Operating Instructions

VLT® AutomationDrive FC 302

12-pulse
EU DECLARATION OF CONFORMITY

Danfoss A/S
Danfoss Drives A/S

declares under our sole responsibility that the

Product category: Frequency Converter

Type designation(s): FC-302XYYZZ**************

Character X: N or P
Character YYY: K25, K37, K55, K75, 1K1, 1K5, 2K2, 3K0, 3K7, 4K0, 5K5, 7K5, 11K, 15K, 18K, 22K, 30K, 37K, 45K, 55K, 75K, 90K, 110, 132, 150, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1M0, 1M2
Character ZZ: T2, T5, T6, T7
* may be any number or letter indicating drive options which do not impact this DoC.
The meaning of the 39 characters in the type code string can be found in appendix 00729776.

Covered by this declaration is in conformity with the following directive(s), standard(s) or other normative document(s), provided that the product is used in accordance with our instructions.

Low Voltage Directive 2014/35/EU

EMC Directive 2014/30/EU

EN63000:2018 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of
hazardous substances

For products including available Safe Torque Off (STO) function according to unit typecode on the nameplate: X, B or R at character 18 of the typecode.

**Machine Directive 2006/42/EC**

EN/IEC 61800-5-2:2007
(Safe Stop function conforms with STO – Safe Torque Off, SIL 2 Capability)

Adjustable speed electrical power drive systems –
Part 5-2: Safety requirements – Functional

**Other standards considered:**

EN ISO 13849-1:2015
(Safe Stop function, PL d
(MTTFD=14000 years, DC=90%, Category 3)
(Safe Stop function, SIL 2 (PFH = 1E-10/h, 1E-8/h for specific variants, PFD = 1E-10, 1E-4 for specific variants, SFF>99%, HFT=0))

(Safe Stop function, SIL CL 2)

(Stop Category 0)

Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
Functional safety of electrical/electronic/programmable electronic safety-related systems
Part 1: General requirements
Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
Safety of machinery - Electrical equipment of machines - Part 1: General requirements

For products including ATEX option, it requires STO function in the products. The products can have the VLT PTC Thermistor Card MCB112 installed from factory *(2 at character 32 in the typecode)*, or it can be separately installed as an additional part.

**2014/34/EU - Equipment for explosive atmospheres (ATEX)**

Based on EU harmonized standard:
EN 50495: 2010

Safety devices required for safe functioning of equipment with respect to explosion risks.

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*CAUTION: See manual for additional instruction*

**Notified Body:**
PTB Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig,
has assessed the conformity of the "ATEX certified motor thermal protection systems" of Danfoss FC VLT Drives with Safe Torque Off function and has issued the certificate PTB 14 ATEX 3009.
1 Introduction

1.1 Purpose of the Manual

The frequency converter is designed to provide high shaft performance on electrical motors. Read these operating instructions carefully for proper use. Incorrect handling of the frequency converter may cause improper operation of the frequency converter or related equipment, shorten lifetime, or cause other troubles.

These operating instructions provide information on:

- Start-up.
- Installation.
- Programming.
- Troubleshooting.
- Chapter 1 Introduction introduces the manual and informs about approvals, symbols, and abbreviations used in this manual.
- Chapter 2 Safety Instructions entails instructions on how to handle the frequency converter in a safe way.
- Chapter 3 How to Install guides through the mechanical and electrical installations.
- Chapter 4 How to Programme explains how to operate and programme the frequency converter via the LCP.
- Chapter 5 General Specifications contains technical data about the frequency converter.
- Chapter 6 Warnings and Alarms assists in solving problems that may occur when using the frequency converter.

VLT® is a registered trademark. DeviceNet™ is a trademark of ODVA, Inc.

1.2 Additional Resources

- The VLT® AutomationDrive FC 301/FC 302 Design Guide details all technical information about the frequency converter and customer design and applications.
- The VLT® AutomationDrive FC 301/FC 302 Programming Guide provides information on how to programme and includes complete parameter descriptions.
- The VLT® PROFIBUS DP MCA 101 Installation Guide provides information about installing and troubleshooting of the PROFIBUS fieldbus option.
- The VLT® PROFIBUS DP MCA 101 Programming Guide provides the information required for controlling, monitoring, and programming the frequency converter via a PROFIBUS fieldbus.
- The VLT® DeviceNet MCA 104 Installation Guide provides information about installing and troubleshooting of the DeviceNet® fieldbus option.
- The VLT® DeviceNet MCA 104 Programming Guide provides the information required for controlling, monitoring, and programming the frequency converter via a DeviceNet® fieldbus.

Danfoss technical documentation is also available online at http://drives.danfoss.com/knowledge-center/technical-documentation/.

1.3 Document and Software Version

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

<table>
<thead>
<tr>
<th>Edition</th>
<th>Remarks</th>
<th>Software version</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG34Q4xx</td>
<td>F14 and F15 enclosure sizes added.</td>
<td>7.4x</td>
</tr>
<tr>
<td></td>
<td>Software version update.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1 Document and Software Version

1.4 Approvals and Certifications

1.4.1 Approvals

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

NOTICE

Imposed limitations on the output frequency (due to export control regulations):

From software version 6.72 onwards, the output frequency of the frequency converter is limited to 590 Hz. Software versions 6.xx also limit the maximum output frequency to 590 Hz, but these versions cannot be flashed, that is, neither downgraded nor upgraded.
The 1400–2000 kW (1875–2680 hp) 690 V frequency converters are approved for CE only.

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.

1.6 Abbreviations and Conventions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>60° AVM</td>
<td>60° asynchronous vector modulation</td>
</tr>
<tr>
<td>A</td>
<td>Ampere/AMP</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>AD</td>
<td>Air discharge</td>
</tr>
<tr>
<td>AEO</td>
<td>Automatic energy optimization</td>
</tr>
<tr>
<td>Al</td>
<td>Analog input</td>
</tr>
<tr>
<td>AIC</td>
<td>Ampere interrupting current</td>
</tr>
<tr>
<td>AMA</td>
<td>Automatic motor adaptation</td>
</tr>
<tr>
<td>AWG</td>
<td>American wire gauge</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees celsius</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit breaker</td>
</tr>
<tr>
<td>CD</td>
<td>Constant discharge</td>
</tr>
<tr>
<td>CDM</td>
<td>Complete drive module: The frequency converter, feeding section, and auxiliaries</td>
</tr>
<tr>
<td>CE</td>
<td>European Conformity (European safety standards)</td>
</tr>
<tr>
<td>CM</td>
<td>Common mode</td>
</tr>
<tr>
<td>CT</td>
<td>Constant torque</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input</td>
</tr>
<tr>
<td>DM</td>
<td>Differential mode</td>
</tr>
<tr>
<td>D-TYPE</td>
<td>Drive dependent</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromotive force</td>
</tr>
<tr>
<td>ETR</td>
<td>Electronic thermal relay</td>
</tr>
<tr>
<td>f_{jog}</td>
<td>Motor frequency when jog function is activated</td>
</tr>
<tr>
<td>f_m</td>
<td>Motor frequency</td>
</tr>
<tr>
<td>f_{max}</td>
<td>Maximum output frequency, the frequency converter applies on its output</td>
</tr>
<tr>
<td>f_{min}</td>
<td>Minimum motor frequency from the frequency converter</td>
</tr>
<tr>
<td>f_{MN}</td>
<td>Nominal motor frequency</td>
</tr>
<tr>
<td>FC</td>
<td>Frequency converter</td>
</tr>
<tr>
<td>Hiperface®</td>
<td>Hiperface® is a registered trademark by Stegmann</td>
</tr>
<tr>
<td>HO</td>
<td>High overload</td>
</tr>
<tr>
<td>hp</td>
<td>Horse power</td>
</tr>
<tr>
<td>HTL</td>
<td>HTL encoder (10–30 V) pulses - High-voltage transistor logic</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>I_{MN}</td>
<td>Nominal motor current</td>
</tr>
<tr>
<td>I_{VLT,MAX}</td>
<td>Maximum output current</td>
</tr>
<tr>
<td>I_{VLT,N}</td>
<td>Rated output current supplied by the frequency converter</td>
</tr>
<tr>
<td>kHz</td>
<td>Kilohertz</td>
</tr>
<tr>
<td>LCP</td>
<td>Local control panel</td>
</tr>
<tr>
<td>lsb</td>
<td>Least significant bit</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
</tr>
<tr>
<td>mA</td>
<td>Milliamperes</td>
</tr>
<tr>
<td>MCM</td>
<td>Mille circular mil</td>
</tr>
<tr>
<td>MCT</td>
<td>Motion control tool</td>
</tr>
<tr>
<td>mH</td>
<td>Inductance in milli Henry</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>ms</td>
<td>Millisecond</td>
</tr>
<tr>
<td>msb</td>
<td>Most significant bit</td>
</tr>
<tr>
<td>nF</td>
<td>Capacitance in nano Farad</td>
</tr>
<tr>
<td>nതVLT</td>
<td>Efficiency of the frequency converter defined as ratio between power output and power input</td>
</tr>
<tr>
<td>nF</td>
<td>Capacitance in nano Farad</td>
</tr>
<tr>
<td>NO</td>
<td>Normal overload</td>
</tr>
<tr>
<td>Nm</td>
<td>Newton meter</td>
</tr>
<tr>
<td>P_{DC,cont.}</td>
<td>Rated power of the brake resistor (average power during continuous braking)</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed circuit board</td>
</tr>
<tr>
<td>PCD</td>
<td>Process data</td>
</tr>
<tr>
<td>PDS</td>
<td>Power drive system: a CDM and a motor</td>
</tr>
<tr>
<td>PELV</td>
<td>Protective extra low voltage</td>
</tr>
<tr>
<td>P_m</td>
<td>Frequency converter nominal output power as high overload (HO)</td>
</tr>
<tr>
<td>P_{MN}</td>
<td>Nominal motor power</td>
</tr>
<tr>
<td>PM motor</td>
<td>Permanent magnet motor</td>
</tr>
<tr>
<td>Process PID</td>
<td>PID (proportional integrated differential) regulator that maintains the speed, pressure, temperature, and so on</td>
</tr>
<tr>
<td>R_{br,nom}</td>
<td>Nominal resistor value that ensures a brake power on the motor shaft of 150/160% for 1 minute</td>
</tr>
<tr>
<td>RCD</td>
<td>Residual current device</td>
</tr>
<tr>
<td>Regen</td>
<td>Regenerative terminals</td>
</tr>
<tr>
<td>R_{min}</td>
<td>Minimum permissible brake resistor value by frequency converter</td>
</tr>
<tr>
<td>RMS</td>
<td>Root mean square</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>R_{rec}</td>
<td>Recommended brake resistor resistance of Danfoss brake resistors</td>
</tr>
<tr>
<td>s</td>
<td>Second</td>
</tr>
<tr>
<td>SCCR</td>
<td>Short circuit current rating</td>
</tr>
<tr>
<td>SFAVM</td>
<td>Stator flux-oriented asynchronous vector modulation</td>
</tr>
<tr>
<td>STW</td>
<td>Status word</td>
</tr>
<tr>
<td>SMPS</td>
<td>Switch mode power supply</td>
</tr>
</tbody>
</table>
### Table 1.2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>THD</td>
<td>Total harmonic distortion</td>
</tr>
<tr>
<td>TLM</td>
<td>Torque limit</td>
</tr>
<tr>
<td>TTL</td>
<td>TTL encoder (5 V) pulses - transistor transistor logic</td>
</tr>
<tr>
<td>U_{MN}</td>
<td>Nominal motor voltage</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories (US organization for the safety certification)</td>
</tr>
<tr>
<td>V</td>
<td>Volts</td>
</tr>
<tr>
<td>VT</td>
<td>Variable torque</td>
</tr>
<tr>
<td>VVC^</td>
<td>Voltage vector control plus</td>
</tr>
</tbody>
</table>

### 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 in drawings are in mm (in).

* Indicates a default setting of a parameter.
2 Safety Instructions

2.1 Safety Symbols

The following symbols are used in this guide:

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

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

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

2.2 Qualified Personnel

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

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

2.3 Safety Regulations

**WARNING**
HIGH VOLTAGE
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

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

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

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

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

- Stop the motor.
- Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.
- Disconnect or lock PM motor.
- Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in Table 2.1.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.
### Table 2.1 Discharge Time

<table>
<thead>
<tr>
<th>Voltage [V]</th>
<th>Power range [kW (hp)]</th>
<th>Minimum waiting time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380–500</td>
<td>250–1000 (350–1350)</td>
<td>30</td>
</tr>
<tr>
<td>525–690</td>
<td>355–2000 (475–2700)</td>
<td>40</td>
</tr>
</tbody>
</table>

### WARNING

**LEAKAGE CURRENT HAZARD**

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

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

### WARNING

**EQUIPMENT HAZARD**

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

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

### WARNING

**UNINTENDED MOTOR ROTATION WINDMILLING**

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

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

### CAUTION

**INTERNAL FAILURE HAZARD**

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

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

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

3.1 Pre-installation

3.1.1 Planning the Installation Site

**NOTICE**
Plan the installation of the frequency converter before commencing. Not planning the installation thoroughly can result in extra work during and after installation.

Select the best possible operation site by considering the following (see details on the following pages, and the respective design guides):

- Ambient operating temperature.
- Installation method.
- How to cool the unit.
- Position of the frequency converter.
- Cable routing.
- Ensure that the power source supplies the correct voltage and necessary current.
- Ensure that the motor current rating is within the maximum current from the frequency converter.
- If the frequency converter is without built-in fuses, ensure that the external fuses are rated correctly.

3.1.1.1 Inspection on Receipt

After receiving the delivery, immediately check whether the items supplied match the shipping documents. Danfoss does not honor claims for faults registered later.

Register a complaint immediately:

- With the carrier if there is visible transport damage.
- With the responsible Danfoss representative if there are visible defects or incomplete delivery.

3.1.2 Transportation and Unpacking

Locate the frequency converter as close as possible to the final installation site before unpacking.

Remove the box and handle the frequency converter on the pallet, as long as possible.

3.1.3 Lifting Unit

Always lift the frequency converter via the dedicated lifting eyes.
Illustration 3.2 Recommended Lifting Method, Enclosure Size F9/F10.

Illustration 3.3 Recommended Lifting Method, Enclosure Size F11/F12/F13/F14.
NOTICE
The plinth is provided in the same packaging as the frequency converter, but is not attached during shipment. The plinth is required to allow airflow cooling to the frequency converter. Position the frequency converter on top of the plinth in the final installation location. The angle from the top of the frequency converter to the lifting cable must be >60°.

In addition to Illustration 3.1 to Illustration 3.3, a spreader bar can be used to lift the frequency converter.
3.1.4 Mechanical Dimensions

Table 3.1: Mechanical Dimensions, Enclosure Sizes F8 and F9

All dimensions in mm (in)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>F8 (in)</th>
<th>F9 (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>1400</td>
<td>2100</td>
</tr>
<tr>
<td>Width</td>
<td>607</td>
<td>607</td>
</tr>
<tr>
<td>Depth</td>
<td>1497</td>
<td>1497</td>
</tr>
</tbody>
</table>

How to Install VLT® AutomationDrive FC 302
How to Install

VLT® AutomationDrive FC 302

Table 3.3 Mechanical Dimensions, Enclosure Sizes F12 and F13

All dimensions in mm (in)

How to Install VLT® AutomationDrive FC 302
Table 3.4 Mechanical Dimensions, Enclosure Size F14

All dimensions in mm (in)
Table 3.5 Mechanical Dimensions Enclosure Size F15

All dimensions in mm (in)
<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>F8</th>
<th>F9</th>
<th>F10</th>
<th>F11</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
</tr>
<tr>
<td>NEMA</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>IP</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
</tr>
<tr>
<td>NEMA</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Shipping dimensions [mm (in)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
</tr>
<tr>
<td>Width</td>
<td>970 (38.2)</td>
<td>1568 (61.7)</td>
<td>1760 (69.3)</td>
<td>2559 (100.7)</td>
</tr>
<tr>
<td>Depth</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
</tr>
<tr>
<td>Frequency converter dimensions [mm (in)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
</tr>
<tr>
<td>Width</td>
<td>800 (31.5)</td>
<td>1400 (55.1)</td>
<td>1600 (63.0)</td>
<td>2400 (94.5)</td>
</tr>
<tr>
<td>Depth</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
</tr>
<tr>
<td>Max weight [kg (lb)]</td>
<td>440 (970)</td>
<td>656 (1446)</td>
<td>880 (1940)</td>
<td>1096 (2416)</td>
</tr>
<tr>
<td>Table 3.6 Mechanical Dimensions, Enclosure Sizes F8–F11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>F12</th>
<th>F13</th>
<th>F14</th>
<th>F15</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
</tr>
<tr>
<td>NEMA</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>IP</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
<td>21, 54</td>
</tr>
<tr>
<td>NEMA</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Shipping dimensions [mm (in)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
<td>2324 (91.5)</td>
</tr>
<tr>
<td>Width</td>
<td>2160 (85.0)</td>
<td>2960 (116.5)</td>
<td>2578 (101.5)</td>
<td>3778 (148.7)</td>
</tr>
<tr>
<td>Depth</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
<td>1130 (44.5)</td>
</tr>
<tr>
<td>Frequency converter dimensions [mm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
<td>2204 (86.8)</td>
</tr>
<tr>
<td>Width</td>
<td>2000 (78.7)</td>
<td>2800 (110.2)</td>
<td>2400 (94.5)</td>
<td>3600 (141.7)</td>
</tr>
<tr>
<td>Depth</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
<td>606 (23.9)</td>
</tr>
<tr>
<td>Max weight [kg (lb)]</td>
<td>1022 (2253)</td>
<td>1238 (2729)</td>
<td>1410 (3108)</td>
<td>1626 (3585)</td>
</tr>
<tr>
<td>Table 3.7 Mechanical Dimensions, Enclosure Sizes F12–F15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2 Mechanical Installation

3.2.1 Preparation for Installation

To ensure reliable and effective installation of the frequency converter, make the following preparations:

- Provide a suitable mounting arrangement. The mounting arrangement depends on the design, weight, and torque of the frequency converter.
- To ensure that the space requirements are met, examine the mechanical drawings.
- Ensure that all wiring is done in accordance with national regulations.

3.2.2 Tools Required

- Drill with 10 mm or 12 mm bit.
- Tape measure.
- Wrench with relevant metric sockets (7–17 mm).
- Extensions to wrench.
- Sheet metal punch for conduits or cable glands in IP21/NEMA 1 and IP54 units.
- Lifting bar to lift the unit (rod or tube maximum Ø 25 mm (1 in), able to lift minimum 400 kg (880 lb)).
- Crane or other lifting aid to place the frequency converter in position.

3.2.3 General Considerations

Space

To allow airflow and cable access, ensure sufficient space above and below the frequency converter. In addition, allow for enough space in front of the unit to open the panel door, see Illustration 3.5 to Illustration 3.12.
Wire access
Ensure that proper wire access is present including the necessary bending allowance.

**NOTICE**
All cable lugs/shoes must mount within the width of the terminal bus bar.

**NOTICE**
Because the motor wiring carries high frequency current, it is important that mains cables, motor cables, and control wires are run separately. Use metallic conduit or separated shielded wire. Failure to isolate mains cables, motor cables, and control wiring could result in the mutual signal coupling which may cause nuisance trip cases.
3.2.4 Terminal Locations, F8–F15

The F enclosures are available in 8 different sizes. The F8 consists of the rectifier and inverter modules in 1 cabinet. The F10, F12, and F14 consist of a rectifier cabinet on the left and an inverter cabinet on the right. The F9, F11, F13, and F15 have the option cabinet added to the F8, F10, F12, and F14, respectively.

3.2.4.1 Inverter and Rectifier, Enclosure Sizes F8, and F9

Illustration 3.13 Terminal Locations Inverter and Rectifier, Enclosure Sizes F8, and F9. The gland plate is 42 mm (1.65 in) below 0.0 level.
3.2.4.2 Inverter, Enclosure Sizes F10 and F11

Illustration 3.14 Terminal Locations – Left, Front, and Right Views. The gland plate is 42 mm (1.65 in) below 0.0 level.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground bar</td>
</tr>
<tr>
<td>2</td>
<td>Motor terminals</td>
</tr>
<tr>
<td>3</td>
<td>Brake terminals</td>
</tr>
</tbody>
</table>

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Operating Instructions
3.2.4.3 Inverter, Enclosure Sizes F12 and F13

<table>
<thead>
<tr>
<th></th>
<th>Ground bar</th>
<th>Motor terminals</th>
<th>Brake terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Illustration 3.15 Terminal Locations – Left, Front, and Right Views. The gland plate is 42 mm (1.65 in) below 0.0 level.
3.2.4.4 Inverter, Enclosure Sizes F14 and F15

Illustration 3.16 Terminal Locations – Left, Front, and Right Views. The gland plate is 42 mm (1.65 in) below 0.0 level.
3.2.4.5 Rectifier, Enclosure Sizes F10, F11, F12, and F13

Illustration 3.17 Terminal Locations – Left, Front, and Right Views. The gland plate is 42 mm (1.65 in) below 0.0 level.
3.2.4.6 Rectifier, Enclosure Sizes F14 and F15

Illustration 3.18 Terminal Locations – Left, Front, and Right Views. The gland plate is 42 mm (1.65 in) below 0.0 level.
3.2.4.7 Options Cabinet, Enclosure Size F9

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Left side view</td>
</tr>
<tr>
<td>2</td>
<td>Front view</td>
</tr>
<tr>
<td>3</td>
<td>Right side view</td>
</tr>
</tbody>
</table>

Illustration 3.19 Terminal Locations Options Cabinet, Enclosure Size F9
3.2.4.8 Options Cabinet, Enclosure Sizes F11 and F13

Illustration 3.20 Terminal Locations Options Cabinet, Enclosure Sizes F11 and F13

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left side view</td>
</tr>
<tr>
<td>2</td>
<td>Front view</td>
</tr>
<tr>
<td>3</td>
<td>Right side view</td>
</tr>
<tr>
<td>4</td>
<td>Ground bar</td>
</tr>
</tbody>
</table>

How to Install

Operating Instructions
3.2.5 Cooling and Airflow

Cooling
Cooling can be achieved in different ways:
- By using the cooling ducts at the top and bottom of the unit.
- By taking air in and out the back of the unit.
- By combining the cooling methods.

Duct cooling
A dedicated option has been developed to optimize the installation of frequency converters in Rittal TS8 enclosures utilizing the frequency converter fan for forced air cooling of the backchannel. The air out of the top of the enclosure could be ducted outside a facility so the heat losses from the backchannel are not dissipated within the control room. Ducting the air outside the facility ultimately reduces the air-conditioning requirements of the facility.

Back cooling
The backchannel air can also be ventilated in and out of the back of a Rittal TS8 enclosure. The backchannel takes cool air from outside the facility and returns warm air to outside the facility, thus reducing air-conditioning requirements.

Airflow
Ensure sufficient airflow over the heat sink. The flow rate is shown in Table 3.8.

<table>
<thead>
<tr>
<th>Enclosure protection</th>
<th>Door fans/Top fan airflow</th>
<th>Heat sink fans</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP21/NEMA 1</td>
<td>700 m³/h (412 cfm)¹</td>
<td>985 m³/h (580 cfm)¹</td>
</tr>
<tr>
<td>IP54/NEMA 12</td>
<td>525 m³/h (309 cfm)¹</td>
<td>985 m³/h (580 cfm)¹</td>
</tr>
</tbody>
</table>

Table 3.8 Heat Sink Airflow
1) Airflow per fan. Enclosure sizes F contain multiple fans.
The fan runs for the following reasons:

- AMA.
- DC Hold.
- Pre-Mag.
- DC Brake.
- 60% of nominal current is exceeded.
- Specific heat sink temperature exceeded (power size dependent).

The fan runs for minimum 10 minutes.

**External ducts**

If more duct work is added externally to the Rittal cabinet, calculate the pressure drop in the ducting. To derate the frequency converter according to the pressure drop, refer to *Illustration 3.22*.

---

**3.2.6 Gland/Conduit Entry – IP21 (NEMA 1) and IP54 (NEMA12)**

Cables are connected through the gland plate from the bottom. Remove the plate and plan where to place the entry for the glands or conduits. Prepare holes in the shaded areas on the drawings in *Illustration 3.24 to Illustration 3.31.*

**NOTICE**

To ensure the specified protection degree, and proper cooling of the unit, fit the gland plate to the frequency converter. If the gland plate is not mounted, the frequency converter may trip on *alarm 69, Pwr. Card Temp*.

---

**Illustration 3.22 Enclosure Size F, Derating vs. Pressure Change (Pa)**

Drive air flow: 985 m³/h (580 cfm)

**Illustration 3.23 Example of Proper Installation of the Gland Plate**

**Illustration 3.24 F8, Cable Entry Viewed from the Bottom of the Frequency Converter**
Illustration 3.25 F9, Cable Entry Viewed from the Bottom of the Frequency Converter

Illustration 3.26 F10, Cable Entry Viewed from the Bottom of the Frequency Converter
Illustration 3.27 F11, Cable Entry Viewed from the Bottom of the Frequency Converter

Illustration 3.28 F12, Cable Entry Viewed from the Bottom of the Frequency Converter
Illustration 3.29 F13, Cable Entry Viewed from the Bottom of the Frequency Converter

Illustration 3.30 F14, Cable Entry Viewed from the Bottom of the Frequency Converter
Illustration 3.31 F15, Cable Entry Viewed from the Bottom of the Frequency Converter
3.3 Installing the Panel Options

3.3.1 Panel Options

Space heaters and thermostat
Space heaters are mounted on the cabinet interior of enclosure size F10–F15 frequency converters. They are controlled via an automatic thermostat, and help control humidity inside the enclosure, by that extending the lifetime of frequency converter components in damp environments. The thermostat default settings turn on the heaters at 10 °C (50 °F) and turn them off at 15.6 °C (60 °F).

Cabinet light with power outlet
A light mounted on the cabinet interior of enclosure size F10–F15 frequency converters increases visibility during servicing and maintenance.

Transformer tap set-up
If the cabinet light with power outlet, and/or the space heaters and thermostat are installed, transformer T1 requires the taps to be set to the proper input voltage. A 380–480/500 V unit is initially set to the 525 V tap and a 525–690 V unit is set to the 690 V tap. This initial setting ensures that no overvoltage of secondary equipment occurs if the tap is not changed before power is applied.

To set the proper tap at terminal T1, located in the rectifier cabinet, see Table 3.9. For location in the frequency converter, see the illustration of the rectifier in Illustration 3.32.

<table>
<thead>
<tr>
<th>Input voltage range [V]</th>
<th>Tap to select [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>380–440</td>
<td>400</td>
</tr>
<tr>
<td>441–490</td>
<td>460</td>
</tr>
<tr>
<td>491–550</td>
<td>525</td>
</tr>
<tr>
<td>551–625</td>
<td>575</td>
</tr>
<tr>
<td>626–660</td>
<td>660</td>
</tr>
<tr>
<td>661–690</td>
<td>690</td>
</tr>
</tbody>
</table>

Table 3.9 Transformer Tap Setting

IRM (insulation resistance monitor)
Monitors the insulation resistance in ungrounded systems (IT systems in IEC terminology) between the system phase conductors and ground. There is an ohmic prewarning and a main alarm setpoint for the insulation level. Associated with each setpoint is an SPDT alarm relay for external use.

Manual motor starters
Provide 3-phase power for electric blowers often required for larger motors. Power for the starters is provided from the load side of any supplied contactor, circuit breaker, or disconnect switch. Power is fused before each motor starter and is off when the incoming power to the frequency converter is off. Up to 2 starters are allowed (only 1 if a 30 A, fuse-protected circuit is ordered).

The manual motor starter is integrated into the frequency converter’s STO and includes the following features:

- Operation switch (on/off).
- Short circuit and overload protection with test function.
- Manual reset function.
30 A, fuse-protected terminals
- 3-phase power matching incoming mains voltage for powering auxiliary customer equipment.
- Not available if 2 manual motor starters are selected.
- Terminals are off when the incoming power to the frequency converter is off.
- Power for the fused protected terminals is provided from the load side of any supplied circuit breaker or disconnect switch.

24 V DC supply
- 5 A, 120 W, 24 V DC.
- Protected against output overcurrent, overload, short circuits, and overtemperature.
- For powering 3rd party accessory devices such as sensors, PLC I/O, contactors, temperature probes, indicator lights, and/or other electronic hardware.
- Diagnostics include a dry DC-ok contact, a green DC-ok LED, and a red overload LED.

External temperature monitoring
Designed for monitoring temperatures of external system components, such as the motor windings and/or bearings. Includes 8 universal input modules plus 2 dedicated thermistor input modules. All 10 modules are integrated into the frequency converter's STO circuit and can be monitored via a fieldbus network (requires a separate module/bus coupler).

Universal inputs (8) – signal types
- RTD inputs (including Pt100), 3-wire, or 4-wire.
- Thermocouple.
- Analog current or analog voltage.

Extra features:
- 1 universal output, configurable for analog voltage, or analog current.
- 2 output relays (NO).
- Dual-line LC display and LED diagnostics.
- Sensor lead wire break, short circuit, and incorrect polarity detection.
- Interface set-up software.

Dedicated thermistor inputs (2) – features

**NOTICE**
If the frequency converter is connected to a thermistor, the thermistor control wires must be reinforced/double insulated for PELV isolation. A 24 V DC supply for the thermistor power is recommended.
- Each module can monitor up to 6 thermistors in series.
- Fault diagnostics for wire breakage or short circuits of sensor leads.

- ATEX/UL/CSA certification.
- A third thermistor input can be provided by the VLT® PTC Thermistor Card MCB 112, if necessary.

3.4 Electrical Installation

See chapter 2 Safety Instructions for general safety instructions.

**WARNING**
HIGH VOLTAGE
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.
- Only qualified personnel must perform installation, start-up, and maintenance.

**WARNING**
INDUCED VOLTAGE
Induced voltage from output motor cables from different frequency converters 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 frequency converters.

**WARNING**
SHOCK HAZARD
The frequency converter can cause a DC current in the PE 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 permitted on the supply side.

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

Overcurrent protection
- Extra protective equipment such as short-circuit protection or motor thermal protection between frequency converter and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. See maximum fuse ratings in chapter 3.4.13 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 5.6 Electrical Data 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 property damage can occur if the motor overheats.

3.4.1 Transformer Selection

Use the frequency converter with a 12-pulse isolation transformer.

3.4.2 Power Connections

Cabling and fusing

⚠️ NOTICE

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. UL applications require 75 °C copper conductors. 75 °C (167 °F) and 90 °C (194 °F) copper conductors are thermally acceptable for the frequency converter to use in non-UL applications.

The power cable connections are located as in Illustration 3.32. Dimensioning of the cable cross-section must be done in accordance with the current ratings and local legislation. See chapter 5.1 Mains Supply for details.

For protection of the frequency converter, use the recommended fuses, or ensure that the unit has built-in fuses. Recommended fuses are detailed in in chapter 3.4.13 Fuses. Always ensure that fusing conforms to local regulations.

If the mains switch is included, the connection of mains is fitted to the mains switch.
See chapter 5.1 Mains Supply for the correct dimensioning of the motor cable cross-section and length.

**NOTICE**

Only use the cross-section the field wiring terminals are designed for. The terminals do not accept a wire of 1 size large.

![Diagram](image)

Illustration 3.33 A) Temporary 6-Pulse Connection
B) 12-Pulse Connection

**Notes**

1) When 1 of the rectifier modules is inoperable, use the operable rectifier module to run the frequency converter at a reduced power. Contact Danfoss for reconnection details.
Shielding of cables
Avoid installation with twisted shield ends (pigtails). They spoil the shielding effect at higher frequencies. If it is necessary to break the shield to install a motor isolator or motor contactor, the shield must be continued at the lowest possible HF impedance.

Connect the motor cable shield to both the decoupling plate of the frequency converter and to the metal housing of the motor.

Make the shield connections with the largest possible surface area (cable clamp). For this purpose, use the supplied installation devices within the frequency converter.

Cable length and cross-section
The frequency converter has been EMC tested with a given cable length. Keep the motor cable as short as possible to reduce the noise level and leakage currents.

Switching frequency
When frequency converters are used with sine-wave filters to reduce the acoustic noise from a motor, set the switching frequency according to the instruction in parameter 14-01 Switching Frequency.

<table>
<thead>
<tr>
<th>Term. no.</th>
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<th>97</th>
<th>98</th>
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</tr>
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<tr>
<td>U</td>
<td>V</td>
<td>W</td>
<td>PE</td>
<td></td>
</tr>
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<td>U1</td>
<td>V1</td>
<td>W1</td>
<td>PE</td>
<td></td>
</tr>
<tr>
<td>W2</td>
<td>U2</td>
<td>V2</td>
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<td></td>
</tr>
<tr>
<td>U1</td>
<td>V1</td>
<td>W1</td>
<td>PE</td>
<td></td>
</tr>
</tbody>
</table>

Motor voltage 0–100% of mains voltage.
3 wires out of motor
Delta-connected
6 wires out of motor
Star-connected U2, V2, W2
U2, V2, and W2 to be interconnected separately.

Table 3.10 Terminal Connections
1) Protective Earth connection

**NOTICE**
In motors without phase insulation paper or other insulation reinforcement suitable for operation with voltage supply (such as a frequency converter), fit a sine-wave filter on the output of the frequency converter.
1 Brake resistor temperature switch
2 Auxiliary relay (01, 02, 03, 04, 05, 06)
3 SCR enable/disable
4 Auxiliary fan (100, 101, 102, 103)
5 Inverter module
6 Brake terminals 81 (-R), 82 (+R)
7 Motor connection T1 (U), T2 (V), T3 (W)
8 Mains L2-1 (R2), L2-2 (S2), L3-2 (T2)
9 Mains L1-1 (R1), L2-1 (S1), L3-1 (T1)
10 Ground PE terminals
11 12-pulse rectifier module

| 1 | DC-bus connections for common DC-bus (DC+, DC-) |
| 2 | DC-bus connections for common DC-bus (DC+, DC-) |
| 3 | AUX fan (100, 101, 102, 103) |
| 4 | Mains fuses F10/F12 (6 pieces) |
| 5 | Mains L1-2 (R2), L2-2 (S2), L3-2 (T2) |
| 6 | Mains L1-1 (R1), L2-1 (S1), L3-1 (T1) |
| 7 | 12-pulse rectifier module |

Illustration 3.35 Rectifier and Inverter Cabinet, Enclosure Sizes F8 and F9

Illustration 3.36 Rectifier Cabinet, Enclosure Sizes F10 and F12
1. NAMUR fuse. See Table 3.25 for part numbers.
2. NAMUR terminals (optional)
3. External temperature monitoring
4. AUX relay (01, 02, 03, 04, 05, 06)
5. Motor connection, 1 per module T1 (U), T2 (V), T3 (W)
6. Brake 81 (-R), 82 (+R)
7. AUX fan (100, 101, 102, 103)
8. Fan fuses. See Table 3.22 for part numbers.
9. SMPS fuses. See Table 3.21 for part numbers.

Illustration 3.37 Inverter Cabinet, Enclosure Sizes F10 and F11

1. DC-busbar access
2. DC-busbar access
3. Mains fuses (6 pieces)
4. Mains L1-2 (R2), L2-2 (S2), L3-2 (T2)
5. Mains L1-1 (R1), L2-1 (S1), L3-1 (T1)
6. 12-pulse rectifier modules
7. DC inductor

Illustration 3.38 Rectifier Cabinet, Enclosure Size F14 and F15
1. NAMUR fuse. See Table 3.25 for part numbers.
2. NAMUR terminals (optional)
3. External temperature monitoring
4. AUX relay (01, 02, 03, 04, 05, 06)
5. AUX fan (100, 101, 102, 103)
6. Motor connection, 1 per module T1 (U), T2 (V), T3 (W)
7. Brake 81 (-R), 82 (+R)
8. Fan fuses. See Table 3.22 for part numbers.
9. SMPS fuses. See Table 3.21 for part numbers.

Illustration 3.39 Inverter Cabinet, Enclosure Sizes F12 and F13
1. Auxiliary relay (01, 02, 03, 04, 05, 06)
2. AUX fan (100, 101, 102, 103)
3. Fan fuses. See Table 3.22 for part numbers.
4. SMPS fuses. See Table 3.21 for part numbers.
5. Brake B1 (-R), B2 (+R)
6. Motor connection, 1 per module T1 (U), T2 (V), T3 (W)

Illustration 3.40 Inverter Cabinet, Enclosure Size F14 and F15
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Specification</th>
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<tr>
<td>1</td>
<td>Safety relay coil fuse with Pilz relay</td>
<td>See chapter 3.4.14 Fuse Tables for part numbers.</td>
</tr>
<tr>
<td>2</td>
<td>Pilz relay terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RCD or IRM terminal</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Mains fuses (6 pieces)</td>
<td>See chapter 3.4.14 Fuse Tables for part numbers.</td>
</tr>
<tr>
<td>5</td>
<td>2x3-phase manual disconnect</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mains L1-2 (R2), L2-2 (S2), L3-2 (T2)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mains L1-1 (R1), L2-1 (S1), L3-1 (T1)</td>
<td></td>
</tr>
</tbody>
</table>

Illustration 3.41 Options Cabinet, Enclosure Size F9

<table>
<thead>
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<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety relay coil fuse with Pilz relay</td>
<td>See chapter 3.4.14 Fuse Tables for part numbers.</td>
</tr>
<tr>
<td>2</td>
<td>Pilz relay terminal</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Mains fuses (6 pieces)</td>
<td>See chapter 3.4.14 Fuse Tables for part numbers.</td>
</tr>
<tr>
<td>4</td>
<td>Mains L1-2 (R2), L2-2 (S2), L3-2 (T2)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mains L1-1 (R1), L2-1 (S1), L3-1 (T1)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2x3-phase manual disconnect</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>RCD or IRM terminal</td>
<td></td>
</tr>
</tbody>
</table>

Illustration 3.42 Options Cabinet, Enclosure Sizes F11 and F13
1. Safety relay coil fuse with Pilz relay
   See chapter 3.4.14 Fuse Tables for part numbers.
2. Pilz relay terminal
3. RCD or IRM terminal
4. Mains fuses (6 pieces)
   See chapter 3.4.14 Fuse Tables for part numbers.
5. Mains L1-2 (R2), L2-2 (S2), L3-2 (T2)
6. Mains L1-1 (R1), L2-1 (S1), L3-1 (T1)
7. 2x3-phase manual disconnect

Illustration 3.43 Options Cabinet, Enclosure Size F15
Grounding

To obtain electromagnetic compatibility (EMC), consider the following basic issues when installing a frequency converter.

- Safety grounding: The frequency converter has a high leakage current (>3.5 mA) and must be grounded appropriately for safety reasons. Apply local safety regulations.
- High frequency grounding: Keep the ground wire connections as short as possible. Connect the different ground systems at the lowest possible conductor impedance. This is obtained by keeping the conductor as short as possible and by using the greatest possible surface area.

The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible high frequency impedance. This avoids having different high-frequency voltages for the individual devices and avoids the risk of radio interference currents running in any connection cables used between the devices. The radio interference has been reduced.

To obtain a low high-frequency impedance, use the fastening bolts of the devices as high frequency connection to the rear plate. Remove any insulating paint or similar from the fastening points.

Extra Protection (RCD)

EN/IEC61800-5-1 (Power drive system product standard) requests special care if the leakage current exceeds 3.5 mA. Reinforce grounding in the following ways:

- Ground wire of at least 10 mm² (7 AWG).
- Install 2 separate ground wires, both complying with the dimensioning rules. See EN 60364-5-54 § 543.7 for further information.

If local safety regulations are complied with, ELCB relays, multiple protective earthing, or grounding can be used as extra protection.

A ground fault may cause a DC component to develop in the fault current.

If ELCB relays are used, observe local regulations. Relays must be suitable for the protection of 3-phase equipment with a bridge rectifier and for a brief discharge on power-up.

See also Special Conditions in the product relevant design guide.

RFI Switch

Mains supply isolated from ground

Turn off (OFF)\(^1\) the RFI switch via parameter 14-50 RFI Filter on the frequency converter and parameter 14-50 RFI Filter on the filter if:

- The frequency converter is supplied from an isolated mains source (IT mains, floating delta, and grounded delta).
- The frequency converter is supplied from TT/TN-S mains with grounded leg.

\(^1\) Not available for 525–600/690 V frequency converters.

For further reference, see IEC 364-3.

Set parameter 14-50 RFI Filter to [1] ON if:

- Optimum EMC performance is needed.
- Parallel motors are connected.
- The motor cable length is above 25 m (82 ft).

In OFF, the internal RFI capacities (filter capacitors) between the chassis and the DC link are cut off to avoid damage to the DC link and to reduce the ground capacity currents (according to IEC 61800-3).

Also refer to the application note VLT on IT mains. It is important to use isolation monitors which are compatible with power electronics (IEC 61557-8).
3.4.6 Torque

When tightening all connection of mains, it is important to tighten with the correct torque. Too low or too high torque results in a poor connection of mains. To ensure correct torque, use a torque wrench.

![Illustration 3.44 Tightening Torques](image)

**Table 3.11 Tightening Torques**

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>Terminal</th>
<th>Torque</th>
<th>Bolt size</th>
</tr>
</thead>
<tbody>
<tr>
<td>F8–F15</td>
<td>Mains</td>
<td>19–40 Nm</td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td>(168–354 in-lb)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brake</td>
<td>8.5–20.5 Nm</td>
<td>M8</td>
</tr>
<tr>
<td></td>
<td>Regen</td>
<td>(75–181 in-lb)</td>
<td></td>
</tr>
</tbody>
</table>

3.4.7 Shielded Cables

**NOTICE**

Danfoss recommends using shielded cables between the LCL filter and the frequency converter. Unshielded cables can be used between the transformer and the LCL filter input side.

Make sure to connect shielded and armored cables properly to ensure high EMC immunity and low emissions.

The connection can be made using either cable glands or clamps.

- EMC cable glands: Available cable glands can be used to ensure optimum EMC connection.
- EMC cable clamp: Clamps allowing easy connection are supplied with the frequency converter.

3.4.8 Motor Cable

Connect the motor to terminals U/T1/96, V/T2/97, W/T3/98. Ground to terminal 99. All types of 3-phase asynchronous standard motors can be used with a frequency converter. The factory setting is for clockwise rotation with the frequency converter output connected as follows:

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>96, 97, 98</td>
<td>Mains U/T1, V/T2, W/T3</td>
</tr>
<tr>
<td>99</td>
<td>Ground</td>
</tr>
</tbody>
</table>

**Table 3.12 Motor Connection Terminals**

- Terminal U/T1/96 connected to U-phase.
- Terminal V/T2/97 connected to V-phase.
- Terminal W/T3/98 connected to W-phase.

![Illustration 3.45 Wiring for Clockwise and Counterclockwise Motor Rotation](image)

The direction of rotation can be changed by switching 2 phases in the motor cable or by changing the setting of parameter 4-10 Motor Speed Direction.

A motor rotation check can be performed using parameter 1-28 Motor Rotation Check and following the steps shown on the display.
Requirements
F8/F9 requirements: The cables must be of equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

F10/F11 requirements: Motor phase cable quantities must be multiples of 2, resulting in 2, 4, 6, or 8 (1 cable is not allowed) to obtain equal number of wires attached to both inverter module terminals. The cables must be equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

F12/F13 requirements: Motor phase cable quantities must be multiples of 3, resulting in 3, 6, 9, or 12 (1, 2, or 3 cables are not allowed) to obtain an equal number of wires attached to each inverter module terminal. The wires must be of equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

F14/F15 requirements: Motor phase cable quantities must be multiples of 4, resulting in 4, 8, 12, or 16 (1, 2, or 3 cables are not allowed) to obtain an equal number of wires attached to each inverter module terminal. The wires must be of equal length within 10% between the inverter module terminals and the first common point of a phase. The recommended common point is the motor terminals.

Output junction box requirements: The length, minimum 2.500 mm (98.4 in), and quantity of cables must be equal from each inverter module to the common terminal in the junction box.

NOTICE
If a retrofit application requires an unequal number of wires per phase, consult Danfoss for requirements and documentation, or use the top/bottom entry side cabinet option.

3.4.9 Brake Cable for Frequency Converters with Factory-installed Brake Chopper Option

(Only standard with letter B in position 18 of product type code).

Use a shielded connection cable to the brake resistor. The maximum length from the frequency converter to the DC bar is limited to 25 m (82 ft).

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>81, 82</td>
<td>Brake resistor terminals</td>
</tr>
</tbody>
</table>

Table 3.13 Brake Resistor Terminals

The connection cable to the brake resistor must be shielded. Connect the shield to the conductive backplate on the frequency converter and to the metal cabinet of the brake resistor with cable clamps. Size the brake cable cross-section to match the brake torque. See also the instructions Brake Resistor and Brake Resistors for Horizontal Applications for further information regarding safe installation.

NOTICE
Depending on the supply voltage, voltages up to 1099 V DC can occur on the terminals.

F enclosure requirements
Connect the brake resistor to the brake terminals in each inverter module.

3.4.10 Shielding against Electrical Noise

Before mounting the mains power cable, mount the EMC metal cover to ensure best EMC performance.

NOTICE
The EMC metal cover is only included in frequency converters with an RFI filter.
3.4.11 Connection of Mains

Mains and ground must be connected as detailed in Table 3.14.

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-1, 92-1, 93-1</td>
<td>Mains R1/L1-1, S1/L2-1, T1/L3-1</td>
</tr>
<tr>
<td>91-2, 92-2, 93-2</td>
<td>Mains R2/L1-2, S2/L2-2, T2/L3-2</td>
</tr>
<tr>
<td>94</td>
<td>Ground</td>
</tr>
</tbody>
</table>

Table 3.14 Mains and Ground Connection Terminals

**NOTICE**

To ensure that the mains voltage of the frequency converter matches the supply of the plant, check the nameplate.

Ensure that the power supply can supply the necessary current to the frequency converter.

If the frequency converter is without built-in fuses, ensure that the external fuses have the correct current rating. See chapter 3.4.13 Fuses.

3.4.12 External Fan Supply

In case the frequency converter is supplied by DC, or if the fan must run independently of the power supply, an external power supply can be applied. The connection is made on the power card.

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>100, 101</td>
<td>Auxiliary supply S, T</td>
</tr>
<tr>
<td>102, 103</td>
<td>Internal supply S, T</td>
</tr>
</tbody>
</table>

Table 3.15 External Fan Supply Terminals

The connector on the power card provides the connection of mains voltage for the cooling fans. The fans are connected from factory to be supplied from a common AC line (jumpers between 100–102 and 101–103). If an external supply is needed, remove the jumpers and connect the supply to terminals 100 and 101. Use a 5 A fuse for protection. UL applications require a LittleFuse KLK-5 or equivalent.

3.4.13 Fuses

**WARNING**

SHORT-CIRCUIT AND OVERCURRENT

All frequency converters must have the mains fuses for the short circuit and overcurrent protection. If they are not included in the frequency converter, they must be installed during frequency converter installation. Operating frequency converters without having mains fuses can result in death or serious injury.

- Install the mains fuses for the short circuit and overcurrent protection during the installation, if they are not included in the frequency converter.

**Branch circuit protection**

To protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines and so on, must be short-circuited and overcurrent protected according to national/international regulations.

**Short-circuit protection**

To avoid electrical or fire hazard, protect the frequency converter against short circuit. Danfoss recommends using the fuses mentioned in Table 3.16 to Table 3.27 to protect service personnel and equipment if there is an internal failure in the frequency converter. The frequency converter provides full short-circuit protection if there is a short circuit on the motor output.

**Overcurrent protection**

To avoid fire hazard due to overheating of the cables in the installation, provide overload protection. The frequency converter is equipped with an internal overcurrent protection, which can be used for upstream overload protection (UL applications excluded). See parameter 4-18 Current Limit. Moreover, fuses or circuit breakers can be used to provide the overcurrent protection in the installation. Overcurrent protection must always be carried out according to national regulations.

**UL Compliance**

The fuses listed in Table 3.16 to Table 3.27 are suitable for use on a circuit capable of delivering 100000 $A_{\text{rms}}$ (symmetrical), 240 V (if applicable), 480 V, 500 V, or 600 V depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 $A_{\text{rms}}$.

When the circuit breaker is provided with the frequency converter, the circuit breaker's ampere interrupting current rating (AIC), which is usually lower than 100000 $A_{\text{rms}}$, determines the frequency converter SCCR.
### Table 3.16 Mains Fuses, 380–500 V

<table>
<thead>
<tr>
<th>Power size</th>
<th>Enclosure</th>
<th>Rating</th>
<th>Bussmann</th>
<th>Spare Bussmann</th>
<th>Estimated fuse power loss [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC 302</td>
<td>F8/F9</td>
<td>700</td>
<td>170M4017</td>
<td>176F8591</td>
<td>25</td>
</tr>
<tr>
<td>P250T5</td>
<td>F8/F9</td>
<td>700</td>
<td>170M4017</td>
<td>176F8591</td>
<td>30</td>
</tr>
<tr>
<td>P355T5</td>
<td>F8/F9</td>
<td>700</td>
<td>170M4017</td>
<td>176F8591</td>
<td>38</td>
</tr>
<tr>
<td>P400T5</td>
<td>F8/F9</td>
<td>700</td>
<td>170M4017</td>
<td>176F8591</td>
<td>3500</td>
</tr>
<tr>
<td>P450T5</td>
<td>F10/F11</td>
<td>700</td>
<td>170M6013</td>
<td>176F8592</td>
<td>3940</td>
</tr>
<tr>
<td>P500T5</td>
<td>F10/F11</td>
<td>700</td>
<td>170M6013</td>
<td>176F8592</td>
<td>2625</td>
</tr>
<tr>
<td>P560T5</td>
<td>F10/F11</td>
<td>700</td>
<td>170M6013</td>
<td>176F8592</td>
<td>3940</td>
</tr>
<tr>
<td>P630T5</td>
<td>F12/F13</td>
<td>700</td>
<td>170M6018</td>
<td>176F9181</td>
<td>57</td>
</tr>
<tr>
<td>P700T5</td>
<td>F12/F13</td>
<td>700</td>
<td>170M6018</td>
<td>176F9181</td>
<td>83</td>
</tr>
</tbody>
</table>

### Table 3.17 Mains Fuses, 525–690 V

<table>
<thead>
<tr>
<th>Power size</th>
<th>Enclosure</th>
<th>Rating</th>
<th>Bussmann</th>
<th>Spare Bussmann</th>
<th>Estimated fuse power loss [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P450</td>
<td>F8/F9</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
<tr>
<td>P500</td>
<td>F8/F9</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
<tr>
<td>P560</td>
<td>F8/F9</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
<tr>
<td>P630</td>
<td>F10/F11</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
<tr>
<td>P710</td>
<td>F10/F11</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
<tr>
<td>P800</td>
<td>F10/F11</td>
<td>1100</td>
<td>170M8611</td>
<td>176F8769</td>
<td>25</td>
</tr>
</tbody>
</table>

### Table 3.18 Inverter Module DC-Link Fuses, 380–500 V

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>Bussmann PN</th>
<th>Rating</th>
<th>Siba</th>
</tr>
</thead>
<tbody>
<tr>
<td>P450</td>
<td>170M8611</td>
<td>1100 A, 1000 V</td>
<td>20 781 32.1000</td>
</tr>
<tr>
<td>P500</td>
<td>170M8611</td>
<td>1100 A, 1000 V</td>
<td>20 781 32.1000</td>
</tr>
<tr>
<td>P560</td>
<td>170M6467</td>
<td>1400 A, 700 V</td>
<td>20 681 32.1400</td>
</tr>
<tr>
<td>P630</td>
<td>170M6467</td>
<td>1400 A, 700 V</td>
<td>20 681 32.1400</td>
</tr>
<tr>
<td>P710</td>
<td>170M8611</td>
<td>1100 A, 1000 V</td>
<td>20 781 32.1000</td>
</tr>
<tr>
<td>P800</td>
<td>170M6467</td>
<td>1400 A, 700 V</td>
<td>20 681 32.1400</td>
</tr>
</tbody>
</table>

### Table 3.19 Inverter Module DC-Link Fuses, 525–690 V

1) The Bussmann 170M fuses shown use the -/80 visual indicator, -TN/80 Type T, -/110 or TN/110. Type T indicator fuses of the same size and amperage may be substituted for external use.
### 3.4.14 Supplementary Fuses

<table>
<thead>
<tr>
<th>Size/type</th>
<th>Bussmann PN</th>
<th>Rating</th>
<th>Alternative fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5–4.0 A fuse</td>
<td>P450–P800, 380–500 V</td>
<td>LPJ-6 SP or SPI</td>
<td>6 A, 600 V Any listed Class J Dual Element, Time Delay, 6 A</td>
</tr>
<tr>
<td></td>
<td>P630–P1M8, 525–690 V</td>
<td>LPJ-10 SP or SPI</td>
<td>10 A, 600 V Any listed Class J Dual Element, Time Delay, 10 A</td>
</tr>
<tr>
<td>4.0–6.3 A fuse</td>
<td>P450–P800, 380–500 V</td>
<td>LPJ-10 SP or SPI</td>
<td>10 A, 600 V Any listed Class J Dual Element, Time Delay, 10 A</td>
</tr>
<tr>
<td></td>
<td>P630–P1M8, 525–690 V</td>
<td>LPJ-15 SP or SPI</td>
<td>15 A, 600 V Any listed Class J Dual Element, Time Delay, 15 A</td>
</tr>
<tr>
<td>6.3–10 A fuse</td>
<td>P450–P800, 380–500 V</td>
<td>LPJ-15 SP or SPI</td>
<td>15 A, 600 V Any listed Class J Dual Element, Time Delay, 15 A</td>
</tr>
<tr>
<td></td>
<td>P630–P1M8, 525–690 V</td>
<td>LPJ-20 SP or SPI</td>
<td>20 A, 600 V Any listed Class J Dual Element, Time Delay, 20 A</td>
</tr>
<tr>
<td>10–16 A fuse</td>
<td>P450–P800, 380–500 V</td>
<td>LPJ-25 SP or SPI</td>
<td>25 A, 600 V Any listed Class J Dual Element, Time Delay, 25 A</td>
</tr>
<tr>
<td></td>
<td>P630–P1M8, 525–690 V</td>
<td>LPJ-20 SP or SPI</td>
<td>20 A, 600 V Any listed Class J Dual Element, Time Delay, 20 A</td>
</tr>
</tbody>
</table>

Table 3.20 Manual Motor Controller Fuses

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>Bussmann PN</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>F8–F15</td>
<td>KTK-4</td>
<td>4 A, 600 V</td>
</tr>
</tbody>
</table>

Table 3.21 SMPS Fuse

<table>
<thead>
<tr>
<th>Size/type</th>
<th>Bussmann PN</th>
<th>LittelFuse</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>P315–P800, 380–500 V</td>
<td>–</td>
<td>KLK-15</td>
<td>15 A, 600 V</td>
</tr>
<tr>
<td>P500–P1M8, 525–690 V</td>
<td>–</td>
<td>KLK-15</td>
<td>15 A, 600 V</td>
</tr>
</tbody>
</table>

Table 3.22 Fan Fuses

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>Bussmann PN</th>
<th>Rating</th>
<th>Alternative fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>F8–F15</td>
<td>LPJ-30 SP or SPI</td>
<td>30 A, 600 V</td>
<td>Any listed Class J Dual Element, Time Delay, 30 A</td>
</tr>
</tbody>
</table>

Table 3.23 30 A Fuse Protected Terminal Fuse

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>Bussmann PN</th>
<th>Rating</th>
<th>Alternative fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>F8–F15</td>
<td>LPJ-6 SP or SPI</td>
<td>6 A, 600 V</td>
<td>Any listed Class J Dual Element, Time Delay, 6 A</td>
</tr>
</tbody>
</table>

Table 3.24 Control Transformer Fuse

<table>
<thead>
<tr>
<th>Enclosure size</th>
<th>Bussmann PN</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>F8–F15</td>
<td>GMC-800MA</td>
<td>800 mA, 250 V</td>
</tr>
</tbody>
</table>
3.4.15 Motor Insulation

For motor cable lengths \( \leq \) the maximum cable length listed in chapter 5.4 Cable Specifications, the motor insulation ratings in Table 3.28 are recommended. Peak voltage can be up to twice the DC-link voltage, and 2.8 times the mains voltage, due to transmission line effects in the motor cable. If a motor has lower insulation rating, use a dU/dt or sine-wave filter.

<table>
<thead>
<tr>
<th>Nominal mains voltage [V]</th>
<th>Motor insulation [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>( U_N \leq 420 )</td>
<td>Standard ( U_{LL}=1300 )</td>
</tr>
<tr>
<td>420 &lt; ( U_N \leq 500 )</td>
<td>Reinforced ( U_{LL}=1600 )</td>
</tr>
<tr>
<td>500 &lt; ( U_N \leq 600 )</td>
<td>Reinforced ( U_{LL}=1800 )</td>
</tr>
<tr>
<td>600 &lt; ( U_N \leq 690 )</td>
<td>Reinforced ( U_{LL}=2000 )</td>
</tr>
</tbody>
</table>

Table 3.28 Motor Insulation Ratings

3.4.16 Motor Bearing Currents

All motors installed with VLT® AutomationDrive FC 302 frequency converters with a power rating of 250 kW or higher must have NDE (Non-Drive End) insulated bearings installed to eliminate circulating bearing currents. To minimize DE (Drive End) bearing and shaft currents, ensure that the frequency converter, motor, driven machine, and motor to the driven machine are grounded properly.

Standard mitigation strategies:
1. Use an insulated bearing.
2. Apply rigorous installation procedures.
   2a Ensure that the motor and load motor are aligned.
   2b Strictly follow the EMC installation guideline.
   2c Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.
   2d Provide a good high frequency connection between the motor and the frequency converter, for example by using shielded cable which has a 360° connection in the motor and the frequency converter.
   2e Make sure that the impedance from the frequency converter to the building ground is lower than the grounding impedance of the machine.
   2f Make a direct ground connection between the motor and load motor.
3. Lower the IGBT switching frequency.
4. Modify the inverter waveform, 60° AVM vs. SF4VM.
5. Install a shaft grounding system or use an isolating coupling.
6. Apply conductive lubrication.
7. Use minimum speed settings where possible.
8. Ensure that the mains voltage is balanced to ground.
9. Use a dU/dt or sine-wave filter.

3.4.17 Brake Resistor Temperature Switch

- Torque: 0.5–0.6 Nm (5 in-lb)
- Screw size: M3

This input can be used to monitor the temperature of an externally connected brake resistor. If the input between 104 and 106 is established, the frequency converter trips on warning/alarm 27 Brake IGBT. If the connection is closed between 104 and 105, the frequency converter trips on warning/alarm 27 Brake IGBT. Install a KLIXON switch that is normally closed. If this function is not used, short circuit 106 and 104 together.

- Normally closed: 104–106 (factory installed jumper)
- Normally open: 104–105

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>106, 104, 105</td>
<td>Brake resistor temperature switch.</td>
</tr>
</tbody>
</table>

Table 3.29 Brake Resistor Temperature Switch Terminals

**CAUTION**

**MOTOR COASTING**

If the temperature of the brake resistor gets too high and the thermal switch drops out, the frequency converter stops braking and the motor starts coasting.

Illustration 3.47 Brake Resistor Temperature Switch
3.4.18 Control Cable Routing

Tie all control wires down to the designated control cable routing. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

Fieldbus connection
Connections are made to the relevant options on the control card. For details, see the relevant fieldbus instruction. Place the cable in the provided path inside the frequency converter and tie it down with other control wires.

Installation of 24 V DC external supply
- Torque: 0.5–0.6 Nm (5 in-lb)
- Screw size: M3

<table>
<thead>
<tr>
<th>Terminal number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 (-), 36 (+)</td>
<td>24 V DC external supply</td>
</tr>
</tbody>
</table>

Table 3.30 Terminals for 24 V DC external supply

24 V DC external supply can be used as low voltage supply to the control card and any option cards installed. This enables full operation of the LCP (including parameter setting) without connection to the mains. A warning of low voltage is given when 24 V DC has been connected; however, there is no tripping.

**NOTICE**
To ensure correct galvanic isolation (type PELV) on the control terminals of the frequency converter, use 24 V DC PELV supply.

3.4.19 Access to Control Terminals

All terminals to the control cables are located beneath the LCP. They are accessed by opening the door of the IP21/IP54 unit, or by removing the covers of the IP00 unit.

3.4.20 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in Illustration 3.48.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.
2. Insert the bare control wire into the contact.
3. To fasten the control wire into the contact, remove the screwdriver.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or reduced performance.

**NOTICE**
To minimize interference, keep control wires as short as possible and separate from high-power cables.

See chapter 5.4 Cable Specifications for control terminal wiring sizes and chapter 3.5 Connection Examples for typical control wiring connections.
3.4.21 Electrical Installation, Control Cables

Illustration 3.50 Wiring Diagram

A=Analog, D=Digital
*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the VLT® Frequency Converters Safe Torque Off Operating Instructions.

Illustration 3.51 Diagram Showing all Electrical Terminals with NAMUR Option
In rare cases and depending on the installation, long control cables and analog signals can result in 50/60 Hz ground loops due to noise from mains supply cables.

If ground loops occur, it may be necessary to break the shield or insert a 100 nF capacitor between the shield and the chassis.

To avoid ground currents from both groups affecting other groups, connect the digital and analog inputs and outputs separately to the frequency converter common inputs (terminal 20, 55, 39). For example, switching on the digital input can disturb the analog input signal.

**Input polarity of control terminals**

<table>
<thead>
<tr>
<th>12</th>
<th>13</th>
<th>18</th>
<th>19</th>
<th>27</th>
<th>29</th>
<th>32</th>
<th>33</th>
<th>20</th>
<th>37</th>
</tr>
</thead>
<tbody>
<tr>
<td>+24 VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Illustration 3.52 PNP (Source)**

1. Shielding clamps
2. Removed shielding

**Illustration 3.54 Grounding of Shielded/Armored Control Cables**

Remember to connect the shields in a proper way to ensure optimum electrical immunity.

### 3.4.22 Switches S201, S202, and S801

Use switches S201 (A53) and S202 (A54) to configure the analog input terminals 53 and 54 as a current (0–20 mA) or a voltage (-10 V to +10 V).

Enable termination on the RS485 port (terminals 68 and 69) via the switch S801 (BUS TER).

See **Illustration 3.50**.

**Default setting:**

- S201 (A53) = OFF (voltage input)
- S202 (A54) = OFF (voltage input)
- S801 (Bus termination) = OFF
NOTICE
When changing the function of S201, S202, or S801, do not use force during the switch over. Remove the LCP fixture (cradle) when operating the switches. Do not operate the switches when the frequency converter is powered.

3.5 Connection Examples
3.5.1 Start/Stop
Terminal 18 = Parameter 5-10 Terminal 18 Digital Input [8]
Start
Terminal 27 = Parameter 5-12 Terminal 27 Digital Input [0]
No operation (Default coast inverse)
Terminal 37 = STO

3.5.2 Pulse Start/Stop
Terminal 18 = Parameter 5-10 Terminal 18 Digital Input [9]
Latched start
Terminal 27 = Parameter 5-12 Terminal 27 Digital Input [6]
Stop inverse
Terminal 37 = STO
3.5.3 Speed up/Speed down

Terminals 29/32 = Speed up/Speed down

Terminal 32 = Parameter 5-14 Terminal 32 Digital Input [22] Speed down.

![Illustration 3.58 Speed up/Speed down]

**NOTICE**
Terminal 29 only in FC x02 (x=series type).

3.5.4 Potentiometer Reference

Voltage reference via a potentiometer
Terminal 53, low voltage = 0 V.
Terminal 53, high voltage = 10 V.
Terminal 53, low reference/feedback = 0 RPM.
Terminal 53, high reference/feedback = 1500 RPM.
Switch S201 = OFF (U)

![Illustration 3.59 Potentiometer Reference]

3.6 Final Set-up and Test

To test the set-up and to ensure that the frequency converter is running, follow these steps.

**Step 1. Locate the motor nameplate.**

**NOTICE**
The motor is either star (Y) or delta connected (Δ). This information is on the motor nameplate.

![Illustration 3.60 Nameplate]
Step 2. Enter the motor nameplate data in this parameter list.
To access this list, press [Quick Menu] then select Q2 Quick Setup.

1. Parameter 1-20 Motor Power [kW]
2. Parameter 1-21 Motor Power [HP]
3. Parameter 1-22 Motor Voltage
4. Parameter 1-23 Motor Frequency
5. Parameter 1-24 Motor Current
6. Parameter 1-25 Motor Nominal Speed

Step 3. Activate the Automatic Motor Adaptation (AMA).
Performing an AMA ensures optimum performance. The AMA measures the values from the motor model equivalent diagram.

1. Connect terminal 37 to terminal 12 (if terminal 37 is available).
2. Connect terminal 27 to terminal 12 or set parameter 5-12 Terminal 27 Digital Input to [0] No function.
3. Activate the AMA parameter 1-29 Automatic Motor Adaptation (AMA).
4. Select between complete or reduced AMA. If a sine-wave filter is mounted, run only the reduced AMA, or remove the sine-wave filter during the AMA procedure.
5. Press [OK]. The display shows Press [Hand On] to start.
6. Press [Hand On]. A progress bar indicates if the AMA is in progress.

Stop the AMA during operation
1. Press [Off]. The frequency converter enters into alarm mode, and the display shows that the user terminated the AMA.

Successful AMA
1. The display shows Press [OK] to finish AMA.
2. To exit the AMA state, press [OK].

Unsuccessful AMA
1. The frequency converter enters into alarm mode. A description of the alarm can be found in chapter 6 Warnings and Alarms.
2. Report Value in the [Alarm Log] shows the last measuring sequence carried out by the AMA, before the frequency converter entered alarm mode. This number along with the description of the alarm helps with troubleshooting. State the alarm number and description when contacting Danfoss service.

NOTICE
Incorrectly registered motor nameplate data, or a too significant difference between the motor power size and the frequency converter power size often causes unsuccessful AMA.

Step 4. Set the speed limit and ramp time.

- Parameter 3-02 Minimum Reference
- Parameter 3-03 Maximum Reference

Step 5. Set up the desired limits for speed and ramp time.

- Parameter 4-11 Motor Speed Low Limit [RPM] or parameter 4-12 Motor Speed Low Limit [Hz]
- Parameter 4-13 Motor Speed High Limit [RPM] or parameter 4-14 Motor Speed High Limit [Hz]
- Parameter 3-41 Ramp 1 Ramp Up Time
- Parameter 3-42 Ramp 1 Ramp Down Time

3.7 Additional Connections

3.7.1 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to be able to control an electro-mechanical brake:

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the frequency converter is unable to support the motor, for example due to the load being too heavy.
- Select [32] Mechanical brake control in parameter group 5-4* Relays for applications with an electro-mechanical brake.
- The brake is released when the motor current exceeds the preset value in parameter 2-20 Release Brake Current.
- The brake is engaged when the output frequency is less than the frequency set in parameter 2-21 Activate Brake Speed [RPM] or parameter 2-22 Activate Brake Speed [Hz], and only if the frequency converter carries out a stop command.

If the frequency converter is in alarm mode or in an overvoltage situation, the mechanical brake immediately cuts in.
3.7.2 Parallel Connection of Motors

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

**NOTICE**

Installations with cables connected in a common joint as in Illustration 3.61 are only recommended for short cable lengths.

**NOTICE**

When motors are connected in parallel, *parameter 1-29 Automatic Motor Adaptation (AMA)* cannot be used.

**NOTICE**

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

Problems can occur at start-up and at low RPM values if motor sizes are widely different because relatively high ohmic resistance in the stator of small motors calls for a higher voltage at start-up and at low RPM values.

3.7.3 Motor Thermal Protection

The electronic thermal relay (ETR) provides the overload protection. When the current is high, the ETR activates the trip function. The trip response time varies with the current magnitude inversely. The overload trip function provides the Class 20 motor overload protection.

The electronic thermal relay in the frequency converter has received UL Approval for single motor overload protection, when *parameter 1-90 Motor Thermal Protection* is set to [4] ETR Trip and *parameter 1-24 Motor Current* is set to the rated motor current (see motor nameplate). For motor thermal protection, it is also possible to use the VLT® PTC Thermistor Card MCB 112 option. This card provides ATEX certificate to protect motors in explosion hazardous areas, Zone 1/21, and Zone 2/22. When *parameter 1-90 Motor Thermal Protection* is set to [20] ATEX ETR and is combined with the use of MCB 112, it is possible to control an Ex-e motor in explosion hazardous areas. Consult the relevant *programming guide* for details on how to set up the frequency converter for safe operation of Ex-e motors.
4 How to Programme

4.1 The Graphical LCP

The LCP is divided into 4 functional groups:
1. Graphical display with status lines.
2. Menu keys and indicator lights - changing parameters and switching between display functions.
4. Operation keys and indicator lights.

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

Display lines:
- **Status line**: Status messages showing icons and graphics.
- **Line 1–2**: Operator data lines showing data defined or selected. Add up to 1 extra line by pressing [Status].
- **Status line**: Status messages showing text.

**NOTICE**
If start-up is delayed, the LCP shows the INITIALIZING message until it is ready. Adding or removing options can delay the start-up.
## 4.1.1 Initial Commissioning

The easiest way of carrying out the initial commissioning is by pressing [Quick Menu] and following the quick set-up procedure using LCP 102 (read Table 4.1 from left to right). The example applies to open-loop applications.

<table>
<thead>
<tr>
<th>Press</th>
<th>Quick Menu</th>
<th>OK</th>
<th>Q2 Quick Menu.</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter 0-01 Language</td>
<td>OK</td>
<td>Set language.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-20 Motor Power [kW]</td>
<td>OK</td>
<td>Set motor nameplate power.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-22 Motor Voltage</td>
<td>OK</td>
<td>Set nameplate voltage.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-23 Motor Frequency</td>
<td>OK</td>
<td>Set nameplate frequency.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-24 Motor Current</td>
<td>OK</td>
<td>Set nameplate current.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-25 Motor Nominal Speed</td>
<td>OK</td>
<td>Set nameplate speed in RPM.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 5-12 Terminal 27 Digital Input</td>
<td>OK</td>
<td>If terminal default is [2] Coast inverse, it is possible to change this setting to [0] No function. No connection to terminal 27 is then needed for running AMA.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 1-29 Automatic Motor Adaptation (AMA)</td>
<td>OK</td>
<td>Set desired AMA function. Enable complete AMA is recommended.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 3-02 Minimum Reference</td>
<td>OK</td>
<td>Set the minimum speed of the motor shaft.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 3-03 Maximum Reference</td>
<td>OK</td>
<td>Set the maximum speed of the motor shaft.</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 3-41 Ramp 1 Ramp Up Time</td>
<td>OK</td>
<td>Set the ramp-up time with reference to synchronous motor speed, ( n_s ).</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 3-42 Ramp 1 Ramp Down Time</td>
<td>OK</td>
<td>Set the ramp-down time with reference to synchronous motor speed, ( n_s ).</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Parameter 3-13 Reference Site</td>
<td>OK</td>
<td>Set the site from where the reference must work.</td>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.1 Quick Set-up Procedure**
Another easy way of commissioning the frequency converter is by using the smart application set-up (SAS), which can also be found by pressing [Quick Menu]. To set up the applications listed, follow the instructions on the successive screens.

The [Info] key can be used throughout the SAS to see help information for various selections, settings, and messages. The following 3 applications are included:
- Mechanical brake.
- Conveyor.
- Pump/fan.

The following 4 fieldbusses can be selected:
- PROFIBUS.
- PROFINET.
- DeviceNet.
- EtherNet/IP.

**NOTICE**
The frequency converter ignores the start conditions when SAS is active.

**NOTICE**
The smart set-up runs automatically on the first power-up of the frequency converter or after a reset to factory settings. If no action is taken, the SAS screen automatically disappears after 10 minutes.

### 4.2 Quick Set-up

<table>
<thead>
<tr>
<th>0-01 Language</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option:</td>
<td></td>
</tr>
<tr>
<td>[0] * English</td>
<td>Part of language packages 1–4</td>
</tr>
<tr>
<td>[1] Deutsch</td>
<td>Part of language packages 1–4</td>
</tr>
<tr>
<td>[2] Francais</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[3] Dansk</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[4] Spanish</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[5] Italiano</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[6] Svenska</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[7] Nederlands</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[10] Chinese</td>
<td>Part of language package 2</td>
</tr>
<tr>
<td>[20] Suomi</td>
<td>Part of language package 1</td>
</tr>
<tr>
<td>[22] English US</td>
<td>Part of language package 4</td>
</tr>
</tbody>
</table>

1-20 Motor Power [kW]

**Range:** [0.09 - 3000.00 kW]

**Function:** Size related*

**NOTICE**
This parameter cannot be adjusted while the motor is running.

Enter the nominal motor power in kW according to the motor nameplate data. The default value corresponds to the nominal rated output of the frequency converter. This parameter is visible in the LCP if parameter 0-03 Regional Settings is set to [0] International.

1-22 Motor Voltage

**Range:** [10 - 1000 V]

**Function:** Size related*

Enter the nominal motor voltage according to the motor nameplate data. The default value corresponds to the nominal rated output of the frequency converter.
1-23 Motor Frequency

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size related*</td>
<td>[20 - 1000 Hz]</td>
</tr>
</tbody>
</table>

**NOTICE**
From software version 6.72 onwards, the output frequency of the frequency converter is limited to 590 Hz.

Select the motor frequency value from the motor nameplate data. If a value other than 50 Hz or 60 Hz is selected, adapt the load-independent settings in parameter 1-50 Motor Magnetisation at Zero Speed to parameter 1-53 Model Shift Frequency. For 87 Hz operation with 230/400 V motors, set the nameplate data for 230 V/50 Hz. To run at 87 Hz, adapt parameter 4-13 Motor Speed High Limit [RPM] and parameter 3-03 Maximum Reference.

1-24 Motor Current

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size related*</td>
<td>[0.10 - 10000.00 A]</td>
</tr>
</tbody>
</table>

**NOTICE**
This parameter cannot be adjusted while the motor is running.

Enter the nominal motor current value from the motor nameplate data. The data is used for calculating motor torque, motor thermal protection, and so on.

1-25 Motor Nominal Speed

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size related*</td>
<td>[100 - 60000 RPM]</td>
</tr>
</tbody>
</table>

**NOTICE**
This parameter cannot be adjusted while the motor is running.

Enter the nominal motor speed value from the motor nameplate data. The data is used for calculating automatic motor compensations.

1-29 Automatic Motor Adaptation (AMA)

<table>
<thead>
<tr>
<th>Option:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[0]</td>
<td>OFF</td>
</tr>
<tr>
<td>[1]</td>
<td>Enable complete AMA</td>
</tr>
<tr>
<td>[2]</td>
<td>Enable reduced AMA</td>
</tr>
</tbody>
</table>

**NOTICE**
This parameter cannot be adjusted while the motor is running.

The AMA function optimizes dynamic motor performance by automatically optimizing the advanced motor parameters (parameter 1-30 Stator Resistance (Rs) to parameter 1-35 Main Reactance (Xh)) at motor standstill.

Activate the AMA function by pressing [Hand on] after selecting [1] Enable completeAMA or [2] Enable reduced AMA. See also chapter 3.6.1 Final Set-up and Test. After a normal sequence, the display reads: "Press [OK] to finish AMA". After pressing [OK], the frequency converter is ready for operation.

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

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

**NOTICE**
Avoid generating external torque during AMA.

**NOTICE**
If 1 of the settings in parameter group 1-2* Motor Data is changed, parameter 1-30 Stator Resistance (Rs) to parameter 1-39 Motor Poles return to their default setting.
### 3-02 Minimum Reference

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
</table>
| Size related* | Enter the minimum reference. The minimum reference is the lowest value obtainable by summing all references. Minimum reference is active only when parameter 3-00 Reference Range is set to [0] Min.- Max. The minimum reference unit matches:
- The unit selected in parameter 3-00 Reference/ Feedback Unit. |

If option [10] Synchronization is selected in parameter 1-00 Configuration Mode, this parameter defines the maximum speed deviation when performing the position offset defined in parameter 3-26 Master Offset.

### 3-03 Maximum Reference

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
</table>
| Size related* | Enter the maximum reference. The maximum reference is the highest value obtainable by summing all references. The maximum reference unit matches:
- The unit selected in parameter 3-00 Reference Range. |

If [9] Positioning is selected in parameter 1-00 Configuration Mode, this parameter defines the default speed for positioning.

### 3-41 Ramp 1 Ramp Up Time

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size related*</td>
<td>Enter the ramp-up time, that is, the acceleration time from 0 RPM to the synchronous motor speed ( n_s ). Select a ramp-up time which prevents the output current from exceeding the current limit in parameter 4-18 Current Limit during ramping. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-down time in parameter 3-42 Ramp 1 Ramp Down Time.</td>
</tr>
</tbody>
</table>

\[
\text{Par. 3-41} = \frac{t_{\text{acc}}}{[s]} \times n_s \left[\text{RPM}\right] \times \left[\frac{\text{RPM}}{\text{RPM}}\right]
\]

### 3-42 Ramp 1 Ramp Down Time

<table>
<thead>
<tr>
<th>Range:</th>
<th>Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size related*</td>
<td>Enter the ramp-down time, that is, the deceleration time from the synchronous motor speed ( n_s ) to 0 RPM. Select a ramp-down time such that no overvoltage occurs in the inverter due to regenerative operation of the motor, and such that the generated current does not exceed the current limit set in parameter 4-18 Current Limit. The value 0.00 corresponds to 0.01 s in speed mode. See ramp-up time in parameter 3-41 Ramp 1 Ramp Up Time.</td>
</tr>
</tbody>
</table>

\[
\text{Par. 3-42} = \frac{t_{\text{dec}}}{[s]} \times n_s \left[\text{RPM}\right] \times \left[\frac{\text{RPM}}{\text{RPM}}\right]
\]

### 5-12 Terminal 27 Digital Input

**Option:** Function: Select the function from the available digital input range.

- No operation [0]
- Reset [1]
- Coast inverse [2]
- Coast and reset inverse [3]
- Quick stop inverse [4]
- DC-brake inverse [5]
- Stop inverse [6]
- Start [8]
- Latched start [9]
- Reversing [10]
- Start reversing [11]
- Enable start forward [12]
- Enable start reverse [13]
- Jog [14]
- Preset ref bit 0 [16]
- Preset ref bit 1 [17]
- Preset ref bit 2 [18]
- Freeze reference [19]
- Freeze output [20]
- Speed up [21]
- Speed down [22]
- Set-up select bit 0 [23]
- Set-up select bit 1 [24]
- Catch up [26]
- Slow down [29]
### 5-12 Terminal 27 Digital Input

<table>
<thead>
<tr>
<th>Option</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse input</td>
<td>[32]</td>
</tr>
<tr>
<td>Ramp bit 0</td>
<td>[34]</td>
</tr>
<tr>
<td>Ramp bit 1</td>
<td>[35]</td>
</tr>
<tr>
<td>Mains failure inverse</td>
<td>[36]</td>
</tr>
<tr>
<td>DigiPot Increase</td>
<td>[55]</td>
</tr>
<tr>
<td>DigiPot Decrease</td>
<td>[56]</td>
</tr>
<tr>
<td>DigiPot Clear</td>
<td>[57]</td>
</tr>
<tr>
<td>Reset Counter A</td>
<td>[62]</td>
</tr>
<tr>
<td>Reset Counter B</td>
<td>[65]</td>
</tr>
</tbody>
</table>

### 4.3 Parameter Menu Structure
<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>34-25</td>
<td>PCO 5 Read from MCO</td>
<td>35-46 Term. X48/2 Filter Time Constant</td>
</tr>
<tr>
<td>34-24</td>
<td>PCO 4 Read from MCO</td>
<td>42-50 Cut Off Speed</td>
</tr>
<tr>
<td>34-26</td>
<td>PCO 6 Read from MCO</td>
<td>42-51 Speed Limit</td>
</tr>
<tr>
<td>34-25</td>
<td>PCO 7 Read from MCO</td>
<td>42-52 Fail Safe Reaction</td>
</tr>
<tr>
<td>34-28</td>
<td>PCO 8 Read from MCO</td>
<td>42-53 Start Ramp</td>
</tr>
<tr>
<td>34-29</td>
<td>PCO 9 Read from MCO</td>
<td>42-54 Ramp Down Time</td>
</tr>
<tr>
<td>34-30</td>
<td>PCO 10 Read from MCO</td>
<td>42-55 Safe Fieldbus</td>
</tr>
<tr>
<td>34-40</td>
<td>Inputs &amp; Outputs</td>
<td>36-04 Terminal X49/7 Mode</td>
</tr>
<tr>
<td>34-41</td>
<td>Digital Inputs</td>
<td>36-08 Terminal X49/9 Mode</td>
</tr>
<tr>
<td>34-42</td>
<td>Terminal X48/8 Min. Scale</td>
<td>36-10 Terminal X49/11 Mode</td>
</tr>
<tr>
<td>34-43</td>
<td>Terminal X49/7 Max. Scale</td>
<td>36-12 Terminal X49/11 Mode</td>
</tr>
<tr>
<td>34-44</td>
<td>Terminal X49/7 Bus Control</td>
<td>36-14 Terminal X49/11 Bus Control</td>
</tr>
<tr>
<td>34-45</td>
<td>Terminal X49/7/7/777</td>
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<td>Actual Position</td>
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<td>36-22 Terminal X49/11/7777777777</td>
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<td>42-16 Tolerance Error</td>
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<td>Temperature Sensor Alarm Function</td>
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</tr>
<tr>
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<td>Term. X48/4 Low Temp. Limit</td>
<td>42-24 Safe Input</td>
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<td>Term. X48/4 High Temp. Limit</td>
<td>42-21 Type</td>
</tr>
<tr>
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</tr>
<tr>
<td>35-25</td>
<td>Term. X48/7 Temp. Monitor</td>
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</tr>
<tr>
<td>35-26</td>
<td>Term. X48/7 Low Temp. Limit</td>
<td>42-24 Delta V</td>
</tr>
<tr>
<td>35-27</td>
<td>Term. X48/7 High Temp. Limit</td>
<td>42-25 Delta T</td>
</tr>
<tr>
<td>35-34</td>
<td>Term. X48/10 Filter Time Constant</td>
<td>42-26 Zero Speed</td>
</tr>
<tr>
<td>35-35</td>
<td>Term. X48/10 Temp. Monitor</td>
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</tr>
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<td>35-37</td>
<td>Term. X48/10 High Temp. Limit</td>
<td>42-29 Safe Input</td>
</tr>
<tr>
<td>35-40</td>
<td>Analog Input X48/2</td>
<td>42-30 Safe Input</td>
</tr>
<tr>
<td>35-42</td>
<td>Term. X48/2 Low Current</td>
<td>42-31 Safe Input</td>
</tr>
<tr>
<td>35-43</td>
<td>Term. X48/2 High Current</td>
<td>42-32 Safe Input</td>
</tr>
<tr>
<td>35-44</td>
<td>Term. X48/2 Low Ref./Feedb. Value</td>
<td>42-33 Safe Input</td>
</tr>
<tr>
<td>35-45</td>
<td>Term. X48/2 High Ref./Feedb. Value</td>
<td>42-34 Safe Input</td>
</tr>
<tr>
<td>35-46</td>
<td>Term. X48/2 Filter Time Constant</td>
<td>42-35 Safe Input</td>
</tr>
<tr>
<td>35-47</td>
<td>Term. X48/2 Temp. Monitor</td>
<td>42-36 Safe Input</td>
</tr>
<tr>
<td>35-48</td>
<td>Term. X48/2 Low Temp. Limit</td>
<td>42-37 Safe Input</td>
</tr>
<tr>
<td>35-49</td>
<td>Term. X48/2 High Temp. Limit</td>
<td>42-38 Safe Input</td>
</tr>
<tr>
<td>35-50</td>
<td>Term. X48/2 Low Ref./Feedb. Value</td>
<td>42-39 Safe Input</td>
</tr>
<tr>
<td>35-51</td>
<td>Term. X48/2 High Ref./Feedb. Value</td>
<td>42-40 Safe Input</td>
</tr>
</tbody>
</table>
5 General Specifications

5.1 Mains Supply

Mains supply (L1-1, L2-1, L3-1, L1-2, L2-2, L3-2)

Supply voltage 380–500 V ±10%
Supply voltage 525–690 V ±10%

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

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 L1-1, L2-1, L3-1, L1-2, L2-2, L3-2 (power-ups) Maximum 1 time/2 minutes

Environment according to EN 60664-1
Overvoltage category III/pollution degree 2

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

5.2 Motor Output and Motor Data

Motor output (U, V, W)

Output voltage 0–100% of supply voltage
Output frequency 0–590 Hz
Switching on output Unlimited
Ramp times 0.001–3600 s

Torque characteristics
Starting torque (constant torque) Maximum 150% for 60 s\(^1\) once in 10 minutes
Starting/overload torque (variable torque) Maximum 110% up to 0.5 s\(^1\) once in 10 minutes
Torque rise time in FLUX (for 5 kHz fsw) 1 ms
Torque rise time in VVC\(^+\) (independent of fsw) 10 ms

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

5.3 Ambient Conditions

Surroundings
Enclosure IP21/Type 1, IP54/Type 12
Vibration test 0.7 g
Maximum relative humidity 5–95% (IEC 721-3-3; Class 3K3 (non-condensing)) during operation
Aggressive environment (IEC 60068-2-43) Class H\(2\)
Ambient temperature (with SFAVM switching mode)
- with derating Maximum 55 °C (131 °F)\(^1\)
- at full continuous frequency converter output current Maximum 45 °C (113 °F)\(^1\)

1) For more information on derating, see special conditions in the VLT® AutomationDrive FC 301/FC 302 Design Guide

Derating for high altitude, see special conditions in the VLT® AutomationDrive FC 301/FC 302 Design Guide
5.4 Cable Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</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 control terminals, flexible/rigid wire without sleeve</td>
<td>1.5 mm²/16 AWG</td>
</tr>
<tr>
<td>Maximum cross-section to control terminals, flexible wire with sleeve</td>
<td>1 mm²/18 AWG</td>
</tr>
<tr>
<td>Maximum cross-section to control terminals, flexible wire with collar</td>
<td>0.5 mm²/20 AWG</td>
</tr>
<tr>
<td>Minimum cross-section to control terminals</td>
<td>0.25 mm²/24 AWG</td>
</tr>
</tbody>
</table>

5.5 Control Input/output and Control Data

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Number</th>
<th>Terminal Number</th>
<th>Logic</th>
<th>Voltage Level</th>
<th>Voltage Level, Logic 0 PNP</th>
<th>Voltage Level, Logic 1 PNP</th>
<th>Voltage Level, Logic 0 NPN</th>
<th>Voltage Level, Logic 1 NPN</th>
<th>Pulse Frequency Range</th>
<th>Maximum Voltage on Input</th>
<th>Input Capacitance</th>
<th>Input Resistance, Rᵢ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital inputs</td>
<td>4 (6)</td>
<td>18, 19, 27¹, 29, 32, 33</td>
<td>PNP or NPN</td>
<td>0–24 V DC</td>
<td>&lt;5 V DC</td>
<td>&gt;10 V DC</td>
<td>&gt;19 V DC</td>
<td>&gt;14 V DC</td>
<td>0–110 kHz</td>
<td>±20 V</td>
<td>400 nF</td>
<td>4.5 ms</td>
</tr>
<tr>
<td>Safe Torque Off (terminal 37)</td>
<td>2</td>
<td>53, 54</td>
<td>Voltage or current</td>
<td>0–24 V DC</td>
<td>&lt;4 V DC</td>
<td>&gt;20 V DC</td>
<td>50 mA rms</td>
<td>60 mA rms</td>
<td></td>
<td></td>
<td></td>
<td>approximately 4 kΩ</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 output.
2) Except Safe Torque Off input terminal 37.
3) See chapter 2.3.1 Safe Torque Off (STO) for further information about terminal 37 and STO.
### Resolution for analog inputs
10 bit (+ sign)

### Accuracy of analog inputs
Maximum error 0.5% of full scale

### Bandwidth
100 Hz

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

---

#### Pulse/encoder inputs

<table>
<thead>
<tr>
<th>Programmable pulse/encoder inputs</th>
<th>2/1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal number pulse/encoder</td>
<td>29(^1), 33(^2)/32(^2), 33(^3)</td>
</tr>
<tr>
<td>Maximum frequency at terminal 29, 32, 33</td>
<td>110 kHz (Push-pull driven)</td>
</tr>
<tr>
<td>Maximum frequency at terminal 29, 32, 33</td>
<td>5 kHz (Open collector)</td>
</tr>
<tr>
<td>Minimum frequency at terminal 29, 32, 33</td>
<td>4 Hz</td>
</tr>
</tbody>
</table>

**Voltage level**: See section 5.1 in the *Digital Inputs* in the *programming guide*.

**Maximum voltage on input**: 28 V DC

**Input resistance, **\( R_i \)**: Approximately 4 k\( \Omega \)

**Pulse input accuracy (0.1–1 kHz)**: Maximum error: 0.1% of full scale

**Encoder input accuracy (1–11 kHz)**: Maximum error: 0.05% of full scale

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

1) FC 302 only.

2) Pulse inputs are 29 and 33.

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

---

#### Digital output

<table>
<thead>
<tr>
<th>Programmable digital/pulse outputs</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal number</td>
<td>27, 29(^1)</td>
</tr>
<tr>
<td>Voltage level at digital/frequency output</td>
<td>0–24 V</td>
</tr>
<tr>
<td>Maximum output current (sink or source)</td>
<td>40 mA</td>
</tr>
<tr>
<td>Maximum load at frequency output</td>
<td>1 k( \Omega )</td>
</tr>
<tr>
<td>Maximum capacitive load at frequency output</td>
<td>10 nF</td>
</tr>
<tr>
<td>Minimum output frequency at frequency output</td>
<td>0 Hz</td>
</tr>
<tr>
<td>Maximum output frequency at frequency output</td>
<td>32 kHz</td>
</tr>
<tr>
<td>Accuracy of frequency output</td>
<td>Maximum error: 0.1% of full scale</td>
</tr>
<tr>
<td>Resolution of frequency outputs</td>
<td>12 bit</td>
</tr>
</tbody>
</table>

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

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

---

#### Analog output

<table>
<thead>
<tr>
<th>Number of programmable analog outputs</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal number</td>
<td>42</td>
</tr>
<tr>
<td>Current range at analog output</td>
<td>0/4 to 20 mA</td>
</tr>
<tr>
<td>Maximum load GND - analog output less than</td>
<td>500 ( \Omega )</td>
</tr>
<tr>
<td>Accuracy on analog output</td>
<td>Maximum error: 0.5% of full scale</td>
</tr>
<tr>
<td>Resolution on analog output</td>
<td>12 bit</td>
</tr>
</tbody>
</table>

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
Control card, 24 V DC output
Terminal number: 12, 13
Output voltage: 24 V ±1, -3 V
Maximum load: 200 mA

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

Control card, 10 V DC output
Terminal number: ±50
Output voltage: 10.5 V ±0.5 V
Maximum load: 15 mA

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

Control 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).

Control card, USB serial communication
USB standard: 1.1 (Full speed)
USB plug: USB type B “device” plug

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB ground connection is not galvanically isolated from protection earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

Relay outputs
Programmable relay outputs: 2
Relay 01 terminal number: 1-3 (break), 1 2 (make)
Maximum terminal load (AC-1) on 1-3 (NC), 1-2 (NO) (Resistive load): 240 V AC, 2 A
Maximum terminal load (AC-15) on 1-3 (NC), 1-2 (NO) (Inductive load @ cosφ0.4): 240 V AC, 0.2 A
Maximum terminal load (DC-1) on 1-2 (NO), 1-3 (NC) (Resistive load): 60 V DC, 1 A
Maximum terminal load (DC-13) on 1-2 (NO), 1-3 (NC) (Inductive load): 24 V DC, 0.1 A
Relay 02 (FC 302 only) terminal number: 4-6 (break), 4-5 (make)
Maximum terminal load (AC-15) on 4-5 (NO) (Resistive load): 400 V AC, 2 A
Maximum terminal load (AC-15) on 4-5 (NO) (Inductive load @ cosφ0.4): 240 V AC, 0.2 A
Maximum terminal load (DC-1) on 4-5 (NO) (Resistive load): 80 V DC, 2 A
Maximum terminal load (DC-13) on 4-5 (NO) (Inductive load): 24 V DC, 0.1 A
Maximum terminal load (AC-13) on 4-6 (NC) (Resistive load): 240 V AC, 2 A
Maximum terminal load (AC-13) on 4-6 (NC) (Inductive load @ cosφ0.4): 240 V AC, 0.2 A
Maximum terminal load (DC-13) on 4-6 (NC) (Resistive load): 50 V DC, 2 A
Maximum terminal load (DC-13) on 4-6 (NC) (Inductive load): 24 V DC, 0.1 A
Minimum terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO): 24 V DC 10 mA, 24 V AC 20 mA

Environment according to EN 60664-1
Overvoltage category III/pollution degree 2

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

Control card performance
Scan interval: 1 ms
Control characteristics

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

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

Protection and Features

- Electronic motor thermal protection against overload.
- If the temperature reaches a predefined level, temperature monitoring of the heat sink ensures that the frequency converter trips. An overload temperature cannot be reset until the temperature of the heat sink is below the values stated in the tables in chapter 5.6 Electrical Data (Guideline - these temperatures can vary for different power sizes, enclosure sizes, enclosure ratings, and so on).
- The frequency converter is protected against short circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- If the DC-link voltage is too low or too high, monitoring of the DC-link voltage ensures that the frequency converter trips.
- The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the DC link, and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and/or change the switching pattern to ensure the performance of the frequency converter.
## 5.6 Electrical Data

<table>
<thead>
<tr>
<th>Mains supply 6x380–500 V AC</th>
<th>P250</th>
<th>P315</th>
<th>P355</th>
<th>P400</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High/Normal Load</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>HO</td>
<td>NO</td>
<td>HO</td>
<td>NO</td>
</tr>
<tr>
<td>Typical shaft output at 400 V [kW]</td>
<td>250</td>
<td>315</td>
<td>315</td>
<td>355</td>
</tr>
<tr>
<td>Typical shaft output at 460 V [hp]</td>
<td>350</td>
<td>450</td>
<td>450</td>
<td>500</td>
</tr>
<tr>
<td>Typical shaft output at 500 V [kW]</td>
<td>315</td>
<td>355</td>
<td>355</td>
<td>400</td>
</tr>
<tr>
<td>Enclosure protection rating</td>
<td>IP21</td>
<td>F8/F9</td>
<td>F8/F9</td>
<td>F8/F9</td>
</tr>
<tr>
<td>Enclosure protection rating</td>
<td>IP54</td>
<td>F8/F9</td>
<td>F8/F9</td>
<td>F8/F9</td>
</tr>
<tr>
<td><strong>Output current</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>480</td>
<td>600</td>
<td>600</td>
<td>658</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 400 V) [A]</td>
<td>720</td>
<td>660</td>
<td>900</td>
<td>724</td>
</tr>
<tr>
<td>Continuous (at 460/500 V) [A]</td>
<td>443</td>
<td>540</td>
<td>540</td>
<td>590</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 460/500 V) [A]</td>
<td>665</td>
<td>594</td>
<td>810</td>
<td>649</td>
</tr>
<tr>
<td>Continuous kVA (at 400 V) [kVA]</td>
<td>333</td>
<td>416</td>
<td>416</td>
<td>456</td>
</tr>
<tr>
<td>Continuous kVA (at 460 V) [kVA]</td>
<td>353</td>
<td>430</td>
<td>430</td>
<td>470</td>
</tr>
<tr>
<td>Continuous kVA (at 500 V) [kVA]</td>
<td>384</td>
<td>468</td>
<td>468</td>
<td>511</td>
</tr>
<tr>
<td><strong>Maximum input current</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 400 V) [A]</td>
<td>472</td>
<td>590</td>
<td>590</td>
<td>647</td>
</tr>
<tr>
<td>Continuous (at 460/500 V) [A]</td>
<td>436</td>
<td>531</td>
<td>531</td>
<td>580</td>
</tr>
<tr>
<td>Maximum cable size, mains [mm&lt;sup&gt;2&lt;/sup&gt; (AWG&lt;sup&gt;2&lt;/sup&gt;)]&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4x90 (3/0)</td>
<td>4x90 (3/0)</td>
<td>4x240 (500 mcm)</td>
<td>4x240 (500 mcm)</td>
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<tr>
<td>Maximum cable size, motor [mm&lt;sup&gt;2&lt;/sup&gt; (AWG&lt;sup&gt;2&lt;/sup&gt;)]&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4x240 (4x500 MCM)</td>
<td>4x240 (4x500 MCM)</td>
<td>4x240 (4x500 MCM)</td>
<td>4x240 (4x500 MCM)</td>
</tr>
<tr>
<td>Maximum cable size, brake [mm&lt;sup&gt;2&lt;/sup&gt; (AWG&lt;sup&gt;2&lt;/sup&gt;)]&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2x185 (2x350 MCM)</td>
<td>2x185 (2x350 MCM)</td>
<td>2x185 (2x350 MCM)</td>
<td>2x185 (2x350 MCM)</td>
</tr>
<tr>
<td>Maximum external mains fuses [A]&lt;sup&gt;d&lt;/sup&gt;</td>
<td>700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated power loss at 400 V [W]&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5164</td>
<td>6790</td>
<td>6960</td>
<td>7701</td>
</tr>
<tr>
<td>Estimated power loss at 460 V [W]&lt;sup&gt;e&lt;/sup&gt;</td>
<td>4822</td>
<td>6082</td>
<td>6345</td>
<td>6953</td>
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<tr>
<td>Weight, enclosure protection rating IP21, IP54 [kg (lb)]&lt;sup&gt;f&lt;/sup&gt;</td>
<td>440/656 (970/1446)</td>
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<tr>
<td>Efficiency&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0.98</td>
<td></td>
<td></td>
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<tr>
<td>Output frequency</td>
<td>0–590 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat sink overtemperature trip</td>
<td>95 °C (203 °F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power card ambient trip</td>
<td>75 °C (167 °F)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s

Table 5.1 Mains Supply 6x380–500 V AC
### Table 5.2 Mains Supply 6x380–500 V AC

<table>
<thead>
<tr>
<th>FC 302</th>
<th>P450</th>
<th>P500</th>
<th>P560</th>
<th>P630</th>
<th>P710</th>
<th>P800</th>
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<tr>
<td><strong>High/Normal Load</strong></td>
<td>HO/NO</td>
<td>HO/NO</td>
<td>HO/NO</td>
<td>HO/NO</td>
<td>HO/NO</td>
<td>HO/NO</td>
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<tr>
<td><strong>Typical shaft output at 400 V [kW]</strong></td>
<td>450</td>
<td>500</td>
<td>500</td>
<td>560</td>
<td>630</td>
<td>630</td>
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<tr>
<td><strong>Typical shaft output at 460 V [hp]</strong></td>
<td>600</td>
<td>650</td>
<td>650</td>
<td>750</td>
<td>900</td>
<td>900</td>
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<tr>
<td><strong>Typical shaft output at 500 V [kW]</strong></td>
<td>530</td>
<td>560</td>
<td>560</td>
<td>630</td>
<td>630</td>
<td>710</td>
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<tr>
<td><strong>Enclosure protection rating IP21, 54 without/with options cabinet</strong></td>
<td>F10/F11</td>
<td>F10/F11</td>
<td>F10/F11</td>
<td>F10/F11</td>
<td>F10/F11</td>
<td>F12/F13</td>
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<td><strong>Output current</strong></td>
<td></td>
<td></td>
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<tr>
<td>Continuous (at 400 V) [A]</td>
<td>800</td>
<td>880</td>
<td>880</td>
<td>990</td>
<td>990</td>
<td>1120</td>
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<td>Intermittent (60 s overload) (at 400 V) [A]</td>
<td>1200</td>
<td>968</td>
<td>1320</td>
<td>1089</td>
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<td>Continuous (at 460/500 V) [A]</td>
<td>730</td>
<td>780</td>
<td>780</td>
<td>890</td>
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<td>1050</td>
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<td>Intermittent (60 s overload) (at 460/500 V) [A]</td>
<td>1095</td>
<td>858</td>
<td>1170</td>
<td>979</td>
<td>1335</td>
<td>1155</td>
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<td>Continuous kVA (at 400 V) [kVA]</td>
<td>554</td>
<td>610</td>
<td>610</td>
<td>686</td>
<td>686</td>
<td>776</td>
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<td>Continuous kVA (at 460 V) [kVA]</td>
<td>582</td>
<td>621</td>
<td>621</td>
<td>709</td>
<td>709</td>
<td>837</td>
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<td>Continuous kVA (at 500 V) [kVA]</td>
<td>632</td>
<td>675</td>
<td>675</td>
<td>771</td>
<td>771</td>
<td>909</td>
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<td>Maximum input current</td>
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<td></td>
<td></td>
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<tr>
<td>Continuous (at 400 V) [A]</td>
<td>779</td>
<td>857</td>
<td>857</td>
<td>964</td>
<td>964</td>
<td>1090</td>
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<tr>
<td>Continuous (at 460/500 V) [A]</td>
<td>711</td>
<td>759</td>
<td>759</td>
<td>867</td>
<td>867</td>
<td>1022</td>
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<tr>
<td>Maximum cable size, motor [mm² (AWG²)]</td>
<td>8x150 (8x300 MCM)</td>
<td>12x150 (12x300 MCM)</td>
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<tr>
<td>Maximum cable size, mains [mm² (AWG²)]</td>
<td>6x120 (6x250 MCM)</td>
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</tr>
<tr>
<td>Maximum cable size, brake [mm² (AWG²)]</td>
<td>4x185 (4x350 MCM)</td>
<td>6x185 (6x350 MCM)</td>
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<td></td>
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<tr>
<td>Maximum external mains fuses [A]</td>
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<td>1500</td>
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<td></td>
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<tr>
<td>Estimated power loss at 400 V [W]</td>
<td>9492</td>
<td>10647</td>
<td>10631</td>
<td>12338</td>
<td>11263</td>
<td>13201</td>
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<tr>
<td>Estimated power loss at 460 V [W]</td>
<td>8730</td>
<td>9414</td>
<td>9398</td>
<td>11006</td>
<td>10063</td>
<td>12353</td>
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<tr>
<td>F9/F11/F13 maximum added losses A1 RFI, CB, or Disconnect, &amp; contactor F9/F11/F13</td>
<td>893</td>
<td>963</td>
<td>951</td>
<td>1054</td>
<td>978</td>
<td>1093</td>
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<tr>
<td>Maximum panel options losses [W]</td>
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<td></td>
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<td></td>
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<tr>
<td>Weight, enclosure protection rating IP21, IP54 [kg (lb)]</td>
<td>1004/1299 (2213/2864)</td>
<td>1004/1299 (2213/2864)</td>
<td>1004/1299 (2213/2864)</td>
<td>1004/1299 (2213/2864)</td>
<td>1004/1299 (2213/2864)</td>
<td>1004/1299 (2213/2864)</td>
</tr>
<tr>
<td>Weight Rectifier Module [kg (lb)]</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>136 (300)</td>
<td>136 (300)</td>
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<tr>
<td>Weight Inverter Module [kg (lb)]</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>136 (300)</td>
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<tr>
<td>Efficiency</td>
<td>0.98</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Output frequency</td>
<td>0–590 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat sink overttemperature trip</td>
<td>95 °C (203 °F)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Power card ambient trip</td>
<td>75 °C (167 °F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A) High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s
## General Specifications

### Mains Supply 6x525–690 V AC

<table>
<thead>
<tr>
<th>FC 302</th>
<th>P355</th>
<th>P400</th>
<th>P500</th>
<th>P560</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High/Normal Load</strong> HO/NO</td>
<td>HO</td>
<td>NO</td>
<td>HO</td>
<td>NO</td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>315</td>
<td>355</td>
<td>315</td>
<td>400</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>400</td>
<td>450</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>355</td>
<td>450</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Enclosure protection rating</td>
<td>IP21</td>
<td>F8/F9</td>
<td>F8/F9</td>
<td>F8/F9</td>
</tr>
<tr>
<td>Enclosure protection rating</td>
<td>IP54</td>
<td>F8/F9</td>
<td>F8/F9</td>
<td>F8/F9</td>
</tr>
</tbody>
</table>

### Output current

- **Continuous** (at 550 V) [A]
  - 395
  - 470
  - 429
  - 523
  - 523
  - 596
  - 596
  - 630

- **Intermittent** (60 s overload) (at 550 V) [A]
  - 593
  - 517
  - 644
  - 575
  - 785
  - 656
  - 894
  - 693

- **Continuous** (at 575/690 V) [A]
  - 380
  - 450
  - 410
  - 500
  - 500
  - 570
  - 570
  - 630

- **Intermittent** (60 s overload) (at 575/690 V) [A]
  - 570
  - 495
  - 615
  - 550
  - 750
  - 627
  - 855
  - 693

- **Continuous kVA** (at 550 V) [kVA]
  - 376
  - 448
  - 409
  - 498
  - 498
  - 568
  - 568
  - 600

- **Continuous kVA** (at 575 V) [kVA]
  - 378
  - 448
  - 408
  - 498
  - 498
  - 568
  - 568
  - 627

- **Continuous kVA** (at 690 V) [kVA]
  - 454
  - 538
  - 490
  - 598
  - 598
  - 681
  - 681
  - 753

### Maximum input current

- **Continuous** (at 550 V) [A]
  - 381
  - 453
  - 413
  - 504
  - 504
  - 574
  - 574
  - 607

- **Continuous** (at 575 V) [A]
  - 366
  - 434
  - 395
  - 482
  - 482
  - 549
  - 549
  - 607

- **Continuous** (at 690 V) [A]
  - 366
  - 434
  - 395
  - 482
  - 482
  - 549
  - 549
  - 607

### Maximum cable size, mains

- 4x85 (3/0)

### Maximum cable size, motor

- 4x250 (500 MCM)

### Maximum cable size, brake

- 2x185 (2x350 MCM)
- 2x185 (2x350 MCM)
- 2x185 (2x350 MCM)

### Maximum external mains fuses [A]φ

- 630

### Estimated power loss at 600 V [W]φ

- 5107
- 6132
- 5538
- 6903
- 7336
- 8343
- 8331
- 9244

### Estimated power loss at 690 V [W]φ

- 5383
- 6449
- 5818
- 7249
- 7671
- 8727
- 8715
- 9673

### Weight

- 440/656 (970/1446)

### Efficiencyφ

- 0.98

### Output frequency

- 0–590 Hz

### Heat sink overtemperature trip

- 85 °C (185 °F)

### Power card ambient trip

- 75 °C (167 °F)

A) High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s

Table 5.3 Mains Supply 6x525–690 V AC
## Mains supply 6x525–690 V AC

<table>
<thead>
<tr>
<th>FC 302</th>
<th>P630</th>
<th>P710</th>
<th>P800</th>
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<tr>
<td><strong>High/Normal Load</strong></td>
<td>HO/NO</td>
<td>HO/NO</td>
<td>HO/NO</td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>500</td>
<td>560</td>
<td>670</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>650</td>
<td>750</td>
<td>950</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>630</td>
<td>710</td>
<td>800</td>
</tr>
<tr>
<td>Enclosure protection rating IP21, IP54</td>
<td>F10/F11</td>
<td>F10/F11</td>
<td>F10/F11</td>
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### Output current

<table>
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<tr>
<th></th>
<th>Continuous (at 550 V) [A]</th>
<th>Inter mittent (60 s overload) (at 550 V) [A]</th>
<th>Continuous (at 575/690 V) [A]</th>
<th>Inter mittent (60 s overload) (at 575/690 V) [A]</th>
<th>Continuous kVA (at 550 V) [kVA]</th>
<th>Continuous kVA (at 575 V) [kVA]</th>
<th>Continuous kVA (at 690 V) [kVA]</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>659</td>
<td>763</td>
<td>763</td>
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<td>889</td>
<td>988</td>
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<td>839</td>
<td>1145</td>
<td>978</td>
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<td>1087</td>
<td>1040</td>
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<td>630</td>
<td>730</td>
<td>730</td>
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### Maximum input current

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<tr>
<th></th>
<th>Continuous (at 550 V) [A]</th>
<th>Continuous (at 575 V) [A]</th>
<th>Continuous (at 690 V) [A]</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>642</td>
<td>743</td>
<td>743</td>
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<td>743</td>
<td>866</td>
<td>866</td>
</tr>
<tr>
<td></td>
<td>613</td>
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<td>828</td>
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<tr>
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</tr>
<tr>
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### Maximum cable size, motor

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<tr>
<th></th>
<th>[mm$^2$] (AWG$^{(2)}$)</th>
<th>8x150 (8x300 MCM)</th>
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### Maximum cable size, mains

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<tr>
<th></th>
<th>[mm$^2$] (AWG$^{(2)}$)</th>
<th>6x120 (6x250 MCM)</th>
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### Maximum cable size, brake

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<tr>
<th></th>
<th>[mm$^2$] (AWG$^{(2)}$)</th>
<th>4x185 (4x350 MCM)</th>
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### Maximum external mains fuses [A]$^{(3)}$

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### Estimated power loss

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<th>at 600 V [W]$^{(4)}$</th>
<th>at 690 V [W]$^{(4)}$</th>
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<td></td>
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<td>10771</td>
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### F3/F4 maximum added losses CB or disconnect & contactor

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### Maximum panel options losses [W]

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### Weight, enclosure protection rating IP21, IP54 [kg (lb)]

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<th>1004/1299 (2213/2864)</th>
<th>1004/1299 (2213/2864)</th>
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<tbody>
<tr>
<td>Weight, rectifier module [kg (lb)]</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>102 (225)</td>
</tr>
<tr>
<td>Weight, inverter module [kg (lb)]</td>
<td>102 (225)</td>
<td>102 (225)</td>
<td>136 (300)</td>
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<tr>
<td>Efficiency$^{(5)}$</td>
<td>0.98</td>
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### Output frequency

<table>
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<tr>
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<th>0–590 Hz</th>
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### Heat sink overtemperature trip

<table>
<thead>
<tr>
<th></th>
<th>85 °C (185 °F)</th>
</tr>
</thead>
</table>

### Power card ambient trip

<table>
<thead>
<tr>
<th></th>
<th>75 °C (167 °F)</th>
</tr>
</thead>
</table>

$^{(1)}$ High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s

---

Table 5.4 Mains Supply 6x525–690 V AC
<table>
<thead>
<tr>
<th>Mains supply 6x525–690 V AC</th>
<th>P900</th>
<th>P1M0</th>
<th>P1M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC 302</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High/Normal Load: HO/NO</td>
<td>HO</td>
<td>NO</td>
<td>HO</td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>750</td>
<td>850</td>
<td>850</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>1050</td>
<td>1150</td>
<td>1150</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>900</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Enclosure protection rating IP21, IP54 without/with options cabinet</td>
<td>F12/F13</td>
<td>F12/F13</td>
<td>F12/F13</td>
</tr>
</tbody>
</table>

### Output current

<table>
<thead>
<tr>
<th>Continuous (at 550 V) [A]</th>
<th>988</th>
<th>1108</th>
<th>1108</th>
<th>1317</th>
<th>1317</th>
<th>1479</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent (60 s overload) (at 550 V) [A]</td>
<td>1482</td>
<td>1219</td>
<td>1662</td>
<td>1449</td>
<td>1976</td>
<td>1627</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>945</td>
<td>1060</td>
<td>1060</td>
<td>1260</td>
<td>1260</td>
<td>1415</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 575/690 V) [A]</td>
<td>1418</td>
<td>1166</td>
<td>1590</td>
<td>1386</td>
<td>1890</td>
<td>1557</td>
</tr>
</tbody>
</table>

### Maximum input current

| Continuous (at 550 V) [A] | 962  | 1079 | 1079 | 1282 | 1282 | 1440 |
| Continuous (at 575 V) [A] | 920  | 1032 | 1032 | 1227 | 1227 | 1378 |
| Continuous (at 690 V) [A] | 920  | 1032 | 1032 | 1227 | 1227 | 1378 |

### Maximum cable size

- Motor [mm² (AWG²)]: 12x150 (12x300 MCM)
- Mains F12 [mm² (AWG²)]: 8x240 (8x500 MCM)
- Mains F13 [mm² (AWG²)]: 8x400 (8x900 MCM)
- Brake [mm² (AWG²)]: 6x185 (6x350 MCM)

### External mains fuses [A]¹¹

<table>
<thead>
<tr>
<th>1600</th>
<th>2000</th>
<th>2500</th>
</tr>
</thead>
<tbody>
<tr>
<td>13755</td>
<td>15592</td>
<td>15107</td>
</tr>
<tr>
<td>14457</td>
<td>16375</td>
<td>15899</td>
</tr>
</tbody>
</table>

### Estimated power loss

- 600 V [W]⁶: 1246/1541 (2747/3397)
- 690 V [W]⁶: 1246/1541 (2747/3397)
- 1280/1575 (2822/3472)

### Efficiency

- 0.98

### Weight

- Enclosure protection rating IP21, IP54 [kg (lb)]: 1246/1541 (2747/3397)
- Rectifier module [kg (lb)]: 136 (300)
- Inverter module [kg (lb)]: 102 (225)

### Heat sink overtemperature trip

- 85 °C (185 °F)

### Power card ambient trip

- 75 °C (167 °F)

---

A) High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s

---

Table 5.5 Mains Supply 6x525–690 V AC
### Mains supply 6x525–690 V AC

<table>
<thead>
<tr>
<th>FC 302</th>
<th>P1M4</th>
<th>P1M6</th>
<th>P1M8</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/Normal Load(^a) HO/NO</td>
<td>HO</td>
<td>NO</td>
<td>HO</td>
</tr>
<tr>
<td>Typical shaft output at 550 V [kW]</td>
<td>1100</td>
<td>1250</td>
<td>1250</td>
</tr>
<tr>
<td>Typical shaft output at 575 V [hp]</td>
<td>1550</td>
<td>1700</td>
<td>1700</td>
</tr>
<tr>
<td>Typical shaft output at 690 V [kW]</td>
<td>1400</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td>Enclosure protection rating IP21, IP54</td>
<td>F14/F15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without/with options cabinet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output current</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>1479</td>
<td>1652</td>
<td>1652</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 550 V) [A]</td>
<td>2219</td>
<td>1817</td>
<td>2478</td>
</tr>
<tr>
<td>Continuous (at 575/690 V) [A]</td>
<td>1415</td>
<td>1580</td>
<td>1580</td>
</tr>
<tr>
<td>Intermittent (60 s overload) (at 575/690 V) [A]</td>
<td>2122</td>
<td>1738</td>
<td>2370</td>
</tr>
<tr>
<td>Continuous kVA (at 550 V) [kVA]</td>
<td>1409</td>
<td>1574</td>
<td>1574</td>
</tr>
<tr>
<td>Continuous kVA (at 575 V) [kVA]</td>
<td>1409</td>
<td>1574</td>
<td>1574</td>
</tr>
<tr>
<td>Continuous kVA (at 690 V) [kVA]</td>
<td>1691</td>
<td>1888</td>
<td>1888</td>
</tr>
<tr>
<td><strong>Maximum input current</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous (at 550 V) [A]</td>
<td>1440</td>
<td>1608</td>
<td>1608</td>
</tr>
<tr>
<td>Continuous (at 575 V) [A]</td>
<td>1378</td>
<td>1538</td>
<td>1538</td>
</tr>
<tr>
<td>Continuous (at 690 V) [A]</td>
<td>1378</td>
<td>1538</td>
<td>1538</td>
</tr>
<tr>
<td>Maximum cable size, motor [mm(^2) (AWG(^2))]</td>
<td>12x150 (12x300 MCM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cable size, mains F14 [mm(^2) (AWG(^2))]</td>
<td>8x240 (8x500 MCM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cable size, mains F15 [mm(^2) (AWG(^2))]</td>
<td>8x400 (8x900 MCM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cable size, brake [mm(^2) (AWG(^2))]</td>
<td>6x185 (6x350 MCM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum external mains fuses [A](^a)</td>
<td>2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated power loss at 600 V [W](^a)</td>
<td>18843</td>
<td>21464</td>
<td>21464</td>
</tr>
<tr>
<td>Estimated power loss at 690 V [W](^a)</td>
<td>19191</td>
<td>21831</td>
<td>21831</td>
</tr>
<tr>
<td>F3/F4 Maximum added losses CB or disconnect &amp; contactor</td>
<td>1016</td>
<td>1267</td>
<td>1277</td>
</tr>
<tr>
<td>Maximum panel options losses [W]</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight, enclosure protection rating IP21/IPS4 [kg (lb)]</td>
<td>635/756 (1399/1666)</td>
<td>640/762 (1411/1680)</td>
<td>640/762 (1411/1680)</td>
</tr>
<tr>
<td>Weight, rectifier module [kg (lb)]</td>
<td>136 (300)</td>
<td>150 (331)</td>
<td></td>
</tr>
<tr>
<td>Weight, inverter module [kg (lb)]</td>
<td>136 (300)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency(^a)</td>
<td>0.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output frequency</td>
<td>0–590 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat sink overtemperature trip</td>
<td>85 °C (185 °F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power card ambient trip</td>
<td>75 °C (167 °F)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) High overload = 150% torque during 60 s, Normal overload = 110% torque during 60 s

---

**Table 5.6 Mains Supply 6x525–690 V AC**
1) For type of fuse see chapter 3.4.13 Fuses.

2) American wire gauge.

3) Measured using 5 m (16.4 ft) shielded motor cables at rated load and rated frequency.

4) The typical power loss is at nominal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions). Values are based on a typical motor efficiency. Motors with lower efficiency also add to the power loss in the frequency converter and the opposite way.

If the switching frequency is increased compared to the default setting, the power losses can rise significantly. LCP and typical control card power consumptions are included. Further extra losses of up to 30 W may be incurred due to extra options and customer load. However, the typical extra losses are only 4 W extra each for a fully loaded control card, or options for slot A or slot B.

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (±5%).
6 Warnings and Alarms

6.1 Warning and Alarm Types

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

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

Resetting the frequency converter after trip/trip lock
A trip can be reset in any of 4 ways:
• Press [Reset] on the LCP.
• Digital reset input command.
• Serial communication reset input command.
• Auto reset.

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

Warning and alarm displays
• A warning is displayed in the LCP along with the warning number.
• An alarm flashes along with the alarm number.

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

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

Illustration 6.2 Status Indicator Lights (LEDs)

6.2 Warning and Alarm Definitions

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

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

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

WARNING 1, 10 Volts low
The control card voltage is less than 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.
A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed in parameter 6-01 Live Zero Timeout Function. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

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

WARNING/ALARM 3, No motor
No motor is connected to the output of the frequency converter.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier. Options are programmed in parameter 14-12 Function at Mains Imbalance.

Troubleshooting
- Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high
The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

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

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the frequency converter trips after a certain time.

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

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

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

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

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

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter is >90% if parameter 1-90 Motor Thermal Protection is set to warning options, or whether the frequency converter trips when the counter reaches 100% if parameter 1-90 Motor Thermal Protection is set to trip options. The fault occurs when the motor runs with more than 100% overload for too long.

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

WARNING/ALARM 11, Motor thermistor overtemp
The thermistor may be disconnected. Select whether the frequency converter issues a warning or an alarm in parameter 1-90 Motor Thermal Protection.

Troubleshooting
• Check for motor overheating.
• Check if the motor is mechanically overloaded.
• 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 is set to terminal 53 or 54.
• When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50.
• If a KTY Sensor is used, check for correct connection between terminals 54 and 55.
• If using a thermal switch or thermistor, check that the programming of parameter 1-93 Thermistor Resource matches sensor wiring.
• If using a KTY Sensor, check the programming of parameter 1-95 KTY Sensor Type, parameter 1-96 KTY Thermistor Resource, and parameter 1-97 KTY Threshold level match sensor wiring.

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in parameter 4-16 Torque Limit Motor Mode or the value in parameter 4-17 Torque Limit Generator Mode. Parameter 14-25 Trip Delay at Torque Limit can change this warning from a warning-only condition to a warning followed by an alarm.

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

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up. If extended mechanical brake control is selected, a trip can be reset externally.

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

ALARM 14, Earth (ground) fault
There is current from the output phases to ground, either in the cable between the frequency converter and the motor, or in the motor itself.

Troubleshooting
• Remove the power to the frequency converter and repair the ground fault.
• Check for ground faults in the motor by measuring the resistance to the ground of the motor cables and the motor with a megohmmeter.
• Perform a current sensor test.

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact Danfoss:
• Parameter 15-40 FC Type.
• Parameter 15-41 Power Section.
• Parameter 15-42 Voltage.
• Parameter 15-43 Software Version.
• Parameter 15-45 Actual Typecode String.
• Parameter 15-49 SW ID Control Card.
• Parameter 15-50 SW ID Power Card.
• Parameter 15-60 Option Mounted.
• Parameter 15-61 Option SW Version (for each option slot).

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Troubleshooting
• Remove the power to the frequency converter and repair the short circuit.
WARNING
HIGH VOLTAGE
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.
• Disconnect power before proceeding.

WARNING/ALARM 17, Control word timeout
There is no communication with the frequency converter. The warning is only active when parameter 8-04 Control Word Timeout Function is not set to [0] Off. If parameter 8-04 Control Word Timeout Function is set to [2] Stop and [26] Trip, a warning appears and the frequency converter ramps down until it trips and then 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 a proper installation based on EMC requirements.

WARNING/ALARM 22, Hoist mechanical brake
The value of this warning/alarm shows the type of warning/alarm.
0 = The torque reference was not reached before timeout (parameter 2-27 Torque Ramp Up Time).
1 = Expected brake feedback not received before timeout (parameter 2-23 Activate Brake Delay, parameter 2-25 Brake Release Time).

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in parameter 14-53 Fan Monitor ([0] Disabled).

Troubleshooting
• Check the fan resistance.
• Check the soft charge fuses.

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in parameter 14-53 Fan Monitor ([0] Disabled).

Troubleshooting
• Check the fan resistance.
• Check the soft charge fuses.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational, but without the brake function.

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

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in parameter 2-16 AC brake Max. Current. The warning is active when the dissipated braking is >90% of the brake resistor power. If [2] Trip is selected in parameter 2-13 Brake Power Monitoring, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING
HIGH VOLTAGE ON THE BRAKE RESISTOR
If the brake transistor is short-circuited, there is a risk of substantial power being transmitted to the brake resistor.
• Find and fix the reason for exceeding the power limit.

WARNING/ALARM 27, Brake chopper fault
The brake IGBT is monitored during operation. If a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational, but since the brake IGBT has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive. Remove the power to the frequency converter and remove the brake resistor.
This warning/alarm could also occur if the brake resistor overheats. Terminals 104 and 106 are available as brake resistors Klixon inputs.
The 12-pulse frequency converter may generate this warning/alarm when one of the disconnects or circuit breakers is opened while the unit is on.

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. The temperature fault resets when the temperature falls below a defined heat sink temperature. The trip and reset points vary based on the frequency converter power size.
Troubleshooting
Check for the following conditions:
- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

For D, E, and F enclosures, this alarm is based on the temperature measured by the heat sink sensor mounted inside the IGBT modules. For the F enclosures, the thermal sensor in the rectifier module can also cause this alarm.

Troubleshooting
- Check the fan resistance.
- Check the soft charge fuses.
- Check the IGBT thermal sensor.

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

**WARNING**
High Voltage
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.
- Disconnect power before proceeding.

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

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

**WARNING**
High Voltage
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.
- Disconnect power before proceeding.

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

ALARM 32, Motor phase W missing
Motor phase W between the frequency converter and the motor is missing.

**WARNING**
High Voltage
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.
- Disconnect power before proceeding.

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

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period.

Troubleshooting
- Let the unit cool to operating temperature.

**WARNING/ALARM 34, Fieldbus communication fault**
The fieldbus on the communication option card is not working.

**WARNING/ALARM 36, Mains failure**
This warning/alarm is only active if the supply voltage to the frequency converter is lost and parameter 14-10 Mains Failure is not set to [0] No Function.

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

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in Table 6.1 is shown.

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

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

<table>
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<tr>
<th>Number</th>
<th>Text</th>
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<tr>
<td>0</td>
<td>The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss Service.</td>
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<tr>
<td>256–258</td>
<td>The power EEPROM data is defective or too old.</td>
</tr>
<tr>
<td>512</td>
<td>The control board EEPROM data is defective or too old.</td>
</tr>
<tr>
<td>513</td>
<td>Communication timeout reading EEPROM data.</td>
</tr>
<tr>
<td>514</td>
<td>Communication timeout reading EEPROM data.</td>
</tr>
<tr>
<td>515</td>
<td>Application-oriented control cannot recognize the EEPROM data.</td>
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Table 6.1 Internal Fault, Code Numbers

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 45, Earth fault
Ground fault.

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

ALARM 46, Power card supply
The supply on the power card is out of range.
There are 3 supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, and ±18 V.
When powered with 24 V DC with the VLT® 24 V DC Supply Option MCB 107, only the 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

WARNING 47, 24 V supply low
The supply on the power card is out of range.
There are 3 supplies generated by the switch mode supply (SMPS) on the power card:
- 24 V.
- 5 V.
- ±18 V.

Troubleshooting
- Check for a defective power card.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of the allowable limits. The supply is measured on the control card.

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

WARNING 49, Speed limit
The warning is shown when the speed is outside of the specified range in parameter 4-11 Motor Speed Low Limit (RPM) and parameter 4-13 Motor Speed High Limit [RPM]. When the speed is below the specified limit in parameter 1-86 Trip Speed Low [RPM] (except when starting or stopping), the frequency converter trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss service department.

ALARM 51, AMA check $U_{nom}$ and $I_{nom}$
The settings for motor voltage, motor current, and motor power are wrong.

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

ALARM 52, AMA low $I_{nom}$
The motor current is too low.

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

ALARM 53, AMA motor too big
The motor is too large for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range
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
Continue to restart the AMA, until the AMA is carried out.

NOTICE
Repeated runs may heat the motor to a level where the resistance $R_s$ and $R_r$ are increased. Usually, however, this behavior is not critical.

ALARM 58, AMA Internal fault
Contact the Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in parameter 4-18 Current Limit. Ensure that motor data in parameters 1-20 to 1-25 is set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock
External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the frequency converter (via serial communication, digital I/O, or by pressing [Reset]).

WARNING/ALARM 61, Feedback error
An error has occurred between the calculated motor speed and the speed measurement from the feedback device. The function warning/alarm/disable is set in parameter 4-30 Motor Feedback Loss Function. Accepted error setting in parameter 4-31 Motor Feedback Speed Error and the allowed time the error occur setting in parameter 4-32 Motor Feedback Loss Timeout. During a commissioning procedure, the function could be effective.

WARNING 62, Output frequency at maximum limit
The output frequency is higher than the value set in parameter 4-19 Max 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 cut-out temperature of the control card is 85 °C (185 °F).

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

WARNING 66, Heat sink temperature low
The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

Troubleshooting
The heat sink temperature measured as 0 °C (32 °F) could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. This warning results if the sensor wire between the IGBT and the gatetransistor card is disconnected. Also, check the IGBT thermal sensor.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
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 the operation of the door fans.
- Check that the filters for the door fans are not blocked.
- Check that the gland plate is properly installed on IP21/IP54 (NEMA 1/12) frequency converters.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers of the cards.

ALARM 71, PTC 1 safe stop
STO has been activated from the VLT® PTC Thermistor Card MCB 112 (motor too warm). Normal operation can resume when the MCB 112 applies 24 V DC to terminal 37 (when the motor temperature is acceptable) and when the digital input from the MCB 112 is deactivated. When that happens, a reset signal is sent (via bus, digital I/O, or by pressing [Reset]).

NOTICE
If automatic restart is enabled, the motor could start when the fault is cleared.

ALARM 72, Dangerous failure
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
STO activated. With automatic restart enabled, the motor can start when the fault is cleared.

WARNING 76, Power unit setup
The required number of power units does not match the detected number of active power units.

This warning occurs when replacing a module for an F-size enclosure if the power-specific data in the module power card does not match the rest of the frequency converter.

Troubleshooting
- Confirm that the spare part and its power card are the correct part number.

WARNING 77, Reduced power mode
The frequency converter is operating in reduced power mode (less than the allowed number of inverter sections). This warning is generated on power cycle when the frequency converter is set to run with fewer inverters and remains on.

ALARM 79, Illegal power section configuration
The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

ALARM 80, Drive initialised to default value
Parameter settings are initialized to default settings after a manual reset. To clear the alarm, reset the unit.

ALARM 81, CSIV corrupt
CSIV file has syntax errors.

ALARM 82, CSIV parameter error
CSIV failed to initialize a parameter.

ALARM 85, Dang fail PB
PROFIBUS/PROFIsafe error.

WARNING/ALARM 104, Mixing fan fault
The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing-fan fault can be configured as a warning or an alarm trip in parameter 14-53 Fan Monitor.

Troubleshooting
- Cycle power to the frequency converter to determine if the warning/alarm returns.
**ALARM 243, Brake IGBT**
This alarm is only for enclosure size F frequency converters. It is equivalent to WARNING/ALARM 27, Brake chopper fault. The report number does not describe the module which has the failed brake IGBT. The open Klixon can be identified in the report number.

The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure sizes F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.

**ALARM 244, Heat Sink temperature**
This alarm is only for enclosure type F frequency converters. It is equivalent to ALARM 29, Heat Sink temp.

The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure size F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14 or F15.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.

**ALARM 245, Heat Sink sensor**
This alarm is only for enclosure size F frequency converters. It is equivalent to ALARM 39, Heat sink sensor.

The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure sizes F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14 or F15.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.

The 12-pulse frequency converter may generate this warning/alarm when 1 of the disconnects or circuit breakers is opened while the unit is on.

**ALARM 246, Power card supply**
This alarm is only for enclosure size F frequency converters. It is equivalent to ALARM 46, Power card supply.

The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure sizes F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14 or F15.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.
ALARM 247, Power card temperature
This alarm is only for enclosure size F frequency converters. It is equivalent to ALARM 69, Power card temperature. The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure sizes F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14 or F15.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.

ALARM 248, Illegal power section configuration
This alarm is only for enclosure size F frequency converters. It is equivalent to ALARM 79, Illegal power section configuration. The report value in the alarm log indicates which power module generated the alarm:

1 = Left most inverter module.
2 = Middle inverter module in enclosure sizes F12 or F13.
2 = Right inverter module in enclosure sizes F10 or F11.
2 = Second frequency converter from the left inverter module in enclosure size F14 or F15.
3 = Right inverter module in enclosure sizes F12 or F13.
3 = Third from the left inverter module in enclosure size F14 or F15.
4 = Far right inverter module in enclosure size F14 or F15.
5 = Rectifier module.
6 = Right rectifier module in enclosure size F14 or F15.

WARNING 250, New spare part
The power or switch mode supply has been exchanged. Restore the frequency converter type code in the EEPROM. Select the correct type code in parameter 14-23 Typecode Setting according to the label on the frequency converter. Remember to select Save to EEPROM at the end.

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