MAKING MODERN LIVING POSSIBLE

Service Manual

VLT® Decentral Drive FCD 302

THE REAL DRIVE

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1 Introduction

1.1 Purpose

The purpose of this manual is to provide detailed technical information and instructions to enable a qualified technician to identify faults and perform repairs on FCD 302 frequency converters.

It provides the reader with a general view of the unit's main assemblies and a description of the internal processing. With this information, technicians should have an understanding of the frequency converter operation for troubleshooting and repair.

This manual provides instructions for the frequency converter models and voltage ranges described in *Table 1.1* and .

1.2 VLT FCAF-6 Product Overview

The FCD 302 frequency converter is designed for decentral mounting. It is especially applicable in food and beverage industries, or for other material handling applications.

With the FCD 302 it is possible to realise the cost saving potential of decentral installation. Decentral location of the power electronics renders the central panels obsolete, saving cost, space and effort for installation and wiring.

The basic design is extremely service-friendly, comprising a pluggable electronic part and a flexible and spacious wiring box. Exchange of electronics requires no re-wiring.

The FCD 302 is a part of the VLT® frequency converter family. Functionality, programming, and operation are therefore similar to that of the other family members.

1.3 For Your Safety

1.3.1 Warnings

⚠WARNING

Frequency converters contain dangerous voltages when connected to mains. Only a competent technician should carry out service.

⚠WARNING

Power is required and devices connected to mains are energized at rated voltage. Use extreme caution when conducting tests in a powered frequency converter. Contact with powered components could result in electrical shock and personal injury.

1. Disconnect mains before inspecting or making repairs.
2. DO NOT touch electrical parts of frequency converter when connected to mains. After removing power from mains, wait before touching any electrical parts. See the label on the frequency converter for specific discharge time.
3. The [Stop] key on the control panel does not disconnect mains.
4. During operation and while programming parameters, the motor may start without warning. Activate the [Stop] key when changing data.

1.4 Electrostatic Discharge (ESD)

⚠WARNING

When performing service, use proper ESD procedures to prevent damage to sensitive components.

Many electronic components within the frequency converter are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

1.5 RCDs

1.5.1 Leakage Current (>3,5 mA)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

1.6 Type Code Description

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	39	39
	F	C	D	3	0	2	P				T	4				H	1											X	A		B		X	X	X	X	X	D	

130BB797.10

Position	Description	Choices/options	
01-03	Product group	FCD	Decentral Drive
04-06	Frequency converter series	302	Advanced performance
07-10	Power size	PK37	0.37 kW/0.5 HP
		PK55	0.55 kW/0.75 HP
		PK75	0.75 kW/1.0 HP
		P1K1	1.1 kW/1.5 HP
		P1K5	1.5 kW/2.0 HP
		P2K2	2.2 kW/3.0 HP
		P3K0	3.0 kW/4.0 HP
		PXXX	Installation box only (without power section)
11-12	Phases, Mains voltage	T	Three phase
		4	380-480 V AC
13-15	Enclosure	B66	Standard Black - IP66/Type 4X
		W66	Standard White - IP66/Type 4X
		W69	Hygienic White - IP66K/Type 4X
16-17	RFI filter	H1	RFI filter class A1/C2
18	Brake	X	No brake
		S	Brake chopper + mechanical brake Supply

Position	Description	Choices/options	
19	Hardware configuration	1	Complete product, small unit, stand alone mount
		2	Complete product, small unit, motor mount
		3	Complete product, large unit, stand alone mount
		X	Drive part, small unit (No installation box)
		Y	Drive part, large unit (No installation box)
		R	Installation box, small unit, stand alone mount (No drive part)
		S	Installation box, small unit, motor mount (No drive part)
		T	Installation box, large unit, stand alone mount (No drive part)
20	Brackets	X	No brackets
		E	Flat brackets
		F	40 mm brackets
21	Threads	X	No installation box
		M	Metric threads

Position	Description	Choices/options	
22	Switch option	X	No switch option
		E	Service switch on mains input
		F	Service switch on motor output
		G	Service switch on motor output (bottom)
		H	Circuit breaker & mains disconnect (large unit only)
		K	Service switch on mains input with additional looping terminals (large unit only)
23	Display	X	No display connector (No installation box)
		C	With Display Connector
24	Sensor plugs	X	No sensor plugs
		E	Direct mount 4xM12
		F	Direct mount 6xM12
25	Motor plug	X	No motor plug
26	Mains plug	X	No mains plug
27	Fieldbus plug	X	No fieldbus plug
28	Reserved	X	For future use
29-30	A option	AX	No A option
		A0	PROFIBUS DP
		AN	EtherNet/IP
		AL	PROFINET
31-32	B option	BX	No B option
		BR	Encoder option
		BU	Resolver option
33-37	Reserved	XXXXX	For future use
38-39	D option	DX	No D option
		D0	24 V DC back-up input

Table 1.1 Type Code Description

Not all choices/options are available for each FCD 302 variant. To verify if the appropriate version is available, please consult the Drive Configurator on the internet: *http://driveconfig.danfoss.com*.

NOTE

A and D options for FCD 302 are integrated in the control card and therefore pluggable options for frequency converters can not be used here. Future retrofit will require exchange of the entire control card. B options are pluggable, using the same concept as for frequency converters.

1.7 Tools Required

1.7.1 Recommended Tools and Equipment

Equipment	Size	Description
Screwdrivers		
Socket (Hex)	8	For fastening inverter screws/mounting of brackets
Slotted	0.4x2.5	For spring loaded power and control terminals
Slotted/Torx	1.0x5.5	For cable clamps inside the installation box
Spanner	19, 24, 28	For blind-plugs
Service cables, for control and power, Part no. 130B5979		Test cable set
LCP part no. 130B1078		Local control panel
LCP cable part no. 130B5776		Connection cable for local control panel

1.8 Exploded View of the FCD 302

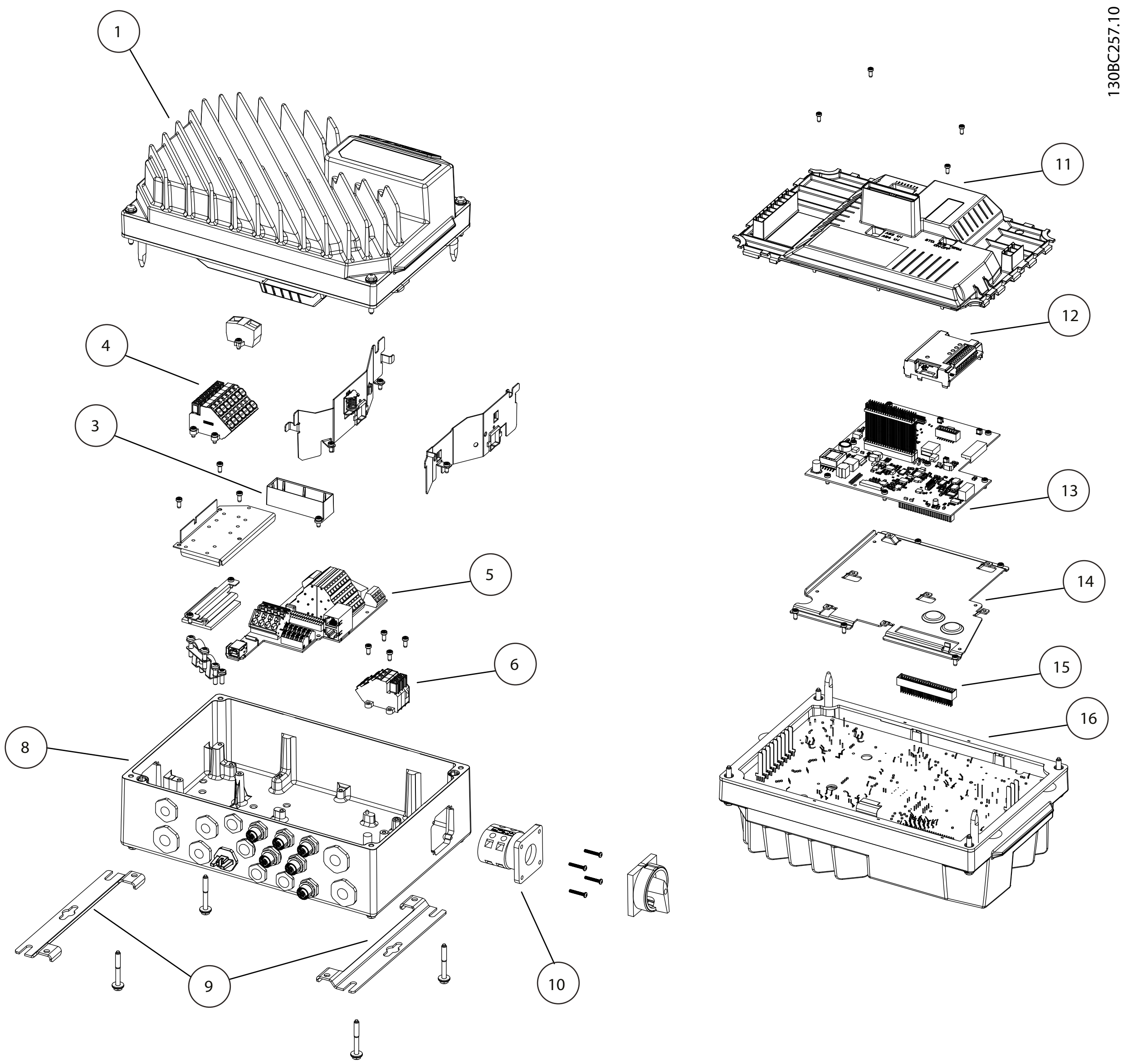


Illustration 1.1 Exploded View FCD 302 Small Unit

1	Inverter part	10	Service switch
3	Plastic guide for PCB stacker, for installation card - control card interconnection	11	Inverter part plastic cover
4	Motor terminal 7 pole (U,V,W,+M,-M,+R,-R); 3 pole (U,V,W)	12	B-option
5	Main termination board for installation box (installation card)	13	Control card
6	Mains terminal (L1, L2, L3)	14	Mounting plate for control card
8	Installation box	15	48-pin connector for control card
9	Mounting brackets	16	Inverter part

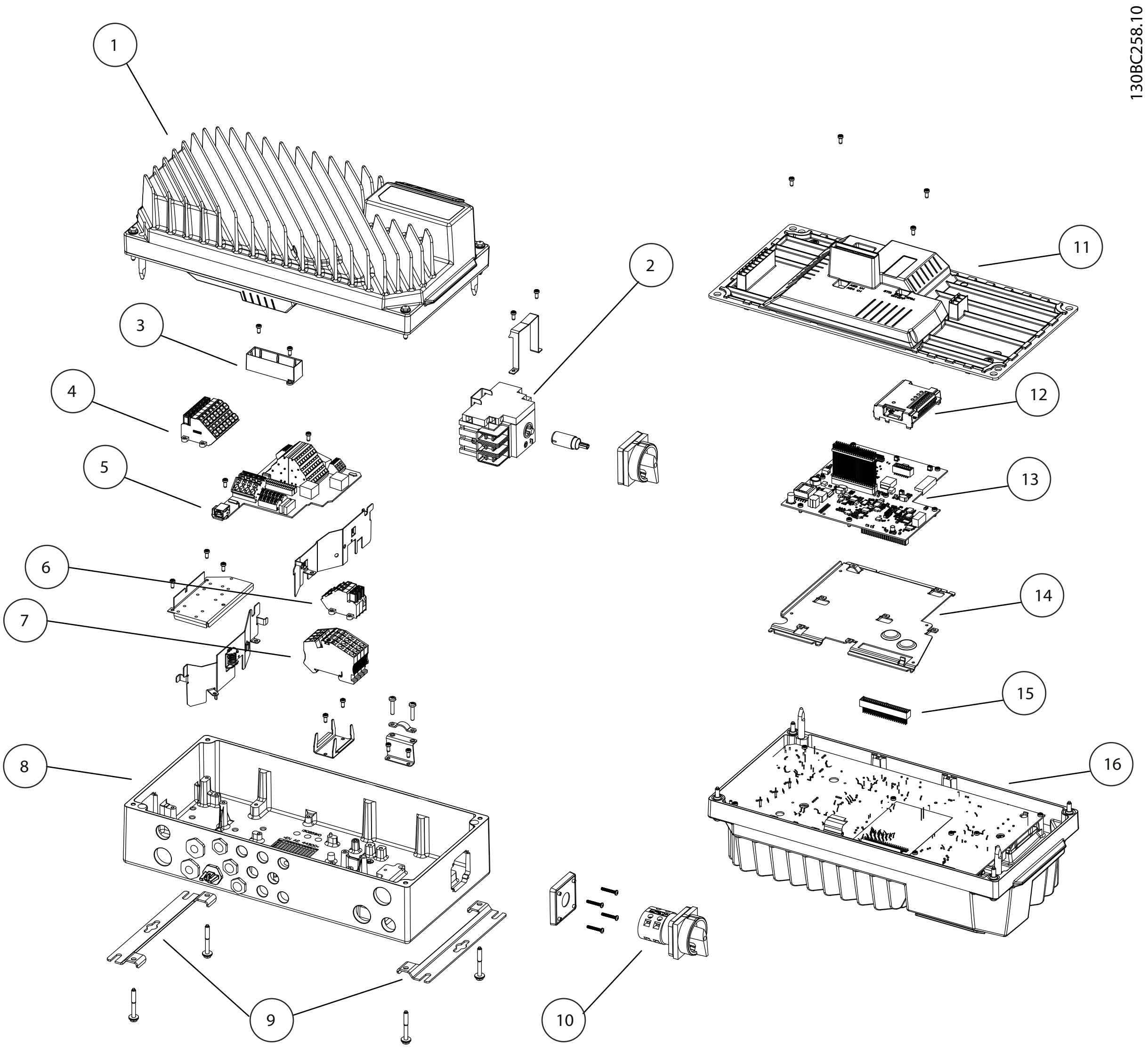


Illustration 1.2 Exploded View FCD 302 Large Unit

1	Inverter part	9	Mounting brackets
2	Circuit breaker	10	Service switch
3	Plastic guide for PCB stacker, for installation card - control card interconnection	11	Inverter part plastic cover
4	Motor terminal 7 pole (U,V,W,+M,-M,+R,-R); 3 pole (U,V,W)	12	B-option
5	Main termination board for installation box (installation card)	13	Control card
6	Mains terminal (L1, L2, L3)	14	Mounting plate for control card
7	Looping terminal	15	48-pin connector for control card
8	Installation box	16	Inverter part

1.9 Ratings Tables

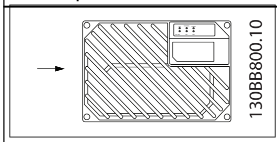
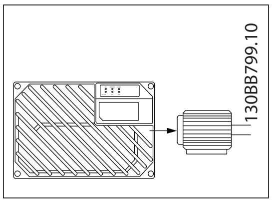
Mains Supply 3x380-480 V AC								
Frequency Converter		**PK37**	**PK55**	**PK75**	**P1K1**	**P1K5**	**P2K2**	**P3K0**
Rated Shaft Output [kW]		0.37	0.55	0.75	1.1	1.5	2.2	3.0
Rated Shaft Output [hp]		0.5	0.75	1.0	1.5	2.0	3.0	4.0
Max. input current								
	Continuous (3x380-440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5
	Intermittent (3x380-440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4
	Continuous (3x441-480 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7
	Intermittent (3x441-480 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1
	Recommended max. fuse size*	gG-25						
	Built-in circuit breaker (large unit)	CTI-25M Danfoss part no.: 047b3151						
	Recommended circuit breaker (small unit)	CTI-45MB Danfoss part no.: 047B3164						
	Power loss at max. load [W]	35	42	46	58	62	88	116
	Efficiency	0.93	0.95	0.96	0.96	0.97	0.97	0.97
	Weight, small unit [kg]	9.8						N/A
	Weight, large unit [kg]	13.9						
Output current								
	Continuous (3x380-440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.2	7.2
	Intermittent (3x380-440 V) [A]	2.1	2.9	3.8	4.8	6.6	8.3	11.5
	Continuous (3x441-480 V) [A]	1.2	1.6	2.1	3.0	3.4	4.8	6.3
	Intermittent (3x441-480 V) [A]	1.9	2.6	3.4	4.8	5.4	7.7	10.1
	Continuous kVA (400 V AC) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0
	Continuous kVA (460 V AC) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0
	Max. cable size: (mains, motor, brake) [mm^2/ AWG]	6/10						

Table 1.2 FCD 302 Shaft Output, Output Current and Input Current

**To meet UL/cULrequirements, use the following pre-fuses.*

Recommended maximum pre-fuse size 25 A

Brand	Fuse Type	UL File no.	UL Category (CCN code)
Bussmann	FWH-25	E91958	JFHR2
Bussmann	KTS-R25	E52273	RK1/JDDZ
Bussmann	JKS-25	E4273	J/JDDZ
Bussmann	JJS-25	E4273	T/JDDZ
Bussmann	FNW-R-25	E4273	CC/JDDZ
Bussmann	KTK-R-25	E4273	CC/JDDZ
Bussmann	LP-CC-25	E4273	CC/JDDZ
SIBA	5017906-025	E180276	RK1/JDDZ
LITTLE FUSE	KLS-R25	E81895	RK1/JDDZ
FERRAZ-SHAWMUT	ATM-R25	E163267/ E2137	CC/JDDZ
FERRAZ-SHAWMUT	A6K-25R	E163267/ E2137	RK1/JDDZ
FERRAZ-SHAWMUT	HSJ25	E2137	J/HSJ

Table 1.3 FCD 302 Pre-fuses Meeting UL/cUL Requirements

DC voltage level	380-480 V units (V DC)
Inverter undervoltage disable	373
Undervoltage warning	410
Inverter undervoltage re-enable (warning reset)	398
Overvoltage warning (without brake)	778
Dynamic brake turn on	778
Inverter overvoltage re-enable (warning reset)	795
Overvoltage warning (with brake)	810
Overvoltage trip	820

Table 1.4 FCD 302 DC Voltage Level

Fuses

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

Circuit breaker

The unit is suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical Amperes, 480 V maximum.

2 Operator Interface and Frequency Converter Control

2.1 Introduction

Frequency converters are designed with self-diagnostic circuitry to isolate fault conditions and activate display messages which greatly simplify troubleshooting and service. The operating status of the frequency converter is displayed in real-time. Virtually, every command given to the frequency converter results in some indication on the LCP. Fault logs are maintained within the frequency converter for fault history.

The frequency converter monitors supply and output voltages along with the operational condition of the motor and load. When the frequency converter issues a warning or alarm, it cannot be assumed that the fault lies within the frequency converter itself. In fact, for most service calls, the fault condition will be found outside of the frequency converter. Most of the warnings and alarms that the frequency converter displays, are generated by response to faults outside of the frequency converter. This service manual provides techniques and test procedures to help isolate a fault condition whether in the frequency converter or elsewhere.

Familiarity with the information provided on the display is important. Additional diagnostic data can be accessed easily through the LCP.

2.2 User Interface LED

2.2.1 LED Panel

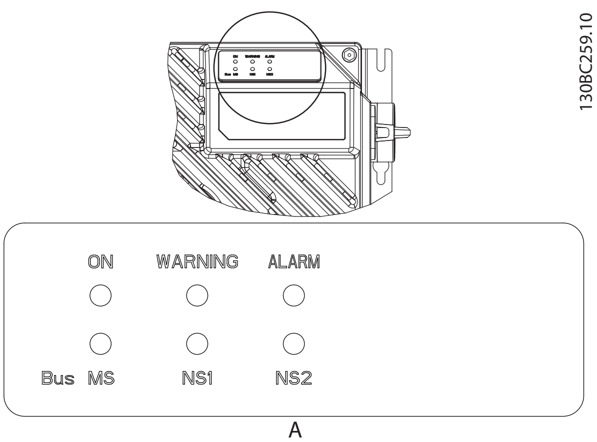


Illustration 2.1 LED Panel

2.2.2 Frontal LEDs

The actual status can be read on the outside of the FCD products. Six LEDs signal the actual status of the unit with the meaning described in *Table 2.1*.

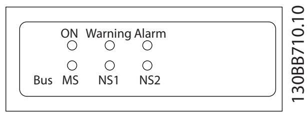


Illustration 2.2 Frontal LEDs

Name	Colour	Status	Indication
ON	Green	On	The frequency converter receives power from mains voltage, or external 24 V supply.
		Off	No power from mains voltage, or external 24 V supply.
Warning	Yellow	On	Warning situation is present.
		Off	No warning is present.
Alarm	Red	Flashing	Alarm is present.
		Off	No alarm is present
Bus MS	Only relevant if optional fieldbus is present. See Profibus manual: MG34NXYY, Ethernet manual: MG90JXYY and Profinet manual: MG90UXYY, for specific information.		Bus Module Status
Bus NS1			Bus Network Status 1
Bus NS2			Bus Network Status 2

Table 2.1 LED Status

2.3 Local Control Panel

The LCP is the combined display and keypad, which can be attached to the display connector outside the unit (without opening the enclosure) via the LCP cable/plug. 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

2

- 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 MG04GXYY* for details on use of the NLCP.

2.3.1 LCP Layout

The LCP is divided into four functional groups (see *Illustration 2.3*).

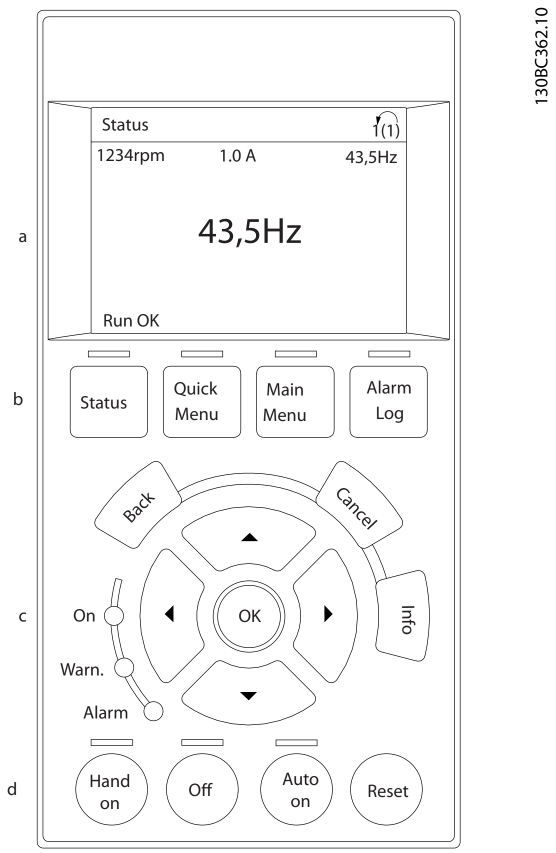


Illustration 2.3 LCP

a. Display area.

b. Display menu keys for changing the display to show status options, programming, or error message history. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.

c. Operational mode keys and reset.

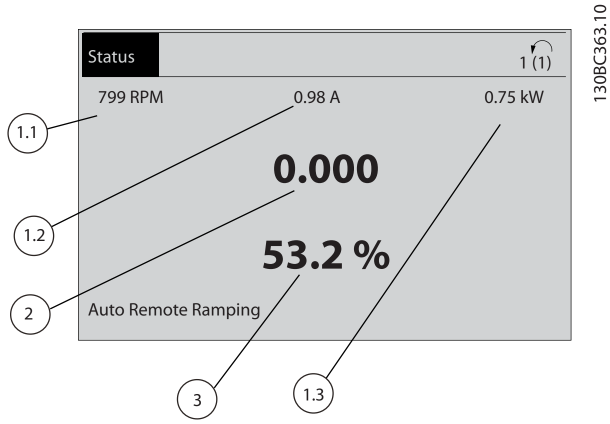
2.3.2 Setting LCP Display Values

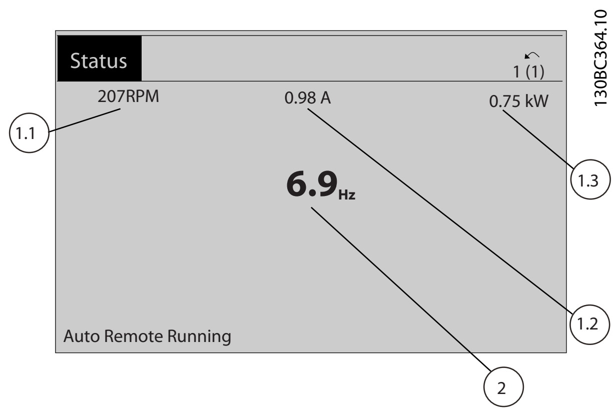
The display area is activated when the frequency converter receives power from mains voltage, or an external 24 V supply.

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

- Each display readout has a parameter associated with it.
- The frequency converter status at the bottom line of the display is generated automatically and is not selectable. See *2.6 Status Messages* for more information.

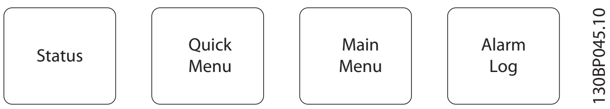
Display	Parameter number	Default setting
1.1	0-20	Motor RPMs
1.2	0-21	Motor current
1.3	0-22	Motor power (kW)
2	0-23	Motor frequency
3	0-24	Reference in percent





2.3.3 Display Menu Keys

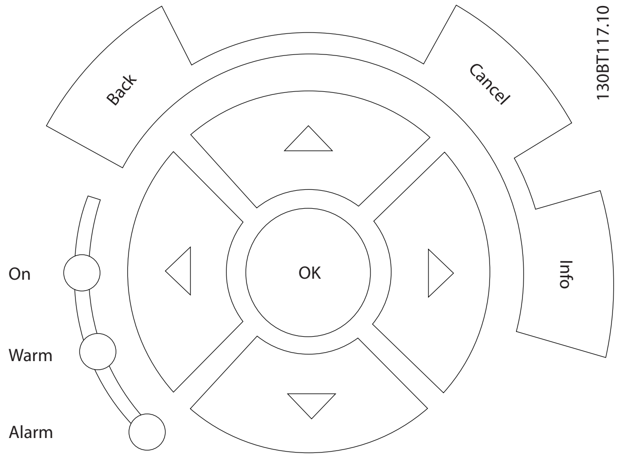
Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.



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].

2.3.4 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.

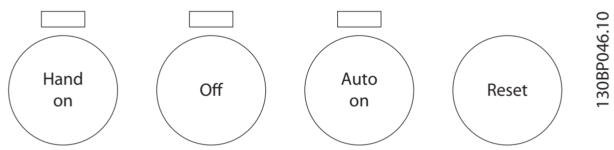


Key	Function
Back	Reverts to the previous step or list in the menu structure.
Cancel	Cancels the last change or command as long as the display mode has not changed.
Info	Press for a definition of the function being displayed.
Navigation Keys	Use the four navigation arrows to move between items in the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

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.

2.3.5 Operation Keys

Operation keys are found at the bottom of the LCP.



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.

2.4 Copying Parameter SettingsBack 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.

2.4.1 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.

2.4.2 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.

2.5 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 prior to 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

2.5.1 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.

2.5.2 resetinitialisationManual InitialisationManual 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 the following frequency converter information

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

2.6 Status Messages

Status messages appear in the bottom of the display - see *Illustration 2.4* as example.
The left part of the status line indicates the active operation mode of the frequency converter.
The centre part of the status line indicates the references site.
The last part of the status line gives the operation status, e.g. *Running, Stop or Stand by*.

Other status messages may appear related to the software version and frequency converter type.

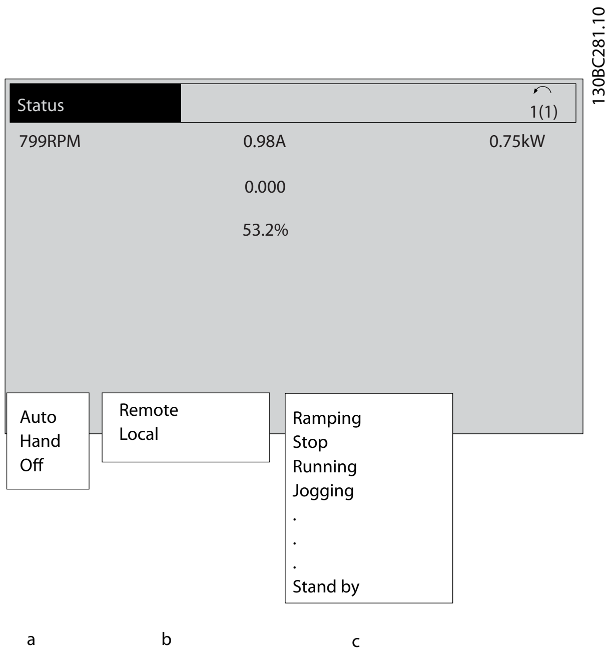


Illustration 2.4 Status Message - Example

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; status indicator lights.

<u>Operation Mode</u>
Off The frequency converter is stopped. The frequency converter does not react to any control signal until [Auto On] or [Hand On] on the LCP is pressed.

[**Auto On**] The frequency converter is started and stopped by external commands via the control terminals and/or the serial communication.

[**Hand On**] The frequency converter is started from the LCP. Only *stop* commands, alarm resets (Reset), *reversing*, DC brake, and *set-up selection* signals can be applied to the control terminals.

<u>Reference Site</u>
Remote The reference is given via external signals (analog or digital), serial communication, or internal preset references.

Local The reference is given via the LCP.

<u>Operation Status</u>
AC Brake

AC Brake was selected in *2-10 Brake Function*. The motor is slowed down via the active down ramp and feeds the frequency converter with generative energy. The AC Brake over-magnetizes the motor to achieve a controlled end of the active ramp.

AMA finish OK
Enable complete or reduced AMA was selected in *1-29 Automatic Motor Adaptation (AMA)*. The Automatic Motor Adaptation was carried out successfully.

AMA ready
Enable complete or reduced AMA was selected in *1-29 Automatic Motor Adaptation (AMA)*. The Automatic Motor Adaptation is ready to start. Press [Hand On] on the LCP to start.

AMA running
Enable complete or reduced AMA was selected in *1-29 Automatic Motor Adaptation (AMA)*. The 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)* is reached.

Bus Jog 1
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The Jog 1 function is activated via serial communication. The motor is running with *8-90 Bus Jog 1 Speed*.

Bus Jog 2
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The Jog 2 function is activated via serial communication. The motor is running with *8-91 Bus Jog 2 Speed*.

Catch up
The output frequency is corrected by the value set in *3-12 Catch up/slow Down Value*.

1. Catch up is selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is active.
2. Catch up was activated via serial communication.

Coast

1. Coast inverse has been selected as a function for a digital input (parameter group 5-1*). The corresponding terminal (e.g. Terminal 27) is not connected.
2. Coast is on 0 on serial communication.

Control ready
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The frequency converter needs the second part (e.g. 0x047F) of the two-part start command via serial communication to allow starting. Using a terminal is not possible.

Ctrl. Ramp-down
A function with Ctrl. 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*. The frequency converter ramps down the motor using a controlled ramp down.

Current High
In *4-51 Warning Current High*, a current limit is set. The output current of the frequency converter is above this limit.

Current Low
In *4-50 Warning Current Low*, a current limit is set. The output current of the frequency converter is below this limit.

DC Hold
The motor is driven with a permanent DC current, *2-00 DC Hold Current*. DC hold is selected in *1-80 Function at Stop*. A Stop command (e.g. Stop (inverse)) is active.

DC Stop
The motor is momentarily driven with a DC current, *2-01 DC Brake Current*, for a specified time, *2-02 DC Braking Time*.

1. DC Brake is activated (OFF) in *2-03 DC Brake Cut In Speed [RPM]* and a Stop command (e.g. Stop (inverse)) is active.
2. DC Brake (inverse) is selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is not active.
3. The DC Brake is activated via serial communication.

DC Voltage U0
In *1-01 Motor Control Principle* U/f and in *1-80 Function at Stop* DC Voltage U0 is selected. A Stop command (e.g. Stop (inverse)) is activated. The voltage selected according to the *1-55 U/f Characteristic - U* is applied to the motor.

Feedback high
In *4-57 Warning Feedback High*, an upper feedback limit is set. The sum of all active feedbacks is above the feedback limit.

Feedback low
In *4-56 Warning Feedback Low*, a lower feedback limit is set. The sum of all active feedback is below the feedback limit.

Flying start
In *1-73 Flying Start*, the Flying start function is activated. The frequency converter is testing if the connected motor is running with a speed that is in the adjusted speed range. The process was started by connecting a digital input (parameter group 5-1*) programmed as Coast inverse or by connecting to mains.

Freeze output
The remote reference is active and the momentarily given speed is saved.

1. Freeze output was selected as a function for a digital input (Group 5-1*). The corresponding terminal is active. Speed control is only possible via the terminal functions Speed up and Speed down.
2. Hold ramp is activated via serial communication.

Freeze output request
A freeze output command has been given, but the motor will remain stopped until a *Run permissive* signal is received via a digital input.

Freeze Ref.
Freeze Ref. was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal is controlled. 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 the motor will be stopped until a *Run permissive* signal is received via a digital input.

Jogging
The motor is running with *3-19 Jog Speed [RPM]*.

1. Jog was selected as function for a digital input (parameter group 5-1*). The corresponding terminal (e.g. Terminal 29) is active.
2. The Jog function is activated via the serial communication.
3. The Jog function was selected as a reaction for a monitoring function (e.g. No signal). The monitoring function is active.

Kinetic backup
In *14-10 Mains Failure*, a function was set as kinetic backup. The Mains Voltage is below the value set in *14-11 Mains Voltage at Mains Fault*. The frequency converter is running the motor momentarily with kinetic energy from the inertia of the load.

Motor check (frequency converter 100/200 only)
In *1-80 Function at Stop*, the function Motor check was selected. A stop command (e.g. Stop inverse) is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.

Off1
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The OFF 1 function is activated via serial communication. The motor is stopped via the ramp.

Off2
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The OFF 2 function is activated via serial communication. The output of the frequency converter is disabled immediately and the motor coasted.

Off3
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The OFF 3 function is activated via serial communication. The motor is stopped via the ramp.

OVC control
Overvoltage Control is activated in *2-17 Over-voltage Control*. The connected motor is supplying the frequency converter with generative energy. The Overvoltage Control adjusts the UF ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.

PowerUnit Off
Only with frequency converters with installed option (ext. 24 V supply). The mains supply to the frequency converter is cut off, but the control card is still supplied with 24 V.

Pre-magnetize
Pre-magnetization is selected in *1-80 Function at Stop*. A stop command (e.g. Stop inverse) is activated. A suitable constant magnetizing current is applied to the motor.

Protection md
The frequency converter has detected a critical status (e.g. an overcurrent, overvoltage). To avoid tripping the frequency converter (alarm), protection mode is activated, which includes reducing the switching frequency to 4 kHz. If possible, protection mode ends after approximately 10 s. Activation of protection mode can be restricted by adjusting the *14-26 Trip Delay at Inverter Fault*.

QStop
The motor is stopped using a quick stop ramp *3-81 Quick Stop Ramp Time*.

1. Quick stop inverse was chosen as a function for a digital input (parameter group 5-1*). The corresponding terminal (e.g. Terminal 27) is not active.
2. 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
In *4-55 Warning Reference High* a reference high limit is set. The sum of all active references is above the reference limit.

Ref. low
In *4-54 Warning Reference Low* a reference low limit is set. The sum of all active references is below the reference limit.

Run on ref.
The frequency converter is running in the reference range. The feedback value matches the set reference value.

Run request (frequency converter 100/200 only)
A start command has been given, but the motor will be stopped until a *Run permissive* signal is received via digital input.

Running
The motor is driven by the frequency converter, the ramping phase is done and the motor revolutions are outside the *On Reference* range. Occurs when one of the motor speed limits (Par. 4-11/4-12/4-13 or 4-14) is set, but the maximum reference is outside this range.

Sleep Boost (frequency converter 100/200 only)
The boost function in *22-45 Setpoint Boost* is enabled. This function is only possible in *Closed loop* operation.

Speed down
The output frequency is corrected by the value set in *3-12 Catch up/slow Down Value*.

1. Speed down was selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is active.
2. Speed down was activated via serial communication.

Speed high
In *4-53 Warning Speed High*, a value is set. The speed of the motor is above this value.

Speed low
In *4-52 Warning Speed Low*, a value is set. The speed of the motor is below this value.

Standby
[Auto On] The frequency converter starts the motor using a start signal in a digital input (if the parameter is programmed accordingly) or via serial communication.

Start delay
In *1-71 Start Delay*, the delay of the starting time was set. A Start command was activated and the delay time is still running. The motor will start after the delay time has expired.

Start fwd/rev
Enable start forward and *Enable start reverse* were selected as functions for two different digital inputs (parameter group 5-1*). To start the motor, a direction dependent start signal has to be given and the corresponding terminal has to be active.

Start inhibit
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. The start inhibition is active. The frequency converter needs the first part (e.g. 0x047E) of the two-part start command via serial communication to allow starting. See also operation status control ready.

Stop
[Off] was pressed on the LCP or Stop inverse was selected as a function for a digital input (Group 5-1*). The corresponding terminal is not active.

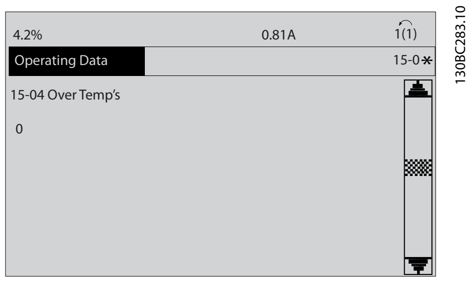
Trip
An alarm occurred. It is possible, provided the cause of the alarm is cleared, to reset the alarm via a *Reset* signal ([Reset] key on the LCP, a control terminal or serial communication).

Trip lock
A serious alarm occurred. It is possible, provided the cause of the alarm was cleared, to reset the alarm after the mains have been switched off and on again. This can be done via a *reset* signal ([Reset] on the LCP, a control terminal or serial communication).

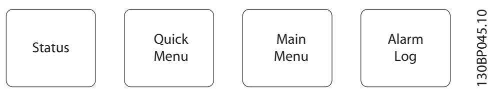
Unit/Drive not ready
[1] PROFIDrive profile was selected in *8-10 Control Word Profile*. A control word is sent to the frequency converter via serial communication with Off 1, Off 2 and Off 3 active. Start inhibit is active. To enable start, see operation status Start inhibit.

2.7 Service Functions

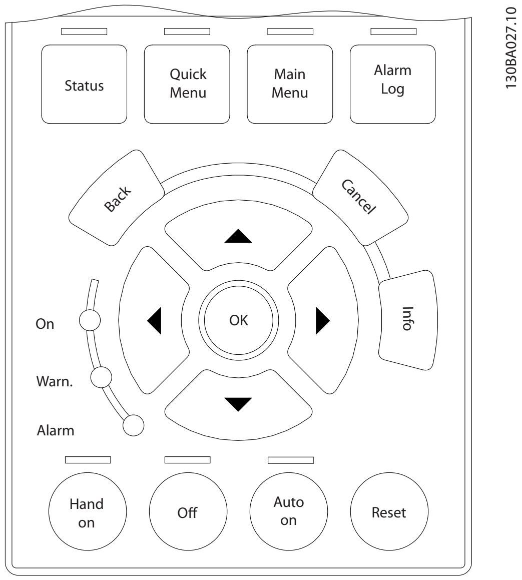
Service information for the frequency converter can be shown on display lines 3 and 4. Included in the data are counters that tabulate operating hours, power ups and trips; fault logs that store frequency converter status values present at the 20 most recent events that stopped the frequency converter and frequency converter nameplate data. The service information is accessed by displaying items in the frequency converter's 15-** parameter group.



Parameter settings are displayed by pressing the [Main Menu] key on the LCP.



Use the arrow keys [▲], [▼], [►] and [◄] on the LCP to scroll through parameters.



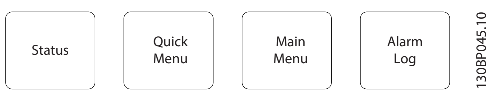
See the frequency converter Series Programming Guides for detailed information on accessing and displaying parameters and for descriptions and procedures for service information available in the 15-** parameter group.

2.8 Control Terminals

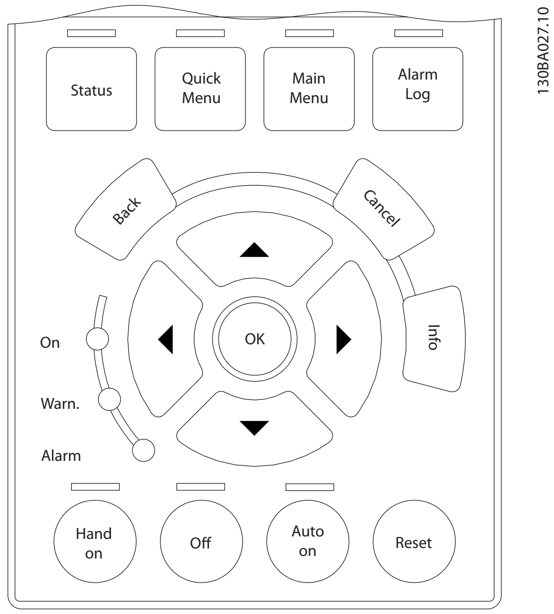
Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. See *Table 2.2*. The setting selected in the parameter enables the function of the terminal.

It is important to confirm that the control terminal is programmed for the correct function.

Parameter settings are displayed by pressing the [Main Menu] key on the LCP.



Use the arrow keys [▲], [▼], [►] and [◄] on the LCP to scroll through parameters.



See the Programming Guide for details on changing parameters and the functions available for each control terminal.

In addition, the input terminal must be receiving a signal. Confirm that the control and power sources are wired to the terminal. Then check the signal.

Signals can be checked in two ways. Digital input can be selected for display by pressing [Status] key as discussed previously, or a voltmeter may be used to check for voltage at the control terminal. See procedure details in *6 Test Procedures*.

In summary, for proper frequency converter functioning, the frequency converter input control terminals must be:

- wired properly
- powered
- programmed correctly for the intended function
- receiving a signal

2.9 Frequency Converter Inputs and Outputs

The frequency converter operates by receiving control input signals. The frequency converter can also output status data or control auxiliary devices. Control input is connected to the frequency converter in three possible ways. One way for frequency converter control is through the LCP on the front of the frequency converter when operating in local (hand) mode. These inputs include start, stop, reset, and speed reference.

Another control source is through serial communication from a serial bus. A serial communication protocol supplies commands and references to the frequency converter, can program the frequency converter, and reads status data from the frequency converter. The serial bus connects to the frequency converter through the RS-485 serial port or through a communication option card.

The third way is through signal wiring connected to the frequency converter control terminals. The frequency converter control terminals are located below the frequency converter LCP. Improperly connected control wiring can be the cause of a motor not operating or the frequency converter not responding to a remote input.

2.9.1 Input signals

The frequency converter can receive two types of remote input signals: digital or analog. Digital inputs are wired to terminals 18, 19, 20 (common), 27, 29, 32, and 33. Analog inputs are wired to terminals 53 or 54 and 55 (common). The terminal functions are set by a switch marked A53 and A54 on the inverter part plastic cover.

Analog signals can be either voltage (0 to +/-10 V DC) or current (0 to 20 mA or 4 to 20 mA). Analog signals can be varied like dialling a rheostat up and down. The frequency converter can be programmed to increase or decrease output in relation to the amount of current or voltage. For example, a sensor or external controller may supply a variable current or voltage. The frequency converter output, in turn, regulates the speed of the motor connected to the frequency converter in response to the analog signal.

Digital signals are a simple binary 0 or 1 which, in effect, act as a switch. Digital signals are controlled by a 0 to 24 V DC signal. A voltage signal lower than 5 V DC is a logic 0. A voltage higher than 10 V DC is a logic 1. Zero is open, one is close. Digital inputs to the frequency converter are switched commands such as start, stop, reverse, coast, reset, and so on. (Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols.)

The RS-485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is common and may be used for terminating screens only when the control cable run between frequency converters, not between frequency converters and other devices. See *2.11 Earthing Screened Cables* for correct methods for terminating a screened control cable.

2.9.2 Output signals

The frequency converter also produces output signals that are carried through either the RS-485 serial bus or terminal 42. Output terminal 42 operates in the same manner as the inputs. The terminal can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 V DC. In addition, a pulse reference can be provided on terminals 27 and 29. Output analog signals generally indicate the frequency converter frequency, current, torque and so on to an external controller or system. Digital outputs can be control signals used to open or close a damper, for example, or send a start or stop command to auxiliary equipment.

Additional terminals are Form C relay outputs on terminals 01, 02, and 03, and terminals 04, 05, and 06.

Terminals 12 and 13 provide 24 V DC low voltage power, to the digital input terminals (18-33). Those terminals must be supplied with power from either terminal 12 or 13, or from a customer supplied external 24 V DC power source. Improperly connected control wiring is a common service issue for a motor not operating or the frequency converter not responding to a remote input.

2.10 Control Terminal Functions

The following describes the functions of the control terminals. Many of these terminals have multiple functions determined by parameter settings. Some options provide additional terminals. See *Illustration 2.5*.

Terminal No.	Function
01, 02, 03 and 04, 05, 06	Two Form C output relays. Maximum 240 V AC, 2 A. Minimum 24 V DC, 10 mA or 24 V AC, 100 mA. Can be used for indicating status and warnings. Physically located on the installation card.
12, 13	24 V DC power supply to digital inputs and external transducers. The maximum output current is 600 mA.
18, 19, 27, 29, 32, 33	Digital inputs for controlling the frequency converter. R = 4 kohm. Less than 5 V = logic 0 (open). Greater than 10 V = logic 1 (closed). Terminals 27 and 29 are programmable as digital/pulse outputs.
20	Common for digital inputs.
35, 36	Input terminals for 24 V backup supply
37	0–24 V DC input for safety stop.
39	Common for analog output.
42	The analog output for indicating values such as frequency, reference, current and torque. The analog signal is 0/4 to 20 mA at a maximum of 500 Ω. .
50	10 V DC, 15 mA maximum analog supply voltage for potentiometer or thermistor.
53, 54	Selectable for 0 to +/-10 V DC voltage input, R = 10 kΩ, or analog signals 0/4 to 20 mA at a maximum of 200 Ω. Used for reference or feedback signals. A thermistor can be connected here.
55	Common for terminals 53 and 54.
61	RS-485 common.
62, 63	Profibus RS-485 interface
66, 67	Common and +5 V for external Profibus termination
68, 69	RS-485 interface and serial communication.

Term	18	19	27	29	32	33	37	53	54	42	1-3	4-6
Par.	5-10	5-11	5-12	5-13	5-14	5-15	5-19	6-1*	6-2*	6-5*	5-4*	5-4*

Table 2.2 Control Terminals and Associated Parameter

Control terminals must be programmed. Each terminal has specific functions it is capable of performing and a numbered parameter associated with it. The setting selected in the parameter enables the function of the terminal. See the *Operating Instructions MG04FXYY* for details.

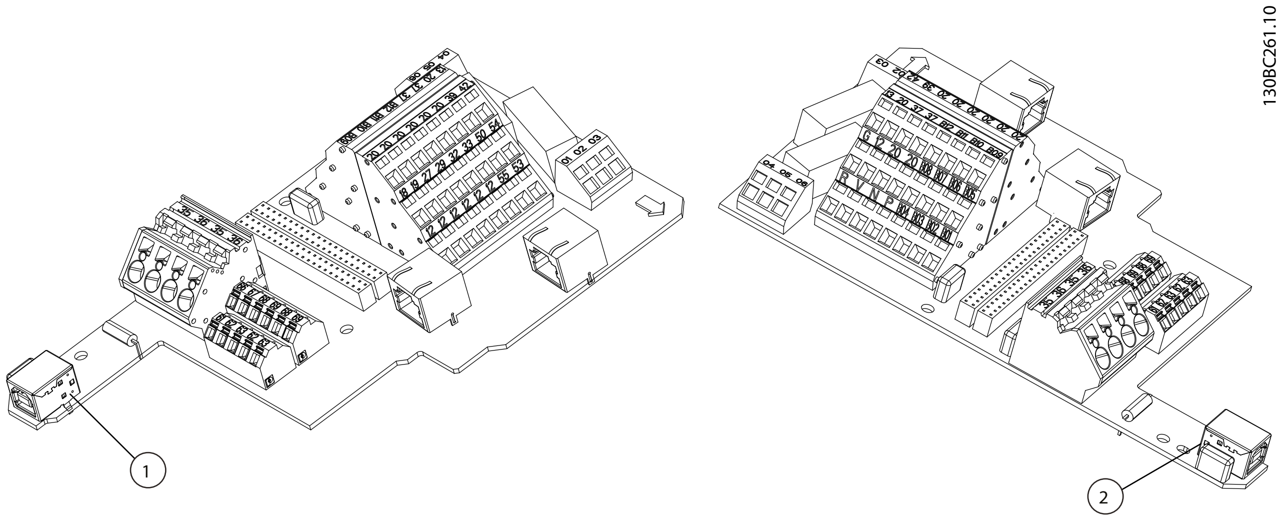
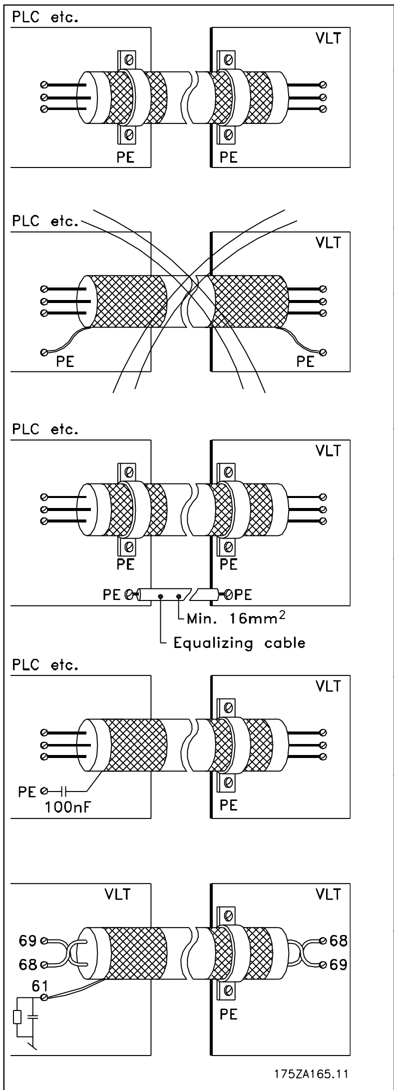


Illustration 2.5 Control Terminals

1-2	USB connection

2.11 Earthing Screened Cables

It is recommended that the screened control cables be connected with cable clamps at both ends to the metal cabinet of the frequency converter with cable clamps at both ends. *Table 2.3* shows earth cabling for optimal results.



Correct earthing Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical connection.	
Incorrect earthing Do not use twisted cable ends (pigtails) since these increase screen impedance at high frequencies.	
Earth potential protection When the earth potential between the frequency converter and the PLC or other interface device is different, electrical noise may occur that can disturb the entire system. This can be resolved by fitting an equalizing cable next to the control cable. Minimum cable cross section is 8 AWG.	
50/60 Hz earth loops When using very long control cables, 50/60 Hz earth loops may occur that can disturb the entire system. This can be resolved by connecting one end of the screen with a 100 nF capacitor and keeping the lead short.	
Serial communication control cables Low frequency noise currents between frequency converters can be eliminated by connecting one end of the screened cable to frequency converter terminal 61. This terminal connects to earth through an internal RC link. It is recommended to use twisted-pair cables to reduce the differential mode interference between conductors.	

Table 2.3 Earthing Screened Cables

3

3 Internal Frequency Converter Operation

3.1 General

This section is intended to provide an operational overview of the frequency converter’s main assemblies and circuitry. With this information, a repair technician should have a better understanding of the frequency converter's operation and aid in the troubleshooting process.

3.2 Description of Operation

A frequency converter is an electronic controller that supplies a regulated amount of AC power to a three phase induction motor in order to control the speed of the motor. By supplying variable frequency and voltage to the motor, the frequency converter controls the motor speed, or maintains a constant speed as the load on the motor changes. The frequency converter can also stop and start a motor without the mechanical stress associated with a line start.

In its basic form, the frequency converter can be divided into four main sections: rectifier, intermediate circuit (DC bus), inverter, and control.

The main frequency converter components are grouped into three sections consisting of control logic, logic to power interface, and power. These are covered in greater detail in *3.3 Sequence of Operation* which describes power and control signals within the frequency converter.

3.2.1 Control card external interfaces

The primary circuit of the control card is the micro controller system, which supervises and controls all functions of the frequency converter operation. The control card also contains several other circuits, shown in *Illustration 3.1*.

The control card has an interface to a local control panel (LCP). The LCP is a keypad/display connected to the frequency converter through an external cable. The LCP provides the interface between the frequency converter's internal digital logic and the operator. All the programmable parameter settings of the frequency converter can be uploaded into the EEPROM of the LCP. This function is useful for maintaining a backup frequency converter profile and parameter set. When downloaded, it is used to programme other frequency converters or to restore a program to a repaired unit. The LCP is removable during operation to prevent undesired program changes.

With the addition of a remote mounting kit, the LCP can be mounted in a remote location of up to 3 metres away.

Control terminals, with programmable functions, are provided for input commands such as run, stop, forward, reverse and speed reference. Additional output terminals are provided to supply signals to run peripheral devices or for monitoring and reporting status.

The control card logic is capable of communicating via serial link or USB with outside devices such as personal computers or programmable logic controllers (PLC).

The control card also provides a 24 V DC output for external use. The 24 V DC supply is capable of supplying 600 mA current, which may be used to power external encoders or other devices. The 24 V DC supply can also be used for switching functions such as start, stop and forward/reverse.

A 10 V DC supply on terminal 50, rated at 15 mA, is also available for use with speed reference circuitry.

Two relays for monitoring the status of the frequency converter are located in the installation box. These are programmable through parameter group 5-4*. The relays are Form C, meaning each has one normally open contact and one normally closed contact on a single throw. The contacts of each relay are rated for a maximum load of 240 V AC at 2 amps.

The control card also has an option B slot, enabling the addition of option modules for speed feedback.

The frequency converter is available with an optional secondary SMPS which is powered from a customer-supplied 24 V DC source. This SMPS is integrated at the control card and provides power to the control card with mains input disconnected. It can keep units with communication options alive on a network when the frequency converter is not powered from the mains.

Fieldbus options can also be integrated on the control card (not pluggable). See *1.6 Type Code Description* for available fieldbuses.

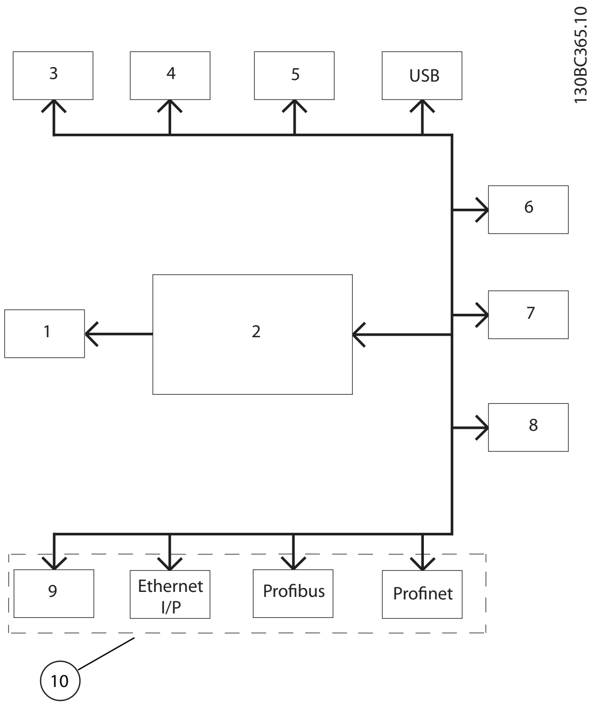


Illustration 3.1 Control Card External Interfaces

1	Power card	6	Relay 1 and Relay 2
2	Micro controller system	7	Analog in, Analog out
3	LCP	8	Digital in, Digital out
4	B-option slot	9	24 V backup supply
5	Standard bus	10	Optional at control card

3.2.2 Interface between control and power card

The control card generates the signals controlling the gate drive at the power card. The gate drive signals from the control card to the output transistors (IGBTs) are isolated and buffered on the power card. In units that have the dynamic brake option, the driver circuits for the brake transistors are also located on this card.

Much of the fault processing for output short circuit and earth fault conditions is handled by the control card. The power card provides conditioning of these signals. Scaling of current feedback and voltage feedback is accomplished by the control card.

The power card contains two switch mode power supplies (SMPS) which provide the unit with 24 V DC and 5 V DC operating voltage. The control card is powered by these two supplies. The 24 V DC SMPS is supplied by the DC bus voltage.

3.2.3 Power Section

The power section of the inverter contains:

- circuit for mains rectification
- DC-link circuitry containing the DC coils, DC capacitors and the inrush circuit.

The inverter section contains IGBT modules.

The rectifier section comprises six diodes, two for each phase.

The DC coil contains two coils wounded on a common core. One coil resides in the positive side of the DC link and the other in the negative. The coil reduces grid harmonics.

The DC-link circuitry smoothes the pulsating DC voltage created by the conversion from the grid. The DC-link capacitors are arranged into a capacitor bank along with soft charger and balancing circuitry. Each inverter contains two DC capacitors.

The inverter section is made up of six IGBTs, commonly referred to as switches. Two switches are required for each phase of the three-phase power, amounting to a total of six switches per IGBT module (half-phase per switch).

A Hall effect-type current sensor is located on each phase of the inverter output to measure motor current. This type of device is used instead of more common current transformer (CT) devices to reduce the frequency and phase distortion that CTs introduce into the signal. The Hall sensor monitors the average, peak, and earth leakage currents, and feeds the current sensor signal level to the control card.

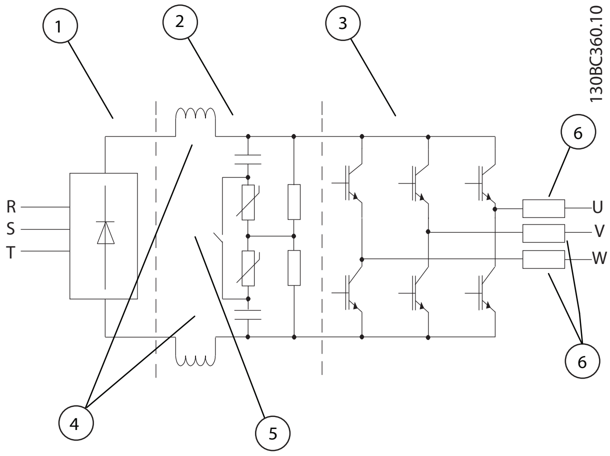


Illustration 3.2 Power Section

1	Rectifier	4	DC choke
2	DC link	5	Inrush circuits
3	Inverter	6	Current sense

3.3 Sequence of Operation

3.3.1 Brake Option

For frequency converters equipped with the dynamic brake option, one brake IGBT along with terminals 81(R-) and 82(R+) is included in each inverter module for connecting an external brake resistor(s).

The function of the brake IGBT is to limit the voltage in the intermediate circuit, whenever the maximum voltage limit is exceeded. It does this by switching the internally or externally mounted resistor across the DC bus to remove excess DC voltage present on the bus capacitors. Excess DC bus voltage is generally a result of an overhauling load causing regenerative energy to be returned to the DC bus. This occurs, for example, when the load drives the motor causing the voltage to return to the DC bus circuit.

Placing the brake resistor externally has the advantages of selecting the resistor based on application need, dissipating the energy outside of the LCP, and protecting the frequency converter from overheating if the brake resistor is overloaded.

The Brake IGBT gate signal originates on the control card and is delivered to the brake IGBTs. Additionally, the power and control cards monitor the brake IGBT and brake resistor connection for short circuits and overloads.

3.3.2 Mechanical Holding Brake

A mechanical holding brake is mounted directly on the application. The static holding torque functions as a static hold on the motor shaft. The output of the frequency converter directly controls a holding brake. The output terminals to the brake are located in the output connectors (M+) and (M-). (M+) is the positive voltage and (M-) is the negative. The output voltage is approximately 180 V DC.

When the frequency converter is in alarm mode or in an over-voltage situation, the mechanical brake immediately cuts in.

A v cannot provide a safe control of a mechanical brake. A redundancy circuitry for the brake control must be included in the total installation. The motor shaft normally performs static braking.

4 Troubleshooting

4.1 Troubleshooting Tips

Before attempting to repair a frequency converter, here are some tips to follow to make the job easier and possibly prevent unnecessary damage to functional components.

1. Ensure that no voltage is present on the frequency converter before troubleshooting. Check for the presence of AC input voltage and DC bus voltage and ensure there is none before working on the unit. **Remember that voltage may be present for as long as 4 minutes after removing power from the unit. See the label on the front of the frequency converter for the specific discharge time.** Some points in the frequency converter are referenced to the negative DC bus and are at bus potential even though it may appear on diagrams to be a neutral reference.
2. Darkened LED lights does not mean that the frequency converter has no dangerous internal voltage. Do not assume the unit contains no voltage when the indicator lights are off.
3. Never apply power to a unit that is suspected of being faulty. Many faulty components within the frequency converter can cause damage to other components when power is applied.
4. Never attempt to defeat any fault protection circuitry within the frequency converter. That will result in unnecessary component damage and may cause personal injury.
5. Always use factory approved replacement parts. The frequency converter has been designed to operate within certain specifications. Incorrect parts may affect tolerances and result in further damage to the unit.
6. Read the instruction and service manuals. A thorough understanding of the unit is the best approach. If ever in doubt, consult the factory or authorized repair centre for assistance.

4.2 Exterior Fault Troubleshooting

There may be slight differences in servicing a frequency converter that has been operational for some extended period of time compared to a new installation. When using proper troubleshooting procedures, make no assumptions. To assume a motor is wired properly because the frequency converter has been in service for some time may cause you to overlook issues like loose connections, improper programming, or added equipment. It is best to develop a detailed approach, beginning with a physical inspection of the system. See *Table 4.1* for items to examine.

4.3 Fault Symptom Troubleshooting

This troubleshooting section is divided into sections based on the symptom being experienced. To start, *Table 4.1* provides a visual inspection check list. Many times the root cause of the problem may be due to the way the frequency converter has been installed or wired. The check list provides guidance through a variety of items to inspect during any frequency converter service process.

Next, symptoms are approached as the technician most commonly discovers them:

- reading an unrecognised frequency converter display
- problems with motor operation, or
- a warning or alarm displayed by the frequency converter

Remember, the frequency converter processor monitors inputs and outputs as well as internal frequency converter functions, so an alarm or warning does not necessarily indicate a problem within the frequency converter itself.

Each incident has further descriptions on how to troubleshoot that particular symptom. When necessary, further referrals are made to other parts of the manual for additional procedures. *5 Frequency Converter and Motor Applications* presents detailed discussions on areas of frequency converter and system troubleshooting that an experienced repair technician should understand in order to make effective diagnoses.

4.4 Visual Inspection

The *Table 4.1* lists a variety of conditions that require visual inspection as part of any initial troubleshooting procedure.

Inspect For	Description
Auxiliary equipment	Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on either the input power side of frequency converter or the output side to motor. Examine the operation and condition of these items for possible causes of operational faults. Check the function and installation of pressure sensors or encoders or other devises that provide feedback to the frequency converter.
Cable routing	Avoid routing motor wiring, mains wiring, and signal wiring in parallel. If parallel routing is unavoidable, try to maintain a separation of 150-200 mm (6–8 inches) between the cables or separate them with an earthed conductive partition. Avoid routing cables through free air. For unscreened cabling, run input power and motor power in separate conduit.
Control wiring	Check for broken or damaged wires and connections. Check the voltage source of the signals. The use of screened cable or a twisted pair is recommended. Ensure the screen is terminated correctly. For unscreened control wiring, run in separate conduit from power cabling.
LCP	Warnings, alarms, drive status, fault history and many other important items are available via the LCP on the frequency converter.
EMC considerations	Check for proper installation with regard to electromagnetic capability.
Environmental conditions	Under specific conditions, these units can be operated within a maximum ambient of 45° C (131° F). Humidity levels must be less than 95% noncondensing. Check for harmful airborne contaminates such as sulphur based compounds.
Earthing	The frequency converter requires a dedicated earth wire from its chassis to the building earth. It is also suggested that the motor be earthed to the frequency converter chassis as well. The use of a conduit or mounting the frequency converter onto a metal surface is not considered a suitable earth. Check for good earth connections that are tight and free of oxidation.
Input power wiring	Check for loose connections. Check for proper fusing. Check for blown fuses in the installation.
Motor	Check the nameplate ratings of the motor. Ensure that the motor ratings coincide with the frequency converters. Make sure that the frequency converter's motor parameters (1-20 – 1-25) are set according to the motor ratings.
Output to motor wiring	Check for loose connections. Check for switching components in the output circuit. Check for faulty contacts in the switch gear.
Programming	Make sure that the frequency converter parameter settings are correct according to motor, application, and I/O configuration.

Table 4.1 Visual Inspection

4.5 Fault Symptoms

4.5.1 No LED lights

To troubleshoot no green LED light:

- Check that power is supplied.
- Cycle power to the unit.
- Reinitialise the frequency converter.

If there is still no green LED light:

- Remove the inverter part.
- Check ribbon cable is connected to the control card (see *7.2.2 Control Card* and *7 Disassembly and Assembly Instructions* for details).

4.5.2 Intermittent Display

Cutting out or flashing of the entire display and power LED indicates that the power supply (SMPS) is shutting down as a result of being overloaded. This may be due to improper control wiring, or overload of the 24 V output, or a fault within the frequency converter itself.

The first step is to rule out a problem in the control wiring . To do this, disconnect all control wiring from the control terminal blocks on the installation card.

If the display stays lit, then the problem is in the control wiring (external to the frequency converter). All control wiring should be checked for shorts or incorrect connections.

If the display continues to cut out, follow the procedure for No Display as though the display were not lit at all.

4.5.3 Motor Will not Run

In the event that this symptom is detected, first verify that the unit is properly powered up (display is lit) and that there are no warning or alarm messages displayed. The most common cause of this is either incorrect control logic or an incorrectly programmed frequency converter. Such occurrences will result in one or more of the following status messages being displayed.

Cause: LCP Stop
Action: The [Off] key has been pressed.

Press the [Auto On] or [Hand On] key.

Cause: Standby
This indicates that there is no start signal at terminal 18.

Action: Ensure that a start command is present at terminal 18. Refer to *6.3.5 Input Terminal Signal Tests*.

Cause: Unit ready
Terminal 27 is low (no signal).

Action: Ensure that terminal 27 is logic “1”. Refer to *6.3.5 Input Terminal Signal Tests*.

Run OK, 0 Hz
This indicates that a run command has been given to the frequency converter, but the reference (speed command) is zero or missing.

Check the control wiring to ensure that the proper reference signal is present at the frequency converter input terminals and that the unit is properly programmed to accept the signal provided. Refer to *6.3.5 Input Terminal Signal Tests*.

Off 1 (2 or 3)
This indicates that bit #1 (or #2, or #3) in the control word is logic “0”. This will only occur when the frequency converter is being controlled via the fieldbus.

A correct control word must be transmitted to the frequency converter over the communication bus to correct this.

STOP
One of the digital input terminals 18, 19, 27, 29, 32, or 33 (parameter 5-1*) is programmed for *Stop Inverse* and the corresponding terminal is low (logic “0”).

Ensure that the above parameters are programmed correctly and that any digital input programmed for *Stop Inverse* is high (logic “1”).

Display Indication That the Unit is Functioning, but No Output
If the unit is equipped with an external 24 V DC option, check that mains power is applied to the frequency converter.

NOTE

In this case, the LCP shows 'DC under volt [8]'.

4.5.4 Incorrect Motor Operation

Occasionally, a fault can occur where the motor will continue to run, but not in the correct manner. The symptoms and causes may vary considerably. Many of the possible problems are listed below by symptom along with recommended procedures for determining their causes.

Wrong speed/unit will not respond to command
Possible incorrect reference (speed command).

Ensure that the unit is programmed correctly according to the reference signal being used, and that all reference limits are set correctly as well.

Motor speed unstable
Possible incorrect parameter settings, faulty current feedback circuit, loss of motor (output) phase.

4

Check the settings of all motor parameters, including all motor compensation settings (Slip Compensation, Load Compensation, etc.) For Closed Loop operation, check PID settings.

Motor runs rough
Possible over-magnetization (incorrect motor settings), or an IGBT misfiring.

NOTE

Motor may also stall when loaded or the frequency converter may trip occasionally on Alarm 13.

Check setting of all motor parameters.

Motor draws high current but cannot start
Possible open winding in motor or open phase in connection to motor.

Run an AMA to check the motor for open windings and unbalanced resistance. Inspect all motor wiring connections.

Motor will not brake
Possible fault in the brake circuit. Possible incorrect setting in the brake parameters. The ramp down time too short. Note: May be accompanied by an alarm or warning message.

Check all brake parameters and ramp down time (parameters 2-0* and 3-4*).

4.6 Alarm MessagesWarningWarning/Alarm Messages

4.6.1 Warning/Alarm Code List

A warning or an alarm is signalled by the LEDs on the front of the frequency converter and by a code on the display.

A **warning** indicates a condition that may require attention or a trend that may eventually require attention. A warning remains active until the cause is no longer present. Under some circumstances motor operation may continue.

A **trip** is the action when an alarm has appeared. The trip removes power to the motor and can be reset after the condition has been cleared by pressing the [reset] button or through a digital input (parameter 5-1*). The event that caused an alarm cannot damage the frequency converter or cause a dangerous condition. Alarms must be reset to restart operation once their cause has been rectified.

This may be done in three ways:

1. Pressing the [Reset] button on the control panel LCP.
2. A digital reset input.
3. Serial communication/optional fieldbus reset signal.

NOTE

After a manual reset using the [Reset] button on the LCP, the [Auto On] button must be pressed to restart the motor.

A **trip lock** is an action when an alarm occurs which may cause damage to the frequency converter or connected equipment. Power is removed from the motor. A trip lock can only be reset after the condition is cleared by cycling power. Once the problem has been rectified, only the alarm continues flashing until the frequency converter is reset.

An X marked in *Table 4.2* means that action occurs. A warning precedes an alarm.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock
1	10 volts low	X		
2	Live zero error	(X)	(X)	
3	No motor	(X)		
4	Mains phase loss	(X)	(X)	(X)
5	DC link voltage high	X		
6	DC link voltage low	X		
7	DC overvoltage	X	X	
8	DC undervoltage	X	X	
9	Inverter overloaded	X	X	
10	Motor overtemperature	(X)	(X)	
11	Motor thermistor overtemperature	(X)	(X)	
12	Torque limit	X	X	
13	Overcurrent	X	X	X
14	Earth (ground) fault	X	X	X
15	Hardware mismatch			
16	Short circuit		X	X

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock
17	Control word time-out	(X)	(X)	
22	Hoist mechanical brake		X	
25	Brake resistor short circuit	X		
26	Brake resistor power limit	(X)	(X)	
27	Brake chopper fault	X	X	
28	Brake check failed	(X)	(X)	
29	Heatsink temp	X	X	X
30	Motor phase U missing	(X)	(X)	(X)
31	Motor phase V missing	(X)	(X)	(X)
32	Motor phase W missing	(X)	(X)	(X)
33	Inrush fault		X	X
34	Fieldbus communication fault	X	X	
36	Mains failure	X	X	
38	Internal fault		X	X
39	Heatsink sensor		X	X
40	Overload of Digital Output Terminal 27	(X)		
41	Overload of Digital Output Terminal 29	(X)		
42	Overload of Digital Output on X30/6 or Overload of Digital Output on X30/7	(X)		
46	Power card supply		X	X
47	24 V supply low	X	X	X
48	1.8 V supply low		X	X
49	Speed limit	X		
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 time-out		X	
58	AMA internal fault	X	X	
59	Current limit	X		
60	External interlock	X		
61	Encoder loss	(X)	(X)	
62	Output frequency at maximum limit	X	X	
63	Mechanical brake low		(X)	
64	Voltage limit	X		
65	Control board overtemperature	X	X	X
66	Heatsink temperature low	X		
67	Option configuration has changed		X	
68	Safe stop activated	(X)	(X)[1)]	
69	Power card temperature		X	X
70	Illegal frequency converter configuration			
71	PTC 1 safe stop	X	X	
72	Dangerous failure	X	X	X
73	Safe stop auto restart	X		
79	Illegal PS config			
80	Drive initialised to default value		X	
81	CSIV corrupt		X	
82	CSIV parameter error		X	
90	Encoder loss	(X)	(X)	
91	Analog input 54 wrong settings			X

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock
92	No flow	(X)	(X)	
243	Brake IGBT		X	
244	Heatsink temperature	X	X	X
245	Heatsink sensor		X	X
246	Power card supply		X	X
247	Power card temperature		X	X
248	Illegal PS config			
250	New spare part			X
251	New type code		X	X

Table 4.2 Warning/Alarm Code List

(X) Programmable: dependent on parameter setting.

1) Cannot be auto reset via parameter selection.

LED indication	
Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

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 will only appear 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. This condition can be caused by broken wiring or faulty device sending the signal.

Troubleshooting:

Check the 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).

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

WARNING/ALARM 3, No motor
No motor has been connected to the output of the frequency converter. This warning or alarm will only appear if programmed by the user in *1-80 Function at Stop*.

Troubleshooting: Check the connection between the frequency converter and the motor.

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 frequency converter 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 frequency converter 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 functions in *2-10 Brake Function*

Increase *14-26 Trip Delay at Inverter Fault*

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

Troubleshooting:

Make sure that the supply voltage matches the frequency converter voltage.

WARNING/ALARM 9, Inverter overloaded
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 gives 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 is overloaded by more than 100% 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 should increase. When running below the frequency converter continuous current rating, the counter should decrease.

NOTE

See the derating section in the *Design Guide MG04HXYY* for more details if a high switch frequency is required.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter should give a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault is that the motor is overloaded by more than 100% for too long.

Troubleshooting:

Check if motor is overheating.

If the motor is mechanically overloaded

That the motor *1-24 Motor Current* is set correctly.

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

The setting in *1-91 Motor External Fan*.

Run AMA in *1-29 Automatic Motor Adaptation (AMA)*.

WARNING/ALARM 11, Motor thermistor overtemp
The thermistor or the thermistor connection is disconnected. Select whether the frequency converter gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*.

Troubleshooting:

Check if motor is overheating.

Check if the motor is mechanically overloaded.

Check that the thermistor is connected correctly between terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply), or between terminal 18 or 19 (digital input PNP only) and terminal 50.

If a KTY sensor is used, check for correct connection between terminal 54 and 55.

If using a thermal switch or thermistor, check the programming of *1-93 Thermistor Resource* matches sensor wiring.

If using a KTY sensor, check the programming of parameters 1-95, 1-96, and 1-97 match sensor wiring.

WARNING/ALARM 12, Torque limit
The torque is higher than the value in *4-16 Torque Limit Motor Mode* (in motor operation) or the torque is higher than the value in *4-17 Torque Limit Generator Mode* (in regenerative operation). *14-25 Trip Delay at Torque Limit* can be used to change this from a warning only condition to a warning followed by an alarm.

WARNING/ALARM 13, Overcurrent
The inverter peak current limit (approx. 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then thefrequency converter trips and issues an alarm. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting:

This fault may be caused by shock loading or fast acceleration with high inertia loads.

Turn off the frequency converter. Check if the motor shaft can be turned.

Make sure that the motor size matches the frequency converter.

Incorrect motor data in parameters 1-20 through 1-25.

ALARM 14, Earth (ground) fault
There is a discharge from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting:

Turn off the frequency converter and remove the earth fault.

Measure the resistance to earth of the motor leads and the motor with a megohmmeter to check for earth faults in the motor.

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 on the motor terminals.
Turn off the frequency converter and remove the short-circuit.

WARNING/ALARM 17, Control word time-out
There is no communication to the frequency converter.
The warning will only be active when *8-04 Control Word Timeout Function* is NOT set to OFF.
If *8-04 Control Word Timeout Function* is set to *Stop* and *Trip*, a warning appears and the frequency converter ramps down until it trips, while giving 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.

WARNING 22, Hoist mechanical brake
The report value will show what kind it is.
0=The torque reference was not reached before time-out.
1=There was no brake feedback before the time-out.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If it short circuits, the brake function is disconnected and the warning appears. The frequency converter still works, but without the brake function. Turn off 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 percentage, as a mean value over the last 120 seconds, on the basis of the resistance value of the brake resistor, and the intermediate circuit voltage. The warning is active when the dissipated braking power is higher than 90%. If *Trip* [2] has been selected in *2-13 Brake Power Monitoring*, the frequency converter cuts out and issues this alarm, when the dissipated braking power is higher than 100%.

⚠WARNING

There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and if it short-circuits, the brake function disconnects and issues a warning. The frequency converter is still able to run, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Turn off the frequency converter and remove the brake resistor.
This alarm/warning could also occur should the brake resistor overheat.

WARNING/ALARM 28, Brake check failed
Brake resistor fault: 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 be reset until the temperature falls below a defined heatsink temperature. The trip and reset point are different based on the frequency converter power size.

Troubleshooting:

Ambient temperature too high.

Motor cable too long.

Incorrect clearance above and below the frequency converter.

Dirty heatsink.

Blocked air flow around the frequency converter.

This alarm can also be caused by the thermal sensor in the rectifier power module.

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

ALARM 31, Motor phase V missing
Motor phase V between the frequency converter and the motor is missing.
Turn off 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.
Turn off 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 35, Out of frequency range:
This warning is active if the output frequency has reached the high limit (set in parameter *4-53 Warning Speed High*) or low limit (set in *4-52 Warning Speed Low*). In *Process Control, Closed Loop*, *1-00 Configuration Mode* this warning is displayed.

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 Off. Check the fuses to the frequency converter.

ALARM 38, Internal fault
It may be necessary to contact your frequency converter supplier. Some typical alarm messages:

0	Serial port cannot be initialised. Serious hardware failure
256-258	Power EEPROM data is defect or too old
512	Control board EEPROM data is defect or too old
513	Communication time out reading EEPROM data
514	Communication time out reading EEPROM data
515	Application Orientated Control cannot recognise the EEPROM data
516	Cannot write to the EEPROM because a write command is on progress
517	Write command is under time out
518	Failure in the EEPROM
519	Missing or invalid Barcode data in EEPROM
783	Parameter value outside of min/max limits
1024-1279	A CAN telegram that must be sent, couldn't be sent
1281	Digital Signal Processor flash time-out
1282	Power micro software version mismatch
1283	Power EEPROM data version mismatch
1284	Cannot read Digital Signal Processor software version
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	Option A did not respond when calculating Platform Version.
1380	Option B did not respond when calculating Platform Version.
1536	An exception in the Application Orientated Control is registered. Debug information written in LCP
1792	DSP watchdog is active. Debugging of power part data Motor Orientated Control data not transferred correctly
2049	Power data restarted
2064-2072	H081x: option in slot x has restarted
2080-2088	H082x: option in slot x has issued a power up-wait
2096-2104	H083x: option in slot x has issued a legal power up-wait
2304	Could not read any data from power EEPROM
2305	Missing SW version from power unit
2314	Missing power unit data from power unit
2315	Missing SW version from power unit
2316	Missing io_statepage from power unit
2324	The power card configuration is determined to be incorrect at power up.
2325	A power card has stopped communicating while main power is applied
2326	The power card configuration is determined to be incorrect after the power card register delay.
2327	Too many power card locations have been registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD
2562	No communication from ATACD to DSP (state running)
2816	Stack overflow of control board module
2817	Scheduler slow tasks
2818	Fast tasks
2819	Parameter thread
2820	LCP Stack overflow
2821	Serial port overflow
2822	USB port overflow
2836	cfListMempool to small
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	Out of memory

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 the 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 the short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

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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 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. When powered with 24 V DC, only the 24 V and 5 V supplies are monitored. When powered with three phase mains voltage, all three supplied are monitored.

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 your Danfoss supplier.

WARNING 48, 1.8 V supply low
The 1.8 Volt DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card.

WARNING 49, Speed limit
The speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*.

ALARM 50, AMA calibration failed
Contact your Danfoss supplier.

ALARM 51, AMA check Unom and Inom
The setting of motor voltage, motor current, and motor power is presumably wrong. Check the settings.

ALARM 52, AMA low Inom
The motor current is too low. Check the settings.

ALARM 53, AMA motor too big
The motor is too big for the AMA to be carried out.

ALARM 54, AMA motor too small
The motor is too small for the AMA to be carried out.

ALARM 55, AMA parameter out of range
The parameter values found from the motor are outside acceptable range.

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

ALARM 57, AMA time-out
Try to start the AMA again a number of times, until the AMA is carried out. Repeated runs may heat the motor to a level where the resistances Rs and Rr are increased. In most cases, however, this is not critical.

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*.

WARNING 60, External interlock
External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the frequency converter (via serial communication, digital I/O, or by pressing the reset button on LCP).

WARNING 61, Tracking error
An error has been detected between the calculated motor speed and the speed measurement from the feedback device. The function for Warning/Alarm/Disable is set in *4-30 Motor Feedback Loss Function*, error setting in *4-31 Motor Feedback Speed Error*, and the allowed error time in *4-32 Motor Feedback Loss Timeout*. During a commissioning procedure the function may be effective.

WARNING 62, Output frequency at maximum limit
The output frequency is higher than the value set in *4-19 Max Output Frequency*

ALARM 63, mechanical brake Low
The actual motor current has not exceeded the release-brake current within the start-delay time window.

WARNING 64, Voltage limit
The load and speed combination demands a motor voltage higher than the actual DC link voltage.

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

WARNING 66, Heatsink temperature low
This warning is based on the temperature sensor in the IGBT module. See*1.9 Ratings Tables* for the temperature reading that will trigger this warning.

Troubleshooting:

The heatsink temperature measured as 0° C could indicate that the temperature sensor is defective, thereby causing the fan speed to increase to the maximum. If the sensor wire between the IGBT and the gate drive card is disconnected, this warning is produced. Also, check the IGBT thermal sensor.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down.

ALARM 68, Safe stop activated
Safe stop has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing the reset key. See *5-19 Terminal 37 Safe Stop*.

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

Troubleshooting:

Check the operation of the door fans.

Make sure that the filters for the door fans are not blocked.

Make sure that the gland plate is properly installed on IP21 and IP54 (NEMA 1 and NEMA 12) frequency converters.

ALARM 70, Illegal frequency converter Configuration
The current control board and power board combination is illegal.

WARNING/ALARM 71, PTC 1 safe stop
Safe Stop has been activated from the MCB 112 PTC thermistor card (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to T-37 again (when the motor temperature reaches an acceptable level) and when the digital input from the MCB 112 is deactivated. When this happens, a reset signal is sent (via serial communication, digital I/O, or by pressing reset button on LCP). Note that if automatic restart is enabled, the motor may start when the fault is cleared.

ALARM 72, Dangerous failure
Safe stop with trip lock. Unexpected signal levels on the safe stop and digital input from the MCB 112 PTC thermistor card.

Warning 73, Safe stop auto restart
Safe stopped. Note that with automatic restart enabled, the motor may start when the fault is cleared.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also, the MK102 connector on the power card is not installed.

ALARM 80, Drive initialised to default value
Parameter settings are initialised to default settings after a manual reset.

WARNING 81, CSIV corrupt
CSIV file has syntax errors.

WARNING 82, CSIV parameter error
CSIV has failed to record a parameter.

ALARM 91, Analog input 54 wrong settings
Switch A54 must be set in the position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 92, No flow
A no-load situation has been detected in the system. See parameter group 22-2*.

ALARM 244, Heatsink temperature
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F2 or F4 frequency converter.

2 = right inverter module in F1 or F3 frequency converter.

3 = right inverter module in F2 or F4 frequency converter.

5 = rectifier module.

ALARM 245, Heatsink sensor
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F2 or F4 frequency converter.

2 = right inverter module in F1 or F3 frequency converter.

3 = right inverter module in F2 or F4 frequency converter.

5 = rectifier module.

ALARM 246, Power card supply
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F2 or F4 frequency converter.

2 = right inverter module in F1 or F3 frequency converter.

3 = right inverter module in F2 or F4 frequency converter.

5 = rectifier module.

ALARM 247, Power card temperature
This alarm is only for F Frame frequency converters. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F2 or F4 frequency converter.

2 = right inverter module in F1 or F3 frequency converter.

3 = right inverter module in F2 or F4 frequency converter.

5 = rectifier module.

ALARM 250, New spare part
The power or switch mode power supply has been exchanged. The frequency converter type code must be restored in the EEPROM. Select the correct type code in *14-23 Typecode Setting* according to the label on the unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New type code
The frequency converter has a new type code.

5

5 Frequency Converter and Motor Applications

5.1 Torque Limit, Current Limit, and Unstable Motor Operation

Excessive loading of the frequency converter may result in warning or tripping on torque limit, overcurrent, or inverter time. This is not a concern if the frequency converter is properly sized for the application and intermittent load conditions cause anticipated operation in torque limit or an occasional trip. However, nuisance or unexplained occurrences may be the result of improperly setting specific parameters. The following parameters are important in matching the frequency converter to the motor for optimum operation. These settings need careful attention.

> *1-03 Torque Characteristics* sets the mode in which the frequency converter will operate.
>
> Parameters 1-20 through 1-29 match the frequency converter to the motor and adapt to the motor characteristics.
>
> Parameters 4-17 and 14-25 set the torque control features of the frequency converter for the application.

1-00 Configuration Mode sets the frequency converter for open or closed loop operation or torque mode operation. In a closed loop configuration, a feedback signal controls the frequency converter speed. The settings for the PID controller play a key role for stable operation in closed loop, as described in the *Operating Instructions MG04FXYY*. In open loop, the frequency converter calculates the torque requirement based on current measurements of the motor.

1-03 Torque Characteristics sets the frequency converter for constant or variable torque operation. It is imperative that the correct torque characteristic is selected, based on the application. If, for example, the load type is constant torque, such as a conveyor, and variable torque is selected, the frequency converter may have great difficulty starting the load, if started at all. Consult the factory if uncertain about the torque characteristics of an application.

Parameters 1-20 through 1-25 configure the frequency converter for the connected motor. These are motor power, voltage, frequency, current, and rated motor speed. Accurate setting of these parameters is very important. Enter the motor data required as listed on the motor nameplate. For effective and efficient load control, the frequency converter relies on this information for calculating the output waveform in response to the changing demands of the application.

1-29 Automatic Motor Adaptation (AMA) activates the automatic motor adaptation (AMA) function. When AMA is performed, the frequency converter measures the electrical resistance of the motor stator windings, R1. Since AMA can not calculate R2, X1, X2, and Xm (*1-31 Rotor Resistance (Rr)* to *1-35 Main Reactance (Xh)*) they must be requested from the motor manufacturer the optimal performance of the frequency converter data. *1-31 Rotor Resistance (Rr)* and *1-35 Main Reactance (Xh)*, as stated, should be set by the values supplied by the motor manufacturer, or left at the factory default values.

NOTE

Never adjust these parameters to random values even though it may seem to improve operation. Such adjustments can result in unpredictable operation under changing conditions.

4-17 Torque Limit Generator Mode sets the limit for frequency converter torque. The factory setting is 160% for the frequency converter and will vary with motor power setting. For example, a frequency converter programmed to operate a smaller rated motor will yield a higher torque limit value than the same frequency converter programmed to operate a larger size motor. It is important that this value not be set too low for the requirements of the application. In some cases, it may be desirable to have a torque limit set at a lesser value. This offers protection for the application in that the frequency converter will limit the torque. It may, however, require higher torque at initial start up. Under these circumstances, nuisance tripping may occur.

14-25 Trip Delay at Torque Limit works in conjunction with torque limit. This parameter selects the length of time the frequency converter operates in torque limit prior to a trip. The factory default value is off. This means that the frequency converter will not trip on torque limit, but it does not mean it will never trip from an overload condition. Built into the frequency converter is an internal inverter thermal protection circuit. This circuit monitors the output load on the inverter. If the load exceeds 100% of the continuous rating of the frequency converter, a timer is activated. If the load remains excessive long enough, the frequency converter will trip on inverter time. Adjustments cannot be made to alter this circuit. Improper parameter settings effecting load current can result in premature trips of this type. The timer can be displayed.

5.1.1 Overvoltage Trips

This trip occurs when the DC bus voltage reaches its DC bus alarm voltage high (see *1.9 Ratings Tables*). Before tripping, the frequency converter will display a high voltage warning. Most times an over voltage condition is due to fast deceleration ramps with respect to the inertia of the load. During deceleration of the load, inertia of the system acts to sustain the running speed. Once the motor frequency drops below the running speed, the load begins overhauling the motor. At this point the motor becomes a generator and starts returning energy to the frequency converter. This is called regenerative energy. Regeneration occurs when the speed of the load is greater than the commanded speed. This return voltage is rectified by the diodes in the IGBT modules and raises the DC bus. If the amount of returned voltage is too high, the frequency converter will trip.

There are a few ways to overcome this situation. One method is to reduce the deceleration rate so it takes longer for the frequency converter to decelerate. A general rule of thumb is that the frequency converter can only decelerate the load slightly faster than it would take for the load to naturally coast to a stop. A second method is to allow the overvoltage control circuit to take care of the deceleration ramp. When enabled the overvoltage control circuit regulates deceleration at a rate that maintains the DC bus voltage at an acceptable level. One caution with overvoltage control is that it will not make corrections to unrealistic ramp rates. For example, if the deceleration ramp needs to be 100 seconds due to the inertia, and the ramp rate is set at 3 seconds, overvoltage control will initially engage and then disengage and allow the frequency converter to trip. This is purposely done so the units operation is not misinterpreted. A third method in controlling regenerated energy is with a dynamic brake. The frequency converter monitors the level of the DC bus. Should the level become too high, the frequency converter switches the resistor across the DC bus and dissipates the unwanted energy into the external resistor bank mounted outside of the frequency converter. This will actually increase the rate of deceleration.

Less often is the case that the overvoltage condition is caused by the load while it is running at speed. In this case the dynamic brake option can be used or the overvoltage control circuit. It works with the load in this way. As stated earlier, regeneration occurs when the speed of the load is greater than the commanded speed. Should the load become regenerative while the frequency converter is running at a steady state speed, the overvoltage circuit will increase the frequency to match the speed of the load. The same restriction on the amount of influence applies. The frequency converter will add about 10% to the base speed before a trip occurs. Otherwise, the speed could continue to rise to potentially unsafe levels.

5.1.2 Mains Phase Loss Trips

The frequency converter actually monitors phase loss by monitoring the amount of ripple voltage on the DC bus. Ripple voltage on the DC bus is a product of a phase loss. The main concern is that ripple voltage causes overheating in the DC bus capacitors and the DC coil. If the ripple voltage on the DC bus is left unchecked, the lifetime of the capacitors and DC coil would be drastically reduced.

When the input voltage becomes unbalanced or a phase disappears completely, the ripple voltage increases. This causes the frequency converter to trip and issue the Alarm 4. In addition to missing phase voltage, increased bus ripple can be caused by a line disturbance or imbalance. Line disturbances may be caused by line notching, defective transformers or other loads that may be effecting the form factor of the AC waveform. Mains imbalances which exceed 3% cause sufficient DC bus ripple to initiate a trip.

Output disturbances can have the same effect of increased ripple voltage on the DC bus. A missing or lower than normal output voltage on one phase can cause increased ripple on the DC bus. When a mains imbalance trip occurs, it is necessary to check both the input and output voltage of the frequency converter.

Severe imbalance of supply voltage or phase loss can easily be detected with a voltmeter. Line disturbances most likely need to be viewed through an oscilloscope. Conduct tests for input imbalance of supply voltage, input waveform, and output imbalance of supply voltage as described in *4 Troubleshooting*.

5.1.3 Control Logic Problems

Problems with control logic can often be difficult to diagnose, since there is usually no associated fault indication. The typical complaint is simply that the frequency converter does not respond to a given command. There are two basic commands that must be given to any frequency converter in order to obtain an output. First, the frequency converter must be told to run (start command). Second, the frequency converter must be told how fast to run (reference or speed command).

The frequency converters are designed to accept a variety of signals. First determine what types of signals the frequency converter is receiving. There are six digital inputs (terminals 18, 19, 27, 29, 32, 33), two analog inputs (53 and 54), and the fieldbus (68, 69). The presence of a correct reading will indicate that the desired signal has been detected by the microprocessor of the frequency converter. See *2.9 Frequency Converter Inputs and Outputs*.

Using the status information displayed by the frequency converter is the best method of locating problems of this nature. By selecting within parameter group 0-2* LCP, line 2 or 3 of the display can be set to indicate the signals coming in. The presence of a correct reading indicates that the desired signal is detected by the microprocessor of the frequency converter. This data also may be read in parameter group 16-6*.

If there is not a correct indication, the next step is to determine whether the signal is present at the input terminals of the frequency converter. This can be performed with a voltmeter or oscilloscope in accordance with the *6.3.5 Input Terminal Signal Tests*.

If the signal is present at the terminal, the control card is defective and must be replaced. If the signal is not present, the problem is external to the frequency converter. The circuitry providing the signal along with its associated wiring must then be checked.

5.1.4 Programming Problems

Difficulty with frequency converter operation can be a result of improper programming of the frequency converter parameters. Three areas where programming errors may affect drive and motor operation are motor settings, references and limits, and I/O configuration. See *2.9 Frequency Converter Inputs and Outputs*.

The frequency converter must be set up correctly for the motor(s) connected to it. Parameters 1-20 – 1-25 must have data from the motor nameplate entered into the frequency converter. This enables the frequency converter processor to match the frequency converter to power characteristics of the motor. The most common result of inaccurate motor data is the motor drawing higher than normal amounts of current to perform the task expected of it. In such cases, setting the correct values for these parameters and performing the automatic motor adaptation (AMA) function will usually solve the problem.

Any references or limits set incorrectly will result in less than acceptable frequency converter performance. For instance, if maximum reference is set too low, the motor will be unable to reach full speed. These parameters must be set according to the requirements of the particular installation. References are set in the parameter group 3-0*.

Incorrectly set I/O configuration usually results in the frequency converter not responding to the function as commanded. It must be remembered that for every control terminal input or output, there are corresponding parameters settings. These determine how the frequency converter responds to an input signal or the type of signal present at that output. Utilising an I/O function must be thought of as a two step process. The desired I/O terminal must be wired properly, and the corresponding parameter must be set accordingly. Control terminals are programmed in the 5-0* and 6-0* parameter groups.

5.1.5 Motor/Load Problems

Problems with the motor, motor wiring or mechanical load on the motor can develop in a number of ways. The motor or motor wiring can develop a phase-to-phase or phase-to-earth short resulting in an alarm indication. Checks must be made to determine whether the problem is in the motor wiring or the motor itself.

A motor with unbalanced, or non-symmetrical, impedances on all three phases can result in uneven or rough operation, or unbalanced output currents. Measurements should be made with a clamp-on style ammeter to determine whether the current is balanced on the three output phases.

An incorrect mechanical load will usually be indicated by a torque limit alarm or warning. Disconnecting the motor from the load, if possible, can determine if this is the case.

Quite often, the indications of motor problems are similar to those of a defect in the frequency converter itself. To determine whether the problem is internal or external to the frequency converter, disconnect the motor from the frequency converter output terminals. If the three voltage measurements are balanced, the frequency converter is functioning correctly. The problem therefore is external to the frequency converter.

If the voltage measurements are not balanced, the frequency converter is malfunctioning. This typically means that one or more output IGBT is not switching on and off correctly. This can be a result of a defective IGBT or gate signal from the gate drive card.

5.2 Internal Frequency Converter Problems

The vast majority of problems related to failed frequency converter power components can be identified by performing a visual inspection and the static tests as described in *6 Test Procedures*. However, there are a number of possible problems that must be diagnosed in a different manner. The following discusses many of the most common of these problems.

5.2.1 Overtemperature Faults

Overtemperature faults in the frequency converter are typically the result of blocked airflow or a faulty cooling fan. The overtemperature alarm message displayed indicates where the fault exists.
Alarm 244, *Heatsink Overtemperature*. This normally indicates a heatsink fan not functioning. While an overtemperature alarm message is displayed, all cooling fans should be operating at full speed. Check the fans before resetting the frequency converter to determine the fault location.
Alarm 247, *Power Card Overtemperature*. This normally indicates that the ambient temperature inside the drive enclosure is too high. Check all air passages to ensure that nothing is obstructing the air flow.
With either of these alarms, the report value in the Alarm Log displays which module experienced the overtemperature condition.

5.2.2 Current Sensor Faults

When a current sensor fails, it is indicated sometimes by an overcurrent alarm that cannot be reset, even with the motor cables disconnected.
However, the frequency converter will experience frequent false earth fault trips. This is due to the DC offset failure mode of the sensors.

To explain this, it is necessary to investigate the internal makeup of a Hall effect type current sensor. Included inside the device is an op-amp to amplify the signal to usable levels in the receiving circuitry. Like any op-amp, the output at zero input level (zero current flow being measured) should be zero volts, exactly halfway between the plus and minus power supply voltages. A tolerance of +/-15 mV is acceptable. In a three phase system that is operating correctly, the sum of the three output currents should always be zero.

When the sensor becomes defective, the output voltage level varies by more than the 15 mV. The defective current sensor in that phase indicates current flow when there is none. This results in the sum of the three output currents being a value other than zero, which is an indication of leakage current flowing. If the deviation from zero (current amplitude) approaches a specific level, the frequency converter assumes an earth fault and issues an alarm.

The simplest method of determining whether a current sensor is defective is to disconnect the motor from the frequency converter, and then observe the current in the frequency converter display. With the motor disconnected, the current should be zero. A frequency converter with a defective current sensor will indicate some current flow. An indication of a fraction of one amp is tolerable. However, that value should be considerably less than one amp. If the display shows more than one amp of current, there is a defective current sensor.

To determine which current sensor is defective, measure the voltage offset at zero current for each current sensor. See the current sensor test procedure.

5.2.3 Signal and Power Wiring Considerations for Active Filter Electromagnetic Compatibility

The following is an overview of general signal and power wiring considerations when addressing the Electromagnetic Compatibility (EMC) concerns for typical commercial and industrial equipment. Certain high-frequency phenomena (RF emissions, RF immunity) are discussed. Special installations or compliance to the European CE EMC directives will require strict adherence to relevant standards and are not discussed here.

5.2.4 Effect of EMI

While Electromagnetic Interference (EMI) related disturbances to filter operation are uncommon, the following detrimental EMI effects may be seen:

- Serial communication transmission errors
- CPU exception faults
- Unexplained filter trips

Disturbance resulting from other nearby equipment is more common. Generally, other industrial control equipment has a high level of EMI immunity. However, non-industrial, commercial, and consumer equipment is often susceptible to lower levels of EMI. Detrimental effects to these systems may include the following:

- Pressure/flow/temperature signal transmitter signal distortion or aberrant behaviour
- Radio and TV interference
- Telephone interference
- Computer network data loss
- Digital control system faults

5.2.5 Sources of EMI

Frequency converters utilise Insulated-Gate Bipolar Transistors (IGBTs) to provide an efficient and cost effective means to create the Pulse Width Modulated (PWM) output waveform necessary for accurate unit control. These devices rapidly switch the fixed DC bus voltage creating a variable frequency, variable voltage PWM waveform. This high rate of voltage change [dU/dt] is the primary source of the filter generated EMI.

The high rate of voltage change caused by the IGBT switching creates high frequency EMI.

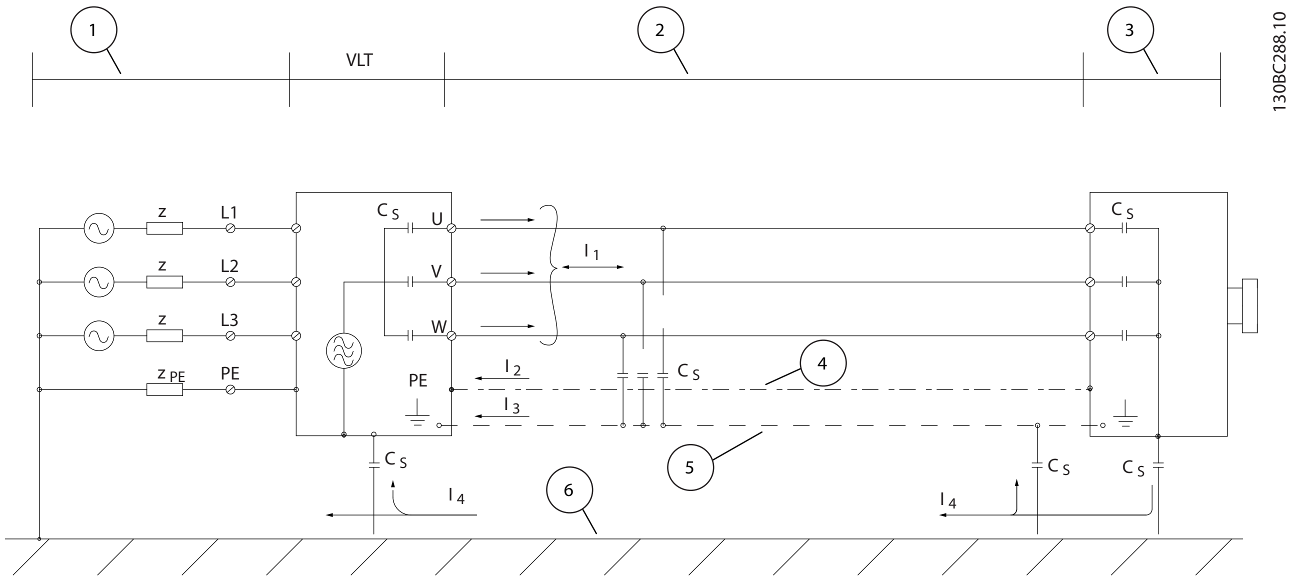


Illustration 5.1 Filter Functionality Diagram

1	Line	4	Earth wire
2	Motor cable screened	5	Screen
3	Motor	6	Earth plane

5.2.6 EMI Propagation

Frequency converter genrated EMI is both conducted to the mains and radiated to nearby conductors. See *Illustration 5.2*.

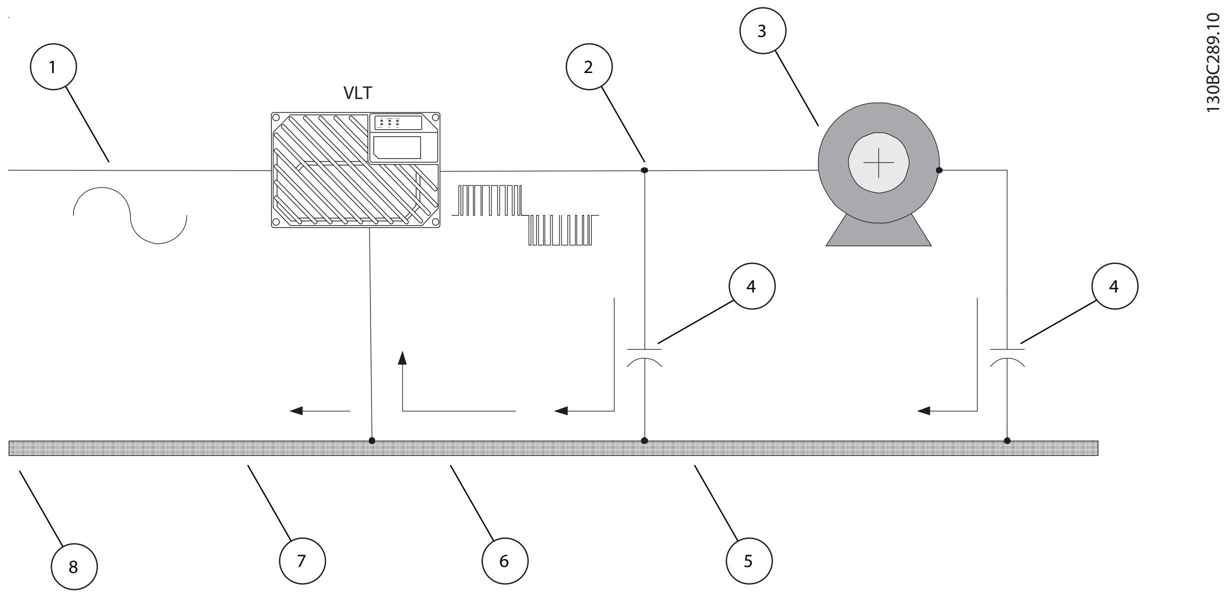


Illustration 5.2 Earth Currents

1	AC line	5	Potential 3
2	Motor cable	6	Potential 2
3	Motor	7	Potential 1
4	Stray capacitance	8	Earth

High earth circuit impedance at high frequencies results in an instantaneous voltage at points reputed to be at *earth potential*. This voltage can appear throughout a system as a common mode signal that can interfere with control signals.

Theoretically, these currents will return to the filter's DC bus via the earth circuit and a high frequency (HF) bypass network within the filter itself. However, imperfections in the filter earthing or the equipment earth system can cause some of the currents to travel out to the power network.

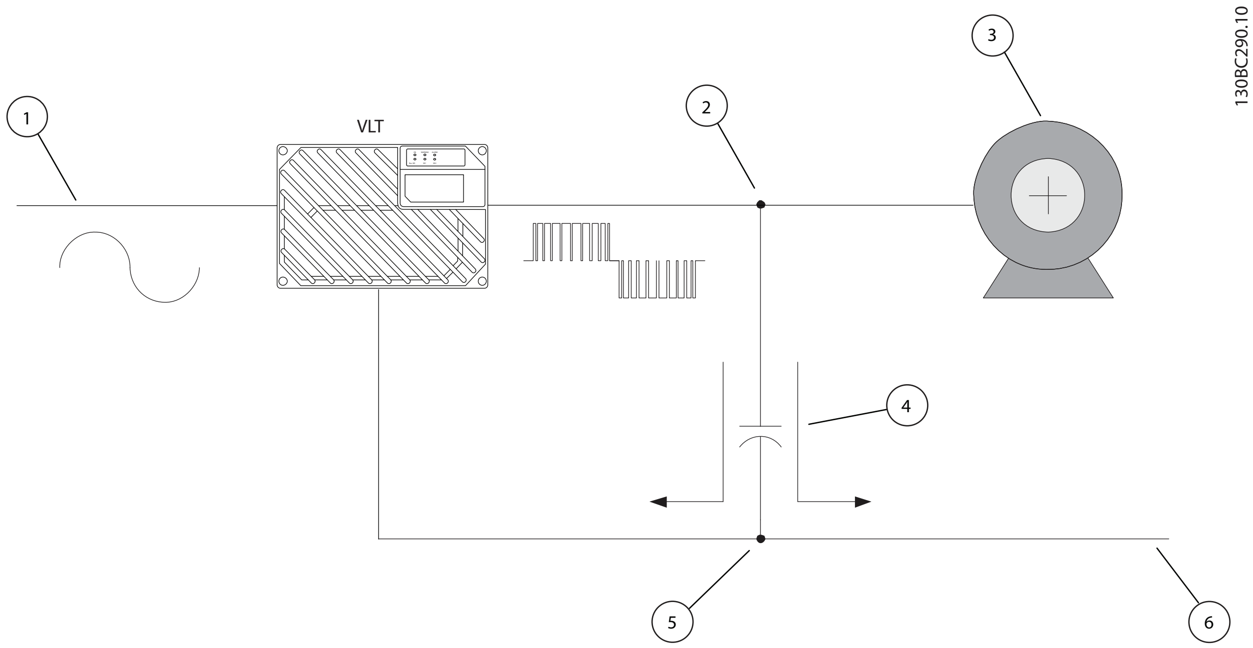


Illustration 5.3 Capacitive Coupling between Power Cables and Control Wiring

1	AC line	4	Stray capacitance
2	Motor cable	5	Signal wiring
3	Motor	6	To Building Management System

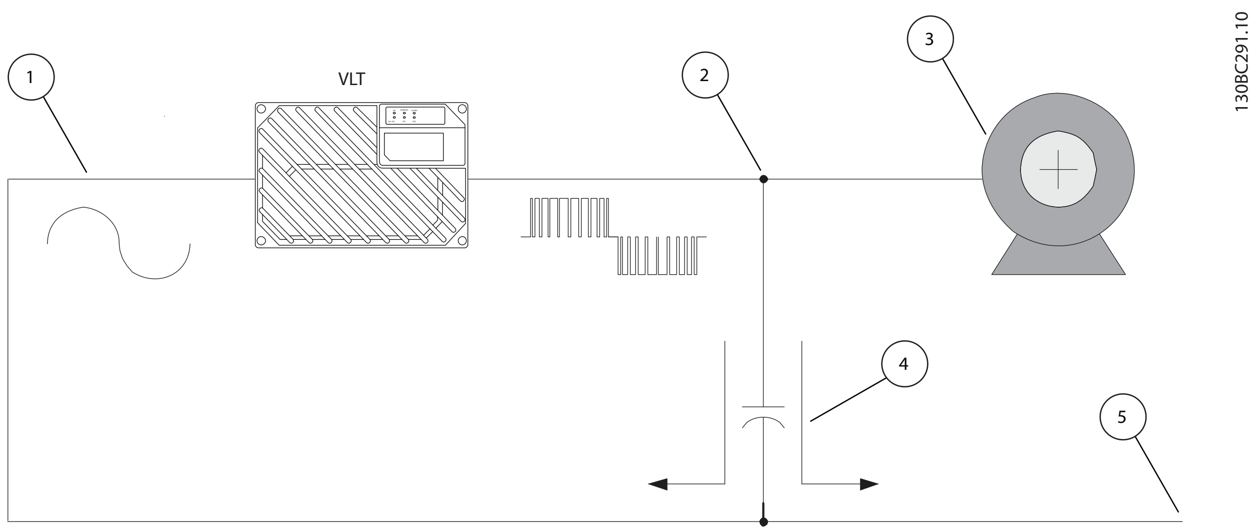


Illustration 5.4 Coupling between Mains and Motor Cables

1	AC line	4	Stray capacitance
2	Motor cable	5	AC line
3	Motor		

Ensure power cables and control wiring are always well separated, to avoid EMI.

These cables should be installed so they cross at right angles where necessary.

These cables should not run parallel to each other over longer distances.

6 Test Procedures

6.1 Introduction

⚠CAUTION

Touching electrical parts of frequency converter may be fatal even after equipment has been disconnected from AC power. Wait 4 minutes after power has been removed before touching any internal components to ensure that capacitors have fully discharged. See label on front of frequency converter for specific discharge time.

This section contains detailed procedures for testing frequency converters. Previous sections of this manual provide symptoms, alarms and other conditions which require additional test procedures to further diagnose the frequency converter. The results of these tests indicate the appropriate repair actions. Again, because the frequency converter monitors input and output signals, motor conditions, AC and DC power and other functions, the source of fault conditions may exist outside of the frequency converter itself. Testing described here will isolate many of these conditions as well. *7 Disassembly and Assembly Instructions* describe detailed procedures for removing and replacing frequency converter components.

Frequency converter testing is divided into *Static Tests* and *Dynamic Tests*. Static tests are conducted without power applied to the frequency converter. Most frequency converter problems can be diagnosed simply with these tests. Static tests are performed with little or no disassembly. The purpose of static testing is to check for shorted power components. Perform these tests on any unit suspected of containing faulty power components prior to applying power.

⚠CAUTION

Power is required. All devices and power supplies connected to mains are energised at rated voltage. Use extreme caution when conducting tests on a powered frequency converter. Contact with powered components could result in electrical shock and personal injury.

Dynamic tests are performed with power applied to the frequency converter. Dynamic testing traces signal circuitry to isolate faulty components.

Replace any defective component and retest the frequency converter with the new component before applying power to the frequency converter.

6.1.1 Tools Required for Testing

- Digital volt/ohm meter capable of reading true RMS
- Analog volt meter
- Oscilloscope
- Clamp-on style ammeter
- Test cable
- Local control panel

6.1.2 Test Cable

The test cable connects the installation box to the inverter part when these are disassembled for testing purposes.

6.2 Static Test Procedures

Perform all tests using a meter capable of testing diodes. Use a digital volt/ohmmeter (VOM) set on the diode scale or an analog ohmmeter set on Rx100 scale. Before making any checks disconnect all input, motor and brake resistor connections.

The appropriate terminals are described in the test procedures in this section. Some terminals are optional and not present on all frequency converter configurations.

NOTE

For best troubleshooting results, it is recommended that static test procedures described in this section be performed in the order presented.

Diode Drop

A diode drop reading will vary depending on the model of ohmmeter. Whatever the ohmmeter displays as a typical forward bias diode is defined as a *diode drop* in these procedures. With a typical DVM, the voltage drop across most components will be around .300 to .500. The opposite reading is referred to as infinity and most DMVs will display the value OL for overload.

Before starting the tests, remove the inverter part from the installation part. Refer to *7 Disassembly and Assembly Instructions*

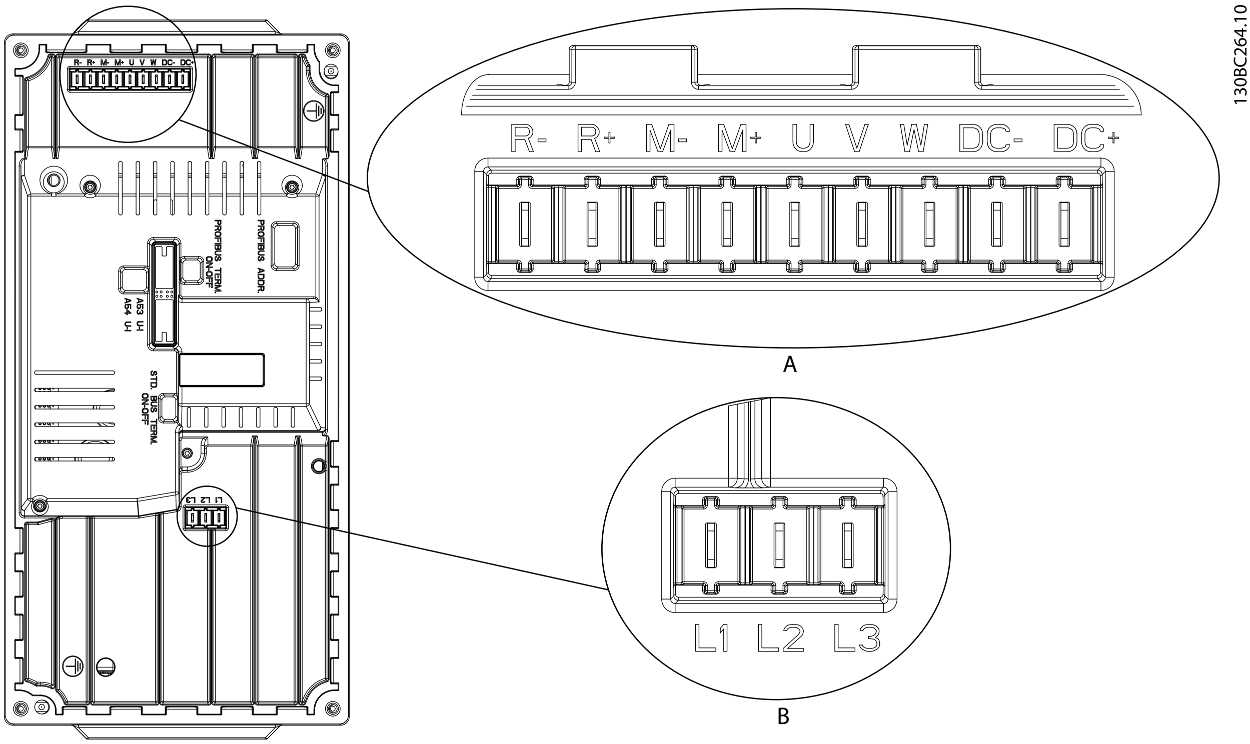


Illustration 6.1 Terminal Location for Static Tests

6.2.1 Test for presence of DC Bus Voltage

Wait 4 minutes after power off before taking the measurement.

1. Set the multimeter to the “DC voltage” position.
2. Check the DC bus for remaining charge by measuring the voltage on the DC terminals.
3. Measure from terminal (DC-) to terminal (DC+).

The voltage reading must be 0 V.

6.2.2 Earth Test

Set the multimeter to the “ohm” position.

Earth test part I

1. Measure from the (DC-) terminal to one of the two earthing spears.
2. Measure from the (DC+) terminal to one of the two earthing spears.

Each reading must be greater than 1 (one) MΩ.

Earth test part II

1. Measure from the L1 terminal to one of the two earthing spears.
2. Measure from the L2 terminal to one of the two earthing spears.
3. Measure from the L3 terminal to one of the two earthing spears.

Each reading must be greater than 1 (one) MΩ.

Earth test part III

1. Measure from the W terminal to one of the two ground pins.
2. Measure from the V terminal to one of the two ground pins.
3. Measure from the U terminal to one of the two ground pins.

Each reading must be greater than 1 (one) MΩ.

Earth test part IV

1. Measure from the R+ terminal to the R- terminal.
2. Measure from the (DC-) terminal to the R- terminal.

Each reading must be greater than 1 (one) MΩ.

6.2.3 Rectifier Section Tests

Set the multimeter to the “check diodes” position.

Rectifier section test part I

1. Connect the positive (+) meter lead to the (DC-) terminal.
2. Connect the negative (-) meter lead to the L1, L2 and L3 terminals in turn.

Each reading should show a diode drop.

Rectifier section test part II

1. Reverse the meter leads.
2. Connect the negative (-) meter lead to the (DC-) terminal.
3. Connect the positive (+) meter lead to the L1, L2 and L3 terminals in turn.

Each reading should show infinity or open circuit, overload (OL).

Rectifier section test part III

1. Connect the positive (+) meter lead to the (DC+) terminal.
2. Connect the negative (-) meter lead to the L1, L2 and L3 terminals in turn.

Each reading should show infinity or open circuit, overload (OL).

Rectifier section test part IV

1. Reverse the meter leads.
2. Connect the negative (-) meter lead to the (DC+) terminal.
3. Connect the positive (+) meter lead to the L1, L2 and L3 terminals in turn.

Each reading should show a diode drop.

6.2.4 Inverter Section Tests

The inverter section is primarily made up of the IGBTs used for switching the DC bus voltage to create the output to the motor. IGBTs are grouped into modules comprised of six IGBTs. Depending on the size of the unit, either one, two, or three IGBT modules are present. The frequency converter also has 1 snubber capacitor on the IGBT module.

⚠CAUTION

Disconnect motor leads when testing inverter section. With leads connected, a short circuit in one phase will read in all phases, making isolation difficult.

Before starting tests, ensure that meter is set to diode scale.

Inverter test part I

1. Connect the positive (+) meter lead to the (+) positive DC bus connector (DC+) on the power card.
2. Connect the negative (–) meter lead to terminals U, V, and W in sequence.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the frequency converter being charged by the meter.

Inverter test part II

1. Reverse the meter leads by connecting the negative (–) meter lead to the positive (+) DC bus connector (DC+) on the power card.
2. Connect the positive (+) meter lead to U, V, and W in sequence. Each reading should show a diode drop.

Incorrect reading

An incorrect reading in any inverter test indicates a failed IGBT module. Replace the inverter according to the disassembly instructions.

Inverter test part III

1. Connect the positive (+) meter lead to the negative (-) DC bus connector (DC-) on the power card.
2. Connect the negative (–) meter lead to terminals U, V, and W in sequence.

Each reading should show a diode drop.

Inverter test part IV

1. Reverse the meter leads by connecting the negative (–) meter lead to the negative (-) DC bus connector (DC-) on the power card.
2. Connect the positive (+) meter lead to U, V, and W in sequence.

Each reading should show infinity. The meter will start at a low value and slowly climb toward infinity due to capacitance within the frequency converter being charged by the meter.

Indications of a failure in this circuit

IGBT failures may be caused by the frequency converter being exposed to repeated short circuits or earth faults, or by extended frequency converter operation outside of its normal operating parameters.

6.2.5 Brake IGBT Test

This test can only be carried out on units equipped with a dynamic brake option. If a brake resistor is connected to terminals R-(81) and R+(82), disconnect it before proceeding. Use an ohmmeter set on diode check or Rx100 scale.

Brake IGBT test part I

1. Connect the positive (+) meter lead to the brake resistor terminal R+(82).
2. Connect the negative (-) meter lead to the brake resistor terminal R-(81).

The reading should indicate infinity. The meter may start out at a value and climb toward infinity as capacitance is charged within the frequency converter.

Brake IGBT test part II

1. Connect the positive (+) meter lead to the brake resistor terminal R-(81).
2. Connect the negative (-) meter lead to the brake resistor terminal R+(82).

The reading should indicate a diode drop.

Brake IGBT test part III

1. Connect the positive (+) meter lead to the brake resistor terminal R-(81).
2. Connect the negative (-) meter lead to the negative (-) DC bus connector (DC-).

The reading should indicate infinity. The meter may start out at a value and climb toward infinity as capacitance is charged within the frequency converter.

Incorrect reading

An incorrect reading on any of the above tests indicates that the brake IGBT is defective. Replace the inverter in accordance with the disassembly procedures.

6

6.3 Dynamic Test Procedures

Refer to the terminal locations in *Illustration 6.2* for performing dynamic test procedures.

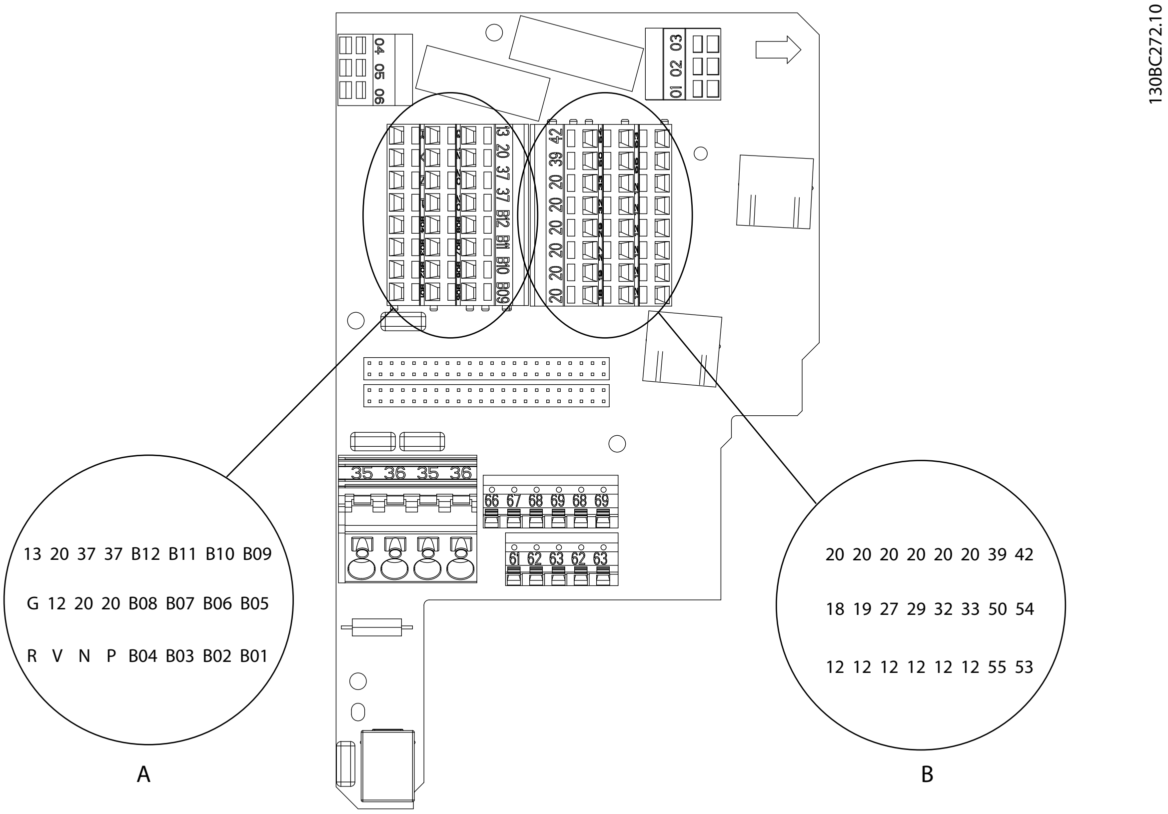


Illustration 6.2 Terminal Locations for Dynamic Tests

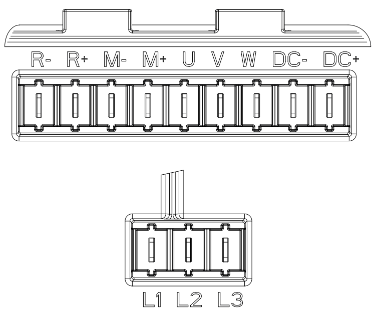


Illustration 6.3 Terminal Locations for Dynamic Tests

⚠WARNING

Never disconnect the input cabling to the frequency converter with power applied due to danger of severe injury or death.

⚠WARNING

Take all the necessary safety precautions for system start up prior to applying power to the frequency converter.

Use the test cable to connect terminals for all dynamic tests.

NOTE

Test procedures in this section are numbered for reference only. Tests do not need to be performed in this order. Perform tests only as necessary.

Measurement	Meter	Minimum load	From terminal	To terminal	Required value
DC output 24 V	RMS voltmeter		Terminal 12	GND terminal 55	24 V DC
DC output 10 V	RMS voltmeter		Terminal 50	GND terminal 55	10 V DC
DC output 5 V (to BUS option)	RMS voltmeter		Terminal 67	GND terminal 70	5 V DC
DC output 5 V (to LCP option)	RMS voltmeter		Terminal 97 (V)	GND terminal G	5 V DC
Motor current	Current clamp	25%	Terminal 96 (U)	Terminal 97 (V) and Terminal 98 (V)	Dependent on the load. Imbalance should be within 2 %
Motor voltage	Analog voltmeter	25%	Terminal 96 (U)	Terminal 97 (V) and Terminal 98 (V)	Dependent on the load. Imbalance should be within 2 %
Supply current	Current clamp	25%	Terminal 91 (L1)	Terminal 92 (L2) and Terminal 93 (L3)	Dependent on the load. Imbalance should be within 5 %
Supply voltage	RMS voltmeter	25%	Terminal 91 (L1)	Terminal 92 (L2) and Terminal 93 (L3)	380-480 V 10 % and maximum imbalance 2%
UDC voltage and ripple	RMS voltmeter	25%	Terminal 88 (DC-)	Terminal 89 (V) (DC +)	480-750 V Ripple 300 Hz and under 1%
Analog and digital output	RMS meter		Terminal 12	Terminal 50	Dependent upon how the I/O is set up by the parameter
Analog input			Terminal 50 Terminal 50 Terminal 39	Terminal 53 Terminal 54 Terminal 42	
Relay 1	RMS voltmeter or ohmmeter		Terminal 01	Terminal 02 and Terminal 03	OFF (inactive): Terminals 01 and 03 are shorted. ON (Active): Terminals 01 and 02 are shorted
Relay 2 (not active when mechanical brake installed in inverter part)	RMS voltmeter or ohmmeter		Terminal 04	Terminal 05 and 06	Off (inactive): Terminals 04 and 06 are shorted. ON (Active): Terminals 04 and 05 are shorted
Brake control signals output – dynamic braking	RMS voltmeter		Terminal 81 (R-)	Terminal 82 (R+)	UDC bus voltage when active. Normal value is about 565 V at first switch on. Dependent upon input voltage.
Brake control signals output – mechanical brake	RMS voltmeter		Terminal M+	Terminal M-	ON (active): nominal 180 V OFF (inactive): 0 V NOTE: DIRECT CONNECTION TO SUPPLY LINES

Measurement	Meter	Minimum load	From terminal	To terminal	Required value
DC input 24 V external back-up voltage	RMS voltmeter		Terminal 36 (+)	Terminal 35 (-)	24 V DC

Table 6.1 Dynamic Test Overview

6.3.1 No Display Test

A frequency converter with no display can be the result of several causes. Verify first that there is no display whatsoever. A single character in the display or a dot in the upper corner of the display indicates a communication error and is typically caused by an option card not properly installed. When this condition occurs, the green power-on LED is illuminated.

If the LCD display is completely dark and the green power-on LED is not lit, proceed with the following tests.

First test for proper input voltage.

6.3.2 Supply Voltage and Current Test

1. Apply power to frequency converter. Ensure minimum load of 25%.
2. Use the DVM to measure the input mains voltage between the frequency converter input terminals in sequence:
   L1 to L2
   L1 to L3
   L2 to L3

For 380–480 V frequency converters, all measurements must be within the range of 342–528 V AC.

In addition to the actual voltage reading, the balance of the voltage between the phases is also important. The frequency converter can operate within specifications as long as the imbalance of supply voltage is not more than 3%.

Danfoss calculates mains imbalance per an IEC specification.

$$\text{Imbalance} = 0.67X(V_{max} - V_{min})/Vavg$$

Although the frequency converter can operate at higher mains imbalances, the lifetime of components, such as DC bus capacitors, will be shortened.

Incorrect reading

NOTE

Open (blown) pre-fuses or tripped circuit breakers usually indicate a more serious problem. Before replacing fuses or resetting breakers, perform static tests described.

An incorrect reading here requires that the main supply be investigated further. Typical items to check would be:

- Open (blown) pre-fuses or tripped circuit breakers
- Open disconnects or line side contactors
- Problems with the power distribution system

Check of intermediate circuit voltage level, UDC voltage and ripple:
- Use an RMS voltmeter to measure voltage from terminal 88 (DC-) to terminal 89 (DC+). The meter should read in the range 480-750 (VAC +/- 10%*SQR(2)).

If the Input Voltage Test was successful check for voltage to the control card.

6.3.3 Basic Control Card Voltage Test

1. Measure the control voltage at terminal 12 with respect to terminal 20. The meter should read 24 V DC (between 21 and 27 V DC).

An incorrect reading here could indicate the supply is being loaded down by a fault in the customer connections. Unplug the terminal strip and repeat the test. If this test is successful, then continue. Remember to check the customer connections.

2. Measure the 10 V DC control voltage at terminal 50 with respect to terminal 55. The meter should read 10 V DC (between 9.2 and 11.2 V DC).

An incorrect reading here could indicate the supply is being loaded down by a fault in the customer connections. Unplug the terminal strip and repeat the test. If this test is successful, then continue. Remember to check the customer connections.

A correct reading of both control card voltages would indicate the LCP or the control card is defective. Replace the LCP with a known good one. If the problem persists, replace the control card in accordance with the disassembly instructions.

6.3.4 Output Imbalance of Motor Voltage and Current

Checking the balance of the frequency converter output voltage and current measures the electrical functioning between the frequency converter and the motor. In testing the phase-to-phase output, both voltage and current are monitored. Conduct static tests on the inverter section of the frequency converter before this procedure.

If the voltage is balanced but the current is not, this indicates the motor is drawing an uneven load. This could be the result of a defective motor, a poor connection in the wiring between the frequency converter and the motor, or, if applicable, a defective motor overload.

If the output current is unbalanced as well as the voltage, the frequency converter is not gating the output properly. This could be the result of a defective power card, gate drive, connections between the gate drive card and IGBTs, or the output circuitry of the frequency converter improperly connected.

NOTE

Use an analog voltmeter for monitoring output voltage. Digital voltmeters are sensitive to waveform and switching frequencies and commonly return erroneous readings.

The initial test can be made with the motor connected and running its load. If suspect readings are recorded then the motor leads may have to be disconnected to further isolate the problem.

1. Ensure minimum load of 25%.
2. Using a voltmeter, measure AC output voltage at frequency converter motor terminals 96 (U), 97 (V), and 98 (W). Measure phase to phase checking U to V, then U to W, and then V to W.

All three readings should be within 8 V AC of each other. The actual value of the voltage depends on the speed at which the frequency converter is running. The volts/hertz ratio is relatively linear (except in VT mode) so at 50 Hz/60 Hz the voltage should be approximately equal to the mains voltage applied. At 25 Hz/30 Hz, it is about half of that and so on for any other speed selected. The exact voltage reading is less important than balance between phases.

2. Next, monitor three output phases at frequency converter motor terminals 96 (U), 97 (V), and 98 (W) with the clamp on the ammeter. An analog device is preferred. To achieve an accurate reading, run the frequency converter above 40 Hz as this is normally the frequency limitation of such meters.

The output current should be balanced from phase to phase and no phase should be more than 2 to 3% different from another. If the above tests are successful, the frequency converter is operating normally.

3. If a greater imbalance exists than described above, disconnect the motor leads and repeat the voltage balance test.

Since the current will follow the voltage, it is necessary to differentiate between a load problem and a frequency converter problem. Should a voltage imbalance in the output be detected with the motor disconnected, then replace the frequency converter.

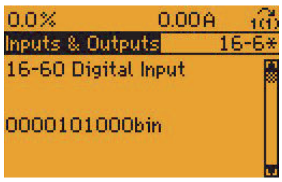
If the voltage was balanced but the current imbalanced when the motor was connected, then the load is suspect. There could be a faulty connection between the frequency converter and motor or a defect in the motor itself. Look for bad connections at any junctions of the output wires including connections made to contactors and overloads. Also, check for burned or open contacts in such devices.

6.3.5 Input Terminal Signal Tests

The presence of signals on either the digital or analog input terminals of the frequency converter can be verified on the frequency converter display. Digital or analog input status can be selected or read in parameters 16-60 through 16-64.

Digital inputs

With digital inputs displayed, control terminals 18, 19, 27, 29, 32, and 33 are shown left to right, with a 1 indicating the presence of a signal.



130BB038.10

If the desired signal is not present in the display, the problem may be either in the external control wiring to the frequency converter or a faulty control card. To determine the fault location, use a voltmeter to test for voltage at the control terminals.

NOTE

Note that to access the terminals, removal of the inverter part is required.

Verify the control voltage power supply is correct as follows.

1. With a voltmeter measure voltage at control card terminal 12 and 13 with respect to terminal 20. The meter should read between 21 and 27 V DC.

If the 24 V supply voltage is not present, conduct the Control Card Voltage Test.

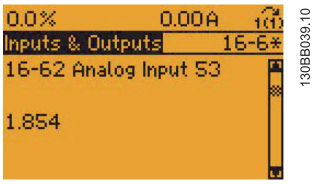
If 24 V is present, proceed with checking the individual inputs as follows

2. Connect the (-) negative meter lead to reference terminal 20.
3. Connect the (+) positive meter lead to the terminals in sequence.

The presence of a signal at the desired terminal should correspond to the digital input display readout. A reading of 24 V DC indicates the presence of a signal. A reading of 0 V DC indicates no signal is present.

Analog inputs

The value of signals on analog input terminals 53 and 54 can also be displayed. The voltage or current in mA, depending on the switch setting, is shown in line 2 of the display.



If the desired signal is not present in the display, the problem may be either in the external control wiring to the frequency converter or a faulty control card. To determine the fault location, use a voltmeter to test for a signal at the control terminals.

Verify the reference voltage power supply (10 V DC) is correct as follows.

1. With a voltmeter, measure the voltage at control card terminal 50 with respect to terminal 55. The meter should read between 9.2 and 11.2 V DC.

If the 10 V supply voltage is not present, conduct the Control Card Voltage Test in *6.3.3 Basic Control Card Voltage Test*.

If the 10 volts is present proceed with checking the individual inputs as follows.

2. Connect the (-) negative meter lead to reference terminal 55.
3. Connect the (+) positive meter lead to desired terminal 53 or 54.

For analog input terminals 53 and 54, a DC voltage between 0 and +10 V DC should be read to match the analog signal being sent to the frequency converter. Or a reading of 0.9 to 4.8 V DC corresponds to a 4 to 20 mA signal

Note that a (-) minus sign preceding any reading above indicates a reversed polarity. In this case, reverse the wiring to the analog terminals.

DC input 24 V External Supply Test

Test the DC input 24 V external supply, if present for the unit. Perform this optional test when continued back-up power supply is required, when units are otherwise switched off.
- Use the RMS voltmeter to measure input voltage from terminal 36 (+) to terminal 35 (-). The meter should read (+) 24 V DC.

7 Disassembly and Assembly Instructions

7.1.1 Installation Part

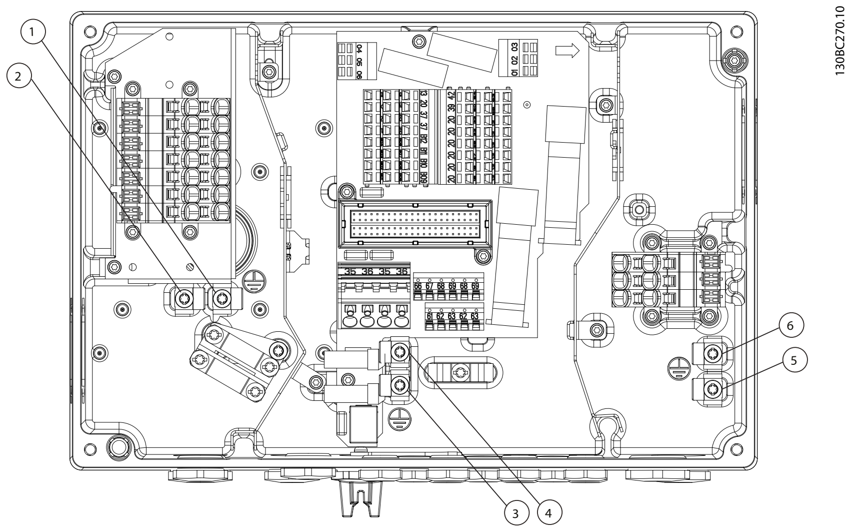


Illustration 7.1 Installation Part Small Unit

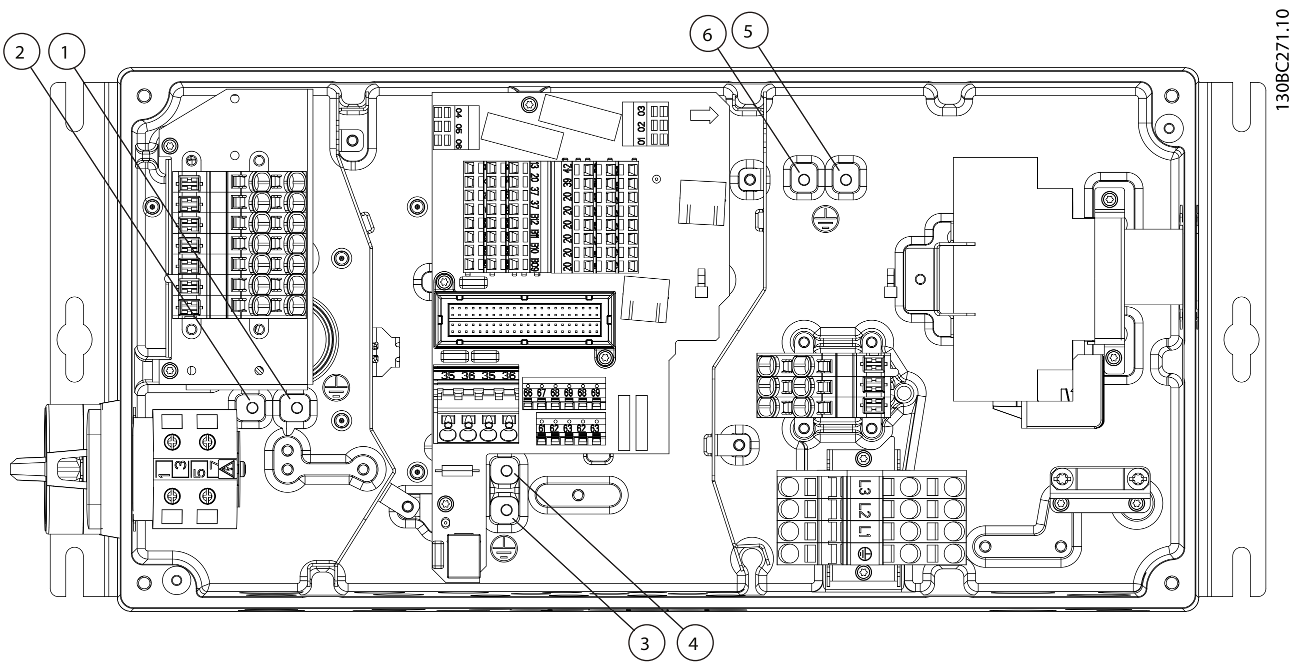


Illustration 7.2 Installation Part Large Unit

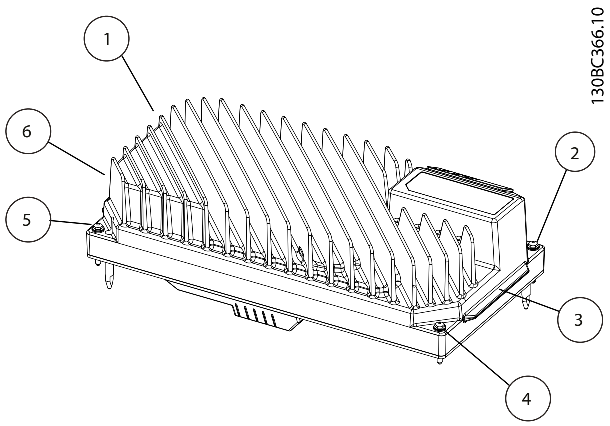


Illustration 7.3 Removal of Inverter Part - Location of Bolts and Handles

1	Bolt	4	Bolt
2	Bolt	5	Bolt
3	Handles on inverter part	6	Handles on inverter part

To access the installation part:

1. Prepare a protective sheet on which to place the inverter part once it is removed, for example the portable ESD mat. It is important to avoid scratching the painted surface.
2. Using an 8 mm socket, remove the four bolts, fastening the inverter part to the installation part, one in each corner of the unit.
3. Hold on to the handles on the inverter part.
4. Lift the inverter part straight upwards.
5. Rotate it so the painted surface is facing downwards.
6. Place the inverter part carefully on to the protective sheet.

To re-assemble the inverter and installation parts:

1. Ensure the six (6) earth screws in the installation part are tightened to torque 3 Nm. The earth screw positions are marked with arrows in the illustrations Installation Part Small Unit and Installation Part Large Unit.
2. Lift the inverter part and rotate it so the painted surface is facing upwards.
3. Align the earthing spears on the inverter part, with the holes in the installation part.
4. Align the PCB stacker covers on the inverter part, with the PCB stackers on the installation part. Carefully separate the two (2) PCB stackers, ensuring there is a space between them to fit the PCB stacker guide on the plastic cover. The stackers are delicate and easily damaged during re-assembly.
5. Lower the inverter part carefully onto the installation part.
6. Reinstall the four bolts using an 8 mm socket, tightening torque 3 Nm.

7.1.2 Main Termination Board for Installation Box (Installation Card)

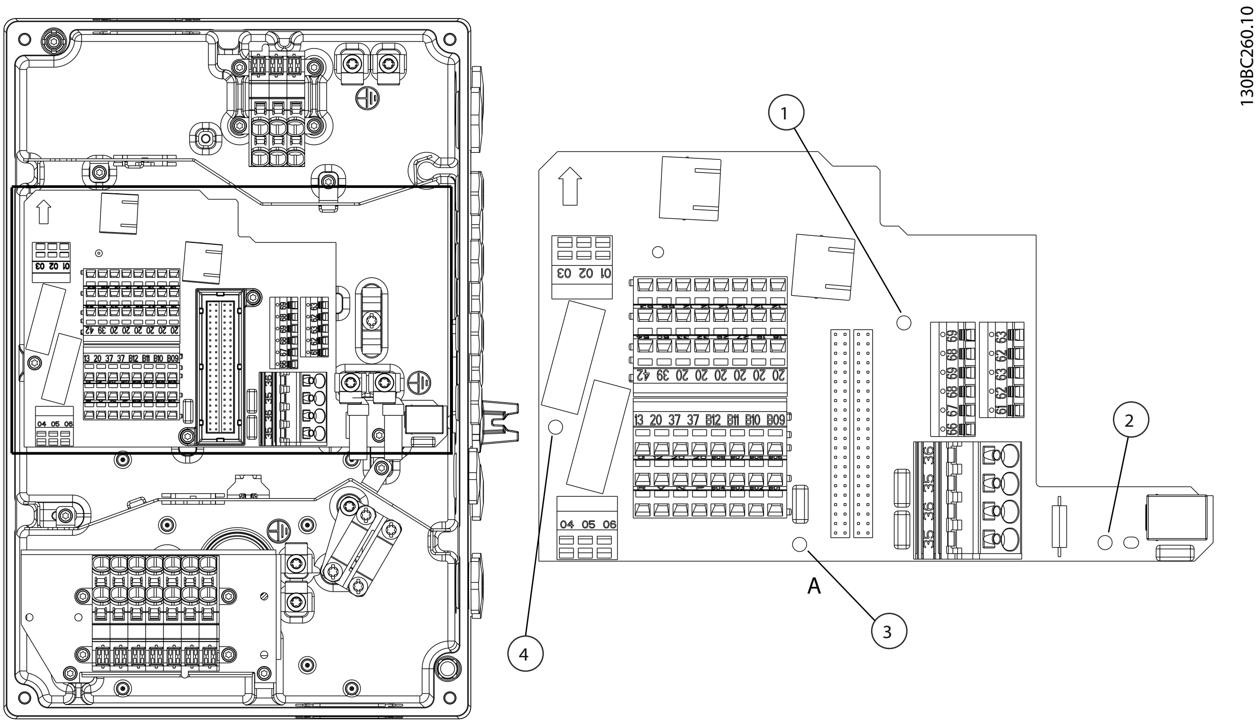


Illustration 7.4 Main Termination Board for Installation Box (Installation Card)

1-4	Screws

To remove the installation card:

1. Note the terminal numbers corresponding to the wire colours on the installation card terminal block.
2. Remove all wires from the main terminal block on the installation card.
3. At each terminal depress the lever using a standard flat screwdriver. Then pull the wire out.
4. Remove the four screws fastening the installation card to the base. Use a Torx 10 screwdriver.
5. Carefully lift the installation card out, vertically.

To install a new installation card:

1. Align the guide pins with the corresponding holes in the installation card.
2. Lower the installation card carefully into position.
3. Tighten the four screws fastening the installation card to the base. Use a Torx 10 screwdriver, tightening torque 1.1 Nm.
4. Re-connect all wires, to the same terminals noted in card removal step 1.
5. At each terminal depress the lever using a flat screwdriver. Insert the wire while the lever is depressed.

7.1.3 Switch and Circuit Breaker

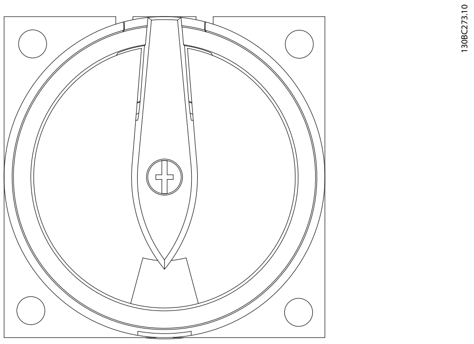


Illustration 7.5 Switch

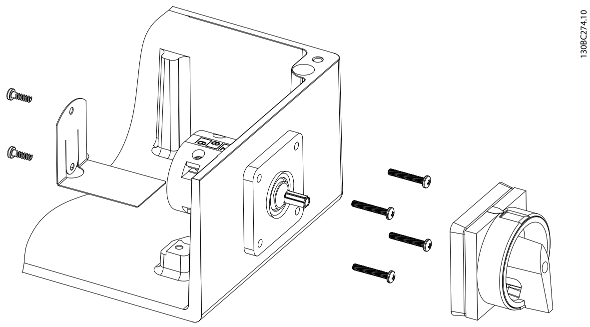


Illustration 7.6 Switch for Small and Large Unit

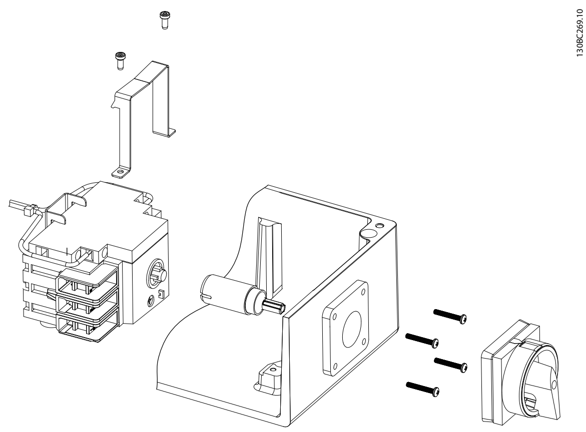


Illustration 7.7 Circuit Breaker for Large Unit

To remove the switch:

1. Remove the screw in the handle using a crosshead screwdriver, and remove the handle.
2. Pry off the face plate using a flat head screwdriver.
3. Remove the four (4) screws fastening the switch to the enclosure. Use a crosshead screwdriver.
4. Loosen the eight (8) screws which fasten the cables to the switch. Use a crosshead screwdriver.
5. Remove the cables.
6. For the large unit, remove the bracket holding the circuit breaker.
7. Pull the switch out horizontally, through the hole in the enclosure.

To install a new switch:

1. Insert the switch through the hole in the enclosure.
2. For the large unit, replace the circuit breaker bracket.
3. Ensure the yellow earth label on the internal section of the switch is face-up.
4. Note that the switch cables and terminals are labelled with numbers. Insert the cables into their corresponding terminals.
5. Tighten the five eight (8). Tightening torque 1.5 Nm.
6. Outside the enclosure, ensure the switch handle is pointing up.
7. Re-install the face plate. Check that the face plate is oriented correctly, indicating 0 for 'off', and I for 'on'.
8. Re-install the screw in the handle. Use a crosshead screwdriver, tightening torque 0.7 Nm.

7.1.4 GLCP Plug

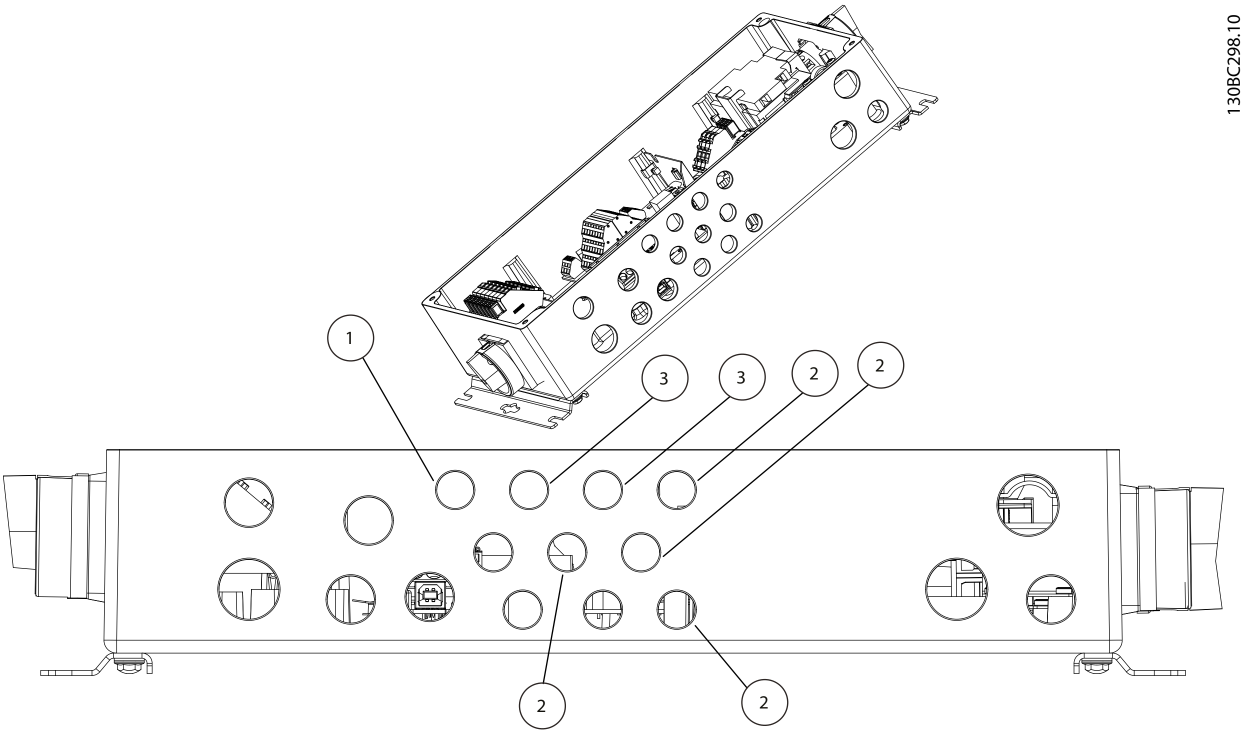


Illustration 7.8 Plug positions

1	GLCP plug
2	Sensor plug
3	Relay plug

To remove the GLCP plug:

1. Note the terminal addresses of the wires before disassembly.
2. Remove the black plastic plug by hand.
3. Remove the GLCP plug using an adjustable spanner.

To install a new GLCP plug:

1. Insert the new GLCP plug into the hole in the enclosure.
2. Re-install the GLCP plug. Tightening torque 2.5 Nm. Re-install the black plastic plug by hand
3. Re-install the wires to the original terminal addresses.

7.1.5 Sensor Plugs

To remove a sensor plug:

1. Note the terminal addresses of the wires before removal
2. Remove the sensor plugs.

To install a sensor plug:

1. Insert the sensor plug into the hole in the enclosure.
2. Re-install the plug. Tightening torque 2.5 Nm
3. Re-install wires to the original terminal addresses.

7.1.6 Relay

To remove the relay connection:

1. Note the terminal addresses of the wires before disassembly.
2. Remove the relay plugs.

To install the relay connection:

1. Re-install the relay plugs. Tightening torque 2.5 Nm.
2. Re-install wires to the original terminal addresses.

7.2 Inverter Part

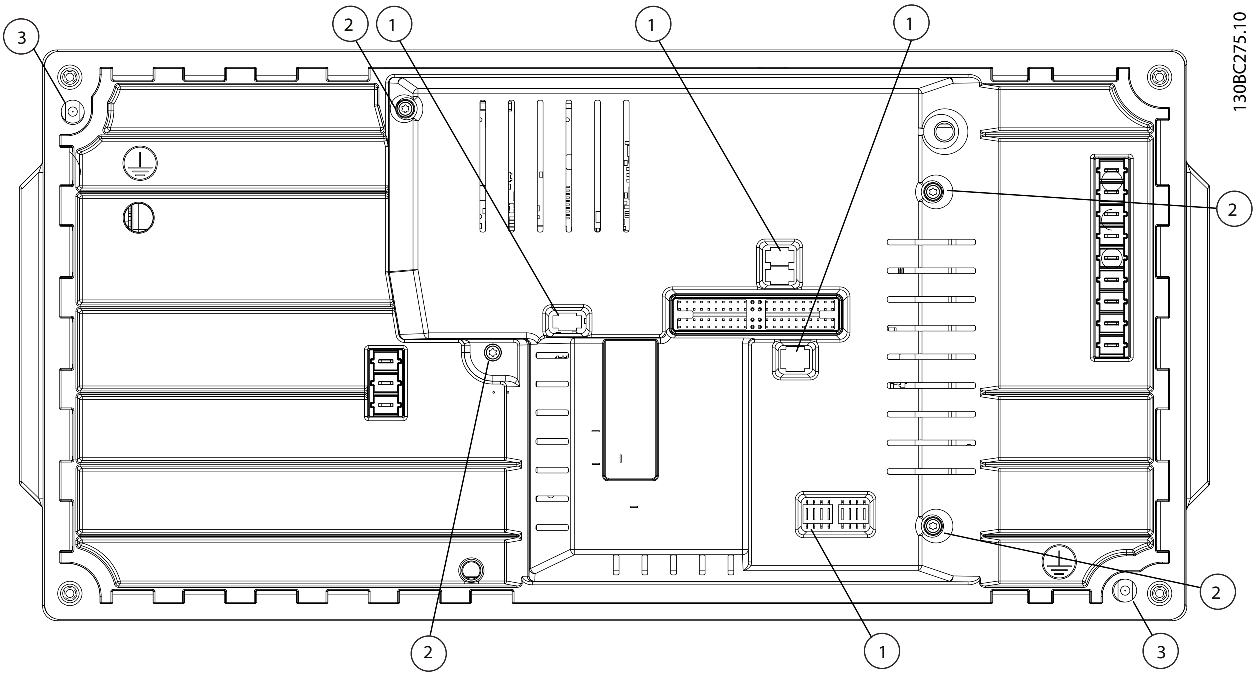


Illustration 7.9 Inverter Part

1	Dip switch	3	Earthing spear
2	Screw		

7.2.1 Plastic Cover and Gasket

To remove the plastic cover and gasket:

1. Make note of the dip switch positions.
2. Remove the four (4) screws fastening the plastic cover. Use a Torx10 screwdriver.
3. Carefully lift the cover vertically, lifting the gasket at the same time.
4. Take care not to damage the board stackers.

To install a new plastic cover and gasket:

1. Check the gasket is intact, and sits firmly upon the cover.
2. Carefully align the cover with earthing spears, mains terminals, motor terminals, and PCB stacker.
3. Note, the PCB stackers are delicate and easily damaged during assembly.
4. Fasten the four (4) screws. Use a Torx 10 screwdriver, tightening torque 1.2 Nm.
5. Check the earthing spears are tightened to 4 Nm.
6. Check numbering of dip switches, and reset if necessary.

7.2.2 Control Card

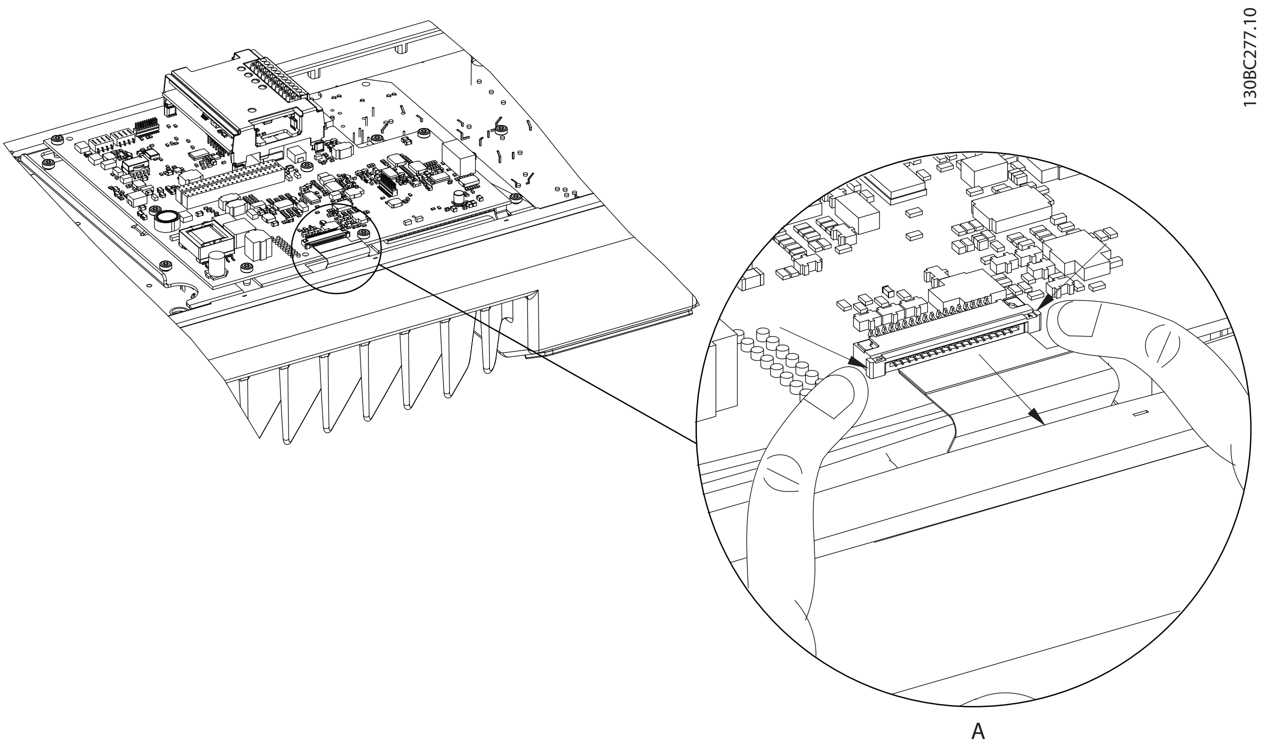


Illustration 7.10 Remove the Ribbon Cable

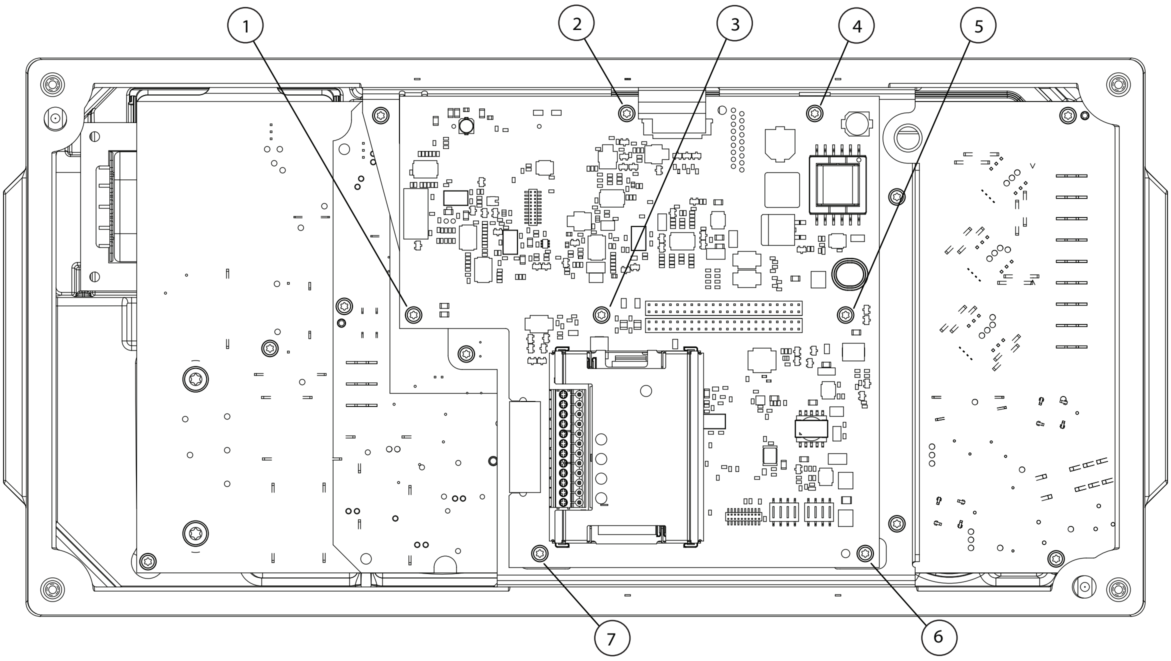


Illustration 7.11 Location of Control Card Screws

1-7	Screws

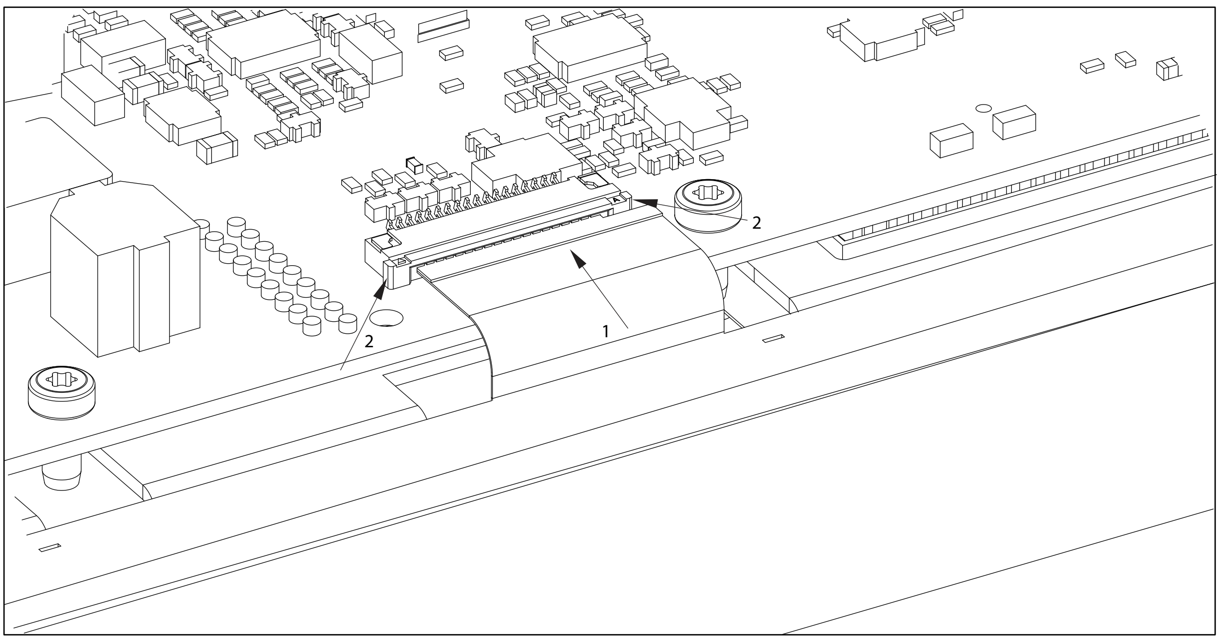


Illustration 7.12 Connect the Ribbon Cable

To remove the control card:

1. Release the ribbon cable connector by squeezing carefully on both sides by hand.
2. Carefully remove the ribbon cable.
3. Remove the seven (7) screws. Use a Torx 10 screwdriver.
4. Remove the two (2) PCB stackers.
5. Lift carefully at lower right corner to disconnect the 48-pin plug.
6. Lift the control card out vertically.

To install the control card:

1. Ensure the gap pads are present and intact.
2. Align the control card socket with the 48-pin plug and carefully press down.
3. Fasten the seven (7) screws. Use a Torx 10 screwdriver, tightening torque 1.2 Nm.
4. Re-install the two (2) PCB stackers. Ensure there is a gap between them.
5. Reconnect the ribbon cable. Squeeze the connector carefully by hand on both sides. Slide the cable in, ensuring it is correctly aligned.

7.2.3 B-Option

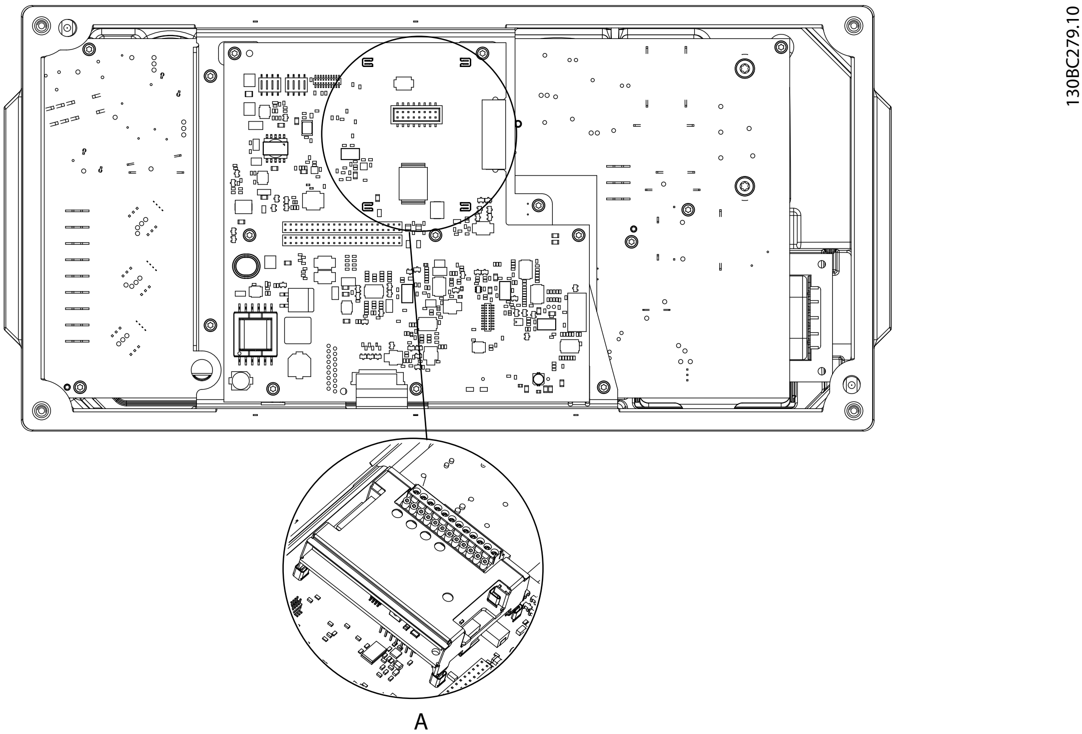


Illustration 7.13 Location of B-Option

To remove the B-option:

1. Remove the cable connecting the B-option to the control card.
2. Lift the B-option off the control card.

To install a new B-option:

1. Remove the protection from the plug on the B-option.
2. Click the B-option into place.
3. Connect the cable between the B-option and the connector on the control card.

8 Special Test Equipment

8.1 Test Equipment

Test cables have been developed to aid in troubleshooting these products. It is highly recommended for repair and servicing this equipment that these tools be available to the technician. Without them, some troubleshooting procedures described in this manual cannot be carried out. Test equipment described in this section is available from Danfoss.

WARNING

Main input power is required and all devices and power supplies connected to mains are energised at rated voltage. Use extreme caution when conducting tests on a powered frequency converter. Contact with powered components could result in electrical shock and personal injury.

9 Spare Parts List

For the latest spare parts list, visit the Danfoss website at www.danfossdrives.com, or VLT Shop at *www.vltshop.danfoss.net*

10 Wiring Diagrams

10.1 Frequency Converter

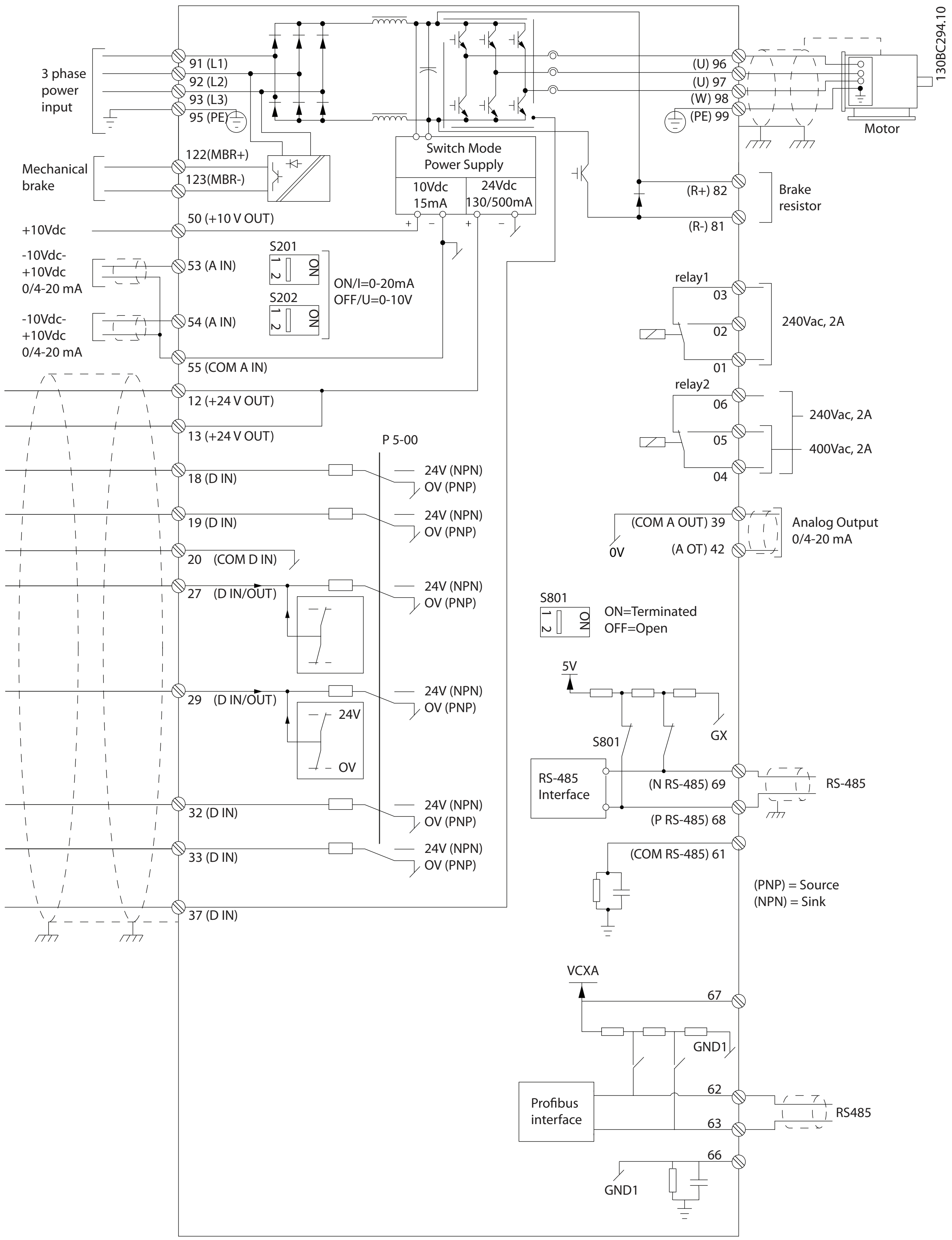


Illustration 10.1 Electrical Installation

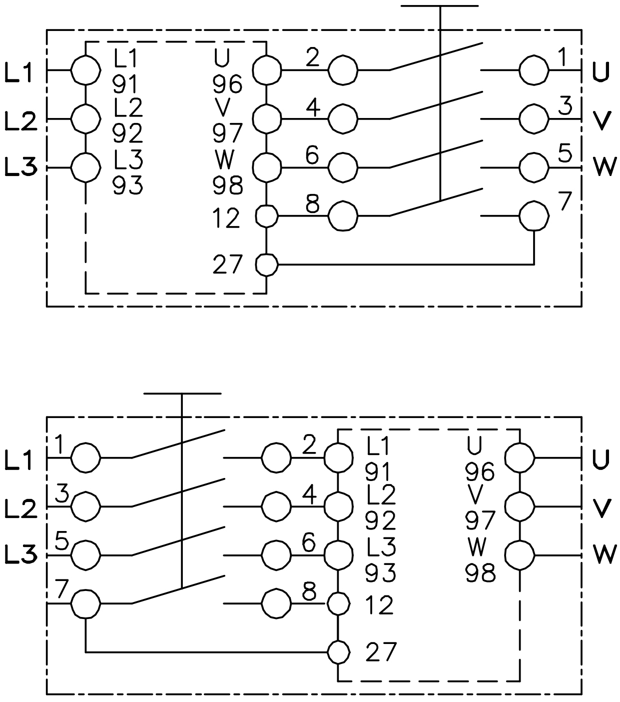


Illustration 10.2 Motor and Mains Connection with Service Switch

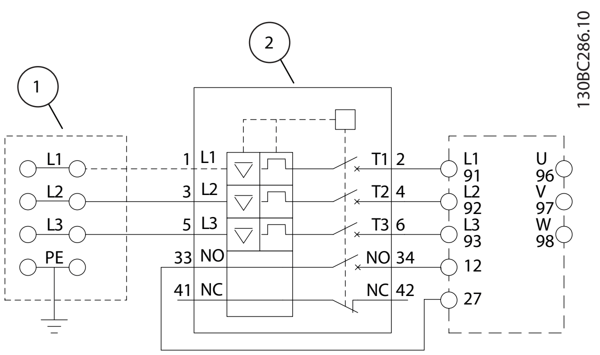


Illustration 10.3 Circuit Breaker and Mains Disconnect

1	Looping terminals
2	Circuit breaker

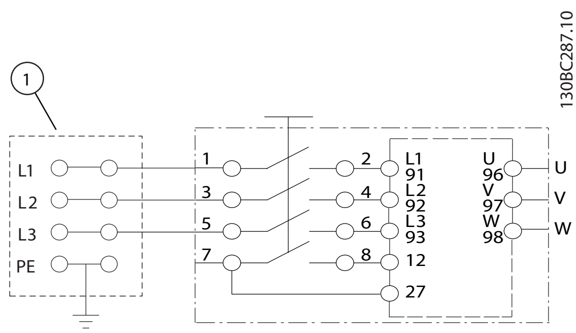


Illustration 10.4 Service Switch at Mains with Looping Terminals

1	Looping terminals

Area	Title	Functions
1	Mains input	Three-phase AC mains power supply to the frequency converter.
2	Recifier	The rectifier bridge converts the AC input to DC current for use within the frequency converter.
3	DC bus	The frequency converter's intermediate DC-bus circuit handles the DC current for internal routing.
4	DC line 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 a regulated DC current supply • Provides ride-through protection for short power losses
6	Inverter	The inverter converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7	Output to motor	By controlling the voltage and frequency, the frequency converter provides regulated motor control from 0-50/60 Hz at 100% supply voltage.
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 10.1 Frequency Converter Internal Components

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