Operating Guide
VLT® HVAC Basic Drive FC 101

Contents

1 Introduction

1.1 Purpose of the Operating Guide

The operating guide provides information for safe instal-
lation and commissioning of the frequency converter.

The operating guide is intended for use by qualified
personnel.
Read and follow the operating guide to use the frequency
converter safely and professionally, and pay particular
attention to the safety instructions and general warnings.
Keep this operating guide available with the frequency
converter at all times.
VLT® is a registered trademark.

1.2 Additional Resources

- *VLT® HVAC Basic Drive FC 101 Programming Guide*
  provides information on how to program and
  includes complete parameter descriptions.

- *VLT® HVAC Basic Drive FC 101 Design Guide*
  provides all technical information about the
  frequency converter, customer design, and
  applications. It also lists options and accessories.

The technical documentation is available in electronic form
online at *www.danfoss.com/en/search/?filter=type
%3Adocumentation*.

MCT 10 Set-up Software support
Download the software from *www.danfoss.com/en/service-
and-support/downloads/dds/vlt-motion-control-tool-mct-10/*.

During the installation process of the software, enter
access code 81463800 to activate the FC 101 functionality.
A license key is not required for using the FC 101
functionality.

The latest software does not always contain the latest
updates for frequency converters. Contact the local sales
office for the latest frequency converter updates (in the
form of *.upd files), or download the frequency converter
updates from *www.danfoss.com/en/service-and-support/
downloads/dds/vlt-motion-control-tool-mct-10/#Overview*.

1.3 Document and Software Version

The operating guide is regularly reviewed and updated. All
suggestions for improvement are welcome.

Edition	Remarks	Software version
MG18AAxx	Update due to new SW & HW version.	4.2x

From software version 4.0x and later (production week 33
2017 and after), the variable speed heat sink cooling fan
function is implemented in the frequency converter for
power sizes 22 kW (30 hp) 400 V IP20 and below, and 18.5
kW (25 hp) 400 V IP54 and below. This function requires
software and hardware updates and introduces restrictions
with regards to backwards compatibility for H1–H5 and I2–
I4 enclosure sizes. Refer to *Table 1.1* for the limitations.

Software compatibility	Old control card (production week 33 2017 or before)	New control card (production week 34 2017 or after)
Old software (OSS-file version 3.xx and below)	Yes	No
New software (OSS-file version 4.xx or higher)	No	Yes
Hardware compatibility	**Old control card (production week 33 2017 or before)**	**New control card (production week 34 2017 or after)**
Old power card (production week 33 2017 or before)	Yes (only software version 3.xx or below)	Yes (MUST update software to version 4.xx or higher)
New power card (production week 34 2017 or after)	Yes (MUST update software to version 3.xx or below, the fan continuously runs at full speed)	Yes (only software version 4.xx or higher)

Table 1.1 Software and Hardware Compatibility

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1.4 Certificates and Approvals

Certification		IP20	IP54
EC Declaration of Conformity	CE	✓	✓
UL Listed	c (UL) US	✓	–
RCM		✓	✓
EAC	EAC	✓	✓
UkrSEPRO	089	✓	✓

Table 1.2 Certificates and Approvals

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

1.5 Disposal

	Equipment containing electrical components must not be disposed of together with domestic waste. It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

2 Safety

2.1 Safety Symbols

The following symbols are used in this document:

⚠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 or operate this equipment.

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

2.3 Safety

⚠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.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the frequency converter.

⚠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. Start the motor with an external switch, a fieldbus command, an input reference signal from the local control panel (LCP), via remote operation using MCT 10 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.
- Ensure that the frequency converter is fully wired and assembled when it is connected to AC mains, DC supply, or load sharing.

⚠WARNING

DISCHARGE TIME

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

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

2

Voltage [V]	Power range [kW (hp)]	Minimum waiting time (minutes)
3x200	0.25–3.7 (0.33–5)	4
3x200	5.5–11 (7–15)	15
3x400	0.37–7.5 (0.5–10)	4
3x400	11–90 (15–125)	15
3x600	2.2–7.5 (3–10)	4
3x600	11–90 (15–125)	15

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠WARNING

EQUIPMENT HAZARD

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

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**

- **Ensure that electrical work conforms to national and local electrical codes.**

- **Follow the procedures in this manual.**

⚠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.**

2.4 Motor Thermal Protection

Set *parameter 1-90 Motor Thermal Protection* to *[4] ETR trip 1* to enable the motor thermal protection function.

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3 Installation

3.1 Mechanical Installation

3.1.1 Side-by-side Installation

The frequency converter can be mounted side by side but requires the clearance above and below for cooling.

Size	IP class	Power [kW (hp)]			Clearance above/below [mm (in)]
		3x200–240 V	3x380–480 V	3x525–600 V	
H1	IP20	0.25–1.5 (0.33–2)	0.37–1.5 (0.5–2)	–	100 (4)
H2	IP20	2.2 (3)	2.2–4 (3–5)	–	100 (4)
H3	IP20	3.7 (5)	5.5–7.5 (7.5–10)	–	100 (4)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	–	100 (4)
H5	IP20	11 (15)	18.5–22 (25–30)	–	100 (4)
H6	IP20	15–18.5 (20–25)	30–45 (40–60)	18.5–30 (25–40)	200 (7.9)
H7	IP20	22–30 (30–40)	55–75 (70–100)	37–55 (50–70)	200 (7.9)
H8	IP20	37–45 (50–60)	90 (125)	75–90 (100–125)	225 (8.9)
H9	IP20	–	–	2.2–7.5 (3–10)	100 (4)
H10	IP20	–	–	11–15 (15–20)	200 (7.9)
I2	IP54	–	0.75–4.0 (1–5)	–	100 (4)
I3	IP54	–	5.5–7.5 (7.5–10)	–	100 (4)
I4	IP54	–	11–18.5 (15–25)	–	100 (4)
I6	IP54	–	22–37 (30–50)	–	200 (7.9)
I7	IP54	–	45–55 (60–70)	–	200 (7.9)
I8	IP54	–	75–90 (100–125)	–	225 (8.9)

Table 3.1 Clearance Required for Cooling

NOTICE!

With IP21/NEMA Type1 option kit mounted, a distance of 50 mm (2 in) between the units is required.

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3.1.2 Frequency Converter Dimensions

Size	IP class	Power [kW (hp)]			Height [mm (in)]		a	Width [mm (in)]		Depth [mm (in)]	Mounting hole [mm (in)]			Maximum weight kg (lb)
		3x200–240 V	3x380–480 V	3x525–600 V	A	A[1]		B	b	C	d	e	f	
H1	IP20	0.25–1.5 (0.33–2.0)	0.37–1.5 (0.5–2.0)	–	195 (7.7)	273 (10.7)	183 (7.2)	75 (3.0)	56 (2.2)	168 (6.6)	9 (0.35)	4.5 (0.18)	5.3 (0.21)	2.1 (4.6)
H2	IP20	2.2 (3.0)	2.2–4.0 (3.0–5.0)	–	227 (8.9)	303 (11.9)	212 (8.3)	90 (3.5)	65 (2.6)	190 (7.5)	11 (0.43)	5.5 (0.22)	7.4 (0.29)	3.4 (7.5)
H3	IP20	3.7 (5.0)	5.5–7.5 (7.5–10)	–	255 (10.0)	329 (13.0)	240 (9.4)	100 (3.9)	74 (2.9)	206 (8.1)	11 (0.43)	5.5 (0.22)	8.1 (0.32)	4.5 (9.9)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	–	296 (11.7)	359 (14.1)	275 (10.8)	135 (5.3)	105 (4.1)	241 (9.5)	12.6 (0.50)	7 (0.28)	8.4 (0.33)	7.9 (17.4)
H5	IP20	11 (15)	18.5–22 (25–30)	–	334 (13.1)	402 (15.8)	314 (12.4)	150 (5.9)	120 (4.7)	255 (10)	12.6 (0.50)	7 (0.28)	8.5 (0.33)	9.5 (20.9)
H6	IP20	15–18.5 (20–25)	30–45 (40–60)	18.5–30 (25–40)	518 (20.4)	595 (23.4)/635 (25), 45 kW	495 (19.5)	239 (9.4)	200 (7.9)	242 (9.5)	–	8.5 (0.33)	15 (0.6)	24.5 (54)
H7	IP20	22–30 (30–40)	55–75 (70–100)	37–55 (50–70)	550 (21.7)	630 (24.8)/690 (27.2), 75 kW	521 (20.5)	313 (12.3)	270 (10.6)	335 (13.2)	–	8.5 (0.33)	17 (0.67)	36 (79)
H8	IP20	37–45 (50–60)	90 (125)	75–90 (100–125)	660 (26)	800 (31.5)	631 (24.8)	375 (14.8)	330 (13)	335 (13.2)	–	8.5 (0.33)	17 (0.67)	51 (112)
H9	IP20	–	–	2.2–7.5 (3.0–10)	269 (10.6)	374 (14.7)	257 (10.1)	130 (5.1)	110 (4.3)	205 (8.0)	11 (0.43)	5.5 (0.22)	9 (0.35)	6.6 (14.6)
H10	IP20	–	–	11–15 (15–20)	399 (15.7)	419 (16.5)	380 (15)	165 (6.5)	140 (5.5)	248 (9.8)	12 (0.47)	6.8 (0.27)	7.5 (0.30)	12 (26.5)

1) Including decoupling plate

The dimensions are only for the physical units.

NOTICE!
When installing in an application, allow space above and below the units for cooling. The amount of space for free air passage is listed in *Table 3.1*.

Table 3.2 Dimensions, Enclosure Sizes H1–H10

Enclosure		Power [kW (hp)]			Height [mm (in)]		a	Width [mm (in)]		Depth [mm (in)]	Mounting hole [mm (in)]			Maximum weight
Size	IP class	3x200–240 V	3x380–480 V	3x525–600 V	A	A[1]	a	B	b	C	d	e	f	kg (lb)
I2	IP54	–	0.75–4.0 (1.0–5.0)	–	332 (13.1)	–	318.5 (12.53)	115 (4.5)	74 (2.9)	225 (8.9)	11 (0.43)	5.5 (0.22)	9 (0.35)	5.3 (11.7)
I3	IP54	–	5.5–7.5 (7.5–10)	–	368 (14.5)	–	354 (13.9)	135 (5.3)	89 (3.5)	237 (9.3)	12 (0.47)	6.5 (0.26)	9.5 (0.37)	7.2 (15.9)
I4	IP54	–	11–18.5 (15–25)	–	476 (18.7)	–	460 (18.1)	180 (7.0)	133 (5.2)	290 (11.4)	12 (0.47)	6.5 (0.26)	9.5 (0.37)	13.8 (30.42)
I6	IP54	–	22–37 (30–50)	–	650 (25.6)	–	624 (24.6)	242 (9.5)	210 (8.3)	260 (10.2)	19 (0.75)	9 (0.35)	9 (0.35)	27 (59.5)
I7	IP54	–	45–55 (60–70)	–	680 (26.8)	–	648 (25.5)	308 (12.1)	272 (10.7)	310 (12.2)	19 (0.75)	9 (0.35)	9.8 (0.39)	45 (99.2)
I8	IP54	–	75–90 (100–125)	–	770 (30)	–	739 (29.1)	370 (14.6)	334 (13.2)	335 (13.2)	19 (0.75)	9 (0.35)	9.8 (0.39)	65 (143.3)

1) Including decoupling plate

The dimensions are only for the physical units.

NOTICE

When installing in an application, allow space above and below the units for cooling. The amount of space for free air passage is listed in *Table 3.1*.

Table 3.3 Dimensions, Enclosure Sizes I2–I8

3

3.2 Electrical Installation

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper conductors are required. 75 °C (167 °F) is recommended.

Power [kW (hp)]				Torque [Nm (in-lb)]					
Enclosure size	IP class	3x200–240 V	3x380–480 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
H1	IP20	0.25–1.5 (0.33–2.0)	0.37–1.5 (0.5–2.0)	0.8 (7.0)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
H2	IP20	2.2 (3.0)	2.2–4.0 (3.0–5.0)	0.8 (7.0)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
H3	IP20	3.7 (5.0)	5.5–7.5 (7.5–10)	0.8 (7.0)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
H5	IP20	11 (15)	18.5–22 (25–30)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
H6	IP20	15–18.5 (20–25)	30–45 (40–60)	4.5 (40)	4.5 (40)	–	0.5 (4.0)	3 (27)	0.5 (4.0)
H7	IP20	22–30 (30–40)	55 (70)	10 (89)	10 (89)	–	0.5 (4.0)	3 (27)	0.5 (4.0)
H7	IP20	–	75 (100)	14 (124)	14 (124)	–	0.5 (4.0)	3 (27)	0.5 (4.0)
H8	IP20	37–45 (50–60)	90 (125)	24 (212)[1]	24 (212)[1]	–	0.5 (4.0)	3 (27)	0.5 (4.0)

Table 3.4 Tightening Torques for Enclosure Sizes H1–H8, 3x200–240 V and 3x380–480 V

Power [kW (hp)]			Torque [Nm (in-lb)]					
Enclosure size	IP class	3x380–480 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
I2	IP54	0.75–4.0 (1.0–5.0)	0.8 (7.0)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
I3	IP54	5.5–7.5 (7.5–10)	0.8 (7.0)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
I4	IP54	11–18.5 (15–25)	1.4 (12)	0.8 (7.0)	0.8 (7.0)	0.5 (4.0)	0.8 (7.0)	0.5 (4.0)
I6	IP54	22–37 (30–50)	4.5 (40)	4.5 (40)	–	0.5 (4.0)	3 (27)	0.6 (5.0)
I7	IP54	45–55 (60–70)	10 (89)	10 (89)	–	0.5 (4.0)	3 (27)	0.6 (5.0)
I8	IP54	75–90 (100–125)	14 (124)/24 (212)[2]	14 (124)/24 (212)[2]	–	0.5 (4.0)	3 (27)	0.6 (5.0)

Table 3.5 Tightening Torques for Enclosure Sizes I2–I8

Power [kW (hp)]			Torque [Nm (in-lb)]					
Enclosure size	IP class	3x525–600 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
H9	IP20	2.2–7.5 (3.0–10)	1.8 (16)	1.8 (16)	Not recommended	0.5 (4.0)	3 (27)	0.6 (5.0)
H10	IP20	11–15 (15–20)	1.8 (16)	1.8 (16)	Not recommended	0.5 (4.0)	3 (27)	0.6 (5.0)
H6	IP20	18.5–30 (25–40)	4.5 (40)	4.5 (40)	–	0.5 (4.0)	3 (27)	0.5 (4.0)
H7	IP20	37–55 (50–70)	10 (89)	10 (89)	–	0.5 (4.0)	3 (27)	0.5 (4.0)
H8	IP20	75–90 (100–125)	14 (124)/24 (212)[2]	14 (124)/24 (212)[2]	–	0.5 (4.0)	3 (27)	0.5 (4.0)

Table 3.6 Tightening Torques for Enclosure Sizes H6–H10, 3x525–600 V

1) Cable dimensions >95 mm²

2) Cable dimensions ≤95 mm²

3.2.1 IT Mains

⚠CAUTION

IT Mains

Installation on isolated mains source, that is, IT mains. Ensure that the supply voltage does not exceed 440 V (3x380–480 V units) when connected to mains.

On IP20, 200–240 V, 0.25–11 kW (0.33–15 hp) and 380–480 V, IP20, 0.37–22 kW (0.5–30 hp) units, open the RFI switch by removing the screw on the side of the frequency converter when at IT grid.
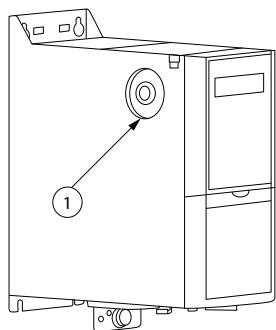
| 1 | EMC screw |

Figure 3.1 IP20, 200–240 V, 0.25–11 kW (0.33–15 hp), IP20, 0.37–22 kW (0.5–30 hp), 380–480 V

On 400 V, 30–90 kW (40–125 hp) and 600 V units, set *parameter 14-50 RFI Filter* to *[0] Off* when operating in IT mains.

For IP54, 400 V, 0.75–18.5 kW (1.0–25 hp) units, the EMC screw is inside the frequency converter, as shown in *Figure 3.2*.
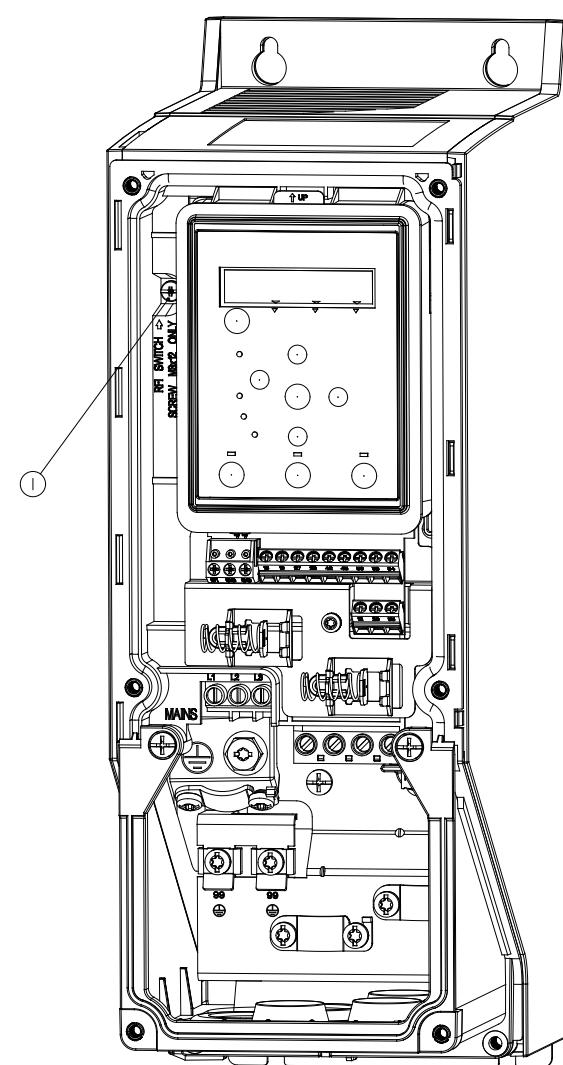
| 1 | EMC screw |

Figure 3.2 IP54, 400 V, 0.75–18.5 kW (1.0–25 hp)

NOTICE!

If reinserted, use only M3x12 screw.

3

3.2.2 Connecting to Mains and Motor

The frequency converter is designed to operate all standard 3-phase asynchronous motors. For maximum cross-section on cables, see *chapter 6.4 General Technical Data*.

- Use a shielded/armored motor cable to comply with EMC emission specifications and connect this cable to both the decoupling plate and the motor.

- Keep the motor cable as short as possible to reduce the noise level and leakage currents.

- For further details on mounting the decoupling plate, see *VLT® HVAC Basic Drive Decoupling Plate Mounting Instruction*.

- Also see *EMC-Correct Installation* in the *VLT® HVAC Basic Drive FC 101 Design Guide*.

1. Mount the ground cables to the ground terminal.

2. Connect the motor to terminals U, V, and W, and then tighten the screws according to the torques specified in *chapter 3.2.1 Electrical Installation in General*.

3. Connect the mains supply to terminals L1, L2, and L3, and then tighten the screws according to the torques specified in *chapter 3.2.1 Electrical Installation in General*.

Relays and terminals on enclosure sizes H1–H5

1	Mains
2	Ground
3	Motor
4	Relays
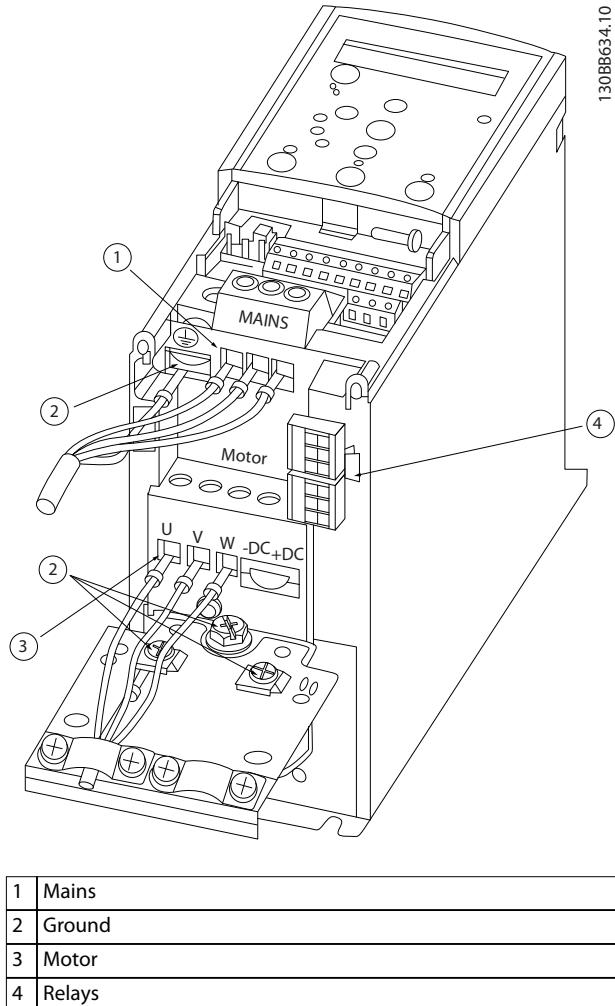
Figure 3.3 Enclosure Sizes H1–H5
IP20, 200–240 V, 0.25–11 kW (0.33–15 hp)
IP20, 380–480 V, 0.37–22 kW (0.5–30 hp)

Relays and terminals on enclosure size H6
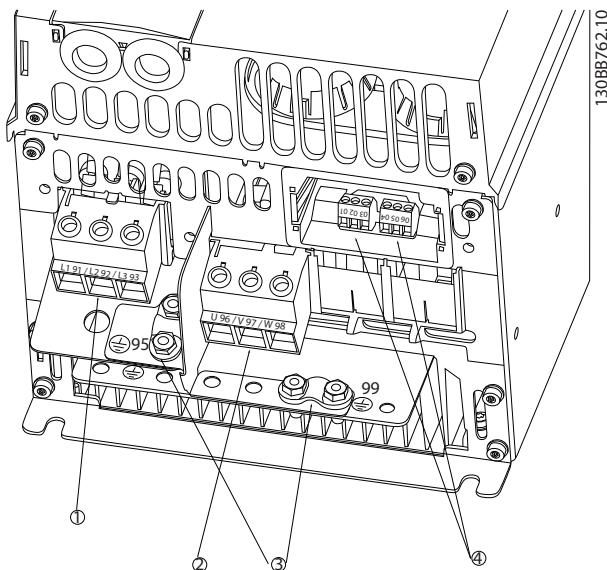
1	Mains
2	Motor
3	Ground
4	Relays

Figure 3.4 Enclosure Size H6

IP20, 380–480 V, 30–45 kW (40–60 hp)

IP20, 200–240 V, 15–18.5 kW (20–25 hp)

IP20, 525–600 V, 22–30 kW (30–40 hp)

Relays and terminals on enclosure size H7
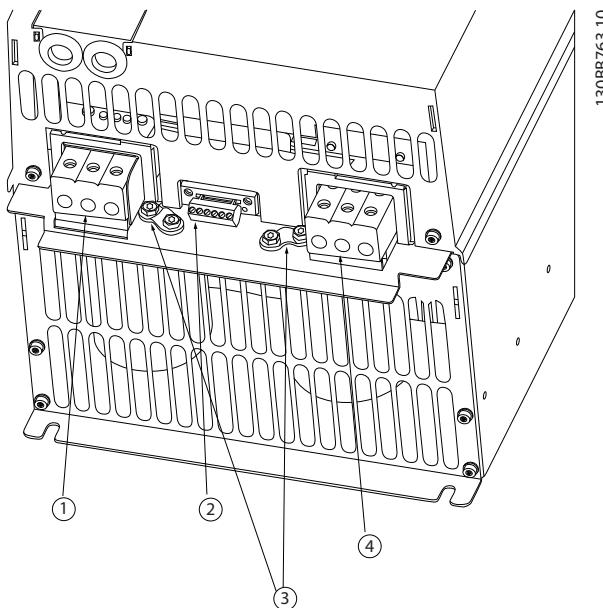
1	Mains
2	Relays
3	Ground
4	Motor

Figure 3.5 Enclosure Size H7

IP20, 380–480 V, 55–75 kW (70–100 hp)

IP20, 200–240 V, 22–30 kW (30–40 hp)

IP20, 525–600 V, 45–55 kW (60–70 hp)

3

Relays and terminals on enclosure size H8
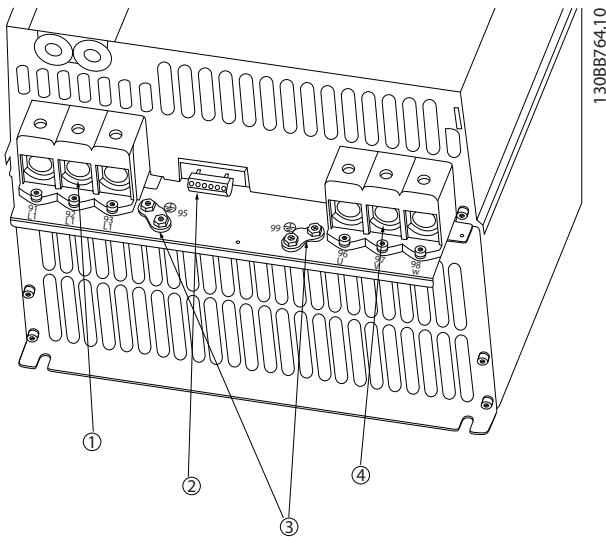
1	Mains
2	Relays
3	Ground
4	Motor

Figure 3.6 Enclosure Size H8

IP20, 380–480 V, 90 kW (125 hp)

IP20, 200–240 V, 37–45 kW (50–60 hp)

IP20, 525–600 V, 75–90 kW (100–125 hp)

Connecting to mains and motor for enclosure size H9
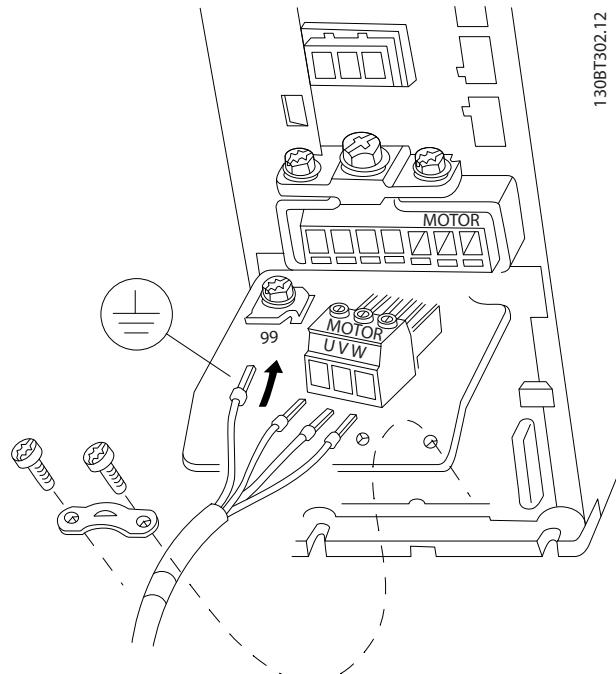
Figure 3.7 Connecting the Frequency Converter to the Motor, Enclosure Size H9

IP20, 600 V, 2.2–7.5 kW (3.0–10 hp)

3

Complete the following steps to connect the mains cables for enclosure size H9. Use the tightening torques described in *chapter 3.2.1 Electrical Installation in General*.

1. Slide the mounting plate into place and tighten the 2 screws as shown in *Figure 3.8*.
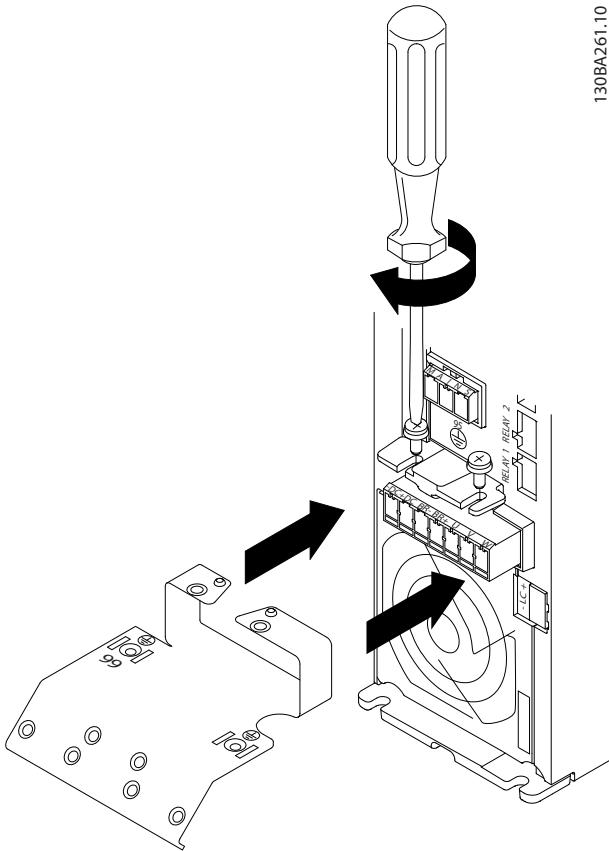
Figure 3.8 Mounting the Mounting Plate

2. Mount the ground cable as shown in *Figure 3.9*.
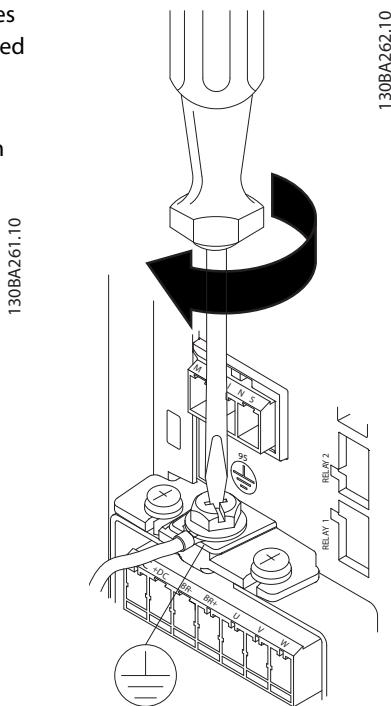
Figure 3.9 Mounting the Ground Cable

3. Insert the mains cables to the mains plug and tighten the screws as shown in *Figure 3.10*.
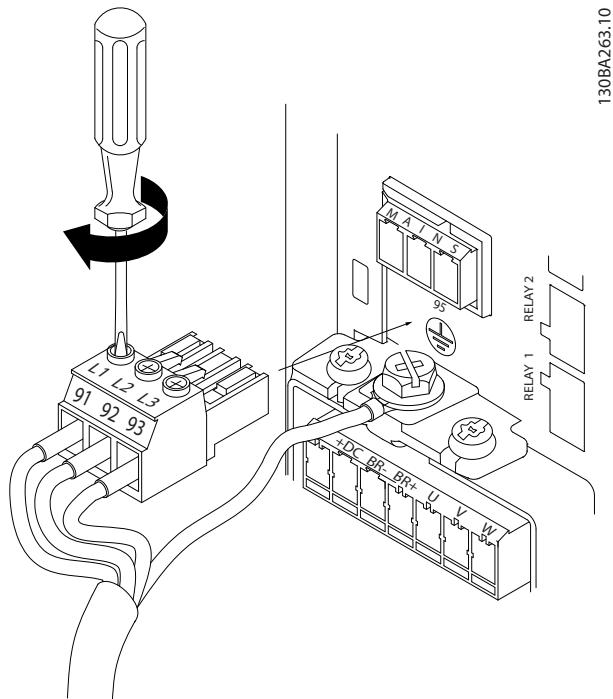
Figure 3.10 Mounting the Mains Plug

3

4. Mount the support bracket across the mains cables and tighten the screws as shown in *Figure 3.11*.

130BA264.10
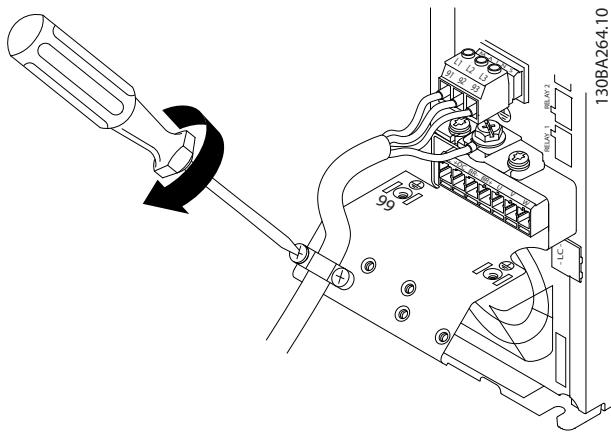
Figure 3.11 Mounting the Support Bracket

Relays and terminals on enclosure size H10

130BA725.10
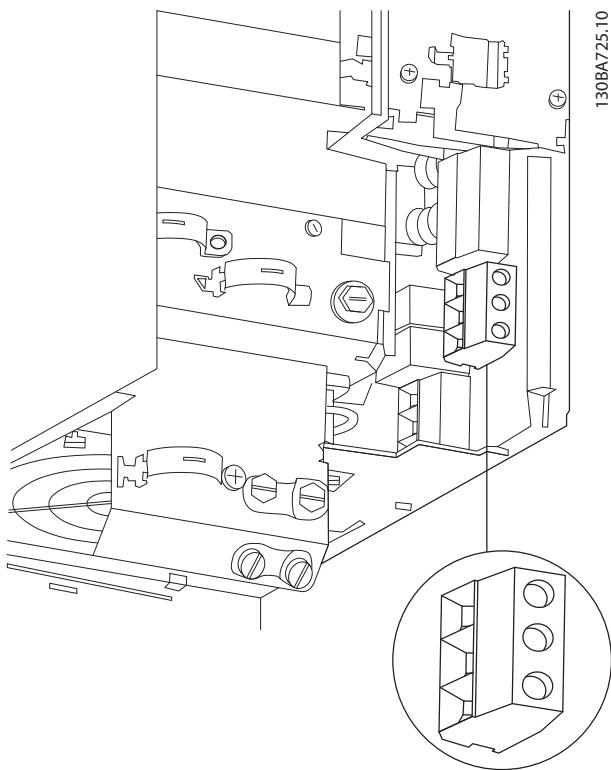
Figure 3.12 Enclosure Size H10
IP20, 600 V, 11–15 kW (15–20 hp)

Enclosure size I2

130BC299.10
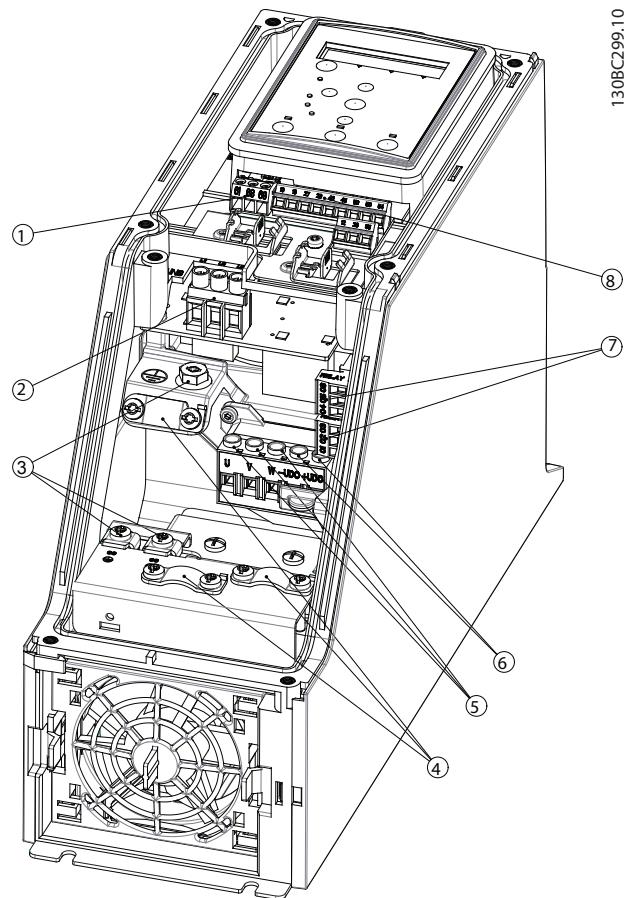
1	RS485
2	Mains
3	Ground
4	Cable clamps
5	Motor
6	UDC
7	Relays
8	I/O

Figure 3.13 Enclosure Size I2
IP54, 380–480 V, 0.75–4.0 kW (1.0–5.0 hp)

3
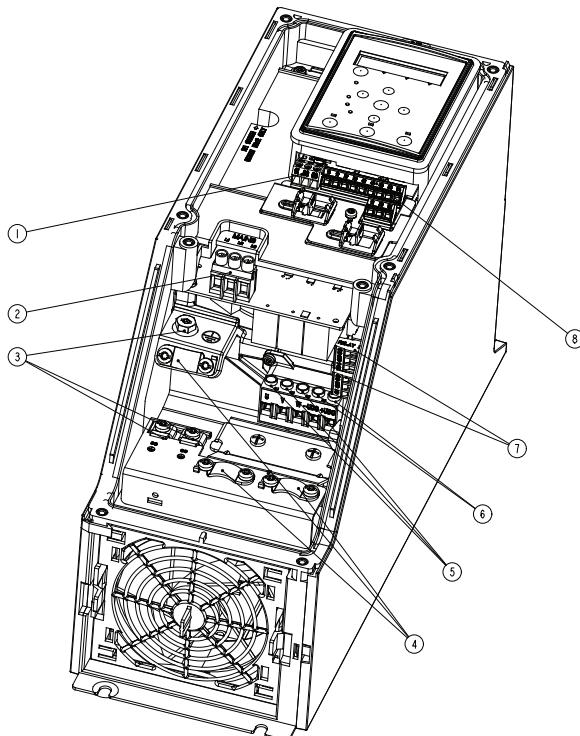
Enclosure size I3
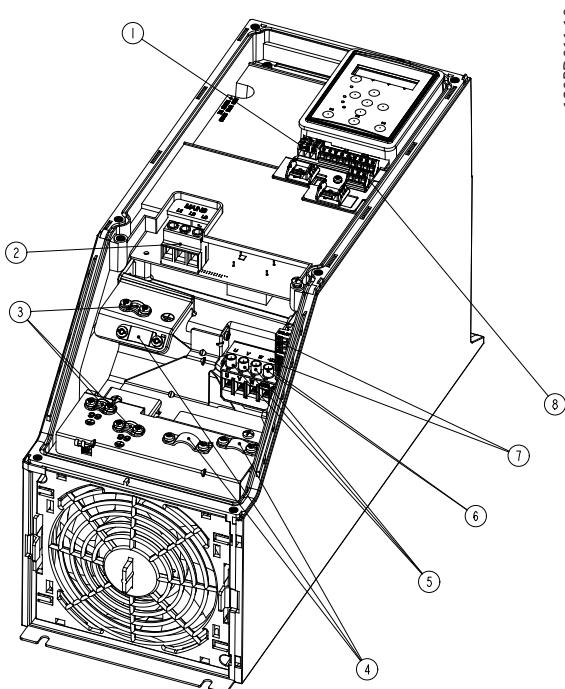
1	RS485
2	Mains
3	Ground
4	Cable clamps
5	Motor
6	UDC
7	Relays
8	I/O

Figure 3.14 Enclosure Size I3
IP54, 380–480 V, 5.5–7.5 kW (7.5–10 hp)

Enclosure size I4

1	RS485
2	Mains
3	Ground
4	Cable clamps
5	Motor
6	UDC
7	Relays
8	I/O

Figure 3.15 Enclosure Size I4
IP54, 380–480 V, 0.75–4.0 kW (1.0–5.0 hp)

3
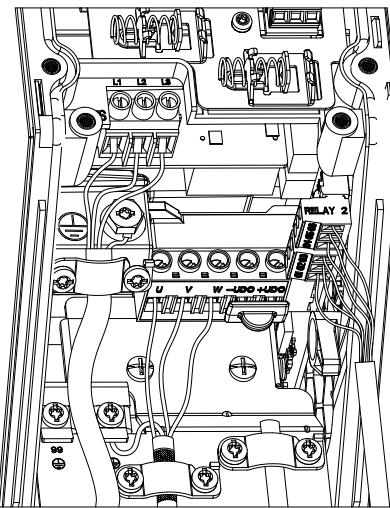
Figure 3.16 IP54 Enclosure Sizes I2, I3, I4

Enclosure size I6

Figure 3.17 Connecting to Mains for Enclosure Size I6 IP54, 380–480 V, 22–37 kW (30–50 hp)

Figure 3.18 Connecting to Motor for Enclosure Size I6 IP54, 380–480 V, 22–37 kW (30–50 hp)
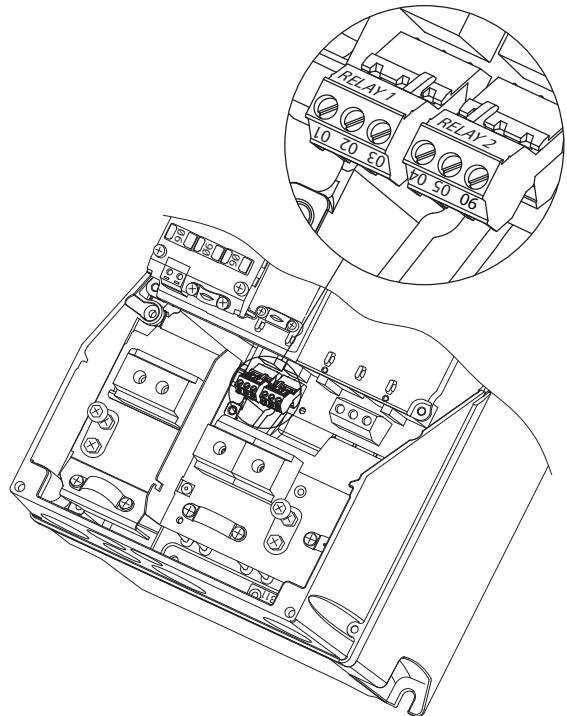
Figure 3.19 Relays on Enclosure Size I6 IP54, 380–480 V, 22–37 kW (30–50 hp)

3

Enclosure sizes I7, I8
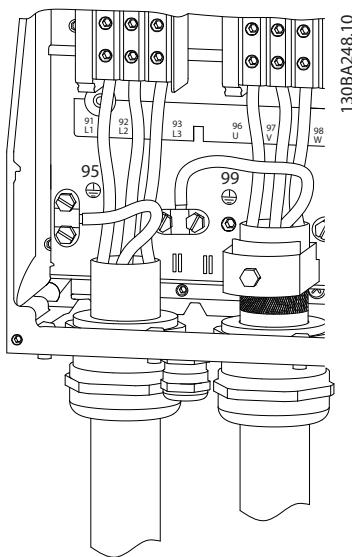
Figure 3.20 Enclosure Sizes I7, I8
IP54, 380–480 V, 45–55 kW (60–70 hp)
IP54, 380–480 V, 75–90 kW (100–125 hp)

3.2.3 Fuses and Circuit Breakers

Branch circuit protection
To prevent fire hazards, protect the branch circuits in an installation - switch gear, machines, and so on - against short circuits and overcurrent. Follow national and local regulations.

Short-circuit protection
Danfoss recommends using the fuses and circuit breakers listed in *Table 3.7* to protect service personnel or other equipment in case of an internal failure in the unit or a short circuit on the DC link. The frequency converter provides full short-circuit protection in case of a short circuit on the motor.

Overcurrent protection
Provide overload protection to avoid overheating of the cables in the installation. Overcurrent protection must always be carried out according to local and national regulations. Circuit breakers and fuses must be designed for protection in a circuit capable of supplying a maximum of 100000 A$_{rms}$(symmetrical), 480 V maximum.

UL/Non-UL compliance
To ensure compliance with UL or IEC 61800-5-1, use the circuit breakers or fuses listed in *Table 3.7*.
Circuit breakers must be designed for protection in a circuit capable of supplying a maximum of 10000 A$_{rms}$ (symmetrical), 480 V maximum.

NOTICE!

In the event of malfunction, failure to follow the protection recommendation may result in damage to the frequency converter.

	Circuit breaker		Fuse				
	UL	Non-UL	UL				Non-UL
			Bussmann	Bussmann	Bussmann	Bussmann	Maximum fuse
Power [kW (hp)]			Type RK5	Type RK1	Type J	Type T	Type G
3x200–240 V IP20							
0.25 (0.33)			FRS-R-10	KTN-R10	JKS-10	JJN-10	10
0.37 (0.5)			FRS-R-10	KTN-R10	JKS-10	JJN-10	10
0.75 (1.0)			FRS-R-10	KTN-R10	JKS-10	JJN-10	10
1.5 (2.0)			FRS-R-10	KTN-R10	JKS-10	JJN-10	10
2.2 (3.0)	–	–	FRS-R-15	KTN-R15	JKS-15	JJN-15	16
3.7 (5.0)			FRS-R-25	KTN-R25	JKS-25	JJN-25	25
5.5 (7.5)			FRS-R-50	KTN-R50	JKS-50	JJN-50	50
7.5 (10)			FRS-R-50	KTN-R50	JKS-50	JJN-50	50
11 (15)			FRS-R-80	KTN-R80	JKS-80	JJN-80	65
15 (20)	Cutler-Hammer EGE3100FFG	Moeller NZMB1-A125	FRS-R-100	KTN-R100	JKS-100	JJN-100	125
18.5 (25)			FRS-R-100	KTN-R100	JKS-100	JJN-100	125
22 (30)	Cutler-Hammer JGE3150FFG	Moeller NZMB1-A160	FRS-R-150	KTN-R150	JKS-150	JJN-150	160
30 (40)			FRS-R-150	KTN-R150	JKS-150	JJN-150	160
37 (50)	Cutler-Hammer JGE3200FFG	Moeller NZMB1-A200	FRS-R-200	KTN-R200	JKS-200	JJN-200	200
45 (60)			FRS-R-200	KTN-R200	JKS-200	JJN-200	200

3

Power [kW (hp)]	Circuit breaker		Fuse				
	UL	Non-UL	UL				Non-UL
			Bussmann	Bussmann	Bussmann	Bussmann	Maximum fuse
			Type RK5	Type RK1	Type J	Type T	Type G
3x380–480 V IP20							
0.37 (0.5)			FRS-R-10	KTS-R10	JKS-10	JJS-10	10
0.75 (1.0)			FRS-R-10	KTS-R10	JKS-10	JJS-10	10
1.5 (2.0)			FRS-R-10	KTS-R10	JKS-10	JJS-10	10
2.2 (3.0)			FRS-R-15	KTS-R15	JKS-15	JJS-15	16
3.0 (4.0)			FRS-R-15	KTS-R15	JKS-15	JJS-15	16
4.0 (5.0)	–	–	FRS-R-15	KTS-R15	JKS-15	JJS-15	16
5.5 (7.5)			FRS-R-25	KTS-R25	JKS-25	JJS-25	25
7.5 (10)			FRS-R-25	KTS-R25	JKS-25	JJS-25	25
11 (15)			FRS-R-50	KTS-R50	JKS-50	JJS-50	50
15 (20)			FRS-R-50	KTS-R50	JKS-50	JJS-50	50
18.5 (25)			FRS-R-80	KTS-R80	JKS-80	JJS-80	65
22 (30)			FRS-R-80	KTS-R80	JKS-80	JJS-80	65
30 (40)	Cutler-Hammer EGE3125FFG	Moeller NZMB1-A125	FRS-R-125	KTS-R125	JKS-R125	JJS-R125	80
37 (50)			FRS-R-125	KTS-R125	JKS-R125	JJS-R125	100
45 (60)			FRS-R-125	KTS-R125	JKS-R125	JJS-R125	125
55 (70)	Cutler-Hammer JGE3200FFG	Moeller NZMB1-A200	FRS-R-200	KTS-R200	JKS-R200	JJS-R200	150
75 (100)			FRS-R-200	KTS-R200	JKS-R200	JJS-R200	200
90 (125)	Cutler-Hammer JGE3250FFG	Moeller NZMB2-A250	FRS-R-250	KTS-R250	JKS-R250	JJS-R250	250
3x525–600 V IP20							
2.2 (3.0)			FRS-R-20	KTS-R20	JKS-20	JJS-20	20
3.0 (4.0)			FRS-R-20	KTS-R20	JKS-20	JJS-20	20
3.7 (5.0)	–	–	FRS-R-20	KTS-R20	JKS-20	JJS-20	20
5.5 (7.5)			FRS-R-20	KTS-R20	JKS-20	JJS-20	20
7.5 (10)			FRS-R-20	KTS-R20	JKS-20	JJS-20	30
11 (15)	–	–	FRS-R-30	KTS-R30	JKS-30	JJS-30	35
15 (20)			FRS-R-30	KTS-R30	JKS-30	JJS-30	35
18.5 (25)	Cutler-Hammer EGE3080FFG	Cutler-Hammer EGE3080FFG	FRS-R-80	KTS-R80	JKS-80	JJS-80	80
22 (30)			FRS-R-80	KTS-R80	JKS-80	JJS-80	80
30 (40)			FRS-R-80	KTS-R80	JKS-80	JJS-80	80
37 (50)	Cutler-Hammer JGE3125FFG	Cutler-Hammer JGE3125FFG	FRS-R-125	KTS-R125	JKS-125	JJS-125	125
45 (60)			FRS-R-125	KTS-R125	JKS-125	JJS-125	125
55 (70)			FRS-R-125	KTS-R125	JKS-125	JJS-125	125
75 (100)	Cutler-Hammer JGE3200FAG	Cutler-Hammer JGE3200FAG	FRS-R-200	KTS-R200	JKS-200	JJS-200	200
90 (125)		–	FRS-R-200	KTS-R200	JKS-200	JJS-200	200
3x380–480 V IP54							

	Circuit breaker		Fuse				
	UL	Non-UL	UL				Non-UL
			Bussmann	Bussmann	Bussmann	Bussmann	Maximum fuse
Power [kW (hp)]			Type RK5	Type RK1	Type J	Type T	Type G
0.75 (1.0)	–	PKZM0-16	FRS-R-10	KTS-R-10	JKS-10	JJS-10	16
1.5 (2.0)		PKZM0-16	FRS-R-10	KTS-R-10	JKS-10	JJS-10	16
2.2 (3.0)		PKZM0-16	FRS-R-15	KTS-R-15	JKS-15	JJS-15	16
3.0 (4.0)		PKZM0-16	FRS-R-15	KTS-R-15	JKS-15	JJS-15	16
4.0 (5.0)		PKZM0-16	FRS-R-15	KTS-R-15	JKS-15	JJS-15	16
5.5 (7.5)		PKZM0-25	FRS-R-25	KTS-R-25	JKS-25	JJS-25	25
7.5 (10)		PKZM0-25	FRS-R-25	KTS-R-25	JKS-25	JJS-25	25
11 (15)		PKZM4-63	FRS-R-50	KTS-R-50	JKS-50	JJS-50	63
15 (20)		PKZM4-63	FRS-R-50	KTS-R-50	JKS-50	JJS-50	63
18.5 (25)		PKZM4-63	FRS-R-80	KTS-R-80	JKS-80	JJS-80	63
22 (30)	Moeller NZMB1-A125	–	FRS-R-80	KTS-R-80	JKS-80	JJS-80	125
30 (40)			FRS-R-125	KTS-R-125	JKS-125	JJS-125	125
37 (50)			FRS-R-125	KTS-R-125	JKS-125	JJS-125	125
45 (60)	Moeller NZMB2-A160	–	FRS-R-125	KTS-R-125	JKS-125	JJS-125	160
55 (70)			FRS-R-200	KTS-R-200	JKS-200	JJS-200	160
75 (100)	Moeller NZMB2-A250	–	FRS-R-200	KTS-R-200	JKS-200	JJS-200	200
90 (125)			FRS-R-250	KTS-R-250	JKS-200	JJS-200	200

Table 3.7 Circuit Breakers and Fuses

3

3.2.4 EMC-correct Electrical Installation

General points to be observed to ensure EMC-correct electrical installation:

- Use only shielded/armored motor cables and shielded/armored control cables.

- Ground the shield at both ends.

- Avoid installation with twisted shield ends (pigtails), because it reduces the shielding effect at high frequencies. Use the cable clamps provided.

- Ensure the same potential between the frequency converter and the ground potential of PLC.

- Use star washers and galvanically conductive installation plates.

22 MG18AA22

130BB761.10

3

PLC etc.

Panel

PLC

Output contactor, etc.

Grounding rail

Cable insulation stripped

Min. 0.0248 in² [16 mm²]
Equalizing cable

All cable entries in
one side of panel

Control cables

Motor cable

Min. 7.9 in [200 mm]
between control
cable, line cable
and between line power
motor cable

Line power supply

L1
L2
L3
PE

Reinforced protective ground

Motor, 3 phases and
Protective ground

Figure 3.21 EMC-correct Electrical Installation

NOTICE!

For North America use metal conduits instead of screened cables.

3.2.5 Control Terminals

Remove the terminal cover to access the control terminals.

Use a flat-edged screwdriver to push down the lock lever of the terminal cover under the LCP, then remove the terminal cover as shown in *Figure 3.22*.

For IP54 units, control terminals can be accessed after removing the front cover.

130BD331.10
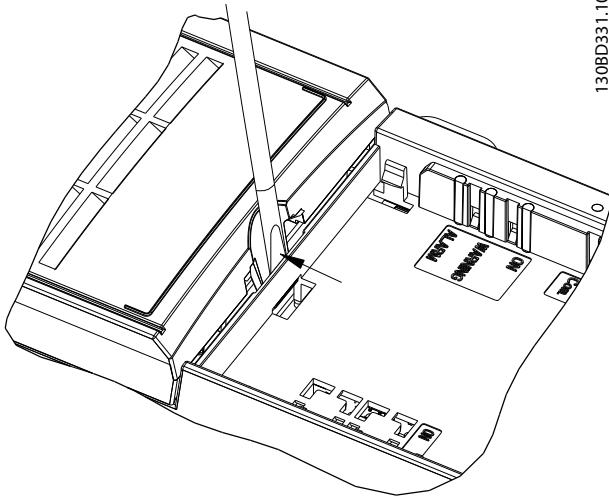
Figure 3.22 Removing the Terminal Cover

Figure 3.23 shows all the frequency converter control terminals. Applying start (terminal 18), connection between terminals 12-27, and an analog reference (terminal 53 or 54, and 55) make the frequency converter run.

The digital input mode of terminal 18, 19, and 27 is set in *parameter 5-00 Digital Input Mode* (PNP is default value). Digital input 29 mode is set in *parameter 5-03 Digital Input 29 Mode* (PNP is default value).

130BF892.10

BUS TER.
OFF [ ] ON

61	68	69
	P	N

COMM. GND

| 18 | 19 | 27 | 29 | 42 | 45 | 50 | 53 | 54 |

DIG IN
DIG IN
DIG IN
DIG IN
0/4-20 mA A OUT/DIG OUT
0/4-20 mA A OUT/DIG OUT
10 V OUT
10 V/20 mA IN
10 V/20 mA IN

12	20	55

+24V
GND
GND
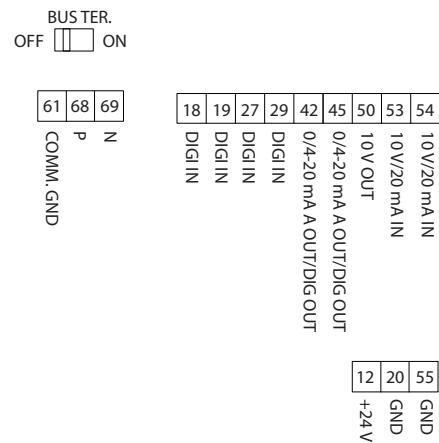
Figure 3.23 Control Terminals

Figure 3.24 Basic Wiring Schematic Drawing
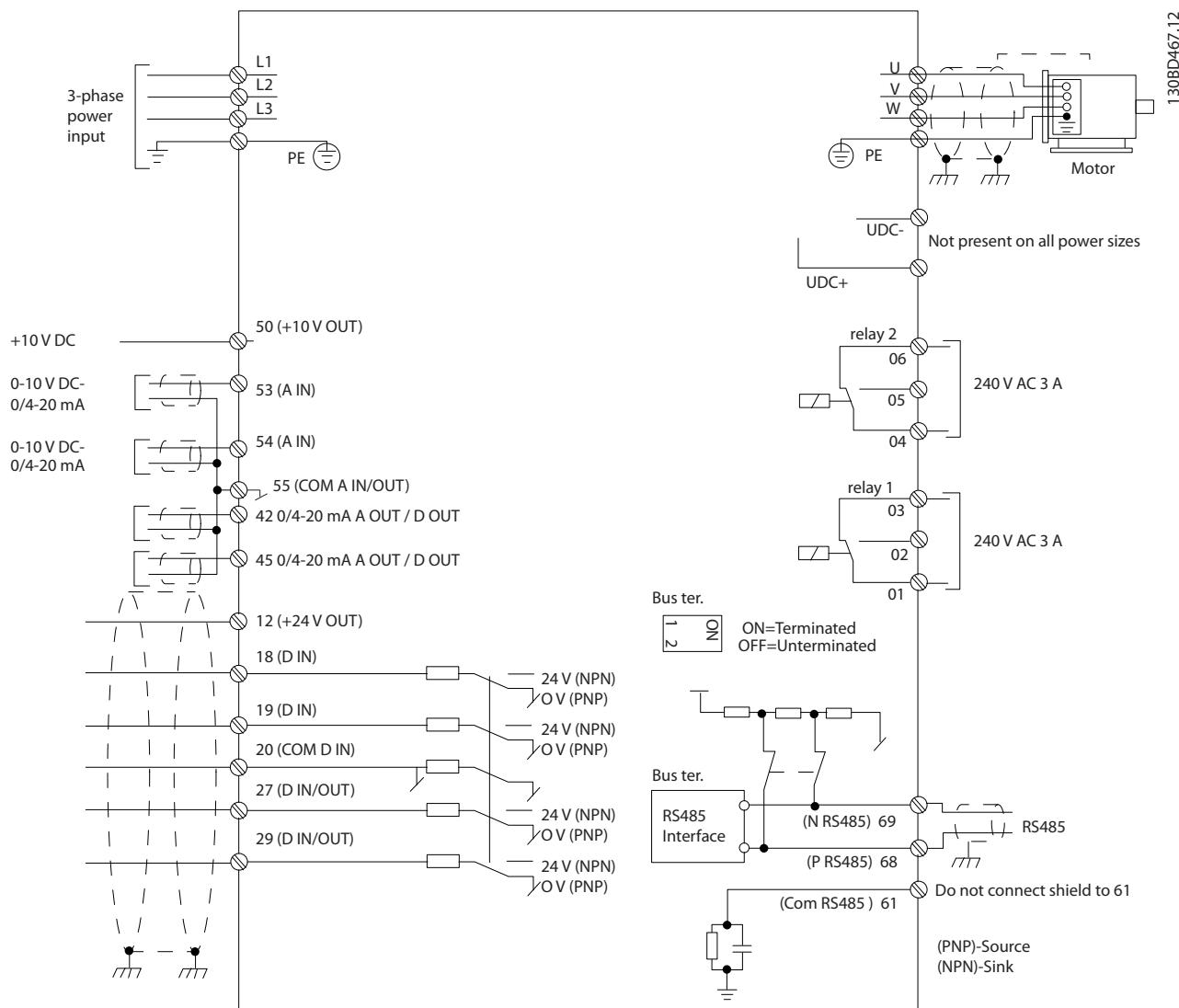
NOTICE!

There is no access to UDC- and UDC+ on the following units:

- **IP20, 380–480 V, 30–90 kW (40–125 hp)**

- **IP20, 200–240 V, 15–45 kW (20–60 hp)**

- **IP20, 525–600 V, 2.2–90 kW (3–125 hp)**

- **IP54, 380–480 V, 22–90 kW (30–125 hp)**

3.2.6 Acoustic Noise or Vibration

If the motor or the equipment driven by the motor - for example, a fan - is making noise or vibrations at certain frequencies, configure the following parameters or parameter groups to reduce or eliminate the noise or vibrations:

- *Parameter group 4-6* Speed Bypass.

- Set *parameter 14-03 Overmodulation* to *[0] Off*.

- Switching pattern and switching frequency *parameter group 14-0* Inverter Switching*.

- *Parameter 1-64 Resonance Dampening*.

4 Programming

4.1 Local Control Panel (LCP)

The frequency converter can be programmed from the LCP or from a PC via the RS485 COM port by installing the MCT 10 Set-up Software. Refer to *chapter 1.2 Additional Resources* for more details about the software.

The LCP is divided into 4 functional sections.

> A. Display
>
> B. Menu key
>
> C. Navigation keys and indicator lights
>
> D. Operation keys and indicator lights
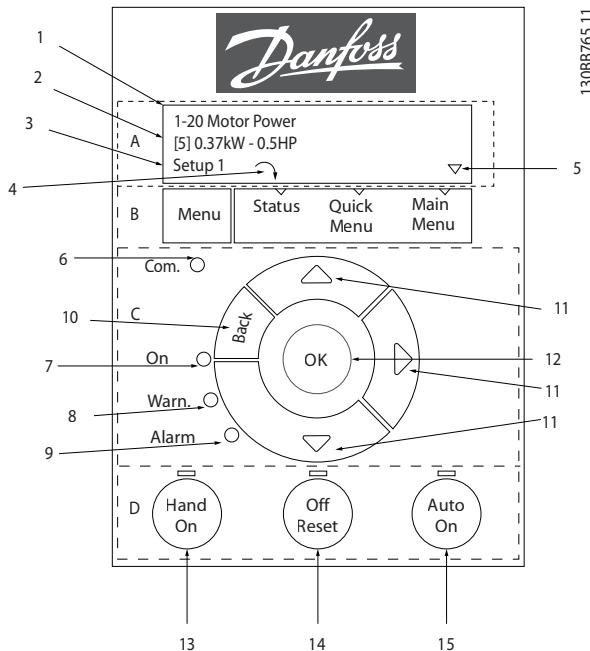
Figure 4.1 Local Control Panel (LCP)

A. Display
The LCD-display is illuminated with 2 alphanumeric lines. All data is shown on the LCP.

Figure 4.1 describes the information that can be read from the display.

1	Parameter number and name.
2	Parameter value.
3	Set-up number shows the active set-up and the edit set-up. If the same set-up acts as both active and edit set-up, only that set-up number is shown (factory setting). When active and edit set-up differ, both numbers are shown in the display (set-up 12). The number flashing, indicates the edit set-up.
4	Motor direction is shown to the bottom left of the display – indicated by a small arrow pointing either clockwise or counterclockwise.
5	The triangle indicates if the LCP is in Status, Quick Menu, or Main Menu.

Table 4.1 Legend to *Figure 4.1*, Part I

B. Menu key
Press [Menu] to select among Status, Quick Menu, or Main Menu.

C. Navigation keys and indicator lights

6	Com. LED: Flashes during bus communication.
7	Green LED/On: Control section is working correctly.
8	Yellow LED/Warn.: Indicates a warning.
9	Flashing Red LED/Alarm: Indicates an alarm.
10	[Back]: For moving to the previous step or layer in the navigation structure.
11	[▲] [▼] [►]: For navigating among parameter groups and parameters, and within parameters. They can also be used for setting local reference.
12	[OK]: For selecting a parameter and for accepting changes to parameter settings.

Table 4.2 Legend to *Figure 4.1*, Part II

D. Operation keys and indicator lights

13	[Hand On]: Starts the motor and enables control of the frequency converter via the LCP. **NOTICE!** *[2] Coast inverse* **is the default option for** *parameter 5-12 Terminal 27 Digital Input*. **If there is no 24 V supply to terminal 27, [Hand On] does not start the motor. Connect terminal 12 to terminal 27.**
14	[Off/Reset]: Stops the motor (Off). If in alarm mode, the alarm is reset.
15	[Auto On]: The frequency converter is controlled either via control terminals or serial communication.

Table 4.3 Legend to *Figure 4.1*, Part III

4.2 Set-up Wizard

The built-in wizard menu guides the installer through the set-up of the frequency converter in a clear and structured manner for open-loop applications, closed-loop applications, and quick motor settings.
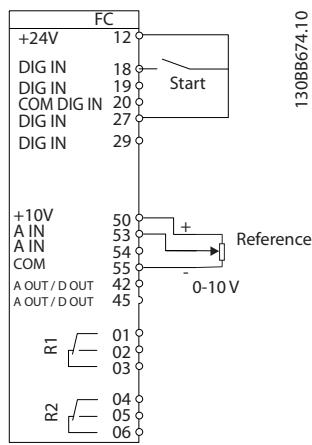
Figure 4.2 Frequency Converter Wiring

The wizard is shown after power-up until any parameter has been changed. The wizard can always be accessed again through the quick menu. Press [OK] to start the wizard. Press [Back] to return to the status view.

Figure 4.3 Start-up/Quit Wizard
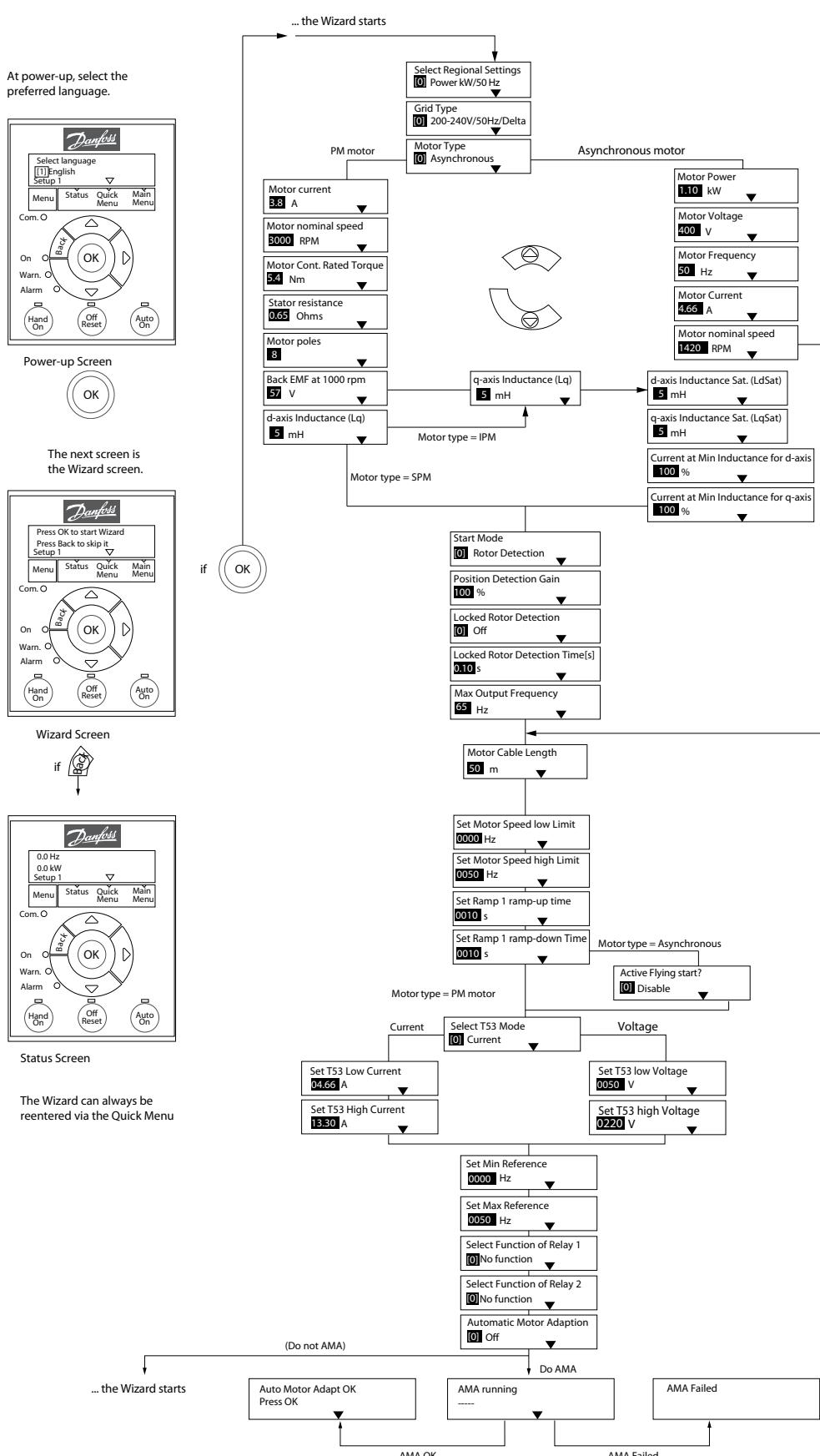
Figure 4.4 Set-up Wizard for Open-loop Applications

Set-up Wizard for Open-loop Applications

Parameter	Option	Default	Usage
Parameter 0-03 Regional Settings	*[0] International* *[1] US*	*[0] International*	–
Parameter 0-06 GridType	*[0] 200–240 V/50 Hz/IT-grid* *[1] 200–240 V/50 Hz/Delta* *[2] 200–240 V/50 Hz* *[10] 380–440 V/50 Hz/IT-grid* *[11] 380–440 V/50 Hz/Delta* *[12] 380–440 V/50 Hz* *[20] 440–480 V/50 Hz/IT-grid* *[21] 440–480 V/50 Hz/Delta* *[22] 440–480 V/50 Hz* *[30] 525–600 V/50 Hz/IT-grid* *[31] 525–600 V/50 Hz/Delta* *[32] 525–600 V/50 Hz* *[100] 200–240 V/60 Hz/IT-grid* *[101] 200–240 V/60 Hz/Delta* *[102] 200–240 V/60 Hz* *[110] 380–440 V/60 Hz/IT-grid* *[111] 380–440 V/60 Hz/Delta* *[112] 380–440 V/60 Hz* *[120] 440–480 V/60 Hz/IT-grid* *[121] 440–480 V/60 Hz/Delta* *[122] 440–480 V/60 Hz* *[130] 525–600 V/60 Hz/IT-grid* *[131] 525–600 V/60 Hz/Delta* *[132] 525–600 V/60 Hz*	Size related	Select the operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.

4

Parameter	Option	Default	Usage
Parameter 1-10 Motor Construction	**[0] Asynchron* *[1] PM, non-salient SPM* *[3] PM, salient IPM*	*[0] Asynchron*	Setting the parameter value might change these parameters: • *Parameter 1-01 Motor Control Principle.* • *Parameter 1-03 Torque Characteristics.* • *Parameter 1-08 Motor Control Bandwidth.* • *Parameter 1-14 Damping Gain.* • *Parameter 1-15 Low Speed Filter Time Const.* • *Parameter 1-16 High Speed Filter Time Const.* • *Parameter 1-17 Voltage filter time const.* • *Parameter 1-20 Motor Power.* • *Parameter 1-22 Motor Voltage.* • *Parameter 1-23 Motor Frequency.* • *Parameter 1-24 Motor Current.* • *Parameter 1-25 Motor Nominal Speed.* • *Parameter 1-26 Motor Cont. Rated Torque.* • *Parameter 1-30 Stator Resistance (Rs).* • *Parameter 1-33 Stator Leakage Reactance (X1).* • *Parameter 1-35 Main Reactance (Xh).* • *Parameter 1-37 d-axis Inductance (Ld).* • *Parameter 1-38 q-axis Inductance (Lq).* • *Parameter 1-39 Motor Poles.* • *Parameter 1-40 Back EMF at 1000 RPM.* • *Parameter 1-44 d-axis Inductance Sat. (LdSat).* • *Parameter 1-45 q-axis Inductance Sat. (LqSat).* • *Parameter 1-46 Position Detection Gain.* • *Parameter 1-48 Current at Min Inductance for d-axis.* • *Parameter 1-49 Current at Min Inductance for q-axis.* • *Parameter 1-66 Min. Current at Low Speed.* • *Parameter 1-70 Start Mode.* • *Parameter 1-72 Start Function.* • *Parameter 1-73 Flying Start.* • *Parameter 1-80 Function at Stop.* • *Parameter 1-82 Min Speed for Function at Stop [Hz].* • *Parameter 1-90 Motor Thermal Protection.* • *Parameter 2-00 DC Hold/Motor Preheat Current.* • *Parameter 2-01 DC Brake Current.* • *Parameter 2-02 DC Braking Time.* • *Parameter 2-04 DC Brake Cut In Speed.* • *Parameter 2-10 Brake Function.* • *Parameter 4-14 Motor Speed High Limit [Hz].* • *Parameter 4-19 Max Output Frequency.* • *Parameter 4-58 Missing Motor Phase Function.* • *Parameter 14-65 Speed Derate Dead Time Compensation.*

Parameter	Option	Default	Usage
Parameter 1-20 Motor Power	0.12–110 kW/0.16–150 hp	Size related	Enter the motor power from the nameplate data.
Parameter 1-22 Motor Voltage	50–1000 V	Size related	Enter the motor voltage from the nameplate data.
Parameter 1-23 Motor Frequency	20–400 Hz	Size related	Enter the motor frequency from the nameplate data.
Parameter 1-24 Motor Current	0.01–10000.00 A	Size related	Enter the motor current from the nameplate data.
Parameter 1-25 Motor Nominal Speed	50–9999 RPM	Size related	Enter the motor nominal speed from the nameplate data.
Parameter 1-26 Motor Cont. Rated Torque	0.1–1000.0 Nm	Size related	This parameter is available when *parameter 1-10 Motor Construction* is set to options that enable permanent magnet motor mode. **NOTICE!** **Changing this parameter affects the settings of other parameters.**
Parameter 1-29 Automatic Motor Adaption (AMA)	See *parameter 1-29 Automatic Motor Adaption (AMA)*.	Off	Performing an AMA optimizes motor performance.
Parameter 1-30 Stator Resistance (Rs)	0.000–99.990 Ω	Size related	Set the stator resistance value.
Parameter 1-37 d-axis Inductance (Ld)	0.000–1000.000 mH	Size related	Enter the value of the d-axis inductance. Obtain the value from the permanent magnet motor datasheet.
Parameter 1-38 q-axis Inductance (Lq)	0.000–1000.000 mH	Size related	Enter the value of the q-axis inductance.
Parameter 1-39 Motor Poles	2–100	4	Enter the number of motor poles.
Parameter 1-40 Back EMF at 1000 RPM	10–9000 V	Size related	Line-line RMS back EMF voltage at 1000 RPM.
Parameter 1-42 Motor Cable Length	0–100 m	50 m	Enter the motor cable length.
Parameter 1-44 d-axis Inductance Sat. (LdSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Ld. Ideally, this parameter has the same value as *parameter 1-37 d-axis Inductance (Ld)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-45 q-axis Inductance Sat. (LqSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Lq. Ideally, this parameter has the same value as *parameter 1-38 q-axis Inductance (Lq)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-46 Position Detection Gain	20–200%	100%	Adjusts the height of the test pulse during position detection at start.
Parameter 1-48 Current at Min Inductance for d-axis	20–200%	100%	Enter the inductance saturation point.
Parameter 1-49 Current at Min Inductance for q-axis	20–200%	100%	This parameter specifies the saturation curve of the d- and q-inductance values. From 20–100% of this parameter, the inductances are linearly approximated due to *parameter 1-37 d-axis Inductance (Ld)*, *parameter 1-38 q-axis Inductance (Lq)*, *parameter 1-44 d-axis Inductance Sat. (LdSat)*, and *parameter 1-45 q-axis Inductance Sat. (LqSat)*.
Parameter 1-70 Start Mode	[0] Rotor Detection [1] Parking	[0] Rotor Detection	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	[0] Disabled	Select *[1] Enabled* to enable the frequency converter to catch a motor spinning due to mains drop-out. Select *[0] Disabled* if this function is not required. When this parameter is set to *[1] Enabled*, *parameter 1-71 Start Delay* and *parameter 1-72 Start Function* are not functional. *Parameter 1-73 Flying Start* is active in VVC+ mode only.
Parameter 3-02 Minimum Reference	-4999.000–4999.000	0	The minimum reference is the lowest value obtainable by summing all references.
Parameter 3-03 Maximum Reference	-4999.000–4999.000	50	The maximum reference is the lowest obtainable by summing all references.

4

Parameter	Option	Default	Usage
Parameter 3-41 Ramp 1 Ramp Up Time	0.05–3600.00 s	Size related	If asynchronous motor is selected, the ramp-up time is from 0 to rated *parameter 1-23 Motor Frequency*. If PM motor is selected, the ramp-up time is from 0 to *parameter 1-25 Motor Nominal Speed*.
Parameter 3-42 Ramp 1 Ramp Down Time	0.05–3600.00 s	Size related	For asynchronous motors, the ramp-down time is from rated *parameter 1-23 Motor Frequency* to 0. For PM motors, the ramp-down time is from *parameter 1-25 Motor Nominal Speed* to 0.
Parameter 4-12 Motor Speed Low Limit [Hz]	0.0–400.0 Hz	0 Hz	Enter the minimum limit for low speed.
Parameter 4-14 Motor Speed High Limit [Hz]	0.0–400.0 Hz	100 Hz	Enter the maximum limit for high speed.
Parameter 4-19 Max Output Frequency	0.0–400.0 Hz	100 Hz	Enter the maximum output frequency value. If *parameter 4-19 Max Output Frequency* is set lower than *parameter 4-14 Motor Speed High Limit [Hz]*, *parameter 4-14 Motor Speed High Limit [Hz]* is set equal to *parameter 4-19 Max Output Frequency* automatically.
Parameter 5-40 Function Relay	See *parameter 5-40 Function Relay*.	[9] Alarm	Select the function to control output relay 1.
Parameter 5-40 Function Relay	See *parameter 5-40 Function Relay*.	[5] Drive running	Select the function to control output relay 2.
Parameter 6-10 Terminal 53 Low Voltage	0.00–10.00 V	0.07 V	Enter the voltage that corresponds to the low reference value.
Parameter 6-11 Terminal 53 High Voltage	0.00–10.00 V	10 V	Enter the voltage that corresponds to the high reference value.
Parameter 6-12 Terminal 53 Low Current	0.00–20.00 mA	4 mA	Enter the current that corresponds to the low reference value.
Parameter 6-13 Terminal 53 High Current	0.00–20.00 mA	20 mA	Enter the current that corresponds to the high reference value.
Parameter 6-19 Terminal 53 mode	[0] Current [1] Voltage	[1] Voltage	Select if terminal 53 is used for current or voltage input.
Parameter 30-22 Locked Rotor Protection	[0] Off [1] On	[0] Off	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1 s	0.10 s	–

Table 4.4 Set-up Wizard for Open-loop Applications

Set-up Wizard for Closed-loop Applications

... the Wizard starts

| 0-03 Regional Settings |
| [0] Power kW/50 Hz |

| 0-06 Grid Type |
| [0] 200-240V/50Hz/Delta |

| 1-00 Configuration Mode |
| [3] Closed Loop |

| 1-10 Motor Type |
| [0] Asynchronous |

PM motor   Asynchronous motor

| 1-24 Motor Current |
| 3.8 A |

| 1-25 Motor Nominal Speed |
| 3000 RPM |

| 1-26 Motor Cont. Rated Torque |
| 5.4 Nm |

| 1-30 Stator Resistance |
| 0.65 Ohms |

| 1-39 Motor Poles |
| 8 |

| 1-40 Back EMF at 1000 RPM |
| 57 V |

| 1-37 d-axis inductance(Lq) |
| 5 mH |

| 1-38 q-axis inductance(Lq) |
| 5 mH |

Motor type = IPM

Motor type = SPM

| 1-20 Motor Power |
| 1.10 kW |

| 1-22 Motor Voltage |
| 400 V |

| 1-23 Motor Frequency |
| 50 Hz |

| 1-24 Motor Current |
| 04.66 A |

| 1-25 Motor nominal speed |
| 1420 RPM |

| 1-44 d-axis Inductance Sat. (LdSat) |
| 5 mH |

| (1-45) q-axis Inductance Sat. (LqSat) |
| 5 mH |

| (1-48) Current at Min Inductance for d-axis |
| 100 % |

| 1-49 Current at Min Inductance for q-axis |
| 100 % |

| (1-70) Start Mode |
| [0] Rotor Detection |

| 1-46 Position Detection Gain |
| 100 % |

| 30-22 Locked Rotor Detection |
| [0] Off |

| 30-23 Locked Rotor Detection Time[s] |
| 0.10 s |

| 4-19 Max Ouput Frequency |
| 0065 Hz |

| 1-42 Motor Cable Length |
| 50 m |

| 4-12 Motor speed low limit |
| 0016 Hz |

| 4-13 Motor speed high limit |
| 0050 Hz |

| 3-41 Ramp 1 ramp-up time |
| 0010 s |

| 3-42 Ramp1 ramp-down time |
| 0010 s |

Motor type = Asynchronous

| 1-73 Flying Start |
| [0] No |

Motor type = PM motor

| 20-00 Feedback 1 source |
| [1] Analog input 54 |

This dialog is forced to be set to [1] Analog input 54

| 3-16 Reference Source 2 |
| [0] No Operation |

| 3-02 Min Reference |
| 0.00 |

| 3-03 Max Reference |
| 50.00 |

| 3-10 Preset reference [0] |
| 0.00 % |

| 6-29 Terminal 54 Mode |
| [1] Voltage |

Current   Voltage

| 6-22 T54 Low Current |
| 04.66 A |

| 6-24 T54 low Feedback |
| 0016 Hz |

| 6-23 T54 high Current |
| 13.30 A |

| 6-25 T54 high Feedback |
| 0050 Hz |

| 6-26 T54 Filter time const. |
| 0.01 s |

| 20-81 PI Normal/Inverse Control |
| [0] Normal |

| 20-83 PI Normal/Inverse Control |
| 0050 Hz |

| 20-93 PI Proportional Gain |
| 00.50 |

| 20-94 PI integral time |
| 0020.00 s |

| 1-29 Automatic Motor Adaption |
| [0] Off |

| 6-20 T54 low Voltage |
| 0050 V |

| 6-24 T54 low Feedback |
| 0016 Hz |

| 6-21 T54 high Voltage |
| 0220 V |

| 6-25 T54 high Feedback |
| 0050 Hz |

... the Wizard starts

Figure 4.5 Set-up Wizard for Closed-loop Applications

Parameter	Range	Default	Usage
Parameter 0-03 Regional Settings	*[0] International* *[1] US*	*[0] International*	–
Parameter 0-06 GridType	[0]–[132] see *Table 4.4.*	Size selected	Select the operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.
Parameter 1-00 Configuration Mode	*[0] Open loop* *[3] Closed loop*	*[0] Open loop*	Select *[3] Closed loop.*

4

4

Parameter	Range	Default	Usage
Parameter 1-10 Motor Construction	*[0] Asynchron* *[1] PM, non-salient SPM* *[3] PM, salient IPM*	*[0] Asynchron*	Setting the parameter value might change these parameters: ● *Parameter 1-01 Motor Control Principle.* ● *Parameter 1-03 Torque Characteristics.* ● *Parameter 1-08 Motor Control Bandwidth.* ● *Parameter 1-14 Damping Gain.* ● *Parameter 1-15 Low Speed Filter Time Const.* ● *Parameter 1-16 High Speed Filter Time Const.* ● *Parameter 1-17 Voltage filter time const.* ● *Parameter 1-20 Motor Power.* ● *Parameter 1-22 Motor Voltage.* ● *Parameter 1-23 Motor Frequency.* ● *Parameter 1-24 Motor Current.* ● *Parameter 1-25 Motor Nominal Speed.* ● *Parameter 1-26 Motor Cont. Rated Torque.* ● *Parameter 1-30 Stator Resistance (Rs).* ● *Parameter 1-33 Stator Leakage Reactance (X1).* ● *Parameter 1-35 Main Reactance (Xh).* ● *Parameter 1-37 d-axis Inductance (Ld).* ● *Parameter 1-38 q-axis Inductance (Lq).* ● *Parameter 1-39 Motor Poles.* ● *Parameter 1-40 Back EMF at 1000 RPM.* ● *Parameter 1-44 d-axis Inductance Sat. (LdSat).* ● *Parameter 1-45 q-axis Inductance Sat. (LqSat).* ● *Parameter 1-46 Position Detection Gain.* ● *Parameter 1-48 Current at Min Inductance for d-axis.* ● *Parameter 1-49 Current at Min Inductance for q-axis.* ● *Parameter 1-66 Min. Current at Low Speed.* ● *Parameter 1-70 Start Mode.* ● *Parameter 1-72 Start Function.* ● *Parameter 1-73 Flying Start.* ● *Parameter 1-80 Function at Stop.* ● *Parameter 1-82 Min Speed for Function at Stop [Hz].* ● *Parameter 1-90 Motor Thermal Protection.* ● *Parameter 2-00 DC Hold/Motor Preheat Current.* ● *Parameter 2-01 DC Brake Current.* ● *Parameter 2-02 DC Braking Time.* ● *Parameter 2-04 DC Brake Cut In Speed.* ● *Parameter 2-10 Brake Function.* ● *Parameter 4-14 Motor Speed High Limit [Hz].* ● *Parameter 4-19 Max Output Frequency.* ● *Parameter 4-58 Missing Motor Phase Function.* ● *Parameter 14-65 Speed Derate Dead Time Compensation.*

4

Parameter	Range	Default	Usage
Parameter 1-20 Motor Power	0.09–110 kW	Size related	Enter the motor power from the nameplate data.
Parameter 1-22 Motor Voltage	50–1000 V	Size related	Enter the motor voltage from the nameplate data.
Parameter 1-23 Motor Frequency	20–400 Hz	Size related	Enter the motor frequency from the nameplate data.
Parameter 1-24 Motor Current	0–10000 A	Size related	Enter the motor current from the nameplate data.
Parameter 1-25 Motor Nominal Speed	50–9999 RPM	Size related	Enter the motor nominal speed from the nameplate data.
Parameter 1-26 Motor Cont. Rated Torque	0.1–1000.0 Nm	Size related	This parameter is available when *parameter 1-10 Motor Construction* is set to options that enable permanent magnet motor mode. **NOTICE!** **Changing this parameter affects the settings of other parameters.**
Parameter 1-29 Automatic Motor Adaption (AMA)		Off	Performing an AMA optimizes motor performance.
Parameter 1-30 Stator Resistance (Rs)	0–99.990 Ω	Size related	Set the stator resistance value.
Parameter 1-37 d-axis Inductance (Ld)	0.000–1000.000 mH	Size related	Enter the value of the d-axis inductance. Obtain the value from the permanent magnet motor datasheet.
Parameter 1-38 q-axis Inductance (Lq)	0.000–1000.000 mH	Size related	Enter the value of the q-axis inductance.
Parameter 1-39 Motor Poles	2–100	4	Enter the number of motor poles.
Parameter 1-40 Back EMF at 1000 RPM	10–9000 V	Size related	Line-line RMS back EMF voltage at 1000 RPM.
Parameter 1-42 Motor Cable Length	0–100 m	50 m	Enter the motor cable length.
Parameter 1-44 d-axis Inductance Sat. (LdSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Ld. Ideally, this parameter has the same value as *parameter 1-37 d-axis Inductance (Ld)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-45 q-axis Inductance Sat. (LqSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Lq. Ideally, this parameter has the same value as *parameter 1-38 q-axis Inductance (Lq)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-46 Position Detection Gain	20–200%	100%	Adjusts the height of the test pulse during position detection at start.
Parameter 1-48 Current at Min Inductance for d-axis	20–200%	100%	Enter the inductance saturation point.
Parameter 1-49 Current at Min Inductance for q-axis	20–200%	100%	This parameter specifies the saturation curve of the d- and q-inductance values. From 20–100% of this parameter, the inductances are linearly approximated due to *parameter 1-37 d-axis Inductance (Ld)*, *parameter 1-38 q-axis Inductance (Lq)*, *parameter 1-44 d-axis Inductance Sat. (LdSat)*, and *parameter 1-45 q-axis Inductance Sat. (LqSat)*.
Parameter 1-70 Start Mode	[0] Rotor Detection [1] Parking	[0] Rotor Detection	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	[0] Disabled	Select [1] Enabled to enable the frequency converter to catch a spinning motor in, for example, fan applications. When PM is selected, this parameter is enabled.
Parameter 3-02 Minimum Reference	-4999.000–4999.000	0	The minimum reference is the lowest value obtainable by summing all references.
Parameter 3-03 Maximum Reference	-4999.000–4999.000	50	The maximum reference is the highest value obtainable by summing all references.
Parameter 3-10 Preset Reference	-100–100%	0	Enter the setpoint.
Parameter 3-41 Ramp 1 Ramp Up Time	0.05–3600.0 s	Size related	Ramp-up time from 0 to rated *parameter 1-23 Motor Frequency* for asynchronous motors. Ramp-up time from 0 to *parameter 1-25 Motor Nominal Speed* for PM motors.

Parameter	Range	Default	Usage
Parameter 3-42 Ramp 1 Ramp Down Time	0.05–3600.0 s	Size related	Ramp-down time from rated *parameter 1-23 Motor Frequency* to 0 for asynchronous motors. Ramp-down time from *parameter 1-25 Motor Nominal Speed* to 0 for PM motors.
Parameter 4-12 Motor Speed Low Limit [Hz]	0.0–400.0 Hz	0.0 Hz	Enter the minimum limit for low speed.
Parameter 4-14 Motor Speed High Limit [Hz]	0.0–400.0 Hz	100 Hz	Enter the minimum limit for high speed.
Parameter 4-19 Max Output Frequency	0.0–400.0 Hz	100 Hz	Enter the maximum output frequency value. If *parameter 4-19 Max Output Frequency* is set lower than *parameter 4-14 Motor Speed High Limit [Hz]*, *parameter 4-14 Motor Speed High Limit [Hz]* is set equal to *parameter 4-19 Max Output Frequency* automatically.
Parameter 6-20 Terminal 54 Low Voltage	0.00–10.00 V	0.07 V	Enter the voltage that corresponds to the low reference value.
Parameter 6-21 Terminal 54 High Voltage	0.00–10.00 V	10.00 V	Enter the voltage that corresponds to the high reference value.
Parameter 6-22 Terminal 54 Low Current	0.00–20.00 mA	4.00 mA	Enter the current that corresponds to the low reference value.
Parameter 6-23 Terminal 54 High Current	0.00–20.00 mA	20.00 mA	Enter the current that corresponds to the high reference value.
Parameter 6-24 Terminal 54 Low Ref./Feedb. Value	-4999–4999	0	Enter the feedback value that corresponds to the voltage or current set in *parameter 6-20 Terminal 54 Low Voltage*/ *parameter 6-22 Terminal 54 Low Current*.
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	-4999–4999	50	Enter the feedback value that corresponds to the voltage or current set in *parameter 6-21 Terminal 54 High Voltage*/ *parameter 6-23 Terminal 54 High Current*.
Parameter 6-26 Terminal 54 Filter Time Constant	0.00–10.00 s	0.01	Enter the filter time constant.
Parameter 6-29 Terminal 54 mode	*[0] Current* *[1] Voltage*	*[1] Voltage*	Select if terminal 54 is used for current or voltage input.
Parameter 20-81 PI Normal/ Inverse Control	*[0] Normal* *[1] Inverse*	*[0] Normal*	Select *[0] Normal* to set the process control to increase the output speed when the process error is positive. Select *[1] Inverse* to reduce the output speed.
Parameter 20-83 PI Start Speed [Hz]	0–200 Hz	0 Hz	Enter the motor speed to be attained as a start signal for commencement of PI control.
Parameter 20-93 PI Proportional Gain	0.00–10.00	0.01	Enter the process controller proportional gain. Quick control is obtained at high amplification. However, if amplification is too high, the process may become unstable.
Parameter 20-94 PI Integral Time	0.1–999.0 s	999.0 s	Enter the process controller integral time. Obtain quick control through a short integral time, though if the integral time is too short, the process becomes unstable. An excessively long integral time disables the integral action.
Parameter 30-22 Locked Rotor Protection	*[0] Off* *[1] On*	*[0] Off*	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1.00 s	0.10 s	–

Table 4.5 Set-up Wizard for Closed-loop Applications

Motor set-up

The motor set-up wizard guides users through the needed motor parameters.

Parameter	Range	Default	Usage
Parameter 0-03 Regional Settings	*[0] International* *[1] US*	0	–
Parameter 0-06 GridType	*[0]–[132] see Table 4.4.*	Size related	Select the operating mode for restart after reconnection of the frequency converter to mains voltage after power-down.

Parameter	Range	Default	Usage
Parameter 1-10 Motor Construction	**[0] Asynchron* *[1] PM, non-salient SPM* *[3] PM, salient IPM*	*[0] Asynchron*	Setting the parameter value might change these parameters: ● *Parameter 1-01 Motor Control Principle.* ● *Parameter 1-03 Torque Characteristics.* ● *Parameter 1-08 Motor Control Bandwidth.* ● *Parameter 1-14 Damping Gain.* ● *Parameter 1-15 Low Speed Filter Time Const.* ● *Parameter 1-16 High Speed Filter Time Const.* ● *Parameter 1-17 Voltage filter time const.* ● *Parameter 1-20 Motor Power.* ● *Parameter 1-22 Motor Voltage.* ● *Parameter 1-23 Motor Frequency.* ● *Parameter 1-24 Motor Current.* ● *Parameter 1-25 Motor Nominal Speed.* ● *Parameter 1-26 Motor Cont. Rated Torque.* ● *Parameter 1-30 Stator Resistance (Rs).* ● *Parameter 1-33 Stator Leakage Reactance (X1).* ● *Parameter 1-35 Main Reactance (Xh).* ● *Parameter 1-37 d-axis Inductance (Ld).* ● *Parameter 1-38 q-axis Inductance (Lq).* ● *Parameter 1-39 Motor Poles.* ● *Parameter 1-40 Back EMF at 1000 RPM.* ● *Parameter 1-44 d-axis Inductance Sat. (LdSat).* ● *Parameter 1-45 q-axis Inductance Sat. (LqSat).* ● *Parameter 1-46 Position Detection Gain.* ● *Parameter 1-48 Current at Min Inductance for d-axis.* ● *Parameter 1-49 Current at Min Inductance for q-axis.* ● *Parameter 1-66 Min. Current at Low Speed.* ● *Parameter 1-70 Start Mode.* ● *Parameter 1-72 Start Function.* ● *Parameter 1-73 Flying Start.* ● *Parameter 1-80 Function at Stop.* ● *Parameter 1-82 Min Speed for Function at Stop [Hz].* ● *Parameter 1-90 Motor Thermal Protection.* ● *Parameter 2-00 DC Hold/Motor Preheat Current.* ● *Parameter 2-01 DC Brake Current.* ● *Parameter 2-02 DC Braking Time.* ● *Parameter 2-04 DC Brake Cut In Speed.* ● *Parameter 2-10 Brake Function.* ● *Parameter 4-14 Motor Speed High Limit [Hz].* ● *Parameter 4-19 Max Output Frequency.* ● *Parameter 4-58 Missing Motor Phase Function.* ● *Parameter 14-65 Speed Derate Dead Time Compensation.*

Parameter	Range	Default	Usage
Parameter 1-20 Motor Power	0.12–110 kW/0.16–150 hp	Size related	Enter the motor power from the nameplate data.
Parameter 1-22 Motor Voltage	50–1000 V	Size related	Enter the motor voltage from the nameplate data.
Parameter 1-23 Motor Frequency	20–400 Hz	Size related	Enter the motor frequency from the nameplate data.
Parameter 1-24 Motor Current	0.01–10000.00 A	Size related	Enter the motor current from the nameplate data.
Parameter 1-25 Motor Nominal Speed	50–9999 RPM	Size related	Enter the motor nominal speed from the nameplate data.
Parameter 1-26 Motor Cont. Rated Torque	0.1–1000.0 Nm	Size related	This parameter is available when *parameter 1-10 Motor Construction* is set to options that enable permanent magnet motor mode. **NOTICE** **Changing this parameter affects the settings of other parameters.**
Parameter 1-30 Stator Resistance (Rs)	0–99.990 Ω	Size related	Set the stator resistance value.
Parameter 1-37 d-axis Inductance (Ld)	0.000–1000.000 mH	Size related	Enter the value of the d-axis inductance. Obtain the value from the permanent magnet motor datasheet.
Parameter 1-38 q-axis Inductance (Lq)	0.000–1000.000 mH	Size related	Enter the value of the q-axis inductance.
Parameter 1-39 Motor Poles	2–100	4	Enter the number of motor poles.
Parameter 1-40 Back EMF at 1000 RPM	10–9000 V	Size related	Line-line RMS back EMF voltage at 1000 RPM.
Parameter 1-42 Motor Cable Length	0–100 m	50 m	Enter the motor cable length.
Parameter 1-44 d-axis Inductance Sat. (LdSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Ld. Ideally, this parameter has the same value as *parameter 1-37 d-axis Inductance (Ld)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-45 q-axis Inductance Sat. (LqSat)	0.000–1000.000 mH	Size related	This parameter corresponds to the inductance saturation of Lq. Ideally, this parameter has the same value as *parameter 1-38 q-axis Inductance (Lq)*. However, if the motor supplier provides an induction curve, enter the induction value, which is 200% of the nominal current.
Parameter 1-46 Position Detection Gain	20–200%	100%	Adjusts the height of the test pulse during position detection at start.
Parameter 1-48 Current at Min Inductance for d-axis	20–200%	100%	Enter the inductance saturation point.
Parameter 1-49 Current at Min Inductance for q-axis	20–200%	100%	This parameter specifies the saturation curve of the d- and q-inductance values. From 20–100% of this parameter, the inductances are linearly approximated due to *parameter 1-37 d-axis Inductance (Ld)*, *parameter 1-38 q-axis Inductance (Lq)*, *parameter 1-44 d-axis Inductance Sat. (LdSat)*, and *parameter 1-45 q-axis Inductance Sat. (LqSat)*.
Parameter 1-70 Start Mode	[0] Rotor Detection [1] Parking	[0] Rotor Detection	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	[0] Disabled	Select *[1] Enabled* to enable the frequency converter to catch a spinning motor.
Parameter 3-41 Ramp 1 Ramp Up Time	0.05–3600.0 s	Size related	Ramp-up time from 0 to rated *parameter 1-23 Motor Frequency*.
Parameter 3-42 Ramp 1 Ramp Down Time	0.05–3600.0 s	Size related	Ramp-down time from rated *parameter 1-23 Motor Frequency* to 0.
Parameter 4-12 Motor Speed Low Limit [Hz]	0.0–400.0 Hz	0.0 Hz	Enter the minimum limit for low speed.
Parameter 4-14 Motor Speed High Limit [Hz]	0.0–400.0 Hz	100.0 Hz	Enter the maximum limit for high speed.
Parameter 4-19 Max Output Frequency	0.0–400.0 Hz	100.0 Hz	Enter the maximum output frequency value. If *parameter 4-19 Max Output Frequency* is set lower than *parameter 4-14 Motor Speed High Limit [Hz]*, *parameter 4-14 Motor Speed High Limit [Hz]* is set equal to *parameter 4-19 Max Output Frequency* automatically.

4

Parameter	Range	Default	Usage
Parameter 30-22 Locked Rotor Protection	*[0] Off* *[1] On*	*[0] Off*	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1.00 s	0.10 s	–

Table 4.6 Motor Set-up Wizard Settings

Changes made

The changes made function lists all parameters changed from default settings.

- The list shows only parameters that have been changed in the current edit set-up.

- Parameters that have been reset to default values are not listed.

- The message *Empty* indicates that no parameters have been changed.

Changing parameter settings

1. To enter the Quick Menu, press the [Menu] key until the indicator in the display is placed above Quick Menu.

2. Press [▲] [▼] to select the wizard, closed-loop set-up, motor set-up, or changes made.

3. Press [OK].

4. Press [▲] [▼] to browse through the parameters in the Quick Menu.

5. Press [OK] to select a parameter.

6. Press [▲] [▼] to change the value of a parameter setting.

7. Press [OK] to accept the change.

8. Press either [Back] twice to enter Status, or press [Menu] once to enter the Main Menu.

The main menu accesses all parameters

1. Press the [Menu] key until the indicator in the display is placed above Main Menu.

2. Press [▲] [▼] to browse through the parameter groups.

3. Press [OK] to select a parameter group.

4. Press [▲] [▼] to browse through the parameters in the specific group.

5. Press [OK] to select the parameter.

6. Press [▲] [▼] to set/change the parameter value.

7. Press [OK] to accept the change.

4.3 Parameter List

No.	Parameter
0-**	**Operation / Display**
0-0*	**Basic Settings**
0-01	Language
0-03	Regional Settings
0-04	Operating State at Power-up
0-06	GridType
0-07	Auto DC Braking
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	Link Setups
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
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
0-42	[Auto on] Key on LCP
0-44	[Off/Reset] 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
1-**	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-03	Torque Characteristics
1-06	Clockwise Direction
1-08	Motor Control Bandwidth
1-1*	**Motor Selection**
1-10	Motor Construction
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-29	Automatic Motor Adaption (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-33	Stator Leakage Reactance (X1)
1-35	Main Reactance (Xh)
1-37	d-axis Inductance (Ld)
1-38	q-axis Inductance (Lq)
1-39	Motor Poles
1-4*	**Adv. Motor Data II**
1-40	Back EMF at 1000 RPM
1-42	Motor Cable Length
1-43	Motor Cable Length Feet
1-44	d-axis Inductance Sat. (LdSat)
1-45	q-axis Inductance Sat. (LqSat)
1-46	Position Detection Gain
1-48	Current at Min Inductance for d-axis
1-49	Current at Min Inductance for q-axis
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-52	Min Speed Normal Magnetising [Hz]
1-55	U/f Characteristic - U
1-56	U/f Characteristic - F
1-6*	**Load Depen. Setting**
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-82	Min Speed for Function at Stop [Hz]
1-88	AC Brake Gain
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-93	Thermistor Source
2-**	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold/Motor Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-04	DC Brake Cut In Speed
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-16	AC Brake, Max current
2-17	Over-voltage Control
2-19	Over-voltage Gain
3-**	**Reference / Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
4-**	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-12	Motor Speed Low Limit [Hz]
4-14	Motor Speed High Limit [Hz]
4-18	Current Limit
4-19	Max Output Frequency
4-4*	**Adj. Warnings 2**
4-40	Warning Freq. Low
4-41	Warning Freq. High
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current 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
4-6*	**Speed Bypass**
4-61	Bypass Speed From [Hz]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
5-**	**Digital In/Out**
5-0*	**Digital I/O mode**
5-00	Digital Input Mode
5-03	Digital Input 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
5-3*	**Digital Outputs**
5-34	On Delay, Digital Output
5-35	Off Delay, Digital Output
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
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-02	Fire Mode Live Zero Timeout Function
6-1*	**Analog Input 53**
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
6-19	Terminal 53 mode
6-2*	**Analog Input 54**
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
6-29	Terminal 54 mode
6-7*	**Analog/Digital Output 45**
6-70	Terminal 45 Mode
6-71	Terminal 45 Analog Output
6-72	Terminal 45 Digital Output
6-73	Terminal 45 Output Min Scale
6-74	Terminal 45 Output Max Scale
6-76	Terminal 45 Output Bus Control
6-9*	**Analog/Digital Output 42**
6-90	Terminal 42 Mode
6-91	Terminal 42 Analog Output
6-92	Terminal 42 Digital Output
6-93	Terminal 42 Output Min Scale
6-94	Terminal 42 Output Max Scale
6-98	Drive Type
8-**	**Comm. and Options**
8-0*	**General Settings**
8-01	Control Site
8-02	Control Source
8-03	Control Timeout Time
8-04	Control Timeout Function
8-3*	**FC Port Settings**
8-30	Protocol
8-31	Address
8-32	Baud Rate
8-33	Parity / Stop Bits
8-35	Minimum Response Delay
8-36	Maximum Response Delay
8-37	Maximum Inter-char delay
8-4*	**FC MC protocol set**
8-42	PCD Write Configuration
8-43	PCD Read Configuration
8-5*	**Digital/Bus**
8-50	Coasting Select
8-51	Quick Stop Select
8-52	DC Brake Select
8-53	Start Select
8-54	Reversing Select
8-55	Set-up Select
8-56	Preset Reference Select
8-7*	**BACnet**
8-70	BACnet Device Instance
8-72	MS/TP Max Masters
8-73	MS/TP Max Info Frames
8-74	"I am" Service
8-75	Intialisation Password
8-79	Protocol Firmware version
8-8*	**FC Port Diagnostics**
8-80	Bus Message Count
8-81	Bus Error Count
8-82	Slave Messages Rcvd
8-83	Slave Error Count
8-84	Slave Messages Sent
8-85	Slave Timeout Errors
8-88	Reset FC port Diagnostics
8-9*	**Bus Feedback**
8-94	Bus Feedback 1
8-95	Bus Feedback 2
13-**	**Smart Logic**
13-0*	**SLC Settings**
13-00	SL Controller Mode
13-01	Start Event
13-02	Stop Event
13-03	Reset SLC
13-1*	**Comparators**
13-10	Comparator Operand
13-11	Comparator Operator
13-12	Comparator Value
13-2*	**Timers**
13-20	SL Controller Timer
13-4*	**Logic Rules**
13-40	Logic Rule Boolean 1
13-41	Logic Rule Operator 1
13-42	Logic Rule Boolean 2
13-43	Logic Rule Operator 2
13-44	Logic Rule Boolean 3
13-5*	**States**
13-51	SL Controller Event
13-52	SL Controller Action
14-**	**Special Functions**
14-0*	**Inverter Switching**
14-01	Switching Frequency
14-03	Overmodulation
14-07	Dead Time Compensation Level
14-08	Damping Gain Factor
14-09	Dead Time Bias Current Level
14-1*	**Mains Failure**
14-10	Mains Failure
14-11	Mains Fault Voltage Level
14-12	Response to Mains Imbalance
14-15	Kin. Back-up Trip Recovery Level
14-2*	**Reset Functions**
14-20	Reset Mode
14-21	Automatic Restart Time
14-22	Operation Mode
14-23	Typecode Setting
14-27	Action At Inverter Fault
14-28	Production Settings
14-29	Service Code
14-3*	**Current Limit Ctrl.**
14-30	Current Lim Ctrl, Proportional Gain
14-31	Current Lim Ctrl, Integration Time
14-32	Current Lim Ctrl, Filter Time

14-4* Energy Optimising	16-09 Custom Readout	20-03 Feedback 2 Source	24-01 Fire Mode Configuration
14-40 VT Level	**16-1* Motor Status**	20-04 Feedback 2 Conversion	24-05 FM Preset Reference
14-41 AEO Minimum Magnetisation	16-10 Power [kW]	20-12 Reference/Feedback Unit	24-06 Fire Mode Reference Source
14-44 d-axis current optimization for IPM	16-11 Power [hp]	**20-2* Feedback/Setpoint**	24-07 Fire Mode Feedback Source
14-5* Environment	16-12 Motor Voltage	20-20 Feedback Function	24-09 FM Alarm Handling
14-50 RFI Filter	16-13 Frequency	20-21 Setpoint 1	**24-1* Drive Bypass**
14-51 DC-Link Voltage Compensation	16-14 Motor current	**20-6* Sensorless**	24-10 Drive Bypass Function
14-52 Fan Control	16-15 Frequency [%]	20-60 Sensorless Unit	24-11 Drive Bypass Delay Time
14-53 Fan Monitor	16-16 Torque [Nm]	20-69 Sensorless Information	**30-** Special Features**
14-55 Output Filter	16-17 Speed [RPM]	**20-8* PI Basic Settings**	**30-2* Adv. Start Adjust**
14-6* Auto Derate	16-18 Motor Thermal	20-81 PI Normal/ Inverse Control	30-22 Locked Rotor Protection
14-61 Function at Inverter Overload	16-22 Torque [%]	20-83 PI Start Speed [Hz]	30-23 Locked Rotor Detection Time [s]
14-63 Min Switch Frequency	16-26 Power Filtered [kW]	20-84 On Reference Bandwidth	**30-5* Unit Configuration**
14-64 Dead Time Compensation Zero Current Level	16-27 Power Filtered [hp]	**20-9* PI Controller**	30-58 LockPassword
14-65 Speed Derate Dead Time Compensation	**16-3* Drive Status**	20-91 PI Anti Windup	
14-9* Fault Settings	16-30 DC Link Voltage	20-93 PI Proportional Gain	
14-90 Fault Level	16-34 Heatsink Temp.	20-94 PI Integral Time	
15-** Drive Information	16-35 Inverter Thermal	20-97 PI Feed Forward Factor	
15-0* Operating Data	16-36 Inv. Nom. Current	**22-** Appl. Functions**	
15-00 Operating hours	16-37 Inv. Max. Current	**22-0* Miscellaneous**	
15-01 Running Hours	16-38 SL Controller State	22-01 Power Filter Time	
15-02 kWh Counter	**16-5* Ref. & Feedb.**	22-02 Sleepmode CL Control Mode	
15-03 Power Up's	16-50 External Reference	**22-2* No-Flow Detection**	
15-04 Over Temp's	16-52 Feedback[Unit]	22-23 No-Flow Function	
15-05 Over Volt's	16-54 Feedback 1 [Unit]	22-24 No-Flow Delay	
15-06 Reset kWh Counter	16-55 Feedback 2 [Unit]	**22-3* No-Flow Power Tuning**	
15-07 Reset Running Hours Counter	**16-6* Inputs & Outputs**	22-30 No-Flow Power	
15-3* Alarm Log	16-60 Digital Input	22-31 Power Correction Factor	
15-30 Alarm Log: Error Code	16-61 Terminal 53 Setting	22-33 Low Speed [Hz]	
15-31 InternalFaultReason	16-62 Analog input 53	22-34 Low Speed Power [kW]	
15-4* Drive Identification	16-63 Terminal 54 Setting	22-37 High Speed [Hz]	
15-40 FC Type	16-64 Analog input 54	22-38 High Speed Power [kW]	
15-41 Power Section	16-65 Analog output 42 [mA]	**22-4* Sleep Mode**	
15-42 Voltage	16-66 Digital Output	22-40 Minimum Run Time	
15-43 Software Version	16-67 Pulse input 29 [Hz]	22-41 Minimum Sleep Time	
15-44 Ordered TypeCode	16-71 Relay output	22-43 Wake-Up Speed [Hz]	
15-45 Actual Typecode String	16-72 Counter A	22-44 Wake-Up Ref./FB Diff	
15-46 Drive Ordering No	16-73 Counter B	22-45 Setpoint Boost	
15-48 LCP Id No	16-79 Analog output 45 [mA]	22-46 Maximum Boost Time	
15-49 SW ID Control Card	**16-8* Fieldbus & FC Port**	22-47 Sleep Speed [Hz]	
15-50 SW ID Power Card	16-86 FC Port REF 1	22-48 Sleep Delay Time	
15-51 Drive Serial Number	**16-9* Diagnosis Readouts**	22-49 Wake-Up Delay Time	
15-52 OEM Information	16-90 Alarm Word	**22-6* Broken Belt Detection**	
15-53 Power Card Serial Number	16-91 Alarm Word 2	22-60 Broken Belt Function	
15-57 File Version	16-92 Warning Word	22-61 Broken Belt Torque	
15-59 Filename	16-93 Warning Word 2	22-62 Broken Belt Delay	
15-9* Parameter Info	16-94 Ext. Status Word	**22-8* Flow Compensation**	
15-92 Defined Parameters	16-95 Ext. Status Word 2	22-80 Flow Compensation	
15-97 Application Type	16-97 Alarm Word 3	22-81 Square-linear Curve Approximation	
15-98 Drive Identification	16-98 Warning Word 3	22-82 Work Point Calculation	
16-** Data Readouts	**18-** Info & Readouts**	22-84 Speed at No-Flow [Hz]	
16-0* General Status	**18-1* Fire Mode Log**	22-86 Speed at Design Point [Hz]	
16-00 Control Word	18-10 FireMode Log:Event	22-87 Pressure at No-Flow Speed	
16-01 Reference [Unit]	**18-5* Ref. & Feedb.**	22-88 Pressure at Rated Speed	
16-02 Reference [%]	18-50 Sensorless Readout [unit]	22-89 Flow at Design Point	
16-03 Status Word	**20-** Drive Closed Loop**	22-90 Flow at Rated Speed	
16-05 Main Actual Value [%]	**20-0* Feedback**	**24-** Appl. Functions 2**	
	20-00 Feedback 1 Source	**24-0* Fire Mode**	
	20-01 Feedback 1 Conversion	24-00 FM Function	

5 Warnings and Alarms

Fault number	Alarm/ warning bit number	Fault text	Warning	Alarm	Trip locked	Cause of problem
2	16	Live zero error	X	X	–	The signal on terminal 53 or 54 is less than 50% of the value set in *parameter 6-10 Terminal 53 Low Voltage*, *parameter 6-12 Terminal 53 Low Current*, *parameter 6-20 Terminal 54 Low Voltage*, or *parameter 6-22 Terminal 54 Low Current*. See also *parameter group 6-0* Analog I/O Mode*.
4	14	Mains ph. loss	X	X	X	Missing phase on the supply side or too high voltage imbalance. Check the supply voltage. See *parameter 14-12 Response to Mains Imbalance*.
7	11	DC over volt	X	X	–	DC-link voltage exceeds the limit.
8	10	DC under volt	X	X	–	DC-link voltage drops below voltage warning low-limit.
9	9	Inverter overload	X	X	–	More than 100% load for a long time.
10	8	Motor ETR over	X	X	–	The motor is too hot due to more than 100% load for a long time. See *parameter 1-90 Motor Thermal Protection*.
11	7	Motor th over	X	X	–	Thermistor or thermistor connection is disconnected. See *parameter 1-90 Motor Thermal Protection*.
13	5	Over Current	X	X	X	Inverter peak current limit is exceeded.
14	2	Earth Fault	–	X	X	Discharge from output phases to ground.
16	12	Short Circuit	–	X	X	Short circuit in motor or on motor terminals.
17	4	Ctrl. word TO	X	X	–	No communication to frequency converter. See *parameter group 8-0* General Settings*.
24	50	Fan Fault	X	X	–	The heat sink cooling fan is not working (only on 400 V, 30–90 kW units).
30	19	U phase loss	–	X	X	Motor phase U is missing. Check the phase. See *parameter 4-58 Missing Motor Phase Function*.
31	20	V phase loss	–	X	X	Motor phase V is missing. Check the phase. See *parameter 4-58 Missing Motor Phase Function*.
32	21	W phase loss	–	X	X	Motor phase W is missing. Check the phase. See *parameter 4-58 Missing Motor Phase Function*.
38	17	Internal fault	–	X	X	Contact the local Danfoss supplier.
44	28	Earth Fault	–	X	X	Discharge from output phases to ground, using the value of *parameter 15-31 InternalFaultReason* if possible.
46	33	Control Voltage Fault	–	X	X	Control voltage is low. Contact the local Danfoss supplier.
47	23	24 V supply low	X	X	X	24 V DC supply may be overloaded.
50		AMA calibration failed	–	X	–	Contact the local Danfoss supplier.
51	15	AMA Unom,Inom	–	X	–	The setting of motor voltage, motor current, and motor power is wrong. Check the settings.
52	–	AMA low Inom	–	X	–	The motor current is too low. Check the settings.
53	–	AMA big motor	–	X	–	The motor is too big to perform AMA.
54	–	AMA small mot	–	X	–	The motor is too small to perform AMA.
55	–	AMA par. range	–	X	–	The parameter values found from the motor are outside the acceptable range.

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Fault number	Alarm/ warning bit number	Fault text	Warning	Alarm	Trip locked	Cause of problem
56	–	AMA user interrupt	–	X	–	The AMA has been interrupted by the user.
57	–	AMA timeout	–	X	–	Try to start the AMA again a number of times, until the AMA is carried out. **NOTICE!** **Repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. In most cases, however, this is not critical.**
58	–	AMA internal	X	X	–	Contact the local Danfoss supplier.
59	25	Current limit	X	–	–	The current is higher than the value in *parameter 4-18 Current Limit*.
60	44	External Interlock	–	X	–	External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the frequency converter (via serial communication, digital I/O, or by pressing the [Reset] key on the LCP).
66	26	Heat sink Temperature Low	X	–	–	This warning is based on the temperature sensor in the IGBT module (on 400 V, 30–90 kW (40–125 hp) and 600 V units).
69	1	Pwr. Card Temp	X	X	X	The temperature sensor on the power card exceeds the upper or lower limits.
70	36	Illegal FC configu-ration	–	X	X	The control card and power card are not matched.
79	–	Illegal power section configu-ration	X	X	–	Internal fault. Contact the local Danfoss supplier.
80	29	Drive initialised	–	X	–	All parameter settings are initialized to default settings.
87	47	Auto DC Braking	X		–	The frequency converter is auto DC braking.
95	40	Broken Belt	X	X	–	Torque is below the torque level set for no load, indicating a broken belt. See *parameter group 22-6* Broken Belt Detection*.
126	–	Motor Rotating	–	X	–	High back EMF voltage. Stop the rotor of the PM motor.
200	–	Fire Mode	X	–	–	Fire mode has been activated.
202	–	Fire Mode Limits Exceeded	X	–	–	Fire mode has suppressed 1 or more warranty voiding alarms.
250	–	New sparepart	–	X	X	The power or switch mode power supply has been exchanged (on 400 V, 30–90 kW (40–125 hp) and 600 V units). Contact the local Danfoss supplier.
251	–	New Typecode	–	X	X	The frequency converter has a new type code (on 400 V, 30–90 kW (40–125 hp) and 600 V units). Contact the local Danfoss supplier.

Table 5.1 Warnings and Alarms

6 Specifications

6.1 Mains Supply

6.1.1 3x200–240 V AC

Frequency converter	PK25	PK37	PK75	P1K5	P2K2	P3K7	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K
Typical shaft output [kW]	0.25	0.37	0.75	1.5	2.2	3.7	5.5	7.5	11.0	15.0	18.5	22.0	30.0	37.0	45.0
Typical shaft output [hp]	0.33	0.5	1.0	2.0	3.0	5.0	7.5	10.0	15.0	20.0	25.0	30.0	40.0	50.0	60.0
Enclosure protection rating IP20	H1	H1	H1	H1	H2	H3	H4	H4	H5	H6	H6	H7	H7	H8	H8
Maximum cable size in terminals (mains, motor) [mm² (AWG)]	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	16 (6)	16 (6)	16 (6)	35 (2)	35 (2)	50 (1)	50 (1)	95 (0)	120 (4/0)
Output current															
40 °C (104 °F) ambient temperature															
Continuous (3x200–240 V) [A]	1.5	2.2	4.2	6.8	9.6	15.2	22.0	28.0	42.0	59.4	74.8	88.0	115.0	143.0	170.0
Intermittent (3x200–240 V) [A]	1.7	2.4	4.6	7.5	10.6	16.7	24.2	30.8	46.2	65.3	82.3	96.8	126.5	157.3	187.0
Maximum input current															
Continuous (3x200–240 V) [A]	1.1	1.6	2.8	5.6	8.6/ 7.2	14.1/ 12.0	21.0/ 18.0	28.3/ 24.0	41.0/ 38.2	52.7	65.0	76.0	103.7	127.9	153.0
Intermittent (3x200–240 V) [A]	1.2	1.8	3.1	6.2	9.5/ 7.9	15.5/ 13.2	23.1/ 19.8	31.1/ 26.4	45.1/ 42.0	58.0	71.5	83.7	114.1	140.7	168.3
Maximum mains fuses	See *chapter 3.2.3 Fuses and Circuit Breakers*.														
Estimated power loss [W], Best case/typical[1)	12/ 14	15/ 18	21/ 26	48/ 60	80/ 102	97/ 120	182/ 204	229/ 268	369/ 386	512	697	879	1149	1390	1500
Weight enclosure protection rating IP20 [kg (lb)]	2.0 (4.4)	2.0 (4.4)	2.0 (4.4)	2.1 (4.6)	3.4 (7.5)	4.5 (9.9)	7.9 (17.4)	7.9 (17.4)	9.5 (20.9)	24.5 (54)	24.5 (54)	36.0 (79.4)	36.0 (79.4)	51.0 (112.4)	51.0 (112.4)
Efficiency [%], best case/typical[2)	97.0/ 96.5	97.3/ 96.8	98.0/ 97.6	97.6/ 97.0	97.1/ 96.3	97.9/ 97.4	97.3/ 97.0	98.5/ 97.1	97.2/ 97.1	97.0	97.1	96.8	97.1	97.1	97.3
Output current															
50 °C (122 °F) ambient temperature															
Continuous (3x200–240 V) [A]	1.5	1.9	3.5	6.8	9.6	13.0	19.8	23.0	33.0	41.6	52.4	61.6	80.5	100.1	119
Intermittent (3x200–240 V) [A]	1.7	2.1	3.9	7.5	10.6	14.3	21.8	25.3	36.3	45.8	57.6	67.8	88.6	110.1	130.9

Table 6.1 3x200–240 V AC, 0.25–45 kW (0.33–60 hp)

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Efficiency measured at nominal current. For energy efficiency class, see chapter 6.4.12 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

6.1.2 3x380–480 V AC

Frequency converter	PK37	PK75	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5	P11K	P15K
Typical shaft output [kW]	0.37	0.75	1.5	2.2	3.0	4.0	5.5	7.5	11.0	15.0
Typical shaft output [hp]	0.5	1.0	2.0	3.0	4.0	5.0	7.5	10.0	15.0	20.0
Enclosure protection rating IP20	H1	H1	H1	H2	H2	H2	H3	H3	H4	H4
Maximum cable size in terminals (mains, motor) [mm^2 (AWG)]	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	16 (6)	16 (6)
Output current - 40 °C (104 °F) ambient temperature										
Continuous (3x380–440 V)[A]	1.2	2.2	3.7	5.3	7.2	9.0	12.0	15.5	23.0	31.0
Intermittent (3x380–440 V) [A]	1.3	2.4	4.1	5.8	7.9	9.9	13.2	17.1	25.3	34.0
Continuous (3x441–480 V) [A]	1.1	2.1	3.4	4.8	6.3	8.2	11.0	14.0	21.0	27.0
Intermittent (3x441–480 V) [A]	1.2	2.3	3.7	5.3	6.9	9.0	12.1	15.4	23.1	29.7
Maximum input current										
Continuous (3x380–440 V) [A]	1.2	2.1	3.5	4.7	6.3	8.3	11.2	15.1	22.1	29.9
Intermittent (3x380–440 V) [A]	1.3	2.3	3.9	5.2	6.9	9.1	12.3	16.6	24.3	32.9
Continuous (3x441–480 V) [A]	1.0	1.8	2.9	3.9	5.3	6.8	9.4	12.6	18.4	24.7
Intermittent (3x441–480 V) [A]	1.1	2.0	3.2	4.3	5.8	7.5	10.3	13.9	20.2	27.2
Maximum mains fuses	See *chapter 3.2.3 Fuses and Circuit Breakers*.									
Estimated power loss [W], best case/typical[1]	13/15	16/21	46/57	46/58	66/83	95/118	104/131	159/198	248/274	353/379
Weight enclosure protection rating IP20 [kg (lb)]	2.0 (4.4)	2.0 (4.4)	2.1 (4.6)	3.3 (7.3)	3.3 (7.3)	3.4 (7.5)	4.3 (9.5)	4.5 (9.9)	7.9 (17.4)	7.9 (17.4)
Efficiency [%], best case/typical[2]	97.8/97.3	98.0/97.6	97.7/97.2	98.3/97.9	98.2/97.8	98.0/97.6	98.4/98.0	98.2/97.8	98.1/ 97.9	98.0/ 97.8
Output current - 50 °C (122 °F) ambient temperature										
Continuous (3x380–440 V) [A]	1.04	1.93	3.7	4.85	6.3	8.4	10.9	14.0	20.9	28.0
Intermittent (3x380–440 V) [A]	1.1	2.1	4.07	5.4	6.9	9.2	12.0	15.4	23.0	30.8
Continuous (3x441–480 V) [A]	1.0	1.8	3.4	4.4	5.5	7.5	10.0	12.6	19.1	24.0
Intermittent (3x441–480 V) [A]	1.1	2.0	3.7	4.8	6.1	8.3	11.0	13.9	21.0	26.4

Table 6.2 3x380–480 V AC, 0.37–15 kW (0.5–20 hp), Enclosure Sizes H1–H4

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Typical: under rated condition.

Best case: the optimal condition is adopt, such as the higher input voltage and lower switching frequency.

Frequency converter	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	18.5	22.0	30.0	37.0	45.0	55.0	75.0	90.0
Typical shaft output [hp]	25.0	30.0	40.0	50.0	60.0	70.0	100.0	125.0
Enclosure protection rating IP20	H5	H5	H6	H6	H6	H7	H7	H8
Maximum cable size in terminals (mains, motor) [mm² (AWG)]	16 (6)	16 (6)	35 (2)	35 (2)	35 (2)	50 (1)	95 (0)	120 (250MCM)
Output current - 40 °C (104 °F) ambient temperature								
Continuous (3x380–440 V)[A]	37.0	42.5	61.0	73.0	90.0	106.0	147.0	177.0
Intermittent (3x380–440 V) [A]	40.7	46.8	67.1	80.3	99.0	116.0	161.0	194.0
Continuous (3x441–480 V) [A]	34.0	40.0	52.0	65.0	80.0	105.0	130.0	160.0
Intermittent (3x441–480 V) [A]	37.4	44.0	57.2	71.5	88.0	115.0	143.0	176.0
Maximum input current								
Continuous (3x380–440 V) [A]	35.2	41.5	57.0	70.0	84.0	103.0	140.0	166.0
Intermittent (3x380–440 V) [A]	38.7	45.7	62.7	77.0	92.4	113.0	154.0	182.0
Continuous (3x441–480 V) [A]	29.3	34.6	49.2	60.6	72.5	88.6	120.9	142.7
Intermittent (3x441–480 V) [A]	32.2	38.1	54.1	66.7	79.8	97.5	132.9	157.0
Maximum mains fuses	See *chapter 3.2.3 Fuses and Circuit Breakers*.							
Estimated power loss [W], best case/typical[1]	412/456	475/523	733	922	1067	1133	1733	2141
Weight enclosure protection rating IP20 [kg (lb)]	9.5 (20.9)	9.5 (20.9)	24.5 (54)	24.5 (54)	24.5 (54)	36.0 (79.4)	36.0 (79.4)	51.0 (112.4)
Efficiency [%], best case/typical[2]	98.1/97.9	98.1/97.9	97.8	97.7	98	98.2	97.8	97.9
Output current - 50 °C (122 °F) ambient temperature								
Continuous (3x380–440 V) [A]	34.1	38.0	48.8	58.4	72.0	74.2	102.9	123.9
Intermittent (3x380–440 V) [A]	37.5	41.8	53.7	64.2	79.2	81.6	113.2	136.3
Continuous (3x441–480 V) [A]	31.3	35.0	41.6	52.0	64.0	73.5	91.0	112.0
Intermittent (3x441–480 V) [A]	34.4	38.5	45.8	57.2	70.4	80.9	100.1	123.2

Table 6.3 3x380–480 V AC, 18.5–90 kW (25–125 hp), Enclosure Sizes H5–H8

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Efficiency measured at nominal current. For energy efficiency class, see chapter 6.4.12 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

Frequency converter	PK75	P1K5	P2K2	P3K0	P4KO	P5K5	P7K5	P11K	P15K	P18K
Typical shaft output [kW]	0.75	1.5	2.2	3.0	4.0	5.5	7.5	11	15	18.5
Typical shaft output [hp]	1.0	2.0	3.0	4.0	5.0	7.5	10.0	15	20	25
Enclosure protection rating IP54	I2	I2	I2	I2	I2	I3	I3	I4	I4	I4
Maximum cable size in terminals (mains, motor) [mm² (AWG)]	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	16 (6)	16 (6)	16 (6)
Output current										
40 °C (104 °F) ambient temperature										
Continuous (3x380–440 V) [A]	2.2	3.7	5.3	7.2	9.0	12.0	15.5	23.0	31.0	37.0
Intermittent (3x380–440 V) [A]	2.4	4.1	5.8	7.9	9.9	13.2	17.1	25.3	34.0	40.7
Continuous (3x441–480 V) [A]	2.1	3.4	4.8	6.3	8.2	11.0	14.0	21.0	27.0	34.0
Intermittent (3x441–480 V) [A]	2.3	3.7	5.3	6.9	9.0	12.1	15.4	23.1	29.7	37.4
Maximum input current										
Continuous (3x380–440 V) [A]	2.1	3.5	4.7	6.3	8.3	11.2	15.1	22.1	29.9	35.2
Intermittent (3x380–440 V) [A]	2.3	3.9	5.2	6.9	9.1	12.3	16.6	24.3	32.9	38.7
Continuous (3x441–480 V) [A]	1.8	2.9	3.9	5.3	6.8	9.4	12.6	18.4	24.7	29.3
Intermittent (3x441–480 V) [A]	2.0	3.2	4.3	5.8	7.5	10.3	13.9	20.2	27.2	32.2
Maximum mains fuses	See chapter 3.2.3 Fuses and Circuit Breakers.									
Estimated power loss [W], best case/typical[1]	21/16	46/57	46/58	66/83	95/118	104/131	159/198	248/274	353/379	412/456
Weight enclosure protection rating IP54 [kg (lb)]	5.3 (11.7)	5.3 (11.7)	5.3 (11.7)	5.3 (11.7)	5.3 (11.7)	7.2 (15.9)	7.2 (15.9)	13.8 (30.4)	13.8 (30.4)	13.8 (30.4)
Efficiency [%], best case/typical[2]	98.0/97.6	97.7/97.2	98.3/97.9	98.2/97.8	98.0/97.6	98.4/98.0	98.2/97.8	98.1/97.9	98.0/97.8	98.1/97.9
Output current - 50 °C (122 °F) ambient temperature										
Continuous (3x380–440 V) [A]	1.93	3.7	4.85	6.3	7.5	10.9	14.0	20.9	28.0	33.0
Intermittent (3x380–440 V) [A]	2.1	4.07	5.4	6.9	9.2	12.0	15.4	23.0	30.8	36.3
Continuous (3x441–480 V) [A]	1.8	3.4	4.4	5.5	6.8	10.0	12.6	19.1	24.0	30.0
Intermittent (3x441–480 V) [A]	2.0	3.7	4.8	6.1	8.3	11.0	13.9	21.0	26.4	33.0

Table 6.4 3x380–480 V AC, 0.75–18.5 kW (1–25 hp), Enclosure Sizes I2–I4

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Efficiency measured at nominal current. For energy efficiency class, see chapter 6.4.12 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

Frequency converter	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	22.0	30.0	37.0	45.0	55.0	75.0	90.0
Typical shaft output [hp]	30.0	40.0	50.0	60.0	70.0	100.0	125.0
Enclosure protection rating IP54	I6	I6	I6	I7	I7	I8	I8
Maximum cable size in terminals (mains, motor) [mm² (AWG)]	35 (2)	35 (2)	35 (2)	50 (1)	50 (1)	95 (3/0)	120 (4/0)
Output current							
40 °C (104 °F) ambient temperature							
Continuous (3x380–440 V) [A]	44.0	61.0	73.0	90.0	106.0	147.0	177.0
Intermittent (3x380–440 V) [A]	48.4	67.1	80.3	99.0	116.6	161.7	194.7
Continuous (3x441–480 V) [A]	40.0	52.0	65.0	80.0	105.0	130.0	160.0
Intermittent (3x441–480 V) [A]	44.0	57.2	71.5	88.0	115.5	143.0	176.0
Maximum input current							
Continuous (3x380–440 V) [A]	41.8	57.0	70.3	84.2	102.9	140.3	165.6
Intermittent (3x380–440 V) [A]	46.0	62.7	77.4	92.6	113.1	154.3	182.2
Continuous (3x441–480 V) [A]	36.0	49.2	60.6	72.5	88.6	120.9	142.7
Intermittent (3x441–480 V) [A]	39.6	54.1	66.7	79.8	97.5	132.9	157.0
Maximum mains fuses							
Estimated power loss [W], best case/typical[1]	496	734	995	840	1099	1520	1781
Weight enclosure protection rating IP54 [kg (lb)]	27 (59.5)	27 (59.5)	27 (59.5)	45 (99.2)	45 (99.2)	65 (143.3)	65 (143.3)
Efficiency [%], best case/typical[2]	98.0	97.8	97.6	98.3	98.2	98.1	98.3
Output current - 50 °C (122 °F) ambient temperature							
Continuous (3x380–440 V) [A]	35.2	48.8	58.4	63.0	74.2	102.9	123.9
Intermittent (3x380–440 V) [A]	38.7	53.9	64.2	69.3	81.6	113.2	136.3
Continuous (3x441–480 V) [A]	32.0	41.6	52.0	56.0	73.5	91.0	112.0
Intermittent (3x441–480 V) [A]	35.2	45.8	57.2	61.6	80.9	100.1	123.2

Table 6.5 3x380–480 V AC, 22–90 kW (30–125 hp), Enclosure Sizes I6–I8

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Efficiency measured at nominal current. For energy efficiency class, see chapter 6.4.12 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

6.1.3 3x525–600 V AC

Frequency converter	P2K2	P3K0	P3K7	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	2.2	3.0	3.7	5.5	7.5	11.0	15.0	18.5	22.0	30.0	37	45.0	55.0	75.0	90.0
Typical shaft output [hp]	3.0	4.0	5.0	7.5	10.0	15.0	20.0	25.0	30.0	40.0	50.0	60.0	70.0	100.0	125.0
Enclosure protection rating IP20	H9	H9	H9	H9	H9	H10	H10	H6	H6	H6	H7	H7	H7	H8	H8
Maximum cable size in terminals (mains, motor) [mm² (AWG)]	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	10 (8)	10 (8)	35 (2)	35 (2)	35 (2)	50 (1)	50 (1)	50 (1)	95 (0)	120 (4/0)
Output current - 40 °C (104 ° F) ambient temperature															
Continuous (3x525–550 V) [A]	4.1	5.2	6.4	9.5	11.5	19.0	23.0	28.0	36.0	43.0	54.0	65.0	87.0	105.0	137.0
Intermittent (3x525–550 V) [A]	4.5	5.7	7.0	10.5	12.7	20.9	25.3	30.8	39.6	47.3	59.4	71.5	95.7	115.5	150.7
Continuous (3x551–600 V) [A]	3.9	4.9	6.1	9.0	11.0	18.0	22.0	27.0	34.0	41.0	52.0	62.0	83.0	100.0	131.0
Intermittent (3x551–600 V) [A]	4.3	5.4	6.7	9.9	12.1	19.8	24.2	29.7	37.4	45.1	57.2	68.2	91.3	110.0	144.1
Maximum input current															
Continuous (3x525–550 V) [A]	3.7	5.1	5.0	8.7	11.9	16.5	22.5	27.0	33.1	45.1	54.7	66.5	81.3	109.0	130.9
Intermittent (3x525–550 V) [A]	4.1	5.6	6.5	9.6	13.1	18.2	24.8	29.7	36.4	49.6	60.1	73.1	89.4	119.9	143.9
Continuous (3x551–600 V) [A]	3.5	4.8	5.6	8.3	11.4	15.7	21.4	25.7	31.5	42.9	52.0	63.3	77.4	103.8	124.5
Intermittent (3x551–600 V) [A]	3.9	5.3	6.2	9.2	12.5	17.3	23.6	28.3	34.6	47.2	57.2	69.6	85.1	114.2	137.0
Maximum mains fuses	See *chapter 3.2.3 Fuses and Circuit Breakers.*														
Estimated power loss [W], best case/typical[1]	65	90	110	132	180	216	294	385	458	542	597	727	1092	1380	1658
Weight enclosure protection rating IP54 [kg (lb)]	6.6 (14.6)	6.6 (14.6)	6.6 (14.6)	6.6 (14.6)	6.6 (14.6)	11.5 (25.3)	11.5 (25.3)	24.5 (54)	24.5 (54)	24.5 (54)	36.0 (79.3)	36.0 (79.3)	36.0 (79.3)	51.0 (112.4)	51.0 (112.4)
Efficiency [%], best case/typical[2]	97.9	97	97.9	98.1	98.1	98.4	98.4	98.4	98.4	98.5	98.5	98.7	98.5	98.5	98.5
Output current - 50 °C (122 °F) ambient temperature															
Continuous (3x525–550 V) [A]	2.9	3.6	4.5	6.7	8.1	13.3	16.1	19.6	25.2	30.1	37.8	45.5	60.9	73.5	95.9
Intermittent (3x525–550 V) [A]	3.2	4.0	4.9	7.4	8.9	14.6	17.7	21.6	27.7	33.1	41.6	50.0	67.0	80.9	105.5
Continuous (3x551–600 V) [A]	2.7	3.4	4.3	6.3	7.7	12.6	15.4	18.9	23.8	28.7	36.4	43.3	58.1	70.0	91.7
Intermittent (3x551–600 V) [A]	3.0	3.7	4.7	6.9	8.5	13.9	16.9	20.8	26.2	31.6	40.0	47.7	63.9	77.0	100.9

Table 6.6 3x525–600 V AC, 2.2–90 kW (3–125 hp), Enclosure Sizes H6–H10

1) 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 drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

2) Efficiency measured at nominal current. For energy efficiency class, see chapter 6.4.12 Ambient Conditions. For part load losses, see drives.danfoss.com/knowledge-center/energy-efficiency-directive/#/.

6.2 EMC Emission Test Results

6.2.1 EMC Emission Test Results

The following test results have been obtained using a system with a frequency converter, a shielded control cable, a control box with potentiometer, and a shielded motor cable.

RFI filter type	Conduct emission. Maximum shielded cable length [m (ft)]						Radiated emission			
	Industrial environment									
EN 55011	Class A Group 2 Industrial environment		Class A Group 1 Industrial environment		Class B Housing, trades and light industries		Class A Group 1 Industrial environment		Class B Housing, trades and light industries	
EN/IEC 61800-3	Category C3 Second environment Industrial		Category C2 First environment Home and office		Category C1 First environment Home and office		Category C2 First environment Home and office		Category C1 First environment Home and office	
	Without external filter	With external filter	Without external filter	With external filter	Without external filter	With external filter	Without external filter	With external filter	Without external filter	With external filter
H4 RFI filter (EN55011 A1, EN/IEC61800-3 C2)										
0.25–11 kW (0.34–15 hp) 3x200–240 V IP20	–	–	25 (82)	50 (164)	–	20 (66)	Yes	Yes	–	No
0.37–22 kW (0.5–30 hp) 3x380–480 V IP20	–	–	25 (82)	50 (164)	–	20 (66)	Yes	Yes	–	No
H2 RFI filter (EN 55011 A2, EN/IEC 61800-3 C3)										
15–45 kW (20–60 hp) 3x200–240 V IP20	25 (82)	–	–	–	–	–	No	–	No	–
30–90 kW (40–120 hp) 3x380–480 V IP20	25 (82)	–	–	–	–	–	No	–	No	–
0.75–18.5 kW (1–25 hp) 3x380–480 V IP54	25 (82)	–	–	–	–	–	Yes	–	–	–
22–90 kW (30–120 hp) 3x380–480 V IP54	25 (82)	–	–	–	–	–	No	–	No	–
H3 RFI filter (EN55011 A1/B, EN/IEC 61800-3 C2/C1)										
15–45 kW (20–60 hp) 3x200–240 V IP20	–	–	50 (164)	–	20 (66)	–	Yes	–	No	–

RFI filter type	Conduct emission. Maximum shielded cable length [m (ft)]						Radiated emission			
	Industrial environment									
30–90 kW (40–120 hp) 3x380–480 V IP20	–	–	50 (164)	–	20 (66)	–	Yes	–	No	–
0.75–18.5 kW (1–25 hp) 3x380–480 V IP54	–	–	25 (82)	–	10 (33)	–	Yes	–	–	–
22–90 kW (30–120 hp) 3x380–480 V IP54	–	–	25 (82)	–	10 (33)	–	Yes	–	No	–

Table 6.7 EMC Emission Test Results

6

6.3 Special Conditions

6.3.1 Derating for Ambient Temperature and Switching Frequency

Ensure that the ambient temperature measured over 24 hours is at least 5 °C (41 °F) lower than the maximum ambient temperature that is specified for the frequency converter. If the frequency converter is operated at a high ambient temperature, decrease the continuous output current. For derating curve, see *VLT® HVAC Basic Drive FC 101 Design Guide*.

6.3.2 Derating for Low Air Pressure and High Altitudes

The cooling capability of air is decreased at low air pressure. For altitudes above 2000 m (6562 ft), contact Danfoss regarding PELV. Below 1000 m (3281 ft) altitude, derating is not necessary. For altitudes above 1000 m (3281 ft), decrease the ambient temperature or the maximum output current. Decrease the output by 1% per 100 m (328 ft) altitude above 1000 m (3281 ft) or reduce the maximum ambient temperature by 1 °C (33.8 °F) per 200 m (656 ft).

6.4 General Technical Data

Protection and features

- Electronic motor thermal protection against overload.

- Temperature monitoring of the heat sink ensures that the frequency converter trips if there is overtemperature.

- The frequency converter is protected against short circuits between motor terminals U, V, W.

- When a motor phase is missing, the frequency converter trips and issues an alarm.

- When a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).

- Monitoring of the DC-link voltage ensures that the frequency converter trips when the DC-link voltage is too low or too high.

- The frequency converter is protected against ground faults on motor terminals U, V, W.

6.4.1 Mains Supply (L1, L2, L3)

Supply voltage	200–240 V ±10%
Supply voltage	380–480 V ±10%
Supply voltage	525–600 V ±10%
Supply frequency	50/60 Hz
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 (cosφ) near unity	(>0.98)
Switching on the input supply L1, L2, L3 (power-ups) enclosure sizes H1–H5, I2, I3, I4	Maximum 1 time/30 s
Switching on the input supply L1, L2, L3 (power-ups) enclosure sizes H6–H10, I6–I8	Maximum 1 time/minute
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2
The unit is suitable for use on a circuit capable of delivering not more than 100000 A$_{rms}$ symmetrical Amperes, 240/480 V maximum.	

6.4.2 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–400 Hz
Switching on output	Unlimited
Ramp times	0.05–3600 s

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6.4.3 Cable Length and Cross-section

Maximum motor cable length, shielded/armored (EMC-correct installation)	See *chapter 6.2 EMC Emission Test Results*
Maximum motor cable length, unshielded/unarmored	50 m (164 ft)
Maximum cross-section to motor, mains[1]	
Cross-section DC terminals for filter feedback on enclosure sizes H1–H3, I2, I3, I4	4 mm²/11 AWG
Cross-section DC terminals for filter feedback on enclosure sizes H4–H5	16 mm²/6 AWG
Maximum cross-section to control terminals, rigid wire	2.5 mm²/14 AWG
Maximum cross-section to control terminals, flexible cable	2.5 mm²/14 AWG
Minimum cross-section to control terminals	0.05 mm²/30 AWG

1) See *chapter 6.1.2 3x380–480 V AC* for more information.

6.4.4 Digital Inputs

Programmable digital inputs	4
Terminal number	18, 19, 27, 29
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	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Digital input 29 as thermistor input	Fault: >2.9 kΩ and no fault: <800 Ω
Digital input 29 as pulse input	Maximum frequency 32 kHz push-pull-driven & 5 kHz (O.C.)

6.4.5 Analog Inputs

Number of analog inputs	2
Terminal number	53, 54
Terminal 53 mode	*Parameter 16-61 Terminal 53 Setting*: 1 = voltage, 0 = current
Terminal 54 mode	*Parameter 16-63 Terminal 54 Setting*: 1 = voltage, 0 = current
Voltage level	0–10 V
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	20 V
Current level	0/4–20 mA (scalable)
Input resistance, R_i	<500 Ω
Maximum current	29 mA
Resolution on analog input	10 bit

6.4.6 Analog Output

Number of programmable analog outputs	2
Terminal number	42, 45[1]
Current range at analog output	0/4–20 mA
Maximum load to common at analog output	500 Ω
Maximum voltage at analog output	17 V
Accuracy on analog output	Maximum error: 0.4% of full scale
Resolution on analog output	10 bit

1) Terminals 42 and 45 can also be programmed as digital outputs.

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6.4.7 Digital Output

Number of digital outputs	4
Terminals 27 and 29	
Terminal number	27, 29[1]
Voltage level at digital output	0–24 V
Maximum output current (sink and source)	40 mA
Terminals 42 and 45	
Terminal number	42, 45[2]
Voltage level at digital output	17 V
Maximum output current at digital output	20 mA
Maximum load at digital output	1 kΩ

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

2) Terminals 42 and 45 can also be programmed as analog output.

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

6.4.8 Control Card, RS485 Serial Communication

Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number	61 common for terminals 68 and 69

6.4.9 Control Card, 24 V DC Output

Terminal number	12
Maximum load	80 mA

6.4.10 Relay Output

Programmable relay outputs	2
Relay 01 and 02 (enclosure size H1–H5 & I2–I4)	01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (NO)
Maximum terminal load (AC-1)[1] on 01–02/04–05 (NO) (resistive load)	250 V AC, 3 A
Maximum terminal load (AC-15)[1] on 01–02/04–05 (NO) (inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 01–02/04–05 (NO) (resistive load)	30 V DC, 2 A
Maximum terminal load (DC-13)[1] on 01–02/04–05 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 01–03/04–06 (NC) (resistive load)	250 V AC, 3 A
Maximum terminal load (AC-15)[1] on 01–03/04–06 (NC) (inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 01–03/04–06 (NC) (resistive load)	30 V DC, 2 A
Minimum terminal load on 01–03 (NC), 01–02 (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 parts 4 and 5. Endurance of the relay varies with different load type, switching current, ambient temperature, driving configuration, working profile, and so forth. It is recommended to mount a snubber circuit when connecting inductive loads to the relays.

Programmable relay outputs	
Relay 01 terminal number (enclosure size H9)	01–03 (NC), 01–02 (NO)
Maximum terminal load (AC-1)[1] on 01–03 (NC), 01–02 (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 01–02 (NO), 01–03 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (inductive load)	24 V DC, 0.1 A
Relay 01 and 02 terminal number (enclosure size H6, H7, H8, H9 (relay 2 only), H10, and I6–I8)	01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (NO)
Maximum terminal load (AC-1)[1] on 04–05 (NO) (resistive load)[2)3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 04–05 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 04–05 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 04–05 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 04–06 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 04–06 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 04–06 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 04–06 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (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 parts 4 and 5. Endurance of the relay varies with different load type, switching current, ambient temperature, driving configuration, working profile, and so forth. It is recommended to mount a snubber circuit when connecting inductive loads to the relays.
2) Overvoltage Category II.
3) UL applications 300 V AC 2 A.

6.4.11 Control Card, 10 V DC Output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

6.4.12 Ambient Conditions

Enclosure protection rating	IP20, IP54 (Not for outdoor installation)
Enclosure kit available	IP21, TYPE 1
Vibration test	1.0 g
Maximum relative humidity	5–95% (IEC 60721-3-3; Class 3K3 (non-condensing)) during operation
Aggressive environment (IEC 60721-3-3), coated (standard) enclosure sizes H1–H5	Class 3C3
Aggressive environment (IEC 60721-3-3), non-coated enclosure sizes H6–H10	Class 3C2
Aggressive environment (IEC 60721-3-3), coated (optional) enclosure sizes H6–H10	Class 3C3
Aggressive environment (IEC 60721-3-3), non-coated enclosure sizes I2–I8	Class 3C2
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature[1]	See maximum output current at 40/50 °C (104/122 °F) in *chapter 6.1.2 3x380–480 V AC*.
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance, enclosure sizes H1–H5 and I2–I4	-20 °C (-4 °F)
Minimum ambient temperature at reduced performance, enclosure sizes H6–H10 and I6–I8	-10 °C (14 °F)
Temperature during storage/transport	-30 to +65/70 °C (-22 to +149/158°F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)
Derating for high altitude, see *chapter 6.3.2 Derating for Low Air Pressure and High Altitudes*.	
Safety standards	EN/IEC 61800-5-1, UL 508C
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, Immunity	EN 61800-3, EN 61000-3-12, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
Energy efficiency class[2]	IE2

1) Refer to 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.*

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