ENGINEERING TOMORROW

Operating Guide

VLT® HVAC Drive FC 131

vlt-drives.danfoss.com

Contents

1 Introduction

1.1 Purpose of this Operating Guide

This Operating Guide provides information for safe installation and commissioning of the AC drive. It is intended for use by qualified personnel.

Read and follow the instructions to use the drive safely and professionally.

Pay particular attention to the safety instructions and general warnings. Always keep this Operating Guide with the drive.

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1.2 Additional Resources

1.2.1 Other Resources

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

- The VLT® HVAC Drive FC 131 Programming Guide provides information on how to program and includes complete parameter descriptions.
- The VLT® HVAC Drive FC 131 Design Guide provides all technical information about the drive. It also lists options and accessories.

The technical documentation is available in electronic form online at www.danfoss.com.

1.2.2 MCT 10 Setup Software Support

Download the software from the service and support section on www.danfoss.com.

During the installation process of the software, enter access code 81463800 to activate the VLT® HVAC Drive FC 131 functionality. A license key is not required for using the VLT® HVAC Drive FC 131 functionality.

The latest software does not always contain the latest updates for drives. Contact the local sales office for the latest drive updates (in the form of *.upd files), or download the drive updates from the service and support section on www.danfoss.com.

1.3 Document and Software Version

The Operating Guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this manual is English.

Table 1: Document and Software Version

Edition	Remarks	Software version
AQ367426199594, version 0101	First edition.	4.6x

1.4 Certificates and Approvals

Table 2: Certificates and Approvals

Certification		IP54
EC Declaration of Conformity	CE	□
RCM		□
EAC	EAC	□
UkrSEPRO	089	□

1.5 Disposal

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

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

⚠ D A N G E R ⚠

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G ⚠

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N ⚠

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

N O T I C E

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

To allow trouble-free and safe operation of the unit, only qualified personnel with proven skills are allowed to transport, store, assemble, install, program, commission, maintain, and decommission this equipment.

Persons with proven skills:

- Are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plant, and machinery in accordance with pertinent laws and regulations.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in all manuals provided with the unit, especially the instructions given in the Operating Guide.
- Have good knowledge of the generic and specialist standards applicable to the specific application.

2.3 Safety Precautions

⚠ W A R N I N G

HIGH VOLTAGE

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

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

⚠ W A R N I N G ⚠

UNINTENDED START

When the drive 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.

- Disconnect the drive from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Ensure that the drive is fully wired and assembled when it is connected to AC mains, DC supply, or load sharing.

⚠ WARNING ⚠

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.
- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully. The minimum waiting time is specified in the table *Discharge time* and is also visible on the nameplate on top of the drive.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Table 3: Discharge Time

Voltage [V]	Power range [kW (hp)]	Minimum waiting time (minutes)
3x400	0.75–7.5 (1.0–10)	4
3x400	11–90 (15–125)	15

⚠ WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠ WARNING ⚠

EQUIPMENT HAZARD

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

- Ensure that only trained and qualified personnel 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 drive can result in serious injury when the drive is not properly closed.

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

2.4 Motor Thermal Protection

Procedure

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

3 Installation

3.1 Mechanical Installation

3.1.1 Side-by-side Installation

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

Table 4: Clearance Required for Cooling

Size	IP class	Power [kW (hp)]	Clearance above/below [mm (in)]
I2	IP54	0.75–4.0 (1.0–5.0)	100 (4.0)
I3	IP54	5.5–7.5 (7.5–10)	100 (4.0)
I4	IP54	11–18.5 (15–25)	100 (4.0)
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)

N O T I C E

The drives are not suitable for outdoor mounting.

3.1.2 Drive Dimensions

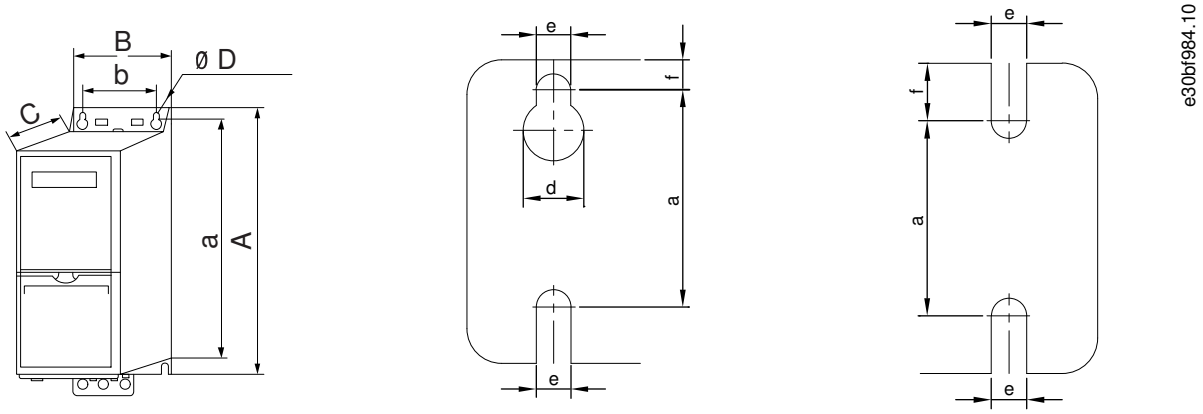

Illustration 1: Dimensions

Table 5: Dimensions, Enclosure Sizes I2–I8

Enclosure Size		I2	I3	I4	I6	I7	I8
IP class		IP54	IP54	IP54	IP54	IP54	IP54
Power [kW (hp)]	**3x380–480 V**	0.75–4.0 (1.0–5.0)	5.5–7.5 (7.5–10)	11–18.5 (15–25)	22–37 (30–50)	45–55 (60–70)	75–90 (100–125)
Height [mm (in)]	**A**	332 (13.1)	368 (14.5)	476 (18.7)	650 (25.6)	680 (26.8)	770 (30)
	a	318.5 (12.53)	354 (13.9)	460 (18.1)	624 (24.6)	648 (25.5)	739 (29.1)
Width [mm (in)]	**B**	115 (4.5)	135 (5.3)	180 (7.0)	242 (9.5)	308 (12.1)	370 (14.6)
	b	74 (2.9)	89 (3.5)	133 (5.2)	210 (8.3)	272 (10.7)	334 (13.2)

Enclosure Size		I2	I3	I4	I6	I7	I8
Depth [mm (in)]	C	225 (8.9)	237 (9.3)	290 (11.4)	260 (10.2)	310 (12.2)	335 (13.2)
Mounting hole [mm (in)]	d	11 (0.43)	12 (0.47)	12 (0.47)	19 (0.75)	19 (0.75)	19 (0.75)
	e	5.5 (0.22)	6.5 (0.26)	6.5 (0.26)	9 (0.35)	9 (0.35)	9 (0.35)
	f	9 (0.35)	9.5 (0.37)	9.5 (0.37)	9 (0.35)	9.8 (0.39)	9.8 (0.39)
Maximum weight kg (lb)		5.3 (11.7)	7.2 (15.9)	13.8 (30.42)	27 (59.5)	45 (99.2)	65 (143.3)

The dimensions are only for the physical units. 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 3.1.1 Side-by-side Installation.

3.2 Electrical Installation

3.2.1 Electrical Installation in General

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.

Table 6: Tightening Torques for Enclosure Sizes I2–I8

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)	1.2 (11)	1.2 (11)	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)[1]	14 (124)/24 (212)[1]	–	0.5 (4.0)	3 (27)	0.6 (5.0)

[1] Cable dimensions ≤95 mm^2.

3.2.2 IT Mains

⚠ C A U T I O N ⚠

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.

For IP54, 400 V, 0.75–18.5 kW (1.0–25 hp) units, open the RFI switch by removing the EMC screw inside the drive when at IT grid. The EMC screw is shown in the the following illustration.

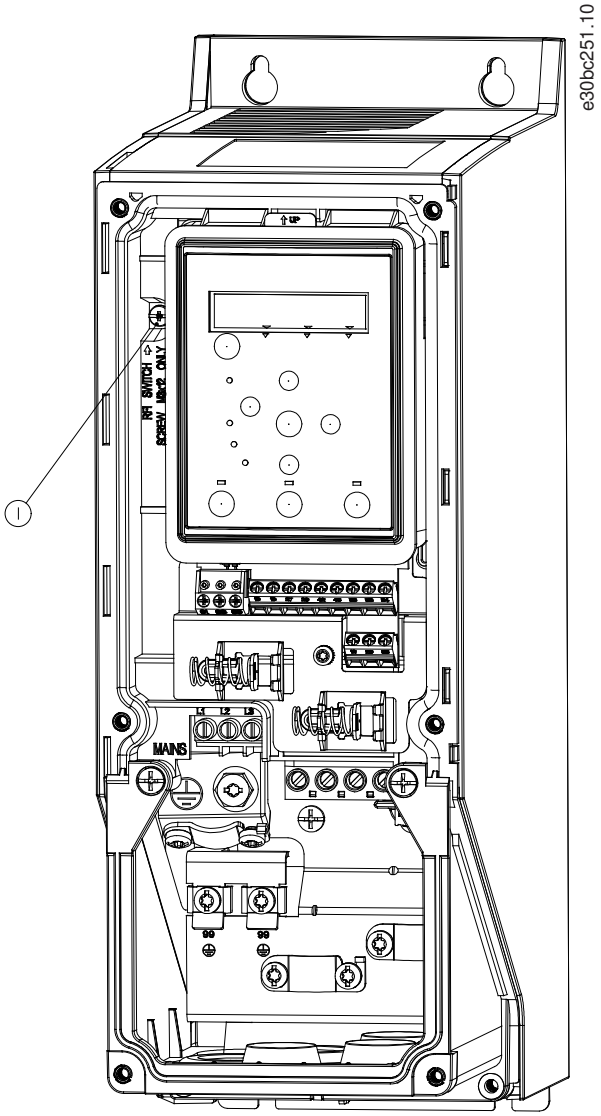

Illustration 2: IP54, 400 V, 0.75–18.5 kW (1–25 hp)

1	EMC screw

For IP54, 400 V, 22-90 kW (30–125 hp) units, the RFI switch can be opened in *parameter 14-50 RFI Filter*. Select *[1] On* to turn the RFI filter on. The RFI filter ensures that the drive complies with EMC standards. Select *[0] Off* only when the drive is connected to IT mains.

N O T I C E

If reinserted, use only M3x12 screw.

3.2.3 Mains and Motor Connection

3.2.3.1 Introduction

The drive is designed to operate all standard 3-phase induction motors.

- Use a shielded/armored motor cable to comply with EMC emission specifications and connect this cable to the motor.
- Keep the motor cable as short as possible to reduce the noise level and leakage currents.
- Also see EMC-Correct Installation in the 3.2.5 EMC-compliant Electrical Installation.

3.2.3.2 Connecting to Mains and Motor

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

3.2.3.3 Enclosure Size I2

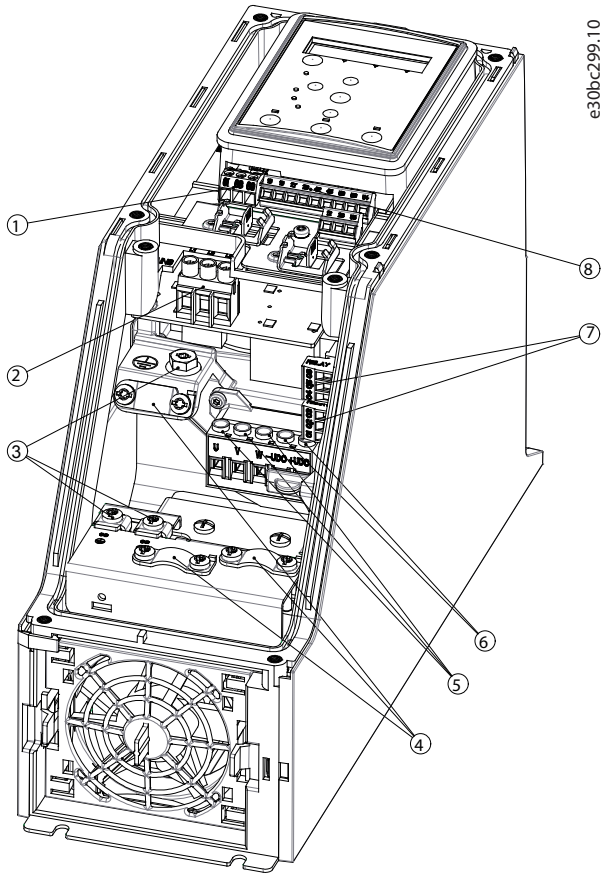

Illustration 3: Enclosure Size I2, IP54, 380–480 V, 0.75–4.0 kW (1.0–5.0 hp)

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

3.2.3.4 Enclosure Size I3

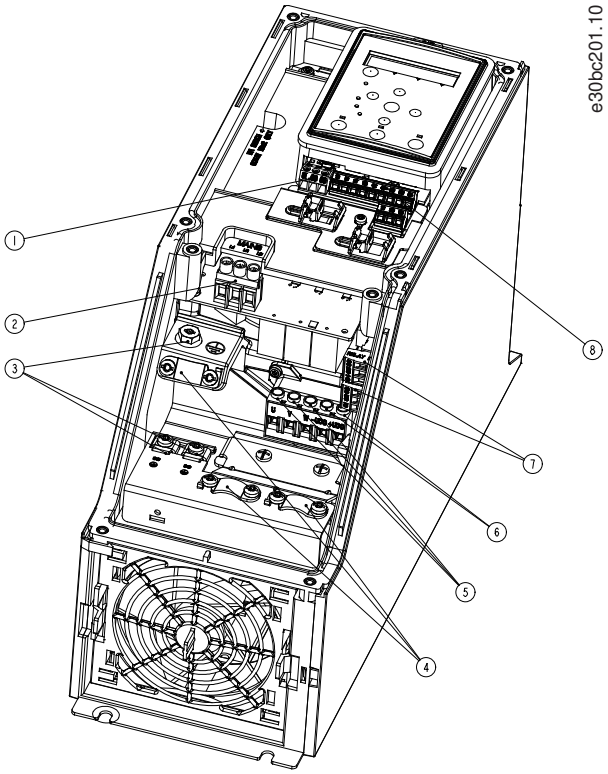

Illustration 4: Enclosure Size I3, IP54, 380–480 V, 5.5–7.5 kW (7.5–10 hp)

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

3.2.3.5 Enclosure Size I4

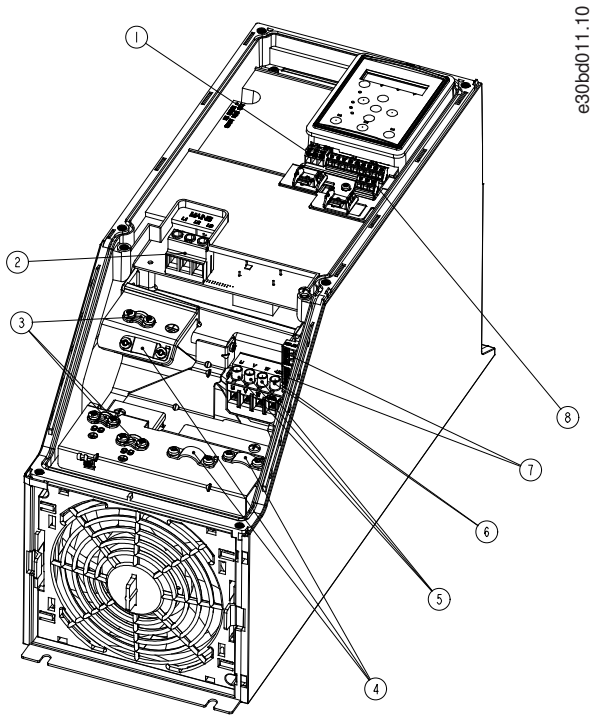

Illustration 5: Enclosure Size I4, IP54, 380–480 V, 11–18.5 kW (15–25 hp)

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

3.2.3.6 IP54 Enclosure Sizes I2, I3, I4

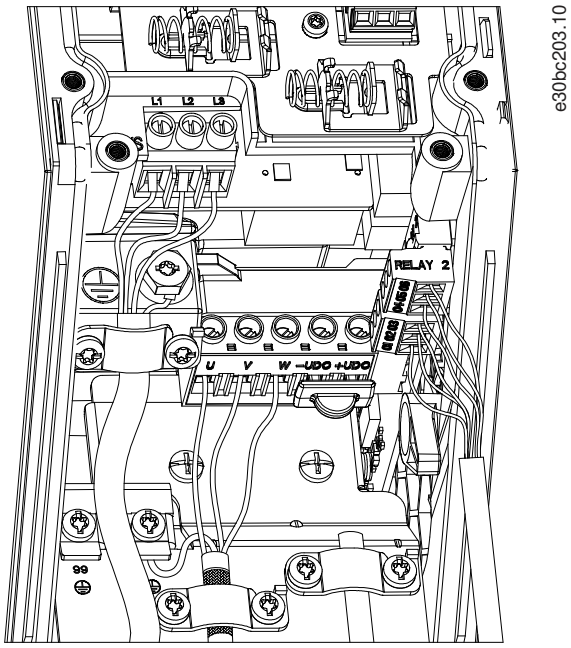

Illustration 6: IP54 Enclosure Sizes I2, I3, I4

3.2.3.7 Enclosure size I6

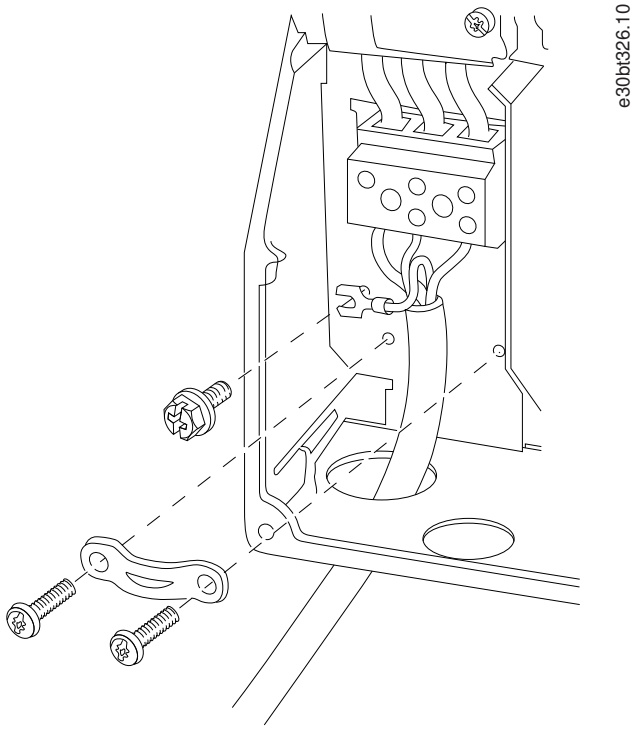

Illustration 7: Connecting to Mains for Enclosure Size I6, IP54, 380–480 V, 22–37 kW (30–50 hp)

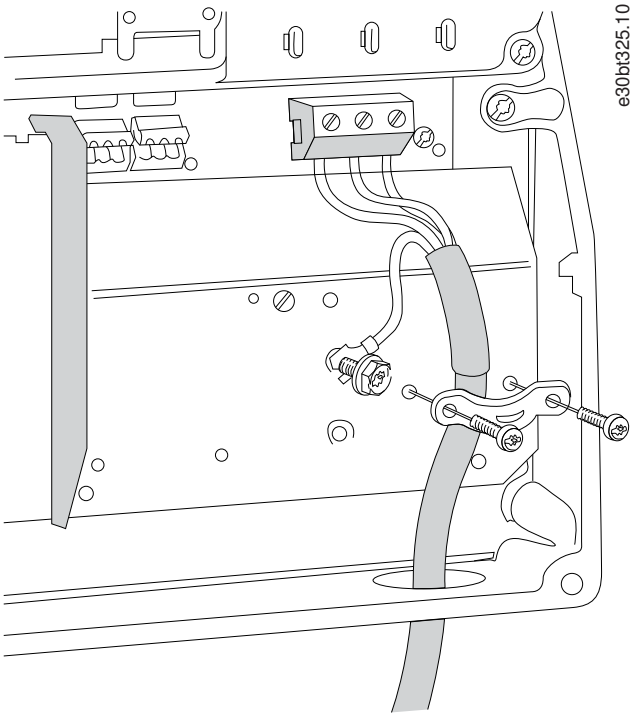

Illustration 8: Connecting to Motor for Enclosure Size I6, IP54, 380–480 V, 22–37 kW (30–50 hp)

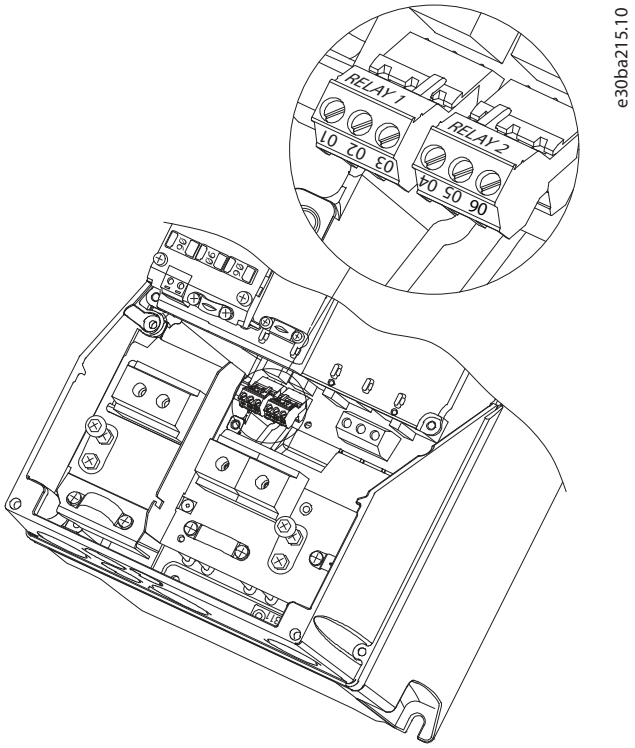

Illustration 9: Relays on Enclosure Size I6, IP54, 380–480 V, 22–37 kW (30–50 hp)

3.2.3.8 Enclosure size I7, I8

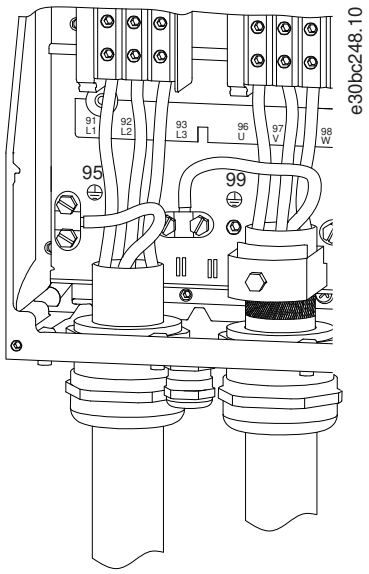

Illustration 10: Enclosure Sizes I7, I8, IP54, 380–480 V, 45–55 kW (60–70 hp), IP54, 380–480 V, 75–90 kW (100–125 hp)

3.2.4 Fuses and Circuit Breakers

3.2.4.1 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.

3.2.4.2 Short-circuit Protection

Danfoss recommends using the fuses and circuit breakers listed in this chapter 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 drive provides full short-circuit protection in case of a short circuit on the motor.

3.2.4.3 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. Design circuit breakers and fuses for protection in a circuit capable of supplying a maximum of 100000 A_{rms} (symmetrical), 480 V maximum.

3.2.4.4 UL/Non-UL Compliance

To ensure compliance with UL or IEC 61800-5-1, use the circuit breakers or fuses listed in this chapter. Circuit breakers must be designed for protection in a circuit capable of supplying a maximum of 10000 A_{rms} (symmetrical), 480 V maximum.

3.2.4.5 Recommendation of Fuses and Circuit Breakers

N O T I C E

If a malfunction occurs, failure to follow the protection recommendation may result in damage to the drive.

Table 7: Fuses and Circuit Breakers

	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

3x380–480 V IP54							
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

3.2.5 EMC-compliant Electrical Installation

To ensure EMC-correct electrical installation, observe the following:

- 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 drive and the ground potential of PLC.
- Use star washers and galvanically conductive installation plates.

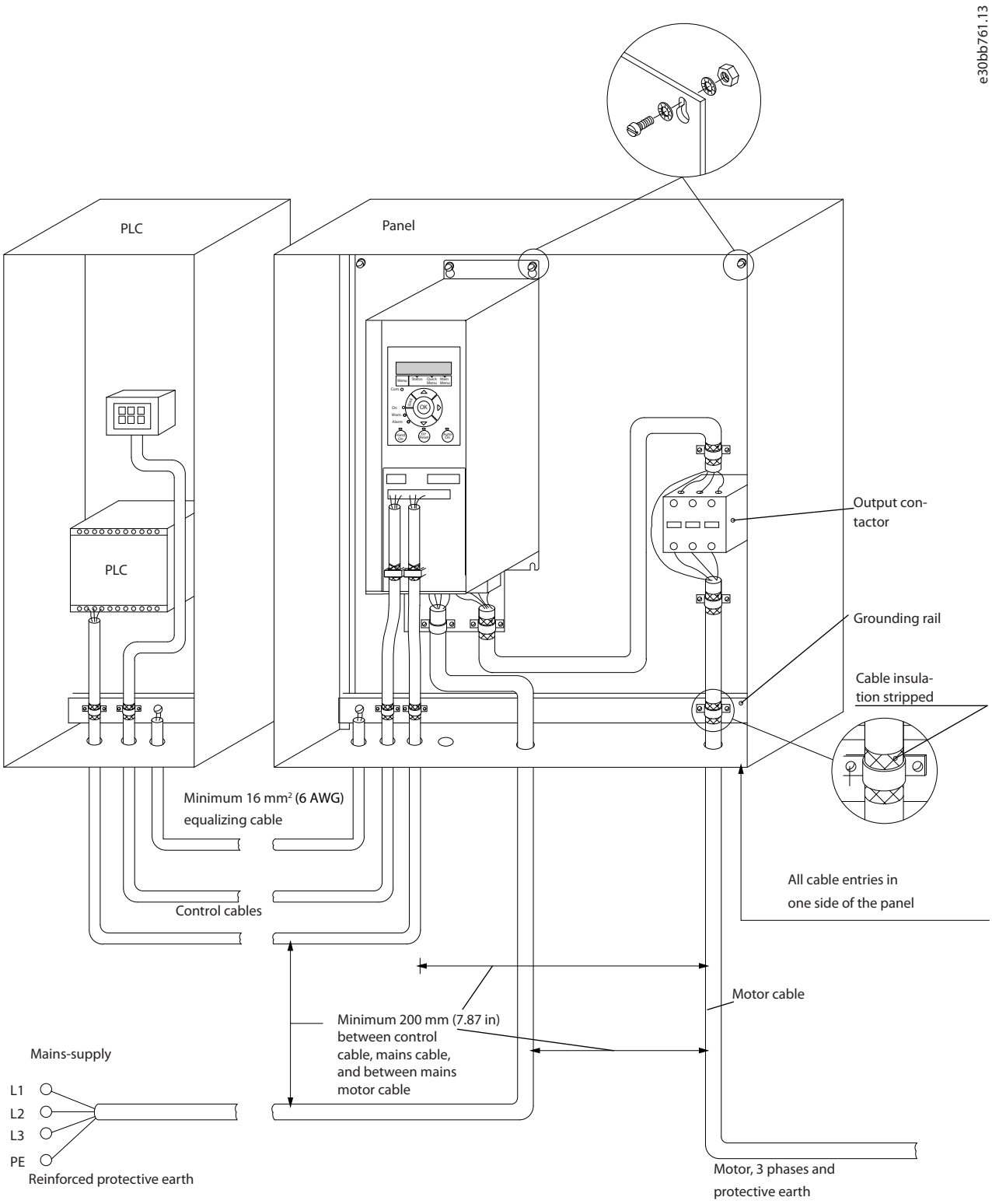

Illustration 11: EMC-compliant Installation

3.2.6 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 the following illustration.

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

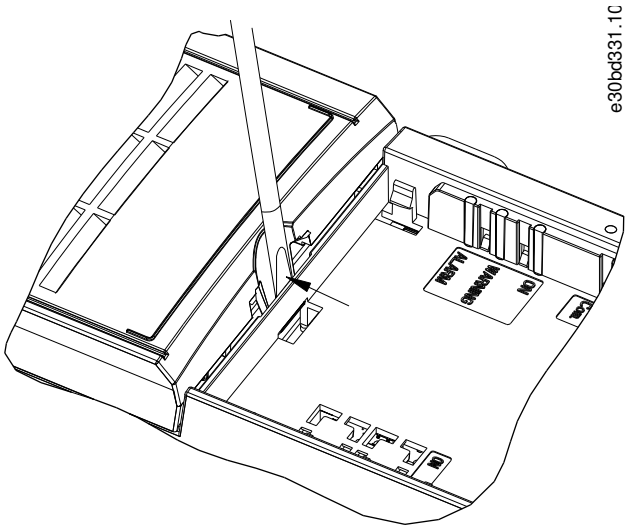

Illustration 12: Removing the Terminal Cover

The following illustration shows all the drive control terminals. Applying start (terminal 18), connection between terminals 12-27, and an analog reference (terminal 53 or 54, and 55) make the drive 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).

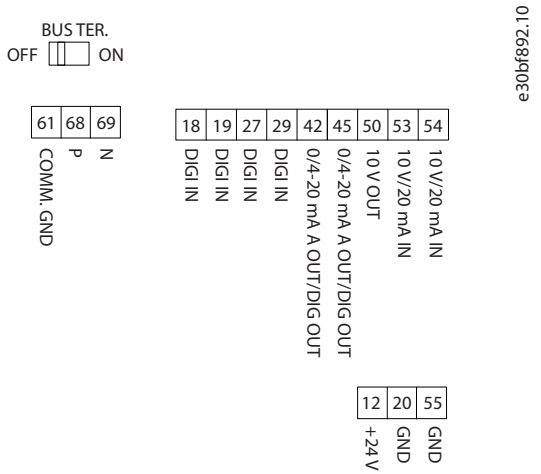

Illustration 13: Control Terminals

3.2.7 Electrical Wiring

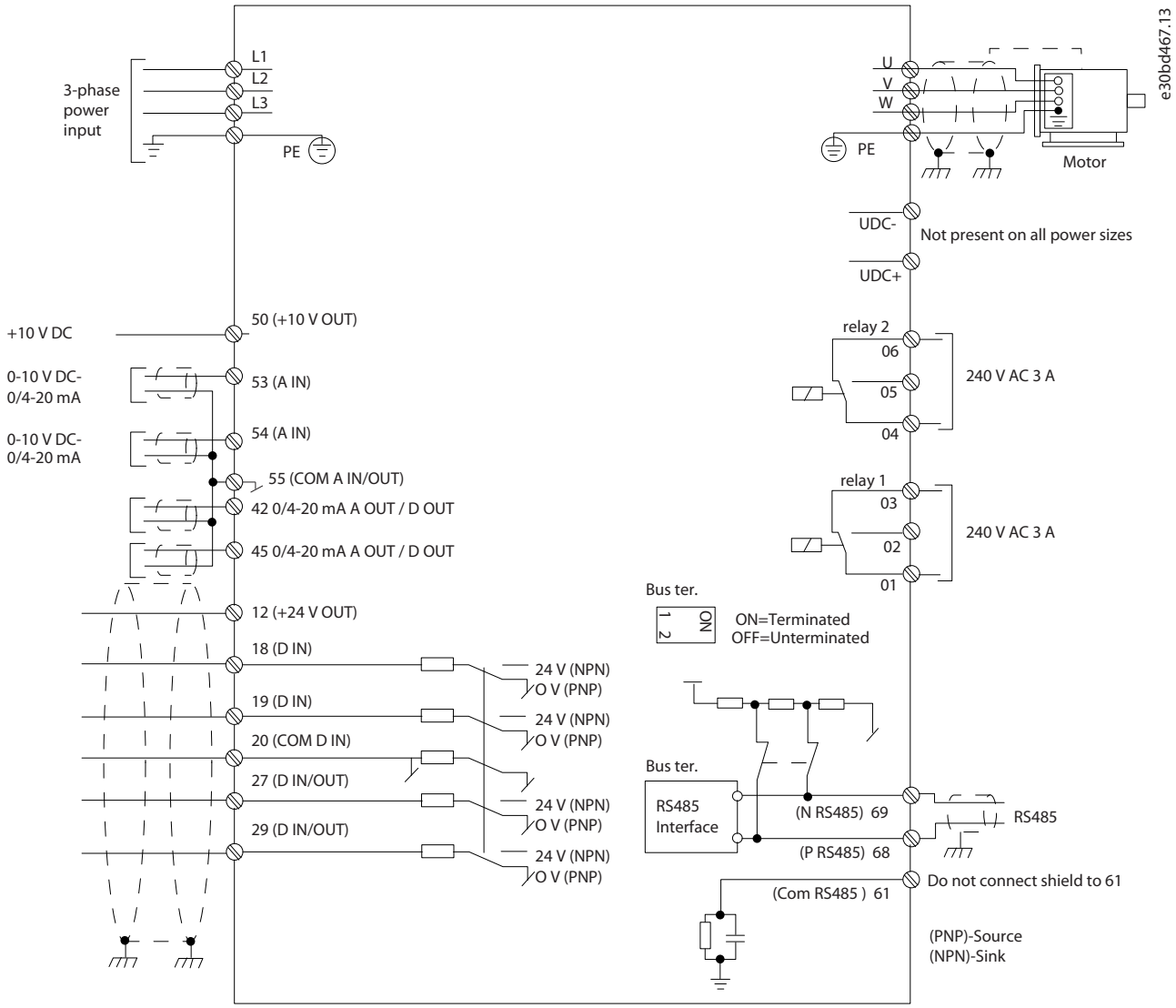

Illustration 14: Basic Wiring Schematic Drawing

N O T I C E

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

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

3.2.8 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 LCP is divided into 4 functional sections.

- A. Display
- B. Menu key
- C. Navigation keys and indicator lights
- D. Operation keys and indicator lights

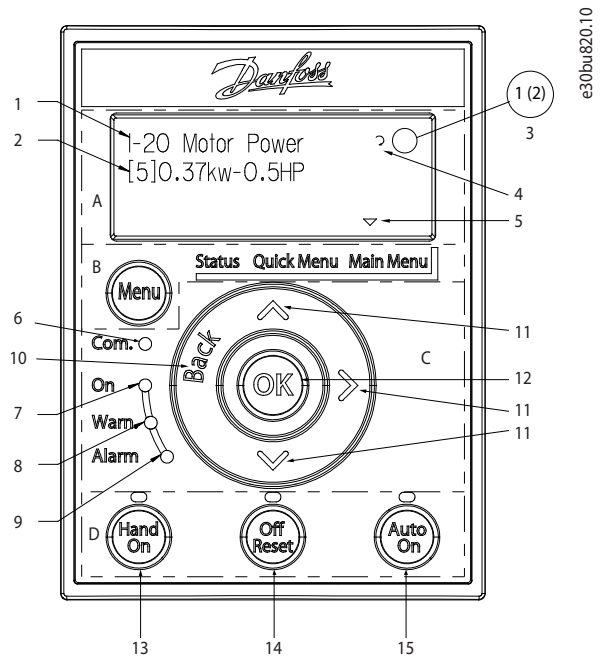

Illustration 15: Local Control Panel (LCP 32)

A. Display

The graphical LCD-display is illuminated with clear white backlight and can show either 3 full lines (in programming mode) or 2 full & 2 ½ lines (in status mode). The following table describes the information that can be read from the display.

Table 8: Legend to Section A, Illustration 3

1	Parameter number and name.
2	Parameter value.
3	Setup number shows the active setup and the edit setup (only in Status menu). The number outside brackets is active setup, and the number inside brackets is edit setup. For example, 1(2) means 1 is the active setup, and 2 is the edit setup.
4	Motor direction is shown to the bottom left of the display – indicated by a small arrow pointing either clockwise or counter-clockwise.
5	The triangle indicates if the LCP is in Status, Quick Menu, or Main Menu.

B. Menu key

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

C. Navigation keys and indicator lights

Table 9: Legend to Section C, Illustration 3

6	Com. (yellow indicator): Flashes during bus communication.
7	On (green indicator): Shows the power on status.
8	Warn. (yellow indicator): Indicates a warning.
9	Alarm (red indicator): Indicates an alarm.
10	[Back]: For moving to the previous step or layer in the navigation structure.
11	Up arrow key, down arrow key, and right arrow key: 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.

D. Operation keys and indicator lights

Table 10: Legend to Section D, Illustration 3

13	[Hand On]: Starts the motor and enables control of the drive via the LCP. **N O T I C E** *[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 compressor (Off). If in alarm mode, the alarm is reset.
15	[Auto On]: The drive is controlled either via control terminals or serial communication.

4.2 Set-up Wizard

4.2.1 Setup Wizard Introduction

The built-in wizard menu guides the installer through the setup of the drive in a clear and structured manner for open-loop and closed-loop applications, and for quick motor settings.

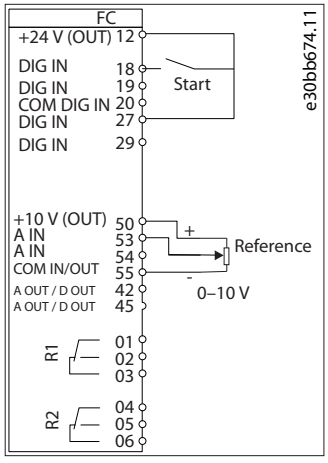

Illustration 16: Drive Wiring

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.

4.2.2 Setup Wizard for Open-loop Applications

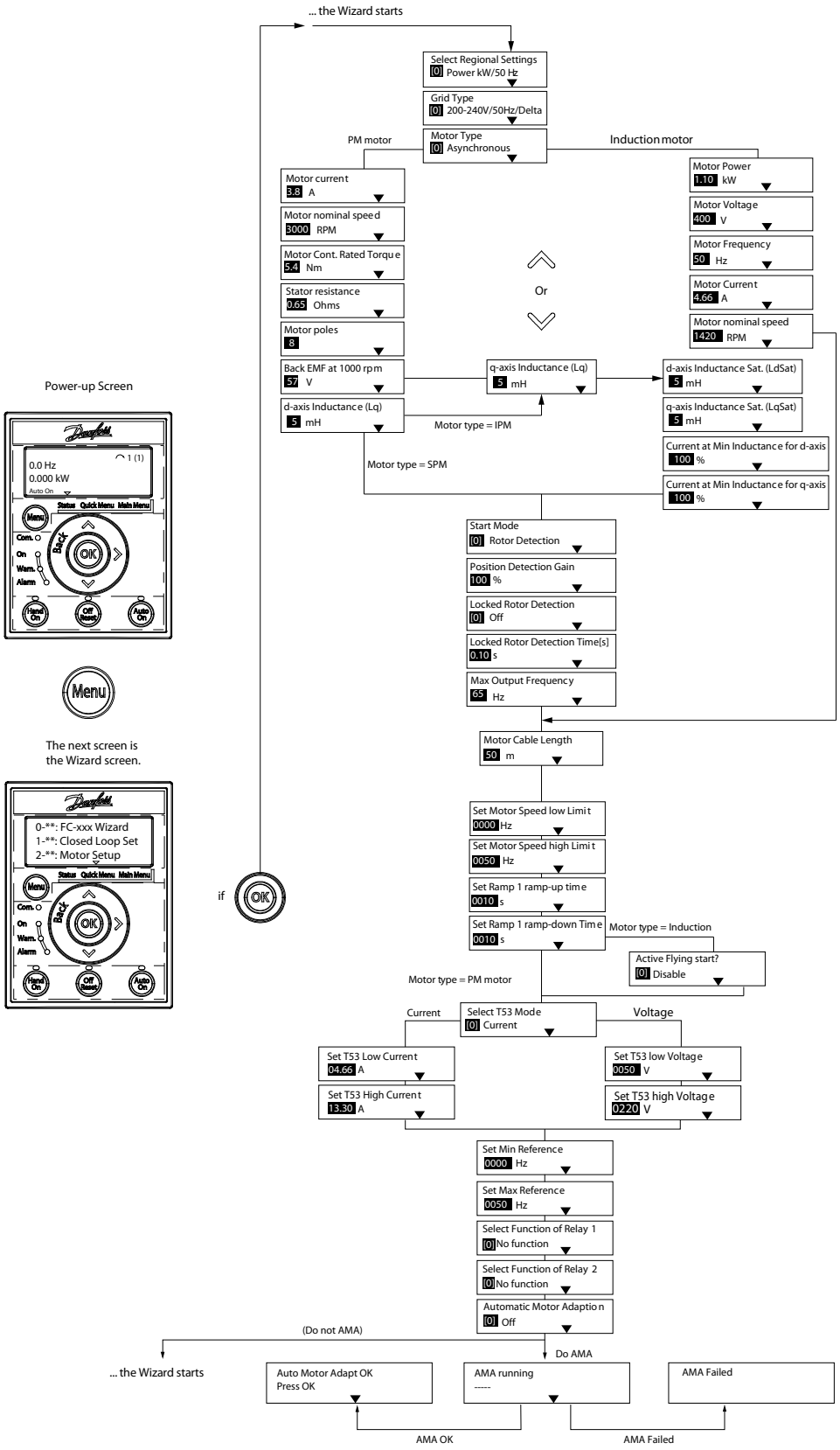

Illustration 17: Setup Wizard for Open-loop Applications

Table 11: Setup Wizard for Open-loop Applications

Parameter	Option/range	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 drive to mains voltage after power down.
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	Option/range	Default	Usage
			• *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 PM 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 1-20 Motor Power	0.18–110 kW/0.25–150 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	0.01–1000.00 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 motor mode.

Parameter	Option/range	Default	Usage
			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	Option/range	Default	Usage
Parameter 1-70 PM Start Mode	[0] Rotor Detection [1] Parking [3] Rotor Last Position	*[1] Parking*	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	*[0] Disabled*	Select *[1] Enabled* to enable the drive 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.
Parameter 3-41 Ramp 1 Ramp Up Time	0.01–3600.00 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	0.01–3600.00 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	Option/range	Default	Usage
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 Detection	[0] Off [1] On	*[0] Off*	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1 s	*0.10 s*	–

4.2.3 Setup Wizard for Closed-loop Applications

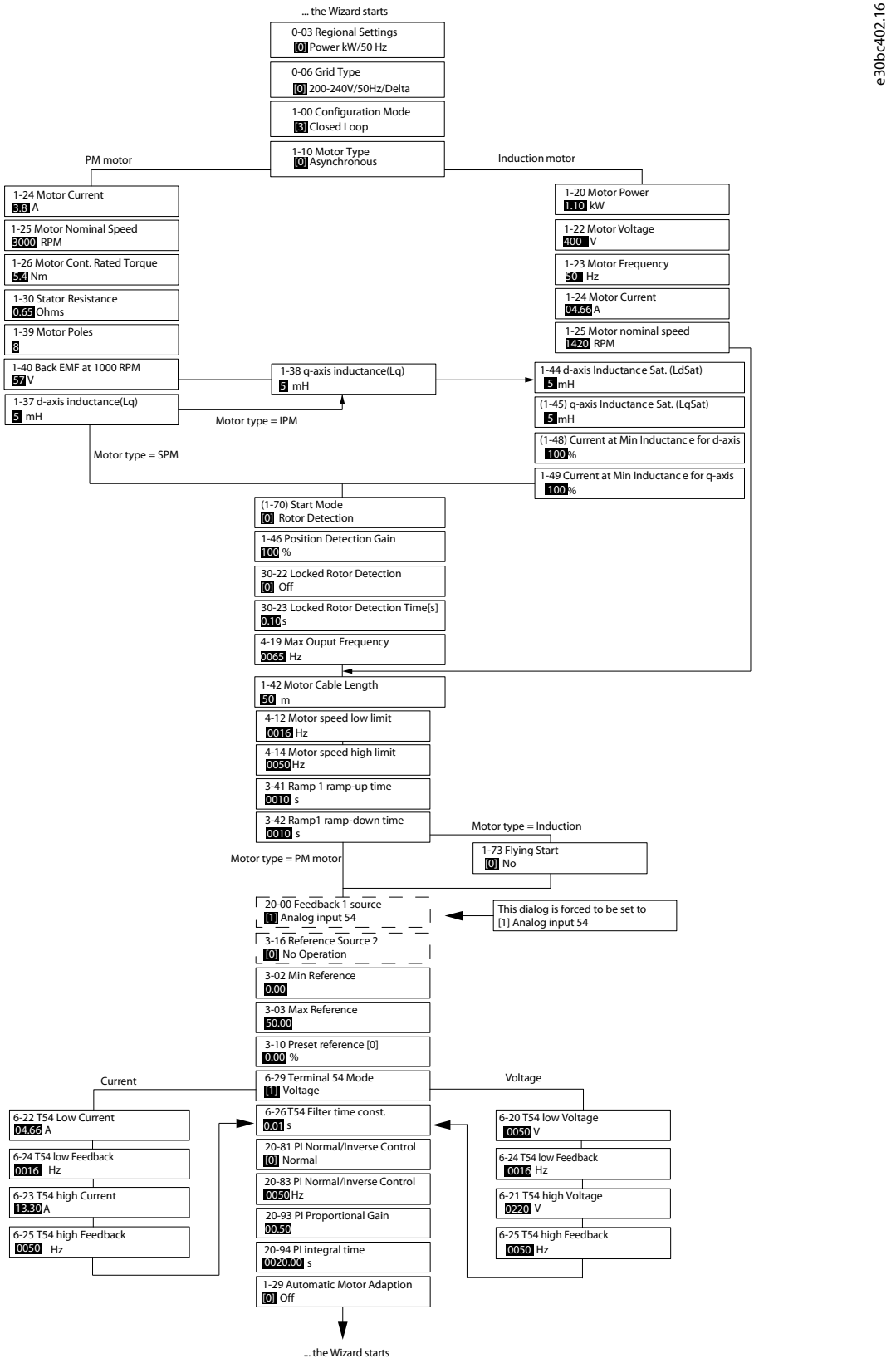

Illustration 18: Setup Wizard for Closed-loop Applications

Table 12: Setup Wizard for Closed-loop Applications

Parameter	Option/range	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 selected	Select the operating mode for restart after reconnection of the drive to mains voltage after power down.
Parameter 1-00 Configuration Mode	[0] Open loop [3] Closed loop	*[0] Open loop*	Select *[3] Closed loop*.
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	Option/range	Default	Usage
			• *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 PM 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 1-20 Motor Power	0.18–110 kW/0.25–150 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	0.01–1000.00 A	Size related	Enter the motor current from the nameplate data.
Parameter 1-25 Motor Nominal Speed	50–60000 RPM	Size related	Enter the motor nominal speed from the nameplate data.
Parameter 1-26 Motor Cont. Rated Torque	0.1–10000.0 Nm	Size related	This parameter is available when *parameter 1-10 Motor Construction* is set to options that enable permanent motor mode.

Parameter	Option/range	Default	Usage
			N O T I C E 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)	0.000–9999.000 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	Option/range	Default	Usage
Parameter 1-70 PM Start Mode	[0] Rotor Detection [1] Parking [3] Rotor Last Position	*[1] Parking*	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	*[0] Disabled*	Select *[1] Enabled* to enable the drive 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 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	-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	Option/range	Default	Usage
Low Ref./Feedb. Value			
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 Detection	[0] Off [1] On	*[0] Off*	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1.00 s	*0.10 s*	–

4.2.4 Motor Setup

The motor setup wizard guides users through the needed motor parameters.

Table 13: Motor Setup Wizard Settings

Parameter	Option/range	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	Size selected	Select the operating mode for restart after reconnection of the drive to mains voltage after power down.

Parameter	Option/range	Default	Usage
	[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		
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	Option/range	Default	Usage
			• *Parameter 1-66 Min. Current at Low Speed*. • *Parameter 1-70 PM 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 1-20 Motor Power	0.18–110 kW/0.25–150 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 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	Option/range	Default	Usage
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 PM Start Mode	[0] Rotor Detection [1] Parking [3] Rotor Last Position	*[1] Parking*	Select the PM motor start mode.
Parameter 1-73 Flying Start	[0] Disabled [1] Enabled	*[0] Disabled*	Select *[1] Enabled* to enable the drive 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	Option/range	Default	Usage
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.
Parameter 30-22 Locked Rotor Detection	[0] Off [1] On	*[0] Off*	–
Parameter 30-23 Locked Rotor Detection Time [s]	0.05–1.00 s	*0.10 s*	–

4.2.5 Changes Made Function

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

- The list shows only parameters that have been changed in the current edit setup.
- Parameters that have been reset to default values are not listed.
- The message *Empty* indicates that no parameters have been changed.

4.2.6 Changing Parameter Settings

Procedure

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 setup, motor setup, 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.

4.2.7 Accessing All Parameters via the Main Menu

Procedure

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.

5 Warnings and Alarms

5.1 List of Warnings and Alarms

Table 14: 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	–	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*.
3	–	No motor	X	–	–	No motor is connected to the output of the drive.
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 Function at 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	–	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 drive. 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 (40–125 hp) 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 Alarm Log Value* if possible.
46	33	Control voltage fault	–	X	X	Control voltage is low. Contact the local Danfoss supplier.

Fault number	Alarm/ warning bit number	Fault text	Warning	Alarm	Trip locked	Cause of problem
47	23	24 V supply low	X	X	X	24 V DC supply may be overloaded.
51	15	AMA U_{nom}, I_{nom}	–	X	–	The setting of motor voltage, motor current, and motor power is wrong. Check the settings.
52	–	AMA low I_{nom}	–	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 motor	–	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.
56	–	AMA user interrupt	–	X	–	The AMA has been interrupted by the user.
57	–	AMA timeout	–	X	–	Try to restart the AMA several 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 drive (via serial communication, digital I/O, or by pressing [Reset] button 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) 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 configuration	–	X	X	The control card and power card are not matched.
79	–	Illegal power section configuration	X	X	–	Internal fault. Contact the local Danfoss supplier.
80	29	Drive initialised	–	X	–	All parameter settings are initialized to default settings.

Fault number	Alarm/ warning bit number	Fault text	Warning	Alarm	Trip locked	Cause of problem
92	–	No-Flow	X	X	–	A no-flow condition has been detected in the system. *Parameter 22-23 No-Flow Function* is set for alarm.
93	38	Dry pump	X	X	–	A dry-pump condition has been detected in the system. *Parameter 22-26 Dry Pump Function* is set for alarm.
94	39	End of curve	X	X	–	An end-of-curve condition has been detected in the system. *Parameter 22-50 End of Curve Function* is set for alarm.
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*.
99	–	Locked rotor	–	X	X	The rotor is blocked.
101	–	Flow/pressure Info Missing	–	–	–	Sensorless-pump table is missing or wrong. Download sensorless-pump table again.
126	–	Motor Rotating	–	X	–	High back EMF voltage. Stop the rotor of the PM motor.
127	–	Back EMF too high	X	–	–	This warning applies to PM motors only. When the back EMF exceeds 90% x U_{invmax} (overvoltage threshold) and does not drop to normal level within 5 s, this warning is reported. The warning remains until the back EMF returns to a normal level.
159	36	Check valve failure	X	–	–	When the drive is not in operation, a broken check valve leads to the motor runs in reverse.
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 spare part	–	X	X	The power or switch mode power supply has been exchanged (on 400 V, 30–90 kW (40–125 hp) units). Contact the local Danfoss supplier.
251	–	New type code	–	X	X	The drive has a new type code (on 400 V, 30–90 kW (40–125 hp) units). Contact the local Danfoss supplier.

5.2 LCP Errors Messages

LCP errors are not warnings or alarms. They do not affect the operation of the drive. An LCP error example on the LCP is shown in the following illustration.

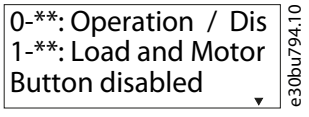

Illustration 19: LCP Error Example

Table 15: LCP Error List

LCP error code	Error message	Description
Err 84	LCP comm. Lost	Communication between the LCP and the drive is lost.
Err 85	Key disabled	The LCP key is disabled. One of the LCP keys has been disabled in *parameter group 0-4* LCP Keypad*.
Err 86	LCP copy failed	Data copy failure. This error occurs when data is copied from drive to LCP, or from LCP to drive (*parameter 0-50 LCP Copy*).
Err 88	Data not compatible	LCP data incompatible. This error occurs when data is being copied from LCP to drive (*parameter 0-50 LCP Copy*). The typical reason is that data is moved between drive and LCP that have major software differences.
Err 89	Read only	Parameter read only. An operation is issued via LCP to write a value to a parameter that is read-only.
Err 90	Database busy	The parameter database of the drive is busy.
Err 91	Parameter invalid	The parameter value that is input via the LCP is invalid.
Err 92	Exceeds limits	The parameter value that is input via the LCP exceeds limits.
Err 93	Motor is running	The LCP copy operation cannot be performed when the drive is running.
Err 95	Not while running	The parameter cannot be changed while the drive is running.
Err 96	Password rejected	The password that is input via the LCP is incorrect.

6 Specifications

6.1 Mains Supply

6.1.1 3x380–480 V AC

Table 16: 3x380–480 V AC, 0.75–18.5 kW (1.0–25 hp), Enclosure Sizes I2–I4

Drive	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
Protection rating IP54	I2	I2	I2	I2	I2	I3	I3	I4	I4	I4
Maximum cable size in terminals (mains, motor) [mm^2 (AWG)]	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)	16 (6)	16 (6)	16 (6)
Output current at 40°C (104°F) ambient temperature										
Continuous (3x380–440 V) [A]	2.2	3.7	5.3	7.2	9.0	12	15.5	23	31	37
Intermittent (3x380–440 V) [A]	2.4	4.1	5.8	7.9	9.9	13.2	17.1	25.3	34	40.7
Continuous (3x441–480 V) [A]	2.1	3.4	4.8	6.3	8.2	11	14	21	27	34
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 3.2.4.5 Recommendation of 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/ 97.6	97.7/ 97.2	98.3/ 97.9	98.2/ 97.8	98/ 97.6	98.4/ 98	98.2/ 97.8	98.1/ 97.9	98/ 97.8	98.1/ 97.9
Output current at 50°C (122°F) ambient temperature										
Continuous (3x380–440 V) [A]	1.93	3.7	4.85	6.3	7.5	10.9	14	20.9	28	33

Drive	PK75	P1K5	P2K2	P3K0	P4KO	P5K5	P7K5	P11K	P15K	P18K
Intermittent (3x380–440 V) [A]	2.1	4.07	5.4	6.9	9.2	12	15.4	23	30.8	36.3
Continuous (3x441–480 V) [A]	1.8	3.4	4.4	5.5	6.8	10	12.6	19.1	24	30
Intermittent (3x441–480 V) [A]	2.0	3.7	4.8	6.1	8.3	11	13.9	21	26.4	33

[1] Applies for dimensioning of drive 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 Danfoss MyDrive® ecoSmart website.

[2] Efficiency measured at nominal current. For energy efficiency class, see 6.4.13 Ambient Conditions. For part load losses, see Danfoss MyDrive® ecoSmart website.

Table 17: 3x380–480 V AC, 22–90 kW (30–125 hp), Enclosure Sizes I6–I8

Drive	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical shaft output [kW]	22	30	37	45	55	75	90
Typical shaft output [hp]	30	40	50	60	70	100	125
Protection rating IP54	I6	I6	I6	I7	I7	I8	I8
Maximum cable size in terminals (mains, motor) [mm^2 (AWG)]	35 (2)	35 (2)	35 (2)	50 (1)	50 (1)	95 (3/0)	120 (4/0)
Output current at 40°C (104°F) ambient temperature							
Continuous (3x380–440 V) [A]	44	61	73	90	106	147	177
Intermittent (3x380–440 V) [A]	48.4	67.1	80.3	99	116.6	161.7	194.7
Continuous (3x441–480 V) [A]	40	52	65	80	105	130	160
Intermittent (3x441–480 V) [A]	44	57.2	71.5	88	115.5	143	176
Maximum input current							
Continuous (3x380–440 V) [A]	41.8	57	70.3	84.2	102.9	140.3	165.6
Intermittent (3x380–440 V) [A]	46	62.7	77.4	92.6	113.1	154.3	182.2
Continuous (3x441–480 V) [A]	36	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
Maximum mains fuses	See 3.2.4.5 Recommendation of Fuses and Circuit Breakers.						
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	97.8	97.6	98.3	98.2	98.1	98.3
Output current at 50°C (122°F) ambient temperature							
Continuous (3x380–440 V) [A]	35.2	48.8	58.4	63	74.2	102.9	123.9

Drive	P22K	P30K	P37K	P45K	P55K	P75K	P90K
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	41.6	52	56	73.5	91	112
Intermittent (3x441–480 V) [A]	35.2	45.8	57.2	61.6	80.9	100.1	123.2

[1] Applies for dimensioning of drive 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 Danfoss MyDrive® ecoSmart website.

[2] Efficiency measured at nominal current. For energy efficiency class, see 6.4.13 Ambient Conditions. For part load losses, see Danfoss MyDrive® ecoSmart website.

6.2 EMC Emission Test Results

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

Table 18: EMC Emission Test Results

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
H2 RFI filter (EN 55011 A2, EN/IEC 61800-3 C3)										
0.75–18.5 kW (1.0–25 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)										
0.75–18.5 kW (1.0–25 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	–

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 (9 °F) lower than the maximum ambient temperature that is specified for the drive. If the drive is operated at a high ambient temperature, decrease the constant output current. For derating specifications, see the VLT® HVAC Drive FC 131 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 cooling air temperature by 1 °C (1.8 °F) per 200 m (656 ft).

6.4 General Technical Data

6.4.1 Protection and Features

- Electronic motor thermal protection against overload.
- Temperature monitoring of the heat sink ensures that the drive trips if there is overtemperature.
- The drive is protected against short circuits between motor terminals U, V, W.
- When a motor phase is missing, the drive trips and issues an alarm.
- When a mains phase is missing, the drive trips or issues a warning (depending on the load).
- Monitoring of the DC-link voltage ensures that the drive trips when the DC-link voltage is too low or too high.
- The drive is protected against ground faults on motor terminals U, V, W.

6.4.2 Mains Supply (L1, L2, L3)

Supply voltage	380–480 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 I2–I4	Maximum 1 time/30 s
Switching on the input supply L1, L2, L3 (power-ups) enclosure sizes 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, 480 V maximum.

6.4.3 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

6.4.4 Cable Length and Cross-section

Maximum motor cable length, shielded/armored (EMC-correct installation)	See 6.2 EMC Emission Test Results.
Maximum motor cable length, unshielded/unarmoured	50 m (164 ft)
Maximum cross-section to motor, mains	See 6.1.1 3x380–480 V AC for more information
Cross-section DC terminals for filter feedback on enclosure sizes I2–I4	4 mm^2/11 AWG

Maximum cross-section to control terminals, rigid wire	2.5 mm^2/14 AWG
Maximum cross-section to control terminals, flexible cable	2.5 mm^2/14 AWG
Minimum cross-section to control terminals	0.05 mm^2/30 AWG

6.4.5 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.)

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

6.4.6 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

6.4.7 Analog Outputs

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.

6.4.8 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.

6.4.9 Control Card, RS485 Serial Communication

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

6.4.10 Control Card, 24 V DC Output

Terminal number	12
Maximum load	80 mA

6.4.11 Relay Output

Programmable relay outputs	2
Relay 01 and 02 (enclosure size 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	
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 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.

6.4.12 Control Card, 10 V DC Output

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

6.4.13 Ambient Conditions

Enclosure protection rating	IP54 (not for outdoor installation)
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), 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 6.1.1 3x380–480 V AC.
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance, enclosure sizes I2–I4	-20 °C (-4 °F)
Minimum ambient temperature at reduced performance, enclosure sizes 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)
Safety standards	EN/IEC 61800-5-1
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 chapter Special Conditions in the operating 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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