ENGINEERING TOMORROW

Service Guide
VLT® AutomationDrive FC 360

vlt-drives.danfoss.com

Contents

1 Introduction

1.1 Purpose of the Manual

This manual is intended to be used by a qualified technician authorized by Danfoss to service the VLT® AutomationDrive FC 360 frequency converters.
This manual provides the following information:

- Data for the different enclosure types.
- Description of user interfaces and internal processing.
- Troubleshooting and test instructions.
- Assembly and disassembly instructions.

This manual provides instructions for the frequency converter models and voltage ranges described in *chapter 1.6.2 Enclosure Sizes and Power Ratings*.

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1.2 Additional Resources

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

- *VLT® AutomationDrive FC 360 Quick Guide* provides information required to install and commission the frequency converter.
- *VLT® AutomationDrive FC 360 Design Guide* provides detailed information about the design and applications of the frequency converter.
- *VLT® AutomationDrive FC 360 Programming Guide* provides information on how to programme and includes complete parameter descriptions.

Contact the local Danfoss supplier for the documentation.

1.3 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version and the corresponding software version.
In the frequency converter, read the software version in *parameter 15-43 Software Version*.

Edition	Remarks	Software version
MG06D5	Update due to new hardware and software release.	1.8x

Table 1.1 Document and Software Version

1.4 Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
ACP	Application control processor
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EEPROM	Electrically erasable programmable read-only memory
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
IGBT	Insulated-gate bipolar transistor
IP	Ingress protection
I_{LIM}	Current limit
I_{INV}	Rated inverter output current
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
L_d	Motor d-axis inductance
L_q	Motor q-axis inductance
LCP	Local control panel
LED	Light-emitting diode
MCP	Motor control processor
N.A.	Not applicable
NEMA	National Electrical Manufacturers Association
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PE	Protective earth
PELV	Protective extra low voltage
PWM	Pulse width modulation
R_s	Stator resistance
Regen	Regenerative terminals
RPM	Revolutions per minute
RFI	Radio frequency interference
SCR	Silicon controlled rectifier
SMPS	Switch mode power supply
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage
X_h	Motor main reactance

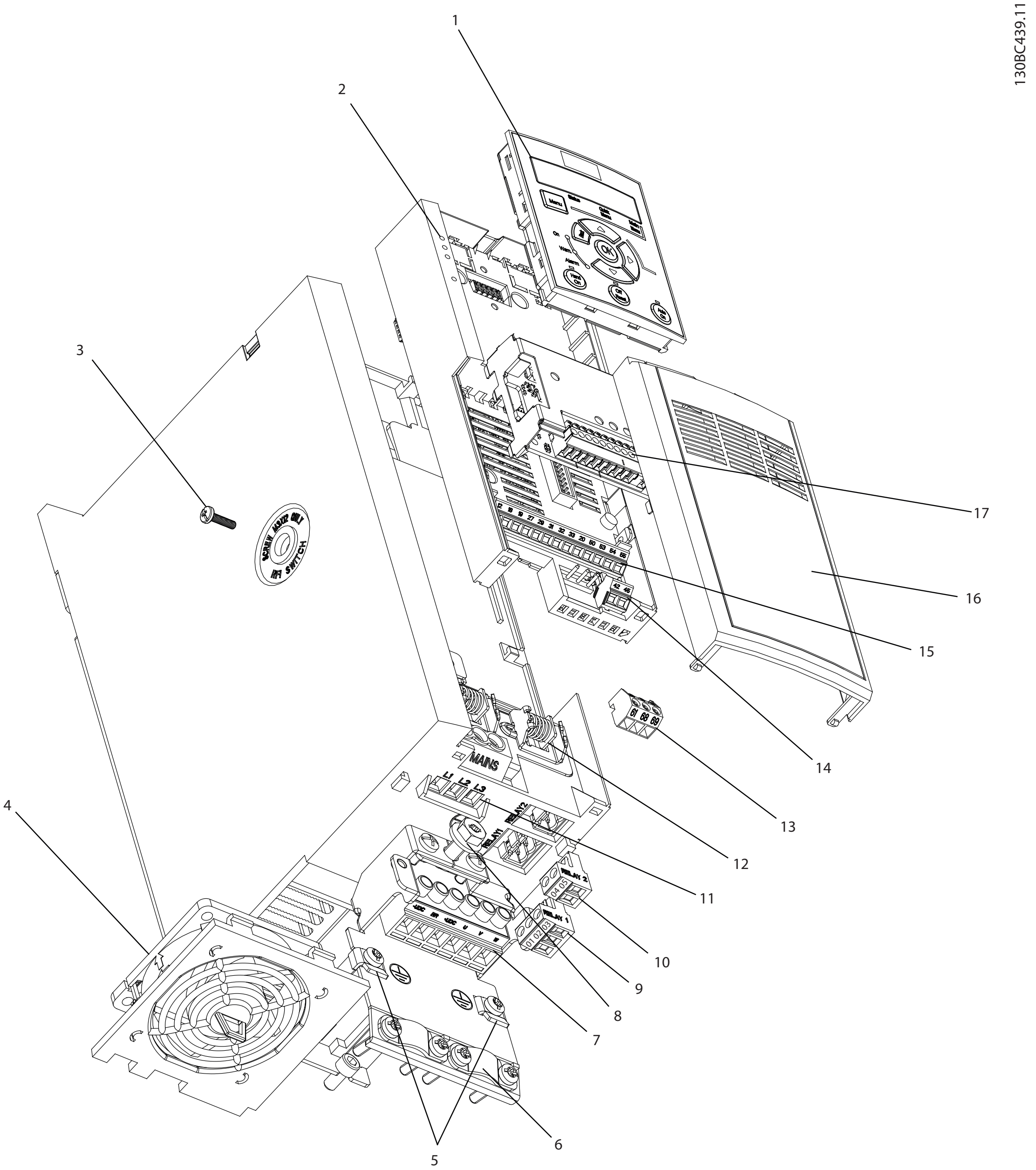
Table 1.2 Abbreviations

1.5 Conventions

- Numbered lists indicate procedures.
- Bulleted lists indicate other information.
- Italicized text indicates the following:
    - Cross-reference.
    - Link.
    - Parameter name.
    - Parameter option.
    - Parameter group name.
- All dimensions in drawings are in mm (inch).
- An asterisk (*) indicates default setting of a parameter.

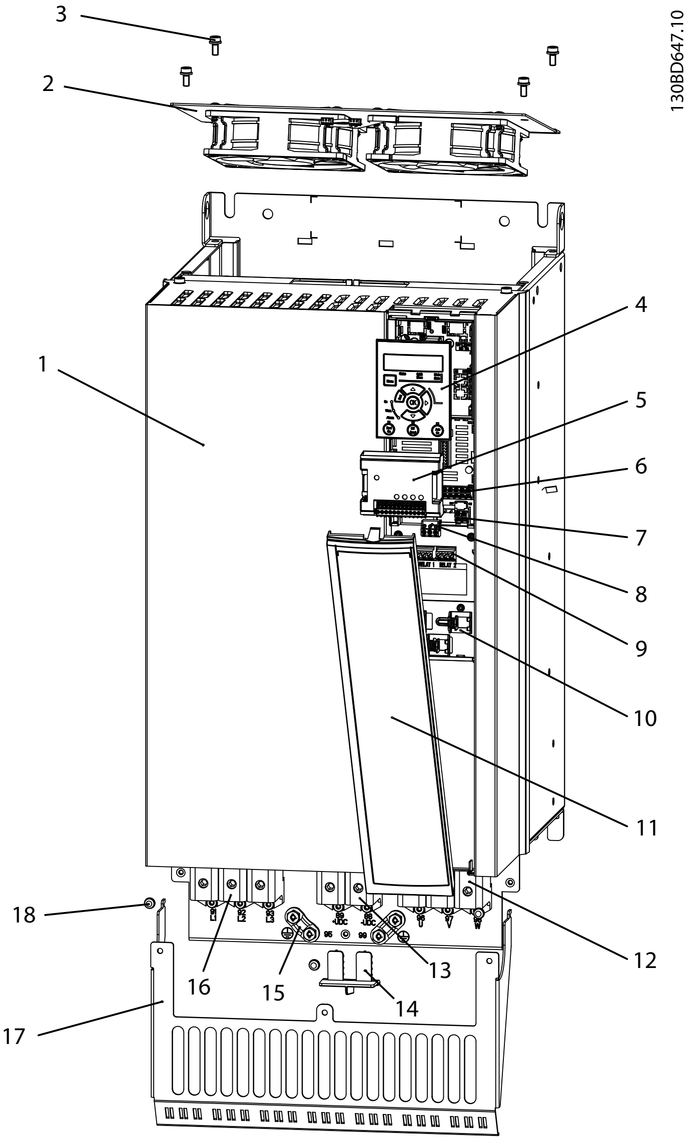
1.6 Product Overview

1.6.1 Exploded Views



1	NLCP (accessory)	10	2-pole relay 2 (0.37–7.5 kW/0.5–10 hp), pluggable 3-pole relay 2 (11–22 kW/15–30 hp), pluggable
2	Control cassette	11	Mains terminals
3	RFI switch (screw M3x12 only)	12	Cable strain relief (accessory for 0.37–2.2 kW units)
4	Removable fan assembly	13	Pluggable RS485 terminal
5	Grounding clamp (accessory)	14	Fixed I/O terminals
6	Shielded cable grounding clamp and strain relief (accessory)	15	Fixed I/O terminals
7	Motor terminals (U, V, W), and brake and load sharing terminals	16	Terminal cover
8	PE ground	17	B options (MCB 102/MCB 103 accessories)
9	3-pole relay 1		

Illustration 1.1 Exploded View, J1–J5 (0.37–22 kW/0.5–30 hp), IP20 (Taking J2 as an Example)



1	J7 frequency converter	10	I/O cable clamps
2	Removable fan assembly	11	Terminal cover
3	M5 screw X4 (for fan assembly)	12	Motor terminals
4	NLCP (accessory)	13	Load sharing terminals
5	B options (MCB 102/MCB 103 accessories)	14	Removable plugger (for load sharing terminal)
6	I/O terminals	15	Shielded cable grounding clamps
7	I/O terminals	16	Mains terminals
8	Pluggable RS485 terminals	17	Decoupling plate (accessory)
9	Relay terminal 1&2, fixed	18	M4 screw X3 (for decoupling plate)

Illustration 1.2 Exploded View, J6–J7 (30–75 kW/40–100 hp), IP20 (Taking J7 as an Example)

1.6.2 Enclosure Sizes and Power Ratings

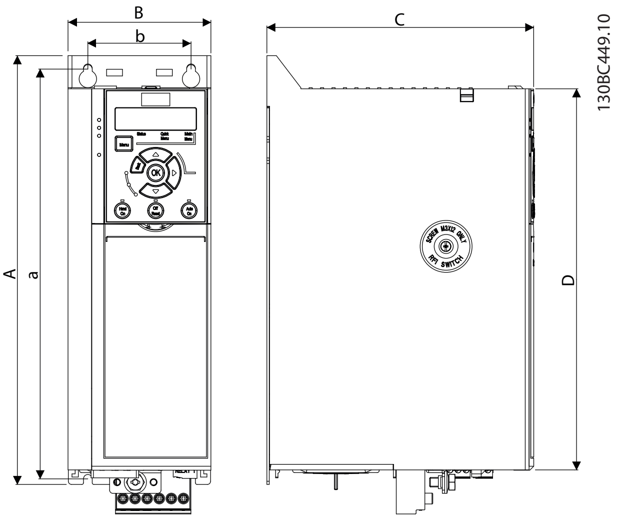
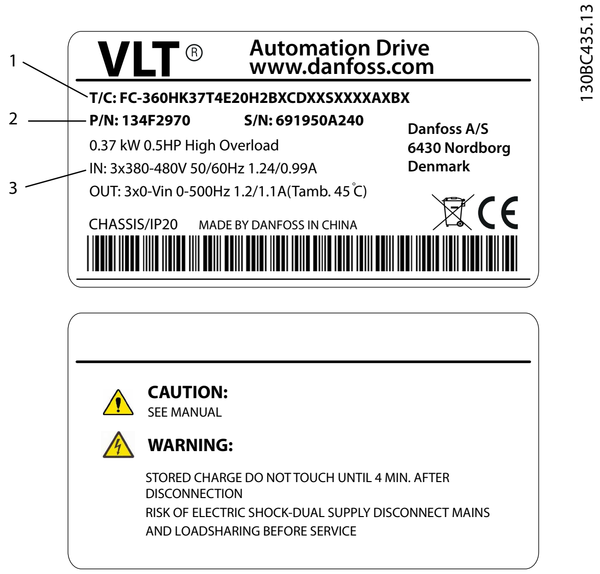
Enclosure size 380–480 V	J1	J2	J3	J4	J5	J6	J7
Power size [kW (hp)]	**0.37–2.2 (0.5–3)**	**3.0–5.5 (4.0–7.5)**	**7.5 (10)**	**11–15 (15–20)**	**18.5–22 (25–30)**	**30–45 (40–60)**	**55–75 (75–100)**
Dimensions [mm (in)]							
Height A	210 (8.3)	272.5 (10.7)	272.5 (10.7)	317.5 (12.5)	410 (16.1)	515 (20.3)	550 (21.7)
Width B	75 (3.0)	90 (3.5)	115 (4.5)	133 (5.2)	150 (5.9)	233 (9.2)	308 (12.1)
Depth C	168 (6.6)	168 (6.6)	168 (6.6)	245 (9.6)	245 (9.6)	241 (9.5)	323 (12.7)
Depth C with option B	173 (6.8)	173 (6.8)	173 (6.8)	250 (9.8)	250 (9.8)	241 (9.5)	323 (12.7)
D	180 (7.1)	240 (9.4)	240 (9.4)	270 (10.6)	364.7 (14.4)	452 (17.8)	484.5 (19.0)
Mounting holes							
a	198 (7.8)	260 (10.2)	260 (10.2)	297.5 (11.7)	390 (15.4)	495 (19.5)	521 (20.5)
b	60 (2.4)	70 (2.8)	90 (3.5)	105 (4.1)	120 (4.7)	200 (7.9)	270 (10.6)
Mounting screw	M4	M5	M5	M6	M6	M8	M8

Table 1.3 Enclosure Sizes, Power Ratings, and Dimensions

1

1.7 Identification and Variants

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



1	Type code
2	Ordering number
3	Specifications

Illustration 1.3 Nameplates 1 and 2

1–6: Product Name	
7: Overload	H: Heavy duty Q: Normal duty1)
8–10: Power size	0.37–75 kW (0.5–100 hp). For example: K37: 0.37 kW2) (0.5 hp) 1K1: 1.1 kW (1.5 hp) 11 K: 11 kW (15 hp)
11–12: Voltage class	T4: 380–480 V 3 phases
13–15: IP class	E20: IP20
16–17: RFI	H1: C2 Class3) H2: C3 Class
18: Brake chopper	X: No B: Built-in4)
19: LCP	X: No
20: PCB coating	C: 3C3
21: Mains terminals	D: Load sharing
29–30: Embedded fieldbus	AX: No A0: PROFIBUS AL: PROFINET
31–32: Option B	BX: No option

Table 1.4 Type Code: Selection of Different Features and Options

For options and accessories, refer to the section Options and Accessories in the VLT® AutomationDrive FC 360 Design Guide.

1) Only 11–75 kW (15–100 hp) for normal duty variants. PROFIBUS and PROFINET are unavailable for normal duty.

2) For all power sizes, see chapter 8.1.1 Mains Supply 3x380–480 V AC.

3) H1 RFI filter is available for 0.37–22 kW (0.5–30 hp).

4) 0.37–22 kW (0.5–30 hp) with built-in brake chopper. 30–75 kW (40–100 hp) with external brake chopper only.

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

130BC437.11

Illustration 1.4 Type Code String

1.8 Ordering Numbers: Options, Accessories, and Spare Parts

Description	Ordering numbers
VLT® Control Panel LCP 21	132B0254[1)]
LCP remote mounting kit with 3 m cable	132B0102[2)]
Blind cover, FC 360	132B0262[1)]
Graphical LCP adapter	132B0281
VLT® Control Panel LCP 102	130B1107
VLT® Encoder Input MCB 102, FC 360	132B0282
VLT® Resolver Input MCB 103, FC 360	132B0283
Terminal cover for MCB, J1, FC 360	132B0263
Terminal cover for MCB, J2, FC 360	132B0265
Terminal cover for MCB, J3, FC 360	132B0266
Terminal cover for MCB, J4, FC 360	132B0267
Terminal cover for MCB, J5, FC 360	132B0268
Decoupling plate mounting kit, J1	132B0258
Decoupling plate mounting kit, J2, J3	132B0259
Decoupling plate mounting kit, J4, J5	132B0260
Decoupling plate mounting kit, J6	132B0284
Decoupling plate mounting kit, J7	132B0285
LCP remote mounting cable, 3 m (10 ft)	132B0132
VLT® Control Panel LCP 21 - RJ45 Converter Kit	132B0254

Table 1.5 Ordering Numbers for Options and Accessories

1) 2 kinds of packages, 6 pieces or 72 pieces.

2) 2 pieces in 1 package.

Description	Ordering numbers
Standard control cassette	132B0255
Control cassette (with PROFIBUS)	132B0256
Control cassette (with PROFINET)	132B0257
Fan 50x15 IP21 for J1 0.37–1.5 kW (0.5–2 hp)	132B0275
Fan 50x20 IP21 for J1 2.2 kW (3 hp)	132B0276
Fan 60x20 IP21 for J2	132B0277
Fan 70x20 IP21 for J3	132B0278
Fan 92x38 IP21 for J4	132B0279
Fan 120x38 IP21 for J5	132B0280
Fan 92x38 IP21 for J6	132B0295
Fan 120x38 IP21 for J7	132B0313
Relay & RS485 header for J1–J5	132B0264
Power control card, 30 kW (40 hp)	132B0287
Power control card, 37 kW (50 hp)	132B0290
Power control card, 45 kW (60 hp)	132B0291
RFI auxiliary card, J6	132B0292
Rectifier module, 30–37 kW (40–50 hp)	132B0293
Rectifier module, 45 kW (60 hp)	132B0294
Front cover, J6	132B0296
Mains terminal, J6	132B0297
Motor terminal, J6	132B0298
DC bus terminal, J6	132B0299
Power control card supply cable, J6	132B0300
Fan extension cable, J6	132B0301
Isolation RFI foil, J6	132B0302
Cradle for power card & bus bar, J6	132B0303
Power control card, 55 kW (75 hp)	132B0305
Power control card, 75 kW (100 hp)	132B0306
Power card, J7	132B0307
RFI auxiliary card, J7	132B0308
Rectifier module, J7	132B0309
IGBT module with gate drive cable, J7	132B0310
DC capacitor, 55 kW (75 hp)	132B0311
DC capacitor, 75 kW (100 hp)	132B0312
Front cover, J7	132B0314
Mains, motor terminal, 55 kW (75 hp)	132B0315
DC bus terminal, 55 kW (75 hp)	132B0316
Mains, motor, DC bus terminal, 75 kW (100 hp)	132B0317
Temperature sensing cable, J7	132B0318
Power control card supply cable, J7	132B0319
Fan extension cable, J7	132B0320
Isolation RFI foil, J7	132B0321
Isolation inrush foil, J7	132B0322

Table 1.6 Ordering Numbers for Spare Parts

1

1.9 Ratings Tables

1.9.1 Short Circuit and Overcurrent Trips

The frequency converter is protected against short circuits with current measurement in the DC link (0.37–22 kW) or in each of the 3 motor phases (30–75 kW). A short circuit between 2 output phases causes an overcurrent in the frequency converter. The frequency converter turns off the IGBTs individually when the short-circuit current exceeds the permitted value (*Alarm 16 Trip Lock*).

1.9.2 DC Voltage Levels

	380–440 V AC		**441–480 V AC**
	J1–J5	J6–J7	J1–J7
Inrush circuit disabled [V]	314	372	422
Undervoltage [V]	314	372	422
Undervoltage re-enables [V]	314+30	372+30	422+30
Overvoltage [V]	800	800	800
Overvoltage re-enables [V]	800-30	800-30	800-30
IT Grid turn on [V]	800+30	800+30	800+30

Table 1.7 DC Voltage Levels

1.10 Tools Required for Service

Item	Description
ESD protection kit	Wrist strap and mat
Metric socket set	10–42 mm
Torque wrench	Torque range 1.3–7.0 Nm (11.5–62.0 in-lb)
Torx driver set	T10 and T20
Needle nose pliers	–
Ratchet	–
Screwdrivers	Standard and Phillips

Table 1.8 Tools Required for Service of Frequency Converter

Item	Description
Digital voltmeter or digital ohmmeter	• Rated for true RMS. • Supports diode mode. • Rated for 1000 V DC or 600 V units.
Analog voltmeter	–
Oscilloscope	–
Clamp-on ammeter	Clamp-on ammeter rated for true RMS. Also known as a clamp-on ampere meter.

Table 1.9 Instruments Recommended for Testing of Frequency Converter

1.11 Service Report

Report the serial number (S/N) of the frequency converter when requesting support or preparing the service report. The serial number is listed on the nameplate. Refer to *chapter 1.7 Identification and Variants* for details.

2 Safety

2.1 Introduction

This section describes requirements to personnel and safe practices to observe when performing service and maintenance procedures.

2.2 Safety Symbols

The following symbols are used in this guide:

⚠WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

2.3 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel are allowed to install or operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this guide.

Authorized personnel
Authorized personnel are qualified personnel, trained by Danfoss to service Danfoss products.

2.4 Safety Precautions

⚠WARNING

HIGH VOLTAGE

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

- **Only qualified personnel must perform installation, start-up, and maintenance.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that there is no remaining voltage on the drive.**

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC power supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP or LOP, via remote operation using MCT-10 Set-up Software, or after a cleared fault condition.
To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **The frequency converter, motor, and any driven equipment must be fully wired and assembled when the frequency converter is connected to AC mains, DC power supply, or load sharing.**

2

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
- **Disconnect or lock PM motor.**
- **Wait for the capacitors to discharge fully. The minimum waiting time is specified in *Table 2.1* and is also visible on the product label on top of the frequency converter.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

Voltage [V]	Power range [kW (hp)]	Minimum waiting time (minutes)
380–480	0.37–7.5 kW (0.5–10 hp)	4
380–480	11–75 kW (15–100 hp)	15

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠WARNING

EQUIPMENT HAZARD

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

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this guide.**

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠WARNING

SHOCK HAZARD AND RISK OF INJURY

For dynamic test procedures, mains input power is required, and all devices and supplies connected to mains are energized at rated voltage. Contact with powered components can result in death or serious injury.

- **Do not touch energized parts of the frequency converter when connected to mains.**

⚠CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury when the frequency converter is not properly closed.

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

⚠WARNING

SHOCK HAZARD

The drive can cause a DC current in the PE conductor and thus result in death or serious injury.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side.**

Failure to follow the recommendation means that the RCD cannot provide the intended protection.

⚠CAUTION

RISK OF INJURY OR PROPERTY DAMAGE
Do not assume that a motor is wired properly after completed service of the frequency converter.

Check for:

- **Loose connections.**
- **Improper programming.**
- **Added equipment.**

Failure to perform these checks can result in personal injury, property damage, or less than optimal performance.

NOTICE

LIFTING - EQUIPMENT DAMAGE RISK
Incorrect lifting can result in equipment damage.

- **Use lifting lugs where provided.**
- **For vertical lift, prevent uncontrolled rotation.**
- **For lift machine, do not lift other equipment with motor lifting points only.**

NOTICE

INSTALLATION - EQUIPMENT DAMAGE RISK
Incorrect installation can result in equipment damage.

- **Before installation, check for fan cover damage, shaft damage, foot or mounting damage, and loose fasteners.**
- **Check nameplate details.**
- **Ensure level mounting surface, balanced mounting. Avoid misalignment.**
- **Ensure that gaskets, sealants, and guards are correctly fitted.**
- **Ensure correct belt tension.**

2.5 Electrostatic Discharge (ESD)

⚠CAUTION

ELECTROSTATIC DISCHARGE
When performing service, use proper electrostatic discharge (ESD) procedures to prevent damage to sensitive components. Many electronic components within the frequency converter are sensitive to static electricity. The voltage of static electricity can reduce lifetime, affect performance, or completely destroy sensitive electronic components.

- **Do not touch components on the circuit boards.**
- **Hold circuit boards by the edges or corners only.**

3

3 Frequency Converter Control

3.1 Introduction

This section describes the optional display interfaces available for the frequency converter, the inputs and outputs, and the control terminal functions.

The following optional interfaces are available:

- Numerical Local Control Panel (LCP 21).
- Graphical Local Control Panel (GLCP or LCP 102).

Use the selected interface to adapt parameter settings or read status.
Commands given to the frequency converter are indicated on the selected interface display. Fault logs are maintained within the frequency converter, for fault history. The frequency converter issues warnings and alarms for fault conditions arising within or external to the frequency converter itself. Usually, the fault condition is found outside of the frequency converter.

3.1.1 Numerical Local Control Panel

The numerical local control panel LCP 21 is divided into 4 functional sections.

A. Numeric display.

B. Menu key.

C. Navigation keys and indicator lights (LEDs).

D. Operation keys and indicator lights (LEDs).

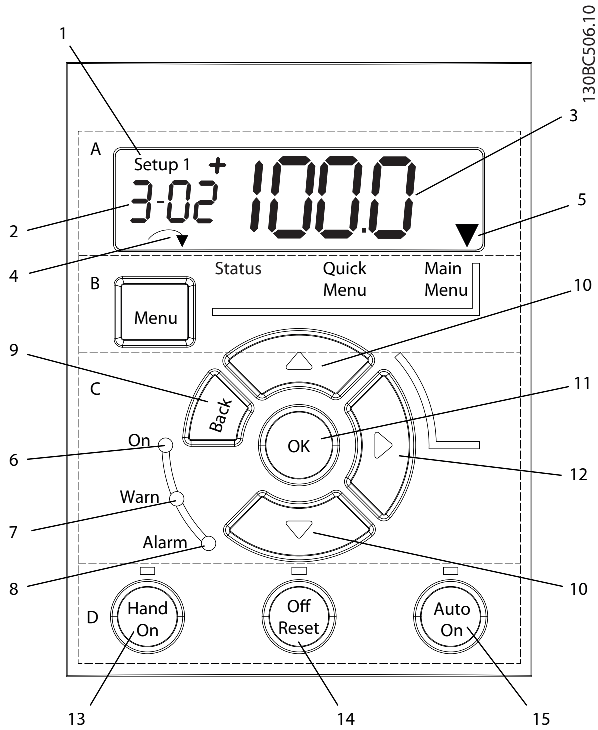


Illustration 3.1 View of the LCP 21

A. Numeric display

The LCD display is backlit with 1 numeric line. All data is shown in the LCP.

1	The set-up number shows the active set-up and the edit set-up. If the same set-up acts as both active and edit set-up, only that set-up number is shown (factory setting). When active and edit set-ups differ, both numbers are shown in the display (set-up 12). The number flashing indicates the edit set-up.
2	Parameter number.
3	Parameter value.
4	Motor direction is shown at the bottom left of the display. A small arrow indicates the direction.
5	The triangle indicates whether the LCP is in Status, Quick Menu, or Main Menu.

Table 3.1 Legend to *Illustration 3.1*, Section A

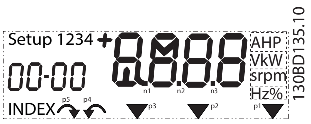


Illustration 3.2 Display Information

B. Menu key

To select between Status, Quick Menu, or Main Menu, press [Menu].

C. Indicator lights (LEDs) and navigation keys

	Indicator	Light	Function
6	On	Green	ON turns on when the frequency converter receives power from the mains voltage, a DC bus terminal, or a 24 V external supply.
7	Warn	Yellow	When warning conditions are met, the yellow WARN LED turns on, and text appears in the display area identifying the problem.
8	Alarm	Red	A fault condition causes the red alarm LED to flash and an alarm text is shown.

Table 3.2 Legend to *Illustration 3.1*, Indicator Lights (LEDs)

	Key	Function
9	[Back]	For moving to the previous step or layer in the navigation structure.
10	[▲] [▼]	For switching between parameter groups, parameters, and within parameters, or increasing/decreasing parameter values. Arrows can also be used for setting local reference.
11	[OK]	Press to access parameter groups or to enable a selection.
12	[►]	Press to move from left to right within the parameter value to change each digit individually.

Table 3.3 Legend to *Illustration 3.1*, Navigation Keys

D. Operation keys and indicator lights (LEDs)

	Key	Function
13	Hand On	Starts the frequency converter in local control. • An external stop signal by control input or serial communication overrides the local hand on.
14	Off/Reset	Stops the motor but does not remove power to the frequency converter, or resets the frequency converter manually after a fault has been cleared. If in alarm mode, the alarm is reset if the alarm condition is removed.
15	Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or bus communication.

Table 3.4 Legend to *Illustration 3.1*, Section D

⚠WARNING

HIGH VOLTAGE

Touching the frequency converter after pressing the [Off/Reset] key is still dangerous, because the key does not disconnect the frequency converter from the mains.

- Disconnect the frequency converter from the mains and wait for the frequency converter to fully discharge. See the discharge time in *Table 2.1*.

3

3.1.2 Graphical Local Control Panel

The graphical local control panel LCP 102 has a larger display area, which shows more information than LCP 21. LCP 102 supports English, Chinese, and Portuguese displays.

The GLCP is divided into 4 functional groups (see *Illustration 3.3*).

- A. Display area.
- B. Display menu keys.
- C. Navigation keys and indicator lights (LEDs).
- D. Operation keys and reset.

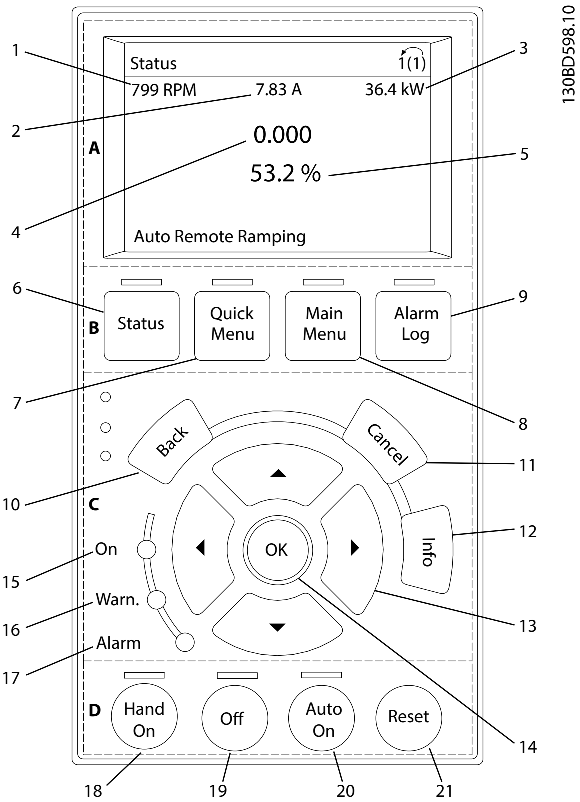


Illustration 3.3 Graphic Local Control Panel (GLCP)

A. Display area
The display area is activated when the frequency converter receives power from the mains voltage or a DC bus terminal.

The information shown on the LCP can be customized for user applications. Select options in the *Quick Menu Q3-13 Display Settings*.

Display	Parameter number	Default setting
1	0-20	*[1602] Reference [%]*
2	0-21	*[1614] Motor Current*
3	0-22	*[1610] Power [kW]*
4	0-23	*[1613] Frequency*
5	0-24	*[1502] kWh Counter*

Table 3.5 Legend to *Illustration 3.3*, Display Area

B. 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
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Shows a list of current warnings, the last 10 alarms, and the maintenance log.

Table 3.6 Legend to *Illustration 3.3*, Display Menu Keys

C. Navigation keys and indicator lights (LEDs)
Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also 3 frequency converter status indicator lights in this area.

	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode has not changed.
12	Info	Press for a definition of the function being shown.
13	Navigation keys	To move between items in the menu, use the 4 navigation keys.
14	OK	Press to access parameter groups or to enable a selection.

Table 3.7 Legend to *Illustration 3.3*, Navigation Keys

	Indicator	Light	Function
15	On	Green	ON turns on when the frequency converter receives power from the mains voltage or a DC bus terminal.
16	Warn	Yellow	When warning conditions are met, the yellow WARN LED turns on, and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red alarm LED to flash, and an alarm text is shown.

Table 3.8 Legend to *Illustration 3.3*, Indicator Lights (LEDs)

D. Operation keys and reset
Operation keys are at the bottom of the LCP.

	Key	Function
18	Hand On	Starts the frequency converter in hand-on mode. • An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the motor but does not remove power to the frequency converter.
20	Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter manually after a fault has been cleared.

Table 3.9 Legend to *Illustration 3.3*, Operation Keys and Reset

NOTICE

To adjust the display contrast, press [Status] and the [▲]/[▼] keys.

3.2 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 sent to the frequency converter in 3 ways:

- Via the optional LCP connected by cable to the frequency converter, operating in hand-on mode. These inputs include:
  - Start.
  - Stop.
  - Reset.
  - Speed reference.
- Via serial communication from a fieldbus that is connected to the frequency converter through the RS485 serial port. The serial communication protocol is used to:
  - Supply commands and references to the frequency converter.
  - Program the frequency converter.
  - Read status data from the frequency converter.
- Via signal wiring connected to the frequency converter control terminals.

NOTICE

Improperly connected control wiring can result in the frequency converter failing to start or to respond to a remote input.

3.2.1 Input Signals

The frequency converter can receive 2 types of remote input signals: Digital or analog. Digital inputs are wired to terminals 18, 19, 20 (common), 27, 29, 31, 32 and 33. Analog inputs are wired to terminals 53 or 54 and 55 (common).

The terminals can be configured as follows:

- Terminals 32, 33: 24 V encoder feedback.
- Terminals 29, 33: Pulse inputs.
- Terminals 27, 29: Digital or pulse outputs.

Analog signals
Analog signals can be either voltage (0 V to +10 V DC) or current (0–20 mA or 4–20 mA). 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
Digital signals are a simple binary 0 or 1 acting as a switch. A 0–24 V DC signal controls the digital signals. A voltage signal lower than 5 V DC is a logic 0. A voltage higher than 10 V DC is a logic 1. 0 is open, and 1 is closed. Digital inputs to the frequency converter are switched commands such as start, stop, reverse, coast, and reset. (Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols).

The RS485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is a common terminal. It is used for terminating screens only when the control cable is run between frequency converters, and not between frequency converters and other devices.

3.2.2 Output Signals

The frequency converter also produces output signals that are carried either through the RS485 fieldbus or terminals 42 or 45. Output terminal 42 can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 V DC. Output analog signals generally indicate the 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, 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.

NOTICE

In J1-J3 enclosures relay output 2 is a 2-pole output. Only terminals 04 and 05 are available.

Terminal 12 provides 24 V DC low voltage power, often used to supply power to the digital input terminals (18–33). In FC 360, there is overload protection on 24 V supply. Terminals 18–33 must be supplied with power from either terminal 12, 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.

Terminals 27, 29, 42 and 45 can be configured as digital outputs

Terminal number	42, 45[1)]
Voltage level at digital output	17 V
Maximum output current at digital output	20 mA
Maximum load at digital output	1 kΩ

Table 3.10 Digital Output

1) Terminals 42 and 45 can also be programmed as analog outputs.

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

Terminal	Parameter	Default setting	Description
68 (+)	8–3*		RS485 Interface. A control card switch is provided for termination resistance.
69 (-)	8–3*		
Relays			
01, 02, 03	5–40 [0]	[0] No operation	Form C relay output. These relays are in various locations depending upon the frequency converter configuration and size. Usable for AC or DC voltage and resistive or inductive loads. RO2 in J1-J3 enclosure is 2-pole, only terminal 04 and terminal 05 are available.
04, 05, 06	5–40 [1]	[0] No operation	

Table 3.11 Terminal Descriptions

3.3 Service Functions

24 different items can be accessed. Included in the data are:

- Counters that tabulate hour runs, and so on.
- Fault logs that store frequency converter status values present at the 10 most recent events that stopped the frequency converter.
- Frequency converter nameplate data.

Parameter 14-28 Production Settings and *parameter 14-29 Service Code* are the relevant service parameters.

Press [Main Menu] to display the parameter settings.

Press the navigation keys [▲], [▼], [►] to scroll through parameters.

See the *VLT® AutomationDrive FC 360 Quick Guide* for detailed information on accessing and displaying parameters, and for descriptions and procedures for service information available in parameter group *6-** Analog In/ Out*.

3.4 Control Terminals

For proper frequency converter functioning, the input control terminals must be:

- Wired properly.
- Powered.
- Programmed correctly for the intended function.

Ensure that the input terminal is wired correctly:

1. Confirm that the control and power sources are wired to the terminal.
2. Check the signal in either of 2 ways:
    - Press [Display Mode], then select *Digital Input*. The LCP shows the digital inputs which are correctly wired.
    - Use a voltmeter to check for voltage at the control terminal.

Confirm that each control terminal is programmed for the correct function. Each terminal has specific functions and a numbered parameter associated with it. The setting selected in the parameter enables the function of the terminal.

See the *VLT® AutomationDrive FC 360 Quick Guide* for details on changing parameters and the functions available for each control terminal.

3.5 Grounding Screened Cables

Connect the shielded control cables to the metal cabinet of the frequency converter with cable clamps at both ends. *Illustration 3.5* shows ground cabling for optimal results.

Correct grounding
To ensure the best possible electrical connection, fit control cables and cables for serial communication with cable clamps at both ends.

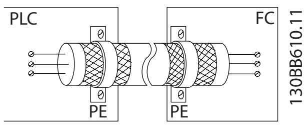
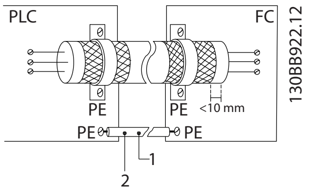


Illustration 3.4 Correct Grounding

Incorrect grounding
Do not use twisted cable ends (pigtails) since they increase shield impedance at high frequencies.

Ground potential protection
When the ground potential between the frequency converter and the PLC or other interface device is different, electrical noise may occur that can disturb the entire system. Resolve the electrical noise by fitting an equalizing cable next to the control cable. Minimum cable cross-section is 10 mm^2 (8 AWG).



1	Minimum 10 mm^2 (8 AWG)
2	Equalizing cable

Illustration 3.5 Ground Potential Protection

50/60 Hz ground loops

When using long control cables, 50/60 Hz ground loops may occur that can disturb the entire system. Resolve the ground loops by connecting 1 end of the shield with a 100 nF capacitor and keeping the lead short.

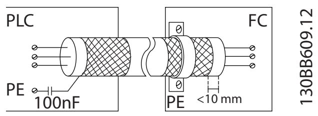


Illustration 3.6 50/60 Hz Ground Loops

Serial communication control cables

Low-frequency noise currents between frequency converters can be eliminated by connecting 1 end of the shielded cable to frequency converter terminal 61. This terminal connects to ground through an internal RC link. To reduce the differential mode interference between conductors, use twisted-pair cables.

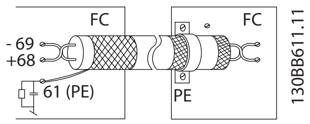


Illustration 3.7 Serial Communication Control Cables

4 Troubleshooting

4.1 Troubleshooting Tips

Before performing troubleshooting on a frequency converter

1. Read the warnings in *chapter 2 Safety*.
2. Note all warnings concerning voltages present in the frequency converter. Verify the presence of AC input voltage and DC-link voltage before working on the unit. Some points in the frequency converter are referenced to the negative DC-link. They are at DC-link potential even though it sometimes appears on diagrams to be a neutral reference.
3. Wait for discharge of the DC-link. For discharge time, see *Table 2.1* or the label on the frequency converter.
4. Do not apply power to a unit that is suspected of being faulty. Many faulty components within the frequency converter can damage other components when power is applied. Always perform the procedure for testing the unit after repair as described in *chapter 6.4 Initial Start-up or After-repair Tests*.
5. Do not attempt to defeat any fault protection circuitry within the frequency converter, as this results in unnecessary component damage and can cause personal injury.
6. Use factory approved replacement parts. The frequency converter is designed to operate within certain specifications. Incorrect parts can affect tolerances and result in further damage to the unit.
7. Read the *VLT® AutomationDrive FC 360 Quick Guide*. When in doubt, consult the factory or authorized repair center for assistance.

4.2 Exterior Fault Troubleshooting

There may be slight differences in servicing a frequency converter that has been operational for extended time, compared to a new installation. In either case, use proper troubleshooting procedures.

⚠CAUTION

RISK OF INJURY OR PROPERTY DAMAGE

Never assume that a motor is wired properly after a service of the frequency converter. Check for:

- **Loose connections.**
- **Improper programming.**
- **Added equipment.**

Failure to perform these checks can result in personal injury, property damage, or less than optimal performance.

Take a systematic approach, beginning with a visual inspection of the system. See *Table 4.1* for items to examine.

4.3 Fault Symptom Troubleshooting

The troubleshooting procedures are divided into sections based on the symptom being experienced.

- See the visual inspection check list in *Table 4.1*. Often, incorrect installation or wiring of the frequency converter causes the problem. The check list provides guidance through the items to inspect during servicing of the frequency converter.
- The most common fault symptoms are described in *chapter 4.5 Fault Symptoms*:
  - Problems with motor operation.
  - A warning or alarm shown by the frequency converter.

  The frequency converter processor monitors inputs and outputs and internal frequency converter functions. An alarm or warning does not necessarily indicate a problem within the frequency converter itself.

For each incident, further description explains how to troubleshoot that particular symptom. When necessary, further referrals are made to other parts of the guide for more procedures.

When troubleshooting is complete, perform the list of tests provided in *chapter 6.4 Initial Start-up or After-repair Tests*.

4.4 Visual Inspection

Visually inspect the conditions that are described in *Table 4.1* as part of an initial troubleshooting procedure.

Inspect for	Description
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on input power side of frequency converter or output side to motor. • Examine operation and condition of these items as possible causes for operational faults. • Check function and installation of pressure sensors or encoders used for feedback to frequency converter.
Cable routing	• Avoid routing motor wiring, AC line 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 a grounded conductive partition. • Avoid routing cables through free air.
Control wiring	• Check for broken or damaged wires and connections. • Check the voltage source of the signals. Though not always necessary depending on the installation conditions, the use of shielded cable or a twisted pair is recommended. • Ensure that the shield is terminated correctly.
Frequency converter cooling	• Check operational status of all cooling fans. • Check for blockage or constrained air passages. Verify that bottom gland plate is installed.
Frequency converter display	The display shows: • Warnings • Alarms • Frequency converter status • Fault history and many other important items.
Frequency converter interior	• Frequency converter interior must be free of: - Dirt. - Metal chips. - Moisture. - Corrosion. • Check for burnt or damaged power components or carbon deposits that were the result of a catastrophic component failure. • Check for cracks or breaks in the housings of power semiconductors, or pieces of broken component housings loose inside the unit.
EMC considerations	• Check for proper installation regarding electromagnetic capability. • Refer to the *VLT® AutomationDrive FC 360 Quick Guide* and this chapter for further details.
Environmental conditions	• Under specific conditions, these units can be operated within a maximum ambient temperature of 50° C (122° F). • Humidity levels must be less than 95% non-condensing. • Check for harmful airborne contaminates such as sulfur-based compounds.
Grounding	• The frequency converter requires a dedicated ground wire from its chassis to the building ground. • It is also suggested that the motor is grounded to the frequency converter enclosure as well. • The use of conduit or mounting of the frequency converter to a metal surface is not considered suitable grounding. • Check for good ground connections that are tight and free of oxidation.

Inspect for	Description
Input power wiring	• Check for loose connections. • Check for proper fusing. • Check for blown fuses.
Motor	• Check nameplate ratings of motor. • Ensure that motor ratings match frequency converter ratings. • Ensure that the motor parameters (1–20 to 1–25) are set according to motor ratings.
Output to motor wiring	• Check for loose connections. • Check for switching components in output circuit. • Check for faulty contacts in switch gear.
Programming	• Ensure that frequency converter parameter settings are correct according to motor, application, and I/O configuration.
Proper clearance	These frequency converters require top and bottom clearance adequate to ensure proper air flow for cooling in accordance with the frequency converter size.
Vibration	• Though subjective, look for an unusual amount of vibration that the frequency converter may be subjected to. • Mount the frequency converter solidly or use shock mounts.

Table 4.1 Visual Inspection

4.5 Fault Symptoms

4.5.1 No Display

The LCP display provides 2 display indications. One with the backlit alphanumeric display. The other is 3 LED indicator lights near the bottom of the LCP. If the green power-on LED is illuminated but the backlit display is dark, it indicates that the LCP is defective and must be replaced. Be certain, however, that the display is dark.

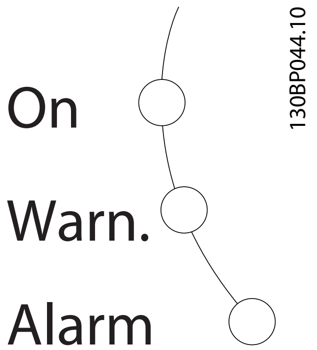


Illustration 4.1 LED Indicator Lights

Having a single character or just a dot in the upper corner of the LCP indicates that communications may have failed with the control card. This situation typically appears when a fieldbus communication option has been installed in the frequency converter and is either not connected properly or is malfunctioning.

If neither indication is available, then the source of the problem is elsewhere. Proceed to the next troubleshooting steps.

4.5.2 Intermittent Display

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

The first step is to rule out a problem in the control wiring. To do so, disconnect all control wiring by unscrewing or unplugging the control terminal blocks from the control card.

If the display stays lit, the problem is in the control wiring (external to the frequency converter). Check all control wiring for short circuits or incorrect connections.

If the display continues to cut out, follow the procedure for *chapter 4.5.1 No Display* as though the display was not lit at all.

4.5.3 Motor Does Not Run

If this symptom is detected, verify that the unit is properly powered up (display is lit) and that there are no warning or alarm messages shown. The most common cause of this problem is either incorrect control logic or an incorrectly programmed frequency converter. Such occurrences result in 1 or more of the following status messages being shown.

LCP stop
[Off/Reset] has been pressed. Line 2 of the display also flashes when this situation occurs.

Troubleshooting

- Press [Auto On] or [Hand On].
- Refer to *chapter 6.3.11 Input Terminal Signal Tests*.

Unit ready
Terminal 27 is low (no signal).

Troubleshooting

- Ensure that terminal 27 is logic 1.
- Refer to *chapter 6.3.11 Input Terminal Signal Tests*.

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

Troubleshooting

- Check control wiring to ensure that the proper reference signal is present at the input terminals.
- Also check that the unit is properly programmed to accept the signal provided.
- Refer to *chapter 6.3.11 Input Terminal Signal Tests*.

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

Troubleshooting

- Ensure that the correct control word is transmitted to the frequency converter over the communication bus.

Stop
One of the digital input terminals 18, 19, 27, 29, 31, 32, or 33 is programmed for stop inverse, and the corresponding terminal is low (logic 0).

Troubleshooting

- Ensure that the digital input terminals are programmed correctly.
- Ensure that the digital input programmed for stop inverse is high (logic 1).

4.5.4 Incorrect Motor Operation

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

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

Troubleshooting

- Ensure that the unit is programmed correctly according to the reference signal being used, and that all reference limits are set correctly.
- Perform the tests described in *chapter 6.3.11 Input Terminal Signal Tests* to check for faulty reference signals.

Motor speed unstable

- Possible incorrect parameter settings.
- Faulty current feedback circuit.
- Loss of motor (output) phase.

Troubleshooting

- Check settings of all motor parameters, including all motor compensation settings (slip compensation, load compensation, and so on).
- For closed-loop operation, check PID settings.
- Perform the tests described in *chapter 6.3.11 Input Terminal Signal Tests* to check for faulty reference signals.
- Perform the tests described in *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test* to check for loss of motor phase.

Motor runs rough
Possible overmagnetization (incorrect motor settings), or an IGBT misfiring.

NOTICE

The motor may also stall when loaded or the frequency converter may trip occasionally on *alarm 13, Overcurrent*.

Troubleshooting

- Check setting of all motor parameters, see *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test*.
- If output voltage is unbalanced, see *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test*.

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

- Perform the tests described in *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test* to ensure that frequency converter is providing correct output.
- Check motor for open windings. Check all motor wiring connections.
- Run an AMA to check the motor for open windings and unbalanced resistance. Inspect all motor wiring connections.

4.6 Warnings and Alarms

When the frequency converter fault circuitry detects a fault condition or a pending fault, a warning or alarm is issued. A flashing display on the LCP indicates an alarm or warning condition and the associated number code on line 2. Sometimes a warning precedes an alarm.

4.6.1 Alarms

An alarm causes the frequency converter to trip (suspend operation). The frequency converter has 3 trip conditions, which are shown in line 1:

Trip (auto restart)
The frequency converter is programmed to restart automatically after the fault is removed. The number of automatic reset attempts can be continuous or limited to a programmed number of attempts. If the selected number of automatic reset attempts is exceeded, the trip condition changes to trip (reset).

Trip (reset)
Requires resetting of the frequency converter before operation after a fault is cleared. To reset the frequency converter manually, press [Reset] or use a digital input, or a fieldbus command. For NLCP, stop and reset are the same key, [Off/Reset]. If [Off/Reset] is used to reset the frequency converter, press [Start] to initiate a run command in either hand-on mode or auto-on mode.

Trip lock (disc>mains)
Disconnect the mains AC input power to the frequency converter long enough for the display to go blank. Remove the fault condition and reapply power. Following power-up, the fault indication changes to trip (reset) and allows for manual, digital, or fieldbus reset.

4.6.2 Warnings

During a warning, the frequency converter remains operational, although the warning flashes for as long as the condition exists. The frequency converter could, however, reduce the warning condition. For example, if the warning shown was *warning 12, Torque Limit*, the frequency converter would reduce speed to compensate for the overcurrent condition. Sometimes, if the condition is not corrected or worsens, an alarm condition is activated and the frequency converter stops output to the motor terminals. Line 1 identifies the warning in plain language, and line 2 identifies the warning number.

4.6.3 Warning/alarm Messages

The LEDs on the front of the frequency converter and a code in the display signal a warning or an alarm.

LED indication	
Warning	Yellow
Alarm	Flashing red

Table 4.2 Control Terminals and Associated Parameter

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

An alarm triggers a **trip**. The trip removes power to the motor. It can be reset after the condition has been cleared by pressing [Reset], or through a digital input (*parameter group 5–1* Digital Inputs*). 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.

The reset can be done in 3 ways:

- Press [Reset].
- A digital reset input.
- Serial communication/optional fieldbus reset signal.

NOTICE

After a manual reset pressing [Reset], press [Auto On] to restart the motor.

A warning precedes an alarm.

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

The warnings and alarms are explained in *Table 4.3*.

Number	Description	Warning	Alarm	Trip lock	Cause
2	Live zero error	X	X	–	Signal on terminal 53 or 54 is less than 50% of value set in *parameter 6-10 Terminal 53 Low Voltage*, *parameter 6-12 Terminal 53 Low Current*, *parameter 6-20 Terminal 54 Low Voltage*, and *parameter 6-22 Terminal 54 Low Current*.
3	No motor	X	–	–	No motor has been connected to the output of the frequency converter, or 1 motor phase is missing.
4	Mains phase loss[1)]	X	X	X	Missing phase on supply side, or the voltage imbalance is too high. Check the supply voltage.
7	DC overvoltage[1)]	X	X	–	Intermediate circuit voltage exceeds limit.
8	DC undervoltage[1)]	X	X	–	Intermediate circuit voltage drops below the voltage warning low limit.
9	Inverter overloaded	X	X	–	More than 100% load for too long.
10	Motor ETR overtemperature	X	X	–	Motor is too hot due to more than 100% load for too long.
11	Motor thermistor overtem-perature	X	X	–	Thermistor or thermistor connection is disconnected.
12	Torque limit	X	X	–	Torque exceeds value set in either *parameter 4-16 Torque Limit Motor Mode* or *parameter 4-17 Torque Limit Generator Mode*.
13	Overcurrent	X	X	X	Inverter peak current limit is exceeded. For J1–J6 units, if this alarm occurs on power-up, check whether power cables are mistakenly connected to the motor terminals.
14	Earth fault	–	X	X	Discharge from output phases to ground.
16	Short circuit	–	X	X	Short circuit in motor or on motor terminals. For J7 units, if this alarm occurs on power-up, check whether power cables are mistakenly connected to the motor terminals.
17	Control word timeout	X	X	–	No communication to frequency converter.
18	Start failed	–	X	–	–
25	Brake resistor short-circuited	–	X	X	Brake resistor is short-circuited, thus the brake function is disconnected.
26	Brake overload	X	X	–	The power transmitted to the brake resistor over the last 120 s exceeds the limit. Possible corrections: Decrease brake energy via lower speed or longer ramp time.
27	Brake IGBT/Brake chopper short-circuited	–	X	X	Brake transistor is short-circuited, thus brake function is disconnected.
28	Brake check	–	X	–	Brake resistor is not connected/working.
30	U phase loss	–	X	X	Motor phase U is missing. Check the phase.
31	V phase loss	–	X	X	Motor phase V is missing. Check the phase.
32	W phase loss	–	X	X	Motor phase W is missing. Check the phase.
34	Fieldbus fault	X	X	–	PROFIBUS communication issues have occurred.
35	Option fault	–	X	–	Fieldbus or option B detects internal faults.
36	Mains failure	X	X	–	This warning/alarm is only active if the supply voltage to the frequency converter is less than the value set in *parameter 14-11 Mains Fault Voltage Level*, and *parameter 14-10 Mains Failure* is NOT set to *[0] No Function*.
38	Internal fault	–	X	X	Contact the local Danfoss supplier.
40	Overload T27	X	–	–	Check the load connected to terminal 27 or remove short-circuit connection.
41	Overload T29	X	–	–	Check the load connected to terminal 29 or remove short-circuit connection.

Number	Description	Warning	Alarm	Trip lock	Cause
46	Gate drive voltage fault	–	X	X	–
47	24 V supply low	X	X	X	24 V DC may be overloaded.
50	AMA calibration	–	X	–	–
51	AMA check U_{nom} and I_{nom}	–	X	–	Wrong setting for motor voltage and/or motor current.
52	AMA low I_{nom}	–	X	–	Motor current is too low. Check the settings.
53	AMA big motor	–	X	–	The power size of the motor is too large for the AMA to operate.
54	AMA small motor	–	X	–	The power size of the motor is too small for the AMA to operate.
55	AMA parameter range	–	X	–	The parameter values of the motor are outside of the acceptable range. AMA does not run.
56	AMA interrupt	–	X	–	The AMA is interrupted.
57	AMA timeout	–	X	–	–
58	AMA internal	–	X	–	Contact Danfoss.
59	Current limit	X	X	–	Frequency converter overload.
60	External interlock	–	X	–	–
61	Feedback error	X	X	–	The difference between the speed reference and the feedback exceeds the limit.
63	Mechanical brake low	–	X	–	Actual motor current has not exceeded release brake current within start delay time window.
65	Control card temp	X	X	X	The cutout temperature of the control card is 80 °C (176 °F).
69	Power card temp	X	X	X	The cutout temperature of the power card has exceeded the upper limit.
70	Illegal FC config	–	X	X	–
80	Frequency converter initialized to default value	–	X	–	All parameter settings are initialized to default settings.
87	Auto DC brake	X	–	–	Occurs in IT mains when the frequency converter coasts and the DC voltage is higher than 830 V. Energy on DC-link is consumed by the motor. This function can be enabled/disabled in *parameter 0-07 Auto DC Braking*.
90	Feedback monitor	X	X	–	A feedback fault is detected by option B.
95	Broken belt	X	X	–	–
99	Locked rotor	–	X	–	–
101	Flow/pressure information missing	–	X	X	–
120	Position control fault	–	X	–	–
124	Tension limit	–	X	–	–
126	Motor rotating	–	X	–	–
127	Back EMF too high[2)]	X	–	–	Try to start PM motor, which is rotating at an abnormal high speed.
250	New spare part	–	X	X	–
251	New type code	–	X	X	–

Table 4.3 Warnings and Alarms Code List

1) These faults may be caused by mains distortions. Installing a Danfoss line filter may rectify this problem.

2) For enclosure size J7, the warning can also be caused by high UDC voltage.

For diagnosis, read out the alarm words, warning words, and extended status words.

Bit	Hex	Dec	Alarm word (*parameter 16-90 Alarm Word*)	Alarm word 2 (*parameter 16-91 Alarm Word 2*)	Alarm word 3 (*parameter 16-97 Alarm Word 3*)	Warning word (*parameter 16-92 Warning Word*)	Warning word 2 (*parameter 16-93 Warning Word 2*)	Extended status word (*parameter 16-94 Ext. Status Word*)	Extended status word 2 (*parameter 16-95 Ext. Status Word 2*)
0	00000001	1	Brake check	Reserved	Reserved	Reserved	Reserved	Ramping	Off
1	00000002	2	Pwr. card temp	Gate drive voltage fault	Reserved	Pwr. card temp	Reserved	AMA tuning	Hand/Auto
2	00000004	4	Earth fault	Reserved	Reserved	Reserved	Reserved	Start CW/CCW	PROFIBUS OFF1 active
3	00000008	8	Ctrl. card temp	Reserved	Reserved	Ctrl. card temp	Reserved	Slowdown	PROFIBUS OFF2 active
4	00000010	16	Ctrl. word TO	Illegal FC config	Reserved	Ctrl. word TO	Reserved	Catch up	PROFIBUS OFF3 active
5	00000020	32	Overcurrent	Reserved	Reserved	Overcurrent	Reserved	Feedback high	Reserved
6	00000040	64	Torque limit	Reserved	Reserved	Torque limit	Reserved	Feedback low	Reserved
7	00000080	128	Motor Th. over	Reserved	Reserved	Motor Th. over	Reserved	Output current high	Control ready
8	00000100	256	Motor ETR over	Broken belt	Reserved	Motor ETR over	Broken belt	Output current low	Frequency converter ready
9	00000200	512	Inverter overld.	Reserved	Reserved	Inverter overld.	Reserved	Output freq. high	Quick stop
10	00000400	1024	DC undervolt.	Start failed	Reserved	DC undervolt.	Reserved	Output freq. low	DC brake
11	00000800	2048	DC overvolt.	Reserved	Reserved	DC overvolt.	Reserved	Brake check OK	Stop
12	00001000	4096	Short circuit	External interlock	Reserved	Reserved	Reserved	Braking max	Latched
13	00002000	8192	Reserved	Reserved	Reserved	Reserved	Reserved	Braking	Reserved
14	00004000	16384	Mains ph. loss	Reserved	Reserved	Mains ph. loss	Reserved	Reserved	Freeze output
15	00008000	32768	AMA not OK	Reserved	Reserved	No motor	Auto DC brake	OVC active	Reserved
16	00010000	65536	Live zero error	Reserved	Reserved	Live zero error	Reserved	AC brake	Jog
17	00020000	131072	Internal fault	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
18	00040000	262144	Brake overload	Reserved	Reserved	Brake resistor power limit	Reserved	Reserved	Start
19	00080000	524288	U phase loss	Reserved	Reserved	Reserved	Reserved	Reference high	Reserved
20	00100000	1048576	V phase loss	Option detection	Reserved	Reserved	Overload T27	Reference low	Start delay
21	00200000	2097152	W phase loss	Option fault	Reserved	Reserved	Reserved	Reserved	Sleep

Bit	Hex	Dec	Alarm word (*parameter 16-90 Alarm Word*)	Alarm word 2 (*parameter 16-91 Alarm Word 2*)	Alarm word 3 (*parameter 16-97 Alarm Word 3*)	Warning word (*parameter 16-92 Warning Word*)	Warning word 2 (*parameter 16-93 Warning Word 2*)	Extended status word (*parameter 16-94 Ext. Status Word*)	Extended status word 2 (*parameter 16-95 Ext. Status Word 2*)
22	00400000	4194304	Fieldbus fault	Locked rotor	Reserved	Fieldbus fault	Reserved	Reserved	Sleep boost
23	00800000	8388608	24 V supply low	Position ctrl. fault	Reserved	24 V supply low	Reserved	Reserved	Running
24	01000000	16777216	Mains failure	Tension Limit	Reserved	Mains failure	Reserved	Reserved	Bypass
25	02000000	33554432	Reserved	Current limit	Reserved	Current limit	Reserved	Reserved	Reserved
26	04000000	67108864	Brake resistor	Reserved	Reserved	Reserved	Reserved	Reserved	External interlock
27	08000000	134217728	Brake IGBT	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
28	10000000	268435456	Option change	Feedback fault	Reserved	Encoder loss	Reserved	Reserved	FlyStart active
29	20000000	536870912	Frequency converter initialized	Encoder loss	Reserved	Reserved	Back EMF too high	Reserved	Heat sink clean warning
30	40000000	1073741824	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
31	80000000	2147483648	Mech. brake low	Reserved	Reserved	Reserved	Reserved	Database busy	Reserved

Table 4.4 Description of Alarm Word, Warning Word, and Extended Status Word

The alarm words, warning words and extended status words can be accessed via fieldbus or optional fieldbus for diagnosis.

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common.
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform the input terminal signal test.

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

Troubleshooting

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

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

Troubleshooting

- Extend the ramp time.
- Change the ramp type.

WARNING/ALARM 8, DC under voltage
If the DC-link voltage (DC-link) drops below the undervoltage limit, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Check that the supply voltage matches the frequency converter voltage.
- Perform the input voltage test.
- Perform the soft charge circuit test.

WARNING/ALARM 9, Inverter overload
The frequency converter is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection issues a warning at 90% and trips at 100%, while giving an alarm. The frequency converter cannot be reset until the counter is below 0%.
The fault occurs when the frequency converter has run with more than 100% overload for too long.

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.
- Compare the output current shown on the LCP with measured motor current.
- Show the thermal frequency converter load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter increases. When running below the frequency converter continuous current rating, the counter decreases.

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

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that motor data in *parameters 1-20 to 1-25* is set correctly.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp
Check whether the thermistor is disconnected. Select whether the frequency converter issues a warning or an alarm in *parameter 1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check that *parameter 1-93 Thermistor Resource* selects terminal 53 or 54.
- When using terminal 18, 19, 31, 32, or 33 (digital inputs), check that the thermistor is connected correctly between the digital input terminal used (digital input PNP only) and terminal 50. Select the terminal to use in *parameter 1-93 Thermistor Resource*.

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*.
Parameter 14-25 Trip Delay at Torque Limit can change this warning from a warning-only condition to a warning followed by an alarm.

4

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.
- If torque limit occurs while running, increase the torque limit. Make sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 5 s, then the frequency converter trips and issues an alarm. Shock loading or fast acceleration with high-inertia loads can cause this fault.

Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Check that the motor size matches the frequency converter.
- Check *parameters 1-20 to 1-25* for correct motor data.

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

Troubleshooting

- Remove power to the frequency converter and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.

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

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

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter.
The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to *[0] Off*.
If *parameter 8-04 Control Word Timeout Function* is set to *[5] Stop and Trip*, a warning appears. The frequency converter then ramps down until it trips, while giving an alarm.
Parameter 8-03 Control Timeout Time could possibly be increased.

Troubleshooting

- Check connections on the serial communication cable.
- Increase *parameter 8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

ALARM 18, Start failed
The speed cannot exceed the value set in *parameter 1-78 Compressor Start Max Speed [Hz]* during start within the allowed time, which is set in *parameter 1-79 Compressor Start Max Time to Trip*. The alarm may be caused by a blocked motor.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during start-up. If a short circuit occurs, the brake function is disabled and the alarm appears. The frequency converter is tripped.

Troubleshooting

- Remove the power to the frequency converter and check the connection of the brake resistor.

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in *parameter 2-11 Brake Resistor (ohm)*. The warning is active when the dissipated braking power is higher than the value set in *parameter 2-12 Brake Power Limit (kW)*. The frequency converter trips if the warning persists for 1200 s.

Troubleshooting

- Decrease brake energy via lower speed or longer ramp time.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during start-up. If a short circuit occurs, the brake function is disabled, and an alarm is issued. The frequency converter is tripped.

Troubleshooting

- Remove the power to the frequency converter and remove the brake resistor.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working.

Troubleshooting

- Check if brake resistor is connected or it is too large for the frequency converter.

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

Troubleshooting

- Remove power from 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.

Troubleshooting

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

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

Troubleshooting

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

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

ALARM 38, Internal fault
When an internal fault occurs, a code number is shown.

Troubleshooting
See *Table 4.5* for the causes and solutions for different internal faults. If the fault persists, contact the Danfoss supplier or service department for assistance.

Fault number	Cause	Solution
140–142	Power board EEPROM data error	Upgrade the software in the frequency converter to the latest version.
176	The firmware in the frequency converter does not match the frequency converter.	Upgrade the software in the frequency converter to the latest version.
256	Flash ROM checksum error	Upgrade the software in the frequency converter to the latest version.
2304	Firmware mismatch between the control card and the power card.	Upgrade the software in the frequency converter to the latest version.
2560	Communication error between the control card and the power card.	Upgrade the software in the frequency converter to the latest version. If the alarm occurs again, check the connection between the control card and the power card.
3840	Serial flash version error	Upgrade the software in the frequency converter to the latest version.
4608	Frequency converter power size error	Upgrade the software in the frequency converter to the latest version. If the alarm occurs again, contact a Danfoss supplier.
5632	Option hardware version error	The hardware version of the option or the fieldbus variant is not compatible with the frequency converter software.
5888	Option software version error	The software version of the option or the fieldbus variant is not compatible with the frequency converter software. Change either the fieldbus software or the frequency converter software.
6144	The option is not supported	Check if the product supports this option.
6400	Option combination error	Remove the option.
Other	Other internal faults	Power cycle the frequency converter. If the alarm occurs again, contact a Danfoss supplier.

Table 4.5 Internal Fault List

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove the short-circuit connection. Check *parameter 5-00 Digital I/O Mode* and *parameter 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 *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

ALARM 46, Power card supply
The supply for the gate drive on the power card is out of range. It is generated by the switch mode supply (SMPS) on the power card.

Troubleshooting

- Check for a defective power card.

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card.

ALARM 50, AMA calibration failed
A calibration error has occurred. Contact a Danfoss supplier or the Danfoss service department.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong.

Troubleshooting

- Check the settings in *parameters 1-20* to *1-25*.

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

Troubleshooting

- Check the setting in *parameter 1-24 Motor Current*.

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

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

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

ALARM 56, AMA interrupted by user
The AMA is manually interrupted.

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

ALARM 58, Internal fault
Contact a Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *parameter 4-18 Current Limit*.

Troubleshooting

- Ensure that motor data in *parameters 1-20* to *1-25* is set correctly.
- Possibly increase the current limit.
- Be sure that the system can operate safely at a higher limit.

ALARM 60, External interlock
A digital input signal indicates a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip.

Troubleshooting

- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the frequency converter.

WARNING/ALARM 61, Feedback error
An error between calculated speed and speed measurement from feedback device.

Troubleshooting

- Check the settings for warning/alarm/disabling in *parameter 4-30 Motor Feedback Loss Function*.
- Set the tolerable error in *parameter 4-31 Motor Feedback Speed Error*.
- Set the tolerable feedback loss time in *parameter 4-32 Motor Feedback Loss Timeout*.

ALARM 63, Mechanical brake low
The actual motor current has not exceeded the release brake current within the start delay time window.

WARNING/ALARM 65, Control card over temperature
The cutout temperature of the control card has exceeded the upper limit.

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check the fan operation.
- Check the control card.

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

ALARM 68, Safe stop activated
Safe Torque Off (STO) is activated. If STO is in manual restart mode (default), to resume normal operation, apply 24 V DC to terminals 37 and 38 and initiate a reset signal (via fieldbus, digital I/O, or [Reset]/[Off Reset] key). If STO is in automatic restart mode, applying 24 V DC to terminals 37 and 38 automatically resumes the frequency converter to normal operation.

ALARM 69, Power card temperature
The cutout temperature of the power card has exceeded the upper limit.

Troubleshooting

- Check that the ambient operating temperature is within limits.
- Check fan operation.
- Check the power card.

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

Troubleshooting

- To clear the alarm, reset the unit.

WARNING 87, Auto DC-Braking
Occurs in IT mains when the frequency converter coasts, and the DC voltage is higher than 830 V for 400 V units and 425 V for 200 V units. The motor consumes energy on the DC link. This function can be enabled/disabled in *parameter 0-07 Auto DC Braking*.

ALARM 88, Option detection
A new option configuration has been detected. Set *parameter 14-89 Option Detection* to *[1] Enable Option Change*, and power cycle the frequency converter to accept the new configuration.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *Parameter 22-60 Broken Belt Function* is set for alarm.

Troubleshooting

- Troubleshoot the system and reset the frequency converter after clearing the fault.

ALARM 99, Locked Rotor
The rotor is blocked. It is only enabled for PM motor control.

Troubleshooting

- Check if the motor shaft is locked.
- Check if the start current triggers the current limit set in *parameter 4-18 Current Limit*.
- Check if it increases the value in *parameter 30-23 Locked Rotor Detection Time [s]*.

ALARM 126, Motor Rotating
During AMA start-up, the motor is rotating. It is only valid for PM motor.

Troubleshooting

- Check if the motor is rotating before starting the AMA.

WARNING 127, Back EMF too High
This warning applies to PM motors only. When the back EMF exceeds 90% x U_{invmax} (overvoltage threshold) and does not drop to a normal level within 5 s, this warning is reported. The warning remains until the back EMF returns to a normal level.

5 Frequency Converter and Motor Applications

5.1 Torque Limit, Current Limit and Unstable Motor Operation

Excessive loading of the frequency converter can result in warning or tripping on torque limit, overcurrent, or inverter overload. Avoid this situation by sizing the frequency converter properly for the application. Ensure that intermittent load conditions cause anticipated operation in torque limit or an occasional trip. Pay attention to the following parameters when matching the frequency converter to the motor for optimum operation.

Parameters 1-20 to *1-25* configure the frequency converter for the connected motor.

These parameters set:

- Motor power.
- Voltage.
- Frequency.
- Current.
- Nominal motor speed.

It is important to set these parameters accurately. Enter the motor data required as listed on the motor nameplate. The frequency converter relies on this information for accurate motor control in dynamic loading applications.

Parameter 1-29 Automatic Motor Adaption (AMA) activates the automatic motor adaptation (AMA) function. When AMA is performed, the frequency converter measures the electrical characteristics of the motor and sets various frequency converter parameters based on the findings. This function sets the following parameter values:

- *Parameter 1-30 Stator Resistance (Rs)*
- *Parameter 1-35 Main Reactance (Xh)*
- *Parameter 1-37 d-axis Inductance (Ld)*

If motor operation is unstable, perform AMA if this operation has not already been performed. AMA can only be performed on single-motor applications within the programming range of the frequency converter. Refer to the *operating guide/quick guide* for more information on this function.

Set *parameter 1-30 Stator Resistance (Rs)* and *parameter 1-35 Main Reactance (Xh)* parameters for the AMA function. Use factory default values, or values that are supplied by the motor manufacturer.

NOTICE

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

5.1.1 Overvoltage Trips

Overvoltage trip occurs when the DC-bus voltage reaches its overvoltage limit (see *chapter 1.9.1 Short Circuit and Overcurrent Trips*). Before tripping, the frequency converter shows an overvoltage warning. Mostly, fast deceleration ramps regarding load inertia causes an overvoltage condition. 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. The motor then becomes a generator and starts returning energy to the frequency converter. This action is called regeneration. Regeneration occurs when the speed of the load is greater than the commanded speed. The diodes in the IGBT modules rectify this return and raise the DC-bus voltage. If the returned voltage is too high, the frequency converter trips.

Avoiding overvoltage trip

- To extend the deceleration time, reduce the deceleration rate. Normally, the frequency converter can only decelerate the load slightly faster than it would take for the load to coast to a stop naturally.
- Allow the overvoltage control function (*parameter 2-17 Over-voltage Control*) to control the deceleration ramp. When enabled, the overvoltage control function regulates deceleration at a rate that maintains the DC-bus voltage at an acceptable level.

NOTICE

Overvoltage control does not correct unrealistic ramp rates. If the DC-bus voltage exceeds a certain voltage, the overvoltage control increases the frequency.

For example, the deceleration ramp has to be 100 s due to the inertia, and the ramp rate is set at 3 s. Overvoltage control initially engages, then disengages and allows the frequency converter to trip. This action is purposely done so the operation is not misinterpreted.

- Use an AC brake, which increases the loss in motor and reduces the DC-bus voltage.
- Use a brake resistor as this is the most efficient way to handle overvoltage issues. Refer to the *operating guide/quick guide* and the *design guide* for more details.

5.1.2 Mains Phase Loss Trips

The frequency converter 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, and can cause overheating in the DC bus capacitors and the DC coil. If the ripple voltage on the DC bus is unchecked, the lifetime of the capacitors is reduced drastically.

When the input voltage becomes unbalanced or a phase disappears completely, the ripple voltage increases. This increase causes the frequency converter to trip and issue *Alarm 4, Mains Phase Loss*. In addition to missing phase voltage, a line disturbance or imbalance can cause an increased bus ripple.

Possible sources of disturbance

- Line notching.
- Defective transformers.
- Other loads that affect the form factor of the AC waveform.

Mains imbalances that exceed 3% cause sufficient DC bus ripple to initiate a trip. Other causes of increased ripple voltage on the DC bus include:

- Output disturbance.
- Missing or lower than normal output voltage on 1 phase.

Checks
When a mains imbalance trip occurs, check both the input and output voltage of the frequency converter.
Severe imbalance of supply voltage or phase loss is detectable with a voltmeter. View line disturbances through an oscilloscope.

Conduct tests for:

- Input imbalance of supply voltage.
- Input waveform.
- Output imbalance of supply voltage.

Refer to *chapter 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. Typically, the frequency converter does not respond to a given command. To obtain an output, provide these basic commands to the frequency converter:

- Start Command: To execute.
- Reference or Speed Command: To identify the speed of execution.

The frequency converters are designed to accept various signals. First determine which of these signals the frequency converter is receiving:

- Digital inputs (18, 19, 27, 29, 32, 33).
- Analog outputs (42).
- 10 V output.
- Analog inputs (53, 54).
- Serial communication bus (68, 69).

The presence of a correct reading indicates that the microprocessor of the frequency converter has detected the desired signal. See *chapter 3.2 Frequency Converter Inputs and Outputs*.

This data can also be read in parameter group *16-6* Inputs & Outputs*.

If there is no correct indication, check if the signal is present at the input terminals of the frequency converter. Use a voltmeter or oscilloscope in accordance with *chapter 6.3.11 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 operation of the frequency converter can be a result of improper programming of the frequency converter parameters.

The 3 areas where programming errors can affect frequency converter and motor operation are:

- Motor settings.
- References and limits.
- I/O configuration.

Refer to *chapter 3.2 Frequency Converter Inputs and Outputs*.

Set up the frequency converter correctly for the motor or motors connected to it. *Parameter 1-20 Motor Power [kW] – parameter 1-25 Motor Nominal Speed* must have data from the motor nameplate entered into the frequency converter. This data enables the frequency converter processor to match the frequency converter to the power characteristics of the motor. The most common result of inaccurate motor data is that the motor draws higher than normal amounts of current to perform the task. In such cases, setting the correct values to these parameters and performing the AMA function usually solves the problem.

Any references or limits set incorrectly result in poor frequency converter performance. For instance, if maximum reference is set too low, the motor is unable to reach full speed. Set these parameters according to the requirements of the particular installation. References are set in *parameter group 3-0* Reference/Ramps*.

Incorrectly set I/O configuration usually results in the frequency converter not responding to the function as commanded. Remember that for every control terminal input or output, there are corresponding parameter settings. These settings determine how the frequency converter responds to an input signal or the type of signal present at that output. Utilizing an I/O function involves a 2-step process. First, wire the I/O terminal properly, and then set the corresponding parameter. Control terminals are programmed in *parameter groups 5-0* Digital I/O Mode* and *6-0* Analog I/O Mode*.

5.1.5 Motor Load Problems

The motor or motor wiring can develop a phase-to-phase or phase-to-ground short circuit resulting in an alarm indication. Check whether the problem is in the motor wiring or the motor itself.

A motor with unbalanced or asymmetrical impedances on all 3 phases can result in rough operation or unbalanced output currents. For measurements, use a clamp-on style ammeter to determine whether the current is balanced on the 3 output phases. Refer to *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test*.

Usually, a current limit warning indicates an incorrect mechanical load. If possible, disconnect the motor from the load to determine if the load is incorrect.

Often, the indications of motor problems are similar to the problems of a defective frequency converter. To determine whether the problem is with the frequency converter, disconnect the motor from the frequency converter motor terminals. Perform the test in *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test*. If the 3 voltage measurements are balanced, the frequency converter functions correctly.

If the voltage measurements are not balanced, the frequency converter malfunctions. Typically, 1 or more output IGBTs do not function correctly. This problem can be a result of a defective IGBT or gate signal.

5.2 Internal Frequency Converter Problems

5.2.1 Overtemperature Faults

If an overtemperature indication is displayed, determine whether this condition actually exists within the frequency converter or whether the thermal sensor is defective.

5.2.2 Current Sensor Faults

When a current sensor fails, an overcurrent alarm is sometimes issued. The alarm cannot be reset, even with the motor cables disconnected. However, the frequency converter experiences frequent false ground fault trips. This is due to the DC offset failure mode of the sensors.

The simplest method of determining whether a current sensor is defective is to disconnect the motor from the frequency converter. Then observe the current in the frequency converter display. With the motor disconnected, the current should be 0. A frequency converter with a defective current sensor indicates some current flow. An indication of a fraction of 1 amp is tolerable. However, that value should be considerably less than 1 amp. If the display shows more than 1 amp of current, there is a defective current sensor.

5.2.3 Signal and Power Wiring Considerations for Electromagnetic Compatibility

This section provides an overview of general signal and power wiring considerations when addressing the electromagnetic compatibility (EMC) concerns for typical commercial and industrial equipment. Only certain high-frequency phenomena (such as RF emissions, RF immunity) are discussed. Low-frequency phenomena (such as harmonics, mains voltage imbalance, notching) are not covered.

NOTICE

Special installations or compliance to the European CE EMC directives require strict adherence to relevant standards and are not discussed here.

5.2.4 Effects of EMI

While electromagnetic interference-related (EMI) disturbances to the operation of the frequency converter are uncommon, the following detrimental EMI effects sometimes occur:

- Motor speed fluctuations.
- Serial communication transmission errors.
- Frequency converter CPU exception faults.
- Unexplained frequency converter trips.

A 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 include the following:

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

5.2.5 Sources of EMI

Modern frequency converters (see *Illustration 5.1*) utilize IGBTs to provide an efficient and cost-effective way to create the pulse-width modulated (PWM) output waveform necessary for accurate motor control. These devices rapidly switch the fixed DC-bus voltage creating a variable frequency and variable voltage PWM waveform. This high rate of voltage change (dU/dt) is the primary source of the frequency converter generated EMI.

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

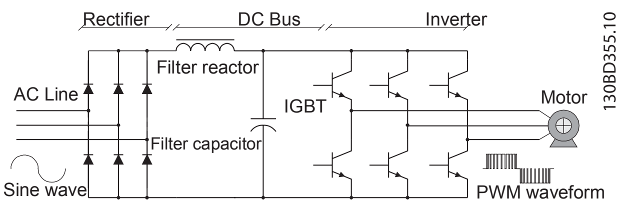
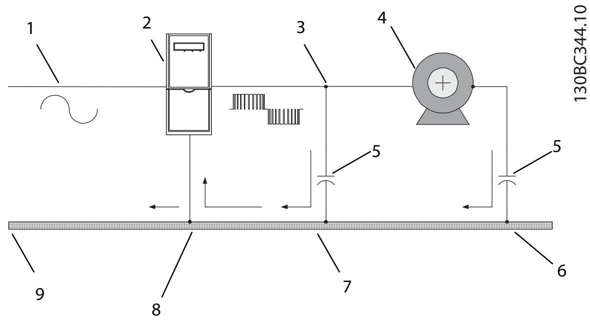


Illustration 5.1 Frequency Converter Functionality Diagram

5.2.6 EMI Propagation

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



1	AC line
2	Frequency converter
3	Motor cable
4	Motor
5	Stray capacitance
6	Signal wiring
7	Signal wiring
8	Signal wiring
9	Ground

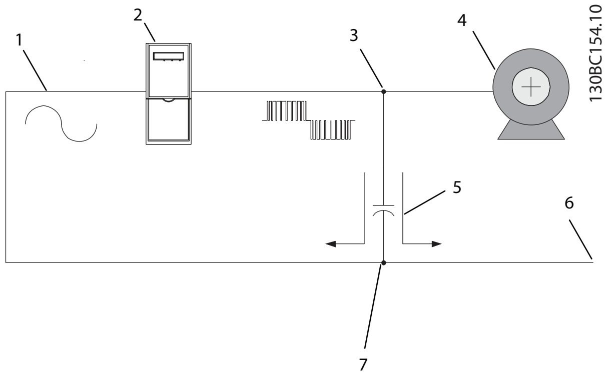
Illustration 5.2 Ground Currents

NOTICE

Stray capacitance between the motor conductors, equipment ground, and other nearby conductors results in induced high-frequency currents.

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

Theoretically, these currents return to the DC-bus via the ground circuit and a high-frequency (HF) bypass network within the frequency converter itself. However, imperfections in the frequency converter grounding or the equipment ground system can cause some of the currents to travel out to the power network.



1	AC line
2	Frequency converter
3	Motor cable
4	Motor
5	Stray capacitance
6	AC line, to BMS
7	Signal wiring

Illustration 5.3 Signal Conductor Currents

NOTICE

Unprotected or poorly routed signal conductors located close to or in parallel to motor and mains conductors are susceptible to EMI.

Signal conductors are especially vulnerable when they run in parallel to the power conductors for any distance. EMI coupled into these conductors can affect either the frequency converter or the interconnected control device. See *Illustration 5.3*.

While these currents tend to travel back to the frequency converter, imperfections in the system cause some current to flow in undesirable paths. This flow exposes other locations to the EMI.

NOTICE

High-frequency currents can be coupled into the mains supplying the frequency converter, when the mains conductors are located close to the motor cables.

5.2.7 Preventive Measures

EMI-related problems are more effectively alleviated during the design and installation phases rather than after the system is in service. Many of the listed steps can be implemented at a relatively low cost compared to the cost of identifying and fixing the problem later.

Grounding

Ground the frequency converter and motor solidly to the equipment frame. A good high-frequency connection is necessary to allow the high-frequency currents to return to the frequency converter instead of traveling through the power network. The ground connection is ineffective if it has high impedance to high-frequency currents. Therefore, it must be as short and direct as possible. Flat-braided cable has lower high-frequency impedance than round cable. Mounting the frequency converter or motor onto a unpainted surface creates an effective ground connection. In addition, running a separate ground conductor directly between the frequency converter and the running motor is recommended.

Cable routing

Avoid parallel routing of:

- Motor wiring.
- Mains wiring.
- Signal wiring.

If parallel routing is unavoidable, preferably maintain a separation of 200 mm (6–8 in) between the cables or separate them with a grounded conductive partition. Avoid routing cables through free air.

Signal cable selection

Single conductor 600 V rated wires provide the least protection from EMI. Twisted pair and shielded twisted-pair cables are available, which are designed to minimize the effects of EMI. While unshielded twisted-pair cables are often adequate, shielded twisted-pair cables provide another degree of protection. Terminate the signal cable shield in a manner that is appropriate for the connected equipment. Avoid terminating the shield through a pigtail connection as it increases the high-frequency impedance and spoils the effectiveness of the shield.

A simple alternative is to twist the existing single conductors to provide a balanced capacitive and inductive coupling. This operation cancels differential mode interference. While not as effective as true twisted-pair cable, it can be implemented in the field using the materials at hand.

Motor cable selection
Motor conductors have the greatest influence on the EMI characteristics of the system. These conductors must receive the highest attention whenever EMI is a problem. Single conductor wires provide the least protection from EMI emissions. Often, if these conductors are routed separately from the signal and mains wiring, no further consideration is needed. If the conductors are routed close to other susceptible conductors, or if the system is suspected to cause EMI problems, consider alternate motor wiring methods.

Installing shielded power cable is the most effective way to alleviate EMI problems. The cable shield forces the noise current to flow directly back to the frequency converter. Thus, the noise current cannot get back into the power network or take other undesirable high-frequency paths. Unlike most signal wiring, the shielding on the motor cable must be terminated at both ends.

If a shielded motor cable is not available, then 3-phase conductors along with ground in a conduit provide some degree of protection. This technique is not as effective as shielded cable due to the unavoidable contact of the conduit with various points within the equipment.

Serial communications cable selection
There are various serial communication interfaces and protocols on the market. Each of these interfaces recommends 1 or more specific types of twisted pair, shielded twisted pair, or proprietary cables. Refer to the manufacturer’s documentation when selecting these cables. Similar recommendations apply to serial communication cables as to other signal cables. Using twisted-pair cables and routing them away from power conductors is encouraged. While shielded cable provides extra EMI protection, the shield capacitance may reduce the maximum allowable cable length at high data rates.

6 Test Procedures

6.1 Introduction

WARNING

PERSONAL INJURY RISK

Touching electrical parts of the frequency converter may be fatal even after equipment has been disconnected from AC power.

- **Before touching any potentially live parts of the frequency converter, refer to *chapter 2 Safety*.**
- **Wait for the frequency converter components to discharge fully. See *Table 2.1* or the label on the frequency converter for specific discharge time.**

This section contains detailed procedures for testing frequency converters. Previous sections of this guide provide symptoms, alarms, and other conditions which require more test procedures to diagnose the frequency converter further. The results of these tests indicate the appropriate repair actions.

Among other things, the frequency converter monitors:
- Input and output signals.
- Motor conditions.
- AC and DC power.

This monitoring function helps stating the source of fault conditions existing outside of the frequency converter.

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 before applying power.

CAUTION

SHOCK AND INJURY HAZARD

All devices and supplies connected to mains are energized at rated voltage. Contact with powered components could result in electrical shock and personal injury.

- **Use extreme caution when conducting tests on a powered frequency converter.**
- **Do not touch energized parts of the frequency converter when connected to mains.**

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

Tools for dynamic test procedures include:
- Digital Volt-Ohm Meter (VOM) capable of reading real RMS.
- Analog volt meter.
- Oscilloscope.
- Current meter.

6.2 Static Test Procedures

6.2.1 Zero Voltage DC-Link Test

1. After power off, wait for discharge of the DC-link before taking the measurement. For duration of discharge time, see *Table 2.1*.
2. Set the multimeter to the DC voltage position.
3. Check the DC-link for remaining charge by measuring the voltage on the DC terminals.
4. Measure from terminal (-DC) to terminal (+DC).

When the voltage reading is 0 V, it is safe to proceed with the static tests.

The purpose of performing static testing is to check for any short circuit of the power components.

For all tests, use a meter capable of testing diodes. Use a digital Volt-Ohm Meter (VOM) set on the diode scale or an analog ohmmeter set on Rx100 scale.

Before making any checks, disconnect all connections for:
- Input.
- Motor.
- Brake resistor.

Ensure that the frequency converter is disconnected from power before performing static tests.

WARNING

SHOCK HAZARD

Disconnection of the input cable while the frequency converter is powered could result in electrical shock causing death or personal injury.

- **Do not disconnect the input cable while the frequency converter is powered.**

6.2.2 Pre-requisite

⚠CAUTION

ELECTROSTATIC DISCHARGE

Failure to follow the ESD regulations can cause personal injury and property damage.

- **Prepare the work area according to the ESD regulations.**
- **Ground ESD mat and wrist strap. Ensure that the ground connection between body, ESD mat, and frequency converter is always present while servicing the frequency converter.**
- **Handle disassembled electronic parts carefully and always protected from ESD.**

- Perform the static test before powering up the fault unit.
- Perform static test after completing the repair and assembly of the frequency converter.
- Connect the frequency converter to the mains only after completion of static tests.
- Complete all necessary precautions for system start-up before applying power to the frequency converter.

6.2.3 Rectifier Circuit Tests

Pay close attention to the polarity of the meter leads to ensure the identification of any faulty component, in case an incorrect reading appears.

Rectifier test part 1

1. Connect the positive (+) meter lead to the positive (+) DC bus terminal on the 6-pole connector.
2. Connect the negative (-) meter lead to terminals L1, L2, L3 in turn on the 3-pole mains connector.

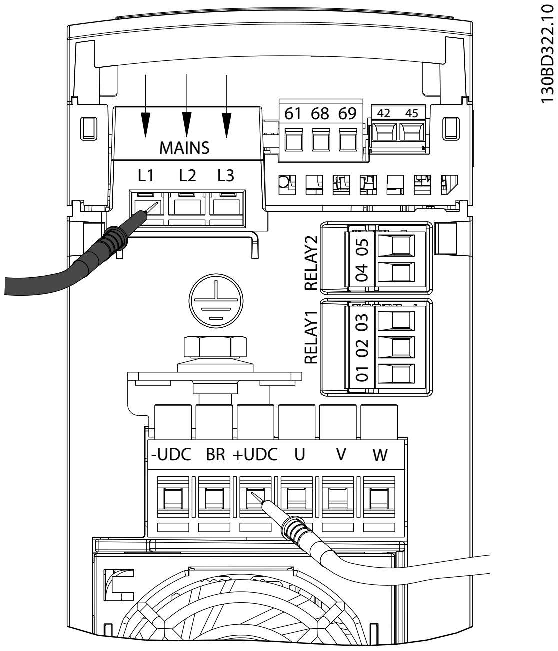


Illustration 6.1 Connecting Meter Leads for Rectifier Test, Part 1, J1-J3

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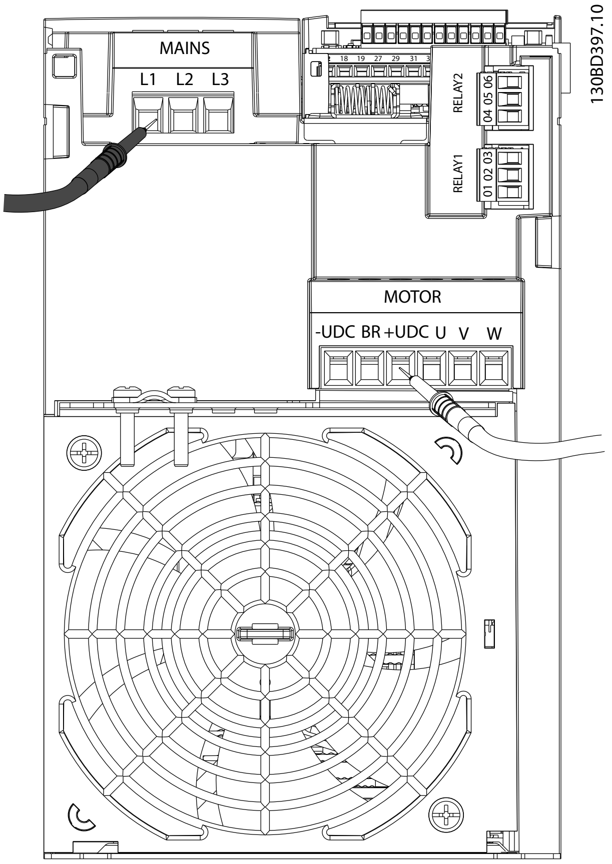

Illustration 6.2 Connecting Meter Leads for Rectifier Test, Part 1, J4-J5

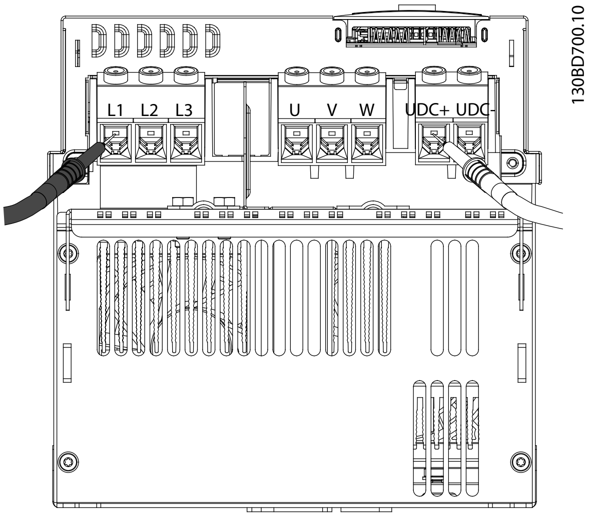

Illustration 6.3 Connecting Meter Leads for Rectifier Test, Part 1, J6

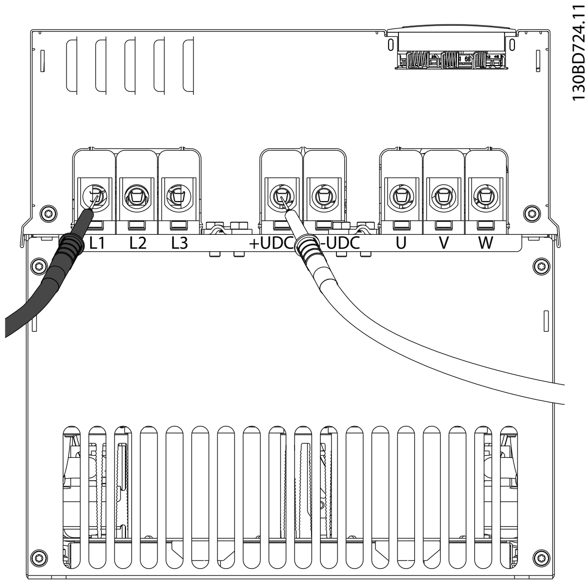

Illustration 6.4 Connecting Meter Leads for Rectifier Test, Part 1, J7

Each reading should show infinity directly in diode measuring mode. In Ω measuring mode, the meter starts at a low value and slowly climbs towards infinity due to capacitance within the frequency converter being charged by the meter.

Rectifier test part 2

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

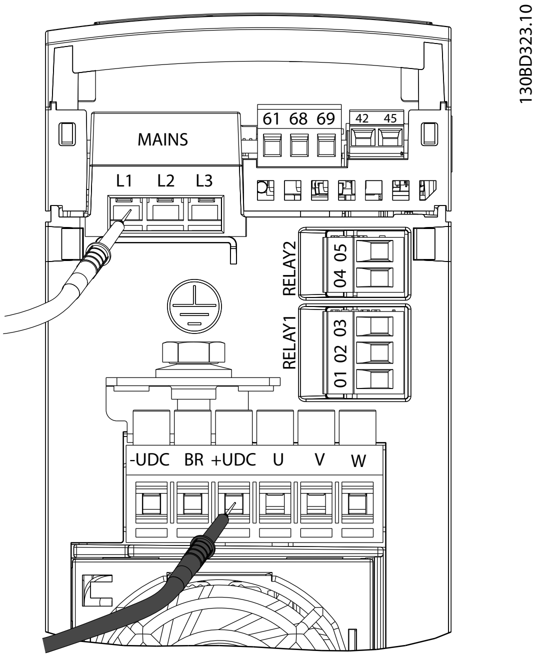

Illustration 6.5 Connecting Meter Leads for Rectifier Test, Part 2, J1-J3

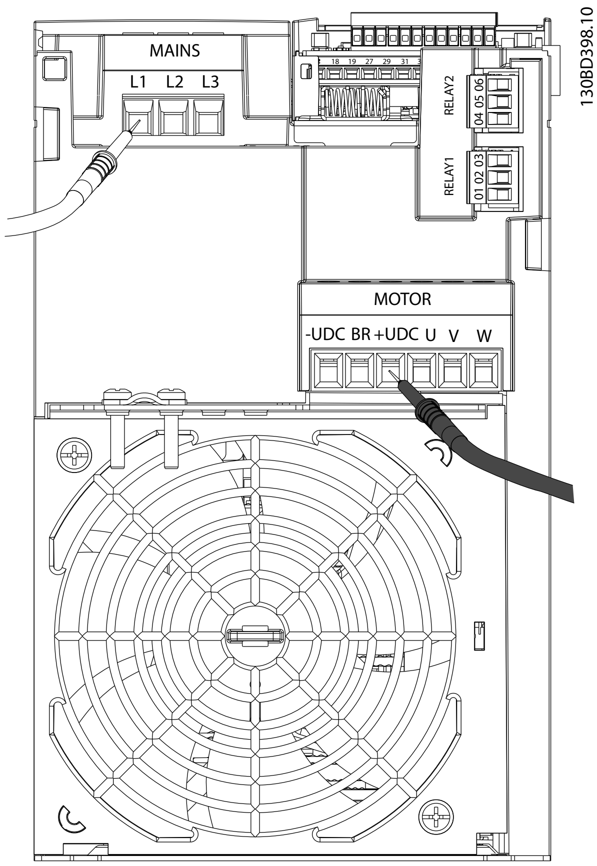

Illustration 6.6 Connecting Meter Leads for Rectifier Test, Part 2, J4-J5

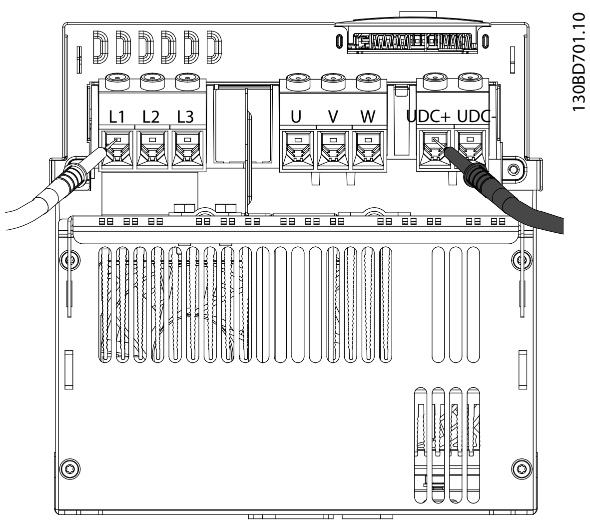

Illustration 6.7 Connecting Meter Leads for Rectifier Test, Part 2, J6

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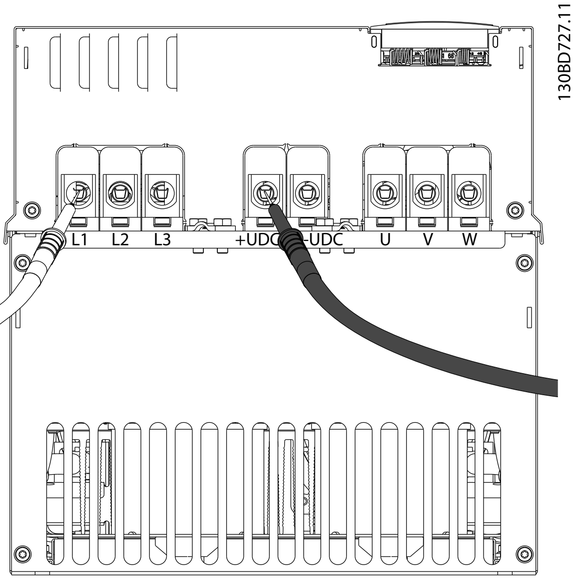

Illustration 6.8 Connecting Meter Leads for Rectifier Test, Part 2, J7

Each reading should show a diode drop.

Rectifier test part 3

5. Connect the positive (+) meter lead to the negative (-) DC bus terminal.
6. Connect the negative (-) meter lead to terminals L1, L2, L3 in turn.

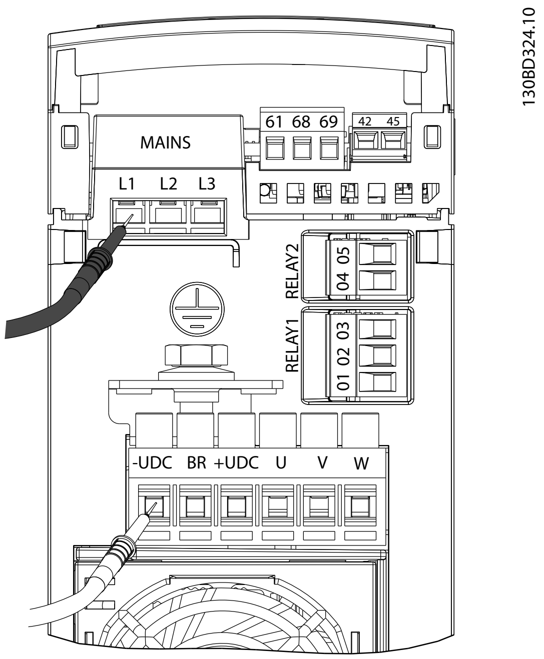

Illustration 6.9 Connecting Meter Leads for Rectifier Test, Part 3, J1-J3

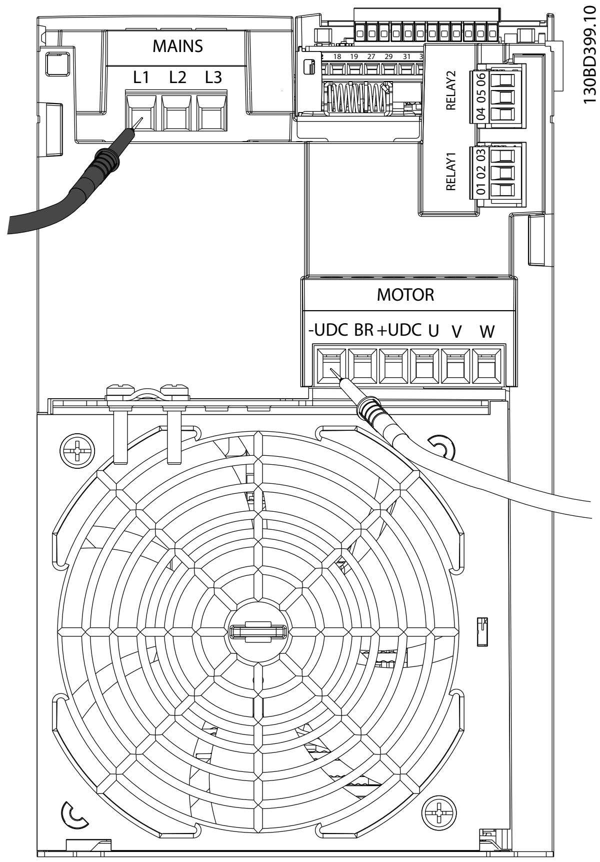

Illustration 6.10 Connecting Meter Leads for Rectifier Test, Part 3, J4-J5

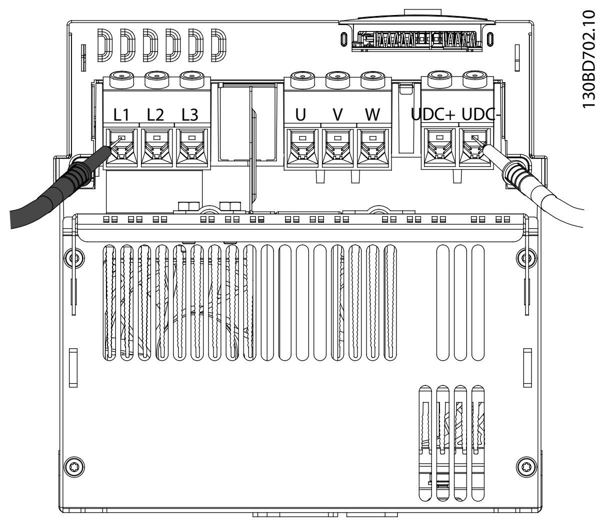

Illustration 6.11 Connecting Meter Leads for Rectifier Test, Part 3, J6

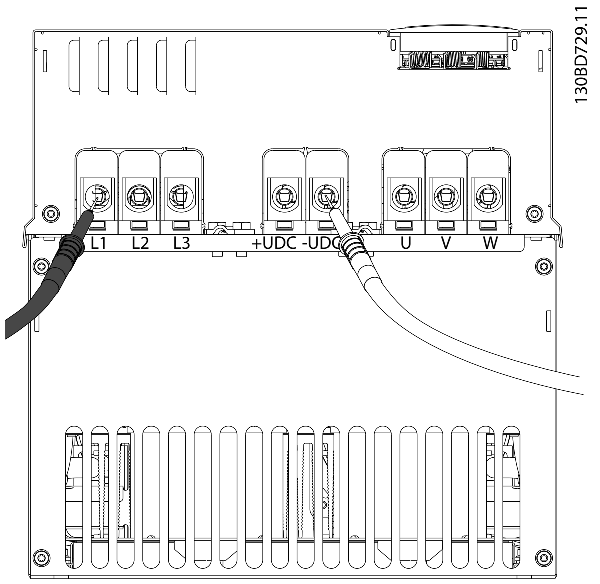

Illustration 6.12 Connecting Meter Leads for Rectifier Test, Part 3, J7

Each reading should show a diode drop.

Rectifier test part 4

7. Reverse the meter leads by connecting the negative (-) meter lead to the negative (-) DC bus terminal.
8. Connect the positive (+) meter lead to terminals L1, L2, L3 in turn.

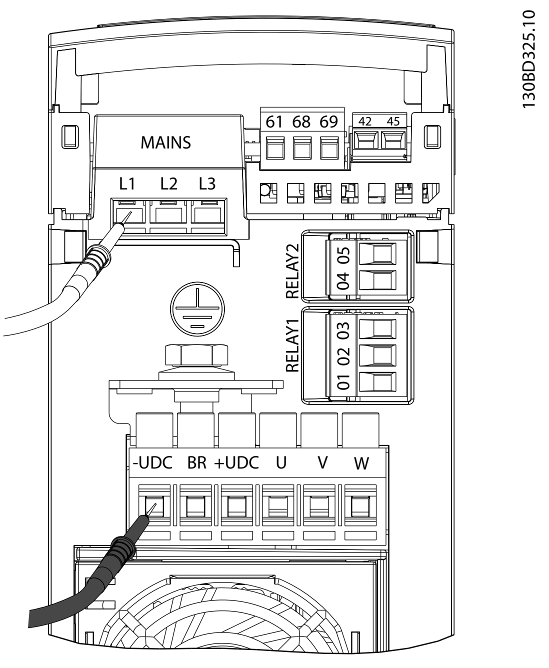

Illustration 6.13 Connecting Meter Leads for Rectifier Test, Part 4, J1-J3

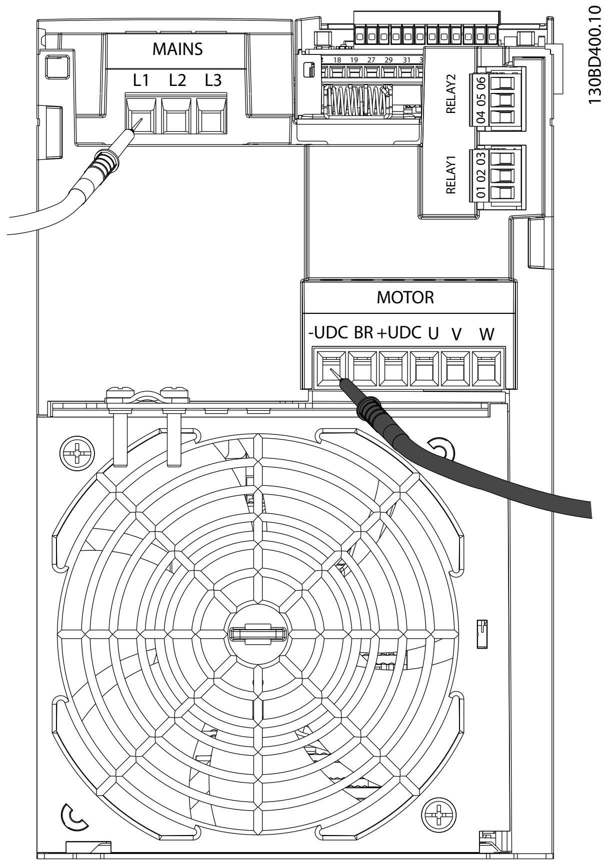

Illustration 6.14 Connecting Meter Leads for Rectifier Test, Part 4, J4-J5

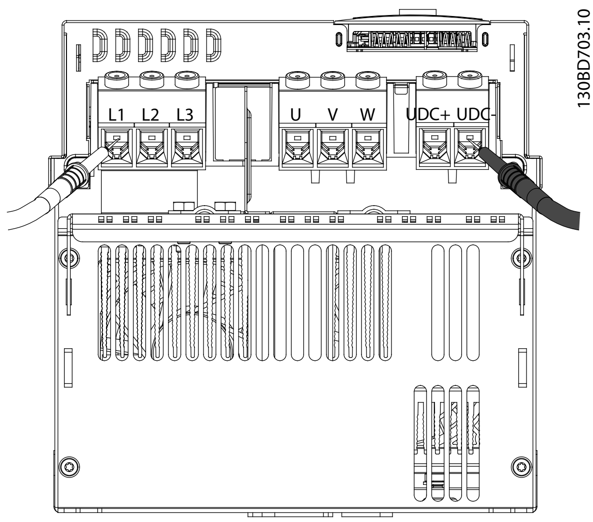

Illustration 6.15 Connecting Meter Leads for Rectifier Test, Part 4, J6

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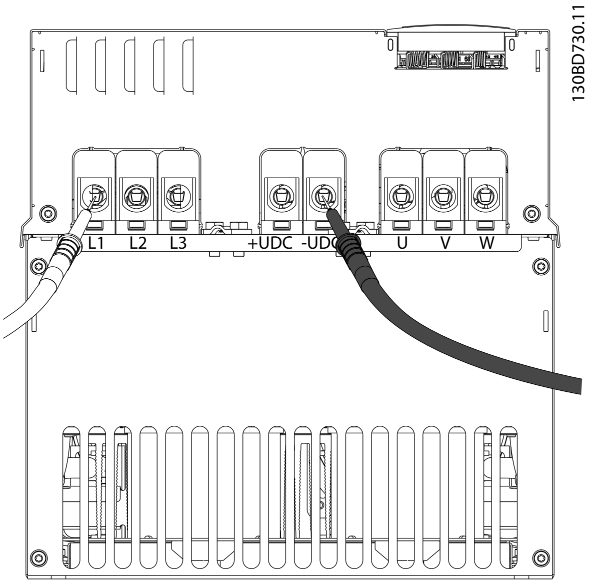


Illustration 6.16 Connecting Meter Leads for Rectifier Test, Part 4, J7

Each reading should show infinity directly in diode measuring mode. In Ω measuring mode, the meter starts at a low value and slowly climbs towards infinity due to capacitance within the frequency converter being charged by the meter.

6.2.4 Inverter Section Tests

Inverter test part I

1. Connect the positive (+) meter lead to the (+) positive DC bus terminal on the 6-pole connector.
2. Connect the negative (–) meter lead to terminals U, V, and W in turn on the 6-pole connector.

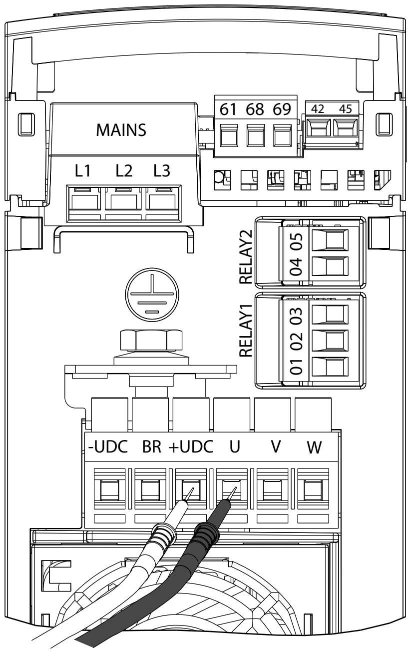


Illustration 6.17 Connecting Meter Leads for Inverter Section Test, Part I, J1-J3

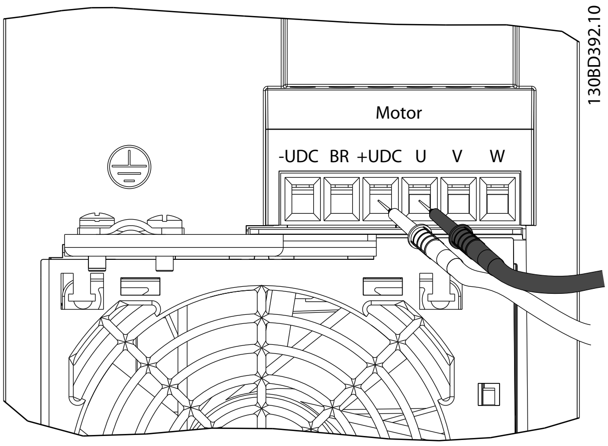


Illustration 6.18 Connecting Meter Leads for Inverter Section Test, Part I, J4-J5

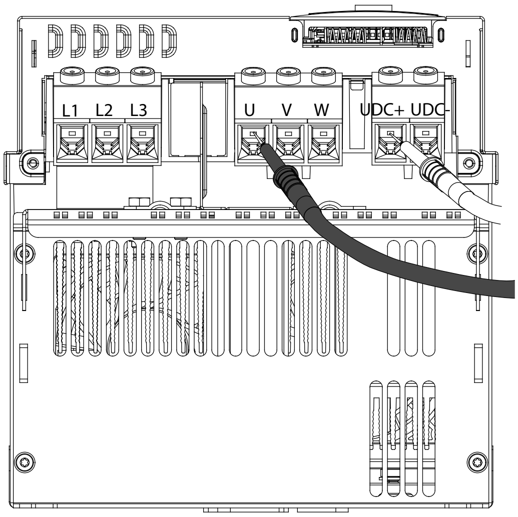


Illustration 6.19 Connecting Meter Leads for Inverter Section Test, Part I, J6

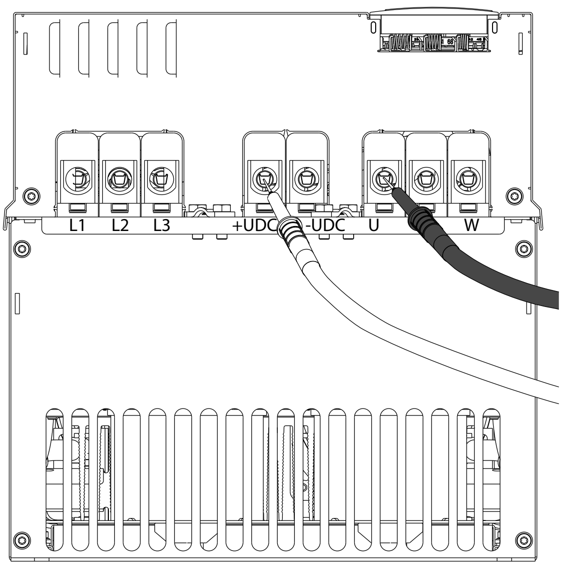


Illustration 6.20 Connecting Meter Leads for Inverter Section Test, Part I, J7

Each reading should show infinity directly in diode measuring mode. In Ω measuring mode, the meter starts at a low value and slowly climbs towards 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 terminal.
2. Connect the positive (+) meter lead to U, V, and W in turn.

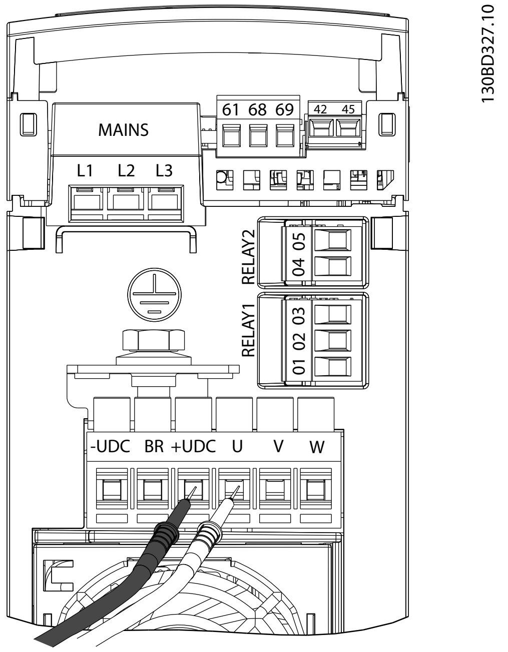


Illustration 6.21 Connecting Meter Leads for Inverter Section Test, Part II, J1-J3

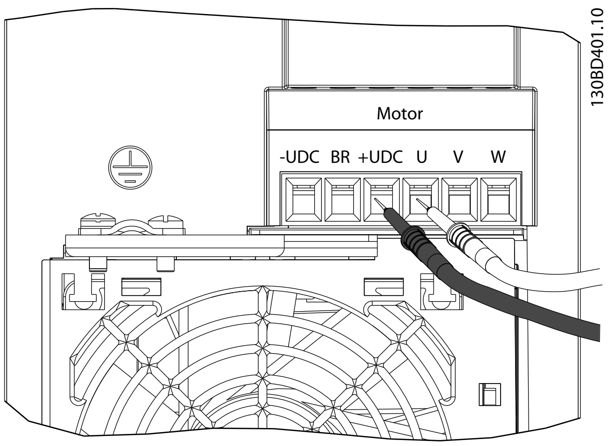


Illustration 6.22 Connecting Meter Leads for Inverter Section Test, Part II, J4-J5

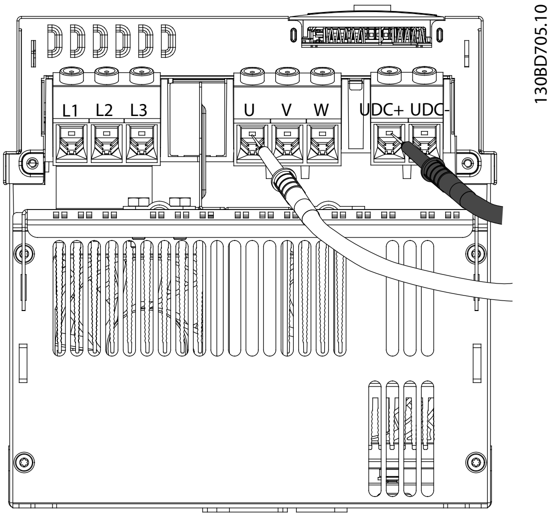


Illustration 6.23 Connecting Meter Leads for Inverter Section Test, Part II, J6

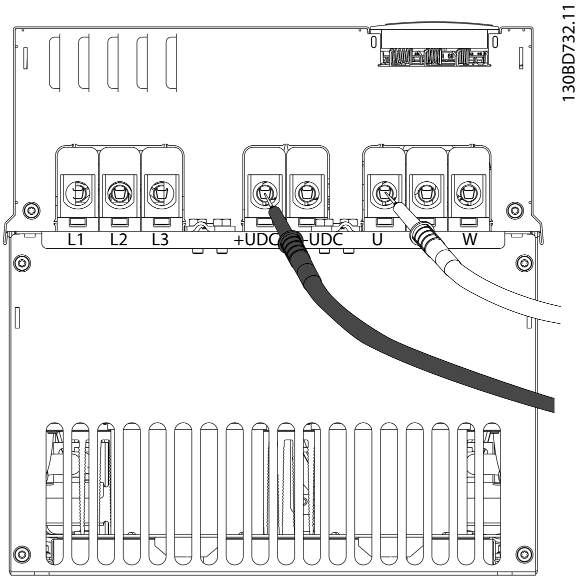


Illustration 6.24 Connecting Meter Leads for Inverter Section Test, Part II, J7

Each reading should show a diode drop.

Inverter test part III

1. Connect the positive (+) meter lead to the negative (-) DC bus terminal.
2. Connect the negative (–) meter lead to terminals U, V, and W in turn.

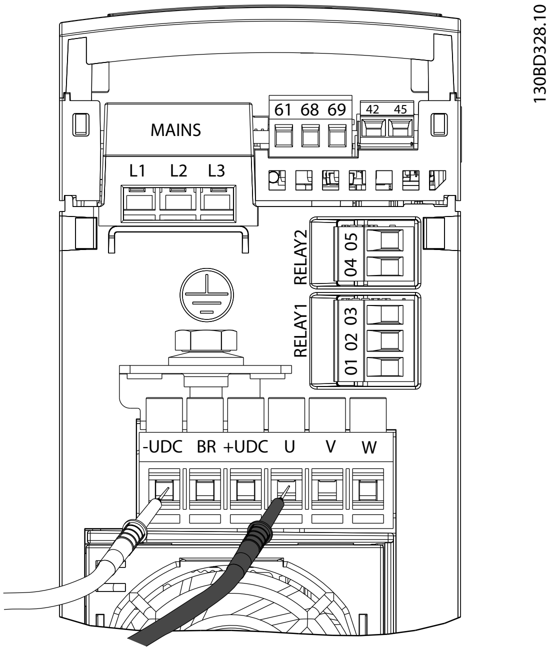


Illustration 6.25 Connecting Meter Leads for Inverter Section Test, Part III, J1-J3

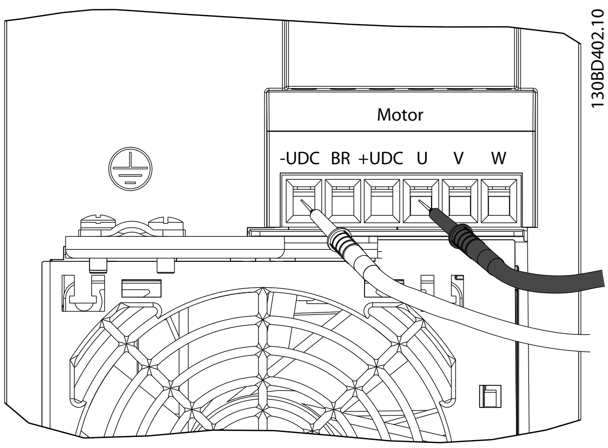


Illustration 6.26 Connecting Meter Leads for Inverter Section Test, Part III, J4-J5

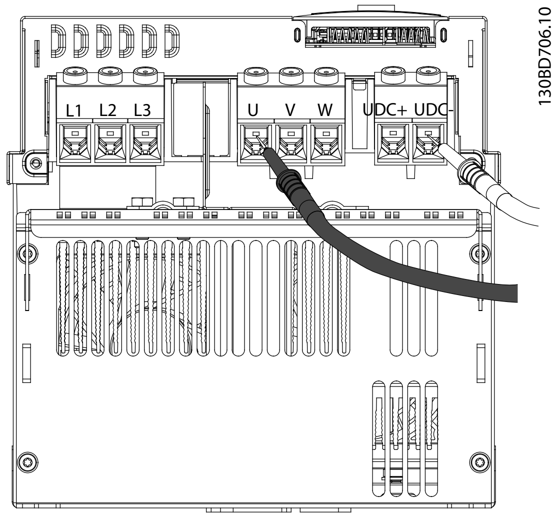


Illustration 6.27 Connecting Meter Leads for Inverter Section Test, Part III, J6

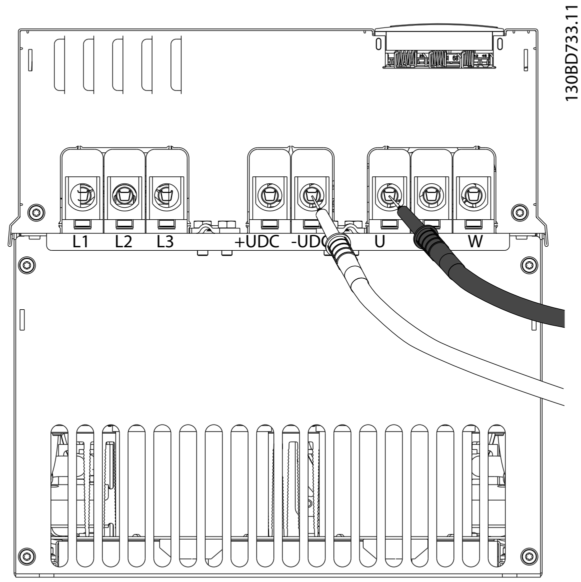


Illustration 6.28 Connecting Meter Leads for Inverter Section Test, Part III, J7

Each reading should show a diode drop.

6

Inverter test part IV

1. Reverse the meter leads by connecting the negative (–) meter lead to the negative (-) DC bus terminal.
2. Connect the positive (+) meter lead to terminals U, V, and W in turn.

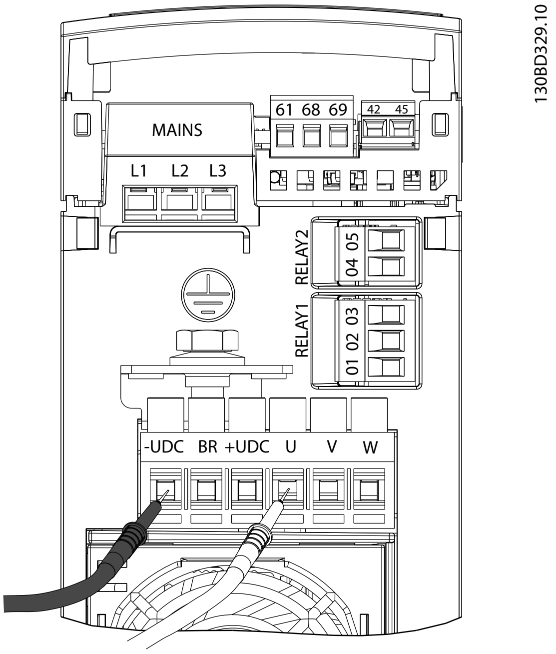


Illustration 6.29 Connecting Meter Leads for Inverter Section Test, Part IV, J1-J3

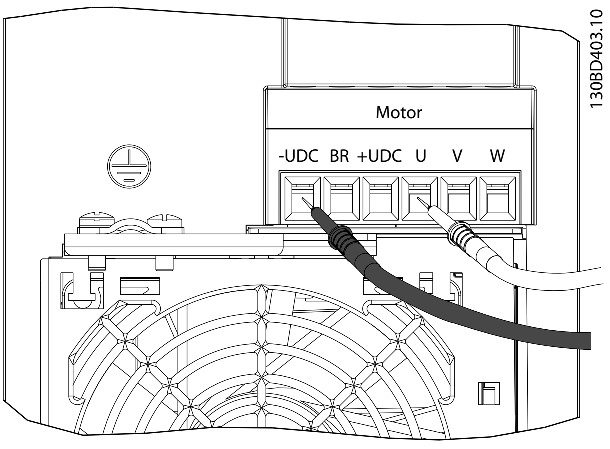


Illustration 6.30 Connecting Meter Leads for Inverter Section Test, Part IV, J4-J5

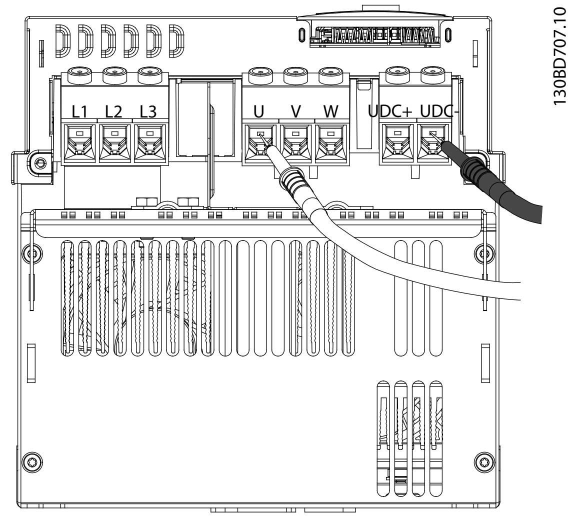


Illustration 6.31 Connecting Meter Leads for Inverter Section Test, Part IV, J6

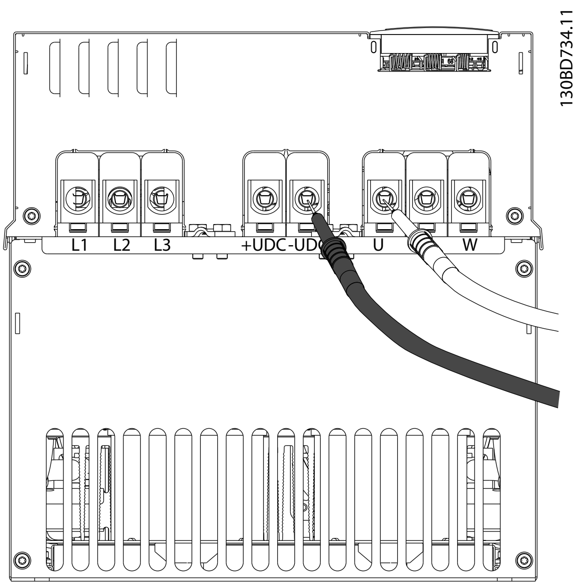


Illustration 6.32 Connecting Meter Leads for Inverter Section Test, Part IV, J7

Each reading should show infinity directly in diode measuring mode. In Ω measuring mode, the meter starts at a low value and slowly climbs towards infinity due to capacitance within the frequency converter being charged by the meter.

6.3 Dynamic Test Procedures

6.3.1 Safety Warnings

See *chapter 2 Safety* for general safety instructions.

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

⚠CAUTION

SHOCK AND INJURY HAZARD

For dynamic test procedures, mains input power is required and all devices and supplies connected to mains are energized at rated voltage. Contact with powered components could result in electrical shock and personal injury.

- **Do not touch energized parts of the frequency converter when connected to mains.**

⚠CAUTION

SHOCK HAZARD

Disconnection of input cabling with mains power applied can result in personal injury. Contact with powered components could result in electrical shock and personal injury.

- **When power is applied, do not disconnect input cabling.**

6.3.2 Access to Terminals U, V, and W for Dynamic Tests

For dynamic tests, access terminals U, V, and W externally at the base of the frequency converter.

6.3.3 Zero Voltage DC-Link Test

1. After power off, wait for discharge of DC-link before taking the measurement. For duration of discharge time, see *Table 2.1*.
2. Set the multimeter to the DC voltage position.
3. Check the DC-link for remaining charge by measuring the voltage on the DC terminals.
4. Measure from terminal (UDC-) to terminal (UDC+).

When the voltage reading is 0 V, it is safe to proceed with the dynamic tests.

6.3.4 Dynamic Test on IGBT

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

Preparation

1. Close the cover on the frequency converter.
2. Disconnect the motor from the frequency converter.
3. Ensure that the frequency converter is powered up.
4. Program the frequency converter to approximately 50 Hz on start.
5. Set the multimeter to 1000 V AC.

Procedure for dynamic test on the IGBT

NOTICE

Short-circuiting the U, V, W terminals, or any terminal of U, V, W, UDC+, UDC- to PE, can damage the frequency converter permanently. Do not touch more than 1 terminal at a time with the measuring probes.

1. Connect the positive terminal of the multimeter lead to the U connector, and connect the negative terminal to the V terminal.
2. Connect the positive terminal of the multimeter lead to the U connector, and connect the negative terminal to the W terminal.
3. Connect the positive terminal of the multimeter lead to the V connector, and connect the negative terminal to the W terminal.

The meter reading is 450 V ±25 V when performing the dynamic test at 400 V mains. With PM motors the reading may differ. Contact hotline for help.

The reading must be within ±1.5%.

6.3.5 No Display Test (Display is Optional)

A frequency converter with no display in the LCP can be the result of several causes. First, verify that there is no display. A single character in the display or a dot in the upper corner of the display indicates a communication error. Check that all option cards are properly installed. When this condition occurs, the green power-on LED is illuminated.

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

First test for proper input voltage.

6.3.6 Input Voltage Test

1. Apply power to frequency converter.
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 380–500 V frequency converters, all measurements must be within the range of 342–528 V AC. Readings of less than 342 V AC indicate problems with the input mains voltage.

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 according to an IEC specification.

$$\text{Imbalance}=0.67 \times (V_{max}-V_{min})/V_{avg}$$

For example, if 3-phase readings were taken and the results were 500 V AC, 478.5 V AC, and 478.5 V AC; then 500 V AC is V_{max}, 478.5 V AC is V_{min}, and 485.7 V AC is V_{avg}, resulting in an imbalance of 3%.

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

NOTICE

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

An incorrect reading here requires further investigation of the main supply.

Check for:

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

If this test was successful, check for voltage to the control card.

6.3.7 Basic Control Card Voltage Test

1. Measure the control voltage at terminal 12 regarding terminal 20.
   The meter must read 21–27 V DC.

An incorrect reading here could indicate that a fault in the customer connections loads down the supply. Disconnect control wiring and repeat the test. If this test is successful, then continue. Remember to check the customer connections. If still unsuccessful, replace the unit.

2. Measure the 10 V DC control voltage at terminal 50 regarding terminal 55. The meter must read between 9.2 and 11.2 V DC.

An incorrect reading here could indicate that a fault in the customer connections loads down the supply. Disconnect control wiring and repeat the test. If this test is successful, then continue. Remember to check the customer connections. If still unsuccessful, replace the unit.

6.3.8 Input Imbalance of Supply Voltage Test

Theoretically, the current drawn on all 3 input phases must be equal. Some imbalance may be seen, however, due to variations in the phase-to-phase input voltage, and single-phase loads within the frequency converter.

A current measurement of each phase reveals the balanced condition of the line. To obtain an accurate reading, the frequency converter must run at its rated load, or at a load of not less than 40%.

1. Perform the input voltage test before checking the current, in accordance with procedure. Voltage imbalances automatically result in a corresponding current imbalance.
2. Apply power to the frequency converter and place it in run.
3. Using a clamp-on ammeter (analog preferred), read the current on each of 3 input lines at L1 (R), L2 (S), and L3 (T).
   Typically, the current should not vary from phase-to-phase by more than 5%. If a greater current variation exists, it indicates a possible problem with the mains supply to the frequency converter, or a problem within the frequency converter. One way to determine if the mains supply is at fault is to swap 2 of the incoming phases. This assumes that 2 phases read 1 current while the 3rd deviates by more than 5%. If all 3 phases are different from one another, swap the phase with the highest current with the phase with the lowest current:
   - 3a Remove power to frequency converter.
   - 3b Swap the phase that appears to be incorrect with 1 of the other 2 phases.
   - 3c Reapply power to the frequency converter and place it in run.
   - 3d Repeat the current measurements.

If the imbalance of supply voltage moves with swapping the leads, the mains supply is suspect. Otherwise, it may indicate a problem with the gating of the rectifiers.

6.3.9 Input Waveform Test

Testing the current waveform on the input of the frequency converter can help troubleshooting mains phase loss conditions or suspected problems with the diodes in the rectifier. Phase loss caused by the mains supply can be easily detected. If a diode in the rectifier becomes defective, the frequency converter responds with a phase loss.

The following measurements require an oscilloscope with voltage and current probes.

Under normal operating conditions, the waveform of a single phase of input AC voltage to the frequency converter appears as in *Illustration 6.33*.

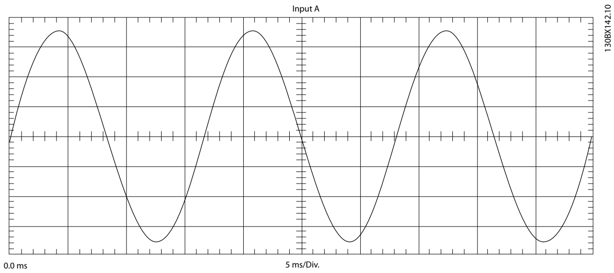


Illustration 6.33 Normal AC Input Voltage Waveform

The waveform shown in *Illustration 6.34* shows the input current waveform for the same phase as shown in *Illustration 6.33* while the frequency converter is running at 40% load. The 2 positive and 2 negative jumps are typical of any 6-diode bridge.

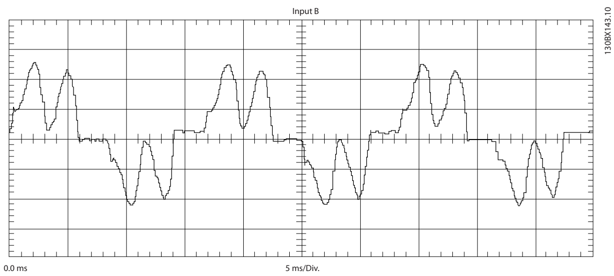


Illustration 6.34 AC Input Current Waveform with Diode Bridge

With a phase loss, the current waveform of the remaining phases would take on the appearance shown in *Illustration 6.35*.

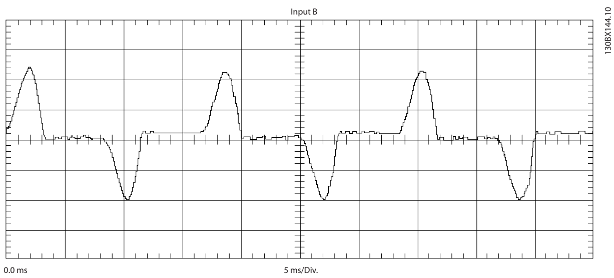


Illustration 6.35 Input Current Waveform with Phase Loss

Always verify the condition of the input voltage waveform before forming a conclusion. The current waveform follows the voltage waveform. If the voltage waveform is incorrect, proceed to investigate the reason for the AC supply problem. If the voltage waveform on all 3 phases is correct, but the current waveform is not, the input rectifier circuit in the frequency converter is suspect. Perform the static soft charge and rectifier tests and also the dynamic diode module test.

6.3.10 Output Imbalance of Motor Supply Voltage Test

Check the balance of the output voltage and current to measure 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, it indicates that 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 a defective motor overload.

If the output current and the voltage are unbalanced, it indicates that the frequency converter is not working properly. It could be the result of a defective power card or an improper connection of the output circuitry.

NOTICE

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

Perform the initial test with the motor connected and running its load.

If suspect readings are recorded, then:

- Stop the motor and wait until the motor has stopped rotating.
- Set the frequency converter to coast.
- Disconnect the motor cables to isolate the problem further.

Then:

1. Using a voltmeter, measure AC output voltage at frequency converter motor terminals U, V, and W. Measure phase-to-phase checking U to V, then U to W, and then V to W.
   All 3 readings must 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 V/Hz ratio is relatively linear (except in VT mode). For example, if the rated motor frequency is 60 Hz, the voltage should be approximately equal to the applied mains voltage. At 30 Hz, it is about half of the applied mains voltage for any other speed selected. The exact voltage reading is less important than balance between phases.
2. Stop the frequency converter and disconnect mains.
3. Reconnect the motor to the frequency converter.
4. Connect mains to the frequency converter, and start the frequency converter.
5. Monitor current on the 3 output phases at the motor terminals U, V, and W, using the clamp-on 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 must be balanced from phase to phase, and no phase must be more than 2–3% different from another. If these tests are successful, the frequency converter is operating normally.

6. If the imbalance is greater than described previously, disconnect the motor cables and repeat the voltage balance test.
7. Stop the motor and disconnect mains from the frequency converter.

Since the current follows the voltage, it is necessary to differentiate between a load problem and a frequency converter problem. When a voltage imbalance in the output is detected with the motor disconnected, the inverter is faulty. Exchange the frequency converter.

6.3.11 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 *parameter 16-60 Digital Input* to *parameter 16-64 Analog input 54*.

Digital inputs

From right side to left, bits 0, 1, 2, 3, 4, 5, and 10 represent digital inputs 33, 32, 29, 27, 19, 18, and 31.

If the required signal is not present in the display, the problem is 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.

Verify that the control voltage supply is correct as follows.

1. Use a voltmeter for measuring voltage at control card terminal 12 with reference to terminal 20. The meter should read 21–27 V DC.

If the 24 V supply voltage is not present, test the control card as described in *chapter 6.3.7 Basic 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 wanted terminal must 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 that no signal is present.

Analog inputs

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

If the required signal is not present in the display, the problem is 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 that the reference voltage supply is correct as follows.

1. Use a voltmeter for measuring the voltage at control card terminal 50 with reference to terminal 55. The meter must read 9.2–11.2 V DC.

If the 10 V supply voltage is not present, conduct *chapter 6.3.7 Basic Control Card Voltage Test* earlier in this section.

If 10 V 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 wanted terminal 53 or 54.

Analog input terminals 53 and 54 require a DC voltage between 0 and +10 V DC to match the analog signal sent to the frequency converter. A reading of 0.9–4.8 V DC corresponds to a 4–20 mA signal.

NOTICE

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

6

6

6.4 Initial Start-up or After-repair Tests

Perform these tests under the following conditions:

- Starting a frequency converter for the first time.
- Approaching a frequency converter that is suspected of being faulty.
- After repair of the frequency converter.

Following this procedure ensures that all circuitry in the frequency converter is functioning properly before putting it into operation.

1. Perform visual inspection procedures as described in *Table 4.1*.
2. Perform static test procedures to ensure that the frequency converter is safe to start.
3. Disconnect motor cables from output terminals (U, V, W) of the frequency converter.
4. Apply AC power to the frequency converter.
5. Give the frequency converter a run command and slowly increase reference (speed command) to approximately 40 Hz.
6. Use an analog voltmeter or a DVM capable of measuring true RMS to measure phase-to-phase output voltage on all 3 phases: U to V, U to W, V to W. All voltages must be balanced within 8 V. If measuring unbalanced voltage, refer to *chapter 6.3.10 Output Imbalance of Motor Supply Voltage Test*.
7. Stop the frequency converter and remove input power. Wait for the discharge time listed in *Table 2.1* to allow DC capacitors to discharge fully.
8. Reconnect motor cables to frequency converter output terminals (U, V, W).
9. Reapply power and restart the frequency converter. Adjust motor speed to a nominal level.
10. Set load to 50%.
11. Using a clamp-on ammeter, measure output current on each output phase. All currents must be balanced.
12. The correct measurement is 50% rated current.

6.5 Flashing of Frequency Converter after Control Card Replacement

After replacing the control card, flash the frequency converter via the MCT-10 Set-up Software.

1. Select MCT-10 Set-up Software in the *Start* menu.
2. Select *Configure bus*.
3. Fill in the relevant data in the *Serial fieldbus configuration*-window.
4. Click the *Scan bus* icon and find the frequency converter.
   - 4a The frequency converter appears in the *ID*-view.
5. Click *Software upgrader*.
6. Select the oss file.
7. In the dialog window, tick *Force upgrade* and then click *Start upgrade*.
   - 7a The firmware flashes.
8. Click *Done* when the upgrade is complete.

7 Disassembly and Assembly Instructions

7.1 Electrostatic Discharge (ESD)

CAUTION

ELECTROSTATIC DISCHARGE

Failure to follow the ESD regulations can cause personal injury and property damage.

- **Prepare the work area according to the ESD regulations.**
- **Ground ESD mat and wrist strap. Ensure that the ground connection between body, ESD mat, and frequency converter is always present while servicing the frequency converter.**
- **Handle disassembled electronic parts carefully and always protected from ESD.**

7.2 General Disassembly Procedure

This procedure explains how to remove the outer parts of the frequency converter that are common for all enclosure sizes. When this procedure is completed, the inside components are accessible.

7.2.1 Removing LCP

Remove the LCP with a flat-edged screwdriver (accessed from the top).

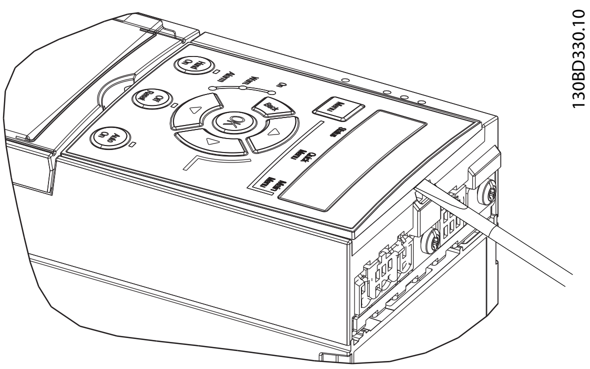


Illustration 7.1 Remove LCP

7.2.2 Removing Plastic Cover

Remove the plastic cover beneath the LCP by pushing down the lock lever with a flat-edged screwdriver and lift the plastic cover upwards.

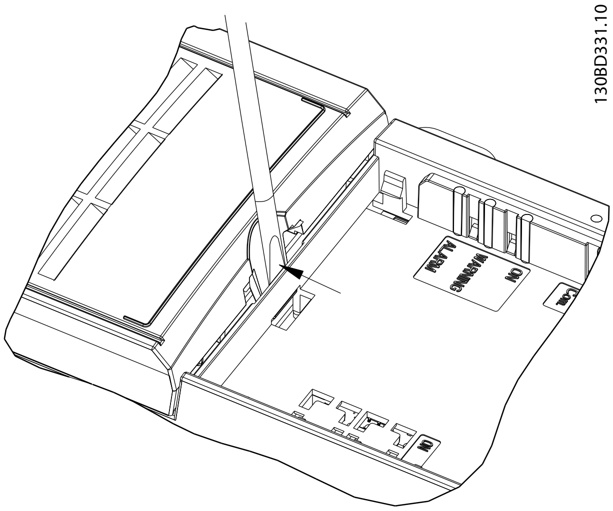


Illustration 7.2 Remove Cover

7.2.3 Removing Front Cover (J6)

1. Remove the 4 screws (T20, M4X8) that fasten the front cover to the base plate, as shown in *Illustration 7.3* and *Illustration 7.4*.

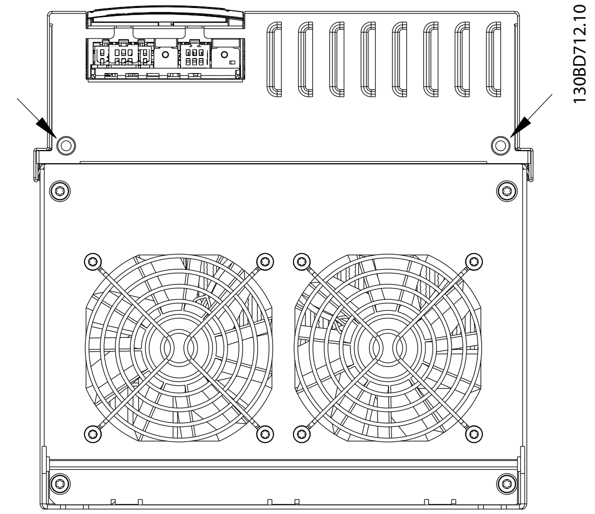


Illustration 7.3 Top Plate

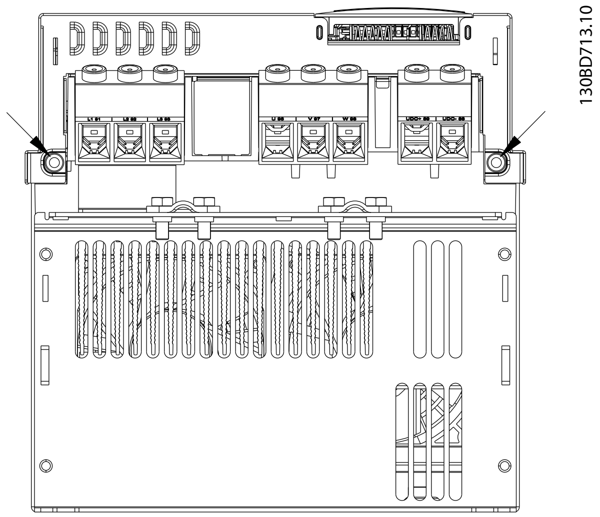


Illustration 7.4 Bottom Plate

2. Remove the 3 screws on the I/O decoupling plate, as shown in *Illustration 7.5*.

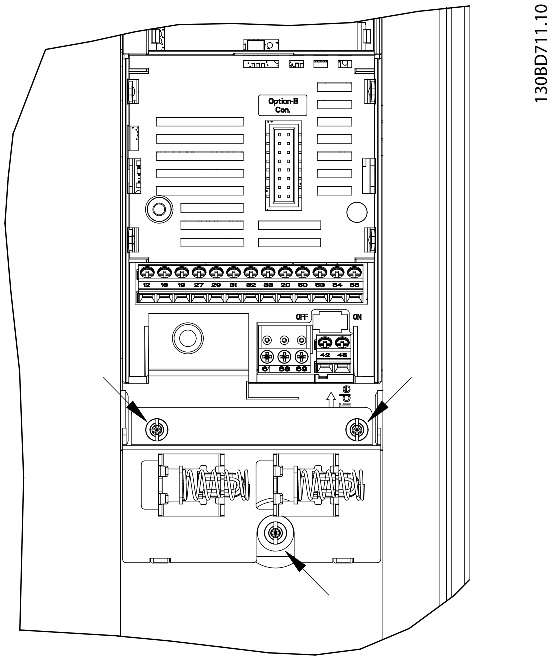


Illustration 7.5 Screws on the I/O Decoupling Plate

3. Lift the front cover.

7.2.4 Removing Front Cover (J7)

1. Remove the 4 screws (T20, M5x10) at the top and bottom surfaces of the front cover, as shown in *Illustration 7.6* and *Illustration 7.7*.

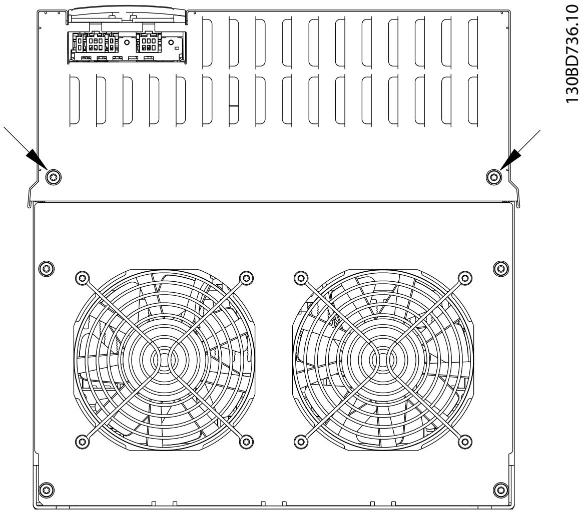


Illustration 7.6 Top Plate

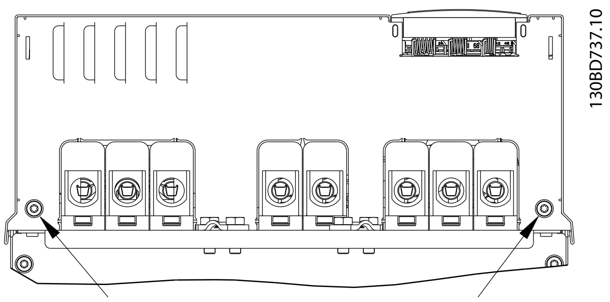


Illustration 7.7 Bottom Plate

2. Remove the 2 screws (T10, M3.5x8) on the I/O decoupling plate, as shown in *Illustration 7.8*.

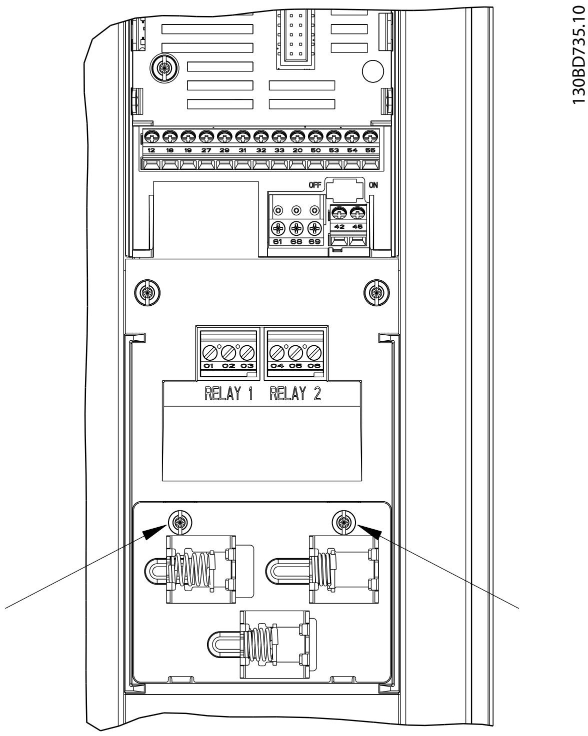


Illustration 7.8 Screws on I/O Decoupling Plate

3. Lift the front cover.

7.3 Control Card Cassette Replacement

7.3.1 Replacement Procedure for J1–J5

1. Remove the LCP and the plastic cover beneath it.
2. Loosen the control card cassette by removing the 2 screws (T10, M3x6 upper, M3x16 lower) on the left side, as shown in *Illustration 7.9*.

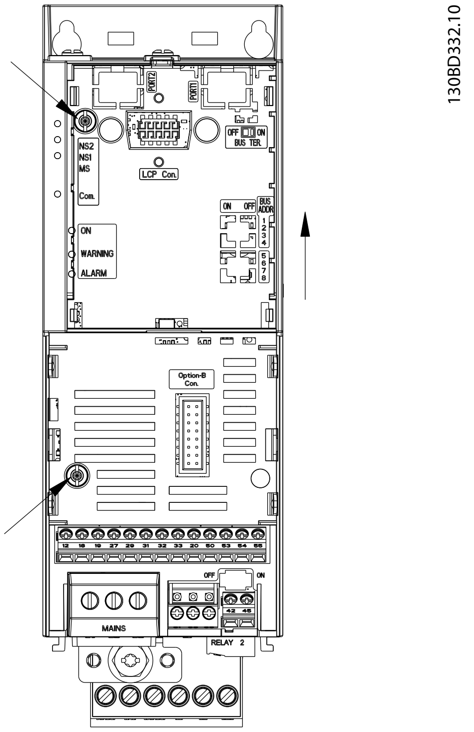


Illustration 7.9 Loosen the Control Card Cassette

3. Push the control card cassette upwards to release it from the power section.
4. Remove the connection cable from the control card cassette, as shown in *Illustration 7.10*.

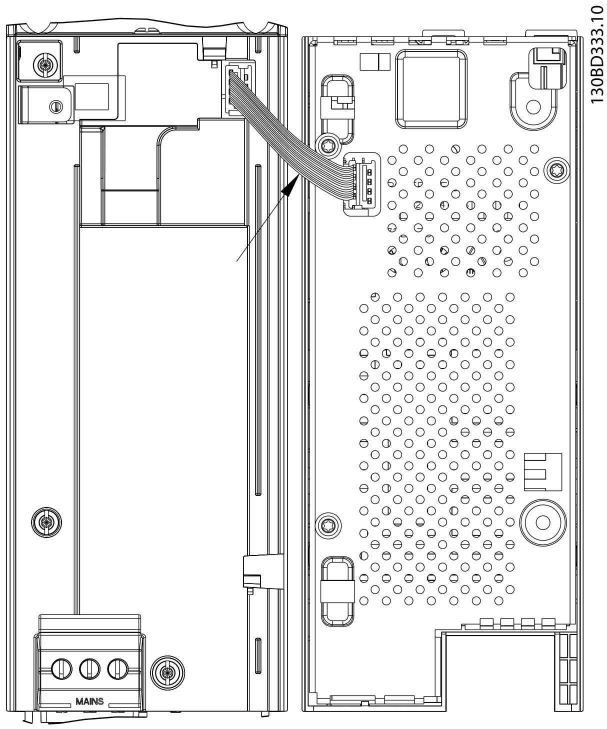


Illustration 7.10 Connection Cable for Control Card Cassette

5. Install a new control card cassette in reverse order.

Flash the frequency converter after a new control card cassette is installed. For more details, see *chapter 6.5 Flashing of Frequency Converter after Control Card Replacement*.

7.3.2 Replacement Procedure for J6

1. Remove the LCP and the plastic cover beneath it.
2. Remove the front cover.
3. Loosen the control card cassette by removing the 2 screws (T10, M3x6), as shown in *Illustration 7.11*

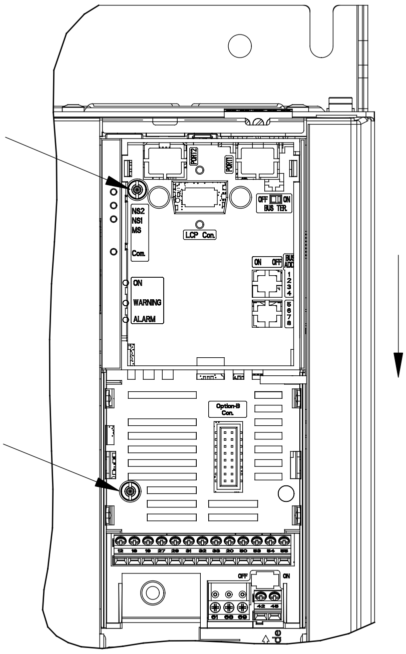


Illustration 7.11 Loosen the Control Card Cassette

4. Push the control card cassette downwards to release it from the power section.
5. Remove the connection cable from the control card cassette, as shown in *Illustration 7.12*.
6. Install a new control card cassette in reverse order.

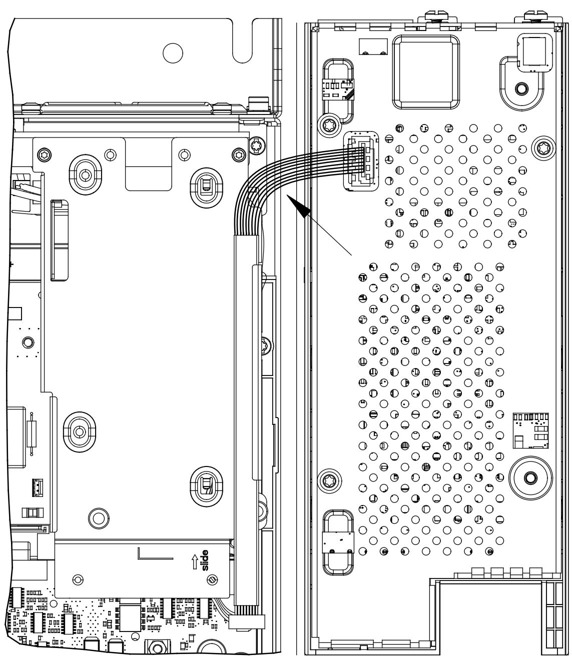


Illustration 7.12 Connection Cable for Control Card Cassette

Flash the frequency converter when a new control card cassette is installed. For more details, see *chapter 6.5 Flashing of Frequency Converter after Control Card Replacement*.

7.3.3 Replacement Procedure for J7

1. Remove the LCP and the plastic cover beneath it.
2. Remove the front cover.
3. Loosen the control card cassette by removing the screws (T10, M3x6), as shown in *Illustration 7.13*.

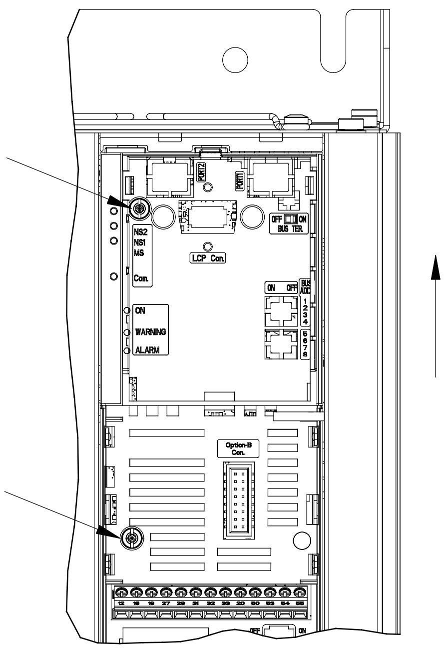


Illustration 7.13 Loosen the Control Card Cassette

4. Push the control card cassette upwards to release it from the support plate.
5. Remove the connection cable from the control card, as shown in *Illustration 7.14*.

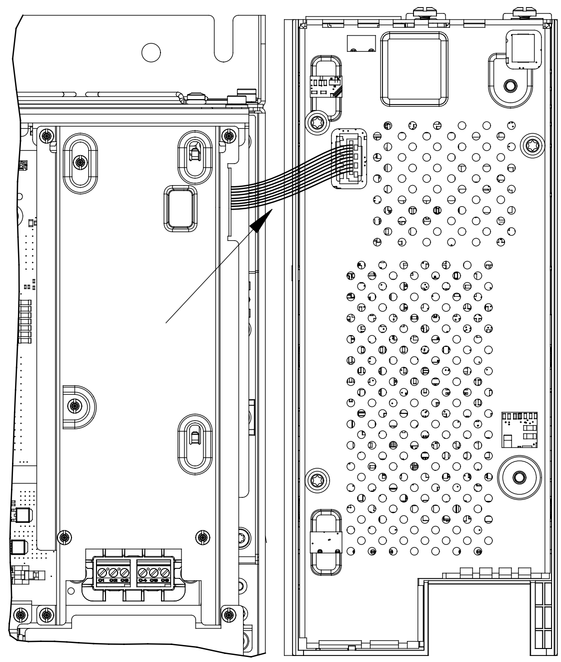


Illustration 7.14 Connection Cable for Control Card Cassette

6. Install a new control card cassette in reverse order.

Flash the frequency converter when a new control card cassette is installed. For more details, see *chapter 6.5 Flashing of Frequency Converter after Control Card Replacement*.

7

7.4 Fan Replacement

7.4.1 Replacement Procedure for J1 and J2

1. Grab the center handle and release the retaining lever at the back plate using a flat-edged screwdriver.
2. Dismount the fan from the power section.

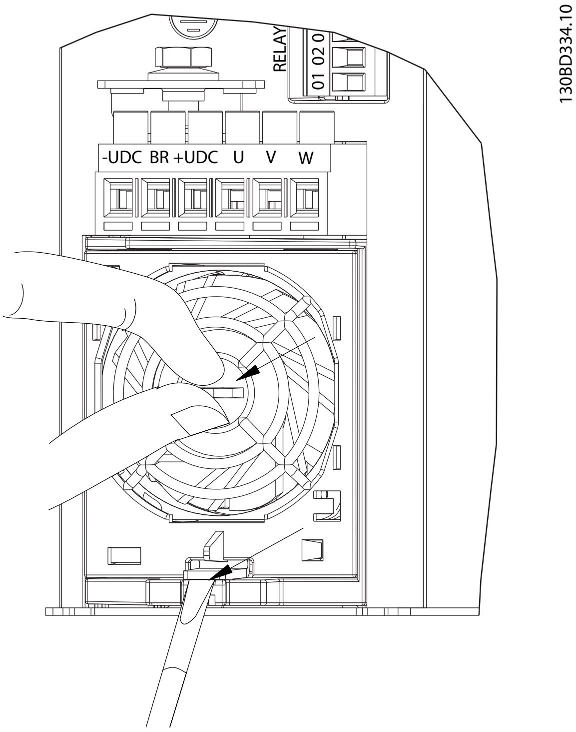


Illustration 7.15 Center Handle

3. Unplug the fan cable.

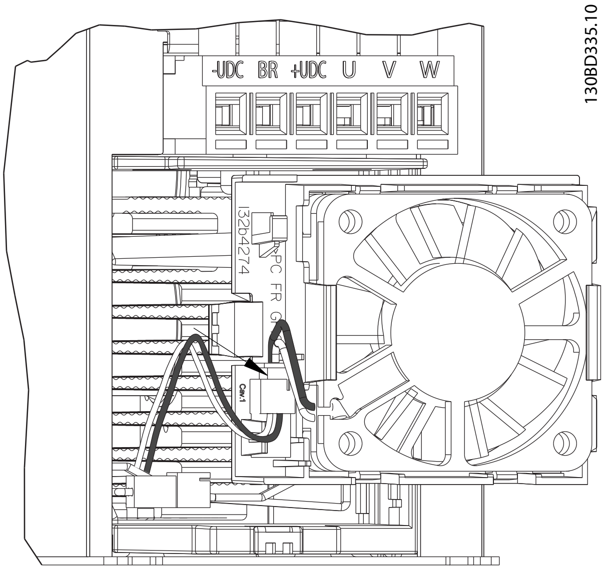


Illustration 7.16 Fan Cable Plug

4. Remove the fan completely.
5. Install a new fan in reverse order.

7.4.2 Replacement Procedure for J3

1. Remove the screw (M3x6) in the bottom right corner of the frequency converter.

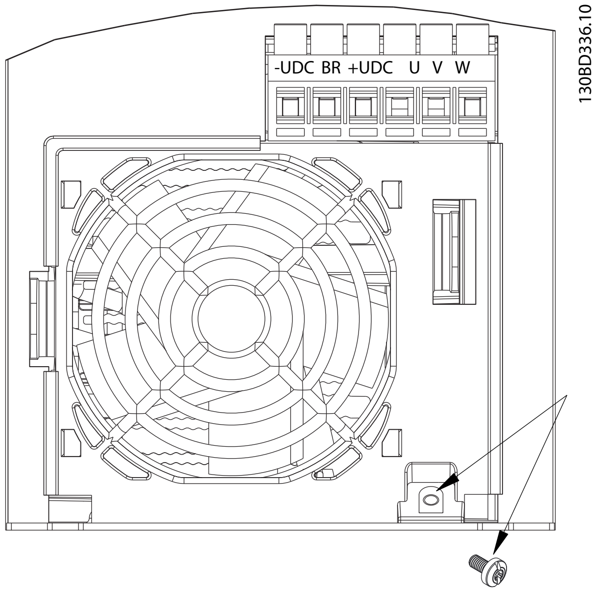


Illustration 7.17 Screws to Remove

2. Press the 2 levers on each side of the fan and pull it outwards.

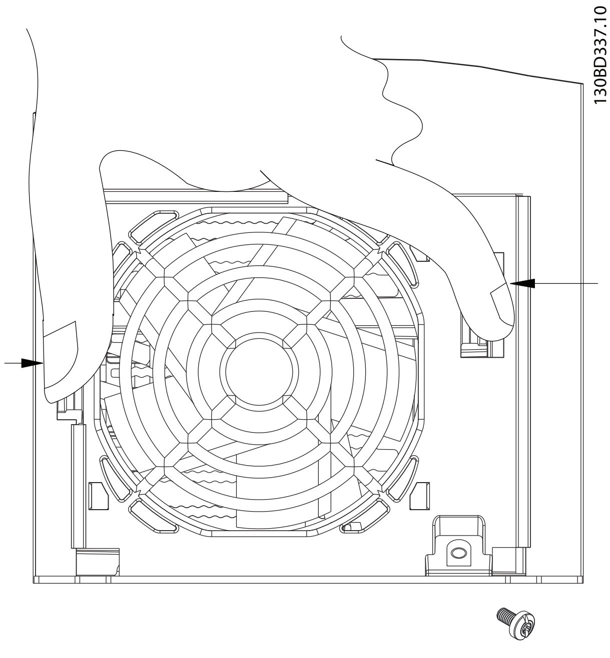


Illustration 7.18 Levers for Releasing the Fan

3. Unplug the fan cable.

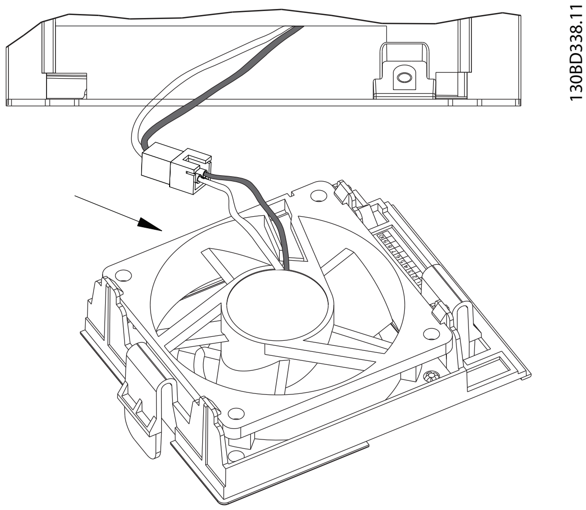


Illustration 7.19 Fan Cable Plug

4. Remove the fan.
5. Install a new fan in reverse order.

7

7.4.3 Replacement Procedure for J4

1. Remove the fan from the power section by grabbing the center handle and using a flat-edged screwdriver to release the retaining lever at the plate.

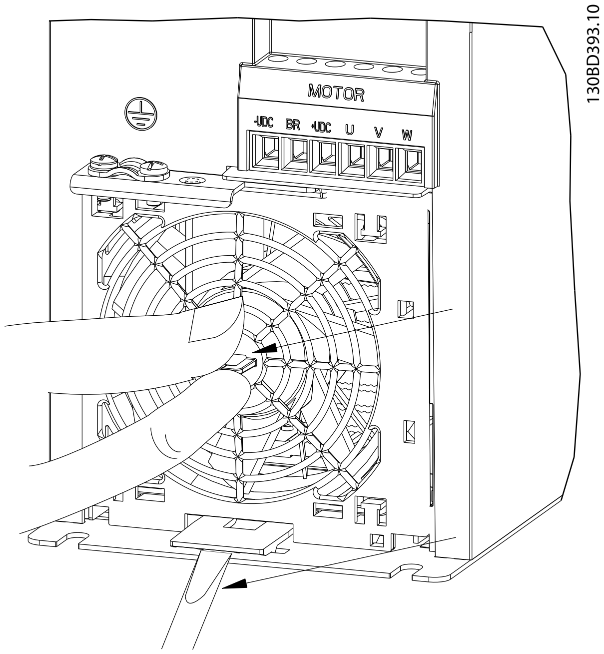


Illustration 7.20 Grabbing Center Handle and Releasing Lever

2. Unplug the fan cable.

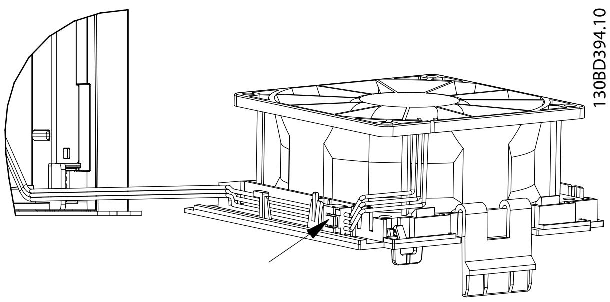


Illustration 7.21 Fan Cable Plug

3. Remove the fan.
4. Install a new fan in reverse order.

7.4.4 Replacement Procedure for J5

1. Unscrew the 2 M4x50 screws in the upper left and bottom right corners and grab the center handle to remove the fan from the power section.

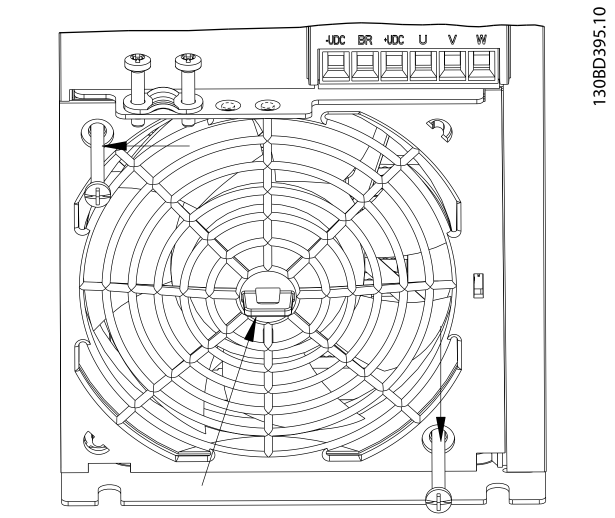


Illustration 7.22 Screws and Center Handle.

2. Unplug the fan cable.

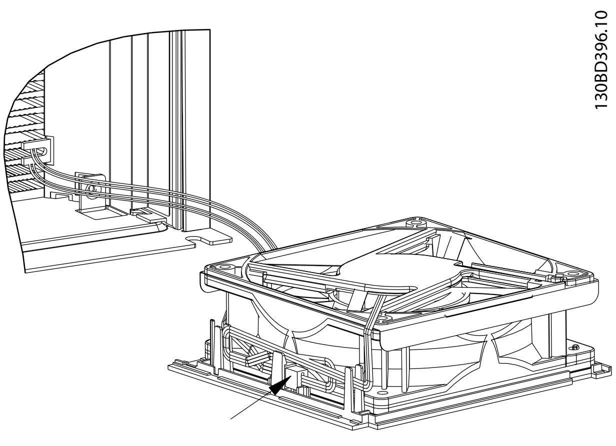


Illustration 7.23 Fan Cable Plug

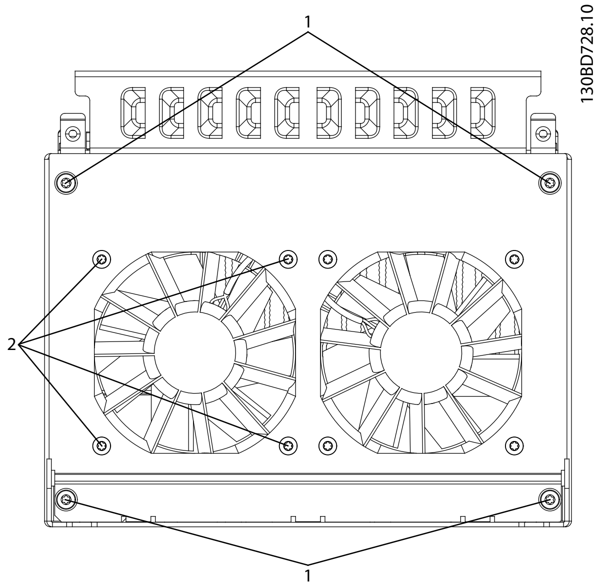
3. Remove the fan.
4. Install a new fan in reverse order.

7.4.5 Replacement Procedure for J6 and J7

NOTICE

If a fan does not function, ensure that the fan extension cable is not damaged. If the cable is damaged, replace it before replacing the fan.

1. Remove the 4 screws (T20, M5x10, torque 2.3 Nm) on the fan top plate, as shown in *Illustration 7.24*.
2. Take apart the fan connectors, and remove the 4 screws (T20, M5x12 self-cutting) for the defective fan, as shown in *Illustration 7.24*.
3. Install a new fan in reverse order.



1	Screws for the top plate
2	Screws for a fan

Illustration 7.24 Fan Top Plate

7.5 Power Control Card Replacement

7.5.1 Replacement Procedure for J6

1. For ease of access, remove the control card cassette with support plate by removing the screws as shown in *Illustration 7.25*.
   - 1a 2 M3.5x8 screws (T10, torque: 1.5 Nm), at the top of the support plate.
   - 1b 2 M4x8 screws (T20, torque: 1.5 Nm), at the bottom of the support plate.

NOTICE

If the RFI auxiliary card to the left of the control card cassette is damaged, go to step 2 in *chapter 7.6.1 Replacement Procedure for J6* for more information on how to replace it.

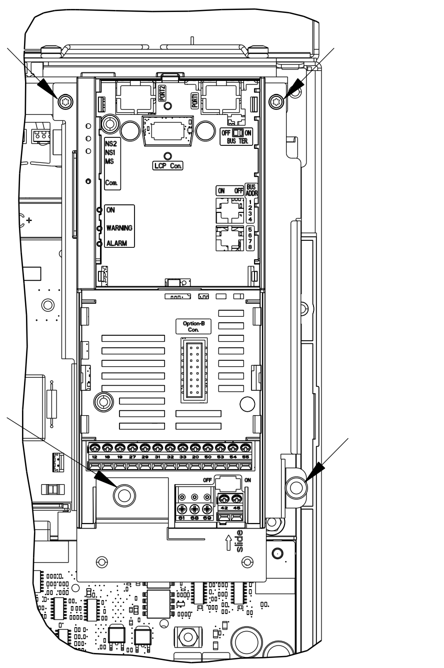
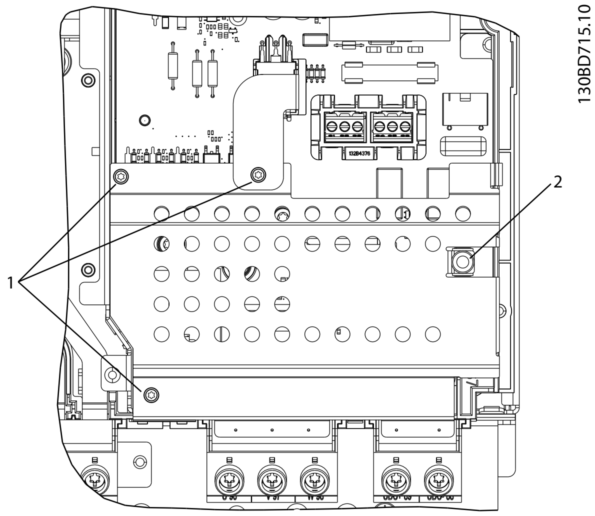


Illustration 7.25 Control Card Cassette with Support Plate

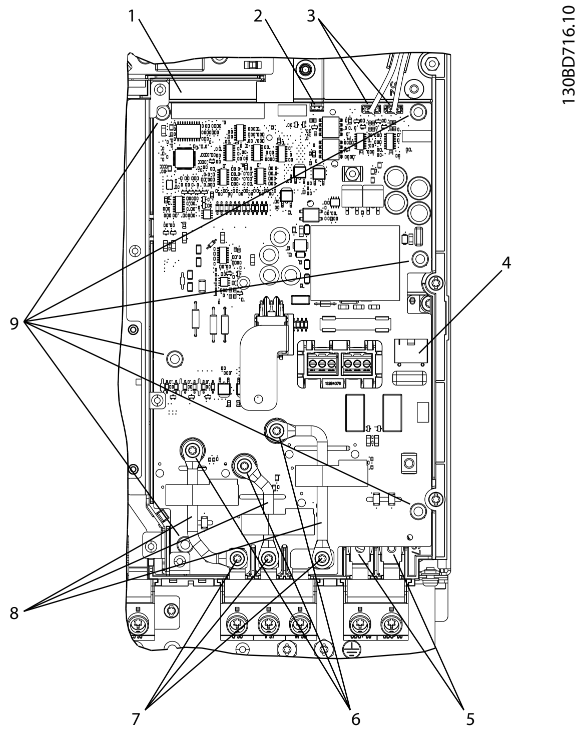
2. Remove the 3 M3.5x8 screws (T10) and 1 M4x8 screw (T20, torque: 1.5 Nm) on the current sensor cover plate, as shown in *Illustration 7.26*.



1	Screws (T10, M3.5x8)
2	Screw (T20, M4x8)

Illustration 7.26 Current Sensor Cover Plate

3. Remove the cover plate and leave the heat sink on the MOSFET transistor.
4. Detach the following cables:
    - 4a 2 fan cables.
    - 4b Cable to the relay on the RFI auxiliary card.
    - 4c Cable to the power card.
    - 4d Power control card supply cable.
5. Remove the 6 M4x8 screws (T20, torque: 1.5 Nm), the 3 M4x42 screws (T20, torque: 3.0 Nm), and the 3 M4x18 screws (T20, torque: 3.0 Nm), as shown in *Illustration 7.27*
6. Remove the motor terminal connectors and the busbar, and then gently remove the power control card.



1	Cable to power card
2	Cable to the relay on RFI auxiliary card
3	Fan cables
4	Power control card supply cable
5	Screws (T20, M4x12)
6	Screws (T20, M4x42)
7	Screws (T20, M4x18)
8	Busbar
9	Screws (T20, M4x8)

Illustration 7.27 Power Control Card

7. Install a new power control card in reverse order.

7.5.2 Replacement Procedure for J7

1. For ease of access, remove the control card cassette with the support plate by removing the 4 screws (T10, M3x6, torque: 1.5 Nm), as shown in *Illustration 7.28*.
2. Remove the control card flat cable from the power control card connector FK 100, as shown in *Illustration 7.29*.

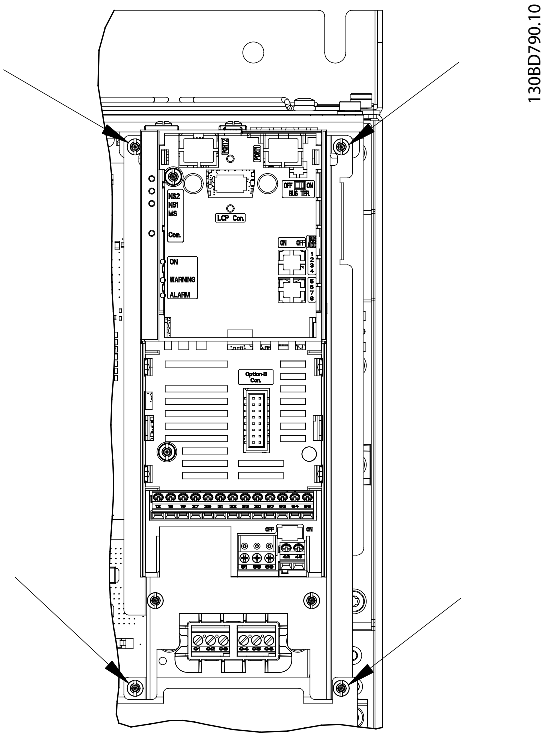
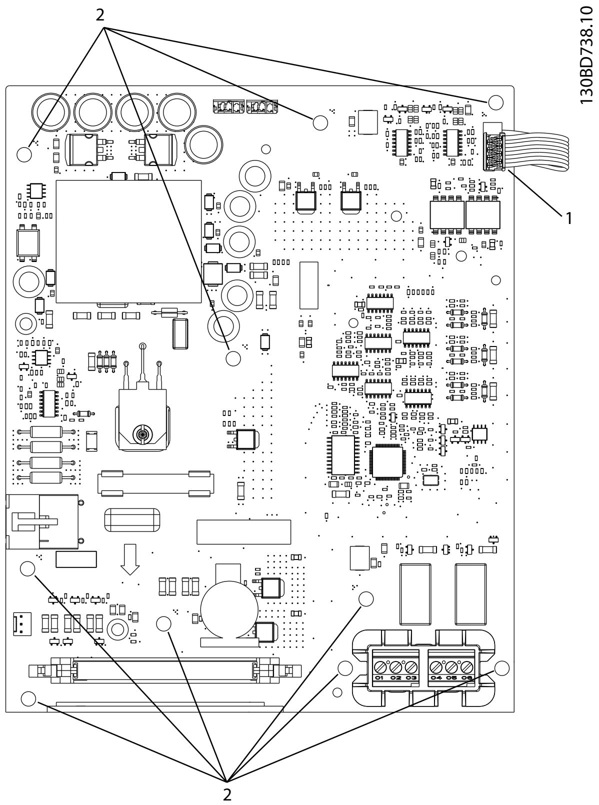


Illustration 7.28 Control Card Cassette with Support Plate

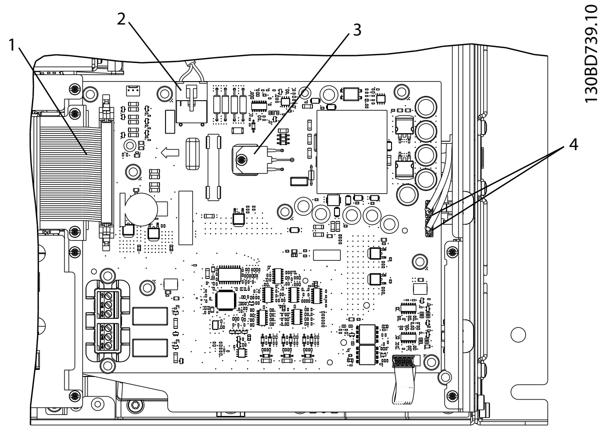
3. Remove the 10 M4x8 screws (T20, torque: initial 0.5 Nm, final 1.5 Nm) on the power control card, as shown in *Illustration 7.29*.



1	FK 100
2	Screws (T20, M4x8)

Illustration 7.29 Power Control Card

4. Remove the M3x10 screw (T10, torque: 1.5 Nm) from the MOSFET transistor heat sink, as shown in *Illustration 7.30*.



1	44-pole cable
2	Power control card supply cable
3	Screw (T10, M3x10), from MOSFET transistor heat sink
4	Fan cables

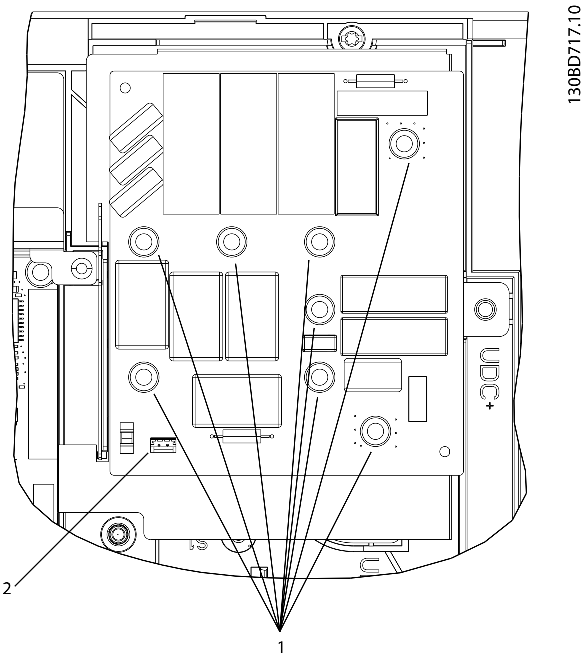
Illustration 7.30 Power Control Card

5. Remove the 2 fan cables and the power control card supply cable. Release the 44-pole cable jumper from its connector on the power control card.
6. Install a power control card in reverse order.

7.6 Power Card Replacement

7.6.1 Replacement Procedure for J6

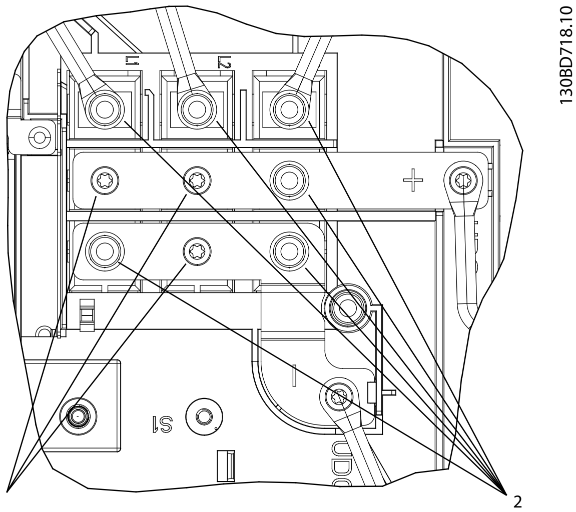
1. Remove the power control card. See *chapter 7.5.1 Replacement Procedure for J6* for details.
2. Remove the 8 M4x8 screws (T20, torque: 1.5 Nm) on the RFI auxiliary card and take off connector MK101, as shown in *Illustration 7.31*. Remove the RFI auxiliary card. Examine the plastic foil under the RFI auxiliary card. If it is damaged, replace it.



1	Screws (T20, M4x8)
2	Connector MK101

Illustration 7.31 RFI Auxiliary Card

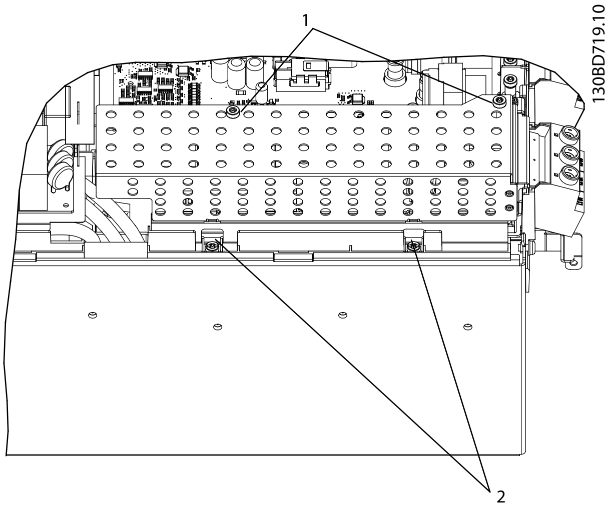
3. Remove the 6 hex nuts (M4x10, torque: 3.0 Nm) by using an N8 socket wrench, and remove the 3 M4x12 screws (T20, torque: 3.0 Nm).



1	Screws (M4x12)
2	Hex nuts (M4x10)

Illustration 7.32 Rectifier Module and Busbars

4. Remove the 2 screws (T10, M3x8, torque: 1.5 Nm) on the top surface of the mains input cover and lift the cover, as shown in *Illustration 7.33*. Pay attention to the 2 fixations.

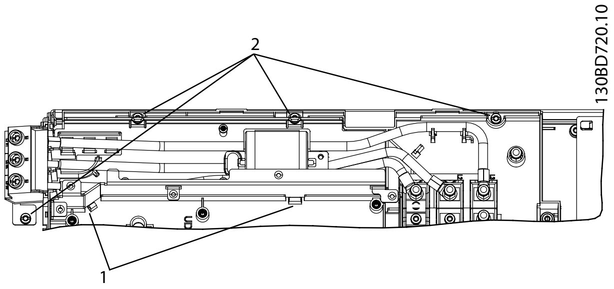


1	Screws (T10, M3x8)
2	Fixations

Illustration 7.33 Mains Input Cover

7

5. Remove the 4 screws (T20, M4x12), and release the 2 levers, as shown in *Illustration 7.34*. Then remove the mains input screen and cables.



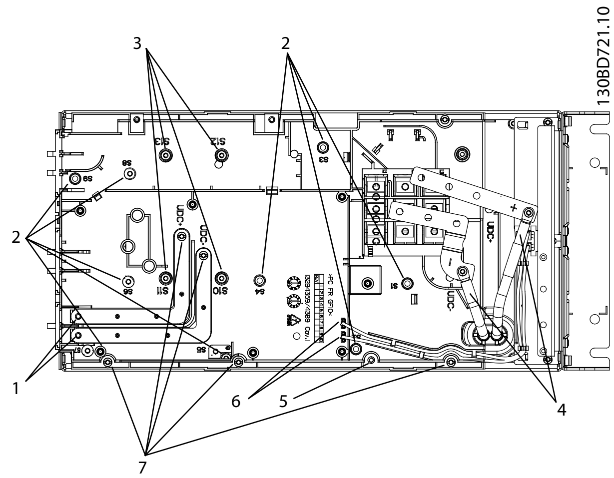
1	Levers
2	Screws (T20, M4x12)

Illustration 7.34 Mains Input Screen and Cables

6. Remove the power card and busbar cradle:
   - 6a Remove the 5 M4x12 screws (T20).
   - 6b Remove the hex nut (M4x30) by using an N7 socket wrench.
   - 6c Remove the 9 M4x8 screws (T20).
   - 6d Remove the 4 M5x16 screws (T20) from the IGBT module.
   - 6e Remove the UDC output connector by removing the 2 screws (T20, M4x12, torque: 2.3 Nm).
   - 6f Gently lift the power card and busbar cradle with the power card attached.

NOTICE

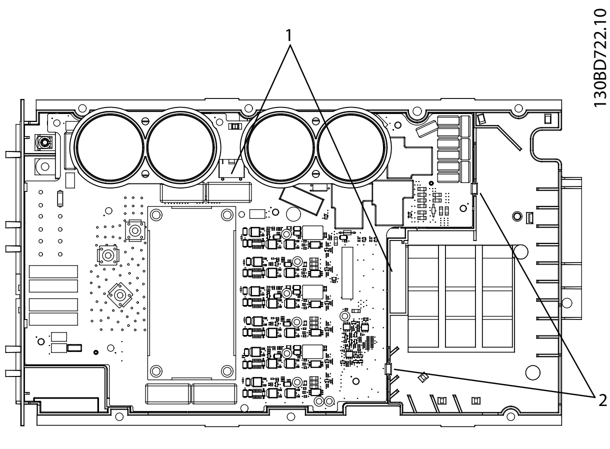
Pay attention to the suction of the thermal grease under the IGBT module when lifting the power card and busbar cradle.



1	Screws (T20, M4x12), for UDC output connector
2	Screws (T20, M4x8)
3	Screws (T20, M5x16), from the IGBT module
4	DC coil cables
5	Hex nut (M4x30)
6	Fan cables
7	Screws (T20, M4x12)

Illustration 7.35 Power Card and Busbar Cradle

7. Remove the power control card supply cable and the ribbon cable, and push the 2 flaps to release the power card from the power card and busbar cradle.



1	Power control card supply cable and ribbon cable
2	Flaps

Illustration 7.36 Power Card

8. Install a new power card in reverse order. Make sure to use the right torques.

7.6.2 Replacement Procedure for J7

1. Remove the power control card.
2. Remove the remaining screw (T10, M3x6) on the EMC screen plate, as shown in *Illustration 7.37*. Lift the EMC plate and take it out from the bosses, as shown in *Illustration 7.38*.

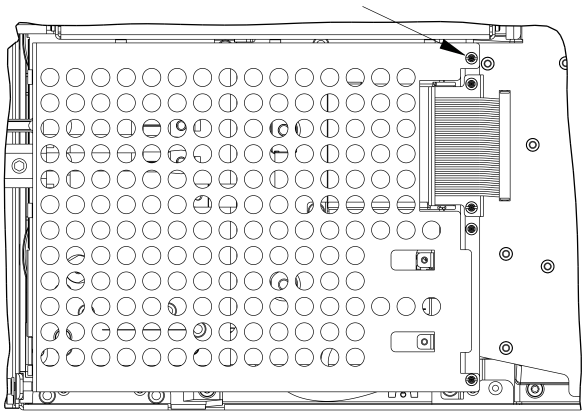


Illustration 7.37 EMC Screen Plate

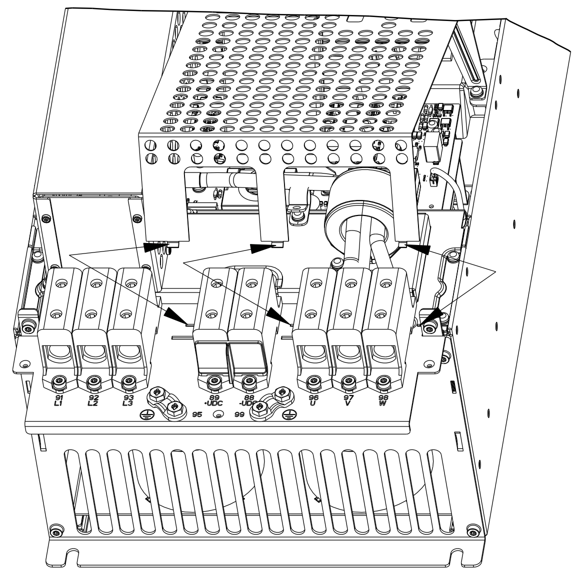
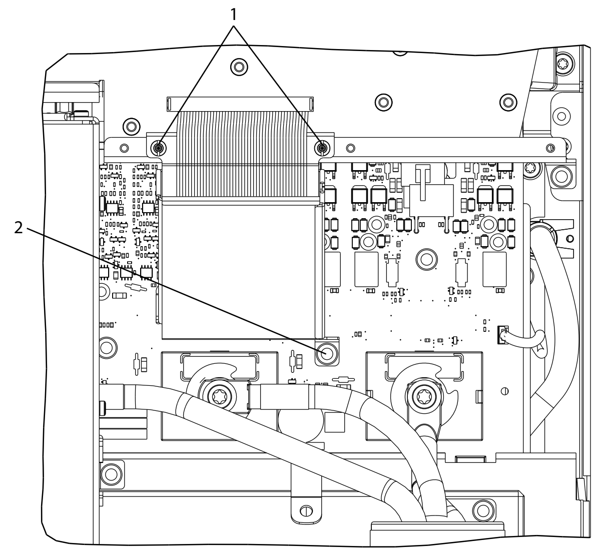


Illustration 7.38 Lift the EMC Screen Plate

3. Remove the 2 screws (T10, M3x6) on the flat cable tray and the M4x8 screw (T20), as shown in *Illustration 7.39*. Release the connector from the power control card, and then remove the flat cable tray.



1	Screws (T10, M3.5x8)
2	Screw (T20, M4x8)

Illustration 7.39 Flat Cable Tray

4. Remove the 4 screws (T20, M4x8, torque: 1.5 Nm) from the mounting plate for the power control card. Take out the 2 fan connectors from the wire saddle, and remove the mounting plate, as shown in *Illustration 7.40*.

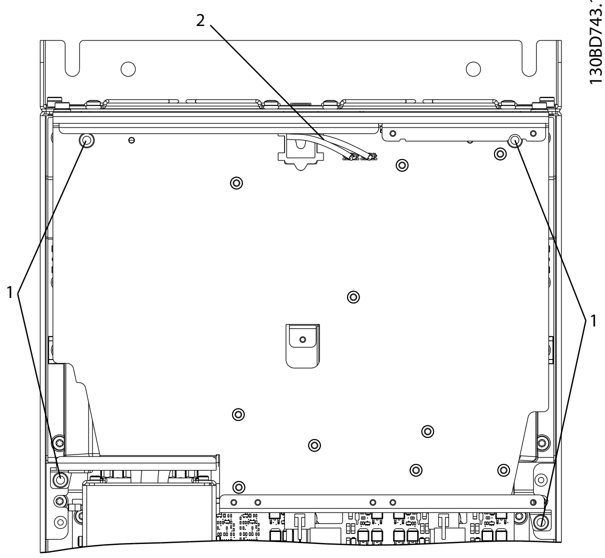


Illustration 7.40 Mounting Plate for Power Control Card

7

5. Remove the 8 screws (T20, M4x8, torque: initial 0.5 Nm; final 1.5 Nm) from the RFI auxiliary card. The positions of the screws are shown in *Illustration 7.41*. Remove the RFI card and the insulation foil beneath it. If the insulation foil is damaged, replace it.

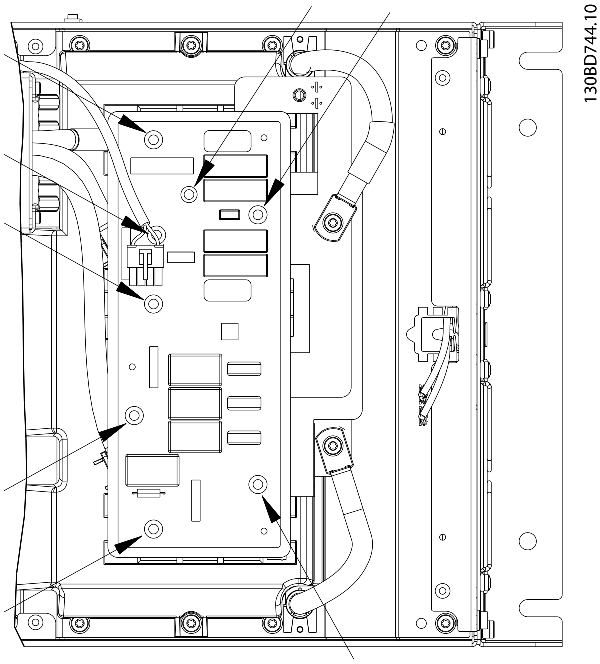
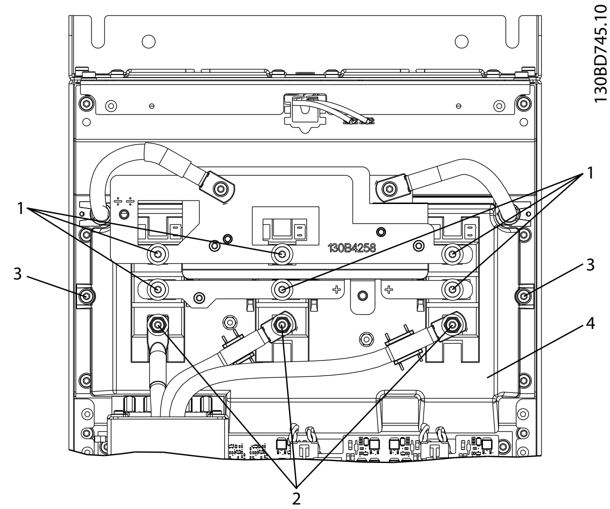


Illustration 7.41 Positions of M4 Screws

6. Remove the 3 hex spacers that hold the 3 AC wires by using an N10 socket wrench, as shown in *Illustration 7.42*.
7. Remove the 6 screws (T25, M6x14, torque: 3.5 Nm) from the rectifier busbar assembly, as shown in *Illustration 7.42*. Lift the busbar and position it towards the bottom wall of the frequency converter.
8. Remove the 2 screws (T20, M5x12, torque: 3.5 Nm) and then remove the rectifier cover, as shown in *Illustration 7.42*.



1	Screws (T25, M6x14)
2	Hex spacers
3	Screws (T20, M5x12)
4	Rectifier cover

Illustration 7.42 Rectifier Busbar Assembly

9. Remove the 5 screws (T20, M4x8, torque: 1.5 Nm) around the RFI filter assembly, as shown in *Illustration 7.43*.

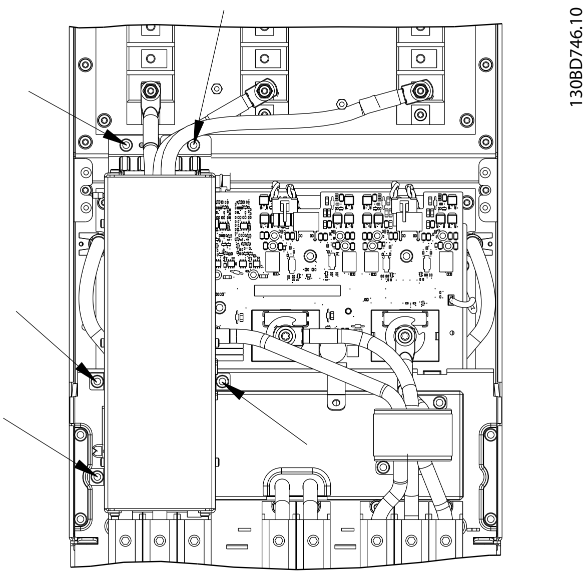


Illustration 7.43 RFI Filter Assembly

10. Loosen the 3 screws in the AC input terminal block by using an N5 Allen key, as shown in *Illustration 7.44*, and remove the RFI filter assembly.

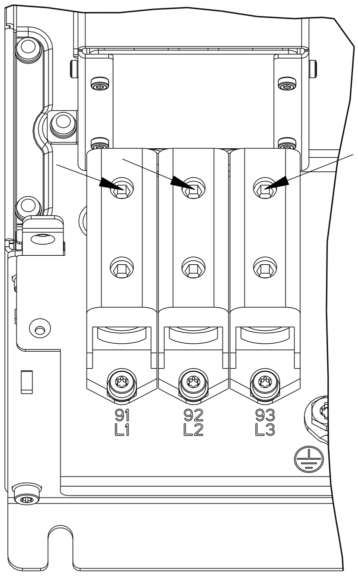


Illustration 7.44 AC Input Terminals

11. (75 kW only) Remove the 2 screws (T20 M5x10, torque: 2.3 Nm) on L1 input terminal and remove the terminal, as shown in *Illustration 7.45*.

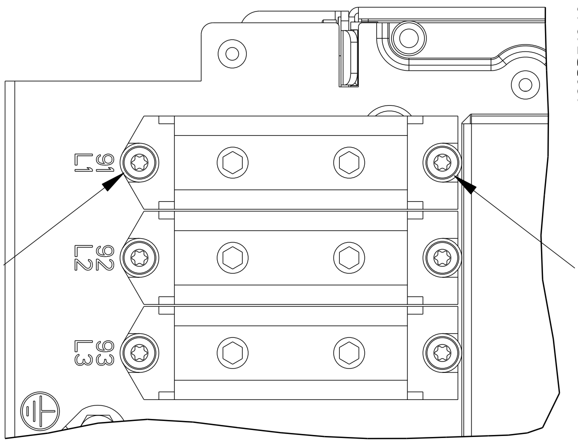


Illustration 7.45 Remove L1 Mains Terminal

12. Remove the 3 M6x90 screws (with current sensor tubes, T20, torque: 3.5 Nm) from the motor cables on the current sensors.

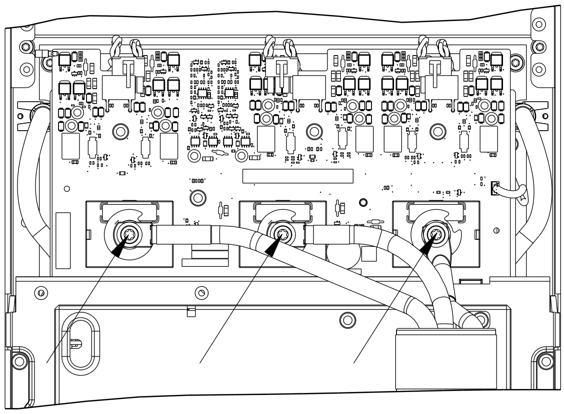


Illustration 7.46 Motor Cables on the Current Sensors

13. (75 kW only) Remove the W output terminal by removing the 2 M5x10 screws (T20, torque: 2.3 Nm), as shown in *Illustration 7.47*. Pull out the W phase cable through the ferrite core.

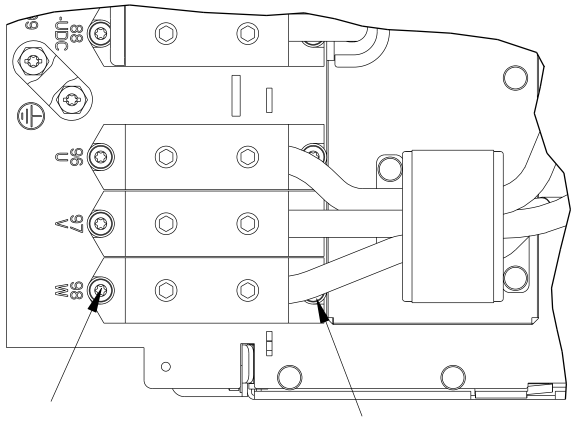
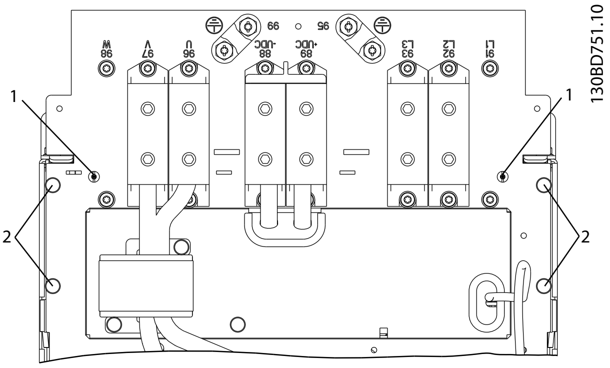


Illustration 7.47 Remove W Motor Terminal

14. (55 kW and 75 kW) Remove 4 M4x8 screws (T20, torque 1.5 Nm) and 2 M3x6 screws (T10, torque: 1.5 Nm) from the terminal assembly, as shown in *Illustration 7.48*.

NOTICE

The 55 kW terminals are smaller and in 3-phase and 2-phase blocks. The M3x6 screws for 55 kW frequency converters can be directly accessed.



1	Screws (T10, M3x6)
2	Screws (T20, M4x8)

Illustration 7.48 Terminal Assembly

15. Remove the terminal assembly.
16. Remove the 4 screws (T20, M5x10, torque: 2.3 Nm) on the bottom plate, and then remove the bottom plate, as shown in *Illustration 7.49*.

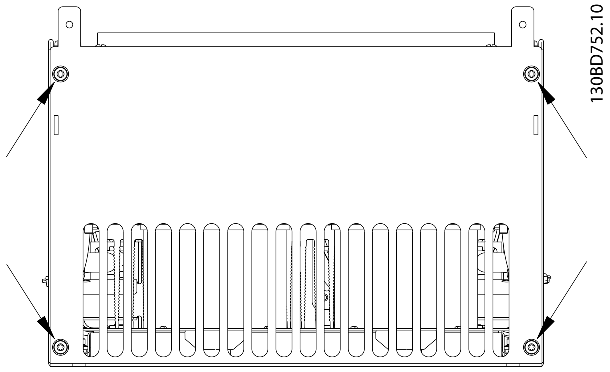
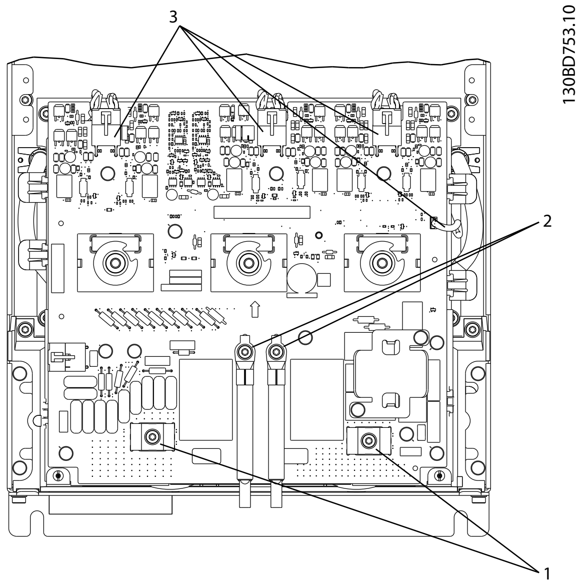


Illustration 7.49 Remove the Bottom Plate

17. Remove the insulation inrush foil, and then remove the following screws:
    - 17a 2 M5x23 screws (T20, torque: 3.5 Nm) that fasten the power card to the DC capacitors.
    - 17b 2 M5x35 screws (T20, torque: 3.5 Nm) that fasten the UDC cables to the power card.
    - 17c 11 M4x8 screws (T20, M4x8, initial torque: 0.5 Nm, final torque: 1.5 Nm).



1	Screws (T20, M5x23), fastening the power card to the DC capacitors
2	Screws (T20, M5x35), fixing the UDC cables
3	Gate trigger cables and temperature sensor

Illustration 7.50 Power Card

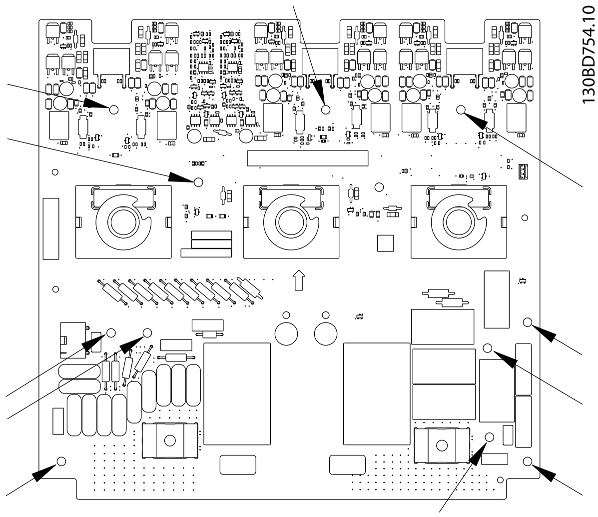


Illustration 7.51 M4x8 Screws

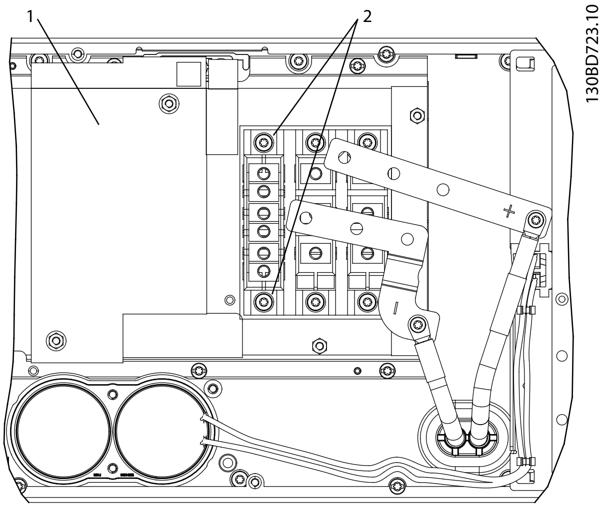
18. Release the temperature sensor from its connector. Pull out the gate trigger cables, and remove the power card.
19. Install a new power card in reverse order.

7.7 Rectifier Module Replacement

7.7.1 Replacement Procedure for J6

1. Remove the power card. See *chapter 7.6.1 Replacement Procedure for J6* for details.
2. Remove the 2 screws (T20, M5x16) on a defective rectifier, and remove the rectifier.
3. Grease the new rectifier on the base plate, and fasten the screws. Initial torque: 0.8 Nm; final torque: 3.5 Nm.

Note: Ensure that the insulation foil next to the rectifiers is not damaged.



1	Insulation foil
2	Screws (T20, M5x16)

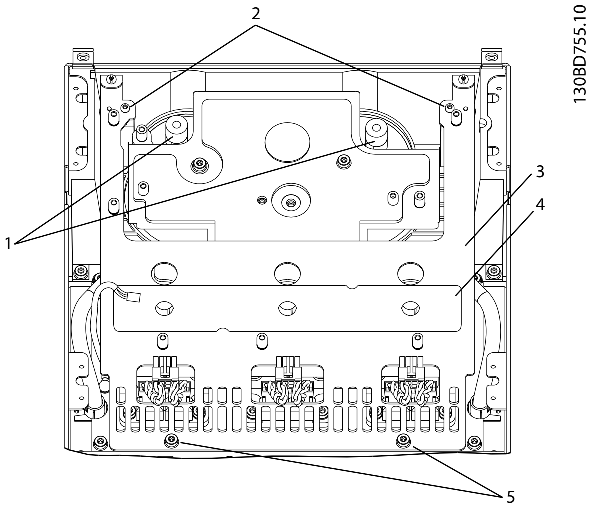
Illustration 7.52 Rectifier Module

7.7.2 Replacement Procedure for J7

1. Complete the first 8 steps in *chapter 7.6.2 Replacement Procedure for J7* to remove the RFI auxiliary card, the rectifier busbar assembly, and the rectifier cover.
2. Remove the 2 screws (T20, M5x16, torque: initial 0.8 Nm; final 3.5 Nm) on the defective rectifier, and then remove the rectifier.
3. Install a new rectifier module in reverse order.

7.8 IGBT and DC Capacitor Replacement (J7)

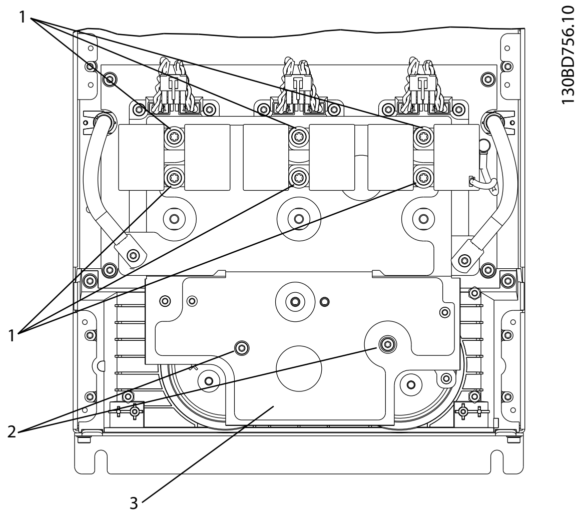
1. Remove the power card.
2. Remove the inrush ground plate assembly.
   - 2a Remove the current sensor tube fixture.
   - 2b Remove the 2 DC capacitor connection tubes.
   - 2c Remove the insulation inrush foil that is on top of the inrush ground plate assembly.
   - 2d Remove the 2 M5x10 screws (T20, torque: 2.3 Nm).
   - 2e Remove the 2 M4 screws (T10, self-cutting, torque: 1.5 Nm).
   - 2f Pass the IGBT trigger cables through the openings and remove the inrush ground plate assembly.



1	DC capacitor connection tubes
2	Screws (T10, M4, self-cutting)
3	Inrush ground plate assembly
4	Current sensor tube fixture
5	Screws (T20, M5x10)

Illustration 7.53 Inrush Ground Plate Assembly

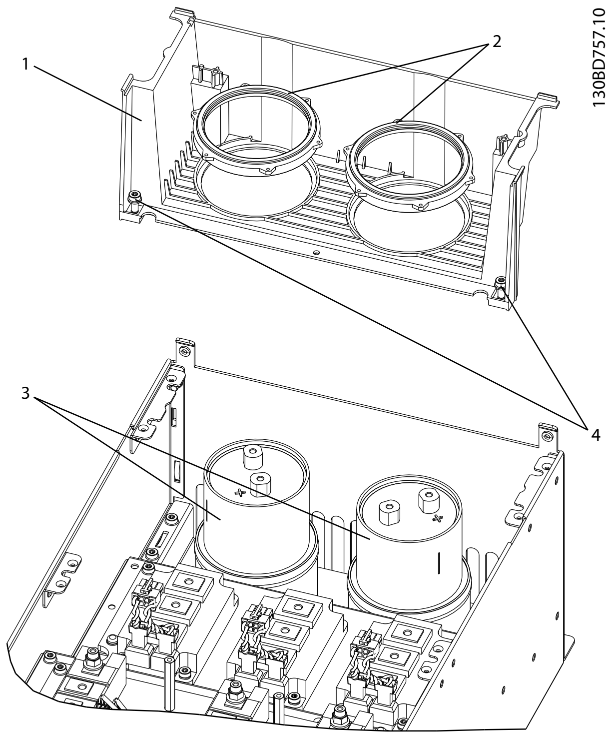
3. Remove the IGBT busbar assembly.
   - 3a Remove the 6 M6x15 screws (T30, torque: 3.5 Nm) that connect the film capacitors to the IGBTs, together with the film capacitors.
   - 3b Remove the 2 M5x10 screws (T20, torque: 3.5 Nm) that fasten the IGBT busbar assembly to the DC capacitors.
   - 3c Remove the 2 M5 screws (T20, torque: 3.5 Nm) that fasten the DC cables to the IGBT busbar assembly.
   - 3d Remove the IGBT busbar assembly.



1	Screws (T30, M6x15)
2	Screws (T20, M5x10)
3	IGBT busbar assembly

Illustration 7.54 IGBT Busbar Assembly

4. Remove the 4 screws on the defective IGBT (T20, M5x15, torque: initial: 0.8 Nm, final: 3.5 Nm). When installing new IGBTs, fasten screws in diagonal crossover pattern.
5. Remove the 2 M5x10 screws (T20, torque: 2.3 Nm) and pull out the support sealing plastic, as shown in *Illustration 7.55*.



1	Support sealing plastic
2	DC capacitor sealing gaskets
3	DC capacitors
4	Screws (T20, M5x10)

Illustration 7.55 Remove the Support Sealing Plastic

6. Remove the 4 M5x10 screws (T20, torque: 2.3 Nm) that hold the capacitor bank, as shown in *Illustration 7.56*.

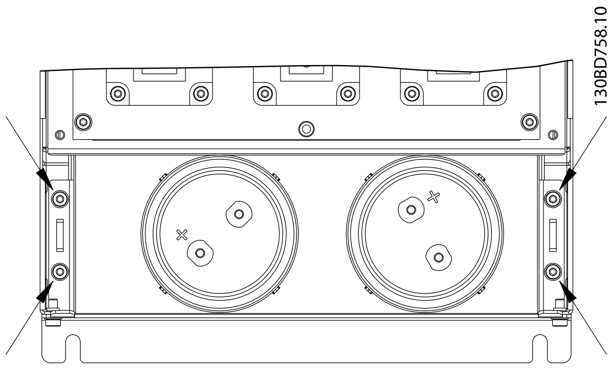


Illustration 7.56 Capacitor Bank

7. Pull out the capacitor bank and replace any defective capacitor by unscrewing the plastic nut at the bottom of the capacitor.

8. Install a new IGBT module in reverse order. Make sure to use correct torques for screws and correct crossover patterns for IGBTs. When installing the support sealing plastic, check the rubber gaskets for correct positioning (underside).

8 Specifications

8.1 Mains Supply 3x380–480 V AC

Frequency converter typical shaft output [kW (hp)]	**HK37 0.37 (0.5)**	**HK55 0.55 (0.75)**	**HK75 0.75 (1)**	**H1K1 1.1 (1.5)**	**H1K5 1.5 (2)**	**H2K2 2.2 (3)**	**H3K0 3 (4)**	**H4K0 4 (5.5)**	**H5K5 5.5 (7.5)**	**H7K5 7.5 (10)**
Enclosure protection rating IP20	J1	J1	J1	J1	J1	J1	J2	J2	J2	J3
Output current										
Shaft output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5
Continuous (3x380–440 V) [A]	1.2	1.7	2.2	3	3.7	5.3	7.2	9	12	15.5
Continuous (3x441–480 V) [A]	1.1	1.6	2.1	2.8	3.4	4.8	6.3	8.2	11	14
Intermittent (60 s overload) [A]	1.9	2.7	3.5	4.8	5.9	8.5	11.5	14.4	19.2	24.8
Continuous kVA (400 V AC) [kVA]	0.84	1.18	1.53	2.08	2.57	3.68	4.99	6.24	8.32	10.74
Continuous kVA (480 V AC) [kVA]	0.9	1.3	1.7	2.5	2.8	4.0	5.2	6.8	9.1	11.6
Maximum input current										
Continuous (3x380–440 V) [A]	1.2	1.6	2.1	2.6	3.5	4.7	6.3	8.3	11.2	15.1
Continuous (3x441–480 V) [A]	1.0	1.2	1.8	2.0	2.9	3.9	4.3	6.8	9.4	12.6
Intermittent (60 s overload) [A]	1.9	2.6	3.4	4.2	5.6	7.5	10.1	13.3	17.9	24.2
Additional specifications										
Maximum cable cross-section (mains, motor, brake, and load sharing) [mm^2 (AWG)]	4 (12)									
Estimated power loss at rated maximum load [W]2)	20.88	25.16	30.01	40.01	52.91	73.97	94.81	115.5	157.54	192.83
Weight [kg (lb)], enclosure protection rating IP20	2.3 (5.1)	2.3 (5.1)	2.3 (5.1)	2.3 (5.1)	2.3 (5.1)	2.5 (5.5)	3.6 (7.9)	3.6 (7.9)	3.6 (7.9)	4.1 (9.0)
Efficiency [%]3)	96.2	97.0	97.2	97.4	97.4	97.6	97.5	97.6	97.7	98.0

Table 8.1 Mains Supply 3x380–480 V AC - Heavy Duty1)

Frequency converter typical shaft output [kW (hp)]	H11K 11 (15)	H15K 15 (20)	H18K 18.5 (25)	H22K 22 (30)	H30K 30 (40)	H37K 37 (50)	H45K 45 (60)	H55K 55 (75)	H75K 75 (100)
Enclosure protection rating IP20	J4	J4	J5	J5	J6	J6	J6	J7	J7
Output current									
Continuous (3x380–440 V) [A]	23	31	37	42.5	61	73	90	106	147
Continuous (3x441–480 V) [A]	21	27	34	40	52	65	77	96	124
Intermittent (60 s overload) [A]	34.5	46.5	55.5	63.8	91.5	109.5	135	159	220.5
Continuous kVA (400 V AC) [kVA]	15.94	21.48	25.64	29.45	42.3	50.6	62.4	73.4	101.8
Continuous kVA (480 V AC) [kVA]	17.5	22.4	28.3	33.3	43.2	54.0	64.0	79.8	103.1
Maximum input current									
Continuous (3x380–440 V) [A]	22.1	29.9	35.2	41.5	57	70.3	84.2	102.9	140.3
Continuous (3x441–480 V) [A]	18.4	24.7	29.3	34.6	49.3	60.8	72.7	88.8	121.1
Intermittent (60 s overload) [A]	33.2	44.9	52.8	62.3	85.5	105.5	126.3	154.4	210.5
Additional specifications									
Maximum cable size (mains, motor, brake) [mm^2 (AWG)]	16 (6)				50 (1/0)				95 (3/0)
Estimated power loss at rated maximum load [W][2)]	289.53	393.36	402.83	467.52	630	848	1175	1250	1507
Weight [kg (lb)], enclosure protection rating IP20	9.4 (20.7)	9.5 (20.9)	12.3 (27.1)	12.5 (27.6)	22.4 (49.4)	22.5 (49.6)	22.6 (49.8)	37.3 (82.2)	38.7 (85.3)
Efficiency [%][3)]	97.8	97.8	98.1	97.9	98.1	98.0	97.7	98.0	98.2

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

Frequency converter typical shaft output [kW (hp)]	Q11K 11 (15)	Q15K 15 (20)	Q18K 18.5 (25)	Q22K 22 (30)	Q30K 30 (40)	Q37K 37 (50)	Q45K 45 (60)	Q55K 55 (75)	Q75K 75 (100)
Enclosure protection rating IP20	J4	J4	J5	J5	J6	J6	J6	J7	J7
Output current									
Continuous (3x380–440 V) [A]	23	31	37	42.5	61	73	90	106	147
Continuous (3x441–480 V) [A]	21	27	34	40	52	65	77	96	124
Intermittent (60 s overload) [A]	25.3	34.1	40.7	46.8	67.1	80.3	99	116.6	161.7
Continuous kVA (400 V AC) [kVA]	15.94	21.48	25.64	29.45	42.3	50.6	62.4	73.4	101.8
Continuous kVA (480 V AC) [kVA]	17.5	22.4	28.3	33.3	43.2	54.0	64.0	79.8	103.1
Maximum input current									
Continuous (3x380–440 V) [A]	22.1	29.9	35.2	41.5	57	70.3	84.2	102.9	140.3
Continuous (3x441–480 V) [A]	18.4	24.7	29.3	34.6	49.3	60.8	72.7	88.8	121.1
Intermittent (60 s overload) [A]	24.3	32.9	38.7	45.7	62.7	77.3	92.6	113.2	154.3
Additional specifications									
Maximum cable size (mains, motor, brake) [mm^2 (AWG)]	16 (6)				50 (1/0)				95 (3/0)
Estimated power loss at rated maximum load [W][2)]	289.53	393.36	402.83	467.52	630	848	1175	1250	1507
Weight [kg (lb)], enclosure protection rating IP20	9.4 (20.7)	9.5 (20.9)	12.3 (27.1)	12.5 (27.6)	22.4 (49.4)	22.5 (49.6)	22.6 (49.8)	37.3 (82.2)	38.7 (85.3)
Efficiency [%][3)]	97.8	97.8	98.1	97.9	98.1	98.0	97.7	98.0	98.2

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

1) Heavy duty=150–160% current during 60 s, Normal duty=110% current during 60 s.

2) The typical power loss is at nominal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions).

Values are based on a typical motor efficiency (IE2/IE3 border line). Motors with lower efficiency add to the power loss in the frequency converter and motors with high efficiency reduce power loss.

Applies to dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may rise. LCP and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses (though typically only 4 W extra for a fully loaded control card, fieldbus, or options for slot B).

For power loss data according to EN 50598-2, refer to www.danfoss.com/vltenergyefficiency.

3) Measured using 5 m shielded motor cables at rated load and rated frequency for enclosure sizes J1–J5, and using 33 m shielded motor cables at rated load and rated frequency for enclosure sizes J6 and J7. For energy efficiency class, see the Ambient Conditions section in chapter 8 Specifications. For part load losses, see www.danfoss.com/vltenergyefficiency.

8.2 General Technical Data

Mains supply (L1, L2, L3)

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

1) The frequency converter can run at -25% input voltage with reduced performance. The maximum output power of the frequency converter is 75% if input voltage is -25%, and 85% if input voltage is -15%.
Full torque cannot be expected at mains voltage lower than 10% below the lowest rated supply voltage of the frequency converter.

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cos ϕ)	Near unity (>0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤7.5 kW (10 hp)	Maximum 2 times/minute
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW (15–100 hp)	Maximum 1 time/minute

The unit is suitable for use on a circuit capable of delivering less than 5000 RMS symmetrical Amperes, 480 V maximum.

Motor output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency in U/f mode (for AM motor)	0–500 Hz
Output frequency in VVC$^+$ mode (for AM motor)	0–200 Hz
Output frequency in VVC$^+$ mode (for PM motor)	0–400 Hz
Switching on output	Unlimited
Ramp time	0.01–3600 s

Torque characteristics

Starting torque (high overload)	Maximum 160% for 60 s[1)2)]
Overload torque (high overload)	Maximum 160% for 60 s[1)2)]
Starting torque (normal overload)	Maximum 110% for 60 s[1)2)]
Overload torque (normal overload)	Maximum 110% for 60 s[1)2)]
Starting current	Maximum 200% for 1 s
Torque rise time in VVC$^+$ (independent of f_{sw})	Maximum 50 ms

1) Percentage relates to the nominal torque. It is 150% for 11–75 kW (15–100 hp) frequency converters.
2) Once every 10 minutes.

Cable lengths and cross-sections[1)]

Maximum motor cable length, shielded	50 m (164 ft)
Maximum motor cable length, unshielded	0.37–22 kW (0.5–30 hp): 75 m (246 ft), 30–75 kW (40–100 hp): 100 m (328 ft)
Maximum cross-section to control terminals, flexible/rigid wire	2.5 mm^2/14 AWG
Minimum cross-section to control terminals	0.55 mm^2/30 AWG

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

Digital inputs

Programmable digital inputs	7
Terminal number	18, 19, 27[1)], 29[1)], 31, 32, 33
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	< 5 V DC
Voltage level, logic 1 PNP	> 10 V DC
Voltage level, logic 0 NPN	> 19 V DC
Voltage level, logic 1 NPN	< 14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	4 Hz–32 kHz
(Duty cycle) minimum pulse width	4.5 ms

Input resistance, R_i	Approximately 4 kΩ

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

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

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

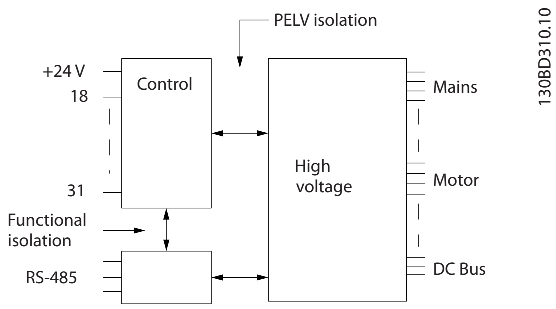


Illustration 8.1 Analog Inputs

NOTICE

HIGH ALTITUDE

For installation at altitudes above 2000 m (6562 ft), contact Danfoss hotline regarding PELV.

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Maximum frequency at terminal 29, 33	32 kHz (push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	See the section on digital input
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy	Maximum error: 0.1% of full scale

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

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

Control card, RS485 serial communication

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

The RS485 serial communication circuit is galvanically isolated from the supply voltage (PELV).

Digital outputs

Programmable digital/pulse outputs	2
Terminal number	27, 29[1)]
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	4 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error: 0.1% of full scale
Resolution of frequency output	10 bit

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

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

Control card, 24 V DC output

Terminal number	12
Maximum load	100 mA

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

Relay outputs

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

1) IEC 60947 t 4 and 5.
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation.
The relays can be used on different loads (resistive load or inductive load) with different life cycles. The life cycle depends on the configuration of the specific load.

Control card, +10 V DC output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	15 mA

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

Control characteristics

Resolution of output frequency at 0–500 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, and 33)	≤2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	±0.5% of nominal speed
Speed accuracy (closed loop)	±0.1% of nominal speed

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

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Ambient conditions	
Enclosure sizes J1–J7	IP20
Vibration test, all enclosure sizes	1.0 g
Relative humidity	5–95% (IEC 721-3-3); Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Test method according to IEC 60068-2-43 H_2S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	Maximum 55 °C (131 °F) [1)2)]
- at full continuous output current with some power size	Maximum 50 °C (122 °F)
- at full continuous output current	Maximum 45 °C (113 °F)
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)
EMC standards, emission	EN 61800-3, EN 61000-3-2, EN 61000-3-3, EN 61000-3-11, EN 61000-3-12, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
Energy efficiency class[3)]	IE2

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1) Refer to Special Conditions in the design guide for:

- *Derating for high ambient temperature.*
- *Derating for high altitude.*

2) To prevent control card overtemperature on PROFIBUS and PROFINET variants of VLT® AutomationDrive FC 360, avoid full digital/analog I/O load at ambient temperature higher than 45 °C (113 °F).
3) Determined according to EN 50598-2 at:

- *Rated load.*
- *90% rated frequency.*
- *Switching frequency factory setting.*
- *Switching pattern factory setting.*

Control card performance	
Scan interval	1 ms

Protection and features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heat sink ensures that the frequency converter trips when the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heat sink is below the temperature limit.
- The frequency converter is protected against short circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load and parameter setting).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips when the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against ground faults on motor terminals U, V, W.

8.3 Fuse

Use fuses and/or circuit breakers on the supply side to protect service personnel and equipment from injuries and damage if there is component breakdown inside the frequency converter (first fault).

Branch circuit protection
Protect all branch circuits in an installation, switchgear, and machines against short circuit and overcurrent according to national/international regulations.

NOTICE

The recommendations do not cover branch circuit protection for UL.

Table 8.4 lists the recommended fuses that have been tested.

⚠WARNING

PERSONAL INJURY AND EQUIPMENT DAMAGE RISK
Malfunction or failing to follow the recommendations may result in personal risk and damage to the frequency converter and other equipment.

- **Select fuses according to recommendations. Possible damage can be limited to be inside the frequency converter.**

NOTICE

Using fuses or circuit breakers is mandatory to ensure compliance with IEC 60364 for CE.

Danfoss recommends using the fuses in *Table 8.4* on a circuit capable of delivering 100000 A_{rms} (symmetrical), 380–480 V depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 A_{rms}.

Enclosure size	Power [kW (hp)]	CE compliance fuse
J1	0.37–1.1 (0.5–1.5)	gG-10
	1.5 (2)	
	2.2 (3)	
J2	3.0 (4)	gG-25
	4.0 (5.5)	
	5.5 (7.5)	
J3	7.5 (10)	gG-32
J4	11–15 (15–20)	gG-50
J5	18.5 (25)	gG-80
	22 (30)	
J6	30 (40)	gG-125
	37 (50)	
	45 (60)	
J7	55 (75)	aR-250
	75 (100)	

Table 8.4 CE Fuse, 380–480 V, Enclosure Sizes J1–J7

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8.4 Connection Tightening Torques

Make sure to use the right torques when tightening all electrical connections. Too low or too high torque may cause electrical connection problems. Use a torque wrench to ensure that correct torques are applied.

Enclosure size	Power [kW (hp)]	Torque [Nm (in-lb)]						
		Mains	Motor	DC connection	Brake	Ground	Control	Relay
J1	0.37–2.2 (0.5–3)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	3 (26.6)	0.44 (3.89)	0.5 (4.4)
J2	3.0–5.5 (4–7.5)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	3 (26.6)	0.44 (3.89)	0.5 (4.4)
J3	7.5 (10)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	0.8 (7.1)	3 (26.6)	0.44 (3.89)	0.5 (4.4)
J4	11–15 (15–20)	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	1.6 (14.2)	0.44 (3.89)	0.5 (4.4)
J5	18.5–22 (25–30)	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	1.2 (10.6)	1.6 (14.2)	0.44 (3.89)	0.5 (4.4)
J6	30–45 (40–60)	3.5 (31.0)	3.5 (31.0)	3.5 (31.0)	–	1.6 (14.2)	0.44 (3.89)	0.5 (4.4)
J7	55 (75)	12 (106.2)	12 (106.2)	12 (106.2)	–	1.6 (14.2)	0.44 (3.89)	0.5 (4.4)
J7	75 (100)	14 (123.9)	14 (123.9)	14 (123.9)	–	1.6 (14.2)	0.44 (3.89)	0.5 (4.4)

Table 8.5 Tightening Torques

Index

T

U

V

W

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