



# Operating Guide

# VLT<sup>®</sup> AutomationDrive FC 301/302

0.25-75 kW





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# 1 Introduction

## 1.1 Purpose of the Manual

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

The operating guide is intended for use by qualified personnel.

Read and follow the instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the frequency converter.

VLT® is a registered trademark.

## 1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

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

Supplementary publications and manuals are available from Danfoss. See [drives.danfoss.com/knowledge-center/technical-documentation/](http://drives.danfoss.com/knowledge-center/technical-documentation/) for listings.

## 1.3 Manual and Software Version

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

Edition	Remarks	Software version
MG33ARxx	Replaces MG33AQxx	7.XX, 48.XX

Table 1.1 Manual and Software Version

## 1.4 Product Overview

### 1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

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

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

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

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

#### **NOTICE**

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

#### **Foreseeable misuse**

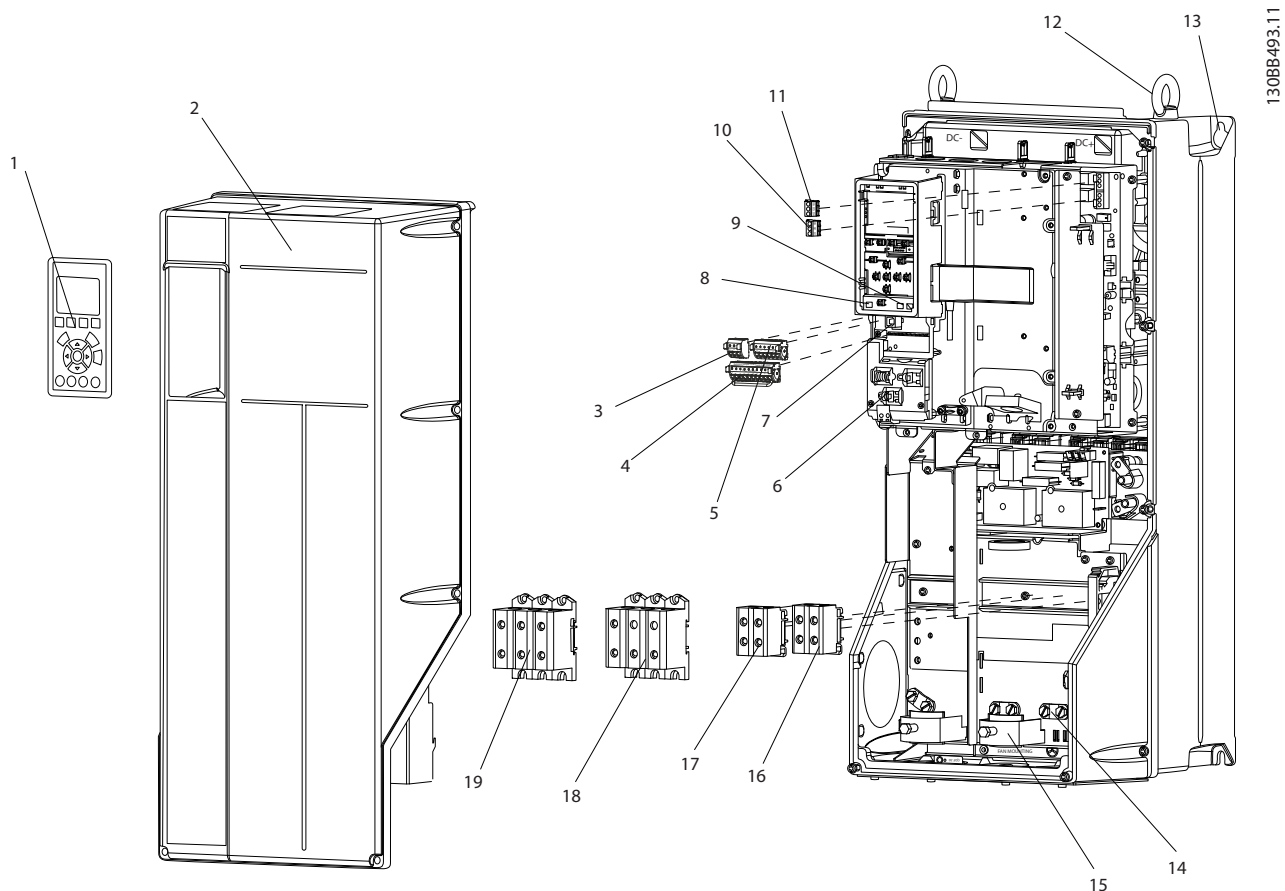
Do not use the frequency converter in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

#### **NOTICE**

**The output frequency of the frequency converter is limited to 590 Hz.**

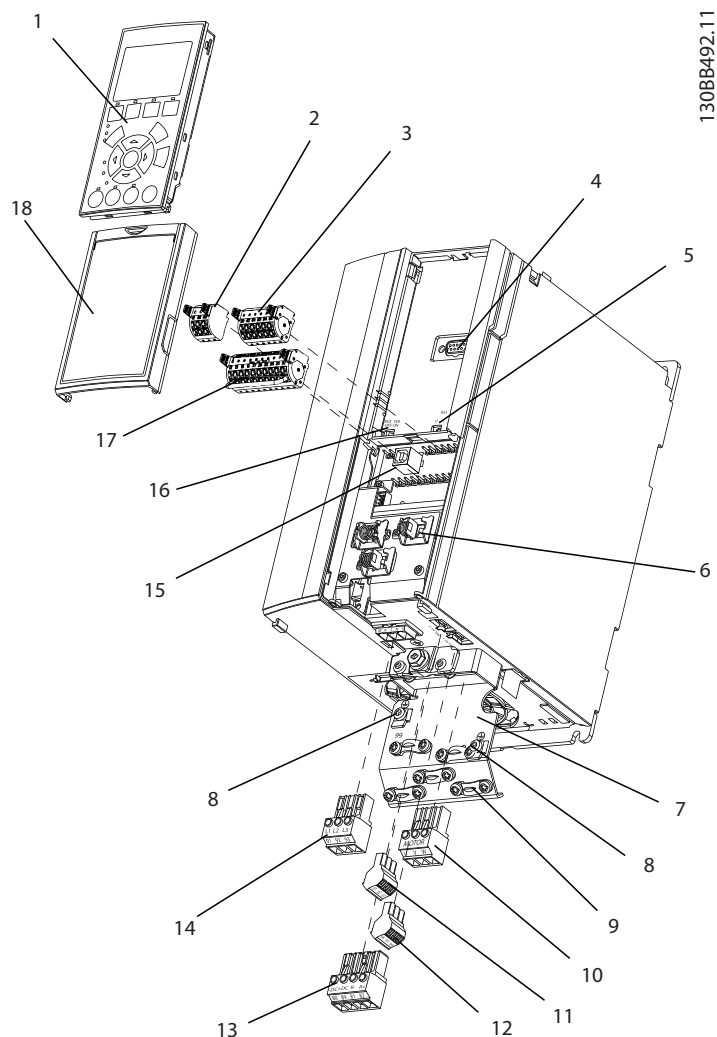
**A version with the maximum output frequency set to 1000 Hz is available with the EU export declaration. Contact Danfoss for more information.**

1.4.2 Exploded Views



1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital I/O and 24 V supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable shield connector
6	Cable shield connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Fieldbus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)	-	-

Illustration 1.1 Exploded View Enclosure Sizes B and C, IP55 and IP66



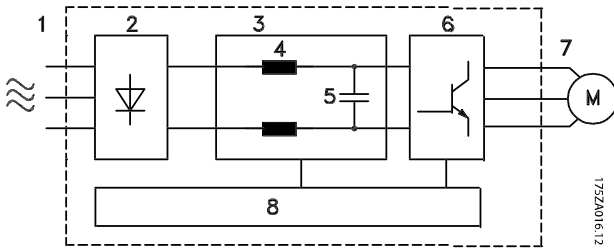
1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 fieldbus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable shield connector	15	USB connector
7	Ground termination plate	16	Fieldbus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V supply
9	Shielded cable grounding clamp and strain relief	18	Cover

Illustration 1.2 Exploded View Enclosure Size A, IP20



### 1.4.3 Block Diagram

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



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

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

Illustration 1.3 Frequency Converter Block Diagram

### 1.4.4 Enclosure Sizes and Power Ratings

For enclosure sizes and power ratings of the frequency converters, refer to *chapter 8.9 Power Ratings, Weight, and Dimensions*.

### 1.5 Approvals and Certifications



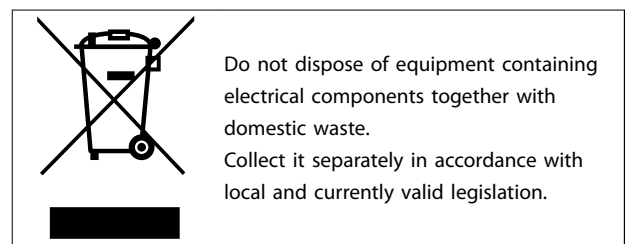
Table 1.2 Approvals and Certifications

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

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

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

### 1.6 Disposal



## 2

## 2 Safety

### 2.1 Safety Symbols

The following symbols are used in this guide:

#### **⚠ WARNING**

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

#### **⚠ CAUTION**

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

#### **NOTICE**

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

### 2.2 Qualified Personnel

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

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

### 2.3 Safety Precautions

#### **⚠ WARNING**

##### **HIGH VOLTAGE**

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

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

#### **⚠ WARNING**

##### **UNINTENDED START**

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

To prevent unintended motor start:

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

#### **⚠ WARNING**

##### **DISCHARGE TIME**

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

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

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

Table 2.1 Discharge Time

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

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

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

**⚠ WARNING****EQUIPMENT HAZARD**

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

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

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

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

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

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

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

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

### 3 Mechanical Installation

3

#### 3.1 Unpacking

##### 3.1.1 Items Supplied

Items supplied vary according to product configuration.

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

#### 3.1.2 Storage

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

#### 3.2 Installation Environments

##### **NOTICE**

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

##### Vibration and shock

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

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

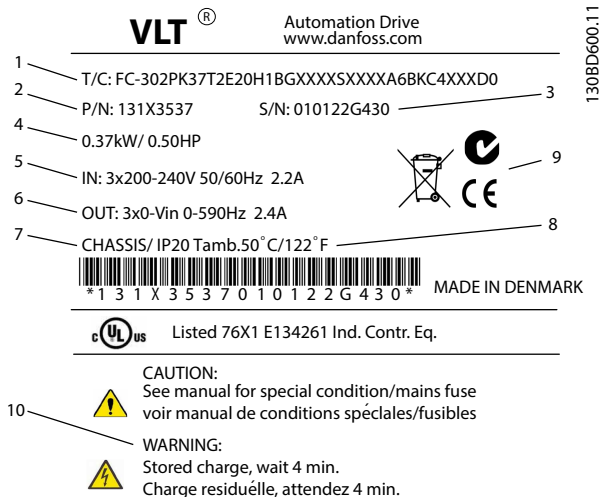
#### 3.3 Mounting

##### **NOTICE**

Improper mounting can result in overheating and reduced performance.

##### Cooling

- Ensure that top and bottom clearance for air cooling is provided. See *Illustration 3.2* for clearance requirements.



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

Illustration 3.1 Product Nameplate (Example)

##### **NOTICE**

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

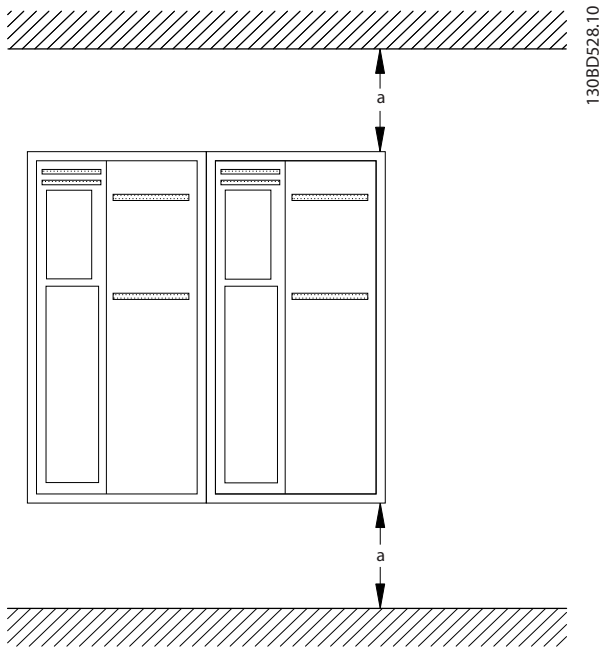


Illustration 3.2 Top and Bottom Cooling Clearance

Enclosure	A1-A5	B1-B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.8)	200 (7.8)	225 (8.9)

Table 3.1 Minimum Airflow Clearance Requirements

**Lifting**

- To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight, and Dimensions*.
- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use hoist rings on the unit, when provided.

**Mounting**

1. Ensure that the strength of the mounting location supports the unit weight. The frequency converter allows side-by-side installation.
2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

**Mounting with mounting plate and railings**

**NOTICE**

A mounting plate is required when mounted on railings.

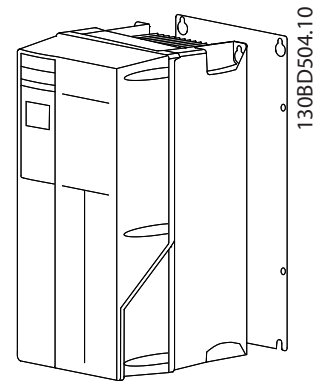


Illustration 3.3 Proper Mounting with Mounting Plate

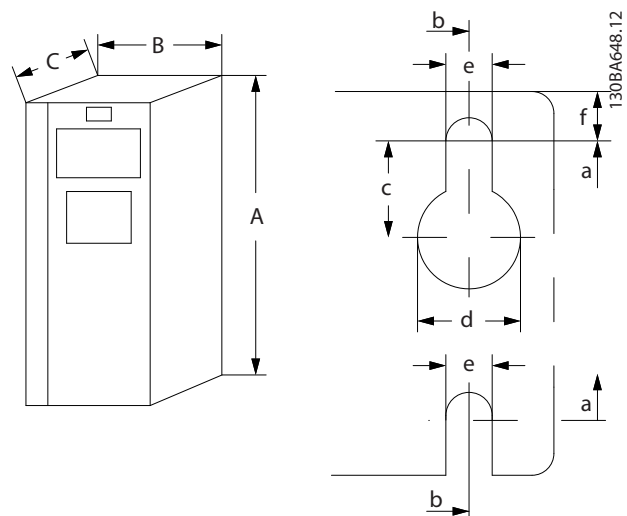


Illustration 3.4 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight, and Dimensions*)

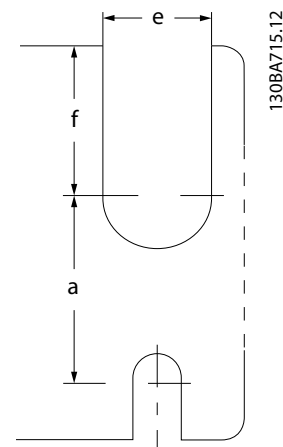


Illustration 3.5 Top and Bottom Mounting Holes (B4, C3, and C4)

## 4 Electrical Installation

### 4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

#### **WARNING**

##### INDUCED VOLTAGE

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

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

#### **CAUTION**

##### SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation may lead to the RCD not providing the intended protection.

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

##### Overcurrent protection

- 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 not factory-supplied, the installer must provide fuses. See maximum fuse ratings in *chapter 8.7 Fuses and Circuit Breakers*.

##### Wire type and ratings

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

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

### 4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

### 4.3 Grounding

#### **WARNING**

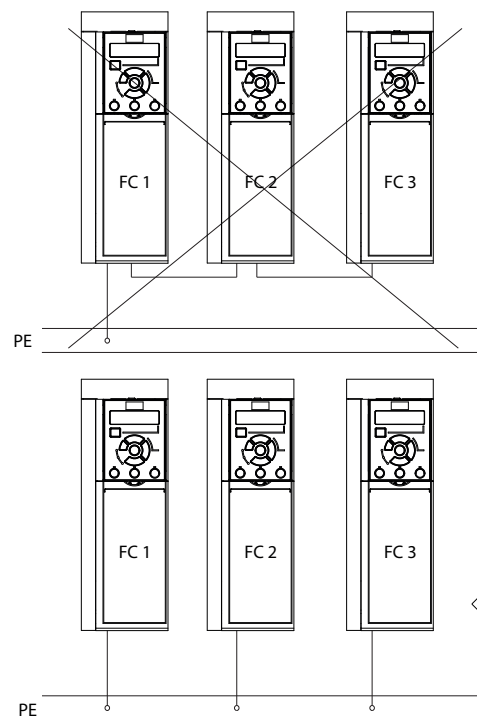
##### LEAKAGE CURRENT HAZARD

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

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

##### For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 frequency converter to another in a daisy-chain fashion (see *Illustration 4.1*).
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm<sup>2</sup> (7 AWG). Separately terminate 2 ground wires, both complying with the dimension requirements.



130BC500.10

Illustration 4.1 Grounding Principle

**For EMC-compliant installation**

- Establish electrical contact between the cable shield and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment (see *chapter 4.6 Motor Connection*).
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

**NOTICE****POTENTIAL EQUALIZATION**

Risk of burst transient when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm<sup>2</sup> (6 AWG).

4.4 Wiring Schematic

4

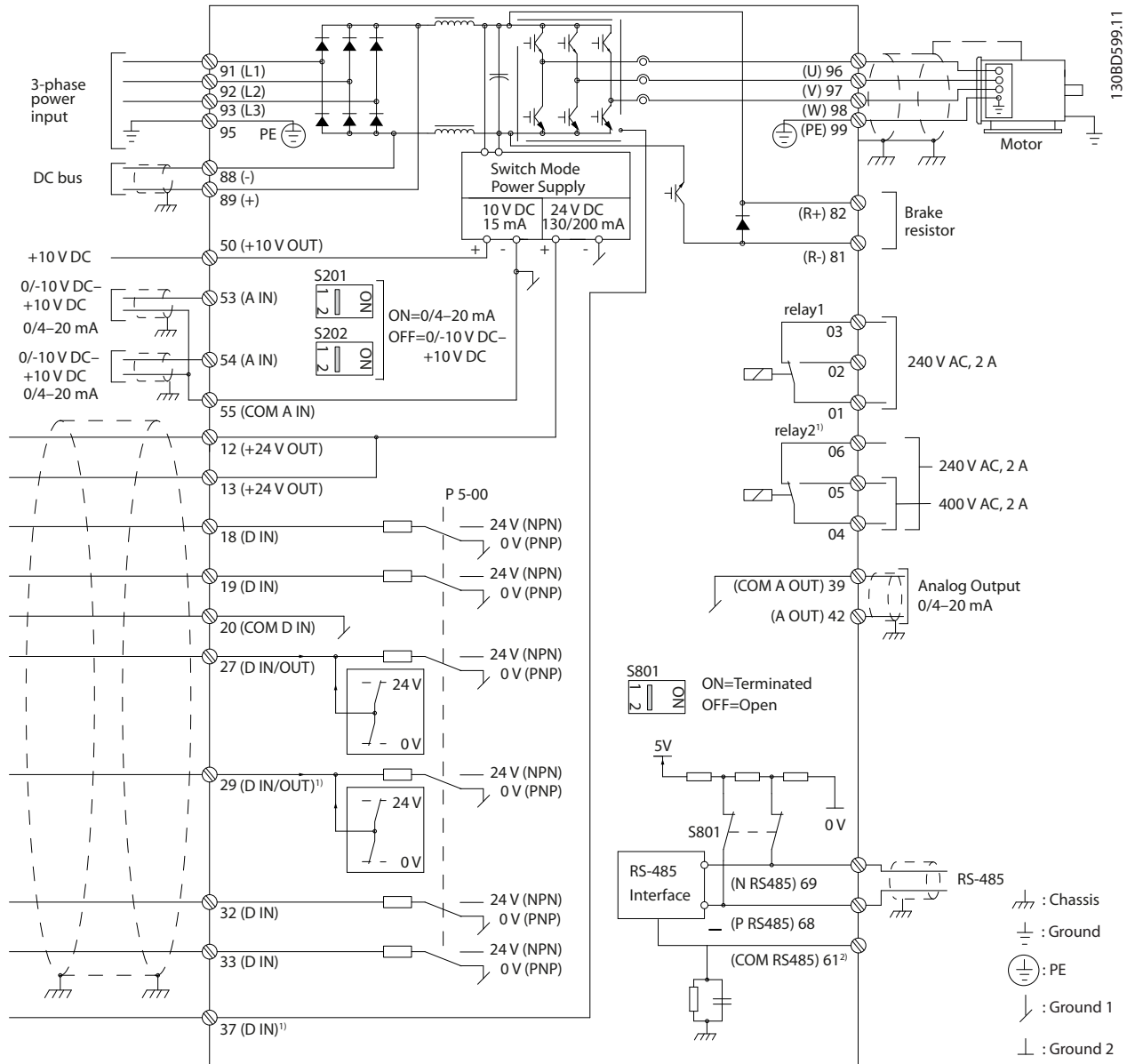


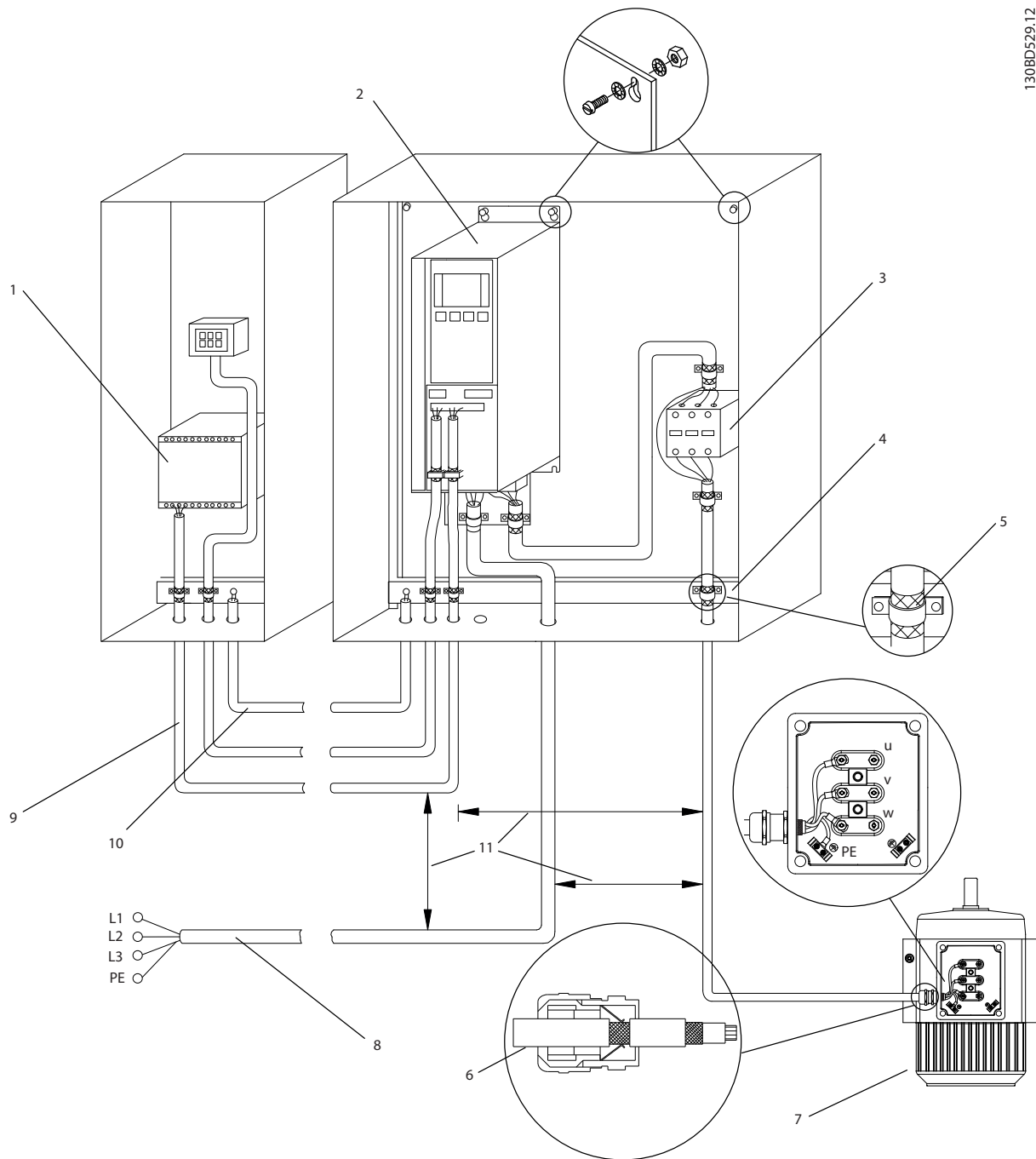
Illustration 4.2 Basic Wiring Schematic

A=Analog, D=Digital

1) Terminal 37 (optional) is used for Safe Torque Off (STO). For installation instructions, refer to the VLT® Safe Torque Off Operating Guide. For FC 301, terminal 37 is only included in enclosure size A1. Relay 2 and terminal 29 have no function in FC 301.

2) Do not connect cable shield.





1	PLC	7	Motor, 3-phase, and PE (shielded)
2	Frequency converter	8	Mains, 3-phase, and reinforced PE (not shielded)
3	Output contactor	9	Control wiring (shielded)
4	Cable clamp	10	Potential equalization minimum 16 mm <sup>2</sup> (0.025 in <sup>2</sup> )
5	Cable insulation (stripped)	11	Clearance between control cable, motor cable, and mains cable: Minimum 200 mm (7.9 in)
6	Cable gland		

Illustration 4.3 EMC-compliant Electrical Connection

For more information about EMC, see *chapter 4.2 EMC-compliant Installation*

**NOTICE**

**EMC INTERFERENCE**

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

4.5 Access

- Remove the cover with a screwdriver (see *Illustration 4.4*) or by loosening attaching screws (see *Illustration 4.5*).

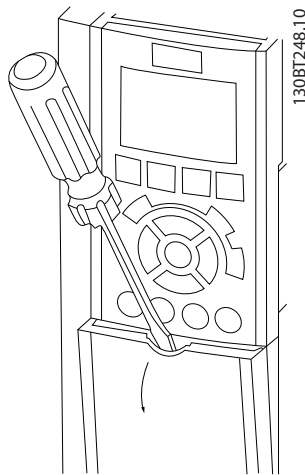


Illustration 4.4 Access to Wiring for IP20 and IP21 Enclosures

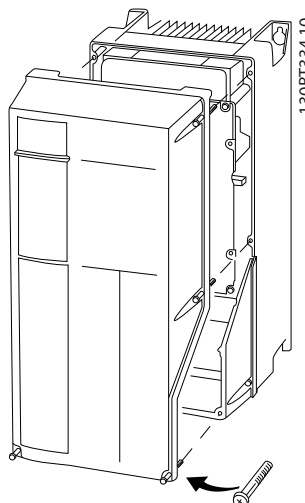


Illustration 4.5 Access to Wiring for IP55 and IP66 Enclosures

Tighten the cover screws using the tightening torques specified in *Table 4.1*.

Enclosure	IP55	IP66
A4/A5	2	2
B1/B2	2.2	2.2
C1/C2	2.2	2.2

No screws to tighten for A1/A2/A3/B3/B4/C3/C4.

Table 4.1 Tightening Torques for Covers [Nm]

4.6 Motor Connection

**WARNING**

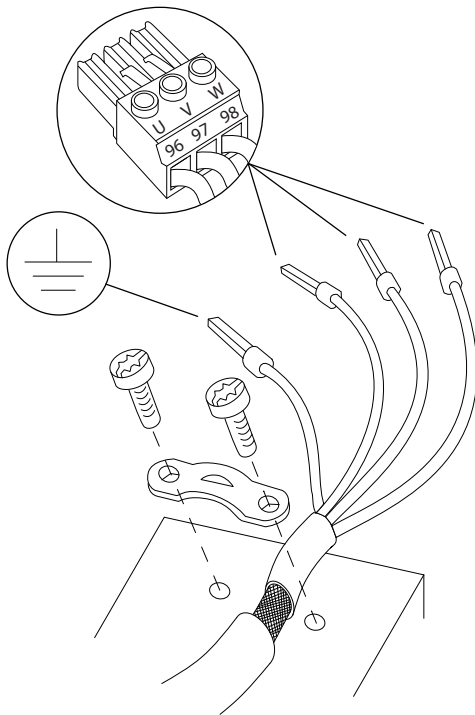
**INDUCED VOLTAGE**

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

- Run output motor cables separately, or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (for example, Dahlander motor or slip ring asynchronous motor) between the frequency converter and the motor.

**Procedure**

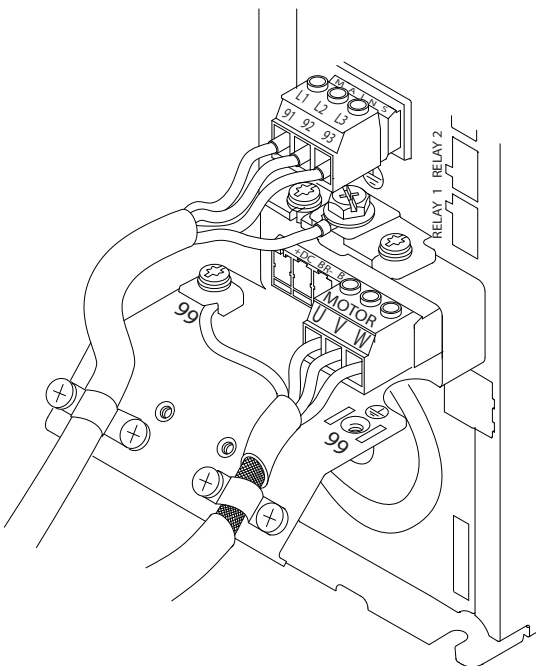
- Strip a section of the outer cable insulation.
- Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable shield and ground.
- Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.6*.
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.6*.
- Tighten the terminals in accordance with the information provided in *chapter 8.8 Connection Tightening Torques*.



130BD531.10

Illustration 4.6 Motor Connection

Illustration 4.7 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.



130BF948.10

Illustration 4.7 Example of Motor, Mains, and Ground Wiring

### 4.7 AC Mains Connection

- Size the wiring based on the input current of the frequency converter. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

#### Procedure

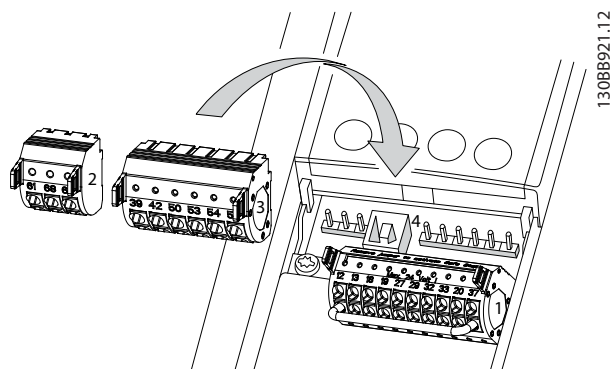
1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 4.7*).
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to [0] Off to avoid damage to the DC link and to reduce ground capacity currents in accordance with IEC 61800-3.

### 4.8 Control Wiring

- Isolate the control wiring from the high-power components in the frequency converter.
- When the frequency converter is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 4.8*.

#### 4.8.1 Control Terminal Types

Illustration 4.8 and Illustration 4.9 show the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 4.2* and *Table 4.3*.



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Illustration 4.8 Control Terminal Locations

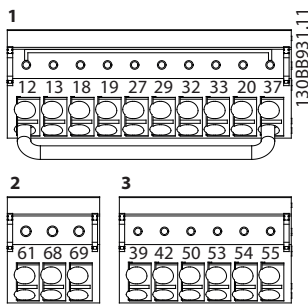


Illustration 4.9 Terminal Numbers

- Connector 1 provides 4 programmable digital inputs terminals, 2 extra digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage. FC 302 and FC 301 (optional in A1 enclosure) also provide a digital input for STO function.
- Connector 2 terminals (+)68 and (-)69 for RS485 serial communication connection.
- Connector 3 provides 2 analog inputs, 1 analog output, 10 V DC supply voltage, and commons for the inputs and output.
- Connector 4 is a USB port available for use with the MCT 10 Set-up Software.

Terminal description			
Terminal	Parameter	Default setting	Description
<b>Digital inputs/outputs</b>			
12, 13	–	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA (130 mA for FC 301) for all 24 V loads.
18	Parameter 5-10 Terminal 18 Digital Input	[8] Start	Digital inputs.
19	Parameter 5-11 Terminal 19 Digital Input	[10] Reversing	
32	Parameter 5-14 Terminal 32 Digital Input	[0] No operation	
33	Parameter 5-15 Terminal 33 Digital Input	[0] No operation	

Terminal description			
Terminal	Parameter	Default setting	Description
27	Parameter 5-12 Terminal 27 Digital Input	[2] Coast inverse	For digital input or output. Default setting is input.
29	Parameter 5-13 Terminal 29 Digital Input	[14] JOG	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	STO	Safe input.
<b>Analog inputs/outputs</b>			
39	–	–	Common for analog output
42	Parameter	[0] No operation	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	–	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum.
53	Parameter group 6-1* Analog Input 1	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	Parameter group 6-2* Analog Input 2	Feedback	
55	–	–	Common for analog input.

Table 4.2 Terminal Description, Digital Inputs/Outputs, Analog Inputs/Outputs

Terminal description			
Terminal	Parameter	Default setting	Description
<b>Serial communication</b>			
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield in the event of EMC problems.

Terminal description			
Terminal	Parameter	Default setting	Description
68 (+)	Parameter group 8-3* FC Port Settings	–	RS485 interface. A control card switch is provided for termination resistance.
69 (-)	Parameter group 8-3* FC Port Settings	–	
Relays			
01, 02, 03	[0]	[0] No operation	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	[1]	[0] No operation	

Table 4.3 Terminal Description, Serial Communication

**Extra terminal**

- 2 form C relay outputs. The location of the outputs depends on the frequency converter configuration.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

**4.8.2 Wiring to Control Terminals**

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 4.10*.

**NOTICE**

Keep control wires as short as possible and separate from high-power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

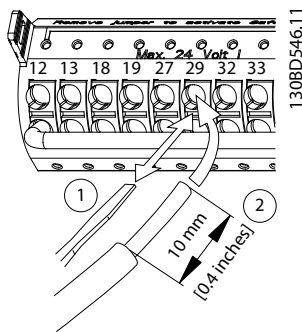


Illustration 4.10 Connecting Control Wires

2. Insert the bare control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

**4.8.3 Enabling Motor Operation (Terminal 27)**

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

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

**4.8.4 Voltage/Current Input Selection (Switches)**

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

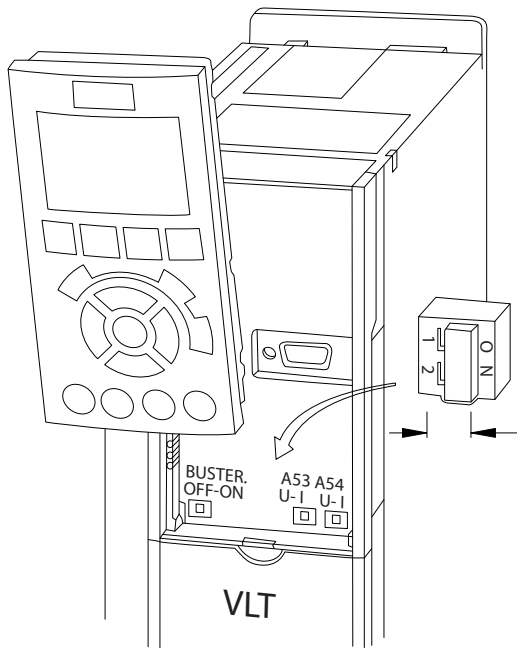
**Default parameter setting**

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

**NOTICE**

Disconnect power to the frequency converter before changing switch positions.

1. Remove the LCP (see *Illustration 4.11*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.



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Illustration 4.11 Location of Terminal 53 and 54 Switches

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

### 4.8.5 Mechanical Brake Control

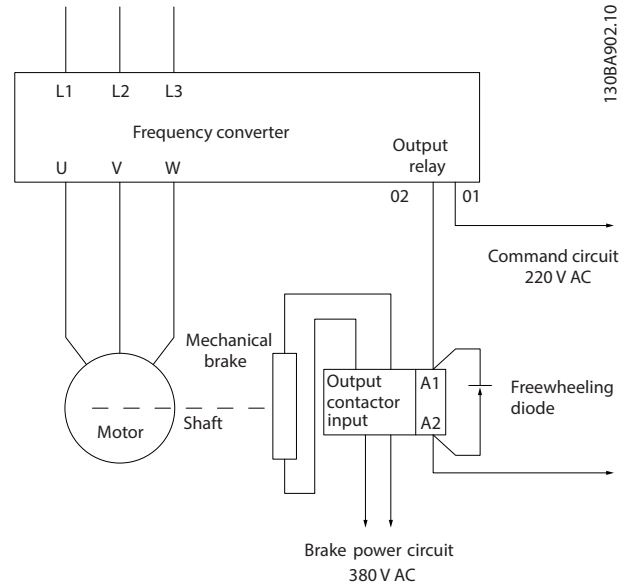
In hoisting/lowering applications, it is necessary to control an electro-mechanical brake.

- 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 keep the motor at standstill, 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 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 closes.

### NOTICE

The frequency converter is not a safety device. It is the responsibility of the system designer to integrate safety devices according to relevant national crane/lift regulations.



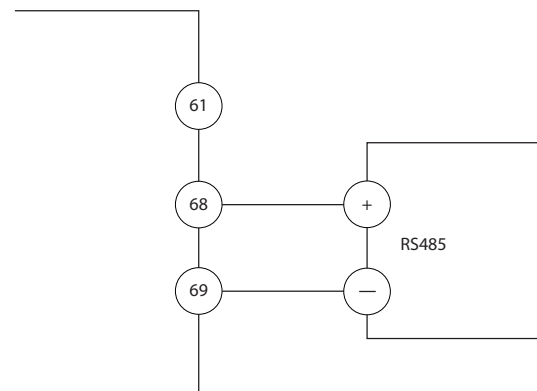
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Illustration 4.12 Connecting the Mechanical Brake to the Frequency Converter

### 4.8.6 RS485 Serial Communication

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

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



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Illustration 4.13 Serial Communication Wiring Diagram

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

1. Protocol type in *parameter 8-30 Protocol*.
  2. Frequency converter address in *parameter 8-31 Address*.
  3. Baud rate in *parameter 8-32 Baud Rate*.
- 2 communication protocols are internal to the frequency converter:
    - Danfoss FC.
    - Modbus RTU.
  - Functions can be programmed remotely using the protocol software and RS485 connection or in *parameter group 8-\*\*\* Communications and Options*.
  - Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications and makes more protocol-specific parameters available.
  - Option cards for the frequency converter are available to provide extra communication protocols. See the option card documentation for installation and operation instructions.

## 4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.4*. Check and mark the items when completed.

**4**

Inspect for	Description	<input checked="" type="checkbox"/>
Auxiliary equipment	<ul style="list-style-type: none"> <li>Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers, residing on the input power side of the frequency converter, or output side to the motor. Ensure that they are ready for full-speed operation.</li> <li>Check the function and installation of any sensors used for feedback to the frequency converter.</li> <li>Remove any power factor correction caps on the motor.</li> <li>Adjust any power factor correction caps on the mains side and ensure that they are dampened.</li> </ul>	
Cable routing	<ul style="list-style-type: none"> <li>Ensure that the motor wiring and control wiring are separated, shielded, or in 3 separate metallic conduits for high frequency interference isolation.</li> </ul>	
Control wiring	<ul style="list-style-type: none"> <li>Check for broken or damaged wires and loose connections.</li> <li>Check that the control wiring is isolated from power and motor wiring for noise immunity.</li> <li>Check the voltage source of the signals, if necessary.</li> </ul> <p>The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.</p>	
Cooling clearance	<ul style="list-style-type: none"> <li>Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see <i>chapter 3.3 Mounting</i>.</li> </ul>	
Ambient conditions	<ul style="list-style-type: none"> <li>Check that requirements for ambient conditions are met.</li> </ul>	
Fusing and circuit breakers	<ul style="list-style-type: none"> <li>Check for proper fusing or circuit breakers.</li> <li>Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.</li> </ul>	
Grounding	<ul style="list-style-type: none"> <li>Check for sufficient ground connections and ensure that those connections are tight and free of oxidation.</li> <li>Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.</li> </ul>	
Input and output power wiring	<ul style="list-style-type: none"> <li>Check for loose connections.</li> <li>Check that the motor and mains cables are in separate conduit or separated shielded cables.</li> </ul>	
Panel interior	<ul style="list-style-type: none"> <li>Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion.</li> <li>Check that the unit is mounted on an unpainted metal surface.</li> </ul>	
Switches	<ul style="list-style-type: none"> <li>Ensure that all switch and disconnect settings are in the proper positions.</li> </ul>	
Vibration	<ul style="list-style-type: none"> <li>Check that the unit is mounted solidly, or that shock mounts are used, as necessary.</li> <li>Check for an unusual amount of vibration.</li> </ul>	

Table 4.4 Installation Check List

### CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury if the frequency converter is not properly closed.

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



## 5 Commissioning

### 5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

#### **⚠ WARNING**

##### HIGH VOLTAGE

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

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

Before applying power:

1. Close the cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring  $\Omega$  values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the frequency converter and the motor.
8. Inspect the frequency converter for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

### 5.2 Applying Power

Apply power to the frequency converter using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that any optional equipment wiring matches the installation application.

3. Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.
4. Apply power to the unit. Do not start the frequency converter now. For units with a disconnect switch, turn it to the ON position to apply power to the frequency converter.

### 5.3 Local Control Panel Operation

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

The LCP has several user functions:

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

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the product relevant *programming guide* for details on use of the NLCP.

#### **NOTICE**

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

#### **NOTICE**

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

#### 5.3.1 Graphic Local Control Panel Layout

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

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

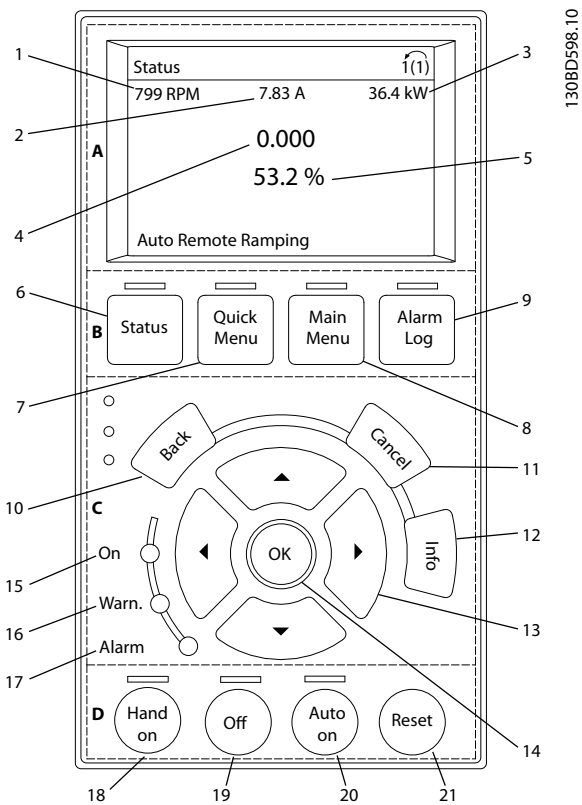


Illustration 5.1 GLCP

**A. Display area**

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

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

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

Table 5.1 Legend to Illustration 5.1, Display Area

**B. Display menu keys**

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

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

Table 5.2 Legend to Illustration 5.1, Display Menu Keys

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

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

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

Table 5.3 Legend to Illustration 5.1, Navigation Keys

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

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

## D. Operation keys and reset

Operation keys are at the bottom of the LCP.

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

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

### NOTICE

The display contrast can be adjusted by pressing [Status] and the [▲]/[▼] keys.

## 5.3.2 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in *chapter 9.2 Parameter Menu Structure*.

Programming data is stored internally in the frequency converter.

- For back-up, upload data into the LCP memory.
- To download data to another frequency converter, connect the LCP to that unit and download the stored settings.
- Restoring factory default settings does not change data stored in the LCP memory.

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

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

- Press [Hand On] or [Auto On] to return to normal operation.

## 5.3.4 Changing Parameter Settings

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

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

### View changes

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

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

## 5.3.5 Restoring Default Settings

### NOTICE

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

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

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

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

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

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

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

**Manual initialization procedure**

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

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

Manual initialization does not reset the following frequency converter information:

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

**5.4 Basic Programming**

**5.4.1 Commissioning with SmartStart**

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically at first power-up or after initialization of the frequency converter.
- Follow the on-screen instructions to complete the commissioning of the frequency converter. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the programming guide.

**NOTICE**

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

**5.4.2 Commissioning via [Main Menu]**

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to *parameter group 0-\*\* Operation/Display* and press [OK].

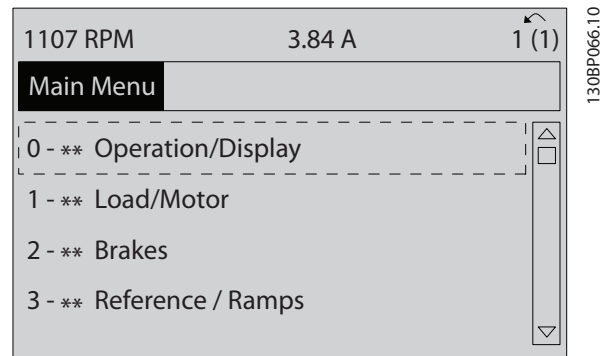


Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to *parameter group 0-0\* Basic Settings* and press [OK].

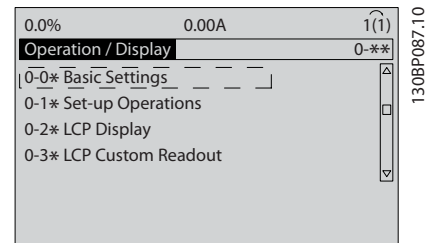


Illustration 5.3 Operation/Display

4. Press the navigation keys to scroll to *parameter 0-03 Regional Settings* and press [OK].

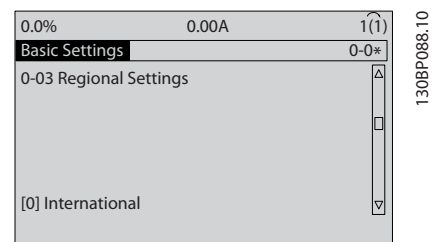


Illustration 5.4 Basic Settings

5. Press the navigation keys to select [0] *International* or [1] *North America* as appropriate and

- press [OK]. (This changes the default settings for several basic parameters).
- 6. Press [Main Menu] on the LCP.
- 7. Press the navigation keys to scroll to *parameter 0-01 Language*.
- 8. Select the language and press [OK].
- 9. If a jumper wire is in place between control terminals 12 and 27, leave *parameter 5-12 Terminal 27 Digital Input* at factory default. Otherwise, select [0] No Operation in *parameter 5-12 Terminal 27 Digital Input*.
- 10. Make the application-specific settings in the following parameters:
  - 10a *Parameter 3-02 Minimum Reference*.
  - 10b *Parameter 3-03 Maximum Reference*.
  - 10c *Parameter 3-41 Ramp 1 Ramp Up Time*.
  - 10d *Parameter 3-42 Ramp 1 Ramp Down Time*.
  - 10e *Parameter 3-13 Reference Site*. Linked to Hand/Auto Local Remote.

### 5.4.3 Asynchronous Motor Set-up

Enter the following motor data. Find the information on the motor nameplate.

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

When running in flux control principle, or for optimum performance in VVC<sup>+</sup> mode, extra motor data is required to set up the following parameters. Find the data in the motor datasheet (this data is typically not available on the motor nameplate). Run a complete automatic motor adaptation (AMA) using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the parameters manually. *Parameter 1-36 Iron Loss Resistance (Rfe)* is always entered manually.

1. *Parameter 1-30 Stator Resistance (Rs)*.
2. *Parameter 1-31 Rotor Resistance (Rr)*.
3. *Parameter 1-33 Stator Leakage Reactance (X1)*.
4. *Parameter 1-34 Rotor Leakage Reactance (X2)*.
5. *Parameter 1-35 Main Reactance (Xh)*.
6. *Parameter 1-36 Iron Loss Resistance (Rfe)*.

**Application-specific adjustment when running VVC<sup>+</sup>**  
 VVC<sup>+</sup> is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

**Application-specific adjustment when running flux**  
 Flux control principle is the preferred control principle for optimum shaft performance in dynamic applications. Perform an AMA since this control mode requires precise motor data. Depending on the application, further adjustments may be required.

See *Table 5.6* for application-related recommendations.

Application	Settings
Low-inertia applications	Keep calculated values.
High-inertia applications	<i>Parameter 1-66 Min. Current at Low Speed</i> . Increase current to a value between default and maximum depending on the application. Set ramp times matching the application. Too fast ramp up causes an overcurrent or overtorque. Too fast ramp down causes an overvoltage trip.
High load at low speed	<i>Parameter 1-66 Min. Current at Low Speed</i> . Increase current to a value between default and maximum depending on the application.
No-load application	Adjust <i>parameter 1-18 Min. Current at No Load</i> to achieve smoother motor operation by reducing torque ripple and vibration.
Flux sensorless control principle only	Adjust <i>parameter 1-53 Model Shift Frequency</i> . Example 1: If the motor oscillates at 5 Hz, and dynamics performance is required at 15 Hz, set <i>parameter 1-53 Model Shift Frequency</i> to 10 Hz. Example 2: If the application involves dynamic load changes at low speed, reduce <i>parameter 1-53 Model Shift Frequency</i> . Observe the motor behavior to make sure that the model shift frequency is not reduced too much. Symptoms of inappropriate model shift frequency are motor oscillations or frequency converter tripping.

**Table 5.6 Recommendations for Flux Applications**

### 5.4.4 PM Motor Set-up

#### **NOTICE**

Valid for FC 302 only.

This section describes how to set up a PM motor.

#### Initial programming steps

To activate PM motor operation, select [1] PM, non-salient SPM in *parameter 1-10 Motor Construction*.

#### Programming motor data

After selecting a PM motor, the PM motor-related parameters in *parameter groups 1-2\* Motor Data, 1-3\* Adv. Motor Data, and 1-4\* Adv. Motor Data II* are active. The necessary data is on the motor nameplate and on the motor datasheet.

Program the following parameters in the order listed:

1. *Parameter 1-24 Motor Current.*
2. *Parameter 1-25 Motor Nominal Speed.*
3. *Parameter 1-26 Motor Cont. Rated Torque.*
4. *Parameter 1-39 Motor Poles.*

Run a complete AMA using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA*.

If a complete AMA is not performed, configure the following parameters manually:

1. *Parameter 1-30 Stator Resistance (Rs)*  
Enter the line-to-common stator winding resistance (Rs). If only line-line data is available, divide the line-line value by 2 to get the line-common value.
2. *Parameter 1-37 d-axis Inductance (Ld)*  
Enter the line-to-common direct axis inductance of the PM motor. If only line-line data is available, divide the line-line value by 2 to get the line-common value.
3. *Parameter 1-40 Back EMF at 1000 RPM.*  
Enter the line-to-line back EMF of the PM Motor at 1000 RPM (RMS value). Back EMF is the voltage generated by a PM motor when no frequency converter is connected and the shaft is turned externally. It is normally specified for nominal motor speed or for 1000 RPM measured between 2 lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows:  
If back EMF is, for example, 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows:  
Back EMF = (Voltage/RPM)x1000 = (320/1800)x1000 = 178.

#### Test motor operation

1. Start the motor at low speed (100–200 RPM). If the motor does not turn, check the installation, general programming, and motor data.
2. Check if the start function in *parameter 1-70 PM Start Mode* fits the application requirements.

#### Rotor detection

This function is the recommended selection for applications where the motor starts from standstill, for example pumps or conveyors. On some motors, a sound is heard when the frequency converter performs the rotor detection. This does not harm the motor.

#### Parking

This function is the recommended selection for applications where the motor is rotating at slow speed, for example windmilling in fan applications. *Parameter 2-06 Parking Current* and *parameter 2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

#### Application-specific adjustment when running VVC+

VVC+ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

Start the motor at nominal speed. If the application does not run well, check the VVC+ PM settings. *Table 5.7* contains recommendations for various applications.

Application	Settings
Low-inertia applications $I_{Load}/I_{Motor} < 5$	Increase <i>parameter 1-17 Voltage filter time const.</i> by factor 5–10. Reduce <i>parameter 1-14 Damping Gain</i> . Reduce <i>parameter 1-66 Min. Current at Low Speed</i> (<100%).
Low-inertia applications $50 > I_{Load}/I_{Motor} > 5$	Keep the default values.
High-inertia applications $I_{Load}/I_{Motor} > 50$	Increase <i>parameter 1-14 Damping Gain</i> , <i>parameter 1-15 Low Speed Filter Time Const.</i> , and <i>parameter 1-16 High Speed Filter Time Const.</i>
High load at low speed <30% (rated speed)	Increase <i>parameter 1-17 Voltage filter time const.</i> Increase <i>parameter 1-66 Min. Current at Low Speed</i> to adjust the starting torque. 100% current provides nominal torque as starting torque. This parameter is independent of <i>parameter 30-20 High Starting Torque Time [s]</i> and <i>parameter 30-21 High Starting Torque Current [%]</i> . Working at a current level higher than 100% for a prolonged time can cause the motor to overheat.

Table 5.7 Recommendations for Various Applications

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, this parameter can be set to 10–100% higher than the default value.

**Application-specific adjustment when running flux**

Flux control principle is the preferred control principle for optimum shaft performance in dynamic applications. Perform an AMA because this control mode requires precise motor data. Depending on the application, further adjustments may be required. See *chapter 5.4.3 Asynchronous Motor Set-up* for application-specific recommendations.

**5.4.5 SynRM Motor Set-up with VVC<sup>+</sup>**

This section describes how to set up a SynRM motor with VVC<sup>+</sup>.

**NOTICE**

The SmartStart wizard covers the basic configuration of SynRM motors.

**Initial programming steps**

To activate SynRM motor operation, select [5] *Sync. Reluctance* in *parameter 1-10 Motor Construction*.

**Programming motor data**

After performing the initial programming steps, the SynRM motor-related parameters in *parameter groups 1-2\* Motor Data, 1-3\* Adv. Motor Data, and 1-4\* Adv. Motor Data II* are active.

Use the motor nameplate data and the motor datasheet to program the following parameters in the order listed:

1. *Parameter 1-23 Motor Frequency.*
2. *Parameter 1-24 Motor Current.*
3. *Parameter 1-25 Motor Nominal Speed.*
4. *Parameter 1-26 Motor Cont. Rated Torque.*

Run a complete AMA using *parameter 1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the following parameters manually:

1. *Parameter 1-30 Stator Resistance (Rs).*
2. *Parameter 1-37 d-axis Inductance (Ld).*
3. *Parameter 1-44 d-axis Inductance Sat. (LdSat).*
4. *Parameter 1-45 q-axis Inductance Sat. (LqSat).*
5. *Parameter 1-48 Inductance Sat. Point.*

**Application-specific adjustments**

Start the motor at nominal speed. If the application does not run well, check the VVC<sup>+</sup> SynRM settings. *Table 5.8* provides application-specific recommendations:

Application	Settings
Low-inertia applications $I_{Load}/I_{Motor} < 5$	Increase <i>parameter 1-17 Voltage filter time const.</i> by factor 5–10. Reduce <i>parameter 1-14 Damping Gain</i> . Reduce <i>parameter 1-66 Min. Current at Low Speed</i> (<100%).
Low-inertia applications $50 > I_{Load}/I_{Motor} > 5$	Keep the default values.
High-inertia applications $I_{Load}/I_{Motor} > 50$	Increase <i>parameter 1-14 Damping Gain</i> , <i>parameter 1-15 Low Speed Filter Time Const.</i> , and <i>parameter 1-16 High Speed Filter Time Const.</i>
High-load at low speed <30% (rated speed)	Increase <i>parameter 1-17 Voltage filter time const.</i> Increase <i>parameter 1-66 Min. Current at Low Speed</i> to adjust the starting torque. 100% current provides nominal torque as starting torque. This parameter is independent of <i>parameter 30-20 High Starting Torque Time [s]</i> and <i>parameter 30-21 High Starting Torque Current [%]</i> ). Working at a current level higher than 100% for a prolonged time can cause the motor to overheat.
Dynamic applications	Increase <i>parameter 14-41 AEO Minimum Magnetisation</i> for highly dynamic applications. Adjusting <i>parameter 14-41 AEO Minimum Magnetisation</i> ensures a good balance between energy efficiency and dynamics. Adjust <i>parameter 14-42 Minimum AEO Frequency</i> to specify the minimum frequency at which the frequency converter should use minimum magnetization.
Motor sizes less than 18 kW (24 hp)	Avoid short ramp-down times.

**Table 5.8 Recommendations for Various Applications**

If the motor starts oscillating at a certain speed, increase *parameter 1-14 Damping Gain*. Increase the damping gain value in small steps. Depending on the motor, this parameter can be set to 10–100% higher than the default value.

## 5.4.6 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimizes compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the entered nameplate data.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select [2] *Enable reduced AMA*.
- If an output filter is connected to the motor, select [2] *Enable reduced AMA*.
- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.
- Run this procedure on a cold motor for best results.

### To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to *parameter group 1-\*\* Load and Motor* and press [OK].
3. Scroll to *parameter group 1-2\* Motor Data* and press [OK].
4. Scroll to *parameter 1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select [1] *Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicates when it is complete.
8. The advanced motor data is entered in *parameter group 1-3\* Adv. Motor Data*.

## 5.5 Checking Motor Rotation

Before running the frequency converter, check the motor rotation.

1. Press [Hand On].
2. Press [▲] for positive speed reference.
3. Check that the speed shown is positive.
4. Verify that the wiring between the frequency converter and the motor is correct.
5. Verify that the motor running direction matches the setting in *parameter 1-06 Clockwise Direction*.

5a When *parameter 1-06 Clockwise Direction* is set to [0] *Normal* (default clockwise):

- a. Verify that the motor turns clockwise.
- b. Verify that the LCP direction arrow is clockwise.

5b When *parameter 1-06 Clockwise Direction* is set to [1] *Inverse* (counterclockwise):

- a. Verify that the motor turns counterclockwise.
- b. Verify that the LCP direction arrow is counterclockwise.

## 5.6 Checking Encoder Rotation

### 5.6.1 Encoder Rotation

If encoder feedback is used, perform the following steps:

1. Select [0] *Open Loop* in *parameter 1-00 Configuration Mode*.
2. Select [1] *24 V encoder* in *parameter 7-00 Speed PID Feedback Source*.
3. Press [Hand On].
4. Press [▶] for positive speed reference (*parameter 1-06 Clockwise Direction* at [0] *Normal*).
5. In *parameter 16-57 Feedback [RPM]*, check that the feedback is positive.

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

### **NOTICE**

#### **NEGATIVE FEEDBACK**

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

### **NOTICE**

If the application uses an encoder with a PM motor, refer to *chapter 6.1.9 PM Motor with an Absolute Encoder*.



## 5.7 Local-control Test

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

If acceleration or deceleration problems occur, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* for resetting the frequency converter after a trip.

## 5.8 System Start-up

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

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

If warnings or alarms occur, see or *chapter 7.4 List of Warnings and Alarms*.

## 6 Application Set-up Examples

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

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

### NOTICE

When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

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### 6.1 Application Examples

#### 6.1.1 AMA

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 1-29 A Automatic Motor Adaptation (AMA)	1] Enable complete AMA
+24 V	13		
D IN	18		
D IN	19		
COM	20	Parameter 5-12 T Terminal 27 Digital Input	2] Coast inverse
D IN	27		
D IN	29	<b>Notes/comments:</b> Set parameter group 1-2* Motor Data according to the motor. D IN 37 is an option.	
D IN	32		
D IN	33		
D IN	37		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.1 AMA with T27 Connected

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 1-29 A Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
+24 V	13		
D IN	18		
D IN	19		
COM	20	Parameter 5-12 T Terminal 27 Digital Input	[0] No operation
D IN	27		
D IN	29	<b>Notes/comments:</b> Set parameter group 1-2* Motor Data according to the motor. D IN 37 is an option.	
D IN	32		
D IN	33		
D IN	37		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.2 AMA without T27 Connected

6.1.2 Speed

		Parameters	
FC		Function	Setting
+24 V	12	130BB926.10	Parameter 6-10 Terminal 53 Low Voltage
+24 V	13		0.07 V*
D IN	18		Parameter 6-11 Terminal 53 High Voltage
D IN	19		10 V*
COM	20		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value
D IN	27		0 Hz
D IN	29		Parameter 6-15 Terminal 53 High Ref./Feedb. Value
D IN	32		50 Hz
D IN	33		* = Default value
D IN	37		Notes/comments: D IN 37 is an option.
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39	<p>A53</p>	

Table 6.3 Analog Speed Reference (Voltage)

		Parameters	
FC		Function	Setting
+24 V	12	130BB927.10	Parameter 6-12 Terminal 53 Low Current
+24 V	13		4 mA*
D IN	18		Parameter 6-13 Terminal 53 High Current
D IN	19		20 mA*
COM	20		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value
D IN	27		0 Hz
D IN	29		Parameter 6-15 Terminal 53 High Ref./Feedb. Value
D IN	32		50 Hz
D IN	33		* = Default value
D IN	37		Notes/comments: D IN 37 is an option.
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39	<p>A53</p>	

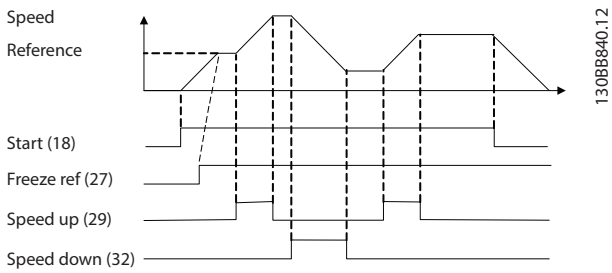
Table 6.4 Analog Speed Reference (Current)

		Parameters	
FC		Function	Setting
+24 V	12	130BB683.10	Parameter 6-10 Terminal 53 Low Voltage
+24 V	13		0.07 V*
D IN	18		Parameter 6-11 Terminal 53 High Voltage
D IN	19		10 V*
COM	20		Parameter 6-14 Terminal 53 Low Ref./Feedb. Value
D IN	27		0 Hz
D IN	29		Parameter 6-15 Terminal 53 High Ref./Feedb. Value
D IN	32		50 Hz
D IN	33		* = Default value
D IN	37		Notes/comments: D IN 37 is an option.
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39	<p>A53</p>	

Table 6.5 Speed Reference (Using a Manual Potentiometer)

		Parameters	
FC		Function	Setting
+24 V	12	130BB804.11	Parameter 5-10 Terminal 18 Digital Input
+24 V	13		[8] Start*
D IN	18		Parameter 5-12 Terminal 27 Digital Input
D IN	19		[19] Freeze Reference
COM	20		Parameter 5-13 Terminal 29 Digital Input
D IN	27		[21] Speed Up
D IN	29		Parameter 5-14 Terminal 32 Digital Input
D IN	32		[22] Speed Down
D IN	33		* = Default value
D IN	37		Notes/comments: D IN 37 is an option.
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39	<p>A53</p>	

Table 6.6 Speed Up/Speed Down



130BB840.12

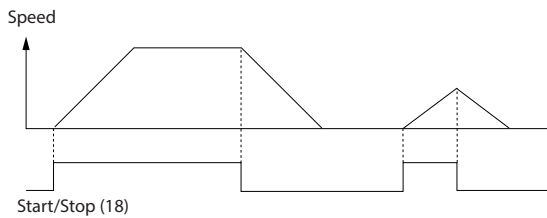
Illustration 6.1 Speed Up/Speed Down

6.1.3 Start/Stop

6

FC		Parameters	
		Function	Setting
+24 V	12	Parameter 5-10 Terminal 18 Digital Input	[8] Start
+24 V	13		
D IN	18	Parameter 5-12 Terminal 27 Digital Input	[0] No operation
D IN	19		
COM	20	Parameter 5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
* = Default value			
<b>Notes/comments:</b>			
If parameter 5-12 Terminal 27 Digital Input is set to [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.			

Table 6.7 Start/Stop Command with Safe Torque Off Option

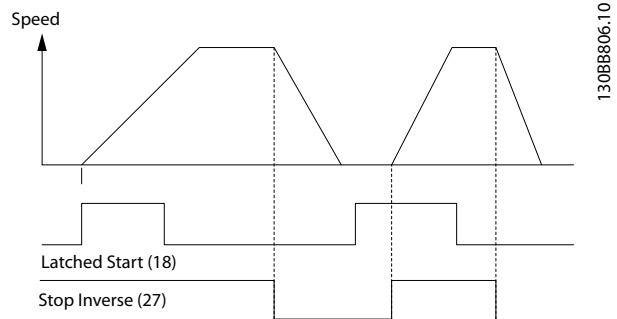


130BB805.12

Illustration 6.2 Start/Stop Command with Safe Torque Off

FC		Parameters	
		Function	Setting
+24 V	12	Parameter 5-10 Terminal 18 Digital Input	[9] Latched Start
+24 V	13		
D IN	18	Parameter 5-12 Terminal 27 Digital Input	[6] Stop Inverse
D IN	19		
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
* = Default value			
<b>Notes/comments:</b>			
If parameter 5-12 Terminal 27 Digital Input is set to [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.			

Table 6.8 Pulse Start/Stop



130BB806.10

Illustration 6.3 Latched Start/Stop Inverse

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 5-10 Terminal 18 Digital Input	[8] Start
+24 V	13		
D IN	18	Parameter 5-11 Terminal 19 Digital Input	[10] Reversing
D IN	19		
COM	20	Parameter 5-12 Terminal 27 Digital Input	[0] No operation
D IN	27		
D IN	29	Parameter 5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
D IN	32		
D IN	33	Parameter 5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
+10 V	50		
A IN	53	Parameter 3-10 Preset Reference	Preset reference 0
A IN	54		Preset reference 1
COM	55		Preset reference 2
A OUT	42		Preset reference 3
COM	39	* = Default value	
		<b>Notes/comments:</b> D IN 37 is an option.	

Table 6.9 Start/Stop with Reversing and 4 Preset Speeds

### 6.1.4 External Alarm Reset

		Parameters	
FC		Function	Setting
+24 V	12	Parameter 5-11 Terminal 19 Digital Input	[1] Reset
+24 V	13		
D IN	18	* = Default value	
D IN	19	<b>Notes/comments:</b> D IN 37 is an option.	
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.10 External Alarm Reset

6.1.5 RS485

		Parameters	
		Function	Setting
		Parameter 8-30 P rotocol	FC*
		Parameter 8-31 A ddress	1*
		Parameter 8-32 B aud Rate	9600*
		* = Default value	
<b>Notes/comments:</b> Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.			

Table 6.11 RS485 Network Connection

6.1.6 Motor Thermistor

**CAUTION**

**THERMISTOR INSULATION**

Risk of personal injury or equipment damage.

- Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.

		Parameters	
		Function	Setting
		Parameter 1-90 Motor Thermal Protection	[2] Thermistor trip
		Parameter 1-93 T hermistor Source	[1] Analog input 53
		* = Default Value	
<b>Notes/comments:</b> If only a warning is required, set parameter 1-90 Motor Thermal Protection to [1] Thermistor warning. D IN 37 is an option.			

Table 6.12 Motor Thermistor

6.1.7 SLC

		Parameters

FC		Function	Setting
+24 V	12	Parameter 4-30 Motor Feedback Loss Function	[1] Warning
+24 V	13		
D IN	18		
D IN	19		
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33	Parameter 4-31 Motor Feedback Speed Error	100 RPM
D IN	37		
D IN	37	Parameter 4-32 Motor Feedback Loss Timeout	5 s
+10 V	50	Parameter 7-00 Speed PID Feedback Source	[2] MCB 102
A IN	53		
A IN	54	Parameter 17-11 Resolution (PPR)	1024*
COM	55		
A OUT	42	Parameter 13-00 S L Controller Mode	[1] On
COM	39		
		Parameter 13-01 Start Event	[19] Warning
		Parameter 13-02 Stop Event	[44] Reset key
		Parameter 13-10 Comparator Operand	[21] Warning no.
		Parameter 13-11 Comparator Operator	[1] ≈*
		Parameter 13-12 Comparator Value	90
		Parameter 13-51 S L Controller Event	[22] Comparator 0
		Parameter 13-52 S L Controller Action	[32] Set digital out A low
		Parameter 5-40 Function Relay	[80] SL digital output A
			*=Default Value

Table 6.13 Using SLC to Set a Relay

Notes/comments:

Exceeding the limit in the feedback monitor issues *warning 90, Feedback monitor*. The SLC monitors *warning 90, Feedback monitor*, and if the warning becomes true, relay 1 is triggered.

External equipment indicates if service is required. If the feedback error goes below the limit again within 5 s, the frequency converter continues, and the warning disappears. But relay 1 is still triggered until [Reset] is pressed on the LCP.

6.1.8 Mechanical Brake Control

FC		Function	Setting
+24 V	12	Parameter 5-40 Function Relay	[32] Mech. brake ctrl.
+24 V	13		
D IN	18		
D IN	19		
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33	Parameter 5-10 Terminal 18 Digital Input	[8] Start*
D IN	37		
D IN	37	Parameter 5-11 Terminal 19 Digital Input	[11] Start reversing
+10 V	50	Parameter 1-71 Start Delay	0.2
A IN	53		
A IN	54	Parameter 1-72 Start Function	[5] VVC+/ FLUX Clockwise
COM	55		
A OUT	42	Parameter 1-76 Start Current	$I_{m,n}$
COM	39		
		Parameter 2-20 Release Brake Current	Application dependent
		Parameter 2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
			*=Default Value
			Notes/comments: -

Table 6.14 Mechanical Brake Control

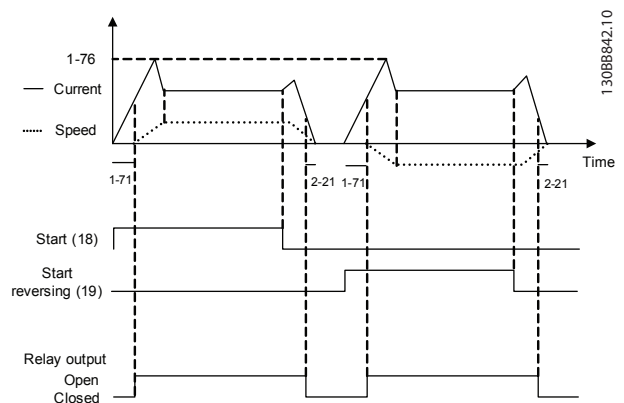


Illustration 6.4 Mechanical Brake Control

## 6.1.9 PM Motor with an Absolute Encoder

### **NOTICE**

Do not use PM motors with incremental encoders.

The automatic rotor detection function is not compatible with all PM motors. When using a PM motor, adjust the motor angle manually. To make the adjustment process easier, show the motor angle (*parameter 16-20 Motor Angle*) on the LCP.

### **NOTICE**

The rotor must be free to move during this adjustment process.

**6**

#### Adjusting the motor angle manually

1. Get the motor angle without magnetization:
  - 1a Set *parameter 1-07 Motor Angle Offset* Adjust to [0] Manual.
  - 1b Set *parameter 1-41 Motor Angle Offset* to 0.
  - 1c Note the motor angle value in *parameter 16-20 Motor Angle*.
2. Get the motor angle with magnetization:
  - 2a Set *parameter 1-72 Start Function* to [0] DC hold/delay time.
  - 2b Set *parameter 1-71 Start Delay* to 15 s.
  - 2c Set *parameter 2-00 DC Hold Current* to 100%
  - 2d Press [Hand On] on the LCP with the speed reference equal to 0 and with the DC hold applied.
  - 2e Note the motor angle in *parameter 16-20 Motor Angle*.
3. Calculate the motor angle offset and use it in *parameter 1-41 Motor Angle Offset*:
  - 3a Calculate the motor angle offset using the formula:  
Motor angle offset = angle without magnetization - angle with magnetization.
  - 3b Enter the calculated value in *parameter 1-41 Motor Angle Offset*.
  - 3c Restore the application-specific values for the start function and the DC hold.

The encoder is now aligned with the rotor angle.



# 7 Maintenance, Diagnostics, and Troubleshooting

This chapter includes:

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

## 7.1 Maintenance and Service

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

### **⚠ WARNING**

#### **UNINTENDED START**

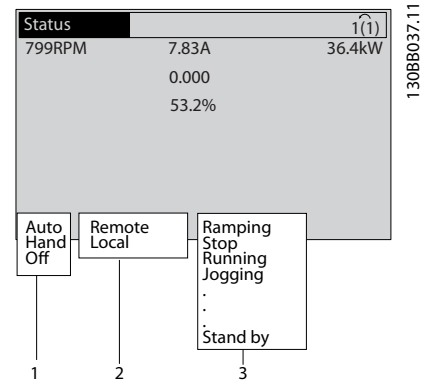
When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor can start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start with an external switch, a fieldbus command, an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

To prevent unintended motor start:

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

## 7.2 Status Messages

When the frequency converter is in *Status mode*, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 7.1*).



1	Operating mode (see <i>Table 7.1</i> )
2	Reference site (see <i>Table 7.2</i> )
3	Operation status (see <i>Table 7.3</i> )

Illustration 7.1 Status Display

*Table 7.1* to *Table 7.3* describe the status messages shown.

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

Table 7.1 Operating Mode

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

Table 7.2 Reference Site

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

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

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

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

Table 7.3 Operation Status

### NOTICE

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

7

## 7.3 Warning and Alarm Types

### Warnings

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

### Alarms

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

### Trip

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

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

A trip can be reset in any of 4 ways:

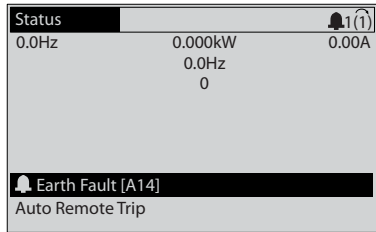
- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

### Trip lock

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

**Warning and alarm displays**

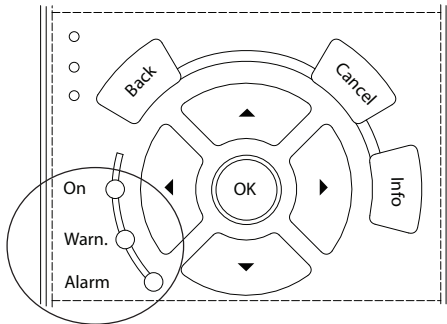
- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.



130BP086.11

Illustration 7.2 Alarm Example

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



130BB467.11

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

Illustration 7.3 Status Indicator Lights

**7.4 List of Warnings and Alarms**

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

**WARNING 1, 10 Volts low**

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

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

**Troubleshooting**

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

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

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

**Troubleshooting**

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

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

**WARNING/ALARM 3, No motor**

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

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

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

**Troubleshooting**

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

**WARNING 5, DC link voltage high**

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

**WARNING 6, DC link voltage low**

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

**WARNING/ALARM 7, DC overvoltage**

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

**Troubleshooting**

- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.

- If the alarm/warning occurs during a power sag, use kinetic back-up (*parameter 14-10 Mains Failure*).

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

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

##### Troubleshooting

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

#### WARNING/ALARM 9, Inverter overload

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

##### Troubleshooting

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

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

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

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

##### Troubleshooting

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

#### WARNING/ALARM 12, Torque limit

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

##### Troubleshooting

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

#### WARNING/ALARM 13, Over current

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

**Troubleshooting**

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

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

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

**Troubleshooting**

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

**ALARM 15, Hardware mismatch**

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

Record the value of the following parameters and contact Danfoss.

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

**ALARM 16, Short circuit**

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

**Troubleshooting**

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

**WARNING****HIGH VOLTAGE**

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

- Disconnect power before proceeding.

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

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

**Troubleshooting**

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

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

The temperature sensor is not connected.

**WARNING/ALARM 21, Parameter error**

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

**Troubleshooting**

- Set the affected parameter to a valid value.

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

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

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

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

**WARNING 23, Internal fan fault**

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

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

**Troubleshooting**

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

**WARNING 24, External fan fault**

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

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

**Troubleshooting**

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

**WARNING 25, Brake resistor short circuit**

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

**Troubleshooting**

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

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

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

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

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

**Troubleshooting**

- Remove power to the frequency converter and remove the brake resistor.

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

The brake resistor is not connected or not working.

**Troubleshooting**

- Check *parameter 2-15 Brake Check*.

**ALARM 29, Heat Sink temp**

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

**Troubleshooting**

Check for the following conditions:

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

**ALARM 30, Motor phase U missing**

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

**⚠ WARNING****HIGH VOLTAGE**

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

- Disconnect power before proceeding.

**Troubleshooting**

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

**ALARM 31, Motor phase V missing**

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

**⚠ WARNING****HIGH VOLTAGE**

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

- Disconnect power before proceeding.

**Troubleshooting**

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

**ALARM 32, Motor phase W missing**

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

## ⚠ WARNING

### HIGH VOLTAGE

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

- Disconnect power before proceeding.

#### Troubleshooting

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

### ALARM 33, Inrush fault

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

#### Troubleshooting

- Let the unit cool to operating temperature.

### WARNING/ALARM 34, Fieldbus communication fault

The fieldbus on the communication option card is not working.

### WARNING/ALARM 35, Option fault

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

### WARNING/ALARM 36, Mains failure

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

#### Troubleshooting

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

### ALARM 37, Phase imbalance

There is a current imbalance between the power units.

### ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 7.4* is shown.

#### Troubleshooting

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

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

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss service department.

Number	Text
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or the Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/allowed.
1318	The option software in slot C1 is not supported/allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The frequency converter also uses this fault code if the MCO does not power up correctly. This situation can occur due to poor EMC protection or improper grounding.
1796	RAM copy error.
2561	Replace the control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376–6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

Table 7.4 Internal Fault Codes

### ALARM 39, Heat sink sensor

No feedback from the heat sink temperature sensor.

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

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

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



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

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

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

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

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

**ALARM 43, Ext. supply**

VLT® Extended Relay Option MCB 113 is mounted without external 24 V DC. Either connect a 24 V DC external supply or specify that no external supply is used via *parameter 14-80 Option Supplied by External 24VDC, [0] No*. A change in *parameter 14-80 Option Supplied by External 24VDC* requires a power cycle.

**ALARM 45, Earth fault 2**

Ground fault.

**Troubleshooting**

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

**ALARM 46, Power card supply**

The supply on the power card is out of range.

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

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

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

**Troubleshooting**

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

**WARNING 47, 24 V supply low**

The supply on the power card is out of range.

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

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

**Troubleshooting**

- Check for a defective power card.

**WARNING 48, 1.8 V supply low**

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

**Troubleshooting**

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

**WARNING 49, Speed limit**

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

**ALARM 50, AMA calibration failed**

Contact the Danfoss supplier or Danfoss service department.

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

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

**Troubleshooting**

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

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

The motor current is too low.

**Troubleshooting**

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

**ALARM 53, AMA motor too big**

The motor is too large for the AMA to operate.

**ALARM 54, AMA motor too small**

The motor is too small for the AMA to operate.

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

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

**ALARM 56, AMA interrupted by user**

The AMA is manually interrupted.

**ALARM 57, AMA internal fault**

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

**ALARM 58, AMA Internal fault**

Contact the Danfoss supplier.

**WARNING 59, Current limit**

The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in *parameters 1-20 to 1-25* is set correctly. Increase the current

limit if necessary. Ensure that the system can operate safely at a higher limit.

#### **WARNING 60, External interlock**

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

#### **WARNING/ALARM 61, Feedback error**

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

##### **Troubleshooting**

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

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

The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*. Check the application for possible causes. Possibly increase the output frequency limit. Be sure that the system can operate safely at a higher output frequency. The warning clears when the output drops below the maximum limit.

#### **ALARM 63, Mechanical brake low**

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

#### **WARNING 64, Voltage Limit**

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

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

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

##### **Troubleshooting**

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

#### **WARNING 66, Heat sink temperature low**

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

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

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

#### **ALARM 68, Safe Stop activated**

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

#### **ALARM 69, Power card temperature**

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

##### **Troubleshooting**

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

#### **ALARM 70, Illegal FC configuration**

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

#### **ALARM 71, PTC 1 safe stop**

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

#### **ALARM 72, Dangerous failure**

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

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

#### **WARNING 73, Safe Stop auto restart**

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

#### **ALARM 74, PTC Thermistor**

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

#### **ALARM 75, Illegal profile sel.**

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

#### **WARNING 76, Power unit setup**

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

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 78, Tracking error

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

#### Troubleshooting

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

#### ALARM 79, Illegal power section configuration

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

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

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

#### ALARM 81, CSIV corrupt

CSIV file has syntax errors.

#### ALARM 82, CSIV parameter error

CSIV failed to initialize a parameter.

#### ALARM 83, Illegal option combination

The mounted options are incompatible.

#### ALARM 84, No safety option

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

#### ALARM 88, Option detection

A change in the option layout is detected.

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

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

#### WARNING 89, Mechanical brake sliding

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

#### ALARM 90, Feedback monitor

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

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

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

#### ALARM 99, Locked rotor

Rotor is blocked.

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

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

#### Troubleshooting

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

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

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

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

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

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

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

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

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

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

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

#### WARNING 250, New spare part

A component in the drive system has been replaced.

#### Troubleshooting

- Reset the drive system to restore normal operation.

#### WARNING 251, New typecode

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

## 7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See <i>Table 4.4</i> .	Check the input power source.
	Missing or open fuses or circuit breaker tripped.	See <i>Open power fuses and tripped circuit breaker</i> in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP.	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals.	Check the 24 V control voltage supply for terminal 12/13 to 20–39 V or 10 V supply for terminals 50–55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/FCD or FCM).	–	Use only LCP 101 (code number 130B1124) or LCP 102 (code number 130B1107).
	Wrong contrast setting.	–	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective.	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective.	–	Contact supplier.
Intermittent display	Overloaded supply (SMPS) due to improper control wiring or a fault within the frequency converter.	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for <i>Display dark/No function</i> in this table.
Motor not running	Service switch open or missing motor connection.	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No mains power with 24 V DC option card.	If the display is functioning, but there is no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit.
	LCP Stop.	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operating mode) to run the motor.
	Missing start signal (Standby).	Check <i>parameter 5-10 Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check <i>parameter 5-12 Terminal 27 Digital Input</i> for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to [0] <i>No operation</i> .
	Wrong reference signal source.	Determine which reference type is active (local, remote, or fieldbus) and check the following points: <ul style="list-style-type: none"> <li>• Preset reference (active or not).</li> <li>• Terminal connection.</li> <li>• Scaling of terminals.</li> <li>• Reference signal.</li> </ul>	Program correct settings. Check <i>parameter 3-13 Reference Site</i> . Set preset reference active in <i>parameter group 3-1* References</i> . Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that <i>parameter 4-10 Motor Speed Direction</i> is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in <i>parameter group 5-1* Digital inputs</i> .	Deactivate reversing signal.
	Wrong motor phase connection.	–	See <i>chapter 5.5 Checking Motor Rotation</i> .

Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in <i>parameter 4-13 Motor Speed High Limit [RPM]</i> , <i>parameter 4-14 Motor Speed High Limit [Hz]</i> , and <i>parameter 4-19 Max Output Frequency</i> .	Program the correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in <i>parameter group 6-0* Analog I/O mode</i> and <i>parameter group 3-1* References</i> .	Program the correct settings.
Motor speed unstable	Incorrect parameter settings.	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in <i>parameter group 1-6* Load Depen. Setting</i> . For closed-loop operation, check settings in <i>parameter group 20-0* Feedback</i> .
Motor runs rough	Overmagnetization.	Check for incorrect motor settings in all motor parameters.	Check motor settings in <i>parameter groups 1-2* Motor data</i> , <i>1-3* Adv Motor Data</i> , and <i>1-5* Load Indep. Setting</i> .
Motor does not brake	Incorrect settings in the brake parameters. Possible too short ramp-down times.	Check brake parameters. Check ramp time settings.	Check <i>parameter groups 2-0* DC Brake</i> and <i>3-0* Reference Limits</i> .
Open power fuses or circuit breaker trip	Phase-to-phase short.	Motor or panel has a short phase-to-phase. Check motor and panel phases for shorts.	Eliminate any shorts detected.
	Motor overload.	Motor is overloaded for the application.	Perform start-up test and verify that motor current is within specifications. If motor current is exceeding the nameplate full load current, the motor may run only with reduced load. Review the specifications for the application.
	Loose connections.	Perform pre-start-up check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (see <i>Alarm 4, Mains phase loss</i> description).	Rotate input power leads into the 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check the mains supply.
	Problem with the frequency converter.	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the frequency converter. Contact supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with frequency converter.	Rotate output motor cables 1 position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact supplier.
Frequency converter acceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data are entered correctly.	Increase the ramp-up time in <i>parameter 3-41 Ramp 1 Ramp Up Time</i> . Increase current limit in <i>parameter 4-18 Current Limit</i> . Increase torque limit in <i>parameter 4-16 Torque Limit Motor Mode</i> .
Frequency converter deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, see <i>chapter 7.4 List of Warnings and Alarms</i> . Check that motor data are entered correctly.	Increase the ramp-down time in <i>parameter 3-42 Ramp 1 Ramp Down Time</i> . Enable overvoltage control in <i>parameter 2-17 Over-voltage Control</i> .

Table 7.5 Troubleshooting

## 8 Specifications

### 8.1 Electrical Data

#### 8.1.1 Mains Supply 200–240 V

Type designation	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical shaft output [kW/(hp)]	0.25 (0.34)	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	3.7 (5.0)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	A1	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
<b>Output current</b>									
Continuous (200–240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7
Intermittent (200–240 V) [A]	2.9	3.8	5.6	7.4	10.6	12.0	17.0	20.0	26.7
Continuous kVA (208 V) [kVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.00
<b>Maximum input current</b>									
Continuous (200–240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15.0
Intermittent (200–240 V) [A]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24.0
<b>Additional specifications</b>									
Maximum cable cross-section <sup>2)</sup> for mains, motor, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	4,4,4 (12,12,12) (minimum 0.2 (24))								
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	6,4,4 (10,12,12)								
Estimated power loss at rated maximum load [W] <sup>3)</sup>	21	29	42	54	63	82	116	155	185
Efficiency <sup>4)</sup>	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96

Table 8.1 Mains Supply 200–240 V, PK25–P3K7

Type designation	P5K5		P7K5		P11K	
	HO	NO	HO	NO	HO	NO
High/normal overload <sup>1)</sup>						
Typical shaft output [kW/(hp)]	5.5 (7.5)	7.5 (10)	7.5 (10)	11 (15)	11 (15)	15 (20)
Enclosure protection rating IP20	B3		B3		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2	
<b>Output current</b>						
Continuous (200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (60 s overload) (200–240 V) [A]	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA (208 V) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4
<b>Maximum input current</b>						
Continuous (200–240 V) [A]	22.0	28.0	28.0	42.0	42.0	54.0
Intermittent (60 s overload) (200–240 V) [A]	35.2	30.8	44.8	46.2	67.2	59.4
<b>Additional specifications</b>						
IP20 maximum cable cross-section <sup>2)</sup> for mains, brake, motor, and load sharing [mm <sup>2</sup> ] ([AWG])	10,10,- (8,8,-)		10,10,- (8,8,-)		35,-,- (2,-,-)	
IP21 maximum cable cross-section <sup>2)</sup> for mains, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	16,10,16 (6,8,6)		16,10,16 (6,8,6)		35,-,- (2,-,-)	
IP21 maximum cable cross-section <sup>2)</sup> for motor [mm <sup>2</sup> ] ([AWG])	10,10,- (8,8,-)		10,10,- (8,8,-)		35,25,25 (2,4,4)	
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	16,10,10 (6,8,8)					
Estimated power loss at rated maximum load [W] <sup>3)</sup>	239	310	371	514	463	602
Efficiency <sup>4)</sup>	0.96		0.96		0.96	

Table 8.2 Mains Supply 200–240 V, P5K5–P11K

Type designation	P15K		P18K		P22K		P30K		P37K	
	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
High/normal overload <sup>1)</sup>										
Typical shaft output [kW/(hp)]	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
<b>Output current</b>										
Continuous (200–240 V) [A]	59.4	74.8	74.8	88.0	88.0	115	115	143	143	170
Intermittent (60 s overload) (200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA (208 V) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
<b>Maximum input current</b>										
Continuous (200–240 V) [A]	54.0	68.0	68.0	80.0	80.0	104	104	130	130	154
Intermittent (60 s overload) (200–240 V) [A]	81.0	74.8	102	88.0	120	114	156	143	195	169
<b>Additional specifications</b>										
IP20 maximum cable cross-section for mains, brake, motor, and load sharing [mm <sup>2</sup> ] ([AWG])	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> ] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W] <sup>3)</sup>	624	737	740	845	874	1140	1143	1353	1400	1636
Efficiency <sup>4)</sup>	0.96		0.97		0.97		0.97		0.97	

Table 8.3 Mains Supply 200–240 V, P15K–P37K

**8.1.2 Mains Supply 380–500 V**

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)]	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	–	–	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
<b>Output current high overload 160% for 1 minute</b>										
Shaft output [kW/(hp)]	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Continuous (380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.6	7.2	10	13	16
Intermittent (380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	9.0	11.5	16	20.8	25.6
Continuous (441–500 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (441–500 V) [A]	1.9	2.6	3.4	4.3	5.4	7.7	10.1	13.1	17.6	23.2
Continuous kVA (400 V) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0	6.9	9.0	11
Continuous kVA (460 V) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0	6.5	8.8	11.6
<b>Maximum input current</b>										
Continuous (380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (380–440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4	14.4	18.7	23
Continuous (441–500 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13
Intermittent (441–500 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1	11.8	15.8	20.8
<b>Additional specifications</b>										
IP20, IP21 maximum cable cross-section <sup>2)</sup> for mains, motor, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	4,4,4 (12,12,12) (minimum 0.2(24))									
IP55, IP66 maximum cable cross-section <sup>2)</sup> for mains, motor, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	4,4,4 (12,12,12)									
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	6,4,4 (10,12,12)									
Estimated power loss at rated maximum load [W <sup>3)</sup>	35	42	46	58	62	88	116	124	187	255
Efficiency <sup>4)</sup>	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97

**Table 8.4 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), PK37–P7K5**



Type designation	P11K		P15K		P18K		P22K	
High/normal overload <sup>1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B3		B3		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2	
<b>Output current</b>								
Continuous (380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (441–500 V) [A]	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (441–500 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
Continuous kVA (400 V) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA (460 V) [kVA]	–	21.5	–	27.1	–	31.9	–	41.4
<b>Maximum input current</b>								
Continuous (380–440 V) [A]	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (441–500 V) [A]	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (441–500 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
<b>Additional specifications</b>								
IP21, IP55, IP66 maximum cable cross-section <sup>2)</sup> for mains, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section <sup>2)</sup> for motor [mm <sup>2</sup> ] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)	
IP20 maximum cable cross-section <sup>2)</sup> for mains, brake, motor, and load sharing [mm <sup>2</sup> ] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load [W] <sup>3)</sup>	291	392	379	465	444	525	547	739
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98	

**Table 8.5 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P11K–P22K**

Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload <sup>1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
<b>Output current</b>										
Continuous (380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (441–500 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (441–500 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA (400 V) [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA (460 V) [kVA]	–	51.8	–	63.7	–	83.7	–	104	–	128
<b>Maximum input current</b>										
Continuous (380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (441–500 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (441–500 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
<b>Additional specifications</b>										
IP20 maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP20 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> ] ([AWG])	35 (2)		50 (1)		50 (1)		95 (4/0)		95 (4/0)	
IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	50 (1)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> ] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> ] ([AWG])	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W] <sup>3)</sup>	570	698	697	843	891	1083	1022	1384	1232	1474
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98		0.99	

**Table 8.6 Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P30K–P75K**

## 8.1.3 Mains Supply 525–600 V (FC 302 only)

Type designation	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)]	0.75 (1)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3 (4.0)	4 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20, IP21	A3	A3	A3	A3	A3	A3	A3	A3
Enclosure protection rating IP55	A5	A5	A5	A5	A5	A5	A5	A5
<b>Output current</b>								
Continuous (525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5
Intermittent (525–550 V) [A]	2.9	4.2	4.6	6.6	8.3	10.2	15.2	18.4
Continuous (551–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (551–600 V) [A]	2.7	3.8	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (525 V) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11.0
Continuous kVA (575 V) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
<b>Maximum input current</b>								
Continuous (525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4
Intermittent (525–600 V) [A]	2.7	3.8	4.3	6.6	8.3	9.3	13.8	16.6
<b>Additional specifications</b>								
Maximum cable cross-section <sup>2)</sup> for mains, motor, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	6,4,4 (10,12,12)							
Estimated power loss at rated maximum load [W] <sup>3)</sup>	35	50	65	92	122	145	195	261
Efficiency <sup>4)</sup>	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

Table 8.7 Mains Supply 525–600 V (FC 302 only), PK75–P7K5

Type designation	P11K		P15K		P18K		P22K		P30K	
	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
High/Normal load <sup>1)</sup>										
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)
Enclosure protection rating IP20	B3		B3		B4		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2		C1	
<b>Output current</b>										
Continuous (525–550 V) [A]	19	23	23	28	28	36	36	43	43	54
Intermittent (525–550 V) [A]	30	25	37	31	45	40	58	47	65	59
Continuous (551–600 V) [A]	18	22	22	27	27	34	34	41	41	52
Intermittent (551–600 V) [A]	29	24	35	30	43	37	54	45	62	57
Continuous kVA (550 V) [kVA]	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
Continuous kVA (575 V) [kVA]	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
<b>Maximum input current</b>										
Continuous at 550 V [A]	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	26	22	32	27	39	34	50	41	56	52
<b>Additional specifications</b>										
IP20 maximum cable cross-section <sup>2)</sup> for mains, brake, motor, and load sharing [mm <sup>2</sup> ] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section <sup>2)</sup> for mains, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	16, 10, 10 (6, 8, 8)		16, 10, 10 (6, 8, 8)		35,-,-(2,-,-)		35,-,-(2,-,-)		50,-,- (1,-,-)	
IP21, IP55, IP66 maximum cable cross-section <sup>2)</sup> for motor [mm <sup>2</sup> ] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)		50,-,- (1,-,-)	
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])			16, 10, 10 (6, 8, 8)						50, 35, 35 (1, 2, 2)	
Estimated power loss at rated maximum load [W] <sup>3)</sup>	220	300	300	370	370	440	440	600	600	740
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98		0.98	

**Table 8.8 Mains Supply 525–600 V (FC 302 only), P11K–P30K**

Type designation	P37K		P45K		P55K		P75K	
	HO	NO	HO	NO	HO	NO	HO	NO
High/Normal load <sup>1)</sup>								
Typical shaft output [kW/(hp)]	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	C3	C3	C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1	C1	C1		C2		C2	
<b>Output current</b>								
Continuous (525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (551–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (551–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA (550 V) [kVA]	51.4	61.9	61.9	82.9	82.9	100.0	100.0	130.5
Continuous kVA (575 V) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
<b>Maximum input current</b>								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
<b>Additional specifications</b>								
IP20 maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	50 (1)			150 (300 MCM)				
IP20 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> ] ([AWG])	50 (1)			95 (4/0)				
IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	50 (1)			150 (300 MCM)				
IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm <sup>2</sup> ] ([AWG])	50 (1)			95 (4/0)				
Maximum cable cross-section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> ] ([AWG])	50, 35, 35 (1, 2, 2)			95, 70, 70 (3/0, 2/0, 2/0)			185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Estimated power loss at rated maximum load [W] <sup>3)</sup>	740	900	900	1100	1100	1500	1500	1800
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98	

**Table 8.9 Mains Supply 525–600 V P37K–P75K (FC 302 only), P37K–P75K**

For fuse ratings, see chapter 8.7 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

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

4) Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4 Ambient Conditions. For part load losses, see [www.danfoss.com/vtenergyefficiency](http://www.danfoss.com/vtenergyefficiency).

**8.1.4 Mains Supply 525–690 V (FC 302 only)**

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
High/normal overload <sup>1)</sup>	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO
Typical shaft output [kW/(hp)]	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20	A3	A3	A3	A3	A3	A3	A3
<b>Output current</b>							
Continuous (525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous (551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10.0
Intermittent (551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12.0	16.0
Continuous kVA 525 V	1.9	2.5	3.5	4.5	5.5	8.2	10.0
Continuous kVA 690 V	1.9	2.6	3.8	5.4	6.6	9.0	12.0
<b>Maximum input current</b>							
Continuous (525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.1	9.9
Intermittent (525–550 V) [A]	3.0	3.9	5.6	7.0	8.8	12.9	15.8
Continuous (551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent (551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
<b>Additional specifications</b>							
Maximum cable cross-section <sup>2)</sup> for mains, motor, brake, and load sharing [mm <sup>2</sup> ] ([AWG])	4, 4, 4 (12, 12, 12) (minimum 0.2 (24))						
Maximum cable cross-section <sup>2)</sup> for disconnect [mm <sup>2</sup> ] ([AWG])	6, 4, 4 (10, 12, 12)						
Estimated power loss at rated maximum load (W) <sup>3)</sup>	44	60	88	120	160	220	300
Efficiency <sup>4)</sup>	0.96	0.96	0.96	0.96	0.96	0.96	0.96

**Table 8.10 A3 Enclosure, Mains Supply 525–690 V IP20/Protected Chassis, P1K1–P7K5**

Type designation	P11K		P15K		P18K		P22K	
High/normal overload <sup>1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	7.5 (10)	11 (15)	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)
Typical shaft output at 690 V [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B4		B4		B4		B4	
Enclosure protection rating IP21, IP55	B2		B2		B2		B2	
<b>Output current</b>								
Continuous (525–550 V) [A]	14.0	19.0	19.0	23.0	23.0	28.0	28.0	36.0
Intermittent (60 s overload) (525–550 V) [A]	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (551–690 V) [A]	13.0	18.0	18.0	22.0	22.0	27.0	27.0	34.0
Intermittent (60 s overload) (551–690 V) [A]	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous kVA (at 550 V) [kVA]	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous kVA (at 690 V) [kVA]	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
<b>Maximum input current</b>								
Continuous (at 550 V) (A)	15.0	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) (at 550 V) (A)	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Continuous (at 690 V) (A)	14.5	19.5	19.5	24.0	24.0	29.0	29.0	36.0
Intermittent (60 s overload) (at 690 V) (A)	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
<b>Additional specifications</b>								
Maximum cable cross-section <sup>2)</sup> for mains/motor, load share, and brake [mm <sup>2</sup> ] ([AWG])	35, 25, 25 (2, 4, 4)							
Maximum cable cross-section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> ] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load (W) <sup>3)</sup>	150	220	220	300	300	370	370	440
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98	

**Table 8.11 B2/B4 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 - Chassis/NEMA 1/NEMA 12 (FC 302 only), P11K–P22K**

Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload <sup>1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)
Typical shaft output at 690 V [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		D3h		D3h	
Enclosure protection rating IP21, IP55	C2		C2		C2		C2		C2	
<b>Output current</b>										
Continuous (525–550 V) [A]	36.0	43.0	43.0	54.0	54.0	65.0	65.0	87.0	87.0	105
Intermittent (60 s overload) (525–550 V) [A]	54.0	47.3	64.5	59.4	81.0	71.5	97.5	95.7	130.5	115.5
Continuous (551–690 V) [A]	34.0	41.0	41.0	52.0	52.0	62.0	62.0	83.0	83.0	100
Intermittent (60 s overload) (551–690 V) [A]	51.0	45.1	61.5	57.2	78.0	68.2	93.0	91.3	124.5	110
continuous kVA (at 550 V) [kVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100
continuous kVA (at 690 V) [kVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
<b>Maximum input current</b>										
Continuous (at 550 V) [A]	36.0	49.0	49.0	59.0	59.0	71.0	71.0	87.0	87.0	99.0
Intermittent (60 s overload) (at 550 V) [A]	54.0	53.9	72.0	64.9	87.0	78.1	105.0	95.7	129	108.9
Continuous (at 690 V) [A]	36.0	48.0	48.0	58.0	58.0	70.0	70.0	86.0	–	–
Intermittent (60 s overload) (at 690 V) [A]	54.0	52.8	72.0	63.8	87.0	77.0	105	94.6	–	–
<b>Additional specifications</b>										
Maximum cable cross-section for mains and motor [mm <sup>2</sup> ] ([AWG])	150 (300 MCM)									
Maximum cable cross-section for load share and brake [mm <sup>2</sup> ] ([AWG])	95 (3/0)									
Maximum cable cross-section <sup>2)</sup> for mains disconnect [mm <sup>2</sup> ] ([AWG])	95, 70, 70 (3/0, 2/0, 2/0)						185, 150, 120 (350 MCM, 300 MCM, 4/0)		–	
Estimated power loss at rated maximum load [W] <sup>3)</sup>	600	740	740	900	900	1100	1100	1500	1500	1800
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98		0.98	

**Table 8.12 B4, C2, C3 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 – Chassis/NEMA1/NEMA 12 (FC 302 only), P30K–P75K**

For fuse ratings, see chapter 8.7 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire, and flexible wire with sleeve, respectively.

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

4) Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4 Ambient Conditions. For part load losses, see [www.danfoss.com/vtenergyefficiency](http://www.danfoss.com/vtenergyefficiency).



## 8.2 Mains Supply

### Mains supply

Supply terminals (6-pulse)	L1, L2, L3
Supply terminals (12-pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage	200–240 V $\pm$ 10%
Supply voltage	FC 301: 380–480 V/FC 302: 380–500 V $\pm$ 10%
Supply voltage	FC 302: 525–600 V $\pm$ 10%
Supply voltage	FC 302: 525–690 V $\pm$ 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 frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz $\pm$ 5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor ( $\lambda$ )	$\geq$ 0.9 nominal at rated load
Displacement power factor ( $\cos \phi$ )	Near unity ( $>$ 0.98)
Switching on input supply L1, L2, L3 (power-ups) $\leq$ 7.5 kW (10 hp)	Maximum 2 times per minute.
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW (15–101 hp)	Maximum 1 time per minute.
Switching on input supply L1, L2, L3 (power-ups) $\geq$ 90 kW (121 hp)	Maximum 1 time per 2 minutes.
Environment according to EN60664-1	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, 240/500/600/690 V maximum.

## 8.3 Motor Output and Motor Data

### Motor output (U, V, W<sup>1)</sup>)

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

### Torque characteristics

Starting torque (constant torque)	Maximum 160% for 60 s <sup>1)</sup> once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s <sup>1)</sup> once in 10 minutes
Torque rise time in flux (for 5 kHz $f_{sw}$ )	1 ms
Torque rise time in VVC <sup>+</sup> (Independent of $f_{sw}$ )	10 ms

1) Percentage relates to the nominal torque.

## 8.4 Ambient Conditions

### Environment

Enclosure	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Vibration test	1.0 g
Maximum THDv	10%
Maximum relative humidity	5–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H <sub>2</sub> S test	Class Kd
Ambient temperature <sup>1)</sup>	Maximum 50 °C (122 °F)(24-hour average maximum 45 °C (113 °F))
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating <sup>1)</sup>	1000 m (3280 ft)

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class <sup>2)</sup>	IE2

1) See special conditions in the design guide, for:

- Derating for high ambient temperature.
- Derating for high altitude.

2) Determined according to EN 50598-2 at:

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

## 8.5 Cable Specifications

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

Maximum motor cable length, shielded	FC 301: 50 m (164 ft)/FC 302: 150 m (492 ft)
Maximum motor cable length, unshielded	FC 301: 75 m (246 ft)/FC 302: 300 m (984 ft)
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm <sup>2</sup> /16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm <sup>2</sup> /18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm <sup>2</sup> /20 AWG
Minimum cross-section to control terminals	0.25 mm <sup>2</sup> /24 AWG

1) For power cables, see electrical tables in chapter 8.1 Electrical Data.

## 8.6 Control Input/Output and Control Data

Digital inputs

Programmable digital inputs	FC 301: 4 (5) <sup>1)</sup> /FC 302: 4 (6) <sup>1)</sup>
Terminal number	18, 19, 27 <sup>1)</sup> , 29 <sup>1)</sup> , 32, 33
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN <sup>2)</sup>	>19 V DC
Voltage level, logic 1 NPN <sup>2)</sup>	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) minimum pulse width	4.5 ms
Input resistance, R <sub>i</sub>	approximately 4 kΩ

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

2) Except STO input terminal 37.

STO terminal 37<sup>1), 2)</sup> (terminal 37 is fixed PNP logic)

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

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

1) See chapter 4.8.5 Safe Torque Off (STO) for further information about terminal 37 and STO.

2) When using a contactor with a DC coil inside in combination with STO, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

Analog inputs

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

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

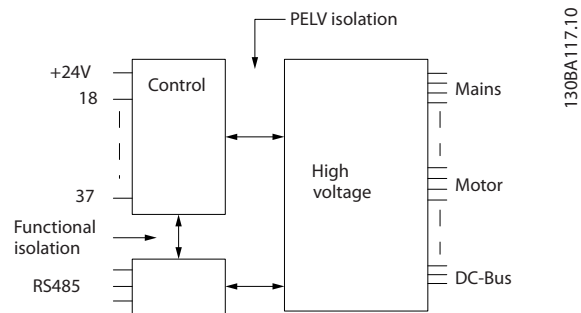


Illustration 8.1 PELV Isolation

Pulse/encoder inputs

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29 <sup>1)</sup> , 33 <sup>2)</sup> /32 <sup>3)</sup> , 33 <sup>3)</sup>
Maximum frequency at terminal 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminal 29, 32, 33	5 kHz (Open collector)
Minimum frequency at terminal 29, 32, 33	4 Hz
Voltage level	See section 5-1* 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**

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

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

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

**Analog output**

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

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

**Control card, 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 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 protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

**Relay outputs**

Programmable relay outputs	FC 301 all kW: 1/FC 302 all kW: 2
Relay 01 terminal number	1-3 (break), 1-2 (make)
Maximum terminal load (AC-1) <sup>1)</sup> on 1-3 (NC), 1-2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 1-2 (NO), 1-3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13) <sup>1)</sup> (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-1) <sup>1)</sup> on 4-5 (NO) (resistive load) <sup>2)3)</sup> overvoltage cat. II	400 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> on 4-5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 4-5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13) <sup>1)</sup> on 4-5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1) <sup>1)</sup> on 4-6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>1)</sup> on 4-6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>1)</sup> on 4-6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13) <sup>1)</sup> 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 1 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).

2) Overvoltage Category II.

3) UL applications 300 V AC 2 A.

**Control card performance**

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

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

## 8.7 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (first fault).

### **NOTICE**

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

#### Recommendations

- gG type fuses.
- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the frequency converter is equal to or lower than the energy provided by Moeller types.

Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damages inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *chapter 8.7.1 CE Compliance* to *chapter 8.7.2 UL Compliance* are suitable for use on a circuit capable of delivering 100000 A<sub>rms</sub> (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 A<sub>rms</sub>.

# 8

## 8.7.1 CE Compliance

### 200–240 V

Enclosure	Power [kW]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.25–1.5	gG-10	gG-25	PKZM0-16	16
A2	0.25–2.2	gG-10 (0.25–1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	3.0–3.7	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
A4	0.25–2.2	gG-10 (0.25–1.5) gG-16 (2.2)	gG-32	PKZM0-25	25
A5	0.25–3.7	gG-10 (0.25–1.5) gG-16 (2.2–3) gG-20 (3.7)	gG-32	PKZM0-25	25
B1	5.5–7.5	gG-25 (5.5) gG-32 (7.5)	gG-80	PKZM4-63	63
B2	11	gG-50	gG-100	NZMB1-A100	100
B3	5.5	gG-25	gG-63	PKZM4-50	50
B4	7.5–15	gG-32 (7.5) gG-50 (11) gG-63 (15)	gG-125	NZMB1-A100	100
C1	15–22	gG-63 (15) gG-80 (18.5) gG-100 (22)	gG-160 (15–18.5) aR-160 (22)	NZMB2-A200	160
C2	30–37	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250
C3	18.5–22	gG-80 (18.5) aR-125 (22)	gG-150 (18.5) aR-160 (22)	NZMB2-A200	150
C4	30–37	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250

Table 8.13 200–240 V, Enclosure Sizes A, B, and C

**380–500 V**

Enclosure	Power [kW]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.37–1.5	gG-10	gG-25	PKZM0-16	16
A2	0.37–4.0	gG-10 (0.37-3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5–7.5	gG-16	gG-32	PKZM0-25	25
A4	0.37-4	gG-10 (0.37-3) gG-16 (4)	gG-32	PKZM0-25	25
A5	0.37–7.5	gG-10 (0.37-3) gG-16 (4–7.5)	gG-32	PKZM0-25	25
B1	11–15	gG-40	gG-80	PKZM4-63	63
B2	18.5–22	gG-50 (18.5) gG-63 (22)	gG-100	NZMB1-A100	100
B3	11–15	gG-40	gG-63	PKZM4-50	50
B4	18.5–30	gG-50 (18.5) gG-63 (22) gG-80 (30)	gG-125	NZMB1-A100	100
C1	30–45	gG-80 (30) gG-100 (37) gG-160 (45)	gG-160	NZMB2-A200	160
C2	55–75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
C3	37–45	gG-100 (37) gG-160 (45)	gG-150 (37) gG-160 (45)	NZMB2-A200	150
C4	55–75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250

**Table 8.14 380–500 V, Enclosure Sizes A, B, and C**

525–600 V

Enclosure	Power [kW]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0.75-4.0	gG-10	gG-25	PKZM0-25	25
A3	5.5–7.5	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
A5	0.75–7.5	gG-10 (0.75–5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11–18	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22–30	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
B3	11–15	gG-25 (11) gG-32 (15)	gG-63	PKZM4-50	50
B4	18.5–30	gG-40 (18.5) gG-50 (22) gG-63 (30)	gG-125	NZMB1-A100	100
C1	37–55	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37–45) aR-250 (55)	NZMB2-A200	160
C2	75	aR-200 (75)	aR-250	NZMB2-A250	250
C3	37–45	gG-63 (37) gG-100 (45)	gG-150	NZMB2-A200	150
C4	55–75	aR-160 (55) aR-200 (75)	aR-250	NZMB2-A250	250

Table 8.15 525–600 V, Enclosure Sizes A, B, and C

525–690 V

Enclosure	Power [kW]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A3	1.1 1.5 2.2 3 4 5.5 7.5	gG-6 gG-6 gG-6 gG-10 gG-10 gG-16 gG-16	gG-25 gG-25 gG-25 gG-25 gG-25 gG-25 gG-25	PKZM0-16	16
B2/B4	11 15 18 22	gG-25 (11) gG-32 (15) gG-32 (18) gG-40 (22)	gG-63	–	–
B4/C2	30	gG-63 (30)	gG-80 (30)	–	–
C2/C3	37 45	gG-63 (37) gG-80 (45)	gG-100 (37) gG-125 (45)	–	–
C2	55 75	gG-100 (55) gG-125 (75)	gG-160 (55–75)	–	–

Table 8.16 525–690 V, Enclosure Sizes A, B, and C



## 8.7.2 UL Compliance

### 200–240 V

Power [kW]	Recommended maximum fuse					
	Bussmann Type RK1 <sup>1)</sup>	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.25–0.37	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.55–1.1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5	KTN-R-50	KS-50	JJN-50	–	–	–
7.5	KTN-R-60	JKS-60	JJN-60	–	–	–
11	KTN-R-80	JKS-80	JJN-80	–	–	–
15–18.5	KTN-R-125	JKS-125	JJN-125	–	–	–
22	KTN-R-150	JKS-150	JJN-150	–	–	–
30	KTN-R-200	JKS-200	JJN-200	–	–	–
37	KTN-R-250	JKS-250	JJN-250	–	–	–

Table 8.17 200–240 V, Enclosure Sizes A, B, and C

8

Power [kW]	Recommended maximum fuse							
	SIBA Type RK1	Littelfuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1 <sup>3)</sup>	Bussmann Type JFHR2 <sup>2)</sup>	Littelfuse JFHR2	Ferraz-Shawmut JFHR2 <sup>4)</sup>	Ferraz-Shawmut J
0.25–0.37	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	–	–	HSJ-6
0.55–1.1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	–	–	HSJ-10
1.5	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	–	–	HSJ-15
2.2	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	–	–	HSJ-20
3.0	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	–	–	HSJ-25
3.7	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	–	–	HSJ-30
5.5	5014006-050	KLN-R-50	–	A2K-50-R	FWX-50	–	–	HSJ-50
7.5	5014006-063	KLN-R-60	–	A2K-60-R	FWX-60	–	–	HSJ-60
11	5014006-080	KLN-R-80	–	A2K-80-R	FWX-80	–	–	HSJ-80
15–18.5	2028220-125	KLN-R-125	–	A2K-125-R	FWX-125	–	–	HSJ-125
22	2028220-150	KLN-R-150	–	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
30	2028220-200	KLN-R-200	–	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
37	2028220-250	KLN-R-250	–	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.18 200–240 V, Enclosure Sizes A, B, and C

- 1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.
- 2) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.
- 3) A6KR fuses from Ferraz Shawmut may substitute A2KR for 240 V frequency converters.
- 4) A50X fuses from Ferraz Shawmut may substitute A25X for 240 V frequency converters.

380–500 V

Power [kW]	Recommended maximum fuse					
	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.37–1.1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-40	JKS-40	JJS-40	–	–	–
15	KTS-R-50	JKS-50	JJS-50	–	–	–
18	KTS-R-60	JKS-60	JJS-60	–	–	–
22	KTS-R-80	JKS-80	JJS-80	–	–	–
30	KTS-R-100	JKS-100	JJS-100	–	–	–
37	KTS-R-125	JKS-125	JJS-125	–	–	–
45	KTS-R-150	JKS-150	JJS-150	–	–	–
55	KTS-R-200	JKS-200	JJS-200	–	–	–
75	KTS-R-250	JKS-250	JJS-250	–	–	–

Table 8.19 380–500 V, Enclosure Sizes A, B, and C

8

Power [kW]	Recommended maximum fuse							
	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type CC	Ferraz Shawmut Type RK1	Bussmann JFHR2	Ferraz Shawmut JFerraz Shawmut J	Ferraz Shawmut JFHR2 <sup>1)</sup>	Littelfuse JFHR2
0.37–1.1	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	–	–
1.5–2.2	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	–	–
3	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	–	–
4	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	–	–
5.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	–	–
7.5	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	–	–
11	5014006-040	KLS-R-40	–	A6K-40-R	FWH-40	HSJ-40	–	–
15	5014006-050	KLS-R-50	–	A6K-50-R	FWH-50	HSJ-50	–	–
18	5014006-063	KLS-R-60	–	A6K-60-R	FWH-60	HSJ-60	–	–
22	2028220-100	KLS-R-80	–	A6K-80-R	FWH-80	HSJ-80	–	–
30	2028220-125	KLS-R-100	–	A6K-100-R	FWH-100	HSJ-100	–	–
37	2028220-125	KLS-R-125	–	A6K-125-R	FWH-125	HSJ-125	–	–
45	2028220-160	KLS-R-150	–	A6K-150-R	FWH-150	HSJ-150	–	–
55	2028220-200	KLS-R-200	–	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
75	2028220-250	KLS-R-250	–	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.20 380–500 V, Enclosure Sizes A, B, and C

1) Ferraz Shawmut A50QS fuses may substitute for A50P fuses.

525–600 V

Power [kW]	Recommended maximum fuse									
	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC	SIBA Type RK1	Littelfuse Type RK1	Ferraz Shawmut Type RK1	Ferraz Shawmut J
0.75–1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11	KTS-R-35	JKS-35	JJS-35	–	–	–	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
15	KTS-R-45	JKS-45	JJS-45	–	–	–	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
18	KTS-R-50	JKS-50	JJS-50	–	–	–	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
22	KTS-R-60	JKS-60	JJS-60	–	–	–	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
30	KTS-R-80	JKS-80	JJS-80	–	–	–	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
37	KTS-R-100	JKS-100	JJS-100	–	–	–	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
45	KTS-R-125	JKS-125	JJS-125	–	–	–	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
55	KTS-R-150	JKS-150	JJS-150	–	–	–	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
75	KTS-R-175	JKS-175	JJS-175	–	–	–	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 8.21 525–600 V, Enclosure Sizes A, B, and C

525–690 V

Power [kW]	Recommended maximum fuse					
	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
[kW]						
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-35	JKS-35	JJS-35	–	–	–
15	KTS-R-45	JKS-45	JJS-45	–	–	–
18	KTS-R-50	JKS-50	JJS-50	–	–	–
22	KTS-R-60	JKS-60	JJS-60	–	–	–
30	KTS-R-80	JKS-80	JJS-80	–	–	–
37	KTS-R-100	JKS-100	JJS-100	–	–	–
45	KTS-R-125	JKS-125	JJS-125	–	–	–
55	KTS-R-150	JKS-150	JJS-150	–	–	–
75	KTS-R-175	JKS-175	JJS-175	–	–	–

Table 8.22 525–690 V, Enclosure Sizes A, B, and C

Power [kW]	Recommended maximum fuse							
	Maximum pre-fuse	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	Littelfuse E81895 RK1/JDDZ	Ferraz Shawmut E163267/E2137 RK1/JDDZ	Ferraz Shawmut E2137 J/HSJ
11	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15–18.5	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.23 525–690 V, Enclosure Sizes B, and C

### 8.8 Connection Tightening Torques

Enclosure Size	200–240 V [kW]	380–500 V [kW]	525–690 V [kW]	Purpose	Tightening torque [Nm] (in-lb)
A2	0.25–2.2	0.37–4	–	Mains, brake resistor, load sharing, motor cables.	0.5–0.6 (4.4–5.3)
A3	3–3.7	5.5–7.5	1.1–7.5		
A4	0.25–2.2	0.37–4	–		
A5	3–3.7	5.5–7.5	–		
B1	5.5–7.5	11–15	–		
B2	11	18.5–22	11–22	Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
				Mains, brake resistor, load sharing cables.	4.5 (39.8)
				Motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
B3	5.5–7.5	11–15	–	Ground.	2–3 (17.7–26.6)
				Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
B4	11–15	18.5–30	11–30	Ground.	2–3 (17.7–26.6)
				Mains, brake resistor, load sharing, motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
C1	15–22	30–45	–	Ground.	2–3 (17.7–26.6)
				Mains, brake resistor, load sharing cables.	10 (89)
				Motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
C2	30–37	55–75	30–75	Ground.	2–3 (17.7–26.6)
				Mains, motor cables.	14 (124) (up to 95 mm <sup>2</sup> (3 AWG)) 24 (212) (over 95 mm <sup>2</sup> (3 AWG))
				Load Sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C3	18.5–22	30–37	37–45	Ground.	2–3 (17.7–26.6)
				Mains, brake resistor, load sharing, motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
C4	37–45	55–75	11–22	Ground.	2–3 (17.7–26.6)
				Mains, motor cables.	14 (124) (up to 95 mm <sup>2</sup> (3 AWG)) 24 (212) (over 95 mm <sup>2</sup> (3 AWG))
				Load Sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)

Table 8.24 Tightening Torque for Cables

8.9 Power Ratings, Weight, and Dimensions

Enclosure size	A1	A2	A3	A4	A5	B1	B2	B3	B4	C1	C2	C3	C4	D3h
Rated power [kW (hp)]	0.25-1.5 (0.34-2)	0.25-2.2 (0.34-3)	3-3.7 (4-5)	0.25-2.2 (0.34-3)	0.25-3.7 (0.34-5)	5.5-7.5 (7.5-10)	15	5.5-7.5 (7.5-10)	11-15 (15-20)	15-22 (20-30)	30-37 (40-50)	18.5-22 (25-30)	30-37 (40-50)	-
	0.37-1.5 (0.5-2)	0.37-4 (0.5-5)	5.5-7.5 (7.5-10)	0.37-4 (0.5-5)	0.37-7.5 (0.5-10)	11-15 (15-20)	18.5-22 (25-30)	11-15 (15-20)	18.5-30 (25-40)	30-45 (40-60)	55-75 (75-100)	37-45 (50-60)	55-75 (75-100)	-
	-	-	0.75-7.5 (1-10)	-	0.75-7.5 (1-10)	11-15 (15-20)	18.5-22 (25-30)	11-15 (15-20)	18.5-30 (25-40)	30-45 (40-60)	55-90 (75-125)	37-45 (50-60)	55-90 (75-125)	-
	-	-	1.1-7.5 (1.5-10)	-	-	11-22 (15-30)	11-22 (15-30)	-	11-30 (15-40)	-	30-75 (40-100)	37-45 (50-60)	37-45 (50-60)	55-75 (75-100)
IP	20	20	20	20	20	20	20	20	20	20	20	20	20	20
NEMA	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis
Height [mm (in)]														
Height of mounting plate A <sup>1)</sup>	200 (7.9)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)	909 (35.8)
Height with ground termination plate for fieldbus cables	316 (12.4)	374 (14.7)	374 (14.7)	-	-	-	-	420 (16.5)	595 (23.4)	-	-	630 (24.8)	800 (31.5)	-
Distance between mounting holes	190 (7.5)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)	-
Width [mm (in)]														
Width of mounting plate	75 (3)	90 (3.5)	130 (5.1)	200 (7.9)	242 (9.5)	242 (9.5)	242 (9.5)	165 (6.5)	230 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	250 (9.8)
Width of mounting plate with 1 C option	-	130 (5.1)	170 (6.7)	-	242 (9.5)	242 (9.5)	242 (9.5)	205 (8.1)	230 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	-
Width of mounting plate with 2 C options	-	150 (5.9)	190 (7.5)	-	242 (9.5)	242 (9.5)	242 (9.5)	225 (8.9)	230 (9.1)	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	-
Distance between mounting holes	60 (2.4)	70 (2.8)	110 (4.3)	171 (6.7)	215 (8.5)	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)	-
Depth [mm (in)]														
Depth without option A/B	207 (8.1)	205 (8.1)	207 (8.1)	175 (6.9)	200 (7.9)	260 (10.2)	260 (10.2)	249 (9.8)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)
With option A/B	222 (8.7)	220 (8.7)	222 (8.7)	175 (6.9)	200 (7.9)	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)





Enclosure size	A1	A2	A3	A4	A5	B1	B2	B3	B4	C1	C2	C3	C4	D3h
Rated power [kW (hp)]	0.25-1.5 (0.34-2)	0.25-2.2 (0.34-3)	3-3.7 (4-5)	0.25-2.2 (0.34-3)	0.25-3.7 (0.34-5)	5.5-7.5 (7.5-10)	15	5.5-7.5 (7.5-10)	11-15 (15-20)	15-22 (20-30)	30-37 (40-50)	18.5-22 (25-30)	30-37 (40-50)	-
	0.37-1.5 (0.5-2)	0.37-4 (0.5-5)	5.5-7.5 (7.5-10)	0.37-4 (0.5-5)	0.37-7.5 (0.5-10)	11-15 (15-20)	18.5-22 (25-30)	11-15 (15-20)	18.5-30 (25-40)	30-45 (40-60)	55-75 (75-100)	37-45 (50-60)	55-75 (75-100)	-
	-	-	0.75-7.5 (1-10)	-	0.75-7.5 (1-10)	11-15 (15-20)	18.5-22 (25-30)	11-15 (15-20)	18.5-30 (25-40)	30-45 (40-60)	55-90 (75-125)	37-45 (50-60)	55-90 (75-125)	-
	-	-	1.1-7.5 (1.5-10)	-	-	-	11-22 (15-30)	-	11-30 (15-40)	-	30-75 (40-100)	37-45 (50-60)	37-45 (50-60)	55-75 (75-100)
Screw holes [mm (in)]														
c	6.0 (0.24)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	12 (0.47)	12 (0.47)	8 (0.31)	-	12.5 (0.49)	12.5 (0.49)	-	-	-
d	ø8 (ø0.31)	ø11 (ø0.43)	ø11 (ø0.43)	ø12 (ø0.47)	ø12 (ø0.47)	ø19 (ø0.75)	ø19 (ø0.75)	12 (0.47)	-	ø19 (ø0.75)	ø19 (ø0.75)	-	-	-
e	ø5 (ø0.2)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø6.5 (ø0.26)	ø6.5 (ø0.26)	ø9 (ø0.35)	ø9 (ø0.35)	6.8 (0.27)	8.5 (0.33)	ø9 (ø0.35)	ø9 (ø0.35)	8.5 (0.33)	8.5 (0.33)	-
f	5 (0.2)	9 (0.35)	6.5 (0.26)	6 (0.24)	9 (0.35)	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)	-
Maximum weight [kg (lb)]	2.7 (6)	4.9 (10.8)	6.6 (14.6)	9.7 (21.4)	13.5/14.2 (30/31)	23 (51)	27 (60)	12 (26.5)	23.5 (52)	45 (99)	65 (143)	35 (77)	50 (110)	62 (137)
Front cover tightening torque [Nm (in-lb)]														
Plastic cover (low IP)	Click	Click	Click	-	-	Click	Click	Click	Click	Click	Click	2 (17.7)	2 (17.7)	-
Metal cover (IP55/66)	-	-	-	1.5 (13.3)	1.5 (13.3)	2.2 (19.5)	2.2 (19.5)	-	-	2.2 (19.5)	2.2 (19.5)	2 (17.7)	2 (17.7)	-

1) See Illustration 3.4 and Illustration 3.5 for top and bottom mounting holes.

Table 8.25 Power Ratings, Weight, and Dimensions

## 9 Appendix

### 9.1 Symbols, Abbreviations, and Conventions

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
$I_{INV}$	Rated inverter output current
$I_{LIM}$	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
$n_s$	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM Motor	Permanent magnet motor
PWM	Pulse width modulation
RPM	Revolutions per minute
Regen	Regenerative terminals
$T_{LIM}$	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 9.1 Symbols and Abbreviations

#### Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information.

Italicized text indicates:

- Cross-reference.
- Link.
- Parameter name.
- Parameter group name.
- Parameter option.
- Footnote.

All dimensions in drawings are in [mm] (in).

### 9.2 Parameter Menu Structure

## 9.2.1 Software 7.XX

1-06	Clockwise Direction	1-71	Start Delay	2-33	Speed PID Start Lowpass Filter Time	3-90	Step Size
1-07	Motor Angle Offset Adjust	1-72	Start Function	<b>3-3*</b>	<b>Reference / Ramps</b>	3-91	Ramp Time
<b>1-1*</b>	<b>Special Settings</b>	1-73	Flying Start	<b>3-0*</b>	<b>Reference Limits</b>	3-92	Power Restore
1-10	Motor Construction	1-74	Start Speed [RPM]	3-00	Reference Range	3-93	Maximum Limit
1-11	Motor Model	1-75	Start Speed [Hz]	3-01	Reference/Feedback Unit	3-94	Minimum Limit
1-14	Damping Gain	1-76	Start Current	3-02	Minimum Reference	3-95	Ramp Delay
1-15	Low Speed Filter Time Const.	<b>1-8*</b>	<b>Stop Adjustments</b>	3-03	Maximum Reference	<b>4-3*</b>	<b>Limits / Warnings</b>
1-16	High Speed Filter Time Const.	1-80	Function at Stop	3-04	Reference Function	4-1*	<b>Motor Limits</b>
1-17	Voltage filter time const.	1-81	Min Speed for Function at Stop [RPM]	<b>3-1*</b>	<b>References</b>	4-10	Motor Speed Direction
1-18	Min. Current at No Load	1-82	Min Speed for Function at Stop [Hz]	3-10	Preset Reference	4-11	Motor Speed Low Limit [RPM]
<b>1-2*</b>	<b>Motor Data</b>	1-83	Precise Stop Function	3-11	Jog Speed [Hz]	4-12	Motor Speed Low Limit [Hz]
1-20	Motor Power [kW]	1-84	Precise Stop Counter Value	3-12	Catch up/slow Down Value	4-13	Motor Speed High Limit [RPM]
1-21	Motor Power [HP]	1-85	Precise Stop Speed Compensation Delay	3-13	Reference Site	4-14	Motor Speed High Limit [Hz]
1-22	Motor Voltage	<b>1-9*</b>	<b>Motor Temperature</b>	3-15	Reference Resource 1	4-17	Torque Limit Generator Mode
1-23	Motor Frequency	1-90	Motor Thermal Protection	3-16	Reference Resource 2	4-18	Current Limit
1-24	Motor Current	1-91	Motor External Fan	3-17	Reference Resource 3	4-19	Max Output Frequency
1-25	Motor Nominal Speed	1-93	Thermistor Resource	3-18	Relative Scaling Reference Resource	<b>4-2*</b>	<b>Limit Factors</b>
1-26	Motor Cont. Rated Torque	1-94	ATEX ETR cur.lim. speed reduction	3-19	Jog Speed [RPM]	4-20	Torque Limit Factor Source
<b>1-3*</b>	<b>Adv. Motor Data</b>	1-95	KTY Sensor Type	<b>3-4*</b>	<b>Ramp 1</b>	4-21	Speed Limit Factor Source
1-30	Stator Resistance (Rs)	1-96	KTY Thermistor Resource	3-40	Ramp 1 Type	4-23	Brake Check Limit Factor Source
1-31	Rotor Resistance (Rr)	1-97	KTY Threshold level	3-41	Ramp 1 Ramp Up Time	4-24	Brake Check Limit Factor
1-33	Stator Leakage Reactance (X1)	1-98	ATEX ETR interpol. points freq.	3-42	Ramp 1 Ramp Down Time	<b>4-3*</b>	<b>Motor Speed Mon.</b>
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