Operating Guide
VLT® AQUA Drive FC 202
355–800 kW, Enclosure Sizes E1h–E4h
## Contents

### 1 Introduction
- 1.1 Purpose of the Manual
- 1.2 Additional Resources
- 1.3 Manual and Software Version
- 1.4 Approvals and Certifications
- 1.5 Disposal

### 2 Safety
- 2.1 Safety Symbols
- 2.2 Qualified Personnel
- 2.3 Safety Precautions

### 3 Product Overview
- 3.1 Intended Use
- 3.2 Power Ratings, Weights, and Dimensions
- 3.3 Interior View of Enclosures E1h and E2h
- 3.4 Interior View of Enclosures E3h and E4h
- 3.5 Control Shelf
- 3.6 Local Control Panel (LCP)

### 4 Mechanical Installation
- 4.1 Items Supplied
- 4.2 Tools Needed
- 4.3 Storage
- 4.4 Operating Environment
- 4.5 Installation and Cooling Requirements
- 4.6 Lifting the Unit
- 4.7 E1h/E2h Mechanical Installation
- 4.8 E3h/E4h Mechanical Installation

### 5 Electrical Installation
- 5.1 Safety Instructions
- 5.2 EMC-compliant Installation
- 5.3 Wiring Schematic
- 5.4 Connecting the Motor
- 5.5 Connecting the AC Mains
- 5.6 Connecting to Ground
- 5.7 Terminal Dimensions
- 5.8 Control Wiring
- 5.9 Pre-start Check List
## 6 Commissioning

- 6.1 Safety Instructions
- 6.2 Applying Power
- 6.3 LCP Menu
- 6.4 Programming the Drive
- 6.5 Testing Before System Start-up
- 6.6 System Start-up
- 6.7 Parameter Settings

## 7 Wiring Configuration Examples

- 7.1 Wiring for Open-loop Speed Control
- 7.2 Wiring for Start/Stop
- 7.3 Wiring for External Alarm Reset
- 7.4 Wiring for a Motor Thermistor
- 7.5 Wiring for Regeneration

## 8 Maintenance, Diagnostics, and Troubleshooting

- 8.1 Maintenance and Service
- 8.2 Heat Sink Access Panel
- 8.3 Status Messages
- 8.4 Warning and Alarm Types
- 8.5 List of Warnings and Alarms
- 8.6 Troubleshooting

## 9 Specifications

- 9.1 Electrical Data
- 9.2 Mains Supply
- 9.3 Motor Output and Motor Data
- 9.4 Ambient Conditions
- 9.5 Cable Specifications
- 9.6 Control Input/Output and Control Data
- 9.7 Fuses
- 9.8 Enclosure Dimensions
- 9.9 Enclosure Airflow
- 9.10 Fastener Torque Ratings

## 10 Appendix

- 10.1 Abbreviations and Conventions
- 10.2 International/North American Default Parameter Settings
- 10.3 Parameter Menu Structure

## Index
1 Introduction

1.1 Purpose of the Manual

This operating guide provides information for safe installation and commissioning of the VLT® drives in an enclosure size E (E1h, E2h, E3h, and E4h).

The operating guide is intended for use by qualified personnel. To use the unit safely and professionally, read and follow this operating guide. Pay particular attention to the safety instructions and general warnings. Always keep the operating guide with the drive.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand advanced E1h–E4h drive functions and programming.

- The VLT® AQUA Drive FC 202 Programming Guide provides greater detail on working with parameters and aqua application examples.
- The VLT® AQUA Drive FC 202, 110–1400 kW Design Guide provides detailed capabilities and functionality to design motor control systems for aqua applications.
- The Safe Torque Off Operating Guide.

Supplementary publications and manuals are available from Danfoss. See www.danfoss.com/en/search/?filter=type%3Adocumentation for listings.

1.3 Manual and Software Version

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

<table>
<thead>
<tr>
<th>Manual version</th>
<th>Remarks</th>
<th>Software version</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG22A2xx</td>
<td>Added output contactor warning and other corrections.</td>
<td>2.70</td>
</tr>
</tbody>
</table>

Table 1.1 Manual and Software Version

1.4 Approvals and Certifications

![Certifications](image)

Table 1.2 Approvals and Certifications

More approvals and certifications are available. Contact the local Danfoss office or partner. Drives of voltage T7 (525–690 V) are UL certified for only 525–690 V.

The drive complies with UL 61800-5-1 thermal memory retention requirements. For more information, refer to the section Motor Thermal Protection in the product-specific design guide.

**NOTICE**

**IMPOSED LIMITATIONS ON THE OUTPUT FREQUENCY**

From software version 1.99, the output frequency of the drive is limited to 590 Hz due to export control regulations.

1.4.1 Compliance with ADN

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

1.5 Disposal

Do not dispose of equipment containing electrical components together with domestic waste. Collect it separately in accordance with local and currently valid legislation.
2 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 drive. Only qualified personnel are allowed to install or 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 personnel must be familiar with the instructions and safety measures described in this manual.

2.3 Safety Precautions

**WARNING**
**HIGH VOLTAGE**
Drives contain high voltage when connected to AC mains input, DC supply, load sharing, or permanent motors. Failure to use qualified personnel to install, start up, and maintain the drive can result in death or serious injury.

- Only qualified personnel must install, start up, and maintain the drive.

**WARNING**
**UNINTENDED START**
When the drive is connected to the 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 drive from the mains.
- Completely wire and assemble the drive, motor, and any driven equipment before connecting the drive to the AC mains, DC supply, or load sharing.

**WARNING**
**DISCHARGE TIME**
The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait 40 minutes after power has been removed before performing service or repair work can result in death or serious injury.

1. Stop the motor.
2. Disconnect AC mains and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.
3. Disconnect or lock motor.
4. Wait 40 minutes for the capacitors to discharge fully.
5. Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

**WARNING**
**LEAKAGE CURRENT HAZARD**
Leakage currents exceed 3.5 mA. Failure to ground the drive properly can result in death or serious injury.

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

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

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

**CAUTION**

HOT SURFACES
The drive contains metal components that are still hot even after the drive has been powered off. Failure to observe the high temperature symbol (yellow triangle) on the drive can result in serious burns.

- Be aware that internal components, such as busbars, may be extremely hot even after the drive has been powered off.
- Exterior areas marked by the high temperature symbol (yellow triangle) are hot while the drive is in use and immediately after being powered off.

**WARNING**

INTERNAL FAILURE HAZARD
Under certain circumstances, an internal failure can cause a component to explode. Failure to keep the enclosure closed and properly secured can cause death or serious injury.

- Do not operate the drive with the door open or panels off.
- Ensure that the enclosure is properly closed and secured during operation.

**NOTICE**

MAINS SHIELD SAFETY OPTION
A mains shield option is available for enclosures with a protection rating of IP21/IP54 (Type 1/Type 12). The mains shield is a cover installed inside the enclosure to protect against the accidental touch of the power terminals, according to BGV A2, VBG 4.
3 Product Overview

3.1 Intended Use

The drive is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The drive is designed to:

• Regulate motor speed in response to system feedback or to remote commands from external controllers.
• Monitor system and motor status.
• Provide motor overload protection.

The drive is designed for industrial and commercial environments in accordance with local laws and standards. Depending on configuration, the drive can be used in standalone applications or form part of a larger system or installation.

**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 drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 9 Specifications*.

3.2 Power Ratings, Weights, and Dimensions

Table 3.1 provides dimensions for standard configurations. For dimensions on optional configurations, see *chapter 9.8 Enclosure Dimensions*.

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>E1h</th>
<th>E2h</th>
<th>E3h</th>
<th>E4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure protection rating</td>
<td>IP21/Type 1</td>
<td>IP21/Type 1</td>
<td>IP20/Chassis</td>
<td>IP20/Chassis</td>
</tr>
<tr>
<td>Unit dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height [mm (in)]</td>
<td>2043 (80.4)</td>
<td>2043 (80.4)</td>
<td>1578 (62.1)</td>
<td>1578 (62.1)</td>
</tr>
<tr>
<td>Width [mm (in)]</td>
<td>602 (23.7)</td>
<td>698 (27.5)</td>
<td>506 (19.9)</td>
<td>604 (23.89)</td>
</tr>
<tr>
<td>Depth [mm (in)]</td>
<td>513 (20.2)</td>
<td>513 (20.2)</td>
<td>482 (19.0)</td>
<td>482 (19.0)</td>
</tr>
<tr>
<td>Weight [kg (lb)]</td>
<td>295 (650)</td>
<td>318 (700)</td>
<td>272 (600)</td>
<td>295 (650)</td>
</tr>
<tr>
<td>Shipping dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height [mm (in)]</td>
<td>2191 (86.3)</td>
<td>2191 (86.3)</td>
<td>1759 (69.3)</td>
<td>1759 (69.3)</td>
</tr>
<tr>
<td>Width [mm (in)]</td>
<td>768 (30.2)</td>
<td>768 (30.2)</td>
<td>746 (29.4)</td>
<td>746 (29.4)</td>
</tr>
<tr>
<td>Depth [mm (in)]</td>
<td>870 (34.3)</td>
<td>870 (34.3)</td>
<td>794 (31.3)</td>
<td>794 (31.3)</td>
</tr>
<tr>
<td>Weight [kg (lb)]</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 3.1 Enclosure Power Ratings and Dimensions
3.3 Interior View of Enclosures E1h and E2h

1 Control shelf (see Illustration 3.3)
2 Local control panel (LCP) cradle
3 RFI filter (optional)
4 Mains fuses (required for UL compliance, but otherwise optional)
5 Mains terminals
6 RFI shield termination
7 Fan power card
8 Space heater (optional)
9 Mains disconnect (optional)
10 Brake/regeneration terminals (optional)
11 Motor terminals
12 Ground terminals

Illustration 3.1 Interior View of Enclosure E1h (Enclosure E2h is Similar)
3.4 Interior View of Enclosures E3h and E4h

<table>
<thead>
<tr>
<th></th>
<th>Load share/regeneration terminals (optional)</th>
<th>8</th>
<th>RFI shield termination (optional, but is standard when RFI filter is ordered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Control shelf (see Illustration 3.3)</td>
<td>9</td>
<td>Fans (used to cool the front section of enclosure)</td>
</tr>
<tr>
<td>3</td>
<td>Local control panel (LCP) cradle</td>
<td>10</td>
<td>Fan power card</td>
</tr>
<tr>
<td>4</td>
<td>RFI filter (optional)</td>
<td>11</td>
<td>Space heater (optional)</td>
</tr>
<tr>
<td>5</td>
<td>Mains fuses (optional)</td>
<td>12</td>
<td>Brake terminals (optional)</td>
</tr>
<tr>
<td>6</td>
<td>Mains terminals</td>
<td>13</td>
<td>Motor terminals</td>
</tr>
<tr>
<td>7</td>
<td>Ground terminals</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Illustration 3.2 Interior View of Enclosure E3h (Enclosure E4h is Similar)
3.5 Control Shelf

Illustration 3.3 View of Control Shelf

<p>| | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LCP cradle (LCP not shown)</td>
<td>8</td>
<td>Control shelf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bus terminal switch (see chapter 5.8.6 Configuring RS485 Serial Communication)</td>
<td>9</td>
<td>USB port</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Serial communication terminals (see Table 5.1)</td>
<td>10</td>
<td>Analog input switches A53/A54 (see chapter 5.8.11 Selecting Voltage/Current Input Signal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Digital input/output terminals (see Table 5.2)</td>
<td>11</td>
<td>Analog input/output terminals (see Table 5.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cable/EMC clamps</td>
<td>12</td>
<td>Brake resistor terminals, 104–106 (on power card underneath control shelf)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Relay 1 and relay 2 (see Illustration 5.19)</td>
<td>13</td>
<td>Power card (underneath the control shelf)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Control card (underneath LCP and control terminals)</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.6 Local Control Panel (LCP)

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

The LCP is used to:
- Control the drive and motor.
- Access drive parameters and program the drive.
- Display operational data, drive status, and warnings.

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

Illustration 3.4 Graphical Local Control Panel (LCP)

A. Display area
Each display readout has a parameter associated with it. See Table 3.2. The information shown on the LCP can be customized for specific applications. Refer to chapter 6.3.1.2 Q1 My Personal Menu.

<table>
<thead>
<tr>
<th>Callout</th>
<th>Parameter number</th>
<th>Default setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1.1</td>
<td>0-20</td>
<td>Reference [Unit]</td>
</tr>
<tr>
<td>A1.2</td>
<td>0-21</td>
<td>Analog input 53 [V]</td>
</tr>
<tr>
<td>A1.3</td>
<td>0-22</td>
<td>Motor current [A]</td>
</tr>
<tr>
<td>A2</td>
<td>0-23</td>
<td>Frequency [Hz]</td>
</tr>
<tr>
<td>A3</td>
<td>0-24</td>
<td>Feedback [Unit]</td>
</tr>
</tbody>
</table>

Table 3.2 LCP Display Area
B. Menu keys
Menu keys are used to access the menu for setting up parameters, toggling through status display modes during normal operation, and viewing fault log data.

<table>
<thead>
<tr>
<th>Callout</th>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Status</td>
<td>Shows operational information.</td>
</tr>
<tr>
<td>B2</td>
<td>Quick Menu</td>
<td>Allows access to parameters for initial set-up instructions. Also provides detailed application steps. Refer to chapter 6.3.1.1 Quick Menu Mode.</td>
</tr>
<tr>
<td>B3</td>
<td>Main Menu</td>
<td>Allows access to all parameters. Refer to chapter 6.3.1.9 Main Menu Mode.</td>
</tr>
<tr>
<td>B4</td>
<td>Alarm Log</td>
<td>Shows a list of current warnings and the last 10 alarms.</td>
</tr>
</tbody>
</table>

Table 3.3 LCP Menu Keys

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

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

Table 3.4 LCP Navigation Keys

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

<table>
<thead>
<tr>
<th>Callout</th>
<th>Indicator light</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>On Green</td>
<td>Activates when the drive receives power from the mains voltage or a 24 V external supply.</td>
</tr>
<tr>
<td>D2</td>
<td>Warn Yellow</td>
<td>Activates when warning conditions are active. Text appears in the display area identifying the problem.</td>
</tr>
<tr>
<td>D3</td>
<td>Alarm Red</td>
<td>Activates during a fault condition. Text appears in the display area identifying the problem.</td>
</tr>
</tbody>
</table>

Table 3.5 LCP Indicator Lights

E. Operation keys and reset
The operation keys are found toward the bottom of the local control panel.

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

Table 3.6 LCP Operation Keys and Reset
4 Mechanical Installation

4.1 Items Supplied

Items supplied can vary according to product configuration.

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

<table>
<thead>
<tr>
<th>VLT® AQUA Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>T/C: FC-202N710T7E21H2C700K00000A893CXXX00D0</td>
</tr>
<tr>
<td>P/N: 131N2885</td>
</tr>
<tr>
<td>S/N: 123454H123</td>
</tr>
<tr>
<td>IN: 3x525-600V 50/60Hz 743/711 A (UL)</td>
</tr>
<tr>
<td>OUT: MOTOR 3x0-Vin 0-500Hz 763/730 A</td>
</tr>
<tr>
<td>OUT: MOTOR 3x0-Vin 0-500Hz 763/730 A (CE)</td>
</tr>
<tr>
<td>IN: 3x525-690V 50/60Hz 866/828 A (CE)</td>
</tr>
<tr>
<td>ASSEMBLED IN USA</td>
</tr>
<tr>
<td>Tamb. 55°C/131°F at Full Output Current Derating</td>
</tr>
<tr>
<td>VLT AQUA Drive <a href="http://www.danfoss.com">www.danfoss.com</a></td>
</tr>
</tbody>
</table>

4.2 Tools Needed

Receiving/unloading

- I-beam and hooks rated to lift the weight of the drive. Refer to chapter 3.2 Power Ratings, Weights, and Dimensions.
- Crane or other lifting aid to place the unit into position.

Installation

- Drill with 10 mm or 12 mm drill bits.
- Tape measurer.
- Various sizes of Phillips and flat bladed screwdrivers.
- Wrench with relevant metric sockets (7–17 mm).
- Wrench extensions.
- Torx drives (T25 and T50).
- Sheet metal punch for conduits or cable glands.
- I-beam and hooks to lift the weight of the drive. Refer to chapter 3.2 Power Ratings, Weights, and Dimensions.
- Crane or other lifting aid to place the drive onto pedestal and into position.

4.3 Storage

Store the drive in a dry location. Keep the equipment sealed in its packaging until installation. Refer to chapter 9.4 Ambient Conditions for recommended ambient temperature.

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

Illustration 4.1 Product Nameplate for E2h Enclosure (Example)

NOTICE

Removing the nameplate from the drive can result in the loss of warranty.
4.4 Operating Environment

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment. For specifications regarding ambient conditions, see chapter 9.4 Ambient Conditions.

**NOTICE**

**CONDUCTION**

Moisture can condense on the electronic components and cause short circuits. Avoid installation in areas subject to frost. Install an optional space heater when the drive is colder than the ambient air. Operating in standby mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

**NOTICE**

**EXTREME AMBIENT CONDITIONS**

Hot or cold temperatures compromise unit performance and longevity.

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

4.4.1 Gases

Aggressive gases, such as hydrogen sulfide, chlorine, or ammonia can damage the electrical and mechanical components. The unit uses conformal-coated circuit boards to reduce the effects of aggressive gases. For conformal-coating class specifications and ratings, see chapter 9.4 Ambient Conditions.

4.4.2 Dust

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

**Periodic maintenance**

When dust accumulates on electronic components, it acts as a layer of insulation. This layer reduces the cooling capacity of the components, and the components become warmer. The hotter environment decreases the life of the electronic components.

Keep the heat sink and fans free from dust buildup. For more service and maintenance information, refer to chapter 8 Maintenance, Diagnostics, and Troubleshooting.

**Cooling fans**

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

4.4.3 Potentially Explosive Atmospheres

**WARNING**

**EXPLOSIVE ATMOSPHERE**

Do not install the drive in a potentially explosive atmosphere. Install the unit in a cabinet outside of this area. Failure to follow this guideline increases risk of death or serious injury.

Systems operated in potentially explosive atmospheres must fulfill special conditions. EU Directive 94/9/EC (ATEX 95) classifies the operation of electronic devices in potentially explosive atmospheres.

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

**Motors with class d protection**

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

**Motors with class e protection**

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

**Motors with class d/e protection**

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

When using a drive in a potentially explosive atmosphere, use the following:

- Motors with ignition protection class d or e.
- PTC temperature sensor to monitor the motor temperature.
- Short motor cables.
- Sine-wave output filters when shielded motor cables are not used.
**NOTICE**

**MOTOR THERMISTOR SENSOR MONITORING**

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

4.5 **Installation and Cooling Requirements**

**NOTICE**

Improper mounting can result in overheating and reduced performance.

**Installation requirements**

- Locate the unit as near to the motor as possible. See chapter 9.5 Cable Specifications for the maximum motor cable length.
- Ensure unit stability by mounting the unit to a solid surface.
- Enclosures E3h and E4h can be mounted:
  - Vertically on the back plate of the panel (typical installation).
  - Vertically upside down on the back plate of the panel.¹
  - Horizontally on its back, mounted on the back plate of the panel.¹
  - Horizontally on its side, mounted on floor of the panel.¹
- Ensure that the strength of the mounting location supports the unit weight.
- Ensure that there is enough space around the unit for proper cooling. Refer to chapter 9.9 Enclosure Airflow.
- Ensure enough access to open the door.
- Ensure cable entry from the bottom.

¹ For non-typical installation, contact the factory.

**Cooling requirements**

- Ensure that top and bottom clearance for air cooling is provided. Clearance requirement: 225 mm (9 in).
- Provide sufficient airflow flow rate. See Table 4.1.
- Consider derating for temperatures starting between 45 °C (113 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level. See the design guide for detailed information.

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

- **Duct cooling**
  Back-channel cooling kits are available to direct the heat sink cooling air out of the panel when IP20/Chassis drives are installed in Rittal enclosures. These kits reduce the heat in the panel and smaller door fans can be specified.

- **Back-wall cooling**
  Installing top and base covers to the unit allows the back-channel cooling air to be ventilated out of the room.

**NOTICE**

For E3h and E4h enclosures (IP20/Chassis), at least 1 door fan is required on the enclosure to remove the heat not contained in the back-channel of the drive. It also removes any additional losses generated by other components inside the drive. To select the appropriate fan size, calculate the total required airflow.

Secure the necessary airflow over the heat sink.

<table>
<thead>
<tr>
<th>Frame</th>
<th>Door fan/top fan [m³/hr (cfm)]</th>
<th>Heat sink fan [m³/hr (cfm)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1hS1h</td>
<td>510 (300)</td>
<td>994 (585)</td>
</tr>
<tr>
<td>E2h</td>
<td>552 (325)</td>
<td>1053–1206 (620–710)</td>
</tr>
<tr>
<td>E3h</td>
<td>595 (350)</td>
<td>994 (585)</td>
</tr>
<tr>
<td>E4h</td>
<td>629 (370)</td>
<td>1053–1206 (620–710)</td>
</tr>
</tbody>
</table>

Table 4.1 Airflow Rate

4.6 **Lifting the Unit**

Always lift the drive using the dedicated lifting eyes. To avoid bending the lifting holes, use a bar.

**WARNING**

**RISK OF INJURY OR DEATH**

Follow local safety regulations for lifting heavy weights. Failure to follow recommendations and local safety regulations can result in death or serious injury.

- Ensure that the lifting equipment is in proper working condition.

  - See chapter 3.2 Power Ratings, Weights, and Dimensions for the weight of the different enclosure sizes.

- Maximum diameter for bar: 20 mm (0.8 in).

- The angle from the top of the drive to the lifting cable: 60° or greater.
4.7 E1h/E2h Mechanical Installation

The E1h and E2h enclosure size is intended only for floor installation, and is shipped with a pedestal and a gland plate. The pedestal and gland plate must be installed for proper installation.

The pedestal is 200 mm (7.9 in) and has an opening in the front to allow airflow necessary to cool the power components of the drive.

The gland plate is necessary to provide cooling air to the control components of the drive via the door fan, and to maintain the IP21/Type 1 or IP54/Type 12 protection rating.

4.7.1 Securing the Pedestal to the Floor

The pedestal must be secured to the floor using 6 bolts before installing the enclosure.

1. Determine proper placement of the unit, concerning operating conditions and cable access.
2. Access the mounting holes by removing the front panel of the pedestal.
3. Set the pedestal on the floor and secure using 6 bolts through the mounting holes. Refer to the circled areas in Illustration 4.3.

4.7.2 Attaching the E1h/E2h to the Pedestal

1. Lift the drive and position it on the pedestal. There are 2 bolts in the rear of the pedestal that slide into the 2 slotted holes in the rear of the enclosure. Position the drive by adjusting the bolts up or down. Loosely secure with 2 M10 nuts and locking brackets. See Illustration 4.4.
2. Verify that there is 225 mm (9 in) top clearance for air exhaust.
3. Verify that the air intake at the bottom front of the unit is not obstructed.
4. Around the top of the pedestal, secure the enclosure using 6 M10x30 fasteners. Refer to Illustration 4.5. Loosely tighten each bolt until all bolts are installed.
5. Fasten each bolt securely and torque to 19 Nm (169 in-lb).
6. Torque the 2 M10 nuts at the rear of the enclosure to 19 Nm (169 in-lb).
4.7.3 Creating Cable Openings

The gland plate is a sheet of metal with studs along the outer edge. The gland plate provides cable entry and cable termination points, and must be installed to maintain the IP21/IP54 (Type 1/Type 12) protection rating. The plate is placed between the drive enclosure and the pedestal. Depending on stud orientation, the plate can be installed from inside the enclosure or the pedestal. For gland plate dimensions, see chapter 9.8.1 E1h Exterior Dimensions.

Refer to Illustration 4.6 for the following steps.

1. Create cable entry holes in the gland plate using a sheet metal punch.
2. Insert the gland plate using 1 of the following methods:
   2a To insert the gland plate through the pedestal, slide the gland plate through the slot (4) in the front of the pedestal.
   2b To insert the gland plate through the enclosure, angle the gland plate until it can be slid under the slotted brackets.
3. Align the studs on the gland plate to the holes in the pedestal and secure with 10 M5 nuts (2).
4. Torque each nut to 2.3 Nm (20 in-lb).
4.8 E3h/E4h Mechanical Installation

The E3h and E4h enclosure sizes are intended to be mounted on a wall or on a mounting panel within an enclosure. A plastic gland plate is installed on the enclosure. It is designed to prevent unintentional access to the terminals in an IP20/protected chasis unit.

**NOTICE**

**REGENERATION/LOAD SHARE OPTION**

Due to the exposed terminals at the top of the enclosure, units with the regeneration/load share option have an IP00 protection rating.

4.8.1 Attaching the E3h/E4h to a Mounting Plate or Wall

1. Drill the mounting holes according to the enclosure size. Refer to chapter 9.8 Enclosure Dimensions.
2. Secure the top of the drive enclosure to the mounting plate or wall.
3. Secure the base of the drive enclosure to the mounting plate or wall.

4.8.2 Creating Cable Openings

The gland plate covers the bottom part of the drive enclosure and must be installed to maintain the IP20/Chassis protection rating. The gland plate consists of plastic squares that can be cut out to provide cable access to the terminals. See Illustration 4.7.

1. Remove the bottom panel and terminal cover. See Illustration 4.8.
   1a Detach the bottom panel by removing 4 T25 screws.
   1b Remove 5 T20 screws that secure the bottom of the drive to the top of the terminal cover, and then pull the terminal cover straight out.
2. Determine the size and position of the motor, mains, and ground cables. Note their position and measurements.

3. Based on the measurement and positions of the cables, create openings in the plastic gland plate by cutting out the necessary squares.
4. Slide the plastic gland plate (7) onto the bottom rails of the terminal cover.
5. Tilt the front of the terminal cover downward until the fastener points (8) rest on the slotted drive brackets (6).
6. Make sure the side panels of the terminal cover are on the outside track guide (5).
7. Push the terminal cover until it is up against the slotted drive bracket.
8. Tilt the front of the terminal cover upward until the fastener hole in the bottom of the drive aligns with the keyhole opening (9) in the terminal. Secure with 2 T25 screws and torque to 2.3 Nm (20 in-lb).
9. Secure the bottom panel with 3 T25 screws and torque to 2.3 Nm (20 in-lb).

Illustration 4.7 Plastic Gland Plate
### Mechanical Installation

#### VLT® AQUA Drive FC 202

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load share/regeneration terminals (optional)</td>
</tr>
<tr>
<td>2</td>
<td>Bottom panel</td>
</tr>
<tr>
<td>3</td>
<td>Terminal cover</td>
</tr>
<tr>
<td>4</td>
<td>Grommet access hole for control wiring</td>
</tr>
<tr>
<td>5</td>
<td>Track guide</td>
</tr>
<tr>
<td>6</td>
<td>Slotted drive bracket</td>
</tr>
<tr>
<td>7</td>
<td>Plastic gland plate (installed)</td>
</tr>
<tr>
<td>8</td>
<td>Fastener point</td>
</tr>
<tr>
<td>9</td>
<td>Keyhole opening</td>
</tr>
</tbody>
</table>

**Illustration 4.8 Assembling the Gland Plate and Terminal Cover**
4.8.3 Installing Load share/Regeneration Terminals

The load share/regeneration terminals, located on the top of the drive, are not installed from the factory to prevent damage during shipping. Refer to Illustration 4.9 for the following steps.

1. Remove the terminal plate, 2 terminals, label, and fasteners from the accessory bag included with the drive.

2. Remove the cover from the load share/regeneration opening on the top of the drive. Put aside the 2 M5 fasteners for reuse later.

3. Remove the plastic backing and install the terminal plate over the load share/regeneration opening. Secure with the 2 M5 fasteners and torque to 2.3 Nm (20 in-lb).

4. Install both terminals to the terminal plate using 1 M10 fastener per terminal. Torque to 19 Nm (169 in-lb).

5. Install the label on the front of the terminals as shown in Illustration 4.9. Secure with 2 M4 screws and torque to 1.2 Nm (10 in-lb).

| 1 | Label fastener, M4 |
| 2 | Label |
| 3 | Load share/regeneration terminal |
| 4 | Terminal fastener, M10 |
| 5 | Terminal plate with 2 openings |

Illustration 4.9 Load share/Regeneration Terminals
5 Electrical Installation

5.1 Safety Instructions

See chapter 2 Safety for general safety instructions.

⚠️ WARNING ⚠️

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

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

⚠️ WARNING ⚠️

SHOCK HAZARD
The drive can cause a DC current in the ground conductor and thus result in death or serious injury.

- 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.

Failure to follow the recommendation means that the RCD cannot provide the intended protection.

Overcurrent protection
- Additional protective equipment such as short-circuit protection or motor thermal protection between drive and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. See maximum fuse ratings in chapter 9.7 Fuses.

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 9.5.1 Cable Specifications for recommended wire sizes and types.

⚠️ CAUTION ⚠️

PROPERTY DAMAGE
Protection against motor overload is not included in the default setting. To add this function, set parameter 1-90 Motor Thermal Protection to [ETR trip] or [ETR warning]. For the North American market, the ETR function provides class 20 motor overload protection in accordance with NEC. Failure to set parameter 1-90 Motor Thermal Protection to [ETR trip] or [ETR warning] means that motor overload protection is not provided and, if the motor overheats, property damage can occur.

5.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in:
- Chapter 5.3 Wiring Schematic.
- Chapter 5.4 Connecting the Motor.
- Chapter 5.6 Connecting to Ground.
- Chapter 5.8 Control Wiring.

NOTICE

TWISTED SHIELD ENDS (PIGTAILS)
Twisted shield ends (pigtails) increase the shield impedance at higher frequencies, reducing the shield effect and increasing the leakage current. Avoid twisted shield ends by using integrated shield clamps.

- For use with relays, control cables, a signal interface, fieldbus, or brake, connect the shield to the enclosure at both ends. If the ground path has high impedance, is noisy, or is carrying current, break the shield connection on 1 end to avoid ground current loops.
- Convey the currents back to the unit using a metal mounting plate. Ensure good electrical contact from the mounting plate through the mounting screws to the drive chassis.
- Use shielded cables for motor output cables. An alternative is unshielded motor cables within metal conduit.
**NOTICE**

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

- Ensure that motor and brake cables are as short as possible to reduce the interference level from the entire system.
- Avoid placing cables with a sensitive signal level alongside motor and brake cables.
- For communication and command/control lines, follow the particular communication protocol standards. For example, USB must use shielded cables, but RS485/ethernet can use shielded UTP or unshielded UTP cables.
- Ensure that all control terminal connections are PELV.

**NOTICE**

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

**NOTICE**

**INSTALLATION AT HIGH ALTITUDE**
There is a risk for overvoltage. Isolation between components and critical parts could be insufficient, and not comply with PELV requirements. Reduce the risk for overvoltage by using external protective devices or galvanic isolation. For installations above 2000 m (6500 ft) altitude, contact Danfoss regarding PELV compliance.

**NOTICE**

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

VLT® AQUA Drive FC 202

1 PLC
2 Minimum 16 mm² (6 AWG) equalizing cable
3 Control cables
4 Minimum 200 mm (7.9 in) required between control cables, motor cables, and mains cables.
5 Mains supply
6 Bare (unpainted) surface
7 Star washers
8 Brake cable (shielded)
9 Motor cable (shielded)
10 Mains cable (unshielded)
11 Output contactor and similar options
12 Cable insulation stripped
13 Common ground busbar. Follow local and national requirements for enclosure grounding.
14 Brake resistor
15 Metal box
16 Connection to motor
17 Motor
18 EMC cable gland

Illustration 5.1 Example of Proper EMC Installation
5.3 Wiring Schematic

Illustration 5.2 Basic Wiring Schematic

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

**WARNING**

**INDUCED VOLTAGE**

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

- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 9.1 Electrical Data*.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided on the pedestal of IP21/IP54 (Type 1/Type 12) units.
- Do not wire a starting or pole-changing device (for example Dahlander motor or slip ring asynchronous motor) between the drive and the motor.

**Procedure**

1. Strip a section of the outer cable insulation.
2. Establish mechanical fixation and electrical contact between the cable shield and ground by positioning the stripped wire under the cable clamp.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 5.6 Connecting to Ground*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 5.3*.
5. Tighten the terminals in accordance with the information provided in *chapter 9.10.1 Fastener Torque Ratings*.
Illustration 5.3 AC motor terminals (E1h shown). For a detailed view of terminals, refer to chapter 5.7 Terminal Dimensions.
5.5 Connecting the AC Mains

- Size the wiring according to the input current of the drive. For maximum wire sizes, see chapter 9.1 Electrical Data.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Strip a section of the outer cable insulation.
2. Establish mechanical fixation and electrical contact between the cable shield and ground by positioning the stripped wire under the cable clamp.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in chapter 5.6 Connecting to Ground.
4. Connect the 3-phase AC input power wiring to terminals R, S, and T (see Illustration 5.4).
5. Tighten the terminals in accordance with the information provided in chapter 9.10.1 Fastener Torque Ratings.
6. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that parameter 14-50 RFI Filter is set to [0] Off to avoid damage to the DC link and to reduce ground capacity currents.

**NOTICE**

**OUTPUT CONTACTOR**

Danfoss does not recommend using an output contactor on 525–590 V drives that are connected to an IT mains network.
Illustration 5.4 AC mains terminals (E1h shown). For a detailed view of terminals, refer to chapter 5.7 Terminal Dimensions.
5.6 Connecting to Ground

**WARNING**

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

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

**For electrical safety**
- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm² (6 AWG) (or 2 rated ground wires terminated separately).
- Tighten the terminals in accordance with the information provided in *chapter 9.10.1 Fastener Torque Ratings*.

**For EMC-compliant installation**
- Establish electrical contact between the cable shield and the drive enclosure by using metal cable glands or by using the clamps provided on the equipment.
- Reduce burst transient by using high-strand wire.
- Do not use pigtails.

**NOTICE**

**POTENTIAL EQUALIZATION**
There is a risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm² (5 AWG).
Illustration 5.5 Ground terminals (E1h shown). For a detailed view of terminals, refer to chapter 5.7 Terminal Dimensions.
5.7 Terminal Dimensions

5.7.1 E1h Terminal Dimensions

Illustration 5.6 E1h Terminal Dimensions (Front View)
Illustration 5.7 E1h Terminal Dimensions (Side Views)
5.7.2 E2h Terminal Dimensions

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mains terminals</td>
</tr>
<tr>
<td>2</td>
<td>Brake or regeneration terminals</td>
</tr>
<tr>
<td>3</td>
<td>Motor terminals</td>
</tr>
<tr>
<td>4</td>
<td>Ground terminals, M10 nut</td>
</tr>
</tbody>
</table>

Illustration 5.8 E2h Terminal Dimensions (Front View)
Illustration 5.9 E2h Terminal Dimensions (Side Views)
5.7.3 E3h Terminal Dimensions

Illustration 5.10 E3h Terminal Dimensions (Front View)
Illustration 5.11 E3h Mains, Motor, and Ground Terminal Dimensions (Side Views)
Illustration 5.12 E3h Load Share/Regeneration Terminal Dimensions
5.7.4 E4h Terminal Dimensions

Illustration 5.13 E4h Terminal Dimensions (Front View)

| 1 | Mains terminals | 3 | Motor terminals |
| 2 | Brake or regeneration terminals | 4 | Ground terminals, M8 and M10 nuts |
Illustration 5.14 E4h Mains, Motor, and Ground Terminal Dimensions (Side Views)
Illustration 5.15 E4h Load Share/Regeneration Terminal Dimensions
5.8 Control Wiring

All terminals to the control cables are inside the drive below the LCP. To access, either open the door (E1h and E2h) or remove the front panel (E3h and E4h).

5.8.1 Control Cable Routing

Tie down and route all control wires as shown in Illustration 5.16. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

- Isolate control wiring from high-power cables in the drive.
- When the drive is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended.

Fieldbus connection

Connections are made to the relevant options on the control card. For more detail, see the relevant fieldbus instruction. The cable must be tied down and routed along with other control wires inside the unit. See Illustration 5.16.

5.8.2 Control Terminal Types

Illustration 5.17 shows the removable drive connectors. Terminal functions and default settings are summarized in Table 5.1 – Table 5.3.

Fieldbus connection

Connections are made to the relevant options on the control card. For more detail, see the relevant fieldbus instruction. The cable must be tied down and routed along with other control wires inside the unit. See Illustration 5.16.

Table 5.1 – Table 5.3

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Parameter</th>
<th>Default setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>–</td>
<td>–</td>
<td>Integrated RC-filter for cable shield. ONLY for connecting the shield in the event of EMC problems.</td>
</tr>
</tbody>
</table>
### Table 5.1 Serial Communication Terminal Descriptions

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Parameter group</th>
<th>Default setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>68 (+)</td>
<td>Parameter 8-3* FC Port Settings</td>
<td>–</td>
<td>RS485 interface. A switch (BUS TER.) is provided on the control card for bus termination resistance. See Illustration 5.23.</td>
</tr>
<tr>
<td>69 (-)</td>
<td>Parameter 8-3* FC Port Settings</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

### Table 5.2 Digital Input/Output Terminal Descriptions

#### Digital input/output terminals

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

### Table 5.3 Analog Input/Output Terminal Descriptions

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Parameter</th>
<th>Default setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>–</td>
<td>–</td>
<td>Common for analog output.</td>
</tr>
<tr>
<td>42</td>
<td>Parameter 6-50 Terminal 42 Output</td>
<td>[0] No operation</td>
<td>Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.</td>
</tr>
<tr>
<td>50</td>
<td>–</td>
<td>+10 V DC</td>
<td>10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.</td>
</tr>
<tr>
<td>53</td>
<td>Parameter 5-1 Analog Input</td>
<td>Reference</td>
<td>Analog input. For voltage or current. Switches A53 and A54 select mA or V.</td>
</tr>
<tr>
<td>54</td>
<td>Parameter 6-2 Analog Input</td>
<td>Feedback</td>
<td>–</td>
</tr>
<tr>
<td>55</td>
<td>–</td>
<td>–</td>
<td>Common for analog input.</td>
</tr>
</tbody>
</table>

### 5.8.3 Relay Terminals

- Relay 1 and relay 2. The location of the outputs depends on the drive configuration. See chapter 3.5 Control Shelf.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

### Table 5.4 Relay Terminal Descriptions

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Parameter</th>
<th>Default setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01, 02, 03</td>
<td>Parameter 5-40 Function Relay</td>
<td>[0] No operation</td>
<td>Form C relay output. For AC or DC voltage and resistive or inductive loads.</td>
</tr>
<tr>
<td>04, 05, 06</td>
<td>Parameter 5-40 Function Relay</td>
<td>[0] No operation</td>
<td>–</td>
</tr>
</tbody>
</table>
5.8.4 Wiring to Control Terminals

The control terminals are located near the LCP. The control terminal connectors can be unplugged from the drive for convenience when wiring, as shown in Illustration 5.17. Either solid or flexible wire can be connected to the control terminals. Use the following procedures to connect or disconnect the control wires.

**NOTICE**

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

**Connecting wire to control terminals**

1. Strip 10 mm (0.4 in) of the outer plastic layer from the end of the wire.
2. Insert the control wire into the terminal.
   - For a solid wire, push the bare wire into the contact. See Illustration 5.20.
   - For a flexible wire, open the contact by inserting a small screwdriver into the slot between the terminal holes and push the screwdriver inward. See Illustration 5.21. Then, insert the stripped wire into the contact and remove the screwdriver.
3. Pull gently on the wire to ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or reduced performance.

**Disconnecting wires from the control terminals**

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

See chapter 9.1 Electrical Data for control terminal wiring sizes and chapter 7 Wiring Configuration Examples for typical control wiring connections.

5.8.5 Enabling Motor Operation
(Terminal 27)

A jumper wire is required between terminal 12 (or 13) and terminal 27 for the drive to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive 24 V DC external interlock command.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. This wire provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads AUTO REMOTE COAST, the unit is ready to operate, but is missing an input signal on terminal 27.
- When factory-installed optional equipment is wired to terminal 27, do not remove that wiring.

**NOTICE**

The drive cannot operate without a signal on terminal 27, unless terminal 27 is reprogrammed using parameter 5-12 Terminal 27 Digital Input.
5.8.6 Configuring RS485 Serial Communication

RS485 is a 2-wire bus interface compatible with multi-drop network topology, and it contains the following features:

- Either Danfoss FC or Modbus RTU communication protocol, which are internal to the drive, can be used.
- Functions can be programmed remotely using the protocol software and RS485 connection or in parameter group 8-** Communications and Options.
- Selecting a specific communication protocol changes various default parameter settings to match the specifications of the protocol, making more protocol-specific parameters available.
- Option cards for the drive are available to provide more communication protocols. See the option card documentation for installation and operation instructions.
- A switch (BUS TER) is provided on the control card for bus termination resistance. See Illustration 5.23.

For basic serial communication set-up, perform the following steps:

1. Connect RS485 serial communication wiring to terminals (+)68 and (-)69.
   1a Use shielded serial communication cable (recommended).
   1b See chapter 5.6 Connecting to Ground for proper grounding.

2. Select the following parameter settings:
   2a Protocol type in parameter 8-30 Protocol.
   2b Drive address in parameter 8-31 Address.
   2c Baud rate in parameter 8-32 Baud Rate.

Illustration 5.22 Serial Communication Wiring Diagram

5.8.7 Wiring Safe Torque Off (STO)

The Safe Torque Off (STO) function is a component in a safety control system. STO prevents the unit from generating the voltage required to rotate the motor.

To run STO, more wiring for the drive is required. Refer to Safe Torque Off Operating Guide for further information.

5.8.8 Wiring the Space Heater

The space heater is an option used to prevent condensation from forming inside the enclosure when the unit is turned off. It is designed to be field wired and controlled by an HVAC management system.

Specifications
- Nominal voltage: 100–240
- Wire size: 12–24 AWG

5.8.9 Wiring the Auxiliary Contacts to the Disconnect

The disconnect is an option that is installed at the factory. The auxiliary contacts, which are signal accessories used with the disconnect, are not installed at the factory to allow more flexibility during installation. The contacts snap into place without the need for tools.

Contacts must be installed in specific locations on the disconnect depending upon their functions. Refer to the datasheet included in the accessory bag that comes with the drive.

Specifications
- $U_{i}/[V]$: 690
- $U_{imp}/[kV]$: 4
- Pollution degree: 3
- $I_{th}/[A]$: 16
- Cable size: 1...2x0.75...2.5 mm$^2$
- Maximum fuse: 16 A/gG
- NEMA: A600, R300, wire size: 18–14 AWG, 1(2)
5.8.10 Wiring the Brake Resistor Temperature Switch

The brake resistor terminal block is located on the power card and allows for the connection of an external brake resistor temperature switch. The switch can be configured as normally closed or normally open. If the input changes, a signal trips the drive and shows alarm 27, Brake chopper fault on the LCP display. At the same time, the drive stops braking and the motor coasts.

1. Locate the brake resistor terminal block (terminals 104–106) on the power card. See Illustration 3.3.
2. Remove the M3 screws that hold the jumper to the power card.
3. Remove the jumper and wire the brake resistor temperature switch in 1 of the following configurations:
   3a Normally closed. Connect to terminals 104 and 106.
   3b Normally open. Connect to terminals 104 and 105.
4. Secure the switch wires with the M3 screws. Torque to 0.5-0.6 Nm (5 in-lb).

5.8.11 Selecting Voltage/Current Input Signal

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

Default parameter setting:
- Terminal 53: Speed reference signal in open loop (see parameter 16-61 Terminal 53 Switch Setting).
- Terminal 54: Feedback signal in closed loop (see parameter 16-63 Terminal 54 Switch Setting).

**NOTICE**

Disconnect power to the drive before changing switch positions.

1. Remove the LCP (local control panel). See chapter 6.3 LCP Menu.
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type (U = voltage, I = current).
5.9 Pre-start Check List

Before completing installation of the unit, inspect the entire installation as detailed in Table 5.5. Check and mark the items when completed.

<table>
<thead>
<tr>
<th>Inspect for</th>
<th>Description</th>
</tr>
</thead>
</table>
| Motor                    | • Confirm continuity of the motor by measuring ohm values on U–V (96–97), V–W (97–98), and W–U (98–96).  
                            • Confirm that the supply voltage matches the voltage of the drive and the motor.         |
| Switches                 | • Ensure that all switch and disconnect settings are in the proper positions.                   |
| Auxiliary equipment      | • Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that reside on the input power side of the drive or output side to the motor. Ensure that they are ready for full-speed operation.  
                            • Check function and installation of any sensors used for feedback to the drive.          
                            • Remove any power factor correction caps on motor.                                          
                            • Adjust any power factor correction caps on the mains side and ensure that they are dampened. |
| Cable routing            | • Ensure that motor wiring, brake wiring (if equipped), and control wiring are separated or shielded, or in 3 separate metallic conduits for high-frequency interference isolation. |
| Control wiring           | • Check for broken or damaged wires and loose connections.                                     
                            • Check that control wiring is isolated from high-power wiring for noise immunity.       
                            • Check the voltage source of the signals, if necessary.                                     
                            • Use shielded cable or twisted pair and ensure that the shield is terminated correctly.  |
| Input and output power wiring | • Check for loose connections.                                                                    
                             • Check that motor and mains are in separate conduit or separated shielded cables.       |
| Grounding                | • Check for good ground connections that are tight and free of oxidation.                        
                            • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding. |
| Fuses and circuit breakers| • Check for proper fusing or circuit breakers.                                                   
                            • Check that all fuses are inserted firmly and are in operational condition and that all circuit breakers (if used) are in the open position. |
| Cooling clearance        | • Look for any obstructions in the airflow path.                                                 
                            • Measure top and bottom clearance of the drive to verify adequate airflow for cooling, see chapter 4.5.1 Installation and Cooling Requirements. |
| Ambient conditions       | • Check that requirements for ambient conditions are met. See chapter 9.4 Ambient Conditions.  |
| Interior of the drive    | • Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion.       
                            • Verify that all installation tools have been removed from unit interior.                  
                            • For E3h and E4h enclosures, ensure that the unit is mounted on an unpainted, metal surface. |
| Vibration                | • Check that the unit is mounted solidly, or that shock mounts are used, if necessary.         
                            • Check for an unusual amount of vibration.                                                    |

Table 5.5 Pre-start Check List

⚠️ **CAUTION**

**POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE**

If the drive is not properly secured with covers, personal injury can occur.

- Before applying power, ensure all safety covers (door and panels) are in place and securely fastened. Refer to chapter 9.10.1 Fastener Torque Ratings.
6 Commissioning

6.1 Safety Instructions

See chapter 2 Safety for general safety instructions.

**WARNING**

HIGH VOLTAGE

Drives contain high voltage when connected to AC mains input power. Failure to use qualified personnel to install, start up, and maintain the drive can result in death or serious injury.

- Only qualified personnel must install, start up, and maintain the drive.

Before applying power:

1. Ensure that input power to the unit is OFF and locked out. Do not rely on the drive disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
5. Check for proper grounding of the drive and the motor.
6. Inspect the drive for loose connections on the terminals.
7. Check that all cable glands are firmly tightened.
8. Confirm that the supply voltage matches the voltage of the drive and the motor.
9. Close and securely fasten the front cover.

6.2 Applying Power

**WARNING**

UNINTENDED START

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

To prevent unintended motor start:

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

1. Confirm that the input voltage between phases is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that optional equipment wiring, if present, matches the installation application.
3. Ensure that all operator devices are in the OFF position.
4. Close all panel doors and securely fasten all covers.
5. Apply power to the unit. DO NOT start the drive now. For units with a disconnect switch, turn to the ON position to apply power to the drive.

**NOTICE**

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING or alarm 60, External Interlock is shown, this status indicates that the unit is ready to operate but is missing an input signal on terminal 27. See chapter 5.8.5 Enabling Motor Operation (Terminal 27) for details.
6.3 LCP Menu

6.3.1.1 Quick Menu Mode

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

- **Quick Menus**
- **01 My Personal Menu**
- **02 Quick Setup**
- **03 Function Setups**
- **04 Smart Start**
- **05 Changes Made**
- **06 Loggings**
- **07 Water and Pumps**

Illustration 6.1 Quick Menu View

6.3.1.2 Q1 My Personal Menu

The Personal Menu is used to determine what is shown in the display area. Refer to chapter 3.6 Local Control Panel (LCP). This menu can also show up to 50 pre-programmed parameters. These 50 parameters are manually entered using parameter 0-25 My Personal Menu.

6.3.1.3 Q2 Quick Setup

The parameters found in the Q2 Quick Setup contain basic system and motor data that are always necessary for configuring the drive. See chapter 6.4.2 Entering System Information for the set-up procedures.

6.3.1.4 Q3 Function Setups

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

6.3.1.5 Q4 Smart Start

Q4 Smart Setup guides the user through typical parameter settings used to configure the motor and selected pump/fan application. The [Info] key can be used to display help information for various selections, settings, and messages.

6.3.1.6 Q5 Changes Made

Select Q5 Changes Made for information about:
- The 10 most recent changes.
- Changes made from default setting.

6.3.1.7 Q6 Loggings

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference [Unit]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 0-20</td>
<td>Display Line 1.1 Small</td>
</tr>
<tr>
<td>Parameter 0-21</td>
<td>Display Line 1.2 Small</td>
</tr>
<tr>
<td>Parameter 0-22</td>
<td>Display Line 1.3 Small</td>
</tr>
<tr>
<td>Parameter 0-23</td>
<td>Display Line 2 Large</td>
</tr>
<tr>
<td>Parameter 0-24</td>
<td>Display Line 3 Large</td>
</tr>
</tbody>
</table>

Table 6.1 Logging Parameter Examples

6.3.1.8 Q7 Water and Pumps

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

6.3.1.9 Main Menu Mode

The Main Menu mode lists all the parameter groups available to the drive. Select the Main Menu mode by pressing the [Main Menu] key. The resulting readout appears on the LCP display.

- **0 RPM**
- **0.00 A**

Illustration 6.2 Main Menu View

All parameters can be changed in the main menu. Option cards added to the unit enable extra parameters associated with the option device.
6.4 Programming the Drive

For detailed information on the key functions on the local control panel (LCP), see chapter 3.6 Local Control Panel (LCP). For information on parameter settings, see the programming guide.

Parameter overview

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

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

<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Parameter Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-** Operation/Display</td>
<td>0-01 Language</td>
<td>Parameter</td>
</tr>
<tr>
<td>0-** Basic Settings</td>
<td>0-02 Motor Speed Unit</td>
<td>Parameter</td>
</tr>
<tr>
<td>Parameter 0-03 Regional Settings</td>
<td>Parameter 0-01 Language</td>
<td>Parameter</td>
</tr>
<tr>
<td>Parameter 0-02 Motor Speed Unit</td>
<td>Parameter 0-03 Regional Settings</td>
<td>Parameter</td>
</tr>
</tbody>
</table>

Table 6.2 Example of Parameter Group Hierarchy

Moving around parameters

Navigate through the parameters using the following LCP keys:

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

6.4.1 Programming Example for an Open-loop Application

This procedure, which is used to configure a typical open-loop application, programs the drive to receive a 0–10 V DC analog control signal on input terminal 53. The drive responds by providing 20–50 Hz output to the motor proportional to the input signal (0–10 V DC=20–50 Hz).

Press [Quick Menu] and complete the following steps:

1. Select Q3 Function Setups and press [OK].
2. Select Parameter Data Set and press [OK].

Illustration 6.3 Q3 Function Setups

3. Select Q3-2 Open Loop Settings and press [OK].

Illustration 6.4 Q3-2 Open Loop Settings

4. Select Q3-21 Analog Reference and press [OK].

Illustration 6.5 Q3-21 Analog Reference
5. Select parameter 3-02 Minimum Reference. Set the minimum internal drive reference to 0 Hz and press [OK].

6. Select parameter 3-03 Maximum Reference. Set the maximum internal drive reference to 60 Hz and press [OK].

7. Select parameter 6-10 Terminal 53 Low Voltage. Set the minimum external voltage reference on terminal 53 at 0 V and press [OK].


10. Select parameter 6-15 Terminal 53 High Ref./Feedb. Value. Set maximum speed reference on terminal 53 at 50 Hz and press [OK].
With an external device providing a 0–10 V control signal connected to drive terminal 53, the system is now ready for operation.

**NOTICE**

In Illustration 6.11, the scroll bar on the right of the display is at the bottom. This position indicates the procedure is complete.

Illustration 6.12 shows the wiring connections used to enable the external device set up.

### 6.4.2 Entering System Information

**NOTICE**

**SOFTWARE DOWNLOAD**


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

**NOTICE**

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

1. Press [Main Menu] on the LCP.
2. Select 0-** Operation/Display and press [OK].
3. Select 0-0* Basic Settings and press [OK].
4. Select parameter 0-03 Regional Settings and press [OK].
5. Select [0] International or [1] North America as appropriate and press [OK]. (This action changes the default settings for some basic parameters).
6. Press [Quick Menus] on the LCP and then select 02 Quick Setup.
7. Change the following parameters settings listed in Table 6.3 if necessary. The motor data is found on the motor nameplate.

### Table 6.3 Quick Setup Settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 0-01 Language</td>
<td>English</td>
</tr>
<tr>
<td>Parameter 1-20 Motor Power [kW]</td>
<td>4.00 kW</td>
</tr>
<tr>
<td>Parameter 1-22 Motor Voltage</td>
<td>400 V</td>
</tr>
<tr>
<td>Parameter 1-23 Motor Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Parameter 1-24 Motor Current</td>
<td>9.00 A</td>
</tr>
<tr>
<td>Parameter 1-25 Motor Nominal Speed</td>
<td>1420 RPM</td>
</tr>
<tr>
<td>Parameter 5-12 Terminal 27 Digital Input</td>
<td>Coast inverse</td>
</tr>
<tr>
<td>Parameter 3-02 Minimum Reference</td>
<td>0.000 RPM</td>
</tr>
<tr>
<td>Parameter 3-03 Maximum Reference</td>
<td>1500.000 RPM</td>
</tr>
<tr>
<td>Parameter 3-41 Ramp 1 Ramp up Time</td>
<td>3.00 s</td>
</tr>
<tr>
<td>Parameter 3-42 Ramp 1 Ramp Down Time</td>
<td>3.00 s</td>
</tr>
<tr>
<td>Parameter 3-13 Reference Site</td>
<td>Linked to Hand/Auto</td>
</tr>
<tr>
<td>Parameter 1-29 Automatic Motor Adaptation (AMA)</td>
<td>Off</td>
</tr>
</tbody>
</table>

**NOTICE**

**MISSING INPUT SIGNAL**

When the LCP shows AUTO REMOTE COASTING or alarm 60, External Interlock, the unit is ready to operate but is missing an input signal. See chapter 5.8.5 Enabling Motor Operation (Terminal 27) for details.

### 6.4.3 Configuring Automatic Energy Optimization

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

1. Press [Main Menu].
2. Select 1-** Load and Motor and press [OK].
3. Select 1-0* General Settings and press [OK].
4. Select parameter 1-03 Torque Characteristics and press [OK].
6.4.4 Configuring Automatic Motor Adaptation

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

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

**NOTICE**

If warnings or alarms occur, see chapter 8.5 List of Warnings and Alarms. Some motors are unable to run the complete version of the test. In that case, or if an output filter is connected to the motor, select [2] Enable reduced AMA.

Run this procedure on a cold motor for best results.

1. Press [Main Menu].
2. Select 1-** Load and Motor** and press [OK].
4. Select parameter 1-29 Automatic Motor Adaptation (AMA) and press [OK].
6. Press [Hand On] and then [OK].
   The test runs automatically and indicates when it is complete.

6.5 Testing Before System Start-up

**WARNING**

MOTOR START

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

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

6.5.1 Motor Rotation

**NOTICE**

If the motor runs in the wrong direction, it can damage equipment. Before running the unit, check the motor rotation by briefly running the motor. The motor runs briefly at either 5 Hz or the minimum frequency set in parameter 4-12 Motor Speed Low Limit [Hz].

1. Press [Hand On].
2. Move the left cursor to the left of the decimal point by using the left arrow key, and enter an RPM that slowly rotates the motor.
3. Press [OK].
4. If the motor rotation is wrong, set parameter 1-06 Clockwise Direction to [1] Inverse.

6.5.2 Encoder Rotation

If encoder feedback is used, perform the following steps:

1. Select [0] Open Loop in parameter 1-00 Configuration Mode.
3. Press [Hand On].
4. Press [►] for positive speed reference (parameter 1-06 Clockwise Direction at [0] Normal).
5. In parameter 16-57 Feedback [RPM], check that the feedback is positive.

For more information on the encoder option, refer to the option manual.

**NOTICE**

NEGATIVE FEEDBACK

If the feedback is negative, the encoder connection is wrong. Use either parameter 5-71 Term 32/33 Encoder Direction or parameter 17-60 Feedback Direction to inverse the direction, or reverse the encoder cables. Parameter 17-60 Feedback Direction is only available with the VLT® Encoder Input MCB 102 option.

6.6 System Start-up

**WARNING**

MOTOR START

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

- Ensure that equipment is safe to operate under any condition.
- Ensure that the motor, system, and any attached equipment are ready for start.
The procedure in this section requires user-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. Examples of external run commands are a switch, button, or programmable logic controller (PLC).
3. Adjust the speed reference throughout the speed range.
4. Ensure that the system is working as intended by checking sound and vibration level of the motor.
5. Remove the external run command.

If warnings or alarms occur, see chapter 8.5 List of Warnings and Alarms.

6.7 Parameter Settings

NOTICE

REGIONAL SETTINGS
Some parameters have different default settings for international or North America. For a list of the different default values, see chapter 10.2 International/North American Default Parameter Settings.

Establishing the correct programming for applications requires setting several parameter functions. Details for parameters are provided in the programming guide.

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

- Parameter settings can be uploaded into the LCP memory and stored as a back-up.
- Multiple units can be programmed quickly by connecting the LCP to the unit and downloading the stored parameter settings.
- Settings that are stored in the LCP are not changed when restoring factory default settings.
- Changes made to default settings as well as any programming entered into parameters are stored and available for viewing in the quick menu. See chapter 6.3 LCP Menu.

6.7.1 Uploading and Downloading Parameter Settings

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

1. Press [Off].
2. Go to parameter 0-50 LCP Copy and press [OK].
3. Select 1 of the following:
   3a To upload data from the control card to the LCP, select [1] All to LCP.
   3b To download data from the LCP to the control card, select [2] All from LCP.
4. Press [OK]. A progress bar shows the uploading or downloading process.
5. Press [Hand On] or [Auto On].

6.7.2 Restoring Factory Default Settings

NOTICE

LOSS OF DATA
Loss of programming, motor data, localization, and monitoring records occurs when restoring default settings. To create a back-up, upload data to the LCP before initialization. Refer to chapter 6.7.1 Uploading and Downloading Parameter Settings.

Restore the default parameter settings by initializing the unit. Initialization is carried out through parameter 14-22 Operation Mode or manually.

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

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

1. Press [Main Menu] twice to access parameters.
2. Go to parameter 14-22 Operation Mode and press [OK].
3. Scroll to Initialization and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit. Default parameter settings are restored during start-up. Start-up takes slightly longer than normal.
6. After alarm 80, Drive initialized to default value appears, press [Reset].

Manual initialization

Manual initialization resets all factory settings except for the following:
- Parameter 15-00 Operating Hours.
- Parameter 15-03 Power Up's.
- Parameter 15-04 Over Temp's.
- Parameter 15-05 Over Volt's.

To perform manual initialization:
1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] simultaneously while applying power to the unit (approximately 5 s or until an audible click sounds and the fan starts). Start-up takes slightly longer than normal.
7 Wiring Configuration Examples

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

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

**NOTICE**
When not using the optional STO feature, a jumper wire is required between terminal 12 (or 13) and terminal 37 for the drive to operate with factory default programming values.

### 7.1 Wiring for Open-loop Speed Control

#### Table 7.1 Analog Speed Reference (Voltage)

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 6-10 Terminal 53 Low Voltage</td>
<td>0.07 V*</td>
</tr>
<tr>
<td>Parameter 6-11 Terminal 53 High Voltage</td>
<td>10 V*</td>
</tr>
<tr>
<td>Parameter 6-14 Terminal 53 Low Ref./Feedb. Value</td>
<td>0 Hz</td>
</tr>
<tr>
<td>Parameter 6-15 Terminal 53 High Ref./Feedb. Value</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>

* = Default value

Notes/comments:
Assumptions are 0 V DC input = 0 Hz speed and 10 V DC input = 50 Hz speed.

#### Table 7.2 Analog Speed Reference (Current)

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 6-12 Terminal 53 Low Current</td>
<td>4 mA*</td>
</tr>
<tr>
<td>Parameter 6-13 Terminal 53 High Current</td>
<td>20 mA*</td>
</tr>
<tr>
<td>Parameter 6-14 Terminal 53 Low Ref./Feedb. Value</td>
<td>0 Hz</td>
</tr>
<tr>
<td>Parameter 6-15 Terminal 53 High Ref./Feedb. Value</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>

* = Default value

Notes/comments:
Assumptions are 4 mA input = 0 Hz speed and 20 mA input = 50 Hz speed.

#### Table 7.3 Speed Reference (Using a Manual Potentiometer)

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 6-12 Terminal 53 Low Current</td>
<td>4 mA*</td>
</tr>
<tr>
<td>Parameter 6-13 Terminal 53 High Current</td>
<td>20 mA*</td>
</tr>
<tr>
<td>Parameter 6-14 Terminal 53 Low Ref./Feedb. Value</td>
<td>0 Hz</td>
</tr>
<tr>
<td>Parameter 6-15 Terminal 53 High Ref./Feedb. Value</td>
<td>50 Hz</td>
</tr>
</tbody>
</table>

* = Default value

Notes/comments:
Assumptions are 0 V DC input = 0 RPM speed and 10 V DC input = 1500 RPM speed.
### 7.2 Wiring for Start/Stop

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 5-10 Digital Input</td>
<td>[8] Start*</td>
</tr>
<tr>
<td>Parameter 5-12 Digital Input</td>
<td>Freeze Ref</td>
</tr>
<tr>
<td>Parameter 5-13 Digital Input</td>
<td>Speed Up</td>
</tr>
<tr>
<td>Parameter 5-14 Digital Input</td>
<td>Speed Down</td>
</tr>
</tbody>
</table>

* = Default value

### Notes/comments:
- If parameter 5-12 Terminal 27 Digital Input is set to [0] No operation, a jumper wire to terminal 27 is not needed.

#### Table 7.5 Start/Stop Command with Safe Torque Off Option

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 5-10 Terminal 18</td>
<td>[8] Start*</td>
</tr>
<tr>
<td>Parameter 5-12 Digital Input</td>
<td>[0] No op</td>
</tr>
<tr>
<td>Parameter 5-19 Digital Input</td>
<td>[1] Safe Stop Alarm</td>
</tr>
</tbody>
</table>

* = Default value

#### Notes/comments:
- If parameter 5-12 Terminal 27 Digital Input is set to [0] No operation, a jumper wire to terminal 27 is not needed.
### Table 7.6 Pulse Start/Stop

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td>Parameter 5-1</td>
<td>[9] Latched</td>
</tr>
<tr>
<td></td>
<td>Digital Input</td>
<td>Start</td>
</tr>
<tr>
<td></td>
<td>Parameter 5-1</td>
<td>[6] Stop Inverse</td>
</tr>
<tr>
<td></td>
<td>Digital Input</td>
<td></td>
</tr>
</tbody>
</table>

* = Default value

### Notes/comments:

Table 7.6 Pulse Start/Stop

---

### Table 7.7 Start/Stop with Reversing and 4 Preset Speeds

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td>Parameter 5-10</td>
<td>[8] Start</td>
</tr>
<tr>
<td></td>
<td>Terminal 18</td>
<td>Digital Input</td>
</tr>
<tr>
<td></td>
<td>Parameter 5-11</td>
<td>[10] Reversing*</td>
</tr>
<tr>
<td></td>
<td>Terminal 19</td>
<td>Digital Input</td>
</tr>
<tr>
<td></td>
<td>Parameter 5-12</td>
<td>[0] No</td>
</tr>
<tr>
<td></td>
<td>Terminal 27</td>
<td>operation</td>
</tr>
<tr>
<td></td>
<td>Parameter 5-14</td>
<td>[16] Preset ref</td>
</tr>
<tr>
<td></td>
<td>Terminal 32</td>
<td>bit 0</td>
</tr>
<tr>
<td></td>
<td>Digital Input</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parameter 5-15</td>
<td>[17] Preset ref</td>
</tr>
<tr>
<td></td>
<td>Terminal 33</td>
<td>bit 1</td>
</tr>
<tr>
<td></td>
<td>Digital Input</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parameter 3-10</td>
<td>Preset</td>
</tr>
<tr>
<td></td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preset ref. 0</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Preset ref. 1</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Preset ref. 2</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>Preset ref. 3</td>
<td>100%</td>
</tr>
</tbody>
</table>

* = Default value

### Notes/comments:

Table 7.7 Start/Stop with Reversing and 4 Preset Speeds

---

### Illustration 7.3 Latched Start/Stop Inverse

#### 7.3 Wiring for External Alarm Reset

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td>Parameter 5-11</td>
<td>[1] Reset</td>
</tr>
<tr>
<td></td>
<td>Terminal 19</td>
<td>Digital Input</td>
</tr>
</tbody>
</table>

* = Default value

### Notes/comments:

Table 7.8 External Alarm Reset
7.4 Wiring for a Motor Thermistor

**WARNING**

**THERMISTOR INSULATION**
Risk of personal injury or equipment damage.

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

### Parameters

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 1-90 Motor Thermal Protection</td>
<td>100%*</td>
</tr>
<tr>
<td>Parameter 1-93 Thermistor Resource</td>
<td>Analog input 53</td>
</tr>
</tbody>
</table>

* = Default value

**Notes/comments:**
If only a warning is desired, set parameter 1-90 Motor Thermal Protection to 1 Thermistor warning.

Table 7.9 Motor Thermistor

---

7.5 Wiring for Regeneration

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 1-90 Motor Thermal Protection</td>
<td>0%</td>
</tr>
</tbody>
</table>

* = Default value

**Notes/comments:**
To disable regeneration, decrease parameter 1-90 Motor Thermal Protection to 0%. If the application uses motor brake power and regeneration is not enabled, the unit trips.

Table 7.10 Regeneration
8 Maintenance, Diagnostics, and Troubleshooting

8.1 Maintenance and Service

This chapter includes:
- Maintenance and service guidelines.
- Status messages.
- Warnings and alarms.
- Basic troubleshooting.

Under normal operating conditions and load profiles, the drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the drive at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, refer to www.danfoss.com/en/service-and-support/.

**WARNING**

**UNINTENDED START**

When the drive 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 drive from the mains.
- Completely wire and assemble the drive, motor, and any driven equipment before connecting the drive to AC mains, DC supply, or load sharing.

1. Remove power from the drive and wait 40 minutes for the capacitors to discharge completely. Refer to chapter 2 Safety.
2. Position the drive so that the back of the drive is fully accessible.
3. Remove the 8 M5 fasteners securing the access panel to the back of the enclosure using a 3 mm hex bit.
4. Inspect the leading edge of the heat sink for damage or debris.
5. Remove material or debris with a vacuum.
6. Reinstall the panel and secure it to the back of the enclosure with the 8 fasteners. Tighten the fasteners according to chapter 9.10.1 Fastener Torque Ratings.

8.2 Heat Sink Access Panel

The drive can be ordered with an optional access panel in the back of the unit. This access panel provides access to the heat sink and allows the heat sink to be cleaned of any dust buildup.

8.2.1 Removing the Heat Sink Access Panel

**NOTICE**

**DAMAGE TO HEAT SINK**

Using fasteners that are longer than those originally supplied with the heat sink panel can damage the heat sink cooling fins.

Illustration 8.1 Heat Sink Access Panel Removed from the Rear of the Drive
8.3 Status Messages

When the drive is in status mode, status messages automatically appear in the bottom line of the LCP display. Refer to Illustration 8.2. Status messages are defined in Table 8.1 – Table 8.3.

<table>
<thead>
<tr>
<th>Status</th>
<th>799RPM</th>
<th>7.83A</th>
<th>36.4kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Auto Hand Off</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Remote Local</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Ramping Stop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Illustration 8.2 Status Display

NOTICE

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

Table 8.1 to Table 8.3 define the meaning of the shown status messages.

<table>
<thead>
<tr>
<th>Off</th>
<th>The drive does not react to any control signal until [Auto On] or [Hand On] is pressed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>The start/stop commands are sent via the control terminals and/or the serial communication.</td>
</tr>
<tr>
<td>Hand</td>
<td>The navigation keys on the LCP can be used to control the drive. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.</td>
</tr>
</tbody>
</table>

Table 8.1 Operating Mode

<table>
<thead>
<tr>
<th>Remote</th>
<th>The speed reference is given from</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• External signals.</td>
</tr>
<tr>
<td></td>
<td>• Serial communication.</td>
</tr>
<tr>
<td></td>
<td>• Internal preset references.</td>
</tr>
<tr>
<td>Local</td>
<td>The drive uses reference values from the LCP.</td>
</tr>
</tbody>
</table>

Table 8.2 Reference Site

<table>
<thead>
<tr>
<th>AC brake</th>
<th>AC brake was selected in parameter 2-10 Brake Function. The AC brake overmagnetizes the motor to achieve a controlled slowdown.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMA finish OK</td>
<td>Automatic motor adaptation (AMA) was carried out successfully.</td>
</tr>
<tr>
<td>AMA ready</td>
<td>AMA is ready to start. To start, press [Hand On].</td>
</tr>
<tr>
<td>AMA running</td>
<td>AMA process is in progress.</td>
</tr>
<tr>
<td>Braking</td>
<td>The brake chopper is in operation. The brake resistor absorbs the generative energy.</td>
</tr>
<tr>
<td>Braking max.</td>
<td>The brake chopper is in operation. The power limit for the brake resistor defined in parameter 2-12 Brake Power Limit (kW) has been reached.</td>
</tr>
<tr>
<td>Coast</td>
<td>• [2] Coast inverse was selected as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is not connected.</td>
</tr>
<tr>
<td></td>
<td>• Coast activated by serial communication.</td>
</tr>
<tr>
<td>Ctrl. ramp-down</td>
<td>[1] Ctrl. ramp-down was selected in parameter 14-10 Mains Failure.</td>
</tr>
<tr>
<td></td>
<td>• The mains voltage is below the value set in parameter 14-11 Mains Voltage at Mains Fault at mains fault.</td>
</tr>
<tr>
<td></td>
<td>• The drive ramps down the motor using a controlled ramp down.</td>
</tr>
<tr>
<td>Current high</td>
<td>The drive output current is above the limit set in parameter 4-51 Warning Current High.</td>
</tr>
<tr>
<td>Current low</td>
<td>The drive output current is below the limit set in parameter 4-52 Warning Speed Low.</td>
</tr>
<tr>
<td>DC hold</td>
<td>DC hold is selected in parameter 1-80 Function at Stop and a stop command is active. The motor is held by a DC current set in parameter 2-00 DC Hold Current.</td>
</tr>
<tr>
<td>DC stop</td>
<td>The motor is held with a DC current (parameter 2-01 DC Brake Current) for a specified time (parameter 2-02 DC Braking Time).</td>
</tr>
<tr>
<td></td>
<td>• DC brake is activated in parameter 2-03 DC Brake Cut In Speed (RPM) and a stop command is active.</td>
</tr>
<tr>
<td></td>
<td>• DC brake (inverse) is selected as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is not active.</td>
</tr>
<tr>
<td></td>
<td>• The DC brake is activated via serial communication.</td>
</tr>
<tr>
<td>Feedback high</td>
<td>The sum of all active feedbacks is above the feedback limit set in parameter 4-57 Warning Feedback High.</td>
</tr>
<tr>
<td>Feedback low</td>
<td>The sum of all active feedbacks is below the feedback limit set in parameter 4-56 Warning Feedback Low.</td>
</tr>
<tr>
<td>Feature</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Freeze output</td>
<td>The remote reference is active, which holds the present speed.</td>
</tr>
<tr>
<td></td>
<td>- [20] Freeze Output was selected as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and speed down.</td>
</tr>
<tr>
<td></td>
<td>- Hold ramp is activated via serial communication.</td>
</tr>
<tr>
<td>Freeze output request</td>
<td>A freeze output command has been given, but the motor remains stopped until a run permissive signal is received.</td>
</tr>
<tr>
<td>Freeze ref.</td>
<td>[19] Freeze Reference was selected as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is active. The drive saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.</td>
</tr>
<tr>
<td>Jog request</td>
<td>A jog command has been given, but the motor is stopped until a run permissive signal is received via a digital input.</td>
</tr>
<tr>
<td>Jogging</td>
<td>The motor is running as programmed in parameter 3-19 Jog Speed RPM.</td>
</tr>
<tr>
<td></td>
<td>- [14] Jog was selected as function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal (for example, terminal 29) is active.</td>
</tr>
<tr>
<td></td>
<td>- The jog function is activated via the serial communication.</td>
</tr>
<tr>
<td></td>
<td>- The jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.</td>
</tr>
<tr>
<td>Motor check</td>
<td>In parameter 1-80 Function at Stop, [2] Motor Check was selected. A stop command is active. To ensure that a motor is connected to the drive, a permanent test current is applied to the motor.</td>
</tr>
<tr>
<td>OVC control</td>
<td>Overvoltage control was activated in parameter 2-17 Over-voltage Control, [2] Enabled. The connected motor is supplying the drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the drive from tripping.</td>
</tr>
<tr>
<td>Power unit off</td>
<td>(For drives with a 24 V DC external supply installed only.) Mains supply to the drive is removed, but the control card is supplied by the 24 V DC external supply.</td>
</tr>
<tr>
<td>Protection md</td>
<td>Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage).</td>
</tr>
<tr>
<td></td>
<td>- To avoid tripping, the switching frequency is reduced to 1500 kHz if parameter 14-55 Output Filter is set to [2] Sine-Wave Filter Fixed. Otherwise, the switching frequency is reduced to 1000 Hz.</td>
</tr>
<tr>
<td></td>
<td>- If possible, protection mode ends after approximately 10 s.</td>
</tr>
<tr>
<td></td>
<td>- Protection mode can be restricted in parameter 14-26 Trip Delay at Inverter Fault.</td>
</tr>
<tr>
<td>QStop</td>
<td>The motor is decelerating using parameter 3-81 Quick Stop Ramp Time.</td>
</tr>
<tr>
<td></td>
<td>- [4] Quick stop inverse was selected as a function for a digital input (parameter group 5-1* Digital Inputs). The corresponding terminal is not active.</td>
</tr>
<tr>
<td></td>
<td>- The quick stop function was activated via serial communication.</td>
</tr>
<tr>
<td>Ramping</td>
<td>The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.</td>
</tr>
<tr>
<td>Ref. high</td>
<td>The sum of all active references is above the reference limit set in parameter 4-55 Warning Reference High.</td>
</tr>
<tr>
<td>Ref. low</td>
<td>The sum of all active references is below the reference limit set in parameter 4-54 Warning Reference Low.</td>
</tr>
<tr>
<td>Run on ref.</td>
<td>The drive is running in the reference range. The feedback value matches the setpoint value.</td>
</tr>
<tr>
<td>Run request</td>
<td>A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.</td>
</tr>
<tr>
<td>Running</td>
<td>The drive is driving the motor.</td>
</tr>
<tr>
<td>Sleep mode</td>
<td>The energy saving function is enabled. This function being enabled means that now the motor has stopped, but that it restarts automatically when required.</td>
</tr>
<tr>
<td>Speed high</td>
<td>The motor speed is above the value set in parameter 4-53 Warning Speed High.</td>
</tr>
<tr>
<td>Speed low</td>
<td>The motor speed is below the value set in parameter 4-52 Warning Speed Low.</td>
</tr>
<tr>
<td>Standby</td>
<td>In auto-on mode, the drive starts the motor with a start signal from a digital input or serial communication.</td>
</tr>
<tr>
<td>Start delay</td>
<td>In parameter 1-71 Start Delay, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.</td>
</tr>
</tbody>
</table>
Start fwd/rev

Enable Start Forward and Enable Start Reverse were selected as functions for 2 different digital inputs (parameter group 5-1*
Digital Inputs). The motor starts in forward or reverse depending on which corresponding terminal is activated.

Stop

The drive has received a stop command from 1 of the following:

- LCP.
- Digital input.
- Serial communication.

Trip

An alarm occurred and the motor is stopped.
Once the cause of the alarm is cleared, reset the drive using 1 of the following:

- Pressing [Reset].
- Remotely by control terminals.
- Via serial communication.
Pressing [Reset] or remotely by control terminals or via serial communication.

Trip lock

An alarm occurred and the motor is stopped.
Once the cause of the alarm is cleared, cycle power to the drive. Reset the drive manually by 1 of the following:

- Pressing [Reset].
- Remotely by control terminals.
- Via serial communication.

Table 8.3 Operation Status

8.4 Warning and Alarm Types

The drive software issues warnings and alarms to assist in diagnosing issues. The warning or alarm number appears in the LCP.

Warning

A warning indicates the drive has encountered an abnormal operating condition that leads to an alarm. A warning stops when the abnormal condition is removed or resolved.

Alarm

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or trip lock. Reset the drive after an alarm.
Reset the drive in any of 4 ways:

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

Trip

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

Trip lock

When trip locking, the drive suspends operation to prevent damage to the drive and other equipment. When a trip lock occurs, the motor coasts to a stop. The drive logic continues to operate and monitor the drive status. The drive starts a trip lock only when serious faults occur that can damage the drive or other equipment. After the faults are fixed, cycle the input power before resetting the drive.

Warning and alarm displays

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

Status

<table>
<thead>
<tr>
<th>0.0Hz</th>
<th>0.000kW</th>
<th>0.00A</th>
</tr>
</thead>
</table>

Illustration 8.3 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

<table>
<thead>
<tr>
<th>Warning</th>
<th>On</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm</td>
<td>Off</td>
<td>On (flashing)</td>
</tr>
<tr>
<td>Trip lock</td>
<td>On</td>
<td>On (flashing)</td>
</tr>
</tbody>
</table>

Illustration 8.4 Status Indicator Lights
8.5 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 drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

**WARNING/ALARM 3, No motor**
No motor has been connected to the output of the drive.

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

**WARNING/ALARM 6, DC link voltage low**
The DC-link voltage (DC) is lower than the low-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

**WARNING/ALARM 7, DC overvoltage**
If the DC-link voltage exceeds the limit, the drive trips after a time.

**Troubleshooting**
- Extend the ramp time.
- Change the ramp type.
- Increase parameter 14-26 Trip Delay at Inverter Fault.
- Check that the supply voltage matches the active front-end drive voltage.
- Perform input voltage test.

**WARNING/ALARM 8, DC under voltage**
If the DC-link voltage drops below the undervoltage limit, the drive checks for 24 V DC back-up supply. If no 24 V DC back-up supply is connected, the drive trips after a fixed time delay. The time delay varies with unit size.

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

**WARNING/ALARM 9, Inverter overload**
The drive has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100% with an alarm. The drive cannot be reset until the counter is below 90%.

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

**WARNING/ALARM 10, Motor overload temperature**
According to the electronic thermal protection (ETR), the motor is too hot.

**Select 1 of these options:**
- The drive issues a warning or an alarm when the counter is >90% if parameter 1-90 Motor Thermal Protection is set to warning options.
- The drive 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 is 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 drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp
Check whether the thermistor is disconnected. Select whether the drive issues a warning or an alarm in parameter 1-90 Motor Thermal Protection.

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

WARNING/ALARM 12, Torque limit
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 drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up.

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

ALARM 14, Earth (ground) fault
There is current from the output phase to ground, either in the cable between the drive and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

Troubleshooting
- Remove power to the drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Reset any potential individual offset in the 3 current transducers in the drive. 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 drive and repair the short circuit.

**WARNING**
HIGH VOLTAGE
Drives 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 drive can result in death or serious injury.
• Disconnect power before proceeding.

**WARNING/ALARM 17, Control word timeout**
There is no communication to the drive.
The warning is only active when parameter 8-04 Control Word Timeout Function is NOT set to [0] Off.
If parameter 8-04 Control Word Timeout Function is set to [5] Stop and trip, a warning appears, and the drive ramps down to a stop and shows an alarm.

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

**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 shown in the display.

Troubleshooting
• Set the affected parameter to a valid value.

**WARNING 22, Hoist mechanical brake**
0 = The torque reference was not reached before timeout.
1 = There was no brake feedback before the timeout.

**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).
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. This alarm also shows if there is a communication error between the power card and the control card.

Check the alarm log (see chapter 3.6 Local Control Panel (LCP)) for the report value associated with this warning.
If the report value is 1, there is a hardware problem with 1 of the fans. If the report value is 11, there is a communication problem between the fan power card and the control card.

Fan troubleshooting
• Cycle power to the drive and check that the fan operates briefly at start-up.
• Check for proper fan operation. Use parameter group 43-** Unit Readouts to show the speed of each fan.

Fan power card troubleshooting
• Check the wiring between the fan power card and the control card.
• Fan power card may need to be replaced.
• Control card may need to be replaced.

**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).
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. This alarm also shows if there is a communication error between the power card and the control card.

Check the alarm log (see chapter 3.6 Local Control Panel (LCP)) for the report value associated with this warning.
If the report value is 1, there is a hardware problem with 1 of the fans. If the report value is 11, there is a communication problem between the power card and the control card.

Fan troubleshooting
• Cycle power to the drive and check that the fan operates briefly at start-up.
• Check for proper fan operation. Use parameter group 43-** Unit Readouts to show the speed of each fan.

Power card troubleshooting
• Check the wiring between the power card and the control card.
• Power card may need to be replaced.
• Control card may need to be replaced.

**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 drive is still operational, but without the brake function.

Troubleshooting
• Remove the power to the drive and replace the brake resistor (refer to parameter 2-15 Brake Check).
WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run-time. The calculation is based on the DC-link voltage and the brake resistor value set in parameter 2-16 AC brake Max. Current. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option [2] Trip is selected in parameter 2-13 Brake Power Monitoring, the drive trips when the dissipated braking power reaches 100%.

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 drive is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Troubleshooting
- Remove power to the drive 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 has been exceeded. This alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules. The temperature fault does not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the drive power size.

Troubleshooting
- Check for the following conditions:
  - Ambient temperature too high.
  - Motor cable too long.
  - Incorrect airflow clearance above and below the drive.
  - Blocked airflow around the drive.
  - Damaged heat sink fan.
  - Dirty heat sink.
- Check fan resistance.
- Check soft charge fuses.
- Check IGBT thermal.

ALARM 30, Motor phase U missing
Motor phase U between the drive and the motor is missing.

WARNING
HIGH VOLTAGE
Drives 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.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the drive.

Troubleshooting
- Remove the power from the drive and check motor phase U.

ALARM 31, Motor phase V missing
Motor phase V between the drive and the motor is missing.

WARNING
HIGH VOLTAGE
Drives 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.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the drive.

Troubleshooting
- Remove the power from the drive and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the drive and the motor is missing.
WARNING
HIGH VOLTAGE
Drives 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.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the drive.

Troubleshooting
- Remove the power from the drive 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.
- Check potential DC-link fault to ground.

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 drive system is lost and parameter 14-10 Mains Failure is not set to option [0] No Function.

- Check the fuses to the drive system and the mains supply to the unit.
- Check that mains voltage conforms to product specifications.
- Check that the following conditions are not present:
  Alarm 307, Excessive THD(V), alarm 321, Voltage imbalance, warning 417, Mains undervoltage, or warning 418, Mains overvoltage is reported if any of the listed conditions are true:
  - The 3-phase voltage magnitude drops below 25% of the nominal mains voltage.
  - Any single-phase voltage exceeds 10% of the nominal mains voltage.
  - Percent of phase or magnitude imbalance exceeds 8%.

- Voltage THD exceeds 10%.

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 8.4 is shown.

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

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

<table>
<thead>
<tr>
<th>Number</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service Department.</td>
</tr>
<tr>
<td>256–259, 266, 268</td>
<td>The power EEPROM data is defective or too old. Replace the power card.</td>
</tr>
<tr>
<td>512–519</td>
<td>Internal fault. Contact the Danfoss supplier or Danfoss Service Department.</td>
</tr>
<tr>
<td>783</td>
<td>Parameter value outside of minimum/maximum limits.</td>
</tr>
<tr>
<td>1024–1284</td>
<td>Internal fault. Contact the Danfoss supplier or Danfoss Service Department.</td>
</tr>
<tr>
<td>1299</td>
<td>The option SW in slot A is too old.</td>
</tr>
<tr>
<td>1300</td>
<td>The option SW in slot B is too old.</td>
</tr>
<tr>
<td>1301</td>
<td>The option SW in slot C0 is too old.</td>
</tr>
<tr>
<td>1302</td>
<td>The option SW in slot C1 is too old.</td>
</tr>
<tr>
<td>1315</td>
<td>The option SW in slot A is not supported (not allowed).</td>
</tr>
<tr>
<td>1316</td>
<td>The option SW in slot B is not supported (not allowed).</td>
</tr>
<tr>
<td>1317</td>
<td>The option SW in slot C0 is not supported (not allowed).</td>
</tr>
<tr>
<td>1318</td>
<td>The option SW in slot C1 is not supported (not allowed).</td>
</tr>
<tr>
<td>1360–2819</td>
<td>Internal fault. Contact the Danfoss supplier or Danfoss Service Department.</td>
</tr>
<tr>
<td>2561</td>
<td>Replace control card.</td>
</tr>
<tr>
<td>2820</td>
<td>LCP stack overflow.</td>
</tr>
<tr>
<td>2821</td>
<td>Serial port overflow.</td>
</tr>
<tr>
<td>2822</td>
<td>USB port overflow.</td>
</tr>
<tr>
<td>3072–5122</td>
<td>Parameter value is outside its limits.</td>
</tr>
<tr>
<td>5123</td>
<td>Option in slot A: Hardware incompatible with control board hardware.</td>
</tr>
<tr>
<td>5124</td>
<td>Option in slot B: Hardware incompatible with control board hardware.</td>
</tr>
<tr>
<td>5125</td>
<td>Option in slot C0: Hardware incompatible with control board hardware.</td>
</tr>
<tr>
<td>5126</td>
<td>Option in slot C1: Hardware incompatible with control board hardware.</td>
</tr>
</tbody>
</table>
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® 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® General Purpose I/O MCB 101).

ALARM 43, Ext. supply
VLT® 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. Another reason can be a defective heat sink fan.
There are 3 supplies generated by the switch mode supply (SMPS) on the power card:
• 24 V.
• 5 V.
• ±18 V.

When powered with VLT® 24 V DC Supply MCB 107, only 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.
• Check for a defective heat sink fan.

WARNING 47, 24 V supply low
The supply on the power card is out of range.

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 drive trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss Service Department.

ALARM 51, AMA check \( U_{\text{nom}} \) and \( I_{\text{nom}} \)
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 the motor data in parameters 1-20 to 1-25 is set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock
A digital input signal indicates a fault condition external to the drive. An external interlock has commanded the drive 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 drive.

WARNING 61, Tracking Error
An error has been detected between the calculated motor speed and the speed measurement from the feedback device. The function for Warning/Alarm/Disable is set in parameter 4-30 Motor Feedback Loss Function. Error setting is found in parameter 4-31 Motor Feedback Speed Error. Allowed error time is found in parameter 4-32 Motor Feedback Loss Timeout. During the commissioning process, this function can be useful.

WARNING 62, Output frequency at maximum limit
If the output frequency reaches the value set in parameter 4-19 Max Output Frequency, the drive issues a warning. The warning ceases when the output drops below the maximum limit. If the drive is unable to limit the frequency, it trips and issues an alarm. The latter may happen in the flux mode if the drive loses control of the motor.

Troubleshooting
- Check that the application is compatible.
- Increase the output frequency limit. Ensure that the system can operate safely at a higher output frequency.

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 drive 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 drive whenever the motor is stopped by setting parameter 2-00 DC Hold/Preheat Current 5% and parameter 1-80 Function at Stop.

ALARM 67, Option module configuration has changed
One or more options have 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.

WARNING/ALARM 71, PTC 1 Safe Stop
Safe Torque Off (STO) has been activated from the VLT® PTC Thermistor Card MCB 112 because the motor is too warm. Once the motor cools and the digital input from the MCB 112 is deactivated, normal operation can resume when the MCB 112 applies 24 V DC to terminal 37 again. When the motor is ready for normal operation, a reset signal is sent (via serial communication, digital I/O, or by...
pressing [Reset] on the LCP). If automatic restart is enabled, the motor can start when the fault is cleared.

ALARM 72, Dangerous failure
Safe Torque Off (STO) with trip lock. Unexpected signal levels on safe torque off and digital input from the VLT® PTC Thermistor Card MCB 112.

WARNING 73, Safe Stop auto restart
Safe Torque Off (STO). With automatic restart enabled, the motor can start when the fault is cleared.

ALARM 74, PTC Thermistor
Alarm related to VLT® 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 76, Power unit setup
The required number of power units does not match the detected number of active power units. When replacing an enclosure size F module, this warning occurs if the powerspecific data in the module power card does not match the rest of the drive. If the power card connection is lost, the unit also triggers this warning.

Troubleshooting
• Confirm that the spare part and its power card are the correct part number.
• Ensure that the 44-pin cables between the MDCIC and power cards are mounted properly.

WARNING 77, Reduced power mode
This warning indicates that the drive is operating in reduced power mode (that is, less than the allowed number of inverter sections). This warning is generated on power cycle when the drive 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 drive.
• Select motor feedback function in parameter 4-30 Motor Feedback Loss Function.
• Adjust the tracking error band in parameter 4-35 Tracking Error and parameter 4-37 Tracking Error Ramping.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also, 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 85, Dang fail PB
PROFIBUS/PROFIsafe error.

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® Encoder Input MCB 102 or VLT® 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.

WARNING 98, Clock fault
Time is not set or the RTC clock has failed.

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

ALARM 99, Locked rotor
The 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 drive to determine if the warning/alarm returns.

WARNING/ALARM 122, Mot. rotat. unexp.
The drive 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 drive has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 65% of the allowed thermal overload.

ALARM 164, ATEX ETR cur.lim.alarm
Operating above the characteristic curve for more than 60 s within a period of 600 s activates the alarm, and the drive trips.

WARNING 165, ATEX ETR freq.lim.warning
The drive 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 drive 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.).

ALARM 244, Heat sink temperature
The maximum temperature of the heat sink has been exceeded. The temperature fault cannot reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the power size. This alarm is equivalent to alarm 29, Heat Sink Temp.

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

WARNING 251, New typecode
The power card or other components are replaced, and the type code has changed.

ALARM 421, Temperature fault
A fault caused by the on-board temperature sensor is detected on the fan power card.

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

ALARM 423, FPC updating
The alarm is generated when the fan power card reports it has an invalid PUD. The control card attempts to update the PUD. A subsequent alarm can result depending on the update. See A424 and A425.

ALARM 424, FPC update successful
This alarm is generated when the control card has successfully updated the fan power card PUD. The drive must be reset to stop the alarm.

ALARM 425, FPC update failure
This alarm is generated after the control card failed to update the fan power card PUD.

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

ALARM 426, FPC config
The number of found fan power cards does not match the number of configured fan power cards. See parameter group 15-6* Option Ident for the number of configured fan power cards.

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

ALARM 427, FPC supply
Supply voltage fault (5 V, 24 V, or 48 V) on fan power card is detected.

Troubleshooting
- Check fan power card wiring.
- Replace fan power card.
## 8.6 Troubleshooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Test</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display dark/No function</td>
<td>Missing input power.</td>
<td>See Table 5.5</td>
<td>Check the input power source.</td>
</tr>
<tr>
<td></td>
<td>Missing or open fuses.</td>
<td>See Open power fuses in this table for possible causes.</td>
<td>Follow the recommendations provided.</td>
</tr>
<tr>
<td></td>
<td>No power to the LCP</td>
<td>Check the LCP cable for proper connection or damage.</td>
<td>Replace the faulty LCP or connection cable.</td>
</tr>
<tr>
<td></td>
<td>Shortcut on control voltage (terminal 12 or 50) or at control terminals.</td>
<td>Check the 24 V control voltage supply for terminal 12/13 to 20–39, or 10 V supply for terminals 50–55.</td>
<td>Wire the terminals properly.</td>
</tr>
<tr>
<td></td>
<td>Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/FCD or FCM).</td>
<td>–</td>
<td>Use only LCP 101 (P/N 13081124) or LCP 102 (P/N 13081107).</td>
</tr>
<tr>
<td></td>
<td>Wrong contrast setting.</td>
<td>–</td>
<td>Press [Status] + [▲]/[▼] to adjust the contrast.</td>
</tr>
<tr>
<td></td>
<td>Display (LCP) is defective.</td>
<td>Test using a different LCP.</td>
<td>Replace the faulty LCP or connection cable.</td>
</tr>
<tr>
<td></td>
<td>Internal voltage supply fault or SMPS is defective.</td>
<td>–</td>
<td>Contact supplier.</td>
</tr>
<tr>
<td>Intermittent display</td>
<td>Overloaded supply (SMPS) due to improper control wiring or a fault within the AC drive.</td>
<td>To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.</td>
<td>If the display stays lit, the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for Display dark/No function.</td>
</tr>
<tr>
<td>Motor not running</td>
<td>Service switch open or missing motor connection.</td>
<td>Check if the motor is connected and the connection is not interrupted by a service switch or other device.</td>
<td>Connect the motor and check the service switch.</td>
</tr>
<tr>
<td></td>
<td>No mains power with 24 V DC option card.</td>
<td>If the display is functioning, but there is no output, check that mains power is applied to the AC drive.</td>
<td>Apply mains power.</td>
</tr>
<tr>
<td></td>
<td>LCP Stop.</td>
<td>Check if [Off] has been pressed.</td>
<td>Press [Auto On] or [Hand On] (depending on operating mode).</td>
</tr>
<tr>
<td></td>
<td>Missing start signal (Standby).</td>
<td>Check parameter 5-10 Terminal 18 Digital Input for correct setting for terminal 18. Use default setting.</td>
<td>Apply a valid start signal.</td>
</tr>
<tr>
<td></td>
<td>Motor coast signal active (Coasting).</td>
<td>Check parameter 5-12 Terminal 27 Digital Input for correct setting for terminal 27 (use default setting).</td>
<td>Apply 24 V on terminal 27 or program this terminal to [0] No operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Local.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remote or bus reference?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Preset reference active?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Terminal connection correct?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scaling of terminals correct?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reference signal available?</td>
<td></td>
</tr>
<tr>
<td>Motor running in wrong direction</td>
<td>Motor rotation limit.</td>
<td>Check that parameter 4-10 Motor Speed Direction is programmed correctly.</td>
<td>Program correct settings.</td>
</tr>
<tr>
<td></td>
<td>Active reversing signal.</td>
<td>Check if a reversing command is programmed for the terminal in parameter group 5-1* Digital inputs.</td>
<td>Deactivate reversing signal.</td>
</tr>
<tr>
<td></td>
<td>Wrong motor phase connection.</td>
<td>–</td>
<td>See chapter 6.5.1 Warning - Motor Start.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible cause</td>
<td>Test</td>
<td>Solution</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>Motor is not reaching maximum speed</td>
<td>Frequency limits set wrong.</td>
<td>Check output limits in parameter 4-13 Motor Speed High Limit (RPM), parameter 4-14 Motor Speed High Limit [Hz], and parameter 4-19 Max Output Frequency</td>
<td>Program correct limits.</td>
</tr>
<tr>
<td>Reference input signal not scaled correctly.</td>
<td>Check reference input signal scaling in parameter group 6-0* Analog I/O mode and parameter group 3-1* References.</td>
<td></td>
<td>Program correct settings.</td>
</tr>
<tr>
<td>Motor speed unstable</td>
<td>Possible incorrect parameter settings.</td>
<td>Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.</td>
<td>Check settings in parameter group 1-6* Load Depen. Setting. For closed-loop operation, check settings in parameter group 20-0* Feedback.</td>
</tr>
<tr>
<td>Motor does not brake</td>
<td>Possible incorrect settings in the brake parameters. Ramp-down times may be too short.</td>
<td>Check brake parameters. Check ramp time settings.</td>
<td>Check parameter groups 2-0* DC Brake and 3-0* Reference Limits.</td>
</tr>
<tr>
<td>Open power fuses</td>
<td>Phase-to-phase short. Motor or panel has a short phase-to-phase. Check motor and panel phases for shorts.</td>
<td>Eliminate any shorts detected.</td>
<td></td>
</tr>
<tr>
<td>Motor overload.</td>
<td>Motor is overloaded for the application.</td>
<td>Perform start-up test and verify that motor current is within specifications. If motor current is exceeding the nameplate full load current, the motor can run only with reduced load. Review the specifications for the application.</td>
<td></td>
</tr>
<tr>
<td>Loose connections.</td>
<td>Perform pre-start-up check for loose connections.</td>
<td>Tighten loose connections.</td>
<td></td>
</tr>
<tr>
<td>Mains current imbalance greater than 3%</td>
<td>Problem with mains power (see alarm 4, Mains phase loss description). Rotate input power leads into the 1 position: A to B, B to C, C to A.</td>
<td>If imbalanced leg follows the wire, it is a power problem. Check the mains supply.</td>
<td></td>
</tr>
<tr>
<td>Problem with the AC drive. Rotate input power leads into the AC drive 1 position: A to B, B to C, C to A.</td>
<td>If the imbalanced leg stays on same input terminal, it is a problem with the AC drive. Contact supplier.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor current imbalance greater than 3%</td>
<td>Problem with motor or motor wiring. Rotate output motor cables 1 position: U to V, V to W, W to U.</td>
<td>If the imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.</td>
<td></td>
</tr>
<tr>
<td>Problem with AC drive. Rotate output motor cables 1 position: U to V, V to W, W to U.</td>
<td>If the imbalanced leg stays on same output terminal, it is a problem with the unit. Contact supplier.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC drive acceleration problems</td>
<td>Motor data are entered incorrectly. If warnings or alarms occur, see chapter 8.5 List of Warnings and Alarms. Check that motor data are entered correctly.</td>
<td>Increase the ramp-up time in parameter 3-41 Ramp 1 Ramp Up Time. Increase current limit in parameter 4-18 Current Limit. Increase torque limit in parameter 4-16 Torque Limit Motor Mode.</td>
<td></td>
</tr>
<tr>
<td>AC drive deceleration problems</td>
<td>Motor data are entered incorrectly. If warnings or alarms occur, see chapter 8.5 List of Warnings and Alarms. Check that motor data are entered correctly.</td>
<td>Increase the ramp-down time in parameter 3-42 Ramp 1 Ramp Down Time. Enable overvoltage control in parameter 2-17 Over-voltage Control.</td>
<td></td>
</tr>
</tbody>
</table>

Table 8.5 Troubleshooting
## 9 Specifications

### 9.1 Electrical Data

#### 9.1.1 Mains Supply 3x380–480 V AC

<table>
<thead>
<tr>
<th>FC 202</th>
<th>N355</th>
<th>N400</th>
<th>N450</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/normal load (High overload=150% current during 60 s, normal overload=110% current during 60 s)</td>
<td>HO</td>
<td>NO</td>
<td>HO</td>
</tr>
<tr>
<td>Typical shaft output at 400 V [kW]</td>
<td>315</td>
<td>355</td>
<td>355</td>
</tr>
<tr>
<td>Typical shaft output at 460 V [hp]</td>
<td>450</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Typical shaft output at 480 V [kW]</td>
<td>355</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Enclosure size</td>
<td>E1h/E3h</td>
<td>E1h/E3h</td>
<td>E1h/E3h</td>
</tr>
<tr>
<td>Output current (3-phase)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>600</td>
<td>658</td>
<td>658</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 400 V) [A]</td>
<td>900</td>
<td>724</td>
<td>987</td>
</tr>
<tr>
<td>Continuous (at 460/480 V) [A]</td>
<td>540</td>
<td>590</td>
<td>590</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 460/480 V) [A]</td>
<td>810</td>
<td>649</td>
<td>885</td>
</tr>
<tr>
<td>Continuous kVA (at 400 V) [kVA]</td>
<td>416</td>
<td>456</td>
<td>456</td>
</tr>
<tr>
<td>Continuous kVA (at 460 V) [kVA]</td>
<td>430</td>
<td>470</td>
<td>470</td>
</tr>
<tr>
<td>Maximum input current</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>578</td>
<td>634</td>
<td>634</td>
</tr>
<tr>
<td>Continuous (at 460/480 V) [A]</td>
<td>520</td>
<td>569</td>
<td>569</td>
</tr>
<tr>
<td>Maximum number and size of cables per phase (E1h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]</td>
<td>4x240 (4x500 mcm)</td>
<td>4x240 (4x500 mcm)</td>
<td>4x240 (4x500 mcm)</td>
</tr>
<tr>
<td>- Brake or regeneration [mm² (AWG)]</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>Maximum number and size of cables per phase (E3h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>- Load share or regeneration [mm² (AWG)]</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
</tr>
<tr>
<td>Maximum external mains fuses [A]</td>
<td>800</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Estimated power loss at 400 V [W]</td>
<td>6178</td>
<td>6928</td>
<td>6851</td>
</tr>
<tr>
<td>Estimated power loss at 460 V [W]</td>
<td>5322</td>
<td>5910</td>
<td>5846</td>
</tr>
<tr>
<td>Efficiency</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Output frequency</td>
<td>0–590 Hz</td>
<td>0–590 Hz</td>
<td>0–590 Hz</td>
</tr>
<tr>
<td>Heat sink overtemperature trip [°C (°F)]</td>
<td>110 (230)</td>
<td>110 (230)</td>
<td>110 (230)</td>
</tr>
<tr>
<td>Control card overtemperature trip [°C (°F)]</td>
<td>80 (176)</td>
<td>80 (176)</td>
<td>80 (176)</td>
</tr>
<tr>
<td>Power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Fan power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Active in-rush card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
</tbody>
</table>

Table 9.1 Technical Specifications, Mains Supply 3x380–480 V AC
### Specifications VLT® AQUA Drive FC 202

<table>
<thead>
<tr>
<th>FC 202</th>
<th>N500</th>
<th>N560</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High/normal load</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(High overload=150% current during 60 s, normal overload=110% current during 60 s)</td>
<td>HO</td>
<td>NO</td>
</tr>
<tr>
<td>Typical shaft output at 400 V [kW]</td>
<td>450</td>
<td>500</td>
</tr>
<tr>
<td>Typical shaft output at 460 V [hp]</td>
<td>600</td>
<td>650</td>
</tr>
<tr>
<td>Typical shaft output at 480 V [kW]</td>
<td>530</td>
<td>560</td>
</tr>
<tr>
<td><strong>Enclosure size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E2h/E4h</td>
<td>E2h/E4h</td>
</tr>
<tr>
<td><strong>Output current (3-phase)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>800</td>
<td>880</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 400 V) [A]</td>
<td>1200</td>
<td>968</td>
</tr>
<tr>
<td>Continuous (at 460/480 V) [A]</td>
<td>730</td>
<td>780</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 460/480 V) [A]</td>
<td>1095</td>
<td>858</td>
</tr>
<tr>
<td>Continuous kVA (at 400 V) [kVA]</td>
<td>554</td>
<td>610</td>
</tr>
<tr>
<td>Continuous kVA (at 460 V) [kVA]</td>
<td>582</td>
<td>621</td>
</tr>
<tr>
<td><strong>Maximum input current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>771</td>
<td>848</td>
</tr>
<tr>
<td>Continuous (at 460/480 V) [A]</td>
<td>704</td>
<td>752</td>
</tr>
<tr>
<td><strong>Maximum number and size of cables per phase (E2h)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)](^{1})</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)](^{1})</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
</tr>
<tr>
<td>- Brake or regeneration [mm² (AWG)](^{1})</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td><strong>Maximum number and size of cables per phase (E4h)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)](^{1})</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)](^{1})</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>- Load share or regeneration [mm² (AWG)](^{1})</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
</tr>
<tr>
<td>**Maximum external mains fuses [A](^{2})</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Estimated power loss at 400 V [W](^{3}, 4)</td>
<td>8352</td>
<td>9473</td>
</tr>
<tr>
<td>Estimated power loss at 460 V [W](^{3}, 4)</td>
<td>7182</td>
<td>7809</td>
</tr>
<tr>
<td>Efficiency(^{4})</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Output frequency [Hz]</strong></td>
<td>0–590</td>
<td>0–590</td>
</tr>
<tr>
<td>Heat sink overtemperature trip [°C (°F)]</td>
<td>110 (230)</td>
<td>100 (212)</td>
</tr>
<tr>
<td>Control card overtemperature trip [°C (°F)]</td>
<td>80 (176)</td>
<td>80 (176)</td>
</tr>
<tr>
<td>Power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Fan power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Active in-rush card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
</tbody>
</table>

**Table 9.2 Technical Specifications, Mains Supply 3x380–480 V AC**

1) American Wire Gauge.
2) For fuse ratings, see chapter 9.7 Fuses.
3) Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies for dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.
4) Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see chapter 9.4 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.
### 9.1.2 Mains Supply 3x525–690 V AC

<table>
<thead>
<tr>
<th>FC 202</th>
<th>N450</th>
<th>N500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High/normal load</strong>&lt;br&gt;(High overload=150% current during 60 s, normal overload=110% current during 60 s)</td>
<td><strong>HO</strong></td>
<td><strong>NO</strong></td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>315</td>
<td>355</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>355</td>
<td>450</td>
</tr>
<tr>
<td><strong>Enclosure size</strong></td>
<td>E1h/E3h</td>
<td>E1h/E3h</td>
</tr>
<tr>
<td><strong>Output current (3-phase)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>395</td>
<td>470</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 550 V) [A]</td>
<td>593</td>
<td>517</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>380</td>
<td>450</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 575/690 V) [A]</td>
<td>570</td>
<td>495</td>
</tr>
<tr>
<td>Continuous kVA (at 550 V) [kVA]</td>
<td>376</td>
<td>448</td>
</tr>
<tr>
<td>Continuous kVA (at 575 V) [kVA]</td>
<td>378</td>
<td>448</td>
</tr>
<tr>
<td>Continuous kVA (at 690 V) [kVA]</td>
<td>454</td>
<td>538</td>
</tr>
<tr>
<td><strong>Maximum input current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>381</td>
<td>453</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>366</td>
<td>434</td>
</tr>
<tr>
<td><strong>Maximum number and size of cables per phase (E1h)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]</td>
<td>4x240 (4x500 mcm)</td>
<td>4x240 (4x500 mcm)</td>
</tr>
<tr>
<td>- Brake or regeneration [mm² (AWG)]</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td><strong>Maximum number and size of cables per phase (E3h)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>- Load share or regeneration [mm² (AWG)]</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
</tr>
<tr>
<td>Maximum external mains fuses [A]</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Estimated power loss at 600 V [W]</td>
<td>4989</td>
<td>6062</td>
</tr>
<tr>
<td>Estimated power loss at 690 V [W]</td>
<td>4920</td>
<td>5939</td>
</tr>
<tr>
<td>Efficiency</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Output frequency [Hz]</td>
<td>0–500</td>
<td>0–500</td>
</tr>
<tr>
<td>Heat sink overtemperature trip [°C (°F)]</td>
<td>110 (230)</td>
<td>110 (230)</td>
</tr>
<tr>
<td>Control card overtemperature trip [°C (°F)]</td>
<td>80 (176)</td>
<td>80 (176)</td>
</tr>
<tr>
<td>Power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Fan power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Active in-rush card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
</tbody>
</table>

Table 9.3 Technical Specifications, Mains Supply 3x525–690 V AC
<table>
<thead>
<tr>
<th>Specifications</th>
<th>VLT® AQUA Drive FC 202</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FC 202</th>
<th>N560</th>
<th>N630</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/normal load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(High overload=150% current during 60 s, normal overload=110% current during 60 s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>500</td>
<td>560</td>
</tr>
<tr>
<td>Enclosure size</td>
<td>E1h/E3h</td>
<td>E1h/E3h</td>
</tr>
<tr>
<td>Output current (3-phase)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>523</td>
<td>596</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 550 V) [A]</td>
<td>785</td>
<td>656</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>500</td>
<td>570</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 575/690 V) [A]</td>
<td>750</td>
<td>627</td>
</tr>
<tr>
<td>Continuous kVA (at 550 V) [kVA]</td>
<td>498</td>
<td>568</td>
</tr>
<tr>
<td>Continuous kVA (at 575 V) [kVA]</td>
<td>498</td>
<td>568</td>
</tr>
<tr>
<td>Continuous kVA (at 690 V) [kVA]</td>
<td>598</td>
<td>681</td>
</tr>
<tr>
<td>Maximum input current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>504</td>
<td>574</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>482</td>
<td>549</td>
</tr>
<tr>
<td>Maximum number and size of cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per phase (E1h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)](^1)</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)](^1)</td>
<td>4x240 (4x500 mcm)</td>
<td>4x240 (4x500 mcm)</td>
</tr>
<tr>
<td>- Brake or regeneration [mm² (AWG)](^1)</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>Maximum number and size of cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per phase (E3h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)](^1)</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)](^1)</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>- Load share or regeneration [mm² (AWG)](^1)</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
</tr>
<tr>
<td>Maximum external mains fuses [A](^2)</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Estimated power loss at 600 V [W](^3),(^4)</td>
<td>6833</td>
<td>8076</td>
</tr>
<tr>
<td>Estimated power loss at 690 V [W](^3),(^4)</td>
<td>6678</td>
<td>7852</td>
</tr>
<tr>
<td>Efficiency(^4)</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Output frequency [Hz]</td>
<td>0–500</td>
<td>0–500</td>
</tr>
<tr>
<td>Heat sink overtemperature trip [°C (°F)]</td>
<td>110 (230)</td>
<td>110 (230)</td>
</tr>
<tr>
<td>Control card overtemperature trip [°C (°F)]</td>
<td>80 (176)</td>
<td>80 (176)</td>
</tr>
<tr>
<td>Power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Fan power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Active in-rush card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
</tbody>
</table>

Table 9.4 Technical Specifications, Mains Supply 3x525–690 V AC
## Table 9.5 Technical Specifications, Mains Supply 3x525–690 V AC

1) American Wire Gauge.
2) For fuse ratings, see chapter 9.7 Fuses.
3) Typical power loss is at normal conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions.) These values are based on a typical motor efficiency (IE/IE3 border line). Lower efficiency motors add to the power loss in the drive. Applies for dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses can increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/. Options and customer load can add up to 30 W to the losses, though usually a fully loaded control card and options for slots A and B each add only 4 W.
4) Measured using 5 m shielded motor cables at rated load and rated frequency. Efficiency measured at nominal current. For energy efficiency class, see chapter 9.4 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>N710</th>
<th>N800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High/normal load</strong></td>
<td><strong>HO</strong></td>
<td><strong>NO</strong></td>
</tr>
<tr>
<td>(High overload=150% current during 60 s, normal overload=110% current during 60 s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>500</td>
<td>560</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>650</td>
<td>750</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>630</td>
<td>710</td>
</tr>
<tr>
<td>Enclosure size</td>
<td>E2h/E4h</td>
<td></td>
</tr>
<tr>
<td><strong>Output current (3-phase)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>659</td>
<td>763</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 550 V) [A]</td>
<td>989</td>
<td>839</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>945</td>
<td>803</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 575/690 V) [A]</td>
<td>628</td>
<td>727</td>
</tr>
<tr>
<td>Continuous kVA (at 550 V) [kVA]</td>
<td>627</td>
<td>727</td>
</tr>
<tr>
<td>Continuous kVA (at 575 V) [kVA]</td>
<td>753</td>
<td>872</td>
</tr>
<tr>
<td><strong>Maximum input current</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>635</td>
<td>735</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>607</td>
<td>704</td>
</tr>
<tr>
<td><strong>Maximum number and size of cables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per phase (E2h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]¹</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]¹</td>
<td>5x240 (5x500 mcm)</td>
<td>5x240 (5x500 mcm)</td>
</tr>
<tr>
<td>- Brake or regeneration [mm² (AWG)]¹</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>Maximum number and size of cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per phase (E4h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mains and motor without brake [mm² (AWG)]¹</td>
<td>6x240 (6x500 mcm)</td>
<td>6x240 (6x500 mcm)</td>
</tr>
<tr>
<td>- Mains and motor with brake [mm² (AWG)]¹</td>
<td>2x185 (2x350 mcm)</td>
<td>2x185 (2x350 mcm)</td>
</tr>
<tr>
<td>- Load share or regeneration [mm² (AWG)]¹</td>
<td>4x185 (4x350 mcm)</td>
<td>4x185 (4x350 mcm)</td>
</tr>
<tr>
<td>Maximum external mains fuses [A]²</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Estimated power loss at 600 V [W]³, ⁴</td>
<td>8543</td>
<td>10346</td>
</tr>
<tr>
<td>Estimated power loss at 690 V [W]³, ⁴</td>
<td>8363</td>
<td>10066</td>
</tr>
<tr>
<td>Efficiency⁴</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Output frequency [Hz]</td>
<td>0–500</td>
<td>0–500</td>
</tr>
<tr>
<td>Heat sink overtemperature trip [°C (°F)]</td>
<td>110 (230)</td>
<td>110 (230)</td>
</tr>
<tr>
<td>Control card overtemperature trip [°C (°F)]</td>
<td>80 (176)</td>
<td>80 (176)</td>
</tr>
<tr>
<td>Power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Fan power card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
<tr>
<td>Active in-rush card overtemperature trip [°C (°F)]</td>
<td>85 (185)</td>
<td>85 (185)</td>
</tr>
</tbody>
</table>
9.2 Mains Supply

Mains supply (L1, L2, L3)
Supply voltage 380–500 V ±10%, 525–690 V ±10%

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

Supply frequency 50/60 Hz ±5%
Maximum imbalance temporary between mains phases 3.0% of rated supply voltage
True power factor (λ) ≥0.9 nominal at rated load
Displacement power factor (cos Φ) near unity (>0.98)
Switching on input supply L1, L2, L3 (power-ups) Maximum 1 time/2 minute
Environment according to EN60664-1 Overvoltage category III/pollution degree 2

The drive is suitable for use on a circuit capable of delivering up to 100 kA short circuit current rating (SCCR) at 480/600 V.
1) Calculations based on UL/IEC61800-3.

9.3 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

1) Dependent on voltage and power.

Torque characteristics
Starting torque (constant torque) Maximum 150% for 60 s
Overload torque (constant torque) Maximum 150% for 60 s

1) Percentage relates to the nominal current of the drive.
2) Once every 10 minutes.

9.4 Ambient Conditions

Environment
E1h/E2h enclosure IP21/Type 1, IP54/Type 12
E3h/E4h enclosure IP20/Chassis
Vibration test (standard/ruggedized) 0.7 g/1.0 g
Relative humidity 5%-95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H1S test Class Kd
Aggressive gases (IEC 60721-3-3) Class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)
Ambient temperature (at SFAVM switching mode)
- with derating Maximum 55 °C (maximum 131 °F)
- with full output power of typical EFF2 motors (up to 90% output current) Maximum 50 °C (maximum 122 °F)
- at full continuous FC output current Maximum 45 °C (maximum 113 °F)
Minimum ambient temperature during full-scale operation 0 °C (32 °F)
Minimum ambient temperature at reduced performance -10 °C (14 °F)
Temperature during storage/transport -25 to +65/70 °C (13 to 149/158 °F)
Maximum altitude above sea level without derating 1000 m (3281 ft)
Maximum altitude above sea level with derating 3000 m (9842 ft)

1) For more information on derating, refer to the product-specific design guide.
9.5 Cable Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum motor cable length, shielded/ armored</td>
<td>150 m (492 ft)</td>
</tr>
<tr>
<td>Maximum motor cable length, unshielded/un armored</td>
<td>300 m (984 ft)</td>
</tr>
<tr>
<td>Maximum cross-section to motor, mains, load sharing, and brake</td>
<td>See chapter 9.1 Electrical Data</td>
</tr>
<tr>
<td>Maximum cross-section to control terminals, rigid wire</td>
<td>1.5 mm²/16 AWG (2x0.75 mm²)</td>
</tr>
<tr>
<td>Maximum cross-section to control terminals, flexible cable</td>
<td>1 mm²/18 AWG</td>
</tr>
<tr>
<td>Maximum cross-section to control terminals, cable with enclosed core</td>
<td>0.5 mm²/20 AWG</td>
</tr>
<tr>
<td>Minimum cross-section to control terminals.</td>
<td>0.25 mm²/23 AWG</td>
</tr>
</tbody>
</table>

1) For power cables, see electrical tables in chapter 9.1 Electrical Data.

9.6 Control Input/Output and Control Data

<table>
<thead>
<tr>
<th>Digital inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable digital inputs</td>
</tr>
<tr>
<td>Terminal number</td>
</tr>
<tr>
<td>Logic</td>
</tr>
<tr>
<td>Voltage level</td>
</tr>
<tr>
<td>Voltage level, logic 0 PNP</td>
</tr>
<tr>
<td>Voltage level, logic 1 PNP</td>
</tr>
<tr>
<td>Voltage level, logic 0 NPN</td>
</tr>
<tr>
<td>Voltage level, logic 1 NPN</td>
</tr>
<tr>
<td>Maximum voltage on input</td>
</tr>
<tr>
<td>Input resistance, (R_i)</td>
</tr>
</tbody>
</table>

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 outputs.

<table>
<thead>
<tr>
<th>Analog inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of analog inputs</td>
</tr>
<tr>
<td>Terminal number</td>
</tr>
<tr>
<td>Modes</td>
</tr>
<tr>
<td>Mode select</td>
</tr>
<tr>
<td>Voltage mode</td>
</tr>
<tr>
<td>Voltage level</td>
</tr>
<tr>
<td>Input resistance, (R_i)</td>
</tr>
<tr>
<td>Maximum voltage</td>
</tr>
<tr>
<td>Current mode</td>
</tr>
<tr>
<td>Current level</td>
</tr>
<tr>
<td>Input resistance, (R_i)</td>
</tr>
<tr>
<td>Maximum current</td>
</tr>
<tr>
<td>Resolution for analog inputs</td>
</tr>
<tr>
<td>Accuracy of analog inputs</td>
</tr>
<tr>
<td>Bandwidth</td>
</tr>
</tbody>
</table>

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
Illustration 9.1 PELV Isolation

Pulse inputs

Programmable pulse inputs
Terminal number pulse 2
Maximum frequency at terminal 29, 33 110 kHz (push-pull driven)
Maximum frequency at terminal 29, 33 5 kHz (open collector)
Minimum frequency at terminal 29, 33 4 Hz
Voltage level See Digital Inputs in chapter 9.6 Control Input/Output and Control Data
Maximum voltage on input 28 V DC
Input resistance, $R_i$ Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz) Maximum error: 0.1% of full scale

Analog output
Number of programmable analog outputs 1
Terminal number 42
Current range at analog output 0/4-20 mA
Maximum resistor load to common at analog output 500 Ω
Accuracy on analog output Maximum error: 0.8% of full scale
Resolution on analog output 8 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
Voltage level at digital/frequency output 0–24 V
Maximum output current (sink or source) 40 mA
Maximum load at frequency output 1 kΩ
Maximum capacitive load at frequency output 10 nF
Minimum output frequency at frequency output 0 Hz
Maximum output frequency at frequency output 32 kHz
Accuracy of frequency output Maximum error: 0.1% of full scale
Resolution of frequency outputs 12 bit

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

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
Control card, 24 V DC output

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Maximum load</th>
</tr>
</thead>
<tbody>
<tr>
<td>12, 13</td>
<td>200 mA</td>
</tr>
</tbody>
</table>

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

Relay outputs

Programmable relay outputs

<table>
<thead>
<tr>
<th>Maximum cross-section to relay terminals</th>
<th>Minimum cross-section to relay terminals</th>
<th>Length of stripped wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 mm² (12 AWG)</td>
<td>0.2 mm² (30 AWG)</td>
<td>8 mm (0.3 in)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relay 01 terminal number</th>
<th>Maximum terminal load (AC-1)(^1) on 1–2 (NO) (Resistive load)(^2), (^3)</th>
<th>Maximum terminal load (AC-15)(^1) on 1–2 (NO) (Inductive load (\cos\varphi 0.4))</th>
<th>Maximum terminal load (DC-1)(^1) on 1–2 (NO) (Resistive load)</th>
<th>Maximum terminal load (DC-13)(^1) on 1–2 (NO) (Inductive load)</th>
<th>Maximum terminal load (AC-1)(^1) on 1–3 (NC) (Resistive load)</th>
<th>Maximum terminal load (AC-15)(^1) on 1–3 (NC) (Inductive load (\cos\varphi 0.4))</th>
<th>Maximum terminal load (DC-1)(^1) on 1–3 (NC) (Resistive load)</th>
<th>Maximum terminal load (DC-13)(^1) on 1–3 (NC) (Inductive load)</th>
<th>Minimum terminal load on 1–3 (NC), 1–2 (NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–3 (break), 1–2 (make)</td>
<td>400 V AC, 2 A</td>
<td>240 V AC, 0.2 A</td>
<td>80 V DC, 2 A</td>
<td>24 V DC, 0.1 A</td>
<td>240 V AC, 2 A</td>
<td>240 V AC, 0.2 A</td>
<td>50 V DC, 2 A</td>
<td>24 V DC, 0.1 A</td>
<td>24 V DC 10 mA, 24 V AC 2 mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relay 02 terminal number</th>
<th>Maximum terminal load (AC-1)(^1) on 4–5 (NO) (Resistive load)(^2), (^3)</th>
<th>Maximum terminal load (AC-15)(^1) on 4–5 (NO) (Inductive load (\cos\varphi 0.4))</th>
<th>Maximum terminal load (DC-1)(^1) on 4–5 (NO) (Resistive load)</th>
<th>Maximum terminal load (DC-13)(^1) on 4–5 (NO) (Inductive load)</th>
<th>Maximum terminal load (AC-1)(^1) on 4–6 (NC) (Resistive load)</th>
<th>Maximum terminal load (AC-15)(^1) on 4–6 (NC) (Inductive load (\cos\varphi 0.4))</th>
<th>Maximum terminal load (DC-1)(^1) on 4–6 (NC) (Resistive load)</th>
<th>Maximum terminal load (DC-13)(^1) on 4–6 (NC) (Inductive load)</th>
<th>Minimum terminal load on 4–6 (NC), 4–5 (NO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4–6 (break), 4–5 (make)</td>
<td>400 V AC, 2 A</td>
<td>240 V AC, 0.2 A</td>
<td>80 V DC, 2 A</td>
<td>24 V DC, 0.1 A</td>
<td>240 V AC, 2 A</td>
<td>240 V AC, 0.2 A</td>
<td>50 V DC, 2 A</td>
<td>24 V DC, 0.1 A</td>
<td>24 V DC 10 mA, 24 V AC 2 mA</td>
</tr>
</tbody>
</table>

1) IEC 60947 part 4 and 5.
2) Overvoltage Category II.
3) UL applications 300 V AC 2 A.

Control card, +10 V DC output

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Output voltage</th>
<th>Maximum load</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>10.5 V ±0.5 V</td>
<td>25 mA</td>
</tr>
</tbody>
</table>

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

Control characteristics

<table>
<thead>
<tr>
<th>Resolution of output frequency at 0–1000 Hz</th>
<th>±0.003 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>System response time (terminals 18, 19, 27, 29, 32, 33)</td>
<td>≤2 m/s</td>
</tr>
<tr>
<td>Speed control range (open loop)</td>
<td>1:100 of synchronous speed</td>
</tr>
<tr>
<td>Speed accuracy (open loop)</td>
<td>30–4000 RPM: Maximum error of ±8 RPM</td>
</tr>
</tbody>
</table>

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

Control card performance

<table>
<thead>
<tr>
<th>Scan interval</th>
<th>5 M/S</th>
</tr>
</thead>
</table>
Control card, USB serial communication

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

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

### 9.7 Fuses

Fuses ensure that possible damage to the drive is limited to damages inside the unit. To ensure compliance with EN 50178,
use identical Bussmann fuses as replacements. Refer to Table 9.6.

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

#### Table 9.6 Fuse Options

<table>
<thead>
<tr>
<th>Input voltage (V)</th>
<th>Bussmann part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>380–500</td>
<td>170M7309</td>
</tr>
<tr>
<td>525–690</td>
<td>170M7342</td>
</tr>
</tbody>
</table>

The fuses listed in Table 9.6 are suitable for use on a circuit capable of delivering 100000 A$_{rms}$ (symmetrical), depending on
the drive voltage rating. With the proper fusing, the drive short-circuit current rating (SCCR) is 100000 A$_{rms}$. E1h and E2h
drives are supplied with internal drive fusing to meet the 100 kA SCCR. E3h and E4h drives must be fitted with Type aR
fuses to meet the 100 kA SCCR.

**NOTICE**
**DISCONNECT SWITCH**
All units ordered and supplied with a factory-installed disconnect switch require Class L branch circuit fusing to meet
the 100 kA SCCR for the drive. If a circuit breaker is used, the SCCR rating is 42 kA. The specific Class L fuse is
determined by the input voltage and power rating of the drive. The input voltage and power rating is found on the
product nameplate. See chapter 4.1 Items Supplied.

<table>
<thead>
<tr>
<th>Input voltage (V)</th>
<th>Power rating (kW)</th>
<th>Short circuit rating (A)</th>
<th>Required protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>380–480</td>
<td>355–450</td>
<td>42000</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100000</td>
<td>Class L fuse, 800 A</td>
</tr>
<tr>
<td>380–480</td>
<td>500–560</td>
<td>42000</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100000</td>
<td>Class L fuse, 1200 A</td>
</tr>
<tr>
<td>525–690</td>
<td>450–630</td>
<td>42000</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100000</td>
<td>Class L fuse, 800 A</td>
</tr>
<tr>
<td>525–690</td>
<td>710–800</td>
<td>42000</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100000</td>
<td>Class L fuse, 1200 A</td>
</tr>
</tbody>
</table>
9.8 Enclosure Dimensions

9.8.1 E1h Exterior Dimensions

Illustration 9.2 Front View of E1h
Illustration 9.3 Side View of E1h

1 Knockout panel
Heat sink access panel (optional)

Illustration 9.4 Back View of E1h
Illustration 9.5 Door Clearance and Gland Plate Dimensions for E1h
9.8.2 E2h Exterior Dimensions

Illustration 9.6 Front View of E2h
Illustration 9.7 Side View of E2h

1 Knockout panel
1 Heat sink access panel (optional)

Illustration 9.8 Back View of E2h
Illustration 9.9 Door Clearance and Gland Plate Dimensions for E2h

1  Gland plate
9.8.3 E3h Exterior Dimensions

Illustration 9.10 Front View of E3h
Illustration 9.11 Side View of E3h
Illustration 9.12 Back View of E3h

1 Heat sink access panel (optional)
### Illustration 9.13 RFI Shield Termination and Gland Plate Dimensions for E3h

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RFI shield termination (standard with RFI option)</td>
</tr>
<tr>
<td>2</td>
<td>Cable/EMC clamp</td>
</tr>
<tr>
<td>3</td>
<td>Gland plate</td>
</tr>
</tbody>
</table>

- **1** RFI shield termination (standard with RFI option)
- **2** Cable/EMC clamp
- **3** Gland plate
9.8.4 E4h Exterior Dimensions

Illustration 9.14 Front View of E4h
Illustration 9.15 Side View of E4h
1 Heat sink access panel (optional)

Illustration 9.16 Back View of E4h
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RFI shield termination (standard with RFI option)</td>
</tr>
<tr>
<td>2</td>
<td>Cable/EMC clamp</td>
</tr>
<tr>
<td>3</td>
<td>Gland plate</td>
</tr>
</tbody>
</table>

**Illustration 9.17 RFI Shield Termination and Gland Plate Dimensions for E4h**
9.9 Enclosure Airflow

9.9.1 Airflow for E1h–E4h Enclosures

Illustration 9.18 Standard Airflow Configuration for E1h/E2h (Left) and E3h/E4h (Right)

Illustration 9.19 Optional Airflow Configuration Through the Back Wall for E1h/E2h (Left) and E3h/E4h (Right)
9.10 Fastener Torque Ratings

Apply the correct torque when tightening fasteners in the locations that are listed in Table 9.7. Too low or too high torque when fastening an electrical connection results in a bad electrical connection. To ensure correct torque, use a torque wrench.

<table>
<thead>
<tr>
<th>Location</th>
<th>Bolt size</th>
<th>Torque [Nm (in-lb)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains terminals</td>
<td>M10/M12</td>
<td>19 (168)/37 (335)</td>
</tr>
<tr>
<td>Motor terminals</td>
<td>M10/M12</td>
<td>19 (168)/37 (335)</td>
</tr>
<tr>
<td>Ground terminals</td>
<td>M8/M10</td>
<td>9.6 (84)/19.1 (169)</td>
</tr>
<tr>
<td>Brake terminals</td>
<td>M8</td>
<td>9.6 (84)</td>
</tr>
<tr>
<td>Load sharing terminals</td>
<td>M10/M12</td>
<td>19 (168)/37 (335)</td>
</tr>
<tr>
<td>Regeneration terminals (Enclosures E1h/E2h)</td>
<td>M8</td>
<td>9.6 (84)</td>
</tr>
<tr>
<td>Regeneration terminals (Enclosures E3h/E4h)</td>
<td>M10/M12</td>
<td>19 (168)/37 (335)</td>
</tr>
<tr>
<td>Relay terminals</td>
<td>.</td>
<td>0.5 (4)</td>
</tr>
<tr>
<td>Door/panel cover</td>
<td>M5</td>
<td>2.3 (20)</td>
</tr>
<tr>
<td>Gland plate</td>
<td>M5</td>
<td>2.3 (20)</td>
</tr>
<tr>
<td>Heat sink access panel</td>
<td>M5</td>
<td>3.9 (35)</td>
</tr>
<tr>
<td>Serial communication cover</td>
<td>M5</td>
<td>2.3 (20)</td>
</tr>
</tbody>
</table>

Table 9.7 Fastener Torque Ratings
10 Appendix

10.1 Abbreviations and Conventions

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Degrees Fahrenheit</td>
</tr>
<tr>
<td>Ω</td>
<td>Ohm</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>AEO</td>
<td>Automatic energy optimization</td>
</tr>
<tr>
<td>ACP</td>
<td>Application control processor</td>
</tr>
<tr>
<td>AMA</td>
<td>Automatic motor adaptation</td>
</tr>
<tr>
<td>AWG</td>
<td>American wire gauge</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CSV</td>
<td>Customer-specific initialization values</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DVM</td>
<td>Digital voltmeter</td>
</tr>
<tr>
<td>EEPROM</td>
<td>Electrically erasable programmable read-only memory</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic discharge</td>
</tr>
<tr>
<td>ETR</td>
<td>Electronic thermal relay</td>
</tr>
<tr>
<td>f</td>
<td>Nominal motor frequency</td>
</tr>
<tr>
<td>HF</td>
<td>High frequency</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, ventilation, and air conditioning</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>I Lim</td>
<td>Current limit</td>
</tr>
<tr>
<td>I INV</td>
<td>Rated inverter output current</td>
</tr>
<tr>
<td>I N</td>
<td>Nominal motor current</td>
</tr>
<tr>
<td>I VMAX</td>
<td>Maximum output current</td>
</tr>
<tr>
<td>I VDN</td>
<td>Rated output current supplied by the drive</td>
</tr>
<tr>
<td>IEC</td>
<td>International electrotechnical commission</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated-gate bipolar transistor</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/output</td>
</tr>
<tr>
<td>IP</td>
<td>Ingress protection</td>
</tr>
<tr>
<td>kHz</td>
<td>Kilohertz</td>
</tr>
<tr>
<td>kW</td>
<td>Kilowatt</td>
</tr>
<tr>
<td>L d</td>
<td>Motor d-axis inductance</td>
</tr>
<tr>
<td>L q</td>
<td>Motor q-axis inductance</td>
</tr>
<tr>
<td>LC</td>
<td>Inductor-capacitor</td>
</tr>
<tr>
<td>LCP</td>
<td>Local control panel</td>
</tr>
<tr>
<td>LED</td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td>LOP</td>
<td>Local operation pad</td>
</tr>
<tr>
<td>mA</td>
<td>Milliamper</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature circuit breakers</td>
</tr>
<tr>
<td>MCO</td>
<td>Motion control option</td>
</tr>
<tr>
<td>MCP</td>
<td>Motor control processor</td>
</tr>
<tr>
<td>MCT</td>
<td>Motion control tool</td>
</tr>
<tr>
<td>MDCIC</td>
<td>Multi-drive control interface card</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>Millivolts</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NTC</td>
<td>Negative temperature coefficient</td>
</tr>
<tr>
<td>P MN</td>
<td>Nominal motor power</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed circuit board</td>
</tr>
<tr>
<td>PE</td>
<td>Protective earth</td>
</tr>
<tr>
<td>PELV</td>
<td>Protective extra low voltage</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional integral derivative</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller</td>
</tr>
<tr>
<td>P/N</td>
<td>Part number</td>
</tr>
<tr>
<td>PROM</td>
<td>Programmable read-only memory</td>
</tr>
<tr>
<td>PS</td>
<td>Power section</td>
</tr>
<tr>
<td>PTC</td>
<td>Positive temperature coefficient</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse width modulation</td>
</tr>
<tr>
<td>R</td>
<td>Stator resistance</td>
</tr>
<tr>
<td>RAM</td>
<td>Random-access memory</td>
</tr>
<tr>
<td>RCD</td>
<td>Residual current device</td>
</tr>
<tr>
<td>Regen</td>
<td>Regenerative terminals</td>
</tr>
<tr>
<td>RFI</td>
<td>Radio frequency interference</td>
</tr>
<tr>
<td>RMS</td>
<td>Root mean square (cyclically alternating electric current)</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>SCR</td>
<td>Silicon controlled rectifier</td>
</tr>
<tr>
<td>SMPS</td>
<td>Switch mode power supply</td>
</tr>
<tr>
<td>S/N</td>
<td>Serial number</td>
</tr>
<tr>
<td>STO</td>
<td>Safe Torque Off</td>
</tr>
<tr>
<td>T LM</td>
<td>Torque limit</td>
</tr>
<tr>
<td>U ALN</td>
<td>Nominal motor voltage</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>VVC</td>
<td>Voltage vector control</td>
</tr>
<tr>
<td>X h</td>
<td>Motor main reactance</td>
</tr>
</tbody>
</table>

Table 10.1 Abbreviations, Acronyms, and Symbols

Conventions

- Numbered lists indicate procedures.
- Bullet lists indicate other information and description of illustrations.
- Italicized text indicates:
  - Cross reference
  - Link
  - Footnote
  - Parameter name
  - Parameter group name
  - Parameter option
- All dimensions are in mm (inch).
### 10.2 International/North American Default Parameter Settings

Setting parameter 0-03 Regional Settings to [0] International or [1] North America changes the default settings for some parameters. *Table 10.2* lists those parameters that are effected.

Changes made to default settings are stored and available for viewing in the quick menu along with any programming entered into parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>International default parameter value</th>
<th>North American default parameter value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 0-03 Regional Settings</td>
<td>International</td>
<td>North America</td>
</tr>
<tr>
<td>Parameter 0-21 Date Format</td>
<td>DD-MM-YYYY</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>Parameter 0-22 Time Format</td>
<td>24 h</td>
<td>12 h</td>
</tr>
<tr>
<td>Parameter 1-20 Motor Power [kW]</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Parameter 1-21 Motor Power [HP]</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Parameter 1-22 Motor Voltage</td>
<td>230 V/400 V/575 V</td>
<td>208 V/460 V/575 V</td>
</tr>
<tr>
<td>Parameter 1-23 Motor Frequency</td>
<td>50 Hz</td>
<td>60 Hz</td>
</tr>
<tr>
<td>Parameter 3-03 Maximum Reference</td>
<td>50 Hz</td>
<td>60 Hz</td>
</tr>
<tr>
<td>Parameter 3-04 Reference Function</td>
<td>Sum</td>
<td>External/Preset</td>
</tr>
<tr>
<td>Parameter 4-13 Motor Speed High Limit [RPM]</td>
<td>1500 RPM</td>
<td>1800 RPM</td>
</tr>
<tr>
<td>Parameter 4-14 Motor Speed High Limit [Hz]</td>
<td>50 Hz</td>
<td>60 Hz</td>
</tr>
<tr>
<td>Parameter 4-19 Max Output Frequency</td>
<td>100 Hz</td>
<td>120 Hz</td>
</tr>
<tr>
<td>Parameter 4-53 Warning Speed High</td>
<td>1500 RPM</td>
<td>1800 RPM</td>
</tr>
<tr>
<td>Parameter 5-12 Terminal 27 Digital Input</td>
<td>Coast inverse</td>
<td>External interlock</td>
</tr>
<tr>
<td>Parameter 5-40 Function Relay</td>
<td>Alarm</td>
<td>No alarm</td>
</tr>
<tr>
<td>Parameter 6-15 Terminal 53 High Ref./Feedb. Value</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Parameter 6-50 Terminal 42 Output</td>
<td>Speed 0-HighLim</td>
<td>Speed 4-20 mA</td>
</tr>
<tr>
<td>Parameter 14-20 Reset Mode</td>
<td>Manual reset</td>
<td>Infinite auto reset</td>
</tr>
<tr>
<td>Parameter 22-85 Speed at Design Point [RPM]</td>
<td>1500 RPM</td>
<td>1800 RPM</td>
</tr>
<tr>
<td>Parameter 22-86 Speed at Design Point [Hz]</td>
<td>50 Hz</td>
<td>60 Hz</td>
</tr>
<tr>
<td>Parameter 24-04 Fire Mode Max Reference</td>
<td>50 Hz</td>
<td>60 Hz</td>
</tr>
</tbody>
</table>

*Table 10.2 International/North American Default Parameter Settings*

1) Parameter 1-20 Motor Power [kW] is only visible when parameter 0-03 Regional Settings is set to [0] International.
2) Parameter 1-21 Motor Power [HP], is only visible when parameter 0-03 Regional Settings is set to [1] North America.
3) This parameter is only visible when parameter 0-02 Motor Speed Unit is set to [0] RPM.
4) This parameter is only visible when parameter 0-02 Motor Speed Unit is set to [1] Hz.

### 10.3 Parameter Menu Structure
15-** Drive Information
15-00 Operating Settings
15-01 Running Hours
15-02 KWh Counter
15-03 Power Up’s
15-04 Over Temp’s
15-05 Over Volts
15-06 Reset KWh Counter
15-07 Reset Running Hours Counter
15-08 Number of Starts
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Value
15-21 Historic Log: Time
15-22 Historic Log: Date and Time
15-23 Historic Log: Terminal 54 Switch Setting
15-3* Alarm Log
15-30 Alarm Log: Error Code
15-31 Alarm Log: Value
15-32 Alarm Log: Time
15-33 Alarm Log: Date and Time
15-34 Alarm Log: Setpoint
15-35 Alarm Log: Feedback
15-36 Alarm Log: Current Demand
15-37 Alarm Log: Process Ctrl Unit
15-38 Alarm Identification
15-40 FC Type
15-41 Power Section
15-42 Power Source
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Factory Default Setting
15-47 Power Card Ordering No
15-48 LCP Id No
15-50 SW ID Power Card
15-51 Frequency Converter Serial Number
15-52 Power Card Type
15-53 Config File Name
15-54 StartUp File Name
15-6* Option Ident
15-60 Option Mounted
15-61 Option Switch Version
15-62 Option Ordering No
15-63 Option Serial No
15-64 Option No
15-65 Option in Slot A
15-66 Option in Slot B
15-67 Option in Slot C
15-68 Option in Slot D
15-69 Option in Slot E1
15-6* Option in Slot C1
15-60 Option in Slot E1
15-65 Option in Slot C1
15-7* Data Log Settings
15-75 Slot C/ED Option Switch Version
15-76 Option Switch Setting
15-77 Slot C1/E1 Option SW Version
15-78 Slot C1/E1 Option SW Version
15-8* Operating Data
15-80 Fan Running Hours
15-81 Preset Fan Running Hours
15-9* Parameter Info
15-90 Parameter Info
15-91 Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-95 Drive Identification
15-99 Parameter Metadata
16-** Data Readouts
16-00 General Status
16-01 Reference [Unit]
16-02 Reference [%]
16-03 Status Word
16-05 Main Actual Value [%]
16-06 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 Motor Angle
16-20 Motor Feedback
16-22 Torque [%]
16-23 Motor Shaft Power [kW]
16-24 Calibrated Status Resistance
16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-28 Power Filtered [A]
16-29 DC Link Voltage
16-30 System Temp.
16-31 Brake Energy [J]
16-32 Brake Energy Average
16-33 Brake Energy Average
16-34 Inverter Thermal
16-36 Inv. Max. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Current Fault Source
16-42 External Reference Average
16-43 Feedback[Unit]
16-44 Digi Pot Reference
16-45 Feedback 1 [Unit]
16-46 Feedback 2 [Unit]
16-47 Feedback 3 [Unit]
16-48 PID Output [A]
16-49 Adjusted Setpoint
16-50 Reference [Fb.]
16-51 PID Dwell Time
16-52 Feedback Unit
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
16-56 Feedback 3 [Unit]
16-57 PID Output [A]
16-58 PID Output [%]
16-59 PID Output [%]
16-60 PID Output [%]
16-61 PID Output [%]
16-62 Analog Input 0 [mA]
16-63 Analog Input 0 [mV]
16-64 Analog Input 0 [mV]
16-65 Analog Input 0 [mV]
16-66 Analog Input 0 [mV]
16-67 Analog Input 0 [mV]
16-68 Analog Input 0 [mV]
16-69 Analog Input 0 [mV]
16-70 Analog Input 0 [mV]
16-71 Analog Input 0 [mV]
16-72 Analog Input 0 [mV]
16-73 Analog Input 0 [mV]
16-74 Analog Input 0 [mV]
16-75 Analog Input 0 [mV]
16-76 Analog Input 0 [mV]
16-77 Analog Input 0 [mV]
16-78 Analog Input 0 [mV]
16-79 Analog Input 0 [mV]
16-80 Analog Input 0 [mV]
16-81 Analog Input 0 [mV]
16-82 Analog Input 0 [mV]
16-83 Analog Input 0 [mV]
16-84 Analog Input 0 [mV]
16-85 Analog Input 0 [mV]
16-86 Analog Input 0 [mV]
16-87 Analog Input 0 [mV]
16-88 Analog Input 0 [mV]
16-89 Analog Input 0 [mV]
16-90 Analog Input 0 [mV]
16-91 Analog Input 0 [mV]
16-92 Analog Input 0 [mV]
16-93 Analog Input 0 [mV]
16-94 Analog Input 0 [mV]
16-95 Analog Input 0 [mV]
16-96 Analog Input 0 [mV]
16-97 Analog Input 0 [mV]
16-98 Analog Input 0 [mV]
16-99 Analog Input 0 [mV]
16-00 General Status
16-01 Reference [Unit]
16-02 Reference [%]
16-03 Status Word
16-05 Main Actual Value [%]
16-06 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 Motor Angle
16-20 Motor Feedback
16-22 Torque [%]
16-23 Motor Shaft Power [kW]
16-24 Calibrated Status Resistance
16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-28 Power Filtered [A]
16-29 DC Link Voltage
16-30 System Temp.
16-31 Brake Energy [J]
16-32 Brake Energy Average
16-33 Brake Energy Average
16-34 Inverter Thermal
16-36 Inv. Max. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Current Fault Source
16-42 External Reference Average
16-43 Feedback[Unit]
16-44 Digi Pot Reference
16-45 Feedback 1 [Unit]
16-46 Feedback 2 [Unit]
16-47 Feedback 3 [Unit]
16-48 PID Output [A]
16-49 Adjusted Setpoint
16-50 Reference [Fb.]
16-51 PID Dwell Time
16-52 Feedback Unit
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
16-56 Feedback 3 [Unit]
16-57 PID Output [A]
16-58 PID Output [%]
16-59 PID Output [%]
16-60 PID Output [%]
16-61 PID Output [%]
16-62 Analog Input 0 [mA]
16-63 Analog Input 0 [mV]
16-64 Analog Input 0 [mV]
16-65 Analog Input 0 [mV]
16-66 Analog Input 0 [mV]
16-67 Analog Input 0 [mV]
16-68 Analog Input 0 [mV]
16-69 Analog Input 0 [mV]
16-70 Analog Input 0 [mV]
16-71 Analog Input 0 [mV]
16-72 Analog Input 0 [mV]
16-73 Analog Input 0 [mV]
16-74 Analog Input 0 [mV]
16-75 Analog Input 0 [mV]
16-76 Analog Input 0 [mV]
16-77 Analog Input 0 [mV]
16-78 Analog Input 0 [mV]
16-79 Analog Input 0 [mV]
16-80 Analog Input 0 [mV]
16-81 Analog Input 0 [mV]
16-82 Analog Input 0 [mV]
16-83 Analog Input 0 [mV]
16-84 Analog Input 0 [mV]
16-85 Analog Input 0 [mV]
16-86 Analog Input 0 [mV]
16-87 Analog Input 0 [mV]
16-88 Analog Input 0 [mV]
16-89 Analog Input 0 [mV]
16-90 Analog Input 0 [mV]
16-91 Analog Input 0 [mV]
16-92 Analog Input 0 [mV]
16-93 Analog Input 0 [mV]
16-94 Analog Input 0 [mV]
16-95 Analog Input 0 [mV]
16-96 Analog Input 0 [mV]
16-97 Analog Input 0 [mV]
16-98 Analog Input 0 [mV]
16-99 Analog Input 0 [mV]
### 22-4° Sleep Mode
- **Sleep Mode**: 23-24 Minimum Sleep Time
- **No Minimum Sleep Time**: 23-25

### 22-4° Minimum Sleep Time
- **Minimum Sleep Time**: 23-26

### 22-4° Wake-up Speed
- **Wake-up Speed [RPM]**: 23-37
- **Wake-up Speed [Hz]**: 23-38

### 22-4° Wake-up Ref./Rel. Difference
- **Wake-up Ref./Rel. Difference**: 23-40

### 22-4° Setpoint Boost
- **Setpoint Boost**: 23-41

### 22-4° Maximum Boost Time
- **Maximum Boost Time**: 23-42

### 22-4° Sleep Mode
- **Sleep Mode**: 23-43

### 22-4° End of Curve Function
- **End of Curve**: 23-44

### 22-4° Start of Curve
- **Start of Curve**: 23-45

### 22-4° Pipe Fill Speed [RPM]
- **Pipe Fill Speed [RPM]**: 23-46

### 22-4° Reset Continuous Bin Data
- **Reset Continuous Bin Data**: 23-47

### 22-4° Reset Timed Bin Data
- **Reset Timed Bin Data**: 23-48

### 22-4° Power Reference Factor
- **Power Reference Factor**: 23-49

### 22-4° Energy Cost
- **Energy Cost**: 23-50

### 22-4° Investment
- **Investment**: 23-51

### 22-4° End of Curve Function
- **End of Curve Function**: 23-52

### 22-4° Pipe Fill Rate
- **Pipe Fill Rate**: 23-53

### 22-4° Manual Abbreviation
- **Manual Abbreviation**: 23-54

### 22-4° Pipe Fill On Time
- **Pipe Fill On Time**: 23-55

### 22-4° Relay On Time
- **Relay On Time**: 23-56

### 22-4° Reset Relay Counters
- **Reset Relay Counters**: 23-57

### 22-4° Service
- **Service**: 23-58

### 22-4° Pump Interlock
- **Pump Interlock**: 23-59

### 22-4° Manual Abbreviation
- **Manual Abbreviation**: 23-60
31-** Bypass Option
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation

35-** Sensor Input Option
35-0* Temp. Input Mode
35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
35-47 Term. X48/2 Live Zero

43-** Unit Readouts
43-0* Component Status
43-00 Component Temp.
43-01 Auxiliary Temp.
43-1* Power Card Status
43-10 HS Temp. ph.U
43-11 HS Temp. ph.V
43-12 HS Temp. ph.W
43-13 PC Fan A Speed
43-14 PC Fan B Speed
43-15 PC Fan C Speed
43-2* Fan Pow.Card Status
43-20 FPC Fan A Speed
43-21 FPC Fan B Speed
43-22 FPC Fan C Speed
43-23 FPC Fan D Speed
43-24 FPC Fan E Speed
43-25 FPC Fan F Speed
Index

A
A53/A54 switches................................................................. 9
Abbreviations........................................................................... 101
AC mains.................................................................................. 26
see also Mains
ADN compliance...................................................................... 3
Airflow
Configurations........................................................................ 99
Heat sink.................................................................................. 14
Alarms
List of...................................................................................... 11, 62
Log........................................................................................... 11
Types of.................................................................................... 61
Ambient conditions
Overview................................................................................ 13
Specifications.......................................................................... 78
Analog
Input specifications.................................................................. 79
Analog input/output
Descriptions and default settings......................................... 41
Terminal locations..................................................................... 9
Approvals and certifications................................................... 3
ATEX monitoring...................................................................... 13
Auto on.................................................................................... 11, 59
Automatic energy optimization.............................................. 50
Automatic motor adaptation (AMA)
Configuring............................................................................ 51
Warning................................................................................... 67
Auxiliary contacts................................................................... 43

B
Back-wall cooling..................................................................... 14
Brake
Location of terminals.......................................................... 7
Status message......................................................................... 59
Terminal torque rating............................................................ 100
Brake resistor
Terminal locations.................................................................. 9
Warning................................................................................... 65
Wiring...................................................................................... 44
Wiring schematic..................................................................... 23
Burst transient.......................................................................... 28
Bus termination switch........................................................ 9, 43
C
Cables
Cable length and cross-section............................................. 79
Creating openings for.......................................................... 16, 17
Installation warning.............................................................. 20
Mains...................................................................................... 26
Maximum number and size per phase.................................... 73
Motor...................................................................................... 24
Routing.................................................................................... 40, 45
Shielded................................................................................... 21
Specifications.......................................................................... 79
Capacitor storage.................................................................... 12
Circuit breakers....................................................................... 45, 82
Compressor functions............................................................ 47
Condensation............................................................................ 13
Control
Characteristics......................................................................... 81
Control card
Location................................................................................ 9
Overtemperature trip point.................................................... 73
RS485 specifications............................................................... 80
Specifications.......................................................................... 81
Warning................................................................................... 68
Control input/output
Descriptions and default settings......................................... 40
Control shelf............................................................................ 7, 8, 9
Control wiring.......................................................................... 40, 42, 45
Cooling
Check list................................................................................ 45
Dust warning............................................................................ 13
Requirements.......................................................................... 14
Current
Input...................................................................................... 44
Leakage................................................................................... 28
Limit......................................................................................... 72
Dust warning............................................................................ 13
Cables
Cable length and cross-section............................................. 79
Creating openings for.......................................................... 16, 17
Installation warning.............................................................. 20
Mains...................................................................................... 26
Maximum number and size per phase.................................... 73
Motor...................................................................................... 24
Routing.................................................................................... 40, 45
Shielded................................................................................... 21
Specifications.......................................................................... 79
Capacitor storage.................................................................... 12
Circuit breakers....................................................................... 45, 82
Compressor functions............................................................ 47
Condensation............................................................................ 13
Control
Characteristics......................................................................... 81
Control card
Location................................................................................ 9
Overtemperature trip point.................................................... 73
RS485 specifications............................................................... 80
Specifications.......................................................................... 81
Warning................................................................................... 68
Control input/output
Descriptions and default settings......................................... 40
Control shelf............................................................................ 7, 8, 9
Control wiring.......................................................................... 40, 42, 45
Cooling
Check list................................................................................ 45
Dust warning............................................................................ 13
Requirements.......................................................................... 14
Current
Input...................................................................................... 44
Leakage................................................................................... 28
Limit......................................................................................... 72
Definitions
Status messages....................................................................... 59
Depth measurements............................................................. 6
Design guide.......................................................................... 3, 14, 78
Digital
Input specifications............................................................... 79
Output specifications............................................................. 80
Digital input/output
Descriptions and default settings......................................... 41
Terminal locations................................................................... 9
Discharge time.......................................................................... 4
Disconnect............................................................................... 7, 43, 46, 82
Disposal instruction................................................................... 3
Index

Door clearance
E1h................................................................. 86
E2h................................................................. 90
E3h................................................................. 94
E4h................................................................. 98
Door/panel cover
Torque rating.................................................. 100
Drive
Clearance requirements...................................... 14
Definition......................................................... 6
Dimensions....................................................... 6
Initialization..................................................... 53
Status............................................................... 59
Duct cooling....................................................... 14

E
Electrical specifications 380–480 V............................... 73
Electrical specifications 525–690 V............................... 75
Electronic thermal relay (ETR)........................................... 20
EMC................................................................. 20, 21, 22
Encoder............................................................................. 51
Energy efficiency class...................................................... 78
Environment.................................................................. 13, 78
Explosive atmosphere...................................................... 13
Exterior dimensions
E1h......................................................................... 83
E2h......................................................................... 87
E3h......................................................................... 91
E4h......................................................................... 95
External alarm reset.......................................................... 56

F
Factory default settings.................................................... 52
Fan power card
Location............................................................... 7, 8
Warning...................................................................... 70
Fans
Location...................................................................... 8
Required airflow...................................................... 14
Servicing................................................................. 13
Warning...................................................................... 64, 69
Fault log...................................................................... 11
Fieldbus....................................................................... 40
Filter.......................................................................... 13
FPC................................................................................. 7
see also Fan power card

Fuses
Location...................................................................... 7, 8
Overcurrent protection.................................................. 20
Pre-start check list...................................................... 45
Specifications......................................................... 82
Troubleshooting......................................................... 72

G
Gases.............................................................................. 13
Gland plate
Description.................................................................... 15
Dimensions for E1h...................................................... 86
Dimensions for E2h...................................................... 90
Dimensions for E3h...................................................... 94
Dimensions for E4h...................................................... 98
Torque rating............................................................. 100

Ground
Check list....................................................................... 45
Connecting.................................................................... 28
Floating delta.............................................................. 26
Grounded delta............................................................ 26
Isolated main............................................................... 26
Terminal torque rating.................................................. 100
Terminals...................................................................... 7, 8
Warning....................................................................... 67

H
Hand on........................................................................ 11, 59
Heat sink
Access panel torque rating.......................................... 100
Cleaning....................................................................... 13, 58
E1h access panel dimensions................................. 85
E2h access panel dimensions................................. 89
E3h access panel dimensions................................. 93
E4h access panel dimensions................................. 97
Overtemperature trip point......................................... 73
Required airflow....................................................... 14
Warning...................................................................... 65, 67, 68, 70

Heater
Location...................................................................... 7, 8
Usage.......................................................................... 13
Wiring of....................................................................... 43
Wiring schematic........................................................ 23

Height measurements.................................................... 6
High voltage............................................................... 46, 65, 66
High voltage warning................................................ 4
Humidity...................................................................... 13
HVAC fan functions..................................................... 47

I
Indicator lights............................................................. 61
Initial set-up............................................................... 46
Input specifications.................................................... 79
Input voltage............................................................. 46
Index

Installation
Check list................................................................. 45
Electrical................................................................. 20
EMC-compliant....................................................... 22, 28
Initialization............................................................ 53
Load share/regeneration terminals.............................. 19
Mechanical............................................................... 15
Qualified personnel..................................................... 4
Quick setup............................................................. 50
Requirements.......................................................... 14
Start up....................................................................... 52
Tools needed............................................................ 12
Interference
EMC........................................................................... 21
Radio.......................................................................... 6
Interior views............................................................ 7
Interlock device.......................................................... 42
Internal fault............................................................. 67
K
Knockout panel.......................................................... 84
L
Label.......................................................................... 12
LCP
Display........................................................................ 10
Indicator lights.......................................................... 11
Location................................................................. 7, 8
Menu......................................................................... 47
Troubleshooting........................................................ 71
Leakage current......................................................... 4, 28
Lifting......................................................................... 12, 14
Load share
Location of terminals.................................................. 8
Terminal torque rating................................................ 100
Terminals................................................................. 8
Warning.................................................................... 4
Wiring schematic....................................................... 23
Load sharing.............................................................. 65, 66
Local control panel (LCP)............................................. 10
M
Main menu................................................................. 47
Mains
Cables....................................................................... 26
Connecting.............................................................. 26
Shield........................................................................ 5
Supply specifications.................................................. 78
Terminal torque rating............................................... 100
Terminals................................................................. 7, 8
Warning.................................................................... 66
Maintenance............................................................. 13, 58
Manual
Version number........................................................ 3
MCT 10....................................................................... 50
MCT 10 Set-up Software............................................... 50
Measurements........................................................... 6
Menu
Descriptions of........................................................ 47
Keys......................................................................... 11
Motor
Cables....................................................................... 20, 24
Class protection........................................................ 13
Connecting.............................................................. 24
Data........................................................................... 72
Output specifications.................................................. 78
Overheating............................................................... 63
Rotation................................................................. 51
Terminal torque rating................................................ 100
Terminals................................................................. 7
Thermistor............................................................... 57
Troubleshooting........................................................ 71, 72
Warning.................................................................... 62, 63, 65
Wiring schematic....................................................... 23
Mounting configurations............................................ 14
N
Nameplate................................................................. 12
Navigation keys........................................................ 11, 48
O
Open loop
Programming example............................................... 48
Wiring for speed control.......................................... 54
Optional equipment.................................................... 42, 46
Overcurrent protection.............................................. 20
Overvoltage.............................................................. 72
P
Parameters................................................................... 47, 52
Pedestal.................................................................... 15
Periodic forming....................................................... 12
Phase loss............................................................... 62
Pigtails................................................................. 20
Potential equalization................................................ 28
Potentiometer........................................................... 41
Power card
Location.................................................................... 9
Warning.................................................................... 68
Power connection..................................................... 20
Power rating............................................................. 6, 12, 73
Programming............................................................ 11, 48, 102
Programming guide................................................... 3
Pumps
Configuring............................................................. 47
Functions................................................................. 47
<table>
<thead>
<tr>
<th>Index</th>
<th>Operating Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Qualified personnel .................................................. 4</td>
</tr>
<tr>
<td></td>
<td>Quick menu ................................................................ 11, 47, 102</td>
</tr>
<tr>
<td>R</td>
<td>Ramp-down time ................................................................ 72</td>
</tr>
<tr>
<td></td>
<td>Ramp-up time .................................................................. 72</td>
</tr>
<tr>
<td></td>
<td>Recycling ......................................................................... 3</td>
</tr>
<tr>
<td></td>
<td>Regeneration .....................................................................</td>
</tr>
<tr>
<td></td>
<td>Location of terminals .................................................. 7</td>
</tr>
<tr>
<td></td>
<td>Terminal torque rating ................................................ 100</td>
</tr>
<tr>
<td></td>
<td>Terminals ......................................................................... 8</td>
</tr>
<tr>
<td></td>
<td>Wiring configuration .................................................... 57</td>
</tr>
<tr>
<td></td>
<td>Regional settings .......................................................... 52</td>
</tr>
<tr>
<td></td>
<td>Relays ............................................................................. 9, 41</td>
</tr>
<tr>
<td></td>
<td>Location .......................................................................... 9, 41</td>
</tr>
<tr>
<td></td>
<td>Output specifications ................................................... 81</td>
</tr>
<tr>
<td></td>
<td>Reset ............................................................................. 11, 61, 68</td>
</tr>
<tr>
<td></td>
<td>RFI ................................................................................ 7, 8, 26, 94, 98</td>
</tr>
<tr>
<td></td>
<td>Rotor ............................................................................... 69</td>
</tr>
<tr>
<td></td>
<td>Warning ........................................................................... 69</td>
</tr>
<tr>
<td></td>
<td>RS485 Configuring .......................................................... 43</td>
</tr>
<tr>
<td></td>
<td>Terminal description ..................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Wiring schematic ........................................................... 23</td>
</tr>
<tr>
<td>S</td>
<td>Safe torque off ................................................................ 3</td>
</tr>
<tr>
<td></td>
<td>Operating guide ............................................................. 3</td>
</tr>
<tr>
<td></td>
<td>Safe Torque Off .............................................................. 41</td>
</tr>
<tr>
<td></td>
<td>Terminal location ........................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Warning .......................................................................... 68, 69</td>
</tr>
<tr>
<td></td>
<td>Wiring of .......................................................................... 43</td>
</tr>
<tr>
<td></td>
<td>Wiring schematic ........................................................... 23</td>
</tr>
<tr>
<td></td>
<td>Safety instructions ........................................................ 4, 20, 46</td>
</tr>
<tr>
<td></td>
<td>Serial communication .....................................................</td>
</tr>
<tr>
<td></td>
<td>Cover torque rating ....................................................... 100</td>
</tr>
<tr>
<td></td>
<td>Descriptions and default settings .................................. 41</td>
</tr>
<tr>
<td></td>
<td>Location .......................................................................... 9</td>
</tr>
<tr>
<td></td>
<td>Service ........................................................................... 58</td>
</tr>
<tr>
<td></td>
<td>Set-up ............................................................................. 11</td>
</tr>
<tr>
<td></td>
<td>Shielding .........................................................................</td>
</tr>
<tr>
<td></td>
<td>Cables ............................................................................ 40</td>
</tr>
<tr>
<td></td>
<td>Clamps ............................................................................ 20</td>
</tr>
<tr>
<td></td>
<td>Mains ............................................................................. 5</td>
</tr>
<tr>
<td></td>
<td>RFI ................................................................................ 7, 8</td>
</tr>
<tr>
<td></td>
<td>RFI termination .............................................................. 94, 98</td>
</tr>
<tr>
<td></td>
<td>Twisted ends .................................................................. 20</td>
</tr>
<tr>
<td></td>
<td>Short circuit .................................................................... 64</td>
</tr>
<tr>
<td></td>
<td>Short circuit current rating (SCCR) .................................. 82</td>
</tr>
<tr>
<td></td>
<td>Sleep mode ...................................................................... 60</td>
</tr>
<tr>
<td></td>
<td>Software version number ................................................. 3</td>
</tr>
<tr>
<td></td>
<td>Space heater .................................................................... 7</td>
</tr>
<tr>
<td></td>
<td>see also Heater ................................................................</td>
</tr>
<tr>
<td></td>
<td>Start/stop ........................................................................ 55</td>
</tr>
<tr>
<td></td>
<td>Status message definitions ............................................ 59</td>
</tr>
<tr>
<td></td>
<td>STO .............................................................................. 3</td>
</tr>
<tr>
<td></td>
<td>see also Safe torque off ................................................</td>
</tr>
<tr>
<td></td>
<td>Storage ........................................................................... 12</td>
</tr>
<tr>
<td></td>
<td>Supply voltage .................................................................. 46, 80</td>
</tr>
<tr>
<td></td>
<td>Switches ......................................................................... 46, 82</td>
</tr>
<tr>
<td></td>
<td>A53 and A54 .................................................................... 79</td>
</tr>
<tr>
<td></td>
<td>A53/A54 ......................................................................... 44</td>
</tr>
<tr>
<td></td>
<td>Brake resistor temperature ............................................. 44</td>
</tr>
<tr>
<td></td>
<td>Bus termination ............................................................ 43</td>
</tr>
<tr>
<td></td>
<td>Disconnect ....................................................................... 46, 82</td>
</tr>
<tr>
<td></td>
<td>Temperature ..................................................................... 13</td>
</tr>
<tr>
<td></td>
<td>Terminals .........................................................................</td>
</tr>
<tr>
<td></td>
<td>Analog input/output ...................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Control locations .......................................................... 9, 40</td>
</tr>
<tr>
<td></td>
<td>Digital input/output ...................................................... 41</td>
</tr>
<tr>
<td></td>
<td>E1h dimensions (front and side views) ......................... 30</td>
</tr>
<tr>
<td></td>
<td>E2h dimensions (front and side views) ......................... 32</td>
</tr>
<tr>
<td></td>
<td>E3h dimensions (front and side views) ......................... 34</td>
</tr>
<tr>
<td></td>
<td>E4h dimensions (front and side views) ......................... 37</td>
</tr>
<tr>
<td></td>
<td>Relays ............................................................................ 41</td>
</tr>
<tr>
<td></td>
<td>Serial communication ................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Terminal 37 .................................................................... 41, 42</td>
</tr>
<tr>
<td></td>
<td>Thermal communication .................................................</td>
</tr>
<tr>
<td></td>
<td>Thermistor .......................................................................</td>
</tr>
<tr>
<td></td>
<td>Cable routing ............................................................... 40</td>
</tr>
<tr>
<td></td>
<td>Terminal location .......................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Warning .......................................................................... 69</td>
</tr>
<tr>
<td></td>
<td>Wiring configurations .................................................... 57</td>
</tr>
<tr>
<td></td>
<td>Tools .............................................................................. 12</td>
</tr>
<tr>
<td></td>
<td>Torque ............................................................................</td>
</tr>
<tr>
<td></td>
<td>Characteristic ............................................................... 78</td>
</tr>
<tr>
<td></td>
<td>Fastener rating .............................................................. 100</td>
</tr>
<tr>
<td></td>
<td>Limit .............................................................................. 63, 72</td>
</tr>
<tr>
<td></td>
<td>Transducer ...................................................................... 41</td>
</tr>
<tr>
<td></td>
<td>Troubleshooting ............................................................</td>
</tr>
<tr>
<td></td>
<td>Fuses .............................................................................. 72</td>
</tr>
<tr>
<td></td>
<td>LCP ............................................................................... 71</td>
</tr>
<tr>
<td></td>
<td>Mains ............................................................................. 72</td>
</tr>
<tr>
<td></td>
<td>Motor .............................................................................. 71, 72</td>
</tr>
<tr>
<td></td>
<td>Warnings and alarms ...................................................... 62</td>
</tr>
<tr>
<td>U</td>
<td>UL certification .............................................................. 3</td>
</tr>
<tr>
<td></td>
<td>Unintended start ............................................................ 4</td>
</tr>
<tr>
<td></td>
<td>USB Port location .......................................................... 9</td>
</tr>
<tr>
<td></td>
<td>Specifications ............................................................... 82</td>
</tr>
</tbody>
</table>
Index

V
Voltage
  Imbalance .................................................................  62
  Input ........................................................................  44

W
Warnings
  List of .........................................................................  11, 62
  Types of ......................................................................  61
Weight ...........................................................................  6
Width measurements......................................................  6
Wiring configurations
  External alarm reset ....................................................  56
  Open loop ...................................................................  54
  Regeneration ...............................................................  57
  Start/stop ....................................................................  55
  Thermistor ....................................................................  57
Wiring control terminals ..................................................  42
Wiring schematic
  Drive ...........................................................................  23