

## 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.



#### **Approval**



## Contents

<b>1 Quick Start</b>	<b>3</b>
1.1 Identification and Variants	3
1.2 Hand On/Auto On Mode	4
1.3 Application Selections	4
1.4 Jumper Terminal 12 and 27	7
1.5 Automatic Motor Adaptation (AMA)	7
<b>2 Introduction</b>	<b>8</b>
2.1 Exploded Views	8
2.2 Product Overview	9
2.3 Additional Resources	9
2.4 Frame Sizes and Power Ratings	9
<b>3 Installation</b>	<b>10</b>
3.1 Mechanical Installation	10
3.2 Electrical Installation	11
3.2.1 General Requirements	13
3.2.2 Earth (Grounding) Requirements	13
3.2.2.1 Leakage Current (>3.5 mA)	13
3.2.3 Mains, Motor and Earth Connections	14
3.2.4 Control Wiring	14
3.2.4.1 Access	14
3.2.4.2 Control Terminal Types	15
3.2.4.3 Control Terminal Functions	15
3.2.4.4 Using Screened Control Cables	16
3.3 Serial Communication	16
<b>4 User Interface and Programming</b>	<b>18</b>
4.1 Programming	18
4.1.1 Programming with the Numerical Local Control Panel (LCP 21)	18
4.1.2 LCP 21	18
4.1.3 The Right-Key Function	19
4.2 Quick Menu	19
4.3 Main Menu	21
4.4 Parameter List	22
4.4.1 Main Menu Structure	23
<b>5 Wiring Examples</b>	<b>27</b>
<b>6 Warnings and Alarms</b>	<b>30</b>
6.1 System Monitoring	30

---

6.2 Warning and Alarm Types	30
6.2.1 Warnings	30
6.2.2 Alarm Trip vs. Alarm Trip Lock	30
6.3 Warning and Alarm Displays	30
6.4 Warning and Alarm Definitions	31
<b>7 Basic Troubleshooting and FAQs</b>	<b>33</b>
7.1 Start Up and Operation	33
<b>8 Specifications</b>	<b>35</b>
8.1 Power-dependent Specifications	35
8.1.1 Mains Supply 3 x 380-480 V AC	35
8.2 General Technical Data	37
8.3 Fuse Specifications	41
8.3.2 Recommendations	41
8.3.3 CE Compliance	41
8.4 Connection Tightening Torques	42
<b>Index</b>	<b>43</b>

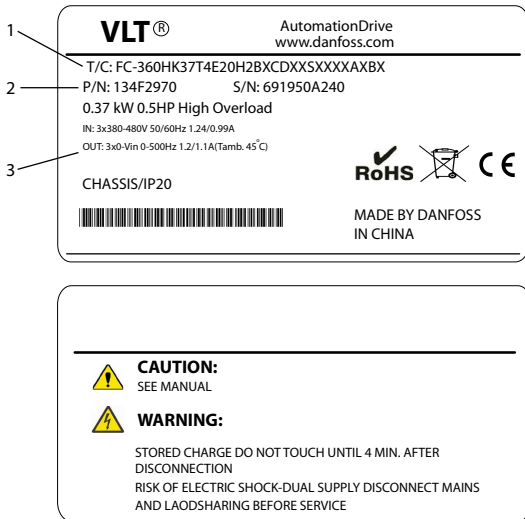
# 1 Quick Start

## **⚠ WARNING**

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

### 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.



130BC435.11

Illustration 1.1 Name Plate 1 and 2

1	Typecode
2	Ordering number
3	Specifications

Table 1.1 Legend to *Illustration 1.1*

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

1-6: Product Name	
7: Overload	H: Heavy Duty Q: Normal Duty <sup>1)</sup>
8-10: Power Size	0.37-75 kW e.g. K37: 0.37 kW <sup>2)</sup> 1K1: 1.1 kW 11K: 11 kW etc.
11-12: Voltage Class	T4: 380-480 V three phases
13-15: IP Class	E20: IP20
16-17: RFI	H2: C3 Class
18: Brake chopper	X: No B: Built-in <sup>4)</sup>
19: LCP	X: No
20: PCB Coating	C: 3C3
21: Mains terminals	D: Load sharing
29-30: Embedded Fieldbus	AX: No A0: Profibus <sup>3)</sup> AL: Profinet <sup>3)</sup>

Table 1.2 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 brake chopper. 30-75 kW external brake chopper only.

### 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. At the first power-up it is in auto on mode.

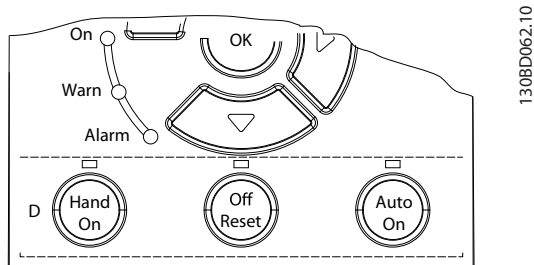


Illustration 1.3 Location of Hand On, Off/Reset and Auto On keys on the NLCP

- Press [Hand On] to provide a local start command to the frequency converter. Press [▲] and [▼] to increase and decrease speed.
- 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

5-12 Terminal 27 Digital Input has coast inverse as default setting. Connect terminals 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

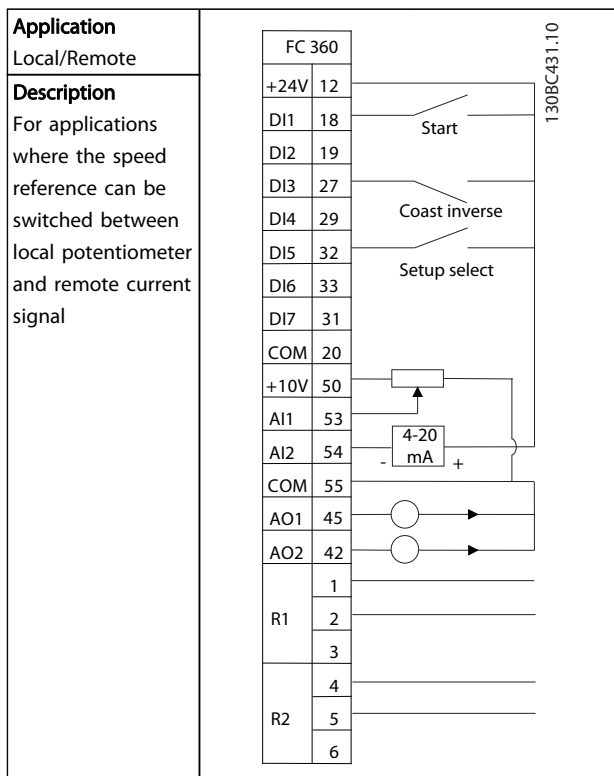
When an application is selected, relevant parameters are automatically set. Customer specific configuration of all parameters based on specific requirements is still possible.

### CAUTION

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

Application	FC 360																																		
Pumps, fans, compressors	<table border="1"> <tr><td>+24V</td><td>12</td></tr> <tr><td>DI1</td><td>18</td></tr> <tr><td>DI2</td><td>19</td></tr> <tr><td>DI3</td><td>27</td></tr> <tr><td>DI4</td><td>29</td></tr> <tr><td>DI5</td><td>32</td></tr> <tr><td>DI6</td><td>33</td></tr> <tr><td>DI7</td><td>31</td></tr> <tr><td>COM</td><td>20</td></tr> <tr><td>+10V</td><td>50</td></tr> <tr><td>AI1</td><td>53</td></tr> <tr><td>AI2</td><td>54</td></tr> <tr><td>COM</td><td>55</td></tr> <tr><td>AO1</td><td>45</td></tr> <tr><td>AO2</td><td>42</td></tr> <tr><td>R1</td><td>1, 2, 3</td></tr> <tr><td>R2</td><td>4, 5, 6</td></tr> </table>	+24V	12	DI1	18	DI2	19	DI3	27	DI4	29	DI5	32	DI6	33	DI7	31	COM	20	+10V	50	AI1	53	AI2	54	COM	55	AO1	45	AO2	42	R1	1, 2, 3	R2	4, 5, 6
+24V	12																																		
DI1	18																																		
DI2	19																																		
DI3	27																																		
DI4	29																																		
DI5	32																																		
DI6	33																																		
DI7	31																																		
COM	20																																		
+10V	50																																		
AI1	53																																		
AI2	54																																		
COM	55																																		
AO1	45																																		
AO2	42																																		
R1	1, 2, 3																																		
R2	4, 5, 6																																		
<b>Description</b>	<p>For applications where a value (e.g. pressure, temperature) must be kept at a desired level by sensor feedback</p>																																		
<b>Parameter settings</b>	<p>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</p>																																		

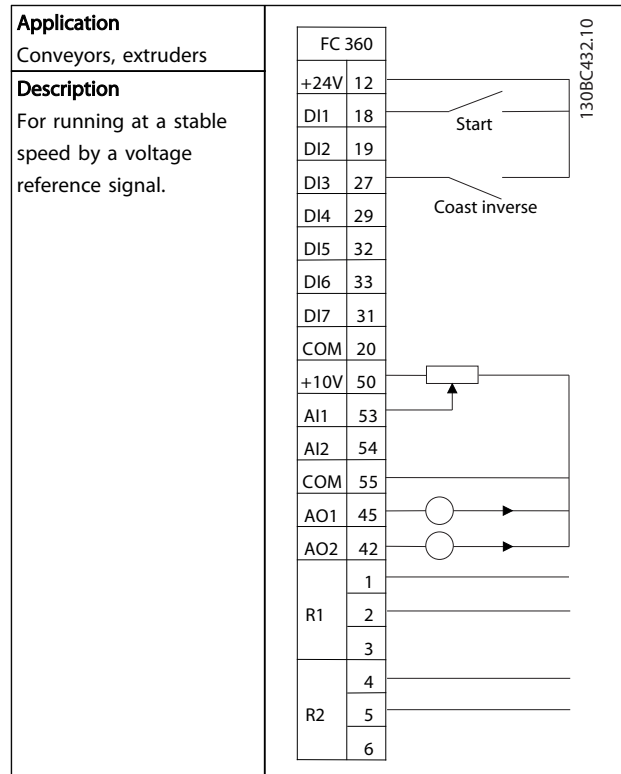
Table 1.3 [1] Process Closed Loop



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 1.4 [2] Local/Remote



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 1.5 [3] Speed Open Loop

1

<p><b>Application</b> Machine tools, texturizers</p> <p><b>Description</b> For precise speed applications with 24 V encoder feedback</p>	
<p><b>Parameter settings</b></p> <p>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 27 Selection): [2] Coast Inverse          5-14 (DI 32 Selection): [82] Encoder input B          5-15 (DI 33 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          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          7-00 (Speed PID Feedback Source): [1] 24 V encoder</p>	

Table 1.6 [4] Speed Close Loop

<p><b>Application</b> Industrial washing machines, conveyors</p> <p><b>Description</b> For applications with 8 different speeds by digital input. By using another digital input, 16 speeds are possible.</p>	
<p><b>Parameter settings</b></p> <p>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</p>	

Table 1.7 [5] Multi-speed

**NOTE**

For further examples, refer to 5 Wiring Examples.



## 1.4 Jumper Terminal 12 and 27

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

- 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 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 measures the electrical characteristics of the motor to optimize compatibility between the frequency converter and the motor under VVC<sup>plus</sup> 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

### To run AMA using the numeric LCP (NLCP)

1. By default parameter setting, connect terminal 12 and 27 before running AMA.
2. Enter the main menu.
3. Go to parameter group *1-\*\* Load and Motor*.
4. Press [OK].
5. Set motor parameters using name plate data for parameter group *J1-1-2\* Motor Data*.
6. Set motor cable length in *1-42 Motor Cable Length*
7. Go to *1-29 Automatic Motor Adaptation (AMA)*.
8. Press [OK].
9. Select *[1] Enable complete AMA*.
10. Press [OK].
11. The test will run automatically and indicate when it is complete.

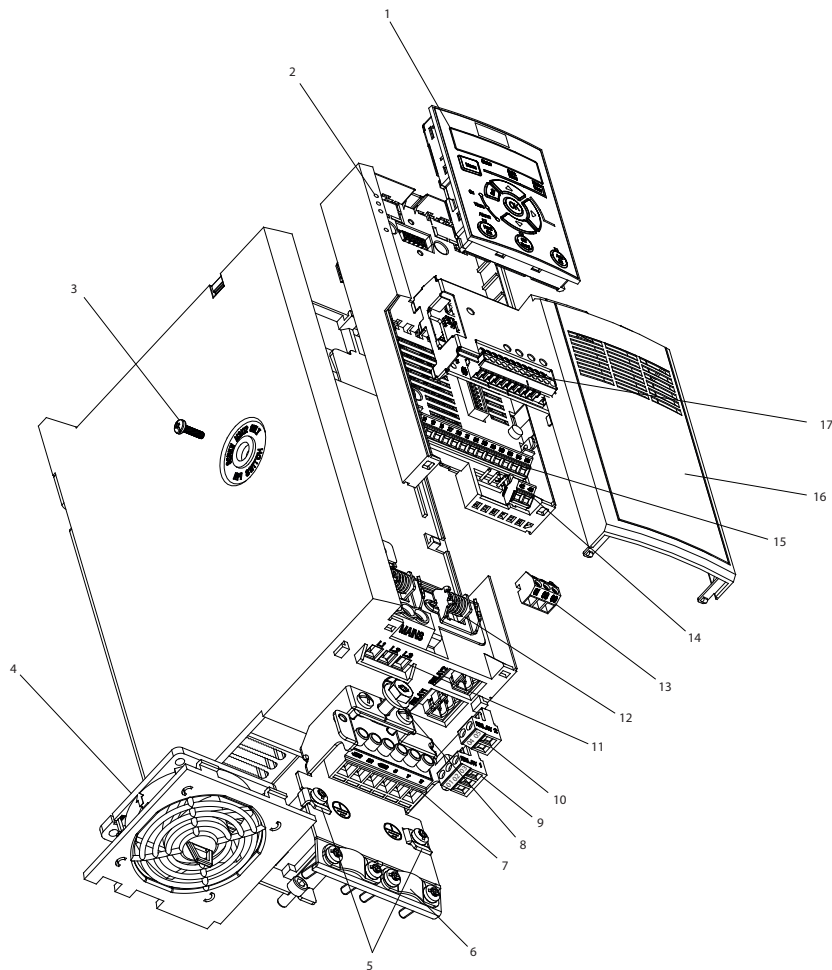
### NOTE

**AMA function in FC 360 does not cause the motor to run and it does not harm the motor.**

## 2 Introduction

### 2

#### 2.1 Exploded Views



130BC439.10

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

1	NLCP (accessory)	10	2-Pole Relay 2 (0.37-7.5 kW) 3-Pole Relay 2 (11-22 kW)
2	Control cassette	11	Mains terminal
3	RFI switch (screw M3x12 only)	12	Cable strain relief (0.37-2.2 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 Legend to *Illustration 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 [www.danfoss.com/Products/Literature/VLT+Technical+Documentation.htm](http://www.danfoss.com/Products/Literature/VLT+Technical+Documentation.htm) for downloads.

## 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
<b>Mounting holes</b>							
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

### 3.1 Mechanical Installation

Select the best possible operation site by considering:

- 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 1000 m 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	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.

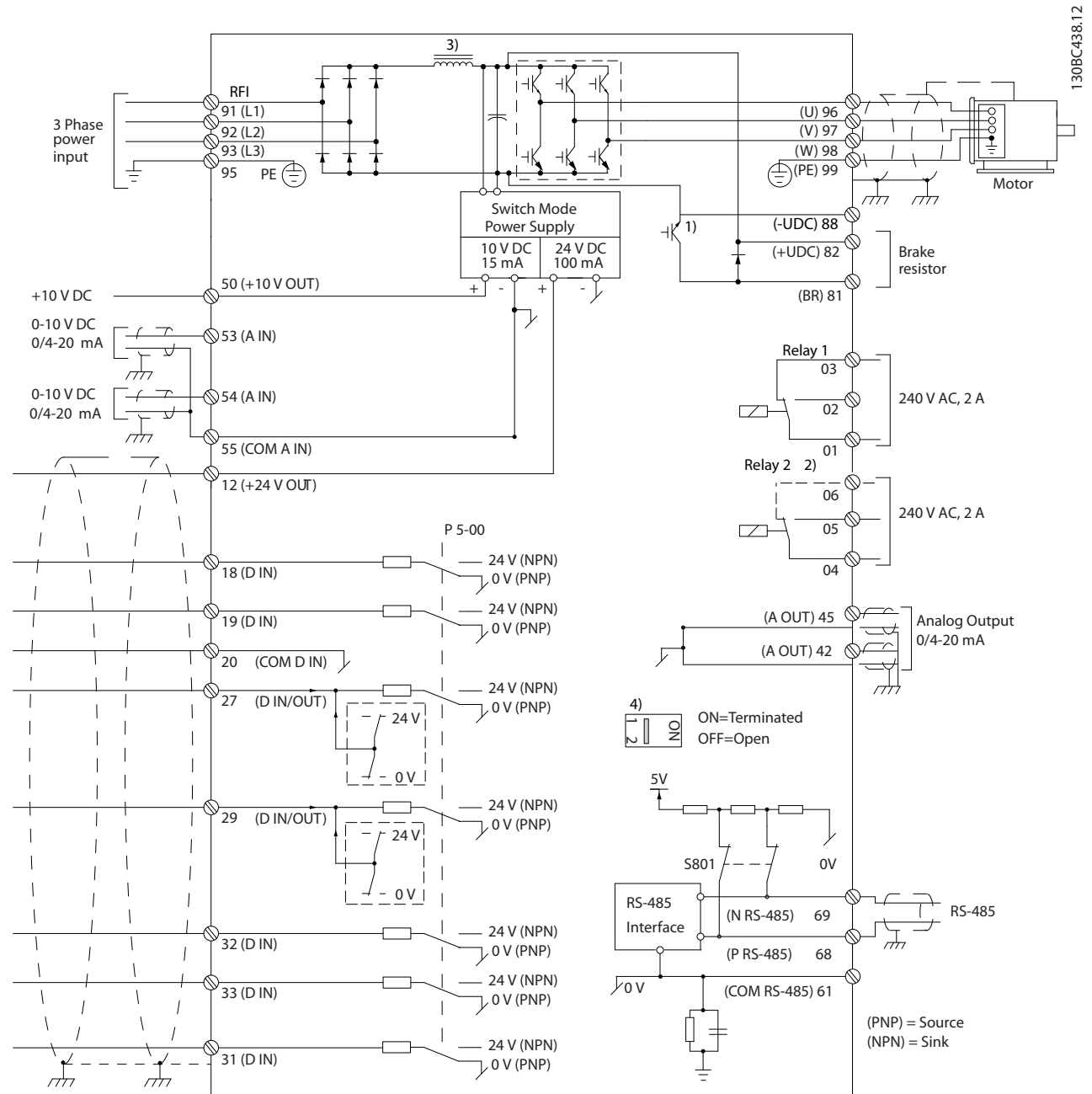


Illustration 3.1 Basic Wiring Schematic Drawing

A=Analog, D=Digital

- 1) Built-in brake 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 terminals 4, 5 and 6 same NO/NC logic as Relay 1.
- 3) Dual DC choke in 30-75 kW
- 4) Switch S801 (bus terminal) can be used to enable termination on the RS-485 port (terminals 68 and 69).

3

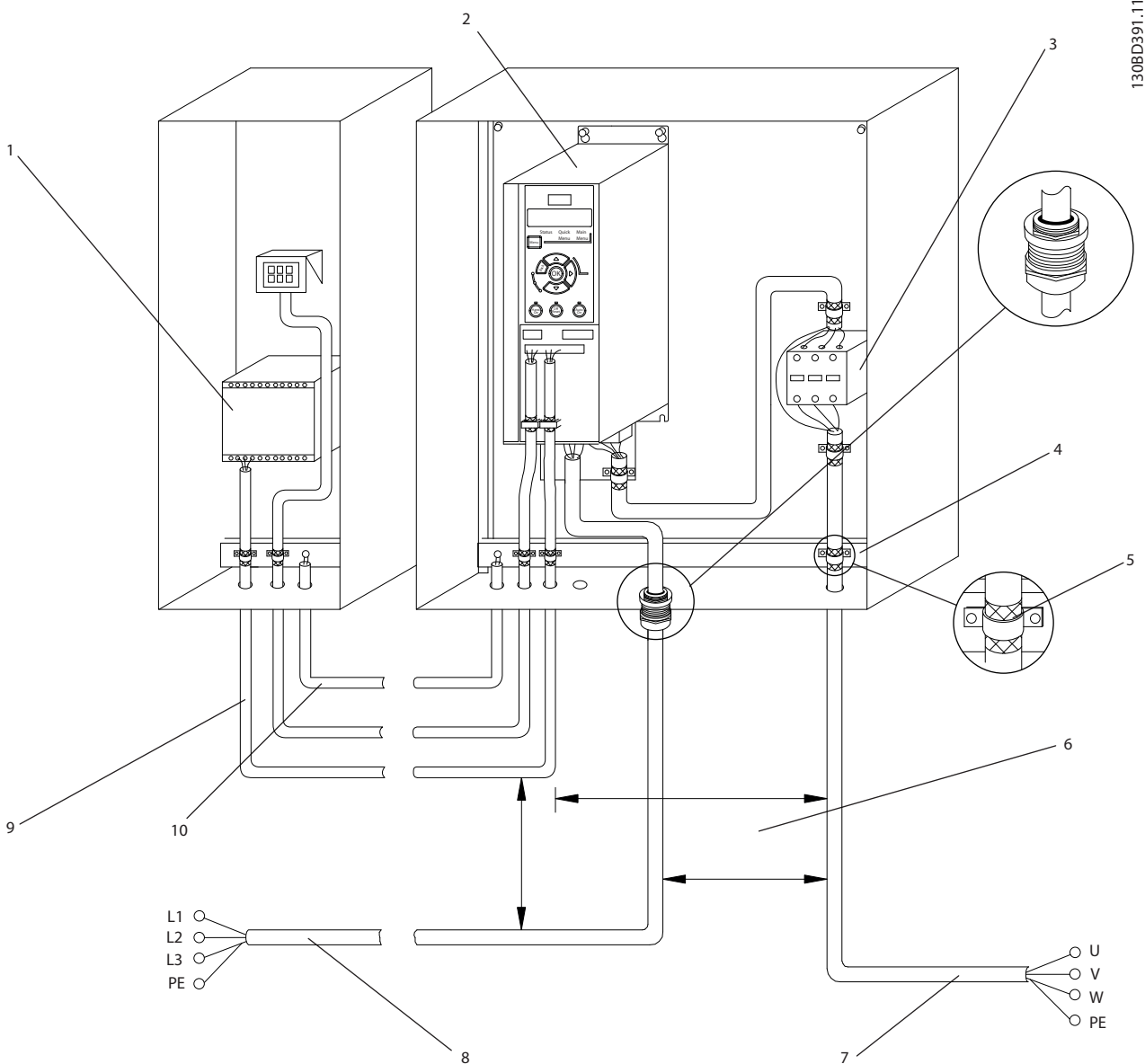


Illustration 3.2 Typical Electrical Connection

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 <sup>2</sup> (0.025 in)

Table 3.2 Legend to Illustration 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 3.2.2.1 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

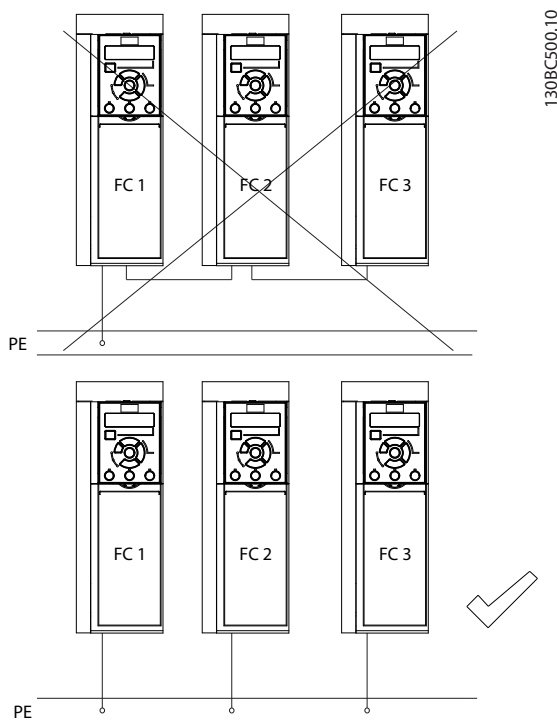


Illustration 3.3 Grounding Principle

#### 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<sup>2</sup> (copper wire)
- 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**

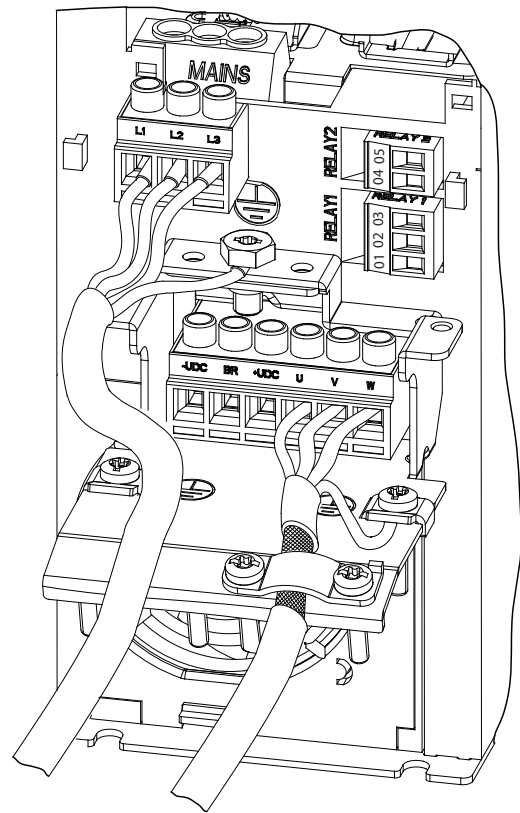
**⚠ WARNING**

**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.



130BC501.10

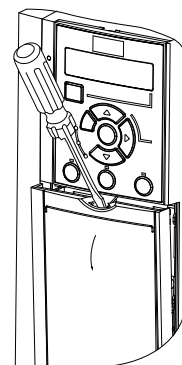
Illustration 3.4 Mains, Motor and Earth Connections

*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*.



01403826

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 3.3.

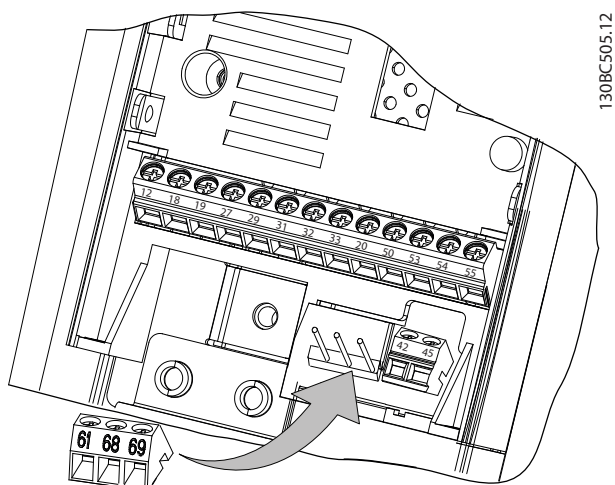


Illustration 3.6 Control Terminal Locations

See 8.2 General Technical Data for terminal ratings details.

Terminal	Parameter	Default setting	Description
<b>Digital I/O, Pulse I/O, Encoder</b>			
12	-	+24 V DC	24 V DC supply voltage. Maximum output current is 100 mA 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	Selectable for either digital input, digital output or pulse output. Default setting is digital input.
		DO [0] No operation	
29	5-13 5-31	DI [14] Jog	
		DO [0] No operation	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
<b>Analog inputs/outputs</b>			
42	6-91	[0] No operation	Programmable analog output. The analog signal is 0-20 mA or 4-20 mA at a maximum of 500 Ω. Can also be configured as digital outputs
45	6-71	[0] No operation	

Terminal	Parameter	Default setting	Description
50	-	+10 V DC	10 V DC analog supply voltage. 15 mA 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
<b>Serial communication</b>			
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*		
<b>Relays</b>			
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 terminals 04 and 05 are available
04, 05, 06	5-40 [1]	[0] No operation	

Table 3.3 Terminal Descriptions

### 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 3.3 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 as close as possible to the control cable.

Minimum cable cross section: 16 mm<sup>2</sup>.

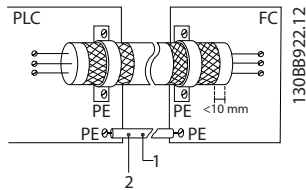


Illustration 3.7 Screening Clamps at Both Ends

1	Min. 16 mm <sup>2</sup>
2	Equalizing cable

Table 3.4 Legend to Illustration 3.7

#### 50/60 Hz 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 100 nF capacitor (keeping leads short).

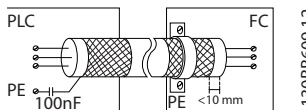


Illustration 3.8 Connection with a 100 nF Capacitor

#### 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 in Illustration 3.9:

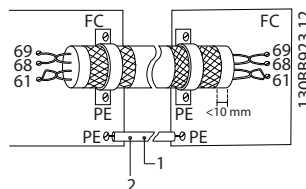


Illustration 3.9 Twisted-pair Cables

1	Min. 16 mm <sup>2</sup>
2	Equalizing cable

Table 3.5 Legend to Illustration 3.9

Alternatively, the connection to terminal 61 can be omitted:

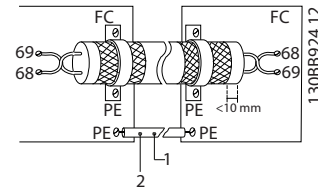


Illustration 3.10 Twisted-pair Cables without Terminal 61

1	Min. 16 mm <sup>2</sup>
2	Equalizing cable

Table 3.6 Legend to Illustration 3.10

## 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

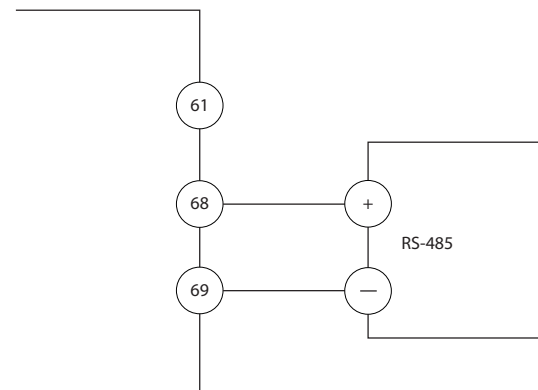


Illustration 3.11 Serial Communication Wiring Diagram

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 (LCP 21)

The FC 360 supports graphic and numerical local control panels as well as blind covers. This chapter covers programming with LCP 21. For programming with the GLCP, see the VLT® AutomationDrive FC 360 Programming Guide.

#### 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](http://www.danfoss.com/BusinessAreas/DrivesSolutions/softwaredownload)

#### 4.1.2 LCP 21

The LCP 21 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)

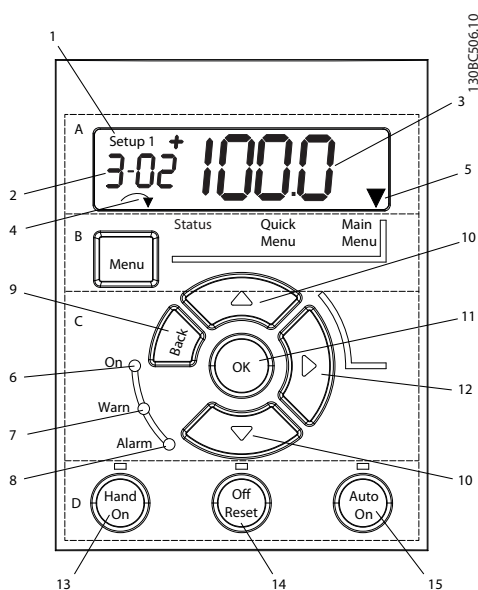


Illustration 4.1 View of the LCP 21

#### A. Numeric Display

The LCD-display is back-lit with 1 numeric line. All data is displayed in 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 Legend to Illustration 4.1



Illustration 4.2 Display Information

#### B. Menu Key

Press [Menu] 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 Legend to Illustration 4.1

D. Operation keys and indicator lights (LEDs)

13	[Hand On]: Starts the motor and enables control of the frequency converter via the LCP. <b>NOTE</b> 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 Legend to Illustration 4.1

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.

Press [▶] 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. Press the [▲] [▼] to change the value. Pressing [▶] will not change the value of the digits or move the decimal point.

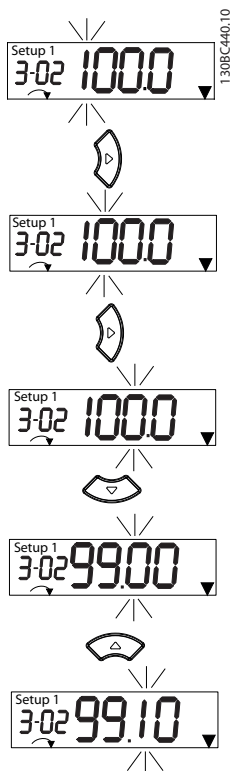


Illustration 4.3 Right Key Function

[▶] 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 Regional Settings [0] International to 1-00 Configuration Mode [0] Open loop).

4.2 Quick Menu

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

1. To enter the Quick Menu, press [Menu] until indicator in display is placed above Quick Menu.
2. Press [▲] [▼] to select either QM1 or QM2, then press [OK].
3. Press [▲] [▼] to browse through the parameters in the Quick Menu.
4. Press [OK] to select a parameter.
5. Press [▲] [▼] 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.

130BC445.11

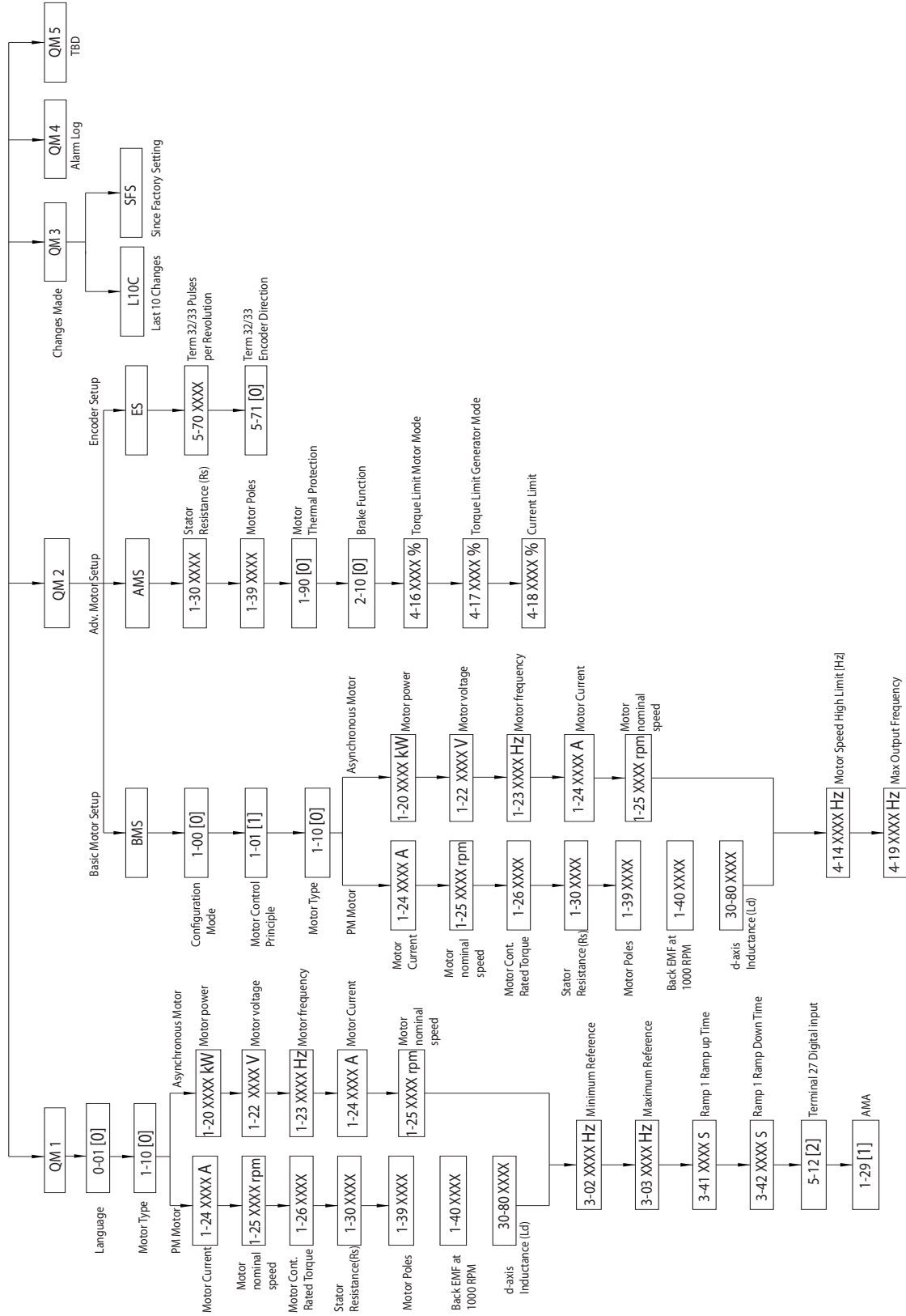


Illustration 4.4 Quick Menu Structure

### 4.3 Main Menu

The Main Menu gives access to all parameters.

1. To enter the Main Menu, press [Menu] 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.

See *Illustration 4.5* for the principles of changing the value of continuous, enumerated and array parameters.

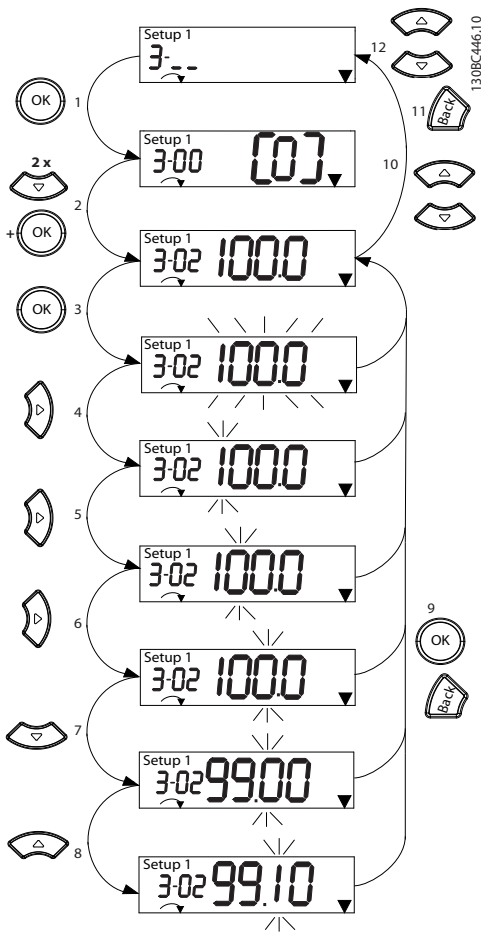


Illustration 4.5 Main Menu Interactions - Continuous Parameters

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 Changing Values in Continuous Parameters

For enumerated parameters the interaction is similar but the parameter value is shown in brackets, because of the LCP 21 digits limitation (4 large digits) and the enum can be greater than 99. When the enum value is greater than 99, the LCP 21 can only display the first part of the bracket.

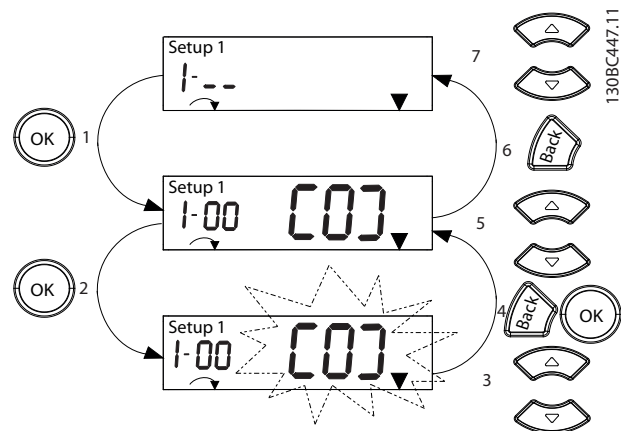


Illustration 4.6 Main Menu Interactions - Enumerated Parameters

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 Changing Values in Enumerated Parameters

Array parameters function as follows:

4.4 Parameter List

4

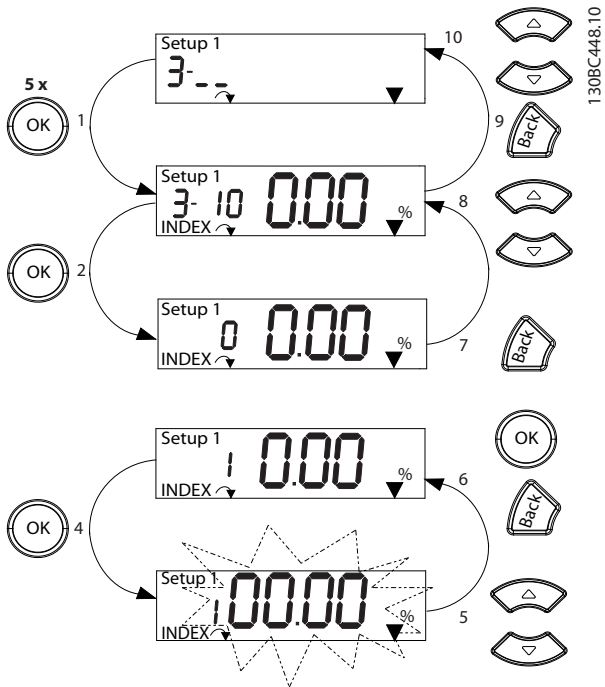


Illustration 4.7 Main Menu Interactions - Array Parameters

1	[OK]: Shows parameter numbers and the value in the first index.
2	[OK]: Index can be selected.
3	[▲][▼]: Select index.
4	[OK]: Value can be edited.
5	[▲][▼]: Change parameter value (flashing).
6	[Back]: Cancels changes [OK]: Accepts changes
7	[Back]: Cancels editing index, a new parameter can be selected.
8	[▲][▼]: Select parameter within the group.
9	[Back]: Removes parameter index value and shows the parameter group.
10	[▲][▼]: Select group.

Table 4.6 Changing Values in Array Parameters



#### 4.4.1 Main Menu Structure

<b>0-0*</b>	<b>Operation / Display</b>				
<b>0-0*</b>	<b>Basic Settings</b>				
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				
<b>0-1*</b>	<b>Set-up Operations</b>				
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<				
<b>0-3*</b>	<b>LCP Custom Readout</b>				
0-30	Custom Readout Unit				
0-31	Custom Readout Min Value				
0-32	Custom Readout Max Value				
<b>0-4*</b>	<b>LCP Keypad</b>				
0-40	[Hand on] Key on LCP				
0-42	[Auto on] Key on LCP				
0-44	[Off/Reset] Key on LCP				
<b>0-5*</b>	<b>Copy/Save</b>				
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<				
<b>0-6*</b>	<b>Password</b>				
0-60	Main Menu Password				
<b>1-*</b>	<b>Load and Motor</b>				
1-0*	<b>General Settings</b>	1-33	Stator Leakage Reactance (X1)	1-33	
1-00	Configuration Mode	1-35	Main Reactance (Xh)	1-35	
[0]*	>Open Loop<	1-39	Motor Poles	1-39	
[1]	>Speed closed loop<	<b>1-4*</b>	<b>Adv. Motor Data II</b>	1-42	
[3]	>Process Closed Loop<	1-42	Motor Cable Length	1-42	
[4]	>Torque open loop<	1-43	Motor Cable Length Feet	1-43	
[6]	>Surface Winder<	<b>1-5*</b>	<b>Load Indep. Setting</b>	*[0]	
[7]	>Extended PID Speed OL<	1-50	Motor Magnetisation at Zero Speed	1-50	
[9]	>Central Winder<	1-52	Min Speed Normal Magnetising [Hz]	1-52	
[10]	>Positioning<	1-55	U/f Characteristic - F	1-55	
[11]	>Synchronisation<	1-56	U/f Characteristic - U	1-56	
1-01	Motor Control Principle	<b>1-6*</b>	<b>Load Depen. Setting</b>	1-60	
[0]	>VVC<	1-60	Low Speed Load Compensation	1-60	
[1]	>VVC+<	1-61	High Speed Load Compensation	1-61	
1-03	Torque Characteristics	1-62	Slip Compensation	1-62	
*[0]	>Constant torque<	1-63	Slip Compensation Time Constant	1-63	
[1]	>Variable Torque<	1-64	Resonance Dampening	1-64	
[2]	>Auto Energy Optim. CT<	1-65	Resonance Dampening Time Constant	1-65	
[3]	>Auto Energy Optim. VT<	<b>1-7*</b>	<b>Start Adjustments</b>	1-71	
1-06	Clockwise Direction	1-71	Start Delay	1-71	
<b>1-1*</b>	<b>Motor Selection</b>	1-72	Start Function	1-72	
1-10	Motor Construction	[0]	>DC Hold/delay time<	[0]	
<b>1-2*</b>	<b>Motor Data</b>	[2]	>Coast/delay time<	[2]	
1-20	Motor Power	[3]	>Start speed cw<	[3]	
[2]	>0.12 kW - 0.16 hp<	[4]	>Horizontal operation<	[4]	
[3]	>0.18 kW - 0.25 hp<	[5]	>VVC+ clockwise<	[5]	
[4]	>0.25 kW - 0.33 hp<	1-73	Flying Start	1-73	
[5]	>0.37 kW - 0.5 hp<	*[0]	>Disabled<	*[0]	
[6]	>0.55 kW - 0.75 hp<	[1]	>Enabled<	[1]	
*[7]	>0.75 kW - 1 hp<	[2]	>Enabled Always<	[2]	
[8]	>1.1 kW - 1.1 hp<	[3]	>Enabled Ref. Dir.<	[3]	
[9]	>1.5 kW - 2 hp<	[4]	>Enab. Always Ref. Dir.<	[4]	
[10]	>2.2 kW - 3 hp<	1-75	Start Speed [Hz]	1-75	
[11]	>3 kW - 4 hp<	1-76	Start Current	1-76	
[12]	>3.7 kW - 5 hp<	1-78	Compressor Start Max Speed [Hz]	1-78	
[13]	>4 kW - 5.4 hp<	1-79	Compressor Start Max Time to Trip	1-79	
[14]	>5.5 kW - 7.5 hp<	<b>1-8*</b>	<b>Stop Adjustments</b>	[11]	
[15]	>7.5 kW - 10 hp<	1-80	Function at Stop	1-80	
[16]	>11 kW - 15 hp<	*[0]	>Coast<	*[0]	
[17]	>15 kW - 20 hp<	[1]	>DC hold / Motor Preheat<	[1]	
[18]	>18.5 kW - 25 hp<	[3]	>Pre-magnetizing<	[3]	
[19]	>22 kW - 30 hp<	<b>1-9*</b>	<b>Motor Temperature</b>	1-82	
[20]	>30 kW - 40 hp<	1-90	Motor Thermal Protection	1-90	
[21]	>37 kW - 50 hp<	*[0]	>No protection<	*[0]	
[22]	>45 kW - 60 hp<	[1]	>Thermistor warning<	[1]	
[23]	>55 kW - 75 hp<	[2]	>Thermistor trip<	[2]	
[24]	>75 kW - 100 hp<	[3]	>ETR warning 1<	[3]	
[25]	>90 kW - 120 hp<	[4]	>ETR trip 1<	[4]	
[26]	>110 kW - 150 hp<	1-93	Thermistor Source	1-93	
1-22	Motor Voltage	<b>2-*</b>	<b>Brakes</b>	2-0*	
1-23	Motor Frequency	2-00	DC-Brake	2-00	
1-24	Motor Current	2-00	DC Hold/Motor Preheat Current	2-00	
1-25	Motor Nominal Speed	2-01	DC Brake Current	2-01	
1-29	Automatic Motor Adaptation (AMA)	2-02	DC Braking Time	2-02	
*[0]	>Off<	2-04	DC Brake Cut In Speed	2-04	
[1]	>Enable Complete AMA<	<b>2-1*</b>	<b>Brake Energy Funct.</b>	2-10	
[2]	>Enable Reduced AMA<	2-10	Brake Function	2-10	
1-3*	<b>Adv. Motor Data I</b>	*[0]	>Off<	*[0]	
1-30	Stator Resistance (Rs)				

[22]	>Speed down<	[32]	>Mech brake ctrl<	[17]	>Above frequency, high<	5-56	Term. 33 High Frequency	6-24	Terminal 54 Low Ref./Feedb. Value
[23]	>Set-up select bit 0<	[36]	>Control word bit 11<	[18]	>Out of feedb. range<	5-57	Term. 33 Low Ref./Feedb. Value	6-25	Terminal 54 High Ref./Feedb. Value
[26]	>Precise stop inverse<	[37]	>Control word bit 12<	[19]	>Below feedback, low<	5-58	Term. 33 High Ref./Feedb. Value	6-26	Terminal 54 Filter Time Constant
[28]	>Catch up<	[40]	>Out of ref range<	[20]	>Above feedback, high<	5-60	Terminal 27 Pulse Output Variable	6-29	Terminal 54 mode
[29]	>Slow down<	[41]	>Below reference, low<	[21]	>Thermal warning<	*[0]	>No operation<	[0]	>Current mode<
[34]	>Ramp bit 0<	[42]	>Above ref, high<	[22]	>Ready, no thermal warning<	[101]	>Voltage mode<	[1]	>Voltage mode<
[60]	>Counter A (up)<	[45]	>Bus ctrl.<	[23]	>Remote/ready,no TW<	[45]	>Bus ctrl.<	6-7*	<b>Analog/Digital Output 45</b>
[61]	>Counter A (down)<	[46]	>Bus control, timeout: On<	[24]	>Ready, no over/under voltage<	[48]	>Bus ctrl., timeout<	6-70	Terminal 45 Mode
[62]	>Reset Counter A<	[47]	>Bus control, timeout: Off<	[25]	>Reverse<	[100]	>Output frequency<	*[0]	>0-20 mA<
[63]	>Counter B (up)<	[55]	>Pulse output <	[26]	>Bus OK<	[101]	>Reference<	[1]	>4-20 mA<
[64]	>Counter B (down)<	[56]	>Heat sink cleaning warning, high<	[27]	>Torque limit & stop<	[102]	>Process Feedback<	[2]	>Digital Output<
[65]	>Reset Counter B<	[60]	>Comparator 0<	[28]	>Brake, no brake warning<	[103]	>Motor Current<	6-71	Terminal 45 Analog Output
[72]	>PID error inverse<	[61]	>Comparator 1<	[29]	>Brake ready, no fault<	[104]	>Torque rel to limit<	*[0]	>No operation<
[73]	>PID reset I part<	[62]	>Comparator 2<	[30]	>Brake fault (IGBT)<	[105]	>Torq relate to rated<	[100]	>Output frequency<
[74]	>PID enable<	[63]	>Comparator 3<	[31]	>Relay 123<	[106]	>Power<	[101]	>Reference<
5-11	Terminal 19 Digital Input	[64]	>Comparator 4<	[32]	>Mech brake ctrl<	[107]	>Speed<	[102]	>Process Feedback<
5-12	Terminal 27 Digital Input	[65]	>Comparator 5<	[36]	>Control word bit 11<	[109]	>Max Out Freq<	[103]	>Motor Current<
5-13	Terminal 29 Digital Input	[70]	>Logic rule 0<	[37]	>Control word bit 12<	5-62	Pulse Output Max Freq 27	[104]	>Torque rel to limit<
[32]	Pulse time based	[71]	>Logic rule 1<	[40]	>Out of ref range<	5-63	Terminal 29 Pulse Output Variable	[105]	>Torq relate to rated<
5-14	Terminal 32 Digital Input	[72]	>Logic rule 2<	[41]	>Below reference, low<	5-65	Pulse Output Max Freq 29	[106]	>Power<
[82]	Encoder input B	[73]	>Logic rule 3<	[42]	>Above ref, high<	5-7*	<b>24V Encoder Input</b>	[107]	>Speed<
5-15	Terminal 33 Digital Input	[74]	>Logic rule 4<	[45]	>Bus ctrl.<	5-70	Term 32/33 Pulses Per Revolution	[111]	>Speed Feedback<
[32]	Pulse time based	[75]	>Logic rule 5<	[46]	>Bus control, timeout: On<	5-71	Term 32/33 Encoder Direction	[139]	>Bus Control<
[81]	Encoder input A	[80]	>SL digital output A<	[47]	>Bus control, timeout: Off<	5-9*	<b>Bus Controlled</b>	[254]	>DC Link Voltage<
5-16	Terminal 31 Digital Input	[81]	>SL digital output B<	[56]	>Heat sink cleaning warning, high<	5-90	Digital & Relay Bus Control	6-72	Terminal 45 Digital Output
5-30	Terminal 27 Digital Output	[82]	>SL digital output C<	[60]	>Comparator 0<	5-93	Pulse Out 27 Bus Control	6-73	Terminal 45 Output Min Scale
*[0]	>No operation<	[83]	>SL digital output D<	[61]	>Comparator 1<	5-94	Pulse Out 27 Timeout Preset	6-74	Terminal 45 Output Max Scale
[1]	>Control Ready<	[91]	>Encoder emulate output A<	[62]	>Comparator 2<	5-95	Pulse Out 29 Bus Control	6-76	Terminal 45 Output Bus Control
[2]	>Drive ready<	[160]	>No alarm<	[63]	>Comparator 3<	5-96	Pulse Out 29 Timeout Preset	6-9*	<b>Analog/Digital Output 42</b>
[3]	>Drive rdy/rem ctrl<	[161]	>Running reverse <	[64]	>Comparator 4<	6-0*	<b>Analog I/O Mode</b>	6-90	Terminal 42 Mode
[4]	>Stand-by/no warning<	[165]	>Local ref active <	[65]	>Comparator 5<	6-00	Live Zero Timeout Time	6-91	Terminal 42 Analog Output
[5]	>Running<	[166]	>Remote ref active<	[70]	>Logic rule 0<	6-01	Live Zero Timeout Function	6-92	Terminal 42 Digital Output
[6]	>Running/no warning<	[167]	>Start command activ<	[71]	>Logic rule 1<	*[0]	>Off<	6-93	Terminal 42 Output Min Scale
[7]	>Run in range/no warn<	[168]	>Drive in hand mode<	[72]	>Logic rule 2<	[1]	>Freeze output<	6-94	Terminal 42 Output Max Scale
[8]	>Run on ref/no warn<	[169]	>Drive in auto mode<	[73]	>Logic rule 3<	[2]	>Stop<	6-96	Terminal 42 Output Bus Control
[9]	>Alarm<	[193]	>Sleep Mode<	[74]	>Logic rule 4<	[3]	>Jogging<	6-98	Drive Type
[10]	>Alarm or warning<	[194]	>Broken Belt Function<	[75]	>Logic rule 5<	[4]	>Max. speed<	7-0*	<b>Controllers</b>
[11]	>At torque limit<	5-31	Terminal 29 Digital Output	[80]	>SL digital output A<	[4]	>Max. speed<	7-00	Speed PID Feedback Source
[12]	>Out of current range<	5-34	On Delay, Digital Output	[81]	>SL digital output B<	[5]	>Stop and trip<	[1]	>24V encoder<
[13]	>Below current, low<	5-35	Off Delay, Digital Output	[82]	>SL digital output C<	6-1*	<b>Analog Input 53</b>	[2]	>MCB 102<
[14]	>Above current, high<	5-4*	<b>Relays</b>	[83]	>SL digital output D<	6-10	Terminal 53 Low Voltage	[3]	>MCB 103<
[15]	>Out of frequency range<	5-40	Function Relay	[91]	>Encoder emulate output A<	6-11	>0.00-10.00 V< *0.07 V	[6]	>Analog Input 53<
[16]	>Below frequency, low<	[0]	>No operation<	[160]	>No alarm<	6-12	>0.00-10.00 V< *10.00 V	[7]	>Analog Input 54<
[17]	>Above frequency, high<	[1]	>Control Ready<	[161]	>Running reverse <	6-12	Terminal 53 High Voltage	[8]	>Frequency input 29<
[18]	>Out of feedb. range<	[2]	>Drive ready<	[166]	>Local ref active <	6-13	>0.00-20.00 mA< *4.00 mA	[9]	>Frequency input 33<
[19]	>Below feedback, low<	[3]	>Drive rdy/rem ctrl<	[167]	>Start command activ<	6-13	Terminal 53 High Current	*[20]	>None<
[20]	>Above feedback, high<	[4]	>Stand-by/no warning<	[168]	>Drive in hand mode<	6-14	>0.00-20.00 mA< *20.00 mA	7-02	Speed PID Proportional Gain
[21]	>Thermal warning<	[5]	>Running<	[169]	>Drive in auto mode<	6-15	Terminal 53 Low Ref./Feedb. Value	7-03	Speed PID Integral Time
[22]	>Ready, no thermal warning<	[6]	>Running/no warning<	[193]	>Sleep Mode<	6-16	Terminal 53 High Ref./Feedb. Value	7-04	Speed PID Differentiation Time
[23]	>Remote/ready,no TW<	[7]	>Run in range/no warn<	[194]	>Broken Belt Function<	6-19	Terminal 53 Filter Time Constant	>0.0-200.0 ms< *30.0 ms	Speed PID Diff. Gain Limit
[24]	>Ready, no over/under voltage<	*[9]	>Alarm<	5-41	On Delay, Relay	[0]	>Current mode<	>1.0-20.0< *5.0	Speed PID Lowpass Filter Time
[25]	>Reverse<	5-42	Off Delay, Relay	5-5*	<b>Pulse Input</b>	*[1]	>Voltage mode<	>1.0-100.0 ms< *10.0 ms	Speed PID Feedback Gear Ratio
[26]	>Bus OK<	[11]	>At torque limit<	5-50	Term. 29 Low Frequency	6-2*	<b>Analog Input 54</b>	>0.0-200.0 ms< *8.0 ms	Speed PID Feed Forward Factor
[27]	>Torque limit & stop<	[12]	>Out of current range<	5-51	Term. 29 High Frequency	6-20	Terminal 54 Low Voltage	>0.0-200.0 ms< *8.0 ms	
[28]	>Brake, no brake warning<	[13]	>Below current, low<	5-52	Term. 29 High Ref./Feedb. Value	6-21	Terminal 54 High Voltage		
[29]	>Brake ready, no fault<	[14]	>Above current, high<	5-53	Term. 29 High Ref./Feedb. Value	6-22	Terminal 54 Low Current		
[30]	>Brake fault (IGBT)<	[15]	>Out of frequency range<	5-55	Term. 33 Low Frequency	6-23	Terminal 54 High Current		
[31]	>Relay 123<	[16]	>Below frequency, low<						

7-1*	<b>Torque PID Ctrl.</b>	7-62	Feedback 2 Conversion	[2]	>Running<	[31]	>SL Time-out 1<	[2]	>Ctrl. ramp-down, trip<
7-12	Torque PID Proportional Gain	<b>8-*</b>	<b>Comm. and Options</b>	[3]	>In range<	[32]	>SL Time-out 2<	[3]	>Coasting<
7-13	Torque PID Integration Time	<b>8-0*</b>	<b>General Settings</b>	[4]	>On reference<	[33]	>Digital input DI18<	[4]	>Kinetic back-up<
7-2*	<b>Process Ctrl. Feedb</b>	8-01	Control Site	[7]	>Out of current range<	[34]	>Digital input DI19<	[5]	>Kinetic back-up, trip<
7-20	Process CL Feedback 1 Resource	8-02	Control Source	[8]	>Below l low<	[35]	>Digital input DI27<	[6]	>Alarm<
[10]	>No function<	8-03	Control Timeout Time	[9]	>Above l high<	[36]	>Digital input DI29<	[14-11]	Mains Voltage at Mains Fault
[1]	>Analog Input 53<	8-04	Control Timeout Function	[16]	>Thermal warning<	[39]	>Start command<	[14-12]	Function at Mains Imbalance
[2]	>Analog Input 54<	<b>8-1*</b>	<b>Ctrl. Word Settings</b>	[17]	>Mains out of range<	*[40]	>Drive stopped<	[*0]	>Trip<
[3]	>Frequency input 29<	8-10	Control Word Profile	[18]	>Reversing<	[42]	>Auto Reset Trip<	[1]	>Warning<
[4]	>Frequency input 33<	<b>8-3*</b>	<b>FC Port Settings</b>	[19]	>Warning<	[50]	>Comparator 4<	[2]	>Disabled<
7-22	Process CL Feedback 2 Resource	8-30	Protocol	[20]	>Alarm (trip)<	[51]	>Comparator 5<	[14-2*	<b>Reset Functions</b>
<b>7-3*</b>	<b>Process PID Ctrl.</b>	*[0]	>FC<	[21]	>Alarm (trip lock)<	[60]	>Logic rule 4<	14-20	Reset Mode
7-30	Process PID Normal/ Inverse Control	[2]	>Modbus RTU<	[22]	>Comparator 0<	[61]	>Logic rule 5<	*[0]	>Manual reset<
*[0]	>Normal<	8-31	Address	[23]	>Comparator 1<	[70]	>SL Time-out 3<	[1]	>Automatic reset x 1<
[1]	>Inverse<	8-32	Baud Rate	[24]	>Comparator 2<	[71]	>SL Time-out 4<	[2]	>Automatic reset x 2<
7-31	Process PID Anti Windup	[0]	>2400 Baud<	[25]	>Comparator 3<	[72]	>SL Time-out 5<	[3]	>Automatic reset x 3<
[0]	>Off<	[1]	>4800 Baud<	[26]	>Logic rule 0<	[73]	>SL Time-out 6<	[4]	>Automatic reset x 4<
*[11]	>On<	*[2]	>9600 Baud<	[27]	>Logic rule 1<	[74]	>SL Time-out 7<	[5]	>Automatic reset x 5<
7-32	Process PID Start Speed	[3]	>19200 Baud<	[28]	>Logic rule 2<	[83]	>Broken Belt<	[6]	>Automatic reset x 6<
>0 - 6000 rpm< *0 rpm	[4]	[4]	>38400 Baud<	[29]	>Logic rule 3<	[13-03]	Reset SLC	[7]	>Automatic reset x 7<
7-33	Process PID Proportional Gain	[5]	>57600 Baud<	[33]	>Digital input DI18<	*[0]	>Do not reset SLC<	[8]	>Automatic reset x 8<
>0.0 - 10.00< *0.01	[6]	[6]	>76800 Baud<	[34]	>Digital input DI19<	[1]	>Reset SLC<	[9]	>Automatic reset x 9<
7-34	Process PID Integral Time	[7]	>115200 Baud<	[35]	>Digital input DI27<	<b>13-1*</b>	<b>Comparators</b>	[10]	>Automatic reset x 10<
>0.10-9999.00 s< *9999.00 s	8-33	[8]	Parity / Stop Bits	[36]	>Digital input DI29<	13-10	Comparator Operand	[11]	>Automatic reset x 15<
Process PID Differentiation Time	*[0]	[1]	>Even Parity, 1 Stop Bit<	*[39]	>Start command<	13-11	Comparator Operator	[12]	>Automatic reset x 20<
>0.00-20.00 s< *0.00 s	[2]	[2]	>Odd Parity, 1 Stop Bit<	[40]	>Drive stopped<	13-12	Comparator Value	14-21	Automatic Restart Time
Process PID Diff. Gain Limit	[3]	[3]	>No Parity, 1 Stop Bit<	[42]	>Auto Reset Trip<	<b>13-2*</b>	<b>Timers</b>	>0-600 s< *10 s	
Process PID Feed Forward Factor	[50]	[50]	>No Parity, 2 Stop Bits<	[50]	>Comparator 4<	13-20	SL Controller Timer	14-22	Operation Mode
>0-200%< *0%	8-35	[51]	Minimum Response Delay	[51]	>Comparator 5<	<b>13-4*</b>	<b>Logic Rules</b>	*[0]	>Normal operation<
On Reference Bandwidth	8-36	[60]	Maximum Response Delay	[60]	>Logic rule 4<	13-40	Logic Rule Boolean 1	[2]	>Initialisation<
<b>7-4*</b>	<b>Adv. Process PID I</b>	8-37	Maximum Inter-char delay	[61]	>Logic rule 5<	13-41	Logic Rule Operator 1	14-23	Typecode Setting
Process PID I-part Reset	8-43	<b>8-4*</b>	<b>FC MC protocol set</b>	[83]	>Broken Belt<	13-42	Logic Rule Boolean 2	14-24	Trip Delay at Current Limit
Process PID Output Neg. Clamp	<b>8-5*</b>	8-43	PCD Read Configuration	13-02	Stop Event	13-43	Logic Rule Operator 2	14-25	Trip Delay at Torque Limit
Process PID Output Pos. Clamp	8-50	<b>8-5*</b>	<b>Digital/Bus</b>	*[0]	>Off<	13-44	Logic Rule Boolean 3	14-27	Action At Inverter Fault
Process PID Gain Scale at Min. Ref.	8-51	8-50	Coasting Select	[1]	>On<	<b>13-5*</b>	<b>States</b>	[0]	>Trip<
Process PID Gain Scale at Max. Ref.	8-52	8-51	Quick Stop Select	[1]	Start Event	13-51	SL Controller Event	*[1]	>Warning or trip after warning<
Process PID Feed Fwd Resource	8-53	8-52	DC Brake Select	[0]	>False<	13-52	SL Controller Action	14-28	Production Settings
>No function<	8-53	Start Select	Start Select	[1]	>True<	<b>14-*</b>	<b>Special Functions</b>	14-29	Service Code
>Analog Input 53<	8-54	Reversing Select	Reversing Select	[2]	>Running<	<b>14-0*</b>	<b>Inverter Switching</b>	<b>14-3*</b>	<b>Current Lim Ctrl.</b>
>Analog Input 54<	8-55	Set-up Select	Set-up Select	[3]	>In range<	14-01	Switching Frequency	14-30	Current Lim Ctrl, Proportional Gain
>Frequency input 29<	8-56	Preset Reference Select	Preset Reference Select	[4]	>On reference<	[0]	>Ran3<	14-31	Current Lim Ctrl, Integration Time
>Frequency input 33<	8-57	Profidrive OFF2 Select	Profidrive OFF2 Select	[7]	>Out of current range<	[1]	>Ran5<	14-32	Current Lim Ctrl, Filter Time
>Local bus reference<	8-58	Profidrive OFF3 Select	Profidrive OFF3 Select	[8]	>Below l low<	[2]	>2.0 kHz<	<b>14-4*</b>	<b>Energy Optimising</b>
>Bus PCD<	<b>8-8*</b>	<b>FC Port Diagnostics</b>	<b>FC Port Diagnostics</b>	[9]	>Above l high<	[3]	>3.0 kHz<	14-40	VT Level
Process PID Feed Fwd Normal/ Inv. Ctrl.	8-80	Bus Message Count	Bus Message Count	[16]	>Thermal warning<	[4]	>4.0 kHz<	14-41	AEO Minimum Magnetisation
PCD Feed Forward	8-81	Bus Error Count	Bus Error Count	[17]	>Mains out of range<	[5]	>5.0 kHz<	>40-75%< *66%	
Process PID Output Normal/ Inv. Ctrl.	8-82	Slave Messages Rcvd	Slave Messages Rcvd	[18]	>Reversing<	[6]	>6.0 kHz<	<b>14-5*</b>	<b>Environment</b>
<b>7-5*</b>	<b>Adv. Process PID II</b>	8-83	Slave Error Count	[19]	>Warning<	[7]	>8.0 kHz<	14-50	RFI Filter
Process PID Extended PID	8-84	Slave Messages Sent	Slave Messages Sent	[20]	>Alarm (trip)<	[8]	>10.0 kHz<	14-51	DC-Link Voltage Compensation
Process PID Feed Fwd Gain	8-85	Slave Timeout Errors	Slave Timeout Errors	[21]	>Alarm (trip lock)<	[9]	>12.0kHz<	14-52	Fan Control
Process PID Feed Fwd Ramp up	8-88	Reset FC port Diagnostics	Reset FC port Diagnostics	[22]	>Comparator 0<	[10]	>16.0kHz<	*[5]	>Constant-on mode<
Process PID Feed Fwd Ramp down	<b>13-*</b>	<b>Smart Logic</b>	<b>Smart Logic</b>	[23]	>Comparator 1<	[14-03]	Overmodulation	[6]	>Constant-off mode<
Process PID Ref. Filter Time	<b>13-0*</b>	<b>SLC Settings</b>	<b>SLC Settings</b>	[24]	>Comparator 2<	[0]	>Off<	[7]	>On-when-inverter-is-on-else-off Mode<
Process PID Fb. Filter Time	13-00	SL Controller Mode	SL Controller Mode	[25]	>Comparator 3<	*[1]	>On<	[8]	>Variable-speed mode<
<b>Feedback Conversion</b>	[1]	>Off<	>Off<	[26]	>Logic rule 0<	<b>14-1*</b>	<b>Mains On/Off</b>	14-55	Output Filter
Feedback 1 Conversion	[0]	>On<	>On<	[27]	>Logic rule 1<	14-10	Mains Failure	<b>14-6*</b>	<b>Auto Derate</b>
>Linear<	[1]	>False<	>False<	[28]	>Logic rule 2<	*[0]	>No function<	14-63	Min Switch Frequency
>Square root<	[1]	>True<	>True<	[30]	>Logic rule 3<	[1]	>Ctrl. ramp-down<	*[2]	>2.0 kHz<

[3]	>3.0 kHz<	16-36	Inv. Nom. Current
[4]	>4.0 kHz<	16-37	Inv. Max. Current
[5]	>5.0 kHz<	16-38	SL Controller State
[6]	>6.0 kHz<	16-39	Control Card Temp.
[7]	>8.0 kHz<	16-5*	<b>Ref. &amp; Feeds.</b>
[8]	>10.0 kHz<	16-50	External Reference
[9]	>12.0 kHz<	16-52	Feedback[Unit]
[10]	>16.0 kHz<	16-57	Feedback [RPM]
		16-6*	<b>Inputs &amp; Outputs</b>
		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*	<b>Fieldbus &amp; FC Port</b>
		16-86	FC Port REF 1
		16-9*	<b>Diagnosis Readouts</b>
		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-*	<b>Data Readouts 2</b>
		18-9*	<b>PID Readouts</b>
		18-90	Process PID Error
		18-91	Process PID Output
		18-92	Process PID Clamped Output
		18-93	Process PID Gain Scaled Output
		22-*	<b>Appl. Functions</b>
		22-4*	<b>Sleep Mode</b>
		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*	<b>Broken Belt Detection</b>
		22-60	Broken Belt Function
		22-61	Broken Belt Torque
		22-62	Broken Belt Delay
		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*	<b>Motor Status</b>
		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*	<b>Drive Status</b>
		16-30	DC Link Voltage
		16-33	Brake Energy /2 min
		16-34	Heatsink Temp.
		16-35	Inverter Thermal

## 5 Wiring Examples

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

		Parameters	
FC		Function	Setting
+24 V	12	1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
D IN	18		
D IN	19	5-12 Terminal 27 Digital Input	[2]* Coast inverse
COM	20		
D IN	27	* = Default Value	
D IN	29	Notes/comments: Parameter group 1-2* Motor Data must be set according to motor	
D IN	32	<b>NOTE</b>	
D IN	33	If terminal 12 and 27 are not connected, set 5-12 to [0]	
D IN	31		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
A OUT	45		

Table 5.1 AMA with T27 Connected

		Parameters	
FC		Function	Setting
+24 V	12	6-10 Terminal 53 Low Voltage	0.07 V*
D IN	18		
D IN	19	6-11 Terminal 53 High Voltage	10 V*
COM	20		
D IN	27	6-14 Terminal 53 Low Ref./Feedb. Value	0
D IN	29		
D IN	32	6-15 Terminal 53 High Ref./Feedb. Value	1500
D IN	33		
D IN	31	6-19 Terminal 53 Mode	[1] Voltage
+10 V	50		
A IN	53	* = Default Value	
A IN	54	Notes/comments:	
COM	55		
A OUT	42		
A OUT	45		

Table 5.2 Analog Speed Reference (Voltage)

		Parameters	
FC		Function	Setting
+24 V	12	6-12 Terminal 53 Low Current	4 mA*
D IN	18		
D IN	19	6-13 Terminal 53 High Current	20 mA*
COM	20		
D IN	27	6-14 Terminal 53 Low Ref./Feedb. Value	0
D IN	29		
D IN	32	6-15 Terminal 53 High Ref./Feedb. Value	1500
D IN	33		
D IN	31	6-19 Terminal 53 Mode	[0] current
+10 V	50		
A IN	53	* = Default Value	
A IN	54	Notes/comments:	
COM	55		
A OUT	42		
A OUT	45		

Table 5.3 Analog Speed Reference (Current)

		Parameters	
FC		Function	Setting
+24 V	12	5-10 Terminal 18 Digital Input	[8] Start
D IN	18		
D IN	19	5-11 Terminal 19 Digital Input	[10] Reversing*
COM	20		
D IN	27	5-12 Terminal 27 Digital Input	[0] No operation
D IN	29		
D IN	32	5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
D IN	33		
D IN	31	5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
+10 V	50		
A IN	53	3-10 Preset Reference	
A IN	54	Preset ref. 0 25%	
COM	55	Preset ref. 1 50%	
A OUT	42	Preset ref. 2 75%	
A OUT	45	Preset ref. 3 100%	
		* = Default Value	
		Notes/comments:	

Table 5.4 Start/Stop with Reversing and 4 Preset Speeds

5

		Parameters	
FC		Function	Setting
+24 V	12	5-11 Terminal 19 Digital Input	[1] Reset
D IN	18	* = Default Value	
D IN	19	<b>Notes/comments:</b>	
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	31		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
A OUT	45		

Table 5.5 External Alarm Reset

		Parameters	
FC		Function	Setting
+24 V	12	6-10 Terminal 53 Low Voltage	0.07 V*
D IN	18	6-11 Terminal 53 High Voltage	10 V*
D IN	19	6-14 Terminal 53 Low Ref./Feedb. Value	0
COM	20	6-15 Terminal 53 High Ref./Feedb. Value	1500
D IN	27	6-19 Terminal 53 Mode	[1] voltage
D IN	29	* = Default Value	
D IN	32	<b>Notes/comments:</b>	
D IN	33		
D IN	31		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
A OUT	45		

Table 5.6 Speed Reference (Using a Manual Potentiometer)

		Parameters	
FC		Function	Setting
+24 V	12	4-30 Motor Feedback Loss Function	[1] Warning
D IN	18	4-31 Motor Feedback Speed Error	100
D IN	19	4-32 Motor Feedback Loss Timeout	5 s
COM	20	7-00 Speed PID Feedback Source	[2] MCB 102
D IN	27	17-11 Resolution (PPR)	1024*
D IN	29	13-00 SL Controller Mode	[1] On
D IN	32	13-01 Start Event	[19] Warning
D IN	33	13-02 Stop Event	[44] Reset key
D IN	31	13-10 Comparato r Operand	[21] Warning no.
+10 V	50	13-11 Comparato r Operator	[1] ~*
A IN	53	13-12 Comparato r Value	90
A IN	54	13-51 SL Controller Event	[22] Comparator 0
COM	55	13-52 SL Controller Action	[32] Set digital out A low
A OUT	42	5-40 Function Relay	[80] SL digital output A
A OUT	45	* = Default Value	
		<b>Notes/comments:</b>	
		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 s, the frequency converter continues and the warning disappears. But Relay 1 will still be triggered until pressing [Off/Reset].	

Table 5.7 Using SLC to Set a Relay

		Parameters																																	
		Function	Setting																																
<table border="1"> <tr><td>FC</td><td></td></tr> <tr><td>+24 V</td><td>12</td></tr> <tr><td>D IN</td><td>18</td></tr> <tr><td>D IN</td><td>19</td></tr> <tr><td>COM</td><td>20</td></tr> <tr><td>D IN</td><td>27</td></tr> <tr><td>D IN</td><td>29</td></tr> <tr><td>D IN</td><td>32</td></tr> <tr><td>D IN</td><td>33</td></tr> <tr><td>D IN</td><td>31</td></tr> <tr><td>+10 V</td><td>50</td></tr> <tr><td>A IN</td><td>53</td></tr> <tr><td>A IN</td><td>54</td></tr> <tr><td>COM</td><td>55</td></tr> <tr><td>A OUT</td><td>42</td></tr> <tr><td>A OUT</td><td>45</td></tr> </table>	FC		+24 V	12	D IN	18	D IN	19	COM	20	D IN	27	D IN	29	D IN	32	D IN	33	D IN	31	+10 V	50	A IN	53	A IN	54	COM	55	A OUT	42	A OUT	45		5-10 Terminal 18 Digital Input	[8] Start*
	FC																																		
	+24 V	12																																	
	D IN	18																																	
	D IN	19																																	
	COM	20																																	
	D IN	27																																	
	D IN	29																																	
	D IN	32																																	
	D IN	33																																	
D IN	31																																		
+10 V	50																																		
A IN	53																																		
A IN	54																																		
COM	55																																		
A OUT	42																																		
A OUT	45																																		
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																																
<table border="1"> <tr><td>FC</td><td></td></tr> <tr><td>+24 V</td><td>12</td></tr> <tr><td>D IN</td><td>18</td></tr> <tr><td>D IN</td><td>19</td></tr> <tr><td>COM</td><td>20</td></tr> <tr><td>D IN</td><td>27</td></tr> <tr><td>D IN</td><td>29</td></tr> <tr><td>D IN</td><td>32</td></tr> <tr><td>D IN</td><td>33</td></tr> <tr><td>D IN</td><td>31</td></tr> <tr><td>+10 V</td><td>50</td></tr> <tr><td>A IN</td><td>53</td></tr> <tr><td>A IN</td><td>54</td></tr> <tr><td>COM</td><td>55</td></tr> <tr><td>A OUT</td><td>42</td></tr> <tr><td>A OUT</td><td>45</td></tr> </table>	FC		+24 V	12	D IN	18	D IN	19	COM	20	D IN	27	D IN	29	D IN	32	D IN	33	D IN	31	+10 V	50	A IN	53	A IN	54	COM	55	A OUT	42	A OUT	45		1-90 Motor Thermal Protection	[2] Thermistor trip
	FC																																		
	+24 V	12																																	
	D IN	18																																	
	D IN	19																																	
	COM	20																																	
	D IN	27																																	
	D IN	29																																	
	D IN	32																																	
	D IN	33																																	
D IN	31																																		
+10 V	50																																		
A IN	53																																		
A IN	54																																		
COM	55																																		
A OUT	42																																		
A OUT	45																																		
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

5

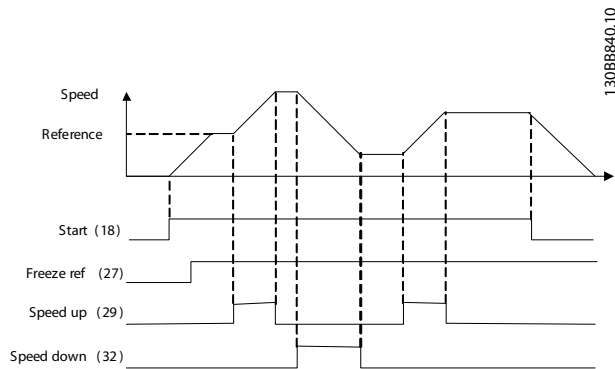


Illustration 5.1 Speed Up/Down

Illustration for Table 5.8

## 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

### 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

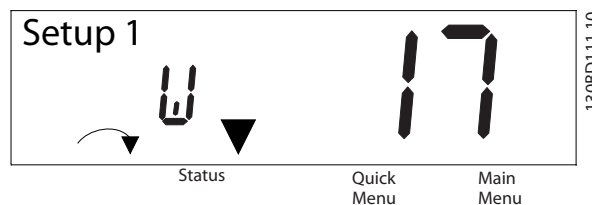


Illustration 6.1 Warning and Alarm Displays

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

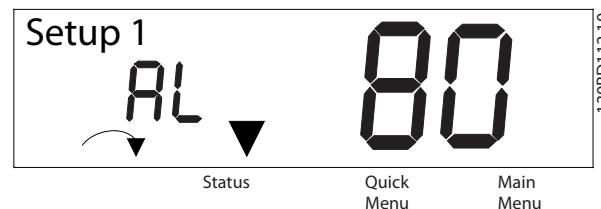


Illustration 6.2 Alarm/Trip Lock Alarm

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

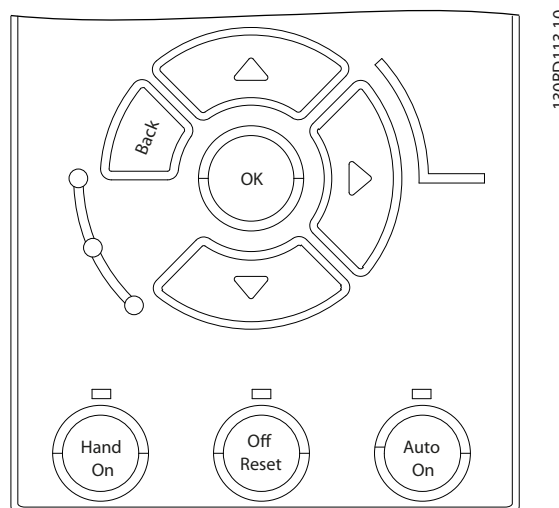


Illustration 6.3 Status Indicator Lights



### 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 <sup>1)</sup>	X	X	X	Missing phase on supply side, or too high voltage imbalance. Check supply voltage.
7	DC over voltage <sup>1)</sup>	X	X		Intermediate circuit voltage exceeds limit.
8	DC under voltage <sup>1)</sup>	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 4-16 Torque Limit Motor Mode or 4-17 Torque Limit Generator Mode.
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.
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 <sub>nom</sub> and I <sub>nom</sub>		X		Wrong setting for motor voltage and/or motor current.
52	AMA low I <sub>nom</sub>		X		Motor current is too low. Check settings.
53	AMA big motor		X		The motor is too big for the AMA to operate.
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.

No.	Description	Warning	Alarm	Trip Lock	Cause of Problem
56	AMA interrupt		X		The user has interrupted the AMA.
57	AMA timeout		X		
58	AMA internal		X		Contact your Danfoss supplier.
59	Current limit	X	X		Frequency converter 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.
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 in IT mains when the frequency converter coasts and V DC is higher than 830 V. Energy on DC link is consumed by the motor. This function can be enabled/disabled in 0-07 Auto DC Braking.
95	Broken belt	X	X		
101	Flow/pressure info missing		X	X	
nw run	<b>Not While RUNning</b>				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.

**Table 6.1 Warnings and Alarms Code List**

<sup>1)</sup> These faults may be caused by mains distortions. Installing Danfoss Line Filter may rectify this problem.

## 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 <i>Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check 5-12 <i>Coast inv.</i> for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to <i>No operation</i> .
	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 <i>Reference Site</i> . Set preset reference active in parameter group 3-1* <i>References</i> . Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that 4-10 <i>Motor Speed Direction</i> is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group 5-1* <i>Digital inputs</i> .	Deactivate reversing signal.
	Wrong motor phase connection		
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in 4-14 <i>Motor Speed High Limit [Hz]</i> and 4-19 <i>Max Output Frequency</i>	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in 6-* <i>Analog I/O mode</i> and parameter group 3-1* <i>References</i> .	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* <i>Analog I/O mode</i> .
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups 1-2* <i>Motor data</i> , 1-3* <i>Adv motor data</i> , and 1-5* <i>Load indep. setting</i> .
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* <i>DC brake</i> and 3-0* <i>Reference limits</i> .

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 <i>Alarm 4 Mains phase loss</i> 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 <i>4-6* Speed Bypass</i> .	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off over-modulation in <i>14-03 Overmodulation</i> .	
		Change switching pattern and frequency in parameter group <i>14-0* Inverter Switching</i> .	
		Increase Resonance Dampening in <i>1-64 Resonance Dampening</i> .	

Table 7.1 Troubleshooting

## 8 Specifications

### 8.1 Power-dependent Specifications

#### 8.1.1 Mains Supply 3 x 380-480 V AC

Frequency converter	HK 37	HK 55	HK75	H1K1	H1K5	H2K2	H3K0	H4K0	H5K5	H7K5
<b>Typical Shaft Output [kW]</b>	<b>0.37</b>	<b>0.55</b>	<b>0.75</b>	<b>1.1</b>	<b>1.5</b>	<b>2.2</b>	<b>3</b>	<b>4</b>	<b>5.5</b>	<b>7.5</b>
Enclosure IP20	J1	J1	J1	J1	J1	J1	J2	J2	J2	J3
<b>Output current</b>										
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	2.8	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 (480 V AC) [kVA]	0.9	1.3	1.7	2.5	2.8	4.0	5.2	6.8	9.1	11.6
<b>Max. input current</b>										
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
<b>Additional specifications</b>										
Max. cable cross section (mains, motor, brake and load sharing) [mm <sup>2</sup> /AWG] <sup>2)</sup>	4 mm <sup>2</sup>									
Estimated power loss at rated max. load [W] <sup>3)</sup>	20.88	25.16	30.01	40.01	52.91	73.97	94.81	115.5	157.54	192.83
Weight, enclosure IP20	2.3	2.3	2.3	2.3	2.3	2.5	3.6	3.6	3.6	4.1
Efficiency [%] <sup>4)</sup>	96.2	97.0	97.2	97.4	97.4	97.6	97.5	97.6	97.7	98.0



Table 8.1 Mains Supply 3 x 380-480 V AC - Heavy Duty <sup>1)</sup>

Frequency converter	H11K	H15K	H18K	H22K	H30K	H37K	H45K	H55K	H75K
<b>Typical Shaft Output [kW]</b>	<b>11</b>	<b>15</b>	<b>18.5</b>	<b>22</b>	<b>30</b>	<b>37</b>	<b>45</b>	<b>55</b>	<b>75</b>
IP20	J4	J4	J5	J5	J6	J6	J6	J7	J7
<b>Output current</b>									
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 480 V AC) [kVA]	17.5	22.4	28.3	33.3					
<b>Max. input current</b>									
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					
<b>Additional specifications</b>									
Max. cable size (mains, motor, brake) [mm <sup>2</sup> /AWG] <sup>2)</sup>	16 mm <sup>2</sup>	16 mm <sup>2</sup>	16 mm <sup>2</sup>	16 mm <sup>2</sup>	50 mm <sup>2</sup>	50 mm <sup>2</sup>	50 mm <sup>2</sup>	50 mm <sup>2</sup>	85 mm <sup>2</sup>
Estimated power loss at rated max. load [W] <sup>3)</sup>	289.53	393.36	402.83	467.52					
Weight enclosure IP20 [kg]	9.4	9.5	12.3	12.5					
Efficiency [%] <sup>4)</sup>	97.8	97.8	98.1	97.9					

Table 8.2 Mains Supply 3x380-480 V AC - Heavy Duty<sup>1)</sup>

Frequency converter	Q11K	Q15K	Q18K	Q22K	Q30K	Q37K	Q45K	Q55K	Q75K
<b>Typical Shaft Output [kW]</b>	<b>11</b>	<b>15</b>	<b>18.5</b>	<b>22</b>	<b>30</b>	<b>37</b>	<b>45</b>	<b>55</b>	<b>75</b>
IP20	J4	J4	J5	J5	J6	J6	J6	J7	J7
<b>Output current</b>									
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]									
<b>Max. input current</b>									
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					
<b>Additional specifications</b>									
Max. cable size (mains, motor, brake) [mm <sup>2</sup> /AWG] <sup>2)</sup>	16 mm <sup>2</sup>			50 mm <sup>2</sup>			85 mm <sup>2</sup>		
Estimated power loss at rated max. load [W] <sup>3)</sup>	289.53	393.36	402.83	467.52					
Weight enclosure IP20 [kg]	9.4	9.5	12.3	12.5					
Efficiency [%] <sup>4)</sup>	97.8	97.8	98.1	97.9					

**Table 8.3 Mains Supply 3x380-480 V AC - Normal Duty<sup>1)</sup>**

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% (tolerance 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.

## 8.2 General Technical Data

### Mains supply (L1, L2, L3)

Supply Terminals	L1, L2, L3
Supply voltage	380-480 V:-15% (-25%) <sup>1)</sup> 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.*

*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 <sup>plus</sup> Mode	0-200 Hz
Switching on output	Unlimited
Ramp times	0.01-3600 s

### Torque characteristics

Starting torque (constant torque)	maximum 160% for 60 s <sup>1)</sup>
Overload torque (constant torque)	maximum 160% for 60 s <sup>1)</sup>
Starting torque (variable torque)	maximum 110% for 60 s <sup>1)</sup>
Overload torque (variable torque)	maximum 110% for 60 s
Starting current	maximum 200% for 1 s
Torque rise time in VVC <sup>plus</sup> (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<sup>1)</sup>

Max. motor cable length, screened	50 m
Max. motor cable length, unscreened	100 m
Maximum cross section to control terminals, flexible/rigid wire	2.5 mm <sup>2</sup> /14 AWG
Minimum cross section to control terminals	0.55 mm <sup>2</sup> / 30 AWG

*1) For power cables, see Table 8.1 to Table 8.3.*

Digital inputs

Programmable digital inputs	7
Terminal number	18, 19, 27 <sup>1)</sup> , 29 <sup>1)</sup> , 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 <sup>2)</sup>	> 19 V DC
Voltage level, logic '1' NPN <sup>2)</sup>	< 14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	4-32 kHz
(Duty cycle) Min. pulse width	4.5 ms
Input resistance, R <sub>i</sub>	approx. 4 kΩ

Analog inputs

Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	software
Voltage level	0-10 V
Input resistance, R <sub>i</sub>	approx. 10 kΩ
Max. voltage	-15 to +20 V
Current level	0/4 to 20 mA (scaleable)
Input resistance, R <sub>i</sub>	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.

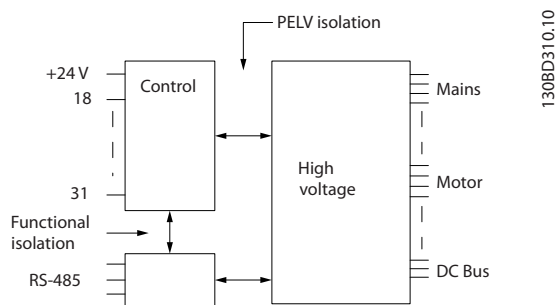


Illustration 8.1 Analog Inputs

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 <sub>i</sub>	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale
Pulse input accuracy (1-32 kHz)	Max. error: 0.05% 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 <sup>1)</sup>
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	4 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 output**

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) <sup>1)</sup> on 01-02/04-05 (NO) (Resistive load)	250 V AC, 3 A
Max. terminal load (AC-15) <sup>1)</sup> on 01-02/04-05 (NO) (Inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Max. terminal load (DC-1) <sup>1)</sup> on 01-02/04-05 (NO) (Resistive load)	30 V DC, 2 A
Max. terminal load (DC-13) <sup>1)</sup> on 01-02/04-05 (NO) (Inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1) <sup>1)</sup> on 01-03/04-06 (NC) (Resistive load)	250 V AC, 3 A
Max. terminal load (AC-15) <sup>1)</sup> on 01-03/04-06 (NC) (Inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Max. terminal load (DC-1) <sup>1)</sup> on 01-03/04-06 (NC) (Resistive load)	30 V DC, 2 A
Min. terminal load on 01-03 (NC), 01-02 (NO)	24 V DC 10 mA, 24 V 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 <sub>2</sub> S test	class Kd
Test method according to IEC 60068-2-43 H <sub>2</sub> S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	max. 55 °C <sup>1)</sup>
- at full continuous output current with some power size	max. 50 °C <sup>1)</sup>
- at full continuous output current	max. 45 °C <sup>1)</sup>
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	3000 m
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3 EN 61800-3, EN 61000-6-1/2,
EMC standards, Immunity	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
---------------	------

**Protection and features**

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the temperature limit. For details of these limits and level, refer to the *VLT® AutomationDrive FC 360 Design Guide*. The frequency converter has an auto derating function to avoid its 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 and parameter setting).
- 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

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.

Table 8.4 and Table 8.5 list the recommended fuses and circuit breakers which have been tested.

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

### 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 in Table 8.4 and Table 8.5 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 in Table 8.5 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	0.37-2.2	Moller PKZM0-16
J2	3.0-5.5	NZMN-1-A-25
J3	7.5	NZMN-1-A-32
J4	11-15	NZMN-1-A-50
J5	18.5-22	NZMN-1-A-80
J6	30-45	NZMN-1-A-160
J7	55-75	NZMN-1-A-250

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

## 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 8.6 Tightening of Terminals

**Index**

**A**

**AC**

- Mains..... 9
- Waveform..... 9

**AMA With T27 Connected..... 27**

**Analog**

- Inputs..... 38
- Outputs..... 39

**Automatic Motor Adaptation..... 7**

**B**

**Branch Circuit Protection..... 41**

**C**

**Clearance Requirements..... 10**

**Control**

- Cable Lengths And Cross Sections..... 37
- Cables..... 16
- Card Performance..... 40
- Card, 24 V DC Output..... 39
- Card, RS-485 Serial Communication..... 39
- Characteristics..... 40
- System..... 9
- Wiring..... 13

**D**

**Danfoss FC..... 17**

**Derating..... 40, 10**

**Digital**

- Input..... 7
- Inputs..... 38
- Outputs..... 39

**E**

**Electrical Noise..... 13**

**EMC..... 40**

**External**

- Controllers..... 9
- Interlock..... 7

**F**

**Floating Delta..... 14**

**Fuses..... 41**

**G**

**Ground**

- Connections..... 13
- Loops..... 16
- Wire..... 13, 14

**Grounded Delta..... 14**

**Grounding..... 13, 14**

**I**

**IEC 61800-3..... 14, 40**

**Induced Voltage..... 13**

**Input**

- Power..... 13, 30
- Signals..... 15
- Voltage..... 30

**Installation..... 10**

**Isolated Mains..... 14**

**L**

**Leakage Current (>3.5 MA)..... 13**

**M**

**Main Menu..... 21**

**Mains**

- Supply (L1, L2, L3)..... 37
- Supply 3 X 380-480 V AC..... 35

**Menu Key..... 18**

**Modbus RTU..... 17**

**Motor**

- Cables..... 13, 14
- Current..... 7
- Data..... 7
- Output..... 37
- Power..... 13
- Protection..... 13, 40
- Status..... 9
- Wiring..... 13, 14

**Multiple Frequency Converters..... 13, 14**

**N**

**Navigation Keys And Indicator Lights (LEDs)..... 18**

**Noise Isolation..... 13**

**Numeric Display..... 18**

**O**

**Open Loop..... 40**

**Operation Keys And Indicator Lights (LEDs)..... 18**

**Optional Equipment..... 14, 9**

**Output Current..... 39**

**Overload Protection..... 13**

**P**

**PELV..... 29, 39**

**Power**

- Connections..... 13
- Factor..... 14

**Power-dependent..... 35**

Programming.....	7
Protection And Features.....	40
Pulse Inputs.....	38
Q	
Quick Menu.....	19
R	
RCD.....	14
Reference.....	iii
Relay Outputs.....	39
Remote Commands.....	9
Reset.....	30, 40
RFI Filter.....	14
S	
Screened Control Cables.....	16
Serial Communication.....	9, 16, 30, 16
Shielded Cable.....	13
Specifications.....	10, 17, 35
Speed Reference.....	27
Start Up.....	33
Supply Voltage.....	39
Surroundings.....	40
Symbols.....	iii
System Feedback.....	9
T	
Technical Data.....	37
Terminal Programming.....	15
Thermistor.....	29
Tightening Of Terminals.....	42
Torque Characteristics.....	37
Trip Function.....	13
Troubleshooting.....	33
V	
Voltage Level.....	38
W	
Warnings And Alarms.....	31, 32
Wire Sizes.....	13
Wiring Examples.....	27

