MAKING MODERN LIVING POSSIBLE

Quick Guide

VLT® AutomationDrive FC 360

VLT®
THE REAL DRIVE

Safety

⚠WARNING

HIGH VOLTAGE!

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

High Voltage

Frequency converters are connected to hazardous mains voltages. Extreme care should be taken to protect against shock. Only trained personnel familiar with electronic equipment should install, start, or maintain this equipment.

⚠WARNING

UNINTENDED START!

When the frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to AC mains could result in death, serious injury, equipment, or property damage.

Unintended Start

When the frequency converter is connected to the AC mains, the motor may be started by means of an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate cautions to guard against an unintended start.

⚠WARNING

DISCHARGE TIME!

Frequency converters contain DC-link capacitors that can remain charged even when the frequency converter is not powered. To avoid electrical hazards, disconnect AC mains, any permanent magnet type motors, and any remote DC-link power supplies, including battery backups, UPS and DC-link connections to other frequency converters. Wait for the capacitors to fully discharge before performing any service or repair work. The amount of wait time is listed in the *Discharge Time* table. Failure to wait the specified time after power has been removed before doing service or repair could result in death or serious injury.

Voltage (V)	Minimum Waiting Time [Minutes]	
	4	15
380-480	0.37-7.5 kW	11-75 kW
High voltage may be present even when the warning LEDs are off!		

Discharge Time

Symbols

The following symbols are used in this manual.

⚠WARNING

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

⚠CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION

Indicates a situation that may result in equipment or property-damage-only accidents.

NOTE

Indicates highlighted information that should be regarded with attention to avoid mistakes or operate equipment at less than optimal performance.

Approvals

CE

Table 1.2

Contents

1 Quick Start

⚠WARNING

Improper use could result in death, serious injury, equipment, or property damage. Before installing or using the equipment, read *1 Safety* and *3 Installation* carefully!

1.1 Identification and Variants

Confirm that the equipment matches the requirements and ordering information by checking power size, voltage and overload data on the name plate of the frequency converter.

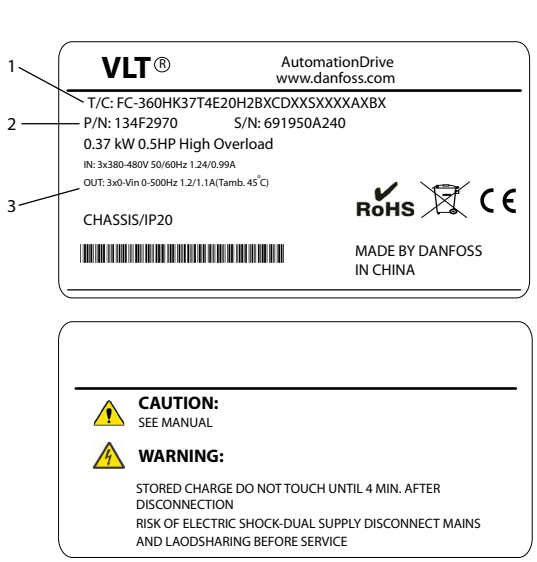

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Illustration 1.1 Name Plate 1 and 2

1) Typecode
2) Ordering Number
3) Specifications

1-6: Product Name	
7: Overload	H: Heavy Duty Q: Normal Duty[1)]
8-10: Power Size	0.37-75 kW e.g. K37: 0.37 kW[2)] 1K1: 1.1 kW 11K: 11 kW etc.
11-12: Voltage Class	4: 380-480 V
13-15: IP Class	E20: IP20
16-17: RFI	H2: C3 Class
18: Braking Chopper	X: No B: Built-in[4)]
19: LCP	X: No
20: PCB Coating	3: 3C3
21: Mains Terminals	D: Load Sharing
29-30: Embedded Fieldbus	AX: No A0: Profibus[3)] AL: Profinet[3)]

Table 1.1 Type Code: Selection of Different Features and Options

See for options and accessories.

1) Only 11-75 kW for Normal Duty variants. Fieldbus unavailable for Normal Duty.

2) For all power sizes see 2.4 Frame Sizes and Power Ratings

3) Not available yet.

4) 0.37-22 kW with built-in braking chopper. 30-75 kW external braking chopper only.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
F	C	-	3	6	0	H				T	4	E	2	0	H	2	X	X	C	D	X	X	S	X	X	X	X	A	X	B	X
						Q											B											A	0		
																												A	L		

130BC437.10

Illustration 1.2 Typecode string

1

1.2 Hand On/Auto On Mode

After installation (see *3 Installation*) there are two simple ways to start up the frequency converter, Hand On and Auto On mode. The first time the frequency converter is powered up it will be in auto on mode.

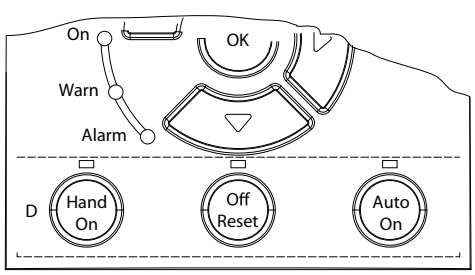


Illustration 1.3 Location of Hand On, Off Reset and Auto On keys on the NLCP

- Press [Hand On] to provide a local start command to the frequency converter. It is then possible to increase and decrease the speed using the arrow keys on the LCP.
- Press [Off/Reset] to stop the frequency converter.
- Press [Auto On] to control the frequency converter either via control terminals or serial communication.

⚠CAUTION

Since the frequency converter is in auto on mode at first power up, the frequency converter may start the motor directly.

NOTE

Terminal 27 Digital input (5-12) has coast inverse as default setting. Connect terminal 12 and 27 to test Hand On/Auto On running.

For LCP operation, see *4 User Interface and Programming*.

1.3 Application Selections

Use the selections for quick application set-up of the most common applications by setting *0-16 Application Selections*. When necessary, the selections can be modified for individual needs. All selections are for Auto On mode.

NOTE

When an application is selected, relevant parameters are automatically set. Further setups to all parameters based on specific requirements is still possible.

⚠CAUTION

If any of the applications below are selected, relay 1 will be set to [Running] and relay 2 will be set to [Alarm]

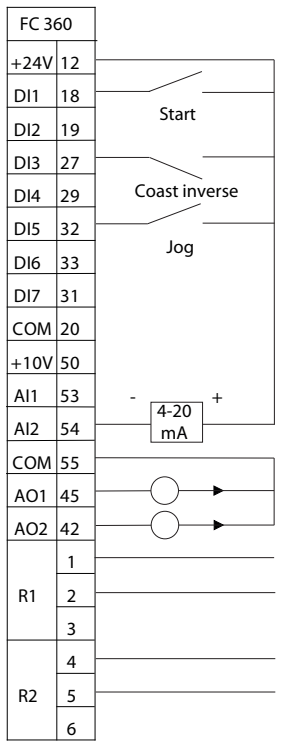
[1] Process Closed Loop

Application

Pumps, fans, compressors

Description

For applications where a value (e.g. pressure, temperature) must be kept at a desired level by sensor feedback



Parameter settings

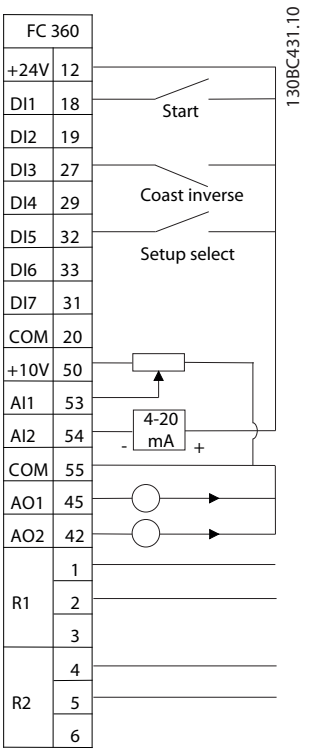
1-00 (Configuration Mode): [3] Process Close Loop
1-03 (Torque Characteristics): [1] Variable Torque
3-00 (Ref Range): [0] Min- Max
3-15 (Ref Source 1): [0] No Function
4-12 (Motor Low Limit): 30.0 Hz
4-14 (Motor High Limit): 50.0 Hz
5-10 (DI 18 Selection): [8] Start
5-12 (DI 27 Selection): [2] Coast Inverse
5-14 (DI 32 Selection): [14] Jog
5-40 (Relay 1 Selection): Running
5-40 (Relay 2 Selection): Alarm
6-22 (AI 54 Low): 4.0 mA
6-23 (AI 54 High): 20.0 mA
6-29 (AI 54 Mode): [0] Current Mode
6-70 (Term 45 Mode): [0] 0-20 mA
6-71 (AO45): [100] Output freq
6-90 (Term 42 Mode): [0] 0-20 mA
6-91 (AO42): [103] Motor current
7-20 (Process CL feedback source): [2] Analog input 54

Table 1.2

[2] Local/Remote

Application
Local/Remote

Description
For applications where the speed reference can be switched between local potentiometer and remote current signal



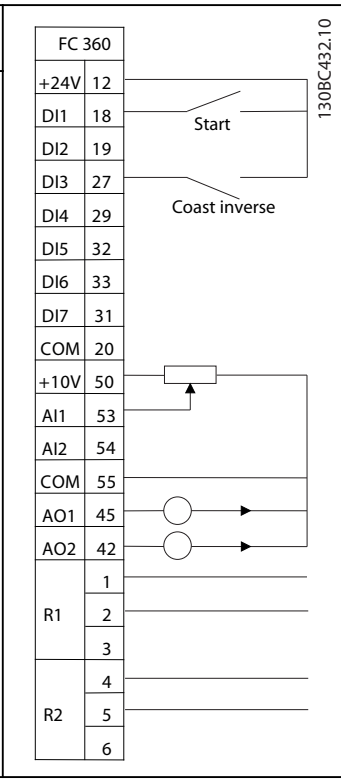
Parameter settings	Setup 1	Setup 2
0-10 (Active Set-up)	[9] Multi Set-up	[9] Multi Set-up
0-12 (Link Set-up)	[20] Linked	[20] Linked
1-00 (Configuration Mode)	[0] Speed Open Loop	[0] Speed Open Loop
3-00 (Ref Range)	[0] Min- Max	[0] Min- Max
3-15 (Ref Source 1)	[1] AI 53	[2] AI 54
3-16 (Ref Source 2)		
4-12 (Motor Low Limit)	25.0 Hz	25.0 Hz
4-14 (Motor High Limit)	50.0 Hz	50.0 Hz
5-10 (DI 18 Selection)	[8] Start	[8] Start
5-12 (DI 27 Selection)	[2] Coast Inverse	[2] Coast Inverse
5-14 (DI 32 Selection)	[23] Set-up select	[23] Set-up select
5-40 (Relay 1 Selection)	Running	Running
5-40 (Relay 2 Selection)	Alarm	Alarm
6-10 (AI 53 Low)	0.07 V	
6-11 (AI 53 High)	10 V	
6-19 (AI 53 Mode)	[1] Voltage Mode	
6-22 (AI 54 Low)		4.0 mA
6-23 (AI 54 High)		20.0 mA
6-29 (AI 54 Mode)		[0] Current Mode
6-70 (Term 45 Mode)	[0] 0-20 mA	[0] 0-20 mA
6-71 (AO45)	[100] Output freq	[100] Output freq
6-90 (Term 42 Mode)	[0] 0-20 mA	[0] 0-20 mA
6-91 (AO42)	[103] Motor current	[103] Motor current

Table 1.3

[3] Speed Open Loop

Application
Conveyors, extruders

Description
For running at a stable speed by a voltage reference signal.



Parameter settings

1-00 (Configuration Mode): [0] Speed Open Loop
3-00 (Ref Range): [0] Min- Max
3-15 (Ref Source 1): [1] AI 53
4-12 (Motor Low Limit): 25.0 Hz
4-14 (Motor High Limit): 50.0 Hz
5-10 (DI 18 Selection): [8] Start
5-12 (DI 27 Selection): [2] Coast Inverse
5-40 (Relay 1 Selection): Running
5-40 (Relay 2 Selection): Alarm
6-10 (AI 53 Low): 0.07 V
6-11 (AI 53 High): 10 V
6-19 (AI 53 Mode): [1] Voltage Mode
6-70 (Term 45 Mode): [0] 0-20 mA
6-71 (AO45): [100] Output freq
6-90 (Term 42 Mode): [0] 0-20 mA
6-91 (AO42): [103] Motor current

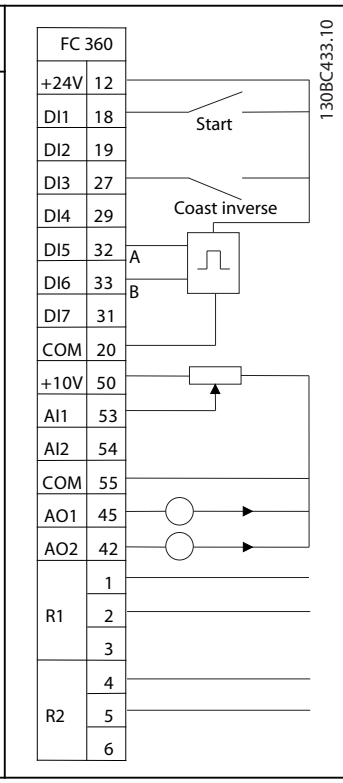
Table 1.4

1

[4] Speed Close Loop

Application
Machine tools, texturizers

Description
For precise speed applications with 24 V encoder feedback



Parameter settings

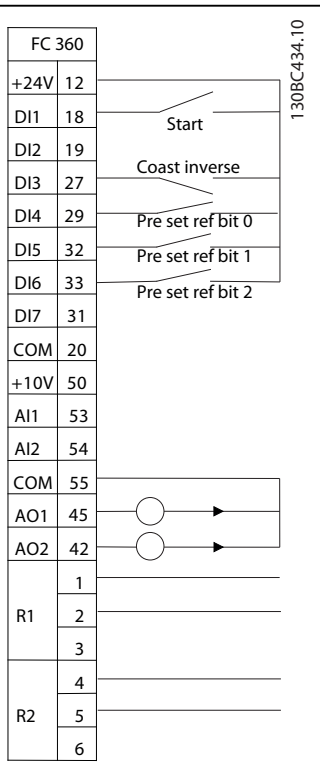
1-00 (Configuration Mode): [1] Speed Close Loop
3-00 (Ref Range): [0] Min- Max
3-15 (Ref Source 1): [1] AI 53
3-16 (Ref Source 2): [11] Local Bus Ref
4-12 (Motor Low Limit): 20.0 Hz
4-14 (Motor High Limit): 50.0 Hz
5-10 (DI 18 Selection): [8] Start
5-12 (DI 27Selection): [2] Coast Inverse
5-14 (DI 32 Selection): [82] Encoder input B
5-15 (DI 23 Selection): [81] Encoder input A
5-40 (Relay 1 Selection): Running
5-40 (Relay 2 Selection): Alarm
6-10 (AI 53 Low): 0.07 V
6-11 (AI 53 High): 10 V
6-19 (AI 53 Mode): [1] Voltage Mode
7-00 (Speed PID Feedback Source): [1] 24 V encoder

Table 1.5

[5] Multi-speed

Application
Industrial washing machines, conveyors

Description
For applications with 8 different speeds by digital input. By using another digital input, 16 speeds are possible.



Parameter settings

1-00 (Configuration Mode): [0] Speed Open Loop
3-00 (Ref Range): [0] Min- Max
3-15 (Ref Source 1): [0] No Function
4-14 (Motor High Limit): 50.0 Hz
5-10 (DI 18 Selection): [8] Start
5-12 (DI 27 Selection): [2] Coast Inverse
5-13 (DI 29 Selection): [16] Preset ref bit 0
5-14 (DI 32 Selection): [17] Preset ref bit 1
5-15 (DI 23 Selection): [18] Preset ref bit 2
6-70 (Term 45 Mode): [0] 0-20 mA
6-71 (AO45): [100] Output freq
6-90 (Term 42 Mode): [0] 0-20 mA
6-91 (AO42): [103] Motor current

Table 1.6

NOTE

For further examples refer to *5 Wiring Examples*.

1.4 Jumper Terminal 12 and 27

A jumper wire may be required between terminal 12 and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive an 24 V DC external interlock command. In many applications, the user wires an external interlock device to terminal 27
- When no interlock device is used, wire a jumper between control terminal 12 to terminal 27. This provides in internal 24 V signal on terminal 27
- No signal present prevents the unit from operating

1.5 Automatic Motor Adaptation (AMA)

Automatic motor adaptation (AMA)
It is highly recommended to run AMA because it is a test procedure that measures the electrical characteristics of the motor to optimize compatibility between the frequency converter and the motor under VVC^{plus} mode.

- The frequency converter builds a mathematical model of the motor for regulating output motor current thus enhancing motor performance.
- Some motors may be unable to run the complete version of the test. In that case, select *Enable reduced AMA*
- If warnings or alarms occur, see *6 Warnings and Alarms*
- Run this procedure on a cold motor for best results

NOTE

AMA does not cause the motor to run and it does not harm the motor.

To run AMA using the numeric LCP (NLCP)

1. Enter the main menu.
2. Go to parameter group *1-** Load and Motor*.
3. Press [OK].
4. Set motor parameters using name plate data for parameter *group 1-2* Motor Data*.
5. Set motor cable length in *1-42 Motor Cable Length*
6. Go to *1-29 Automatic Motor Adaptation (AMA)*.
7. Press [OK].
8. Select *[1] Enable complete AMA*.
9. Press [OK].
10. The test will run automatically and indicate when it is complete.

NOTE

By default parameter setting, connect terminal 12 and 27 before running AMA.

1

2 Introduction

2

2.1 Exploded Views

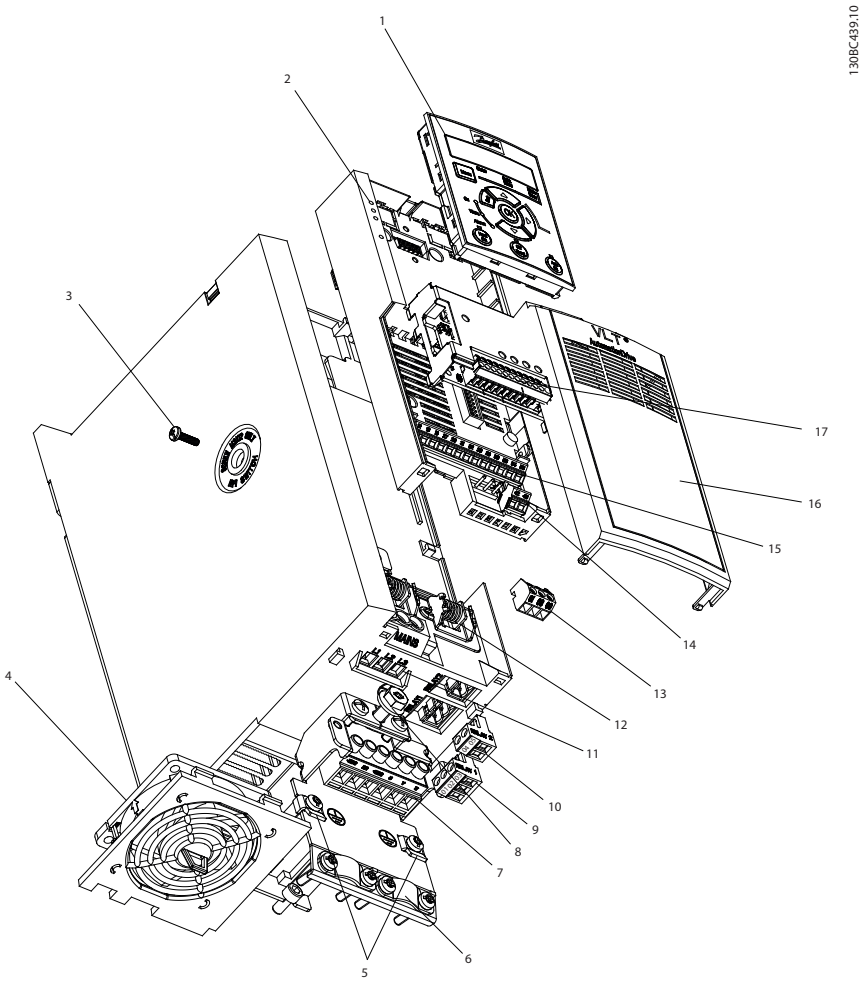


Illustration 2.1 Exploded View J1-J5 (0.37-22 kW), IP20

1	NLCP (accessory)	10	2-Pole Relay 2 (0.37 kW-7.5 kW) 3-Pole Relay 2 (11 kW-22 kW)
2	Control cassette	11	Mains terminal
3	RFI switch (screw M3x12 only)	12	Cable strain relief (0.37-2.22 kW: accessory)
4	Removable fan assembly	13	RS-485 com pluggable terminal
5	Grounding clamp (accessory)	14	Fixed I/O terminals
6	Shielded cable grounding clamp and strain relief (accessory)	15	Fixed I/O terminals
7	Motor terminal (U V W) and brake and load sharing terminal	16	Terminal cover
8	PE ground	17	Option-B (MCB102/103 accessories)
9	3-Pole relay 1		

Table 2.1

2.2 Product Overview

A frequency converter is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The frequency converter can vary the speed of the motor in response to system feedback, such as changing temperature or pressure for controlling fan, compressor, or pump motors. The frequency converter can also regulate the motor by responding to remote commands from external controllers.

In addition, the frequency converter monitors the system and motor status, issues warnings or alarms for fault conditions, starts and stops the motor, optimizes energy efficiency, and offers many more control, monitoring, and efficiency functions. Operation and monitoring functions are available as status indications to an outside control system or serial communication network.

2.3 Additional Resources

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

- The Programming Guide provides greater detail on working with parameters.
- The Design Guide is intended to provide detailed capabilities and functionality to design motor control systems.
- Optional equipment is available that may change some of the procedures described. Be sure to see the instructions supplied with those options for specific requirements.

Contact the local Danfoss supplier or go to *http://www.danfoss.com/Products/Literature/VLT+Technical+Documentation.htm* for downloads.

2

2.4 Frame Sizes and Power Ratings

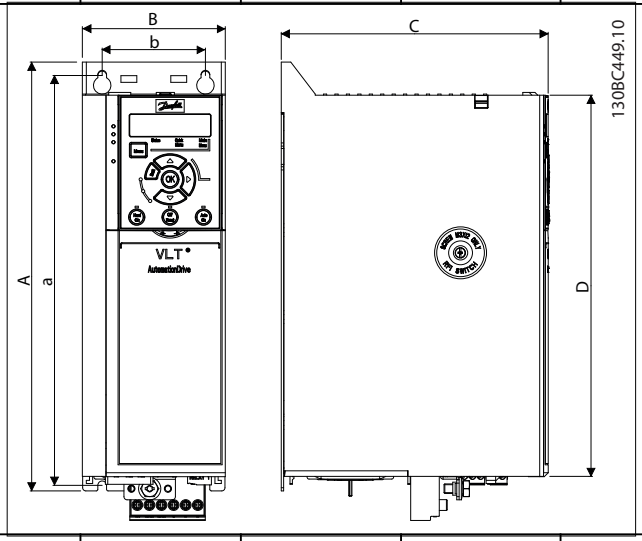
Frame size 380-480 V	J1	J2	J3	J4	J5	J6	J7
Power size [kW]	0.37-2.2	3.0-5.5	7.5	11-15	18.5-22	30-45	55-75
Dimensions [mm]							
Height A	210	272.5	272.5	317.5	410	520	550
Width B	75	90	115	133	150	233	308
Depth C (with option B)	168 (181)	168 (181)	168 (181)	245 (258)	245 (258)	242	332
Mounting holes							
a	198	260	260	297.5	390		
b	60	70	90	105	120		
Mounting screw	M4	M5	M5	M6	M6		

Table 2.2 Frames Sizes, Power Ratings and Dimensions

3 Installation

3.1 Mechanical Installation

3

Select the best possible operation site by considering the following:

- Ambient operating temperature
- Installation method
- How to cool the unit
- Position of the frequency converter
- Cable routing
- Power source supplying correct voltage and necessary current
- Motor current rating within the maximum current from the frequency converter
- Correct rating of external fuses and circuit breakers

Cooling and Mounting:

- Top and bottom clearance for air cooling must be provided, see *Table 3.1* for clearance requirements
- Derating for temperatures starting from 45°C and elevation 1000m above sea level must be considered. See the equipment Design Guide for detailed information.

Enclosure	J1-J5	J6/J7
Clearance above and below the unit [mm]	100-200	

Table 3.1 Minimum Airflow Clearance Requirements

- Mount the unit vertically
- IP20 units (but NOT IP21 units) allow side by side installation
- Improper mounting can result in over heating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided
- See *8.4 Connection Tightening Torques* for proper tightening specifications.

3.2 Electrical Installation

This section contains detailed instructions for wiring the frequency converter.

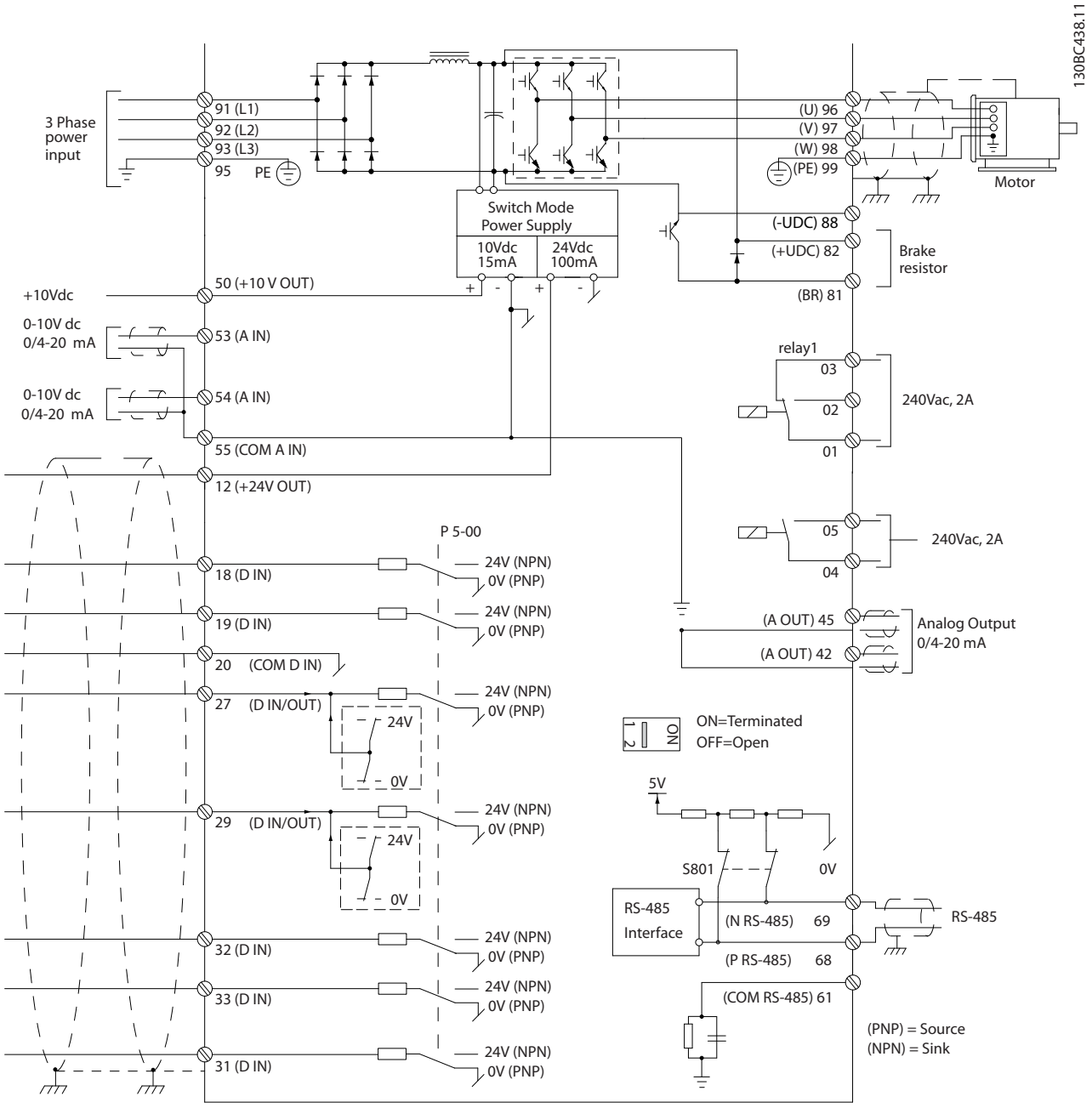


Illustration 3.1 Basic Wiring Schematic Drawing

A=Analog, D=Digital

1) Built-in braking chopper available from 0.37 - 22 kW

2) Relay 2 is 2 pole for J1-J3 and 3 pole for J4-J7. Relay 2 of J4-J7 with terminal 4,5,6, same NO/NC logic as Relay 1.

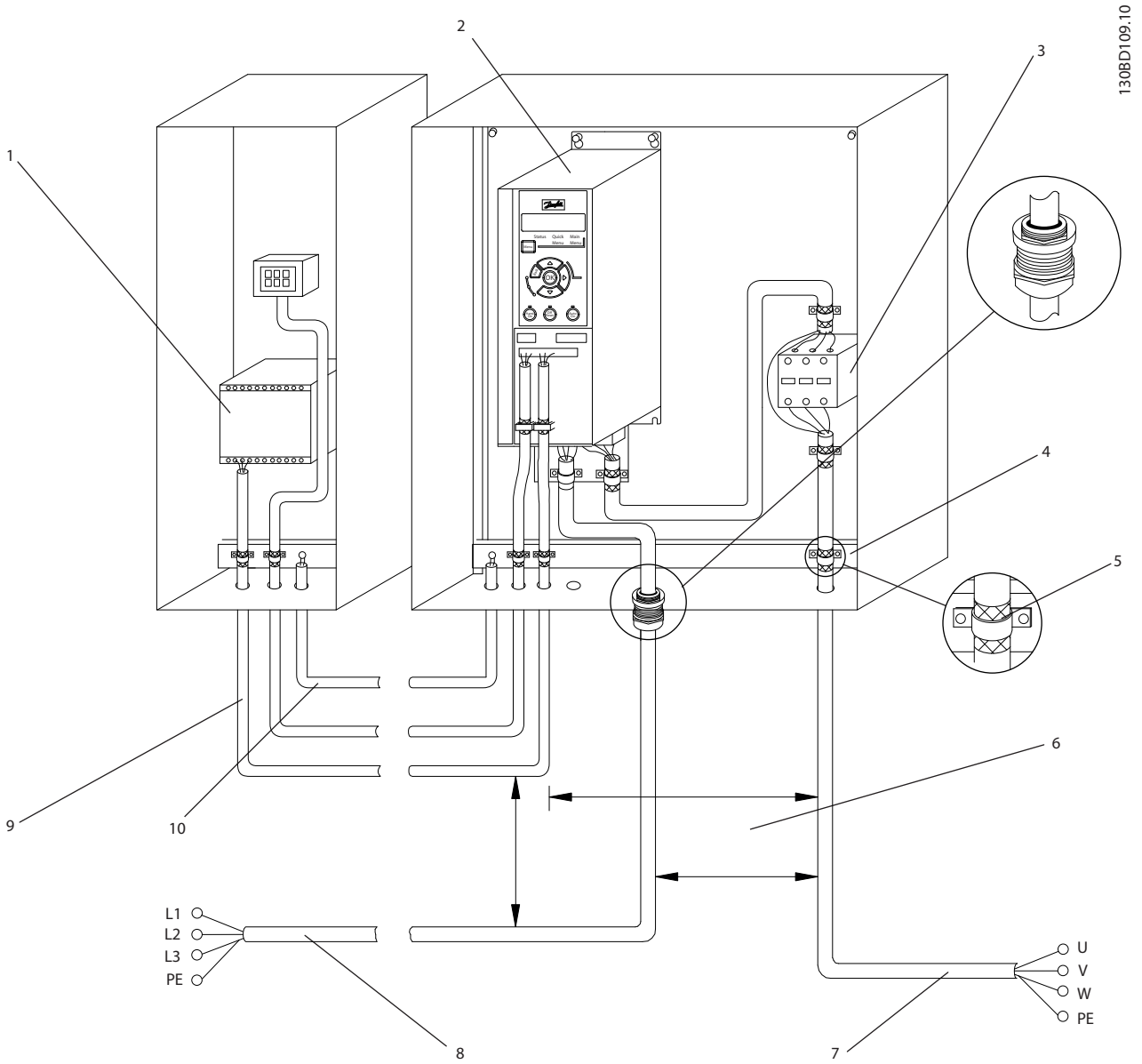


Illustration 3.2 Typical Electrical Connection

1	PLC	6	Min. 200 mm (7.9 in) between control cables, motor and mains
2	Frequency converter	7	Motor, 3-phase and PE
3	Output contactor (Generally not recommended)	8	Mains, 3-phase and reinforced PE
4	Earth (grounding) rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalising min. 16 mm^2 (0.025 in)

Table 3.2

3.2.1 General Requirements

⚠WARNING

EQUIPMENT HAZARD!

Rotating shafts and electrical equipment can be hazardous. Extreme care should be taken to protect against electrical hazards when applying power to the unit. All electrical work must conform to national and local electrical codes and installation, start up, and maintenance should only be performed by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

CAUTION

WIRING ISOLATION!

Run input power, motor wiring and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum frequency converter and associated equipment performance.

Run motor cables from multiple frequency converters separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out.

- An electronically activated function within the frequency converter provides overload protection for the motor. The overload provides Class 20 motor protection. See *6 Warnings and Alarms* for details on the trip function.

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Danfoss recommends that all power connections be made with a minimum 75° C rated copper wire.
- See *8 Specifications* for recommended wire sizes.

3.2.2 Earth (Grounding) Requirements

⚠WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground the frequency converter properly by a certified electrical installer in accordance with national and local electrical codes as well as instructions contained within this document. Ground currents are higher than 3,5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- Proper protective grounding for equipment with ground currents higher than 3,5 mA must be established, see *Leakage Current (>3,5 mA)*
- A dedicated ground wire is required for input power, motor power and control wiring
- Use the clamps provided with the equipment for proper ground connections
- Do not ground one frequency converter to another in a “daisy chain” fashion (see *Illustration 3.3*)
- Keep the ground wire connections as short as possible
- Using high-strand wire to reduce electrical noise is recommended
- Follow motor manufacturer wiring requirements

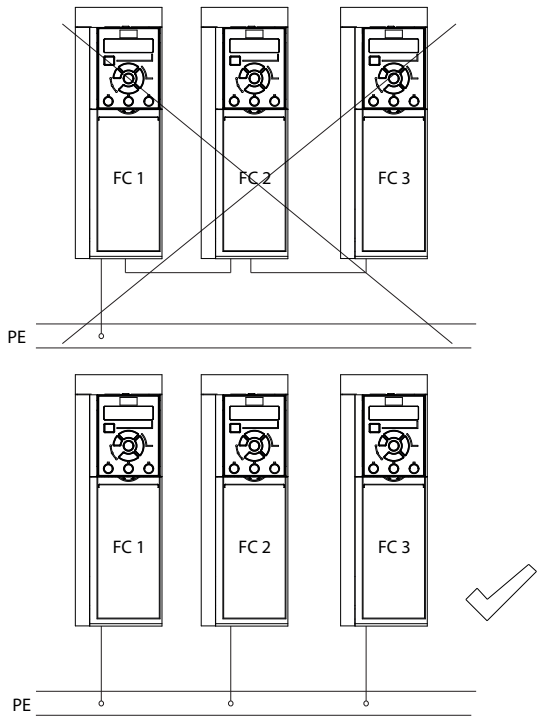


Illustration 3.3 Grounding Principle

3.2.2.1 Leakage Current (>3,5 mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current > 3,5 mA. The earth leakage current depends on various system configurations including RFI filtering, screened motor cables, and frequency converter power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3,5 mA. Earth grounding must be reinforced in one of the following ways:

- Earth ground wire of at least 10 mm^2
- Two separate earth ground wires both complying with the dimensioning rules

See EN 60364-5-54 § 543.7 for further information.

Using RCDs

Where residual current devices (RCDs), also known as earth leakage circuit breakers (ELCBs), are used, comply with the following:

- Use RCDs of type B only which are capable of detecting AC and DC currents
- Use RCDs with an inrush delay to prevent faults due to transient earth currents
- Dimension RCDs according to the system configuration and environmental considerations

3.2.3 Mains, Motor and Earth Connections

⚠WARNING

INDUCED VOLTAGE!

Run output motor cables from multiple frequency converters separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

Earthing (grounding) clamps are provided for motor wiring (see *Illustration 3.4*).

- Do not install power factor correction capacitors between the frequency converter and the motor
- Do not wire a starting or pole-changing device between the frequency converter and the motor
- Follow motor manufacturer wiring requirements
- All frequency converters may be used with an isolated input source as well as with ground reference power lines. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), set *14-50 RFI Filter* to OFF (size J6-J7) or remove the RFI screw (J1-J5). When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce earth capacity currents in accordance with IEC 61800-3.
- Do not install switch between the frequency converter and the motor in IT mains.

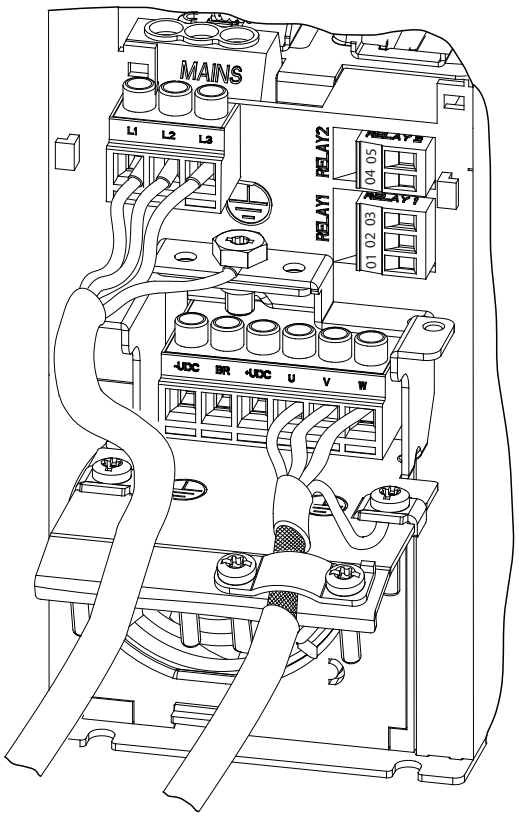


Illustration 3.4 Mains, Motor and Earth Connections

Illustration 3.4 represents mains input, motor, and earth grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

3.2.4 Control Wiring

3.2.4.1 Access

- Remove access cover plate with a screw driver. See *Illustration 3.5*.

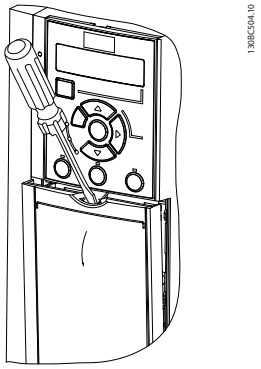


Illustration 3.5 Control Wiring Access for J1-J7 Enclosures

3.2.4.2 Control Terminal Types

Illustration 3.6 shows the frequency converter control terminals. Terminal functions and default settings are summarized in *Table 3.4*.

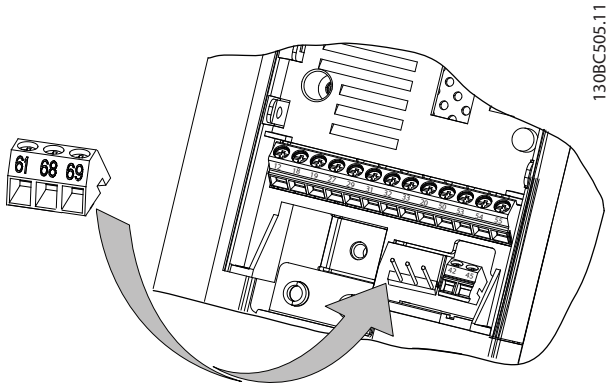


Illustration 3.6 Control Terminal Locations

See *8.2 General Technical Data* for terminal ratings details.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Digital I/O, Pulse I/O, Encoder			
12	-	+24 V DC	24 V DC supply voltage. Maximum output current is 100mA for all 24 V loads.
18	5-10	[8] Start	Digital inputs.
19	5-11	[10] Reversing	
31	5-16	[0] No operation	Digital input, pulse input.
32	5-14	[0] No operation	Digital input, 24 V encoder.
33	5-15	[0] No operation	
27	5-12 5-30	DI [2] Coast inverse DO [0] No operation	Selectable for either digital input, digital output or pulse output. Default setting is digital input.
29	5-13 5-31	DI [14] Jog DO [0] No operation	
20	-		Common for digital inputs and 0V potential for 24V supply.
Analog inputs/outputs			
42	6-91	[0] No operation	Programmable analog output. The analog signal is 0-20mA or 4-20 mA at a maximum of 500Ω. Can also be configured as digital outputs
45	6-71	[0] No operation	
50	-	+10 V DC	10 V DC analog supply voltage. 15mA maximum commonly used for potentiometer or thermistor.
53	6-1*	Reference	Analog input. Selectable for voltage or current.
54	6-2*	Feedback	
55	-		Common for analog input

Table 3.3

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Serial communication			
61	-		Integrated RC-Filter for cable screen. ONLY for connecting the screen when experiencing EMC problems.
68 (+)	8-3*		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3*		
Relays			
01, 02, 03	5-40 [0]	[0] No operation	Form C relay output. These relays are in various locations depending upon the frequency converter configuration and size. Usable for AC or DC voltage and resistive or inductive loads. RO2 in J1-J3 enclosure is 2-pole, only 04,05 terminal available
04, 05, 06	5-40 [1]	[0] No operation	

Table 3.4 Terminal Description

3.2.4.3 Control Terminal Functions

Frequency converter functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it will be supporting in the parameters associated with that terminal. See*Table 3.4* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface and Programming* for details on accessing parameters and for details on programming.
- The default terminal programming is intended to initiate frequency converter functioning in a typical operational mode.

3.2.4.4 Using Screened Control Cables

Correct screening

The preferred method in most cases is to secure control and serial communication cables with screening clamps provided at both ends to ensure best possible high frequency cable contact.

If the earth potential between the frequency converter and the PLC is different, electric noise may occur that will disturb the entire system. Solve this problem by fitting an equalizing cable next to the control cable. Minimum cable cross section: 16 mm^2.

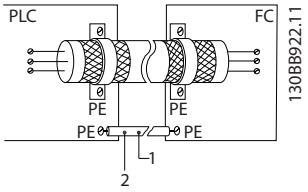


Illustration 3.7

1	Min. 16 mm^2
2	Equalizing cable

Table 3.5

50/60Hz ground loops

With very long control cables, ground loops may occur. To eliminate ground loops, connect one end of the screen-to-ground with a 100nF capacitor (keeping leads short).

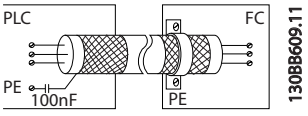


Illustration 3.8

Avoid EMC noise on serial communication

This terminal is connected to earth via an internal RC link. Use twisted-pair cables to reduce interference between conductors. The recommended method is shown below:

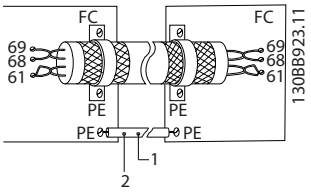


Illustration 3.9

1	Min. 16 mm^2
2	Equalizing cable

Table 3.6

Alternatively, the connection to terminal 61 can be omitted:

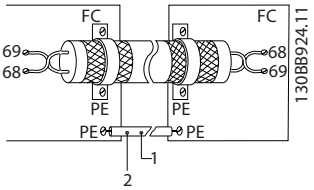


Illustration 3.10

1	Min. 16 mm^2
2	Equalizing cable

Table 3.7

3.3 Serial Communication

Connect RS-485 serial communication wiring to terminals (+)68 and (-)69.

- Screened serial communication cable is recommended
- See *3.2.2 Earth (Grounding) Requirements* for proper grounding

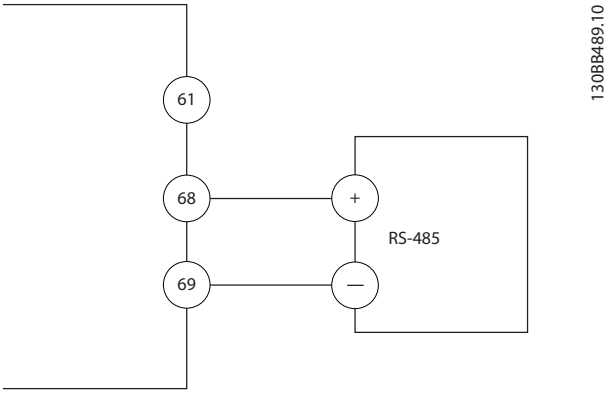


Illustration 3.11 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following

1. Protocol type in *8-30 Protocol*.
2. Frequency converter address in *8-31 Address*.
3. Baud rate in *8-32 Baud Rate*.

- Two communication protocols are internal to the frequency converter. Follow motor manufacturer wiring requirements.

  Danfoss FC

  Modbus RTU

- Functions can be programmed remotely using the protocol software and RS-485 connection or in parameter group *8-** Communications and Options*
- Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications along with making additional protocol-specific parameters available

4 User Interface and Programming

4.1 Programming

4.1.1 Programming with the Numerical Local Control Panel (NLCP)

The FC 360 supports graphic and numerical local control panels as well as blind covers. This chapter covers programming with the NLCP. For programming with the GLCP, see the VLT® Programming Guide, MG06C.

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NOTE

The frequency converter can also be programmed from a PC via RS-485 com-port by installing the MCT-10 Setup software. This software can either be ordered using code number 130B1000 or downloaded from the Danfoss Web site: www.danfoss.com/BusinessAreas/DrivesSolutions/softwaredownload

4.1.2 NLCP

The NLCP is divided into four functional sections.

A. Numeric display

B. Menu key

C. Navigation keys and indicator lights (LEDs)

D. Operation keys and indicator lights (LEDs)

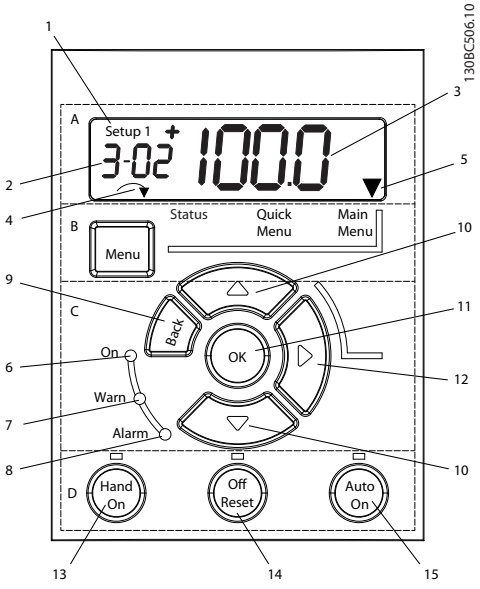


Illustration 4.1

A. Numeric Display

The LCD-display is back-lit with 1 numeric line. All data is displayed on the LCP.

1	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 (Setup 12). The number flashing, indicates the edit set-up.
2	Parameter number.
3	Parameter value.
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

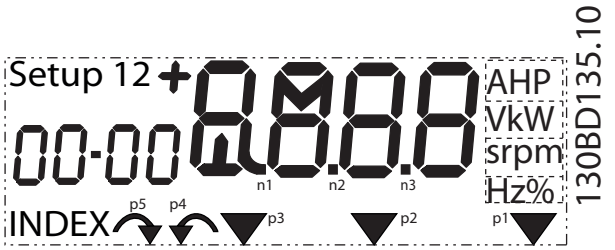


Illustration 4.2 Display Information

B. Menu Key

Use the menu key to select between status, quick menu or main menu.

C. Navigation keys and indicator lights (LEDs)

6	Green LED/On: Control section is working.
7	Yellow LED/Warn.: Indicates a warning.
8	Flashing Red LED/Alarm: Indicates an alarm.
9	[Back]: For moving to the previous step or layer in the navigation structure
10	Arrows [▲] [▼]: For maneuvering between parameter groups, parameters and within parameters or increasing/decreasing parameter values. Can also be used for setting local reference.
11	[OK]: For selecting a parameter and for accepting changes to parameter settings
12	[►]: For moving from left to right within the parameter value in order to change each digit individually. See description in *4.1.3 The Right-Key Function*.

Table 4.2

D. Operation keys and indicator lights (LEDs)

13	[Hand On]: Starts the motor and enables control of the frequency converter via the LCP. **NOTE** **Terminal 27 Digital Input (*5-12 Terminal 27 Digital Input*) has coast inverse as default setting. This means that [Hand On] will not start the motor if there is no 24 V to terminal 27.**
14	[Off/Reset]: stops the motor (off). If in alarm mode the alarm will be reset.
15	[Auto On]: frequency converter is controlled either via control terminals or serial communication.

Table 4.3

4.1.3 The Right-Key Function

WARNING

The [Off/Reset] key is not a safety switch. It does not disconnect the frequency converter from mains.

[►] makes it possible to edit any of the four digits on the display individually. When pressing [►] once the cursor moves to the first digit and the digit starts flashing as shown in *Illustration 4.3*. The value can now be changed using the [▲] [▼] navigation keys. Pressing [►] will not change the value of the digits or move the decimal point.

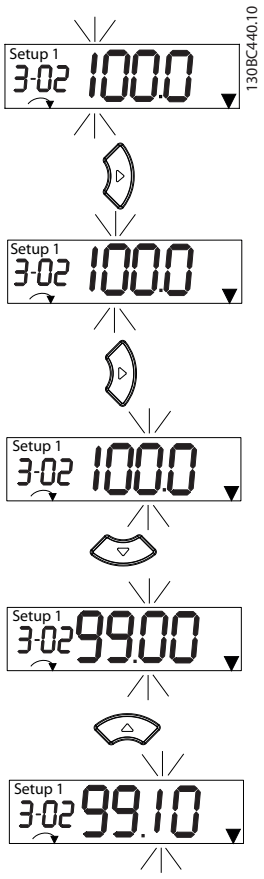


Illustration 4.3 Right Key Function

The right key can also be used for moving between parameter groups: when in main menu, press the right key to move to the first parameter in the next parameter group (e.g. move from 0-03 [0] to 1-00 [0]).

4

4.2 Quick Menu

The Quick Menu gives easy access to the most frequently used parameters.

1. To enter the Quick Menu, press [Menu] key until indicator in display is placed above *Quick Menu*.
2. Use [▲] [▼] to select either QM1 or QM2, then press [OK].
3. Use [▲] [▼] to browse through the parameters in the Quick Menu.
4. Press [OK] to select a parameter.
5. Use [▲] [▼] to change the value of a parameter setting.
6. Press [OK] to accept the change.
7. To exit, press either [Back] twice (or three times if in QM" and QM3) to enter *Status*, or press [Menu] once to enter *Main Menu*.

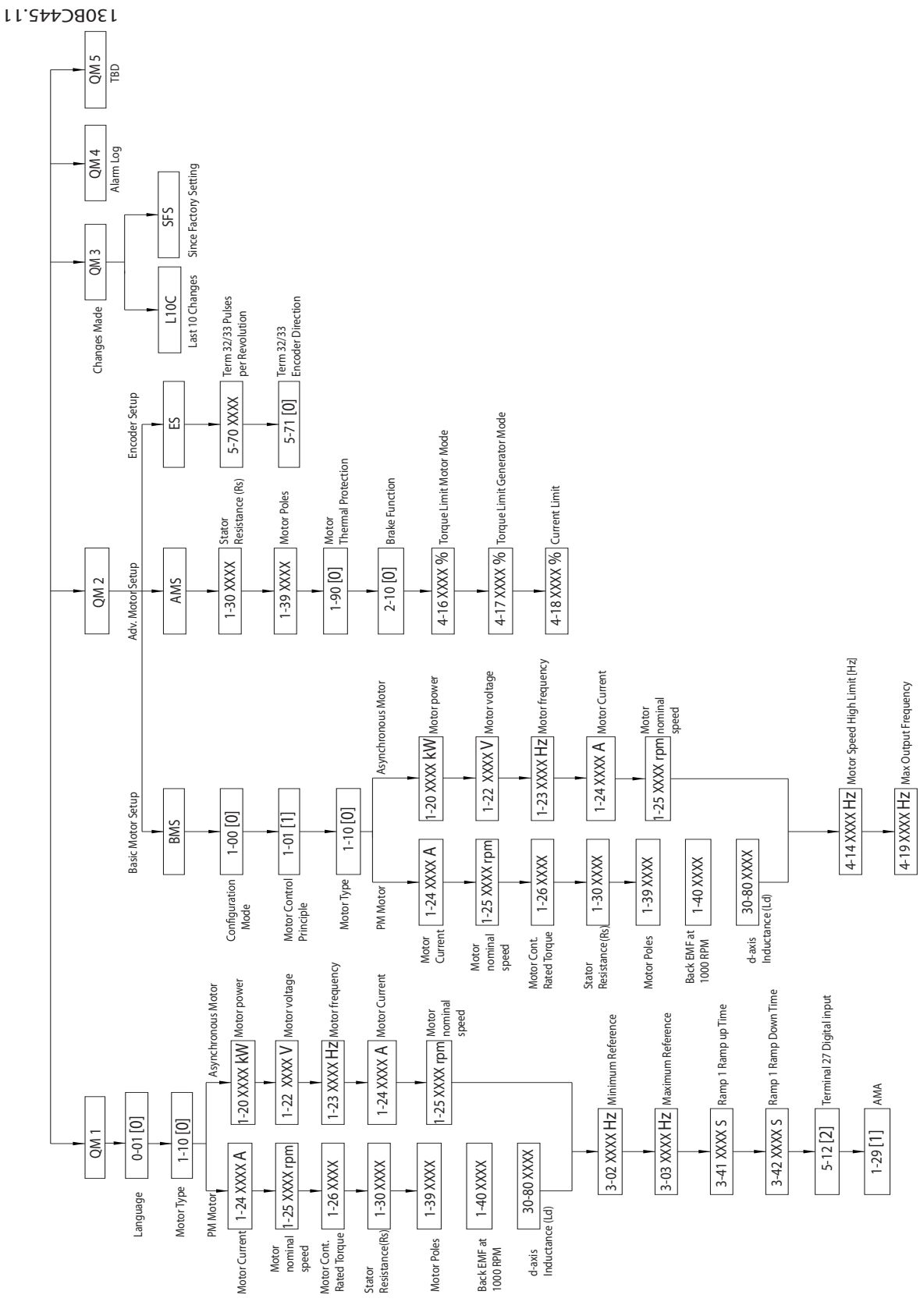


Illustration 4.4 Quick Menu Structure

4.3 Main Menu

The Main Menu gives access to all parameters.

1. To enter the Main Menu, press [Menu] key until indicator in display is placed above *Main Menu*.
2. [▲] [▼]: browse through the parameter groups.
3. Press [OK] to select a parameter group.
4. [▲] [▼]: browse through the parameters in the specific group.
5. Press [OK] to select the parameter.
6. [►] and [▲] [▼]: set/change the parameter value.
7. Press [OK] to accept the value.
8. To exit, press either [Back] twice (or three times for array parameters) to enter *Main Menu*, or press [Menu] once to enter *Status*.

The principles for changing the value of continuous, enumerated and array parameters, respectively, are shown below.

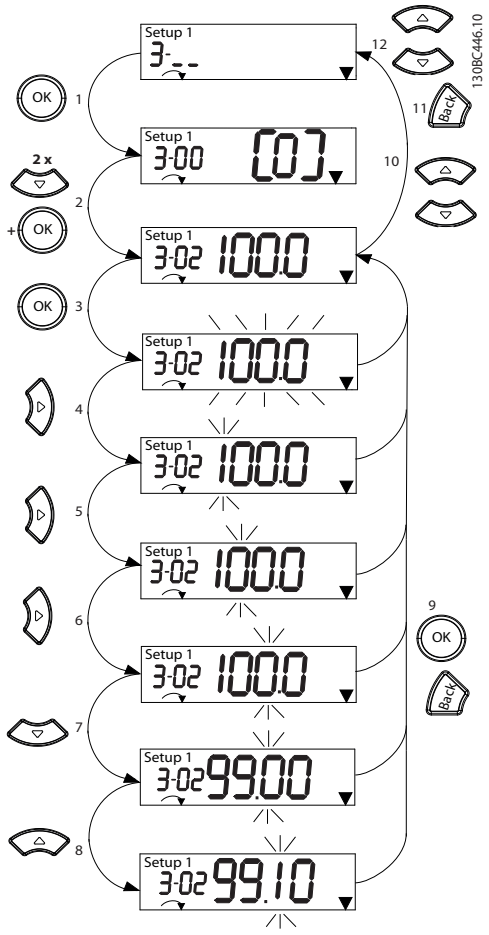


Illustration 4.5 Main Menu Interactions - Continuous Parameters

1	[OK]: the first parameter in the group is shown.
2	Press [▼] repeatedly to move down to the desired parameter.
3	Press [OK] to start editing.
4	[►]: first digit flashing (can be edited).
5	[►]: second digit flashing (can be edited).
6	[►]: third digit flashing (can be edited).
7	[▼]: decreases the parameter value, the decimal point changes automatically
8	[▲]: increases the parameter value.
9	[Back]: cancel changes, return to 2) [OK]: accept changes, return to 2)
10	[▲][▼]: select parameter within the group.
11	[Back]: Removes the value and shows the parameter group.
12	[▲][▼]: select group.

Table 4.4

For enumerated parameters the interaction is similar but the parameter value is shown in brackets, because of the NLCP digits limitation (4 large digits) and the enum can be greater than 99. When the enum value is greater than 99, the NLCP can only display the first part of the bracket.

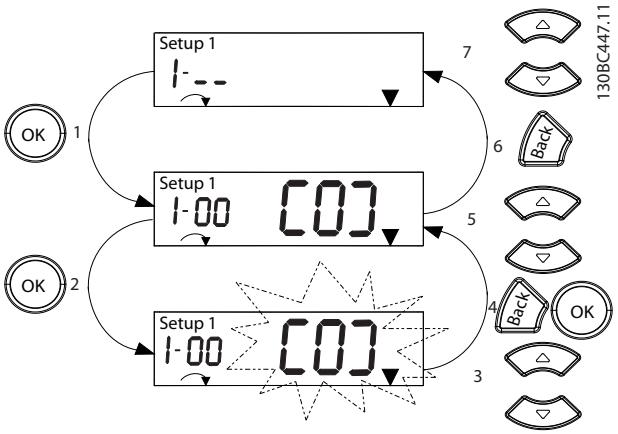


Illustration 4.6 Main Menu Interactions - Enumerated Parameters

1	[OK]: the first parameter in the group is shown.
2	Press [OK] to start editing.
3	[▲][▼]: change parameter value (flashing).
4	Press [Back] to cancel changes or [OK] to accept changes (return to screen 2).
5	[▲][▼]: select parameter within the group.
6	[Back]: Removes the value and shows the parameter group.
7	[▲][▼]: select group.

Table 4.5

Array parameters function as follows:

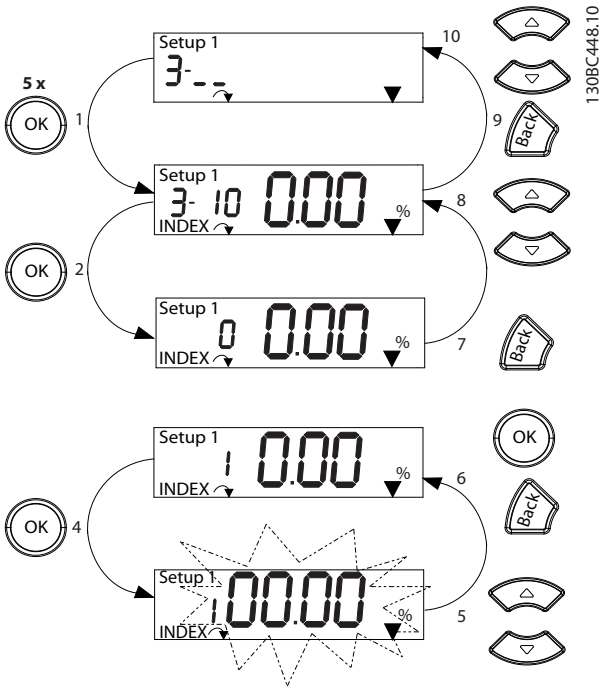


Illustration 4.7 Main Menu Interactions - Array Parameters

1	[OK]: shows parameter numbers and the value in the first index.
2	[OK]: Index can be selected.
3	[▲][▼]: Selects index.
4	[OK]: Value can be edited.
5	[▲][▼]: changes parameter value (flashing).
6	[Back]: cancel changes [OK]: accept changes
7	[Back]: cancels editing index, a new parameter can be selected.
8	[▲][▼]: selects parameter within the group.
9	[Back]: removes parameter index value and shows the parameter group.
10	[▲][▼]: selects group.

Table 4.6

4.4 Parameter List

4

4.4.1 Main Menu Structure

- **0-** Operation / Display**
  - **0-0* Basic Settings**
    - 0-01 Language
    - 0-03 Regional Settings
    - 0-04 Operating State at Power-up
    - 0-06 GridType
      - [10] >380-440V/50Hz/IT-grid<
      - [11] >380-440V/50Hz/Delta<
      - [12] >380-440V/50Hz<
      - [20] >440-480V/50Hz/IT-grid<
      - [21] >440-480V/50Hz/Delta<
      - [22] >440-480V/50Hz<
      - [110] >380-440V/60Hz/IT-grid<
      - [111] >380-440V/60Hz/Delta<
      - [112] >380-440V/60Hz<
      - [120] >440-480V/60Hz/IT-grid<
      - [121] >440-480V/60Hz/Delta<
      - [122] >440-480V/60Hz<
    - 0-07 Auto DC Braking
  - **0-1* Set-up Operations**
    - 0-10 Active Set-up
      - *[1] >Set-up 1<
      - [2] >Set-up 2<
      - [9] >Multi Set-up<
    - 0-11 Programming Set-up
    - 0-12 Link Setups
    - 0-16 Application Selection
      - *[0] None
      - [1] >Process Close Loop<
      - [2] >Local/Remote<
      - [3] >Speed Open Loop<
      - [4] >Speed Close Loop<
      - [5] >Multi Speed<
  - **0-3* LCP Custom Readout**
    - 0-30 Custom Readout Unit
    - 0-31 Custom Readout Min Value
    - 0-32 Custom Readout Max Value
  - **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] >No copy<
      - [1] >All to LCP<
      - [2] >All from LCP<
      - [3] >Size indep. from LCP<
    - 0-51 Set-up Copy
      - *[0] >No copy-
      - [1] >Copy from setup 1<
      - [2] >Copy from setup 2<
      - [9] >Copy from Factory setup<
  - **0-6* Password**
    - 0-60 Main Menu Password
- **1-** Load and Motor**
  - **1-0* General Settings**
    - 1-00 Configuration Mode
      - [0]* >Open Loop<
      - [1] >Speed closed loop<
      - [3] >Process Closed Loop<
      - [4] >Torque open loop<
      - [6] >Surface Winder<
      - [7] >Extended PID Speed OL<
      - [9] >Central Winder<
      - [10] >Positioning<
      - [11] >Synchronisation<
    - 1-01 Motor Control Principle
      - [0] >U/f<
      - *[1] >VVC+<
    - 1-03 Torque Characteristics
      - *[0] >Constant torque<
      - [1] >Variable Torque<
      - [2] >Auto Energy Optim. CT<
      - [3] >Auto Energy Optim. VT<
    - 1-06 Clockwise Direction
  - **1-1* Motor Selection**
    - 1-10 Motor Construction
  - **1-2* Motor Data**
    - 1-20 Motor Power
      - [2] >0.12 kW - 0.16 hp<
      - [3] >0.18 kW - 0.25 hp<
      - [4] >0.25 kW - 0.33 hp<
      - [5] >0.37 kW - 0.5 hp<
      - [6] >0.55 kW - 0.75 hp<
      - *[7] >0.75 kW - 1 hp<
      - [8] >1.1 kW - 1 hp<
      - [9] >1.5 kW - 2 hp<
      - [10] >2.2 kW - 3 hp<
      - [11] >3 kW - 4 hp<
      - [12] >3.7 kW - 5 hp<
      - [13] >4 kW - 5.4 hp<
      - [14] >5.5 kW - 7.5 hp<
      - [15] >7.5 kW - 10 hp<
      - [16] >11 kW - 15 hp<
      - [17] >15 kW - 20 hp<
      - [18] >18.5 kW - 25 hp<
      - [19] >22 kW - 30 hp<
      - [20] >30 kW - 40 hp<
      - [21] >37 kW - 50 hp<
      - [22] >45 kW - 60 hp<
      - [23] >55 kW - 75 hp<
      - [24] >75 kW - 100 hp<
      - [25] >90 kW - 120 hp<
      - [26] >110 kW - 150 hp<
    - 1-22 Motor Voltage
    - 1-23 Motor Frequency
    - 1-24 Motor Current
    - 1-25 Motor Nominal Speed
    - 1-29 Automatic Motor Adaption (AMA)
      - *[0] >Off<
      - [1] >Enable Complete AMA<
      - [2] >Enable Reduced AMA<
  - **1-3* Adv. Motor Data I**
    - 1-30 Stator Resistance (Rs)
    - 1-33 Stator Leakage Reactance (X1)
    - 1-35 Main Reactance (Xh)
    - 1-39 Motor Poles
  - **1-4* Adv. Motor Data II**
    - 1-42 Motor Cable Length
    - 1-43 Motor Cable Length Feet
  - **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**
    - 1-60 Low Speed Load Compensation
    - 1-61 High Speed Load Compensation
    - 1-62 Slip Compensation
    - 1-63 Slip Compensation Time Constant
    - 1-64 Resonance Dampening
    - 1-65 Resonance Dampening Time Constant
  - **1-7* Start Adjustments**
    - 1-71 Start Delay
    - 1-72 Start Function
      - [0] >DC Hold/delay time<
      - *[2] >Coast/delay time<
      - [3] >Start speed cw<
      - [4] >Horizontal operation<
      - [5] >VVC+ clockwise<
    - 1-73 Flying Start
      - *[0] >Disabled<
      - [1] >Enabled<
      - [2] >Enabled Always<
      - [3] >Enabled Ref. Dir.<
      - [4] >Enab. Always Ref. Dir.<
    - 1-75 Start Speed [Hz]
    - 1-76 Start Current
    - 1-78 Compressor Start Max Speed [Hz]
    - 1-79 Compressor Start Max Time to Trip
  - **1-8* Stop Adjustments**
    - 1-80 Function at Stop
      - *[0] >Coast<
      - [1] >DC hold / Motor Preheat<
      - [3] >Pre-magnetizing<
    - 1-82 Min Speed for Function at Stop [Hz]
  - **1-9* Motor Temperature**
    - 1-90 Motor Thermal Protection
      - *[0] >No protection<
      - [1] >Thermistor warning<
      - [2] >Thermistor trip<
      - [3] >ETR warning 1<
      - [4] >ETR trip 1<
    - 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
  - **2-1* Brake Energy Funct.**
    - 2-10 Brake Function
      - *[0] >Off<
      - [1] >Resistor brake<
      - [2] >AC brake<
    - 2-11 Brake Resistor (ohm)
    - 2-12 Brake Power Limit (kW)
    - 2-16 AC Brake, Max current
    - 2-17 Over-voltage Control
      - *[0] >Disabled<
      - [1] >Enabled (not at stop)<
      - [2] >Enabled<
    - 2-19 Over-voltage Gain
  - **2-2* Mechanical Brake**
    - 2-20 Release Brake Current
    - 2-22 Activate Brake Speed [Hz]
- **3-** Reference / Ramps**
  - **3-0* Reference Limits**
    - 3-00 Reference Range
      - *[0] >Min - Max<
      - [1] >-Max - +Max<
    - 3-01 Reference/Feedback Unit
    - 3-02 Minimum Reference
    - 3-03 Maximum Reference
    - 3-04 Reference Function
      - *[0] >Sum<
      - [1] >External/Preset<
  - **3-1* References**
    - 3-10 Preset Reference
      - >-100.00-100.00%< *0.00%
    - 3-11 Jog Speed [Hz]
    - 3-12 Catch up/slow Down Value
    - 3-14 Preset Relative Reference
    - 3-15 Reference 1 Source
      - [0] >No function<
      - *[1] >Analog Input 53<
      - [2] >Analog Input 54<
      - [7] >Frequency input 29<
      - [8] >Frequency input 33<
      - [11] >Local bus reference<
      - [32] >Bus PCD<
    - 3-16 Reference 2 Source
    - 3-17 Reference 3 Source
    - 3-18 Relative Scaling Reference Resource
  - **3-4* Ramp 1**
    - 3-40 Ramp 1 Type
      - *[0] >Linear<
      - [2] >S-ramp Const Time<
    - 3-41 Ramp 1 Ramp Up Time
      - >0.05-3600.00 s< * Size related
    - 3-42 Ramp 1 Ramp Down Time
      - >0.05-3600.00 s< * Size related
  - **3-5* Ramp 2**
    - 3-50 Ramp 2 Type
    - 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
      - [0] >Clockwise<
      - *[2] >Both directions<
    - 4-12 Motor Speed Low Limit [Hz]
    - 4-14 Motor Speed High Limit [Hz]
    - 4-16 Torque Limit Motor Mode
    - 4-17 Torque Limit Generator Mode
    - 4-18 Current Limit
    - 4-19 Max Output Frequency
  - **4-2* Limit Factors**
    - 4-22 Break Away Boost
  - **4-3* Motor Fb Monitor**
    - 4-30 Motor Feedback Loss Function
    - 4-31 Motor Feedback Speed Error
    - 4-32 Motor Feedback Loss Timeout
  - **4-4* Adj. Warnings 2**
    - 4-40 Warning Freq. Low
    - 4-41 Warning Freq. High
    - 4-42 Adjustable Temperature Warning
  - **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]
- **5-** Digital In/Out**
  - **5-0* Digital I/O mode**
    - 5-00 Digital I/O Mode
      - *[0] >PNP<
      - [1] >NPN<
    - 5-01 Terminal 27 Mode
    - 5-02 Terminal 29 Mode
  - **5-1* Digital Inputs**
    - 5-10 Terminal 18 Digital Input
      - [0] >No operation<
      - [1] >Reset<
      - [2] >Coast inverse<
      - [3] >Coast and reset inv<
      - [4] >Quick stop inverse<
      - [5] >DC-brake inverse<
      - [6] >Stop inverse<
      - *[8] >Start<
      - [9] >Latched start<
      - [10] >Reversing<
      - [11] >Start reversing<
      - [12] >Enable start forward<
      - [13] >Enable start reverse<
      - [14] >Jog<
      - [15] >Preset reference on<
      - [16] >Preset ref bit 0<
      - [17] >Preset ref bit 1<
      - [18] >Preset ref bit 2<
      - [19] >Freeze reference<
      - [20] >Freeze output<
      - [21] >Speed up<

[22]	>Speed down<
[23]	>Set-up select bit 0<
[26]	>Precise stop inverse<
[28]	>Catch up<
[29]	>Slow down<
[34]	>Ramp bit 0<
[60]	>Counter A (up)<
[61]	>Counter A (down)<
[62]	>Reset Counter A<
[63]	>Counter B (up)<
[64]	>Counter B (down)<
[65]	>Reset Counter B<
[72]	>PID error inverse<
[73]	>PID reset I part<
[74]	>PID enable<
5-11	Terminal 19 Digital Input
5-12	Terminal 27 Digital Input
5-13	Terminal 29 Digital Input
5-14	Terminal 32 Digital Input
5-15	Terminal 33 Digital Input
5-16	Terminal 31 Digital Input
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
*[0]	>No operation<
[1]	>Control Ready<
[2]	>Drive ready<
[3]	>Drive rdy/rem ctrl<
[4]	>Stand-by/no warning<
[5]	>Running<
[6]	>Running/no warning<
[7]	>Run in range/no warn<
[8]	>Run on ref/no warn<
[9]	>Alarm<
[10]	>Alarm or warning<
[11]	>At torque limit<
[12]	>Out of current range<
[13]	>Below current, low<
[14]	>Above current, high<
[15]	>Out of frequency range<
[16]	>Below frequency, low<
[17]	>Above frequency, high<
[18]	>Out of feedb. range<
[19]	>Below feedback, low<
[20]	>Above feedback, high<
[21]	>Thermal warning<
[22]	>Ready, no thermal warning<
[23]	>Remote,ready,no TW<
[24]	>Ready, no over/under voltage<
[25]	>Reverse<
[26]	>Bus OK<
[27]	>Torque limit & stop<
[28]	>Brake, no brake warning<
[29]	>Brake ready, no fault<
[30]	>Brake fault (IGBT)<
[31]	>Relay 123<
[32]	>Mech brake ctrl<
[36]	>Control word bit 11<
[37]	>Control word bit 12<
[40]	>Out of ref range<
[41]	>Below reference, low<
[42]	>Above ref, high<
[45]	>Bus ctrl.<
[46]	>Bus control, timeout: On<
[47]	>Bus control, timeout: Off<
[55]	>Pulse output <
[56]	>Heat sink cleaning warning, high<
[60]	>Comparator 0<
[61]	>Comparator 1<
[62]	>Comparator 2<
[63]	>Comparator 3<
[64]	>Comparator 4<
[65]	>Comparator 5<
[70]	>Logic rule 0<
[71]	>Logic rule 1<
[72]	>Logic rule 2<
[73]	>Logic rule 3<
[74]	>Logic rule 4<
[75]	>Logic rule 5<
[80]	>SL digital output A<
[81]	>SL digital output B<
[82]	>SL digital output C<
[83]	>SL digital output D<
[91]	>Encoder emulate output A<
[160]	>No alarm<
[161]	>Running reverse <
[165]	>Local ref active <
[166]	>Remote ref active<
[167]	>Start command activ<
[168]	>Drive in hand mode<
[169]	>Drive in auto mode<
[193]	>Sleep Mode<
[194]	>Broken Belt Function<
5-31	Terminal 29 Digital Output
5-34	On Delay, Digital Output
5-35	Off Delay, Digital Output
5-4*	**Relays**
5-40	Function Relay
[0]	>No operation<
[1]	>Control Ready<
[2]	>Drive ready<
[3]	>Drive rdy/rem ctrl<
[4]	>Stand-by/no warning<
[5]	>Running<
[6]	>Running/no warning<
[7]	>Run in range/no warn<
[8]	>Run on ref/no warn<
*[9]	>Alarm<
[10]	>Alarm or warning<
[11]	>At torque limit<
[12]	>Out of current range<
[13]	>Below current, low<
[14]	>Above current, high<
[15]	>Out of frequency range<
[16]	>Below frequency, low<
[17]	>Above frequency, high<
[18]	>Out of feedb. range<
[19]	>Below feedback, low<
[20]	>Above feedback, high<
[21]	>Thermal warning<
[22]	>Ready, no thermal warning<
[23]	>Remote,ready,no TW<
[24]	>Ready, no over/under voltage<
[25]	>Reverse<
[26]	>Bus OK<
[27]	>Torque limit & stop<
[28]	>Brake, no brake warning<
[29]	>Brake ready, no fault<
[30]	>Brake fault (IGBT)<
[31]	>Relay 123<
[32]	>Mech brake ctrl<
[36]	>Control word bit 11<
[37]	>Control word bit 12<
[40]	>Out of ref range<
[41]	>Below reference, low<
[42]	>Above ref, high<
[45]	>Bus ctrl.<
[46]	>Bus control, timeout: On<
[47]	>Bus control, timeout: Off<
[56]	>Heat sink cleaning warning, high<
[60]	>Comparator 0<
[61]	>Comparator 1<
[62]	>Comparator 2<
[63]	>Comparator 3<
[64]	>Comparator 4<
[65]	>Comparator 5<
[70]	>Logic rule 0<
[71]	>Logic rule 1<
[72]	>Logic rule 2<
[73]	>Logic rule 3<
[74]	>Logic rule 4<
[75]	>Logic rule 5<
[80]	>SL digital output A<
[81]	>SL digital output B<
[82]	>SL digital output C<
[83]	>SL digital output D<
[91]	>Encoder emulate output A<
[160]	>No alarm<
[161]	>Running reverse <
[165]	>Local ref active <
[166]	>Remote ref active<
[167]	>Start command activ<
[168]	>Drive in hand mode<
[169]	>Drive in auto mode<
[193]	>Sleep Mode<
[194]	>Broken Belt Function<
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
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
*[0]	>No operation<
[45]	>Bus ctrl.<
[48]	>Bus ctrl., timeout<
[100]	>Output frequency<
[101]	>Reference<
[102]	>Process Feedback<
[103]	>Motor Current<
[104]	>Torque rel to limit<
[105]	>Torq relate to rated<
[106]	>Power<
[107]	>Speed<
[109]	>Max Out Freq<
5-62	Pulse Output Max Freq 27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq 29
5-7*	**24V Encoder Input**
5-70	Term 32/33 Pulses Per Revolution
5-71	Term 32/33 Encoder Direction
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out 27 Bus Control
5-94	Pulse Out 27 Timeout Preset
5-95	Pulse Out 29 Bus Control
5-96	Pulse Out 29 Timeout Preset
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
*[0]	>Off<
[1]	>Freeze output<
[2]	>Stop<
[3]	>Jogging<
[4]	>Max. speed<
[5]	>Stop and trip<
6-1*	**Analog Input 53**
6-10	Terminal 53 Low Voltage
	>0.00-10.00 V< *0.07 V
6-11	Terminal 53 High Voltage
	>0.00-10.00 V< *10.00 V
6-12	Terminal 53 Low Current
	>0.00-20.00 mA< *4.00 mA
6-13	Terminal 53 High Current
	>0.00-20.00 mA< *20.00 mA
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
[0]	>Current mode<
*[1]	>Voltage 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
[0]	>Current mode<
*[1]	>Voltage mode<
6-7*	**Analog/Digital Output 45**
6-70	Terminal 45 Mode
*[0]	>0-20 mA<
[1]	>4-20 mA<
[2]	>Digital Output<
6-71	Terminal 45 Analog Output
*[0]	>No operation<
[100]	>Output frequency<
[101]	>Reference<
[102]	>Process Feedback<
[103]	>Motor Current<
[104]	>Torque rel to limit<
[105]	>Torq relate to rated<
[106]	>Power<
[107]	>Speed<
[111]	>Speed Feedback<
[139]	>Bus Control<
[254]	>DC Link Voltage<
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
6-96	Terminal 42 Output Bus Control
6-98	Drive Type
7-**	**Controllers**
7-0*	**Speed PID Ctrl.**
7-00	Speed PID Feedback Source
[1]	>24V encoder<
[2]	>MCB 102<
[3]	>MCB 103<
[6]	>Analog Input 53<
[7]	>Analog Input 54<
[8]	>Frequency input 29<
[9]	>Frequency input 33<
*[20]	>None<
7-02	Speed PID Proportional Gain
	>0.000-1.000< *0.015
7-03	Speed PID Integral Time
	>2.0-20000.0 ms< *8.0 ms
7-04	Speed PID Differentiation Time
	>0.0-200.0 ms< *30.0 ms
7-05	Speed PID Diff. Gain Limit
	>1.0-20.0< *5.0
7-06	Speed PID Lowpass Filter Time
	>1.0-100.0 ms< *10.0 ms
7-07	Speed PID Feedback Gear Ratio
7-08	Speed PID Feed Forward Factor
7-1*	**Torque PID Ctrl.**
7-12	Torque PID Proportional Gain
7-13	Torque PID Integration Time

7-2* Process Ctrl. Feedb
7-20 Process CL Feedback 1 Resource
*[0] >No function<
[1] >Analog Input 53<
[2] >Analog Input 54<
[3] >Frequency input 29<
[4] >Frequency input 33<
7-22 Process CL Feedback 2 Resource
7-3* Process PID Ctrl.
7-30 Process PID Normal/ Inverse Control
*[0] >Normal<
[1] >Inverse<
7-31 Process PID Anti Windup
[0] >Off<
*[1] >On<
7-32 Process PID Start Speed
>0 - 6000 rpm< *0 rpm
7-33 Process PID Proportional Gain
>0.00 - 10.00< *0.01
7-34 Process PID Integral Time
>0.10-9999.00 s< *9999.00 s
7-35 Process PID Differentiation Time
>0.00-20.00 s< *0.00 s
7-36 Process PID Diff. Gain Limit
7-38 Process PID Feed Forward Factor
>0-200%< *0%
7-39 On Reference Bandwidth
7-4* Adv. Process PID I
7-40 Process PID I-part Reset
7-41 Process PID Output Neg. Clamp
7-42 Process PID Output Pos. Clamp
7-43 Process PID Gain Scale at Min. Ref.
7-44 Process PID Gain Scale at Max. Ref.
7-45 Process PID Feed Fwd Resource
*[0] >No function<
[1] >Analog Input 53<
[2] >Analog Input 54<
[7] >Frequency input 29<
[8] >Frequency input 33<
[11] >Local bus reference<
[32] >Bus PCD<
7-46 Process PID Feed Fwd Normal/ Inv. Ctrl.
7-48 PCD Feed Forward
7-49 Process PID Output Normal/ Inv. Ctrl.
7-5* Adv. Process PID II
7-50 Process PID Extended PID
7-51 Process PID Feed Fwd Gain
7-52 Process PID Feed Fwd Ramp up
7-53 Process PID Feed Fwd Ramp down
7-56 Process PID Ref. Filter Time
7-57 Process PID Fb. Filter Time
7-6* Feedback Conversion
7-60 Feedback 1 Conversion
*[0] >Linear<
[1] >Square root<
7-62 Feedback 2 Conversion
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
8-1* Ctrl. Word Settings
8-10 Control Word Profile
8-3* FC Port Settings
8-30 Protocol
*[0] >FC<
[2] >Modbus RTU<
8-31 Address
8-32 Baud Rate
[0] >2400 Baud<
[1] >4800 Baud<
*[2] >9600 Baud<
[3] >19200 Baud<
[4] >38400 Baud<
[5] >57600 Baud<
[6] >76800 Baud<
[7] >115200 Baud<
8-33 Parity / Stop Bits
*[0] >Even Parity, 1 Stop Bit<
[1] >Odd Parity, 1 Stop Bit<
[2] >No Parity, 1 Stop Bit<
[3] >No Parity, 2 Stop Bits<
8-35 Minimum Response Delay
8-36 Maximum Response Delay
8-37 Maximum Inter-char delay
8-4* FC MC protocol set
8-43 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
8-57 Profidrive OFF2 Select
8-58 Profidrive OFF3 Select
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
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
*[0] >Off<
[1] >On<
13-01 Start Event
[0] >False<
[1] >True<
[2] >Running<
[3] >In range<
[4] >On reference<
[7] >Out of current range<
[8] >Below I low<
[9] >Above I high<
[16] >Thermal warning<
[17] >Mains out of range<
[18] >Reversing<
[19] >Warning<
[20] >Alarm (trip)<
[21] >Alarm (trip lock)<
[22] >Comparator 0<
[23] >Comparator 1<
[24] >Comparator 2<
[25] >Comparator 3<
[26] >Logic rule 0<
[27] >Logic rule 1<
[28] >Logic rule 2<
[29] >Logic rule 3<
[33] >Digital input DI18<
[34] >Digital input DI19<
[35] >Digital input DI27<
[36] >Digital input DI29<
[39] >Start command<
*[40] >Drive stopped<
[42] >Auto Reset Trip<
[50] >Comparator 4<
[51] >Comparator 5<
[60] >Logic rule 4<
[61] >Logic rule 5<
[70] >SL Time-out 3<
[71] >SL Time-out 4<
[72] >SL Time-out 5<
[73] >SL Time-out 6<
[74] >SL Time-out 7<
[83] >Broken Belt<
13-03 Reset SLC
*[0] >Do not reset SLC<
[1] >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
[0] >Ran3<
[1] >Ran5<
[2] >2.0 kHz<
[3] >3.0 kHz<
[4] >4.0 kHz<
*[5] >5.0 kHz<
[6] >6.0 kHz<
[7] >8.0 kHz<
[8] >10.0 kHz<
[9] >12.0kHz<
[10] >16.0kHz<
14-03 Overmodulation
[0] >Off<
*[1] >On<
14-08 Damping Gain Factor
14-1* Mains On/Off
14-10 Mains Failure
*[0] >No function<
[1] >Ctrl. ramp-down<
>[2]< >Ctrl. ramp-down, trip<
[3] >Coasting<
[4] >Kinetic back-up<
[5] >Kinetic back-up, trip<
[6] >Alarm<
14-11 Mains Voltage at Mains Fault
14-12 Function at Mains Imbalance
*[0] >Trip<
[1] >Warning<
[2] >Disabled<
[3] >Derate<
14-15 Kin. Backup Trip Recovery Level
14-2* Reset Functions
14-20 Reset Mode
*[0] >Manual reset<
[1] >Automatic reset x 1<
[2] >Automatic reset x 2<
[3] >Automatic reset x 3<
[4] >Automatic reset x 4<
[5] >Automatic reset x 5<
[6] >Automatic reset x 6<
[7] >Automatic reset x 7<
[8] >Automatic reset x 8<
[9] >Automatic reset x 9<
[10] >Automatic reset x 10<
[11] >Automatic reset x 15<
[12] >Automatic reset x 20<
14-21 Automatic Restart Time
>0-600 s< *10 s
14-22 Operation Mode
*[0] >Normal operation<
[2] >Initialisation<
14-23 Typecode Setting
14-24 Trip Delay at Current Limit
14-25 Trip Delay at Torque Limit
14-27 Action At Inverter Fault
[0] >Trip<
*[1] >Warning or trip after warning<
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
14-40 VT Level
14-41 AEO Minimum Magnetisation
>40-75%< *66%
14-5* Environment
14-50 RFI Filter
14-51 DC-Link Voltage Compensation
14-52 Fan Control
*[5] >Constant-on mode<
[6] >Constant-off mode<
[7] >On-when-Inverter-is-on-else-off Mode<
[8] >Variable-speed mode<
14-55 Output Filter
14-6* Auto Derate
14-63 Min Switch Frequency
*[2] >2.0 kHz<
[3] >3.0 kHz<

[4] >4.0 kHz<
[5] >5.0 kHz<
[6] >6.0 kHz<
[7] >8.0 kHz<
[8] >10.0 kHz<
[9] >12.0 kHz<
[10] >16.0 kHz<

15- Drive Information**
15-0* Operating Data
15-00 Operating hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power Up's
15-04 Over Temp's
15-05 Over Volt's
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-3* Alarm Log
15-30 Alarm Log: Error Code
15-31 InternalFaultReason
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered TypeCode
15-46 Drive Ordering No
15-47 Power Card Ordering No
15-48 LCP Id No
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Drive Serial Number
15-53 Power Card Serial Number
15-9* Parameter Info
15-92 Defined Parameters
15-97 Application Type
15-98 Drive Identification

16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference [%]
16-03 Status Word
16-05 Main Actual Value [%]
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-18 Motor Thermal
16-3* Drive Status
16-30 DC Link Voltage
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-5* Ref. & Feedb.
16-50 External Reference
16-52 Feedback[Unit]
16-57 Feedback [RPM]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Setting
16-62 Analog Input 53
16-63 Terminal 54 Setting
16-64 Analog Input AI54
16-65 Analog Output 42 [mA]
16-66 Digital Output
16-67 Pulse Input 29[Hz]
16-68 Pulse Input 33 [Hz]
16-69 Pulse Output 27 [Hz]
16-70 Pulse Output 29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-79 Analog Output AO45
16-8* Fieldbus & FC Port
16-86 FC Port REF 1
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2

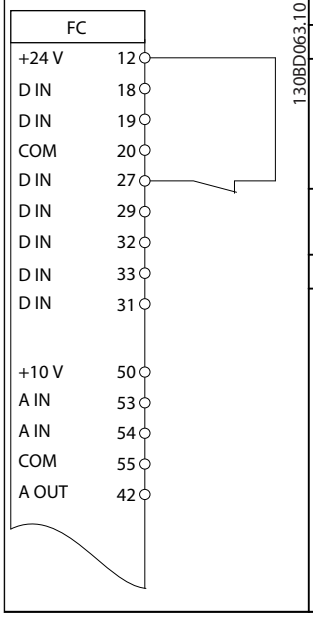
18- Data Readouts 2**
18-9* PID Readouts
18-90 Process PID Error
18-91 Process PID Output
18-92 Process PID Clamped Output
18-93 Process PID Gain Scaled Output

22- Appl. Functions**
22-4* Sleep Mode
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-43 Wake-Up Speed [Hz]
22-44 Wake-Up Ref./FB Diff
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-47 Sleep Speed [Hz]
22-6* Broken Belt Detection
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay

38- Debug only**
38-0* All debug parameters
38-00 TestMonitorMode
38-01 Version And Stack
38-02 Protocol SW version
38-06 LCPEdit Set-up
38-07 EEPROMDdataVers
38-08 PowerDataVariantID
38-09 AMA Retry
38-10 DAC selection
38-12 DAC scale
38-20 MOC_TestUS16
38-21 MOC_TestS16
38-23 TestMocFunctions
38-24 DC Link Power Measurement
38-25 CheckSum
38-30 Analog Input 53 (%)
38-31 Analog Input 54 (%)
38-32 Input Reference 1
38-33 Input Reference 2
38-34 Input Reference Setting
38-35 Feedback (%)
38-36 Fault Code
38-37 Control Word
38-38 ResetCountersControl
38-58 Inverter ETR counter
38-59 Rectifier ETR counter
38-60 DB_ErrorWarnings
38-61 Extended Alarm Word
38-69 AMA_DebugS32
38-74 AOCDebug0
38-75 AOCDebug1
38-76 AO42_FixedMode
38-77 AO42_FixedValue
38-78 DI_TestCounters
38-79 Protect Func. Counter
38-80 Highest Lowest Couple
38-81 DB_SendDebugCmd
38-82 MaxTaskRunningTime
38-83 DebugInformation
38-84 Debug Input Datas
38-85 DB_OptionSelector
38-86 EEPROM_Address
38-87 EEPROM_Value
38-88 Logger Time Remain
38-89 Emulator Version
38-90 LCP FC-Protocol select
38-95 DB_SimulateAlarmWarningExStatus
38-96 Data Logger Password
38-97 Data Logging Period
38-98 Signal to Debug
38-99 Signed Debug Info

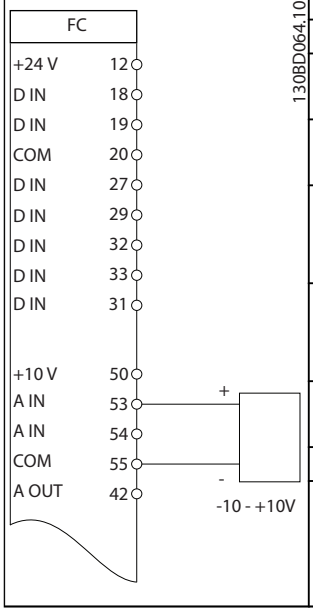
5 Wiring Examples

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



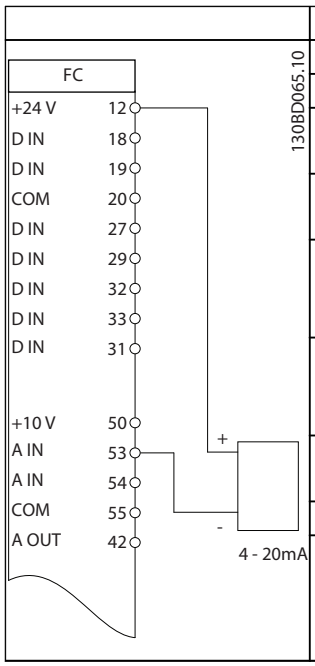
Parameters	
Function	**Setting**
1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
5-12 Terminal 27 Digital Input	[2]* Coast inverse
* = Default Value	
Notes/comments: Parameter group 1-2* must be set according to motor **NOTE** **If terminal 12 and 27 are not connected, set 5-12 to [0]**	

Table 5.1 AMA with T27 Connected



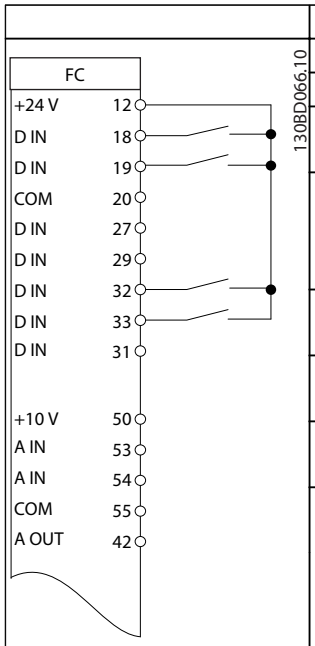
Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07 V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
6-19 Terminal 53 Mode	[1] Voltage
* = Default Value	
Notes/comments:	

Table 5.2 Analog Speed Reference (Voltage)



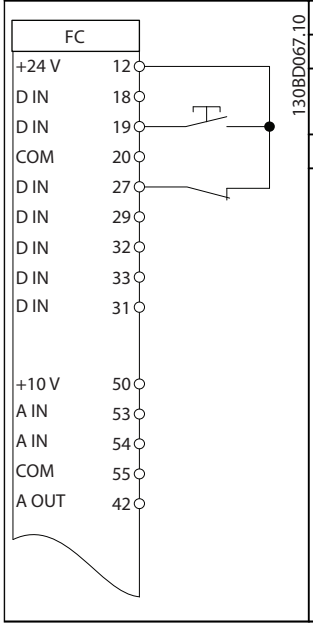
Parameters	
Function	**Setting**
6-12 Terminal 53 Low Current	4 mA*
6-13 Terminal 53 High Current	20 mA*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
6-19 Terminal 53 Mode	[0] current
* = Default Value	
Notes/comments:	

Table 5.3 Analog Speed Reference (Current)



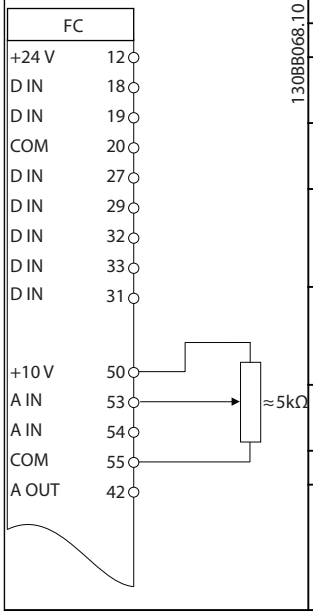
Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start
5-11 Terminal 19 Digital Input	[10] Reversing*
5-12 Terminal 27 Digital Input	[0] No operation
5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
3-10 Preset Reference	
Preset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

Table 5.4 Start/Stop with Reversing and 4 Preset Speeds



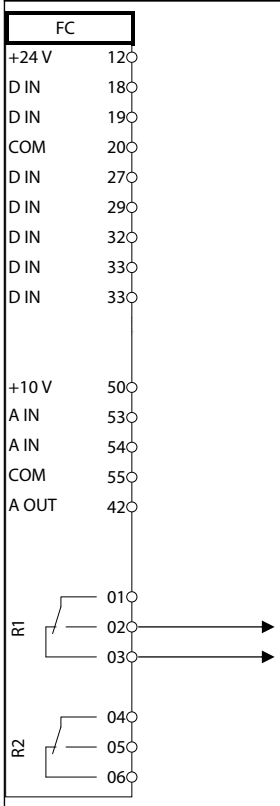
Parameters	
Function	**Setting**
5-11 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments:	

Table 5.5 External Alarm Reset



Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07 V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
6-19 Terminal 53 Mode	[1] voltage
* = Default Value	
Notes/comments:	

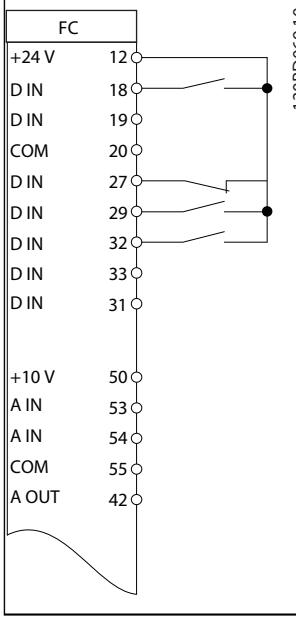
Table 5.6 Speed Reference (using a manual potentiometer)



Parameters	
Function	**Setting**
4-30 Motor Feedback Loss Function	[1] Warning
4-31 Motor Feedback Speed Error	100 RPM
4-32 Motor Feedback Loss Timeout	5 s
7-00 Speed PID Feedback Source	[2] MCB 102
17-11 Resolution (PPR)	1024*
13-00 SL Controller Mode	[1] On
13-01 Start Event	[19] Warning
13-02 Stop Event	[44] Reset key
13-10 Comparator Operand	[21] Warning no.
13-11 Comparator Operator	[1] ≈*
13-12 Comparator Value	90
13-51 SL Controller Event	[22] Comparator 0
13-52 SL Controller Action	[32] Set digital out A low
5-40 Function Relay	[80] SL digital output A
* = Default Value	
Notes/comments: If the limit in the feedback monitor is exceeded, Warning 90 will be issued. The SLC monitors Warning 90 and in the case that Warning 90 becomes TRUE then Relay 1 is triggered. External equipment may then indicate that service may be required. If the feedback error goes below the limit again within 5 sec. then the drive continues and the warning disappears. But Relay 1 will still be triggered until [Reset] on the LCP.	

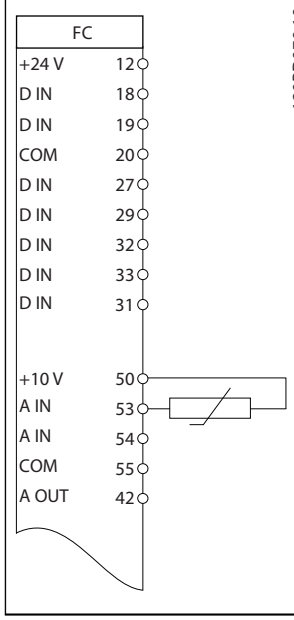
Table 5.7 Using SLC to Set a Relay

5



	Parameters	
	Function	**Setting**
	5-10 Terminal 18 Digital Input	[8] Start*
	5-12 Terminal 27 Digital Input	[19] Freeze Reference
	5-13 Terminal 29 Digital Input	[21] Speed Up
	5-14 Terminal 32 Digital Input	[22] Speed Down
	* = Default Value	
	Notes/comments:	

Table 5.8 Speed Up/Down



	Parameters	
	Function	**Setting**
	1-90 Motor Thermal Protection	[2] Thermistor trip
	1-93 Thermistor Source	[1] Analog input 53
	6-19 Terminal 53 Mode	[1] Voltage
	* = Default Value	
	Notes/comments: If only a warning is desired, *1-90 Motor Thermal Protection* should be set to [1] *Thermistor warning*.	

Table 5.9 Motor Thermistor

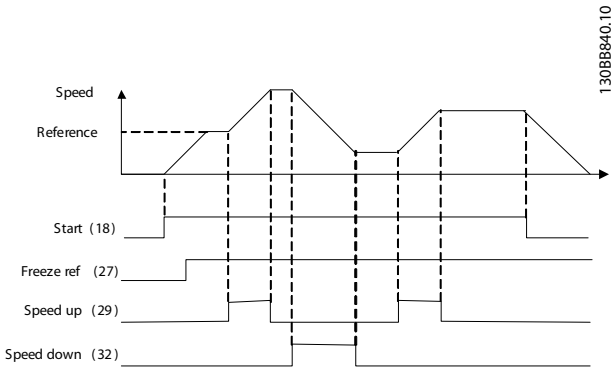


Illustration 5.1

CAUTION

Thermistors must use reinforced or double insulation to meet PELV insulation requirements.

6 Warnings and Alarms

6.1 System Monitoring

The frequency converter monitors the condition of its input power, output, and motor factors as well as other system performance indicators. A warning or alarm may not necessarily indicate a problem internal to the frequency converter itself. In many cases, it indicates failure conditions from input voltage, motor load or temperature, external signals, or other areas monitored by the frequency converter's internal logic. Be sure to investigate those areas exterior to the frequency converter as indicated in the alarm or warning.

6.2 Warning and Alarm Types

6.2.1 Warnings

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

6.2.2 Alarm Trip vs. Alarm Trip Lock

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

A trip can be reset in any of 4 ways:

- Press [Reset]
- Digital reset input command
- Serial communication reset input command
- Auto reset

Very serious faults cause alarms with trip lock which require that input power be cycled before resetting the alarm in any of the 4 ways described above.

6.3 Warning and Alarm Displays

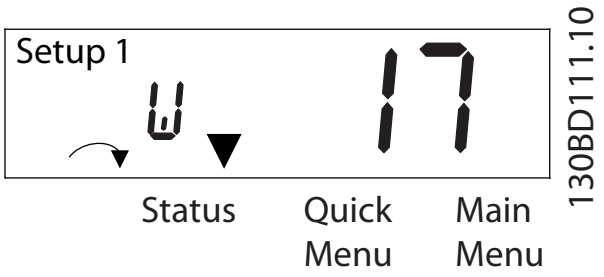


Illustration 6.1

An alarm or trip-lock alarm will flash on display along with the alarm number.

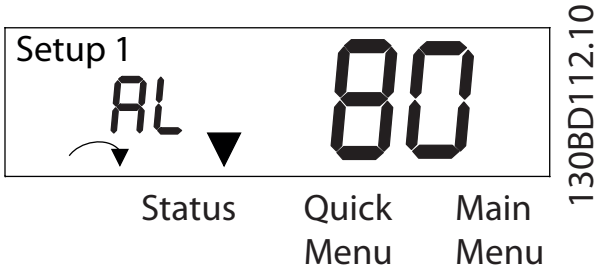


Illustration 6.2

In addition to the text and alarm code on the frequency converter display, there are three status indicator lights.

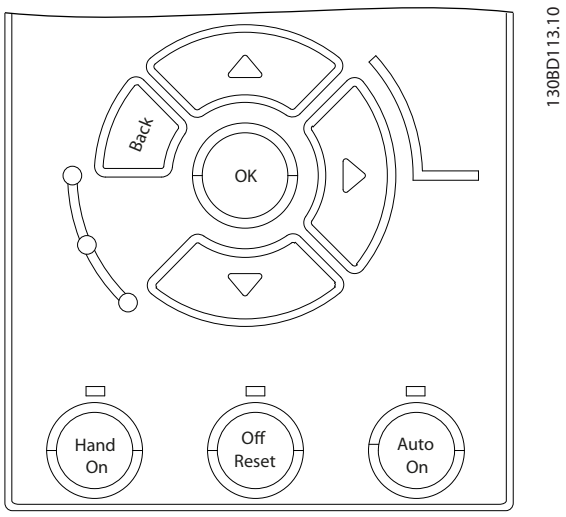


Illustration 6.3

6.4 Warning and Alarm Definitions

No.	Description	Warning	Alarm	Trip Lock	Cause of Problem
2	Live zero error	X	X		Signal on terminal 53 or 54 is less than 50% of value set in *6-10 Terminal 53 Low Voltage*, *6-12 Terminal 53 Low Current*, *6-20 Terminal 54 Low Voltage* and *6-22 Terminal 54 Low Current*.
3	No motor	X			No motor has been connected to the output of the frequency converter.
4	Mains phase loss[1)]	X	X	X	Missing phase on supply side, or too high voltage imbalance. Check supply voltage.
7	DC over voltage[1)]	X	X		Intermediate circuit voltage exceeds limit.
8	DC under voltage[1)]	X	X		Intermediate circuit voltage drops below “voltage warning low” limit.
9	Inverter overloaded	X	X		More than 100% load for too long.
10	Motor ETR over temperature	X	X		Motor is too hot due to more than 100% load for too long.
11	Motor thermistor over temperature	X	X		Thermistor or thermistor connection is disconnected.
12	Torque limit	X	X		Torque exceeds value set in either par. 4-16 or 4-17.
13	Over Current	X	X	X	Inverter peak current limit is exceeded.
14	Earth fault	X	X	X	Discharge from output phases to ground.
16	Short Circuit		X	X	Short-circuit in motor or on motor terminals.
17	Control word timeout	X	X		No communication to frequency converter.
24	Fan fault	X	X		The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (*[0] Disabled*).
25	Brake resistor short-circuited	X	X	X	Brake resistor is short-circuited, thus brake function is disconnected.
26	Brake overload	X	X		The power transmitted to the brake resistor over the last 120 s. exceeds the limit. Possible corrections: decrease brake energy (lower speed or longer ramp time).
27	Brake IGBT/Brake chopper short-circuited	X	X	X	Brake transistor is short-circuited, thus brake function is disconnected.
28	Brake check	X	X		Brake resistor is not connected/working
30	U phase loss		X	X	Motor phase U is missing. Check the phase.
31	V phase loss		X	X	Motor phase V is missing. Check the phase.
32	W phase loss		X	X	Motor phase W is missing. Check the phase.
36	Mains failure	X	X		This warning/alarm is only active if the supply voltage to the frequency converter is lost and *14-10 Mains Failure* is NOT set to *[0] No Function*.
38	Internal fault		X	X	Contact local Danfoss supplier.
40	Overload T27	X			Check the load connected to terminal 27 or remove short-circuit connection.
41	Overload T29	x			Check the load connected to terminal 29 or remove short-circuit connection.
46	Gate drive voltage fault		X	X	
47	24 V supply low	X	X	X	24 V DC may be overloaded.
51	AMA check U_{nom} and I_{nom}		X		Wrong setting for motor voltage and/or motor current.
52	AMA low I_{nom}		X		Motor current is too low. Check settings.
53	AMA big motor		X		The motor is too big for the AMA to operate.

No.	Description	Warning	Alarm	Trip Lock	Cause of Problem
54	AMA small motor		X		The motor is too small for the AMA to operate.
55	AMA parameter range		X		The parameter values of the motor are outside of the acceptable range. AMA will not run.
56	AMA interrupt		X		The user has interrupted the AMA.
57	AMA timeout		X		
58	AMA internal	X	X		Contact your Danfoss supplier.
59	Current limit	X	X		VLT overload.
61	Encoder loss	X	X		
63	Mechanical Brake Low		X		Actual motor current has not exceeded “release brake” current within “start delay” time window.
65	Control card temp	X	X	X	The cutout temperature of the control card is 80 °C.
66	Heat sink Temperature Low	X			The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module.
70	Illegal FC config		X	X	The control card and power card are incompatible.
79	Undefined	X	X		
80	Drive Initialised to Default Value		X		All parameter settings are initialized to default settings.
87	Auto DC braking	X			Occurs when copying from LCP if the LCP contains erroneous data - or if no data was uploaded to the LCP.
95	Broken belt	X	X		
101	Flow/pressure info missing		X	X	
250	New sparepart		X	X	A component in the frequency converter has been replaced.
251	New typecode		X	X	The power card or other components have been replaced and the typecode changed.
nw run	**N**ot **W**hile **RUN**ning				Parameter can only be changed when the motor is stopped.
Err.	A wrong password was entered				Occurs when using a wrong password for changing a password-protected parameter.
[1)] These faults may be caused by mains distortions. Installing Danfoss Line Filter may rectify this problem.					

Table 6.1 Warnings and Alarms Code List

7 Basic Troubleshooting and FAQs

7.1 Start Up and Operation

Symptom	Possible Cause	Test	Solution
Motor not running	LCP Stop	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor.
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check *5-12 Coast inv.* for correct setting for terminal 27 (use default setting).	Apply 24V on terminal 27 or program this terminal to *No operation.*
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs.*	Deactivate reversing signal.
	Wrong motor phase connection		See in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *4-14 Motor Speed High Limit [Hz]* and *4-19 Max Output Frequency*	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in *6-* Analog I/O mode* and parameter group *3-1* References.*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings.	Check settings in parameter group *1-6* Analog I/O mode*.
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor data*, *1-3* Adv motor data*, and *1-5* Load indep. setting*.
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp down times.	Check brake parameters. Check ramp time settings.	Check parameter group*2-0* DC brake* and *3-0* Reference limits*.

Symptom	Possible Cause	Test	Solution
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase for shorts.	Eliminate any shorts detected.
	Motor overload	Motor is overloaded for the application.	Perform startup test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (See *Alarm 4 Mains phase loss* description)	Rotate input power leads into the drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check mains power supply.
	Problem with the frequency converter unit	Rotate input power leads into the frequency converter one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the drive unit	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Acoustic noise or vibration (e.g. a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g. in the motor/fan system	Bypass critical frequencies by using parameters in parameter group 4-6*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off over-modulation in 14-03.	
		Change switching pattern and frequency in parameter group 14-0*.	
		Increase Resonance Dampening in 1-64.	

Table 7.1

7

8 Specifications

8.1 Power-dependent Specifications

8.1.1 Mains Supply 3 x 380-480 V AC

Frequency converter Typical Shaft Output [kW]		HK 37 0.37	HK 55 0.55	HK75 0.75	H1K1 1.1	H1K5 1.5	H2K2 2.2	H3K0 3	H4K0 4	H5K5 5.5	H7K5 7.5
Enclosure IP20		J1	J1	J1	J1	J1	J1	J2	J2	J2	J3
Output current											
	Shaft output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5
	Continuous (3 x 380-439 V) [A]	1.2	1.7	2.2	3	3.7	5.3	7.2	9	12	15.5
	Continuous (3 x 440-480 V) [A]	1.1	1.6	2.1	3	3.4	4.8	6.3	8.2	11	14
	Intermittent (60 s overload) [A]	1.9	2.7	3.5	4.8	5.9	8.5	11.5	14.4	19.2	24.8
	Continuous kVA (400 V AC) [kVA]	0.84	1.18	1.53	2.08	2.57	3.68	4.99	6.24	8.32	10.74
	Continuous kVA (460 V AC) [kVA]	0.91	1.34	1.75	2.5	2.8	4.01	5.24	6.82	9.15	11.64
Max. input current											
	Continuous (3 x 380-439 V) [A]	1.2	1.6	2.1	2.6	3.5	4.7	6.3	8.3	11.2	15.1
	Continuous (3 x 440-480 V) [A]	1.0	1.2	1.8	2.0	2.9	3.9	4.3	6.8	9.4	12.6
	Intermittent (60 s overload) [A]	1.9	2.6	3.4	4.2	5.6	7.5	10.1	13.3	17.9	24.2
Additional specifications											
	Max. cable cross section (mains, motor, brake and load sharing) [mm² (AWG)][2)]	4 mm²									
	Estimated power loss at rated max. load [W] [3)]						52.36			113.85	150.75
	Weight, enclosure IP20	2.3	2.3	2.3	2.3	2.3	2.5	3.6	3.6	3.6	4.1
	Efficiency [4)]						97.62%			98%	98%

Table 8.1 Mains Supply 3 x 380-480 V AC - Heavy Duty [1)]

Frequency converter Typical Shaft Output [kW]		H11K 11	H15K 15	H18K 18.5	H22K 22	H30K 30	H37K 37	H45K 45	H55K 55	H75K 75
IP20		J4	J4	J5	J5	J6	J6	J6	J7	J7
Output current										
	Continuous (3 x 380-439 V) [A]	23	31	37	42.5					
	Continuous (3 x 440-480 V) [A]	21	27	34	40					
	Intermittent (60 s overload) [A]	34.5	46.5	55.5	63.8					
	Continuous kVA (400 V AC) [kVA]	15.94	21.48	25.64	29.45					
	Continuous kVA 460 V AC) [kVA]	17.46	22.45	28.27	33.26					
Max. input current										
	Continuous (3 x 380-439 V) [A]	22.1	29.9	35.2	41.5					
	Continuous (3 x 440-480 V) [A]	18.4	24.7	29.3	34.6					
	Intermittent (60 s overload) [A]	33.2	44.9	52.8	62.3					
Additional specifications										
	Max. cable size (mains, motor, brake) [mm²/ AWG] [2)]	16 mm²	16 mm²	16 mm²	16 mm²	50 mm²	50 mm²	50 mm²	50 mm²	85 mm²
	Estimated power loss at rated max. load [W] [3)]									
	Weight enclosure IP20 [kg]	9.4	9.5	12.3	12.5					
	Efficiency [4)]									

Table 8.2 Mains Supply 3x380-480 V AC - Heavy Duty[1)]

Frequency converter Typical Shaft Output [kW]		Q11K 11	Q15K 15	Q18K 18.5	Q22K 22	Q30K 30	Q37K 37	Q45K 45	Q55K 55	Q75K 75
IP20		J4	J4	J5	J5	J6	J6	J6	J7	J7
Output current										
	Continuous (3x380-439 V) [A]	23	31	37	42.5					
	Continuous (3x440-480 V) [A]	21	27	34	40					
	Intermittent (60 s overload) [A]	25.3	34.1	40.7	46.8					
	Continuous kVA (400 V AC) [kVA]									
	Continuous kVA 460 V AC) [kVA]									
Max. input current										
	Continuous (3x380-439 V) [A]	22.1	29.9	35.2	41.5					
	Continuous (3x440-480 V) [A]	18.4	24.7	29.3	34.6					
	Intermittent (60 s overload) [A]	24.3	32.9	38.7	45.7					
Additional specifications										
	Max. cable size (mains, motor, brake) [mm^2/ AWG] [2)]	16 mm^2				50 mm^2				85 mm^2
	Estimated power loss at rated max. load [W] [3)]									
	Weight enclosure IP20 [kg]	9.4	9.5	12.3	12.5					
	Efficiency [4)]									

Table 8.3 Mains Supply 3x380-480 V AC - Normal Duty[1)]

For fuse ratings, see 8.3 Fuse Specifications

1) Heavy duty = 160% current during 60 s, Normal duty = 110% current during 60 s.

2) American Wire Gauge.

3) The typical power loss is at nominal load conditions and expected to be within ±15% (tolerence relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the frequency converter and opposite.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.
LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or fieldbus, or options for slot B).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (±5%).

4) Measured using 5 m screened motor cables at rated load and rated frequency.

8

8.2 General Technical Data

Mains Supply (L1, L2, L3)	
Supply Terminals	L1, L2, L3
Supply voltage	380-480 V:-15 (-25)[1)] to +10%

1) The frequency converter can run at -25% input voltage with reduced performance. The maximum output power of the frequency converter is 75% in case of -25% input voltage and 85% in case of -15% input voltage.
Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the frequency converter continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cos ϕ)	near unity (> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 7.5 kW	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 11-75 kW	maximum 1 time/min.

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 480 V maximum.

Motor Output (U, V, W)	
Output voltage	0-100% of supply voltage
Output frequency (0.37-75 kW)	0-500 Hz
Output frequency in VVC^{plus} Mode	0-200 Hz
Switching on output	Unlimited
Ramp times	0.01-3600 s

1) Voltage and power dependent

Torque Characteristics	
Starting torque (Constant torque)	maximum 160% for 60 s[1)]
Overload torque (Constant torque)	maximum 160% for 60 s[1)]
Starting torque (Variable torque)	maximum 110% for 60 s[1)]
Overload torque (Variable torque)	maximum 110% for 60 s
Starting current	maximum 200% for 1 s
Torque rise time in VVC^{plus} (independent of fsw)	10 ms

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

Control Cable Lengths and Cross Sections[1)]	
Max. motor cable length, screened	50 m
Max. motor cable length, unscreened	100 m
Maximum cross section to control terminals, flexible/ rigid wire	2.5mm^2/14 AWG
Minimum cross section to control terminals	0.55 mm^2/ 30AWG

1)For power cables, see electrical data tables.

Digital Inputs	
Programmable digital inputs	7
Terminal number	18, 19, 27[1)], 29[1)], 32, 33, 31
Logic	PNP or NPN
Voltage level	0 - 24 V DC
Voltage level, logic'0' PNP	< 5 V DC
Voltage level, logic'1' PNP	> 10 V DC
Voltage level, logic '0' NPN[2)]	> 19 V DC
Voltage level, logic '1' NPN[2)]	< 14 V DC
Maximum voltage on input	28 V DC

Pulse frequency range	4-32 kHz
(Duty cycle) Min. pulse width	4.5 ms
Input resistance, R_i	approx. 4 kΩ

Analog Inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	software
Voltage mode	
Voltage level	0 to +10 V
Input resistance, R_i	approx. 10 kΩ
Max. voltage	-15 to + 20 V
Current mode	
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	11 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	100 Hz

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

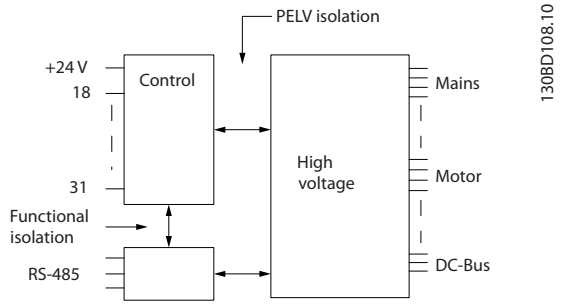


Illustration 8.1

Pulse Inputs	
Programmable pulse inputs	2
Terminal number pulse	32, 33
Max. frequency at terminal, 29, 33	32 kHz (Push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see section on Digital input
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale

Analog Outputs	
Number of programmable analog outputs	2
Terminal number	45, 42
Current range at analog output	0/4-20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8 % of full scale
Resolution on analog output	10 bit

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

Control Card, RS-485 Serial Communication	
Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).

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

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

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

Control Card, 24 V DC Outpu	
Terminal number	12
Max. load	100 mA

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

Relay Outputs	
Programmable relay outputs	2
Relay 01 and 02	01-03 (NC), 01-02 (NO), 04-06 (NC), 04-05 (NO)
Max. terminal load (AC-1)[1)] on 01-02/04-05 (NO) (Resistive load)	250V AC, 3 A
Max. terminal load (AC-15)[1)] on 01-02/04-05 (NO) (Inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 01-02/04-05 (NO) (Resistive load)	30V DC, 2 A
Max. terminal load (DC-13)[1)] on 01-02/04-05 (NO) (Inductive load)	24V DC, 0.1 A
Max. terminal load (AC-1)[1)] on 01-03/04-06 (NC) (Resistive load)	250V AC, 3 A
Max. terminal load (AC-15)[1)]on 01-03/04-06 (NC) (Inductive load @ cosφ 0.4)	250V AC, 0.2 A
Max. terminal load (DC-1)[1)] on 01-03/04-06 (NC) (Resistive load)	30V DC, 2 A
Min. terminal load on 01-03 (NC), 01-02 (NO)	24V DC 10 mA, 24V AC 20 mA

1) IEC 60947 t 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

Control Card, +10 V DC Output	
Terminal number	50
Output voltage	10.5 V ±0.5 V
Max. load	15 mA

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

Control Characteristics	
Resolution of output frequency at 0-500 Hz	± 0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30-4000 RPM: Maximum error of ±8 RPM

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

Surroundings	
Enclosure type J1-J7	IP20, IP21/Type 1
Vibration test all enclosure types	1.0 g
Relative humidity	5-95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	max. 55°C[1)]
- with full output power of typical EFF2 motors (up to 90% output current)	max. 50 °C[1)]
- at full continuous FC output current	max. 45 °C[1)]

1) For more information on derating see the VLT AutomationDrive FC 360 Design Guide, section on Special Conditions.

Minimum ambient temperature during full-scale operation	0°C
Minimum ambient temperature at reduced performance	- 10°C
Temperature during storage/transport	-25 to +65/70°C
Maximum altitude above sea level without derating	1000 m
Maximum altitude above sea level with derating	3000m
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, Immunity	EN 61800-3, 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

Control Card Performance	
Scan interval	1 ms

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Protection and Features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches 95°C ± 5°C. An overload temperature cannot be reset until the temperature of the heatsink is below 70°C ±5°C (Guideline - these temperatures may vary for different power sizes, enclosures etc.). The frequency converter has an auto derating function to avoid it's heatsink reaching 95 °C.
- The frequency converter is protected against short-circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against earth faults on motor terminals U, V, W.

8.3 Fuse Specifications

8.3.1 Fuses

It is recommended to use fuses and/ or circuit breakers on the supply side as protection in case of component break-down inside the frequency converter (first fault).

NOTE

This is mandatory in order to ensure compliance with IEC 60364 for CE or NEC 70 for UL.

⚠WARNING

Personnel and property must be protected against the consequence of component break-down internally in the frequency converter.

Branch Circuit Protection

In order to protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines etc., must be protected against short-circuit and over-current according to national/international regulations.

NOTE

The recommendations given do not cover Branch circuit protection for UL.

Short-circuit protection

Danfoss recommends using the fuses/Circuit Breakers mentioned below to protect service personnel and property in case of component break-down in the frequency converter.

8.3.2 Recommendations

⚠WARNING

In case of malfunction, not following the recommendation may result in personnel risk and damage to the frequency converter and other equipment.

The following tables list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. For Circuit Breakers, Moeller types have been tested to have a recommendation. Other types of circuit breakers may be used provide the limit the energy into the frequency converter to a level equal to or lower than the Moeller types.

If fuses/Circuit Breakers according to recommendations are chosen, possible damages on the frequency converter will mainly be limited to damages inside the unit.

For further information please see Application Note *Fuses and Circuit Breakers*, MN90T

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8.3.3 CE Compliance

Fuses or Circuit Breakers are mandatory to comply with IEC 60364. Danfoss recommend using a selection of the following.

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), 480 V depending on the frequency converter voltage rating. With the proper fusing the frequency converter short circuit current rating (SCCR) is 100,000 Arms.

Frame Size	Power [kW]	gG
J1	0.37-1.1	10
	1.5	
	2.2	
J2	3.0	25
	4.0	
	5.5	
J3	7.5	32
J4	11-15	50
J5	18.5	80
	22	
J6	30	160
	37	
	45	
J7	55	250
	75	

Table 8.4 CE Fuse, 380-480 V, Frame Sizes J1-J7

The circuit breakers below are suitable for use on a circuit capable of delivering 35,000 Arms (symmetrical), 480 V depending on the frequency converter voltage rating. With the proper fusing the frequency converter short circuit current rating (SCCR) is 35,000 Arms.

Frame Size	Power [kW]	EATON
J1	0.37-1.1	Moller PKZM0-16
	1.5	
	2.2	
J2	3.0	NZMN-1-A-25
	4.0	
	5.5	
J3	7.5	NZMN-1-A-32
J4	11-15	NZMN-1-A-50
J5	18.5	NZMN-1-A-80
	22	
J6	30	NZMN-1-A-160
	37	
	45	
J7	55	NZMN-1-A-250
	75	

Table 8.5 CE Circuit Breakers, 380-480 V, Frame Sizes J1-J7

UL Compliance

Fuses or Circuit Breakers are mandatory to comply with NEC 2009. We recommend using a selection of the following

The circuit breakers below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), 480 V depending on the frequency converter voltage rating. With the proper fusing the drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

The circuit breakers below are suitable for use on a circuit capable of delivering 35,000 Arms (symmetrical), 480 V depending on the frequency converter voltage rating. With the proper fusing the frequency converter short circuit current rating (SCCR) is 35,000 Arms.

Frame Size	Power [kW]	Bussmann
J1	0.37-1.1	FRS-R-16
	1.5	
	2.2	
J2	3.0	FRS-R-25
	4.0	
	5.5	
J3	7.5	FRS-R-30
J4	11-15	FRS-R-50
J5	18.5	FRS-R-80
	22	
J6	30	FRS-R-150
	37	
	45	
J7	55	FRS-R-250
	75	

Table 8.6 UL Fuse, 380-480 V, Frame Sizes J1-J7

Frame Size	Power [kW]	EATON
J1	0.37-1.1	XTPR016BC1+XTPAXLSA
	1.5	
	2.2	
J2	3.0	NZMN-2-A-25-NA
	4.0	
	5.5	
J3	7.5	NZMN-2-A-32-NA
J4	11-15	NZMN-2-A-50-NA
J5	18.5	NZMN-2-A-80-NA
	22	
J6	30	NZMN-2-A-160-NA
	37	
	45	
J7	55	NZMN-2-A-250-NA
	75	

Table 8.7 UL Circuit Breakers, 380-480 V, Frame Sizes J1-J7

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8.4 Connection Tightening Torques

When tightening all electrical connections it is very important to tighten with the correct torque. Too low or too high torque results in a bad electrical connection. Use a torque wrench to ensure correct torque

Frame size	Power [kW]	Torque [Nm]					
		Mains	Motor	DC connection	Brake	Earth	Relay
J1	0.37-2.2	1.4	0,8	0,8	0,8	3	0,5
J2	3.0 -55	1.4	0,8	0,8	0,8	3	0,5
J3	7.5	1.4	0,8	0,8	0,8	3	0,5
J4	11-15	1,2	1,2	1,2	1,2	1,6	0,5
J5	18.5-22	1,2	1,2	1,2	1,2	1,6	0,5
J6	30-45	2	2	2	-	2	0.5
J7	55	12	12	12	-	2	0.5
J7	75	14	14	14	-	2	0.5

Table 8.8 Tightening of Terminals

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