MAKING MODERN LIVING POSSIBLE

Operating Instructions

VLT® HVAC Drive FC 102, 1.1-90 kW

VLT®
THE REAL DRIVE

Safety

⚠WARNING

HIGH VOLTAGE!

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

High Voltage

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

⚠WARNING

UNINTENDED START!

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

Unintended Start

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

⚠WARNING

DISCHARGE TIME!

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

Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200-240	1.1-3.7 kW		5.5-45 kW
380-480	1.1-7.5 kW		11-90 kW
525-600	1.1-7.5 kW		11-90 kW
525-690		1.1-7.5 kW	11-90 kW
High voltage may be present even when the warning LED indicator lights are off.			

Discharge Time

Symbols

The following symbols are used in this manual.

⚠WARNING

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

⚠CAUTION

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

CAUTION

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

NOTE

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

Approvals

NOTE

Imposed limitations on the output frequency (due to export control regulations):

From software version 3.92 the output frequency of the frequency converter is limited to 590 Hz.

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1 Introduction

1

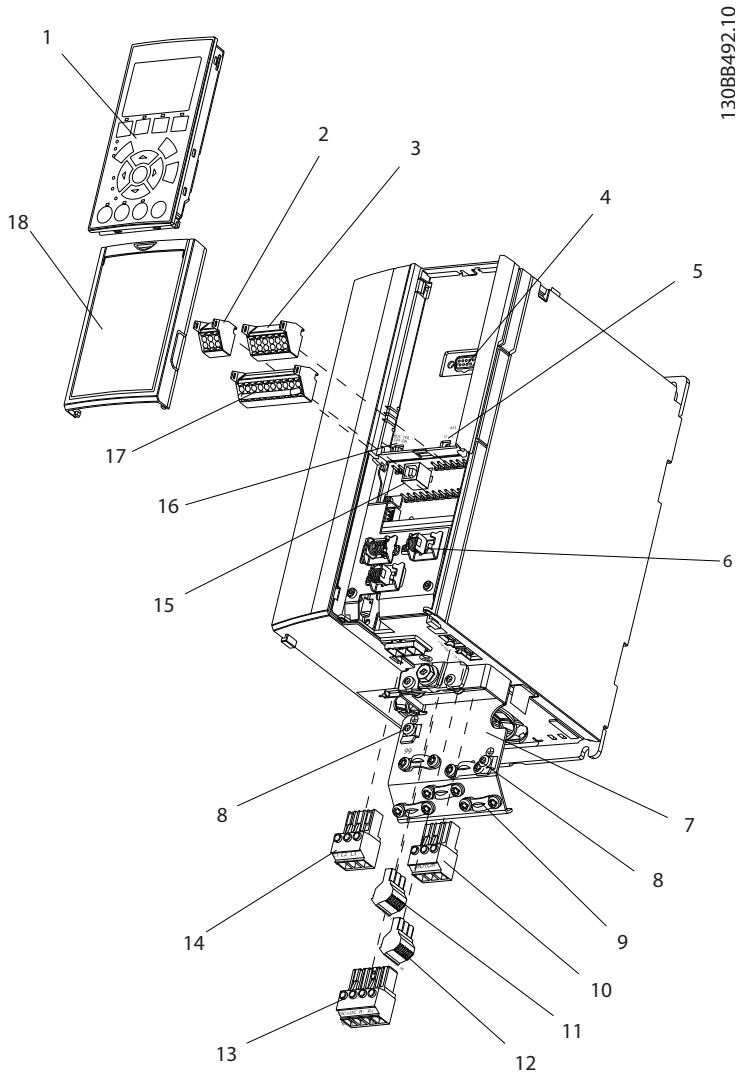

Illustration 1.1 Exploded View A Size

1	LCP	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS-485 serial bus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable strain relief/PE ground	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Shielded cable grounding clamp and strain relief	18	Control cable cover plate

Table 1.1 Legend to *Illustration 1.1*

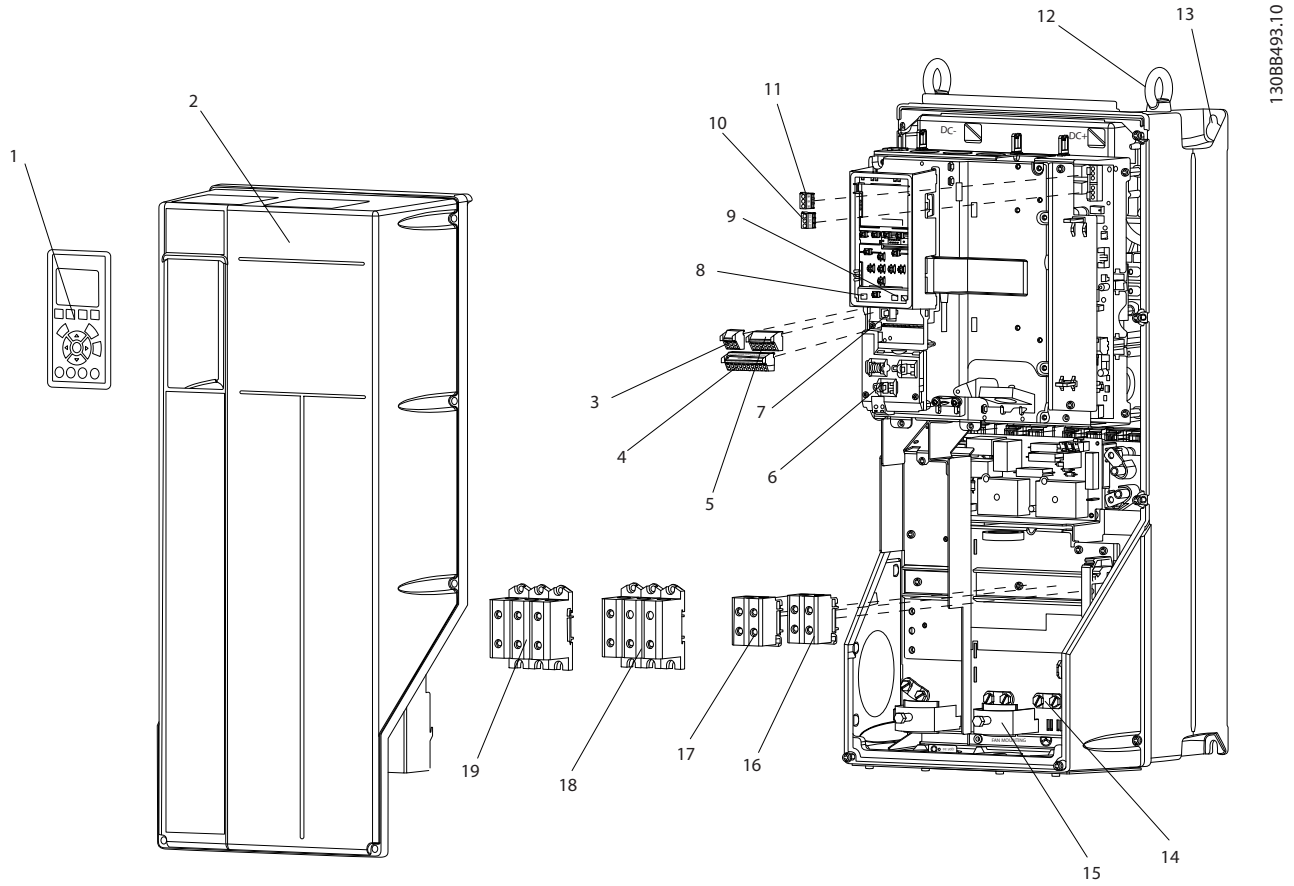

Illustration 1.2 Exploded View B and C Sizes

1	LCP	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS-485 serial bus connector	13	Mounting slot
4	Digital I/O and 24 V power supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable strain relief / PE ground
6	Cable strain relief/PE ground	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Serial bus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)		

Table 1.2 Legend to *Illustration 1.2*

1

1.1 Purpose of the Manual

This manual is intended to provide detailed information for the installation and start up of the frequency converter. *2 Installation* provides requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring and control terminal functions. *3 Start Up and Functional Testing* provides detailed procedures for start up, basic operational programming, and functional testing. The remaining chapters provide supplementary details. These details include user interface, detailed programming, application examples, start-up troubleshooting, and specifications.

1.2 Additional Resources

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

- The *VLT® Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® Design Guide* is intended to provide detailed capabilities and functionality to design motor control systems.
- Supplemental publications and manuals are available from Danfoss.
  See *Danfoss website BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm* for listings.
- Optional equipment is available that may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local Danfoss supplier or visit the Danfoss website: *BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documen-tation.htm*, for downloads or additional information.

1.3 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.

1.4 Internal Frequency Converter Controller Functions

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

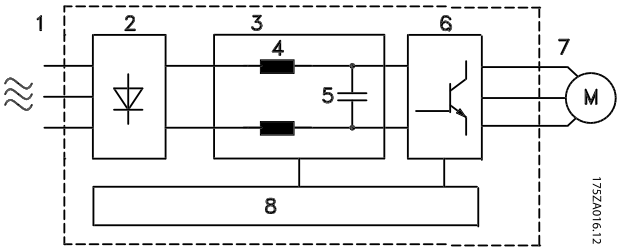

Illustration 1.3 Frequency Converter Block Diagram

Area	Title	Functions
1	Mains input	• Three-phase AC mains power supply to the frequency converter
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power
3	DC bus	• Intermediate DC-bus circuit handles the DC current
4	DC reactors	• Filter the intermediate DC circuit voltage • Prove line transient protection • Reduce RMS current • Raise the power factor reflected back to the line • Reduce harmonics on the AC input
5	Capacitor bank	• Stores the DC power • Provides ride-through protection for short power losses
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor
7	Output to motor	• Regulated three-phase output power to the motor

Area	Title	Functions
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control • User interface and external commands are monitored and performed • Status output and control can be provided

Table 1.3 Legend to *Illustration 1.3*

1.5 Frame Sizes and Power Ratings

References to frames sizes used in this manual are defined in *Table 1.4*.

	Frame Size [kW]											
[V]	A2	A3	A4	A5	B1	B2	B3	B4	C1	C2	C3	C4
200-240	1.1-2.2	3.0-3.7	1.1-2.2	1.1-3.7	5.5-11	15	5.5-11	15-18.5	18.5-30	37-45	22-30	37-45
380-480	1.1-4.0	5.5-7.5	1.1-4.0	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-600	n/a	1.1-7.5	n/a	1.1-7.5	11-18.5	22-30	11-18.5	22-37	37-55	75-90	45-55	75-90
525-690	n/a	1.1-7.5	n/a	n/a	n/a	11-30	n/a	11-37	n/a	37-90	45-55	n/a

Table 1.4 Frames Sizes and Power Ratings

2 Installation

2

2.1 Installation Site Check List

- The frequency converter relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the frequency converter
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
  - 300 m (1000 ft) for unshielded motor leads
  - 150 m (500 ft) for shielded cable.
- Ensure that the ingress protection rating of the frequency converter is suitable for the installation environment. IP55 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.

⚠CAUTION

Ingress protection

IP54, IP55 and IP66 ratings can only be guaranteed if the unit is properly closed.

- **Ensure that all cable glands and unused holes for glands are properly sealed.**
- **Ensure that the unit cover is properly closed**

⚠CAUTION

Device damage through contamination

Do not leave the frequency converter uncovered.

2.2 Frequency Converter and Motor Pre-installation Check List

- Compare the model number of unit on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for same voltage:

  Mains (power)

  Frequency converter

  Motor
- Ensure that the frequency converter output current rating is equal to or greater than motor full load current for peak motor performance

  Motor size and frequency converter power must match for proper overload protection

  If frequency converter rating is less than motor, full motor output cannot be achieved

2.3 Mechanical Installation

2.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional back plate (see *2.3.3 Mounting*)
- Top and bottom clearance for air cooling must be provided. Generally, 100-225 mm (4-10 in) is required. See *Illustration 2.1* for clearance requirements
- Improper mounting can result in over heating and reduced performance
- Derating for temperatures starting between 40 °C (104 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level must be considered. See the equipment Design Guide for detailed information.

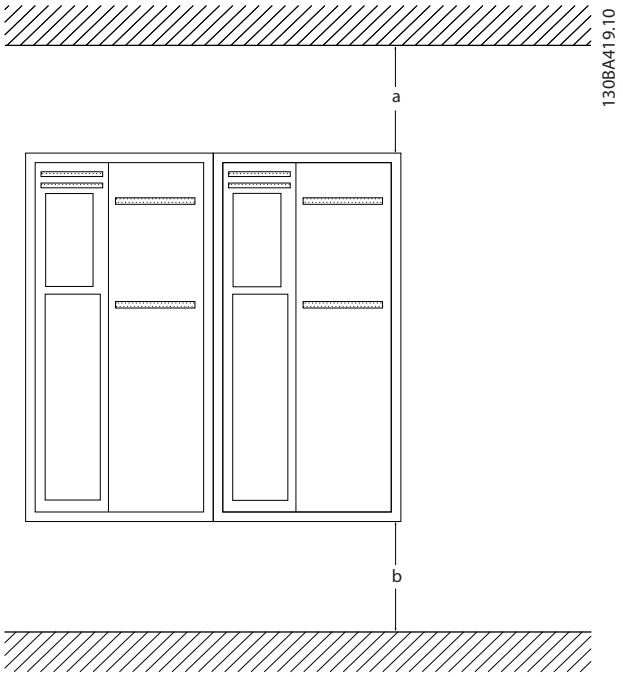

Illustration 2.1 Top and Bottom Cooling Clearance

Enclosure	A2-A5	B1-B4	C1, C3	C2, C4
a/b [mm]	100	200	200	225

Table 2.1 Minimum Airflow Clearance Requirements

2.3.2 Lifting

- Check the weight of the unit to determine a safe lifting method
- Ensure that the lifting device is suitable for the task
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit
- For lifting, use hoist rings on the unit, when provided

2.3.3 Mounting

- Mount the unit vertically
- The frequency converter allows side by side installation
- Ensure that the strength of the mounting location will support the unit weight
- Mount the unit to a solid flat surface or to the optional back plate to provide cooling airflow (see *Illustration 2.2* and *Illustration 2.3*)
- Improper mounting can result in over heating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided

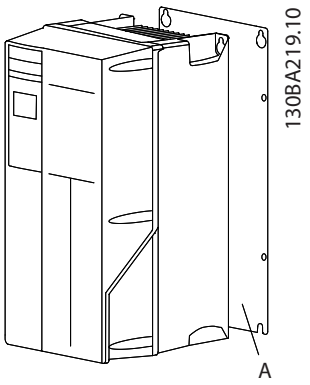

Illustration 2.2 Proper Mounting with Back Plate

Item A is a back plate properly installed for required airflow to cool the unit.

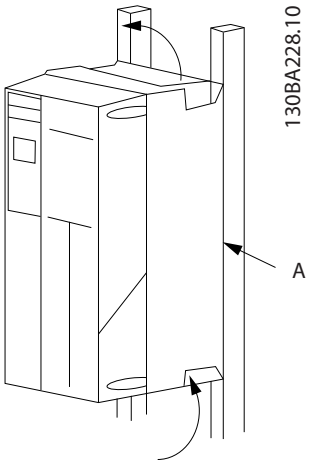

Illustration 2.3 Proper Mounting with Railings

NOTE

Back plate is needed when mounted on railings.

2.3.4 Tightening Torques

See *10.4 Connection Tightening Torques* for proper tightening specifications.

2.4 Electrical Installation

This section contains detailed instructions for wiring the frequency converter. The following tasks are described.

- Wiring the motor to the frequency converter output terminals
- Wiring the AC mains to the frequency converter input terminals
- Connecting control and serial communication wiring
- After power has been applied, checking input and motor power; programming control terminals for their intended functions

Illustration 2.4 shows a basic electrical connection.

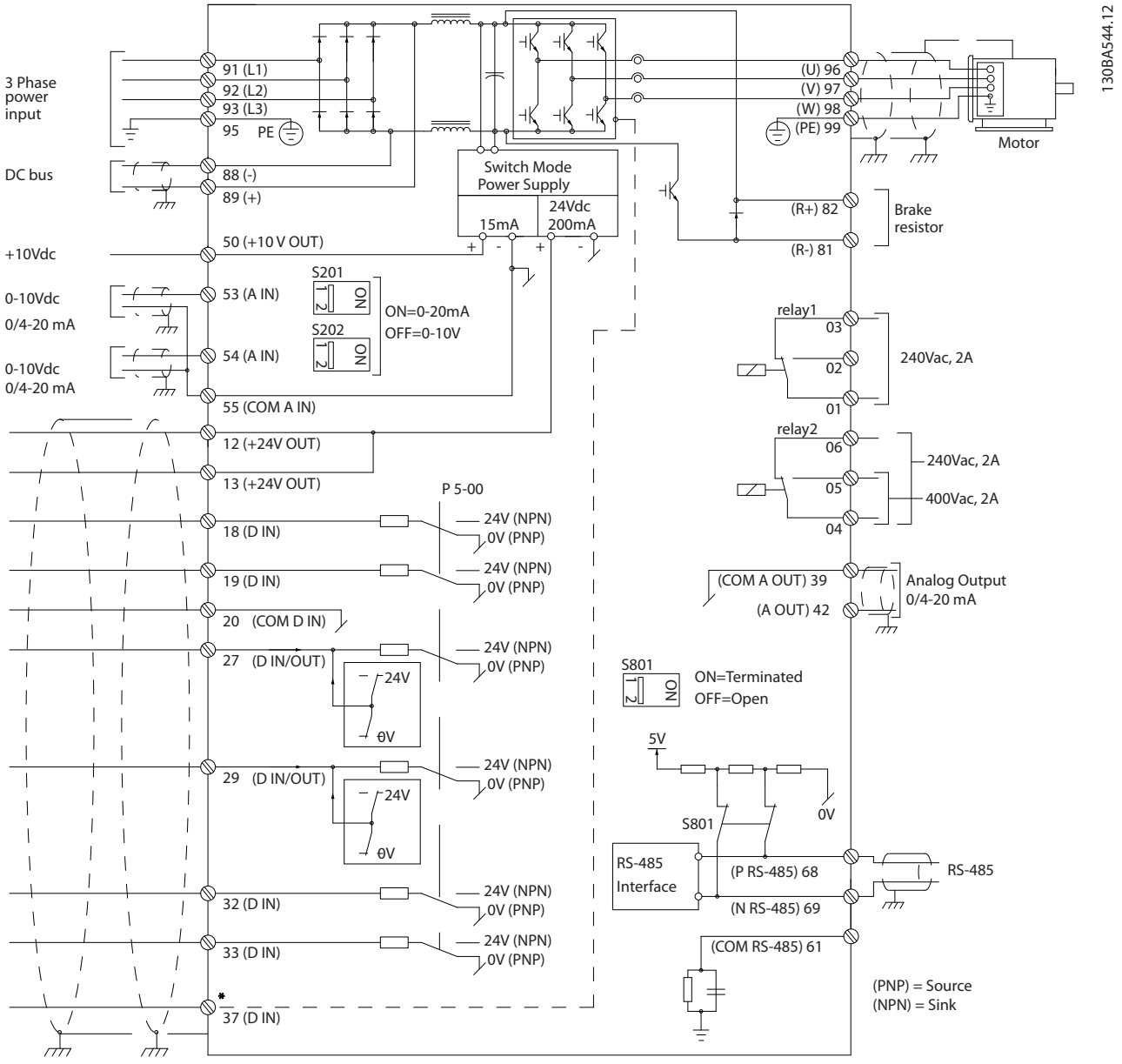

Illustration 2.4 Basic Wiring Schematic Drawing.

* Terminal 37 is an option

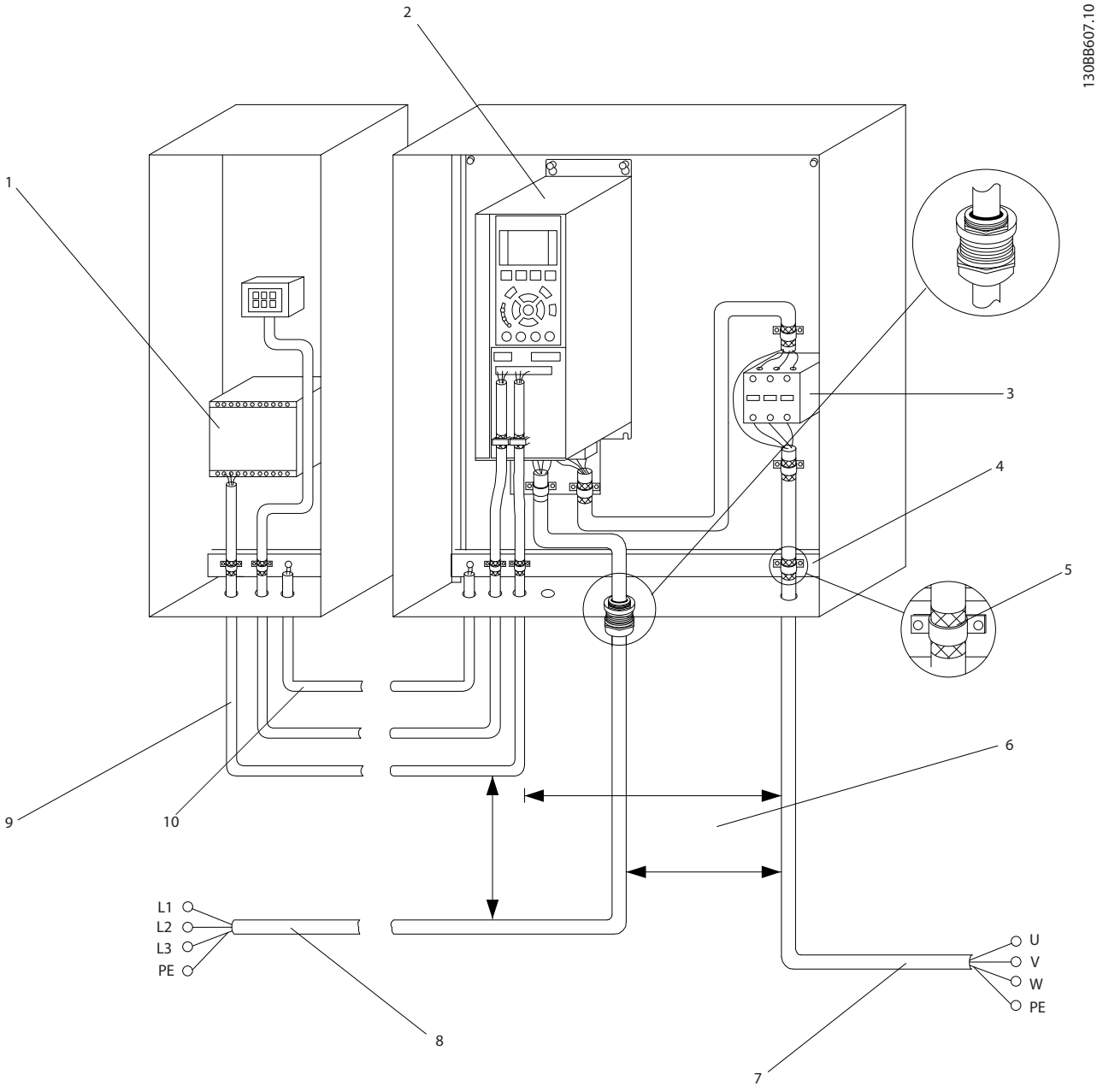

Illustration 2.5 Typical Electrical Connection

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

Table 2.2 Legend to *Illustration 2.5*

2

2.4.1 Requirements

⚠WARNING

EQUIPMENT HAZARD!

Rotating shafts and electrical equipment can be hazardous. All electrical work must conform to national and local electrical codes. It is strongly recommended that installation, start up, and maintenance be performed only 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.

For your safety, comply with the following requirements.

- Electronic controls equipment is connected to hazardous mains voltage. Extreme care should be taken to protect against electrical hazards when applying power to the unit.
- 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.

Overload and Equipment Protection

- An electronically activated function within the frequency converter provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See *8 Warnings and Alarms* for details on the trip function.
- All frequency converters must be provided with short-circuit and over-current protection. Input fusing is required to provide this protection, see *Illustration 2.6*. If not factory supplied, fuses must be provided by the installer as part of installationinstallation. See maximum fuse ratings in *10.3 Fuse Tables*.

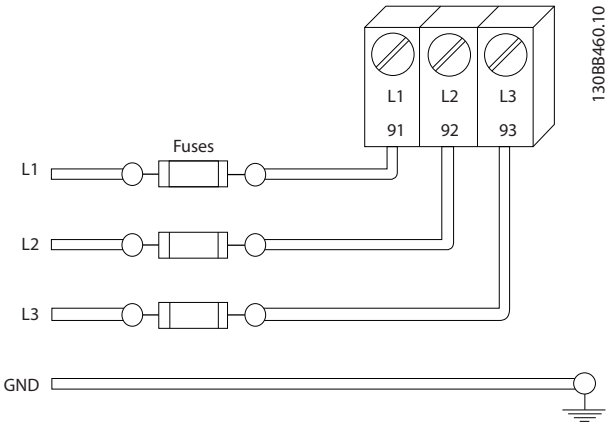

Illustration 2.6 Frequency Converter Fuses

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 *10.1 Power-dependent Specifications* for recommended wire sizes.

2.4.2 Earth (Grounding) Requirements

⚠WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground the frequency converter properly 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.

NOTE

It is the responsibility of the user or certified electrical installer to ensure correct grounding (earthing) of the equipment in accordance with national and local electrical codes and standards.

- Follow all local and national electrical codes to ground electrical equipment properly
- Proper protective grounding for equipment with ground currents higher than 3.5 mA must be established, see *2.4.2.1 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
- Keep the ground wire connections as short as possible
- Using high-strand wire to reduce electrical noise is recommended
- Follow motor manufacturer wiring requirements

2.4.2.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current > 3.5 mA. Frequency converter technology implies high frequency switching at high power. This will generate a leakage current in the earth connection. A fault current in the frequency converter at the output power terminals might contain a DC component which can charge the filter capacitors and cause a transient earth current. The earth leakage current depends on various system configurations including RFI filtering, screened motor cables, and frequency converter power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5 mA. Earth grounding must be reinforced in one of the following ways:

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

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

Using RCDs

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

Use RCDs of type B only which are capable of detecting AC and DC currents

Use RCDs with an inrush delay to prevent faults due to transient earth currents

Dimension RCDs according to the system configuration and environmental considerations

2.4.2.2 Grounding Using Shielded Cable

Earthing (grounding) clamps are provided for motor wiring (see *Illustration 2.7*).

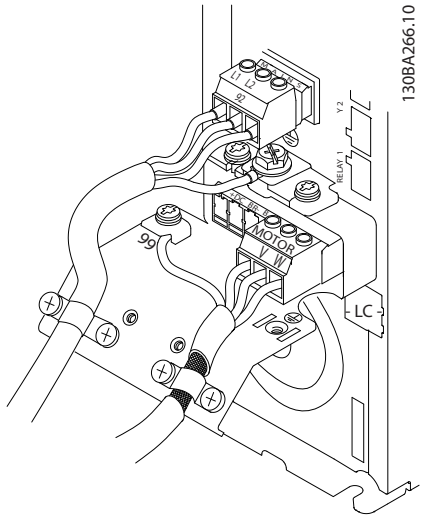

Illustration 2.7 Grounding with Shielded Cable

2.4.3 Motor Connection

⚠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.

- For maximum wire sizes see *10.1 Power-dependent Specifications*
- Comply with local and national electrical codes for cable sizes
- Motor wiring knockouts or access panels are provided at the base of IP21 and higher (NEMA1/12) units
- 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
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W)
- Ground the cable in accordance with grounding instructions provided
- Torque terminals in accordance with the information provided in *10.4 Connection Tightening Torques*

- Follow motor manufacturer wiring requirements

Illustration 2.8, *Illustration 2.9* and *Illustration 2.10* represent mains input, motor, and earth grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

2

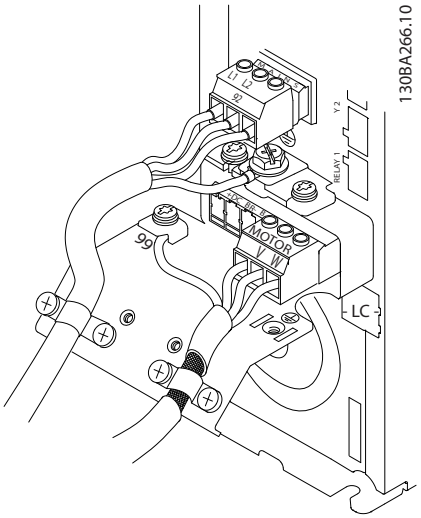

Illustration 2.8 Motor, Mains and Earth Wiring for A-Frame Sizes

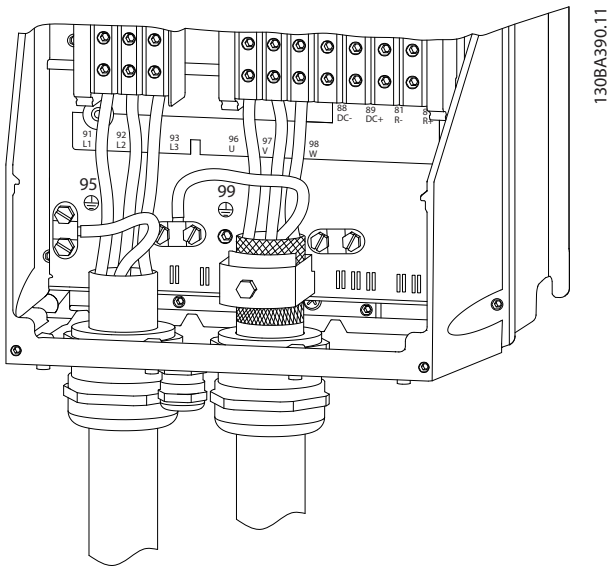

Illustration 2.9 Motor, Mains and Earth Wiring for B-, C- and D-Frame Sizes Using Shielded Cable

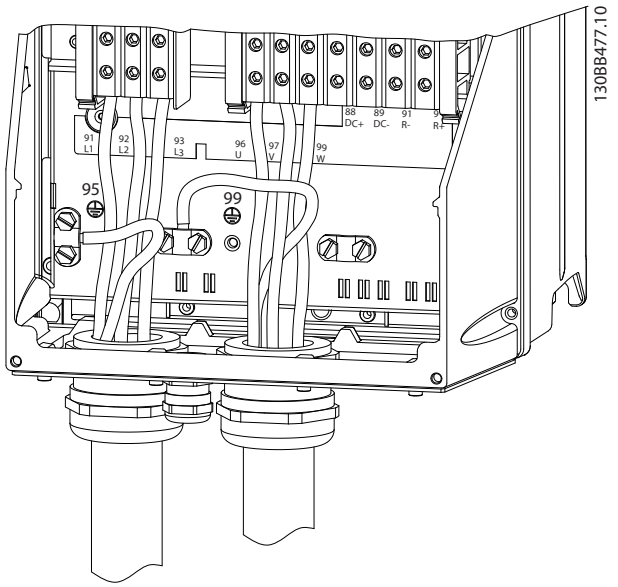

Illustration 2.10 Motor, Mains and Earth Wiring for B-, C- and D-Frame Sizes

2.4.3.1 Motor Connection for A2 and A3

Follow these drawings step by step for connecting the motor to the frequency converter.

1. First terminate the motor earth, then place motor U, V and W wires in plug and tighten.

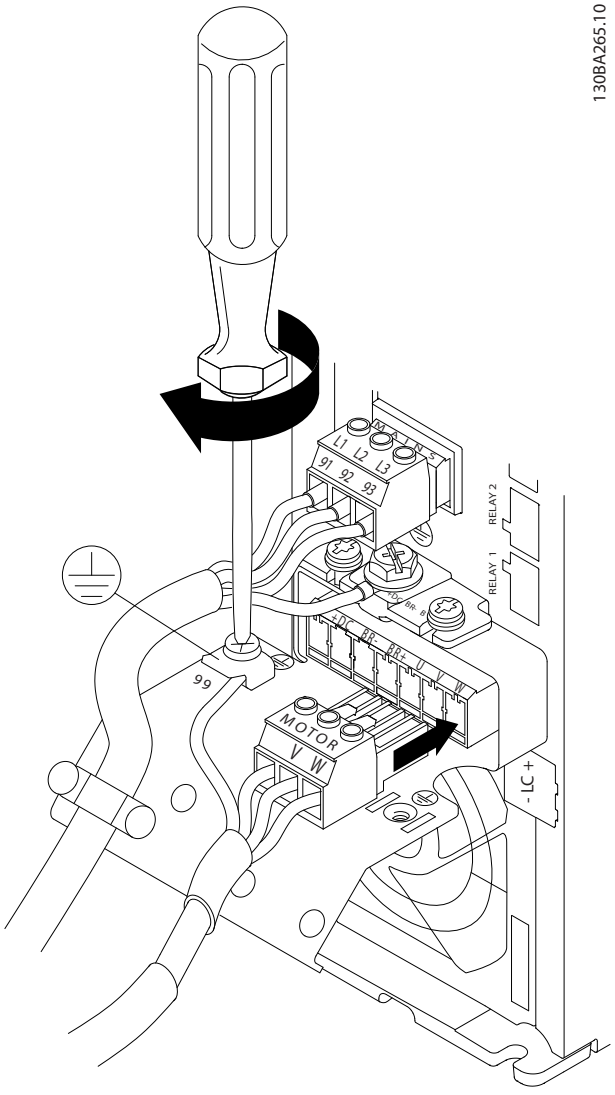

Illustration 2.11 Motor Connection for A2 and A3

2. Mount cable clamp to ensure 360° connection between chassis and screen, note the outer insulation of the motor cable is removed under the clamp.

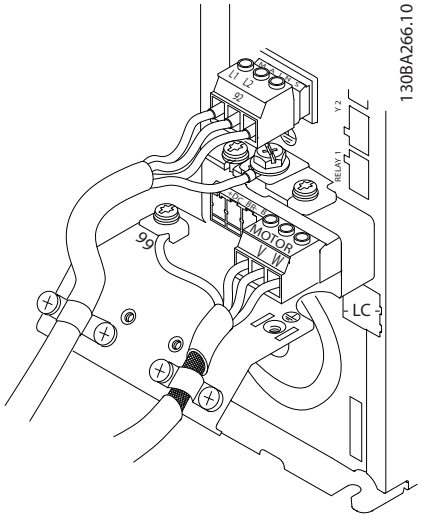

Illustration 2.12 Cable Clamp Mounting

2.4.3.2 Motor Connection for A4/A5

First terminate the motor earth, then place motor U, V and W wires in terminal and tighten. Ensure that the outer insulation of the motor cable is removed under the EMC clamp.

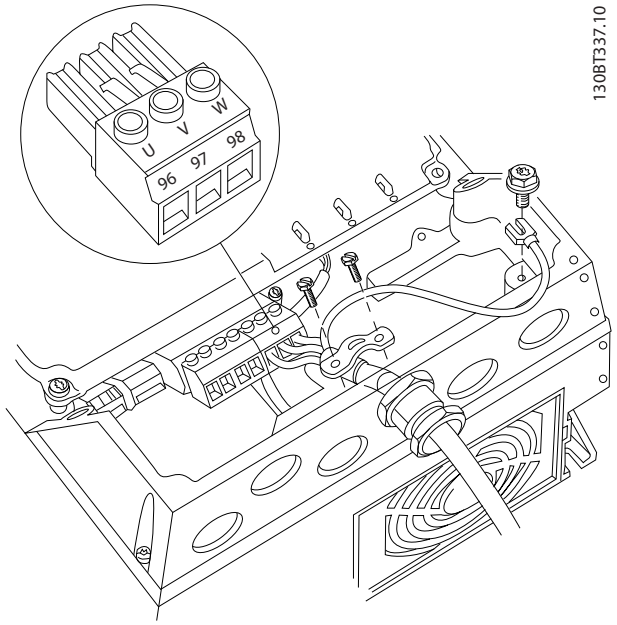

Illustration 2.13 Motor Connection for A4/A5

2

2.4.3.3 Motor Connection for B1 and B2

First terminate the motor earth, then place motor U, V and W wires in terminal and tighten. Ensure that the outer insulation of the motor cable is removed under the EMC clamp.

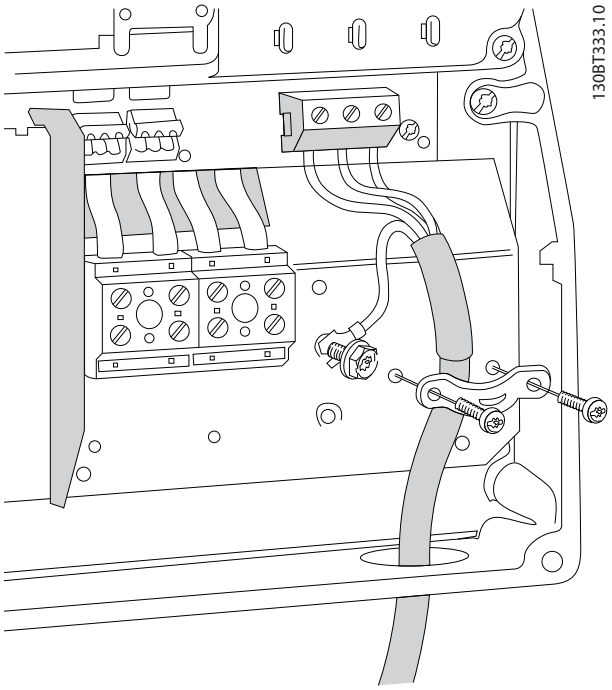

Illustration 2.14 Motor Connection for B1 and B2

2.4.3.4 Motor Connection for C1 and C2

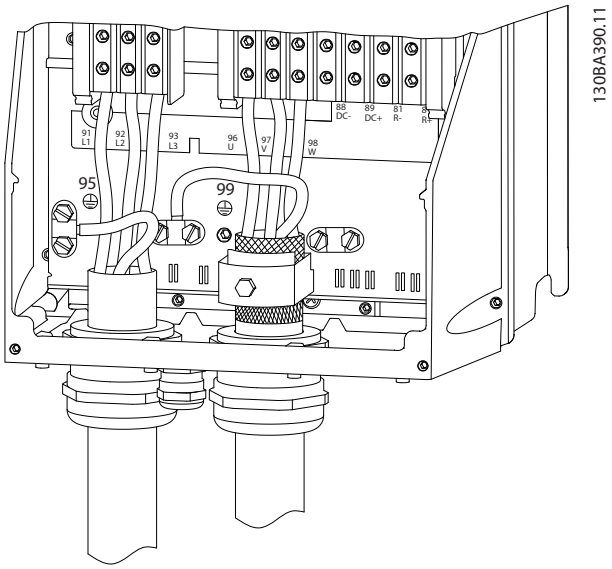

Illustration 2.15 Motor Connection for C1 and C2

First terminate the motor earth, then Place motor U, V and W wires in terminal and tighten. Ensure that the outer insulation of the motor cable is removed under the EMC clamp.

2.4.4 AC Mains Connection

- Size wiring based upon the input current of the frequency converter. For maximum wire sizes see *10.1 Power-dependent Specifications*.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 2.16*).
- Depending on the configuration of the equipment, input power will be connected to the mains input terminals or the input disconnect.

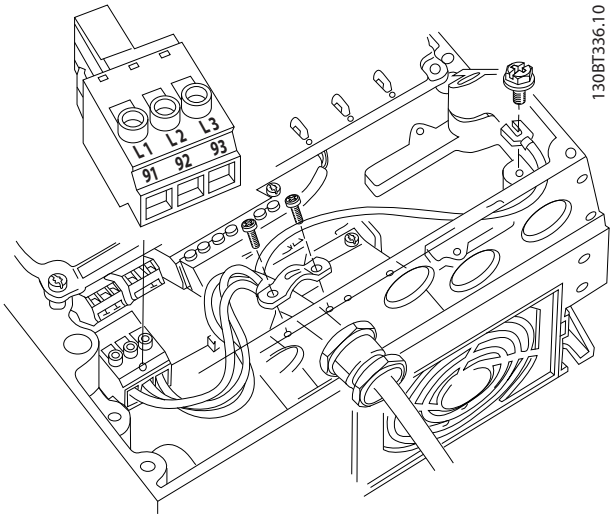

Illustration 2.16 Connecting to AC Mains

- Ground the cable in accordance with grounding instructions provided in *2.4.2 Earth (Grounding) 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. When off, the internal RFI filtercapacitors 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.

2.4.5 Control Wiring

- Isolate control wiring from high power components in the frequency converter.
- If the frequency converter is connected to a thermistor, for PELV isolation, optional thermistor control wiring must be reinforced/double insulated. A 24 V DC supply voltage is recommended.

2.4.5.1 Access

- Remove access cover plate with a screw driver. See *Illustration 2.17*.
- Or remove front cover by loosening attaching screws. See *Illustration 2.18*.

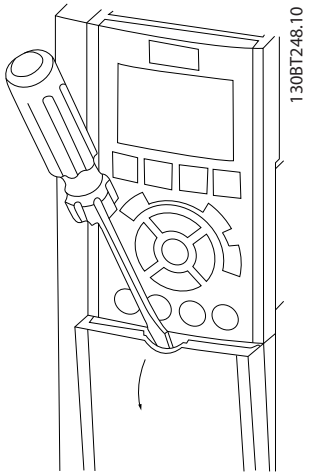

Illustration 2.17 Control Wiring Access for A2, A3, B3, B4, C3 and C4 Enclosures

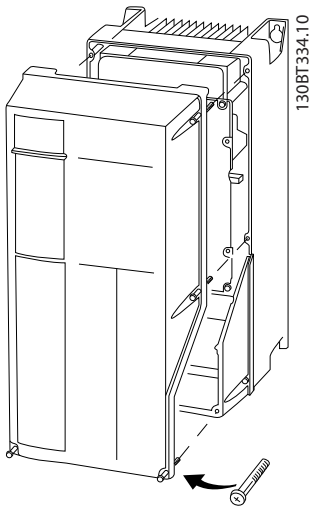

Illustration 2.18 Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures

See *Table 2.3* before tightening the covers.

Frame	IP20	IP21	IP55	IP66
A3/A4/A5	-	-	2	2
B1/B2	-	*	2.2	2.2
C1/C2/C3/C4	-	*	2.2	2.2
* No screws to tighten - Does not exist				

Table 2.3 Tightening Torques for Covers (Nm)

2.4.5.2 Control Terminal Types

Illustration 2.19 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 2.4*.

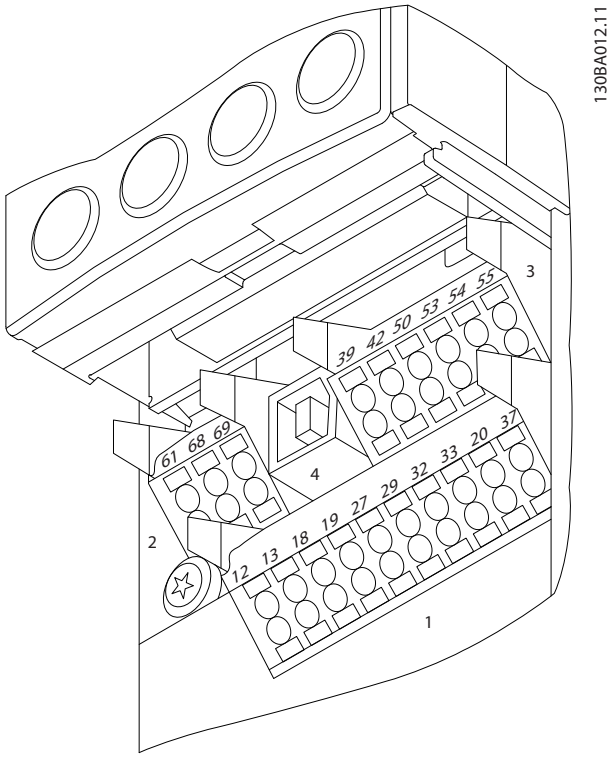

Illustration 2.19 Control Terminal Locations

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output
- **Connector 4** is a USB port available for use with the frequency converter

- Also provided are two Form C relay outputs that are in various locations depending upon the frequency converter configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See *10.2 General Technical Data* for terminal ratings details.

Terminal Description			
Digital Inputs/Outputs			
Terminal	Parameter	Default Setting	Description
12, 13	-	+24 V DC	24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Useable for digital inputs and external transducers.
18	5-10	[8] Start	Digital inputs.
19	5-11	[0] No operation	
32	5-14	[0] No operation	
33	5-15	[0] No operation	
27	5-12	[2] Coast inverse	Selectable for digital input and output. Default setting is input.
29	5-13	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
37	-	Safe Torque Off (STO)	(optional) Safe input. Used for STO
Analog Inputs/Outputs			
39	-		Common for analog output
42	6-50	Speed 0 - High Limit	Programmable analog output. The analog signal is 0-20 mA or 4-20 mA at a maximum of 500 Ω
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. Switches A53 and A54 select mA or V.
54	6-2	Feedback	
55	-		Common for analog input
Serial Communication			
61	-		Integrated RC-Filter for cable screen. ONLY for connecting the screen when experiencing EMC problems.
68 (+)	8-3		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3		
Relays			
01, 02, 03	5-40 [0]	[0] Alarm	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[0] Running	

Table 2.4 Terminal Description

2.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 2.20*.

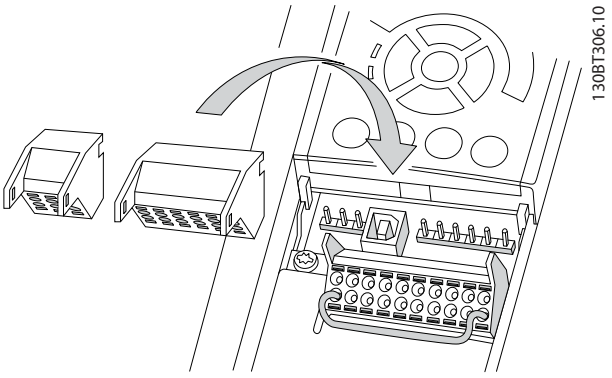

Illustration 2.20 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Illustration 2.21*.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *10.1 Power-dependent Specifications* for control terminal wiring sizes.

See *6 Application Set-Up Examples* for typical control wiring connections.

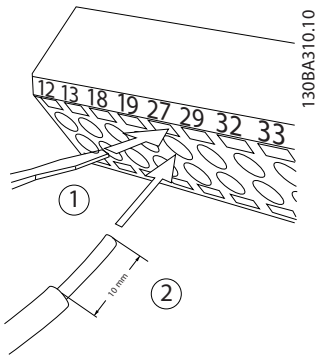

Illustration 2.21 Connecting Control Wiring

2.4.5.4 Using Screened Control Cables

Correct screening

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

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

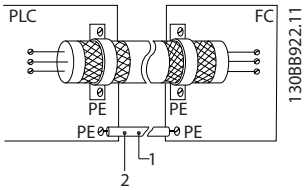

Illustration 2.22 Correct Screening

1	Min. 16 mm^2
2	Equalizing cable

Table 2.5 Legend to *Illustration 2.22*

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).

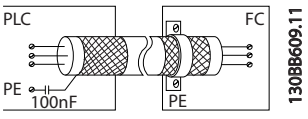

Illustration 2.23 50/60 Hz Ground Loops

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 2.24*:

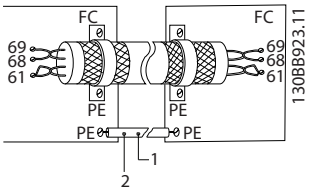

Illustration 2.24 Twisted-pair Cables

1	Min. 16 mm^2
2	Equalizing cable

Table 2.6 Legend to *Illustration 2.24*

Alternatively, the connection to terminal 61 can be omitted:

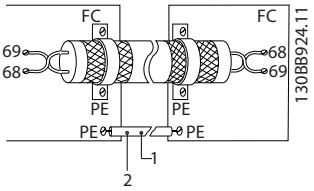

Illustration 2.25 Twisted-pair Cables without Terminal 61

1	Min. 16 mm^2
2	Equalizing cable

Table 2.7 Legend to *Illustration 2.25*

2.4.5.5 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 2.4* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and *5 About Frequency Converter Programming* for details on programming.
- The default terminal programming is intended to initiate frequency converter functioning in a typical operational mode.

2

2.4.5.6 Jumper Terminals 12 and 27

A jumper wire may be required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive a 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 (recommended) or 13 to terminal 27. This provides in internal 24 V signal on terminal 27
- No signal present prevents the unit from operating
- When the status line at the bottom of the LCP reads AUTO REMOTE COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

2.4.5.7 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (0 to 10 V) or current (0/4-20 mA) input signals
- Remove power to the frequency converter before changing switch positions
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the LCP has been removed (see *Illustration 2.26*). Note that some option cards available for the unit may cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.
- Terminal 53 default is for a speed reference signal in open loop set in *16-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed loop set in *16-63 Terminal 54 Switch Setting*

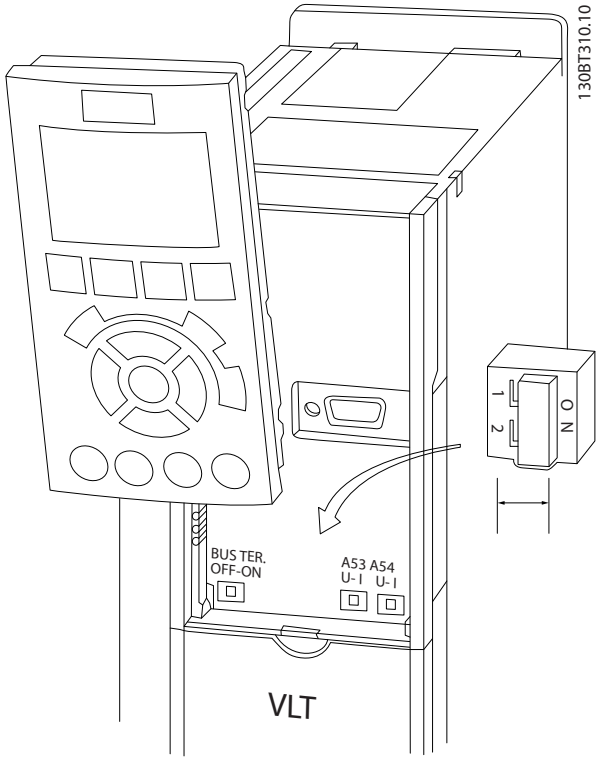

Illustration 2.26 Location of Terminals 53 and 54 Switches

2.4.6 Serial Communication

RS-485 is a two-wire bus interface compatible with multi-drop network topology, i.e. nodes can be connected as a bus, or via drop cables from a common trunk line. A total of 32 nodes can be connected to one network segment. Repeaters divide network segments. Note that each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address, across all segments. Terminate each segment at both ends, using either the termination switch (S801) of the frequency converters or a biased termination resistor network. Always use screened twisted pair (STP) cable for bus cabling, and always follow good common installation practice.
Low-impedance earth (ground) connection of the screen at every node is important, including at high frequencies. Thus, connect a large surface of the screen to earth (ground), for example with a cable clamp or a conductive cable gland. It may be necessary to apply potential-equalizing cables to maintain the same earth (ground) potential throughout the network. Particularly in installations with long cables.
To prevent impedance mismatch, always use the same type of cable throughout the entire network. When connecting a motor to the frequency converter, always use screened motor cable.

Cable	Screened twisted pair (STP)
Impedance	120 Ω
Cable length	Max. 1200 m (including drop lines) Max. 500 m station-to-station

Table 2.8 Cable Information

2.5 Safe Stop

The frequency converter can perform the safety function *Safe Torque Off* (STO, as defined by EN IEC 61800-5-2[1]) and *Stop Category 0* (as defined in EN 60204-1[2]).
Danfoss has named this functionality *Safe Stop*. Before integration and use of Safe Stop in an installation, perform a thorough risk analysis to determine whether the Safe Stop functionality and safety levels are appropriate and sufficient. Safe Stop is designed and approved suitable for the requirements of:

- Safety Category 3 according to EN ISO 13849-1
- Performance Level "d" according to EN ISO 13849-1:2008
- SIL 2 Capability according to IEC 61508 and EN 61800-5-2
- SILCL 2 according to EN 62061

[1] Refer to EN IEC 61800-5-2 for details of Safe torque off (STO) function.
[2] Refer to EN IEC 60204-1 for details of stop category 0 and 1.

Activation and Termination of Safe Stop
The Safe Stop (STO) function is activated by removing the voltage at Terminal 37 of the Safe Inverter. By connecting the Safe Inverter to external safety devices providing a safe delay, an installation for a safe Stop Category 1 can be obtained. The Safe Stop function can be used for asynchronous, synchronous, and permanent magnet motors.

⚠WARNING

After installation of Safe Stop (STO), a commissioning test as specified in *2.5.2 Safe Stop Commissioning Test* must be performed. A passed commissioning test is mandatory after first installation and after each change to the safety installation.

Safe Stop Technical Data
The following values are associated to the different types of safety levels:

Reaction time for T37
- Maximum reaction time: 20 ms

Reaction time = delay between de-energizing the STO input and switching off the frequency converter output bridge.

Data for EN ISO 13849-1
- Performance Level "d"
- $MTTF_d$ (Mean Time To Dangerous Failure): 14000 years
- DC (Diagnostic Coverage): 90%
- Category 3
- Lifetime 20 years

Data for EN IEC 62061, EN IEC 61508, EN IEC 61800-5-2
- SIL 2 Capability, SILCL 2
- PFH (Probability of Dangerous failure per Hour)=1E-10/h
- SFF (Safe Failure Fraction) >99%
- HFT (Hardware Fault Tolerance)=0 (1001 architecture)
- Lifetime 20 years

Data for EN IEC 61508 low demand
- PFDavg for one year proof test: 1E-10
- PFDavg for three year proof test: 1E-10
- PFDavg for five year proof test: 1E-10

No maintenance of the STO functionality is needed.

Security measures have to be taken by the user e.g. installation in a closed cabinet that is only accessible for skilled personnel.

SISTEMA Data
Functional safety data is available via a data library for use with the SISTEMA calculation tool from the IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance), and data for manual calculation. The library is permanently completed and extended.

2.5.1 Terminal 37 Safe Stop Function

The frequency converter is available with safe stop functionality via control terminal 37. Safe stop disables the control voltage of the power semiconductors of the frequency converter output stage. This in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the frequency converter issues an alarm, trips the unit, and coasts the motor to a stop. Manual restart is required. The safe stop function can be used as an emergency stop for the frequency converter. In normal operating mode when safe stop is not required, use the regular stop function instead. When automatic restart is used, ensure the requirements of ISO 12100-2 paragraph 5.3.2.5 are fulfilled.

Liability Conditions
It is the responsibility of the user to ensure that qualified personnel installs and operates the safe stop function:

2

- Read and understand the safety regulations concerning health and safety/accident prevention
- Understand the generic and safety guidelines given in this description and the extended description in the relevant *Design Guide*
- Have a good knowledge of the generic and safety standards applicable to the specific application

User is defined as: integrator, operator, service technician, maintenance technician.

Standards

Use of safe stop on terminal 37 requires that the user satisfies all provisions for safety including relevant laws, regulations and guidelines. The optional safe stop function complies with the following standards.

- IEC 60204-1: 2005 category 0 – uncontrolled stop
- IEC 61508: 1998 SIL2
- IEC 61800-5-2: 2007 – safe torque off (STO) function
- IEC 62061: 2005 SIL CL2
- ISO 13849-1: 2006 Category 3 PL d
- ISO 14118: 2000 (EN 1037) – prevention of unexpected startup

The information and instructions of the instruction manual are not sufficient for a proper and safe use of the safe stop functionality. The related information and instructions of the relevant *Design Guide* must be followed.

Protective Measures

- Qualified and skilled personnel are required for installation and commissioning of safety engineering systems
- The unit must be installed in an IP54 cabinet or in an equivalent environment. In special applications a higher IP degree is required
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D.4
- When external forces influence the motor axis (for example, suspended loads), additional measures are required (for example, a safety holding brake) to eliminate potential hazards

Safe Stop Installation and Set-Up

⚠WARNING

SAFE STOP FUNCTION!

The safe stop function does NOT isolate mains voltage to the frequency converter or auxiliary circuits. Perform work on electrical parts of the frequency converter or the motor only after isolating the mains voltage supply and waiting the length of time specified in *Table 1.1*. Failure to isolate the mains voltage supply from the unit and waiting the time specified could result in death or serious injury.

- It is not recommended to stop the frequency converter by using the Safe Torque Off function. If a running frequency converter is stopped by using the function, the unit trips and stops by coasting. If unacceptable or dangerous, use another stopping mode to stop the frequency converter and machinery, before using this function. Depending on the application, a mechanical brake can be required.
- For synchronous and permanent magnet motor frequency converters, in a multiple IGBT power semiconductor failure: In spite of the activation of the Safe Torque Off function, the system can produce an alignment torque which maximally rotates the motor shaft by 180/p degrees. p denotes the pole pair number.
- This function is suitable for performing mechanical work on the system or affected area of a machine only. It does not provide electrical safety. Do not use this function as a control for starting and/or stopping the frequency converter.

Follow these steps to perform a safe installation of the frequency converter:

1. Remove the jumper wire between control terminals 37 and 12 or 13. Cutting or breaking the jumper is not sufficient to avoid short-circuiting. (See jumper on *Illustration 2.27*.)
2. Connect an external Safety monitoring relay via a NO safety function to terminal 37 (safe stop) and either terminal 12 or 13 (24 V DC). Follow the instruction for the safety device. The Safety monitoring relay must comply with Category 3 /PL “d” (ISO 13849-1) or SIL 2 (EN 62061).

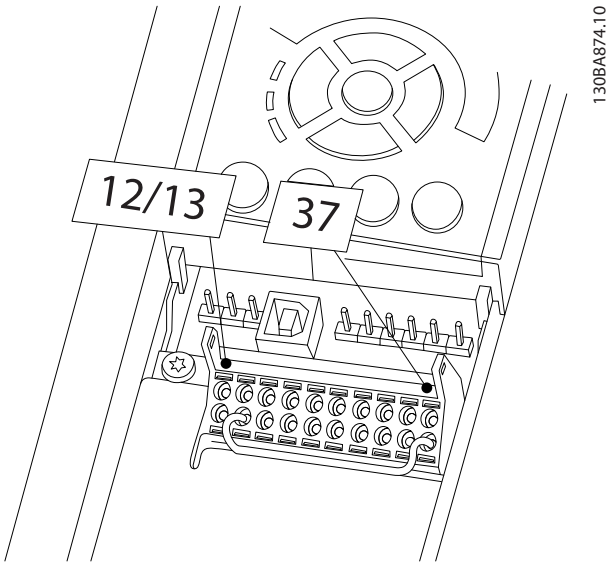

Illustration 2.27 Jumper between Terminal 12/13 (24 V) and 37

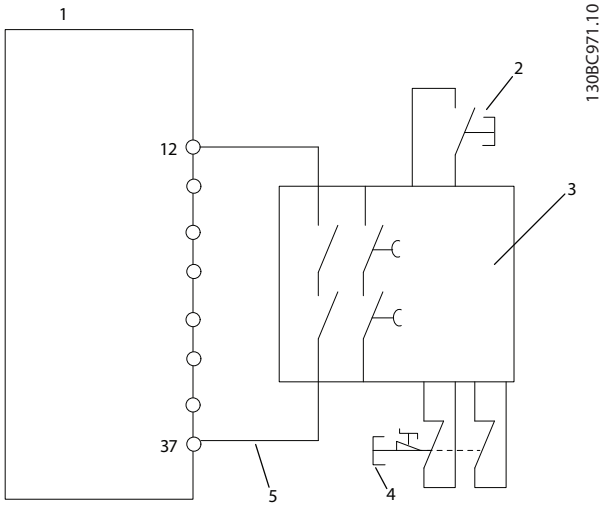

Illustration 2.28 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Cat. 3 /PL "d" (ISO 13849-1) or SIL 2 (EN 62061).

1	Frequency converter
2	[Reset] key
3	Safety relay (cat. 3, PL d or SIL2
4	Emergency stop button
5	Short-circuit protected cable (if not inside installation IP54 cabinet)

Table 2.9 Legend to *Illustration 2.28*

Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of the installation using safe stop. Moreover, perform the test after each modification of the installation.

⚠WARNING

Safe Stop activation (that is removal of 24 V DC voltage supply to terminal 37) does not provide electrical safety. The Safe Stop function itself is therefore not sufficient to implement the Emergency-Off function as defined by EN 60204-1. Emergency-Off requires measures of electrical isolation, for example, by switching off mains via an additional contactor.

1. Activate the Safe Stop function by removing the 24 V DC voltage supply to the terminal 37.
2. After activation of Safe Stop (that is, after the response time), the frequency converter coasts (stops creating a rotational field in the motor). The response time is typically less than 10 ms.

The frequency converter is guaranteed not to restart creation of a rotational field by an internal fault (in accordance with Cat. 3 PL d acc. EN ISO 13849-1 and SIL 2 acc. EN 62061). After activation of Safe Stop, the display shows the text "Safe Stop activated". The associated help text says, "Safe Stop has been activated". This means that the Safe Stop has been activated, or that normal operation has not been resumed yet after Safe Stop activation.

NOTE

The requirements of Cat. 3 /PL "d" (ISO 13849-1) are only fulfilled while 24 V DC supply to terminal 37 is kept removed or low by a safety device which itself fulfills Cat. 3 PL "d" (ISO 13849-1). If external forces act on the motor, it must not operate without additional measures for fall protection. External forces can arise for example, in the event of vertical axis (suspended loads) where an unwanted movement, for example caused by gravity, could cause a hazard. Fall protection measures can be additional mechanical brakes.

By default the Safe Stop function is set to an Unintended Restart Prevention behaviour. Therefore, to resume operation after activation of Safe Stop,

1. reapply 24 V DC voltage to terminal 37 (text Safe Stop activated is still displayed)
2. create a reset signal (via bus, Digital I/O, or [Reset] key.

The Safe Stop function can be set to an Automatic Restart behaviour. Set the value of *5-19 Terminal 37 Safe Stop* from default value [1] to value [3].
Automatic Restart means that Safe Stop is terminated, and normal operation is resumed, as soon as the 24 V DC are applied to Terminal 37. No Reset signal is required.

2

⚠WARNING

Automatic Restart Behaviour is permitted in one of the two situations:

1. **The Unintended Restart Prevention is implemented by other parts of the Safe Stop installation.**
2. **A presence in the dangerous zone can be physically excluded when Safe Stop is not activated. In particular, paragraph 5.3.2.5 of ISO 12100-2 2003 must be observed**

2.5.2 Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of an installation or application, using Safe Stop.
Perform the test again after each modification of the installation or application involving the Safe Stop.

NOTE

A passed commissioning test is mandatory after first installation and after each change to the safety installation.

The commissioning test (select one of cases 1 or 2 as applicable):

Case 1: Restart prevention for Safe Stop is required (that is Safe Stop only where *5-19 Terminal 37 Safe Stop* is set to default value [1], or combined Safe Stop and MCB 112 where *5-19 Terminal 37 Safe Stop* is set to *[6] PTC 1 & Relay A* or *[9] PTC 1 & Relay W/A*):

1.1 Remove the 24 V DC voltage supply to terminal 37 using the interrupt device while the frequency converter drives the motor (that is mains supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted

1.2 Send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed if the motor remains in the Safe Stop state, and the mechanical brake (if connected) remains activated.

1.3 Reapply 24 V DC to terminal 37. The test step is passed if the motor remains in the coasted state, and the mechanical brake (if connected) remains activated.

1.4 Send Reset signal (via Bus, Digital I/O, or [Reset] key). The test step is passed when the motor becomes operational again.

The commissioning test is passed if all four test steps 1.1, 1.2, 1.3 and 1.4 are passed.

Case 2: Automatic Restart of Safe Stop is wanted and allowed (that is, Safe Stop only where *5-19 Terminal 37 Safe Stop* is set to [3], or combined Safe Stop and MCB 112 where *5-19 Terminal 37 Safe Stop* is set to *[7] PTC 1 & Relay W* or *[8] PTC 1 & Relay A/W*):

2.1 Remove the 24 V DC voltage supply to terminal 37 by the interrupt device while the frequency converter drives the motor (that is mains supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted

2.2 Reapply 24 V DC to terminal 37.

The test step is passed if the motor becomes operational again. The commissioning test is passed if both test steps 2.1 and 2.2 are passed.

NOTE

See warning on the restart behaviour in *2.5.1 Terminal 37 Safe Stop Function*

⚠WARNING

The Safe Stop function can be used for asynchronous, synchronous and permanent magnet motors. Two faults can occur in the power semiconductor of the frequency converter. When using synchronous or permanent magnet motors a residual rotation can result from the faults. The rotation can be calculated to Angle = 360/(Number of Poles). The application using synchronous or permanent magnet motors must take this residual rotation into consideration and ensure that it does not pose a safety risk. This situation is not relevant for asynchronous motors.

3 Start Up and Functional Testing

3.1 Pre-start

3.1.1 Safety Inspection

⚠WARNING

HIGH VOLTAGE!

If input and output connections have been connected improperly, there is potential for high voltage on these terminals. If power leads for multiple motors are improperly run in same conduit, there is potential for leakage current to charge capacitors within the frequency converter, even when disconnected from mains input. For initial start up, make no assumptions about power components. Follow pre-start procedures. Failure to follow pre-start procedures could result in personal injury or damage to equipment.

1. Input power to the unit must be OFF and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground,
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
4. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
5. Check for proper grounding of the frequency converter as well as the motor.
6. Inspect the frequency converter for loose connections on terminals.
7. Record the following motor-nameplate data: power, voltage, frequency, full load current, and nominal speed. These values are needed to program motor nameplate data later.
8. Confirm that the supply voltage matches voltage of frequency converter and motor.

CAUTION

Before applying power to the unit, inspect the entire installation as detailed in *Table 3.1*. Check mark those items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the frequency converter or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the frequency converter • Remove power factor correction caps on motor(s), if present	
Cable routing	• Ensure that input power, motor wiring and control wiring are separated or in three separate metallic conduits for high frequency noise isolation	
Control wiring	• Check for broken or damaged wires and loose connections • Check that control wiring is isolated from power and motor wiring for noise immunity • Check the voltage source of the signals, if necessary • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly	
Cooling clearance	• Measure that top and bottom clearance is adequate to ensure proper air flow for cooling	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility	
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits • Humidity levels must be 5-95% non-condensing	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers • Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position	
Earthing (Grounding)	• The unit requires an earth wire (ground wire) from its chassis to the building earth (ground) • Check for good earth connections (ground connections) that are tight and free of oxidation • Earthing (grounding) to conduit or mounting the back panel to a metal surface is not a suitable earth (ground)	
Input and output power wiring	• Check for loose connections • Check that motor and mains are in separate conduit or separated screened cables	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion	
Switches	• Ensure that all switch and disconnect settings are in the proper positions	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used, as necessary • Check for an unusual amount of vibration	

Table 3.1 Start Up Check List

3.2 Applying Power

⚠WARNING

HIGH VOLTAGE!

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

⚠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 comply could result in death, serious injury, equipment, or property damage.

1. Confirm that the input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that optional equipment wiring, if present, matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors should be closed or cover mounted.
4. Apply power to the unit. DO NOT start the frequency converter at this time. For units with a disconnect switch, turn to the ON position to apply power to the frequency converter.

NOTE

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27. See *Illustration 2.27* for details.

3.3 Basic Operational Programming

3.3.1 Required Initial Frequency Converter Programming

NOTE

If the wizard is run, ignore the following.

Frequency converters require basic operational programming before running for best performance. Basic operational programming requires entering motor-nameplate data for the motor being operated and the minimum and maximum motor speeds. Enter data in accordance with the following procedure. Parameter settings recommended are intended for start up and checkout purposes. Application settings may vary. See *4 User Interface* for detailed instructions on entering data through the LCP.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] twice on the LCP.
2. Use the navigation keys to scroll to parameter group *0-** Operation/Display* and press [OK].

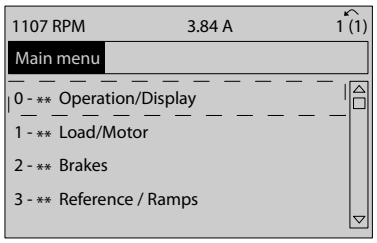

Illustration 3.1 Main Menu

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

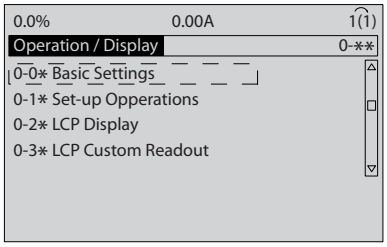

Illustration 3.2 Operation/Display

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

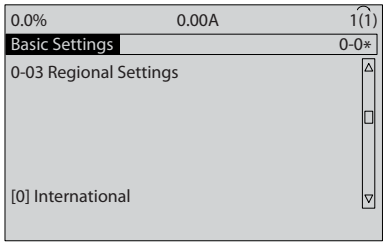

Illustration 3.3 Basic Settings

5. Use navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters. See *5.4 International/North*

American Default Parameter Settings for a complete list.)

6. Press [Quick Menu] on the LCP.
7. Use the navigation keys to scroll to parameter group *Q2 Quick Setup* and press [OK].

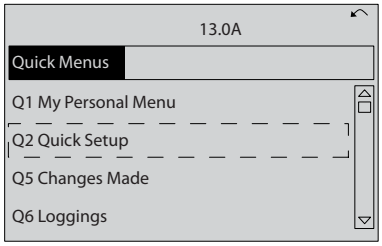

Illustration 3.4 Quick Menus

8. Select language and press [OK].
9. A jumper wire should be in place between control terminals 12 and 27. If this is the case, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise select *No Operation*. For frequency converters with an optional Danfoss bypass, no jumper wire is required.
10. *3-02 Minimum Reference*
11. *3-03 Maximum Reference*
12. *3-41 Ramp 1 Ramp Up Time*
13. *3-42 Ramp 1 Ramp Down Time*
14. *3-13 Reference Site*. Linked to Hand/Auto* Local Remote.

3.4 Asynchronous Motor Setup

Enter the motor data in parameters 1-20/1-21 to 1-25. The information can be found on the motor nameplate.

1. *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]*

   1-22 Motor Voltage

   1-23 Motor Frequency

   1-24 Motor Current

   1-25 Motor Nominal Speed

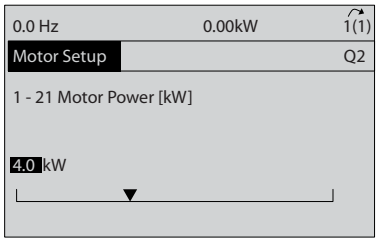

Illustration 3.5 Motor Setup

3.5 PM Motor Setup

CAUTION

Do only use PM motor with fans and pumps.

Initial Programming Steps

1. Activate PM motor operation *1-10 Motor Construction*, select *[1) PM, non salient SPM*
2. Make sure to set *0-02 Motor Speed Unit* to *[0] RPM*

Programming motor data.
After selecting PM motor in *1-10 Motor Construction*, the PM motor-related parameters in parameter groups 1-2*, 1-3* and 1-4* are active.
The information can be found on the motor nameplate and in the motor data sheet.
Following parameters must be programmed in the listed order

1. *1-24 Motor Current*
2. *1-26 Motor Cont. Rated Torque*
3. *1-25 Motor Nominal Speed*
4. *1-39 Motor Poles*
5. *1-30 Stator Resistance (Rs)*
   Enter line to common stator winding resistance (Rs). If only line-line data are available, divide the line-line value with 2 to achieve the line to common (starpoint) value.
   It is also possible to measure the value with an ohmmeter, which will also take the resistance of the cable into account. Divide the measured value by 2 and enter the result.
6. *1-37 d-axis Inductance (Ld)*
   Enter line to common direct axis inductance of the PM motor.
   If only line-line data are available, divide the line-line value with 2 to achieve the line-common (starpoint) value.
   It is also possible to measure the value with an inductancemeter, which will also take the inductance of the cable into account. Divide the measured value by 2 and enter the result.
7. *1-40 Back EMF at 1000 RPM*

Enter line to line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between two lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is e.g. 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF= (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *1-40 Back EMF at 1000 RPM*

Test Motor Operation

1. Start the motor at low speed (100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.
2. Check if start function in *1-70 PM Start Mode* fits the application requirements.

Rotor detection
This function is the recommended choice for applications where the motor starts from standstill e.g. pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

Parking
This function is the recommended choice for applications where the motor is rotating at slow speed eg. windmilling in fan applications. *2-06 Parking Current* and *2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. In case the application does not run well, check the VVC^{plus} PM settings. Recommendations in different applications can be seen in *Table 3.2*.

Application	Settings
Low inertia applications I_{Load}/I_{Motor} <5	*1-17 Voltage filter time const.* to be increased by factor 5 to 10 *1-14 Damping Gain* should be reduced *1-66 Min. Current at Low Speed* should be reduced (<100%)
Low inertia applications 50>I_{Load}/I_{Motor} >5	Keep calculated values
High inertia applications I_{Load}/I_{Motor} > 50	*1-14 Damping Gain*, *1-15 Low Speed Filter Time Const.* and *1-16 High Speed Filter Time Const.* should be increased
High load at low speed <30% (rated speed)	*1-17 Voltage filter time const.* should be increased *1-66 Min. Current at Low Speed* should be increased (>100% for longer time can overheat the motor)

Table 3.2 Recommendations in Different Applications

If the motor starts oscillating at a certain speed, increase *1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

Starting torque can be adjusted in *1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

3.6 Automatic Motor Adaptation

Automatic motor adaptation (AMA) is a test procedure that measures the electrical characteristics of the motor to optimize compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters 1-20 to 1-25.
- It does not cause the motor to run or harm to the motor
- Some motors may be unable to run the complete version of the test. In that case, select *[2] Enable reduced AMA*
- If an output filter is connected to the motor, select *Enable reduced AMA*
- If warnings or alarms occur, see *8 Warnings and Alarms*
- Run this procedure on a cold motor for best results

NOTE

The AMA algorithm does not work when using PM motors.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group *1-** Load and Motor*.
3. Press [OK].
4. Scroll to parameter group *1-2* Motor Data*.
5. Press [OK].
6. Scroll to *1-29 Automatic Motor Adaptation (AMA)*.
7. Press [OK].
8. Select *[1] Enable complete AMA*.
9. Press [OK].
10. Follow on-screen instructions.
11. The test will run automatically and indicate when it is complete.

3.7 Check Motor Rotation

Before running the frequency converter, check the motor rotation. The motor will run briefly at 5 Hz or the minimum frequency set in *4-12 Motor Speed Low Limit [Hz]*.

1. Press [Quick Menu].
2. Scroll to *Q2 Quick Setup*.
3. Press [OK].
4. Scroll to *1-28 Motor Rotation Check*.
5. Press [OK].
6. Scroll to *[1] Enable*.

The following text will appear: *Note! Motor may run in wrong direction*.

7. Press [OK].
8. Follow the on-screen instructions.

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any two of the three motor cables on the motor or frequency converter side of the connection.

3.8 Local-control Test

⚠CAUTION

MOTOR START!

Ensure that the motor, system and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any condition. Failure to ensure that the motor, system, and any attached equipment is ready for start could result in personal injury or equipment damage.

NOTE

The [Hand On] key provides a local start command to the frequency converter. The [Off] key provides the stop function.

When operating in local mode, [▲] and [▼] increase and decrease the speed output of the frequency converter. [◄] and [►] move the display cursor in the numeric display.

1. Press [Hand On].
2. Accelerate the frequency converter by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off].
5. Note any deceleration problems.

If acceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*
- Check that motor data is entered correctly
- Increase the ramp-up time accel time in *3-41 Ramp 1 Ramp Up Time*
- Increase current limit in *4-18 Current Limit*
- Increase torque limit in *4-16 Torque Limit Motor Mode*

If deceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*.
- Check that motor data is entered correctly.
- Increase the ramp-down time decel time in *3-42 Ramp 1 Ramp Down Time*.
- Enable overvoltage control in *2-17 Over-voltage Control*.

See *4.1.1 Local Control Panel* for resetting the frequency converter after a trip.

NOTE

***3.1 Pre-start* to *3.8 Local-control Test* conclude the procedures for applying power to the frequency converter, basic programming, set-up and functional testing.**

3.9 System Start Up

The procedure in this section requires user-wiring and application programming to be completed. *6 Application Set-Up Examples* is intended to help with this task. Other aids to application set-up are listed in *1.2 Additional Resources*. The following procedure is recommended after application set-up by the user is completed.

⚠CAUTION

MOTOR START!

Ensure that the motor, system and any attached equipment is ready for start. It is the responsibility of the user to ensure safe operation under any condition. Failure to do so could result in personal injury or equipment damage.

1. Press [Auto On].
2. Ensure that external control functions are properly wired to the frequency converter and all programming is completed.
3. Apply an external run command.
4. Adjust the speed reference> throughout the speed range.
5. Remove the external run command.
6. Note any problems.

If warnings or alarms occur, see *8 Warnings and Alarms*.

3.10 Acoustic Noise or Vibration

If the motor or the equipment driven by the motor - e.g. a fan blade - is making noise or vibrations at certain frequencies, try the following:

- Speed Bypass, parameter group 4-6*
- Over-modulation, *14-03 Overmodulation* set to off
- Switching pattern and switching frequency parameter group 14-0*
- Resonance Dampening, *1-64 Resonance Dampening*

4 User Interface

4.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The LCP is the user interface to the frequency converter.

The LCP has several user functions.

- Start, stop, and control speed when in local control
- Display operational data, status, warnings and cautions
- Programming frequency converter functions
- Manually reset the frequency converter after a fault when auto-reset is inactive

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the Programming Guide for details on use of the NLCP.

NOTE

The display contrast can be adjusted by pressing [Status] and [▲]/[▼] key.

4.1.1 LCP Layout

The LCP is divided into four functional groups (see *Illustration 4.1*).

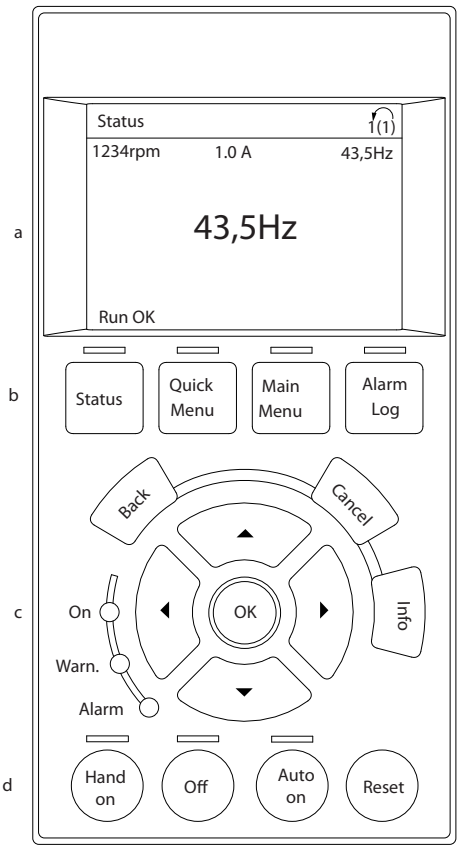

Illustration 4.1 LCP

a. Display area.

b. Display menu keys for changing the display to show status options, programming, or error message history.

c. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.

d. Operational mode keys and reset.

4.1.2 Setting LCP Display Values

The display area is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customized for user application.

- Each display readout has a parameter associated with it
- Options are selected in the quick menu *Q3-13 Display Settings*
- Display 2 has an alternate larger display option
- The frequency converter status at the bottom line of the display is generated automatically and is not selectable

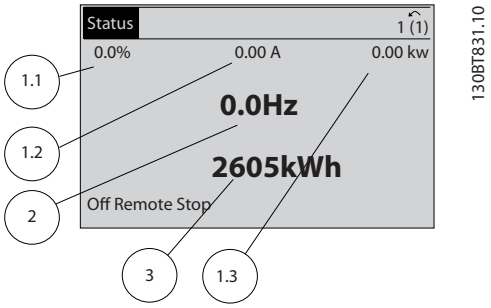

Illustration 4.2 Display Readouts

Display	Parameter number	Default setting
1.1	0-20	Reference %
1.2	0-21	Motor current
1.3	0-22	Power [kW]
2	0-23	Frequency
3	0-24	kWh counter

Table 4.1 Legend to *Illustration 4.2*

4.1.3 Display Menu Keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

Illustration 4.3 Menu Keys

Key	Function
Status	Shows operational information. • In Auto mode, press to toggle between status read-out displays • Press repeatedly to scroll through each status display • Press [Status] plus [▲] or [▼] to adjust the display brightness • The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.
Quick Menu	Allows access to programming parameters for initial set up instructions and many detailed application instructions. • Press to access *Q2 Quick Setup* for sequenced instructions to program the basic frequency controller set up • Follow the sequence of parameters as presented for the function set up
Main Menu	Allows access to all programming parameters. • Press twice to access top-level index • Press once to return to the last location accessed • Press to enter a parameter number for direct access to that parameter
Alarm Log	Displays a list of current warnings, the last 10 alarms, and the maintenance log. • For details about the frequency converter before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].

Table 4.2 Function Description Menu Keys

4

4

4.1.4 Navigation Keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. Three frequency converter status indicator lights are also located in this area.

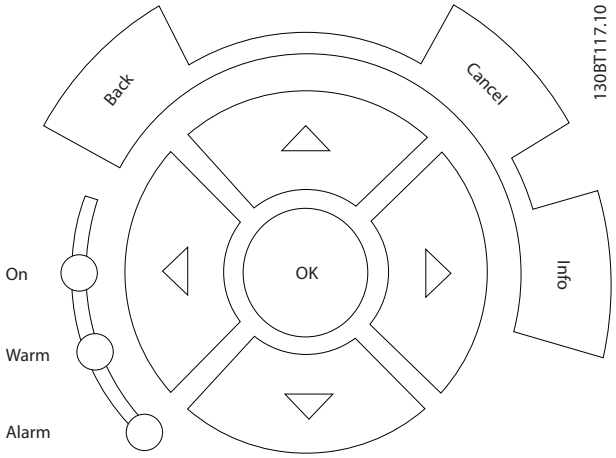

Illustration 4.4 Navigation Keys

Key	Function
Back	Reverts to the previous step or list in the menu structure.
Cancel	Cancels the last change or command as long as the display mode has not changed.
Info	Press for a definition of the function being displayed.
Navigation Keys	Use the four navigation keys to move between items in the menu.
OK	Use to access parameter groups or to enable a choice.

Table 4.3 Navigation Keys Functions

Light	Indicator	Function
Green	ON	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply.
Yellow	WARN	When warning conditions are met, the yellow WARN light comes on and text appears in the display area identifying the problem.
Red	ALARM	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 4.4 Indicator Lights Functions

4.1.5 Operation Keys

Operation keys are found at the bottom of the LCP.

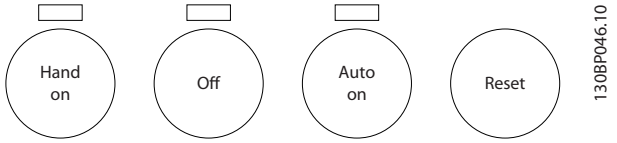

Illustration 4.5 Operation Keys

Key	Function
Hand On	Starts the frequency converter in local control. • Use the navigation keys to control frequency converter speed • An external stop signal by control input or serial communication overrides the local hand on
Off	Stops the motor but does not remove power to the frequency converter.
Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication • Speed reference is from an external source
Reset	Resets the frequency converter manually after a fault has been cleared.

Table 4.5 Operation Keys Functions

4.2 Back Up and Copying Parameter Settings

Programming data is stored internally in the frequency converter.

- The data can be uploaded into the LCP memory as a storage back up
- Once stored in the LCP, the data can be downloaded back into the frequency converter
- Data can also be downloaded into other frequency converters by connecting the LCP into those units and downloading the stored settings. (This is a quick way to program multiple units with the same settings).
- Initialisation of the frequency converter to restore factory default settings does not change data stored in the LCP memory

⚠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, or equipment or property damage.

4.2.1 Uploading Data to the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to *0-50 LCP Copy*.
3. Press [OK].
4. Select *All to LCP*.
5. Press [OK]. A progress bar shows the uploading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

4.2.2 Downloading Data from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to *0-50 LCP Copy*.
3. Press [OK].
4. Select *All from LCP*.
5. Press [OK]. A progress bar shows the downloading process.
6. Press [Hand On] or [Auto On] to return to normal operation.

4.3 Restoring Default Settings

CAUTION

Initialisation restores the unit to factory default settings. Any programming, motor data, localization, and monitoring records will be lost. Uploading data to the LCP provides a backup before initialisation.

Restoring the frequency converter parameter settings back to default values is done by initialisation of the frequency converter. Initialisation can be through *14-22 Operation Mode* or manually.

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

4.3.1 Recommended Initialisation

1. Press [Main Menu] twice to access parameters.
2. Scroll to *14-22 Operation Mode*.
3. Press [OK].
4. Scroll to *Initialisation*.
5. Press [OK].
6. Remove power to the unit and wait for the display to turn off.
7. Apply power to the unit.

Default parameter settings are restored during start up. This may take slightly longer than normal.

8. Alarm 80 is displayed.
9. Press [Reset] to return to operation mode.

4.3.2 Manual Initialisation

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time and apply power to the unit.

Factory default parameter settings are restored during start up. This may take slightly longer than normal.

Manual initialisation does not reset the following frequency converter information

- *15-00 Operating hours*
- *15-03 Power Up's*
- *15-04 Over Temp's*
- *15-05 Over Volt's*

4

5 About Frequency Converter Programming

5.1 Introduction

The frequency converter is programmed for its application functions using parameters. Parameters are accessed by pressing either [Quick Menu] or [Main Menu] on the LCP. (See *4 User Interface* for details on using the LCP function keys.) Parameters may also be accessed through a PC using the MCT 10 Set-up Software (see *5.6 Remote Programming with MCT 10 Set-up Software*).

5

The quick menu is intended for initial start up(*Q2-** Quick Set Up*) and detailed instructions for common frequency converter applications (*Q3-** Function Set Up*). Step-by-step instructions are provided. These instructions enable the user to walk through the parameters used for programming applications in their proper sequence. Data entered in a parameter can change the options available in the parameters following that entry. The quick menu presents easy guidelines for getting most systems up and running.

The main menu accesses all parameters and allows for advanced frequency converter applications.

5.2 Programming Example

Here is an example for programming the frequency converter for a common application in open loop using the quick menu.

- This procedure programs the frequency converter to receive a 0-10 V DC analog control signal on input terminal 53
- The frequency converter will respond by providing 6-60 Hz output to the motor proportional to the input signal (0-10 V DC =6-60 Hz)

Select the following parameters using the navigation keys to scroll to the titles and press [OK] after each action.

1. *3-15 Reference Resource 1*

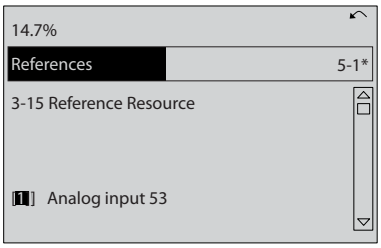

Illustration 5.1 References *3-15 Reference Resource 1*

2. *3-02 Minimum Reference*. Set minimum internal frequency converter reference to 0 Hz. (This sets the minimum frequency converter speed at 0 Hz.)

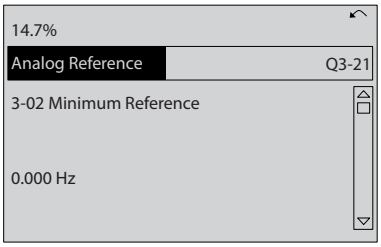

Illustration 5.2 Analog Reference *3-02 Minimum Reference*

3. *3-03 Maximum Reference*. Set maximum internal frequency converter reference to 60 Hz. (This sets the maximum frequency converter speed at 60 Hz. Note that 50/60 Hz is a regional variation.)

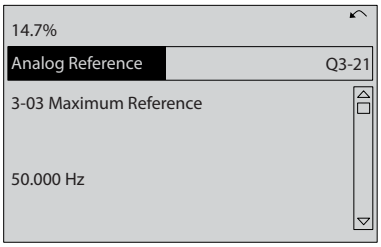

Illustration 5.3 Analog Reference *3-03 Maximum Reference*

4. *6-10 Terminal 53 Low Voltage*. Set minimum external voltage reference on Terminal 53 at 0 V. (This sets the minimum input signal at 0 V.)

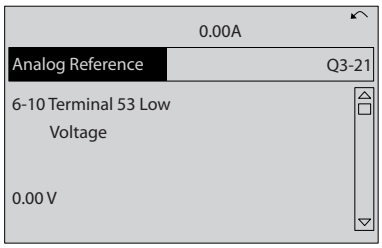

Illustration 5.4 Analog Reference *6-10 Terminal 53 Low Voltage*

5. *6-11 Terminal 53 High Voltage*. Set maximum external voltage reference on Terminal 53 at 10 V. (This sets the maximum input signal at 10 V.)

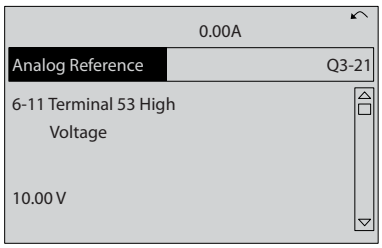

Illustration 5.5 Analog Reference *6-11 Terminal 53 High Voltage*

6. *6-14 Terminal 53 Low Ref./Feedb. Value*. Set minimum speed reference on Terminal 53 at 6 Hz. (This tells the frequency converter that the minimum voltage received on Terminal 53 (0 V) equals 6 Hz output.)

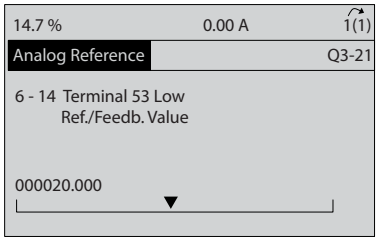

Illustration 5.6 Analog Reference *6-14 Terminal 53 Low Ref./Feedb. Value*

7. *6-15 Terminal 53 High Ref./Feedb. Value*. Set maximum speed reference on Terminal 53 at 60 Hz. (This tells the frequency converter that the maximum voltage received on Terminal 53 (10 V) equals 60 Hz output.)

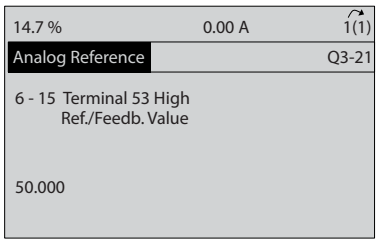

Illustration 5.7 Analog Reference *6-15 Terminal 53 High Ref./ Feedb. Value*

With an external device providing a 0-10 V control signal connected to frequency converter terminal 53, the system is now ready for operation. Note that the scroll bar on the right in the last illustration of the display is at the bottom, indicating the procedure is complete.

Illustration 5.8 shows the wiring connections used to enable this set up.

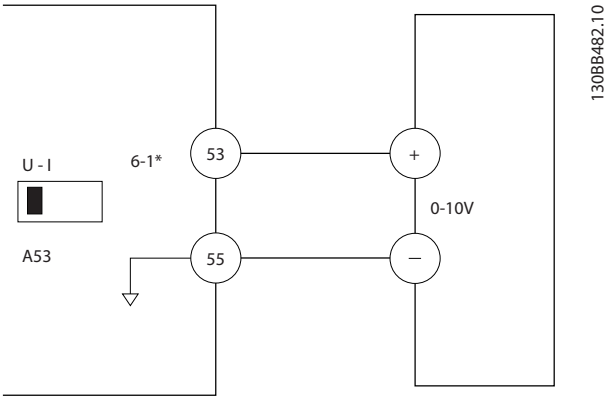

Illustration 5.8 Wiring Example for External Device Providing 0-10 V Control Signal (Frequency Converter Left, External Device Right)

5.3 Control Terminal Programming Examples

Control terminals can be programmed.

- Each terminal has specified functions it is capable of performing
- Parameters associated with the terminal enable the function

See *Table 2.4* for control terminal parameter number and default setting. (Default setting can change based on the selection in *0-03 Regional Settings*.)

The following example shows accessing Terminal 18 to see the default setting.

1. Press [Main Menu] twice, scroll to parameter group *5-** Digital In/Out Parameter Data Set* and press [OK].

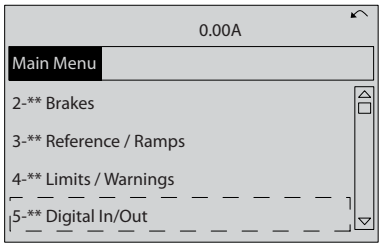

Illustration 5.9 *6-15 Terminal 53 High Ref./Feedb. Value*

2. Scroll to parameter group *5-1* Digital Inputs* and press [OK].

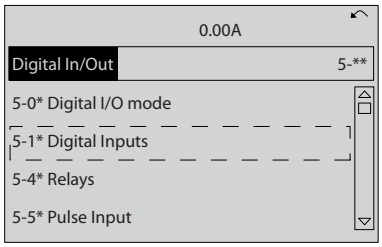

Illustration 5.10 Digital In/Out

3. Scroll to *5-10 Terminal 18 Digital Input*. Press [OK] to access function choices. The default setting *Start* is shown.

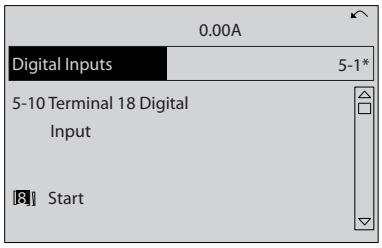

Illustration 5.11 Digital Inputs

5.4 International/North American Default Parameter Settings

Setting *0-03 Regional Settings* to *[0] International* or *[1] North America* changes the default settings for some parameters. *Table 5.1* lists those parameters that are effected.

Parameter	International default parameter value	North American default parameter value
0-03 Regional Settings	International	North America
1-20 Motor Power [kW]	See Note 1	See Note 1
1-21 Motor Power [HP]	See Note 2	See Note 2
1-22 Motor Voltage	230 V/400 V/575 V	208 V/460 V/575 V
1-23 Motor Frequency	50 Hz	60 Hz
3-03 Maximum Reference	50 Hz	60 Hz
3-04 Reference Function	Sum	External/Preset
4-13 Motor Speed High Limit [RPM] See Note 3 and 5	1500 PM	1800 RPM
4-14 Motor Speed High Limit [Hz] See Note 4	50 Hz	60 Hz
4-19 Max Output Frequency	100 Hz	120 Hz
4-53 Warning Speed High	1500 RPM	1800 RPM
5-12 Terminal 27 Digital Input	Coast inverse	External interlock
5-40 Function Relay	Alarm	No alarm
6-15 Terminal 53 High Ref./Feedb. Value	50	60
6-50 Terminal 42 Output	Speed 0-HighLim	Speed 4-20 mA
14-20 Reset Mode	Manual reset	Infinite auto reset

Table 5.1 International/North American Default Parameter Settings

Note 1: 1-20 Motor Power [kW] is only visible when 0-03 Regional Settings is set to [0] International.
Note 2: 1-21 Motor Power [HP], is only visible when 0-03 Regional Settings is set to [1] North America.
Note 3: This parameter is only visible when 0-02 Motor Speed Unit is set to [0] RPM.
Note 4: This parameter is only visible when 0-02 Motor Speed Unit is set to [1] Hz.
Note 5: The default value depends on the number of motor poles. For a 4 poled motor the international default value is 1500 RPM and for a 2 poled motor 3000 RPM. The corresponding values for North America is 1800 and 3600 RPM, respectively.

Changes made to default settings are stored and available for viewing in the quick menu along with any programming entered into parameters.

1. Press [Quick Menu].
2. Scroll to Q5 *Changes Made* and press [OK].

3. Select *Q5-2 Since Factory Setting* to view all programming changes or *Q5-1 Last 10 Changes* for the most recent.

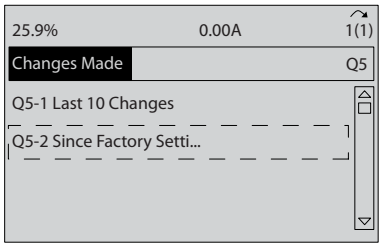

Illustration 5.12 Changes Made

5.4.1 Parameter Data Check

1. Press [Quick Menu].
2. Scroll to *Q5 Changes Made* and press [OK].

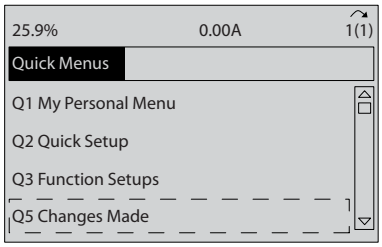

Illustration 5.13 Q5 Changes Made

3. Select *Q5-2 Since Factory Setting* to view all programming changes or *Q5-1 Last 10 Changes* for the most recent.

5.5 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the frequency converter with system details it needs to operate properly. System details may include such things as input and output signal types, programming terminals, minimum and maximum signal ranges, custom displays, automatic restart, and other features.

- See the LCP display to view detailed parameter programming and setting options
- Press [Info] in any menu location to view additional details for that function
- Press and hold [Main Menu] to enter a parameter number for direct access to that parameter
- Details for common application set ups are provided in *6 Application Set-Up Examples*.

Q3-1 General Settings	0-24 Display Line 3 Large	1-00 Configuration Mode	**Q3-31 Single Zone Ext. Set Point**	20-70 Closed Loop Type
Q3-10 Adv. Motor Settings	0-37 Display Text 1	20-12 Reference/Feedback Unit	1-00 Configuration Mode	20-71 PID Performance
1-90 Motor Thermal Protection	0-38 Display Text 2	20-13 Minimum Reference/Feedb.	20-12 Reference/Feedback Unit	20-72 PID Output Change
1-93 Thermistor Source	0-39 Display Text 3	20-14 Maximum Reference/Feedb.	20-13 Minimum Reference/Feedb.	20-73 Minimum Feedback Level
1-29 Automatic Motor Adaptation (AMA)	*Q3-2 Open Loop Settings*	6-22 Terminal 54 Low Current	20-14 Maximum Reference/Feedb.	20-74 Maximum Feedback Level
14-01 Switching Frequency	**Q3-20 Digital Reference**	6-24 Terminal 54 Low Ref./Feedb. Value	6-10 Terminal 53 Low Voltage	20-79 PID Autotuning
4-53 Warning Speed High	3-02 Minimum Reference	6-25 Terminal 54 High Ref./Feedb. Value	6-11 Terminal 53 High Voltage	**Q3-32 Multi Zone / Adv**
Q3-11 Analog Output	3-03 Maximum Reference	6-26 Terminal 54 Filter Time Constant	6-12 Terminal 53 Low Current	1-00 Configuration Mode
6-50 Terminal 42 Output	3-10 Preset Reference	6-27 Terminal 54 Live Zero	6-13 Terminal 53 High Current	3-15 Reference 1 Source
6-51 Terminal 42 Output Min Scale	5-13 Terminal 29 Digital Input	6-00 Live Zero Timeout Time	6-14 Terminal 53 Low Ref./Feedb. Value	3-16 Reference 2 Source
6-52 Terminal 42 Output Max Scale	5-14 Terminal 32 Digital Input	6-01 Live Zero Timeout Function	6-15 Terminal 53 High Ref./Feedb. Value	20-00 Feedback 1 Source
Q3-12 Clock Settings	5-15 Terminal 33 Digital Input	20-21 Setpoint 1	6-22 Terminal 54 Low Current	20-01 Feedback 1 Conversion
0-70 Date and Time	**Q3-21 Analog Reference**	20-81 PID Normal/ Inverse Control	6-24 Terminal 54 Low Ref./Feedb. Value	20-02 Feedback 1 Source Unit
0-71 Date Format	3-02 Minimum Reference	20-82 PID Start Speed [RPM]	6-25 Terminal 54 High Ref./Feedb. Value	20-03 Feedback 2 Source
0-72 Time Format	3-03 Maximum Reference	20-83 PID Start Speed [Hz]	6-26 Terminal 54 Filter Time Constant	20-04 Feedback 2 Conversion
0-74 DST/Summertime	6-10 Terminal 53 Low Voltage	20-93 PID Proportional Gain	6-27 Terminal 54 Live Zero	20-05 Feedback 2 Source Unit
0-76 DST/Summertime Start	6-11 Terminal 53 High Voltage	20-94 PID Integral Time	6-00 Live Zero Timeout Time	20-06 Feedback 3 Source
0-77 DST/Summertime End	6-12 Terminal 53 Low Current	20-70 Closed Loop Type	6-01 Live Zero Timeout Function	20-07 Feedback 3 Conversion
Q3-13 Display Settings	6-13 Terminal 53 High Current	20-71 PID Performance	20-81 PID Normal/ Inverse Control	20-08 Feedback 3 Source Unit
0-20 Display Line 1.1 Small	6-14 Terminal 53 Low Ref./Feedb. Value	20-72 PID Output Change	20-82 PID Start Speed [RPM]	20-12 Reference/Feedback Unit
0-21 Display Line 1.2 Small	6-15 Terminal 53 High Ref./Feedb. Value	20-73 Minimum Feedback Level	20-83 PID Start Speed [Hz]	20-13 Minimum Reference/Feedb.
0-22 Display Line 1.3 Small	*Q3-3 Closed Loop Settings*	20-74 Maximum Feedback Level	20-93 PID Proportional Gain	20-14 Maximum Reference/Feedb.
0-23 Display Line 2 Large	**Q3-30 Single Zone Int. Set Point**	20-79 PID Autotuning	20-94 PID Integral Time	6-10 Terminal 53 Low Voltage

Table 5.2 Quick Menu Structure

6-11 Terminal 53 High Voltage	20-21 Setpoint 1	22-22 Low Speed Detection	22-21 Low Power Detection	22-87 Pressure at No-Flow Speed
6-12 Terminal 53 Low Current	20-22 Setpoint 2	22-23 No-Flow Function	22-22 Low Speed Detection	22-88 Pressure at Rated Speed
6-13 Terminal 53 High Current	20-81 PID Normal/ Inverse Control	*22-24 No-Flow Delay*	22-23 No-Flow Function	22-89 Flow at Design Point
6-14 Terminal 53 Low Ref./Feedb. Value	20-82 PID Start Speed [RPM]	22-40 Minimum Run Time	22-24 No-Flow Delay	22-90 Flow at Rated Speed
6-15 Terminal 53 High Ref./Feedb. Value	20-83 PID Start Speed [Hz]	22-41 Minimum Sleep Time	22-40 Minimum Run Time	1-03 Torque Characteristics
6-16 Terminal 53 Filter Time Constant	20-93 PID Proportional Gain	22-42 Wake-up Speed [RPM]	22-41 Minimum Sleep Time	1-73 Flying Start
6-17 Terminal 53 Live Zero	20-94 PID Integral Time	22-43 Wake-up Speed [Hz]	22-42 Wake-up Speed [RPM]	**Q3-42 Compressor Functions**
6-20 Terminal 54 Low Voltage	20-70 Closed Loop Type	22-44 Wake-up Ref./FB Difference	22-43 Wake-up Speed [Hz]	1-03 Torque Characteristics
6-21 Terminal 54 High Voltage	20-71 PID Performance	22-45 Setpoint Boost	22-44 Wake-up Ref./FB Difference	1-71 Start Delay
6-22 Terminal 54 Low Current	20-72 PID Output Change	22-46 Maximum Boost Time	22-45 Setpoint Boost	22-75 Short Cycle Protection
6-23 Terminal 54 High Current	20-73 Minimum Feedback Level	2-10 Brake Function	22-46 Maximum Boost Time	22-76 Interval between Starts
6-24 Terminal 54 Low Ref./Feedb. Value	20-74 Maximum Feedback Level	2-16 AC brake Max. Current	22-26 Dry Pump Function	22-77 Minimum Run Time
6-25 Terminal 54 High Ref./Feedb. Value	20-79 PID Autotuning	2-17 Over-voltage Control	22-27 Dry Pump Delay	5-01 Terminal 27 Mode
6-26 Terminal 54 Filter Time Constant	***Q3-4 Application Settings***	1-73 Flying Start	22-80 Flow Compensation	5-02 Terminal 29 Mode
6-27 Terminal 54 Live Zero	**Q3-40 Fan Functions**	1-71 Start Delay	22-81 Square-linear Curve Approxi-mation	5-12 Terminal 27 Digital Input
6-00 Live Zero Timeout Time	22-60 Broken Belt Function	1-80 Function at Stop	22-82 Work Point Calculation	5-13 Terminal 29 Digital Input
6-01 Live Zero Timeout Function	22-61 Broken Belt Torque	2-00 DC Hold/Preheat Current	22-83 Speed at No-Flow [RPM]	5-40 Function Relay
4-56 Warning Feedback Low	22-62 Broken Belt Delay	4-10 Motor Speed Direction	22-84 Speed at No-Flow [Hz]	1-73 Flying Start
4-57 Warning Feedback High	4-64 Semi-Auto Bypass Set-up	**Q3-41 Pump Functions**	22-85 Speed at Design Point [RPM]	1-86 Trip Speed Low [RPM]
20-20 Feedback Function	1-03 Torque Characteristics	22-20 Low Power Auto Set-up	22-86 Speed at Design Point [Hz]	1-87 Trip Speed Low [Hz]

Table 5.3 Quick Menu Structure

5.5.2 Main Menu Structure

0- **	**Operation / Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups / Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Access Password
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-03	Torque Characteristics
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-46	Position Detection Gain
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-58	Flystart Test Pulses Current
1-59	Flystart Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Compressor Start Max Time to Trip
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
2- **	**Brakes**
2-0*	**DC-Brake**
2-00	DC Hold/Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
3- **	**Reference / Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-82	Starting Ramp Up Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4- **	**Limits / Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low
4-53	Warning Speed High
4-54	Warning Reference Low
4-55	Warning Reference High
4-56	Warning Feedback Low
4-57	Warning Feedback High
4-58	Missing Motor Phase Function
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
5- **	**Digital In/Out**
5-0*	**Digital I/O mode**
5-00	Digital I/O Mode
5-01	Terminal 27 Mode
5-02	Terminal 29 Mode
5-1*	**Digital Inputs**
5-10	Terminal 18 Digital Input
5-11	Terminal 19 Digital Input
5-12	Terminal 27 Digital Input
5-13	Terminal 29 Digital Input
5-14	Terminal 32 Digital Input
5-15	Terminal 33 Digital Input
5-16	Terminal X30/2 Digital Input
5-17	Terminal X30/3 Digital Input
5-18	Terminal X30/4 Digital Input
5-19	Terminal 37 Safe Stop
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6- **	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-02	Fire Mode Live Zero Timeout Function
6-1*	**Analog Input 53**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-17	Terminal 53 Live Zero
6-2*	**Analog Input 54**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-27	Terminal 54 Live Zero
6-3*	**Analog Input X30/11**
6-30	Terminal X30/11 Low Voltage
6-31	Terminal X30/11 High Voltage
6-34	Term. X30/11 Low Ref./Feedb. Value
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6-36	Term. X30/11 Filter Time Constant
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6-4*	**Analog Input X30/12**
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6-44	Term. X30/12 Low Ref./Feedb. Value
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6-46	Term. X30/12 Filter Time Constant
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6-5*	**Analog Output 42**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
6-52	Terminal 42 Output Max Scale
6-53	Terminal 42 Output Bus Control
6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter

6-6*	**Analog Output X30/8**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
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6-63	Terminal X30/8 Output Bus Control
6-64	Terminal X30/8 Output Timeout Preset
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8-04	Control Timeout Function
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8-1*	**Control Settings**
8-10	Control Profile
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8-31	Address
8-32	Baud Rate
8-33	Parity / Stop Bits
8-34	Estimated cycle time
8-35	Minimum Response Delay
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8-4*	**FC MC protocol set**
8-40	Telegram Selection
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8-5*	**Digital/Bus**
8-50	Coasting Select
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8-53	Start Select
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8-7*	**BACnet**
8-70	BACnet Device Instance
8-72	MS/TP Max Masters
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8-82	Slave Messages Rcvd
8-83	Slave Error Count
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8-89	Diagnostics Count
8-9*	**Bus Jog / Feedback**
8-90	Bus Jog 1 Speed
8-91	Bus Jog 2 Speed
8-94	Bus Feedback 1
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9-63	Actual Baud Rate
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9-65	Profile Number
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9-90	Changed Parameters (1)
9-91	Changed Parameters (2)
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9-94	Changed Parameters (5)
9-99	Profibus Revision Counter
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11-1*	**LON Functions**
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11-15	LON Warning Word
11-17	XIF Revision
11-18	LonWorks Revision
11-2*	**LON Param. Access**
11-21	Store Data Values
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12-00	IP Address Assignment
12-01	IP Address
12-02	Subnet Mask
12-03	Default Gateway
12-04	DHCP Server
12-05	Lease Expires
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12-1*	**Ethernet Link Parameters**
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12-11	Link Duration
12-12	Auto Negotiation
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12-2*	**Process Data**
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12-21	Process Data Config Write
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12-3*	**EtherNet/IP**
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12-31	Net Reference
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12-33	CIP Revision
12-34	CIP Product Code
12-35	EDS Parameter
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12-4*	**Modbus TCP**
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14-03	Overmodulation
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14-2*	**Reset Functions**
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14-23	Typecode Setting
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14-28	Production Settings
14-29	Service Code
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14-30	Current Lim Ctrl, Proportional Gain
14-31	Current Lim Ctrl, Integration Time
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14-4*	**Energy Optimising**
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14-43	Motor Cosphi
14-5*	**Environment**
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14-51	DC Link Compensation
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14-55	Output Filter
14-59	Actual Number of Inverter Units
14-6*	**Auto Derate**
14-60	Function at Over Temperature
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14-90	Fault Level
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15-00	Operating hours
15-01	Running Hours
15-02	kWh Counter
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15-1*	**Data Log Settings**
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15-12	Trigger Event
15-13	Logging Mode
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15-21	Historic Log: Value
15-22	Historic Log: Time
15-23	Historic log: Date and Time
15-3*	**Alarm Log**
15-30	Alarm Log: Error Code
15-31	Alarm Log: Value
15-32	Alarm Log: Time
15-33	Alarm Log: Date and Time
15-4*	**Drive Identification**
15-40	FC Type
15-41	Power Section
15-42	Voltage
15-43	Software Version
15-44	Ordered Typecode String
15-45	Actual Typecode String
15-46	Frequency Converter Ordering No
15-47	Power Card Ordering No
15-48	LCP Id No
15-49	SW ID Control Card
15-50	SW ID Power Card
15-51	Frequency Converter Serial Number
15-53	Power Card Serial Number
15-55	Vendor URL
15-56	Vendor Name
15-59	CSIV Filename
15-6*	**Option Ident**
15-60	Option Mounted
15-61	Option SW Version
15-62	Option Ordering No
15-63	Option Serial No
15-70	Option in Slot A
15-71	Slot A Option SW Version
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15-92	Defined Parameters
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16-00	Control Word
16-01	Reference [Unit]
16-02	Reference [%]
16-03	Status Word
16-05	Main Actual Value [%]
16-09	Custom Readout
16-1*	**Motor Status**
16-10	Power [kW]
16-11	Power [hp]
16-12	Motor Voltage
16-13	Frequency
16-14	Motor current
16-15	Frequency [%]

16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-20 Motor Angle
16-22 Torque [%]
16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
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16-34 Heatsink Temp.
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16-36 Inv. Nom. Current
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16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
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16-43 Timed Actions Status
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-52 Feedback[Unit]
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
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16-58 PID Output [%]
16-6* Inputs & Outputs
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16-61 Terminal 53 Switch Setting
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16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
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
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16-75 Analog In X30/11
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16-8* Fieldbus & FC Port
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16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
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16-94 Ext. Status Word
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18-0* Maintenance Log
18-00 Maintenance Log: Item
18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
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18-1* Fire Mode Log
18-10 FireMode Log:Event
18-11 Fire Mode Log: Time
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18-3* Inputs & Outputs
18-30 Analog Input X42/1
18-31 Analog Input X42/3
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18-33 Analog Out X42/7 [V]
18-34 Analog Out X42/9 [V]
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18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
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18-5* Ref. & Feedb.
18-50 Sensorless Readout [unit]
20- Drive Closed Loop**
20-0* Feedback
20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
20-02 Feedback 1 Source Unit
20-03 Feedback 2 Source
20-04 Feedback 2 Conversion
20-05 Feedback 2 Source Unit
20-06 Feedback 3 Source
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20-08 Feedback 3 Source Unit
20-12 Reference/Feedback Unit
20-13 Minimum Reference/Feedb.
20-14 Maximum Reference/Feedb.
20-2* Feedback/Setpoint
20-20 Feedback Function
20-21 Setpoint 1
20-22 Setpoint 2
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20-3* Feedb. Adv. Conv.
20-30 Refrigerant
20-31 User Defined Refrigerant A1
20-32 User Defined Refrigerant A2
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20-34 Duct 1 Area [m2]
20-35 Duct 1 Area [in2]
20-36 Duct 2 Area [m2]
20-37 Duct 2 Area [in2]
20-38 Air Density Factor [%]
20-6* Sensorless
20-60 Sensorless Unit
20-69 Sensorless Information
20-7* PID Autotuning
20-70 Closed Loop Type
20-71 PID Performance
20-72 PID Output Change
20-73 Minimum Feedback Level
20-74 Maximum Feedback Level
20-79 PID Autotuning
20-8* PID Basic Settings
20-81 PID Normal/ Inverse Control
20-82 PID Start Speed [RPM]
20-83 PID Start Speed [Hz]
20-84 On Reference Bandwidth
20-9* PID Controller
20-91 PID Anti Windup
20-93 PID Proportional Gain
20-94 PID Integral Time
20-95 PID Differentiation Time
20-96 PID Diff. Gain Limit
21- Ext. Closed Loop**
21-0* Ext. CL Autotuning
21-00 Closed Loop Type
21-01 PID Performance
21-02 PID Output Change
21-03 Minimum Feedback Level
21-04 Maximum Feedback Level
21-09 PID Autotuning
21-1* Ext. CL 1 Ref./Fb.
21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
21-12 Ext. 1 Maximum Reference
21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* Ext. CL 1 PID
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
21-23 Ext. 1 Differentation Time
21-24 Ext. 1 Dif. Gain Limit
21-3* Ext. CL 2 Ref./Fb.
21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
21-34 Ext. 2 Feedback Source
21-35 Ext. 2 Setpoint
21-37 Ext. 2 Reference [Unit]
21-38 Ext. 2 Feedback [Unit]
21-39 Ext. 2 Output [%]
21-4* Ext. CL 2 PID
21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
21-42 Ext. 2 Integral Time
21-43 Ext. 2 Differentation Time
21-44 Ext. 2 Dif. Gain Limit
21-5* Ext. CL 3 Ref./Fb.
21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
21-52 Ext. 3 Maximum Reference
21-53 Ext. 3 Reference Source
21-54 Ext. 3 Feedback Source
21-55 Ext. 3 Setpoint
21-57 Ext. 3 Reference [Unit]
21-58 Ext. 3 Feedback [Unit]
21-59 Ext. 3 Output [%]
21-6* Ext. CL 3 PID
21-60 Ext. 3 Normal/Inverse Control
21-61 Ext. 3 Proportional Gain
21-62 Ext. 3 Integral Time
21-63 Ext. 3 Differentation Time
21-64 Ext. 3 Dif. Gain Limit
22- Appl. Functions**
22-0* Miscellaneous
22-00 External Interlock Delay
22-01 Power Filter Time
22-2* No-Flow Detection
22-20 Low Power Auto Set-up
22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* No-Flow Power Tuning
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
22-35 Low Speed Power [HP]
22-36 High Speed [RPM]
22-37 High Speed [Hz]
22-38 High Speed Power [kW]
22-39 High Speed Power [HP]
22-4* Sleep Mode
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-42 Wake-up Speed [RPM]
22-43 Wake-up Speed [Hz]
22-44 Wake-up Ref./FB Difference
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-5* End of Curve
22-50 End of Curve Function
22-51 End of Curve Delay
22-6* Broken Belt Detection
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay
22-7* Short Cycle Protection
22-75 Short Cycle Protection
22-76 Interval between Starts
22-77 Minimum Run Time
22-78 Minimum Run Time Override
22-79 Minimum Run Time Override Value
22-8* Flow Compensation
22-80 Flow Compensation
22-81 Square-linear Curve Approximation
22-82 Work Point Calculation
22-83 Speed at No-Flow [RPM]
22-84 Speed at No-Flow [Hz]
22-85 Speed at Design Point [RPM]
22-86 Speed at Design Point [Hz]
22-87 Pressure at No-Flow Speed
22-88 Pressure at Rated Speed
22-89 Flow at Design Point
22-90 Flow at Rated Speed
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23-01 ON Action
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23-03 OFF Action
23-04 Occurrence
23-0* Timed Actions Settings
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* Maintenance
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
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23-1* Maintenance Reset
23-15 Reset Maintenance Word
23-16 Maintenance Text
23-5* Energy Log
23-50 Energy Log Resolution
23-51 Period Start
23-53 Energy Log
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23-6* Trending
23-60 Trend Variable
23-61 Continuous Bin Data
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23-63 Timed Period Start
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23-65 Minimum Bin Value
23-66 Reset Continuous Bin Data
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23-8* Payback Counter
23-80 Power Reference Factor
23-81 Energy Cost
23-82 Investment
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24- Appl. Functions 2**
24-0* Fire Mode
24-00 Fire Mode Function
24-01 Fire Mode Configuration
24-02 Fire Mode Unit
24-03 Fire Mode Min Reference
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24-06 Fire Mode Reference Source
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24-09 Fire Mode Alarm Handling
24-1* Drive Bypass
24-10 Drive Bypass Function
24-11 Drive Bypass Delay Time
24-9* Multi-Motor Funct.
24-90 Missing Motor Function
24-91 Missing Motor Coefficient 1
24-92 Missing Motor Coefficient 2
24-93 Missing Motor Coefficient 3
24-94 Missing Motor Coefficient 4
24-95 Locked Rotor Function
24-96 Locked Rotor Coefficient 1
24-97 Locked Rotor Coefficient 2
24-98 Locked Rotor Coefficient 3
24-99 Locked Rotor Coefficient 4
25- Cascade Controller**
25-0* System Settings
25-00 Cascade Controller
25-02 Motor Start
25-04 Pump Cycling
25-05 Fixed Lead Pump
25-06 Number of Pumps
25-2* Bandwidth Settings
25-20 Staging Bandwidth
25-21 Override Bandwidth
25-22 Fixed Speed Bandwidth
25-23 SBW Staging Delay
25-24 SBW Destaging Delay
25-25 OBW Time
25-26 Destage At No-Flow
25-27 Stage Function
25-28 Stage Function Time
25-29 Destage Function
25-30 Destage Function Time
25-4* Staging Settings
25-40 Ramp Down Delay
25-41 Ramp Up Delay
25-42 Staging Threshold
25-43 Destaging Threshold
25-44 Staging Speed [RPM]
25-45 Staging Speed [Hz]
25-46 Destaging Speed [RPM]
25-47 Destaging Speed [Hz]
25-5* Alternation Settings
25-50 Lead Pump Alternation
25-51 Alternation Event
25-52 Alternation Time Interval
25-53 Alternation Timer Value
25-54 Alternation Predefined Time
25-55 Alternate if Load < 50%
25-56 Staging Mode at Alternation
25-58 Run Next Pump Delay
25-59 Run on Mains Delay
25-8* Status
25-80 Cascade Status
25-81 Pump Status
25-82 Lead Pump
25-83 Relay Status
25-84 Pump ON Time
25-85 Relay ON Time
25-86 Reset Relay Counters
25-9* Service
25-90 Pump Interlock
25-91 Manual Alternation
26- Analog I/O Option**
26-0* Analog I/O Mode
26-00 Terminal X42/1 Mode
26-01 Terminal X42/3 Mode
26-02 Terminal X42/5 Mode
26-1* Analog Input X42/1
26-10 Terminal X42/1 Low Voltage
26-11 Terminal X42/1 High Voltage
26-14 Term. X42/1 Low Ref./Feedb. Value
26-15 Term. X42/1 High Ref./Feedb. Value
26-16 Term. X42/1 Filter Time Constant
26-17 Term. X42/1 Live Zero
26-2* Analog Input X42/3
26-20 Terminal X42/3 Low Voltage
26-21 Terminal X42/3 High Voltage
26-24 Term. X42/3 Low Ref./Feedb. Value
26-25 Term. X42/3 High Ref./Feedb. Value
26-26 Term. X42/3 Filter Time Constant
26-27 Term. X42/3 Live Zero
26-3* Analog Input X42/5
26-30 Terminal X42/5 Low Voltage
26-31 Terminal X42/5 High Voltage
26-34 Term. X42/5 Low Ref./Feedb. Value
26-35 Term. X42/5 High Ref./Feedb. Value
26-36 Term. X42/5 Filter Time Constant
26-37 Term. X42/5 Live Zero
26-4* Analog Out X42/7
26-40 Terminal X42/7 Output
26-41 Terminal X42/7 Min. Scale
26-42 Terminal X42/7 Max. Scale
26-43 Terminal X42/7 Bus Control
26-44 Terminal X42/7 Timeout Preset
26-5* Analog Out X42/9
26-50 Terminal X42/9 Output
26-51 Terminal X42/9 Min. Scale
26-52 Terminal X42/9 Max. Scale
26-53 Terminal X42/9 Bus Control
26-54 Terminal X42/9 Timeout Preset
26-6* Analog Out X42/11
26-60 Terminal X42/11 Output
26-61 Terminal X42/11 Min. Scale
26-62 Terminal X42/11 Max. Scale
26-63 Terminal X42/11 Bus Control
26-64 Terminal X42/11 Timeout Preset
30- Special Features**
30-2* Adv. Start Adjust
30-22 Locked Rotor Detection
30-23 Locked Rotor Detection Time [s]
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
35- Sensor Input Option**
35-0* Temp. Input Mode
35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
35-47 Term. X48/2 Live Zero
99-* Devel support
99-0* DSP Debug
99-00 DAC 1 selection
99-01 DAC 2 selection
99-02 DAC 3 selection
99-03 DAC 4 selection
99-04 DAC 1 scale
99-05 DAC 2 scale
99-06 DAC 3 scale
99-07 DAC 4 scale
99-08 Test param 1
99-09 Test param 2
99-10 DAC Option Slot
99-1* Hardware Control
99-11 RFI 2
99-12 Fan
99-1* Software Readouts
99-13 Idle time
99-14 Paramdb requests in queue
99-15 Secondary Timer at Inverter Fault
99-16 No of Current Sensors
99-2* Heatsink Readouts
99-20 HS Temp. (PC1)
99-21 HS Temp. (PC2)
99-22 HS Temp. (PC3)
99-23 HS Temp. (PC4)
99-24 HS Temp. (PC5)
99-25 HS Temp. (PC6)
99-26 HS Temp. (PC7)
99-27 HS Temp. (PC8)
99-2* Platform Readouts
99-29 Platform Version
99-4* Software Control
99-40 StartupWizardState
99-5* PC Debug
99-50 PC Debug Selection
99-51 PC Debug 0
99-52 PC Debug 1
99-53 PC Debug 2
99-54 PC Debug 3
99-55 PC Debug 4
99-56 Fan 1 Feedback
99-57 Fan 2 Feedback
99-58 PC Auxiliary Temp
99-59 Power Card Temp.
99-9* Internal Values
99-90 Options present
99-91 Motor Power Internal
99-92 Motor Voltage Internal
99-93 Motor Frequency Internal
99-94 Imbalance derate [%]
99-95 Temperature derate [%]
99-96 Overload derate [%]

5.6 Remote Programming with MCT 10 Set-up Software

Danfoss has a software program available for developing, storing, and transferring frequency converter programming. The MCT 10 Set-up Software allows the user to connect a PC to the frequency converter and perform live programming rather than using the LCP. Additionally, all frequency converter programming can be done off-line and simply downloaded to the frequency converter. Or the entire frequency converter profile can be loaded onto the PC for back up storage or analysis.

The USB connector or RS-485 terminal is available for connecting to the frequency converter.

MCT 10 Set-up Software is available for free download at VLT-software website. A CD is also available by requesting part number 130B1000. For further information, see the Operating Instructions.

6 Application Set-Up Examples

6.1 Introduction

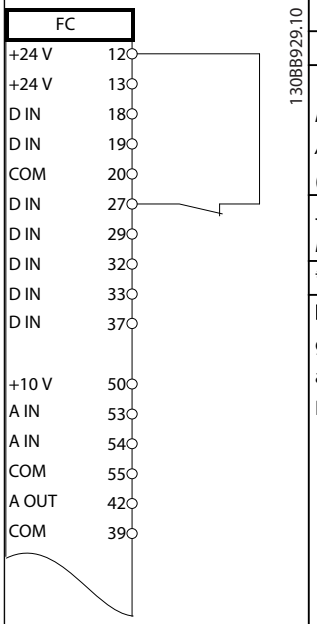
NOTE

When the optional safe stop feature is used, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate when using factory default programming values.

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

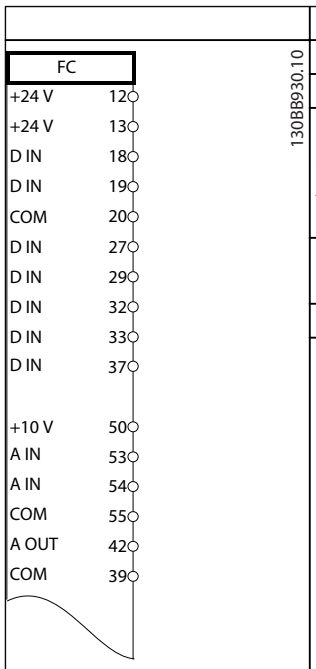
- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings
- Where switch settings for analog terminals A53 or A54 are required, these are also shown

6.2 Application Examples



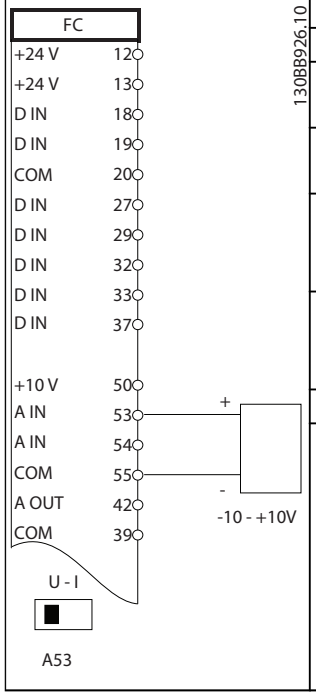
	Parameters	
	Function	**Setting**
	1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
	5-12 Terminal 27 Digital Input	[2]* Coast inverse
	* = Default Value	
	Notes/comments: Parameter group 1-2* must be set according to motor D IN 37 is an option.	

Table 6.1 AMA with T27 Connected



	Parameters	
	Function	**Setting**
	1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
	5-12 Terminal 27 Digital Input	[0] No operation
	* = Default Value	
	Notes/comments: Parameter group 1-2* must be set according to motor D IN 37 is an option.	

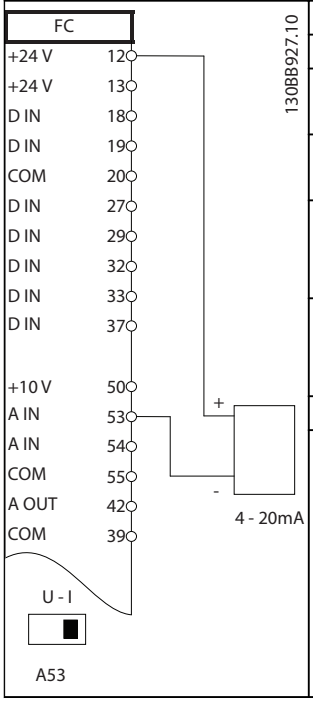
Table 6.2 AMA without T27 Connected



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

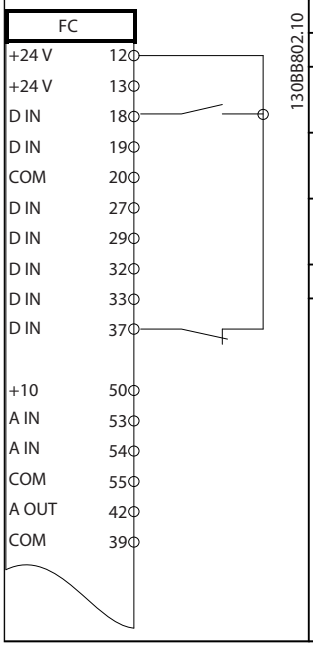
Table 6.3 Analog Speed Reference (Voltage)

6



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

Table 6.4 Analog Speed Reference (Current)



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

Table 6.5 Start/Stop Command with Safe Stop Option

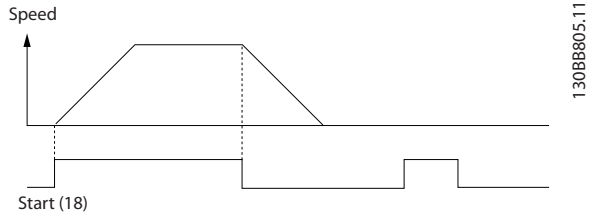
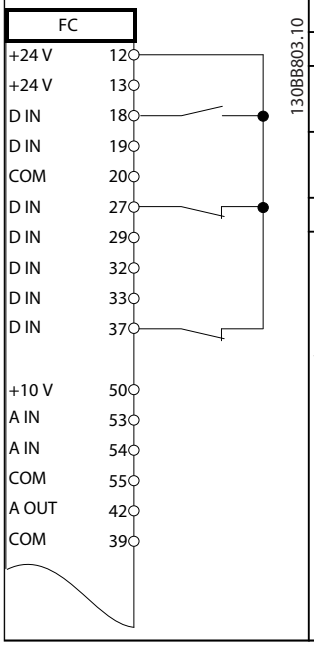


Illustration 6.1 Start/Stop Command with Safe Stop



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

Table 6.6 Pulse Start/Stop

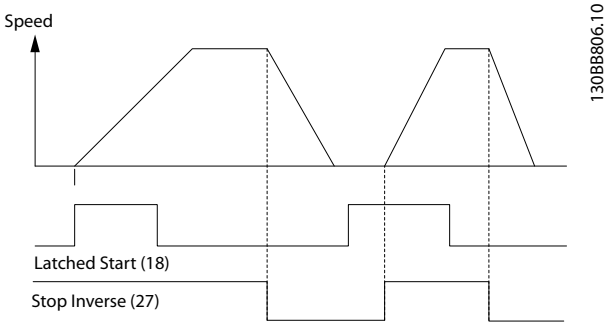
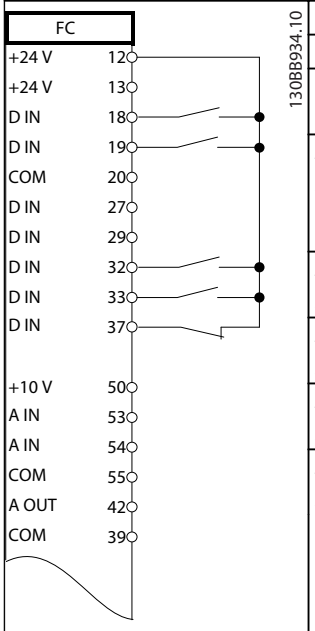
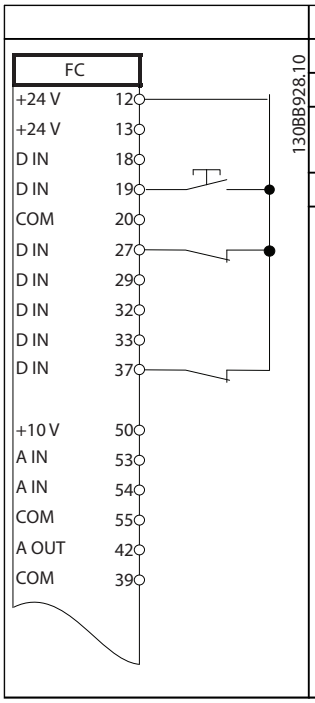


Illustration 6.2 Latched Start/Stop Inverse



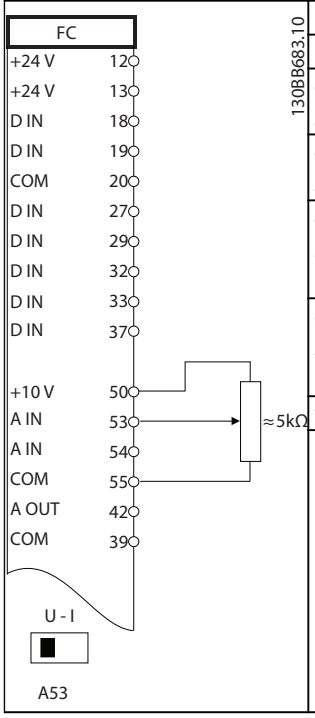
Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start
5-11 Terminal 19 Digital Input	[10] Reversing*
5-12 Terminal 27 Digital Input	[0] No operation
5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
3-10 Preset Reference	
Preset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

Table 6.7 Start/Stop with Reversing and 4 Preset Speeds



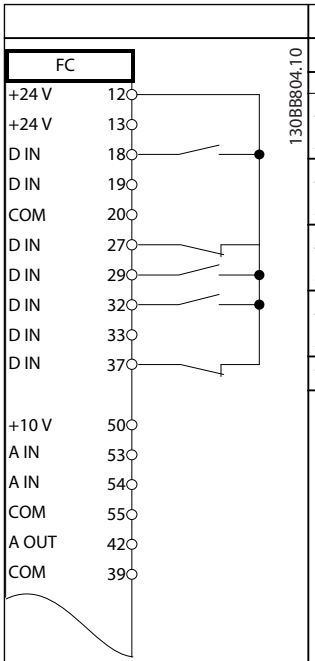
Parameters	
Function	**Setting**
5-11 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments: D IN 37 is an option.	

Table 6.8 External Alarm Reset



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

Table 6.9 Speed Reference (using a Manual Potentiometer)



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

Table 6.10 Speed Up/Down

6

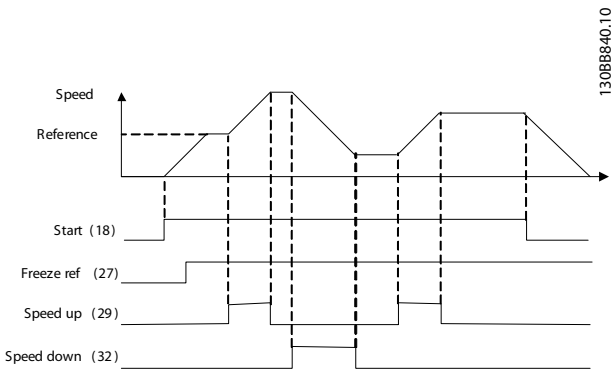
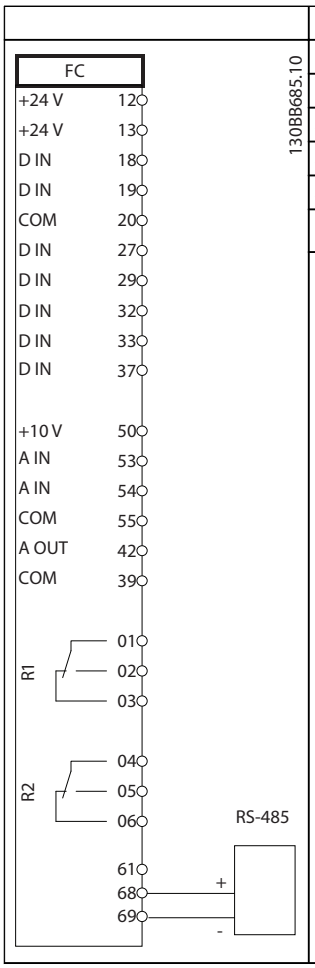
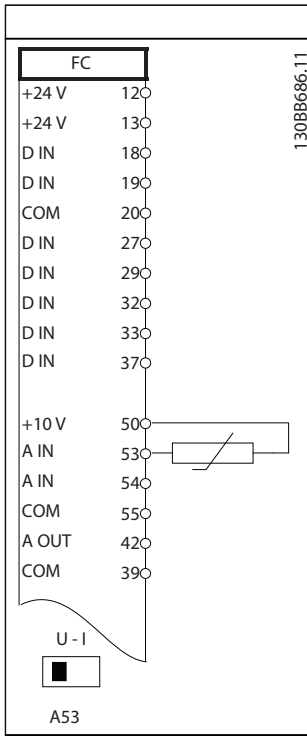


Illustration 6.3 Speed Up/Down



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

Table 6.11 RS-485 Network Connection



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

Table 6.12 Motor Thermistor

CAUTION

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

7 Status Messages

7.1 Status Display

When the frequency converter is in status mode, status messages are generated automatically from within the frequency converter and appear in the bottom line of the display (see *Illustration 7.1*.)

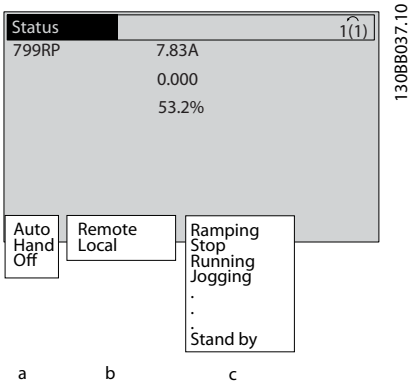


Illustration 7.1 Status Display

a. The first part of the status line indicates where the stop/start command originates.

b. The second part of the status line indicates where the speed control originates.

c. The last part of the status line gives the present frequency converter status. These show the operational mode the frequency converter is in.

NOTE

In auto/remote mode, the frequency converter requires external commands to execute functions.

7.2 Status Message Definitions

The next three tables define the meaning of the status message display words.

	Operation Mode
Off	The frequency converter does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The frequency converter is controlled from the control terminals and/or the serial communication.
Hand On	The navigation keys on the LCP control the frequency converter. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals can override local control.

Table 7.1 Status Message Operation Mode

	Reference Site
Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand On] control or reference values from the LCP.

Table 7.2 Status Message Reference Site

	Operation Status
AC Brake	AC Brake was selected in *2-10 Brake Function*. The AC brake over-magnetizes the motor to achieve a controlled slow down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *2-12 Brake Power Limit (kW)* has been reached.
Coast	• Coast inverse was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication

7

	Operation Status
Ctrl. Ramp-down	Control Ramp-down was selected in *14-10 Mains Failure*. • The mains voltage is below the value set in *14-11 Mains Voltage at Mains Fault* at mains fault • The frequency converter ramps down the motor using a controlled ramp down
Current High	The frequency converter output current is above the limit set in *4-51 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *4-52 Warning Speed Low*
DC Hold	DC hold is selected in *1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *2-00 DC Hold/ Preheat Current*.
DC Stop	The motor is held with a DC current (*2-01 DC Brake Current*) for a specified time (*2-02 DC Braking Time*). • DC Brake is activated in *2-03 DC Brake Cut In Speed [RPM]* and a Stop command is active. • DC Brake (inverse) is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The DC Brake is activated via serial communication.
Feedback high	The sum of all active feedback is above the feedback limit set in *4-57 Warning Feedback High*.
Feedback low	The sum of all active feedback is below the feedback limit set in *4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • Freeze output was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal functions Speed Up and Speed Down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but until a run permissive signal is received, the motor remains stopped.

	Operation Status
Freeze ref.	*Freeze Reference* was chosen as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal functions Speed Up and Speed Down.
Jog request	A jog command has been given, but until a run permissive signal is received via a digital input, the motor is stopped
Jogging	The motor is running as programmed in *3-19 Jog Speed [RPM]*. • *Jog* was selected as function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal (for example, Terminal 29) is active. • The Jog function is activated via the serial communication. • The Jog function was selected as a reaction for a monitoring function (for example, No signal). The monitoring function is active.
Motor check	In *1-80 Function at Stop*, *Motor Check* was selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
OVC control	*Overvoltage* control was activated in *2-17 Overvoltage Control*. The connected motor is supplying the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(For frequency converters with an external 24 V power supply installed only.) Mains supply to the frequency converter is removed, but the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s • Protection mode can be restricted in *14-26 Trip Delay at Inverter Fault*

	Operation Status
QStop	The motor is decelerating using *3-81 Quick Stop Ramp Time*. • *Quick stop inverse* was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active Ramp Up/Down. The reference, a limit value or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *4-54 Warning Reference Low*.
Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The frequency converter runs the motor.
Sleep Mode	The energy saving function is enabled. The motor has stopped, but will restart automatically when required.
Speed high	Motor speed is above the value set in *4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *4-52 Warning Speed Low*.
Standby	In Auto On Auto mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.
Start delay	In *1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor will start after the start delay time expires.
Start fwd/rev	Start forward and start reverse were selected as functions for two different digital inputs (parameter group *5-1* Digital Inputs*). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	The frequency converter has received a stop command from the LCP, digital input or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the frequency converter. The frequency converter can then be reset manually by pressing [Reset] or remotely by control terminals or serial communication.

Table 7.3 Status Message Operation Status

7

8 Warnings and Alarms

8.1 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.

8.2 Warning and Alarm Types

Warnings

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

Alarms

Trip

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] on the LCP
- Digital reset input command
- Serial communication reset input command
- Auto reset

An alarm that causes the frequency converter to trip-lock requires that input power is cycled. The motor will coast to a stop. The frequency converter logic will continue to operate and monitor the frequency converter status. Remove input power to the frequency converter and correct the cause of the fault, then restore power. This action puts the frequency converter into a trip condition as described above and may be reset in any of those 4 ways.

8.3 Warning and Alarm Displays

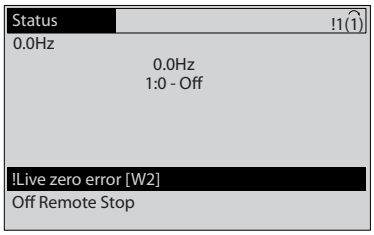


Illustration 8.1 Warning Display

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

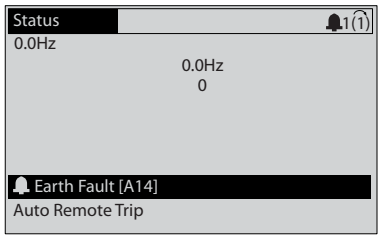


Illustration 8.2 Alarm Display

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

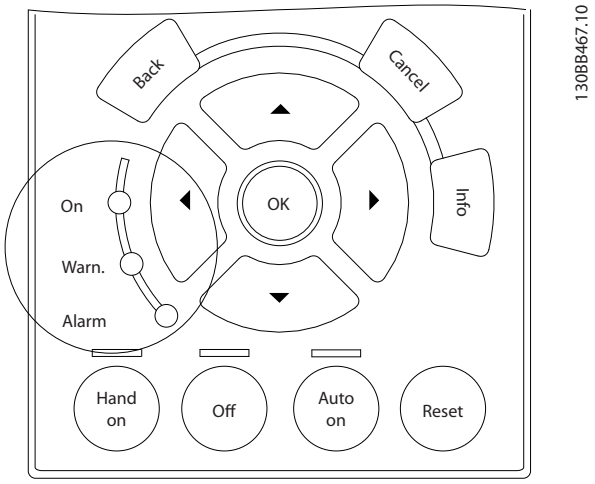


Illustration 8.3 Status Indicator Lights

	Warning LED	Alarm LED
Warning	On	Off
Alarm	Off	On (Flashing)
Trip-Lock	On	On (Flashing)

Table 8.1 Status Indicator Lights Explanations

8.4 Warning and Alarm Definitions

Table 8.2 defines whether a warning is issued before an alarm, and whether the alarm trips the unit or trip locks the unit.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01 Live Zero Timeout Function
4	Mains phase loss	(X)	(X)	(X)	14-12 Function at Mains Imbalance
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over voltage	X	X		
8	DC under voltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		1-90 Motor Thermal Protection
11	Motor thermistor over temperature	(X)	(X)		1-90 Motor Thermal Protection
12	Torque limit	X	X		
13	Over Current	X	X	X	
14	Earth (Ground) fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word timeout	(X)	(X)		8-04 Control Timeout Function
18	Start Failed		X		1-77 Compressor Start Max Speed [RPM], 1-79 Compressor Start Max Time to Trip, 1-03 Torque Characteristics
23	Internal Fan Fault	X			
24	External Fan Fault	X			14-53 Fan Monitor
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13 Brake Power Monitoring
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15 Brake Check
29	Drive over temperature	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
31	Motor phase V missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
32	Motor phase W missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Out of frequency range	X	X		
36	Mains failure	X	X		
37	Phase Imbalance	X	X		
38	Internal fault		X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			5-00 Digital I/O Mode, 5-01 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			5-00 Digital I/O Mode, 5-02 Terminal 29 Mode
42	Overload of Digital Output On X30/6	(X)			5-32 Term X30/6 Digi Out (MCB 101)
42	Overload of Digital Output On X30/7	(X)			5-33 Term X30/7 Digi Out (MCB 101)
46	Pwr. card supply		X	X	
47	24V supply low	X	X	X	
48	1.8V supply low		X	X	
49	Speed limit	X	(X)		1-86 Trip Speed Low [RPM]
50	AMA calibration failed		X		
51	AMA check U_{nom} and I_{nom}		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA Parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External Interlock	X			
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 Safe Stop	X	X[1)]		
72	Dangerous Failure			X[1)]	
73	Safe Stop Auto Restart				
76	Power Unit Setup	X			
77	Reduced Power Mode				
79	Illegal PS config		X	X	
80	Drive Initialized to Default Value		X		
91	Analog input 54 wrong settings			X	
92	NoFlow	X	X		22-2*
93	Dry Pump	X	X		22-2*
94	End of Curve	X	X		22-5*
95	Broken Belt	X	X		22-6*
96	Start Delayed	X			22-7*
97	Stop Delayed	X			22-7*
98	Clock Fault	X			0-7*
201	Fire M was Active				
202	Fire M Limits Exceeded				
203	Missing Motor				
204	Locked Rotor				
243	Brake IGBT	X	X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare parts			X	
251	New Type Code		X	X	

Table 8.2 Alarm/Warning Code List

(X) Dependent on parameter

1) Cannot be Auto reset via 14-20 Reset Mode

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

WARNING 1, 10 Volts low
The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

This condition can be caused by a short in a connected potentiometer or improper wiring of the potentiometer.

Troubleshooting
Remove the wiring from terminal 50. If the warning clears, the problem is with the customer wiring. If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed by the user in *6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. MCB 101 terminals 11 and 12 for signals, terminal 10 common. MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).

Check that the frequency converter programming and switch settings match the analog signal type.

Perform Input Terminal Signal Test.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier on the frequency converter. Options are programmed at *14-12 Function at Mains Imbalance*.

Troubleshooting
Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high
The intermediate circuit voltage (DC) is higher than the high voltage warning limit. The limit is dependent on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The intermediate circuit voltage (DC) is lower than the low voltage warning limit. The limit is dependent on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the frequency converter trips after a time.

Troubleshooting

Connect a brake resistor

Extend the ramp time

Change the ramp type

Activate the functions in *2-10 Brake Function*

Increase *14-26 Trip Delay at Inverter Fault*

If the alarm/warning occurs during a power sag the solution is to use kinetic back-up (*14-10 Mains Failure*)

WARNING/ALARM 8, DC under voltage
If the intermediate circuit voltage (DC link) drops below the under voltage limit, the frequency converter checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

Check that the supply voltage matches the frequency converter voltage.

Perform input voltage test.

Perform soft charge circuit test.

WARNING/ALARM 9, Inverter overload
The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection issues a warning at 98% and trips at 100%, while giving an alarm. The frequency converter *cannot* be reset until the counter is below 90%.
The fault is that the frequency converter has run with more than 100% overload for too long.

Troubleshooting

Compare the output current shown on the LCP with the frequency converter rated current.

Compare the output current shown on the LCP with measured motor current.

Display the Thermal Drive Load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter increases. When running below the frequency converter continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature

According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded

Check that the motor current set in *1-24 Motor Current* is correct.

Ensure that Motor data in parameters 1-20 through 1-25 are set correctly.

If an external fan is in use, check in *1-91 Motor External Fan* that it is selected.

Running AMA in *1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp

Check whether the thermistor is disconnected. Select whether the frequency converter issues a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check *1-93 Thermistor Source* selects terminal 53 or 54.

When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50. Check *1-93 Thermistor Source* selects terminal 18 or 19.

WARNING/ALARM 12, Torque limit

The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this from a warning only condition to a warning followed by an alarm.

Troubleshooting

If the motor torque limit is exceeded during ramp up, extend the ramp up time.

If the generator torque limit is exceeded during ramp down, extend the ramp down time.

If torque limit occurs while running, possibly increase the torque limit. Make sure that the system can operate safely at a higher torque.

Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. This fault can be caused by shock loading or quick acceleration with high inertia loads. It can also appear after kinetic back-up if the acceleration during ramp up is quick. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

Remove power and check if the motor shaft can be turned.

Check that the motor size matches the frequency converter.

Check parameters 1-20 to 1-25 for correct motor data.

ALARM 14, Earth (ground) fault

There is current from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting:

Remove power to the frequency converter and repair the earth fault.

Check for earth faults in the motor by measuring the resistance to ground of the motor leads and the motor with a megohmmeter.

ALARM 15, Hardware mismatch

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact your Danfoss supplier:

15-40 FC Type

15-41 Power Section

15-42 Voltage

15-43 Software Version

15-45 Actual Typecode String

15-49 SW ID Control Card

15-50 SW ID Power Card

15-60 Option Mounted

15-61 Option SW Version (for each option slot)

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

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

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter. The warning is only active when *8-04 Control Word Timeout Function* is NOT set to *[0] Off*.
If *8-04 Control Word Timeout Function* is set to *[5] Stop and Trip*, a warning appears and the frequency converter ramps down until it stops then displays an alarm.

Troubleshooting:

Check connections on the serial communication cable.

Increase *8-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify a proper installation based on EMC requirements.

ALARM 18, Start failed
The speed has not been able to exceed *AP-70 Compressor Start Max Speed [RPM]* during start within the allowed time. (set in *AP-72 Compressor Start Max Time to Trip*). This may be caused by a blocked motor.

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (*[0] Disabled*).

For the D, E, and F Frame filters, the regulated voltage to the fans is monitored.

Troubleshooting

Check for proper fan operation.

Cycle power to the frequency converter and check that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (*[0] Disabled*).

Troubleshooting

Check for proper fan operation.

Cycle power to the frequency converter and check that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational but without the brake function. Remove power to the frequency converter and replace the brake resistor (see *2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 seconds of run time. The calculation is based on the intermediate circuit voltage and the brake resistance value set in *2-16 AC brake Max. Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and if a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational but, since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Remove power to the frequency converter and remove the brake resistor.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working.
Check *2-15 Brake Check*.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault will not reset until the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the frequency converter power size.

Troubleshooting
Check for the following conditions.

Ambient temperature too high.

Motor cable too long.

Incorrect airflow clearance above and below the frequency converter.

Blocked airflow around the frequency converter.

Damaged heatsink fan.

Dirty heatsink.

ALARM 30, Motor phase U missing
Motor phase U between the frequency converter and the motor is missing.

Remove power from the frequency converter and check motor phase U.

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ALARM 31, Motor phase V missing
Motor phase V between the frequency converter and the motor is missing.

Remove power from the frequency converter and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the frequency converter and the motor is missing.

Remove power from the frequency converter and check motor phase W.

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault
The fieldbus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
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*. Check the fuses to the frequency converter and mains power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 8.3* is displayed.

Troubleshooting

Cycle power

Check that the option is properly installed

Check for loose or missing wiring

It may be necessary to contact your Danfoss supplier or service department. Note the code number for further troubleshooting directions.

No.	Text
0	Serial port cannot be initialised. Contact your Danfoss supplier or Danfoss Service Department.
256-258	Power EEPROM data is defective or too old. Replace power card.
512-519	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your Danfoss supplier or the Danfoss Service Department.
1299	Option SW in slot A is too old
1300	Option SW in slot B is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1379-2819	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
2561	Replace control card
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware
5376-6231	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.

Table 8.3 Internal Fault Codes

ALARM 39, Heatsink sensor
No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 45, Earth fault 2
Earth (ground) fault on start-up.

Troubleshooting

Check for proper earthing (grounding) and loose connections.

Check for proper wire size.

Check motor cables for short-circuits or leakage currents.

ALARM 46, Power card supply
The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with three phase mains voltage, all three supplies are monitored.

Troubleshooting

Check for a defective power card.

Check for a defective control card.

Check for a defective option card.

If a 24 V DC power supply is used, verify proper supply power.

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card. The external 24 V DC backup power supply may be overloaded, otherwise contact the Danfoss supplier.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the frequency converter shows a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping) the frequency converter will trip.

ALARM 50, AMA calibration failed
Contact your Danfoss supplier or Danfoss Service Department.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current and motor power are wrong. Check the settings in parameters 1-20 to 1-25.

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings.

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

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

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

ALARM 56, AMA interrupted by user
The user has interrupted the AMA.

ALARM 57, AMA internal fault
Try to restart AMA again. Repeated restarts can over heat the motor.

ALARM 58, AMA internal fault
Contact your Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *4-18 Current Limit*. Ensure that Motor data in parameters 1-20 to 1-25 are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock
A digital input signal is indicating a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock. Reset the frequency converter.

WARNING 62, Output frequency at maximum limit
The output frequency has reached the value set in *4-19 Max Output Frequency*. Check the application to determine the cause. Possibly increase the output frequency limit. Be sure the system can operate safely at a higher output frequency. The warning will clear when the output drops below the maximum limit.

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

Troubleshooting

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

WARNING 66, Heatsink temperature low
The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module.
Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
Loss of the 24 V DC signal on terminal 37 has caused the filter to trip. To resume normal operation, apply 24 V DC to terminal 37 and reset the filter.

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

Check that the ambient operating temperature is within limits.

Check for clogged filters.

Check fan operation.

Check the power card.

ALARM 70, Illegal frequency converter configuration
The control card and power card are incompatible. Contact your supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 80, Drive initialised to default value
Parameter settings are initialised to default settings after a manual reset. Reset the unit to clear the alarm.

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ALARM 92, No flow
A no-flow condition has been detected in the system. *22-23 No-Flow Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 93, Dry pump
A no-flow condition in the system with the frequency converter operating at high speed may indicate a dry pump. *22-26 Dry Pump Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 94, End of curve
Feedback is lower than the set point. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *22-60 Broken Belt Function* is set for alarm. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 96, Start delayed
Motor start has been delayed due to short-cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

WARNING 97, Stop delayed
Stopping the motor has been delayed due to short cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

WARNING 98, Clock fault
Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 200, Fire mode
This warning indicates the frequency converter is operating in fire mode. The warning clears when fire mode is removed. See the fire mode data in the alarm log.

WARNING 201, Fire mode was active
This indicates the frequency converter had entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode one or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 203, Missing motor
With a frequency converter operating multi-motors, an under-load condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a frequency converter operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

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

WARNING 251, New typecode
The power card or other components have been replaced and the typecode changed. Reset to remove the warning and resume normal operation.

9 Basic Troubleshooting

9.1 Start Up and Operation

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See *Table 3.1*	Check the input power source
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes	Follow the recommendations provided
	No power to the LCP	Check the LCP cable for proper connection or damage	Replace the faulty LCP or connection cable
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55	Wire the terminals properly
	Wrong LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM)		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107)
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast
	Display (LCP) is defective	Test using a different LCP	Replace the faulty LCP or connection cable
	Internal voltage supply fault or SMPS is defective		Contact supplier
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the frequency converter	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch
	No mains power with 24 V DC option card	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit
	LCP Stop	Check if [Off] has been pressed	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting)	Apply a valid start signal to start the motor
	Motor coast signal active (Coasting)	Check *5-12 Coast inv*. for correct setting for terminal 27 (use default setting)..	Apply 24 V on terminal 27 or program this terminal to *No operation*
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.

Symptom	Possible cause	Test	Solution
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs.*.	Deactivate reversing signal
	Wrong motor phase connection		See *3.7 Check Motor Rotation* in this manual
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *4-13 Motor Speed High Limit [RPM]*, *4-14 Motor Speed High Limit [Hz]* and *4-19 Max Output Frequency*.	Program correct limits
	Reference input signal not scaled correctly	Check reference input signal scaling in *6-0* Analog I/O Mode* and parameter group *3-1* References*. Reference limits in parameter group *3-0* Reference Limit*.	Program correct settings
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings.	Check settings in parameter group *1-6* Analog I/O mode*. For closed loop operation, check settings in parameter group *20-0* Feedback*..
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters	Check motor settings in parameter groups *1-2* Motor Data*, *1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*.
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp down times	Check brake parameters. Check ramp time settings	Check parameter group *2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase for shorts	Eliminate any shorts detected
	Motor overload	Motor is overloaded for the application	Perform startup test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections	Tighten loose connections
Mains current imbalance greater than 3%	Problem with mains power (See *Alarm 4 Mains phase loss* description)	Rotate input power leads into the frequency converter 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	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 frequency converters	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.

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration (e.g. a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g. in the motor/fan system	Bypass critical frequencies by using parameters in parameter group *4-6* Speed Bypass*	Check if noise and/or vibration have been reduced to an acceptable limit
		Turn off over-modulation in *14-03 Overmodulation*	
		Change switching pattern and frequency in parameter group 14-0* Inverter Switching	
		Increase Resonance Dampening in *1-64 Resonance Dampening*	

Table 9.1 Troubleshooting

10 Specifications

10.1 Power-dependent Specifications

Mains supply 200-240 V AC - Normal overload 110% for 1 minute					
Frequency converter	P1K1	P1K5	P2K2	P3K0	P3K7
Typical Shaft Output [kW]	1.1	1.5	2.2	3	3.7
IP20/Chassis (A2+A3 may be converted to IP21 using a conversion kit. (See also *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))	A2	A2	A2	A3	A3
IP55/Type 12	A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X	A4/A5	A4/A5	A4/A5	A5	A5
Typical Shaft Output [HP] at 208 V	1.5	2.0	2.9	4.0	4.9
Output current					
Continuous (3 x 200-240 V) [A]	6.6	7.5	10.6	12.5	16.7
Intermittent (3 x 200-240 V) [A]	7.3	8.3	11.7	13.8	18.4
Continuous kVA (208 V AC) [kVA]	2.38	2.70	3.82	4.50	6.00
Max. input current					
Continuous (3 x 200-240 V) [A]	5.9	6.8	9.5	11.3	15.0
Intermittent (3 x 200-240 V) [A]	6.5	7.5	10.5	12.4	16.5
Additional specifications					
Estimated power loss at rated max. load [W] [4]	63	82	116	155	185
IP20, IP21 max. cable cross section (mains, motor, brake and load sharing) [mm^2 (AWG)]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))				
IP55, IP66 max. cable cross section (mains, motor, brake and load sharing) [mm^2 (AWG)]	4, 4, 4 (12, 12, 12)				
Max. cable cross section with disconnect	6, 4, 4 (10, 12, 12)				
Weight enclosure IP20 [kg]	4.9	4.9	4.9	6.6	6.6
Weight enclosure IP21 [kg]	5.5	5.5	5.5	7.5	7.5
Weight enclosure IP55 [kg] (A4/A5)	9.7/13.5	9.7/13.5	9.7/13.5	13.5	13.5
Weight enclosure IP66 [kg] (A4/A5)	9.7/13.5	9.7/13.5	9.7/13.5	13.5	13.5
Efficiency [3]	0.96	0.96	0.96	0.96	0.96

Table 10.1 Mains Supply 200-240 V AC

Mains Supply 3x200-240 V AC - Normal overload 110% for 1 minute					
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit. (See also items *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))	B3	B3	B3	B4	B4
IP21/NEMA 1	B1	B1	B1	B2	C1
IP55/Type 12	B1	B1	B1	B2	C1
IP66/NEMA 4X	B1	B1	B1	B2	C1
Frequency converter	P5K5	P7K5	P11K	P15K	P18K
Typical Shaft Output [kW]	5.5	7.5	11	15	18.5
Typical Shaft Output [HP] at 208 V	7.5	10	15	20	25
Output current					
Continuous (3 x 200-240 V) [A]	24.2	30.8	46.2	59.4	74.8
Intermittent (3 x 200-240 V) [A]	26.6	33.9	50.8	65.3	82.3
Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9
Max. input current					
Continuous (3 x 200-240 V) [A]	22.0	28.0	42.0	54.0	68.0
Intermittent (3 x 200-240 V) [A]	24.2	30.8	46.2	59.4	74.8
Additional Specifications					
Estimated power loss at rated max. load [W] [4]	269	310	447	602	737
IP20 max. cable cross-section (mains, brake, motor and load sharing)	10, 10 (8,8-)		35,-,- (2,-,-)	35 (2)	50 (1)
IP21, IP55, IP66 max. cable cross-section (mains, motor) [mm²/AWG]	10, 10 (8,8-)		35, 25, 25 (2, 4, 4)	50 (1)	
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm²/AWG]	16, 10, 16 (6, 8, 6)		35,-,- (2,-,-)	50 (1)	
Weight enclosure IP20 [kg]	12	12	12	23.5	23.5
Weight enclosure IP21 [kg]	23	23	23	27	45
Weight enclosure IP55 [kg]	23	23	23	27	45
Weight enclosure IP66 [kg]	23	23	23	27	45
Efficiency [3]	0.96	0.96	0.96	0.96	0.96

Table 10.2 Mains Supply 3x200-240 V AC

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Mains Supply 3x200-240 V AC - Normal overload 110% for 1 minute				
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit. (See also items *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))	C3	C3	C4	C4
IP21/NEMA 1	C1	C1	C2	C2
IP55/Type 12	C1	C1	C2	C2
IP66/NEMA 4X	C1	C1	C2	C2
Frequency converter	P22K	P30K	P37K	P45K
Typical Shaft Output [kW]	22	30	37	45
Typical Shaft Output [HP] at 208 V	30	40	50	60
Output current				
Continuous (3 x 200-240 V) [A]	88.0	115	143	170
Intermittent (3 x 200-240 V) [A]	96.8	127	157	187
Continuous kVA (208 V AC) [kVA]	31.7	41.4	51.5	61.2
Max. input current				
Continuous (3 x 200-240 V) [A]	80.0	104.0	130.0	154.0
Intermittent (3 x 200-240 V) [A]	88.0	114.0	143.0	169.0
Additional Specifications				
Estimated power loss at rated max. load [W] 4)	845	1140	1353	1636
IP20 max. cable cross-section (mains, brake, motor and load sharing)		150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (mains, motor) [mm^2/AWG]		150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm^2/AWG]		95 (3/0)		
Weight enclosure IP20 [kg]	35	35	50	50
Weight enclosure IP21 [kg]	45	45	65	65
Weight enclosure IP55 [kg]	45	45	65	65
Weight enclosure IP66 [kg]	45	45	65	65
Efficiency 3)	0.97	0.97	0.97	0.97

Table 10.3 Mains Supply 3x200-240 V AC

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Mains Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute							
Frequency converter	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]	1.1	1.5	2.2	3	4	5.5	7.5
Typical Shaft Output [HP] at 460 V	1.5	2.0	2.9	4.0	5.0	7.5	10
IP 20/Chassis (A2+A3 may be converted to IP21 using a conversion kit. (Please see also items *Mechanical mounting* and *IP 21/Type 1 Enclosure kit* in the Design Guide.))	A2	A2	A2	A2	A2	A3	A3
IP55/Type 12	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current							
Continuous (3 x 380-440 V) [A]	3	4.1	5.6	7.2	10	13	16
Intermittent (3 x 380-440 V) [A]	3.3	4.5	6.2	7.9	11	14.3	17.6
Continuous (3 x 441-480 V) [A]	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (3 x 441-480 V) [A]	3.0	3.7	5.3	6.9	9.0	12.1	15.4
Continuous kVA (400 V AC) [kVA]	2.1	2.8	3.9	5.0	6.9	9.0	11.0
Continuous kVA (460 V AC) [kVA]	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Max. input current							
Continuous (3 x 380-440 V) [A]	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (3 x 380-440 V) [A]	3.0	4.1	5.5	7.2	9.9	12.9	15.8
Continuous (3 x 441-480 V) [A]	2.7	3.1	4.3	5.7	7.4	9.9	13.0
Intermittent (3 x 441-480 V) [A]	3.0	3.4	4.7	6.3	8.1	10.9	14.3
Additional specifications							
Estimated power loss at rated max. load [W] 4)	58	62	88	116	124	187	255
IP20, IP21 max. cable cross section (mains, motor, brake and load sharing) [mm²/AWG] 2)	4, 4, 4 (12, 12, 12) (min. 0.2 (24))						
IP55, IP66 max. cable cross section (mains, motor, brake and load sharing) [mm²/AWG] 2)	4, 4, 4 (12, 12, 12)						
Max. cable cross section with disconnect	6, 4, 4 (10, 12, 12)						
Weight enclosure IP20 [kg]	4.8	4.9	4.9	4.9	4.9	6.6	6.6
Weight enclosure IP21 [kg]							
Weight enclosure IP55 [kg] (A4/A5)	9.7/13.5	9.7/13.5	9.7/13.5	9.7/13.5	9.7/13.5	14.2	14.2
Weight enclosure IP66 [kg] (A4/A5)	9.7/13.5	9.7/13.5	9.7/13.5	9.7/13.5	9.7/13.5	14.2	14.2
Efficiency 3)	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 10.4 Mains Supply 3 x 380-480 V AC

Mains Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute					
Frequency converter	P11K	P15K	P18K	P22K	P30K
Typical Shaft Output [kW]	11	15	18.5	22	30
Typical Shaft Output [HP] at 460 V	15	20	25	30	40
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss)	B3	B3	B3	B4	B4
IP21/NEMA 1	B1	B1	B1	B2	B2
IP55/Type 12	B1	B1	B1	B2	B2
IP66/NEMA 4X	B1	B1	B1	B2	B2
Output current					
Continuous (3 x 380-439 V) [A]	24	32	37.5	44	61
Intermittent (3 x 380-439 V) [A]	26.4	35.2	41.3	48.4	67.1
Continuous (3 x 440-480 V) [A]	21	27	34	40	52
Intermittent (3 x 440-480 V) [A]	23.1	29.7	37.4	44	61.6
Continuous kVA (400 V AC) [kVA]	16.6	22.2	26	30.5	42.3
Continuous kVA 460 V AC) [kVA]	16.7	21.5	27.1	31.9	41.4
Max. input current					
Continuous (3 x 380-439 V) [A]	22	29	34	40	55
Intermittent (3 x 380-439 V) [A]	24.2	31.9	37.4	44	60.5
Continuous (3 x 440-480 V) [A]	19	25	31	36	47
Intermittent (3 x 440-480 V) [A]	20.9	27.5	34.1	39.6	51.7
Additional specifications					
Estimated power lossat rated max. load [W] [4]	278	392	465	525	698
IP20 max. cable cross-section (mains, brake, motor and load sharing)	16, 10, - (8, 8, -)		35, -, - (2, -, -)		35 (2)
IP21, IP55, IP66 max. cable cross-section (mains, motor) [mm^2 (AWG)]	10, 10, 16 (6, 8, 6)		35, 25, 25 (2, 4, 4)		50 (1)
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm^2 (AWG)]	10, 10, - (8, 8, -)		35, -, - (2, -, -)		50 (1)
With mains disconnect switch included:	16/6				
Weight enclosure IP20 [kg]	12	12	12	23.5	23.5
Weight enclosure IP21 [kg]	23	23	23	27	27
Weight enclosure IP55 [kg]	23	23	23	27	27
Weight enclosure IP66 [kg]	23	23	23	27	27
Efficiency [3]	0.98	0.98	0.98	0.98	0.98

Table 10.5 Mains Supply 3 x 380-480 V AC

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Mains Supply 3 x 380-480 V AC - Normal overload 110% for 1 minute					
Frequency converter	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	37	45	55	75	90
Typical Shaft Output [HP] at 460 V	50	60	75	100	125
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss)	B4	C3	C3	C4	C4
IP21/NEMA 1	C1	C1	C1	C2	C2
IP55/Type 12	C1	C1	C1	C2	C2
IP66/NEMA 4X	C1	C1	C1	C2	C2
Output current					
Continuous (3 x 380-439 V) [A]	73	90	106	147	177
Intermittent (3 x 380-439 V) [A]	80.3	99	117	162	195
Continuous (3 x 440-480 V) [A]	65	80	105	130	160
Intermittent (3 x 440-480 V) [A]	71.5	88	116	143	176
Continuous kVA (400 V AC) [kVA]	50.6	62.4	73.4	102	123
Continuous kVA 460 V AC) [kVA]	51.8	63.7	83.7	104	128
Max. input current					
Continuous (3 x 380-439 V) [A]	66	82	96	133	161
Intermittent (3 x 380-439 V) [A]	72.6	90.2	106	146	177
Continuous (3 x 440-480 V) [A]	59	73	95	118	145
Intermittent (3 x 440-480 V) [A]	64.9	80.3	105	130	160
Additional specifications					
Estimated power lossat rated max. load [W] [4]	739	843	1083	1384	1474
IP20 max. cable cross-section (mains, brake, motor and load sharing)	50 (1)		150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (mains, motor) [mm^2 (AWG)]			150 (300 MCM)		
IP21, IP55, IP66 max. cable cross-section (brake, load sharing) [mm^2 (AWG)]			95 (3/0)		
With mains disconnect switch included:	35/2	35/2		70/3/0	185/ kcmil350
Weight enclosure IP20 [kg]	23.5	35	35	50	50
Weight enclosure IP21 [kg]	45	45	45	65	65
Weight enclosure IP55 [kg]	45	45	45	65	65
Weight enclosure IP66 [kg]	45	45	45	65	65
Efficiency [3]	0.98	0.98	0.98	0.98	0.99

Table 10.6 Mains Supply 3 x 380-480 V AC

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Mains supply 3 x 525-600 V AC Normal overload 110% for 1 minute									
Size:	P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5	P11K
Typical Shaft Output [kW]	1.1	1.5	2.2	3	3.7	4	5.5	7.5	11
IP20/Chassis	A3	A3	A3	A3	A2	A3	A3	A3	B3
IP21/NEMA 1	A3	A3	A3	A3	A2	A3	A3	A3	B1
IP55/Type 12	A5	A5	A5	A5	A5	A5	A5	A5	B1
IP66/NEMA 4X	A5	A5	A5	A5	A5	A5	A5	A5	B1
Output current									
Continuous (3 x 525-550 V) [A]	2.6	2.9	4.1	5.2	-	6.4	9.5	11.5	19
Intermittent (3 x 525-550 V) [A]	2.9	3.2	4.5	5.7	-	7.0	10.5	12.7	21
Continuous (3 x 525-600 V) [A]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	18
Intermittent (3 x 525-600 V) [A]	2.6	3.0	4.3	5.4	-	6.7	9.9	12.1	20
Continuous kVA (525V AC) [kVA]	2.5	2.8	3.9	5.0	-	6.1	9.0	11.0	18.1
Continuous kVA (575V AC) [kVA]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	17.9
Max. input current									
Continuous (3 x 525-600 V) [A]	2.4	2.7	4.1	5.2	-	5.8	8.6	10.4	17.2
Intermittent (3 x 525-600 V) [A]	2.7	3.0	4.5	5.7	-	6.4	9.5	11.5	19
Additional specifications									
Estim. power loss at rated max. load [W] [4]	50	65	92	122	-	145	195	261	300
IP20 max. cable cross-section (mains, motor, brake and load sharing) [mm²]/[AWG]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))								
IP55, IP66 max. cable cross-section (mains, motor, brake and load sharing) [mm²]/[AWG]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))								
Max. cable cross-section with disconnect	6, 4, 4 (12, 12, 12)								
Mains disconnect switch included:	4/12								
Weight IP20 [kg]	6.5	6.5	6.5	6.5	-	6.5	6.6	6.6	12
Weight IP21/55 [kg]	13.5	13.5	13.5	13.5	13.5	13.5	14.2	14.2	23
Efficiency [4]	0.97	0.97	0.97	0.97	-	0.97	0.97	0.97	0.98

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Table 10.7 [5] With brake and load sharing 95 / 4/0

Mains supply 3 x 525-600 V AC Normal overload 110% for 1 minute									
Size:	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	15	18.5	22	30	37	45	55	75	90
IP20/Chassis	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current									
Continuous (3 x 525-550 V) [A]	23	28	36	43	54	65	87	105	137
Intermittent (3 x 525-550 V) [A]	25	31	40	47	59	72	96	116	151
Continuous (3 x 525-600 V) [A]	22	27	34	41	52	62	83	100	131
Intermittent (3 x 525-600 V) [A]	24	30	37	45	57	68	91	110	144
Continuous kVA (525V AC) [kVA]	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
Continuous kVA (575V AC) [kVA]	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. input current									
Continuous (3 x 525-600 V) [A]	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
Intermittent (3 x 525-600 V) [A]	23	28	36	43	54	65	87	105	137
Additional specifications									
Estim. power loss at rated max. load [W] [4]	400	475	525	700	750	850	1100	1400	1500
IP20 max. cable cross-section (mains, motor, brake and load sharing) [mm^2]/[AWG]									
IP55, IP66 max. cable cross-section (mains, motor, brake and load sharing) [mm^2]/[AWG]									
Max. cable cross-section with disconnect									
Mains disconnect switch included:									
Weight IP20 [kg]	12	12	23.5	23.5	23.5	35	35	50	50
Weight IP21/55 [kg]	23	23	27	27	27	45	45	65	65
Efficiency [4]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 10.8 [5] With brake and load sharing 95/ 4/0

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10.1.1 Mains Supply 3 x 525-690 V AC

Normal overload 110% for 1 minute							
Frequency Converter	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]	1.1	1.5	2.2	3	4	5.5	7.5
Enclosure IP20 (only)	A3	A3	A3	A3	A3	A3	A3
Output current							
Continuous (3x525-550 V) [A]	2.1	2.7	3.9	4.9	6.1	9	11
Intermittent (3x525-550 V) [A]	2.3	3.0	4.3	5.4	6.7	9.9	12.1
Continuous kVA (3x551-690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10
Intermittent kVA (3x551-690 V) [A]	1.8	2.4	3.5	4.9	6.0	8.2	11
Continuous kVA 525 V AC	1.9	2.6	3.8	5.4	6.6	9	12
Continuous kVA 690 V AC	1.9	2.6	3.8	5.4	6.6	9	12
Max. input current							
Continuous (3x525-550 V) [A]	1.9	2.4	3.5	4.4	5.5	8	10
Intermittent (3x525-550 V) [A]	2.1	2.6	3.8	8.4	6.0	8.8	11
Continuous kVA (3x551-690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9
Intermittent kVA (3x551-690 V) [A]	1.5	2.2	3.2	4.4	5.4	7.4	9.9
Additional specifications							
IP20 max. cable cross section[5] (mains, motor, brake and load sharing) [mm²]/(AWG)	[0.2-4]/(24-10)						
Estimated power loss at rated max. load [W] [4]	44	60	88	120	160	220	300
Weight, enclosure IP20 [kg]	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Efficiency [4]	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Table 10.9 Mains Supply 3 x 525-690 V AC

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Normal overload 110% for 1 minute						
Frequency converter	P11K	P15K	P18K	P22K	P45K	P55K
Typical Shaft Output [kW]	15	18.5	22	30	45	55
Typical Shaft Output [HP] at 575 V	16.4	20.1	24	33	60	75
IP21/NEMA 1	B2	B2	B2	B2	-	-
IP55/NEMA 12	B2	B2	B2	B2	-	-
IP20/Chassis	-	-	-	-	C3	C3
Output current						
Continuous (3 x 525-550 V) [A]	19	23	28	36	54	65
Intermittent (3 x 525-550 V) [A]	20.9	25.3	30.8	39.6	59.4	71.5
Continuous (3 x 551-690 V) [A]	18	22	27	34	52	62
Intermittent (3 x 551-690 V) [A]	19.8	24.2	29.7	37.4	57.2	68.2
Continuous kVA (550 V AC) [kVA]	18.1	21.9	26.7	34.3	51.4	62
Continuous kVA (575 V AC) [kVA]	17.9	21.9	26.9	33.8	62.2	74.1
Continuous kVA (690 V AC) [kVA]	21.5	26.3	32.3	40.6	62.2	74.1
Max. input current						
Continuous (3 x 525-690 V) [A]	19.5	24	29	36	-	-
Intermittent (3 x 525-690 V) [A]	21.5	26.4	31.9	39.6	-	-
Continuous (3 x 525-550 V) [A]	-	-	-	-	52	63
Intermittent (3 x 525-550 V) [A]	-	-	-	-	57.2	69.3
Continuous (3 x 551-690 V) [A]	-	-	-	-	50	60
Intermittent (3 x 5251-690 V) [A]	-	-	-	-	55	66
Max. pre-fuses[1] [A]	63	63	63	80	100	125
Additional specifications						
Estimated power loss at rated max. load [W] [4]	285	335	375	430	592	720
Max. cable size (mains, motor, brake) [mm^2]/(AWG) [2]	[35]/(1/0)				[50]/(1)	
Weight IP21 [kg]	27	27	27	27	-	-
Weight IP55 [kg]	27	27	27	27	-	-
Weight IP20 [kg]	-	-	-	-	35	35
Efficiency [4]	0.98	0.98	0.98	0.98	0.98	0.98

Table 10.10 Mains Supply 3 x 525-690 V AC IP20-Chassis/IP21-IP55/NEMA 1-NEMA 12

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Normal overload 110% for 1 minute					
Frequency converter	P30K	P37K	P45K	P55K	P75K
Typical Shaft Output [kW]	37	45	55	75	90
Typical Shaft Output [HP] at 575 V	40	50	60	75	100
IP21/NEMA 1	C2	C2	C2	C2	C2
IP55/NEMA 12	C2	C2	C2	C2	C2
Output current					
Continuous (3 x 525-550 V) [A]	43	54	65	87	105
Intermittent (3 x 525-550 V) [A]	47.3	59.4	71.5	95.7	115.5
Continuous (3 x 551-690 V) [A]	41	52	62	83	100
Intermittent (3 x 551-690 V) [A]	45.1	57.2	68.2	91.3	110
Continuous kVA (550 V AC) [kVA]	41	51.4	61.9	82.9	100
Continuous kVA (575 V AC) [kVA]	40.8	51.8	61.7	82.7	99.6
Continuous kVA (690 V AC) [kVA]	49	62.1	74.1	99.2	119.5
Max. input current					
Continuous (3 x 525-690 V) [A]	49	59	71	87	99
Intermittent (3 x 525-690 V) [A]	53.9	64.9	78.1	95.7	108.9
Max. pre-fuses[1)] [A]	100	125	160	160	160
Additional specifications					
Estimated power loss at rated max. load [W] [4)]	592	720	880	1200	1440
Max. cable size (mains, motor, brake) [mm^2]/(AWG) [2)]		[95]/(4/0)			
Weight IP21 [kg]	65	65	65	65	65
Weight IP55 [kg]	65	65	65	65	65
Efficiency [4)]	0.98	0.98	0.98	0.98	0.98

Table 10.11 Mains Supply 3 x 525-690 V AC IP21-IP55/NEMA 1-NEMA 12

[1)] For type of fuse see 10.3 Fuse Tables

[2)] American Wire Gauge

[3)] Measured using 5 m screened motor cables at rated load and rated frequency

[4)] The typical power loss is at normal 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). Lower efficiency motors will also add to the power loss in the frequency converter and vice versa.

If the switching frequency is raised from nominal 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 typically only 4 W extra for a fully loaded control card or options for slot A or slot B, each).

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (±5%).

10.2 General Technical Data

Mains supply	
Supply Terminals	L1, L2, L3
Supply voltage	200-240 V ±10%
Supply voltage	380-480 V/525-600 V ±10%
Supply voltage	525-690 V ±10%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the FC continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the frequency converter's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cos ϕ)	near unity (> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 7.5 kW	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 11-75 kW	maximum 1 time/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ 90 kW	maximum 1 time/2 min.
Environment according to EN60664-1	overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240/500/600/690 V maximum.

Motor output (U, V, W)	
Output voltage	0 - 100% of supply voltage
Output frequency (1.1-90 kW)	0-590 Hz
Output frequency (110-250 kW)	0-590[1)] Hz
Switching on output	Unlimited
Ramp times	1-3600 s

[1)] Voltage and power dependent

Torque characteristics	
Starting torque (Constant torque)	maximum 110% for 60 s[1)]
Starting torque	maximum 135% up to 0.5 s[1)]
Overload torque (Constant torque)	maximum 110% for 60 s[1)]
Starting torque (Variable torque)	maximum 110% for 60 s[1)]
Overload torque (Variable torque)	maximum 110% for 60 s
Torque rise time in VVC^{plus} (independent of fsw)	10 ms

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

Cable lengths and cross sections for control cables[1)]	
Max. motor cable length, screened	150 m
Max. motor cable length, unscreened	300 m
Maximum cross section to control terminals, flexible/ rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross section to control terminals	0.25 mm^2/24AWG

[1)]For power cables, see electrical data tables.

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Digital inputs	
Programmable digital inputs	4 (6)[1]
Terminal number	18, 19, 27[1], 29[1], 32, 33,
Logic	PNP or NPN
Voltage level	0-24 V DC
Voltage level, logic'0' PNP	<5 V DC
Voltage level, logic'1' PNP	>10 V DC
Voltage level, logic '0' NPN[2]	>19 V DC
Voltage level, logic '1' NPN[2]	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0-110 kHz
(Duty cycle) Min. pulse width	4.5 ms
Input resistance, R_i	approx. 4 kΩ

Safe Stop Terminal 37[3, 4] (Terminal 37 is fixed PNP logic)	
Voltage level	0-24 V DC
Voltage level, logic'0' PNP	<4 V DC
Voltage level, logic'1' PNP	>20 V DC
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA rms
Typical input current at 20 V	60 mA rms
Input capacitance	400 nF

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

[1] Terminals 27 and 29 can also be programmed as output.

[2] Except Safe Stop input Terminal 37.

[3] See for further information about terminal 37 and Safe Stop.

[4] When using a contactor with a DC coil inside in combination with Safe Stop, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

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Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 to +10 V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	20 Hz/100 Hz

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

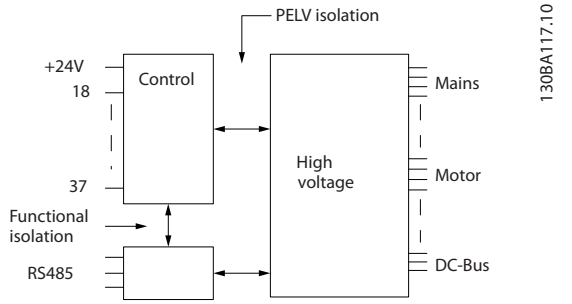

Illustration 10.1 PELV Isolation

Pulse	
Programmable pulse	2/1
Terminal number pulse	29[1)], 33[2)] / 33[3)]
Max. frequency at terminal 29, 33	110 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 *10.2.1 Digital Inputs*
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale
Encoder input accuracy (1-11 kHz)	Max. error: 0.05 % of full scale

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) only

2) Pulse inputs are 29 and 33

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4-20 mA
Max. load GND - analog output	500 Ω
Accuracy on analog output	Max. error: 0.5% of full scale
Resolution on analog output	12 bit

The analogue 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 separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output	
Programmable digital/pulse outputs	2
Terminal number	27, 29 [1]
Voltage level at digital/frequency output	0-24 V
Max. output current (sink or source)	40 mA
Max. load at frequency output	1 kΩ
Max. capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Max. error: 0.1 % of full scale
Resolution of frequency outputs	12 bit

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

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

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3 V
Max. load	200 mA

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

Relay outputs	
Programmable relay outputs	all kW: 2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)[1] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1 A
Max. terminal load (DC-13)[1] (Inductive load)	24 V DC, 0.1 A
Relay 02 (only) Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1] on 4-5 (NO) (Resistive load)[2][3] Overvoltage cat. II	400 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-5 (NO) (Inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1)[1] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 4-6 (NC) (Resistive load)	50 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-6 (NC) (Inductive load)	24 V DC, 0.1 A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

[1] IEC 60947 part 4 and 5

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

[2] Overvoltage Category II

[3] UL applications 300 V AC 2A

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 0-590 Hz	± 0.003 Hz
Repeat accuracy of *Precise start/stop* (terminals 18, 19)	≤± 0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open loop)	1:100 of synchronous speed

Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30-4000 rpm: error ±8 rpm
Speed accuracy (closed loop), depending on resolution of feedback device	0-6000 rpm: error ±0.15 rpm

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

Environment	
Enclosure	IP20[1)]/Type 1, IP21[2)]/Type 1, IP55/Type 12, IP66
Vibration test	1.0 g
Max. relative humidity	5% - 93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Ambient temperature[3)]	Max. 50 °C (24-hour average maximum 45 °C)

[1)] Only for ≤ 3.7 kW (200-240 V), ≤ 7.5 kW (400-480 V)

[2)] As enclosure kit for ≤ 3.7 kW (200-240 V), ≤ 7.5 kW (400-480 V)

[3)] Derating for high ambient temperature, see special conditions in the Design Guide

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

Derating for high altitude, see special conditions in the Design Guide

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011
EMC standards, Immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

See section on special conditions in the Design Guide.

Control card performance	
Scan interval	1 ms

Control card, USB serial communication	
USB standard	1.1 (Full speed)
USB plug	USB type B "device" plug

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB ground connection is not galvanically isolated from protection earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

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 values stated in the tables on the following pages (Guideline - these temperatures may vary for different power sizes, frame sizes, enclosure ratings etc.).
- The frequency converter is protected against short-circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and/ or change the switching pattern in order to ensure the performance of the frequency converter.

10.3 Fuse Tables

10.3.1 Branch Circuit Protection Fuses

For compliance with IEC/EN 61800-5-1 electrical standards the following fuses are recommended.

Frequency converter	Maximum fuse size	Voltage	Type
200-240 V - T2			
1K1-1K5	16A[1]	200-240	type gG
2K2	25A[1]	200-240	type gG
3K0	25A[1]	200-240	type gG
3K7	35A[1]	200-240	type gG
5K5	50A[1]	200-240	type gG
7K5	63A[1]	200-240	type gG
11K	63A[1]	200-240	type gG
15K	80A[1]	200-240	type gG
18K5	125A[1]	200-240	type gG
22K	125A[1]	200-240	type gG
30K	160A[1]	200-240	type gG
37K	200A[1]	200-240	type aR
45K	250A[1]	200-240	type aR
380-480 V - T4			
1K1-1K5	10A[1]	380-500	type gG
2K2-3K0	16A[1]	380-500	type gG
4K0-5K5	25A[1]	380-500	type gG
7K5	35A[1]	380-500	type gG
11K-15K	63A[1]	380-500	type gG
18K	63A[1]	380-500	type gG
22K	63A[1]	380-500	type gG
30K	80A[1]	380-500	type gG
37K	100A[1]	380-500	type gG
45K	125A[1]	380-500	type gG
55K	160A[1]	380-500	type gG
75K	250A[1]	380-500	type aR
90K	250A[1]	380-500	type aR
1) Max. fuses - see national/international regulations for selecting an applicable fuse size.			

Table 10.12 EN50178 fuses 200 V to 480 V

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Enclosure size	Power [kW]	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker Danfoss	Max trip level [A]
A3	1.1	gG-6	gG-25	CTI25M 10-16	16
	1.5	gG-6	gG-25	CTI25M 10-16	16
	2.2	gG-6	gG-25	CTI25M 10-16	16
	3	gG-10	gG-25	CTI25M 10-16	16
	4	gG-10	gG-25	CTI25M 10-16	16
	5.5	gG-16	gG-25	CTI25M 10-16	16
	7.5	gG-16	gG-25	CTI25M 10-16	16
B2	11	gG-25	gG-63		
	15	gG-25	gG-63		
	18	gG-32			
	22	gG-32			
C2	30	gG-40			
	37	gG-63	gG-80		
	45	gG-63	gG-100		
	55	gG-80	gG-125		
	75	gG-100	gG-160		
C3	37	gG-100	gG-125		
	45	gG-125	gG-160		
D	37	gG-125	gG-125		
	45	gG-160	gG-160		
	55-75	gG-200	gG-200		
	90	aR-250	aR-250		
	110	aR-315	aR-315		
	132-160	aR-350	aR-350		
	200	aR-400	aR-400		
	250	aR-500	aR-500		
	315	aR-550	aR-550		
E	355-400	aR-700	aR-700		
	500-560	aR-900	aR-900		
F	630-900	aR-1600	aR-1600		
	1000	aR-2000	aR-2000		
	1200	aR-2500	aR-2500		

Table 10.13 525-690 V, Frame Sizes A, C, D, E and F (non UL fuses)

10.3.2 UL and cUL Branch Circuit Protection Fuses

For compliance with UL and cUL electrical standards the following fuses or UL/cUL approved substitutions are required. Maximum fuse ratings are listed.

Frequency converter	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
200-240 V							
[kW]	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
1K1	KTN-R10	JKS-10	JJN-10	5017906-010	KLN-R10	ATM-R10	A2K-10R
1K5	KTN-R15	JKS-15	JJN-15	5017906-015	KLN-R15	ATM-R15	A2K-15R
2K2	KTN-R20	JKS-20	JJN-20	5012406-020	KLN-R20	ATM-R20	A2K-20R
3K0	KTN-R25	JKS-25	JJN-25	5012406-025	KLN-R25	ATM-R25	A2K-25R
3K7	KTN-R30	JKS-30	JJN-30	5012406-030	KLN-R30	ATM-R30	A2K-30R
5K5	KTN-R50	JKS-50	JJN-50	5012406-050	KLN-R50	-	A2K-50R
7K5	KTN-R50	JKS-60	JJN-60	5012406-050	KLN-R60	-	A2K-50R
11K	KTN-R60	JKS-60	JJN-60	5014006-063	KLN-R60	A2K-60R	A2K-60R
15K	KTN-R80	JKS-80	JJN-80	5014006-080	KLN-R80	A2K-80R	A2K-80R
18K5	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
22K	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
30K	FWX-150	-	-	2028220-150	L25S-150	A25X-150	A25X-150
37K	FWX-200	-	-	2028220-200	L25S-200	A25X-200	A25X-200
45K	FWX-250	-	-	2028220-250	L25S-250	A25X-250	A25X-250
380-480 V, 525-600 V							
[kW]	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
1K1	KTS-R6	JKS-6	JJS-6	5017906-006	KLS-R6	ATM-R6	A6K-6R
1K5-2K2	KTS-R10	JKS-10	JJS-10	5017906-010	KLS-R10	ATM-R10	A6K-10R
3K0	KTS-R15	JKS-15	JJS-15	5017906-016	KLS-R16	ATM-R16	A6K-16R
4K0	KTS-R20	JKS-20	JJS-20	5017906-020	KLS-R20	ATM-R20	A6K-20R
5K5	KTS-R25	JKS-25	JJS-25	5017906-025	KLS-R25	ATM-R25	A6K-25R
7K5	KTS-R30	JKS-30	JJS-30	5012406-032	KLS-R30	ATM-R30	A6K-30R
11K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
15K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
18K	KTS-R50	JKS-50	JJS-50	5014006-050	KLS-R50	-	A6K-50R
22K	KTS-R60	JKS-60	JJS-60	5014006-063	KLS-R60	-	A6K-60R
30K	KTS-R80	JKS-80	JJS-80	2028220-100	KLS-R80	-	A6K-80R
37K	KTS-R100	JKS-100	JJS-100	2028220-125	KLS-R100		A6K-100R
45K	KTS-R125	JKS-150	JJS-150	2028220-125	KLS-R125		A6K-125R
55K	KTS-R150	JKS-150	JJS-150	2028220-160	KLS-R150		A6K-150R
75K	FWH-220	-	-	2028220-200	L50S-225		A50-P225
90K	FWH-250	-	-	2028220-250	L50S-250		A50-P250

Table 10.14 UL fuses, 200-240 V and 380-600 V

10

Recommended max. fuse						
	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2	KTS-R10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11-15	KTS-R-35	JKS-35	JJS-35			
18	KTS-R-45	JKS-45	JJS-45			
22	KTS-R50	JKS-50	JJS-50			
30	KTS-R-60	JKS-60	JJS-60			
37	KTS-R-80	JKS-80	JJS-80			
45	KTS-R-100	JKS-100	JJS-100			
55	KTS-R125	JKS-125	JJS-125			
75	KTS-R150	JKS-150	JJS-150			
90	KTS-R175	JKS-175	JJS-175			

Table 10.15 525-600 V, Frame Sizes A, B and C

Recommended max. fuse				
	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]	Type RK1	Type RK1	Type RK1	Type J
0.37-1.1	5017906-005	KLSR005	A6K-5R	HSJ6
1.5-2.2	5017906-010	KLSR010	A6K-10R	HSJ10
3	5017906-016	KLSR015	A6K-15R	HSJ15
4	5017906-020	KLSR020	A6K-20R	HSJ20
5.5	5017906-025	KLSR25	A6K-25R	HSJ25
7.5	5017906-030	KLSR030	A6K-30R	HSJ30
11-15	5014006-040	KLSR035	A6K-35R	HSJ35
18	5014006-050	KLSR045	A6K-45R	HSJ45
22	5014006-050	KLS-R50	A6K-50R	HSJ50
30	5014006-063	KLSR060	A6K-60R	HSJ60
37	5014006-080	KLSR075	A6K-80R	HSJ80
45	5014006-100	KLSR100	A6K-100R	HSJ100
55	2028220-125	KLS-125	A6K-125R	HSJ125
75	2028220-150	KLS-150	A6K-150R	HSJ150
90	2028220-200	KLS-175	A6K-175R	HSJ175

Table 10.16 525-600 V, Frame Sizes A, B and C

Recommended max. fuse*								
[kW]	Max. prefuse	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	LittelFuse E81895 RK1/JDDZ	Ferraz-Shawmut E163267/E2137 RK1/JDDZ	Ferraz-Shawmut E2137 J/HSJ
11	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15-18.5	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150
* UL compliance 525-600V only								

Table 10.17 525-690 V, Frame Sizes B and C

10.3.3 Substitute Fuses for 240 V

Original fuse	Manufacturer	Substitute fuses
KTN	Bussmann	KTS
FWX	Bussmann	FWH
KLNR	LITTEL FUSE	KLSR
L50S	LITTEL FUSE	L50S
A2KR	FERRAZ SHAWMUT	A6KR
A25X	FERRAZ SHAWMUT	A50X

Table 10.18 Substitute Fuses

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10.4 Connection Tightening Torques

	Power (kW)			Torque (Nm)						
Enclosure	200-240 V	380-480/500 V	525-600 V	525-690 V	Mains	Motor	DC connection	Brake	Earth	Relay
A2	1.1-2.2	1.1-4.0			1.8	1.8	1.8	1.8	3	0.6
A3	3.0-3.7	5.5-7.5	1.1-7.5	1.1-7.5	1.8	1.8	1.8	1.8	3	0.6
A4	1.1-2.2	1.1-4.0			1.8	1.8	1.8	1.8	3	0.6
A5	1.1-3.7	1.1-7.5	1.1-7.5		1.8	1.8	1.8	1.8	3	0.6
B1	5.5-11	11-18	11-18		1.8	1.8	1.5	1.5	3	0.6
B2	15	22-30	22-30	11-30	4.5	4.5	3.7	3.7	3	0.6
B3	5.5 -11	11-18	11-18		1.8	1.8	1.8	1.8	3	0.6
B4	15-18	22-37	22-37	11-37	4.5	4.5	4.5	4.5	3	0.6
C1	18-30	37-55	37-55		10	10	10	10	3	0.6
C2	37-45	75-90	75-90	37-90	14/24[1)]	14/24[1)]	14	14	3	0.6
C3		45-55	45-55	45-55	10	10	10	10	3	0.6
C4	37-55	75-90	75-90		14/24 [1)]	14/24 [1)]	14	14	3	0.6

Table 10.19 Tightening of Terminals

[1)] For different cable dimensions x/y, where x ≤ 95 mm^2 and y ≥ 95 mm^2.

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