



# Operating Guide

## VLT<sup>®</sup> Decentral Drive FCD 302





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# 1 Introduction

## 1.1 Purpose of the Manual

This operating guide provides information for safe installation and commissioning of the frequency converter.

The operating guide is intended for use by qualified personnel. Read and follow the instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the frequency converter.

VLT® is a registered trademark.

## 1.2 Additional Resources

Supplementary publications and manuals are available.

- The *VLT® AutomationDrive FC 301/302 Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® Decentral Drive FCD 302 Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

See [www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm](http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm).

## 1.3 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version and the corresponding software version.

| Edition  | Remarks                             | Software version |
|----------|-------------------------------------|------------------|
| MG04F5xx | STO functionality has been updated. | 7.5X             |

Table 1.1 Document and Software Version

## 1.4 Product Overview

### 1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the frequency converter, the motor, and equipment driven by the motor.
- System and motor status surveillance.

The frequency converter can also be used for motor overload protection.

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

The *VLT® Decentral Drive FCD 302* is designed for decentral mounting, for example, in the food and beverage industry, or for other material handling applications. With the FCD 302, it is possible to reduce costs by placing the power electronics decentrally. Central panels are then rendered obsolete, saving cost, space, and effort for installation and wiring. The basic design is service-friendly, with a pluggable electronic part, and a flexible and “spacious” wiring box. It is easy to change electronics without the need for rewiring.

The FCD 302 is designed according to the EHEDG guidelines, suitable for installation in environments with high focus on ease of cleaning.

### **NOTICE**

**Only frequency converters configured as hygienic enclosure designation, FCD 302 P XXX T4 W69, have the EHEDG certification.**

### **Installation environment**

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

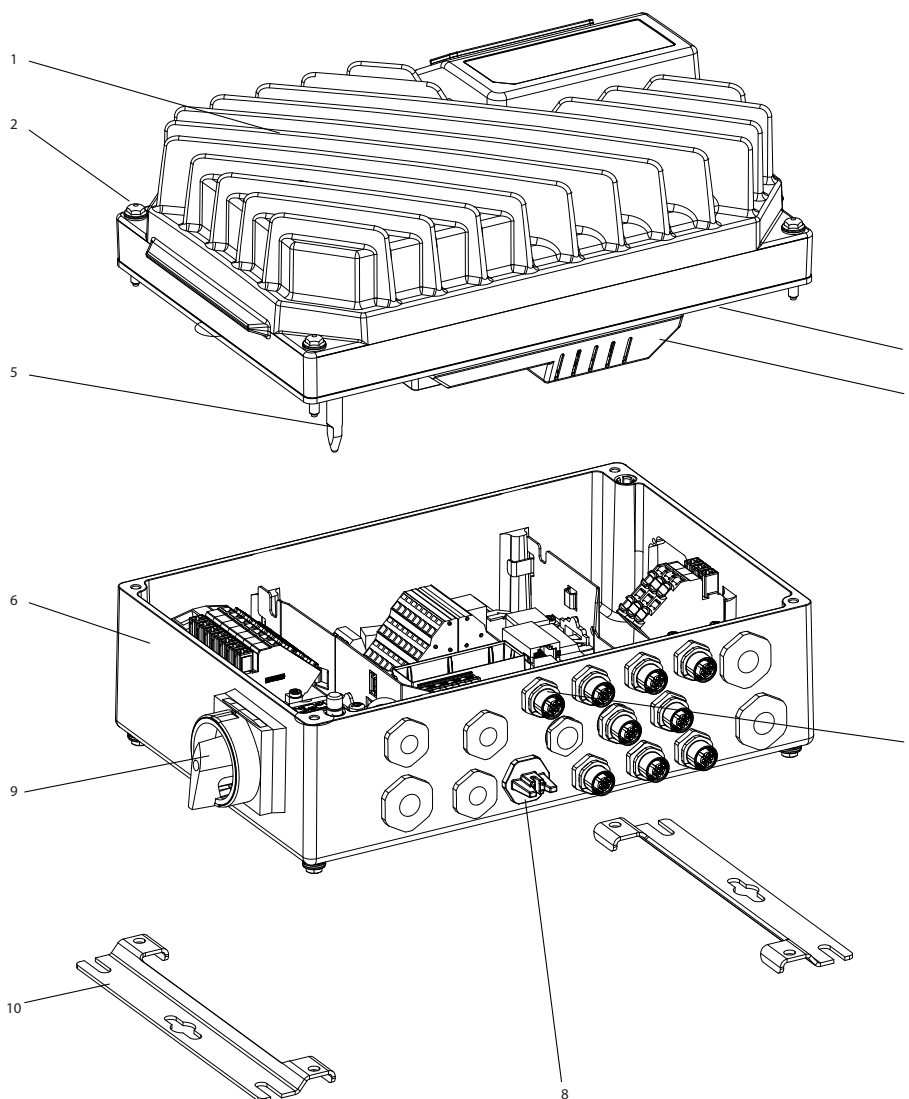
### **NOTICE**

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

### **Foreseeable misuse**

Do not use the frequency converter in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 7 Specifications*.

1.4.2 Exploded Views

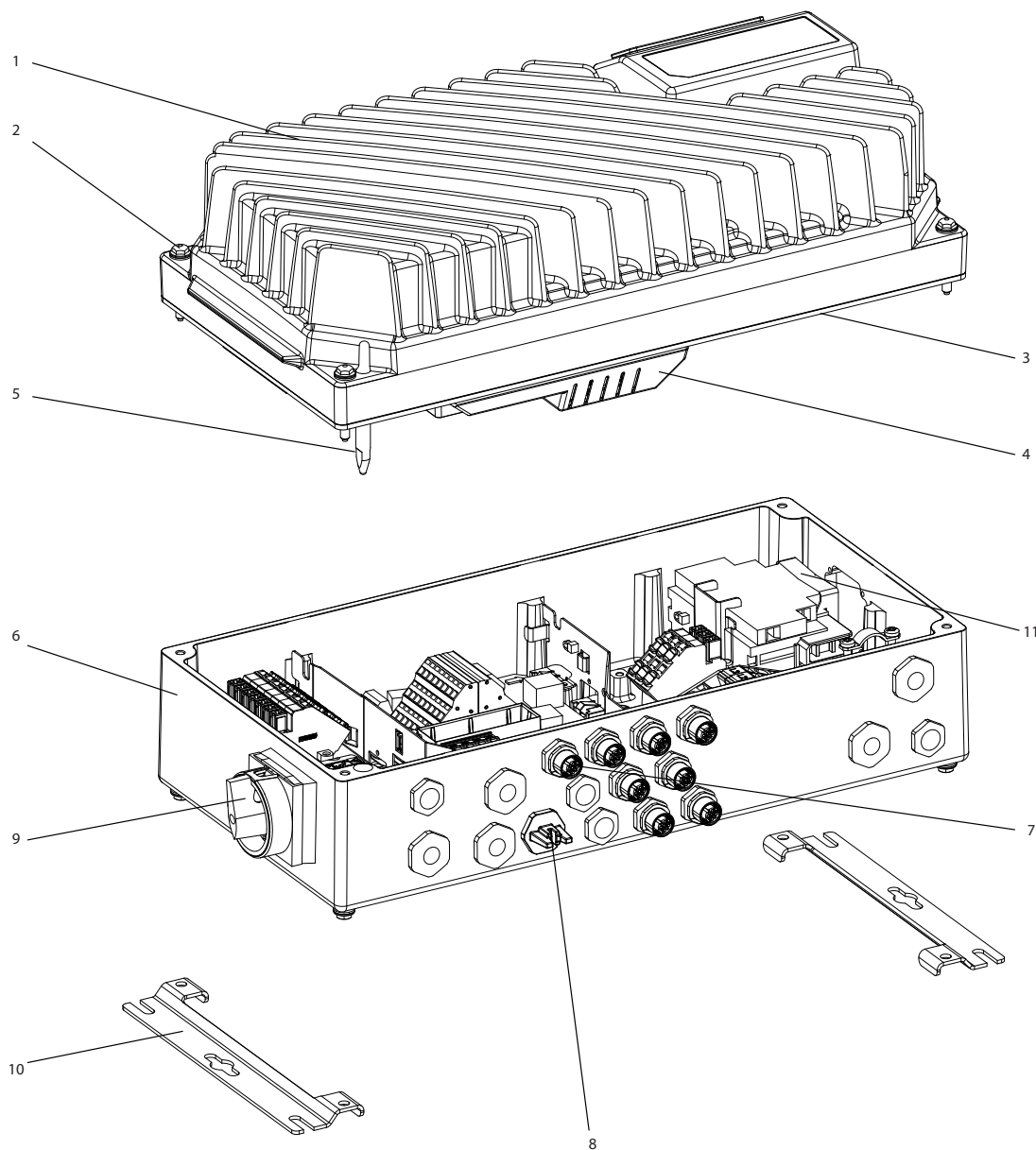


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|   |  |    |   |
|---|--|----|---|
| 1 | Inverter part                            | 6  | Installation box  |
| 2 | Fastening screws (4 x, 1 in each corner) | 7  | Display connection  |
| 3 | Sealing gasket                           | 8  | Access to USB port  |
| 4 | Inverter part plastic cover              | 9  | Service switch-motor side (alternatively, switch located on mains side, or not mounted) |
| 5 | Ground connection pin                    | 10 | Flat mounting brackets  |

Illustration 1.1 Exploded View Small Unit

1.30BC380.10



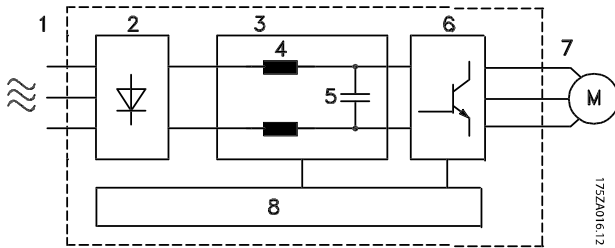
|   |  |    |   |
|---|--|----|---|
| 1 | Inverter part                            | 7  | Display connection  |
| 2 | Fastening screws (4 x, 1 in each corner) | 8  | Access to USB port  |
| 3 | Sealing gasket                           | 9  | Service switch <sup>1)</sup> - motor side (alternatively, switch located on mains side, or not mounted) |
| 4 | Inverter part plastic cover              | 10 | Flat mounting brackets  |
| 5 | Ground connection pin                    | 11 | Circuit breaker <sup>1)</sup> (optional)  |
| 6 | Installation box                         | -  | -   |

1) The unit can be configured with either service switch or circuit breaker, not both. The illustration shown is not configurable in practice, but is shown to illustrate the respective positions of components only.

Illustration 1.2 Exploded View Large Unit

### 1.4.3 Block Diagram

Illustration 1.3 is a block diagram of the internal components of the frequency converter.



1752A016/12

| Area | Title             | Functions  |
|------|-------------------|--|
| 8    | Control circuitry | <ul style="list-style-type: none"> <li>Input power, internal processing, output, and motor current are monitored to provide efficient operation and control.</li> <li>User interface and external commands are monitored and performed.</li> <li>Status output and control can be provided.</li> </ul> |

Illustration 1.3 Frequency Converter Block Diagram

| Area | Title           | Functions  |
|------|-----------------|--|
| 1    | Mains input     | 3-phase AC mains supply to the frequency converter.  |
| 2    | Rectifier       | The rectifier bridge converts the AC input to DC current to supply inverter power.   |
| 3    | DC bus          | Intermediate DC-bus circuit handles the DC current.  |
| 4    | DC reactors     | <ul style="list-style-type: none"> <li>Filter the intermediate DC circuit voltage.</li> <li>Provide mains transient protection.</li> <li>Reduce RMS current.</li> <li>Raise the power factor reflected back to the line.</li> <li>Reduce harmonics on the AC input.</li> </ul> |
| 5    | Capacitor bank  | <ul style="list-style-type: none"> <li>Stores the DC power.</li> <li>Provides ride-through protection for short power losses.</li> </ul>   |
| 6    | Inverter        | The inverter converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.  |
| 7    | Output to motor | Regulated 3-phase output power to the motor.   |

### 1.5 Approvals and Certifications



Table 1.2 Approvals and Certifications

More approvals and certifications are available. Contact the local Danfoss partner. Frequency converters of enclosure size T7 (525–690 V) are UL certified for only 525–600 V.

The frequency converter complies with UL 508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

For compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to *ADN-compliant Installation* in the product-specific *design guide*.



## 1.6 Symbols and Conventions

The following symbols are used in this manual:

### **⚠ WARNING**

Indicates a potentially hazardous situation that could result in death or serious injury.

### **⚠ CAUTION**

Indicates a potentially hazardous situation that could result in minor or moderate injury. It may also be used to alert against unsafe practices.

### **NOTICE**

Indicates important information, including situations that may result in damage to equipment or property.

The following conventions are used in this manual:

- Numbered lists indicate procedures.
- Bullet lists indicate other information and description of illustrations.
- Italicized text indicates:
  - Cross-reference.
  - Link.
  - Footnote.
  - Parameter name.
  - Parameter group name.
  - Parameter option.
- All dimensions in drawings are in mm (inch).

## 2 Safety

### 2.1 Safety Symbols

The following symbols are used in this guide:

#### **⚠ WARNING**

Indicates a potentially hazardous situation that could result in death or serious injury.

#### **⚠ CAUTION**

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

#### **NOTICE**

Indicates important information, including situations that can result in damage to equipment or property.

### 2.2 Qualified Personnel

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

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

### 2.3 Safety Precautions

#### **⚠ WARNING**

##### **HIGH VOLTAGE**

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. 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 frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- Disconnect the frequency converter from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.

#### **⚠ WARNING**

##### **DISCHARGE TIME**

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

1. Stop the motor.
2. Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.
3. Wait for the capacitors to discharge fully before performing any service or repair work. The discharge time is specified in *Table 2.1*.

| Voltage [V] | Minimum waiting time (minutes) |                         |                          |
|-------------|--------------------------------|-------------------------|--------------------------|
|             | 4                              | 7                       | 15                       |
| 200–240     | 0.25–3.7 kW<br>(0.34–5 hp)     | –                       | 5.5–37 kW<br>(7.5–50 hp) |
| 380–500     | 0.25–7.5 kW<br>(0.34–10 hp)    | –                       | 11–75 kW<br>(15–100 hp)  |
| 525–600     | 0.75–7.5 kW<br>(1–10 hp)       | –                       | 11–75 kW<br>(15–100 hp)  |
| 525–690     | –                              | 1.5–7.5 kW<br>(2–10 hp) | 11–75 kW<br>(15–100 hp)  |

Table 2.1 Discharge Time

**⚠ WARNING****LEAKAGE CURRENT HAZARD**

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

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

**⚠ WARNING****EQUIPMENT HAZARD**

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

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

**⚠ WARNING****UNINTENDED MOTOR ROTATION  
WINDMILLING**

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- Ensure that permanent magnet motors are blocked to prevent unintended rotation.

**⚠ CAUTION****INTERNAL FAILURE HAZARD**

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

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

## 3 Mechanical Installation

### 3

### 3.1 Unpacking

#### 3.1.1 Items Supplied

The packaging contains:

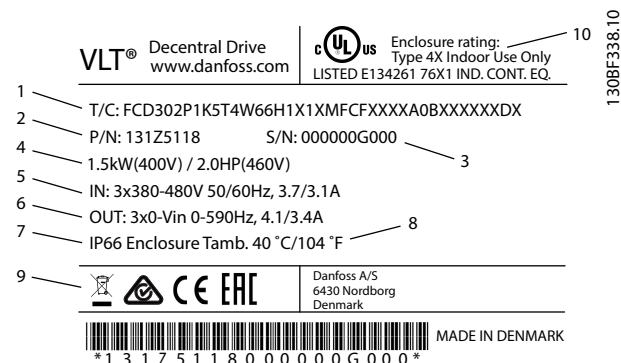
- Accessories bag, supplied only with order of installation box. Contents:
  - 2 cable clamps
  - Bracket for motor cables and loads cables
  - Elevation bracket for cable clamp
  - Screw 4 mm x 20 mm
  - Thread forming 3.5 mm x 8 mm
- Operating Guide
- Frequency converter

Depending on options fitted, the box contains 1 or 2 bags and 1 or more booklets.

#### Procedure

1. Make sure the items supplied and the information on the nameplate correspond to the order confirmation.
2. Check the packaging and the frequency converter visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

#### 3.1.2 Product Identification



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

Illustration 3.1 Product Nameplate (Example)

#### NOTICE

Do not remove the nameplate from the frequency converter (loss of warranty).

### 3.2 Mounting

#### NOTICE

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the frequency converter. Ensure that requirements for air humidity, temperature, and altitude are met.

#### Vibration and shock

The frequency converter complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 7.4 Ambient Conditions*.

### 3.2.1 Recommended Tools and Equipment

| Equipment                           | Size         | Description  |
|-------------------------------------|--------------|--|
| Screwdrivers                        | -            | -  |
| Socket (hex)                        | 8            | For fastening inverter screws/mounting of brackets |
| Slotted                             | 0.4x2.5      | For spring loaded power and control terminals      |
| Slotted/torx                        | 1.0x5.5/TX20 | For cable clamps inside the installation box       |
| Spanner                             | 19, 24, 28   | For blind-plugs                                    |
| LCP, ordering number 130B1078       | -            | Local control panel                                |
| LCP cable, ordering number 130B5776 | -            | Connection cable for local control panel           |

Table 3.1 Recommended Tools and Equipment

### 3.2.2 Mechanical Dimensions

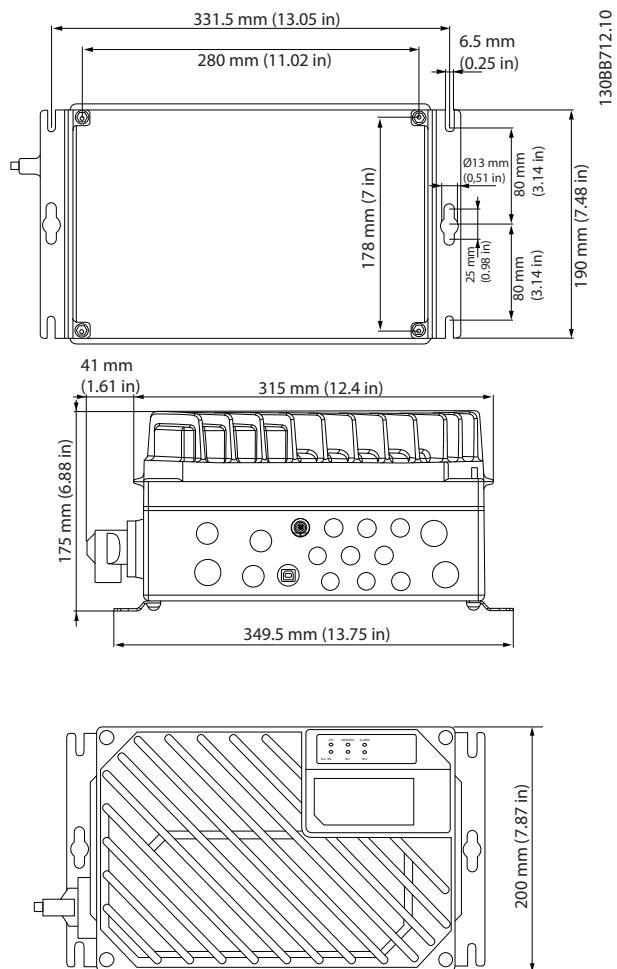


Illustration 3.2 Cable Entries and Hole Sizes (Small Unit)

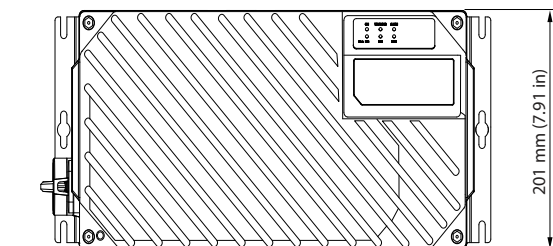
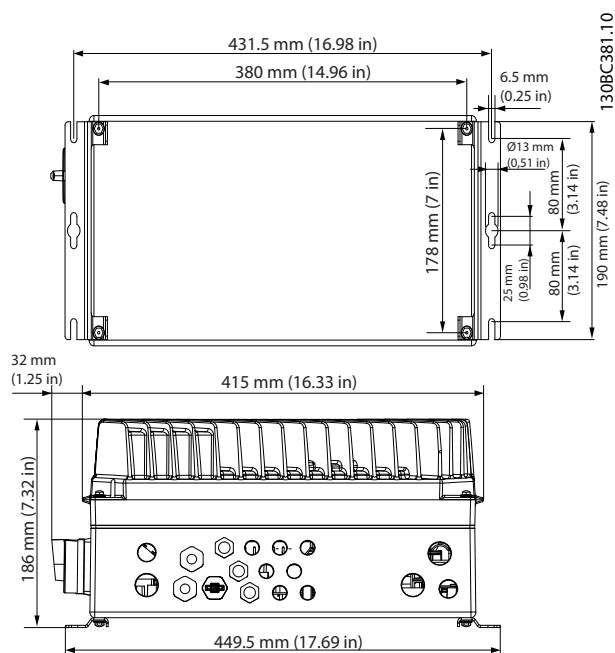


Illustration 3.3 Cable Entries and Hole Sizes (Large Unit)

|              |                            |
|--------------|----------------------------|
| Motor side   | 1xM20, 1xM25               |
| Control side | 2xM20, 9xM16 <sup>1)</sup> |
| Mains side   | 2xM25                      |

Table 3.2 Mechanical Dimensions

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

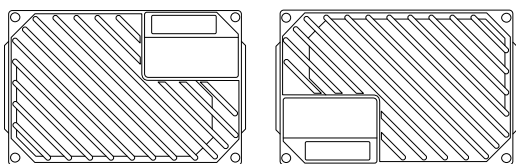
### 3.2.3 Mounting

The VLT<sup>®</sup> Decentral Drive FCD 302 consists of 2 parts:

- The installation box
- The inverter part

See chapter 1.4.2 Exploded Views.

3.2.3.1 Allowed Mounting Positions



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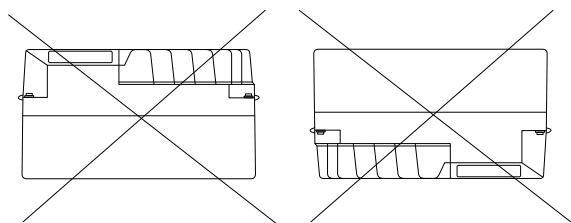
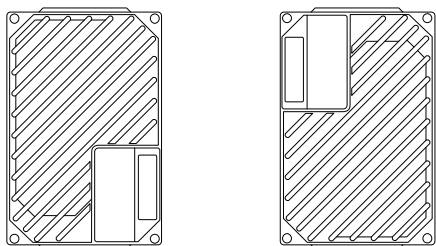
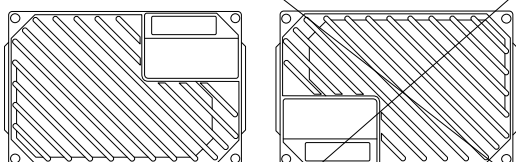


Illustration 3.4 Allowed Mounting Positions - Standard Applications



130BC383.10

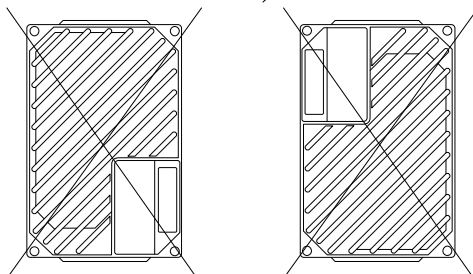


Illustration 3.5 Allowed Mounting Positions - Hygienic Applications

3.2.3.2 Mounting the Installation Box

**CAUTION**

**ELECTRICAL HAZARD**

Do not apply power to the unit at this stage, as this could result in death or serious injury.

**CAUTION**

**DAMAGE OR PERSONAL INJURY**

Failure to tighten the 4 mounting screws can result in personal injury or material damage.

- Ensure that the strength of the mounting location can support the unit weight.

Prerequisites:

- Use the holes on the rear of the installation box to fix the mounting brackets.
- Use proper mounting screws or bolts.
- For hygienic versions, use cable glands designed to meet hygienic application requirements, for example Rittal HD 2410.110/120/130.

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

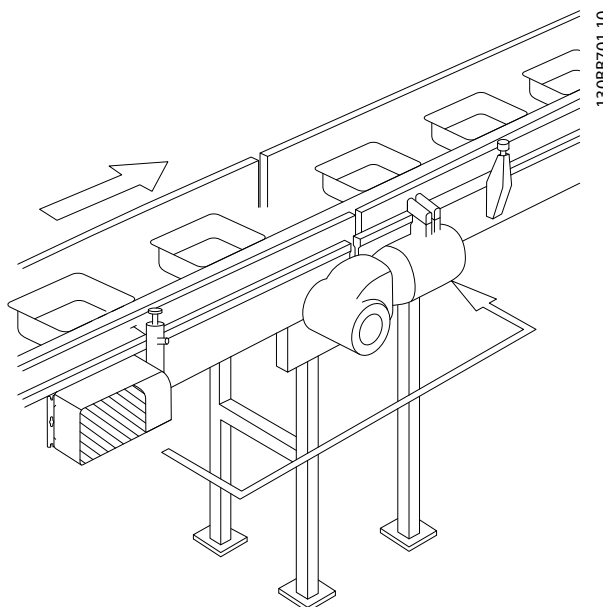


Illustration 3.6 FCD 302 Standalone Mounted with Mounting Brackets

## 4 Electrical Installation

### 4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

#### **⚠ WARNING**

##### INDUCED VOLTAGE

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

- Run output motor cables separately, or
- Use shielded cables.

#### **⚠ CAUTION**

##### SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation below means that the RCD may not provide the intended protection.

- When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side.

##### Overcurrent protection

- Additional protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide the fuses. See UL/cUL approved pre-fuses in *chapter 7.7 Fuses and Circuit Breakers*.

##### Wire type and ratings

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

See *chapter 7.1 Electrical Data* and *chapter 7.5 Cable Specifications* for recommended wire sizes and types.

### 4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.7 Motor Connection*, and *chapter 4.10 Control Wiring*.

### 4.3 Grounding

#### **⚠ WARNING**

##### LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

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

##### For electrical safety

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

##### For EMC-compliant installation

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

**NOTICE**

**POTENTIAL EQUALISATION**

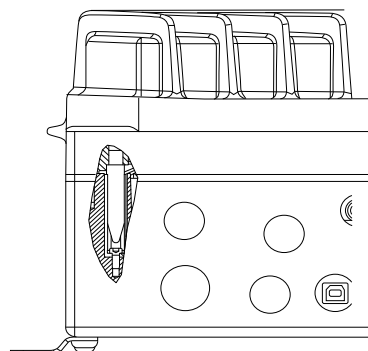
Risk of burst transient, when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm<sup>2</sup> (5 AWG).

4

**CAUTION**

**PE CONNECTION**

The metal pins in the corners of the electronic part and the holes on the corner of the installation box are essential for the protective earth connection. Make sure that they are not loosened, removed, or violated in any way. Tightening torque requirement is 3 Nm. (26 in-lb). See *Illustration 4.1*.



130BC391.10

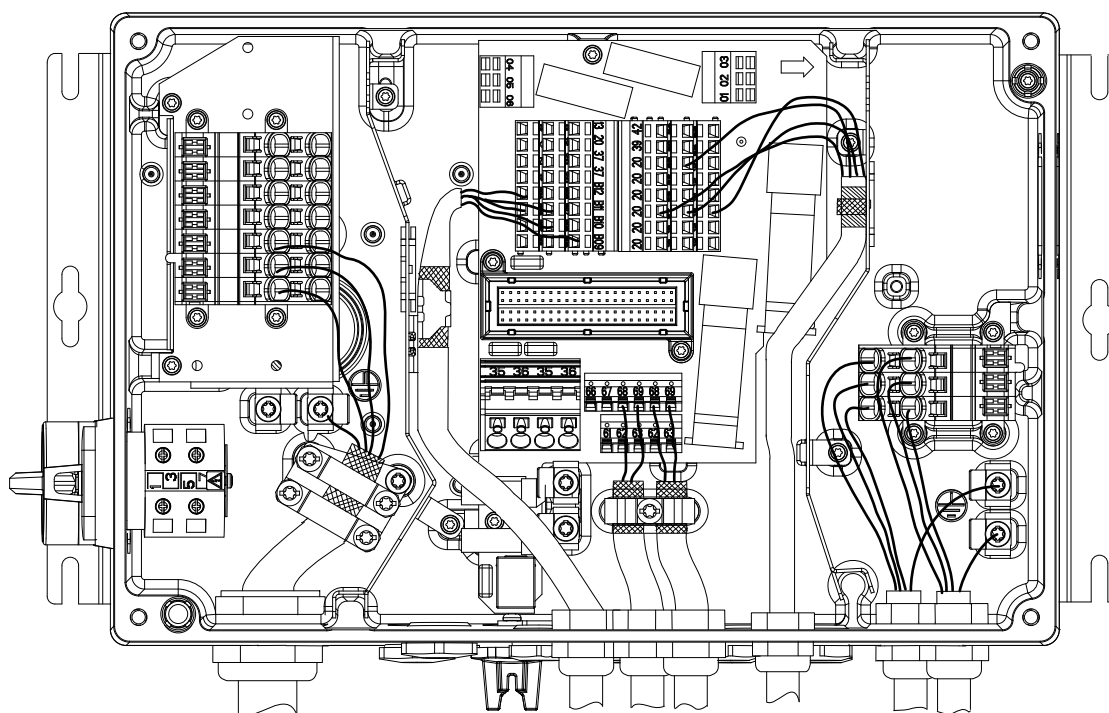
Illustration 4.1 PE Connection between the Installation Box and the Electronic Part

**NOTICE**

The external grounding terminal is available as an accessory (part no: 130B5833).

**Grounding shielded cable**

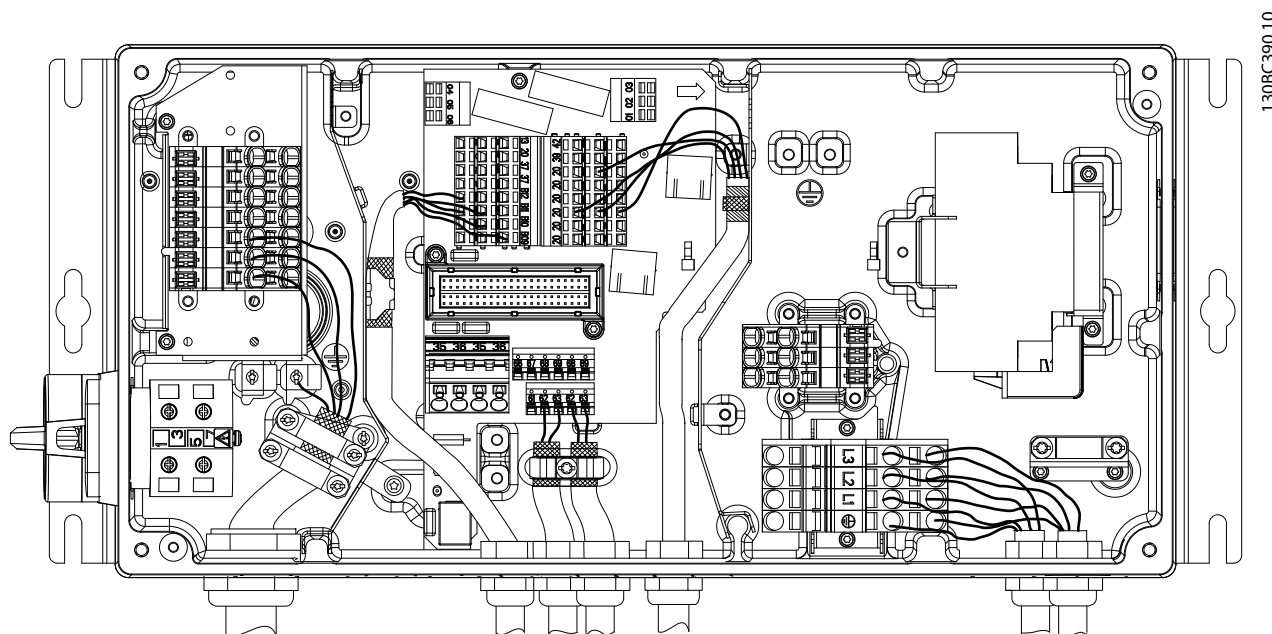
Grounding clamps are provided for motor and control wiring (see *Illustration 4.2*).



130BC403.10

Illustration 4.2 Grounding for Motor and Control Wiring (Small Unit)





4

Illustration 4.3 Grounding Clamp for Motor and Control Wiring (Large Unit)

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

4.4 Wiring Schematic

4

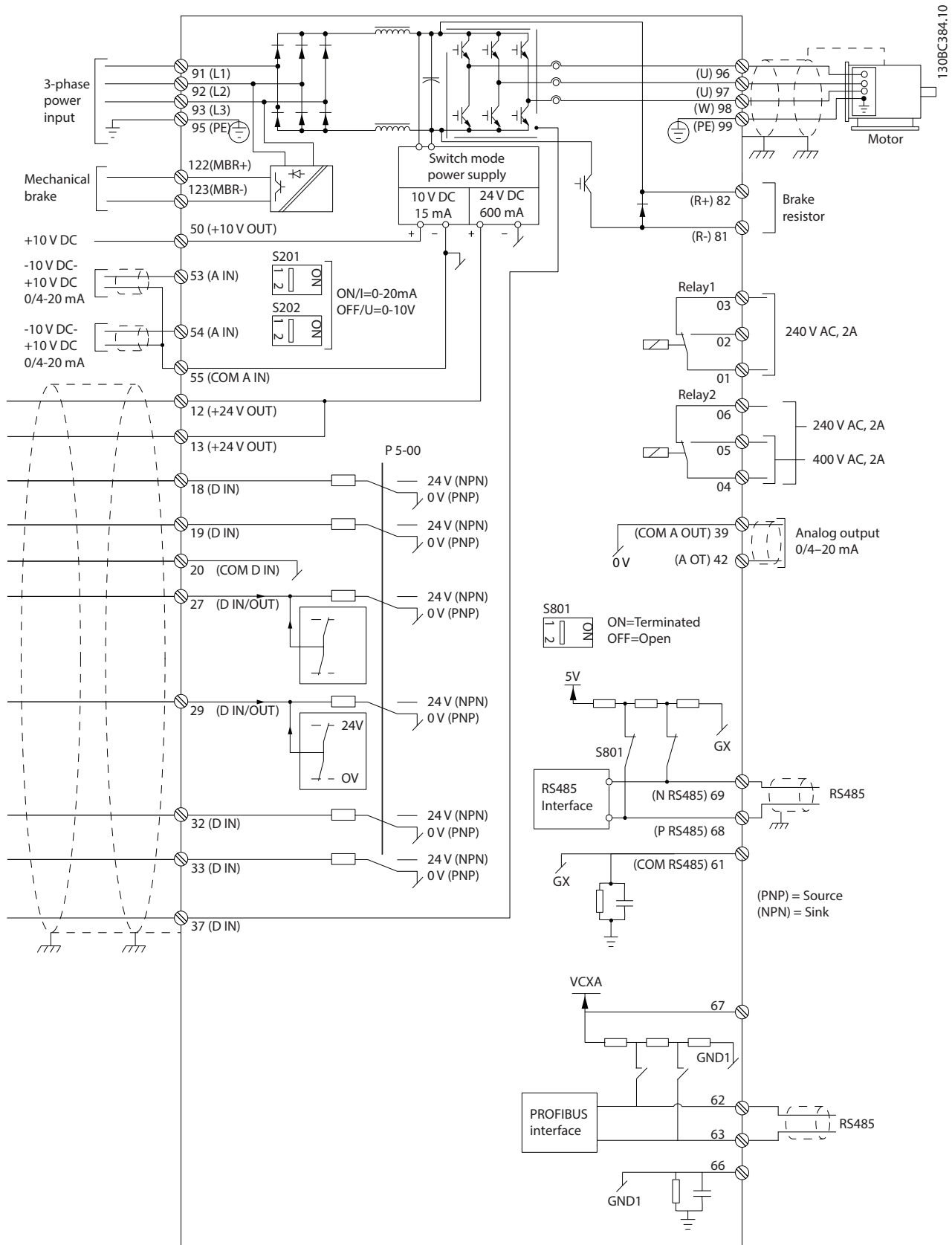
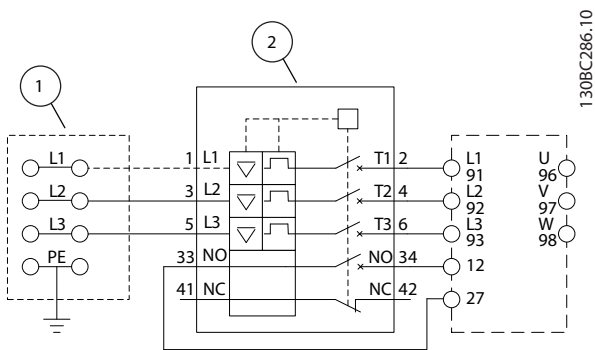
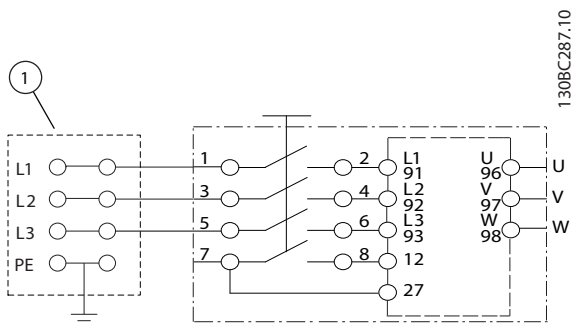


Illustration 4.4 Basic Wiring Schematic



|   |                   |
|---|-------------------|
| 1 | Looping terminals |
| 2 | Circuit breaker   |

Illustration 4.5 Large Unit only: Circuit Breaker and Mains Disconnect



|   |                   |
|---|-------------------|
| 1 | Looping terminals |
|---|-------------------|

Illustration 4.6 Large Unit only: Service Switch at Mains with Looping Terminals

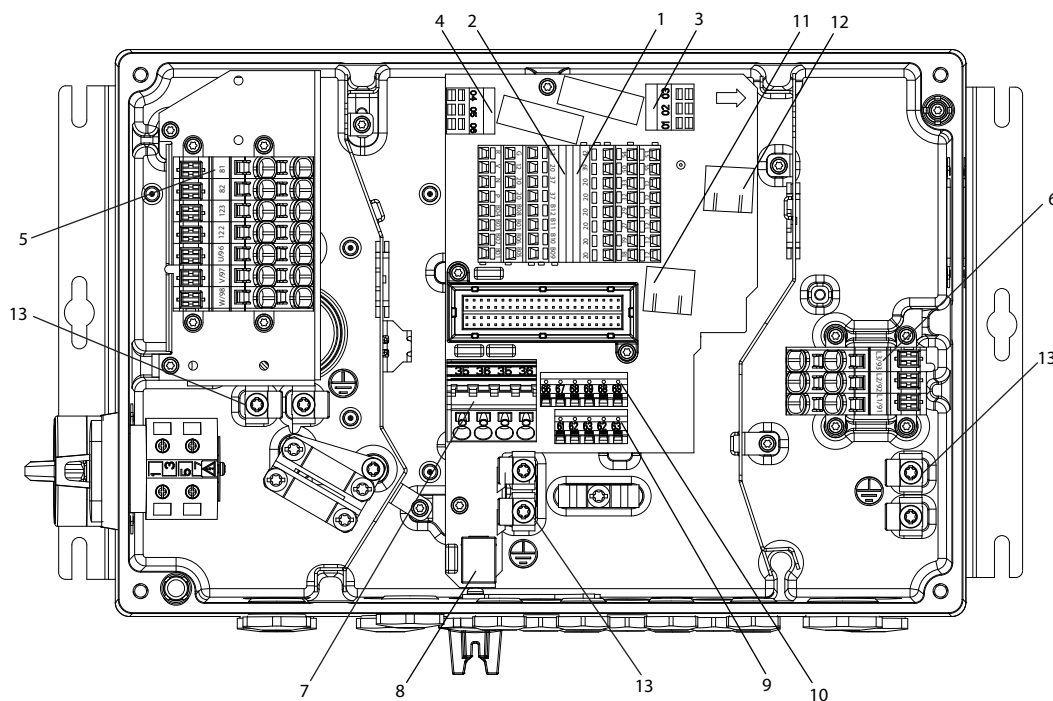
**NOTICE**

**EMC INTERFERENCE**

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

4.5 Location of Terminals

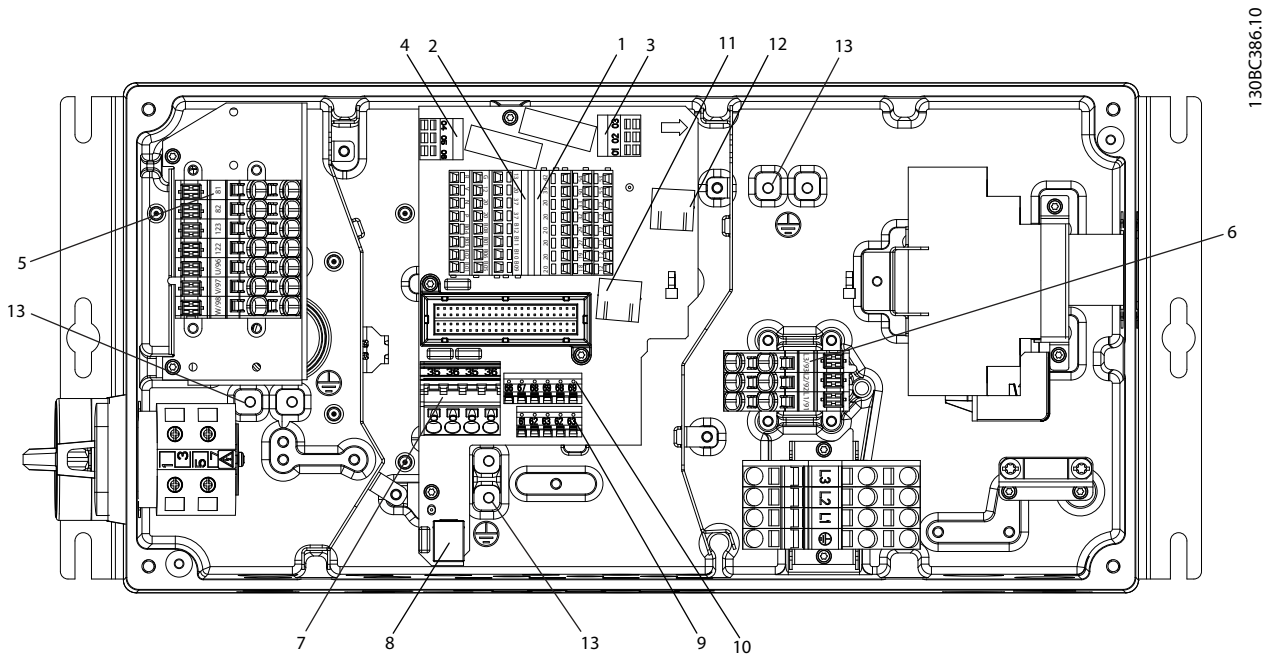
4



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

Illustration 4.7 Location of Terminals (Small Unit)



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

Illustration 4.8 Location of Terminals (Large Unit)

For both small and large units, the service switch is optional. The switch is shown mounted on the motor side. Alternatively, the switch can be on the mains side, or omitted.

For the large unit, the circuit breaker is optional. The large unit can be configured with either service switch or circuit breaker, not both. The setup shown in *Illustration 4.8*, is not configurable in practice, but is shown to illustrate the respective positions of components only.

#### 4.6 Terminal Types

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

1. Open the contact by inserting a small screwdriver into the slot above the contact, as shown in *Illustration 4.9*.
2. Insert the stripped wire into the contact.
3. Remove the screwdriver to fasten the wire into the contact.

4. Ensure that the contact is firmly established and not loose. Loose wiring can result in equipment faults or injury.

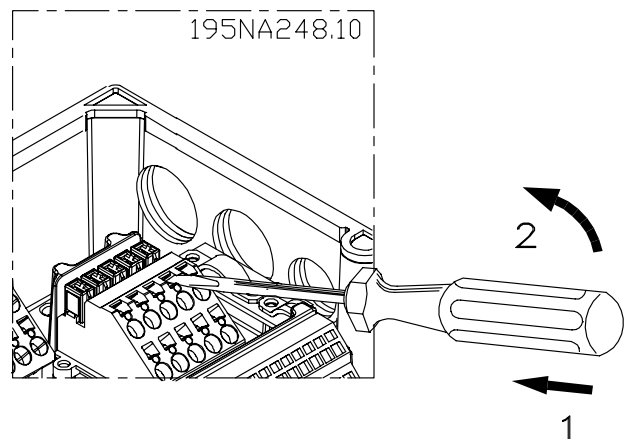


Illustration 4.9 Opening the Terminals

## 4.7 Motor Connection

### **⚠ WARNING**

#### INDUCED VOLTAGE

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

### **NOTICE**

#### MOTOR OVERLOAD PROTECTION

Protection against motor overload is not included in the factory setting. If this function is needed, set *parameter 1-90 Motor Thermal Protection* to either 1 of the trip options or 1 of the warning options. Refer to the *VLT® AutomationDrive FC 301/302 Programming Guide* for further information.

1. Connect the motor to terminals 96, 97, 98.
2. Connect ground to the PE-terminal.
3. Make sure that the shield of the motor cable is properly grounded at both ends (motor and frequency converter).
4. For correct dimensioning of cable cross-section, see *chapter 7.1 Electrical Data*.

| Number |    |    |   |
|--------|----|----|---|
| 96     | 97 | 98 | Motor voltage 0–100% of mains voltage.  |
| U      | V  | W  | 3 wires out of motor.   |
| U1     | V1 | W1 | 6 wires out of motor.   |
| W2     | U2 | V2 |   |
| U1     | V1 | W1 | 6 wires out of motor, star connected.<br>Connect U2, V2, W2 separately (optional terminal block). |
|        |    |    |   |
| PE     | –  | –  | Ground connection.  |

Table 4.1 Terminals 96, 97, 98

### **NOTICE**

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

## 4.7.1 Connecting Several Motors

### Parallel connection of motors

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

### **NOTICE**

- Installations with cables connected in a common joint as in *Illustration 4.10*, is only recommended for short cable lengths (maximum 10 m (32.8 ft)).
- When motors are connected in parallel, *parameter 1-29 Automatic Motor Adaptation (AMA)* cannot be used.

### **NOTICE**

The electronic thermal relay (ETR) of the frequency converter cannot be used as motor overload protection for the individual motor in systems with parallel-connected motors. Provide further motor overload protection by thermistors in each motor or individual thermal relays. Circuit breakers are not suitable as protection.

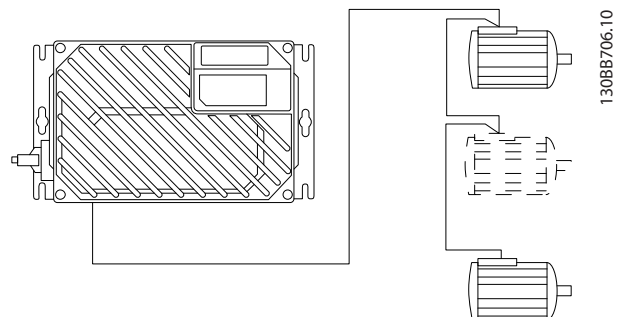


Illustration 4.10 Parallel Connection of Motors

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

To resolve such a problem:

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

### 4.8 AC Mains Connection

Size wiring based on the input current of the frequency converter. See the maximum wire size in *Table 7.1* in *chapter 7 Specifications*.

Comply with local and national electrical codes for cable sizes.

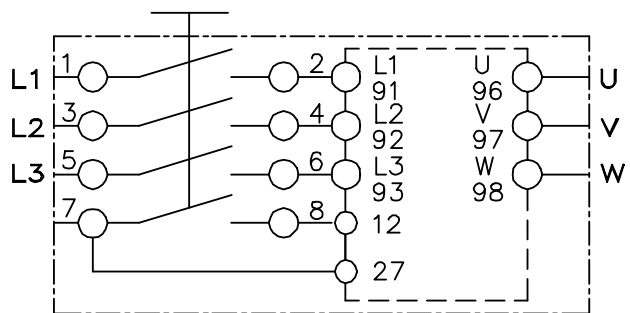
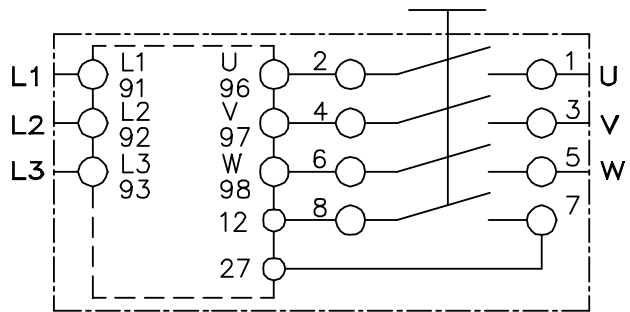
**Procedure**

1. Connect 3-phase AC input power wiring to terminals L1, L2, and L3.
2. Depending on the configuration of the equipment, connect the input power to the mains terminals or the input disconnect.
3. Ground the cable in accordance with grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), set *parameter 14-50 RFI Filter* to OFF. When set to OFF, the internal RFI filter capacitors between the chassis and the DC link are isolated to avoid damage to the DC link and to reduce ground capacity currents in accordance with IEC 61800-3.

| Number |    |    |                           |
|--------|----|----|---------------------------|
| 91     | 92 | 93 | Mains voltage 3x380–480 V |
| L1     | L2 | L3 | –                         |
| PE     | –  | –  | Ground connection         |

Table 4.2 Terminal 91, 92, and 93

### 4.9 Motor and Mains Connection with Service Switch



195NA288.10

Illustration 4.11 Motor and Mains Connection with Service Switch

### 4.10 Control Wiring

**WARNING**

**UNINTENDED START**

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- Disconnect the frequency converter from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.

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

| Terminal number | Function   |
|-----------------|--|
| 01, 02, 03      | Relay 1 output. Usable for AC or DC voltage and resistive or inductive loads.  |
| 04, 05, 06      | Relay 2 output. Usable for AC or DC voltage and resistive or inductive loads.  |
| 12, 13          | 24 V DC digital supply voltage. Useable for digital inputs and external transducers. To use the 24 V DC for digital input common, program <i>parameter 5-00 Digital I/O Mode</i> for PNP operation.                                    |
| 18, 19, 32, 33  | Digital inputs. Selectable for NPN or PNP function in <i>parameter 5-00 Digital I/O Mode</i> . Default is PNP.   |
| 27, 29          | Digital inputs or outputs. Programmable for either <i>parameter 5-01 Terminal 27 Mode</i> for terminal 27 and <i>parameter 5-02 Terminal 29 Mode</i> for terminal 29 selects input/output function. Default setting is input.          |
| 35              | Common (-) for external 24 V control back-up supply. Optional.   |
| 36              | External + 24 V control back-up supply. Optional.  |
| 37              | Safe Torque Off. See <i>chapter 4.16 Safe Torque Off (STO)</i> for details.  |
| 20              | Common for digital inputs. To use for digital input common, program <i>parameter 5-00 Digital I/O Mode</i> for NPN operation.  |
| 39              | Common for analog output.  |
| 42              | Analog output. Programmable for various functions in <i>parameter group 6-5* Analog Output 1</i> . The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω.  |
| 50              | 10 V DC analog supply voltage. 15 mA maximum commonly used for a potentiometer or thermistor.  |
| 53, 54          | Analog input. Selectable for voltage (0 to ±10 V) or current (0 or 4 to ±20 mA). Closed is for current and open is for voltage. Switches are located on the frequency converter control card. See <i>chapter 4.14 DIP Switches</i>     |
| 55              | Common for analog inputs.  |
| 61              | Common for serial communication (RS485 interface). See <i>chapter 4.3 Grounding</i>  |
| 68 (+), 69 (-)  | RS485 interface. When the frequency converter is connected to an RS485 serial communication bus, a switch on the control card is provided for termination resistance. Set the switch to ON for termination and OFF for no termination. |

| Terminal number | Function   |
|-----------------|--|
| 62              | RxD/TxD –P (red cable) for PROFIBUS. See the <i>VLT® PROFIBUS DP MCA 101 Installation Guide</i> for details. |
| 63              | RxD/TxD –N (green cable) for PROFIBUS.   |
| 66              | 0 V for PROFIBUS.  |
| 67              | +5 V for PROFIBUS.   |
| B01–B12         | B-option. See dedicated literature for details.  |
| G, R, V, N, P   | Connection of LCP.   |

Table 4.3 Terminal Description

#### 4.11 Brake Resistor

| Number                 | Function                    |
|------------------------|-----------------------------|
| 81 (optional function) | R- Brake resistor terminals |
| 82 (optional function) | R+                          |

Table 4.4 Brake Resistor Terminals

The connection cable to the brake resistor must be shielded/armored. Connect the shield to the metal cabinet of the frequency converter and to the metal cabinet of the brake resistor with cable clamps.

Dimension the cross-section of the brake cable to match the brake torque.

#### 4.12 Mechanical Brake

| Number                  | Function  |
|-------------------------|---|
| 122 (optional function) | MBR+ Mechanical brake<br>UDC = 0.45 x RMS mains voltage |
| 123 (optional function) | MBR- Maximum current = 0.8 A                            |

Table 4.5 Mechanical Brake Terminals

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

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

When the frequency converter enters alarm mode or is exposed to an overvoltage situation, the mechanical brake



immediately cuts in. For more detailed information, refer to the VLT® AutomationDrive FC 301/302 Programming Guide.

**NOTICE**

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

**4.13 Connection of Sensors/Actuators on M12 Sockets**

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

Table 4.6 4xM12 Connection Input

| Pin | Wire color | Terminal               | Function  |
|-----|------------|------------------------|-----------|
| 1   | Brown      | Reserved <sup>1)</sup> | Reserved  |
| 3   | Blue       | 20                     | 0 V       |
| 4   | Black      | 02, 05                 | NO (24 V) |

Table 4.7 2xM12 Connection Output

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

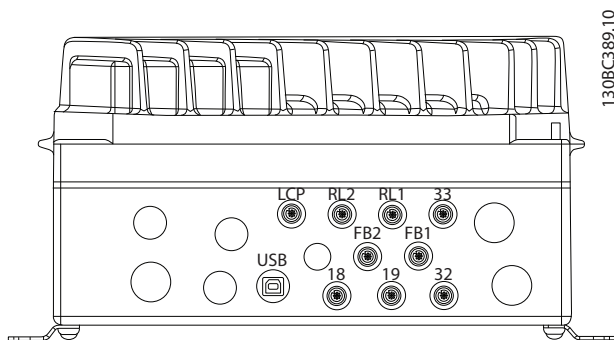
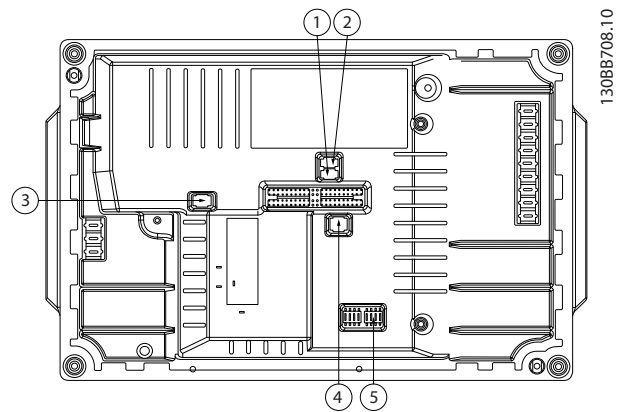


Illustration 4.12 Connection of Sensors/Actuators on M12 Sockets

**4.14 DIP Switches**

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



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

Illustration 4.13 Location of DIP Switches

**NOTICE**

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

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

**4.15 RS485 Serial Communication**

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

- Use shielded serial communication cable (recommended).
- See chapter 4.3 Grounding for proper grounding.

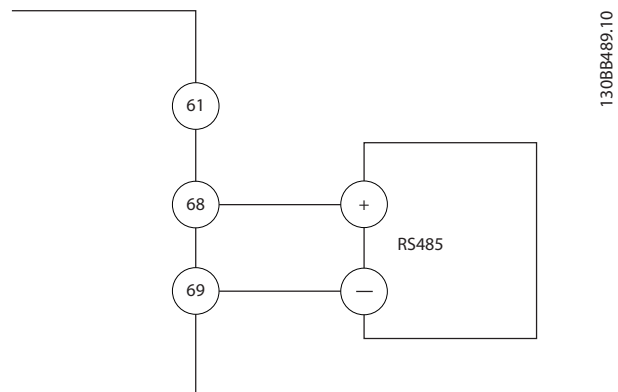


Illustration 4.14 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following:

1. Protocol type in *parameter 8-30 Protocol*.
2. Frequency converter address in *parameter 8-31 Address*.
3. Baud rate in *parameter 8-32 Baud Rate*.

Two communication protocols are internal to the frequency converter.

- Danfoss FC
- Modbus RTU

Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-\*\* Communications and Options*.

Selecting a specific communication protocol changes various default parameter settings to match that protocol's

### 4.17 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.8*. Check and mark the items when completed.

| Inspect for         | Description   | <input checked="" type="checkbox"/> |
|---------------------|---|-------------------------------------|
| Auxiliary equipment | <ul style="list-style-type: none"> <li>• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers located on input power side of the frequency converter, or output side to motor. Examine their operational readiness and ensure that they are ready in all respects for operation at full speed.</li> <li>• Check function and installation of any sensors used for feedback to the frequency converter.</li> <li>• Remove power factor correction caps on motor(s), if present.</li> </ul> | <input type="checkbox"/>            |
| Cable routing       | Ensure that input power, motor wiring, and control wiring are separated or in 3 separate metallic conduits for high frequency noise isolation.  | <input type="checkbox"/>            |
| Control wiring      | <ul style="list-style-type: none"> <li>• Check for broken or damaged wires and connections.</li> <li>• Check the voltage source of the signals, if necessary.</li> <li>• The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly at both ends.</li> </ul>  | <input type="checkbox"/>            |
| EMC considerations  | Check for proper installation regarding electromagnetic compatibility.  | <input type="checkbox"/>            |

specifications and makes additional protocol-specific parameters available.

Option cards for the frequency converter are available to provide additional communication protocols. See the option card documentation for installation and operation instructions.

### 4.16 Safe Torque Off (STO)

To run STO, additional wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Instructions* for further information.

| Inspect for                           | Description  | <input checked="" type="checkbox"/> |
|---------------------------------------|--|-------------------------------------|
| Environmental considerations          | See equipment label for the maximum ambient operating temperature limits. Temperature is not to exceed 40 °C (104 °F). Humidity levels must be 5–95% non-condensing.       | <input type="checkbox"/>            |
| Cooling clearance                     | Units require top and bottom clearance adequate to ensure proper airflow for cooling.  | <input type="checkbox"/>            |
| Fusing and circuit breakers           | Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position. Check for proper fusing or circuit breakers. | <input type="checkbox"/>            |
| Input and output power wiring         | <ul style="list-style-type: none"> <li>• Check for loose connections.</li> <li>• Check for proper fusing or circuit breakers.</li> </ul>                                   | <input type="checkbox"/>            |
| Switches                              | Ensure that all switch and disconnect settings are in the proper position.   | <input type="checkbox"/>            |
| Grounding                             | The equipment requires a dedicated ground wire from its chassis to the plant ground. Check for good ground connections that are tight and free of oxidation.               | <input type="checkbox"/>            |
| Installation box and electronics part | Ensure the installation box and the electronics part is properly closed. Check that all 4 fastening screws are tightened with the right torque.                            | <input type="checkbox"/>            |

| Inspect for                  | Description   | <input checked="" type="checkbox"/> |
|------------------------------|---|-------------------------------------|
| Cable glands and blind plugs | Ensure that the cable glands and blind plugs are properly tightened, to guarantee the right enclosure protection degree is achieved. Liquids and/or excessive dust ingress in the frequency converter can cause suboptimal performance or damage. |                                     |
| Vibration                    | Ensure that the equipment is not exposed to a high level of vibration. Mount the panel solidly or use shock mounts as necessary.  |                                     |

Table 4.8 Start-Up Check List

**CAUTION**

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE  
 Risk of personal injury if the frequency converter is not properly closed.

- Before applying power, ensure that all safety covers are in place and securely fastened.

4.18.1 Installing the Inverter Part

To compress the gasket between the 2 parts:

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

## 5 Commissioning

### 5.1 Applying Power

#### **⚠ WARNING**

##### UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, or after a cleared fault condition.

To prevent unintended motor start:

- Disconnect the frequency converter from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.

See *chapter 2 Safety* for general safety instructions.

#### **⚠ WARNING**

##### HIGH VOLTAGE

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

- Installation, start-up, and maintenance must be performed by qualified personnel only.

Before applying power:

1. Close the cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter 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. Confirm continuity of the motor by measuring  $\Omega$  values on U-V (96–97), V-W (97–98), and W-U (98–96).
7. Check for proper grounding of the frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

Apply power to the frequency converter using the following steps:

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

### 5.2 Local Control Panel Operation

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

The LCP has several user functions:

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

#### **NOTICE**

For commissioning via PC, install the MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, code number 130B1000). For more information and downloads, see [www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm](http://www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm).

**NOTICE**

During start-up, the LCP shows the message *INITIALISING*. When this message is no longer shown, the frequency converter is ready for operation. Adding or removing options can extend the duration of start-up.

5.2.1 Graphic Local Control Panel Layout

The graphic local control panel (GLCP) is divided into 4 functional groups (see *Illustration 5.1*).

- A. Display area.
- B. Display menu keys.
- C. Navigation keys and indicator lights.
- D. Operation keys and reset.

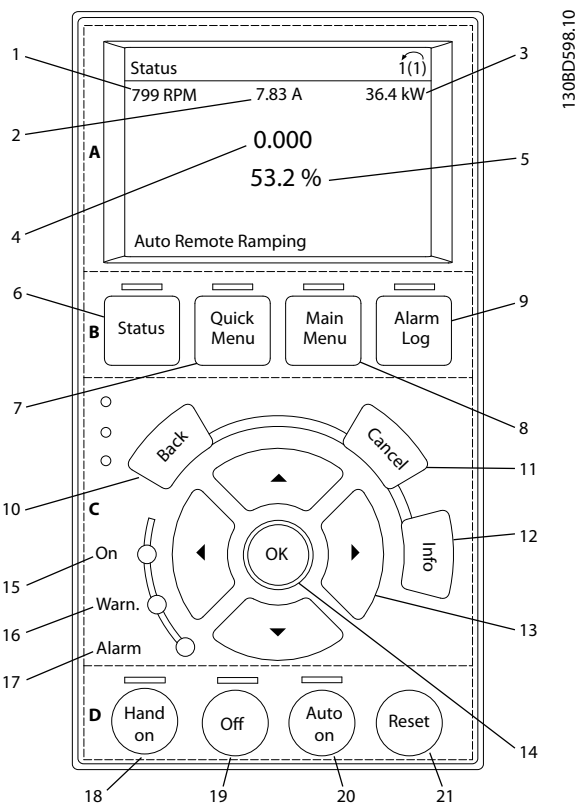


Illustration 5.1 GLCP

**A. Display area**

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

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

| Display | Parameter                                | Default setting      |
|---------|--|----------------------|
| 1       | Parameter 0-20 Display<br>Line 1.1 Small | [1617] Speed [RPM]   |
| 2       | Parameter 0-21 Display<br>Line 1.2 Small | [1614] Motor Current |
| 3       | Parameter 0-22 Display<br>Line 1.3 Small | [1610] Power [kW]    |
| 4       | Parameter 0-23 Display<br>Line 2 Large   | [1613] Frequency     |
| 5       | Parameter 0-24 Display<br>Line 3 Large   | [1602] Reference %   |

Table 5.1 Legend to *Illustration 5.1*, Display Area

**B. Display menu keys**

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

| Key | Function   |   |
|-----|------------|---|
| 6   | Status     | Shows operational information.  |
| 7   | Quick Menu | Allows access to programming parameters for initial set-up instructions and many detailed application instructions. |
| 8   | Main Menu  | Allows access to all programming parameters.  |
| 9   | Alarm Log  | Shows a list of current warnings, the last 10 alarms, and the maintenance log.                                      |

Table 5.2 Legend to *Illustration 5.1*, Display Menu Keys

**C. Navigation keys and indicator lights (LEDs)**

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also 3 frequency converter status indicator lights in this area.

| Key | Function        |  |
|-----|-----------------|--|
| 10  | Back            | Reverts to the previous step or list in the menu structure.                    |
| 11  | Cancel          | Cancels the last change or command as long as the display mode is not changed. |
| 12  | Info            | Press for a definition of the function being showed.                           |
| 13  | Navigation Keys | Press the navigation keys to move between items in the menu.                   |
| 14  | OK              | Press to access parameter groups or to enable a selection.                     |

Table 5.3 Legend to *Illustration 5.1*, Navigation Keys

5

|    | Indicator | Color  | Function   |
|----|-----------|--------|--|
| 15 | On        | Green  | The ON indicator light activates when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V external supply. |
| 16 | Warn      | Yellow | When warning conditions are met, the yellow WARN indicator light comes on and text appears in the display area identifying the problem.            |
| 17 | Alarm     | Red    | A fault condition causes the red alarm LED to flash and an alarm text is shown.  |

Table 5.4 Legend to *Illustration 5.1*, Indicator Lights (LEDs)

D. Operation keys and reset

Operation keys are at the bottom of the LCP.

|    | Key       | Function   |
|----|-----------|--|
| 18 | [Hand On] | Starts the frequency converter in local control. <ul style="list-style-type: none"> <li>An external stop signal by control input or serial communication overrides the local hand on.</li> </ul> |
| 19 | Off       | Stops the motor but does not remove power to the frequency converter.  |
| 20 | [Auto On] | Puts the system in remote operational mode. <ul style="list-style-type: none"> <li>Responds to an external start command by control terminals or serial communication.</li> </ul>                |
| 21 | Reset     | Resets the frequency converter manually after a fault has been cleared.  |

Table 5.5 Legend to *Illustration 5.1*, Operation Keys and Reset

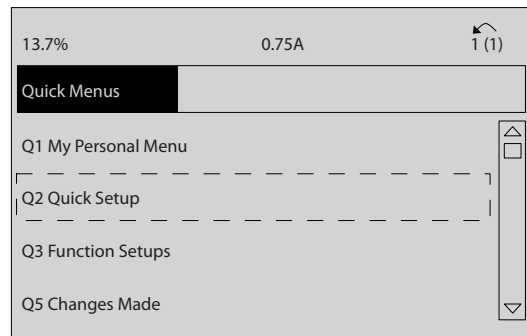
**NOTICE**

To adjust the display contrast, press [Status] and the [▲]/[▼] keys.

5.3 Basic Programming

Frequency converters require basic operational programming before running for best performance. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. Enter the data in accordance with the following procedure. See *chapter 5.2 Local Control Panel Operation*, for detailed instructions on entering data through the LCP. Enter the data with power ON, but before operating the frequency converter.

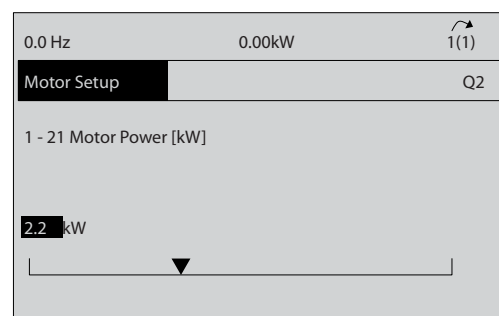
1. Press [Quick Menu] on the LCP.
2. Use the navigation keys to scroll to *parameter group Q2 Quick Setup* and press [OK].



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Illustration 5.2 Parameter Group Q2 Quick Setup

3. Select language and press [OK].
4. Then enter the motor data in *parameter 1-20 Motor Power [kW]*/*parameter 1-21 Motor Power [HP]* through *parameter 1-25 Motor Nominal Speed*. The information can be found on the motor nameplate. The entire quick menu is shown in *International/North American Default Parameter Settings*
  - 4a *Parameter 1-20 Motor Power [kW]*
  - 4b *Parameter 1-21 Motor Power [HP]*
  - 4c *Parameter 1-22 Motor Voltage*
  - 4d *Parameter 1-23 Motor Frequency*
  - 4e *Parameter 1-24 Motor Current*
  - 4f *Parameter 1-25 Motor Nominal Speed*



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Illustration 5.3 Motor Set-up

5. Continue the set-up of Quick Menu parameters:
  - 5a *Parameter 5-12 Terminal 27 Digital Input*. If terminal default is *Coast inverse*, it is possible to change this setting to *No function*.
  - 5b *Parameter 1-29 Automatic Motor Adaptation (AMA)*. Set the desired AMA

function. Enable complete AMA is recommended. See details in *chapter 5.4 System Start-up*.

- 5c *Parameter 3-02 Minimum Reference*. Set the minimum speed of the motor shaft.
- 5d *Parameter 3-03 Maximum Reference*. Set the maximum speed of the motor shaft.
- 5e *Parameter 3-41 Ramp 1 Ramp Up Time*. Set the ramping up time regarding synchronous motor speed, ns.
- 5f *Parameter 3-42 Ramp 1 Ramp Down Time*. Set the ramping down time regarding synchronous motor speed, ns.
- 5g *Parameter 3-13 Reference Site*. Set the site from where the reference must work.

See *chapter 8.1 Quick Menu Parameters* for further details.

## 5.4 System Start-up

Automatic motor adaptation (AMA) is a test procedure which measures the electrical characteristics of the motor. The AMA procedure optimizes compatibility between the frequency converter and the motor. The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power and compares the motor characteristics with the data entered in *parameters 1–20 to 1–25*. Run this procedure at start-up. It does not cause the motor to run and it does not harm the motor. For best result, run the procedure on a cold motor.

### To run AMA

1. Enter the motor nameplate data in the frequency converter, as described in *chapter 5.3 Basic Programming*.
2. Connect terminal 37 to terminal 13.
3. Connect terminal 27 to terminal 12 or set *parameter 5-12 Terminal 27 Digital Input* to [0] *No function*.
4. Activate *parameter 1-29 Automatic Motor Adaptation (AMA)*.
5. Select either complete or reduced AMA.
6. Press [OK]. The display shows *Press [Hand On] to start*.
7. Press [Hand On]. A progress bar indicates that the AMA is in progress.

### Stop the AMA during operation

Press [Off] - the frequency converter enters alarm mode, and the display shows that the AMA procedure is terminated.

### Successful AMA

1. The display shows *Press [OK] to finish AMA*.
2. Press [OK] to exit the AMA state.

### Unsuccessful AMA

1. The frequency converter enters alarm mode. A description of the alarm can be found in *chapter 6.6 List of Warnings and Alarms*.
2. *Report Value* in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the frequency converter entered alarm mode. This number along with the description of the alarm helps with troubleshooting. If contacting Danfoss for service, make sure to mention number and alarm description.

## NOTICE

### Frequent causes of unsuccessful AMA:

- **Incorrectly registered motor nameplate data.**
- **Too great a difference between the motor power size and the frequency converter power size.**

### 5.4.1 Local Control Test

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

If acceleration or deceleration problems occur see *chapter 6 Maintenance, Diagnostics, and Troubleshooting*. See *chapter 6.6 List of Warnings and Alarms* for resetting the frequency converter after a trip.

### 5.4.2 System Start-up

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

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

If warnings or alarms occur, see *chapter 6.5 Warning and Alarm Types* or *chapter 6.6 List of Warnings and Alarms*.

## 5.5 Operation

### 5.5.1 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Press [Main Menu], select *parameter 0-50 LCP Copy* and press [OK].
3. Select [1] *All to LCP* to upload data to the LCP or select [2] *All from LCP* to download data from the LCP.
4. Press [OK]. A progress bar shows the uploading or downloading progress.
5. Press [Hand On] or [Auto On] to return to normal operation.

### 5.5.2 Changing Parameter Settings

Access and change parameter settings from the *Quick Menu* or from the *Main Menu*. The *Quick Menu* only gives access to a limited number of parameters.

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

#### View changes

*Quick Menu Q5 - Changes Made* lists all parameters changed from default settings.

- The list only shows parameters, which are changed in the current edit set-up.
- Parameters, which were reset to default values, are not listed.
- The message *Empty* indicates that no parameters are changed.

### 5.5.3 Restoring Default Settings

#### NOTICE

**Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialization.**

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

- Initialization using *parameter 14-22 Operation Mode* does not reset the frequency converter settings such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

#### Recommended initialization procedure via *parameter 14-22 Operation Mode*

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

Default parameter settings are restored during start-up. The start-up may take slightly longer than normal.

6. *Alarm 80, Drive initialized to default value* is shown.
7. Press [Reset] to return to operating mode.

#### Manual initialization procedure

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

Factory default parameter settings are restored during start-up. The start-up may take slightly longer than usual.

Manual initialization does not reset the following frequency converter information:

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



## 6 Maintenance, Diagnostics, and Troubleshooting

### 6.1 Introduction

This chapter includes:

- Maintenance and service guidelines.
- Status messages.
- Warnings and alarms.
- Basic troubleshooting.

### 6.2 Maintenance and Service

Under normal operating conditions and load profiles, the frequency converter is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the frequency converter at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, contact the local Danfoss supplier.

#### **⚠ WARNING**

##### UNINTENDED START

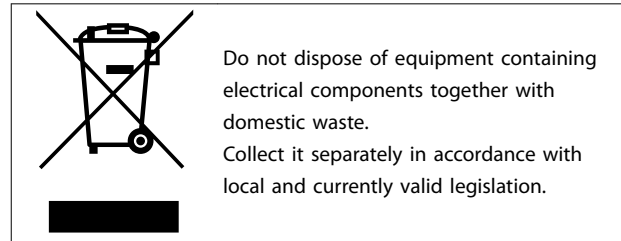
When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor can start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start with an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

To prevent unintended motor start:

- Press [Off/Reset] on the LCP before programming parameters.
- Disconnect the frequency converter from the mains.
- Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.

#### 6.2.1 Cleaning

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



### 6.3 Frontal LEDs

The actual status can be read via 6 LEDs, which signal the actual status of the unit. The meaning of each LED is described in Table 6.1.

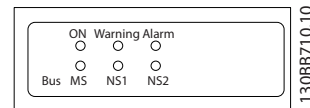


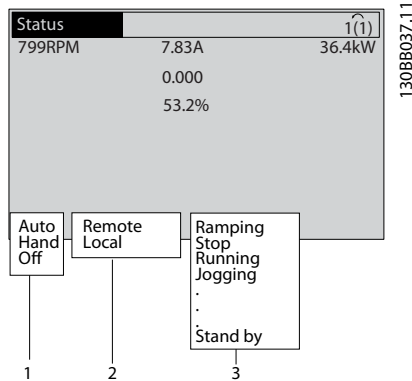
Illustration 6.1 Frontal LEDs

| Name    | Color  | Status   | Indication  |
|---------|--|----------|---|
| ON      | Green  | On       | The frequency converter receives power from mains voltage, or 24 V external supply. |
|         |  | Off      | No power from mains voltage, or 24 V external supply.                               |
| Warning | Yellow   | On       | Warning situation is present.   |
|         |  | Off      | No warning is present.  |
| Alarm   | Red  | Flashing | Alarm is present.   |
|         |  | Off      | No alarm is present   |
| Bus MS  | Only relevant if optional fieldbus is present. See the <i>VLT® AutomationDrive FC 302 PROFIBUS Converter Operating Instructions, VLT® Ethernet/IP MCA 121 Installation Guide, and VLT® PROFINET MCA 120 Installation Guide</i> for specific information. |          | Bus module status   |
| Bus NS1 |  |          | Bus network status 1  |
| Bus NS2 |  |          | Bus network status 2  |

Table 6.1 LED Status

## 6.4 Status Messages

When the frequency converter is in *Status* mode, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 6.2*).



|   |  |
|---|--|
| 1 | Operating mode (see <i>Table 6.2</i> )   |
| 2 | Reference site (see <i>Table 6.3</i> )   |
| 3 | Operation status (see <i>Table 6.4</i> ) |

Illustration 6.2 Status Display

*Table 6.2* to *Table 6.4* describe the status messages shown.

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

Table 6.2 Operating Mode

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

Table 6.3 Reference Site

|                 |   |
|-----------------|---|
| AC Brake        | [2] AC brake is selected in <i>parameter 2-10 Brake Function</i> . The AC brake overmagnetizes the motor to achieve a controlled slow down.   |
| AMA finish OK   | AMA was carried out successfully.   |
| AMA ready       | AMA is ready to start. Press [Hand On] to start.  |
| AMA running     | AMA process is in progress.   |
| Braking         | The brake chopper is in operation. Generative energy is absorbed by the brake resistor.   |
| Braking max.    | The brake chopper is in operation. The power limit for the brake resistor defined in <i>parameter 2-12 Brake Power Limit (kW)</i> has been reached.   |
| Coast           | <ul style="list-style-type: none"> <li>[2] Coast inverse was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not connected.</li> <li>Coast activated by serial communication.</li> </ul>   |
| Ctrl. ramp-down | <p>[1] Control Ramp-down was selected in <i>parameter 14-10 Mains Failure</i>.</p> <ul style="list-style-type: none"> <li>The mains voltage is below the value set in <i>parameter 14-11 Mains Voltage at Mains Fault</i> at mains fault.</li> <li>The frequency converter ramps down the motor using a controlled ramp down.</li> </ul>  |
| Current High    | The frequency converter output current is above the limit set in <i>parameter 4-51 Warning Current High</i> .   |
| Current Low     | The frequency converter output current is below the limit set in <i>parameter 4-52 Warning Speed Low</i> .  |
| DC Hold         | [1] DC hold is selected in <i>parameter 1-80 Function at Stop</i> , and a stop command is active. The motor is held by a DC current set in <i>parameter 2-00 DC Hold/Preheat Current</i> .  |
| DC Stop         | <p>The motor is held with a DC current (<i>parameter 2-01 DC Brake Current</i>) for a specified time (<i>parameter 2-02 DC Braking Time</i>).</p> <ul style="list-style-type: none"> <li>The DC brake cut-in speed is reached in <i>parameter 2-03 DC Brake Cut In Speed [RPM]</i>, and a stop command is active.</li> <li>[5] DC-brake inverse is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active.</li> <li>The DC brake is activated via serial communication.</li> </ul> |
| Feedback high   | The sum of all active feedbacks is above the feedback limit set in <i>parameter 4-57 Warning Feedback High</i> .  |
| Feedback low    | The sum of all active feedbacks is below the feedback limit set in <i>parameter 4-56 Warning Feedback Low</i> .   |

|                       |   |
|-----------------------|---|
| Freeze output         | <p>The remote reference is active, which holds the present speed.</p> <ul style="list-style-type: none"> <li>[20] Freeze output is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is active. Speed control is only possible via the terminal options [21] Speed up and [22] Speed down.</li> <li>Hold ramp is activated via serial communication.</li> </ul>   |
| Freeze output request | A freeze output command was given, but the motor remains stopped until a run permissive signal is received.   |
| Freeze ref.           | [19] Freeze reference is selected as a function for a digital input ( <i>parameter group 5-1* Digital Inputs</i> ). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal options [21] Speed up and [22] Speed down.   |
| Jog request           | A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.   |
| Jogging               | <p>The motor is running as programmed in <i>parameter 3-19 Jog Speed [RPM]</i>.</p> <ul style="list-style-type: none"> <li>[14] Jog was selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal (for example, terminal 29) is active.</li> <li>The jog function is activated via the serial communication.</li> <li>The jog function is selected as a reaction for a monitoring function (for example, for the no signal function). The monitoring function is active.</li> </ul> |
| Motor check           | In <i>parameter 1-80 Function at Stop</i> , [2] Motor Check is selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.  |
| OVC control           | Overvoltage control is activated via <i>parameter 2-17 Over-voltage Control</i> , [2] Enabled. The connected motor supplies the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.  |
| PowerUnit Off         | <p>(Only frequency converters with a 24 V external supply installed).</p> <p>Mains supply to the frequency converter was removed, and the control card is supplied by the external 24 V.</p>  |

|               |   |
|---------------|---|
| Protection md | <p>Protection mode is active. The unit detected a critical status (overcurrent or overvoltage).</p> <ul style="list-style-type: none"> <li>To avoid tripping, the switching frequency is reduced to 4 kHz.</li> <li>If possible, protection mode ends after approximately 10 s.</li> <li>Protection mode can be restricted in <i>parameter 14-26 Trip Delay at Inverter Fault</i>.</li> </ul> |
| Qstop         | <p>The motor is decelerating using <i>parameter 3-81 Quick Stop Ramp Time</i>.</p> <ul style="list-style-type: none"> <li>[4] Quick stop inverse is selected as a function for a digital input (<i>parameter group 5-1* Digital Inputs</i>). The corresponding terminal is not active.</li> <li>The quick stop function is activated via serial communication.</li> </ul>                     |
| Ramping       | The motor accelerates/decelerates using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.  |
| Ref. high     | The sum of all active references is above the reference limit set in <i>parameter 4-55 Warning Reference High</i> .   |
| Ref. low      | The sum of all active references is below the reference limit set in <i>parameter 4-54 Warning Reference Low</i> .  |
| Run on ref.   | The frequency converter runs in the reference range. The feedback value matches the setpoint value.   |
| Run request   | A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.   |
| Running       | The frequency converter drives the motor.   |
| Sleep Mode    | The energy-saving function is enabled. The motor has stopped, but restarts automatically when required.   |
| Speed high    | Motor speed is above the value set in <i>parameter 4-53 Warning Speed High</i> .  |
| Speed low     | Motor speed is below the value set in <i>parameter 4-52 Warning Speed Low</i> .   |
| Standby       | In auto-on mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.   |
| Start delay   | In <i>parameter 1-71 Start Delay</i> , a delay starting time was set. A start command is activated, and the motor starts after the start delay time expires.  |
| Start fwd/rev | [12] Enable start forward and [13] Enable start reverse are selected as options for 2 different digital inputs ( <i>parameter group 5-1* Digital Inputs</i> ). The motor starts in forward or reverse direction depending on which terminal is activated.   |

|           |  |
|-----------|--|
| Stop      | The frequency converter received a stop command from the LCP, digital input, or serial communication.  |
| Trip      | An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.  |
| Trip lock | An alarm occurred, and the motor is stopped. When the cause of the alarm is cleared, cycle power to the frequency converter. The frequency converter can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication. |

Table 6.4 Operation Status

**NOTICE**

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

6.5 Warning and Alarm Types

**Warnings**

A warning is issued when an alarm condition is impending, or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition ceases.

**Alarms**

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

**Trip**

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

**Resetting the frequency converter after trip/trip lock**

A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

**Trip lock**

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

**Warning and alarm displays**

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

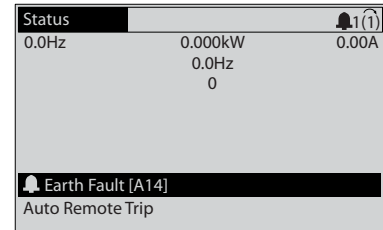
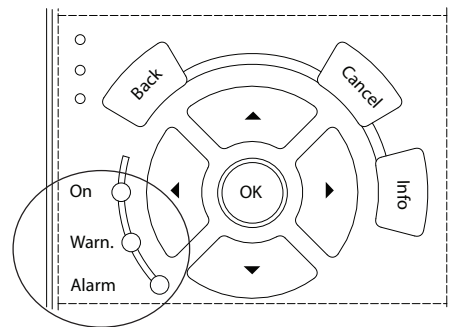


Illustration 6.3 Alarm Example

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



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

Illustration 6.4 Status Indicator Lights

6.6 List of Warnings and Alarms

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

**WARNING 1, 10 Volts low**

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

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

**Troubleshooting**

- Remove the wiring from terminal 50. If the warning clears, the problem is with the wiring. If the warning does not clear, replace the control card.

**WARNING/ALARM 2, Live zero error**

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 frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

**WARNING/ALARM 3, No motor**

No motor is connected to the output of the frequency converter.

**WARNING/ALARM 4, Mains phase loss**

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 frequency converter.

**WARNING 5, DC link voltage high**

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

**WARNING 6, DC link voltage low**

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

**WARNING/ALARM 7, DC overvoltage**

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

**Troubleshooting**

- Connect a brake resistor.
- 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*).

**WARNING/ALARM 8, DC under voltage**

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

**Troubleshooting**

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

**WARNING/ALARM 9, Inverter overload**

The frequency converter 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 frequency converter cannot be reset until the counter is below 90%.

**Troubleshooting**

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

**WARNING/ALARM 10, Motor overload temperature**

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

Select 1 of these options:

- The frequency converter issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The frequency converter trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options.

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

**Troubleshooting**

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

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

**WARNING/ALARM 11, Motor thermistor overtemp**

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

**Troubleshooting**

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

**WARNING/ALARM 12, Torque limit**

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

**Troubleshooting**

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

**WARNING/ALARM 13, Over current**

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the frequency converter 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 the power and check if the motor shaft can be turned.
- Check that the motor size matches the frequency converter.
- Check that the motor data is correct in *parameters 1-20 to 1-25*.

**ALARM 14, Earth (ground) fault**

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

**Troubleshooting**

- Remove power to the frequency converter 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 transducers in the frequency converter. Perform the manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

**ALARM 15, Hardware mismatch**

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

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).

**ALARM 16, Short circuit**

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

**Troubleshooting**

- Remove the power to the frequency converter and repair the short circuit.

**⚠ WARNING****HIGH VOLTAGE**

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- Disconnect power before proceeding.

**WARNING/ALARM 17, Control word timeout**

There is no communication to the frequency converter. 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 frequency converter 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.

**WARNING/ALARM 20, Temp. input error**

The temperature sensor is not connected.

**WARNING/ALARM 21, Parameter error**

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

**Troubleshooting**

- Set the affected parameter to a valid value.

**WARNING/ALARM 22, Hoist mechanical brake**

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

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

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

**WARNING 23, Internal fan fault**

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

**Troubleshooting**

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

**WARNING 24, External fan fault**

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

**Troubleshooting**

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

**WARNING 25, Brake resistor short circuit**

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

**Troubleshooting**

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

**WARNING/ALARM 26, Brake resistor power limit**

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 frequency converter trips when the dissipated braking power reaches 100%.

**WARNING/ALARM 27, Brake chopper fault**

The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The frequency converter 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 power to the frequency converter and remove the brake resistor.

**WARNING/ALARM 28, Brake check failed**

The brake resistor is not connected or not working.

**Troubleshooting**

- Check *parameter 2-15 Brake Check*.

**ALARM 29, Heat Sink temp**

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 frequency converter 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 frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

**ALARM 30, Motor phase U missing**

Motor phase U between the frequency converter and the motor is missing.

**⚠ WARNING**

**HIGH VOLTAGE**

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- Disconnect power before proceeding.

**Troubleshooting**

- Remove the power from the frequency converter and check motor phase U.

**ALARM 31, Motor phase V missing**

Motor phase V between the frequency converter and the motor is missing.

**⚠ WARNING**

**HIGH VOLTAGE**

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- Disconnect power before proceeding.

**Troubleshooting**

- Remove the power from the frequency converter and check motor phase V.

**ALARM 32, Motor phase W missing**

Motor phase W between the frequency converter and the motor is missing.

**⚠ WARNING**

**HIGH VOLTAGE**

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- Disconnect power before proceeding.

**Troubleshooting**

- Remove the power from the frequency converter and check motor phase W.

**ALARM 33, Inrush fault**

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

**Troubleshooting**

- Let the unit cool to operating temperature.

**WARNING/ALARM 34, Fieldbus communication fault**

The fieldbus on the communication option card is not working.

**WARNING/ALARM 35, Option fault**

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

**WARNING/ALARM 36, Mains failure**

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

**Troubleshooting**

- Check the fuses to the frequency converter and mains supply to the unit.

**ALARM 37, Phase imbalance**

There is a current imbalance between the power units.

**ALARM 38, Internal fault**

When an internal fault occurs, a code number defined in *Table 6.5* is shown.

**Troubleshooting**

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

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

| Number  | Text   |
|---------|--|
| 0       | The serial port cannot be initialized. Contact the Danfoss supplier or 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.                        |



| Number    | Text   |
|-----------|--|
| 783       | Parameter value outside of minimum/maximum limits.   |
| 1024–1284 | Internal fault. Contact the Danfoss supplier or the 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 frequency converter 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. |
| 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.  |

Table 6.5 Internal Fault Codes

**ALARM 39, Heat sink sensor**

No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gatedrive card, or the ribbon cable between the power card and gatedrive card.

**WARNING 40, Overload of digital output terminal 27**

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

**WARNING 41, Overload of digital output terminal 29**

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

**WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7**

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

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

**ALARM 43, Ext. supply**

VLT<sup>®</sup> Extended Relay Option MCB 113 is mounted without external 24 V DC. Either connect a 24 V DC external supply or 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.

**ALARM 45, Earth fault 2**

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.

**ALARM 46, Power card supply**

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.

When powered with VLT<sup>®</sup> 24 V DC Supply MCB 107, only the 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.

**WARNING 47, 24 V supply low**

The supply on the power card is out of range.

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

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

**Troubleshooting**

- Check for a defective power card.

**WARNING 48, 1.8 V supply low**

The 1.8 V DC supply used on the control card is outside of the allowable 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.

**WARNING 49, Speed limit**

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 frequency converter trips.

**ALARM 50, AMA calibration failed**

Contact the Danfoss supplier or Danfoss service department.

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

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

**Troubleshooting**

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

**ALARM 52, AMA low  $I_{nom}$** 

The motor current is too low.

**Troubleshooting**

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

**ALARM 53, AMA motor too big**

The motor is too large for the AMA to operate.

**ALARM 54, AMA motor too small**

The motor is too small for the AMA to operate.

**ALARM 55, AMA parameter out of range**

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

**ALARM 56, AMA interrupted by user**

The AMA is manually interrupted.

**ALARM 57, AMA internal fault**

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

**ALARM 58, AMA Internal fault**

Contact the Danfoss supplier.

**WARNING 59, Current limit**

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

**WARNING 60, External interlock**

A digital input signal indicates a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock, and reset the frequency converter.

**WARNING/ALARM 61, Feedback error**

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

**Troubleshooting**

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

**WARNING 62, Output frequency at maximum limit**

The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*. Check the application for possible causes. Possibly 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.

**ALARM 63, Mechanical brake low**

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

**WARNING 64, Voltage Limit**

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

**WARNING/ALARM 65, Control card over temperature**

The cutout temperature of the control card is 85 °C (185 °F).

**Troubleshooting**

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

**WARNING 66, Heat sink temperature low**

The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module. Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* to 5% and *parameter 1-80 Function at Stop*.

**ALARM 67, Option module configuration has changed**

One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

**ALARM 68, Safe Stop activated**

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

**ALARM 69, Power card temperature**

The temperature sensor on the power card is either too hot or too cold.

**Troubleshooting**

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

**ALARM 70, Illegal FC configuration**

The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers of the cards.

**ALARM 71, PTC 1 safe stop**

STO has been activated from the VLT<sup>®</sup> PTC Thermistor Card MCB 112 (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to terminal 37 again (when the motor temperature reaches an acceptable level), and when the digital input from the MCB 112 is deactivated. When that happens, send a reset signal (via bus or digital I/O, or press [Reset]).

**ALARM 72, Dangerous failure**

STO with trip lock. An unexpected combination of STO commands has occurred:

- VLT<sup>®</sup> 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 1 warning* in *parameter 5-19 Terminal 37 Safe Stop*), STO is activated, and X44/10 is not activated.

**WARNING 73, Safe Stop auto restart**

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

**ALARM 74, PTC Thermistor**

Alarm related to VLT<sup>®</sup> PTC Thermistor Card MCB 112. The PTC is not working.

**ALARM 75, Illegal profile sel.**

Do not write the parameter value while the motor is running. Stop the motor before writing the MCO profile to *parameter 8-10 Control Word Profile*.

**WARNING 77, Reduced power mode**

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

**ALARM 78, Tracking error**

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 frequency converter.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

**ALARM 79, Illegal power section configuration**

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

**ALARM 80, Drive initialised to default value**

Parameter settings are initialized to default settings after a manual reset. To clear the alarm, reset the unit.

**ALARM 81, CSIV corrupt**

CSIV file has syntax errors.

**ALARM 82, CSIV parameter error**

CSIV failed to initialize a parameter.

**ALARM 83, Illegal option combination**

The mounted options are incompatible.

**ALARM 84, No safety option**

The safety option was removed without applying a general reset. Reconnect the safety option.

**ALARM 88, Option detection**

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.

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

**WARNING 89, Mechanical brake sliding**

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

**ALARM 90, Feedback monitor**

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

**ALARM 91, Analog input 54 wrong settings**

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

**ALARM 99, Locked rotor**

Rotor is blocked.

**WARNING/ALARM 104, Mixing fan fault**

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 trip in *parameter 14-53 Fan Monitor*.

**Troubleshooting**

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

**WARNING/ALARM 122, Mot. rotat. unexp.**

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

**WARNING 163, ATEX ETR cur.lim.warning**

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

**ALARM 164, ATEX ETR cur.lim.alarm**

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

**WARNING 165, ATEX ETR freq.lim.warning**

The frequency converter is running for more than 50 s below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

**ALARM 166, ATEX ETR freq.lim.alarm**

The frequency converter has operated for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

**WARNING 250, New spare part**

The power or switch mode supply has been exchanged. Restore the frequency converter type code in the EEPROM. Select the correct type code in *parameter 14-23 Typecode Setting* according to the label on the frequency converter. Remember to select Save to EEPROM at the end.

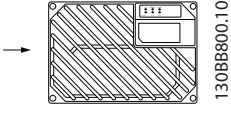
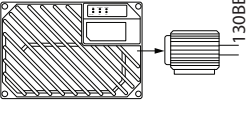
**WARNING 251, New typecode**

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

## 7 Specifications

### 7.1 Electrical Data

#### 7.1.1 Overview

| Mains supply 3x380–480 V AC   |  |   |      |      |      |      |      |      |  |
|---|--|---|------|------|------|------|------|------|--|
| Frequency converter   |  | PK37                                    | PK55 | PK75 | P1K1 | P1K5 | P2K2 | P3K0 |  |
| Rated shaft output [kW]   |  | 0.37                                    | 0.55 | 0.75 | 1.1  | 1.5  | 2.2  | 3.0  |  |
| Rated shaft output [hp]   |  | 0.5                                     | 0.75 | 1.0  | 1.5  | 2.0  | 3.0  | 4.0  |  |
| Maximum input current   |  |   |      |      |      |      |      |      |  |
|  | Continuous (3x380–440 V) [A]   | 1.2                                     | 1.6  | 2.2  | 2.7  | 3.7  | 5.0  | 6.5  |  |
|   | Intermittent (3x380–440 V) [A]   | 1.9                                     | 2.6  | 3.5  | 4.3  | 5.9  | 8.0  | 10.4 |  |
|   | Continuous (3x441–480 V) [A]   | 1.0                                     | 1.4  | 1.9  | 2.7  | 3.1  | 4.3  | 5.7  |  |
|   | Intermittent (3x441–480 V) [A]   | 1.6                                     | 2.2  | 3.0  | 4.3  | 5.0  | 6.9  | 9.1  |  |
|   | Recommended maximum fuse size (non-UL)   | gG-25                                   |      |      |      |      |      |      |  |
|   | Built-in circuit breaker (large unit)  | CTI-25M Danfoss part number: 047B3151   |      |      |      |      |      |      |  |
|   | Recommended circuit breaker Danfoss CTI-25M (small and large unit) part number:      |   |      |      |      |      |      |      |  |
|   | 0.37, 0.55 kW  | Danfoss part number: 047B3148           |      |      |      |      |      |      |  |
|   | 0.75, 1.1 kW   | Danfoss part number: 047B3149           |      |      |      |      |      |      |  |
|   | 1.5 kW, 2.2 kW, and 3 kW   | Danfoss part number: 047B3151           |      |      |      |      |      |      |  |
|   | Recommended circuit breaker Danfoss CTI-45MB <sup>1)</sup> (small unit) part number: |   |      |      |      |      |      |      |  |
|   | 0.55, 0.75 kW  | Danfoss part number: 047B3160           |      |      |      |      |      |      |  |
|   | 1.1 kW   | Danfoss part number: 047B3161           |      |      |      |      |      |      |  |
|   | 1.5 kW   | Danfoss part number: 047B3162           |      |      |      |      |      |      |  |
|   | 2.2 kW   | Danfoss part number: 047B3163           |      |      |      |      |      |      |  |
| Power loss at maximum load [W] <sup>2)</sup>  | 35   | 42                                      | 46   | 58   | 62   | 88   | 116  |      |  |
| Efficiency <sup>3)</sup>  | 0.93   | 0.95                                    | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 |      |  |
| Weight, small unit [kg]   | 9.8 (21.6 lb)  |   |      |      |      |      |      | –    |  |
| Weight, large unit [kg]   | 13.9 (30.6 lb)   |   |      |      |      |      |      |      |  |
| Output current  |  |   |      |      |      |      |      |      |  |
|  | Continuous (3x380–440 V) [A]   | 1.3                                     | 1.8  | 2.4  | 3.0  | 4.1  | 5.2  | 7.2  |  |
|   | Intermittent (3x380–440 V) [A]   | 2.1                                     | 2.9  | 3.8  | 4.8  | 6.6  | 8.3  | 11.5 |  |
|   | Continuous (3x441–480 V) [A]   | 1.2                                     | 1.6  | 2.1  | 3.0  | 3.4  | 4.8  | 6.3  |  |
|   | Intermittent (3x441–480 V) [A]   | 1.9                                     | 2.6  | 3.4  | 4.8  | 5.4  | 7.7  | 10.1 |  |
|   | Continuous kVA (400 V AC) [kVA]  | 0.9                                     | 1.3  | 1.7  | 2.1  | 2.8  | 3.9  | 5.0  |  |
|   | Continuous kVA (460 V AC) [kVA]  | 0.9                                     | 1.3  | 1.7  | 2.4  | 2.7  | 3.8  | 5.0  |  |
|   | Maximum cable size: (Mains, motor, brake) [mm <sup>2</sup> /AWG]                     | Solid cable 6/10<br>Flexible cable 4/12 |      |      |      |      |      |      |  |

**Table 7.1 VLT<sup>®</sup> Decentral Drive FCD 302 Shaft Output, Output Current, and Input Current**

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

2) Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to [www.danfoss.com/vltenergyefficiency](http://www.danfoss.com/vltenergyefficiency).

3) Efficiency measured at nominal current. For energy efficiency class, see chapter 7.4 Ambient Conditions. For part load losses, see [www.danfoss.com/vltenergyefficiency](http://www.danfoss.com/vltenergyefficiency).

## 7.2 Mains Supply

Mains supply (L1, L2, L3)<sup>1)</sup>

|  |                                    |
|--|------------------------------------|
| Supply voltage                                   | 380–480 V $\pm 10\%$ <sup>2)</sup> |
| Supply frequency                                 | 50/60 Hz $\pm 5\%$                 |
| Maximum imbalance temporary between mains phases | 3.0% of rated supply voltage       |
| True power factor ( $\lambda$ )                  | $\geq 0.9$ nominal at rated load   |
| Displacement power factor ( $\cos \phi$ )        | Near unity ( $> 0.98$ )            |
| Switching on input supply L1, L2, L3 (power-ups) | Maximum 2 times/minute             |

1) The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 480 V maximum.

2) Mains voltage low/mains drop-out:

During low mains voltage or a mains drop-out, the frequency converter continues until the DC-link voltage drops below the minimum stop level, which corresponds typically to 15% below the frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

# 7

## 7.3 Motor Output and Motor Data

Motor output (U, V, W)

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

Torque characteristics

|                                   |  |
|-----------------------------------|--|
| Starting torque (constant torque) | Maximum 160% for 60 s <sup>1)</sup>    |
| Starting torque                   | Maximum 180% up to 0.5 s <sup>1)</sup> |
| Overload torque (constant torque) | Maximum 160% for 60 s <sup>1)</sup>    |
| Starting torque (variable torque) | Maximum 110% for 60 s <sup>1)</sup>    |
| Overload torque (variable torque) | Maximum 110% for 60 s <sup>1)</sup>    |

1) Percentage relates to the nominal torque.

## 7.4 Ambient Conditions

### Surroundings

|  |   |
|--|---|
| Enclosure rating   | IP66/Type 4X (indoor)   |
| Vibration test for units with no circuit breaker   | 1.7 g RMS   |
| Mounts unit with integrated circuit breaker on a level, vibration-proof, and torsionally rigid support structure |   |
| Maximum relative humidity  | 5–95% (IEC 60 721-3-3; Class 3K3 (non-condensing) during operation) |
| Ambient temperature  | Maximum 40 °C (75 °F) (24-hour average maximum 35 °C (95 °F))       |
| Temperature during storage/transport   | -25 to +65/70 °C (-13 to +149/158 °F)                               |
| <i>Derating for high ambient temperature</i>   |   |
| Minimum ambient temperature during full-scale operation  | 0 °C (32 °F)  |
| Minimum ambient temperature at reduced performance   | -10 °C (14 °F)  |
| Maximum altitude above sea level   | 1000 m (3280.8 ft)  |
| Energy efficiency class <sup>1)</sup>  | IE2   |

### *Derating for high altitude*

1) Determined according to EN 50598-2 at:

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

## 7.5 Cable Specifications

### Cable lengths and cross-sections for control cables<sup>1)</sup>

|  |                              |
|--|------------------------------|
| Maximum motor cable length, shielded   | 10 m (32.8 ft)               |
| Maximum motor cable length, unshielded, without fulfilling emission specification.           | 10 m (32.8 ft)               |
| Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves    | 1.5 mm <sup>2</sup> /16 AWG  |
| Maximum cross-section to control terminals, flexible wire with cable end sleeves             | 1.5 mm <sup>2</sup> /16 AWG  |
| Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar | 1.5 mm <sup>2</sup> /16 AWG  |
| Minimum cross-section to control terminals   | 0.25 mm <sup>2</sup> /24 AWG |

1) Power cables, see tables in chapter Electrical Data and Wire Sizes in the VLT<sup>®</sup> Decentral Drive FCD 302 Design Guide.

## 7.6 Control Input/Output and Control Data

### Digital inputs

|  |  |
|--|--|
| Programmable digital inputs              | 4 (6) <sup>1)</sup>                                  |
| Terminal number                          | 18, 19, 27 <sup>1)</sup> , 29 <sup>1)</sup> , 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 <sup>2)</sup> | >19 V DC   |
| Voltage level, logic 1 NPN <sup>2)</sup> | <14 V DC   |
| Maximum voltage on input                 | 28 V DC  |
| Pulse frequency range                    | 0–110 kHz  |
| (Duty cycle) Minimum pulse width         | 4.5 ms   |
| Input resistance, R <sub>i</sub>         | Approximately 4 kΩ                                   |

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

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

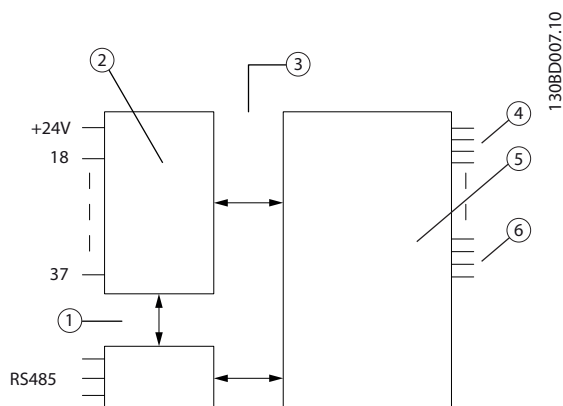
Safe Torque Off terminal 37 (terminal 37 is fixed PNP logic)

|                               |           |
|-------------------------------|-----------|
| Voltage level                 | 0–24 V DC |
| Voltage level, logic 0 PNP    | <4 V DC   |
| Voltage level, logic 1 PNP    | 20 V DC   |
| Nominal input current at 24 V | 50 mA rms |
| Nominal input current at 20 V | 60 mA rms |
| Input capacitance             | 400 nF    |

Analog inputs

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

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



| Item | Description          |
|------|----------------------|
| 1    | Functional isolation |
| 2    | Control              |
| 3    | PELV isolation       |
| 4    | Mains                |
| 5    | High voltage         |
| 6    | Motor                |

Illustration 7.1 Analog Inputs



**Pulse/encoder inputs**

|  |   |
|--|---|
| Programmable pulse/encoder inputs        | 2/1   |
| Terminal number pulse/encoder            | 29, 33 <sup>1)</sup> /32 <sup>2)</sup> , 33 <sup>2)</sup> |
| Maximum frequency at terminal 29, 32, 33 | 110 kHz (Push-pull driven)                                |
| Maximum frequency at terminal 29, 32, 33 | 5 kHz (open collector)                                    |
| Minimum frequency at terminal 29, 32, 33 | 4 Hz  |
| Voltage level                            | See <i>Digital Inputs</i> in this section                 |
| Maximum voltage on input                 | 28 V DC   |
| Input resistance, R <sub>i</sub>         | Approximately 4 kΩ  |
| Pulse input accuracy (0.1–1 kHz)         | Maximum error: 0.1% of full scale                         |
| Encoder input accuracy (1–110 kHz)       | Maximum error: 0.05% of full scale                        |

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

1) Pulse inputs are 29 and 33

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

**Analog output**

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

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

**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 functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).*

**Digital output**

|  |                                   |
|--|-----------------------------------|
| Programmable digital/pulse outputs           | 2                                 |
| Terminal number                              | 27, 29 <sup>1)</sup>              |
| 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) Terminal 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.*

**Control card, 24 V DC output**

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

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

**Relay outputs**

|   |                              |
|---|------------------------------|
| Programmable relay outputs  | 2                            |
| Relay 01 terminal number  | 1-3 (break), 1-2 (make)      |
| Maximum terminal load (AC-1) <sup>1)</sup> on 1-3 (NC), 1-2 (NO) (Resistive load)                           | 240 V AC, 2 A                |
| Maximum terminal load (AC-15) <sup>1)</sup> (Inductive load @ cosφ 0.4)                                     | 240 V AC, 0.2 A              |
| Maximum terminal load (DC-1) <sup>1)</sup> on 1-2 (NO), 1-3 (NC) (Resistive load)                           | 48 V DC, 1 A                 |
| Maximum terminal load (DC-13) <sup>1)</sup> (Inductive load)  | 24 V DC, 0.1 A               |
| Relay 02 terminal number  | 4-6 (break), 4-5 (make)      |
| Maximum terminal load (AC-1) <sup>1)</sup> on 4-5 (NO) (Resistive load) <sup>2)3)</sup> Overvoltage cat. II | 240 V AC, 2 A                |
| Maximum terminal load (AC-15) <sup>1)</sup> on 4-5 (NO) (Inductive load @ cosφ 0.4)                         | 240 V AC, 0.2 A              |
| Maximum terminal load (DC-1) <sup>1)</sup> on 4-5 (NO) (Resistive load)                                     | 80 V DC, 2 A                 |
| Maximum terminal load (DC-13) <sup>1)</sup> on 4-5 (NO) (Inductive load)                                    | 24 V DC, 0.1 A               |
| Maximum terminal load (AC-1) <sup>1)</sup> on 4-6 (NC) (Resistive load)                                     | 240 V AC, 2 A                |
| Maximum terminal load (AC-15) <sup>1)</sup> (Inductive load @ cosφ 0.4)                                     | 240 V AC, 0.2 A              |
| Maximum terminal load (DC-1) <sup>1)</sup> on 4-6 (NO), 4-5 (NC) (Resistive load)                           | 48 V DC, 1 A                 |
| Maximum terminal load (DC-13) <sup>1)</sup> (Inductive load)  | 24 V DC, 0.1 A               |
| Minimum terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)   | 24 V DC 10 mA, 24 V AC 20 mA |

1) IEC 60947 part 4 and 5

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

2) Overvoltage Category II

3) UL applications 300 V AC 2A

**Control card, 10 V DC output**

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

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

**Control characteristics**

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

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

**Control card performance**

|               |      |
|---------------|------|
| Scan interval | 1 ms |
|---------------|------|

**Control card, USB serial communication**

|              |                  |
|--------------|------------------|
| USB standard | 1.1 (Full speed) |
| USB plug     | USB type B plug  |

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

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

The USB ground connection is **not** galvanically isolated from protection ground. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

## 7.7 Fuses and Circuit Breakers

- American Wire Gauge. Maximum cable cross-section is the largest cable cross-section that can be attached to the terminals. Always observe national and local regulations.
- Type gG pre-fuses must be used. To maintain UL/cUL, use pre-fuses of these types (see Table 7.2).
- Measured using a 10 m (32.8 ft) shielded/armoured motor cable with a rated load and rated frequency.

### Fuses

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

### Circuit breaker

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

### Recommended maximum pre-fuse size 25 A

| Brand          | Fuse type              | UL file number | UL Category (CCN code) |
|----------------|------------------------|----------------|------------------------|
| Bussmann       | FWH- <sup>1)</sup>     | E91958         | JFHR2                  |
| Bussmann       | KTS-R <sup>1)</sup>    | E4273          | RK1/JDDZ               |
| Bussmann       | JKS- <sup>1)</sup>     | E4273          | J/JDDZ                 |
| Bussmann       | JJS- <sup>1)</sup>     | E4273          | T/JDDZ                 |
| Bussmann       | FNQ-R- <sup>1)</sup>   | E4273          | CC/JDDZ                |
| Bussmann       | KTK-R- <sup>1)</sup>   | E4273          | CC/JDDZ                |
| Bussmann       | LP-CC- <sup>1)</sup>   | E4273          | CC/JDDZ                |
| SIBA           | 5017906- <sup>1)</sup> | E180276        | RK1/JDDZ               |
| Littelfuse     | KLS-R <sup>1)</sup>    | E81895         | RK1/JDDZ               |
| Ferraz Shawmut | ATM-R <sup>1)</sup>    | E2137          | CC/JDDZ                |
| Ferraz Shawmut | A6K-R <sup>1)</sup>    | E2137          | RK1/JDDZ               |
| Ferraz Shawmut | HSJ <sup>1)</sup>      | E2137          | J/HSJ                  |

**Table 7.2 FCD 302 Pre-fuses Meeting UL/cUL Requirements**

1) 5 A (0.37 kW/0.5 hp), 7A (0.55 kW/0.73 hp), 9 A (0.75 kW/1 hp), 12 A (1.1 kW/1.5 hp), 15 A (1.5 kW/2 hp), 20 A (2.2 kW/3 hp), 25 A (3 kW/4 hp)

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

**Table 7.3 FCD 302 DC Voltage Level**

## 8 Appendix

### 8.1 Quick Menu Parameters

8

| 0-01 Language |                  |  |
|---------------|------------------|--|
| Option:       | Function:        |  |
|               |                  | Defines display language. The frequency converter is delivered with 4 different language packages. English and German are included in all packages. English cannot be erased or manipulated. |
| [0] *         | English          | Part of language packages 1–4  |
| [1]           | Deutsch          | Part of language packages 1–4  |
| [2]           | Francais         | Part of language package 1   |
| [3]           | Dansk            | Part of language package 1   |
| [4]           | Spanish          | Part of language package 1   |
| [5]           | Italiano         | Part of language package 1   |
| [6]           | Svenska          | Part of language package 1   |
| [7]           | Nederlands       | Part of language package 1   |
| [10]          | Chinese          | Part of language package 2   |
| [20]          | Suomi            | Part of language package 1   |
| [22]          | English US       | Part of language package 4   |
| [27]          | Greek            | Part of language package 4   |
| [28]          | Bras.port        | Part of language package 4   |
| [36]          | Slovenian        | Part of language package 3   |
| [39]          | Korean           | Part of language package 2   |
| [40]          | Japanese         | Part of language package 2   |
| [41]          | Turkish          | Part of language package 4   |
| [42]          | Trad.Chinese     | Part of language package 2   |
| [43]          | Bulgarian        | Part of language package 3   |
| [44]          | Srpski           | Part of language package 3   |
| [45]          | Romanian         | Part of language package 3   |
| [46]          | Magyar           | Part of language package 3   |
| [47]          | Czech            | Part of language package 3   |
| [48]          | Polski           | Part of language package 4   |
| [49]          | Russian          | Part of language package 3   |
| [50]          | Thai             | Part of language package 2   |
| [51]          | Bahasa Indonesia | Part of language package 2   |
| [52]          | Hrvatski         | Part of language package 3   |

| 1-20 Motor Power [kW]              |           |  |
|------------------------------------|-----------|--|
| Range:                             | Function: |  |
| Size related* [ 0.09 - 3000.00 kW] |           | <p><b>NOTICE</b></p> <p>This parameter cannot be adjusted while the motor is running.</p> <p>Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the frequency converter.</p> <p>This parameter is visible in the LCP if <i>parameter 0-03 Regional Settings</i> is set to [0] <i>International</i>.</p> |

| 1-22 Motor Voltage           |           |  |
|------------------------------|-----------|--|
| Range:                       | Function: |  |
| Size related* [ 10 - 1000 V] |           | Enter the nominal motor voltage according to the motor nameplate data. The default value corresponds to the nominal rated output of the frequency converter. |

| 1-23 Motor Frequency         |           |   |
|------------------------------|-----------|---|
| Range:                       | Function: |   |
| Size related* [20 - 1000 Hz] |           | <p><b>NOTICE</b></p> <p>From software version 6.72 onwards, the output frequency of the frequency converter is limited to 590 Hz.</p> <p>Select the motor frequency value from the motor nameplate data. If a value other than 50 Hz or 60 Hz is selected, adapt the load-independent settings in <i>parameter 1-50 Motor Magnetisation at Zero Speed</i> to <i>parameter 1-53 Model Shift Frequency</i>. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. To run at 87 Hz, adapt <i>parameter 4-13 Motor Speed High Limit [RPM]</i> and <i>parameter 3-03 Maximum Reference</i>.</p> |

| 1-24 Motor Current |                      |   |
|--------------------|----------------------|---|
| Range:             |                      | Function:   |
| Size related*      | [ 0.10 - 10000.00 A] | <p><b>NOTICE</b></p> <p>This parameter cannot be adjusted while the motor is running.</p> <p>Enter the nominal motor current value from the motor nameplate data. The data is used for calculating motor torque, motor thermal protection, and so on.</p> |

| 1-25 Motor Nominal Speed |                   |   |
|--------------------------|-------------------|---|
| Range:                   |                   | Function:   |
| Size related*            | [100 - 60000 RPM] | <p><b>NOTICE</b></p> <p>This parameter cannot be adjusted while the motor is running.</p> <p>Enter the nominal motor speed value from the motor nameplate data. The data is used for calculating automatic motor compensations.</p> |

**5-12 Terminal 27 Digital Input**

| Option:                 | Function:   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
|-------------------------|---|--------------|-----|-------|-----|---------------|-----|-------------------------|-----|--------------------|-----|------------------|-----|--------------|-----|-------|-----|---------------|-----|-----------|------|-----------------|------|----------------------|------|----------------------|------|-----|------|------------------|------|------------------|------|------------------|------|------------------|------|---------------|------|----------|------|------------|------|---------------------|------|---------------------|------|
|                         | Select the function from the available digital input range.   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
|                         | <table border="1"> <tr><td>No operation</td><td>[0]</td></tr> <tr><td>Reset</td><td>[1]</td></tr> <tr><td>Coast inverse</td><td>[2]</td></tr> <tr><td>Coast and reset inverse</td><td>[3]</td></tr> <tr><td>Quick stop inverse</td><td>[4]</td></tr> <tr><td>DC-brake inverse</td><td>[5]</td></tr> <tr><td>Stop inverse</td><td>[6]</td></tr> <tr><td>Start</td><td>[8]</td></tr> <tr><td>Latched start</td><td>[9]</td></tr> <tr><td>Reversing</td><td>[10]</td></tr> <tr><td>Start reversing</td><td>[11]</td></tr> <tr><td>Enable start forward</td><td>[12]</td></tr> <tr><td>Enable start reverse</td><td>[13]</td></tr> <tr><td>Jog</td><td>[14]</td></tr> <tr><td>Preset ref bit 0</td><td>[16]</td></tr> <tr><td>Preset ref bit 1</td><td>[17]</td></tr> <tr><td>Preset ref bit 2</td><td>[18]</td></tr> <tr><td>Freeze reference</td><td>[19]</td></tr> <tr><td>Freeze output</td><td>[20]</td></tr> <tr><td>Speed up</td><td>[21]</td></tr> <tr><td>Speed down</td><td>[22]</td></tr> <tr><td>Set-up select bit 0</td><td>[23]</td></tr> <tr><td>Set-up select bit 1</td><td>[24]</td></tr> </table> | No operation | [0] | Reset | [1] | Coast inverse | [2] | Coast and reset inverse | [3] | Quick stop inverse | [4] | DC-brake inverse | [5] | Stop inverse | [6] | Start | [8] | Latched start | [9] | Reversing | [10] | Start reversing | [11] | Enable start forward | [12] | Enable start reverse | [13] | Jog | [14] | Preset ref bit 0 | [16] | Preset ref bit 1 | [17] | Preset ref bit 2 | [18] | Freeze reference | [19] | Freeze output | [20] | Speed up | [21] | Speed down | [22] | Set-up select bit 0 | [23] | Set-up select bit 1 | [24] |
| No operation            | [0]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Reset                   | [1]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Coast inverse           | [2]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Coast and reset inverse | [3]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Quick stop inverse      | [4]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| DC-brake inverse        | [5]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Stop inverse            | [6]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Start                   | [8]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Latched start           | [9]   |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Reversing               | [10]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Start reversing         | [11]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Enable start forward    | [12]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Enable start reverse    | [13]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Jog                     | [14]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Preset ref bit 0        | [16]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Preset ref bit 1        | [17]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Preset ref bit 2        | [18]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Freeze reference        | [19]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Freeze output           | [20]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Speed up                | [21]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Speed down              | [22]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Set-up select bit 0     | [23]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |
| Set-up select bit 1     | [24]  |              |     |       |     |               |     |                         |     |                    |     |                  |     |              |     |       |     |               |     |           |      |                 |      |                      |      |                      |      |     |      |                  |      |                  |      |                  |      |                  |      |               |      |          |      |            |      |                     |      |                     |      |

**5-12 Terminal 27 Digital Input**

| Option: | Function:                  |
|---------|----------------------------|
|         | Catch up [28]              |
|         | Slow down [29]             |
|         | Pulse input [32]           |
|         | Ramp bit 0 [34]            |
|         | Ramp bit 1 [35]            |
|         | Mains failure inverse [36] |
|         | DigiPot increase [55]      |
|         | DigiPot decrease [56]      |
|         | DigiPot clear [57]         |
|         | Reset counter A [62]       |
|         | Reset counter B [65]       |

**1-29 Automatic Motor Adaptation (AMA)**

| Option: | Function:  |
|---------|--|
|         | <p>The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor parameters (<i>parameter 1-30 Stator Resistance (Rs)</i> to <i>parameter 1-35 Main Reactance (Xh)</i>) at motor standstill.</p> <p>Activate the AMA function by pressing [Hand on] after selecting [1] or [2]. See also <i>chapter 5.4 System Start-up</i>. After a normal sequence, the display reads: "Press [OK] to finish AMA". After pressing [OK] the frequency converter is ready for operation.</p> <p><b>NOTICE</b></p> <p>This parameter cannot be adjusted while the motor is running.</p> |
| [0]     | OFF  |
| *       |  |
| [1]     | Enable complete AMA  |
| [2]     | Enable reduced AMA   |

- Note:**
- For the best adaptation of the frequency converter, run AMA on a cold motor.
  - AMA cannot be performed while the motor is running.
  - AMA cannot be performed on permanent magnet motors.

**NOTICE**

It is important to set motor *parameter group 1-2\* Motor Data* correctly, since these parameters form part of the AMA algorithm. An AMA must be performed to achieve optimum dynamic motor performance. Depending on the power rating of the motor, it takes up to 10 minutes

**NOTICE**

Avoid generating external torque during AMA, by disconnecting the motor shaft from the application.

**NOTICE**

If 1 of the settings in *parameter group 1-2\* Motor Data* is changed, *parameter 1-30 Stator Resistance (Rs)* to *parameter 1-39 Motor Poles*, the advanced motor parameters return to default setting.

8

| 3-02 Minimum Reference  |   |  |
|---|---|--|
| Range:  | Function:   |  |
| Size related* [-999999.999 - par. 3-03 ReferenceFeedbackUnit] | <p>Enter the minimum reference. The minimum reference is the lowest value obtainable by summing all references.</p> <p>Minimum reference is active only when <i>parameter 3-00 Reference Range</i> is set to [0] Min.- Max.</p> <p>The minimum reference unit matches:</p> <ul style="list-style-type: none"> <li>The configuration of <i>parameter 1-00 Configuration Mode</i>: for [1] Speed closed loop, RPM; for [2] Torque, Nm.</li> <li>The unit selected in <i>parameter 3-01 Reference/ Feedback Unit</i>.</li> </ul> <p>If option [10] Synchronization is selected in <i>parameter 1-00 Configuration Mode</i>, this parameter defines the maximum speed deviation when performing the position offset defined in <i>parameter 3-26 Master Offset</i>.</p> |  |

| 3-03 Maximum Reference  |  |  |
|---|--|--|
| Range:  | Function:  |  |
| Size related* [ par. 3-02 - 999999.999 ReferenceFeedbackUnit] | <p>Enter the maximum reference. The maximum reference is the highest value obtainable by summing all references.</p> <p>The maximum reference unit matches:</p> <ul style="list-style-type: none"> <li>The configuration selected in <i>parameter 1-00 Configu-</i></li> </ul> |  |

| 3-03 Maximum Reference |           |  |
|------------------------|-----------|--|
| Range:                 | Function: |  |
|                        |           | <p>ration Mode: For [1] Speed closed loop, RPM; for [2] Torque, Nm.</p> <ul style="list-style-type: none"> <li>The unit selected in <i>parameter 3-00 Reference Range</i>.</li> </ul> <p>If [9] Positioning is selected in <i>parameter 1-00 Configuration Mode</i>, this parameter defines the default speed for positioning.</p> |

| 3-41 Ramp 1 Ramp Up Time       |  |  |
|--------------------------------|--|--|
| Range:                         | Function:  |  |
| Size related* [ 0.01 - 3600 s] | <p>Enter the ramp-up time, that is the acceleration time from 0 RPM to the synchronous motor speed <math>n_s</math>. Select a ramp-up time which prevents the output current from exceeding the current limit in <i>parameter 4-18 Current Limit</i> during ramping. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-down time in <i>parameter 3-42 Ramp 1 Ramp Down Time</i>.</p> $Par. 3 - 41 = \frac{t_{acc} [s] \times n_s [RPM]}{ref [RPM]}$ |  |

| 3-42 Ramp 1 Ramp Down Time     |  |  |
|--------------------------------|--|--|
| Range:                         | Function:  |  |
| Size related* [ 0.01 - 3600 s] | <p>Enter the ramp-down time, that is the deceleration time from the synchronous motor speed <math>n_s</math> to 0 RPM. Select a ramp-down time such that no overvoltage occurs in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in <i>parameter 4-18 Current Limit</i>. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in <i>parameter 3-41 Ramp 1 Ramp Up Time</i>.</p> $Par. 3 - 42 = \frac{t_{dec} [s] \times n_s [RPM]}{ref [RPM]}$ |  |

## 8.2 Parameter Menu Structure

### Changes during operation

True means that the parameter can be changed while the frequency converter is in operation and false means that it must be stopped before a change can be made.

### 4-Set-up

All set-ups: The parameters can be set individually in each of the 4 set-ups, that is, 1 single parameter can have 4 different data values.

In all set-ups 1 set-up: Data value is the same.

### Conversion index

This number refers to a conversion figure used when writing or reading to and from the frequency converter.

| Conversion index | Conversion factor |
|------------------|-------------------|
| 100              | 1                 |
| 67               | 1/60              |
| 6                | 1000000           |
| 5                | 100000            |
| 4                | 10000             |
| 3                | 1000              |
| 2                | 100               |
| 1                | 10                |
| 0                | 1                 |
| -1               | 0.1               |
| -2               | 0.01              |
| -3               | 0.001             |
| -4               | 0.0001            |
| -5               | 0.00001           |
| -6               | 0.000001          |

| Data type | Description                          | Type   |
|-----------|--------------------------------------|--------|
| 2         | Integer 8                            | Int8   |
| 3         | Integer 16                           | Int16  |
| 4         | Integer 32                           | Int32  |
| 5         | Unsigned 8                           | UInt8  |
| 6         | Unsigned 16                          | UInt16 |
| 7         | Unsigned 32                          | UInt32 |
| 9         | Visible String                       | VisStr |
| 33        | Normalized value 2 bytes             | N2     |
| 35        | Bit sequence of 16 boolean variables | V2     |
| 54        | Time difference w/o date             | TimD   |

See the *VLT® Decentral Drive FCD 302 Design Guide* for further information about data types 33, 35, and 54.



## 8.2.1 Software 7.XX

|                          |                                     |             |                                       |             |   |             |                                      |
|--------------------------|-------------------------------------|-------------|---------------------------------------|-------------|---|-------------|--------------------------------------|
| 1-06                     | Clockwise Direction                 | 1-71        | Start Delay                           | 2-33        | Speed PID Start Lowpass Filter Time     | 3-90        | Step Size                            |
| 1-07                     | Motor Angle Offset Adjust           | 1-72        | Start Function                        | <b>3-3*</b> | <b>Reference / Ramps</b>                | 3-91        | Ramp Time                            |
| <b>1-1*</b>              | <b>Special Settings</b>             | 1-73        | Flying Start                          | <b>3-0*</b> | <b>Reference Limits</b>                 | 3-92        | Power Restore                        |
| 1-10                     | Motor Construction                  | 1-74        | Start Speed [RPM]                     | 3-00        | Reference Range                         | 3-93        | Maximum Limit                        |
| 1-11                     | Motor Model                         | 1-75        | Start Speed [Hz]                      | 3-01        | Reference/Feedback Unit                 | 3-94        | Minimum Limit                        |
| 1-14                     | Damping Gain                        | 1-76        | Start Current                         | 3-02        | Minimum Reference                       | 3-95        | Ramp Delay                           |
| 1-15                     | Low Speed Filter Time Const.        | <b>1-8*</b> | <b>Stop Adjustments</b>               | 3-03        | Maximum Reference                       | <b>4-3*</b> | <b>Limits / Warnings</b>             |
| 1-16                     | High Speed Filter Time Const.       | 1-80        | Function at Stop                      | 3-04        | Reference Function                      | <b>4-1*</b> | <b>Motor Limits</b>                  |
| 1-17                     | Voltage filter time const.          | 1-81        | Min Speed for Function at Stop [RPM]  | <b>3-1*</b> | <b>References</b>                       | 4-10        | Motor Speed Direction                |
| 1-18                     | Min. Current at No Load             | 1-82        | Min Speed for Function at Stop [Hz]   | 3-10        | Preset Reference                        | 4-11        | Motor Speed Low Limit [RPM]          |
| <b>1-2*</b>              | <b>Motor Data</b>                   | 1-83        | Precise Stop Function                 | 3-11        | Jog Speed [Hz]                          | 4-12        | Motor Speed Low Limit [Hz]           |
| 1-20                     | Motor Power [kW]                    | 1-84        | Precise Stop Counter Value            | 3-12        | Catch up/slow Down Value                | 4-13        | Motor Speed High Limit [RPM]         |
| 1-21                     | Motor Power [HP]                    | 1-85        | Precise Stop Speed Compensation Delay | 3-13        | Reference Site                          | 4-14        | Motor Speed High Limit [Hz]          |
| 1-22                     | Motor Voltage                       | <b>1-9*</b> | <b>Motor Temperature</b>              | 3-15        | Reference Resource 1                    | 4-17        | Torque Limit Generator Mode          |
| 1-23                     | Motor Frequency                     | 1-90        | Motor Thermal Protection              | 3-16        | Reference Resource 2                    | 4-18        | Current Limit                        |
| 1-24                     | Motor Current                       | 1-91        | Motor External Fan                    | 3-17        | Reference Resource 3                    | 4-19        | Max Output Frequency                 |
| 1-25                     | Motor Nominal Speed                 | 1-93        | Thermistor Resource                   | 3-18        | Relative Scaling Reference Resource     | <b>4-2*</b> | <b>Limit Factors</b>                 |
| 1-26                     | Motor Cont. Rated Torque            | 1-94        | ATEX ETR cur.lim. speed reduction     | 3-19        | Jog Speed [RPM]                         | 4-20        | Torque Limit Factor Source           |
| <b>1-3*</b>              | <b>Adv. Motor Data</b>              | 1-95        | KTY Sensor Type                       | <b>3-4*</b> | <b>Ramp 1</b>                           | 4-21        | Speed Limit Factor Source            |
| 1-30                     | Stator Resistance (Rs)              | 1-96        | KTY Thermistor Resource               | 3-40        | Ramp 1 Type                             | 4-23        | Brake Check Limit Factor Source      |
| 1-31                     | Rotor Resistance (Rr)               | 1-97        | KTY Threshold level                   | 3-41        | Ramp 1 Ramp Up Time                     | 4-24        | Brake Check Limit Factor             |
| 1-33                     | Stator Leakage Reactance (X1)       | 1-98        | ATEX ETR interpol. points freq.       | 3-42        | Ramp 1 Ramp Down Time                   | <b>4-3*</b> | <b>Motor Speed Mon.</b>              |
| 1-34                     | Rotor Leakage Reactance (X2)        | 1-99        | ATEX ETR interpol. points current     | 3-45        | Ramp 1 S-ramp Ratio at Accel. Start     | 4-30        | Motor Feedback Loss Function         |
| 1-35                     | Main Reactance (Xh)                 | <b>2-*</b>  | <b>Brakes</b>                         | 3-46        | Ramp 1 S-ramp Ratio at Accel. End       | 4-31        | Motor Feedback Speed Error           |
| 1-36                     | Iron Loss Resistance (Rfe)          | <b>2-0*</b> | <b>DC-Brake</b>                       | 3-47        | Ramp 1 S-ramp Ratio at Decel. Start     | 4-32        | Motor Feedback Loss Timeout          |
| 1-37                     | d-axis Inductance (Ld)              | 2-00        | DC Hold Current                       | 3-48        | Ramp 1 S-ramp Ratio at Decel. End       | 4-34        | Tracking Error Function              |
| 1-38                     | q-axis Inductance (Lq)              | 2-01        | DC Brake Current                      | <b>3-5*</b> | <b>Ramp 2</b>                           | 4-35        | Tracking Error                       |
| 1-39                     | Motor Poles                         | 2-02        | DC Braking Time                       | 3-50        | Ramp 2 Type                             | 4-36        | Tracking Error Timeout               |
| 1-40                     | Back EMF at 1000 RPM                | 2-03        | DC Brake Cut In Speed [RPM]           | 3-51        | Ramp 2 Ramp Up Time                     | 4-37        | Tracking Error Ramping               |
| 1-41                     | Motor Angle Offset                  | 2-04        | DC Brake Cut In Speed [Hz]            | 3-52        | Ramp 2 Ramp Down Time                   | 4-38        | Tracking Error Ramping Timeout       |
| 1-44                     | d-axis Inductance Sat. (LdSat)      | 2-05        | Maximum Reference                     | 3-55        | Ramp 2 S-ramp Ratio at Accel. Start     | 4-39        | Tracking Error After Ramping Timeout |
| 1-45                     | q-axis Inductance Sat. (LqSat)      | 2-06        | Parking Current                       | 3-56        | Ramp 2 S-ramp Ratio at Accel. End       | <b>4-4*</b> | <b>Speed Monitor</b>                 |
| 1-47                     | Position Detection Gain             | 2-07        | Parking Time                          | 3-57        | Ramp 2 S-ramp Ratio at Decel. Start     | 4-43        | Motor Speed Monitor Function         |
| 1-48                     | Torque Calibration                  | <b>2-1*</b> | <b>Brake Energy Funct.</b>            | 3-58        | Ramp 2 S-ramp Ratio at Decel. End       | 4-44        | Motor Speed Monitor Max              |
| 1-50                     | Motor Magnetisation at Zero Speed   | 2-10        | Brake Function                        | <b>3-6*</b> | <b>Ramp 3</b>                           | 4-45        | Motor Speed Monitor Timeout          |
| 1-51                     | Min Speed Normal Magnetising [RPM]  | 2-11        | Brake Resistor (ohm)                  | 3-60        | Ramp 3 Type                             | <b>4-5*</b> | <b>Adj. Warnings</b>                 |
| 1-52                     | Min Speed Normal Magnetising [Hz]   | 2-12        | Brake Power Limit (kW)                | 3-61        | Ramp 3 Ramp up Time                     | 4-50        | Warning Current Low                  |
| 1-53                     | Model Shift Frequency               | 2-13        | Brake Power Monitoring                | 3-62        | Ramp 3 Ramp down Time                   | 4-51        | Warning Current High                 |
| 1-54                     | Voltage reduction in fieldweakening | 2-15        | Brake Check                           | 3-65        | Ramp 3 S-ramp Ratio at Accel. Start     | 4-52        | Warning Speed Low                    |
| 1-55                     | U/f Characteristic - U              | 2-16        | AC brake Max. Current                 | 3-66        | Ramp 3 S-ramp Ratio at Accel. End       | 4-53        | Warning Speed High                   |
| 1-56                     | U/f Characteristic - F              | 2-17        | Over-voltage Control                  | 3-67        | Ramp 3 S-ramp Ratio at Decel. Start     | 4-54        | Warning Reference Low                |
| 1-58                     | Flying Start Test Pulses Current    | 2-18        | Brake Check Condition                 | 3-68        | Ramp 3 S-ramp Ratio at Decel. End       | 4-55        | Warning Reference High               |
| 1-59                     | Flying Start Test Pulses Frequency  | 2-19        | Over-voltage Gain                     | <b>3-7*</b> | <b>Ramp 4</b>                           | 4-56        | Warning Feedback Low                 |
| <b>1-6*</b>              | <b>Load Depen. Setting</b>          | <b>2-2*</b> | <b>Mechanical Brake</b>               | 3-70        | Ramp 4 Type                             | 4-57        | Warning Feedback High                |
| 1-60                     | Low Speed Load Compensation         | 2-20        | Release Brake Current                 | 3-71        | Ramp 4 Ramp up Time                     | 4-58        | Missing Motor Phase Function         |
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