TR150 and TR170 Service Manual

BAS-SVM04B-EN

February 2017

BAS-SVM04B-EN

Contents

1

1 Introduction

1.1 Purpose

This manual provides the technical information and instructions required, for a qualified technician approved by Trane to identify faults and perform repairs and maintenance on the frequency converter:

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

The manual applies to frequency converter models and voltage ranges described in *Table 1.2* to *Table 1.4*.

1.2 Product Overview

TR150 and TR170 frequency converters are designed for the Heating, Ventilation, and Air-Conditioning (HVAC) markets. They operate in variable torque mode, and include features suited for fan and pump applications within the HVAC market.

1.3 Safety

⚠CAUTION

Frequency converters contain dangerous voltages when connected to mains. Only qualified personnel should carry out the service. See also *chapter 2.1 Introduction*.

⚠CAUTION

For dynamic test procedures, main input power is required and all devices and power supplies connected to mains are energized at rated voltage. Take extreme caution when conducting tests in a powered frequency converter. Contact with powered components could result in electrical shock and personal injury.

1. DO NOT touch electrical parts of the frequency converter when connected to mains. Also make sure that other voltage inputs have been disconnected (linkage of DC intermediate circuit). There may be high voltage on the DC-link even when the LEDs are turned off. Before touching any potentially live parts of the frequency converter, wait at least as stated in *Table 1.1*.
2. Before conducting repair or inspection, disconnect mains.
3. [Off] on the LCP does not disconnect mains.
4. During operation and while programming parameters, the motor may start without warning. Press [Stop] when changing data.
5. When operating on a PM motor, disconnect motor cable.

Voltage [V]	Power range [kW]	Minimum waiting time (minutes)
3x200	0.25–3.7	4
3x200	5.5–11	15
3x400	0.37–7.5	4
3x400	11–90	15
3x600	2.2–7.5	4
3x600	11–90	15

Table 1.1 Discharge Time

1.4 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.**

1.4.1 Frame Size Definitions

Model	HP @200–240 V AC	kW @200–240 V AC	Frame Size	IP Rating	Repairable Yes/No
PK25	0.33	0.25	H1	IP20	No
PK37	0.5	0.37	H1	IP20	No
PK75	1.0	0.75	H1	IP20	No
P1K5	2.0	1.5	TR150: H1 TR170: H2	IP20	No
P2K2	3.0	2.2	H2	IP20	No
P3K7	5.0	3.7	H3	IP20	No
P5K5	7.5	5.5	H4	IP20	No
P7K5	10.0	7.5	H4	IP20	No
P11K	15.0	11.0	H5	IP20	No
P15K	20.0	15.0	H6	IP20	Yes
P18K	25.0	18.5	H6	IP20	Yes
P22K	30.0	22.0	H7	IP20	Yes
P30K	40.0	30.0	H7	IP20	Yes
P37K	50.0	37.0	H8	IP20	Yes
P45K	60.0	45.0	H8	IP20	Yes

Table 1.2 TR150 and TR170 Frequency Converters 200–240 V AC

Model	HP @380–480 V AC	kW @380–480 V AC	Frame Size	IP Rating	Repairable Yes/No
PK37	0.5	0.37	H1	IP20	No
PK75	1.0	0.75	H1	IP20	No
P1K5	2.0	1.5	TR150:H1 TR170:H2	IP20	No
P2K2	3.0	2.2	H2	IP20	No
P3K0	4.0	3.0	H2	IP20	No
P4K0	5.0	4.0	H2	IP20	No
P5K5	7.5	5.5	H3	IP20	No
P7K5	10.0	7.5	H3	IP20	No
P11K	15.0	11.0	H4	IP20	No
P15K	20.0	15.0	H4	IP20	No
P18K	25.0	18.0	H5	IP20	No
P22K	30.0	22.0	H5	IP20	No
P30K	40.0	30.0	H6	IP20	Yes
P37K	50.0	37.0	H6	IP20	Yes
P45K	60.0	45.0	H6	IP20	Yes
P55K	70.0	55.0	H7	IP20	Yes
P75K	100.0	75.0	H7	IP20	Yes
P90K	125.0	90.0	H8	IP20	Yes
PK75	1.0	0.75	I2	IP54	No
P1K5	2.0	1.5	I2	IP54	No
P2K2	3.0	2.2	I2	IP54	No
P3K3	4.0	3.3	I2	IP54	No
P4K0	5.0	4.0	I2	IP54	No
P5K5	7.5	5.5	I3	IP54	No
P7K5	10.0	7.5	I3	IP54	No
P11K	15.0	11.0	I4	IP54	No
P15K	20.0	15.0	I4	IP54	No
P22K	25.0	18.0	I4	IP54	No
P11K	15.0	11.0	I5	IP54	No
P15K	20.0	15.0	I5	IP54	No
P22K	25.0	18.0	I5	IP54	No
P22K	30.0	22.0	I6	IP54	Yes
P30K	40.0	30.0	I6	IP54	Yes
P37K	50.0	37.0	I6	IP54	Yes
P45K	60.0	45.0	I7	IP54	Yes
P55K	70.0	55.0	I7	IP54	Yes
P75K	100.0	75.0	I8	IP54	Yes
P90K	125.0	90.0	I8	IP54	Yes

Table 1.3 TR150 and TR170 Frequency Converters 380–480 V AC

Model	HP @525–600 V AC	kW @525–600 V AC	Frame Size	IP Rating	Repairable Yes/No
P2K2	3.0	2.2	H9	IP20	No
P3K0	4.0	3.0	H9	IP20	No
P5K5	7.5	5.5	H9	IP20	No
P7K5	10.0	7.5	H9	IP20	No
P11K	15.0	11.0	H10	IP20	Yes
P15K	20.0	15.0	H10	IP20	Yes
P22K	30.0	22.0	H6	IP20	Yes
P30K	40.0	30.0	H6	IP20	Yes
P45K	60.0	45.0	H7	IP20	Yes
P55K	70.0	55.0	H7	IP20	Yes
P75K	100.0	75.0	H8	IP20	Yes
P90K	125.0	90.0	H8	IP20	Yes

Table 1.4 Repairable Yes/No Frequency Converters 525–600 V AC

1.5 Tools Required

Quick Guide for TR150 and TR170.

ESD Protection Kit	Wrist strap and Mat
Metric socket set	7–19 mm
Torque wrench	0.5 N · m to 19 N · m
Socket extensions	100–150 mm (4 in and 6 in)
Torx driver set	T10-T50
Needle nose pliers	
Magnetic sockets	
Ratchet	
Screwdrivers	Standard and Philips

Table 1.5 Required Tools

Additional Tools Recommended for Testing

- Digital voltmeter/ohmmeter (must be rated for 1000 V DC for 600 V units)
- Analog voltmeter
- Oscilloscope
- Clamp-on style ammeter

1.6 Electrical Installation in General

1.6.1 Electrical Installation in General

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper conductors are required. 75 °C (167 °F) is recommended. For TR170 drives operating in ambients over 50 °C (122 °F), copper conductors rated 80 °C (176 °F) or higher are recommended.

Power [kW (hp)]				Torque [N · m (in-lb)]					
Enclosure size	IP class	3x200–240 V	3x380–480 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
TR150									
H1	IP20	0.25–1.5 (0.33–2)	0.37–1.5 (0.5–2)	0.8 (7)	0.8 (7)	0.8 (7)	0.5 (4)	0.8 (7)	0.5 (4)
H2	IP20	2.2 (3)	2.2–4.0 (3–5)	0.8 (7)	0.8 (7)	0.8 (7)	0.5 (4)	0.8 (7)	0.5 (4)
H3	IP20	3.7 (5)	5.5–7.5 (7.5–10)	0.8 (7)	0.8 (7)	0.8 (7)	0.5 (4)	0.8 (7)	0.5 (4)
H4	IP20	5.5–7.5 (7.5–10)	11–15 (15–20)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4)	0.8 (7)	0.5 (4)
H5	IP20	11 (15)	18.5–22 (25–30)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4)	0.8 (7)	0.5 (4)
H6	IP20	15–18.5 (20–25)	30–45 (40–60)	4.5 (40)	4.5 (40)	–	0.5 (4)	3 (27)	0.5 (4)
H7	IP20	22–30 (30–40)	55 (70)	10 (89)	10 (89)	–	0.5 (4)	3 (27)	0.5 (4)
H7	IP20	–	75 (100)	14 (124)	14 (124)	–	0.5 (4)	3 (27)	0.5 (4)
H8	IP20	37–45 (50–60)	90 (125)	24 (212)[1)]	24 (212)[1)]	–	0.5 (4)	3 (27)	0.5 (4)
TR170									
H2	IP20	1.5 (2)	1.5 (2)	0.8 (7)	0.8 (7)	0.8 (7)	0.5 (4)	0.8 (7)	0.5 (4)

Table 1.6 Tightening Torques for Enclosure Sizes H1–H8, 3x200–240 V & 3x380–480 V

Power [kW (hp)]			Torque [N · m (in-lb)]					
Enclosure size	IP class	3x525–600 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
TR150								
H9	IP20	2.2–7.5 (3–10)	1.8 (16)	1.8 (16)	Not recommended	0.5 (4)	3 (27)	0.6 (5)
H10	IP20	11–15 (15–20)	1.8 (16)	1.8 (16)	Not recommended	0.5 (4)	3 (27)	0.6 (5)
H6	IP20	18.5–30 (25–40)	4.5 (40)	4.5 (40)	–	0.5 (4)	3 (27)	0.5 (4)
H7	IP20	37–55 (50–70)	10 (89)	10 (89)	–	0.5 (4)	3 (27)	0.5 (4)
H8	IP20	75–90 (100–125)	14 (124)/24 (212)[2)]	14 (124)/24 (212)[2)]	–	0.5 (4)	3 (27)	0.5 (4)

Table 1.7 Tightening Torques for Enclosure Sizes H6–H10, 3x525–600 V

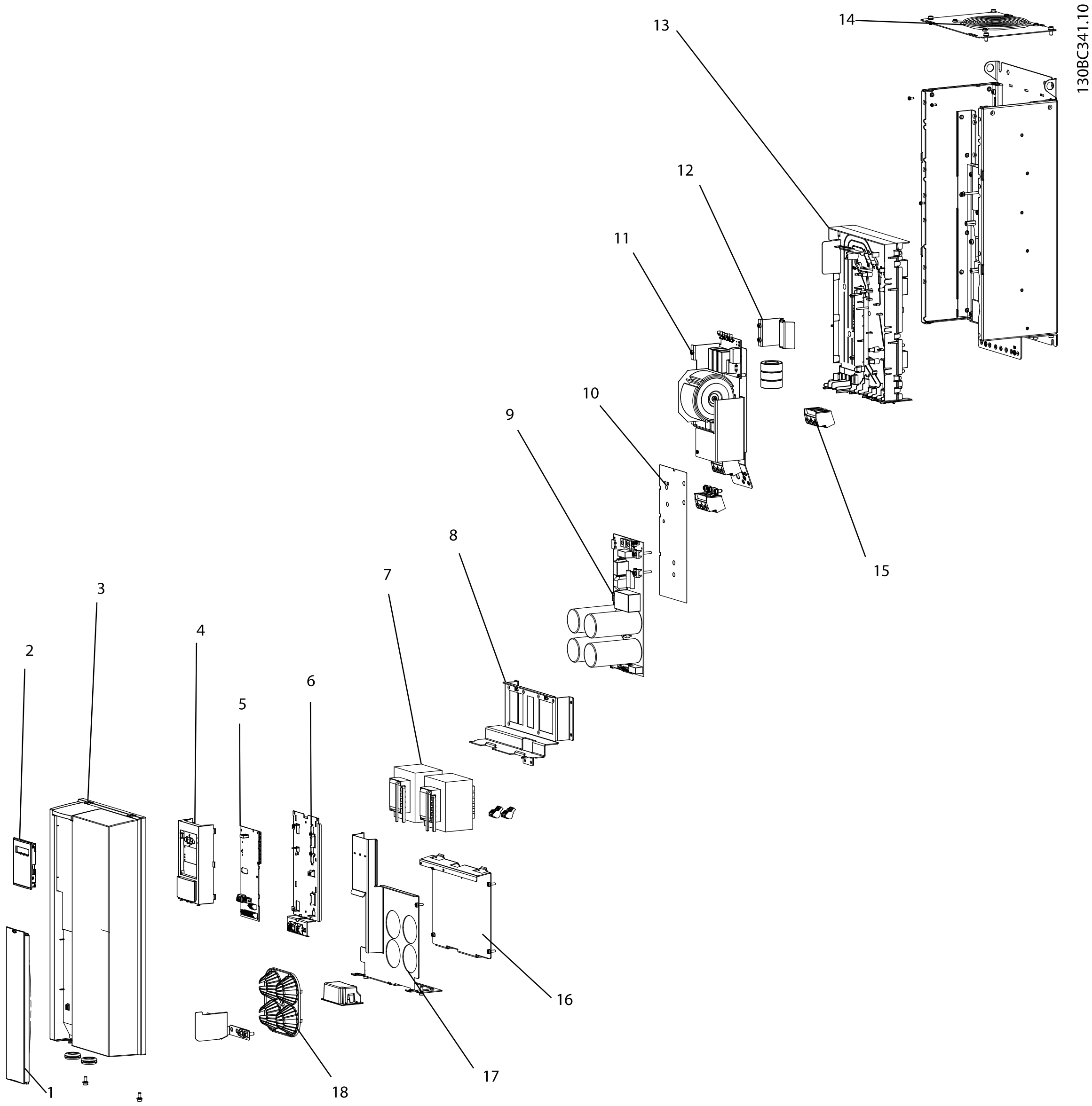
1) Cable dimensions >95 mm^2

2) Cable dimensions ≤95 mm^2

1.7 Exploded Views – H Frame Size

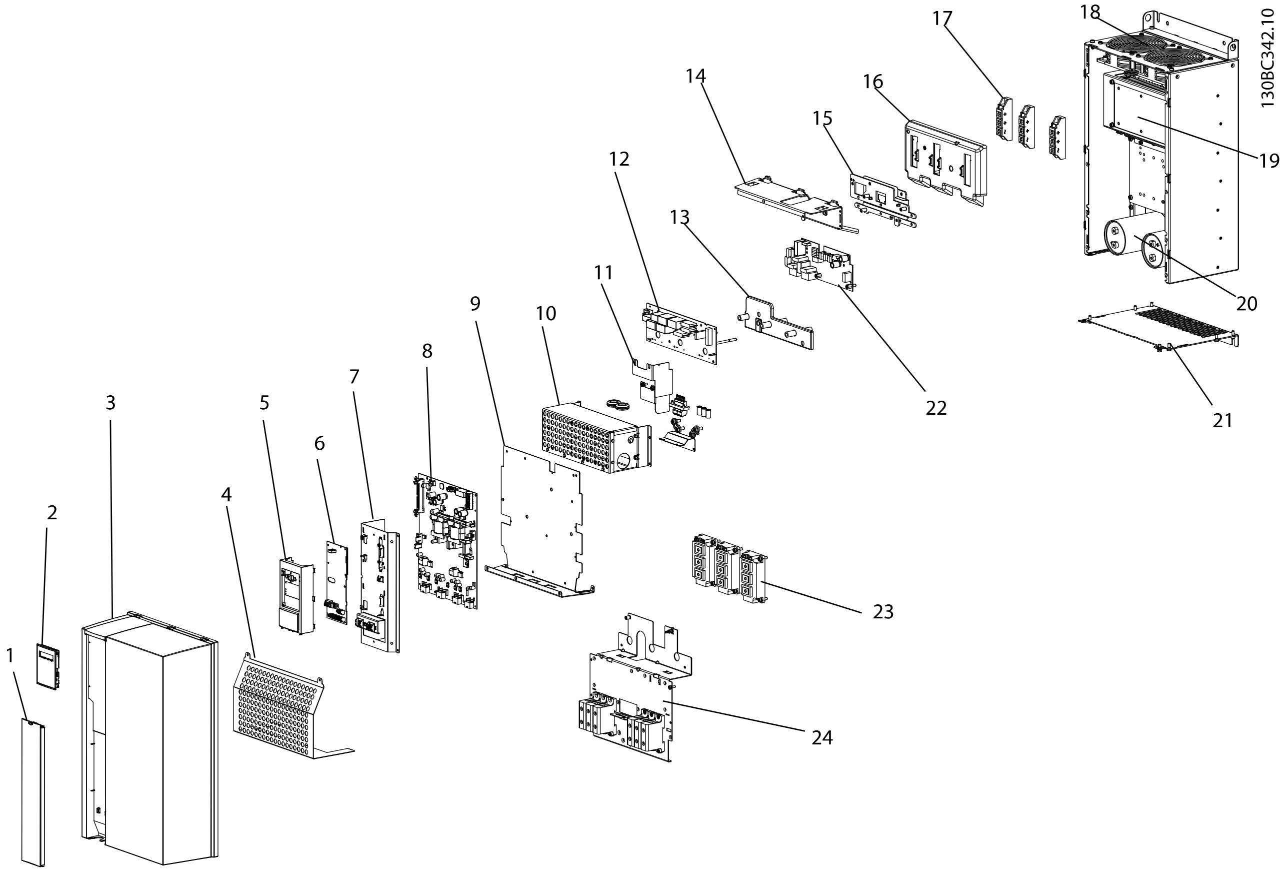
NOTICE

Non-repairable units are not shown with exploded views.



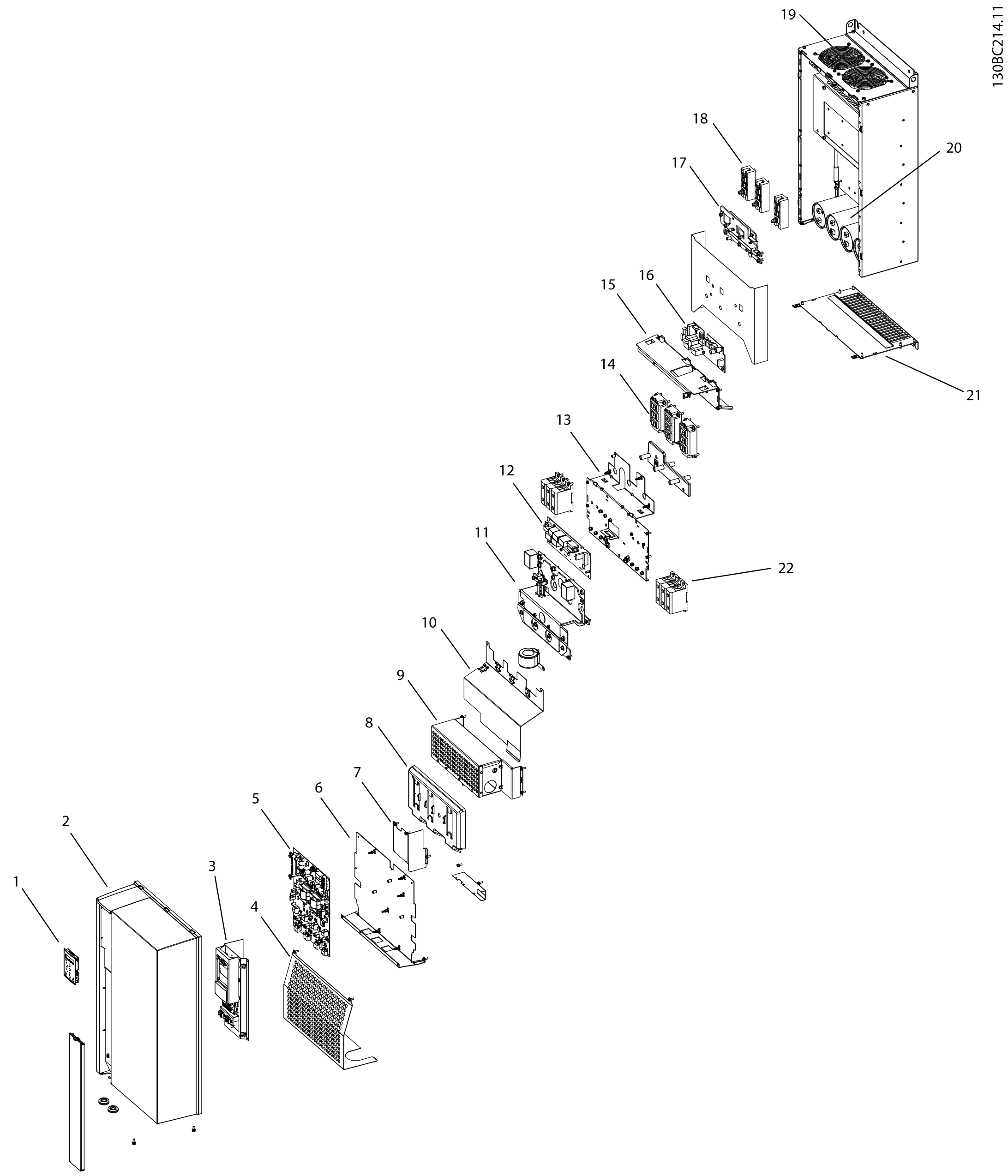
1	Blind cover	10	Filter protection cover
2	Front cover LCP	11	RFI filter
3	Cradle	12	EMC shield
4	Control card	13	Bus bar unit
5	Control card mounting plate	14	Heat sink fan assembly
6	DC coils	15	Connector
7	Coil mounting plate	16	DC coil cover
8	Coil mounting plate	17	Capacitor bank metal cover
9	DC link card	18	Capacitor vibration support

Illustration 1.1 Exploded View - H6 Frame Size



1	Blind cover	13	Relay/transducer card mounting plate
2	LCP	14	DC coil cover plate
3	Front cover	15	Bus bar
4	EMC shield	16	Plastic cover
5	Cradle	17	Rectifier modules
6	Control card	18	Heat sink fan assembly
7	Control card mounting plate	19	DC coils
8	Power card	20	Capacitors
9	Power card mounting plate	21	Base plate
10	RFI filter	22	Relay/transducer card
11	EMC shield	23	IGBT
12	Inrush card	24	Cable mounting plate

Illustration 1.2 Exploded View - H7 Frame Size

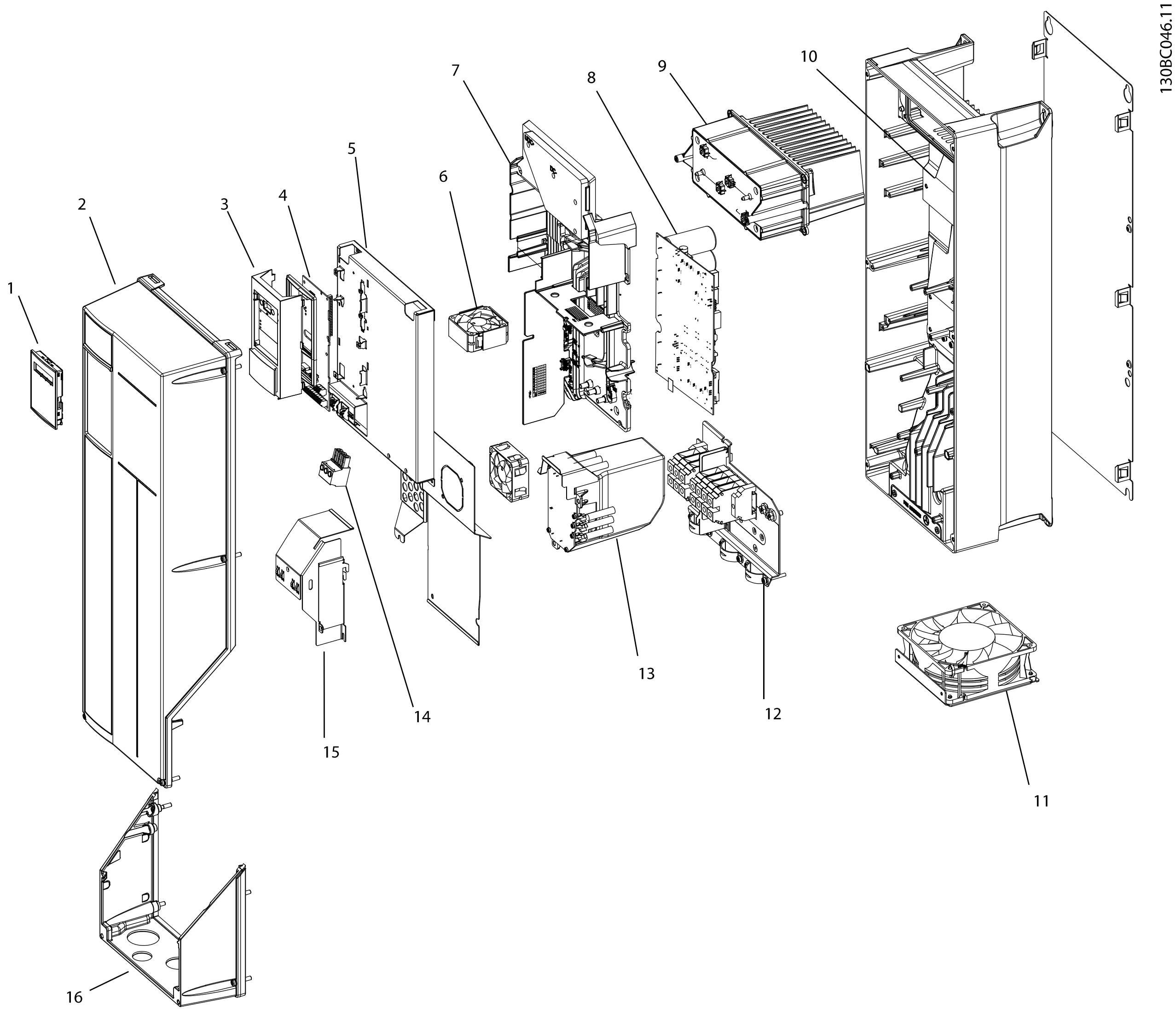


1	LCP	12	SMPS card
2	Front cover	13	Cable mounting plate
3	Cradle, control card, and mounting plate	14	IGBT
4	EMC shield	15	Relay/transducer card mounting plate
5	Power card	16	Relay/transducer card
6	Power card mounting plate	17	Bus bar
7	Support bracket	18	Rectifier modules
8	Plastic cover	19	Heat sink fan assembly
9	RFI filter	20	Capacitors
10	DC coil cover plate	21	Base cover
11	Bus bar unit	22	Connection terminals

Illustration 1.3 Exploded View - H8 Frame Size

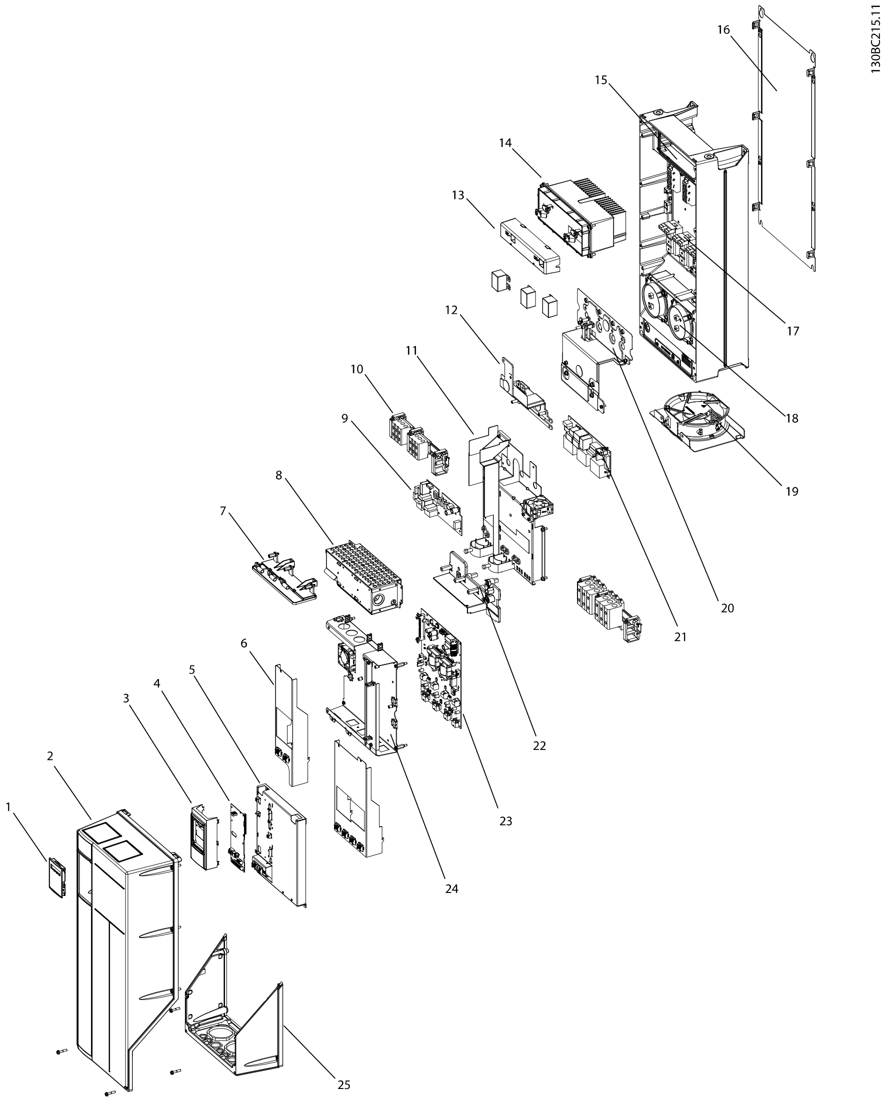
1

1.8 Exploded Views - I Frame Size



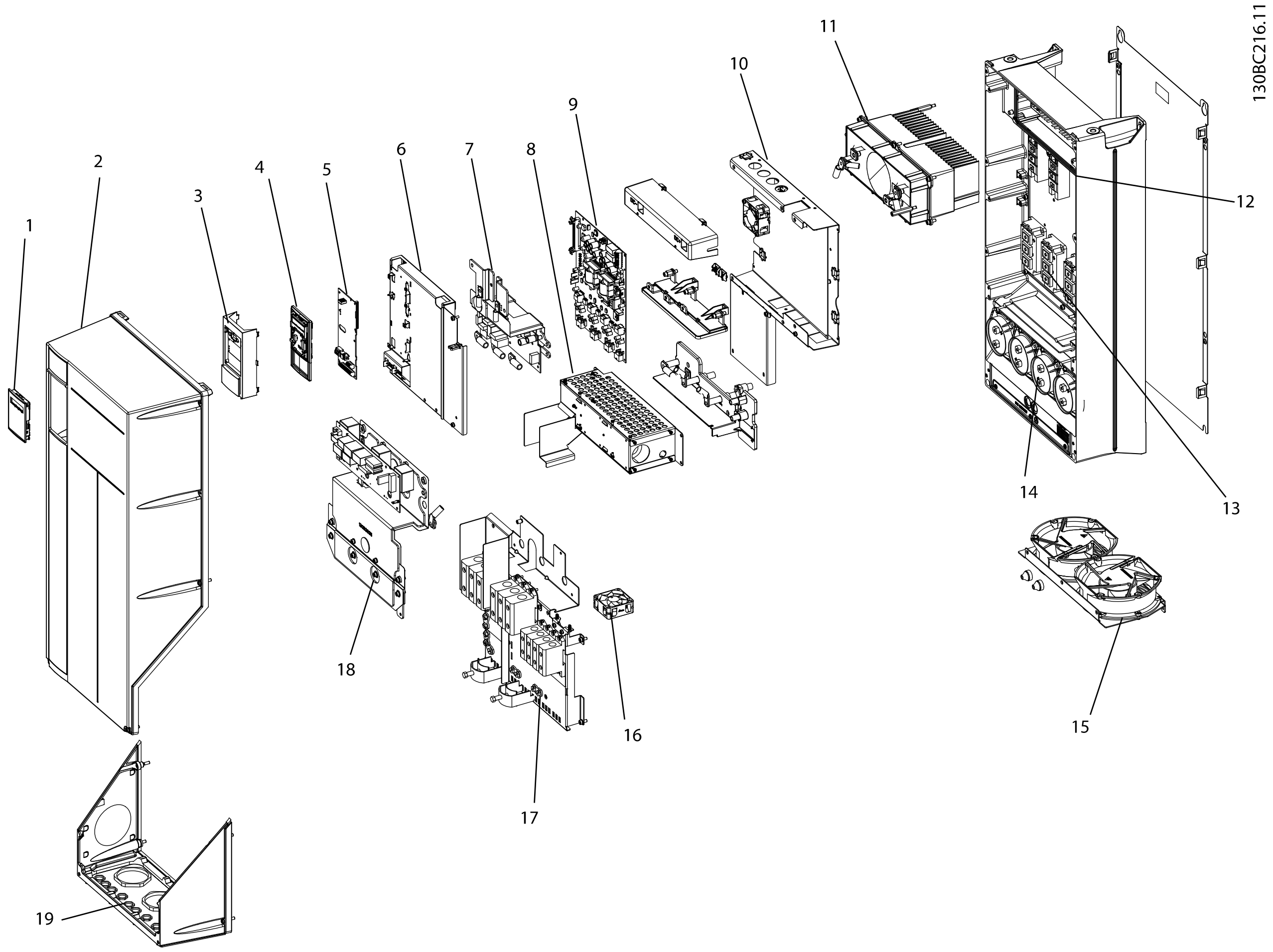
1	Local Control Panel (LCP)	9	DC coil
2	Front cover	10	Heat sink
3	Cradle	11	Fan assembly
4	Control card	12	Cable mounting plate
5	Control card mounting plate	13	RFI filter
6	Fan	14	Connectors
7	Bus bar unit	15	EMC shield
8	Power card	16	Cable entry

Illustration 1.4 Exploded View - I6 Frame Size



1	Local Control Panel (LCP)	14	DC coil
2	Front door	15	Thyristors
3	Cradle	16	Back plate
4	Control card	17	IGBT
5	Control card mounting plate	18	Capacitor
6	Terminal plates	19	Heat sink fan
7	Support bracket	20	Bus bar unit
8	RFI filter	21	Relay/transducer card
9	Inrush card	22	Relay card mounting plate
10	Terminal connectors	23	Power card
11	Cable mounting plate	24	Power card mounting plate
12	Bus bar	25	Cable entry
13	Bracket		

Illustration 1.5 Exploded View - I7 Frame Size



1	LCP	11	DC coil
2	Front cover	12	Rectifier modules
3	Cradle	13	IGBTs
4	LCP gasket	14	Capacitors
5	Control card	15	Heat sink fan assembly
6	Control card mounting plate	16	Fan
7	Support bracket	17	Cable mounting plate
8	RFI filter	18	Relay/transducer card with mounting plate
9	Power Card	19	Cable entry
10	Power card mounting plate		

Illustration 1.6 Exploded View - I8 Frame Size

1.9 Ratings

1.9.1 Short Circuit and Overcurrent Trips

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

1.9.2 DC Voltage Levels

	200–240 V AC		**380–480 V AC**		**525–600 V AC**
	H1–H5	**H6–H8**	**H1–H5** **I2–I3–I4**	**H6–H8** **I6–I8**	**H6–H10**
Inrush circuit enabled					
Inrush circuit disabled	202	184	314	372	532
Undervoltage	202	184	314	372	532
Undervoltage re-enable	202+15	184+16	314+30	372+24	532+20
Overvoltage	410	412	800	800	976
Overvoltage re-enable	410-15	412-16	800-30	800-24	976-20
IT Grid Turn on	410+25	412+25	800+35	800+35	976+35

Table 1.8 DC Voltage Levels

2

2 Frequency Converter Control

2.1 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.

2.2 Status Messages

Status messages appear in the bottom of the display. The left part of the status line indicates the active operation model of the frequency converter.

The center part of the status line indicates the references site. The last part of the status line gives the operation status, for example:

- Running.
- Stop.
- Standby.

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

2.3 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, and speed reference.
- Via serial communication from a fieldbus, connected to the frequency converter through the RS485 serial port, or through a communication option card. The serial communication protocol:
  - Supplies commands and references to the frequency converter.
  - Programs the frequency converter.
  - Reads status data from the frequency converter.
- Via signal wiring connected to the frequency converter control terminals. Improperly connected control wiring can result in the frequency converter failing to start or to respond to a remote input.

2.3.1 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. Analog or digital inputs are wired to terminals 53 or 54 and 55 (common). A switch placed under the LCP sets the terminal functions. Some options include additional terminals.

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

Digital signals are a simple binary 0 or 1 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, 1 is close. Digital inputs to the frequency converter are switched commands such as start, stop, reverse, coast, 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 shields only when the control cable is run between frequency converters, and not between frequency converters and other devices.

Parameters for configuring the input and output using NPN and PNP.

These parameters cannot be changed while the motor is running.

2.3.2 Output Signals

The frequency converter also produces output signals that are carried either through the RS485 serial bus or terminal 42. Output terminal 42 operates in the same manner as the inputs. The terminal can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 V DC. In addition, a pulse reference can be provided on terminals 27 and 29. Output analog signals generally indicate the frequency, 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.

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

Number of digital outputs	2
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 2.1 Digital Output

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

2.4 Service Functions

Service information for the frequency converter can be shown in display lines 1 and 2. 24 different items can be accessed. Included in the data are

- Counters that tabulate hours run, and so on.
- Fault logs that store frequency converter status values present at the ten 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.

Parameter settings are shown by pressing [Main Menu].

Press [▲], [▼], [►] and [◄] to scroll through parameters.

See the *Quick Guide* for detailed information on accessing and showing parameters, and for descriptions and procedures for service information available in *parameter group 6-** Analog In/Out*.

2.5 Control Terminals

For proper function of the 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 *Quick Guide* for details on changing parameters and the functions available for each control terminal.

2

2.6 Control Terminal Functions

Table 2.2 describes the functions of the control terminals. Many of these terminals have multiple functions determined by parameter settings. See *Illustration 2.1*.

Terminal number	Function
01, 02, 03	Form C relay output on control card. Maximum 240 V AC, 2 A. Minimum 24 V DC, 10 mA, or 24 V AC, 100 mA. Can be used for indicating status and warnings. Physically located on power card.
04, 05	Form A relay output on control card. 30 V AC, 42.5 V DC. Can be used for indicating status and warnings.
12, 13	Voltage supply to digital inputs and external transducers. For the 24 V DC to be used for digital inputs, switch 4 on the control card must be closed (ON position). The maximum output current is 200 mA.
16–33	Programmable digital inputs for controlling the frequency converter. R=2 kΩ. Less than 5 V=logic 0 (open). Greater than 10 V=logic 1 (closed).
20	Common for digital inputs.
39	Common for analog and digital outputs.
42, 45	Analog and digital outputs for indicating values such as frequency, reference, current, and torque. The analog signal is 0–20 mA, or 4–20 mA at a maximum of 500 Ω. The digital signal is 24 V DC at a minimum of 600 Ω.
50	10 V DC, 17 mA maximum analog supply voltage for potentiometer or thermistor.
53, 54	0–10 V DC voltage input, R = 10 kΩ Used for reference or feedback signals. A thermistor can be connected here.
55	Common for analog inputs. This common is isolated from the common of all other power supplies. If, for example, the frequency converter's 24 V DC power supply is used to power an external transducer, which provides an analog input signal, terminal 55 must be wired to terminal 39.
60	Programmable 0–20 mA or 4–20 mA, analog current input, Resistance=approx. 200 Ω. Used for reference or feedback signals.
61	RS485 common.
68, 69	RS485 interface and serial communication.

Table 2.2 Terminal Functions

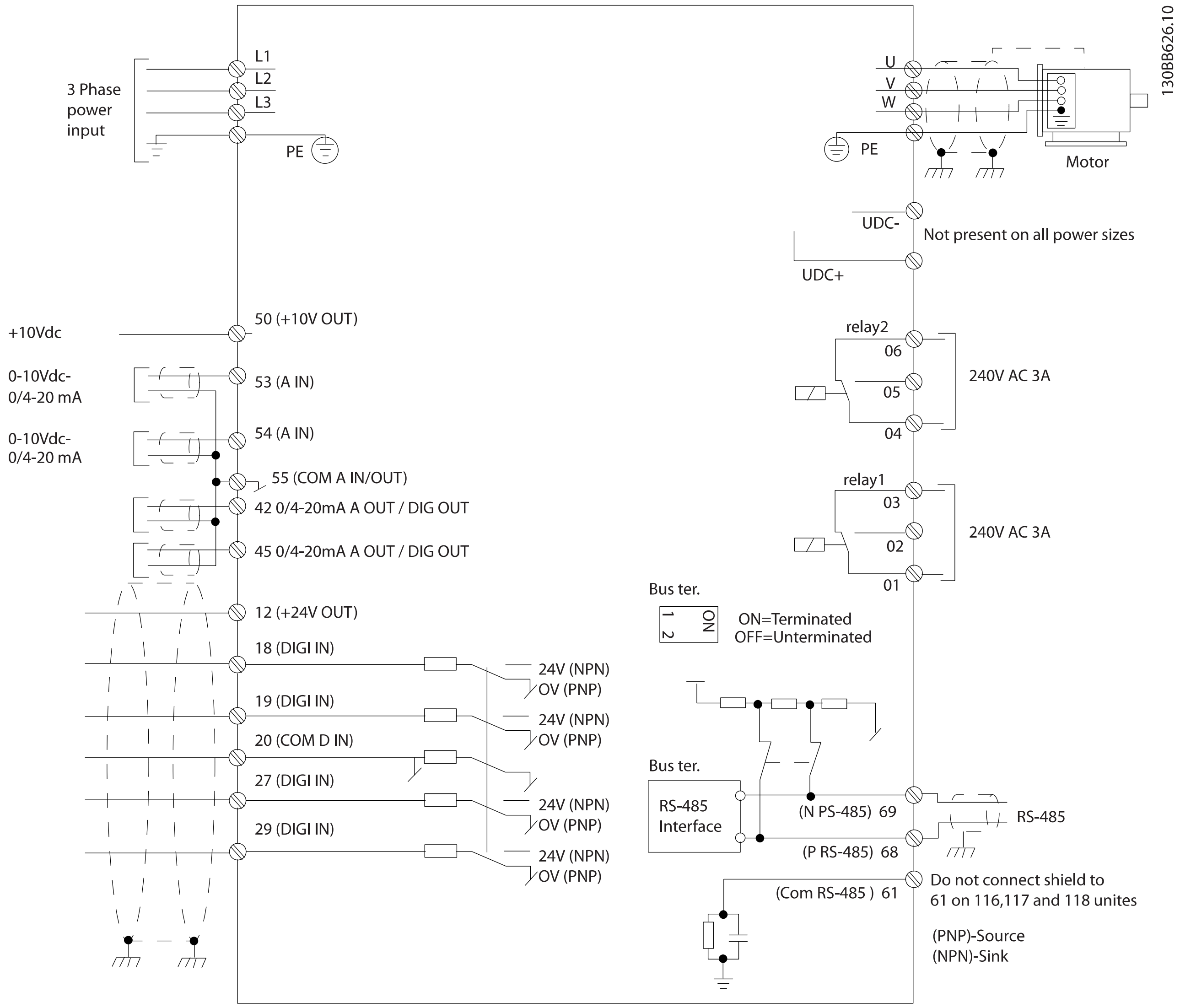


Illustration 2.1 Control Terminal Electrical Overview

Control terminals must be programmed. 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 *TR150 and TR170 Quick Guide* for details.

2

2.7 Grounding Shielded Cables

Connect the shielded control cables to the metal cabinet of the frequency converter with cable camps at both ends. *Illustration 2.3* 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.

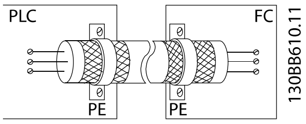
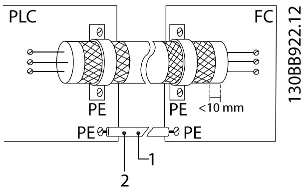


Illustration 2.2 Correct Grounding

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 2.3 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.

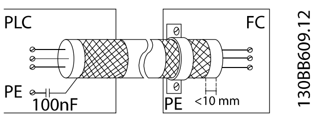


Illustration 2.4 50/60 Hz Ground Loops

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.

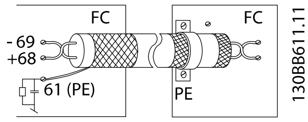


Illustration 2.5 Serial Communication Control Cables

3 Internal Frequency Converter Operation

3.1 General

This chapter provides an operational overview of the main assemblies and circuitry in the frequency converter.

3.2 Description of Operation

3.2.1 Control Logic Section

The control card includes most of the logic section (see *Illustration 3.2*). The primary logic element of the control card is a microprocessor, which supervises and controls all functions of frequency converter operation. In addition, a separate PROM contains the parameters to provide the user with programmable options. These parameters are programmed to enable the frequency converter to meet specific application requirements. This data is stored in an EEPROM providing security during power-down and also allows the flexibility to change the operational characteristics of the frequency converter.

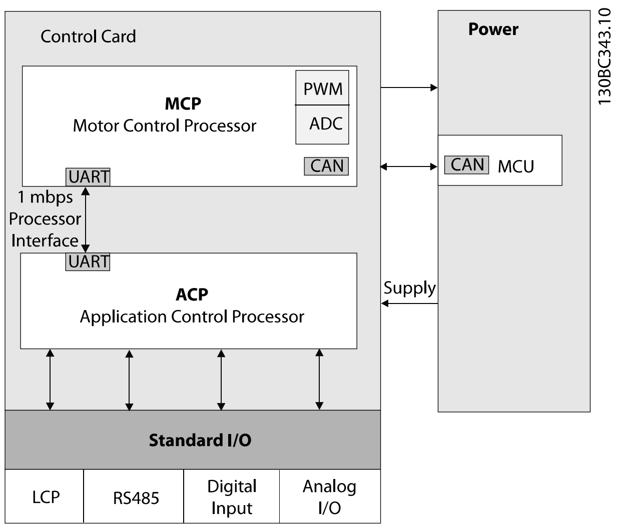


Illustration 3.1 Logic Section

Another part of the logic section is the removable LCP or display mounted on the front of the frequency converter. The LCP provides a user interface to the frequency converter.

All programmable parameter settings can be uploaded into the EEPROM of the LCP. This function helps in maintaining a back-up frequency converter profile and parameter set. Its download function can be used in programming other frequency converters or restoring a program to a repaired unit. The LCP is removable during operation to prevent undesired program changes. With the addition of a remote mounting kit, the LCP can be mounted in a remote location.

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

The control card logic

- Communicates via serial link with outside devices such as personal computers or Programmable Logic Controllers (PLC).
- Provides 2 voltage supplies for use from the control terminals.

24 V DC is used for switching functions such as start, stop, and forward/reverse. The 24 V DC supply also supplies 200 mA of power, which can partly be used to power external encoders or other devices. A 10 V DC supply rated at 17 mA is also available for use with speed reference circuitry.

The analog and digital output signals are powered through an internal supply. The 3 power supplies are isolated from one another to eliminate ground loop conditions in the control input circuitry.

2 relays for monitoring the status of the frequency converter are located on the power card. These relays are programmable through *parameter group 5-4* Relays*. The relays are Form C. These relays have one normally open contact, and one normally closed contact on a single throw. The contacts of the relay are rated for a maximum load of 240 V AC at 2 Amps resistance.

The logic circuitry on the control card allows for adding:

- Option modules for synchronizing control
- Serial communications
- Additional relays
- Cascade pump controller
- Custom operating software

3.2.2 Logic to Power Interface

The logic to power interface isolates the high-voltage components of the power section from the low voltage signals of the logic section. The interface consists of two sections.

- Power Card
- Gate Driver

The control card handles much of the fault processing for output short circuit and ground fault conditions. The power card provides conditioning of these signals. Scaling of current feedback and voltage feedback is accomplished on the interface sections before processing by the control card.

The power card contains a Switch Mode Power Supply (SMPS). The SMPS provides the unit with 24 V DC, 16 V DC, 7 V DC, 6 V DC, and 3.3 V DC operating voltage. SMPS powers the logic and interface circuitry. SMPS is supplied by the DC bus voltage. A secondary SMPS provides power to the logic circuitry with main input disconnected. It can keep units with communication options live on a network when the frequency converter is not powered from the mains.

Circuitry for controlling speed of the cooling fans is also provided on the power card.

3.2.3 Power Section

The DC coil is a single unit 2 two coils wound on a common core. One coil resides in the positive side of the DC bus and the other in the negative. The coil aids in the reduction of mains harmonics.

The DC bus capacitors are arranged into a capacitor bank along with bleeder and balancing circuitry.

The inverter section is made up of six IGBTs, commonly referred to as switches. One switch is necessary for each half phase of the 3-phase power, for a total of 6. The 6 IGBTs are contained in 3 dual modules.

A Hall effect type current sensor is located on each phase of the output to measure motor current.

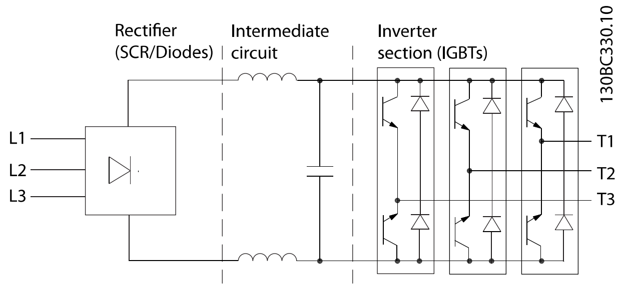


Illustration 3.2 Typical Power Section

3.3 Sequence of Operation

3.3.1 Rectifier Section

The rectifier provides a path for current flowing from the line to the DC-link circuitry. As a result, the DC-link capacitors charge.

The rectifier section consists of 6 diodes.

Inrush current, which appears when connected to grid, is limited with a PTC. A relay short-circuits the PTC when the DC-link capacitors are fully charged.

As long as power is applied to the frequency converter, voltage is present in the DC link and the inverter circuit. Voltage is also fed to the switch mode power supply (SMPS) on the power card and is used for generating all other low voltage supplies.

3.3.2 Intermediate Section

From the rectifier section, voltage passes to the intermediate section. The DC link is an LC filter circuit consisting of the DC-link inductor and the DC-link capacitor bank that smooths the rectified voltage.

The intermediate section consists of the following components:

- The DC-link inductor located in the positive side of the DC link provides series impedance to changing current. This impedance aids the filtering process while reducing harmonic distortion to the input AC current waveform normally inherent in rectifier circuits.
- The DC-link capacitors are arranged into a capacitor bank along with bleeder and balancing circuitry.
- High frequency (HF) filter film capacitors. These capacitors reduce the common mode noise caused by switching into stray capacitors to ground in cable and motor.

The voltage on a fully charged DC link is equal to the peak voltage of the input AC line. Theoretically, this voltage can be calculated by multiplying the AC line value by 1.414 (V AC x 1.414). However, since AC ripple voltage is present on the DC link, the actual DC value is closer to (V AC x 1.38) under unloaded conditions. The DC value can drop to (V AC x 1.32) while running under load.

Example
For a frequency converter sitting idle while connected to a nominal 460 V line, the DC-link voltage is approximately 635 V DC (460 x 1.38). As long as power is applied to the frequency converter, this voltage is present in the DC link and the inverter circuit. Voltage is also fed to the switch mode power supply (SMPS) on the power card which is used for generating all other low voltage supplies. The SMPS is activated when the DC-link voltage reaches approximately 250 V DC.

3.3.3 Inverter Section

The inverter section is made up of six IGBTs, commonly referred to as switches. One switch is necessary for each half phase of the 3-phase power, for a total of six. The six IGBTs are contained in one power module shared with the rectifier. The inverter section receives gate signals from the MOC.

Once a run command and speed reference are present, the IGBTs begin switching to create the output waveform, as shown in *Illustration 3.3*. Looking at the phase to phase voltage waveform with an oscilloscope, a train of pulses of different widths is shown. The amplitude of the pulses measures the DC-link voltage. To view the fundamental sinusoidal curve, set the oscilloscope to filter out high harmonic content.

When measuring current, the normal view will be a sinusoidal curve. The amplitude of the measured current depends on the loading form.

This waveform, as generated by the frequency converter, provides optimal performance and minimal losses in the motor.

Hall effect current sensors monitor the output current and feed it back to the control. The current signal is used for two purposes:

- to compensate for dynamic motor operation.
- to monitor overcurrent conditions, including ground faults and phase-to-phase shorts.

During normal operation, the power card and control monitor various functions within the frequency converter. The current sensors provide current feedback information. The DC bus voltage and mains voltage are monitored and the voltage delivered to the motor. A thermal sensor mounted inside the IGBT module provides heat sink temp feedback for the inverter.

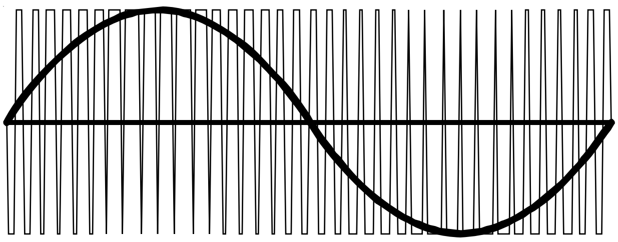


Illustration 3.3 Output Voltage and Current Waveforms

3.3.4 Fan Speed Control

	IP20					
Enclosure	**H6**		**H7**		**H8**	
Voltage	T2	T2	T2	T2	T2	T2
Power rating [kW]	15	18.5	22	30	37	45
FAN start temperature °C	45	45	45	45	45	45
FAN maximum speed temperature °C	60	60	60	60	60	60
FAN stop temperature °C	36	36	36	36	36	36

Table 3.1 Fan Speed Control, IP20, H6–H8, T2

	IP20					
Enclosure	**H6**			**H7**		**H8**
Voltage	T4	T4	T4	T4	T4	T4
Power rating [kW]	30	37	45	55	75	90
FAN start temperature °C	45	45	45	40	40	40
FAN maximum speed temperature °C	60	60	60	55	55	55
FAN stop temperature °C	41	41	41	30	30	30

Table 3.2 Fan Speed Control, IP20, H6–H8, T4

	IP54						
Enclosure	**I6**			**I7**		**I8**	
Voltage	T4	T4	T4	T4	T4	T4	T4
Power rating [kW]	22	30	37	45	55	75	90
FAN start temperature °C	45	45	45	40	40	40	40

3

	IP54						
Enclosure	**I6**			**I7**		**I8**	
FAN maximum speed temperature °C	60	60	60	55	55	55	55
FAN stop temperature °C	35	35	35	30	30	30	30

Table 3.3 Fan Speed Control, IP54, I6–I8

	IP20											
Enclosure	**H9**				**H10**		**H6**		**H7**		**H8**	
Voltage	T6	T6	T6	T6	T6	T6	T6	T6	T6	T6	T6	T6
Power rating [kW]	2.2	3.0	5.5	7.5	11	15	22	30	45	55	75	90
FAN start tempera-ture °C	35	35	35	35	45	45	45	45	40	40	40	40
FAN maximum speed tempera-ture °C	55	55	55	55	60	60	60	60	55	55	55	55
FAN stop tempera-ture °C	31	31	31	31	36	41	41	41	30	30	30	30

Table 3.4 Fan Speed Control, IP20, H9–H10, and H6–H8, T6

4 Troubleshooting

4.1 Troubleshooting Tips

Before repairing a frequency converter, read and understand the following instructions.

1. Note all warnings concerning voltages present in the frequency converter. Always 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.

CAUTION

Voltage can be present for as long as 20 minutes on frequency converters after removing power from the unit. See the label on the front of the frequency converter door for the specific discharge time.

2. Never 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 4.7 After Repair Tests*.
3. Never attempt to defeat any fault protection circuitry within the frequency converter, as this results in unnecessary component damage and can cause personal injury.
4. Always 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.
5. Read the instruction manual. A thorough understanding of the unit is the best approach. If ever in doubt, consult the factory or authorised repair centre 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 different occurring symptom.

1. 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.
2. 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 as well as 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 manual for more procedures.

When troubleshooting is complete, perform the list of tests provided in *chapter 6.5 Initial Start-up Or After Repair Drive Tests*.

4.4 Visual Inspection

Visually inspect the conditions in *Table 4.1* as part of any initial troubleshooting procedure.

Inspect for	Description
Auxiliary equipment	• Look if more auxiliary equipment, switches, disconnects, or input fuses/circuit breakers reside on the 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, and other equipment used for feedback to the frequency converter.
Cable routing	• Avoid routing motor wiring, AC line wiring, and signal wiring in parallel. If parallel routing is unavoidable, 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 screened cable or a twisted pair is recommended. • Ensure that the screen is terminated correctly.
Frequency converter cooling	Check operational status of all cooling fans: • When voltage is applied to the frequency converter, the fan activates for a few seconds. • Check for blockage or constrained air passages.
Frequency converter display	The display shows important items, such as: • Warnings. • Alarms. • Frequency converter status. • Fault history.
Frequency converter interior	• Check that the frequency converter interior is free of: - Dirt. - Metal chips. - Moisture. - Corrosion. • Check for burnt or damaged power components, or carbon deposits that are the result of a catastrophic component failure. • Check for cracks or breaks in the housings of power semiconductors, or pieces of broken component housings, which are loose inside the unit.
EMC considerations	• Check for proper installation regarding electromagnetic capability. • Refer to the frequency converter operating instructions and this chapter for further details.
Environmental conditions	• Under specific conditions, these units can be operated within a maximum ambient of 50 °C (122 °F). • Humidity levels must be less than 95% non-condensing. • Check for harmful airborne contaminates such as sulfur-based compounds.
GLCP	• If supplied, check that the GLCP is correctly installed, and that the display is lit when powered on.
Grounding	• The frequency converter requires a dedicated ground wire from its enclosure to the building ground. It is also suggested to ground the motor to the frequency converter enclosure. • The use of conduit or mounting of the frequency converter to a metal surface is not considered to be suitable grounding. • Check for good ground connections that are tight and free of oxidation.

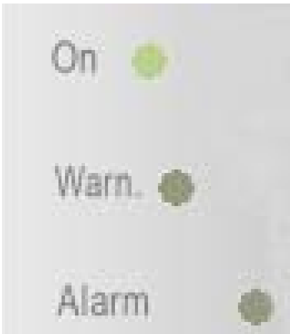
Inspect for	Description
Input power wiring	Check for: • Loose connections. • Proper fusing. • Blown fuses.
Memory module	• Check that the memory module is plugged in correctly.
Motor	• Check nameplate ratings of the motor. • Ensure that motor ratings coincide with frequency converters. • Ensure that the frequency converter motor parameters (*parameter 1-20 Motor Power* to *parameter 1-25 Motor Nominal Speed*) are set according to motor ratings.
Output to motor wiring	Check for: • Loose connections. • Switching components in output circuit. • Faulty contacts in switch gear.
PROFIBUS option	• Check that the option is mounted correctly on the control card.
Programming	Ensure that frequency converter parameter settings are correct according to: • Motor. • Application. • I/O configuration.
Proper clearance	The frequency converter requires top and bottom clearance adequate to ensure proper air flow for cooling in accordance with the frequency converter size. When the heat sink is exposed at the rear of the frequency converter, mount the frequency converter on a flat, solid surface.
Vibration	• Check for exposure to an unusual amount of vibration. • When the frequency converter experiences a high level of vibration, ensure solid mounting or use shock mounts.

Table 4.1 Visual Inspection Check List

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.



130BP044.10

Illustration 4.1 LED Indicator Lights

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.

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 due to overload. Improper control wiring or a fault within the frequency converter itself can cause the overload.

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 Display (Line 2) Flashing

When line 2 flashes, it indicates that an LCP stop command has been given by pressing [Off/Reset]. The frequency converter cannot accept any further run command until the LCP stop is cleared. To clear the LCP stop, press [Auto On] or [Hand On].

⚠CAUTION

IMMEDIATE START

If the frequency converter is operated in local control, or remote control with a maintained run signal, the frequency converter starts immediately. Failure to be prepared for immediate start can cause personal injury.

- **Be prepared for immediate start.**

4.5.4 WRONG or WRONG LCP Shown

The message WRONG or WRONG LCP appears due to a faulty LCP or the use of an incorrect LCP.

Replace the LCP with a correct and functioning one.

NOTICE

Error 84 appears when the LCP cannot communicate with the frequency converter.

4.5.5 Motor Will 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 displayed. The most common cause of this problem is either incorrect control logic or an incorrectly programmed frequency converter. Such occurrences result in one or more of the following status messages being displayed.

LCP Stop

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

Press [Auto On] or [Hand On]. Refer to the Input Terminal Signal Test.

Standby

This message indicates that there is no start signal at terminal 18.

Ensure that a start command is present at terminal 18. Refer to the Input Terminal Signal Test.

Unit ready
Terminal 27 is low (no signal).

Ensure that terminal 27 is logic "1". Refer to the Input Terminal Signal Test.

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

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 the Input Terminal Signal Test.

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.

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

STOP
One of the digital input terminals 16, 17, 27, 29, 32, or 33 is programmed for "Stop Inverse" and the corresponding terminal is low (logic "0").

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

Display Indication that the unit is functioning, but there is no output.
If the unit is equipped with external 24 V DC option, check that the main power is applied to the frequency converter.

NOTICE

In this case, the display alternately flashes Warning 8.

4.5.6 Incorrect Motor Operation

A fault can occur in the event of incorrect motor operation. The symptoms and causes may vary considerably. The following sections list many of the possible problems by symptom along with recommended procedures for determining their causes.

Wrong speed/unit does not respond to command
Possible cause: Incorrect reference (speed command).

Actions:

1. Ensure that the unit is programmed correctly according to the reference signal being used.
2. Ensure that all reference limits are set correctly.
3. Perform the test *chapter 6.4.7 Input Terminal Signal Tests* to check for faulty reference signals.

Motor speed unstable

Possible causes:

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

Actions:

1. Check settings of all motor parameters, including all motor compensation settings (slip compensation, load compensation, and so on).
2. For closed-loop operation, check PID settings.
3. Perform test as described in *chapter 6.4.7 Input Terminal Signal Tests* to check for faulty reference signals.
4. Perform test as described in *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test* to check for loss of motor phase.

Motor runs rough

Possible cause:

- Overmagnetisation (incorrect motor settings).
- IGBT misfiring.

NOTICE

The motor may stall when loaded, or the frequency converter may trip occasionally on *Alarm 13, Over Current*.

Action:

1. Check the setting of all motor parameters, see *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test*.
2. If output voltage is unbalanced, see *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test*.

Motor draws high current but cannot start

Possible causes:

- Open winding in motor.
- Open connection to motor.

Actions:

1. Perform the test in *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test* to ensure that the frequency converter provides correct output (see *Motor Runs Rough* above).
2. Check motor for open windings. Check all motor wiring connections.
3. 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. *Table 4.2* defines whether a warning precedes an alarm and whether the frequency converter suspends operations (trips).

4.6.1 Alarms

An alarm causes the frequency converter to trip (suspend operation). The frequency converter has 3 trip conditions which are displayed on 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. The frequency converter can be reset manually by pressing [Reset], a digital input, or a serial bus command. For TR150 and TR170 frequency converters, stop and reset are the same key. If [Off/Reset] is used to reset the frequency converter, [Start] must be pressed to initiate a run command in either local or remote.

TRIPLOCK (DISC> MAINS)
Requires that the main AC input power to the frequency converter must be disconnected long enough for the display to go blank. The fault condition must be removed and power reapplied. Following power up, the fault indication changes to TRIP (RESET) and allow for manual, digital, or serial bus reset.

Line 2 displays alarm and the associated number while line 3 identifies the alarm in plain language.

NOTICE

When exchanging the unit which requires fire mode activation, carefully check that the Fire Mode parameters

- ***Parameter 24-00 FM Function***
- ***Parameter 24-05 FM Preset Reference***
- ***Parameter 24-09 FM Alarm Handling***

are correctly transferred into the exchange unit.

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 And Alarm Messages

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

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

A **trip** is the action when an alarm has appeared. The trip removes power to the motor. 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] on the LCP, press [Auto On] to restart the motor.

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

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

No.	Description	Warning	Alarm	Trip Lock	Parameter Reference
2	Live zero error	(X)	(X)		6–01
3	No motor	(X)			1–80
4	Mains phase loss	(X)	(X)	(X)	14–12
7	DC over voltage	(X)	(X)		
8	DC under voltage	(X)	(X)		
9	Inverter overloaded	(X)	(X)		
10	Motor ETR over temperature	(X)	(X)		1–90
11	Motor thermistor over temperature	(X)	(X)		1–90
13	Over Current	(X)	(X)	(X)	
14	Ground fault	(X)	(X)	(X)	
16	Short Circuit		(X)	(X)	
17	Control word timeout		(X)		8–04
24	Fan Fault (Only on 400 V 30-90 kW)		(X)		14–53
30	Motor phase U missing		(X)	(X)	4–58
31	Motor phase V missing		(X)	(X)	4–58
32	Motor phase W missing		(X)	(X)	4–58
38	Internal fault		(X)	(X)	
44	Ground fault 2		(X)	(X)	
47	Control Voltage Fault		(X)	(X)	
48	VDD1 Supply Low		(X)	(X)	
50	AMA Calibration Failed		(X)		
51	AMA check U_{nom} and I_{nom}		(X)		
52	AMA low I_{nom}		(X)		
53	AMA motor too big		(X)		
54	AMA motor too small		(X)		
55	AMA Parameter out of range		(X)		
56	AMA interrupted by user		(X)		
57	AMA timeout		(X)		
58	AMA internal fault	(X)	(X)		
59	Current limit	(X)			
60	External Interlock		(X)		
66	Heat sink Temperature Low	(X)			
69	Pwr Card Temperature	(X)	(X)	(X)	
79	Illegal PS config	(X)	(X)		
80	Drive Initialised to Default Value		(X)		
84	LCP Error	X			
87	Auto DC Braking	(X)			
95	Broken Belt	(X)	(X)		22–6*
201	Fire Mode	(X)			
202	Fire M Limits Exceeded	(X)			
250	New spare parts		(X)	(X)	
251	New Type Code		(X)	(X)	

Table 4.2 Alarm/Warning Code List

(X) Dependent on parameter. A trip is the action when an alarm has appeared. The trip coasts the motor and can be reset by pressing [Reset] or make a reset by a digital input (parameter group *5-1* Digital Inputs* [1]). The original event that caused an alarm cannot damage the frequency converter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which can damage the frequency converter or connected parts. A trip lock situation can only be reset by a power cycling.

Warning	Yellow
Alarm	Flashing red

Table 4.3 LED Indication

The alarm words, warning words and extended status words can be read out via serial bus 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 a faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - General Purpose I/O terminals 11 and 12 for signals, terminal 10 common.
  - Analog I/O Option terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform an 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 Function at Mains Imbalance*.

Troubleshooting

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

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

Troubleshooting

Extend the ramp time

Change the ramp type

Increase *parameter 14-26 Trip Delay at Inverter Fault*

WARNING/ALARM 8, DC under voltage
If the DC-link voltage drops below the undervoltage limit, the frequency converter checks for 24 V DC back-up supply. If no 24 V DC back-up supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

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

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

Troubleshooting

- Compare the output current shown on the keypad with the frequency converter rated current.
- Compare the output current shown on the keypad with the measured motor current.
- Show the thermal frequency converter load on the keypad 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 1 of these options:

- The frequency converter issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The frequency converter trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options.

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 the motor data in *parameters 1-20* to *1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- 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*.

⚠WARNING

Live Electrical Components!

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

Disconnect power before proceeding.

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. 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 phase to ground, either in the cable between the frequency converter and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the frequency converter and current going into the frequency converter from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the frequency converter must be the same as the current going into the frequency converter.

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.
- Reset any potential individual offset in the 3 current transducers in the frequency converter. Perform the manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

⚠WARNING

Disconnect power before proceeding.

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

Troubleshooting

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

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

⚠WARNING

Disconnect power before proceeding.

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.

⚠WARNING

Live Electrical Components!

Troubleshooting

- Check connections on the serial communication cable.
- Increase *parameter 8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.

4

4

- Verify a proper installation based on EMC requirements.

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

For frequency converters with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For frequency converters with AC fans, the voltage to the fan is monitored.

Troubleshooting

- Check for proper fan operation.
- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink.

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

WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

WARNING

Disconnect power before proceeding.

Troubleshooting

- Remove the 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.

WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

WARNING

Disconnect power before proceeding.

Troubleshooting

- Remove the 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.

WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to use qualified personnel to install, start up, and maintain the frequency converter can result in death or serious injury.

- **Disconnect power before proceeding.**

WARNING

Disconnect power before proceeding.

Troubleshooting

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

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 4.4* is displayed.

Troubleshooting

Cycle power

Check that the option is properly installed

Check for loose or missing wiring

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

No.	Text
0	Serial port cannot be initialised. Contact your Trane supplier or Trane Service Department.
256-258	Power EEPROM data is defective or too old. Replace power card.
512-519	Internal fault. Contact your Trane supplier or Trane Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your Trane supplier or the Trane Service Department.
1379-2819	Internal fault. Contact your Trane supplier or Trane Service Department.
1792	HW reset of DSP
1793	Motor derived parameters not transferred correctly to DSP

No.	Text
1794	Power data not transferred correctly at power up to DSP
1795	The DSP has received too many unknown SPI telegrams
1796	RAM copy error
2561	Replace control card
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5376-6231	Internal fault. Contact your Trane supplier or Trane Service Department.

Table 4.4 Internal Fault Codes

ALARM 44, Earth fault II
There is a discharge from the output phases to earth, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting

Turn off the frequency converter and remove the earth fault.

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

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

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

Troubleshooting

- Check for a defective control card.
- If an option card is present, check for overvoltage.

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. 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. Repeated restarts can overheat the motor.

ALARM 58, AMA Internal fault
Contact a Trane supplier.

WARNING 59, Current limit
The current is higher than the value in *parameter 4-18 Current Limit*. Ensure that motor data in *parameters 1-20* to *1-25* is set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 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 Vdc to the terminal programmed for external interlock.
- Reset the frequency converter.

WARNING 66, Heatsink temperature low
This warning is based on the temperature sensor in the IGBT module.

Troubleshooting

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

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

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

ALARM 84, LCP error
ALARM 84 is generated by the LCP and indicates an error with the LCP.

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.

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

WARNING 202, Fire mode limits exceeded
While operating in fire mode, 1 or more alarm conditions that would normally trip the unit have been ignored. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. Refer to the fire mode data in the alarm log.

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

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

4.7 After Repair Tests

Following any repair to a frequency converter or testing of a frequency converter suspected of being faulty, the following procedure must be followed. Following the procedure ensures that all circuitry in the frequency converter is functioning properly before putting the unit into operation.

1. Perform visual inspection procedures as described in *Table 4.1*.
2. Perform static test procedures to ensure that frequency converter is safe to start.
3. Disconnect motor cables from output terminals (U, V, W) of frequency converter.
4. Apply AC power to 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, measure phase-to-phase output voltage on all three phases: U to V, U to W, V to W. All voltages must be balanced within 8 V. If unbalanced voltage is measured, refer to *chapter 6.4.2 Input Voltage Test*.
7. Stop the frequency converter and remove input power. Allow 20 minutes for DC capacitors to fully discharge.
8. Reconnect motor cables to frequency converter output terminals (U, V, W).
9. Reapply power and restart frequency converter. Adjust motor speed to a nominal level.
10. Use a clamp-on style ammeter, measure output current on each output phase. All currents must be balanced.

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-link voltage reaches its DC link alarm voltage high (see *chapter 1.9.1 Short Circuit and Overcurrent Trips*). Before tripping, the frequency converter shows a high-voltage warning. Mostly, fast deceleration ramps concerning 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 is called regenerative energy. Regeneration occurs when the speed of the load is greater than the commanded speed. The diodes in the IGBT modules rectify this return and raises the DC link. If the amount of returned energy is too high, the DC voltage increases, causing the frequency converter to trip.

There are a few ways to overcome this situation. One method is to reduce the deceleration rate so it takes longer for the frequency converter to decelerate. A rule of thumb is that the frequency converter can only decelerate the load slightly faster than it would take for the load to naturally coast to a stop. A second method is to allow the overvoltage control function (*parameter 2-17 Over-voltage Control*) to take care of the deceleration ramp. When enabled, the overvoltage control function regulates deceleration at a rate that maintains the DC-link voltage at an acceptable level. One caution with overvoltage control is that it does not make corrections to unrealistic ramp rates.

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 is purposely done so the unit's operation is not misinterpreted.

The frequency converter has an AC brake function, which increases magnetization current to increase loss in motor and reduce DC-link voltage. If the DC-link voltage exceeds a certain voltage, the overvoltage control changes the frequency.

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 drastically reduced.

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 can affect the form factor of the AC waveform.

Mains imbalances which exceed 3% cause sufficient DC-bus ripple to initiate a trip.

Other causes of increased ripple voltage on the DC bus are:

- 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.

See details in *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. The typical complaint is that the frequency converter does not respond to a given command. To obtain an output, give the following 2 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, and 29).
- Analog outputs (42 and 45).
- 10 V output.
- Analog inputs (53 and 54).
- Serial communication bus (68 and 69).

The presence of a correct reading indicates that the microprocessor of the frequency converter has detected the wanted signal. See *chapter 2.3 Frequency Converter Inputs and Outputs*.

This data can also be read in *parameter group 16-6* Inputs and 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 6.4.7 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. Therefore, check the circuitry providing the signal along with its associated wiring.

5.1.4 Programming Problems

Difficulty with operation of the frequency converter can be a result of improper programming of the frequency converter parameters.

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

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

See *chapter 2.3 Frequency Converter Inputs and Outputs*.

Set up the frequency converter correctly for the motor or motors connected to it. Parameters must have data from the motor nameplate entered into the frequency converter. These data enable the frequency converter processor to match the frequency converter to power characteristics of the motor. Inaccurate motor data can cause the motor to draw higher than normal amounts of current when performing a 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 less than acceptable 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 Limits*.

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. Wire the wanted I/O terminal properly, and set the corresponding parameter accordingly. Control terminals are programmed in *parameter group 5-0* Digital I/O Mode* and *parameter group 6-0* Analog I/O Mode*.

5.1.5 Motor/Load Problems

Problems with the motor, motor wiring, or mechanical load on the motor can develop in several ways. 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 uneven or 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. See *chapter 6.4.6 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 defect in the frequency converter itself. To determine whether the problem is internal or external to the frequency converter, disconnect the motor from the frequency converter motor terminals. Perform the initial procedure with no motor connection on all 3-phases with an analog voltmeter, see *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test*. If the 3 voltage measurements are balanced, the frequency converter is functioning correctly. Hence, the problem is external to the frequency converter.

If the voltage measurements are not balanced, the frequency converter is malfunctioning. Typically, 1 or more output IGBTs are not functioning 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 shown, determine whether this condition actually exists within the frequency converter, or whether the thermal sensor is defective.

5.2.2 Current Sensor Faults

Sometimes an over-current alarm that cannot be reset, even with the motor cables disconnected, indicates when a current sensor fails. 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 zero. A frequency converter with a defective current sensor indicates some current flow. An indication of a fraction of 1 A is tolerable. However, that value should be considerably less than 1 A. If the display shows more than 1 A of current, there is a defective current sensor. All 3 current sensors in TR150 and TR170 units are mounted on one circuit board (either power card, SMPS card, or current transducer card). The repair procedure is to replace all 3 current sensors at the same time.

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

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.

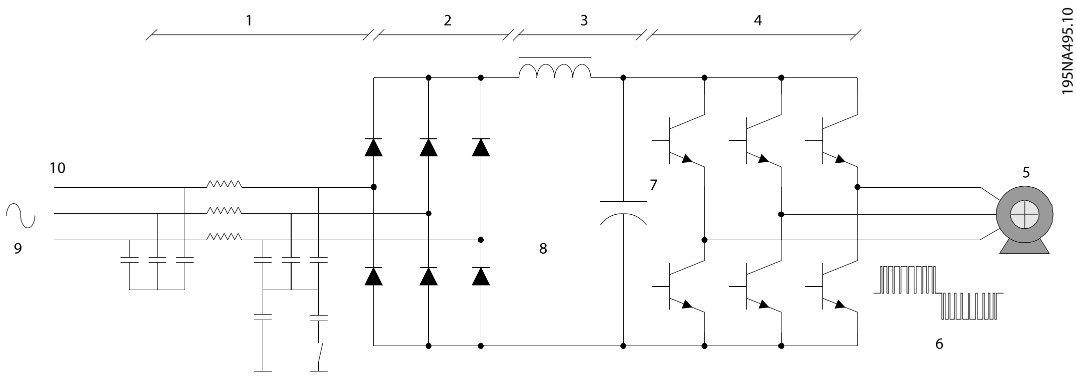
Detrimental effects to these systems include the following:

- 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 fast-switching electronic devices to generate the modulated output voltage waveform necessary for accurate motor control. These devices rapidly switch the fixed DC-link 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.

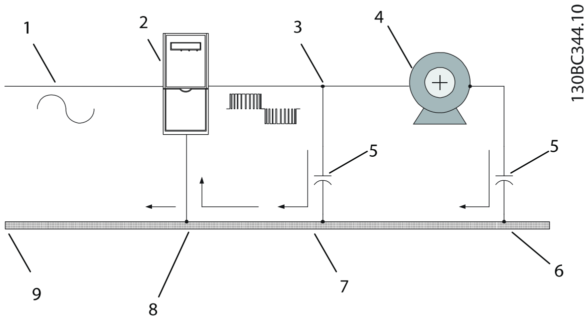


1	RFI filter	6	PWM waveform
2	Rectifier	7	IGBT
3	DC link	8	Filter reactor
4	Inverter	9	Sine-wave
5	Motor	10	AC line

Illustration 5.1 Frequency Converter Principle 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

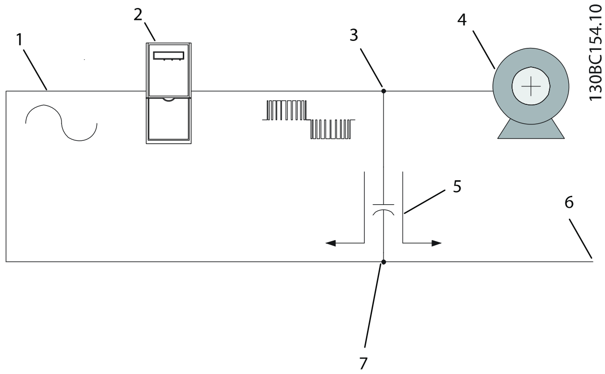
Illustration 5.2 Ground Currents

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 instant 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

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 painted 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.

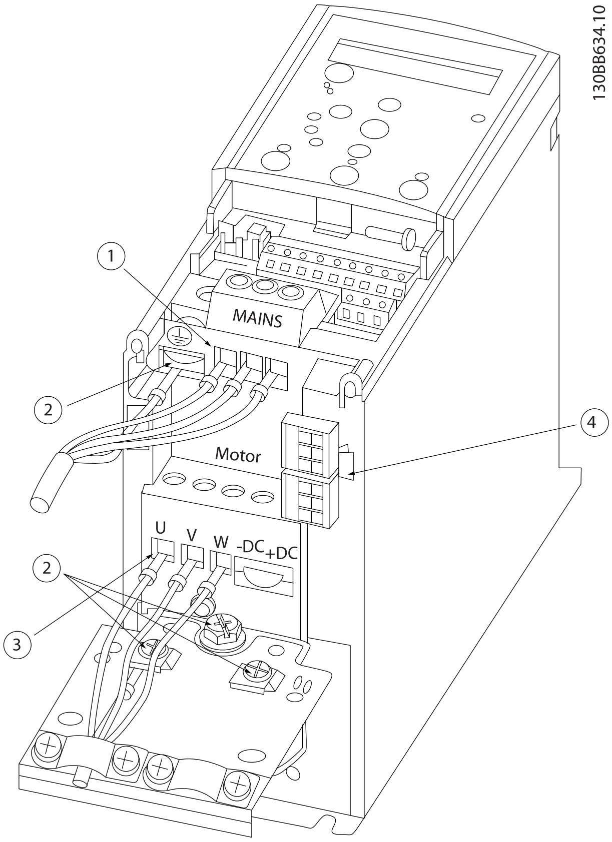
If a shielded motor cable is not available, then 3-phase conductors along with ground in a conduit provides some degree of protection. This technique is not as effective as shielded cable due to the unavoidable contact of the conduit with various points within the equipment.

Serial communications cable selection
There are various serial communication interfaces and protocols in 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

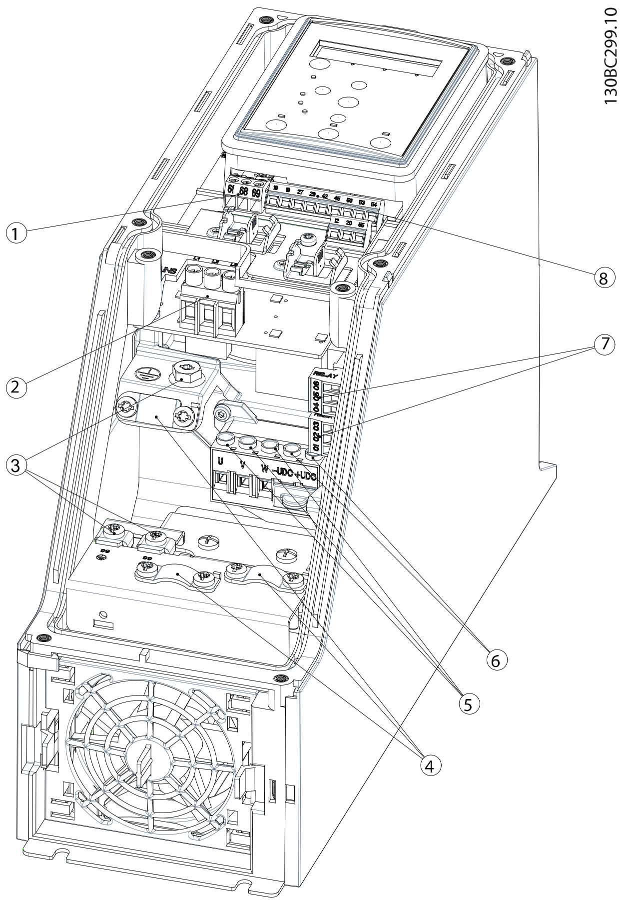
6.1 Non-repairable Units

H1–H5 and I2–I4 are non-repairable units and should not be repaired. The information about Line/Motor/UDC+- terminals is useful to verify what went wrong with these frequency converters, for statistics and WIIS purposes, but also to avoid replacing a frequency converter that is not defective.



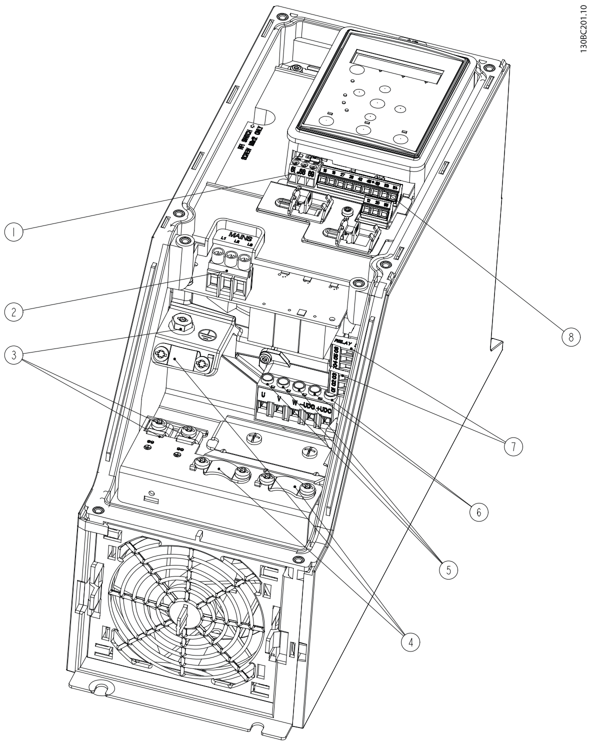
1	Line
2	Ground
3	Motor
4	Relays

Illustration 6.1 H1–H5 Frame
IP20 200–240 V, 0.25–11 kW and IP20 380–480 V, 0.37–22 kW



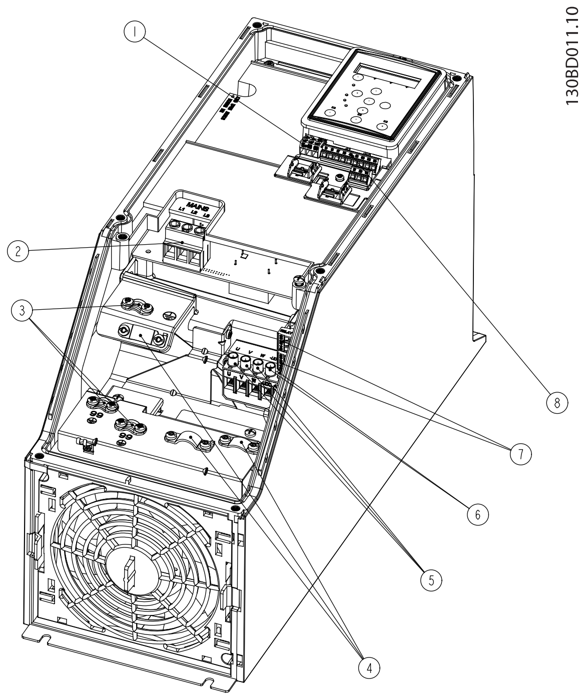
1	RS485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Illustration 6.2 I2 Frame
IP54 380–480 V, 0.75–4.0 kW



1	RS485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Illustration 6.3 I3 Frame
IP54 380–480 V, 5.5–7.5 kW



1	RS485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Illustration 6.4 I4 Frame
IP54 380–480 V, 0.75–4.0 kW

6.2 Introduction

⚠WARNING

DISCHARGE TIME!

Frequency converters contain DC-link capacitors that can remain charged even when the frequency converter is not powered. To avoid electrical hazards, disconnect AC mains, any permanent magnet type motors, and any remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters. Wait for the capacitors to fully discharge before performing any service or repair work. The amount of wait time is listed in the *Table 1.1*. Failure to wait the specified time after power has been removed before doing service or repair could result in death or serious injury.

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

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

⚠CAUTION

For dynamic test procedures, main input power is required. All devices and power supplies connected to mains are energized at rated voltage. Use extreme caution when conducting tests on a powered frequency converter. Contact with powered components could result in electrical shock and personal injury.

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

- Digital voltmeter/ohmmeter capable of reading real RMS
- Analog voltmeter
- Oscilloscope
- Current meter

6.3 Static Test Procedures

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.**

6.3.1 Pre-test Precautions

Consider the following safety precautions before performing static tests.

- Prepare the work area according to the ESD regulations.
- Ground the ESD mat and wrist strap.
- Ensure that the ground connection between body, the ESD mat, and the frequency converter is always present while performing service.
- Handle disassembled electronic parts with care.
- 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 frequency converter.

6

6

6.3.2 Rectifier Circuit Test

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

Described next is the procedure to conduct the static test on the rectifier.

NOTICE

In H6 units the +/-UDC terminals are not readily accessible. Find terminals K601 (+) and K611 (-) between the DC capacitors.
In H7-H8 units the +/-UDC terminals are directly accessible on MK900 on the power card.
In I7-I8 units the +/-UDC terminals are accessible on MK900 on the power card or on MK3 on the current sensor board.
For further details, see *chapter 6.3.5 Location of UDC Terminals* before measuring).

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

Rectifier test part I

1. Connect the positive (+) terminal of the multimeter lead to the positive (+) DC Bus.
2. Connect the negative (-) terminal of the multimeter lead to the input terminal L1, L2, L3 in turn. The multimeter indicates *Infinity*.

Rectifier test part II

3. Reverse the meter leads by connecting the negative (-) terminal of the multimeter lead to the positive (+) DC Bus.
4. Connect the positive (+) terminal of the multimeter lead to the input terminal L1, L2, L3 in turn. The multimeter indicates *Diode drop*.

Rectifier test part III

5. Connect the positive (+) terminal of the multimeter lead to the negative (-) DC Bus.
6. Connect the negative (-) terminal of the multimeter lead to the input terminal L1, L2, L3 in turn. The multimeter indicates a diode drop.

Rectifier test part IV

7. Reverse the meter leads by connecting the negative (-) terminal of the multimeter lead to the negative (-) DC Bus.
8. Connect the positive (+) terminal of the multimeter lead to the input terminal L1, L2, L3 in turn. The multimeter indicates *Infinity*.

6.3.3 Inverter Section Tests

The inverter section is primarily made up of the IGBTs used for switching the DC bus voltage to create the output to the motor. The frequency converter also has clamping capacitors between +UDC and -UDC on the IGBT.

⚠CAUTION

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

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

Inverter test part I

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

Each reading must show infinity.

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 sequence. 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 sequence. Each reading should show a diode drop.

Inverter test part IV

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

Each reading should show infinity.

6.3.4 Intermediate Section Tests

NOTICE

This test is applicable for H7, H8, I7, and I8 units only.

The intermediate section of the frequency converter is made up of the DC bus capacitors, the DC coils, and the balance circuit for the capacitors.

1. Test for short circuits with the ohmmeter set on Rx100 scale or, for a digital meter, select diode.
2. Measure across the positive (+) DC terminal and the negative (–) DC terminal. Observe the meter polarity.
3. The meter starts out with low ohms and then move towards infinity as the meter charges the capacitors.
4. Reverse meter leads.
5. The meter pegs at zero while the meter discharges the capacitors. The meter then begins moving slowly toward 2 diode drops as the meter charges the capacitors in the reverse direction. Although the test does not ensure that the capacitors are fully functional, it ensures that no short circuits exist in the DC link.

Incorrect reading
A short circuit could be caused by a short in the inrush circuit, rectifier, or inverter section. Be sure that the tests for these circuits have already been performed successfully. A failure in one of these sections could be read in the intermediate section since they are all routed via the DC bus.

The only other likely cause would be a defective capacitor within the capacitor bank.

There is not an effective test of the capacitor bank when it is fully assembled. If suspecting a failure within the capacitor bank, replace the entire bank. Replace the capacitor bank in accordance with the disassembly procedures.

6.3.5 Location of UDC Terminals

H6
Remove the IP20 front cover, then remove the capacitor vibration support. The terminals K601 (+UDC) and K611 (-UDC) are located between the 4 capacitors on the circuit board. Remove the metal cover to access these terminals.

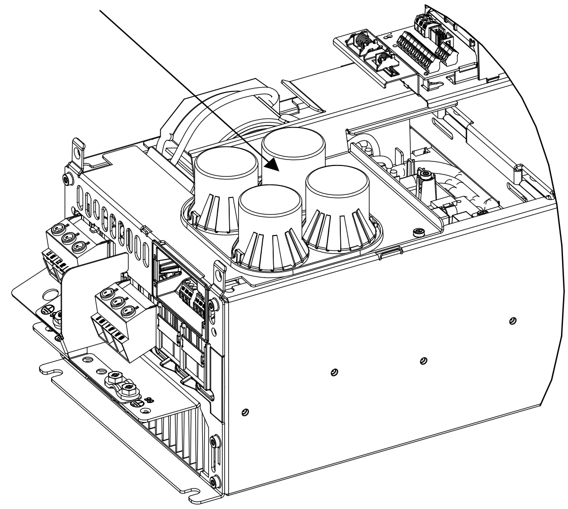


Illustration 6.5 UDC Terminals Location on H6 Frequency Converter

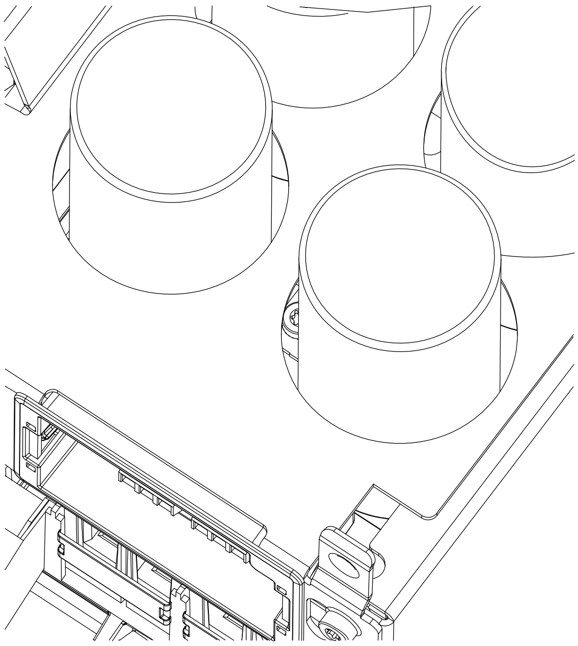


Illustration 6.6 Metal Cover over Terminals

6

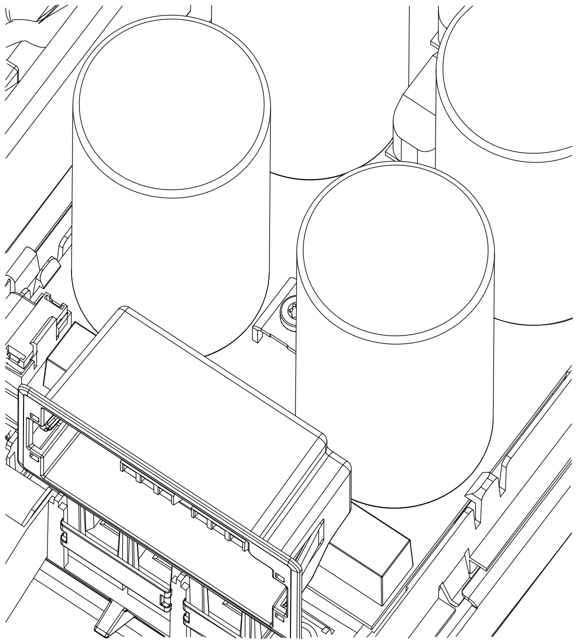


Illustration 6.7 The UDC Terminals on the Circuit Board

H7 and H8

Remove the IP20 front cover to access the terminals directly on the power card MK900.

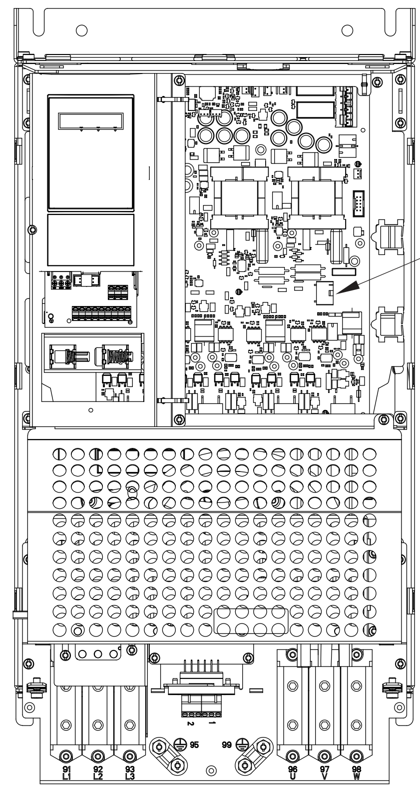


Illustration 6.8 Power Card

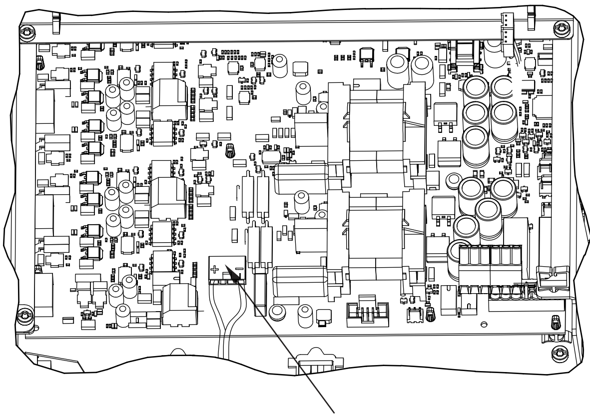


Illustration 6.9 +/- UDC Terminals

H9

The UDC terminals are available on connectors at the bottom of the frequency converter. Static measurements can be done directly from here.

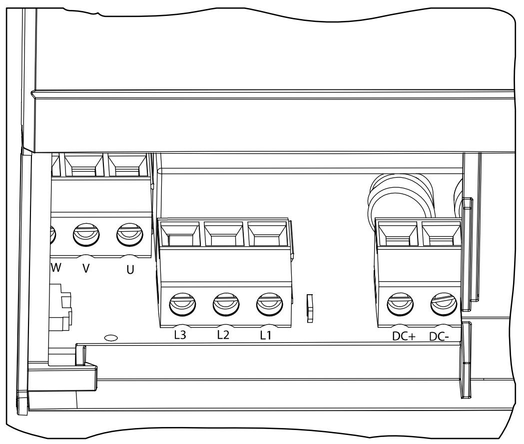


Illustration 6.10 UDC Terminals Location on H9 Frequency Converter

H10

Remove the front terminal cover to access the connectors. The UDC terminals are located inside the frequency converter.

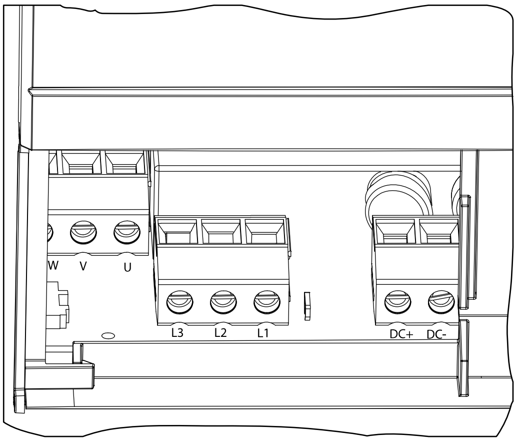


Illustration 6.11 UDC Terminals Location on H10 Frequency Converter

I7 and I8

Remove the IP54 front cover to access the +/- UDC terminals, either on the power card MK900 or on MK3 on the current sensor board.

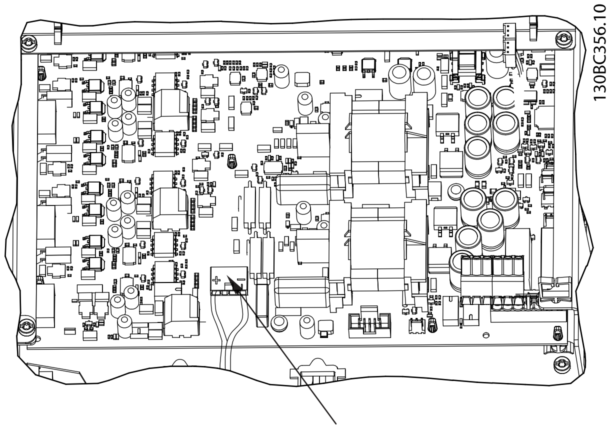


Illustration 6.12 +/- UDC Terminals on Power Card

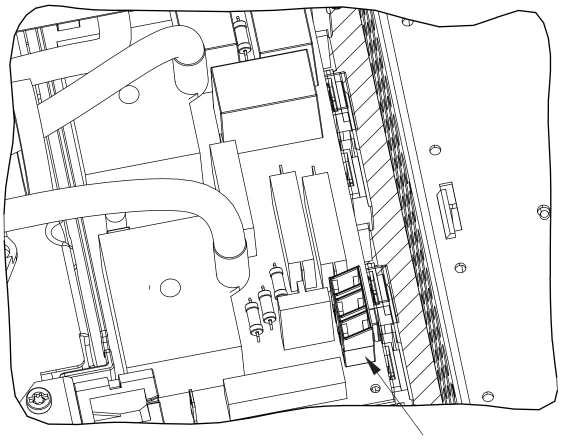


Illustration 6.13 +/- UDC Terminals on Current Sensor Board

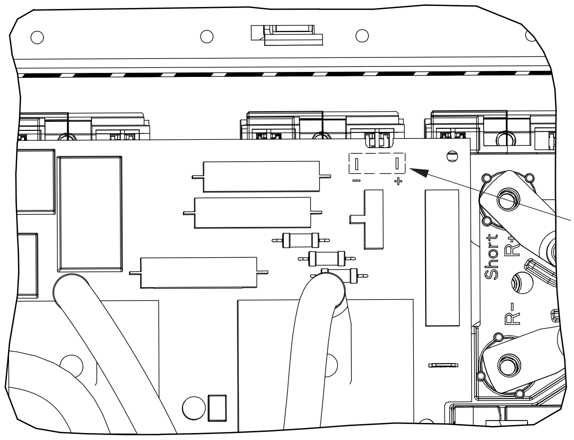


Illustration 6.14 +/- UDC Terminals on Current Sensor Board - Close-up View

6.4 Dynamic Test Procedures

NOTICE

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.

⚠WARNING

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

⚠CAUTION

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

Dynamic tests are conducted to check the IGBT. The tests can indicate if an IGBT is faulty. The fault is indicated by a voltage drop on the terminals UVW.

Preparation:

- Disconnect the motor from the frequency converter.
- Ensure that the frequency converter is powered up.
- Program the frequency converter to approximately 50 Hz on start.
- Set the multimeter to AC 1000 V.

Procedure for dynamic test on the IGBT.

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%.

6.4.1 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.

6.4.2 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 V frequency converters, all measurements must be within the range of 342–550 V AC. Readings of less than 342 V AC indicate problems with the input mains voltage. For 525–600 V frequency converters, all measurements must be within the range of 446–600 V AC. Readings of less than 446 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%.

calculates mains imbalance per an IEC specification.

$$\text{Imbalance}=0.67 \text{ X } (V_{max}–V_{min})/V_{avg}$$

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.

Incorrect reading

⚠CAUTION

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. Typical items to check would be:

- 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.

6.4.3 Basic Control Card Voltage Test

1. Measure the control voltage at terminal 12 with reference to 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 with reference to 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.

6.4.4 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 the 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.

6.4.5 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 diode modules. Phase loss caused by the mains supply can be easily detected. In addition, the diode modules control the rectifier section. If 1 of the diode modules become defective, the frequency converter provides a response which is the same as loss of 1 of the phases.

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 6.15*.

6

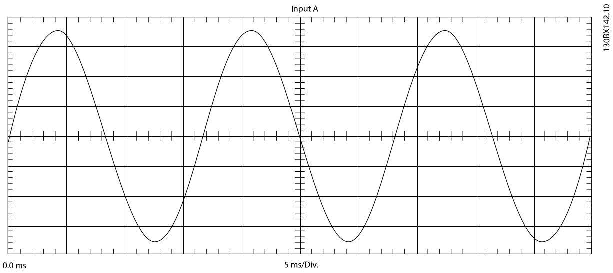


Illustration 6.15 Normal AC Input Voltage Waveform

The waveform shown in *Illustration 6.16* shows the input current waveform for the same phase as shown in *Illustration 6.15* while the frequency converter is running at 40% load. The 2 positive and 2 negative jumps are typical of any 6-diode bridge. It is the same for frequency converters with diode modules.

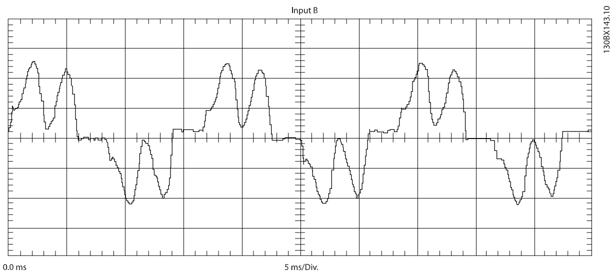


Illustration 6.16 AC Input Current Waveform with Diode Bridge

With a phase loss, the current waveform of the remaining phases would take on the appearance shown in *Illustration 6.17*.

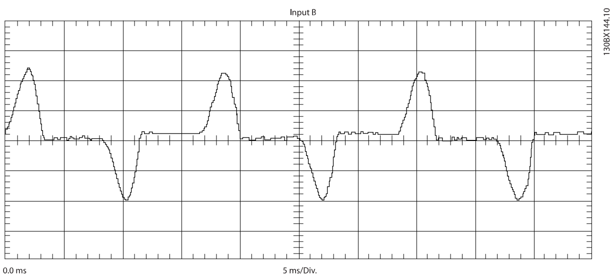


Illustration 6.17 Input Current Waveform with Phase Loss

Always verify the condition of the input voltage waveform before drawing 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.

6.4.6 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.

6.4.7 Input Terminal Signal Tests

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

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

If the desired 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 power supply is correct as follows:

1. Use a voltmeter for measuring voltage at control card terminal 12 and 13 with respect to terminal 20. The meter should read 21-27 V DC.

If the 24 V supply voltage is not present, test the control card in *chapter 6.2.1 Introduction*.

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

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

The presence of a signal at the desired terminal 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 desired 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 power supply is correct as follows.

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

If the 10 V supply voltage is not present, conduct basic control card voltage test, see *chapter 6.4.3 Basic Control Card Voltage Test*.

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 desired terminal 53 or 54.

For analog input terminals 53 and 54, a DC voltage between 0 and +10 V DC must be read to match the analog signal sent to the frequency converter. Or a reading of 0.9 V DC to 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

6.5 Initial Start-up Or After Repair Drive 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 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 6.4.6 Output Imbalance of Motor Supply Voltage Test*.
7. Stop the frequency converter and remove input power. Wait for the discharge time listed in *Table 1.1* 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.

7 H-Frame Size Disassembly and Assembly Instructions

7.1 Electrostatic Discharge (ESD)

CAUTION

Frequency converters contain dangerous voltages when connected to the main voltage. Never perform any disassembly when power is applied. Remove power to the frequency converter, and wait until the frequency converter capacitors fully discharge. Only a competent technician must carry out the service.
Many electronic components within the frequency converter are sensitive to static electricity. Voltages so low that they cannot be felt, seen, or heard can reduce the life, affect performance, or completely destroy sensitive electronic components.

CAUTION

Use correct ESD procedures to prevent damage to sensitive components when servicing the frequency converter.

NOTICE

Frame size is used throughout this manual where ever procedures or components differ between frequency converters based upon the unit's physical size. Refer to *chapter 1.4.1 Frame Size Definitions* to determine frame size.

7.2 General Disassembly Procedure

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

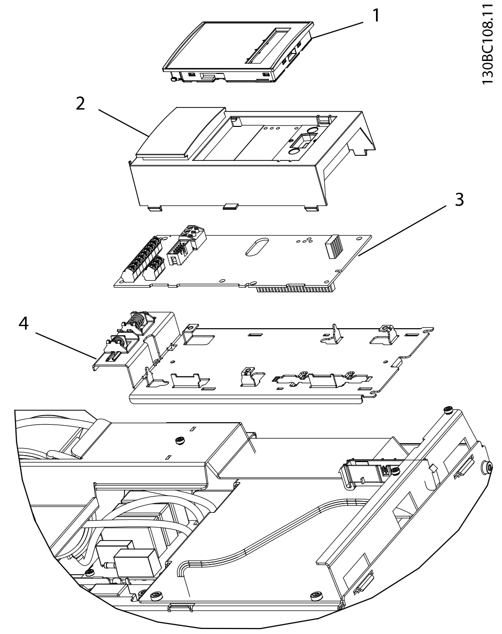
1. Remove the plastic cover beneath the LCP with a flat-edged screwdriver.
2. Loosen and remove 4 screws (T20) on the front cover.
3. Remove the front cover.

7.3 H6 Frame Size Disassembly and Assembly Instructions

7.3.1 Control Card and Control Card Mounting Plate

1. Remove the LCP and the protection foil underneath it.
2. Remove the 3 screws (T10) from the control card.
3. Remove the control card.
4. Remove the 4 bolts on the bottom of the frame underneath the cable connector.
5. Remove the screws (T10) in the control card mounting plate.
6. Press barbs on ribbon cable and remove it.
7. Remove screws (T20) in cover plate.
8. Remove the control card mounting plate.

Reinstall in the reverse order.



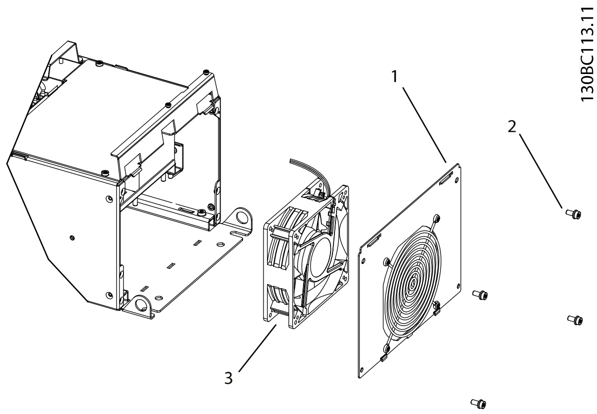
1	LCP
2	Cradle
3	Control card
4	Control card mounting plate

Illustration 7.1 Control Card and Control Card Mounting Plate

7.3.2 Heat sink Fan Assembly

1. Unplug the fan cable
2. Remove 4 screws on fan cover plate.
3. Remove the fan.

Reinstall in the reverse order.



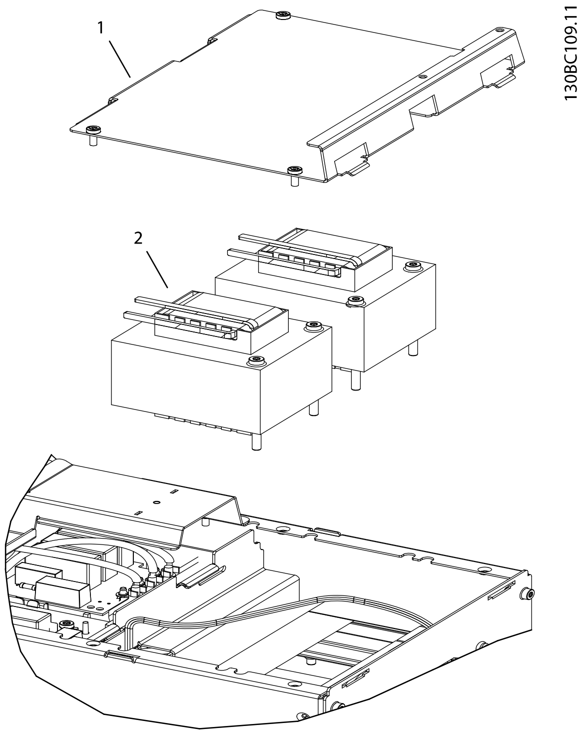
1	Fan cover plate
2	Screws
3	Fan assembly

Illustration 7.2 Heat Sink Fan Assembly

7.3.3 DC Coil

1. Remove the 4 screws on the DC coil cover to access the DC coils.
2. Remove the 4 screws to loosen the cables from the DC Link card.
3. Remove the 6 screws on the DC coils (3 screws on each coil).
4. Remove the coils.

Reinstall in the reverse order.



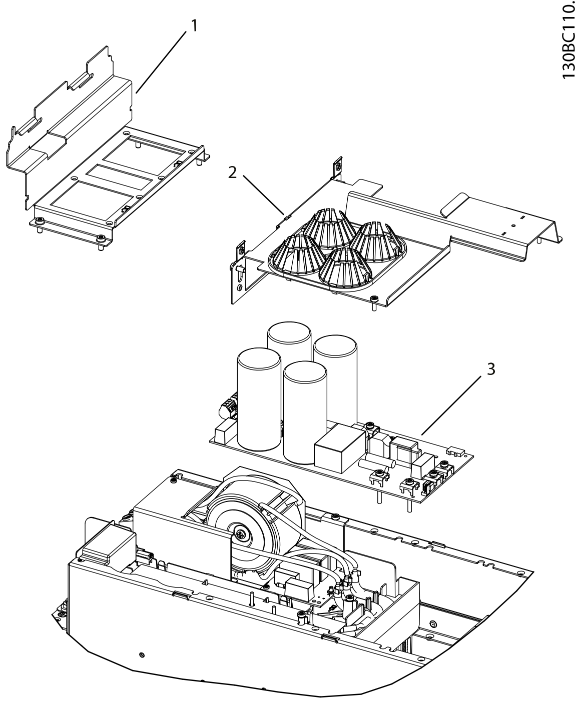
1	DC coil cover
2	DC coils

Illustration 7.3 DC Coil

7.3.4 DC Link Card

1. Remove the 6 screws on coil mounting plate.
2. Remove the coil mounting plate.
3. Loosen the 4 screws from the DC Link card.
4. Press one of the barbs to loosen the link card.
5. Unplug the 10-pin ribbon cable and the filter cable.
6. Remove the DC Link card.

Reinstall in the reverse order. Join the mounting snaps.



1	Coil mounting plate
2	Capacitor bank metal cover
3	DC link card

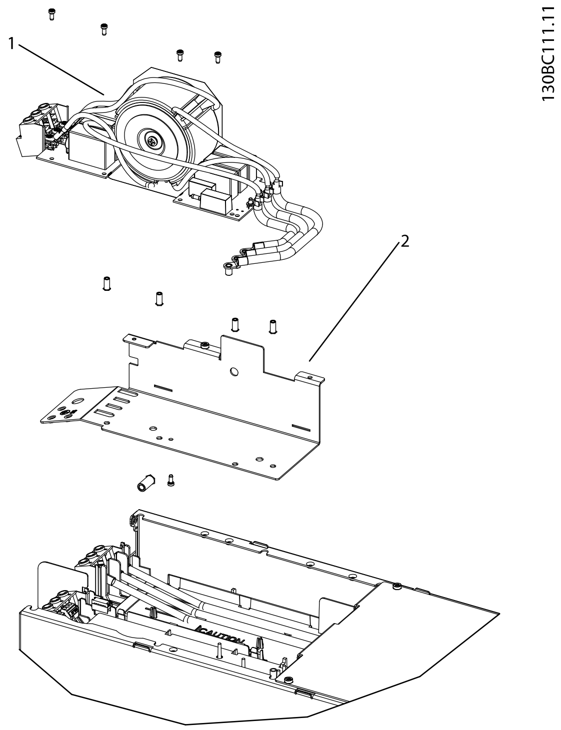
Illustration 7.4 DC Link Card

7

7.3.5 RFI Filter

1. Remove the protection cover.
2. Remove the 6 distance bushes.
3. Remove the 2 screws on the frame side.
4. Remove the 3 screws from U V W cables.
5. Press the barbs on the side of the filter.
6. Remove the RFI filter.

Reinstall in the reverse order.



1	RFI filter
2	EMC shield

Illustration 7.5 RFI Filter

7.3.6 Power Card

1. Remove the 3 screws on the U V W cable connector.
2. Remove the connector.
3. Remove the 3 small screws (T10) from the power card.

NOTICE

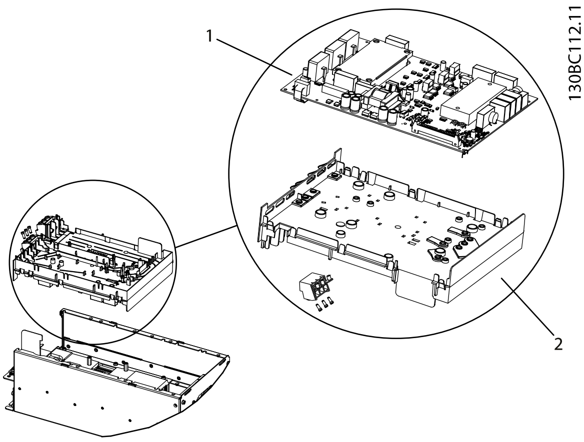
If it is difficult to get out the screws, use a magnet.

4. Remove the 6 remaining screws (T20).
5. Lift the power card and slide it out of the frame.

Reinstall in the reverse order.

NOTICE

If it is difficult to remove the power card, it is helpful to press the frame sides outwards while pressing the barbs on the side of the power card.



1	Power card
2	Power card mounting plate

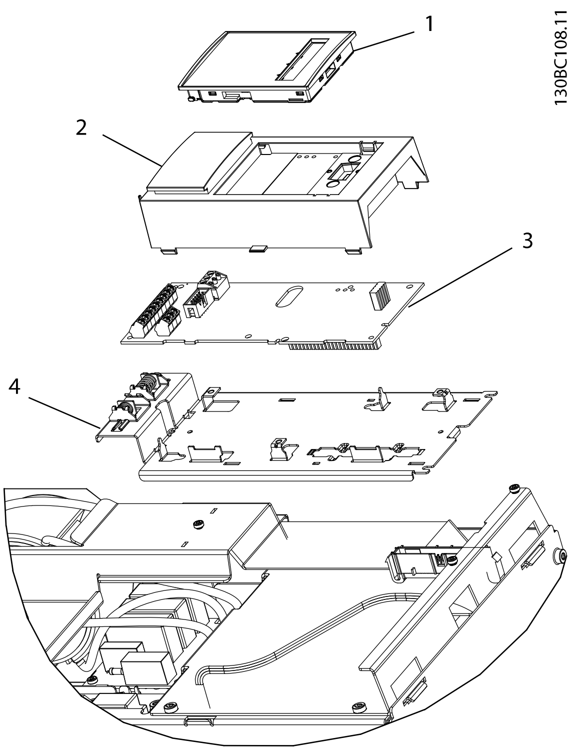
Illustration 7.6 Power Card

7.4 H7 Frame Size Disassembly and Assembly Instructions

7.4.1 Control Card and Control Card Mounting Plate

1. Remove the LCP by pressing the barbs on the side.
2. Remove the foil.
3. Remove the 3 screws (T10).
4. Gently, lift off the control card.
5. Press the barb on the LCP ribbon cable and pull it out of the control card mounting plate.
6. Remove the mounting plate.

Reinstall in the reverse order.



1	LCP
2	Cradle
3	Control card
4	Control card mounting plate

Illustration 7.7 Control Card and Control Card Mounting Plate

7.4.2 Power Card

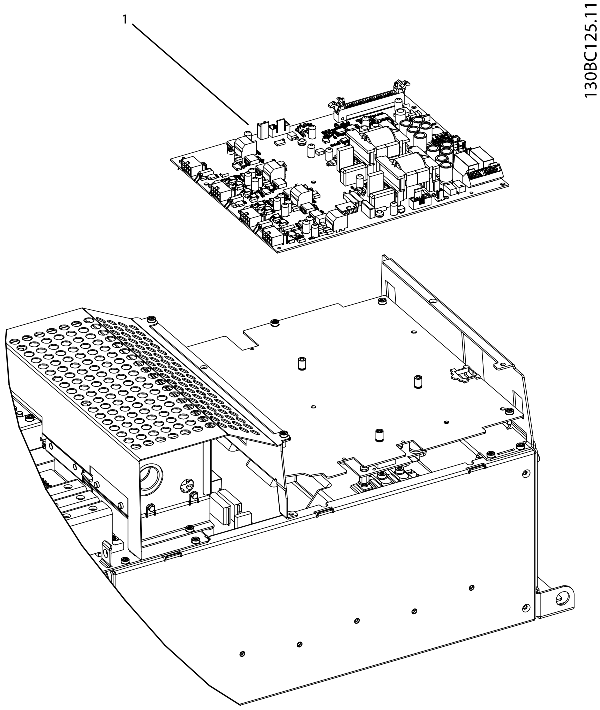
1. Remove the LCP ribbon cable from the power card.
2. Unplug all other cables from the power card, including the 3 gate cables at the bottom of the card.
3. Remove the 3 screws (T20) from the mounting plate.
4. Remove the power card by pushing in the 6 retaining clips.

NOTICE

Use a screwdriver if the retaining clips are hard to reach.

5. Slide the power card out and remove it.

Reinstall in the reverse order.



1	Power card

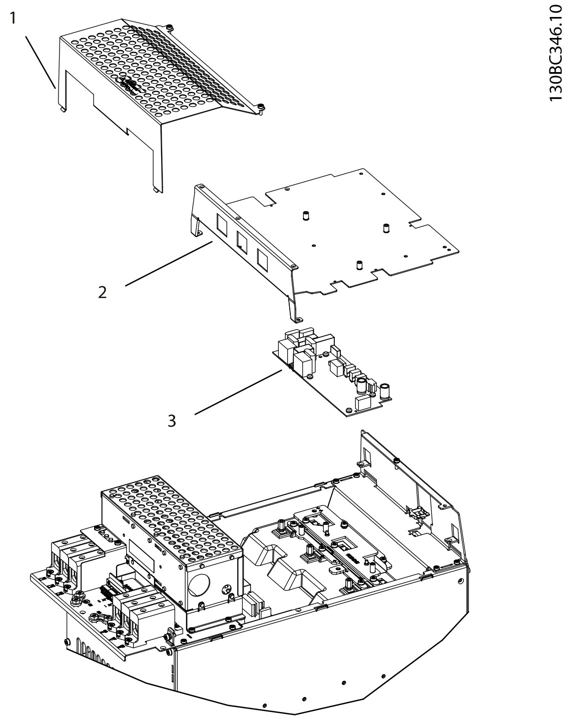
Illustration 7.8 Power Card

7

7.4.3 Inrush Card

1. Remove the 2 screws (T20) from the filter shield.
2. Remove the shield.
3. Remove the 4 screws (T20) from the power card mounting plate.
4. Remove the power card mounting plate.
5. Unplug all cables from the inrush card.
6. Remove the 6 screws (T20) from the inrush card.
7. Remove the inrush card.

Reinstall in the reverse order.



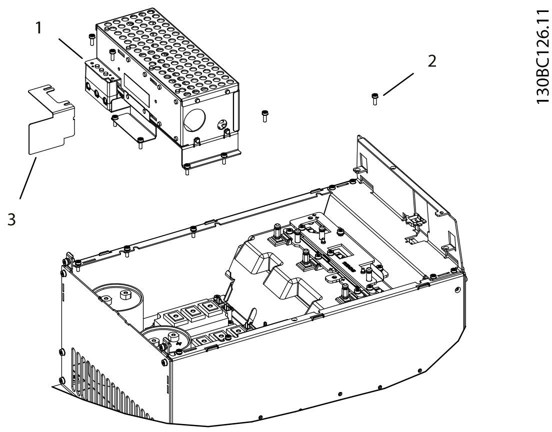
1	EMC shield
2	Power card mounting plate
3	Inrush card

Illustration 7.9 Inrush Card

7.4.4 RFI Filter

1. Remove the red/black cables from the filter cable.
2. Remove the protective foil.
3. Remove the 3 filter cables screws using a hex 8 key.
4. Remove the 2 screws (T20) from the EMC shield.
5. Remove the EMC shield.
6. Remove the 8 screws (T20) on the filter cable cover.
7. Loosen the left cable connector using a hex 5 key
8. Remove the entire filter assembly.

Reinstall in the reverse order.



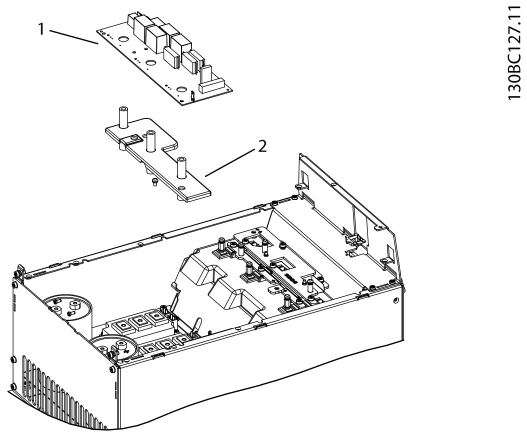
1	RFI filter
2	Screws
3	EMC shield

Illustration 7.10 RFI Filter

7.4.5 Relay Transducer Card

1. Unplug cables on the relay transducer card.
2. Loosen the right cable connector using a hex 5 key.
3. Open the plastic clamp to remove the cables from the connector.
4. Remove the 2 screws (T20) from the holding bracket.
5. Remove the holding bracket.
6. Remove the 3 cable screws (T20).
7. Remove the 3 screws on relay card (T20).
8. Remove the relay card by pushing in the retaining clips on the standoffs. Use a screwdriver if necessary.
9. Remove the mounting plate.

Reinstall in the reverse order.



1	Relay transducer card
2	Relay card mounting plate

Illustration 7.11 Relay or Transducer Card

7.4.6 Rectifier Modules

1. Loosen and remove the 2 cables (T20).
2. Remove the 6 screws (T20) from the shield.
3. Remove metal shield and plastic cover.
4. Remove the 2 screws (T20) from each of the rectifier modules.
5. Remove the 3 rectifier modules.

7.4.7 IGBT

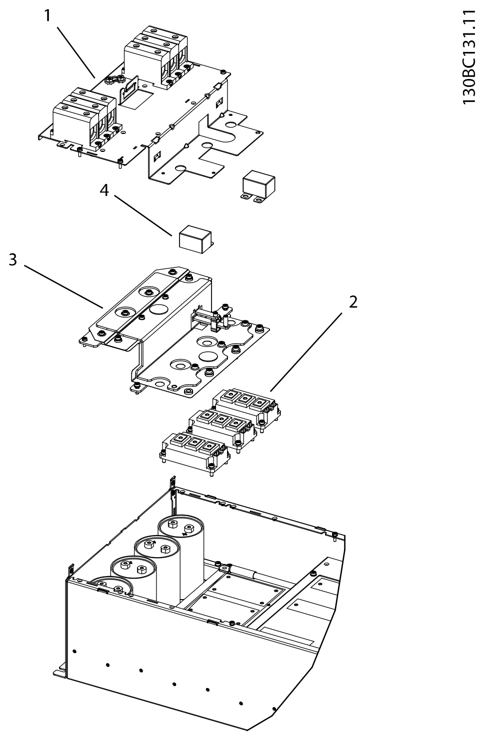
1. Remove the 4 screws (T20) from the cable connector plate.
2. Remove the cable connector plate.
3. Loosen the coil cables (T20).
4. Unplug the cables.
5. Remove the 2 screws from each of the 2 capacitors
6. Remove the capacitors.
7. Remove the 4 screws (T20) from the bus bar.
8. Remove the cables from the IGBTs.
9. Remove the 2 screws (T20) from each IGBT.
10. Remove the IGBTs.

CAUTION

The IGBTs and the heat sink have thermal paste on them. Be careful not to touch the paste directly as it is poisonous.

11. Remove the thermal paste from the IGBT.
12. Clean the heat sink.

Reinstall in the reverse order. Join the mounting snaps.



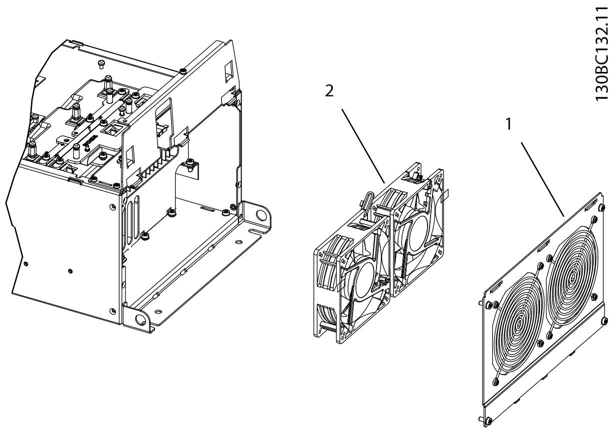
1	Cable mounting plate
2	IGBT
3	Bus bar
4	Capacitor

Illustration 7.12 IGBT

7.4.8 Heat Sink Fan Assembly

1. Remove the 4 screws (T20) from the fan cover plate.
2. Press the fan cover plate outwards using a screwdriver.
3. Remove the fans and the fan cover plate.

Reinstall in the reverse order.



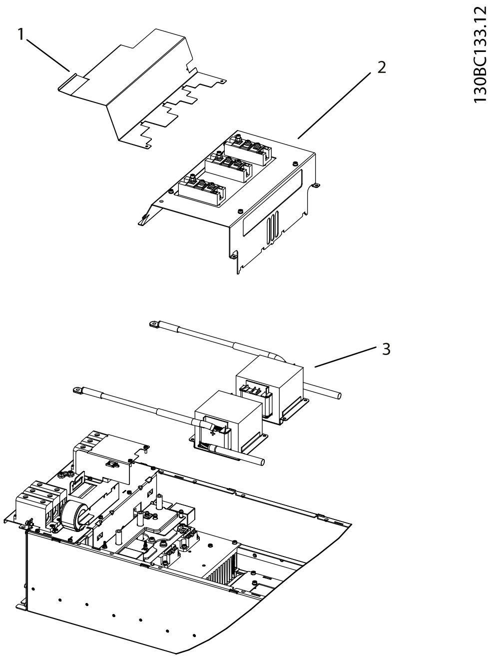
1	Fan cover
2	Fan assembly

Illustration 7.13 Heat Sink Fan Assembly

7.4.9 DC Coil

1. Remove the 4 screws (T20) from the DC coil cover plate.
2. Remove the 4 screws (T20) from the heat sink.
3. Remove the heat sink.
4. Remove 4 screws (T20) from each of the 2 DC Coils.
5. Remove the coils.

Reinstall in the reverse order.



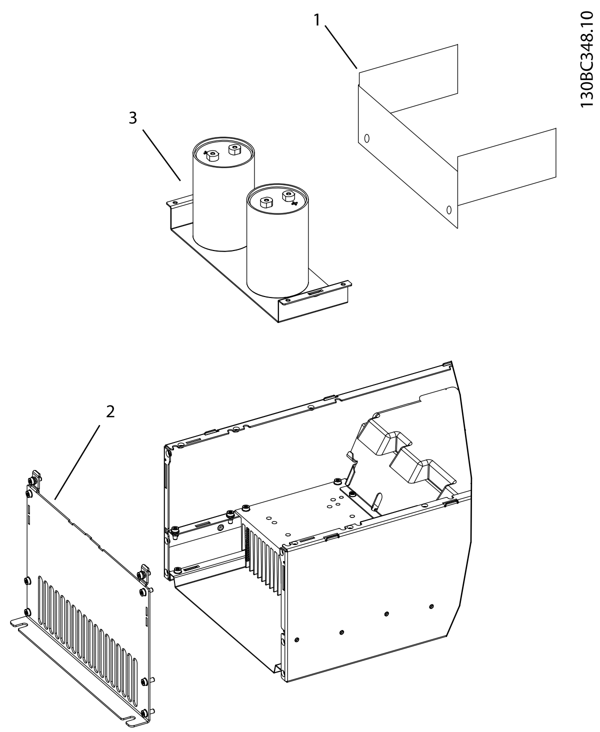
1	DC coil cover plate
2	Heat sink
3	DC coil

Illustration 7.14 DC Coil

7.4.10 Capacitor Bank

1. Remove the foil.
2. Remove the 6 screws on the base plate.
3. Remove the base plate.
4. Remove the 4 screws (T20) from the capacitor mounting plate.
5. Remove the mounting plate.
6. Turn the capacitor bank upside-down.
7. Remove the hex nut with a hex 19 key.
8. Remove the capacitor.

Reinstall in the reverse order.



1	Foil
2	Base plate
3	Capacitor bank

Illustration 7.15 Capacitor Bank

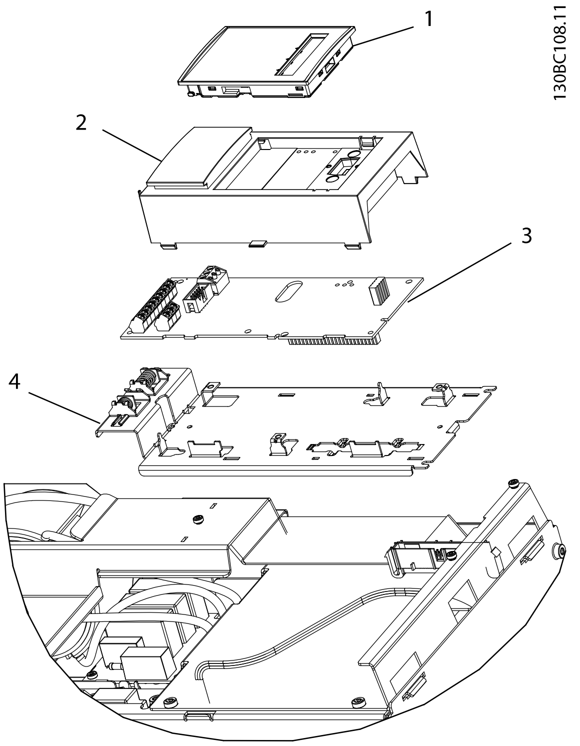
7

7.5 H8 Frame Size Disassembly and Assembly Instructions

7.5.1 Control Card and Control Card Mounting Plate

1. Remove the LCP by pressing the barbs on the side.
2. Remove the foil.
3. Remove the 3 screws (T10).
4. Gently, lift off the control card.
5. Press the barb on the LCP ribbon cable and pull it out of the control card mounting plate.
6. Remove the mounting plate.

Reinstall in the reverse order.



1	LCP
2	Cradle
3	Control card
4	Control card mounting plate

Illustration 7.16 Control Card and Control Card Mounting Plate

7.5.2 Power Card

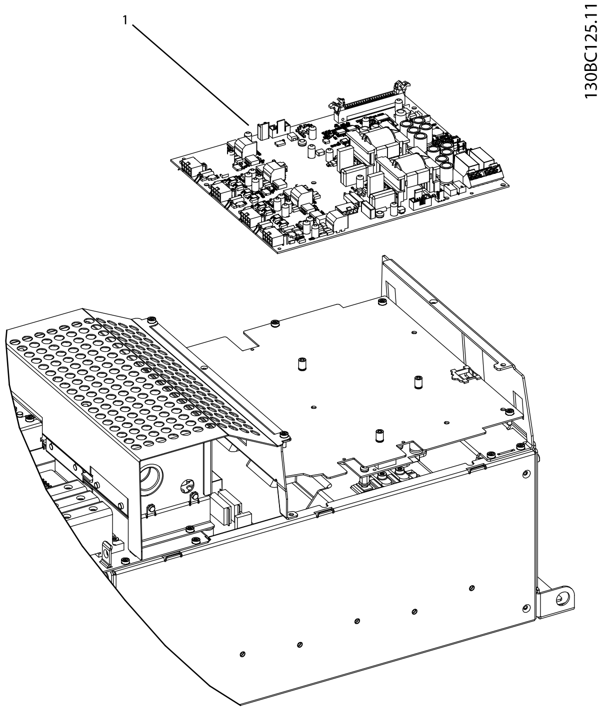
1. Remove 2 screws (T20) from the EMC shield.
2. Remove cables from EMC shield.
3. Remove the EMC shield.
4. Remove the LCP ribbon cable from the power card.
5. Unplug all other cables from the power card.
6. Remove the 3 screws (T20) from the mounting plate.
7. Remove the power card by pushing in the 6 retaining clips.

NOTICE

Use a screwdriver if the retaining clips are hard to reach.

8. Slide the power card out and remove it.

Reinstall in the reverse order.



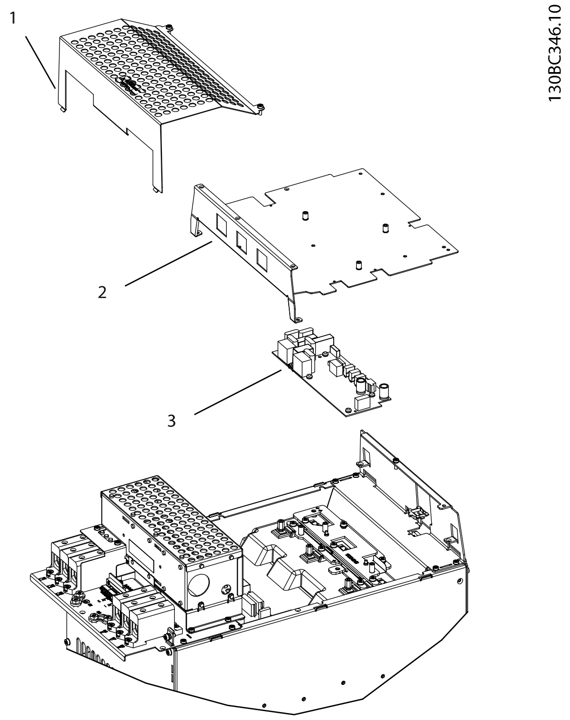
1	Power card

Illustration 7.17 Power Card

7.5.3 Inrush Card

1. Remove the 4 screws (T20) from the power card mounting plate.
2. Remove the power card mounting plate.
3. Unplug all cables from the inrush card.
4. Remove the 6 screws (T20) from the inrush card.
5. Remove the inrush card.

Reinstall in the reverse order.



1	EMC shield
2	Power card mounting plate
3	Inrush card

Illustration 7.18 Inrush Card

7.5.4 Rectifier Modules

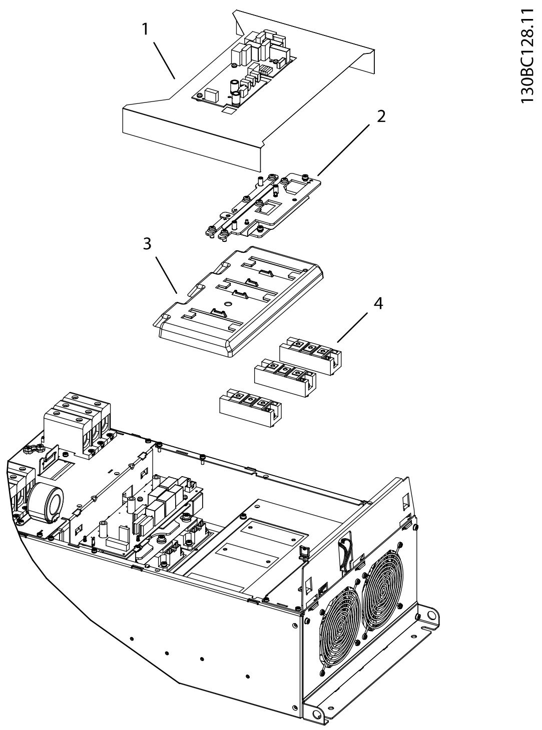
⚠CAUTION

Wear protective gloves when cleaning up the thermal paste as it is poisonous.

1. Remove cables and foil.
2. Remove coil cords (T20).
3. Remove 6 screws (T25).
4. Remove screws in coil cables (T20).
5. Remove the 6 screws (T25) from the bar.
6. Remove the bar.
7. Loosen and remove the 3 cables using a hex 10 key.
8. Remove the plastic cover.
9. Remove the 2 screws (T20) on each of the rectifier modules
10. Remove the thermal paste paper.
11. Clean up any excessive thermal paste.

Reinstall in the reverse order. Join the mounting snaps.

7



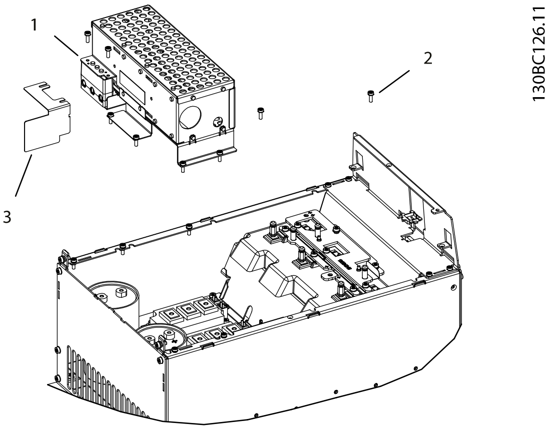
1	Foil
2	Bus bar
3	Plastic cover
4	Rectifier modules

Illustration 7.19 Rectifier Modules

7.5.5 RFI Filter

1. Remove the 3 screws (T20) from the small EMC shield.
2. Remove the EMC shield.
3. Loosen left cable connector using a hex 8 key.
4. Remove the 4 screws (T20) from the filter.
5. Remove the entire filter assembly.

Reinstall in the reverse order.



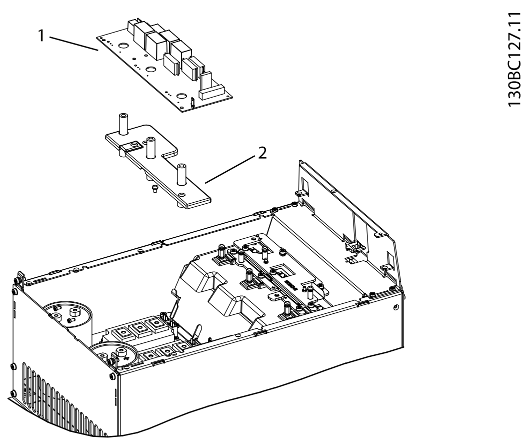
1	RFI filter
2	Screws
3	EMC shield

Illustration 7.20 RFI Filter

7.5.6 Relay Transducer Card

1. Remove the 4 screws (T20) on the plate.
2. Carefully remove cables before removing the plate.
3. Loosen the cables in the right cable connector using a hex 8 key.
4. Pull out the cables.
5. Remove the 3 screws (T30) on the relay card.
6. Remove the 2 10-pin ribbon cables.
7. Remove the 3 screws (T20) from the relay card.
8. Press the 3 retaining clips.
9. Remove the relay card.
10. Remove the relay card mounting plate.

Reinstall in the reverse order.



1	Relay transducer card
2	Relay card mounting plate

Illustration 7.21 Relay Transducer Card

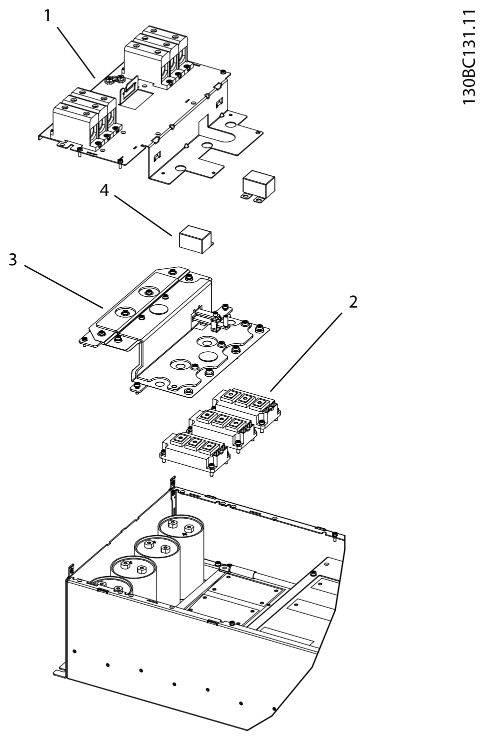
7.5.7 IGBT

⚠CAUTION

Wear protective gloves when cleaning up the thermal paste as it is poisonous.

1. Remove the 2 screws from the cable retaining guide.
2. Remove the cable retaining guide.
3. Remove the 4 screws (T20) from the cable connector plate.
4. Remove the cable connector plate.
5. Remove the 2 cable screws (T20)
6. Remove the 2 screws (T30) in each of the 2 capacitors.
7. Remove the capacitors.
8. Remove the 2 screws (T30) from the bus bar.
9. Remove the 4 screws (T20) holding the capacitors.
10. Remove the bus bar.
11. Remove the gate cables from the IGBTs.
12. Remove the 4 screws from each IGBT.
13. Remove the thermal paper.
14. Remove the thermal paste from the IGBTs and the heat sink.

Reinstall in the reverse order. Join the mounting snaps.



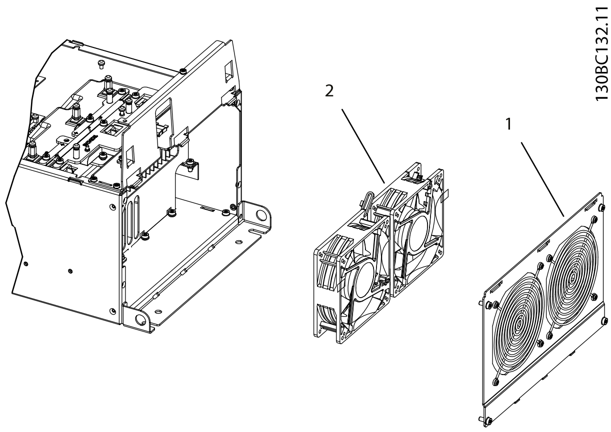
1	Cable mounting plate
2	IGBT
3	Bus bar
4	Capacitor

Illustration 7.22 IGBT

7.5.8 Heat Sink Fan Assembly

1. Remove the 4 screws (T20) from the fan cover plate.
2. Press the fan cover plate outwards using a screwdriver.
3. Remove the fans and the fan cover plate.

Reinstall in the reverse order.



1	Fan cover
2	Fan assembly

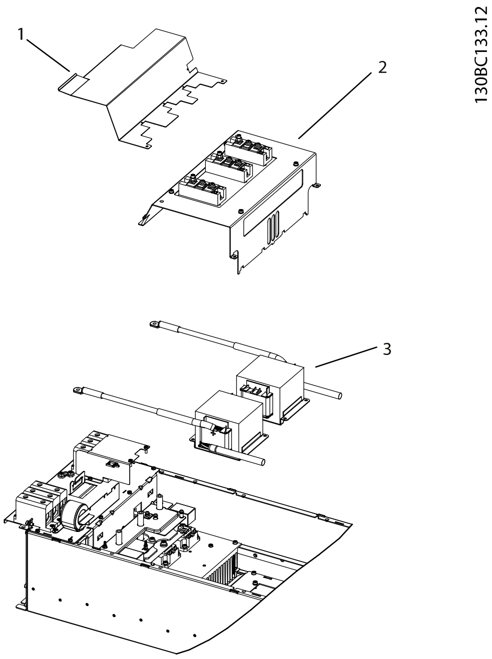
Illustration 7.23 Heat Sink Fan Assembly

7

7.5.9 DC Coil

1. Remove the 4 screws (T20) from the DC coil cover plate.
2. Remove the 4 screws (T20) from the heat sink.
3. Remove the heat sink.
4. Remove 4 screws (T20) from each of the 2 DC Coils.
5. Remove the coils.

Reinstall in the reverse order.



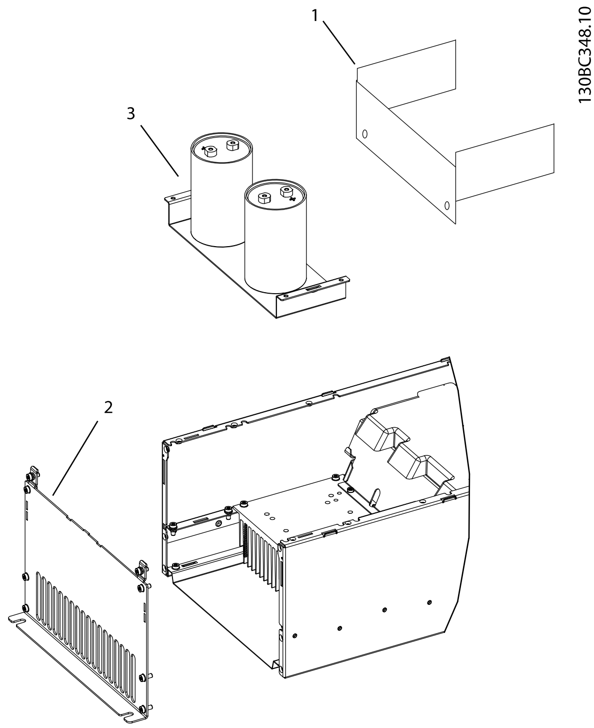
1	DC coil cover plate
2	Heat sink
3	DC coil

Illustration 7.24 DC Coil

7.5.10 Capacitor Bank

1. Remove the foil.
2. Remove the 4 screws from the base plate.
3. Remove the base plate.
4. Remove the 4 screws from the capacitor bank assembly.
5. Remove the assembly.
6. Turn the assembly upside-down.
7. Remove the 2 hex nuts with a hex 19 key.
8. Remove the 2 capacitors.

Reinstall in the reverse order.



1	Foil
2	Base plate
3	Capacitor bank

Illustration 7.25 Capacitor Bank

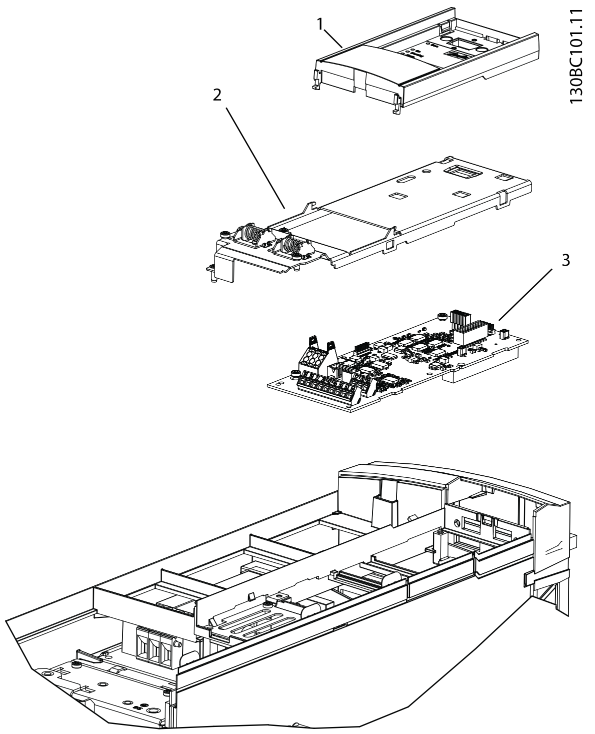
7

7.6 H10 Frame Size Disassembly and Assembly Instructions

7.6.1 Control Card and Control Card Mounting Plate

1. Remove the LCP cradle. LCP cradle can be removed by hand.
2. Remove 3 screws (T10) securing the control card mounting plate to the control assembly support bracket.
3. Carefully lift out the control card.

Reinstall in the reverse order.



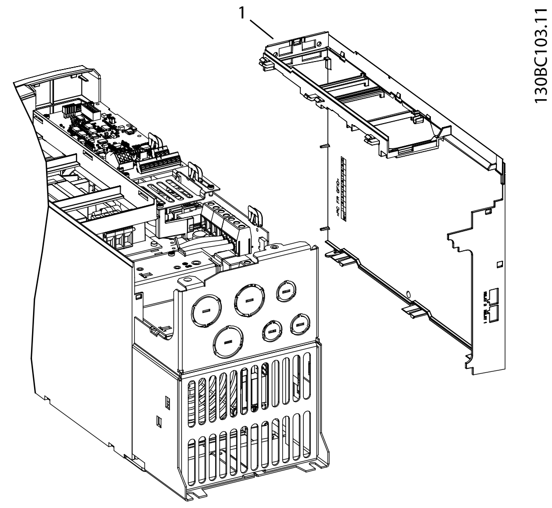
1	LCP
2	Control card mounting plate
3	Control card

Illustration 7.26 Control Card and Control Card Mounting Plate

7.6.2 Power Card Cover

1. Press and loosen the 3 barbs at the bottom, and the 3 barbs at the top.
2. Remove the power card cover.

Reinstall in the reverse order. Join the mounting snaps.



1	Power card cover

Illustration 7.27 Power Card Cover

7.6.3 Power Card

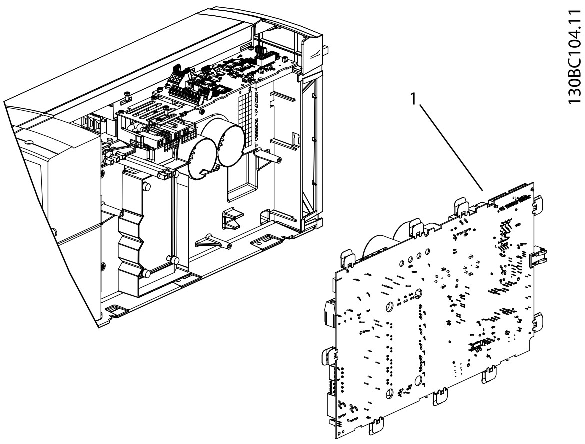
1. Remove the 4 screws (T10) for the DC coil cables.
2. Remove the 5 screws (T10) for the heat sink.
3. Remove the 4 IGBT screws (T25).
4. Unplug fan cable connector.

⚠CAUTION

The power card and the heat sink have thermal paste on them. Wear protective gloves as the paste is poisonous.

5. Lift out the power card.
6. Remove the capacitor bank gasket.

Reinstall in the reverse order.



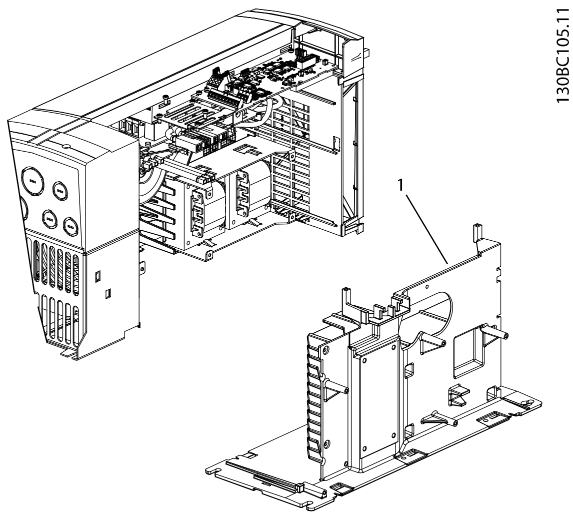
1	Power card

Illustration 7.28 Power Card

7.6.4 Heat Sink and DC Coils

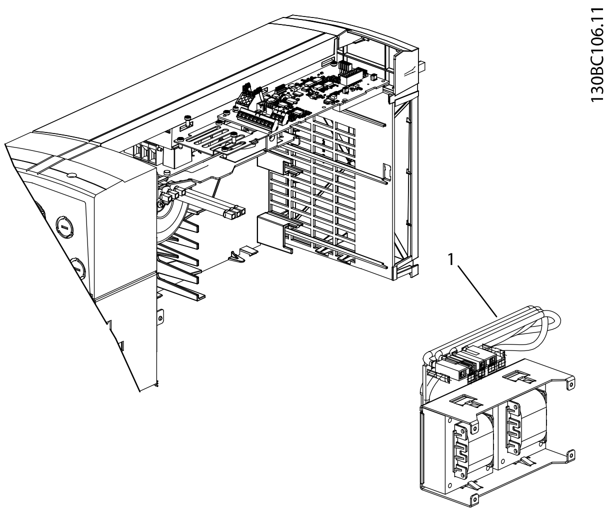
1. Remove the 7 mounting screws from top surface.
2. Press and loosen the 3 barbs at the bottom.
3. Unplug the DC coil cables.
4. Remove the heat sink.
5. Lift out the DC coils.

Reinstall in the reverse order.



1	Heat sink

Illustration 7.29 Heat Sink



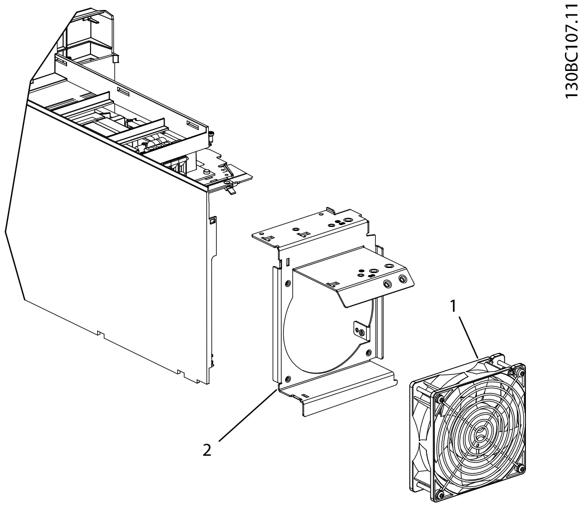
1	DC coil

Illustration 7.30 DC Coil

7.6.5 Heat Sink Fan Assembly

1. Remove 2 screws (T10) on the DC coil mounting plate
2. Remove the plate.
3. Press and loosen the 2 barbs on the fan.
4. Remove the fan.

Reinstall in the reverse order.



1	Heat sink fan
2	Fan mounting plate

Illustration 7.31 Heat Sink Fan Assembly

8 I-Frame Size Disassembly and Assembly Procedures

8.1 General Disassembly Procedure

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

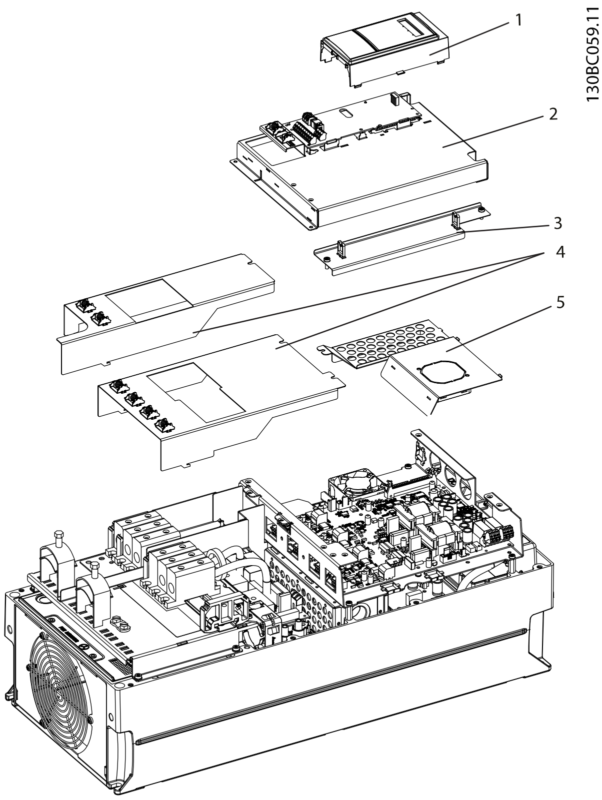
1. Loosen and remove the 4 screws (T20) from the front cover.
2. Remove the front cover.
3. Remove the screw and sheet metal next to the EMC shield.
4. Loosen and remove the 4 screws (T20) from the cable entry.
5. Remove the cable entry.

8.2 I6 Frame Size Disassembly and Assembly Instructions

8.2.1 Control Card and Control Card Mounting Plate

1. Remove LCP cradle.
2. Remove 3 screws (T12) on the control board.
3. Remove the control board.
4. Remove 1 screw (T20) on the fan bracket.
5. Unplug the fan cable and remove the fan.
6. Remove 4 screws (T20) on the control card mounting plate.
7. Unplug ribbon cable.
8. Remove control card mounting plate.

Reinstall in the reverse order.



1	LCP and cradle
2	Control card and mounting plate
3	Support bracket
4	Terminal plates
5	EMC shield

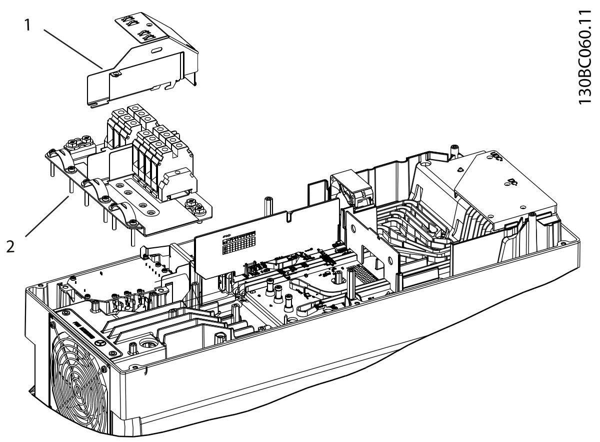
Illustration 8.1 Control Card and Control Card Mounting Plate

8

8.2.2 Cable Mounting Plate

1. Remove the ribbon cable.
2. Remove 1 screw (T20) from shield metal.
3. Use a flat screwdriver to release the retainers and connection terminals.
4. Use a hex 4 key to loosen the screws in the cable connector.
5. Pull out the cables.
6. Slide the connector to the side and remove it.
7. Remove 2 screws (T20) from the mounting plate.

Reinstall in the reverse order.



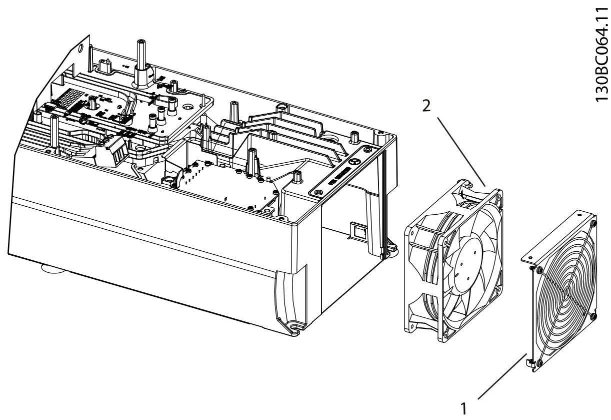
1	EMC shield
2	Cable mounting plate

Illustration 8.2 Cable Mounting Plate

8.2.3 Heat Sink Fan Assembly

1. Unplug cable from power card.
2. Remove 2 screws (T20) from the fan mounting plate.
3. Push the cable downwards. Use a screwdriver to press the gasket down through the entry.
4. Pull out fan assembly.

Reinstall in the reverse order.



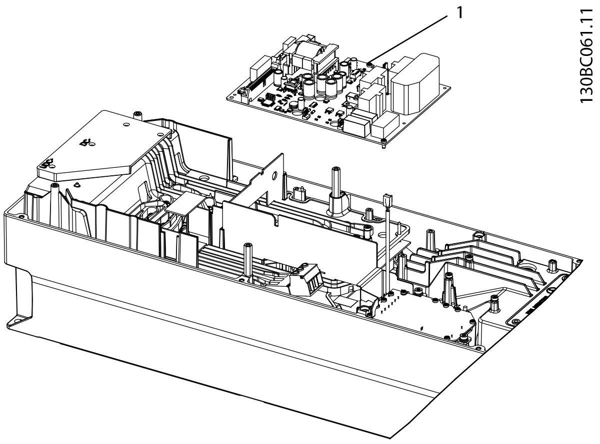
1	Fan cover
2	Fan assembly

Illustration 8.3 Heat Sink Fan Assembly

8.2.4 SMPS Card

1. Remove the 3 black plastic covers.
2. Unplug and remove the fan.
3. Unplug all other cables.
4. Remove the 2 screws (T20) at MK101.
5. Remove the 3 screws (T20) at K103A, K104A, and K105A.
6. Remove the 4 screws (T20) and from the SMPS card.
7. Lift off the SMPS card.

Reinstall in the reverse order.



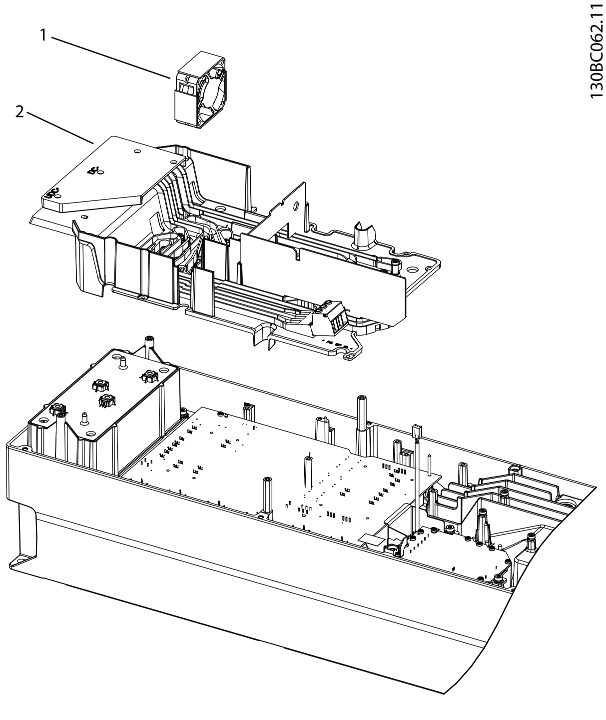
1	SMPS card

Illustration 8.4 SMPS Card

8.2.5 Bus Bar Unit

1. Remove the 2 screws from the snubber capacitor on the bus bar unit.
2. Remove the snubber capacitor.
3. Use a Hex 8 key to remove 2 screws from the bus bar unit.
4. Remove the 6 small screws (T10).
5. Remove the remaining 9 screws (T20).
6. Unplug cables.
7. Lift out the bus bar unit.

Reinstall in the reverse order.



1	Fan
2	Bus bar unit

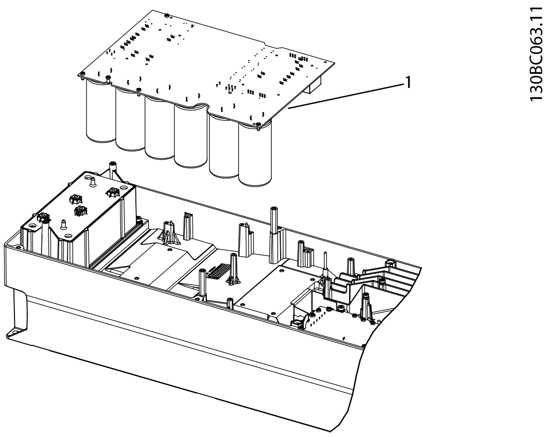
Illustration 8.5 Bus Bar Unit

8

8.2.6 Power Card

1. Remove 7 screws (T20)
2. Remove 5 screws (T10) on the Power Card.
3. Lift out the power card.

Reinstall in the reverse order.



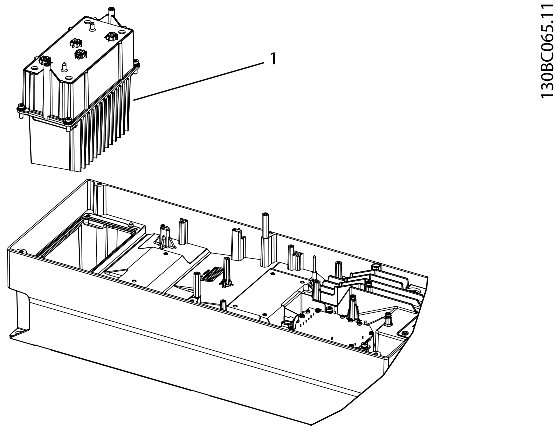
1	Power card

Illustration 8.6 Power Card

8.2.7 DC Coil

1. Remove 4 screws (T20) from the coil.
2. Lift the coil.

Reinstall in the reverse order.



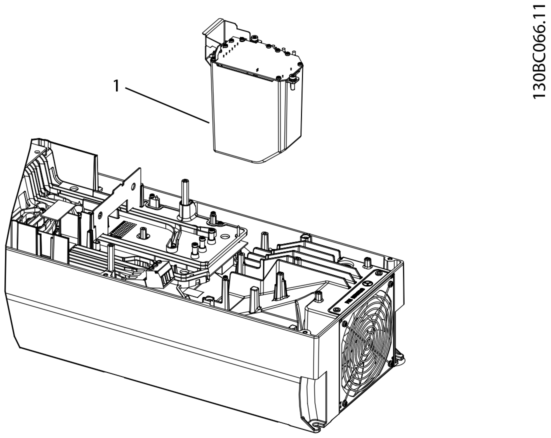
1	DC coil

Illustration 8.7 DC Coil

8.2.8 RFI Filter

1. Remove 2 screws (T20) from the filter.
2. Lift out the filter.

Reinstall in the reverse order.



1	RFI filter

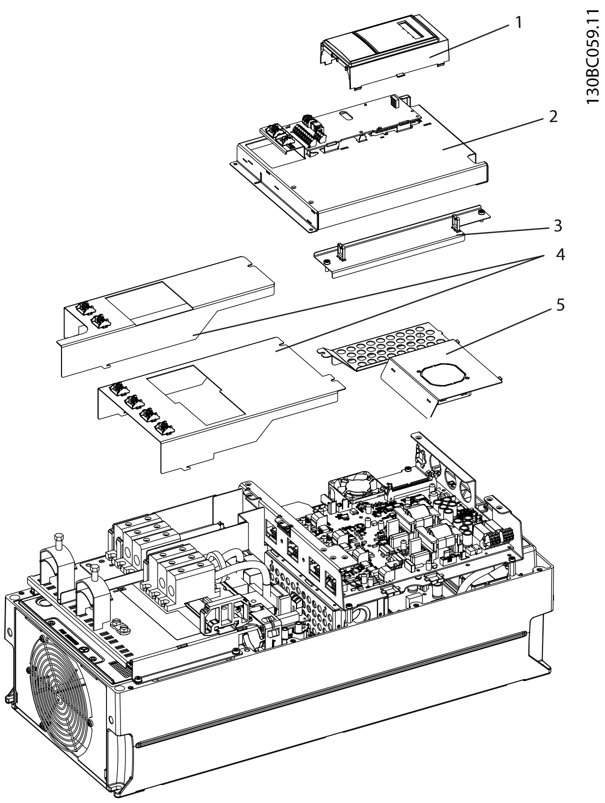
Illustration 8.8 RFI Filter

8.3 I7 Frame Size Disassembly and Assembly Instructions

8.3.1 Control Card and Control Card Mounting Plate

1. Remove 2 screws (T20) from the 2 cover plates.
2. Remove the LCP cradle.
3. Remove 3 screws (T10) from the control card.
4. Remove the control card.
5. Remove 2 screws (T20) from the bracket next to the control card mounting plate.
6. Remove 4 screws (T20) to remove the control card mounting plate.
7. Unplug the LCP ribbon cable.
8. Remove the control card mounting plate.

Reinstall in the reverse order.



1	LCP and cradle
2	Control card and mounting plate
3	EMC shield
4	Terminal plates
5	EMC shield

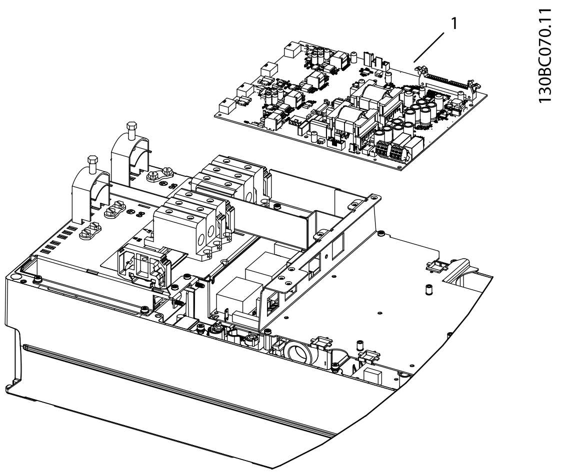
Illustration 8.9 Control Card Mounting Plate

8

8.3.2 Power Card

1. Unplug and remove the LCP ribbon cable.
2. Unplug all other cables from the power card.
3. Remove 3 screws (T20) on the power card.
4. Remove the power card.

Reinstall in the reverse order.



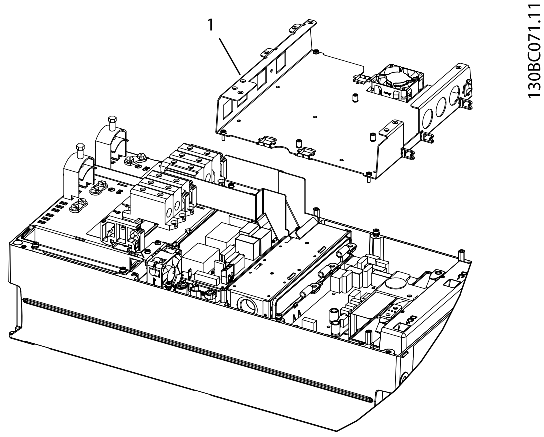
1	Power card

Illustration 8.10 Power Card

8.3.3 Power Card Mounting Plate

1. Remove 4 screws (T20) from the power card mounting plate.
2. Remove the power card mounting plate with the fan attached.

Reinstall in the reverse order.



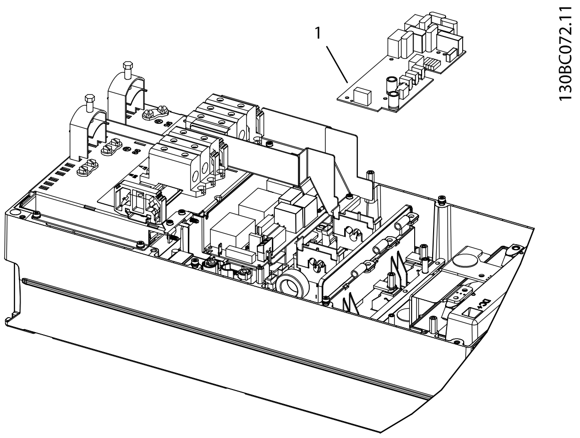
1	Power card mounting plate

Illustration 8.11 Power Card Mounting Plate

8.3.4 Inrush Card

1. Unplug all cables.
2. Remove 6 screws (T20) from the inrush card.
3. Remove the inrush card.

Reinstall in the reverse order.



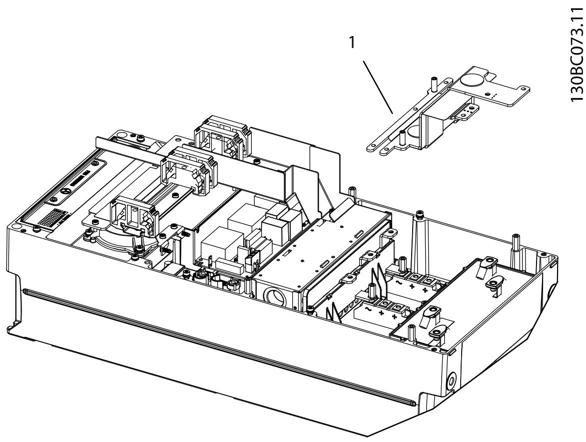
1	Inrush card

Illustration 8.12 Inrush Card

8.3.5 Bus Bar

1. Unplug and remove the red/black cable.
2. Remove the black plastic cover.
3. Remove 8 screws (T20) from the support bracket.
4. Remove the bus bar assembly.

Reinstall in the reverse order.



1	Bus bar

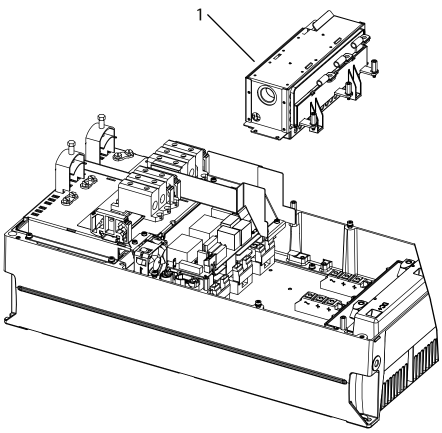
Illustration 8.13 Bus Bar

8

8.3.6 RFI Filter

1. Unplug the 3 filter cables from the thyristors using a hex 8 key.
2. Loosen the 3 cables from the cable connector using a hex 5 key.
3. Remove 3 screws (T20) from the support bracket.
4. Remove support bracket.
5. Remove 4 screws (T20) from the RFI filter.
6. Remove the entire assembly.

Reinstall in the reverse order.



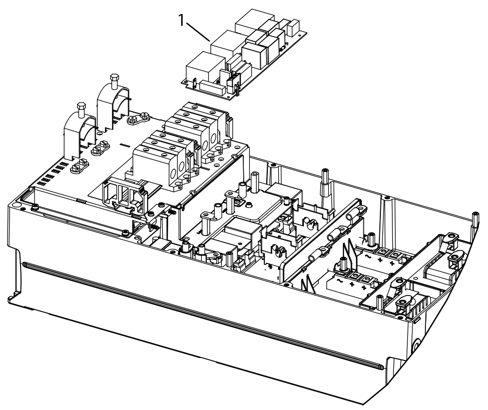
1	RFI filter

Illustration 8.14 RFI Filter

8.3.7 Relay Transducer Card

1. Remove the 3 clamps on each side of the 2 cable connectors.
2. Remove the cable connector with no cables attached.
3. Remove 3 screws (T20) from the support bracket.
4. Loosen the 3 cables from the relay transducer card.
5. Remove the cable connector with cables and retaining guide attached.
6. Unplug all other cables from the relay transducer card.
7. Remove the 3 screws (T20)
8. Remove the relay transducer card.

Reinstall in the reverse order.



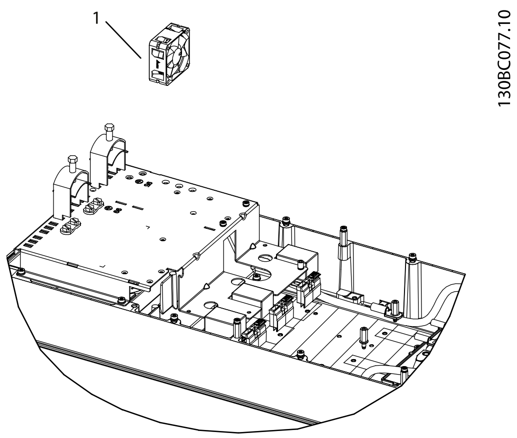
1	Relay transducer card

Illustration 8.15 Relay Transducer Card

8.3.8 Fan

1. Remove 2 screws (T20) on the fan bracket.
2. Remove 2 screws (T20) from the fan.
3. Remove the fan.

Reinstall in the reverse order.



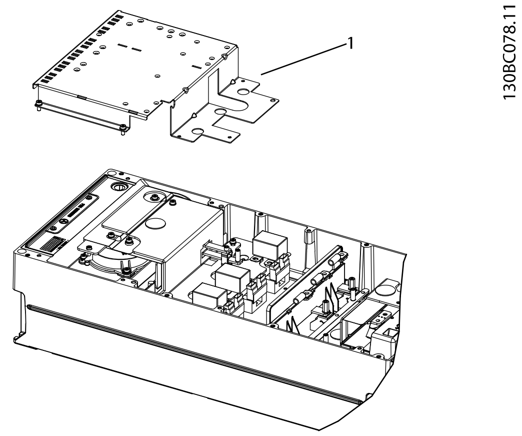
1	Fan

Illustration 8.16 Fan

8.3.9 Terminal Plate

1. Remove the black plastic cover.
2. Remove 4 screws (T20) on the cover plate.
3. Remove the terminal plate.

Reinstall in the reverse order.



1	Terminal plate

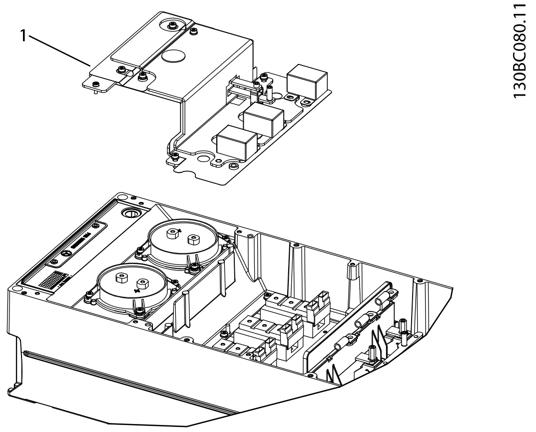
Illustration 8.17 Terminal Plate

8

8.3.10 DC Bus Bar Assembly

1. Remove 2 screws (T20) from the 2 snubbers.
2. Remove the snubbers.
3. Loosen and remove cables from bus bar assembly and DC coil.
4. Remove 6 screws (T20) from the bus bar assembly.
5. Remove the bus bar assembly.

Reinstall in the reverse order.



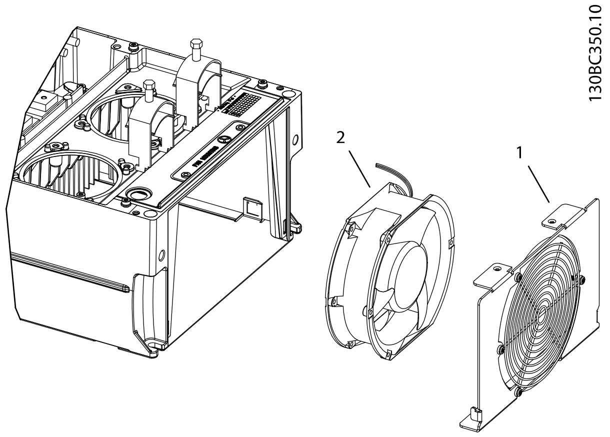
1	DC bus bar assembly

Illustration 8.18 DC Bus Bar Assembly

8.3.11 Heat Sink Fan Assembly

1. Remove gate cables from IGBTs.
2. Remove 2 screws (T20) from the heat sink fan assembly.
3. Push the fan cable down through the gasket.
4. Carefully press the gasket down with a screwdriver.
5. Remove the fan assembly.

Reinstall in the reverse order.



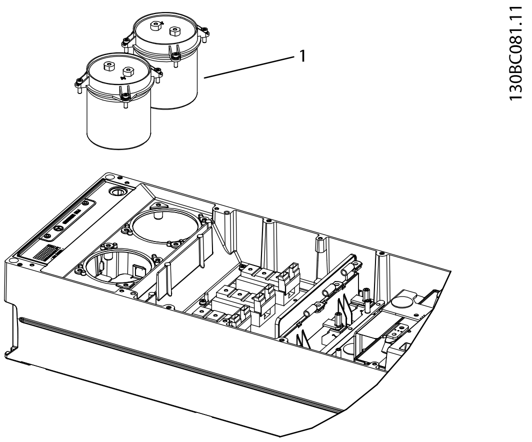
1	Fan cover plate
2	Fan assembly

Illustration 8.19 Heat Sink Fan Assembly

8.3.12 Capacitor Bank

1. Remove 4 screws (T20) from each of the capacitors.
2. Remove the capacitors.

Reinstall in the reverse order.



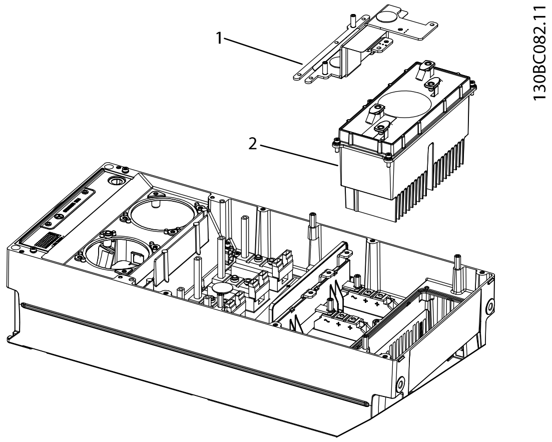
1	Capacitors

Illustration 8.20 Capacitors

8.3.13 DC Coil

1. Remove 5 screws (T20) on the potted coil.
2. Remove the DC coil.

Reinstall in the reverse order.



1	Bus bar
2	DC coil

Illustration 8.21 DC Coil

8

8.3.14 IGBT

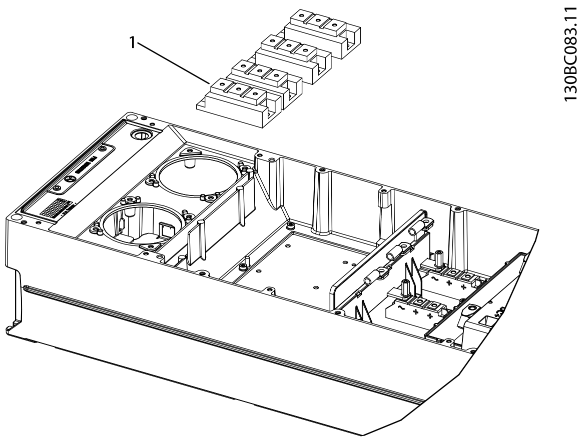
1. Remove 2 screws (T20) from each of the 3 IGBTs.

⚠CAUTION

The IGBTs and the heat sink have thermal paste on them. Wear protective gloves as the paste is poisonous.

2. Remove all IGBTs.

Reinstall in the reverse order.



1	IGBT

Illustration 8.22 IGBT

8.3.15 Thyristor

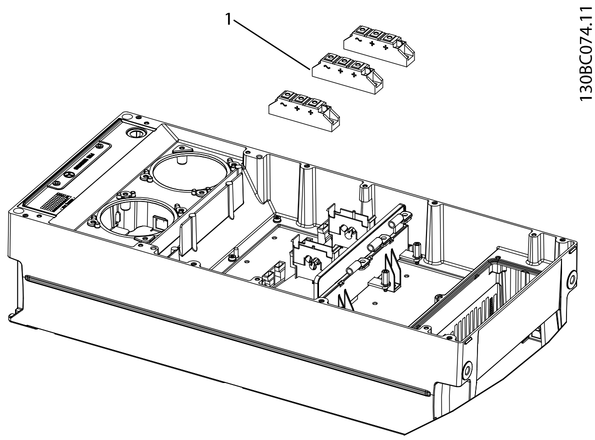
1. Remove 2 screws (T20) from each of the 3 thyristors.

⚠CAUTION

The thyristors and the heat sink have thermal paste on them. Wear protective gloves as the paste is poisonous.

2. Remove the thyristors.

Reinstall in the reverse order.



1	Thyristor

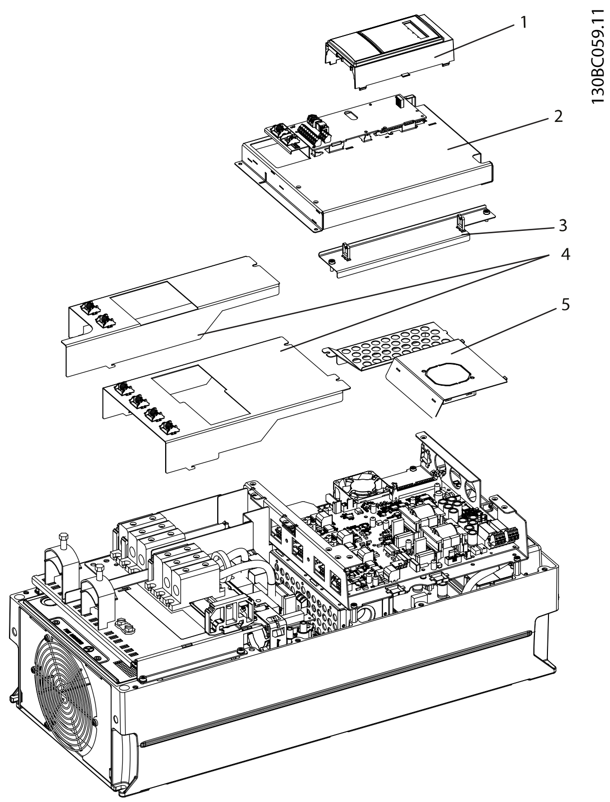
Illustration 8.23 Thyristor

8.4 I8 Frame Size Disassembly and Assembly Procedure

8.4.1 Control Card and Control Card Mounting Plate

1. Remove 2 screws (T20) from the 2 cover plates.
2. Remove the LCP cradle.
3. Remove 3 screws (T10) from the control card.
4. Remove the control card.
5. Remove 2 screws (T20) from the bracket next to the control card mounting plate.
6. Remove 4 screws (T20) to remove the control card mounting plate.
7. Unplug the LCP ribbon cable.
8. Remove the control card mounting plate.

Reinstall in the reverse order.



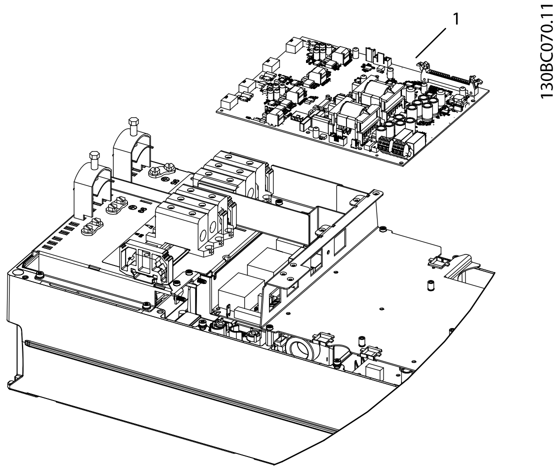
1	LCP and cradle
2	Control card and mounting plate
3	EMC shield
4	Terminal plates
5	EMC shield

Illustration 8.24 Control Card Mounting Plate

8.4.2 Power Card

1. Unplug and remove the LCP ribbon cable.
2. Unplug all other cables from the power card.
3. Remove 3 screws (T20) on the power card.
4. Remove the power card.

Reinstall in the reverse order.



1	Power card

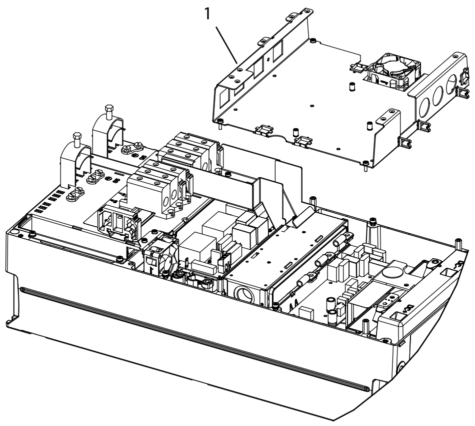
Illustration 8.25 Power Card

8

8.4.3 Power Card Mounting Plate

1. Remove 4 screws (T20) from the power card mounting plate.
2. Remove the power card mounting plate with the fan attached.

Reinstall in the reverse order.



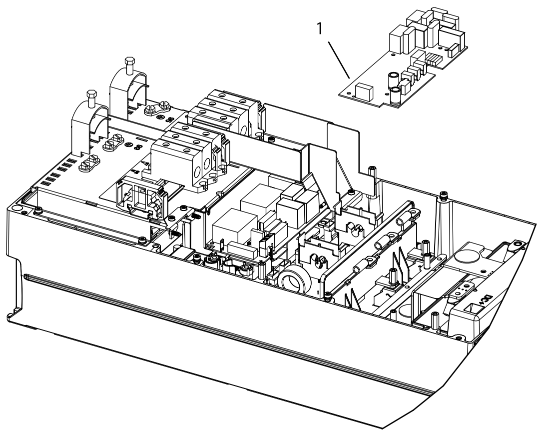
1	Power card mounting plate

Illustration 8.26 Power Card Mounting Plate

8.4.4 Inrush Card

1. Unplug all cables.
2. Remove 6 screws (T20) from the inrush card.
3. Remove the inrush card.

Reinstall in the reverse order.



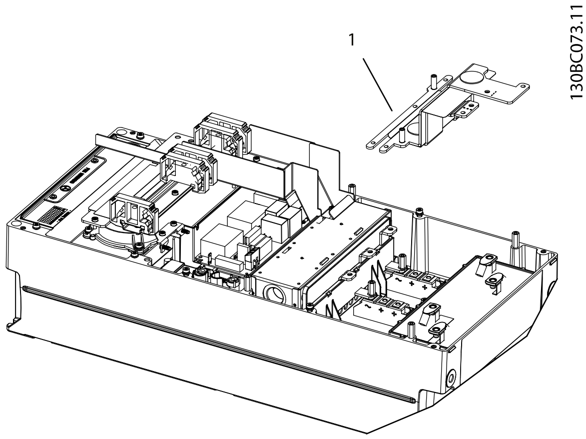
1	Inrush card

Illustration 8.27 Inrush Card

8.4.5 Bus Bar

1. Unplug and remove the red/black cable.
2. Remove the black plastic cover.
3. Remove 6 screws (T20) and 2 screws (T30) from the support bracket.
4. Remove the bus bar assembly.

Reinstall in the reverse order.



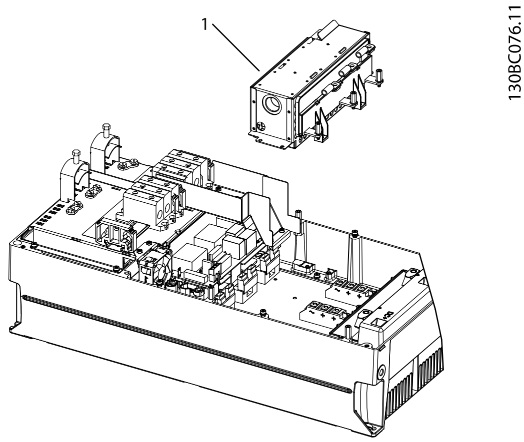
1	Bus bar

Illustration 8.28 Bus Bar

8.4.6 RFI Filter

1. Unplug the 3 filter cables from the thyristors using a hex 8 key.
2. Loosen the 3 cables from the cable connector using a hex 5 key.
3. Remove 3 screws (T20) from the support bracket.
4. Remove support bracket.
5. Remove 4 screws (T20) from the RFI filter.
6. Remove the entire assembly.

Reinstall in the reverse order.



1	RFI filter

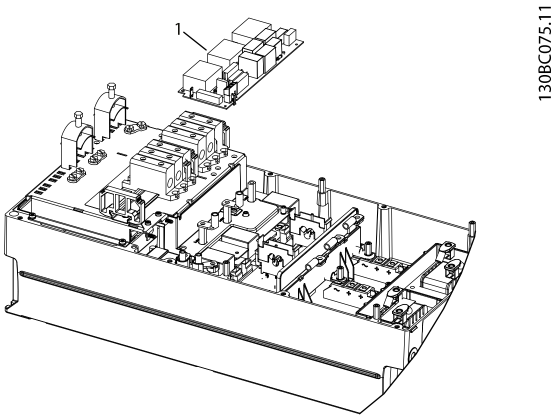
Table 8.1

Illustration 8.29 RFI Filter

8.4.7 Relay Transducer Card

1. Remove 2 screws (T20) from each of the 2 cable connectors.
2. Remove the cable connector.
3. Remove 3 screws (T20) from the support bracket.
4. Loosen the 3 cables (T30) from the relay transducer card.
5. Unplug all other cables from the relay transducer card.
6. Remove the 3 screws (T20).
7. Remove the relay transducer card.

Reinstall in the reverse order.



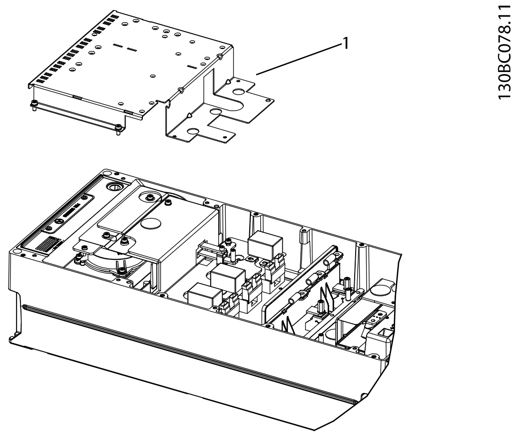
1	Relay transducer card

Illustration 8.30 Relay Transducer Card

8.4.8 Terminal Plate

1. Remove 4 screws (T20) on the cover plate.
2. Remove the complete terminal plate including cable connector.

Reinstall in the reverse order.



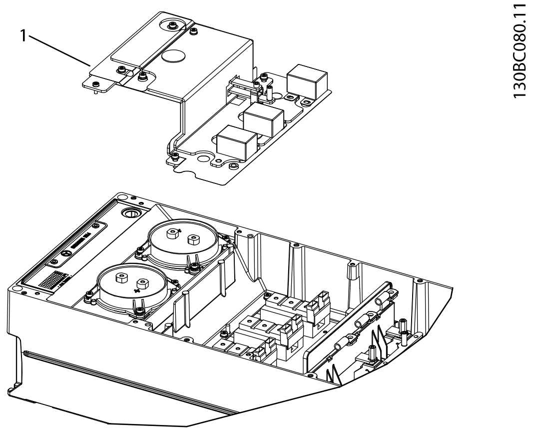
1	Terminal plate

Illustration 8.31 Terminal Plate

8.4.9 DC Bus Bar Assembly

1. Remove 2 screws (T30) from each of the 2 snubbers.
2. Remove the snubbers.
3. Loosen and remove the 2 cables from bus bar assembly and DC coil.
4. Remove 2 screws (T30).
5. Remove 8 screws (T20) on top of the bus bar assembly.
6. Remove the bus bar assembly.

Reinstall in the reverse order.



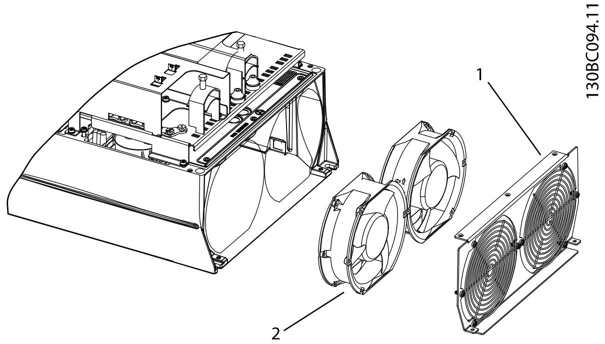
1	Bus bar assembly

Illustration 8.32 DC Bus Bar Assembly

8.4.10 Heat Sink Fan Assembly

1. Remove 4 screws (T20) from the heat sink fan assembly.
2. Push the cables down through the gaskets.
3. Carefully press the gaskets down with a screwdriver.
4. Remove the fan assembly.

Reinstall in the reverse order.



1	Fan cover plate
2	Heat sink fan

Illustration 8.33 Heat Sink Fan Assembly

8

8.4.11 Capacitor Bank

1. Remove 4 screws (T20) from each of the capacitors.
2. Remove the capacitors.

Reinstall in the reverse order.

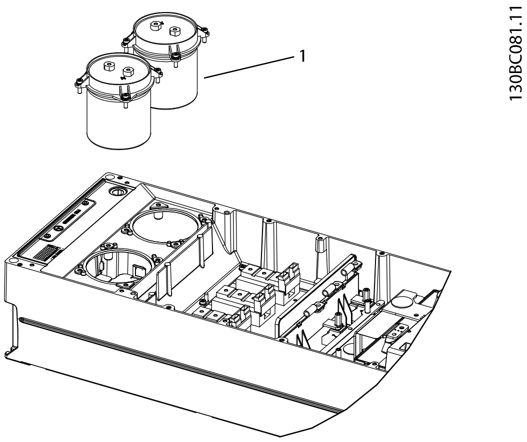


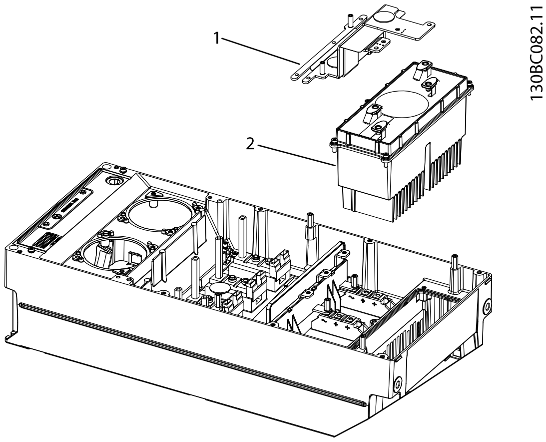
Illustration 8.34 Capacitors

1	Capacitors

8.4.12 DC Coil

1. Remove 5 screws (T20) on the potted coil.
2. Remove the DC coil.

Reinstall in the reverse order.



1	Bus bar
2	DC coil

Illustration 8.35 DC Coil

8.4.13 IGBT

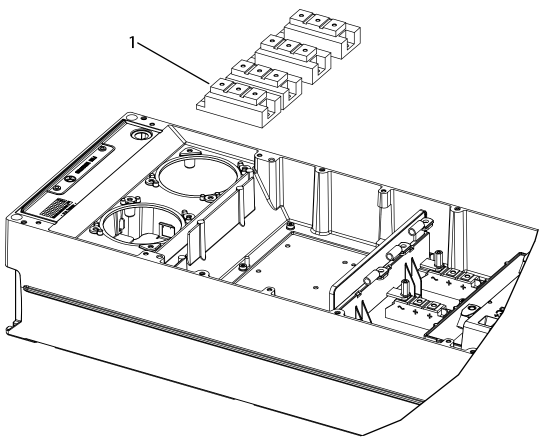
1. Remove 4 screws (T20) from each of the 3 IGBTs.

CAUTION

The UGBTs and the heat sink have thermal paste on them. Wear protective gloves as the paste is poisonous.

2. Remove all IGBTs.

Reinstall in the reverse order.



1	IGBT

Illustration 8.36 IGBT

8.4.14 Thyristor

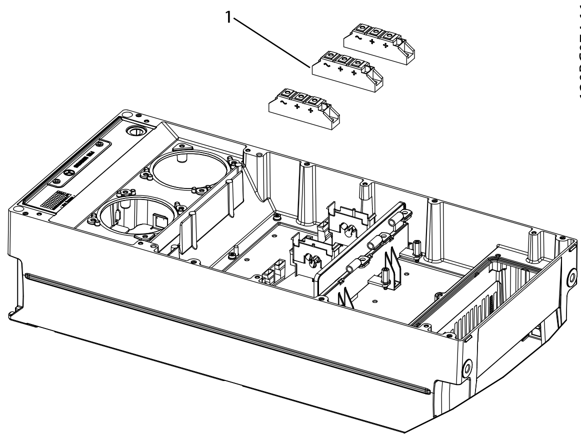
1. Remove 2 screws (T20) from each of the 3 thyristors.

CAUTION

The thyristors and the heat sink have thermal paste on them. Wear protective gloves as the paste is poisonous.

2. Remove the thyristors.

Reinstall in the reverse order.



1	Thyristor

Illustration 8.37 Thyristor

8

9 Block Diagrams

9.1 Block Diagrams, Frame Sizes H and 9

9.1.1 H6 Frame Size

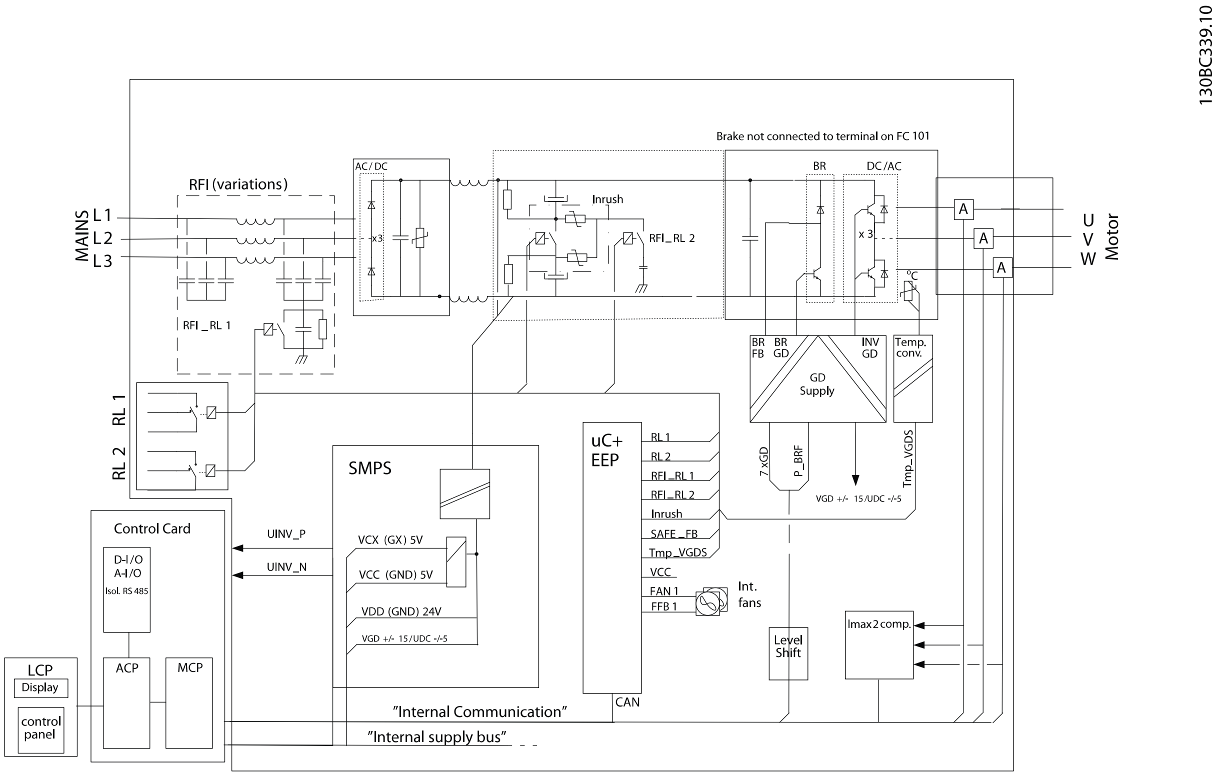


Illustration 9.1 H6 Frame Size

9.1.2 I6 Frame Size

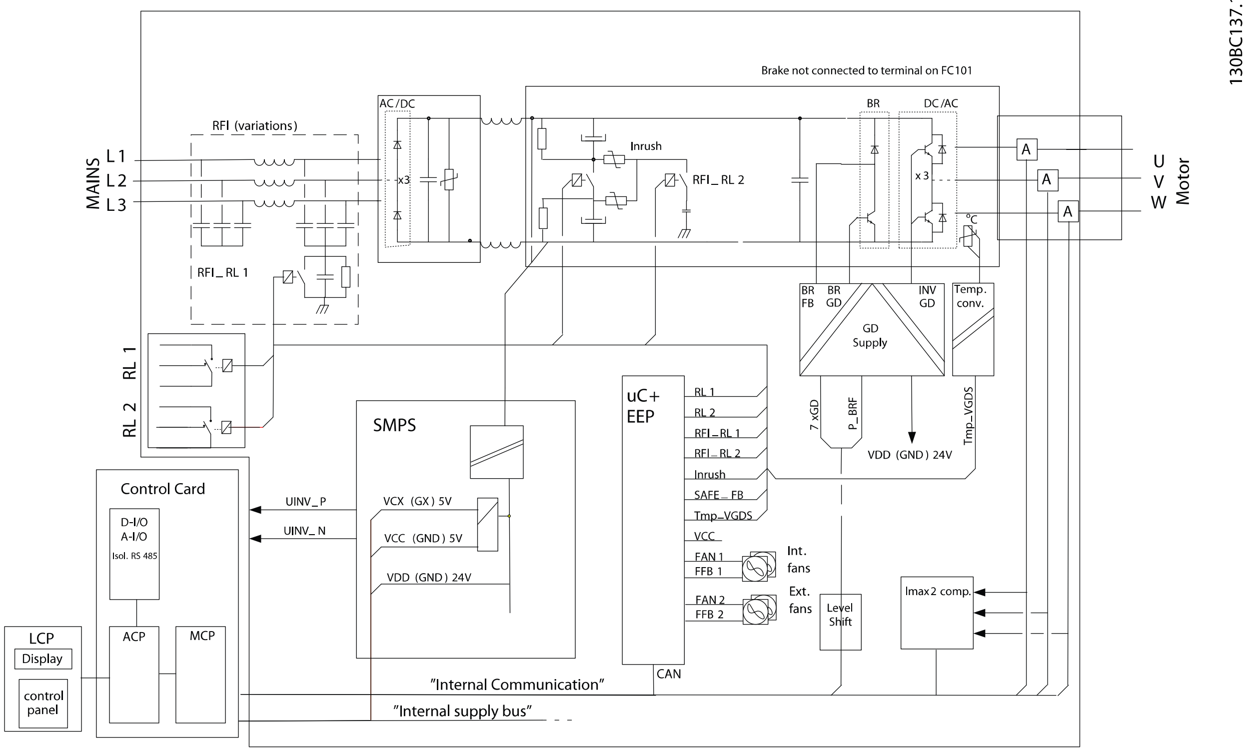


Illustration 9.2 I6 Frame Size

9

9.1.3 H7, H8, I7, I8 Frame Size

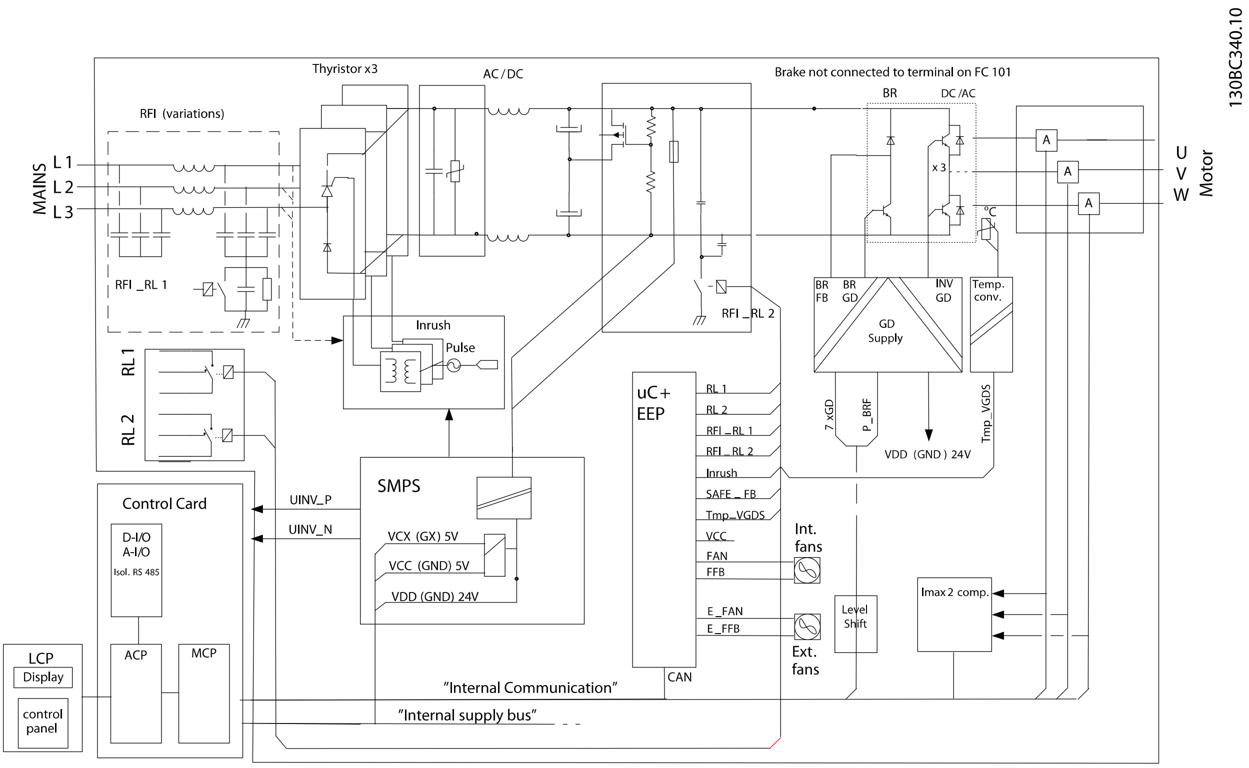


Illustration 9.3 H7, H8, I7, I8 Frame Size

9.1.4 H9 Frame Size

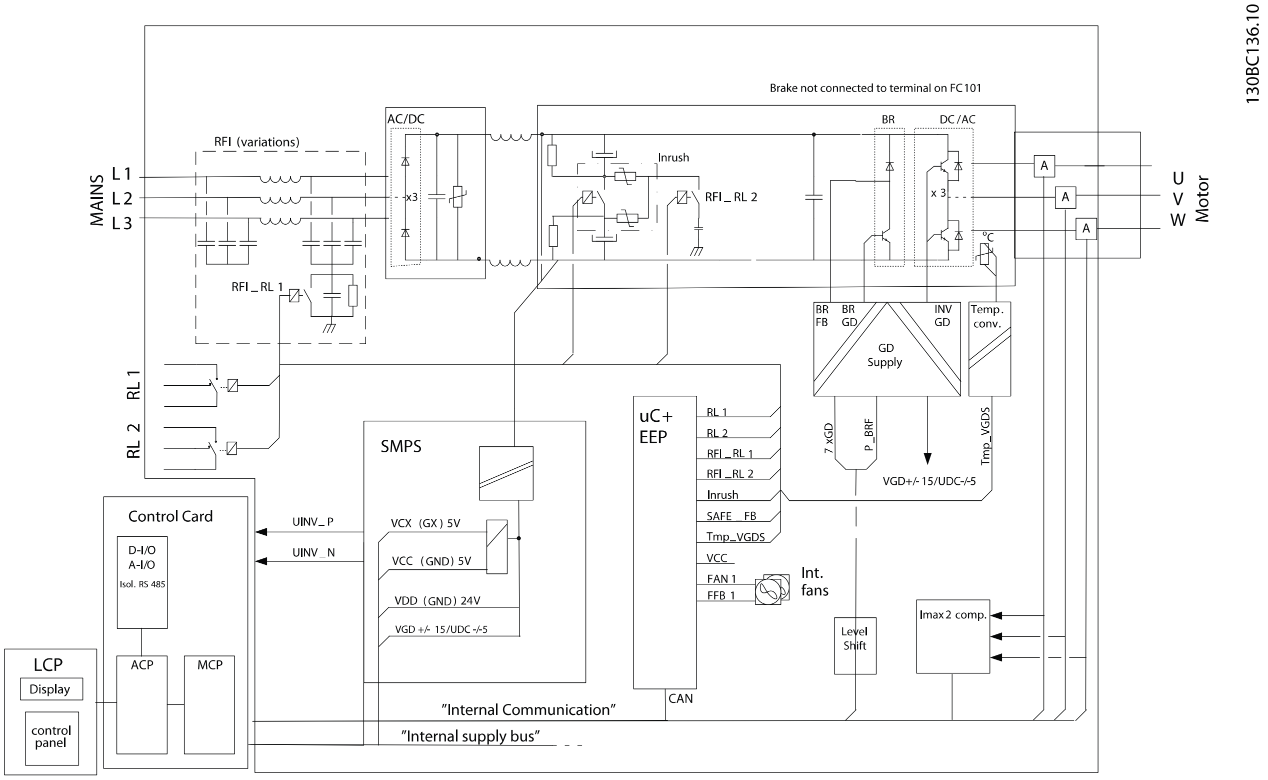


Illustration 9.4 H9 Frame Size

9

9.1.5 H10 Frame Size

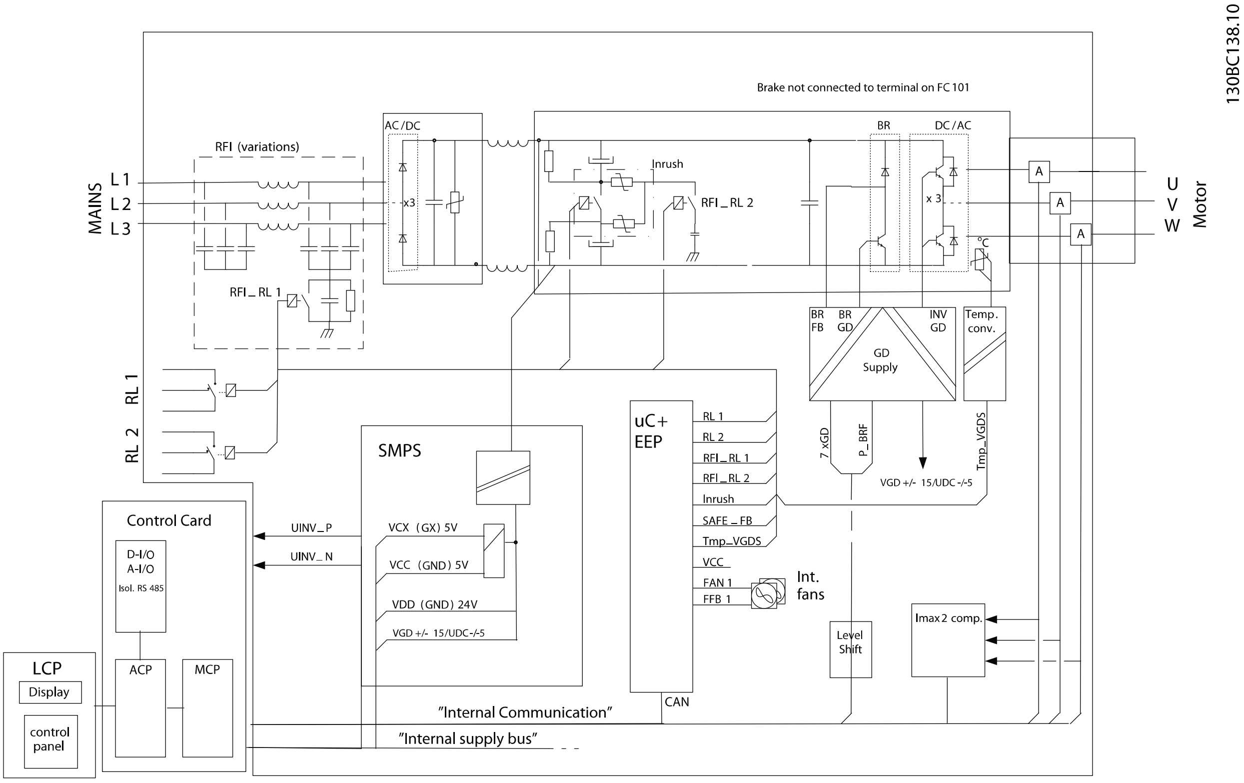


Illustration 9.5 H10 Frame Size

Index

www.trane.com

For more information, contact your local Trane office or e-mail us at comfort@trane.com

Literature Order Number	BAS-SVM04B-EN
Date	February 2017
Supersedes	November 2013

Trane has a policy of continous product and product data improvement and reserves the right to change design and specifications without notice.

130R0538 MG18K202 *MG18K202* 02/2017