MAKING MODERN LIVING POSSIBLE

Operating Instructions

VLT® AutomationDrive FC 301/302

0.25-75 kW

vlt-drives.danfoss.com

THE REAL DRIVE

Contents

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1 Introduction

1.1 Purpose of the Manual

These operating instructions provide information for safe installation and commissioning of the frequency converter.

The operating instructions are intended for use by qualified personnel.
Read and follow the operating instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Always keep these operating instructions 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 *vlt-drives.danfoss.com/Support/Technical-Documentation/* for listings.

1.3 Document 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
MG33AQxx	Replaces MG33APxx	7.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 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*.

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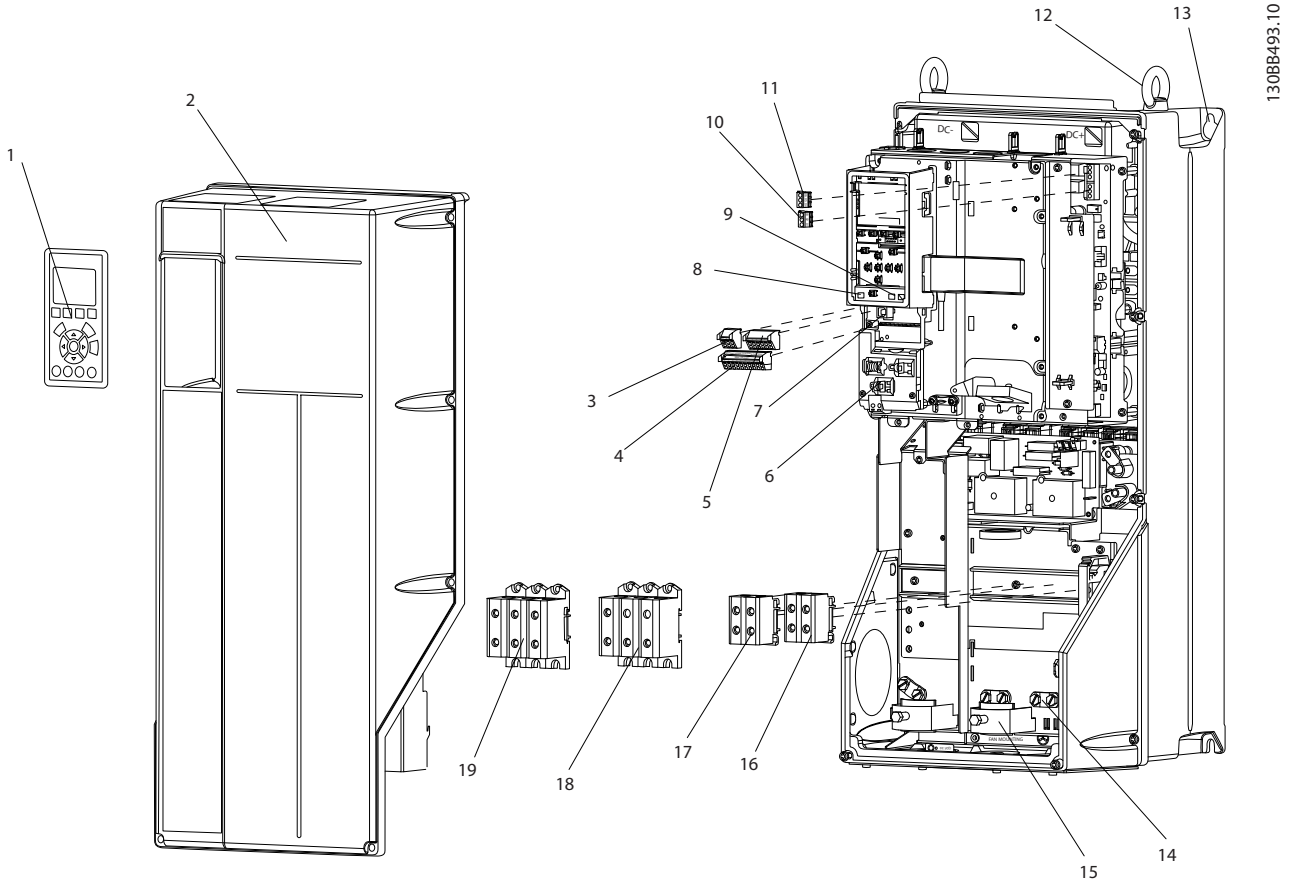
1.4.2 Exploded Views



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 screen connector
6	Cable screen 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

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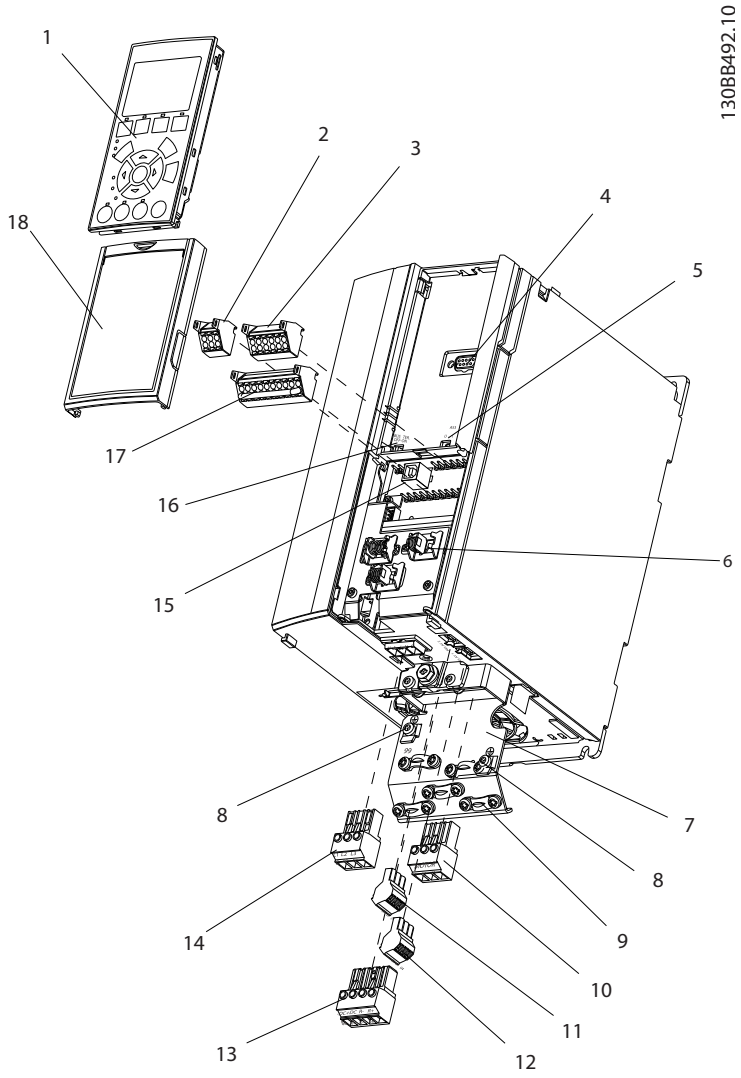

1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 fieldbus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable screen 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	Screened cable grounding clamp and strain relief	18	Cover

Illustration 1.2 Exploded View Enclosure Size A, IP20

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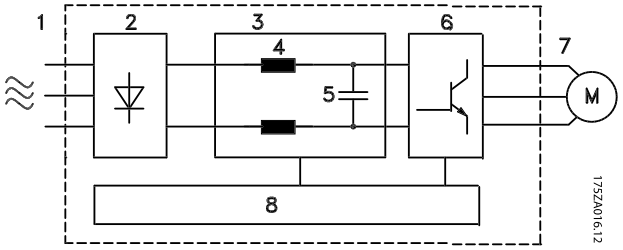
1.4.3 Block Diagram of the Frequency Converter

Illustration 1.3 is a block diagram of the internal components of the frequency converter. See *Table 1.2* for their functions.



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	• Filter the intermediate DC circuit voltage. • Provide mains transient protection. • Reduce RMS current. • Raise the power factor reflected back to the line. • Reduce harmonics on the AC input.
5	Capacitor bank	• Stores the DC power. • Provides ride-through protection for short power losses.
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.
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control. • User interface and external commands are monitored and performed. • Status output and control can be provided.

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*.

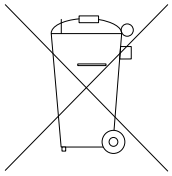
1.5 Approvals and Certifications

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



Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

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2 Safety

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2.1 Safety Symbols

The following symbols are used in this manual:

⚠WARNING

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

⚠CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It 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 authorised to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Additionally, the qualified personnel must be familiar with the instructions and safety measures described in these operating instructions.

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 power 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 duration of waiting time is specified in *Table 2.1*.**

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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 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 manual.**

⚠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.**

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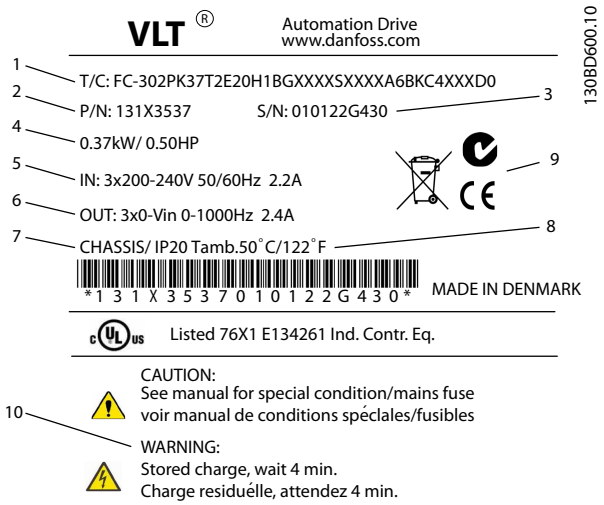
3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may 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.



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 type 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).

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, as well as 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.

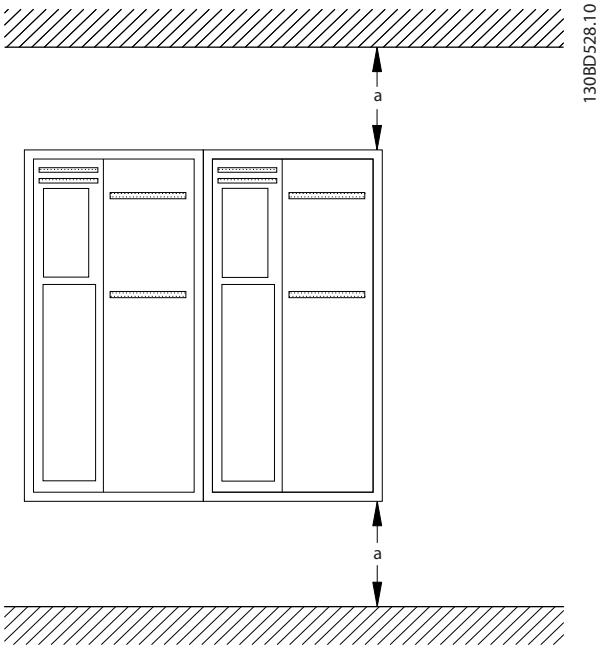


Illustration 3.2 Top and Bottom Cooling Clearance

Enclosure	A1–A5	B1–B4	C1, C3	C2, C4
a [mm]	100	200	200	225

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 mounting plate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

Mounting with mounting plate and railings

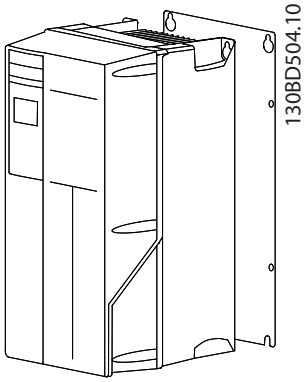


Illustration 3.3 Proper Mounting with Mounting Plate

NOTICE

Mounting plate is required when mounted on railings.

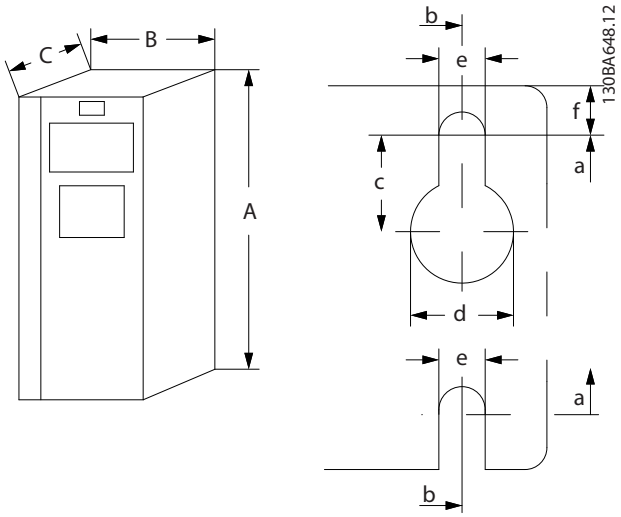


Illustration 3.4 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight, and Dimensions*)

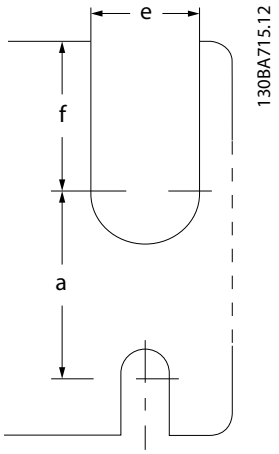


Illustration 3.5 Top and Bottom Mounting Holes (B4, C3, and C4)

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4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

INDUCED VOLTAGE

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

- **Run output motor cables separately, or**
- **Use screened 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 permitted 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 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 one frequency converter to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (7 AWG) (or 2 rated ground wires terminated separately).

For EMC-compliant installation

- Establish electrical contact between the cable screen 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 electrical interference.
- Do not use pigtails.

NOTICE

POTENTIAL EQUALISATION

Risk of electrical interference, when the ground potential between the frequency converter and the control system is different. Install equalising cables between the system components. Recommended cable cross-section: 16 mm^2 (5 AWG).

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4.4 Wiring Schematic

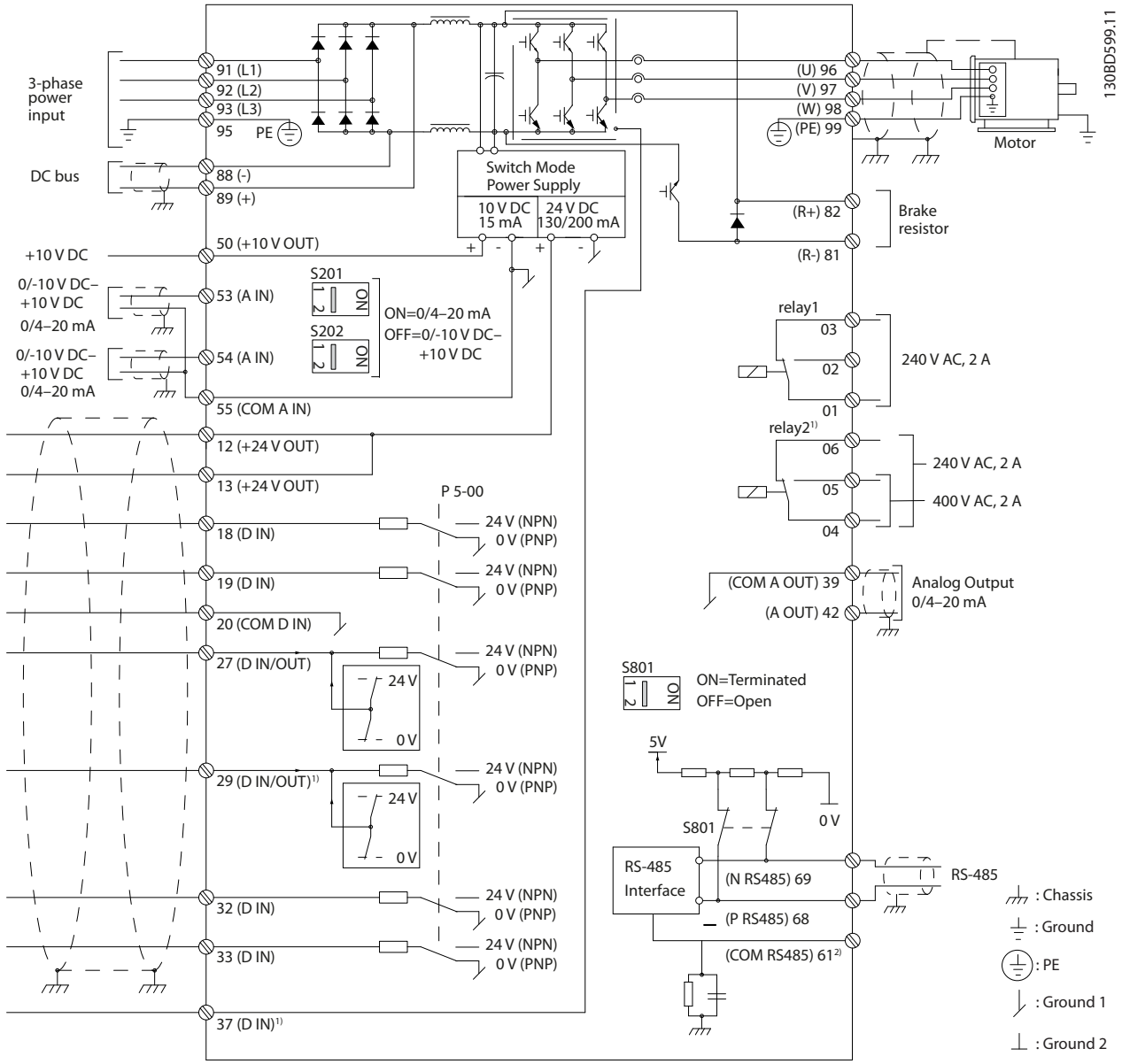

Illustration 4.1 Basic Wiring Schematic

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 Instructions*. Terminal 37 is not included in FC 301 (except enclosure type A1). Relay 2 and terminal 29 have no function in FC 301.

2) Do not connect cable screen.

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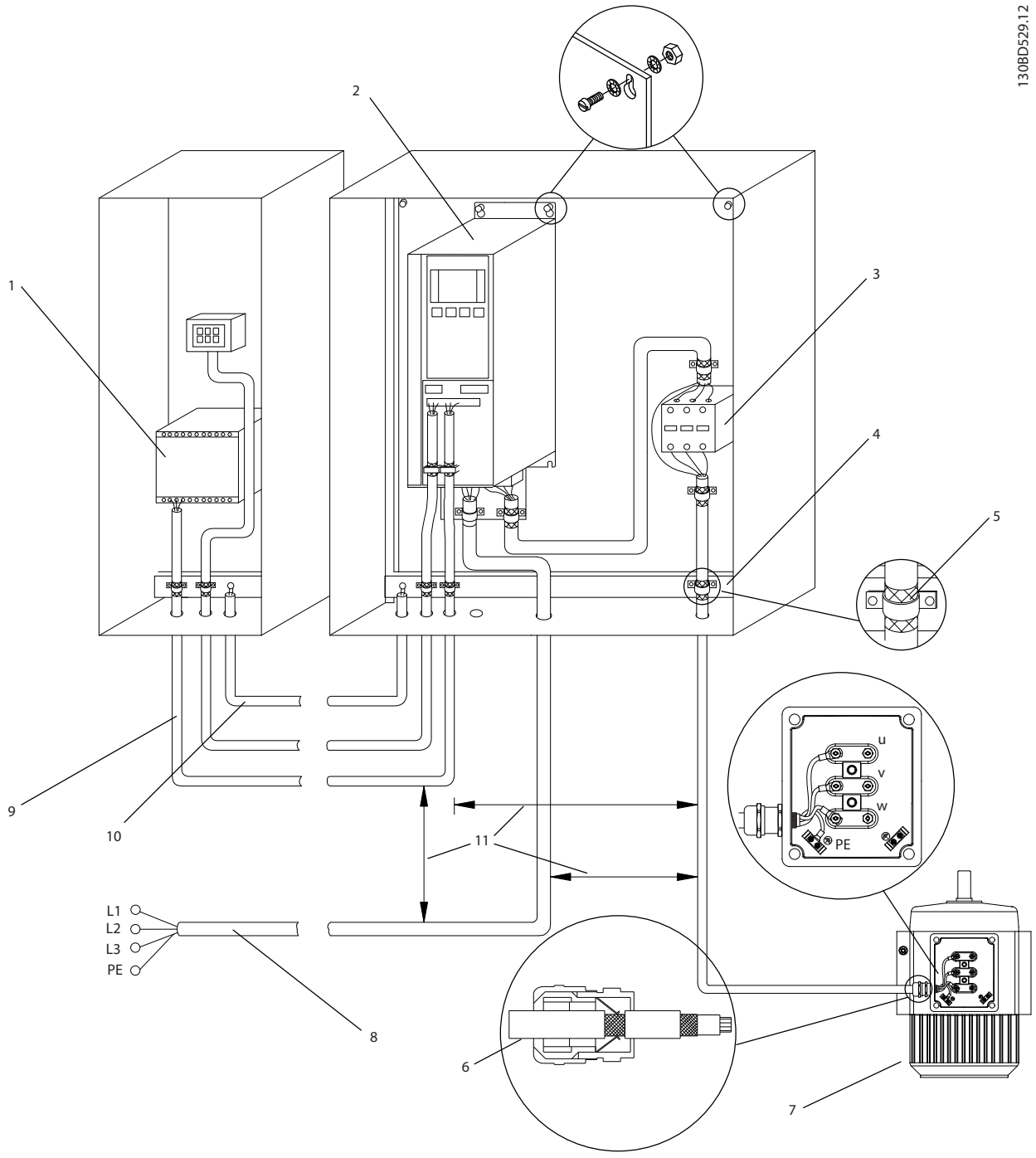

1	PLC	7	Motor, 3-phase and PE (screened)
2	Frequency converter	8	Mains, 3-phase and reinforced PE (not screened)
3	Output contactor	9	Control wiring (screened)
4	Cable clamp	10	Potential equalisation minimum 16 mm^2 (0.025 in^2)
5	Cable insulation (stripped)	11	Clearance between control cable, motor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

Illustration 4.2 EMC-compliant Electrical Connection

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

NOTICE

EMC INTERFERENCE

Use screened 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 behaviour or reduced performance. Minimum 200 mm (7.9 in) clearance between power, motor, and control cables is required.

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4.5 Access

- Remove the cover with a screwdriver (see *Illustration 4.3*) or by loosening attaching screws (see *Illustration 4.4*).

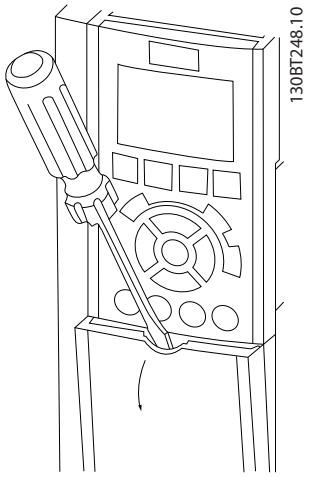

Illustration 4.3 Access to Wiring for IP20 and IP21 Enclosures

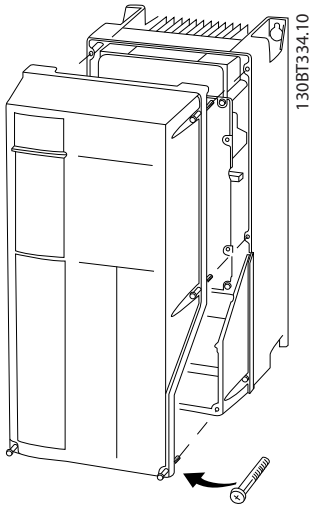

Illustration 4.4 Access to Wiring for IP55 and IP66 Enclosures

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 screened cables could result in death or serious injury.

- Run output motor cables separately, or
- Use screened 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

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable screen and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.5*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.5*.
5. Tighten the terminals in accordance with the information provided in *chapter 8.8 Connection Tightening Torques*.

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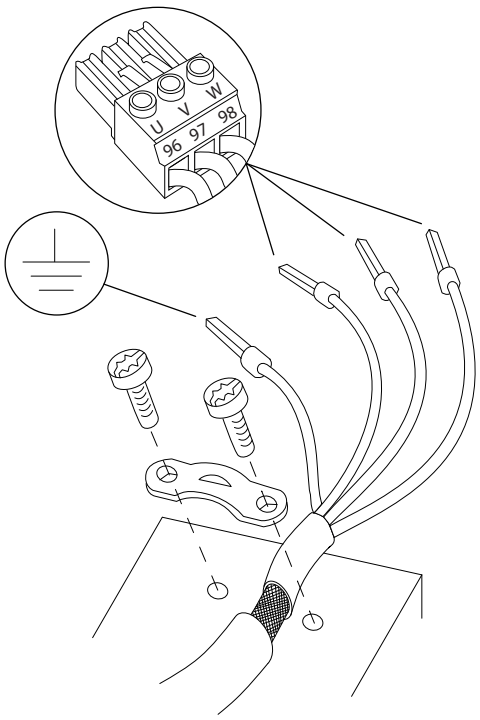

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Illustration 4.5 Motor Connection

Illustration 4.6 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

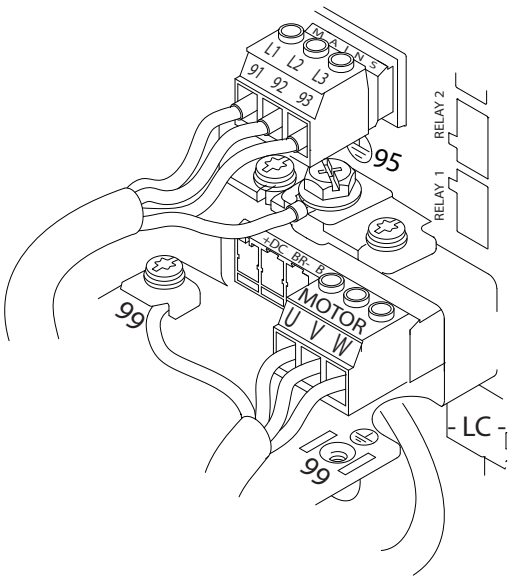

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Illustration 4.6 Example of Motor, Mains, and Ground Wiring

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 4.6*).
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 screened and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 4.7*.

4.8.1 Control Terminal Types

Illustration 4.7 and *Illustration 4.8* show the removable frequency converter connectors. Terminal functions and default settings are summarised in *Table 4.2* and *Table 4.3*.

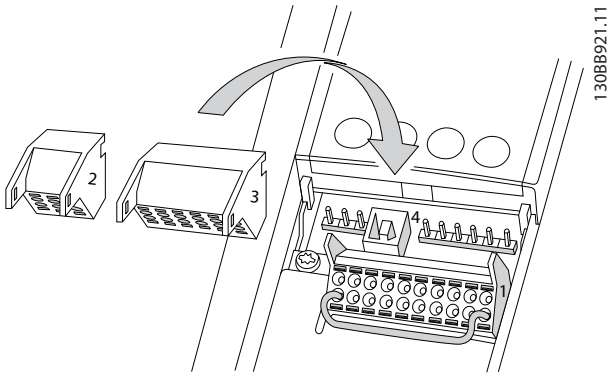

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Illustration 4.7 Control Terminal Locations

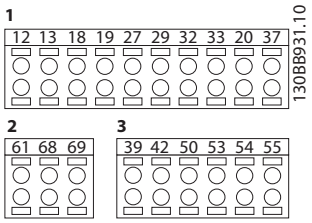

Illustration 4.8 Terminal Numbers

4

- Connector 1 provides 4 programmable digital inputs terminals, 2 additional 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**
Digital inputs/outputs			
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	5-10	*[8] Start*	Digital inputs.
19	5-11	*[10] Reversing*	
32	5-14	*[0] No operation*	
33	5-15	*[0] No operation*	
27	5-12	*[2] Coast inverse*	For digital input or output. Default setting is input.
29	5-13	*[14] JOG*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	STO	Safe input.
Analog inputs/outputs			
39	–		Common for analog output
42	6-50	*[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	6-1*	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	6-2*	Feedback	
55	–	–	Common for analog input.

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

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Serial communication			
61	–	–	Integrated RC-filter for cable screen. ONLY for connecting the screen in the event of EMC problems.
68 (+)	8-3*	–	RS485 interface. A control card switch is provided for termination resistance.
69 (-)	8-3*	–	
Relays			
01, 02, 03	5-40 [0]	*[0] No operation*	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	*[0] No operation*	

Table 4.3 Terminal Description, Serial Communication

Additional terminal

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

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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 4.9*.

NOTICE

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

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

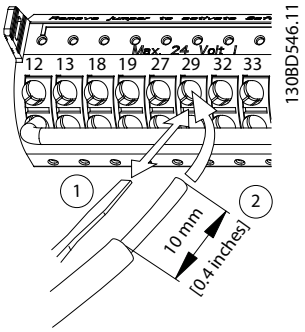

Illustration 4.9 Connecting Control Wires

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 4.10*).
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.

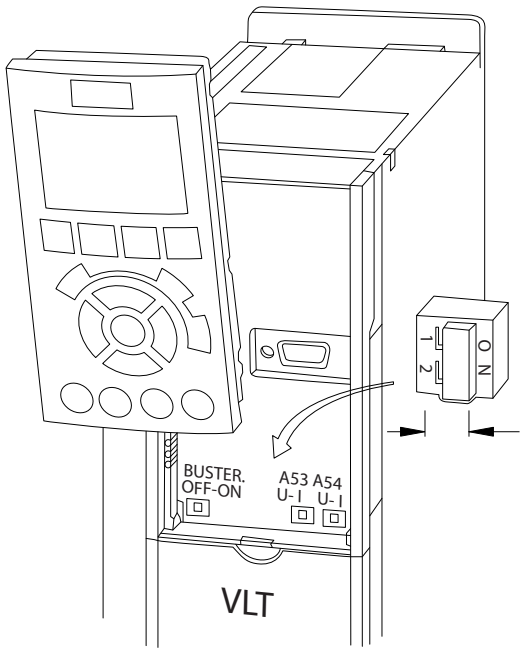

Illustration 4.10 Location of Terminal 53 and 54 Switches

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

4

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.

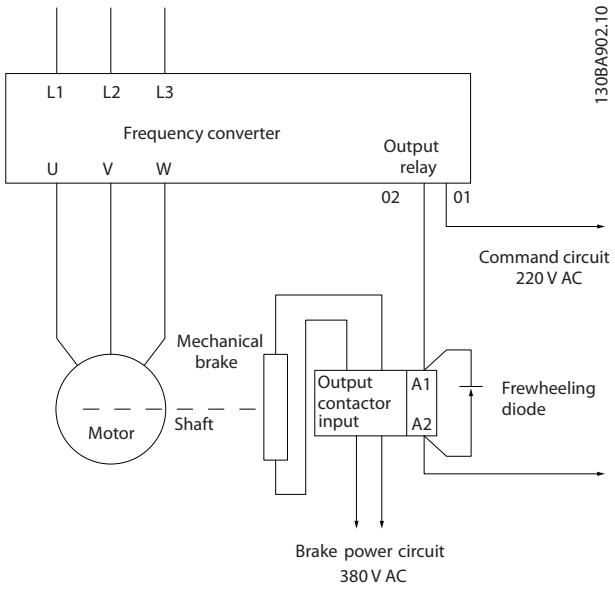

Illustration 4.11 Connecting the Mechanical Brake to the Frequency Converter

4.8.6 RS485 Serial Communication

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

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

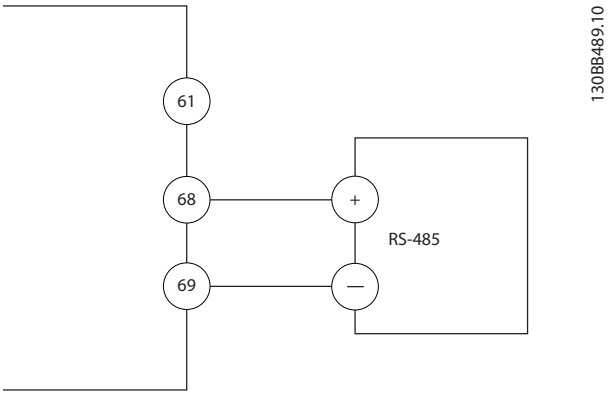

Illustration 4.12 Serial Communication Wiring Diagram

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

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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.

Inspect for	Description	☑
Auxiliary equipment	• 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. • Check the function and installation of any sensors used for feedback to the frequency converter. • Remove any power factor correction caps on the motor. • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that the motor wiring and control wiring are separated, screened, or in 3 separate metallic conduits for high frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that the control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. The use of screened cable or twisted pair is recommended. Ensure that the screen is terminated correctly.	
Cooling clearance	• Ensure that the top and bottom clearance is adequate to ensure proper air flow for cooling, see *chapter 3.3 Mounting*.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that the motor and mains cables are in separate conduit or separated screened cables.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted, metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

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 Ω values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the frequency converter as well as 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.
- Programme 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*.

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.

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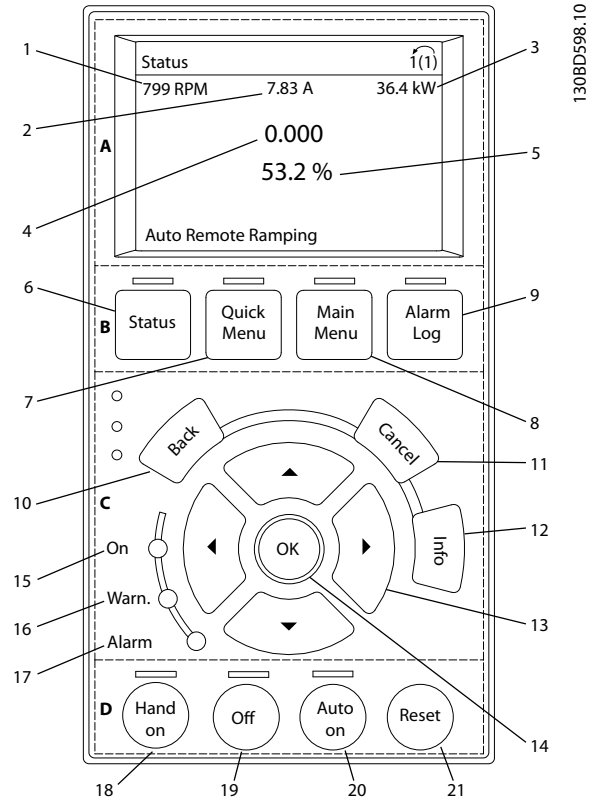

Illustration 5.1 GLCP

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 customised for user application. Select options in the *Quick Menu Q3-13 Display Settings*.

Display	Parameter number	Default setting
1	0-20	*[1617] Speed [RPM]*
2	0-21	*[1614] Motor Current*
3	0-22	*[1610] Power [kW]*
4	0-23	*[1613] Frequency*
5	0-24	*[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	Use the 4 navigation keys to move between items in the menu.
14	OK	Use to access parameter groups or to enable a selection.

Table 5.3 Legend to *Illustration 5.1*, Navigation Keys

	Indicator	Colour	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 light to flash and an alarm text is showed.

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

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D. Operation keys and reset
Operation keys are located at the bottom of the LCP.

	Key	Function
18	Hand On	Starts the frequency converter in local control. • An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the motor but does not remove power to the frequency converter.
20	Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
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

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

5.3.4 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.

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

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

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

5.3.5 Restoring Default Settings

NOTICE

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

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

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

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Recommended initialisation 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. This may take slightly longer than normal.

6. *Alarm 80, Drive initialised to default value* is showed.
7. Press [Reset] to return to operation mode.

Manual initialisation 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. This may take slightly longer than usual.

Manual initialisation 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 initialisation 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].

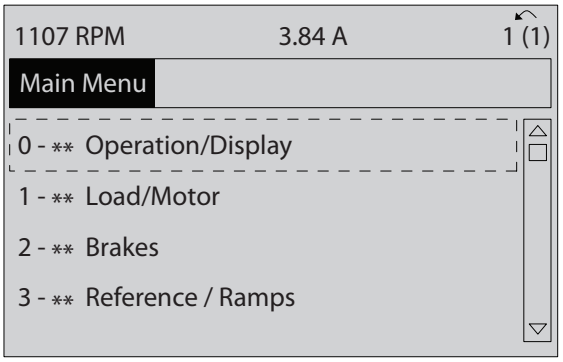

Illustration 5.2 Main Menu

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

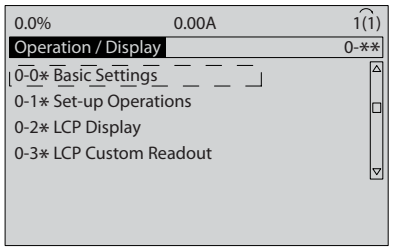

Illustration 5.3 Operation/Display

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

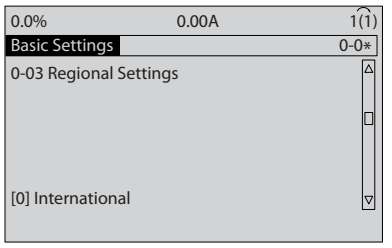

Illustration 5.4 Basic Settings

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

press [OK]. (This changes the default settings for a number of 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+ 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+
VVC+ 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	*Parameter 1-66 Min. Current at Low Speed*. 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	*Parameter 1-66 Min. Current at Low Speed*. Increase current to a value between default and maximum depending on the application.
No-load application	Adjust *parameter 1-18 Min. Current at No Load* to achieve smoother motor operation by reducing torque ripple and vibration.
Flux sensorless control principle only	Adjust *parameter 1-53 Model Shift Frequency*. Example 1: If the motor oscillates at 5 Hz, and dynamics performance is required at 15 Hz, set *parameter 1-53 Model Shift Frequency* to 10 Hz. Example 2: If the application involves dynamic load changes at low speed, reduce *parameter 1-53 Model Shift Frequency*. Observe the motor behaviour 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

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

5.4.5 SynRM Motor Set-up with VVC+

This section describes how to set up a SynRM motor with VVC+.

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 programme 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+ SynRM settings. *Table 5.8* provides application-specific recommendations:

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

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5.4.6 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimises 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 displayed is positive.

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

4a. Verify that the motor turns clockwise.

5a. Verify that the LCP direction arrow is clockwise.

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

4b. Verify that the motor turns counter-clockwise.

5b. Verify that the LCP direction arrow is counter-clockwise.

5.6 Checking Encoder Rotation

Only check encoder rotation if encoder feedback is used. For more information on the encoder option, refer to the option manual.

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.

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.

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.

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

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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*.

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6 Application Set-up Examples

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

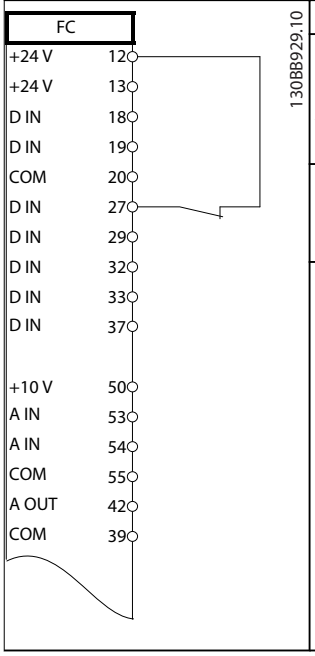
- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

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.

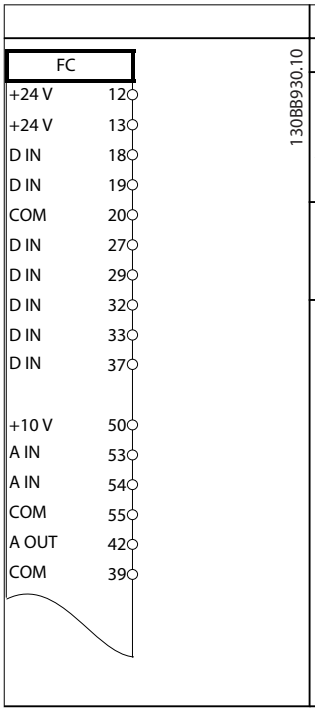
6.1 Application Examples

6.1.1 AMA



	Parameters	
	Function	**Setting**
	Parameter 1-29 A utomatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 T erminal 27 Digital Input	*[2] Coast inverse*
	Notes/comments: Set parameter group *1-2* Motor Data* according to the motor. D IN 37 is an option.	

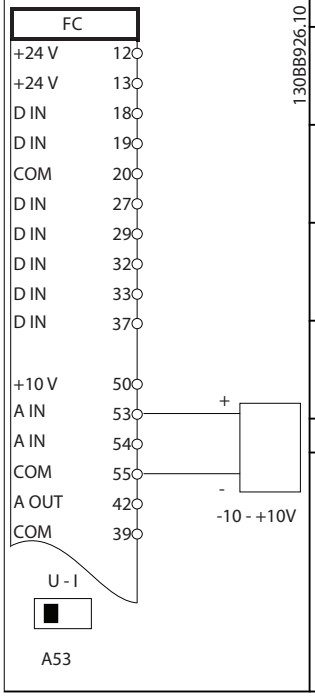
Table 6.1 AMA with T27 Connected



	Parameters	
	Function	**Setting**
	Parameter 1-29 A utomatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 T erminal 27 Digital Input	*[0] No operation*
	Notes/comments: Set parameter group *1-2* Motor Data* according to the motor. D IN 37 is an option.	

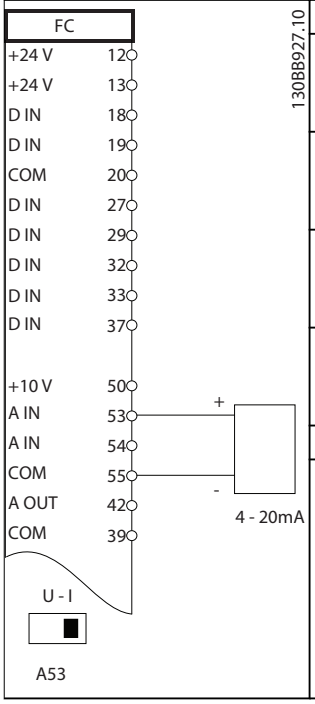
Table 6.2 AMA without T27 Connected

6.1.2 Speed



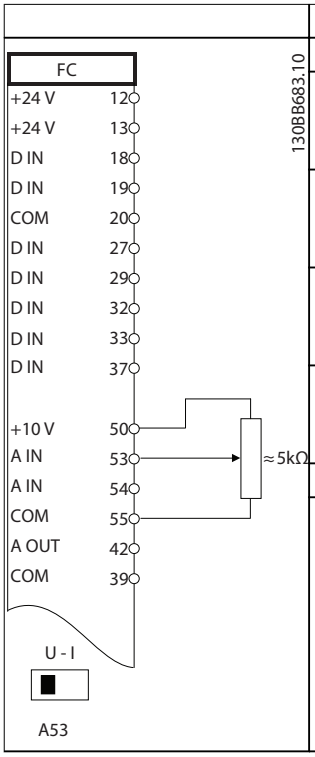
	Parameters	
	Function	**Setting**
	Parameter 6-10 T erminal 53 Low Voltage	0.07 V*
	Parameter 6-11 T erminal 53 High Voltage	10 V*
	Parameter 6-14 T erminal 53 Low Ref./Feedb. Value	0 Hz
	Parameter 6-15 T erminal 53 High Ref./Feedb. Value	50 Hz
	* = Default value	
	Notes/comments: D IN 37 is an option.	

Table 6.3 Analog Speed Reference (Voltage)



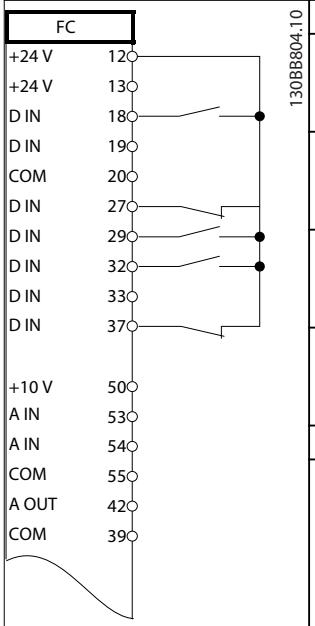
Parameters	
Function	**Setting**
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.4 Analog Speed Reference (Current)



Parameters	
Function	**Setting**
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	1500 Hz
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.5 Speed Reference (Using a Manual Potentiometer)



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
Parameter 5-12 Terminal 27 Digital Input	*[19] Freeze Reference*
Parameter 5-13 Terminal 29 Digital Input	*[21] Speed Up*
Parameter 5-14 Terminal 32 Digital Input	*[22] Speed Down*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.6 Speed Up/Down

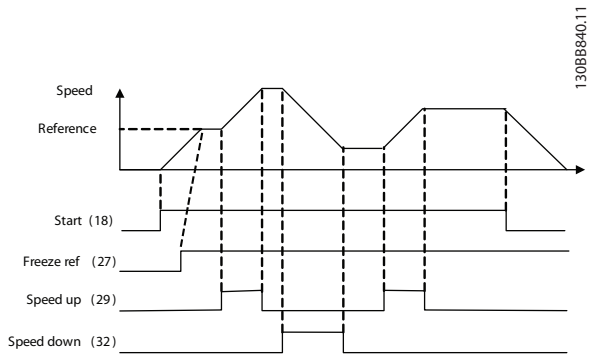


Illustration 6.1 Speed Up/Down

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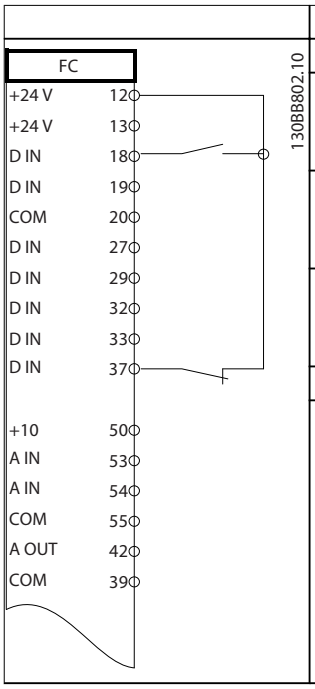
6.1.3 Start/Stop



	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-19 Terminal 37 Safe Stop	*[1] Safe Stop Alarm*
	* = Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 6.7 Start/Stop Command with Safe Stop Option

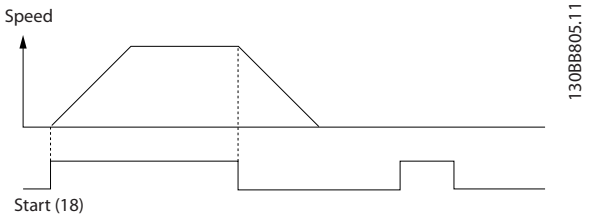
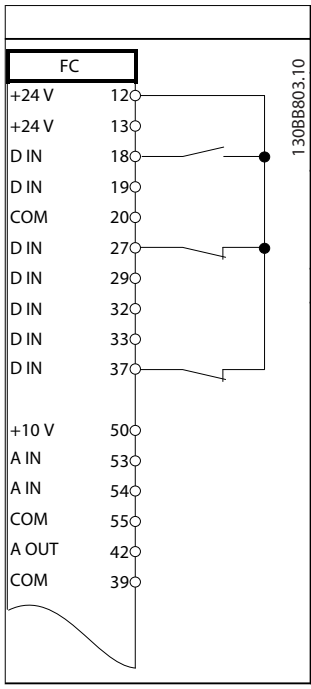


Illustration 6.2 Start/Stop Command with Safe Stop



	Parameters	
	Function	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[9] Latched Start*
	Parameter 5-12 Terminal 27 Digital Input	*[6] Stop Inverse*
	* = Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 6.8 Pulse Start/Stop

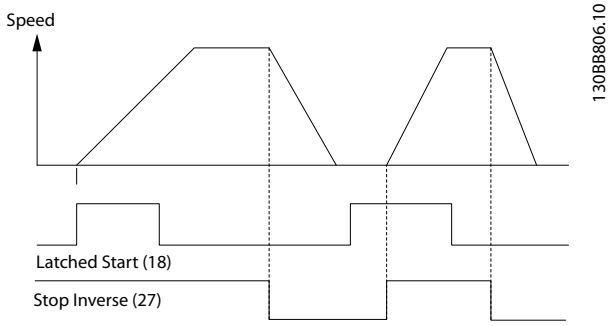
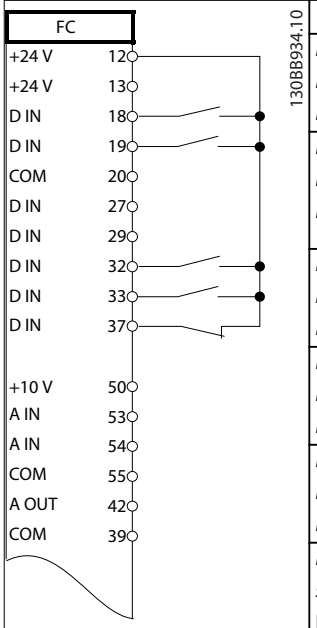


Illustration 6.3 Latched Start/Stop Inverse

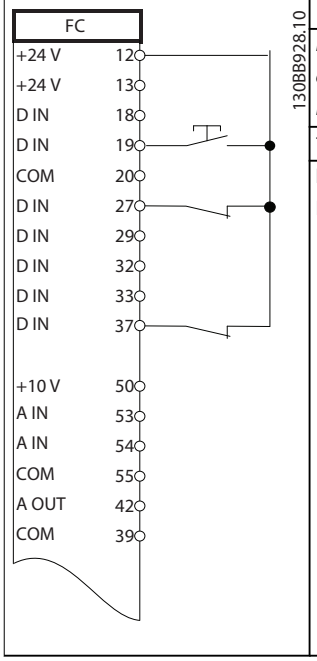
6



Parameters	
Function	**Setting**
Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
Parameter 5-11 Terminal 19 Digital Input	*[10] Reversing*
Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
Parameter 5-14 Terminal 32 Digital Input	*[16] Preset ref bit 0*
Parameter 5-15 Terminal 33 Digital Input	*[17] Preset ref bit 1*
Parameter 3-10 Preset Reference	
Preset reference 0	25%
Preset reference 1	50%
Preset reference 2	75%
Preset reference 3	100%
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.9 Start/Stop with Reversing and 4 Preset Speeds

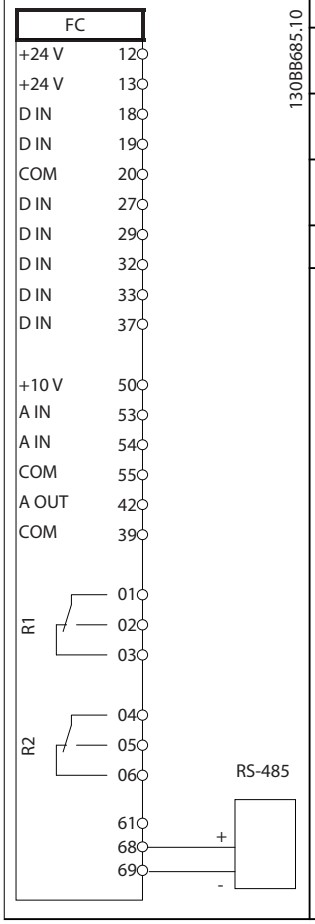
6.1.4 External Alarm Reset



Parameters	
Function	**Setting**
Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
* = Default value	
Notes/comments: D IN 37 is an option.	

Table 6.10 External Alarm Reset

6.1.5 RS485



Parameters	
Function	**Setting**
Parameter 8-30 Protocol	FC*
Parameter 8-31 Address	1*
Parameter 8-32 Baud Rate	9600*
* = Default value	
Notes/comments: Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.	

Table 6.11 RS485 Network Connection

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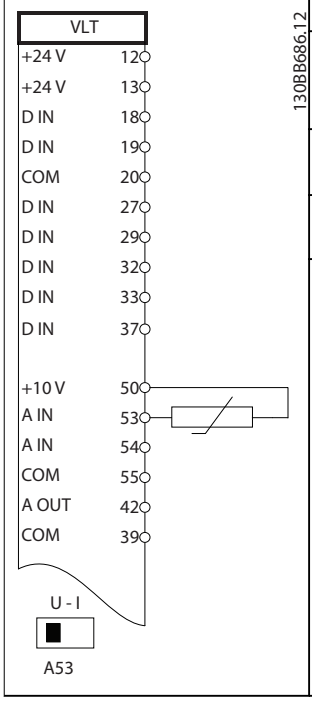
6.1.6 Motor Thermistor

⚠WARNING

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

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

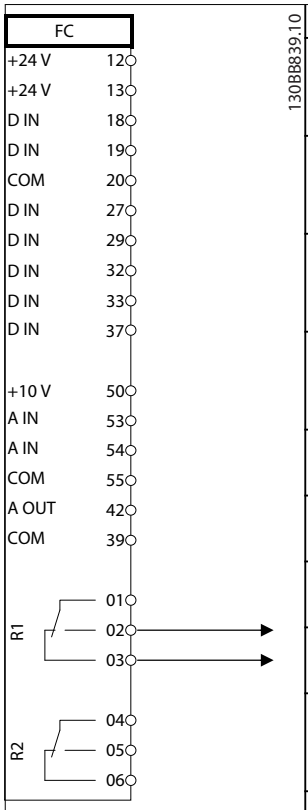


	Parameters	
	Function	**Setting**
	Parameter 1-90 Motor Thermal Protection	*[2] Thermistor trip*
	Parameter 1-93 Thermistor Source	*[1] Analog input 53*
	* = Default Value	
	Notes/comments: If only a warning is required, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN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

Table 6.12 Motor Thermistor

6.1.7 SLC

	Parameters	



Function	Setting
Parameter 4-30 Motor Feedback Loss Function	*[1] Warning*
Parameter 4-31 Motor Feedback Speed Error	100 RPM
Parameter 4-32 Motor Feedback Loss Timeout	5 s
Parameter 7-00 Speed PID Feedback Source	*[2] MCB 102*
Parameter 17-11 Resolution (PPR)	1024*
Parameter 13-00 SL Controller Mode	*[1] On*
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 SL Controller Event	*[22] Comparator 0*
Parameter 13-52 SL 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

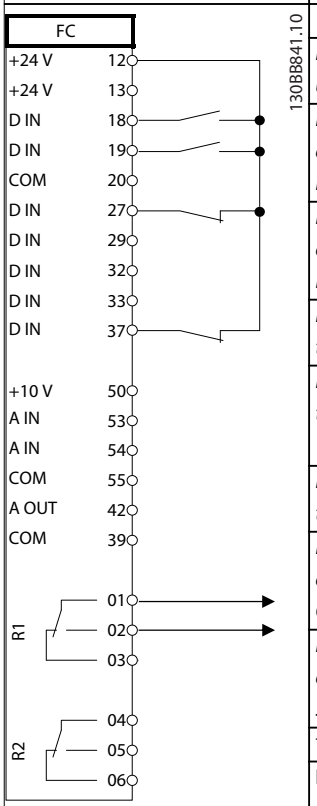
Notes/comments:

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

6.1.8 Mechanical Brake Control



	Parameters	
	Function	**Setting**
	Parameter 5-40 Function Relay	*[32] Mech. brake ctrl.*
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-11 Terminal 19 Digital Input	*[11] Start reversing*
	Parameter 1-71 Start Delay	0.2
	Parameter 1-72 Start Function	*[5] VVC+/ FLUX Clockwise*
	Parameter 1-76 Start Current	$I_{m,n}$
	Parameter 2-20 Release Brake Current	App. 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

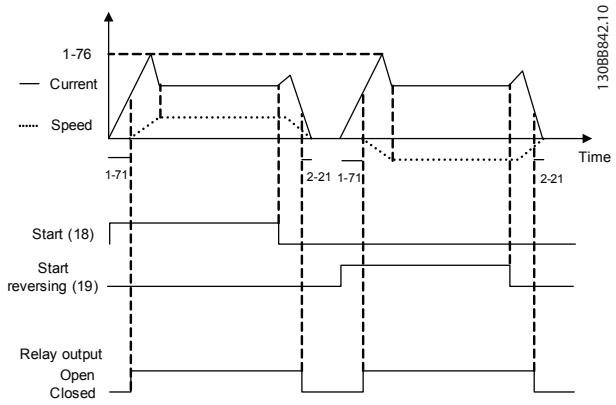


Illustration 6.4 Mechanical Brake Control

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7 Maintenance, Diagnostics, and Troubleshooting

This chapter includes maintenance and service guidelines, status messages, warnings and alarms, and basic trouble-shooting.

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, refer to *www.danfoss.com/contact/sales_and_services/*.

⚠WARNING

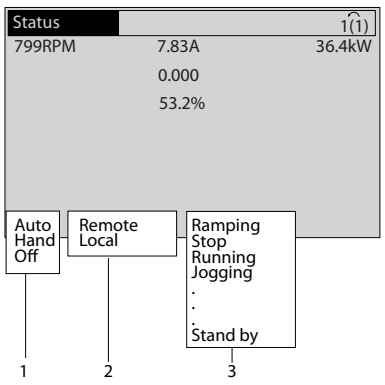
UNINTENDED START

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

- **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.**

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 *Table 7.1*)
2	Reference site (see *Table 7.2*)
3	Operation status (see *Table 7.3*)

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 communi-cation.
Hand On	The frequency converter is controlled by 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 *parameter 2-10 Brake Function*. The AC brake overmagnetises 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 *parameter 2-12 Brake Power Limit (kW)* has been reached.
Coast	• *Coast inverse* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	*[1] Control Ramp-down* was selected in *parameter 14-10 Mains Failure*. • The mains voltage is below the value set in *parameter 14-11 Mains Voltage at Mains Fault* at mains fault • The frequency converter ramps down the motor using a controlled ramp down.
Current High	The frequency converter output current is above the limit set in *parameter 4-51 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *parameter 4-52 Warning Speed Low*.
DC Hold	*[1] DC hold* is selected in *parameter 1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *parameter 2-00 DC Hold/Preheat Current*.
DC Stop	The motor is held with a DC current (*parameter 2-01 DC Brake Current*) for a specified time (*parameter 2-02 DC Braking Time*). • The DC brake cut in speed is reached in *parameter 2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • *[5] DC-brake inverse* is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The DC brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *parameter 4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *parameter 4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • *[20] Freeze output* is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal options *[21] Speed up* and *[22] Speed down*. • Hold ramp is activated via serial communication.
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 (parameter group *5-1* Digital Inputs*). 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	The motor is running as programmed in *parameter 3-19 Jog Speed [RPM]*. • *[14] Jog* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal (for example, terminal 29) is active. • The jog function is activated via the serial communication. • The jog function is selected as a reaction for a monitoring function (for example, for the no signal function). The monitoring function is active.
Motor check	In *parameter 1-80 Function at Stop*, *[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 *parameter 2-17 Over-voltage Control*, *[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.

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Protection md	Protection mode is active. The unit detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *parameter 14-26 Trip Delay at Inverter Fault*.
QStop	The motor is decelerating using *parameter 3-81 Quick Stop Ramp Time*. • *[4] Quick stop inverse* is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function is activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *parameter 4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *parameter 4-54 Warning Reference Low*.
Run on ref.	The 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 *parameter 4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *parameter 4-52 Warning Speed Low*.
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 *parameter 1-71 Start Delay*, a delay starting time was set. A start command is activated, and the motor starts after the start delay time expires.
Start fwd/rev	*[12] Enable start forward* and *[13] Enable start reverse* are selected as options for 2 different digital inputs (parameter group *5-1* Digital Inputs*). 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.

7.3 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

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 showed in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

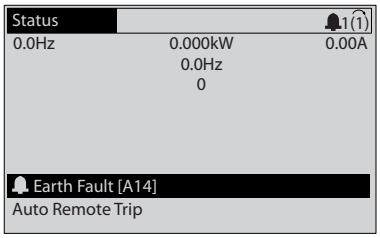
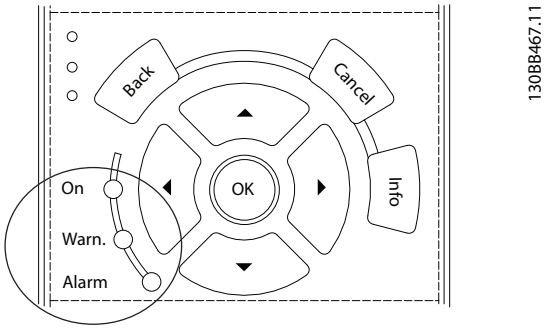


Illustration 7.2 Alarm Example

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



	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (Flashing)
Trip-Lock	On	On (Flashing)

Illustration 7.3 Status Indicator Lights

7.4 List of Warnings and Alarms

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

WARNING 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 the connections on all the 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 on the frequency converter. 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 if a 24 V DC back-up supply is connected. 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 reaches 100% in *parameter 1-90 Motor Thermal Protection*. 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 Source* 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 Source*.

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.

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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. Ground fault is detected by the current transducers that measure 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 should 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 FC 302. Perform the manual initialisation 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 board hardware or software.

Record the value of the following parameters and contact Danfoss:

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

ALARM 16, Short circuit

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

Troubleshooting

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

WARNING/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 a proper installation based on EMC requirements.

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 not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

WARNING 23, Internal fan fault

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

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 and control card.

WARNING 24, External fan fault

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

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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 and control card.

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 (see *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. 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.

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.

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.

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 option *[0] No Function*. 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 displayed.

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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 initialised. Contact the Danfoss supplier or Danfoss Service Department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or 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 (not allowed).
1316	The option software in slot B is not supported (not allowed).
1318	The option software in slot C1 is not supported (not allowed).
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss Service Department.
1792	HW reset of DSP.
1793	Motor derived parameters not transferred correctly to the DSP.
1794	Power data not transferred correctly at power-up to the DSP.
1795	The DSP has received too many unknown SPI telegrams. The frequency converter also uses this fault code if the MCO does not power up correctly, for example 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 gate drive card, or the ribbon cable between the power card and gate drive 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. 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. Check *parameter 5-32 Term X30/6 Digi Out (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)*.

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
- ±18 V

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When powered with 24 V DC 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
- ±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. Check for a defective control card. If an option card is present, check for overvoltage.

WARNING 49, Speed limit
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]*, the frequency converter shows a warning. 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. Check the settings in *parameters 1–20* to *1–25*.

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings in *parameter 4-18 Current Limit*.

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

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

ALARM 55, AMA parameter out of range
The parameter values of the motor are outside of the acceptable range. AMA cannot run.

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* are 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 is indicating a fault condition externally 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. 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.

ALARM 64, Voltage Limit
The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

WARNING/ALARM 65, Control card over temperature
The cut-out temperature of the control card is 80 °C.

Troubleshooting

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

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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* at 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
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]).

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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 of the unit from the 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
Safe Torque Off 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.

Troubleshooting
When replacing an enclosure size F module, this warning occurs, if the power-specific data in the module power card does not match the rest of the frequency converter. 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*. 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 initialised 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 initialise 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.

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- 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 permitted 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 permitted 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 permitted minimum frequency (*parameter 1-98 ATEX ETR interpol. points freq.*).

WARNING 250, New spare part
A component in the frequency converter has been replaced.

Troubleshooting
- Reset the frequency converter for normal operation.

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

Troubleshooting
- Reset to remove the warning and resume normal operation.

7

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power.	See *Table 4.4*.	Check the input power source.
	Missing or open fuses or circuit breaker tripped.	See *Open power fuses and tripped circuit breaker* 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.

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Symptom	Possible cause	Test	Solution
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 *Display dark\No function* 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 devise).	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 *parameter 5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting).	Check *parameter 5-12 Terminal 27 Digital Input* for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or programme this terminal to *[0] No operation*.
	Wrong reference signal source.	Determine which reference type is active (local, remote, or fieldbus) and check the following points: • Preset reference (active or not). • Terminal connection. • Scaling of terminals. • Reference signal.	Programme correct settings. Check *parameter 3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit.	Check that *parameter 4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal.	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection.	–	See *chapter 5.5 Checking Motor Rotation* in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong.	Check output limits in *parameter 4-13 Motor Speed High Limit [RPM]*, *parameter 4-14 Motor Speed High Limit [Hz]*, and *parameter 4-19 Max Output Frequency*	Programme correct limits.
	Reference input signal not scaled correctly.	Check reference input signal scaling in parameter group *6-0* Analog I/O mode* and parameter group *3-1* References*.	Programme 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 parameter group *1-6* Load Depen. Setting*. For closed-loop operation, check settings in parameter group *20-0* Feedback*.
Motor runs rough	Overmagnetisation.	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor data, 1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*.
Motor does not brake	Incorrect settings in the brake parameters. Possible too short ramp-down times.	Check brake parameters. Check ramp time settings.	Check parameter group *2-0* DC Brake* and *3-0* Reference Limits*.

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Symptom	Possible cause	Test	Solution
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 *Alarm 4, Mains phase loss* 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 *chapter 7.4 List of Warnings and Alarms* Check that motor data are entered correctly.	Increase the ramp-up time in *parameter 3-41 Ramp 1 Ramp Up Time*. Increase current limit in *parameter 4-18 Current Limit*. Increase torque limit in *parameter 4-16 Torque Limit Motor Mode*.
Frequency converter deceleration problems	Motor data are entered incorrectly.	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms* Check that motor data are entered correctly.	Increase the ramp-down time in *parameter 3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *parameter 2-17 Over-voltage Control*.

Table 7.5 Troubleshooting

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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]	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3.0	3.7
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
Output current									
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
Maximum input current									
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
Additional specifications									
Maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm²] ([AWG])	4,4,4 (12,12,12) (minimum 0.2 (24))								
Maximum cable cross-section[2] for disconnect [mm²] ([AWG])	6,4,4 (10,12,12)								
Estimated power loss at rated maximum load [W][3]	21	29	42	54	63	82	116	155	185
Efficiency[4]	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

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Type designation	P5K5		P7K5		P11K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	5.5	7.5	7.5	11	11	15
Enclosure protection rating IP20	B3		B3		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2	
Output current						
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
Maximum input current						
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
Additional specifications						
IP20 maximum cable cross-section[2)] for mains, brake, motor, and load sharing [mm^2] ([AWG])	10,10,- (8,8,-)		10,10,- (8,8,-)		35,-,- (2,-,-)	
IP21 maximum cable cross-section[2)] for mains, brake, and load sharing [mm^2] ([AWG])	16,10,16 (6,8,6)		16,10,16 (6,8,6)		35,-,- (2,-,-)	
IP21 maximum cable cross-section[2)] for motor [mm^2] ([AWG])	10,10,- (8,8,-)		10,10,- (8,8,-)		35,25,25 (2,4,4)	
Maximum cable cross-section[2)] for disconnect [mm^2] ([AWG])	16,10,10 (6,8,8)					
Estimated power loss at rated maximum load [W][3)]	239	310	371	514	463	602
Efficiency[4)]	0.96		0.96		0.96	

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

Type designation	P15K		P18K		P22K		P30K		P37K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	15	18.5	18.5	22	22	30	30	37	37	45
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
Output current										
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
Maximum input current										
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
Additional specifications										
IP20 maximum cable cross-section for mains, brake, motor, and load sharing [mm^2] ([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^2] ([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^2] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2)] for disconnect [mm^2] ([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][3)]	624	737	740	845	874	1140	1143	1353	1400	1636
Efficiency[4)]	0.96		0.97		0.97		0.97		0.97	

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

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8.1.2 Mains Supply 380–500 V

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3.0	4.0	5.5	7.5
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
Output current high overload 160% for 1 minute										
Shaft output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5
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
Maximum input current										
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
Additional specifications										
IP20, IP21 maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm²] ([AWG])	4,4,4 (12,12,12) (minimum 0.2(24))									
IP55, IP66 maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm²] ([AWG])	4,4,4 (12,12,12)									
Maximum cable cross-section[2] for disconnect [mm²] ([AWG])	6,4,4 (10,12,12)									
Estimated power loss at rated maximum load [W[3]	35	42	46	58	62	88	116	124	187	255
Efficiency[4]	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

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Type designation	P11K		P15K		P18K		P22K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	11	15	15	18.5	18.5	22.0	22.0	30.0
Enclosure protection rating IP20	B3		B3		B4		B4	
Enclosure protection rating IP21	B1		B1		B2		B2	
Enclosure protection rating IP55, IP66	B1		B1		B2		B2	
Output current								
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
Maximum input current								
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
Additional specifications								
IP21, IP55, IP66 maximum cable cross-section[2)] for mains, brake, and load sharing [mm^2] ([AWG])	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section[2)] for motor [mm^2] ([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[2)] for mains, brake, motor, and load sharing [mm^2] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
Maximum cable cross-section[2)] for disconnect [mm^2] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load [W][3)]	291	392	379	465	444	525	547	739
Efficiency[4)]	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

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Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	30	37	37	45	45	55	55	75	75	90
Enclosure protection rating IP21	C1		C1		C1		C2		C2	
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP55, IP66	C1		C1		C1		C2		C2	
Output current										
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
Maximum input current										
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
Additional specifications										
IP20 maximum cable cross-section for mains and motor [mm^2] ([AWG])	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP20 maximum cable cross-section for brake and load sharing [mm^2] ([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^2] ([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^2] ([AWG])	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Maximum cable cross-section[2)] for mains disconnect [mm^2] ([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][3)]	570	698	697	843	891	1083	1022	1384	1232	1474
Efficiency[4)]	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]	0.75	1.1	1.5	2.2	3	4	5.5	7.5
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
Output current								
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
Maximum input current								
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
Additional specifications								
Maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm^2] ([AWG])	4,4,4 (12,12,12) (minimum 0.2 (24))							
Maximum cable cross-section[2] for disconnect [mm^2] ([AWG])	6,4,4 (10,12,12)							
Estimated power loss at rated maximum load [W][3]	35	50	65	92	122	145	195	261
Efficiency[4]	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

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Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	11	15	15	18.5	18.5	22	22	30	30	37
Enclosure protection rating IP20	B3		B3		B4		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2		C1	
Output current										
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
Maximum input current										
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
Additional specifications										
IP20 maximum cable cross-section[2)] for mains, brake, motor, and load sharing [mm²] ([AWG])	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 maximum cable cross-section[2)] for mains, brake, and load sharing [mm²] ([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[2)] for motor [mm²] ([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[2)] for disconnect [mm²] ([AWG])	16, 10, 10 (6, 8, 8)								50, 35, 35 (1, 2, 2)	
Estimated power loss at rated maximum load [W][3)]	220	300	300	370	370	440	440	600	600	740
Efficiency[4)]	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	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW]	37	45	45	55	55	75	75	90
Enclosure protection rating IP20	C3	C3	C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1	C1	C1		C2		C2	
Output current								
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
Maximum input current								
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
Additional specifications								
IP20 maximum cable cross-section for mains and motor [mm^2] ([AWG])	50 (1)				150 (300 MCM)			
IP20 maximum cable cross-section for brake and load sharing [mm^2] ([AWG])	50 (1)				95 (4/0)			
IP21, IP55, IP66 maximum cable cross-section for mains and motor [mm^2] ([AWG])	50 (1)				150 (300 MCM)			
IP21, IP55, IP66 maximum cable cross-section for brake and load sharing [mm^2] ([AWG])	50 (1)				95 (4/0)			
Maximum cable cross-section[2)] for mains disconnect [mm^2] ([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][3)]	740	900	900	1100	1100	1500	1500	1800
Efficiency[4)]	0.98		0.98		0.98		0.98	

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

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

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
High/normal overload[1]	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO
Typical shaft output (kW)	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Enclosure protection rating IP20	A3	A3	A3	A3	A3	A3	A3
Output current							
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
Maximum input current							
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
Additional specifications							
Maximum cable cross-section[2] for mains, motor, brake, and load sharing [mm²] ([AWG])	4, 4, 4 (12, 12, 12) (minimum 0.2 (24)						
Maximum cable cross-section[2] for disconnect [mm²] ([AWG])	6, 4, 4 (10, 12, 12)						
Estimated power loss at rated maximum load (W)[3]	44	60	88	120	160	220	300
Efficiency[4]	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[1]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW]	7.5	11	11	15	15	18.5	18.5	22
Typical shaft output at 690 V [kW]	11	15	15	18.5	18.5	22	22	30
Enclosure protection rating IP20	B4		B4		B4		B4	
Enclosure protection rating IP21, IP55	B2		B2		B2		B2	
Output current								
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
Maximum input current								
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
Additional specifications								
Maximum cable cross-section[2] for mains/motor, load share, and brake [mm²] ([AWG])	35, 25, 25 (2, 4, 4)							
Maximum cable cross-section[2] for mains disconnect [mm²] ([AWG])	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated maximum load (W)[3]	150	220	220	300	300	370	370	440
Efficiency[4]	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

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Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V (kW)	22	30	30	37	37	45	45	55	50	75
Typical shaft output at 690 V [kW]	30	37	37	45	45	55	55	75	75	90
Enclosure protection rating IP20	B4		C3		C3		D3h		D3h	
Enclosure protection rating IP21, IP55	C2		C2		C2		C2		C2	
Output current										
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
Maximum input current										
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	–	–
Additional specifications										
Maximum cable cross-section for mains and motor [mm^2] ([AWG])	150 (300 MCM)									
Maximum cable cross-section for load share and brake [mm^2] ([AWG])	95 (3/0)									
Maximum cable cross-section[2)] for mains disconnect [mm^2] ([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][3)]	600	740	740	900	900	1100	1100	1500	1500	1800
Efficiency[4)]	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/vltenergyefficiency

4) Efficiency measured at nominal current. For energy efficiency class, see chapter 8.4 Ambient Conditions. For part load losses see www.danfoss.com/vltenergyefficiency.

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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 ±10%
Supply voltage	FC 301: 380–480 V/FC 302: 380-500 V ±10%
Supply voltage	FC 302: 525–600 V ±10%
Supply voltage	FC 302: 525–690 V ±10%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the frequency converter continues until the DC-link voltage drops below the minimum stop level, which corresponds typically to 15% below the 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 ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cos ϕ)	near unity (>0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤7.5 kW	Maximum 2 times per minute.
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW	Maximum 1 time per minute.
Switching on input supply L1, L2, L3 (power-ups) ≥90 kW	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[1)])	
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[1)] once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s[1)] once in 10 minutes
Torque rise time in flux (for 5 kHz f_{sw})	1 ms
Torque rise time in VVC$^+$ (independent of f_{sw})	10 ms

1) Percentage relates to the nominal torque.

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8.4 Ambient Conditions

Environment	
Enclosure	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Vibration test	1.0 g
Maximum THVD	10%
Maximum relative humidity	5–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Ambient temperature[1)]	Maximum 50 °C (24-hour average maximum 45 °C)
Minimum ambient temperature during full-scale operation	0 °C
Minimum ambient temperature at reduced performance	- 10 °C
Temperature during storage/transport	-25 to +65/70 °C
Maximum altitude above sea level without derating[1)]	1000 m
EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[2)]	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[1)]	
Maximum motor cable length, screened	150 m
Maximum motor cable length, unscreened	300 m
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 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)[1)]/FC 302: 4 (6)[1)]
Terminal number	18, 19, 27[1)], 29[1)], 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[2)]	>19 V DC
Voltage level, logic 1 NPN[2)]	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) minimum pulse width	4.5 ms
Input resistance, R_i	approximately 4 kΩ

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STO terminal 37[3, 4] (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) Terminals 27 and 29 can also be programmed as output.

2) Except STO input terminal 37.

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

4) 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 to +10 V (scaleable)
Input resistance, R_i	approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

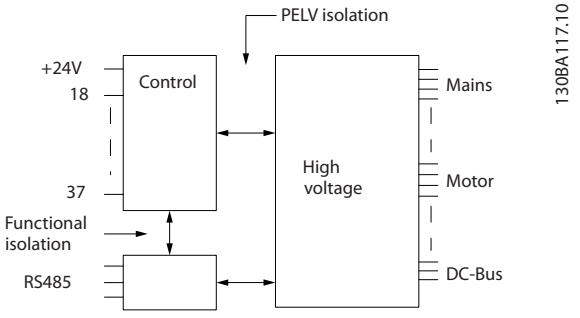

Illustration 8.1 PELV Isolation

Pulse/encoder inputs	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29[1], 33[2]/32[3], 33[3]
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 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

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[1]
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.

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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)[1] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (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)[1] on 4–5 (NO) (resistive load)[2][3] overvoltage cat. II	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 part 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
2) Overvoltage Category II.
3) UL applications 300 V AC2A.

Control card performance	
Scan interval	1 ms

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

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

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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_{rms} (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 A_{rms}.

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 Types A, B, and C

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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 Types A, B, and C

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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 Types 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	gG-6	gG-25	PKZM0-16	16
	1.5	gG-6	gG-25		
	2.2	gG-6	gG-25		
	3	gG-10	gG-25		
	4	gG-10	gG-25		
	5.5	gG-16	gG-25		
	7.5	gG-16	gG-25		
B2/B4	11	gG-25 (11)	gG-63	–	–
	15	gG-32 (15)			
	18	gG-32 (18)			
	22	gG-40 (22)			
B4/C2	30	gG-63 (30)	gG-80 (30)	–	–
C2/C3	37	gG-63 (37)	gG-100 (37)	–	–
	45	gG-80 (45)	gG-125 (45)		
C2	55	gG-100 (55)	gG-160 (55–75)	–	–
	75	gG-125 (75)			

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

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8.7.2 UL Compliance

200–240 V

	Recommended maximum fuse					
Power [kW]	Bussmann Type RK1[1)]	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 Types A, B, and C

	Recommended maximum fuse							
Power [kW]	SIBA Type RK1	Littel fuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1[3)]	Bussmann Type JFHR2[2)]	Littel fuse JFHR2	Ferraz-Shawmut JFHR2[4)]	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 Types 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.

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380–500 V

	Recommended maximum fuse					
Power [kW]	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 Types A, B, and C

	Recommended maximum fuse							
Power [kW]	SIBA Type RK1	Littel fuse Type RK1	Ferraz Shawmut Type CC	Ferraz Shawmut Type RK1	Bussmann JFHR2	Ferraz Shawmut JFerraz Shawmut J	Ferraz Shawmut JFHR2[1)]	Littel fuse 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 Types A, B, and C

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

525–600 V

	Recommended maximum fuse									
Power [kW]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC	SIBA Type RK1	Littel fuse 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 Types A, B, and C

525–690 V

	Recommended maximum fuse					
Power [kW]	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 Types A, B, and C

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	Recommended maximum fuse							
Power [kW]	Max. prefuse	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 Types B, and C

8.8 Connection Tightening Torques

	Torque [Nm]					
Enclosure	Mains	Motor	DC connection	Brake	Ground	Relay
A2	1.8	1.8	1.8	1.8	3	0.6
A3	1.8	1.8	1.8	1.8	3	0.6
A4	1.8	1.8	1.8	1.8	3	0.6
A5	1.8	1.8	1.8	1.8	3	0.6
B1	1.8	1.8	1.5	1.5	3	0.6
B2	4.5	4.5	3.7	3.7	3	0.6
B3	1.8	1.8	1.8	1.8	3	0.6
B4	4.5	4.5	4.5	4.5	3	0.6
C1	10	10	10	10	3	0.6
C2	14/24[1)]	14/24[1)]	14	14	3	0.6
C3	10	10	10	10	3	0.6
C4	14/24[1)]	14/24[1)]	14	14	3	0.6

Table 8.24 Tightening Terminals

1) For different cable dimensions x/y, where x≤95 mm² and y≥95 mm².

Enclosure type			A1	A2		A3		A4	A5	B1	B2	B3	B4	C1	C2	C3	C4	D3h
Rated power [kW]	**200–240 V**		**0.25–1.5**	**0.25–2.2**		**3–3.7**		**0.25–2.2**	**0.25–3.7**	**5.5–7.5**	**11**	**5.5–7.5**	**11–15**	**15–22**	**30–37**	**18.5–22**	**30–37**	–
	380-480/500 V		**0.37–1.5**	**0.37–4.0**		**5.5–7.5**		**0.37-4**	**0.37–7.5**	**11–15**	**18.5–22**	**11–15**	**18.5–30**	**30–45**	**55–75**	**37–45**	**55–75**	–
	525–600 V		–	–		**0.75–7.5**		–	**0.75–7.5**	**11–15**	**18.5–22**	**11–15**	**18.5–30**	**30–45**	**55–90**	**37–45**	**55–90**	–
	525–690 V		–	–		**1.1–7.5**		–	–	–	**11–22**	–	**11–30**	–	**30–75**	**37–45**	**37–45**	**55–75**
IP NEMA	–		20 Chassis	20 Chassis	21 Type 1	20 Chassis	21 Type 1	55/66 Type 12/4X	55/66 Type 12/4X	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	20 Chassis
Height [mm]																		
Height of mounting plate		A[1)]	200	268	375	268	375	390	420	480	650	399	520	680	770	550	660	909
Height with ground termination plate for fieldbus cables		A	316	374	–	374	–	–	–	–	–	420	595	–	–	630	800	–
Distance between mounting holes		a	190	257	350	257	350	401	402	454	624	380	495	648	739	521	631	–
Width [mm]																		
Width of mounting plate		B	75	90	90	130	130	200	242	242	242	165	230	308	370	308	370	250
Width of mounting plate with 1 C option		B	–	130	130	170	170	–	242	242	242	205	230	308	370	308	370	–
Width of mounting plate with 2 C options		B	–	150	150	190	190	–	242	242	242	225	230	308	370	308	370	–
Distance between mounting holes		b	60	70	70	110	110	171	215	210	210	140	200	272	334	270	330	–
Depth [mm]																		
Depth without option A/B		C	207	205	207	205	207	175	200	260	260	249	242	310	335	333	333	375
With option A/B		C	222	220	222	220	222	175	200	260	260	262	242	310	335	333	333	375
Screw holes [mm]																		
		c	6.0	8.0	8.0	8.0	8.0	8.25	8.25	12	12	8	–	12.5	12.5	–	–	–
		d	ø8	ø11	ø11	ø11	ø11	ø12	ø12	ø19	ø19	12	–	ø19	ø19	–	–	–
		e	ø5	ø5.5	ø5.5	ø5.5	ø5.5	ø6.5	ø6.5	ø9	ø9	6.8	8.5	ø9	ø9	8.5	8.5	–
		f	5	9	9	6.5	6.5	6	9	9	9	7.9	15	9.8	9.8	17	17	–
Max weight [kg]			2.7	4.9	5.3	6.6	7.0	9.7	13.5/14.2	23	27	12	23.5	45	65	35	50	62
Front cover tightening torque [Nm]																		
Plastic cover (low IP)			Click	Click		Click		–	–	Click	Click	Click	Click	Click	Click	2.0	2.0	–
Metal cover (IP55/66)			–	–		–		1.5	1.5	2.2	2.2	–	–	2.2	2.2	2.0	2.0	–

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

Table 8.25 Power Ratings, Weight, and Dimensions

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9 Appendix

9.1 Symbols, Abbreviations, and Conventions

°C	Degrees celsius
AC	Alternating current
AEO	Automatic energy optimisation
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.
Italicised text indicates:

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

All dimensions are in [mm] (in).

9.2 Parameter Menu Structure

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- **0-** Operation / Display**
  - **0-0* Basic Settings**
    - 0-01 Language
    - 0-02 Motor Speed Unit
    - 0-03 Regional Settings
    - 0-04 Operating State at Power-up (Hand)
    - 0-09 Performance Monitor
  - **0-1* Set-up Operations**
    - 0-10 Active Set-up
    - 0-11 Edit Set-up
    - 0-12 This Set-up Linked to
    - 0-13 Readout: Linked Set-ups
    - 0-14 Readout: Edit Set-ups / Channel
    - 0-15 Readout: actual setup
  - **0-2* LCP Display**
    - 0-20 Display Line 1.1 Small
    - 0-21 Display Line 1.2 Small
    - 0-22 Display Line 1.3 Small
    - 0-23 Display Line 2 Large
    - 0-24 Display Line 3 Large
    - 0-25 My Personal Menu
  - **0-3* LCP Custom Readout**
    - 0-30 Unit for User-defined Readout
    - 0-31 Min Value of User-defined Readout
    - 0-32 Max Value of User-defined Readout
    - 0-33 Source for User-defined Readout
    - 0-37 Display Text 1
    - 0-38 Display Text 2
    - 0-39 Display Text 3
  - **0-4* LCP Keypad**
    - 0-40 [Hand on] Key on LCP
    - 0-41 [Off] Key on LCP
    - 0-42 [Auto on] Key on LCP
    - 0-43 [Reset] Key on LCP
    - 0-44 [Off/Reset] Key on LCP
    - 0-45 [Drive Bypass] Key on LCP
  - **0-5* Copy/Save**
    - 0-50 LCP Copy
    - 0-51 Set-up Copy
  - **0-6* Password**
    - 0-60 Main Menu Password
    - 0-61 Access to Main Menu w/o Password
    - 0-65 Quick Menu Password
    - 0-66 Access to Quick Menu w/o Password
    - 0-67 Bus Password Access
    - 0-68 Safety Parameters Password
    - 0-69 Password Protection of Safety Parameters
- **1-** Load and Motor**
  - **1-0* General Settings**
    - 1-00 Configuration Mode
    - 1-01 Motor Control Principle
    - 1-02 Flux Motor Feedback Source
    - 1-03 Torque Characteristics
    - 1-04 Overload Mode
    - 1-05 Local Mode Configuration
    - 1-06 Clockwise Direction
    - 1-07 Motor Angle Offset Adjust
  - **1-1* Special Settings**
    - 1-10 Motor Construction
    - 1-11 Motor Model
    - 1-14 Damping Gain
    - 1-15 Low Speed Filter Time Const.
    - 1-16 High Speed Filter Time Const.
    - 1-17 Voltage filter time const.
    - 1-18 Min. Current at No Load
  - **1-2* Motor Data**
    - 1-20 Motor Power [kW]
    - 1-21 Motor Power [HP]
    - 1-22 Motor Voltage
    - 1-24 Motor Current
    - 1-25 Motor Nominal Speed
    - 1-26 Motor Cont. Rated Torque
    - 1-29 Automatic Motor Adaptation (AMA)
  - **1-3* Adv. Motor Data**
    - 1-30 Stator Resistance (Rs)
    - 1-31 Rotor Resistance (Rr)
    - 1-33 Stator Leakage Reactance (X1)
    - 1-34 Rotor Leakage Reactance (X2)
    - 1-35 Main Reactance (Xh)
    - 1-36 Iron Loss Resistance (Rfe)
    - 1-37 d-axis Inductance (Ld)
    - 1-38 q-axis Inductance (Lq)
    - 1-39 Motor Poles
    - 1-40 Back EMF at 1000 RPM
    - 1-41 Motor Angle Offset
    - 1-44 d-axis Inductance Sat. (LdSat)
    - 1-45 q-axis Inductance Sat. (LqSat)
    - 1-46 Position Detection Gain
    - 1-47 Torque Calibration
    - 1-48 Inductance Sat. Point
  - **1-5* Load Indep. Setting**
    - 1-50 Motor Magnetisation at Zero Speed
    - 1-51 Min Speed Normal Magnetising [RPM]
    - 1-52 Min Speed Normal Magnetising [Hz]
    - 1-53 Model Shift Frequency
    - 1-54 Voltage reduction in fieldweakening
    - 1-55 U/f Characteristic - U
    - 1-56 U/f Characteristic - F
    - 1-58 Flying Start Test Pulses Current
    - 1-59 Flying Start Test Pulses Frequency
  - **1-6* Load Depen. Setting**
    - 1-60 Low Speed Load Compensation
    - 1-61 High Speed Load Compensation
    - 1-62 Slip Compensation
    - 1-63 Slip Compensation Time Constant
    - 1-64 Resonance Damping
    - 1-65 Resonance Damping Time Constant
    - 1-66 Min. Current at Low Speed
    - 1-67 Load Type
    - 1-68 Motor Inertia
    - 1-69 System Inertia
  - **1-7* Start Adjustments**
    - 1-70 PM Start Mode
    - 1-71 Start Delay
    - 1-72 Start Function
    - 1-73 Flying Start
    - 1-74 Start Speed [RPM]
    - 1-75 Start Speed [Hz]
    - 1-76 Start Current
  - **1-8* Stop Adjustments**
    - 1-80 Function at Stop
    - 1-81 Min Speed for Function at Stop [RPM]
    - 1-82 Min Speed for Function at Stop [Hz]
    - 1-83 Precise Stop Function
    - 1-84 Precise Stop Counter Value
    - 1-85 Precise Stop Speed Compensation Delay
  - **1-9* Motor Temperature**
    - 1-90 Motor Thermal Protection
    - 1-91 Motor External Fan
    - 1-93 Thermistor Resource
    - 1-94 ATEX ETR cur.lim. speed reduction
    - 1-95 KTY Sensor Type
    - 1-96 KTY Thermistor Resource
    - 1-97 KTY Threshold level
    - 1-98 ATEX ETR interpol. points freq.
    - 1-99 ATEX ETR interpol points current
- **2-** Brakes**
  - **2-0* DC-Brake**
    - 2-00 DC Hold Current
    - 2-01 DC Brake Current
    - 2-02 DC Braking Time
    - 2-03 DC Brake Cut In Speed [RPM]
    - 2-04 DC Brake Cut In Speed [Hz]
    - 2-05 Maximum Reference
    - 2-06 Parking Current
    - 2-07 Parking Time
  - **2-1* Brake Energy Funct.**
    - 2-10 Brake Function
    - 2-11 Brake Resistor (ohm)
    - 2-12 Brake Power Limit (kW)
    - 2-13 Brake Power Monitoring
    - 2-15 Brake Check
    - 2-16 AC brake Max. Current
    - 2-17 Over-voltage Control
    - 2-18 Brake Check Condition
    - 2-19 Over-voltage Gain
  - **2-2* Mechanical Brake**
    - 2-20 Release Brake Current
    - 2-21 Activate Brake Speed [RPM]
    - 2-22 Activate Brake Speed [Hz]
    - 2-23 Activate Brake Delay
    - 2-24 Stop Delay
    - 2-25 Brake Release Time
    - 2-26 Torque Ref
    - 2-27 Torque Ramp Up Time
    - 2-28 Gain Boost Factor
    - 2-29 Torque Ramp Down Time
  - **2-3* Adv. Mech Brake**
    - 2-30 Position P Start Proportional Gain
    - 2-31 Speed PID Start Proportional Gain
    - 2-32 Speed PID Start Integral Time
    - 2-33 Speed PID Start Lowpass Filter Time
- **3-** Reference / Ramps**
  - **3-0* Reference Limits**
    - 3-00 Reference Range
    - 3-01 Reference/Feedback Unit
    - 3-02 Minimum Reference
    - 3-03 Maximum Reference
    - 3-04 Reference Function
  - **3-1* References**
    - 3-10 Preset Reference
    - 3-11 Jog Speed [Hz]
    - 3-12 Catch up/slow Down Value
    - 3-13 Reference Site
    - 3-14 Preset Relative Reference
    - 3-15 Reference Resource 1
    - 3-16 Reference Resource 2
    - 3-17 Reference Resource 3
    - 3-18 Relative Scaling Reference Resource
    - 3-19 Jog Speed [RPM]
  - **3-4* Ramp 1**
    - 3-40 Ramp 1 Type
    - 3-41 Ramp 1 Ramp Up Time
    - 3-42 Ramp 1 Ramp Down Time
    - 3-45 Ramp 1 S-ramp Ratio at Accel. Start
    - 3-46 Ramp 1 S-ramp Ratio at Accel. End
    - 3-47 Ramp 1 S-ramp Ratio at Decel. Start
    - 3-48 Ramp 1 S-ramp Ratio at Decel. End
  - **3-5* Ramp 2**
    - 3-50 Ramp 2 Type
    - 3-51 Ramp 2 Ramp Up Time
    - 3-52 Ramp 2 Ramp Down Time
    - 3-55 Ramp 2 S-ramp Ratio at Accel. Start
    - 3-56 Ramp 2 S-ramp Ratio at Accel. End
    - 3-57 Ramp 2 S-ramp Ratio at Decel. Start
    - 3-58 Ramp 2 S-ramp Ratio at Decel. End
  - **3-6* Ramp 3**
    - 3-60 Ramp 3 Type
    - 3-61 Ramp 3 Ramp up Time
    - 3-62 Ramp 3 Ramp down Time
    - 3-65 Ramp 3 S-ramp Ratio at Accel. Start
    - 3-66 Ramp 3 S-ramp Ratio at Accel. End
    - 3-67 Ramp 3 S-ramp Ratio at Decel. Start
    - 3-68 Ramp 3 S-ramp Ratio at Decel. End
  - **3-7* Ramp 4**
    - 3-70 Ramp 4 Type
    - 3-71 Ramp 4 Ramp up Time
    - 3-72 Ramp 4 Ramp Down Time
    - 3-75 Ramp 4 S-ramp Ratio at Accel. Start
    - 3-76 Ramp 4 S-ramp Ratio at Accel. End
    - 3-77 Ramp 4 S-ramp Ratio at Decel. Start
    - 3-78 Ramp 4 S-ramp Ratio at Decel. End
  - **3-8* Other Ramps**
    - 3-80 Jog Ramp Time
    - 3-81 Quick Stop Ramp Time
    - 3-82 Quick Stop Ramp Type
    - 3-83 Quick Stop S-ramp Ratio at Decel. Start
    - 3-84 Quick Stop S-ramp Ratio at Decel. End
    - 3-89 Ramp Lowpass Filter Time
  - **3-9* Digital Pot.Meter**
    - 3-90 Step Size
    - 3-91 Ramp Time
    - 3-92 Power Restore
    - 3-93 Maximum Limit
    - 3-94 Minimum Limit
    - 3-95 Ramp Delay
- **4-** Limits / Warnings**
  - **4-1* Motor Limits**
    - 4-10 Motor Speed Direction
    - 4-11 Motor Speed Low Limit [RPM]
    - 4-12 Motor Speed Low Limit [Hz]
    - 4-13 Motor Speed High Limit [RPM]
    - 4-14 Motor Speed High Limit [Hz]
    - 4-16 Torque Limit Motor Mode
    - 4-17 Torque Limit Generator Mode
    - 4-18 Current Limit
    - 4-19 Max Output Frequency
  - **4-2* Limit Factors**
    - 4-20 Torque Limit Factor Source
    - 4-21 Speed Limit Factor Source
    - 4-23 Brake Check Limit Factor Source
    - 4-24 Brake Check Limit Factor
  - **4-3* Motor Speed Mon.**
    - 4-30 Motor Feedback Loss Function
    - 4-31 Motor Feedback Speed Error
    - 4-32 Motor Feedback Loss Timeout
    - 4-34 Tracking Error Function
    - 4-35 Tracking Error
    - 4-36 Tracking Error Timeout
    - 4-37 Tracking Error Ramping
    - 4-38 Tracking Error Ramping Timeout
    - 4-39 Tracking Error After Ramping Timeout
  - **4-4* Speed Monitor**
    - 4-43 Motor Speed Monitor Function
    - 4-44 Motor Speed Monitor Max
    - 4-45 Motor Speed Monitor Timeout
  - **4-5* Adj. Warnings**
    - 4-50 Warning Current Low
    - 4-51 Warning Current High
    - 4-52 Warning Speed Low
    - 4-53 Warning Speed High
    - 4-54 Warning Reference Low
    - 4-55 Warning Reference High
    - 4-56 Warning Feedback Low
    - 4-57 Warning Feedback High
    - 4-58 Missing Motor Phase Function
    - 4-59 Motor Check At Start
  - **4-6* Speed Bypass**
    - 4-60 Bypass Speed From [RPM]
    - 4-61 Bypass Speed From [Hz]
    - 4-62 Bypass Speed To [RPM]
    - 4-63 Bypass Speed To [Hz]
- **5-** Digital In/Out**
  - **5-0* Digital I/O mode**
    - 5-00 Digital I/O Mode
    - 5-01 Terminal 27 Mode
    - 5-02 Terminal 29 Mode
  - **5-1* Digital Inputs**
    - 5-10 Terminal 18 Digital Input
    - 5-11 Terminal 19 Digital Input
    - 5-12 Terminal 27 Digital Input
    - 5-13 Terminal 29 Digital Input
    - 5-14 Terminal 32 Digital Input

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5-15	Terminal 33 Digital Input
5-16	Terminal X30/2 Digital Input
5-17	Terminal X30/3 Digital Input
5-18	Terminal X30/4 Digital Input
5-19	Terminal 37 Safe Stop
5-20	Terminal X46/1 Digital Input
5-21	Terminal X46/3 Digital Input
5-22	Terminal X46/5 Digital Input
5-23	Terminal X46/7 Digital Input
5-24	Terminal X46/9 Digital Input
5-25	Terminal X46/11 Digital Input
5-26	Terminal X46/13 Digital Input
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-7*	**24V Encoder Input**
5-70	Term 32/33 Pulses Per Revolution
5-71	Term 32/33 Encoder Direction
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-1*	**Analog Input 1**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-2*	**Analog Input 2**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-3*	**Analog Input 3**
6-30	Terminal X30/11 Low Voltage
6-31	Terminal X30/11 High Voltage
6-34	Term. X30/11 Low Ref./Feedb. Value
6-35	Term. X30/11 High Ref./Feedb. Value
6-36	Term. X30/11 Filter Time Constant
6-4*	**Analog Input 4**
6-40	Terminal X30/12 Low Voltage
6-41	Terminal X30/12 High Voltage
6-44	Term. X30/12 Low Ref./Feedb. Value
6-45	Term. X30/12 High Ref./Feedb. Value
6-46	Term. X30/12 Filter Time Constant
6-5*	**Analog Output 1**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
6-52	Terminal 42 Output Max Scale
6-53	Term 42 Output Bus Ctrl
6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter
6-6*	**Analog Output 2**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
6-62	Terminal X30/8 Max. Scale
6-63	Terminal X30/8 Bus Control
6-64	Terminal X30/8 Output Timeout Preset
6-7*	**Analog Output 3**
6-70	Terminal X45/1 Output
6-71	Terminal X45/1 Min. Scale
6-72	Terminal X45/1 Max. Scale
6-73	Terminal X45/1 Bus Control
6-74	Terminal X45/1 Output Timeout Preset
6-8*	**Analog Output 4**
6-80	Terminal X45/3 Output
6-81	Terminal X45/3 Min. Scale
6-82	Terminal X45/3 Max. Scale
6-83	Terminal X45/3 Bus Control
6-84	Terminal X45/3 Output Timeout Preset
7-**	**Controllers**
7-0*	**Speed PID Ctrl.**
7-00	Speed PID Feedback Source
7-01	Speed PID Droop
7-02	Speed PID Proportional Gain
7-03	Speed PID Integral Time
7-04	Speed PID Differentiation Time
7-05	Speed PID Diff. Gain Limit
7-06	Speed PID Lowpass Filter Time
7-07	Speed PID Feedback Gear Ratio
7-08	Speed PID Feed Forward Factor
7-09	Speed PID Error Correction w/ Ramp
7-1*	**Torque PI Ctrl.**
7-10	Torque PI Feedback Source
7-12	Torque PI Proportional Gain
7-13	Torque PI Integration Time
7-16	Torque PI Lowpass Filter Time
7-18	Torque PI Feed Forward Factor
7-19	Current Controller Rise Time
7-2*	**Process Ctrl. Feedb**
7-20	Process CL Feedback 1 Resource
7-22	Process CL Feedback 2 Resource
7-3*	**Process PID Ctrl.**
7-30	Process PID Normal/ Inverse Control
7-31	Process PID Anti Windup
7-32	Process PID Start Speed
7-33	Process PID Proportional Gain
7-34	Process PID Integral Time
7-35	Process PID Differentiation Time
7-36	Process PID Diff. Gain Limit
7-38	Process PID Feed Forward Factor
7-39	On Reference Bandwidth
7-4*	**Adv. Process PID I**
7-40	Process PID I-part Reset
7-41	Process PID Output Neg. Clamp
7-42	Process PID Output Pos. Clamp
7-43	Process PID Gain Scale at Min. Ref.
7-44	Process PID Gain Scale at Max. Ref.
7-45	Process PID Feed Fwd Resource
7-46	Process PID Feed Fwd Normal/ Inv. Ctrl.
7-48	PCD Feed Forward
7-49	Process PID Output Normal/ Inv. Ctrl.
7-5*	**Adv. Process PID II**
7-50	Process PID Extended PID
7-51	Process PID Feed Fwd Gain
7-52	Process PID Feed Fwd Ramp up
7-53	Process PID Feed Fwd Ramp down
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8-8*	**FC Port Diagnostics**
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8-90	Bus Jog 1 Speed
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10-1*	**DeviceNet**
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30-80 d-axis Inductance (Ld)
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32-30 Incremental Signal Type
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32-32 Absolute Protocol
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32-35 Absolute Encoder Data Length
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32-43 Enc.1 Control
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32-6* PID Controller
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33-21 Master Marker Tolerance Window
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34-07 PCD 7 Write to MCO
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34-21 PCD 1 Read from MCO
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35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
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35-44 Term. X48/2 Low Ref./Feedb. Value
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