (first fault) inside the drive, any potential damage is contained inside the drive enclosure. The drive modules are supplied with built-in AC fuses.

3.6 DC Fuses

The VLT® Ea4 Parallel Drive Modules basic kit contains 2 DC fuses per drive module. These fuses are placed on the DC terminals to ensure that any overcurrent damage is contained inside the drive modules.

N O T I C E

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

Illustration 6: DC Fuse and Microswitch Connector

1	DC fuse
2	Microswitch connector

4 Mechanical Installation

4.1 Fastener Torque Ratings

N O T I C E

Apply the specified torque when tightening fasteners. Too low or too high torque when fastening an electrical connection results in a bad electrical connection.

- To ensure correct torque, use a torque wrench.

Table 1: Fastener Torque Ratings

Location	Bolt size	Torque [Nm (in-lb)]
Mains terminal	M10/M12	19 (168)/37 (335)
Motor terminal	M10/M12	19 (168)/37 (335)
Ground terminal	M8/M10	9.6 (84)/19 (168)
Load sharing terminal	M10/M12	19 (168)/37 (335)
Regen terminal	M10/M12	19 (168)/37 (335)
Relay terminal	–	0.5 (4)
Door/panel cover	M5	2.3 (20)
Heat sink access panel	M5	2.3 (20)
Serial communication cover	M5	2.3 (20)

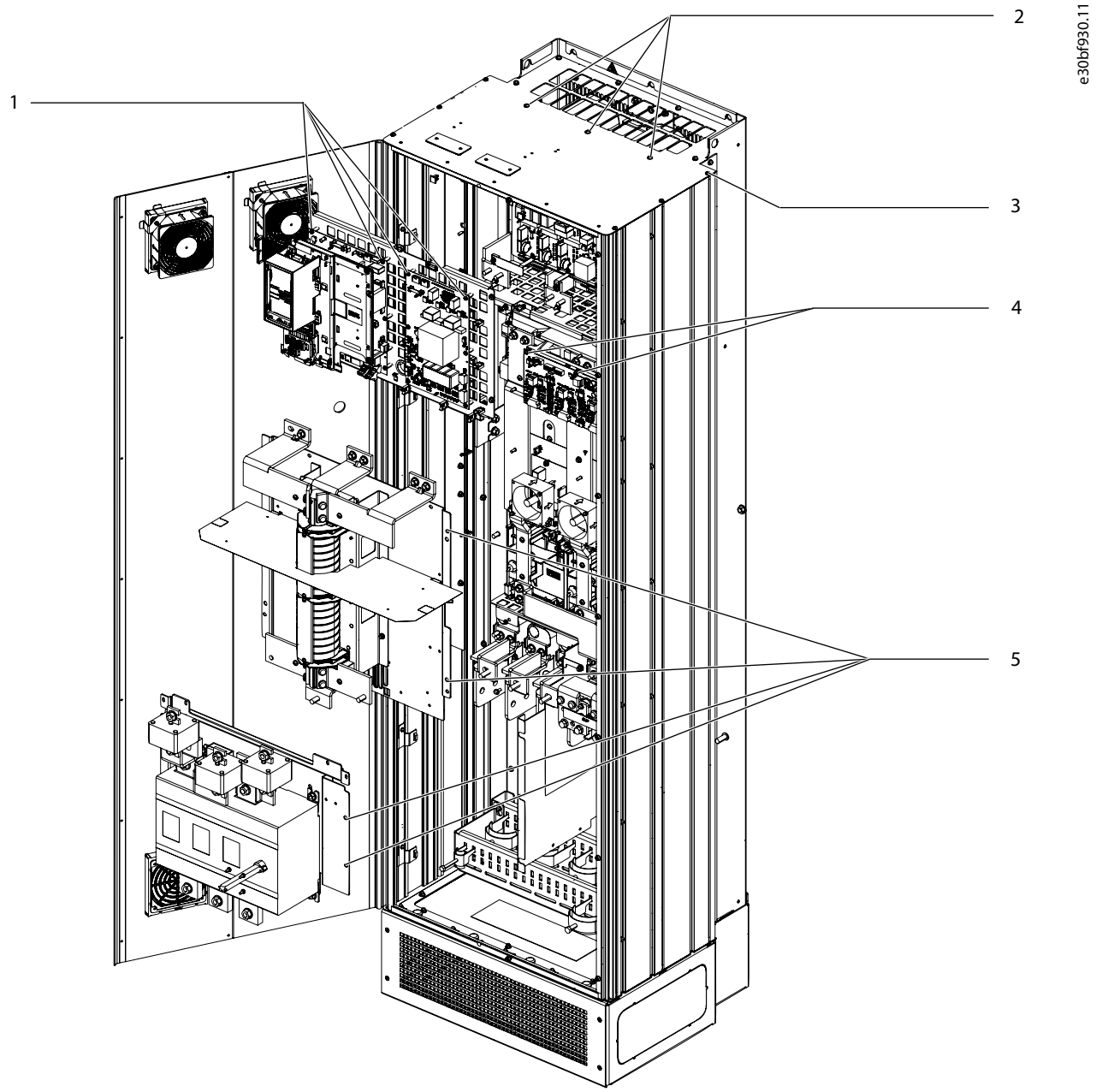


Illustration 7: Unique Torque Values

1	All M4 fasteners [2.3 Nm (20 in-lb)]	4	6 M5 fasteners attaching gate drive card [2.3 Nm (20 in-lb)]
2	3 M5 fasteners [3.9 Nm (35 in-lb)]	5	All M5 fasteners attaching input plates to side mounting rail [3.9 Nm (35 in-lb)]
3	All gasketed M5 fasteners except door screws [3.9 Nm (35 in-lb)]	–	–

4.2 Required Tools

- Lifting equipment rated to lift the weight of the drive module
- Drill with a 12 mm (1/2 in) drill bit
- Tape measurer
- Phillips and flat bladed screwdrivers
- Wrench with 7–17 mm metric sockets and extensions

- T25 and T50 Torx drives
- Sheet metal punch and/or pliers for cable entry plate
- Any additional tools for assembling the cabinet panels according to design plans and established practices

4.3 Operating Environment

N O T I C E

CONDENSATION

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

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

N O T I C E

EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

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

4.3.1 Gases

Aggressive gases, such as hydrogen sulphide, chlorine, or ammonia can damage the electrical and mechanical components. The unit uses conformal-coated circuit boards to reduce the effects of aggressive gases.

For conformal coating class specifications and ratings, see the *Ambient Conditions* section.

4.3.2 Dust

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

- Electronic components.
- Heat sink.
- Fans.

Keep the heat sink and fans free from dust buildup. When dust accumulates on electronic components, it acts as a layer of insulation. This layer reduces the cooling capacity of the components, and the components become warmer. The hotter environment decreases the life of the electronic components. Dust can also accumulate on fan blades, causing an imbalance which prevents the fan from properly cooling the unit. Dust buildup can also damage fan bearings and cause premature fan failure.

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

4.3.3 Potentially Explosive Atmospheres

⚠ W A R N I N G ⚠

EXPLOSIVE ATMOSPHERE

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

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

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

- Class d specifies that if a spark occurs, it is contained in a protected area.
- Class e prohibits any occurrence of a spark.

4.4 Installation Requirements

4.4.1 Thermal Considerations

For heat dissipation values, refer to 7.1 Electrical Data, 380–500 V AC. The following heat sources must be considered when determining cooling requirements:

- Ambient temperature outside enclosure
- Filters (for example, sine-wave and RF)
- Fuses
- Control components

4.4.2 Cooling Requirements

N O T I C E

OVERHEATING

Improper mounting can result in overheating and reduced performance.

– Install the drive following the installation and cooling requirements.

The drive module is equipped with a heat sink fan, which provides the required flow rate of 994 m3 /h (585 cfm) across the heat sink. Also, there are 2 cooling fans mounted on the top of the unit, which provide the required flow rate of 595 m3/h (350 cfm). Typical enclosure designs utilize door fans along with the drive module fans to remove heat/losses from the enclosure.

The drive module utilizes back-channel cooling concept that removes heat sink cooling air. The heat sink cooling air carries approximately 90% of the heat out of the back channel of the drive. Redirect the back-channel air from the panel or the room by using either:

- Back-channel cooling kits to direct the heat sink cooling air out of the panel when IP20/Chassis drives are installed in Rittal enclosures. Use of these kits reduce the heat in the panel, allowing for smaller door fans.
- Back-wall cooling kits that provide top and base covers, allowing back-channel cooling air to be ventilated out of the room.

N O T I C E

When the back channel option is not used, fans mounted in the cabinet must remove all the heat generated inside the enclosure.

– Make sure that the total flow of the cabinet fans meets the recommended airflow.

4.4.3 Busbars

Align busbars vertically to provide maximum airflow. See Table 2 for the rated rms current used for defining the minimum cross-section of customized busbars.

Table 2: Customized Busbar Specifications

Busbar	Rated rms current [A]
Mains	2072
Motor	2150
DC bus	2393

4.5 Exploded View of Parallel Drive System

This example of a 4-module system is composed of a control shelf and 4 VLT® Ea4 Parallel Drive Modules in 2 side-by-side enclosures. The control shelf attaches to the enclosure and holds the LCP and control card, as well as the MDCIC and control terminals. Each module connects to the control shelf via a 44-pin ribbon cable.

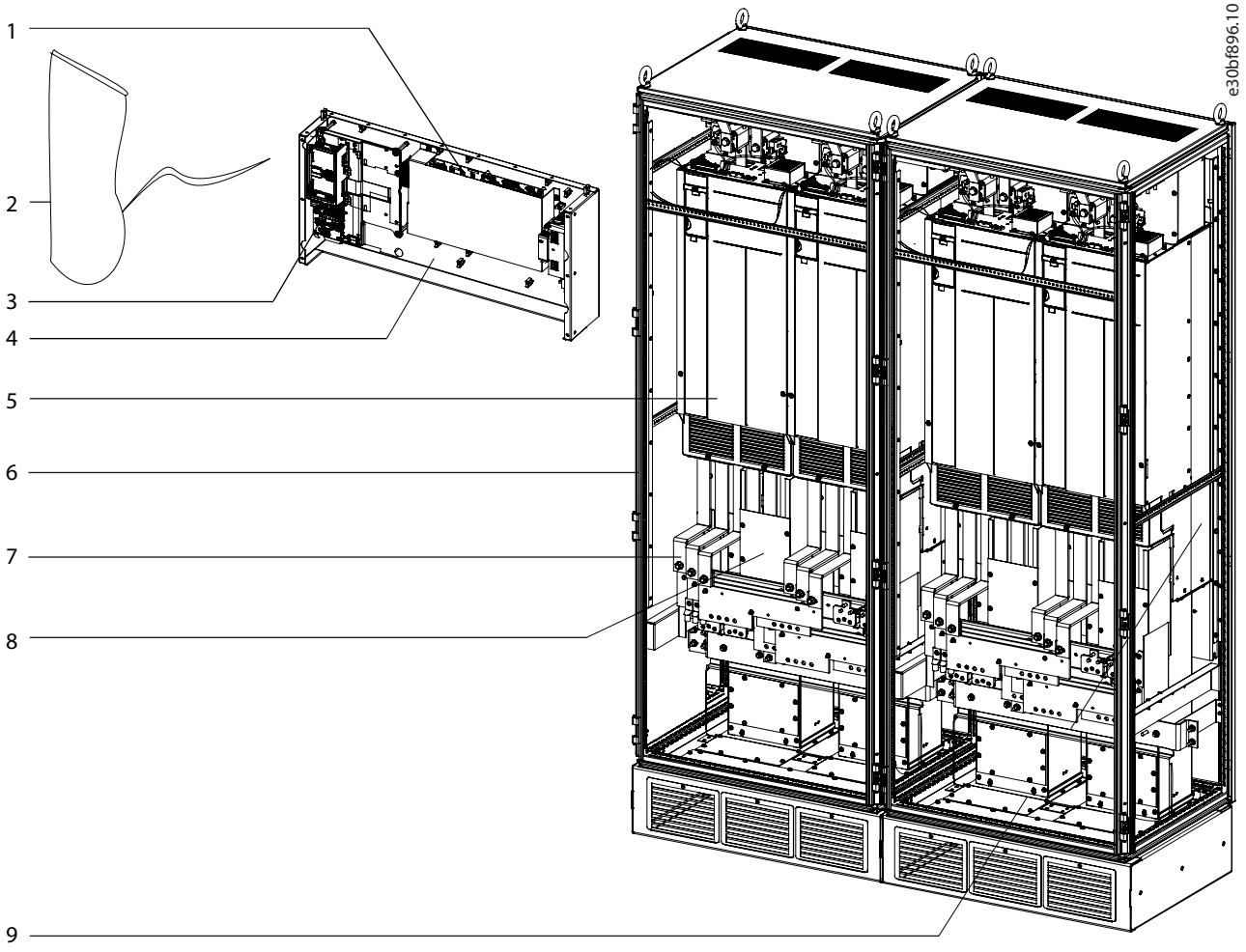


Illustration 8: Exploded View of a 4-module System

1	MDCIC (behind cover plate)	4	Control shelf
2	Local control panel and cable	5	Drive module
3	Control card	6	Enclosure

4.6 Installing the Drive Modules

Procedure

1. Unpack the drive modules.
2. Prepare the drive module for lifting, using an appropriate lifting equipment. See 2.2 Lifting the Drive Module.
3. Secure the top of the drive enclosure to the mounting plate.
4. Secure the base of the drive enclosure to the mounting plate.
5. Line up the groove on the microswitch with the edges on each DC fuse and press firmly until the microswitch clicks into place.
6. Install 2 DC fuses with microswitches onto the tops of the DC-link terminals on each drive module. The microswitches should be installed on the outer side of each terminal.
7. Secure each fuse with 2 M10 screws and torque the screws.
8. Install the next drive module.

4.7 Installing the Control Shelf

N O T I C E

ROUTING CONTROL WIRES

Routing control wiring together or next to power cables and bus bars can cause radio frequency interference.

- Place control wiring at least 00 mm (00 in) away from power cables and bus bars.

Procedure

1. Remove the control shelf assembly from its package.
2. Remove the LCP from the control shelf.
3. Use some type of mounting bracket to install the control shelf. Danfoss does not supply the mounting brackets for the control shelf.
4. Remove the MDCIC cover from the control shelf assembly.
5. Connect the 44-pin ribbon cables from the MDCIC card to the top of the drive modules, following the sequence numbers indicated next to the connectors on the MDCIC.
6. Route the 44-pin ribbon cables inside the cabinet.
7. Connect the external brake fault wiring harness between the microswitch terminals and the brake jumper connector on the top of the drive module.
8. Connect the relay wiring between relay 1 or 2 on the control shelf and the corresponding relay connector on the top of the drive module.

9. Connect the microswitch to the microswitch connector provided on the top of the drive module.

Example

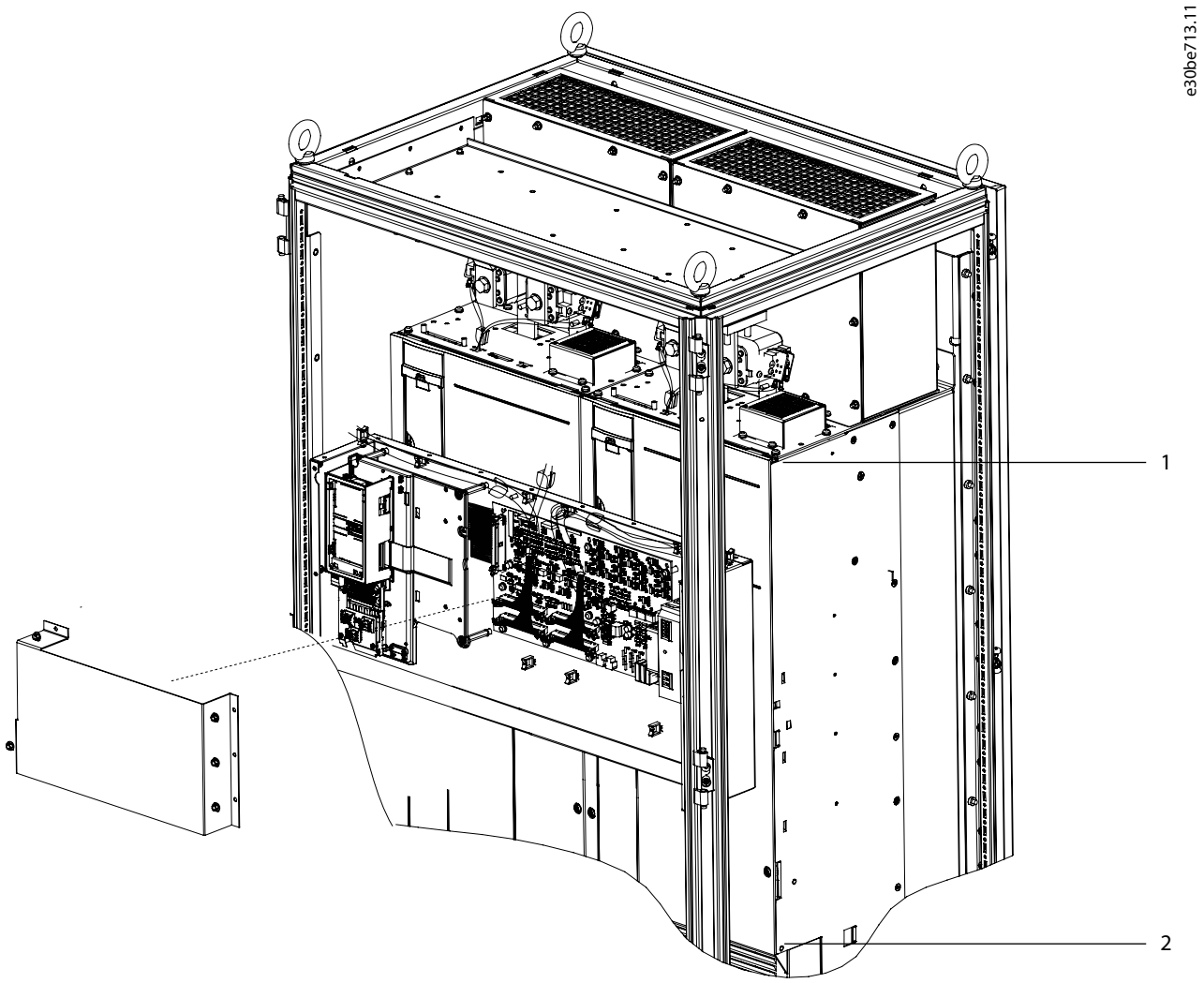


Illustration 9: Positioning the Control Shelf for EMC-compliant Installation

1	Control shelf must stay below this point
2	Control shelf must stay above this point

5 Electrical Installation

5.1 Safety Precautions

NOTICE

EXCESSIVE HEAT AND PROPERTY DAMAGE

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

- Additional protective devices such as short circuit protection or motor thermal protection between drive and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. Refer to the product-specific documentation for fuse specifications.

NOTICE

WIRE TYPE AND RATINGS

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

⚠ WARNING ⚠

INDUCED VOLTAGE

Induced voltage from output motor cables 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.

NOTICE

PROPERTY DAMAGE

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

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

5.2 Electrical Requirements

The following conditions must be met for proper installation. For a list of exceptions, see 1.2 Disclaimer.

- Maximum ambient air temperature is 40 °C (104 °F) at rated current.
- The drive system must be assembled in clean air, according to enclosure classification.
- Maximum voltage and current must not exceed the specified values in 7.1 Electrical Data, 380–500 V AC.
- Follow the local/country electrical code for cable sizing. See 7.1 Electrical Data, 380–500 V AC.

5.3 Wiring Diagram

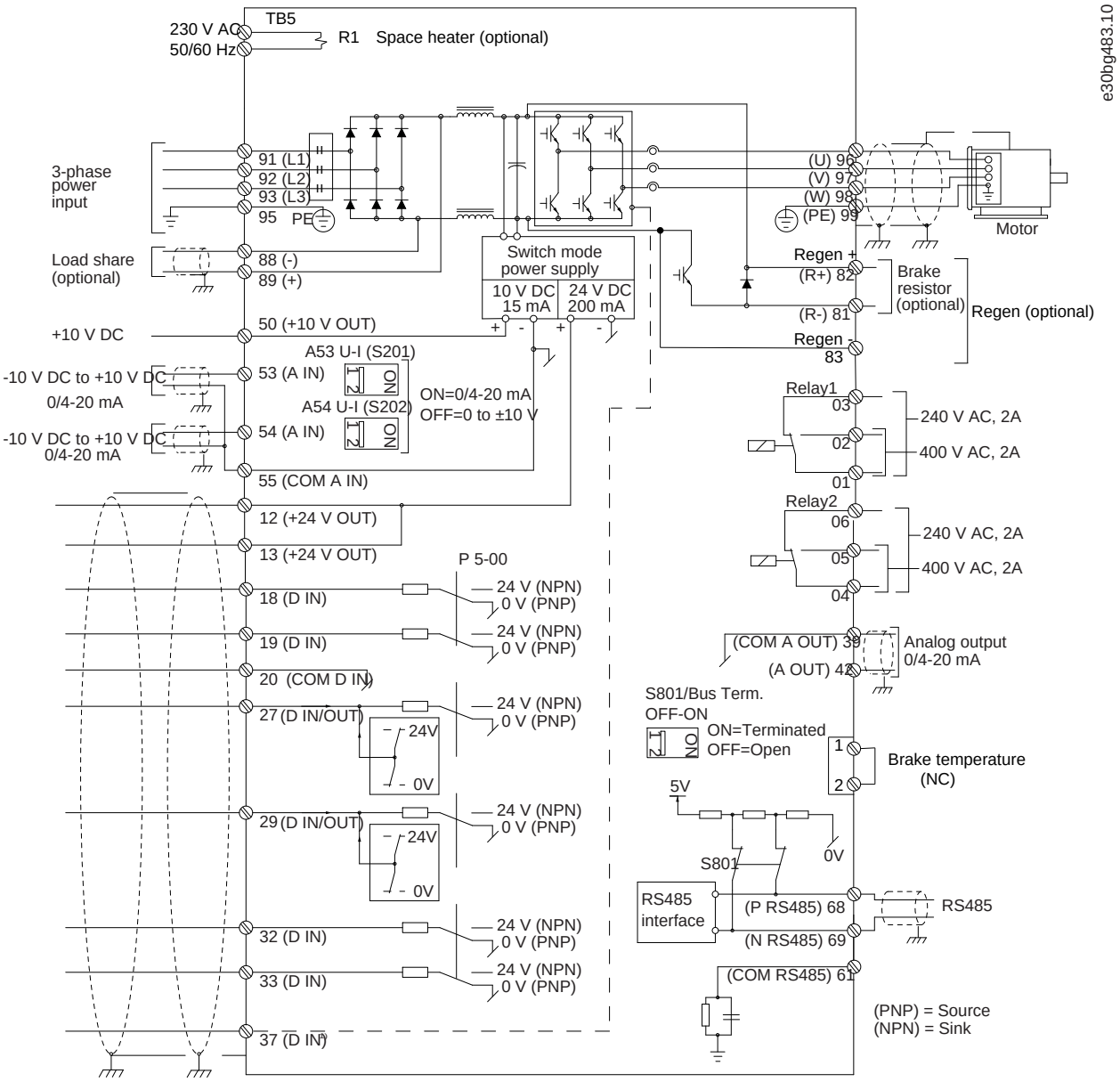


Illustration 10: Ea4 Wiring Diagram

5.4 Block Diagram

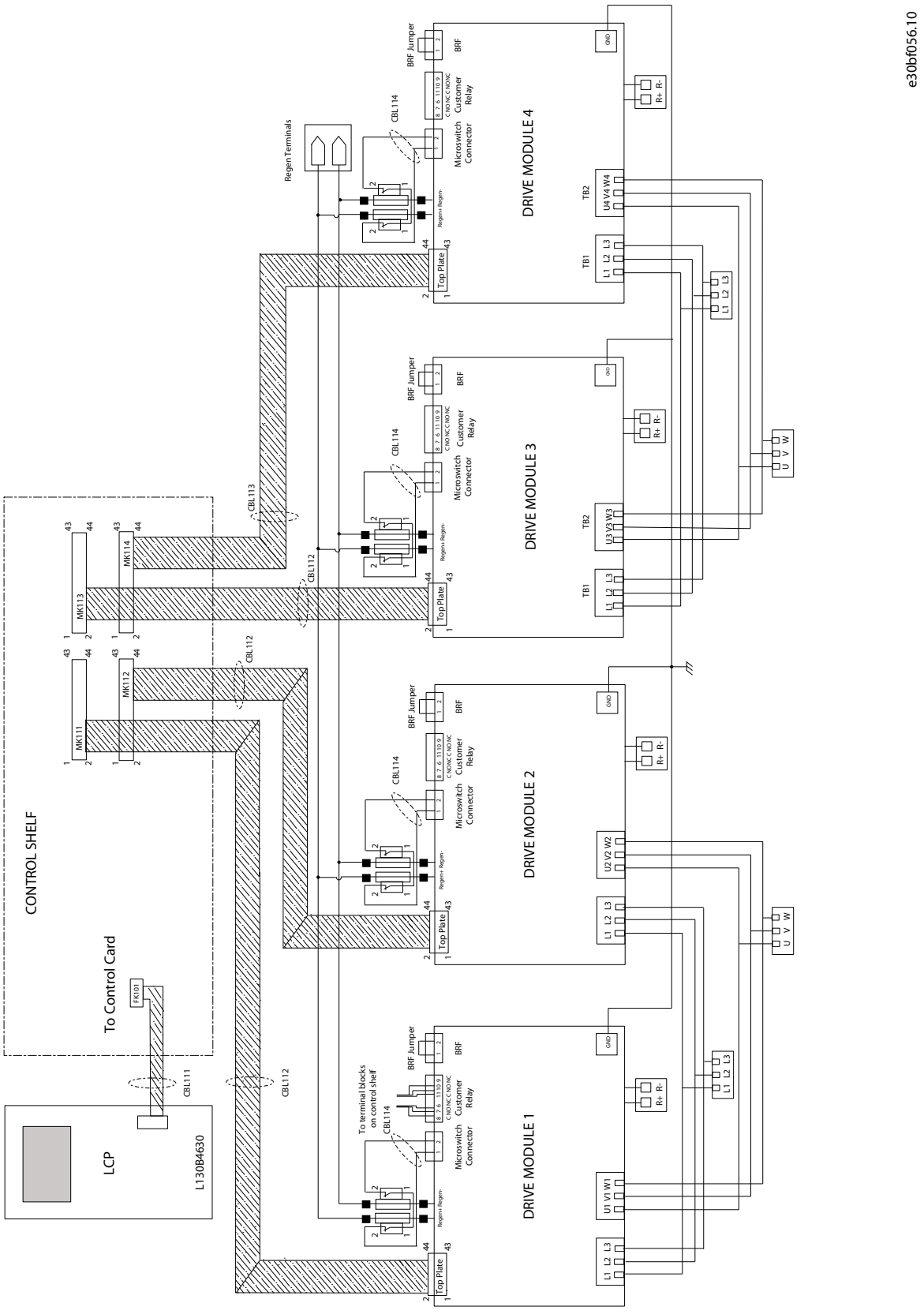


Illustration 11: Eah Block Diagram

5.5 Control Shelf Connections

The control shelf is preassembled. However, verify its various connections against the connection diagram. Illustration 12 shows the various control shelf connections.

N O T I C E

CONNECTION SEQUENCE

If the connections are not made in the correct order, the drive modules do not function.

- Check that the 44-pin ribbon cable is connected to the MDCIC and the control card.
- Check that the STO jumper connection is between the 12th and 37th pins.
- Check that the 44-pin ribbon cables are connected to the MDCIC in the correct order:

2 drive modules	Connect ribbon cables to inverter 1 and then inverter 2. Do not connect inverter terminals 3 and 4.
4 drive modules	Connect ribbon cables to inverter 1, inverter 2, inverter 3, and then inverter 4.

Scaling card position

- Place the corresponding current scaling card on each respective connector.
  - For systems with 2 drive modules, connect inverter 1 and then inverter 2. Do not connect inverter terminals 3 and 4.
  - For systems with 4 drive modules, Inverter 1, Inverter 2, Inverter 3, and Inverter 4.
- Do not reverse the current scaling card. Check that the PCB spacer is fixed on the MDCIC board.
- Ensure correct installation of the STO relay and the supply on the DIN rail.
- Make more checks to ensure that the wiring of the fuse microswitches and the BRF jumpers are properly routed.
- Check that all the screws on the PCBs are secure.
- To ensure proper EMC protection, verify that the MDCIC plate is properly attached to the control shelf assembly.

Example

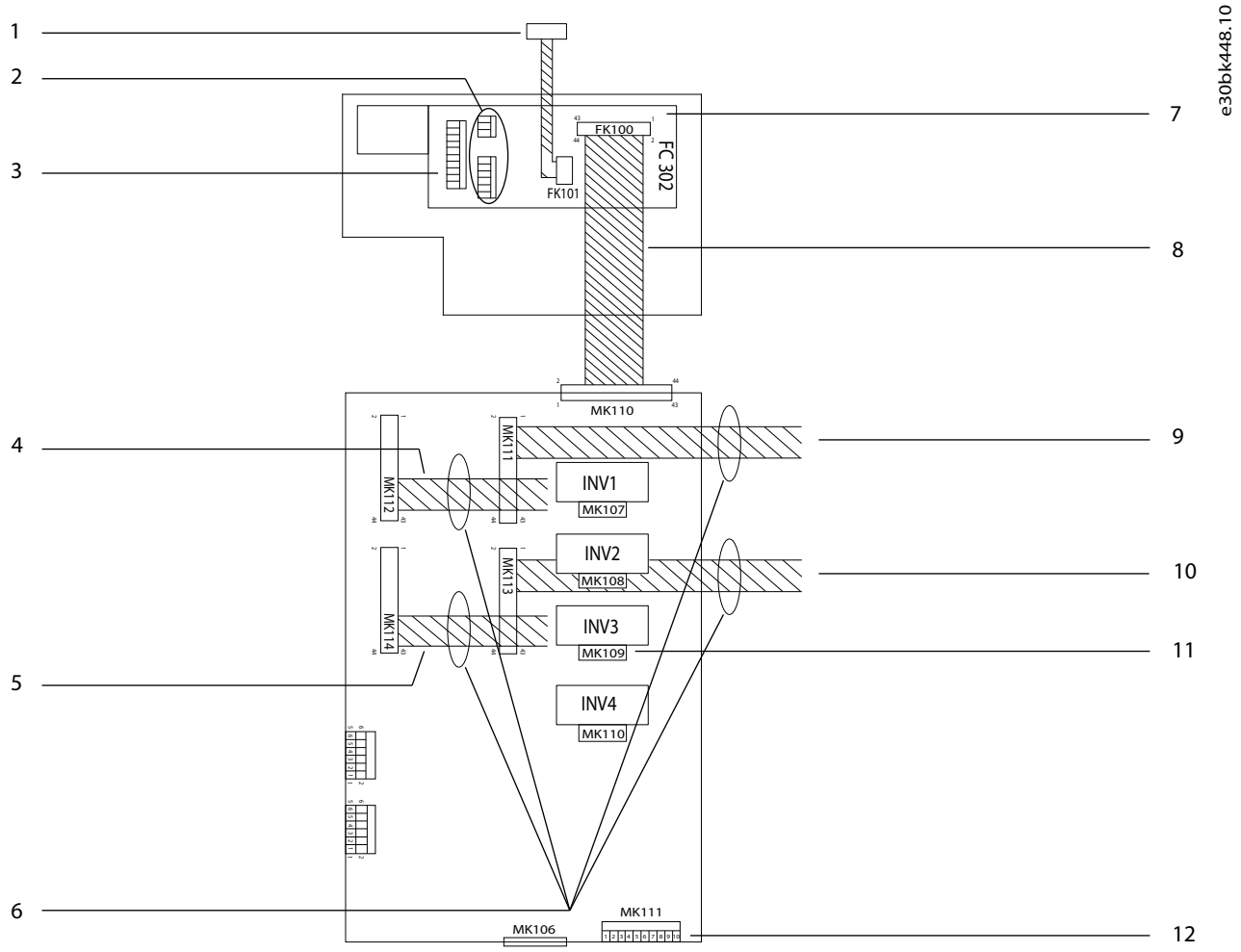


Illustration 12: Control Shelf Connections

1	STO relay	7	44-pin cable to drive module 4 (at MK 114)
2	Terminal block	8	Ferrite cores
3	Cable to remote mounted LCP	9	LCP cradle
4	Analog I/O terminals	10	Ribbon cable from LCP to MDCIC
5	Digital input terminals	11	44-pin cable to drive module 1 (at MK 111)
6	44-pin cable to drive module 3 (at MK 112)	12	44-pin cable to drive module 2 (at MK 113)

5.6 Ground Connections

For EMC-compliant installation:

- Establish electrical contact between the cable shield and the drive enclosure by using metal cable glands or by using the clamps provided on the equipment.
- Reduce burst transient by using high-strand wire.
- Do not use twisted shield ends (pigtails).

⚠ W A R N I N G ⚠

LEAKAGE CURRENT HAZARD

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

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

N O T I C E

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 (5 AWG).

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (6 AWG) (or 2 rated ground wires terminated separately).
- Tighten the terminals. See 4.1 Fastener Torque Ratings.

5.7 Installing DC Bus Fuses

DC fuses are provided in the basic kit. Install the DC fuses at the available DC terminals at individual drive modules. Each DC fuse has a fixture for mounting the microswitches, which are used to detect a fuse failure.

Procedure

1. Install the supplied harness between the microswitch terminals and the brake fault jumper port on the top of the drive modules.
2. Connect the wire harness between the NC and COM terminals.

If successfully installed, the drive powers up when ready for operation. If the DC bus fuse is installed or wired incorrectly, the drive does not power up and the Brake IGBT fault displays.

5.8 Connecting to the Motor

Comply with local and national electrical codes for cable sizes. See 7.1 Electrical Data, 380–500 V AC.

- Follow motor manufacturer wiring requirements.
- Do not wire a starting or pole-changing device (for example, Dahlander motor or slip ring induction motor) between the drive and the motor.

N O T I C E

DRIVE MODULE WIRING

Install an equal number of wires to each set of drive modules.

N O T I C E

MULTIPLE MOTOR CABLES

If connecting more than 1 set of motor terminals, use the same number, size, and length of cables for each set of terminals. For example, do not use 1 cable on one motor terminal and 2 cables on another motor terminal.

Procedure

1. Strip a section of the outer cable insulation.
2. Establish mechanical fixation and electrical contact between the cable shield and ground by positioning the stripped wire under the cable clamp.

3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions. See 5.6 Ground Connections.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
5. Tighten the terminals fasteners. See 4.1 Fastener Torque Ratings.

5.9 Connecting to the AC Mains

Comply with local and national electrical codes for cable sizes. See 7.1 Electrical Data, 380–500 V AC.

N O T I C E

SUPPLY SIDE FUSES

Fuses installed on the supply side ensure that if a component breakdown (first fault) occurs inside the drive module, any potential damage is contained inside the drive enclosure. Each drive module is provided with fast-acting semiconductor fuses on the supply side for protection of the drive module.

N O T I C E

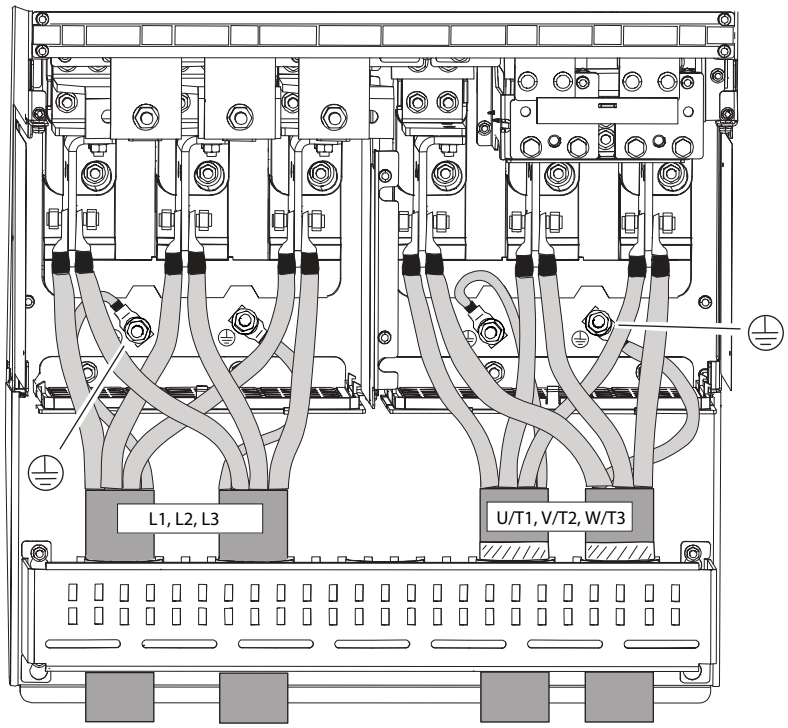
MULTIPLE MAINS CABLES

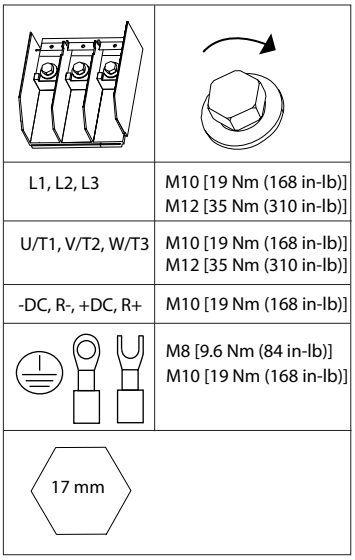
If connecting more than 1 set of mains terminals, use the same number, size, and length of cables for each set of terminals. For example, do not use 1 cable on one mains terminal and 2 cables on another mains terminal.

Procedure

1. Strip a section of the outer cable insulation.
2. Establish mechanical fixation and electrical contact between the cable shield and ground by positioning the stripped wire under the cable clamp.
3. Connect the 3-phase AC input power wiring to terminals R, S, and T.
4. Tighten the terminals fasteners. See 4.1 Fastener Torque Ratings.
5. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to *[0] Off* to avoid damage to the DC link and to reduce ground capacity currents.

5.10 Example of the Ground, Motor, and Mains Wiring



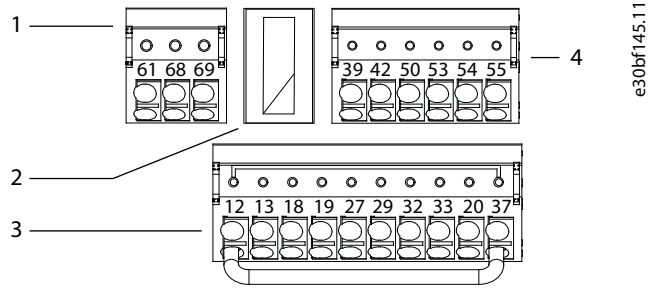


e30bk449.10

Illustration 13: Ground, Motor, Mains Wiring Example

5.11 Installing Control Wiring

5.11.1 Control Terminals



e30bf145.11

Illustration 14: Control Terminal Locations

1	Terminals (+) 68 and (-) 69 are for serial communication connection.	3	4 programmable digital input terminals, 2 extra digital terminals programmable as either input or output, a 24 V DC supply voltage, and a common for optional customer-supplied 24 V DC voltage.
2	USB port available for use with the MCT 10 setup software.	4	2 analog inputs, 1 analog output, 10 V DC supply voltage, and commons for the inputs and output.

Table 3: Serial Communication Terminals

Terminal	Parameter	Default Setting	Description
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield if EMC problems exist.
68	*Parameter group 8-3* FC Port Settings*	–	RS485 interface. A switch (BUS TER.) is provided on the control card for bus termination resistance. See Illustration 20.
69	*Parameter group 8-3* FC Port Settings*	–	

Table 4: Digital Input/Output Terminal Descriptions

Terminal	Parameter	Default setting	Description
12, 13	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.
18	*Parameter 5-10 Terminal 18 Digital Input*	*[8] Start*	Digital inputs.
19	*Parameter 5-11 Terminal 19 Digital Input*	*[10] Reversing*	
32	*Parameter 5-14 Terminal 32 Digital Input*	*[0] No operation*	
33	*Parameter 5-15 Terminal 33 Digital Input*	*[0] No operation*	
27	*Parameter 5-12 Terminal 27 Digital Input*	*[2] Coast inverse*	For digital input or output. Default setting is input.
29	*Parameter 5-13 Terminal 29 Digital Input*	*[14] JOG*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	STO	When not using the optional STO feature, a jumper wire is required between terminal 12 (or 13) and terminal 37. This set-up allows the drive to operate with factory default programming values.

Table 5: Analog Input/Output Terminal Descriptions

Terminal	Parameter	Default setting	Description
39	–	–	Common for analog output.
42	*Parameter 6-50 Terminal 42 Output*	*[0] No operation*	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	–	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.

Terminal	Parameter	Default setting	Description
53	*Parameter group 6-1* Analog Input 1*	Reference	Analog input. For voltage (V) or current (mA).
54	*Parameter group 6-2* Analog Input 2*	Feedback	
55	–	–	Common for analog input.

5.11.2 Relay Terminals

The relay terminals are on the top plate of the drive module. See Illustration 4. Use an extended wiring harness to connect the relay terminal of drive module 1 (the drive module on the far left) to the terminal blocks on the control shelf.

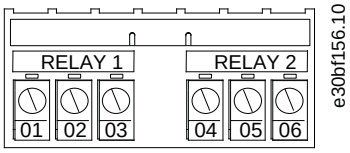


Illustration 15: Relay 1 and Relay 2 Terminals

Table 6: Relay 01 Terminal Descriptions

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

Table 7: Relay 02 Terminal Descriptions

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

5.11.3 Routing Control Cables

Make sure to use the provided wire pathway when routing the control wires from the bottom of the drive system cabinet to the control terminal.

Procedure

1. Tie down and route all control cables at the bottom of the enclosure.
2. Isolate control cables from high-power cables in the drive.
3. Connect the shields in a proper way to ensure optimum electrical immunity.
4. When the drive is connected to a thermistor, ensure that the thermistor control cable is shielded and reinforced/double insulated. A 24 V DC supply is recommended.
5. Connect the control cables to the relevant options on the control card. For more detail, see the relevant fieldbus instructions. The fieldbus cable must be tied down and routed along with the other control cables inside the unit.

   All control terminals are on the control shelf below the LCP.

Example

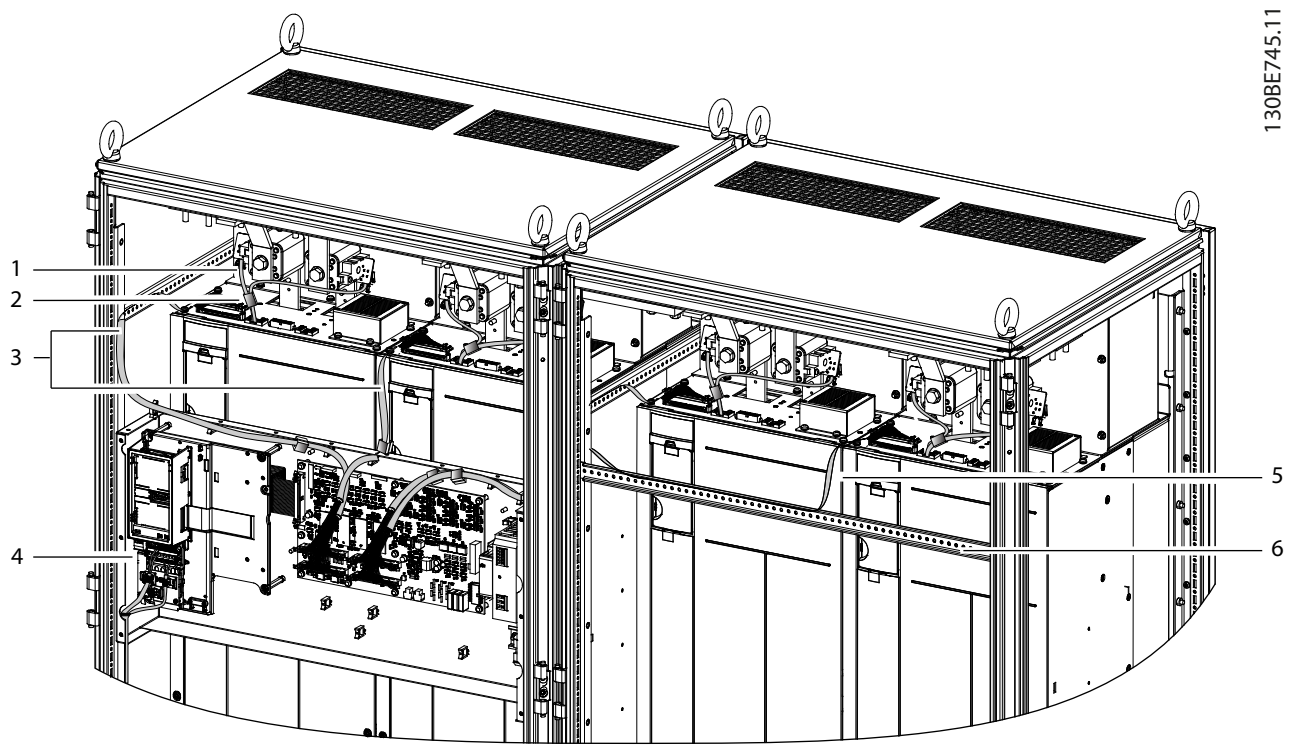


Illustration 16: Control Cable Routing for a 4-drive System

1	Microswitch cable	4	Control terminals
2	Ferrite core	5	44-pin ribbon cable from MDCIC to drive module 4
3	44-pin ribbon cable from MDCIC to drive modules 1 and 2	6	Bracket to support ribbon cable

5.11.4 Connecting the Control Cable to the Control Terminals

The control terminals are located near the LCP, as shown in Illustration 16. The control terminal connectors can be unplugged from the drive for convenience when wiring. Either solid or flexible wire can be connected to the control terminals. For minimum and maximum control cable cross-section, refer to the *Cable Specifications* section.

NOTICE

ELECTRICAL INTERFERENCE

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

Procedure

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

Loose control cable can cause equipment faults or reduced performance.

Example

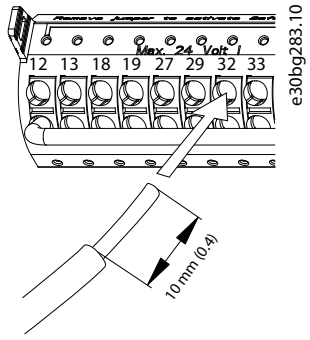


Illustration 17: Connecting a Solid Control Cable to the Terminal Box

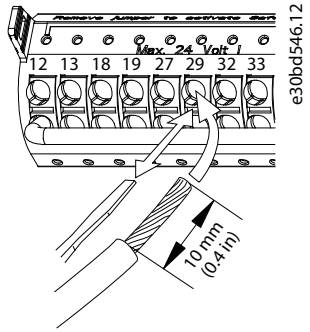


Illustration 18: Connecting a Flexible Control Cable to the Terminal Box

5.11.5 Disconnecting the Control Cable from the Control Terminals

Procedure

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

5.12 Enabling Motor Operation

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

N O T I C E

FACTORY-INSTALLED OPTIONAL EQUIPMENT

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

Procedure

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

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

5.13 RS485 Serial Communication

5.13.1 RS485 Features

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

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

5.13.2 Configuring RS485 Serial Communication

Procedure

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

Example

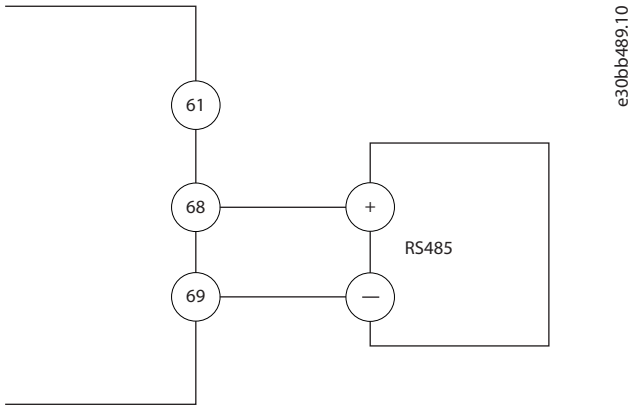


Illustration 19: Serial Communication Wiring Diagram

5.14 Selecting the Voltage/Current Input Signal

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

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

Procedure

1. Disconnect power to the drive.
2. Remove the LCP (local control panel). See the *Local Control Panel (LCP)* section.
3. Remove any optional equipment covering the switches.

4. Set switches A53 and A54 to select the signal type (U = voltage, I = current). See Illustration 20.

Example

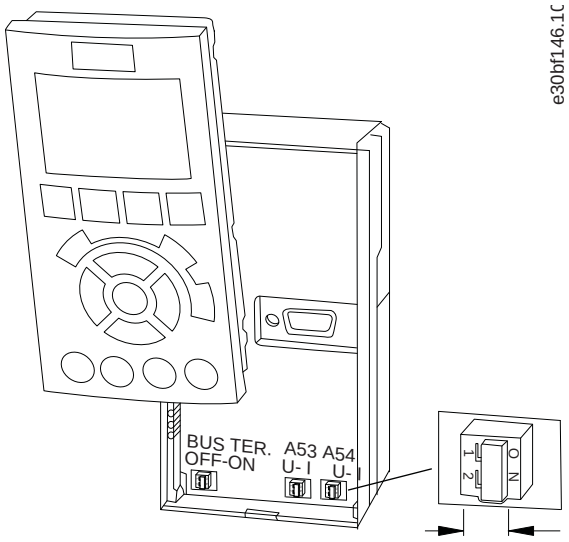


Illustration 20: Location of Switches A53 and A54

6 Operating the Drive

6.1 Pre-start Check List

Table 8: Pre-start Check List

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

Inspect	✓	Check for
		For IP20/Type 1 enclosures, ensure that the unit is mounted on an unpainted, metal surface.
Vibration		Check that the unit is mounted solidly, or that shock mounts are used, if necessary.
		Check for an unusual amount of vibration.

6.2 Applying Power to the Drive

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

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

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

⚠ WARNING ⚠

UNINTENDED START

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

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

NOTICE

MISSING SIGNAL

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

- See 5.12 Enabling Motor Operation for details.

Procedure

1. Before applying power to the drive, verify that the drive and any associated equipment is ready for operation. Refer to the *Pre-start Check List*.
2. Ensure that all operated devices are in the OFF position.
3. Ensure that input power to the unit is OFF and locked out. Do not rely on the drive disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to phase, and phase-to-ground.
6. Ensure that any optional equipment wiring matches the installation requirements.
7. Close and securely fasten all covers and doors on the drive.
8. Confirm that the input voltage is balanced within 3%. If not balanced, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
9. Apply power to the unit, but do not start the drive. For units with a disconnect switch, turn the switch to the ON position to apply power to the drive.

6.3 Local Control Panel (LCP)

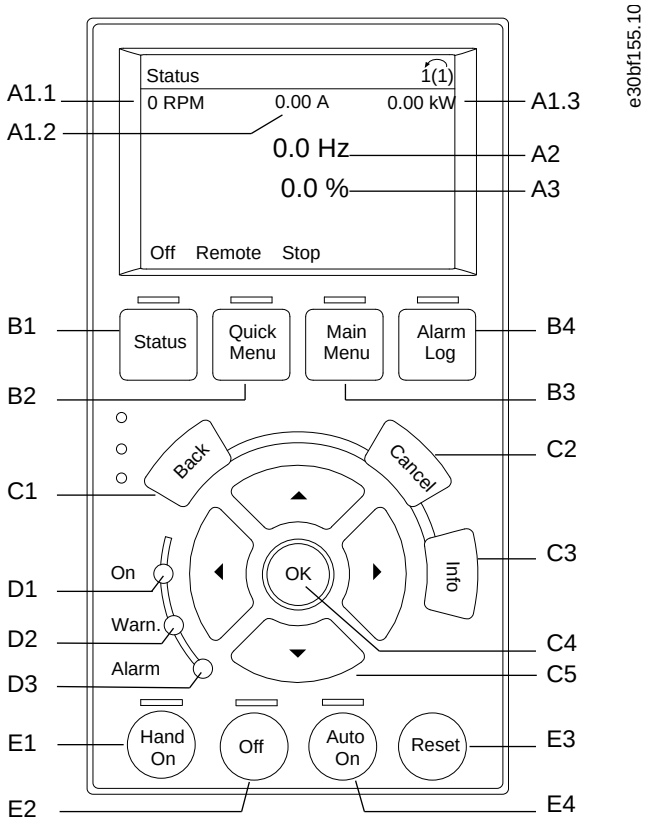


Illustration 21: Graphical Local Control Panel (LCP)

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

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

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

A. Display area

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

Table 9: LCP Display Area

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

B. Menu keys

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

Table 10: LCP Menu Keys

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

C. Navigation keys

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

Table 11: LCP Navigation Keys

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

D. Indicator lights

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

Table 12: LCP Indicator Lights

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

E. Operation keys and reset

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

Table 13: LCP Operation Keys and Reset

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

6.4 LCP Menu

Quick Menus

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

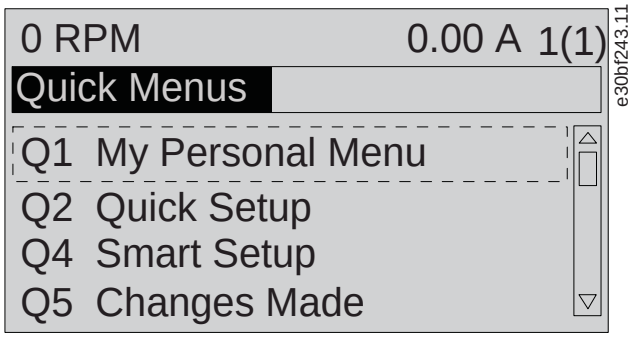


Illustration 22: Quick Menu View

Q1 My Personal Menu

The *Personal Menu* is used to determine what is shown in the display area. Refer to 6.3 Local Control Panel (LCP). This menu can also show up to 50 pre-programmed parameters. These 50 parameters are manually entered using *parameter 0-25 My Personal Menu*.

Q2 Quick Setup

The parameters found in the *Q2 Quick Setup* contain basic system and motor data that are always necessary for configuring the drive. See 6.5 Entering System Information for the setup procedures.

Q4 Smart Setup

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

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

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

Q5 Changes Made

Select *Q5 Changes Made* for information about:

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

Q6 Loggings

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

Table 14: Logging Parameter Examples

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

Q7 Motor Setup

The parameters found in the *Q7 Motor Setup* contain basic and advanced motor data that are always necessary for configuring the drive. This option also includes parameters for encoder setup.

Main Menu

The *Main Menu* mode is used to:

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

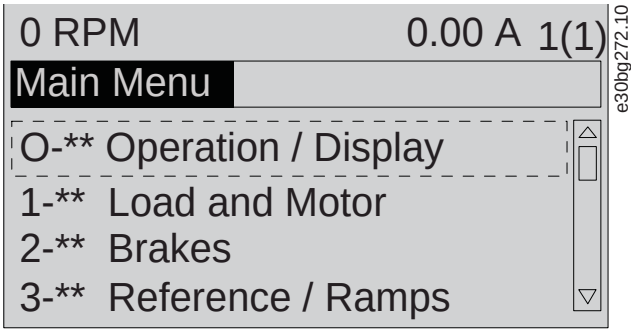


Illustration 23: Main Menu View

For more detailed information on the menus or parameters, refer to the programming guide.

6.5 Entering System Information

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

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

N O T I C E

SOFTWARE DOWNLOAD

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

– See https://www.danfoss.com/en/service-and-support/downloads/?sort=title_asc&filter=download-type%3Dtools.

Procedure

1. Press [Main Menu] on the LCP.
2. Select *0–** Operation/Display* and press [OK].
3. Select *0–0* Basic Settings* and press [OK].
4. Select *parameter 0-03 Regional Settings* and press [OK].
5. Select *[0] International* or *[1] North America* as appropriate and press [OK]. (This action changes the default settings for some basic parameters).
6. Press [Quick Menus] on the LCP and then select *02 Quick Setup*.
7. If needed, change the following parameter settings. Motor data is found on the motor nameplate.
   - **a.** *Parameter 0-01 Language* (English)
   - **b.** *Parameter 1-20 Motor Power* (4.00 kW)
   - **c.** *Parameter 1-22 Motor Voltage* (400 V)
   - **d.** *Parameter 1-23 Motor Frequency* (50 Hz)
   - **e.** *Parameter 1-24 Motor Current* (9.00 A)
   - **f.** *Parameter 1-25 Motor Nominal Speed* (1420 RPM)
   - **g.** *Parameter 5-12 Terminal 27 Digital Input* (Coast Inverse)
   - **h.** *Parameter 3-02 Minimum Reference* (0.000 RPM)
   - **i.** *Parameter 3-03 Maximum Reference* (1500.000 RPM)
   - **j.** *Parameter 3-41 Ramp 1 Ramp up Time* (3.00 s)
   - **k.** *Parameter 3-42 Ramp 1 Ramp Down Time* (3.00 s)
   - **l.** *Parameter 3-13 Reference Site* (Linked to Hand/Auto)
   - **m.** *Parameter 1-29 Automatic Motor Adaptation* (Off)

6.6 Testing Before System Start Up

⚠ W A R N I N G ⚠

MOTOR START

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

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

6.6.1 Testing Motor Rotation

N O T I C E

INCORRECT MOTOR ROTATION

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

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

Procedure

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

   The motor runs briefly at either 5 Hz or the minimum frequency set in *parameter 4-12 Motor Speed Low Limit [Hz]*.
4. If the motor rotation is wrong, set *parameter 1-06 Clockwise Direction* to *[1] Inverse*.

6.7 Starting Up the Drive for the First Time

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

⚠ W A R N I N G ⚠

MOTOR START

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

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

1. Press [Auto On].

   If warnings or alarms occur, see the *Warnings and Alarms* section.
2. Apply an external run command. Examples of external run commands are a switch, button, or programmable logic controller (PLC).
3. Adjust the speed reference throughout the speed range.
4. Ensure that the system is working as intended by checking the sound and vibration levels of the motor.
5. Remove the external run command.

6.8 Status Messages

6.8.1 Status Message Overview

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

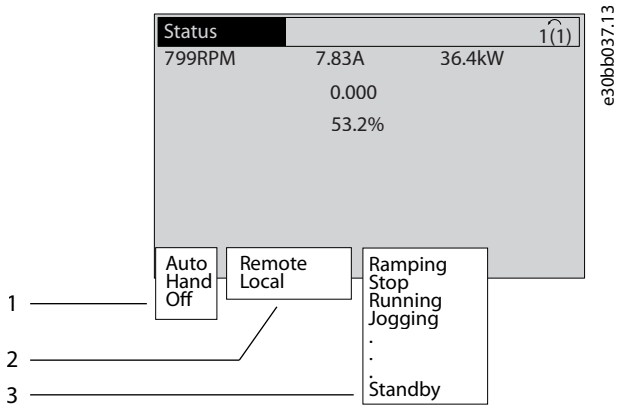


Illustration 24: Status Display

1	See 6.8.2 Status Messages - Operating Mode.	3	See 6.8.4 Status Messages - Operation Status.
2	See 6.8.3 Status Messages - Reference Site.		

6.8.2 Status Messages - Operating Mode

Table 15: Operating Mode

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

6.8.3 Status Messages - Reference Site

Table 16: Reference Site

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

6.8.4 Status Messages - Operation Status

Table 17: Operation Status

Operation status	Description
AC brake	AC brake was selected in *parameter 2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.

Operation status	Description
AMA ready	AMA is ready to start. To start, press [Hand On].
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. The brake resistor absorbs the generative energy.
Coast	• *[2] Coast inverse* was selected as a function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication. • No output from the drive to the motor.
Ctrl. ramp-down	*[1] Ctrl. ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault*. • The drive ramps down the motor in a controlled manner.
Current high	The drive output current is above the limit set in *parameter 4-51 Warning Current High*.
Current low	The drive output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC hold	DC hold is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold Current*.
DC stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • DC brake is activated in *parameter 2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • DC brake (inverse) is selected as a function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedback is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedback is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • *[20] Freeze Output* was selected as a function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and speed down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	*[19] Freeze Reference* was selected as a function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal is active. The drive saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.
Jog request	A jog command has been given, but the motor is stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *parameter 3-19 Jog Speed [RPM]*.

Operation status	Description
	• *[14] Jog* was selected as function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.
OVC control	Overvoltage control was activated by *[2] Enabled* in *parameter 2-17 Over-voltage Control*. The connected motor is supplying the drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the drive from tripping.
Power unit off	(For drives with a 24 V external supply installed only.) Mains supply to the drive is removed, but the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, the switching frequency is reduced to 1.5 kHz if *parameter 14-55 Output Filter* is set to *[2] Sine-Wave Filter Fixed*. Otherwise, the switching frequency is reduced to 1.0 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.
Qstop	The motor is decelerating using *parameter 3-81 Quick Stop Ramp Time*. • *[4] Quick stop inverse* was selected as a function for a digital input (*parameter group 5–1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The drive is driving the motor.
Sleep mode	The energy-saving function is enabled. This function being enabled means that now the motor has stopped, but that it restarts automatically when required.
Speed high	The motor speed is above the value set in *parameter 4-53 Warning Speed High*.
Speed low	The motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
Standby	In auto-on mode, the drive starts the motor with a start signal from a digital input or serial communication.
Start delay	In *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	*[12] Enable Start Forward* and *[13] Enable Start Reverse* were selected as functions for 2 different digital inputs (*parameter group 5–1* Digital Inputs*). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	The drive has received a stop command from 1 of the following:

Operation status	Description
	• LCP. • Digital input. • Serial communication.
Trip/Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, reset the drive using 1 of the following: • Pressing [Reset]. • Remotely by control terminals. • Via serial communication.

6.9 Warnings and Alarms

6.9.1 Warning and Alarm Types

Alarm

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

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

Warning

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

Trip

When tripping, the drive suspends operation to prevent damage to the drive and other equipment. When a trip occurs, the motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive is ready for a reset.

Trip lock

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

LCP notification

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

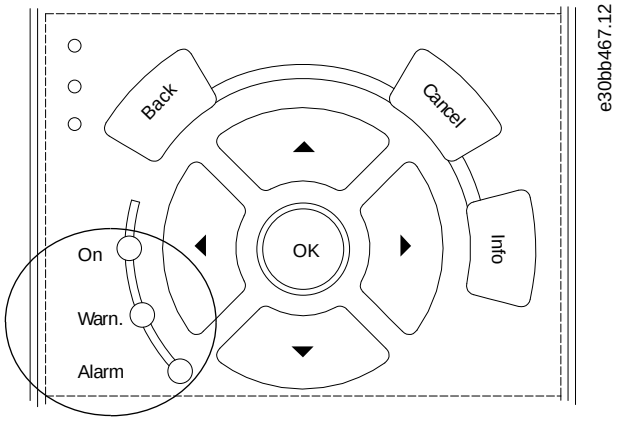


Illustration 25: Status Indicator Lights

Table 18: Fault Types

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

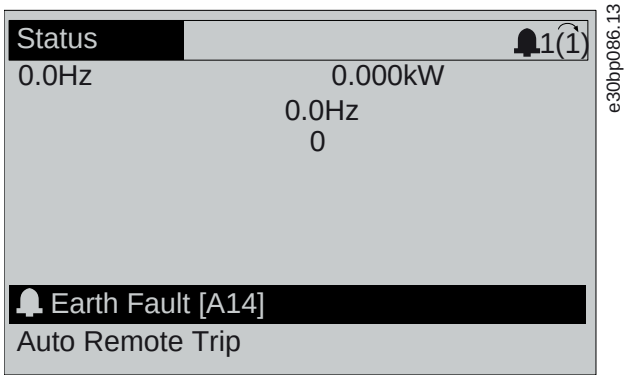


Illustration 26: Alarm Example

6.9.2 Warning and Alarm Types

Alarm

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

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

Warning

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

Trip

When tripping, the drive suspends operation to prevent damage to the drive and other equipment. When a trip occurs, the motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive is ready for a reset.

Trip lock

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

LCP notification

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

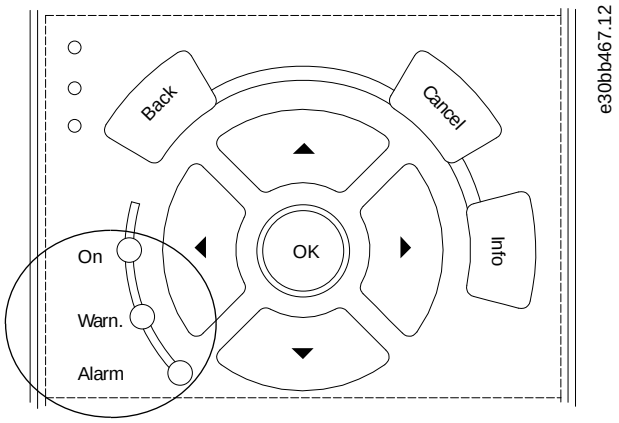


Illustration 27: Status Indicator Lights

Table 19: Fault Types

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

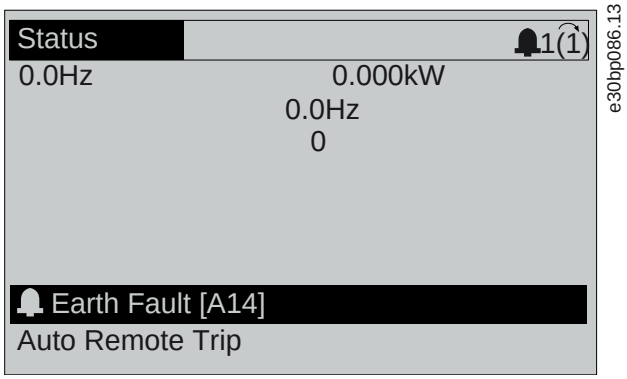


Illustration 28: Alarm Example

6.9.3 WARNING 1, 10 Volts Low

Cause

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

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

Troubleshooting

Remove the wiring from terminal 50.

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

6.9.4 WARNING/ALARM 2, Live Zero Error

Cause

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

Troubleshooting

- Check connections on all analog mains terminals.

- Control card terminals 53 and 54 for signals, terminal 55 common.
- VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
- VLT® Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.

- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

6.9.5 WARNING/ALARM 3, No Motor

Cause

No motor is connected to the output of the drive.

6.9.6 WARNING/ALARM 4, Mains Phase Loss

Cause

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

Troubleshooting

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

6.9.7 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.

6.9.8 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.

6.9.9 WARNING/ALARM 7, DC Overvoltage

Cause

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

Troubleshooting

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

6.9.10 WARNING/ALARM 8, DC Undervoltage

Cause

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

Troubleshooting

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

6.9.11 WARNING/ALARM 9, Inverter Overload

Cause

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

Troubleshooting

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

6.9.12 WARNING/ALARM 10, Motor Overload Temperature

Cause

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

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

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

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

Troubleshooting

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

6.9.13 WARNING/ALARM 11, Motor Thermistor Overtemp

Cause

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

Troubleshooting

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

6.9.14 WARNING/ALARM 12, Torque Limit

Cause

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

Troubleshooting

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

6.9.15 WARNING/ALARM 13, Overcurrent

Cause

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

Troubleshooting

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

6.9.16 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.

6.9.17 ALARM 15, Hardware Mismatch

Cause

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

Troubleshooting

Record the value of the following parameters and contact Danfoss.

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

6.9.18 ALARM 16, Short Circuit

Cause

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

Troubleshooting

⚠ W A R N I N G ⚠

HAZARDOUS VOLTAGE

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

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

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

6.9.19 WARNING/ALARM 17, Control Word Timeout

Cause

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

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

Troubleshooting

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

6.9.20 WARNING/ALARM 20, Temp. Input Error

Cause

The temperature sensor is not connected.

6.9.21 WARNING/ALARM 21, Parameter Error

Cause

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

Troubleshooting

- Set the affected parameter to a valid value.

6.9.22 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*).

6.9.23 WARNING 23, Internal Fan Fault

Cause

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

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

Troubleshooting

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

6.9.24 WARNING 24, External Fan Fault

Cause

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

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

Troubleshooting

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

6.9.25 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*).

6.9.26 WARNING/ALARM 26, Brake Resistor Power Limit

Cause

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

6.9.27 WARNING/ALARM 27, Brake Chopper Fault

Cause

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

Troubleshooting

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

6.9.28 WARNING/ALARM 28, Brake Check Failed

Cause

The brake resistor is not connected or not working.

Troubleshooting

- Check *parameter 2-15 Brake Check*.

6.9.29 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.

6.9.30 ALARM 30, Motor Phase U Missing

Cause

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

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

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

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

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

6.9.31 ALARM 31, Motor Phase V Missing

Cause

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

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

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

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

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

6.9.32 ALARM 32, Motor Phase W Missing

Cause

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

Troubleshooting

⚠ WARNING ⚠

HAZARDOUS VOLTAGE

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

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

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

6.9.33 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.

6.9.34 WARNING/ALARM 34, Fieldbus Communication Fault

Cause

The fieldbus on the communication option card is not working.

6.9.35 WARNING/ALARM 35, Option Fault

Cause

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

6.9.36 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.

6.9.37 ALARM 37, Phase Imbalance

Cause

There is a current imbalance between the power units.

6.9.38 ALARM 38, Internal Fault

Cause

When an internal fault occurs, a code number defined in Table 20 is shown.

Troubleshooting

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

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

Table 20: Internal Fault Codes

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive also uses this fault code if the MCO does not power up correctly. This situation can occur due to poor EMC protection or improper grounding.

Number	Text
1796	RAM copy error.
2561	Replace the control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376– 6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

6.9.39 ALARM 39, Heat Sink Sensor

Cause

There is no feedback from the heat sink temperature sensor.

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

Troubleshooting

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

6.9.40 WARNING 40, Overload of Digital Output Terminal 27

Troubleshooting

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

6.9.41 WARNING 41, Overload of Digital Output Terminal 29

Troubleshooting

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

6.9.42 WARNING 42, Ovrld X30/6-7

Troubleshooting

For terminal X30/6:

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

For terminal X30/7:

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

6.9.43 ALARM 43, Ext. Supply

Cause

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

Troubleshooting
Choose 1 of the following:

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

6.9.44 ALARM 45, Earth Fault 2

Cause
Ground fault.

Troubleshooting

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

6.9.45 ALARM 46, Power Card Supply

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

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

- 24 V.
- 5 V.
- ±18 V.

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

Troubleshooting

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

6.9.46 WARNING 47, 24 V Supply Low

Cause
The supply on the power card is out of range.

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

- 24 V.
- 5 V.
- ±18 V.

Troubleshooting

- Check for a defective power card.

6.9.47 WARNING 48, 1.8 V Supply Low

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

Troubleshooting

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

6.9.48 WARNING 49, Speed Limit

Cause

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

6.9.49 ALARM 50, AMA Calibration Failed

Cause

A calibration error has occurred.

Troubleshooting

- Contact the Danfoss supplier or Danfoss service department.

6.9.50 ALARM 51, AMA Check Unom and Inom

Cause

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

Troubleshooting

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

6.9.51 ALARM 52, AMA Low Inom

Cause

The motor current is too low.

Troubleshooting

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

6.9.52 ALARM 53, AMA Motor Too Big

Cause

The motor is too big for the AMA to operate.

Troubleshooting

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

6.9.53 ALARM 54, AMA Motor Too Small

Cause

The motor is too small for the AMA to operate.

Troubleshooting

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

6.9.54 ALARM 55, AMA Parameter Out of Range

Cause

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

Troubleshooting

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

6.9.55 ALARM 56, AMA Interrupted by User

Cause

The AMA is manually interrupted.

Troubleshooting

- Re-run the AMA calibration.

6.9.56 ALARM 57, AMA Internal Fault

Cause

Internal fault.

Troubleshooting

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

6.9.57 ALARM 58, AMA Internal Fault

Cause
Internal fault.

Troubleshooting
Contact the Danfoss supplier.

6.9.58 WARNING 59, Current Limit

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

Troubleshooting

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

6.9.59 WARNING 60, External Interlock

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

Troubleshooting

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

6.9.60 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.*

6.9.61 WARNING 62, Output Frequency at Maximum Limit

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

Troubleshooting

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

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

6.9.62 ALARM 63, Mechanical Brake Low

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

6.9.63 WARNING 64, Voltage Limit

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

6.9.64 WARNING/ALARM 65, Control Card Overtemperature

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

Troubleshooting

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

6.9.65 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*.

6.9.66 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.

6.9.67 ALARM 68, Safe Stop Activated

Cause

Safe Torque Off (STO) has been activated.

Troubleshooting

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

6.9.68 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.

6.9.69 ALARM 71, PTC 1 Safe Stop

Cause

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

Troubleshooting

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

6.9.70 ALARM 72, Dangerous Failure

Cause

Safe Torque Off (STO) with trip lock.

Troubleshooting

An unexpected combination of STO commands has occurred:

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

6.9.71 WARNING 73, Safe Stop Auto Restart

Cause
STO activated.

Troubleshooting

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

6.9.72 ALARM 74, PTC Thermistor

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

6.9.73 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*.

6.9.74 Warning 76, Power Unit Setup

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

Troubleshooting

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

6.9.75 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.

6.9.76 ALARM 78, Tracking Error

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

Troubleshooting

- Disable the function or select an alarm/warning in *parameter 4-34 Tracking Error Function*.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to drive.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

6.9.77 ALARM 79, Illegal Power Section Configuration

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

6.9.78 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.

6.9.79 ALARM 81, CSIV Corrupt

Cause
The CSIV file has syntax errors.

6.9.80 ALARM 82, CSIV Parameter Error

Cause
CSIV failed to initialize a parameter.

6.9.81 ALARM 83, Illegal Option Combination

Cause
The mounted options are incompatible.

6.9.82 ALARM 84, No Safety Option

Cause
The safety option was removed without applying a general reset.

Troubleshooting

- Reconnect the safety option.

6.9.83 ALARM 85, Dang Fail PB

Cause
PROFIBUS/PROFIsafe error.

6.9.84 ALARM 88, Option Detection

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

Troubleshooting

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

6.9.85 WARNING 89, Mechanical Brake Sliding

Cause
The hoist brake monitor detects a motor speed exceeding 10 RPM.

6.9.86 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.

6.9.87 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.

6.9.88 ALARM 99, Locked Rotor

Cause
The rotor is blocked.

Troubleshooting

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

6.9.89 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.

6.9.90 WARNING/ALARM 122, Mot. Rotat. Unexp.

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

6.9.91 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.

6.9.92 ALARM 164, ATEX ETR Cur.Lim.Alarm

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

6.9.93 WARNING 165, ATEX ETR Freq.Lim.Warning

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

6.9.94 ALARM 166, ATEX ETR Freq.Lim.Alarm

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

6.9.95 ALARM 244, Heat Sink Temperature

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

Troubleshooting
Check for the following:

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

6.9.96 WARNING 251, New Typecode

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

6.9.97 ALARM 421, Temperature Fault

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

Troubleshooting

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

6.9.98 ALARM 423, FPC Updating

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

6.9.99 ALARM 424, FPC Update Successful

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

Troubleshooting

- Press [Reset] to stop the alarm.

6.9.100 ALARM 425, FPC Update Failure

Cause

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

Troubleshooting

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

6.9.101 ALARM 426, FPC Config

Cause

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

Troubleshooting

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

6.9.102 ALARM 427, FPC Supply

Cause

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

Troubleshooting

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

6.9.103 ALARM 432, Inrush Mode Error

Cause

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

Troubleshooting

- Check inrush card wiring.
- Replace inrush card.

6.10 Troubleshooting

Table 21: Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	Check for loose connections.	Check the input power source.
	Missing or open fuses.	See *Open power fuses* in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Short circuit on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminal 12/13 to 20–39, or 10 V supply for terminals 50–55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM).	–	Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N. 130B1107).
	Wrong contrast setting.	–	To adjust the contrast, press [Status] + [▲]/[▼].

Symptom	Possible cause	Test	Solution
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.	–	Contact supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the AC drive.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for *Display dark\No function*.
Motor not running	Service switch open or missing motor connection.	–	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	–	Apply mains power.
	LCP stop.	–	Depending on the operating mode, press [Auto On] or [Hand On].
	Missing start signal (Standby).	–	Apply a valid start signal.
	Motor coast signal active (Coasting).	–	Apply 24 V on terminal 27 or program this terminal to *[0] No operation*.
	Wrong reference signal source.	Check reference signal: • Local • Remote or bus reference? • Preset reference active? • Terminal connection correct? • Scaling of terminals correct? • Reference signal available?	Program correct settings. Check *parameter 3-13 Reference Site*. Set preset reference active in *parameter group 3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in *parameter group 5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.	–	Correct motor phase connection, or set *parameter 1-06 Clockwise Direction* to *[1] Inverse*.
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in *parameter 4-13 Motor Speed High Limit [RPM]*, *parameter 4-14 Motor Speed High Limit [Hz]*, and *parameter 4-19 Max Output Frequency*.	Program correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in *parameter group 6-0* Analog I/O mode* and *parameter group 3-1* References*.	Program correct settings.

Symptom	Possible cause	Test	Solution
Motor speed unstable	Possible incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in *parameter group 1-6* Load Depen. Setting*. For closed-loop operation, check settings in *parameter group 20-0* Feedback*.
Motor runs rough	Possible overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in *parameter groups 1-2* Motor data*, *1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*.
Motor does not brake	Possible incorrect settings in the brake parameters. Ramp-down times may be too short.	Check brake parameters. Check ramp time settings.	Check *parameter groups 2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses	Phase-to-phase short.	Motor or panel has a short phase-to-phase. Check motor and panel phases for shorts.	Eliminate any shorts detected.
	Motor overload.	Motor is overloaded for the application.	Perform start-up test and verify that motor current is within specifications. If motor current is exceeding the nameplate full load current, the motor can run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform pre-start-up check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (see *Alarm 4, Mains phase loss* description).	Rotate input power leads into the AC drive 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the AC drive.	Rotate input power leads into the AC drive 1 position: A to B, B to C, C to A.	If the imbalanced leg stays on same input terminal, it is a problem with the AC drive. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If the imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with AC drive.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If the imbalanced leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
AC drive acceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, refer to the *Warnings and Alarms* section. Check that motor data are entered correctly.	Increase the ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. Increase current limit in *parameter 4-18 Current Limit*. Increase torque limit in *parameter 4-16 Torque Limit Motor Mode*.
AC drive deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, refer to the *Warnings and Alarms* section. Check that motor data are entered correctly.	Increase the ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *parameter 2-17 Over-voltage Control*.

6.11 Maintenance and Service

To prevent breakdown, danger, and damage, examine the drive for loose terminal connections, excessive dust buildup, and worn parts at regular intervals. Replace worn or damaged parts with Danfoss authorized parts. For service and support, contact the local Danfoss supplier.

7 Specifications

7.1 Electrical Data, 380–500 V AC

Table 22: Electrical Data, Mains Supply 3x380–500 V AC (4-Drive System)

VLT® AutomationDrive FC 302	N1M1	
Drive modules	4	
Output Frequency [Hz]	0–590	
High/normal overload High overload=150% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.	**HO**	**NO**
Typical shaft output at 400 V [kW]	1100	1200
Output current (3-phase)		
Continuous at 380–400 V [A]	1730	2150
Intermittent (60 s overload) at 380–400 V [A]	2595	2365
Continuous kVA at 400 V [kVA]	1199	1490
Maximum input current		
Continuous at 380–440 V [A]	1667	2072
Intermittent (60 s overload) at 380–440 V [A]	2500	2279
Maximum number and size of cables per phase		
- Mains [mm^2 (AWG)]	5x240 (5x500 mcm)	
- Motor [mm^2 (AWG)]	4x240 (4x500 mcm)	
- Brake [mm^2 (AWG)]	2x185 (2x350 mcm)	
Power losses [W] per drive module		
Drive modules at 400 V [W][(1)(2)]	4379	5758
Efficiency[(2)]	0.98	
Overtemperature trip ratings [°C (°F)]		
Heat sink	110 (230)	
Control card	80 (176)	
Power card	85 (185)	
Fan power card	85 (185)	
Active in-rush card	85 (185)	

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

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

7.2 Mains Supply to Drive Modules

The unit is suitable for use on a circuit capable of delivering not more than 100 kA short circuit current rating (SCCR) at 480 V.

Supply terminals	L1, L2, L3
Supply voltage[1]	380–500 V ±10%
Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage[2]
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, and L3 (power-ups)	Maximum 1 time/2 minutes
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[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, which corresponds typically to 15% below the drive's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the drive's lowest rated supply voltage.

[2] Calculations based on UL/IEC 61800-3.

7.3 Motor Output

Voltage output	0–100% of supply voltage output
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.

7.4 Torque Characteristics

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

Starting torque (constant torque)	Maximum 150% for 60 s once in 10 minutes[1]
Overload torque (constant torque)	Maximum 150% for 60 s once in 10 minutes[1]
Torque rise time in FLUX (for 5 kHz fsw)	1 ms
Torque rise time in VVC+ (independent of fsw)	10 ms

[1] Percentage relates to the drive's nominal current.

7.5 Ambient Conditions for Drive Modules

Enclosure	IP00/UL Type Chassis
Vibration test (standard/ruggedized)	0.7 g/1.0 g
Relative humidity	5%-95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Aggressive gases (IEC 60721-3-3)	Class 3C3
Test method according to IEC 60068-2-43	H2S (10 days)
Ambient temperature at SFAVM switching mode	
- with derating	Maximum 55 °C (131 °F)[1]
- at full continuous FC output current (HO)	Maximum 45 °C (113 °F)[1]
- at full continuous FC output current (NO)	Maximum 40 °C (104 °F)[1]
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced speed performance	-10 °C (14 °F)

Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating	1000 m (3280 ft)
Maximum altitude above sea level with derating	3000 m (9842 ft)
EMC standards, Emission	IEC/EN 61800-3
EMC standards, Immunity	IEC/EN 61800-3
Energy efficiency class	IE2[2]

[1] When operating the unit above nominal temperatures, apply derating.

[2] Determined according to IEC 61800-9-2 (EN 50598-2) at:

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

7.6 Cable Specifications

Maximum motor cable length, shielded	150 m (492 ft)
Maximum motor cable length, unshielded	300 m (984 ft)
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible cable	1 mm^2/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

7.7 Control Input/Output and Control Data

7.7.1 Digital Inputs

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

Programmable digital inputs	4 (6)
Terminal number[1]	18, 19, 27, 29, 32, 33
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1, PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
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.

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 *VLT®FC Series- 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 (201), 54 (202)
Modes	Voltage or current
Mode select	Switch A53 (S201) and switch A54 (S202)
Voltage mode	Switch A53 (S201)/A54 (S202) = OFF (U)
Voltage level	-10 V to +10 V (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch A53 (S201)/A54 (S202) = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

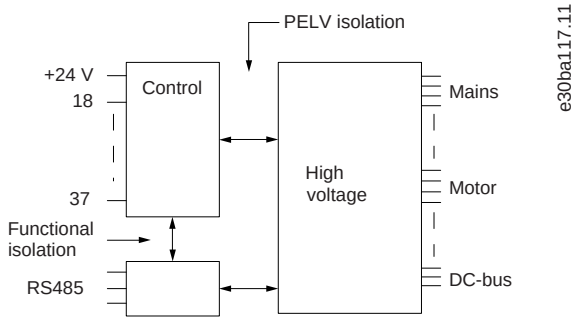


Illustration 29: PELV Isolation

7.7.4 Pulse/encoder Inputs

Programmable pulse/encoder inputs	2/1
Terminal number (pulse)	29(1), 33
Terminal number (encoder)	32, 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] FC 302 only.

[2] Encoder inputs: 32=A and 33=B.

7.7.5 Analog Output

Number of programmable outputs	1
Terminal number	42
Current range at analog output	0/4 to 20 mA
Maximum load GND - analog output less than	500 Ω
Accuracy on analog output	Maximum error: 0.8% of full scale
Resolution of analog output	8 bit

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

7.7.6 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).

7.7.7 Digital Outputs

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

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

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

7.7.8 Control Card, 24 V DC Output

Terminal number	12, 13
Output voltage	24 V +1, -3 V
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

7.7.9 Relay Outputs

Programmable relay outputs	2
Maximum wire cross-section to relay terminals	2.5 mm^2 (12 AWG)
Minimum wire cross-section to relay terminals	0.2 mm^2 (30 AWG)
Length of stripped wire	8 mm (0.3 in)
Relay 01 terminal number	1–3 (break), 1–2 (make)

Maximum terminal load (AC-1)[1] on 1–2 (NO) (Resistive load)[2][3]	400 V AC, 2 A
Maximum terminal load (AC-15)[1] 1–2 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 1–2 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 1–3 (NC) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] 1–3 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–3 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 1–3 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO)	24 V DC 10 mA, 24 V AC 2 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2
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] 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] 4–6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 2 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[1] IEC 60947 parts 4 and 5.

[2] Overvoltage Category II

[3] UL applications 300 V AC 2 A.

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

7.7.10 Control Card, +10 V DC Output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

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

7.7.11 Control Characteristics

Resolution of output frequency at 0–1000 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.

7.7.12 Control Card Performance

Scan interval	5 ms

7.7.13 Control Card, USB Serial Communication

USB standard	1.1 (full speed)[1]
USB plug	USB type B plug[2][3]

[1] Connection to PC is carried out via a standard host/device USB cable.

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

[3] The USB connection is not galvanically isolated from ground. Use only isolated laptop/PC as connection to the USB connector on the drive or an isolated USB cable/converter.

7.8 Fuses

Fuses installed on the supply side ensure that if a component breakdown (first fault) occurs inside the drive, any potential damage is contained within the drive enclosure. For a list of fuses, see Table 23. The drive modules are supplied with built-in AC fuses.

Table 23: Fuse Options

Input voltage [V]	Type of fuse	Bussmann part number
380–500	AC fuse	170M7309
	DC fuse	170M5468

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