TR150 Service Manual

BAS-SVM04A-EN

November 2013

BAS-SVM04A-EN

Contents

1 Introduction

1.1 Purpose

This manual provides the technical information and instructions required, for a qualified technician 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 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 a trained technician should carry out the service. See also .

⚠CAUTION

For dynamic test procedures, main input power is required and all devices and power supplies connected to mains are energised 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). Be aware that 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 [min]
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)

NOTICE

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. Voltages so low that they cannot be felt, seen, or heard can reduce the life, 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	H1	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 FC 101 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	H1	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 FC 101 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 FC 101 Frequency Converters 525–600 V AC

1.5 Tools Required

Quick Guide for TR150.

ESD Protection Kit	Wrist strap and Mat
Metric socket set	7 to 19 mm
Torque wrench	0.5 Nm to 19 Nm
Socket extensions	100 to 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

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper conductors required, (75 °C) recommended.

Power [kW]				Torque [Nm]					
Frame	IP class	3x200-240 V	3x380-480 V	Line	Motor	DC connection	Control terminals	Ground	Relay
H1	IP20	0.25-1.5	0.37-1.5	1.4	0.8	0.8	0.5	0.8	0.5
H2	IP20	2.2	2.2-4	1.4	0.8	0.8	0.5	0.8	0.5
H3	IP20	3.7	5.5-7.5	1.4	0.8	0.8	0.5	0.8	0.5
H4	IP20	5.5-7.5	11-15	1.2	1.2	1.2	0.5	0.8	0.5
H5	IP20	11	18.5-22	1.2	1.2	1.2	0.5	0.8	0.5
H6	IP20	15-18	30-45	4.5	4.5	-	0.5	3	0.5
H7	IP20	22-30	55	10	10	-	0.5	3	0.5
H7	IP20	-	75	14	14	-	0.5	3	0.5
H8	IP20	37-45	90	24[2]	24[2]	-	0.5	3	0.5

Table 1.6 Enclosure H1-H8

Power [kW]			Torque [Nm]					
Frame	IP class	3x525-600 V	Line	Motor	DC connection	Control terminals	Ground	Relay
H9	IP20	2.2-7.5	1.8	1.8	not recommended	0.5	3	0.6
H10	IP20	11-15	1.8	1.8	not recommended	0.5	3	0.6
H6	IP20	18.5-30	4.5	4.5	-	0.5	3	0.5
H7	IP20	37-55	10	10	-	0.5	3	0.5
H8	IP20	75-90	14/24[1]	14/24[1]	-	0.5	3	0.5

Table 1.7 Details of Tightening Torques

[1] *Cable dimensions ≤95 mm²*

[2] *Cable dimensions >95 mm²*

1.6 Exploded Views – H Frame Size

NOTICE

Non-repairable units are not shown with exploded views.

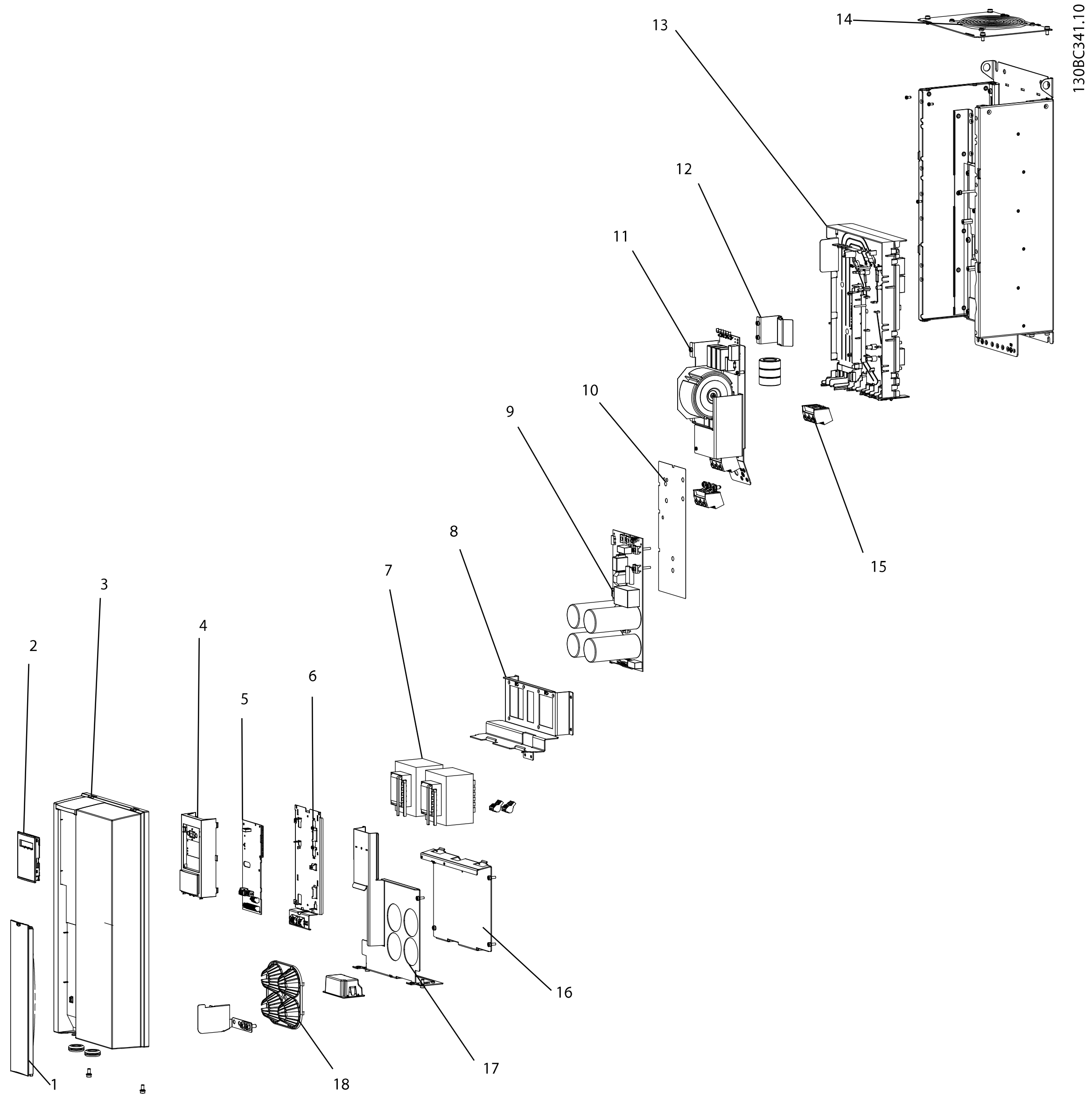

Illustration 1.1 Exploded View - H6 Frame Size

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	Heatsink 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

Table 1.8 Legend to *Illustration 1.1*

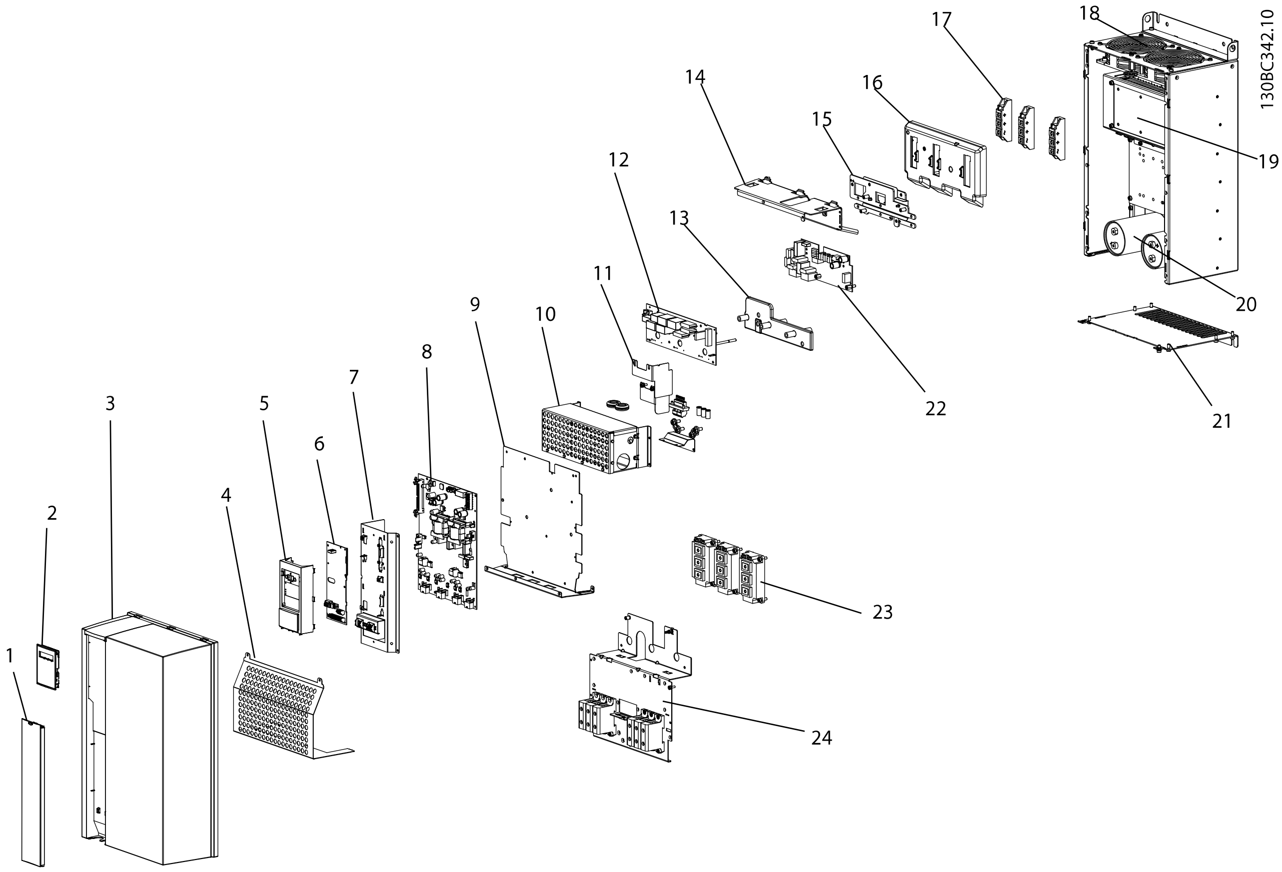

Illustration 1.2 Exploded View - H7 Frame Size

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	Heatsink fan assembly
7	Control card mounting plate	19	DC coils
8	Power card	20	Capacitors
9	Power card mounting plate	21	Bottom plate
10	RFI filter	22	Relay/transducer card
11	EMC shield	23	IGBT
12	Inrush card	24	Cable mounting plate

Table 1.9 Legend to *Illustration 1.2*

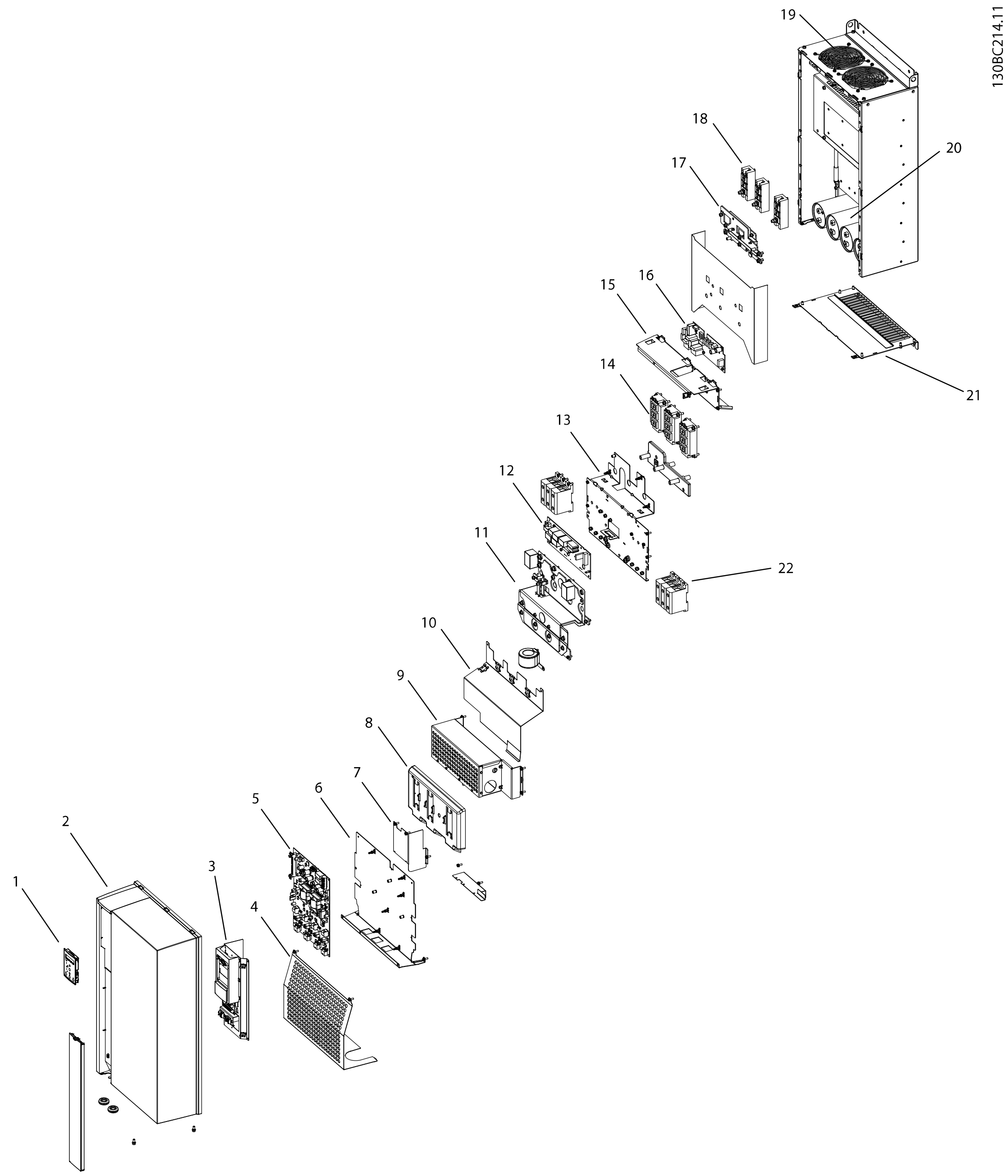

Illustration 1.3 Exploded View - H8 Frame Size

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	Heatsink fan assembly
9	RFI filter	20	Capacitors
10	DC coil cover plate	21	Bottom cover
11	Bus bar unit	22	Connection terminals

Table 1.10 Legend to *Illustration 1.3*

1

1.7 Exploded Views - I Frame Size

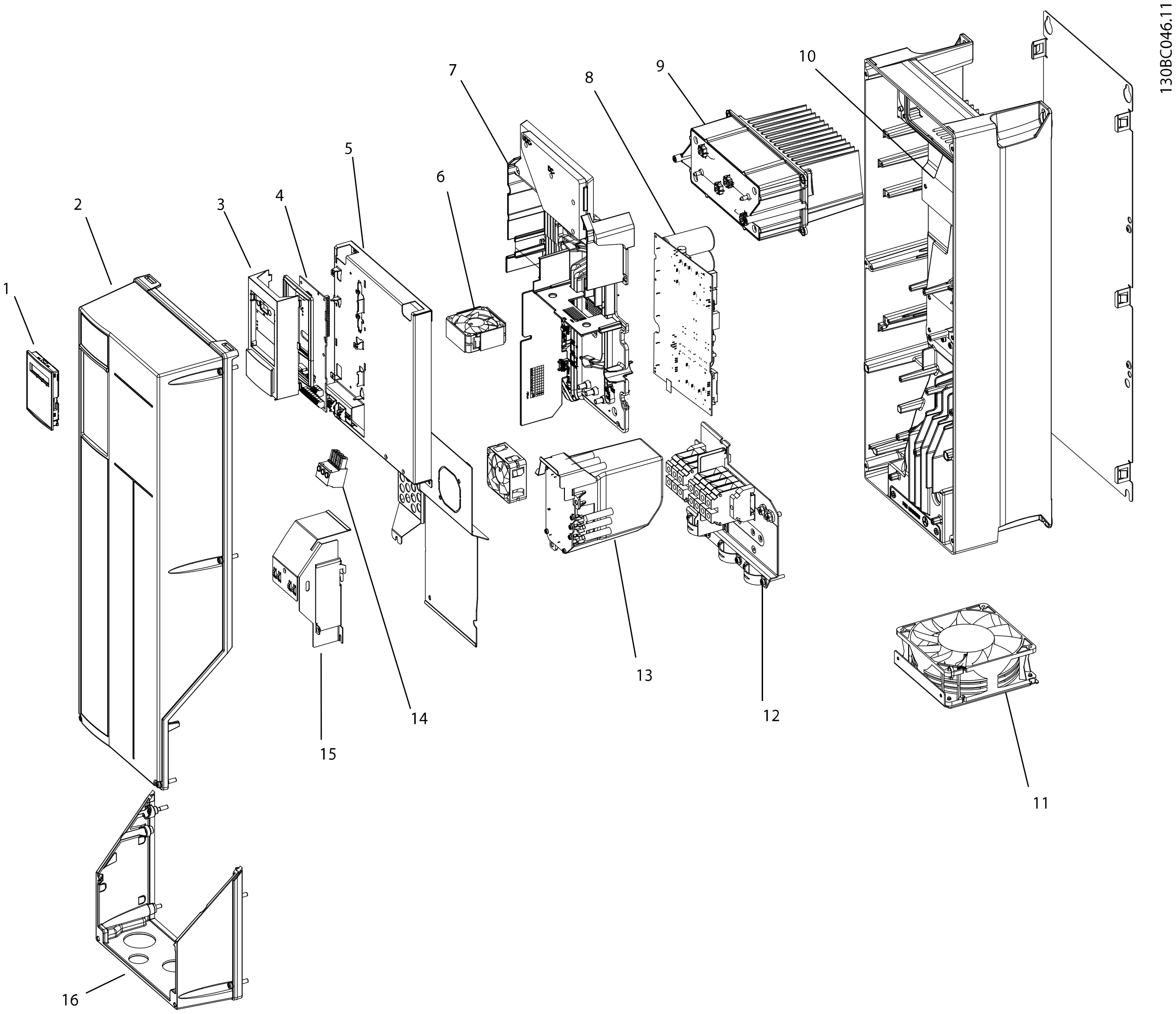

Illustration 1.4 Exploded View - I6 Frame Size

1	Local Control Panel (LCP)	9	DC coil
2	Front cover	10	Heatsink
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

Table 1.11 Legend to *Illustration 1.4*

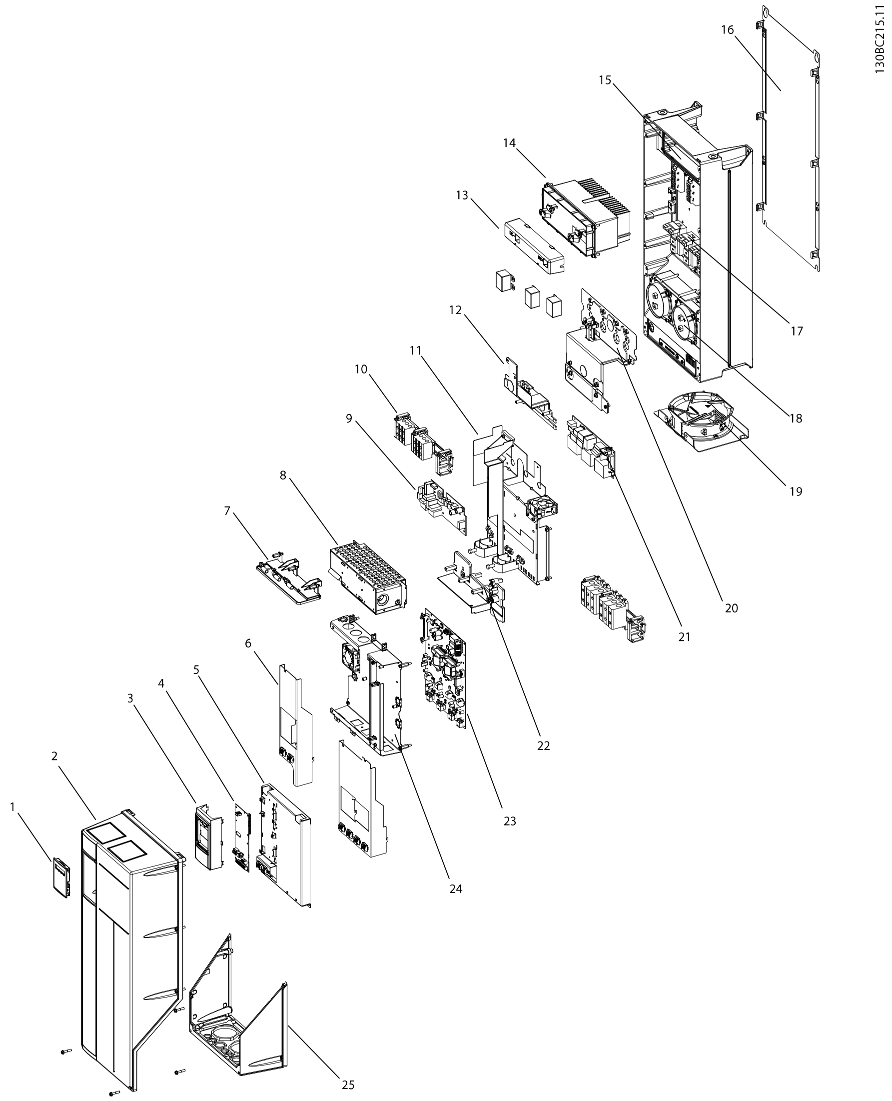

Illustration 1.5 Exploded View - I7 Frame Size

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	Heatsink 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		

Table 1.12 Legend to *Illustration 1.5*

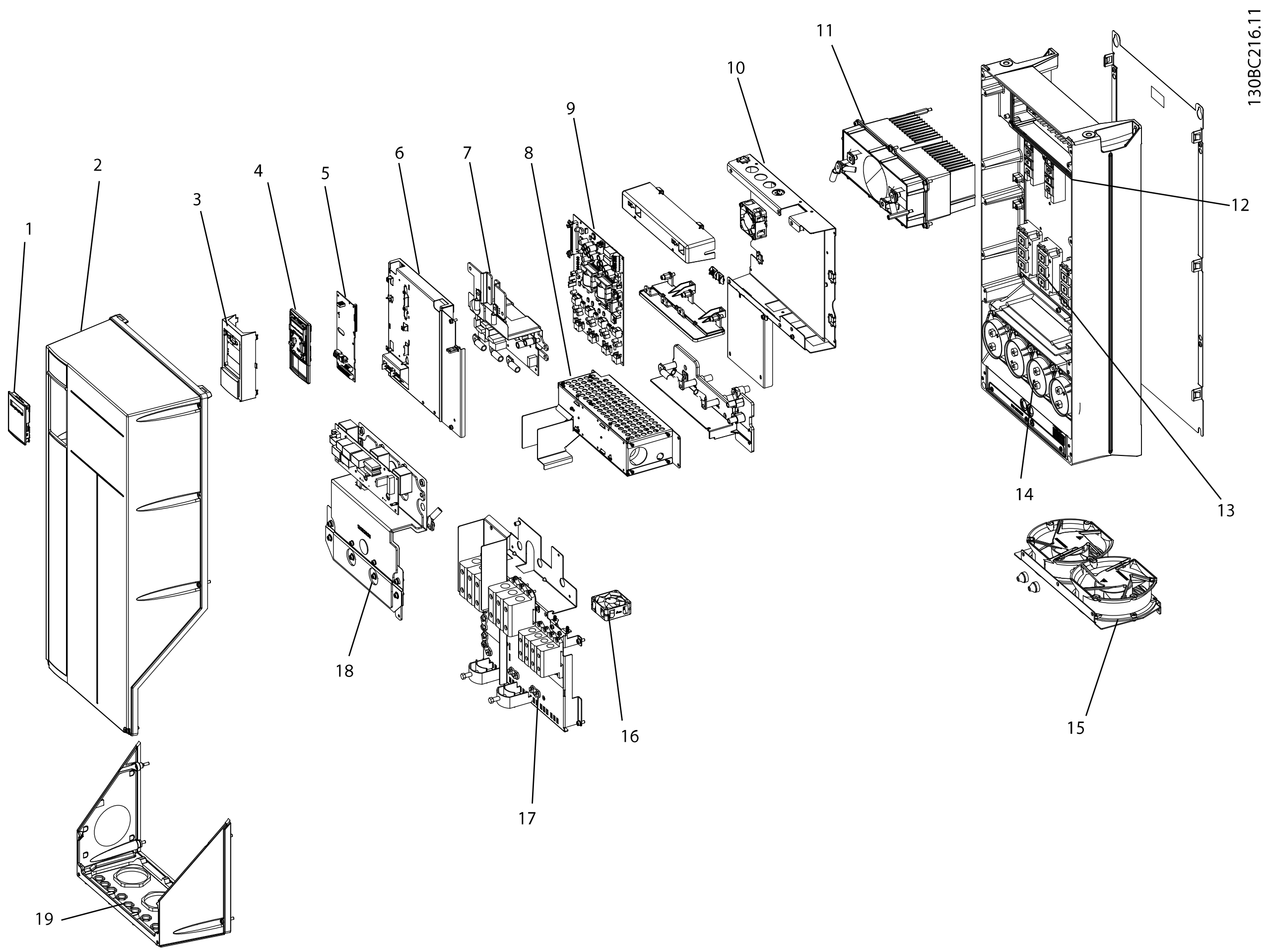

Illustration 1.6 Exploded View - I8 Frame Size

1	LCP	11	DC coil
2	Front cover	12	Rectifier modules
3	Cradle	13	IGBTs
4	LCP gasket	14	Capacitors
5	Control card	15	Heatsink 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		

Table 1.13 Legend to *Illustration 1.6*

1.8 Ratings Tables

1.8.1 Short Circuit and Over-current 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 over current in the inverter. The inverter turns off the IGBTs individually when the short circuit current exceeds the permitted value (Alarm 16 Trip Lock).

1.8.2 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
Under voltage	202	184	314	372	532
Under voltage re-enable	202+15	184+16	314+30	372+24	532+20
Over voltage	410	412	800	800	976
Over voltage 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 1.14 DC Voltage Levels

2

2 Frequency Converter Control

2.1 Introduction

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

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

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

2.2 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 centre part of the status line indicates the references site. The last part of the status line gives the operation status, for example, Running, Stop, or Stand by. Other status messages may appear 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 connected to the frequency converter in three possible ways. One way for the frequency converter control is through the LCP on the front of the frequency converter, when operating in local (hand on) mode. These inputs include start, stop, reset, and speed reference.

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

The third way is through signal wiring connected to the frequency converter control terminals. The frequency converter control terminals are located below the LCP. Improperly connected control wiring can cause a motor not to operate or the frequency converter not 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, and so on. (Do not confuse these digital inputs with serial communication formats where digital bytes are grouped into communication words and protocols).

The RS-485 serial communication connector is wired to terminals (+) 68 and (-) 69. Terminal 61 is a common terminal. It is used for terminating screens only when the control cable is run between frequency converters, and not between frequency converters and other devices.

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 RS-485 serial bus or terminal 42. Output terminal 42 operates in the same manner as the inputs. The terminal can be programmed for either a variable analog signal in mA or a digital signal (0 or 1) in 24 V DC. In addition, a pulse reference can be provided on terminals 27 and 29. Output analog signals generally indicate the frequency, 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
Max. output current at digital output	20 mA
Max. 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 operating hours, etc.
- fault logs that store frequency converter status values present at the ten most recent events that stopped the frequency converter
- frequency converter nameplate data

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

Parameter settings are displayed by pressing [Main Menu].

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

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

2.5 Control Terminals

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.

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

Parameter settings are displayed by pressing [Main Menu].

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

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

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

Signals can be checked in 2 ways. Digital Input can be selected for display by pressing [Display Mode], or a voltmeter can be used to check for voltage at the control terminal.

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

- wired properly
- powered
- programmed correctly for the intended function

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 No.	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.

Terminal No.	Function
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 to 20 mA, or 4 to 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 to 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 to 20 mA or 4 to 20 mA, analog current input, Resistance=approx. 200 Ω. Used for reference or feedback signals.
61	RS-485 common.
68, 69	RS-485 interface and serial communication.

Table 2.2 Terminal Functions

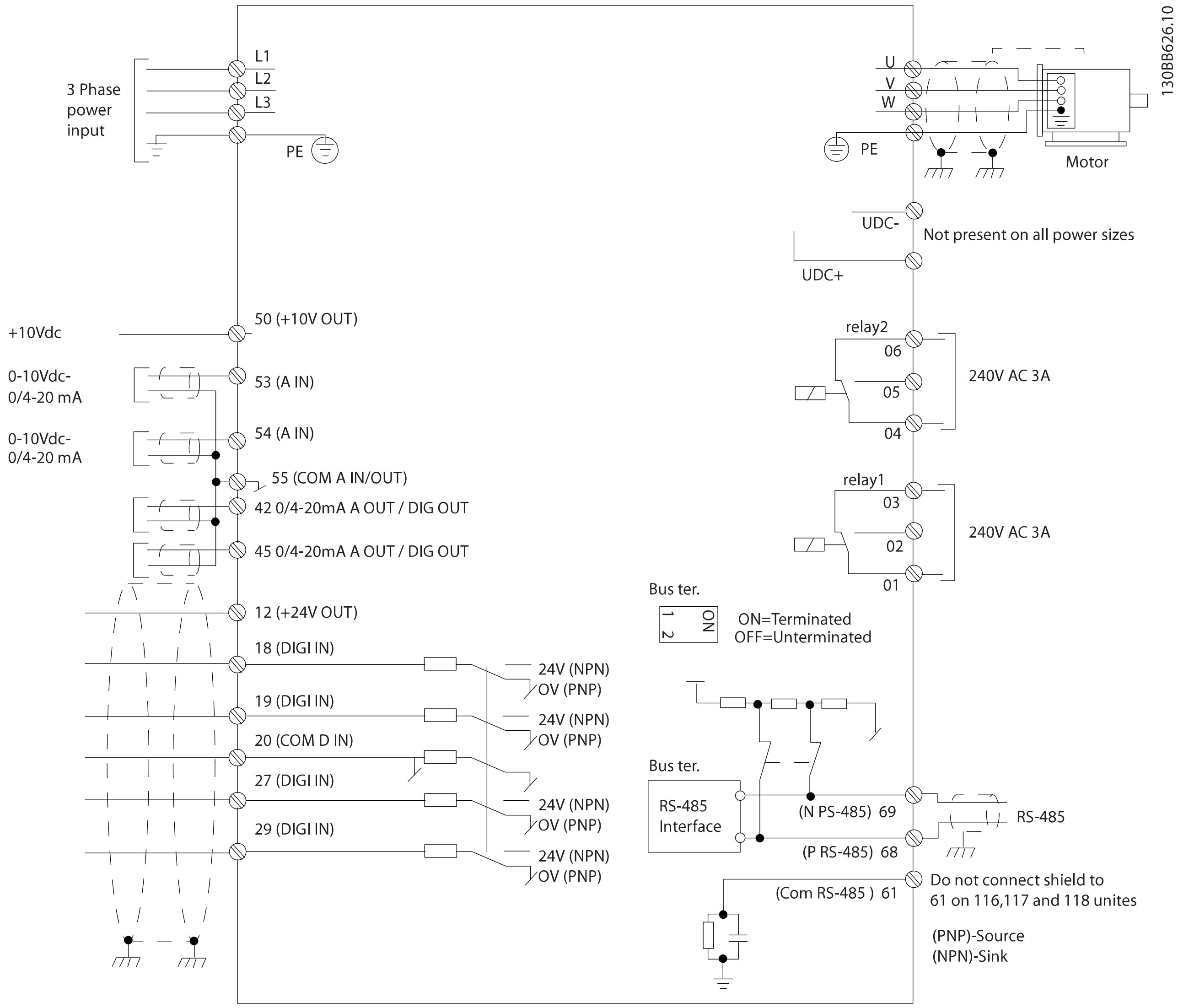

Illustration 2.1 Control Terminal Electrical Overview

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 Quick Guide* for details.

2

2.7 Earthing 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
Control cables and cables for serial communication must be fitted with cable clamps at both ends to ensure the best possible electrical connection.

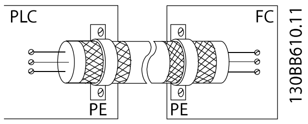

Illustration 2.2 Correct Grounding

Incorrect grounding
Do not use twisted cable ends (pigtails) since they increase screen 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 8 AWG.

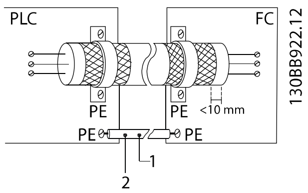

Illustration 2.3 Ground Potential Protection

1	Min. 16 mm^2
2	Equalizing cable

Table 2.3 Legend to *Illustration 2.3*

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

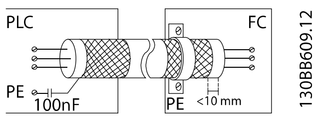

Illustration 2.4 50/60 Hz Ground Loops

Serial communication control cables
Low frequency noise currents between frequency converters can be eliminated by connecting one end of the screened cable to frequency converter terminal 61. This terminal connects to ground through an internal RC link. Use twisted-pair cables to reduce the differential mode interference between conductors.

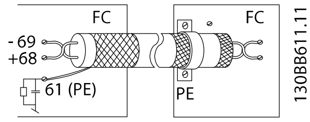

Illustration 2.5 Serial Communication Control Cables

3 Internal Frequency Converter Operation

3.1 General

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

3.2 Description of Operation

A frequency converter is an electronic controller that supplies a regulated amount of AC power to a 3-phase induction motor to control the motor speed. By supplying variable frequency and voltage to the motor, the frequency converter controls the motor speed, also when the load on the motor changes. The frequency converter can also stop and start the motor without the mechanical stress associated with the line start.

In its basic form, the frequency converter can be divided into 4 main sections.

1. Rectifier
2. Intermediate Circuit
3. Inverter
4. Control and Regulation

The main frequency converter components are grouped into three categories. They are:

1. Control Logic Section
2. Logic to Power Interface
3. Power Section

In , these 3 sections are covered in greater detail while describing how power and control signals move throughout the frequency converter.

3.2.1 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.

A custom integrated circuit generates a pulse width modulation (PWM) waveform, which is then sent to the interface circuitry located on the power card.

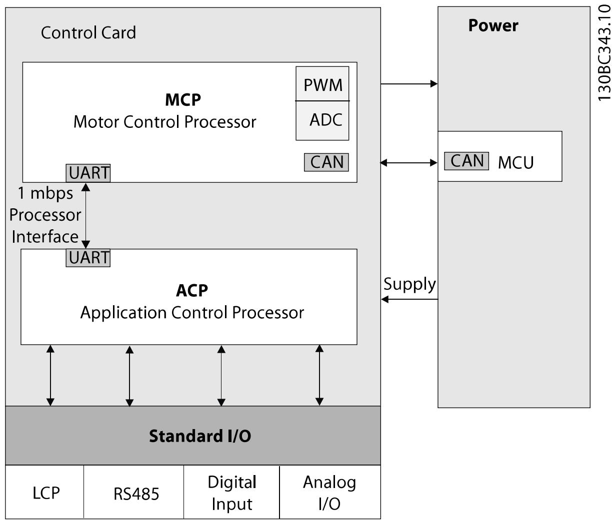

Illustration 3.1 Logic Section

The PWM waveform is improved through the Voltage Vector Control Scheme, VVC^{plus}. VVC^{plus} provides variable frequency and voltage to the motor matching the motor requirements. Also available is the continuous pulsing SFAVM PWM. The dynamic response of the system changes to meet the variable requirements of the load.

Another part of the logic section is the removable LCP or display mounted on the front of the frequency converter. The LCP provides the interface between the internal digital logic and the operator.

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 frequency converter 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. The 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.

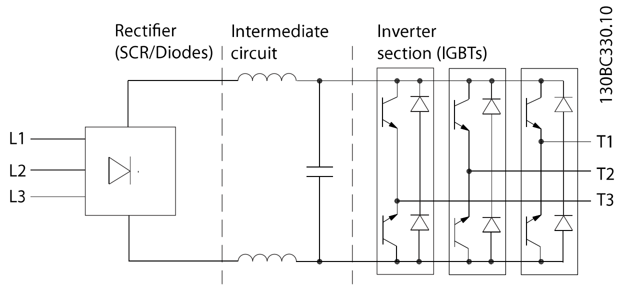

Illustration 3.2 Typical Power Section

3.3 Sequence of Operation

3.3.1 Rectifier Section

Depending on the rating of the frequency converter, the rectifier section is built on either 6 or 3 diodes and 3 thyristors.

Inrush current in units with a normal 6-diode rectifier is limited with a simple PTC and relay circuit.

Phase controlling the thyristors (active inrush control) limits the inrush current in units with diodes and thyristors.

The low voltage power supplies are activated when the DC bus reaches approximately 50 V DC less than the alarm voltage low for the DC bus (see *chapter 1.8.2 DC Voltage Levels*). After a short delay, an inrush enable signal is sent from the control card to the power card SCR gating circuit.

The SCRs are automatically gated when forward biased, as a result acting similar to an uncontrolled rectifier.

When the DC bus capacitors are fully charged, the voltage on the DC bus is equal to the peak voltage of the input AC line. Theoretically, this can be calculated by multiplying the AC line value by 1.414 (V ACx1.414). However, since AC ripple voltage is present on the DC bus, the actual DC value is closer to V ACx1.38 under unloaded conditions and may drop to V ACx1.32 while running under load. For example, a frequency converter connected to a nominal 460 V line, while sitting idle, the DC bus voltage is approximately 635 V DC (460x1.38).

As long as power is applied to the frequency converter, this voltage is present in the intermediate circuit and the inverter circuit. It is also fed to the Switch Mode Power Supply (SMPS) on the power card and is used for generating all other low voltage supplies.

130BC134.10

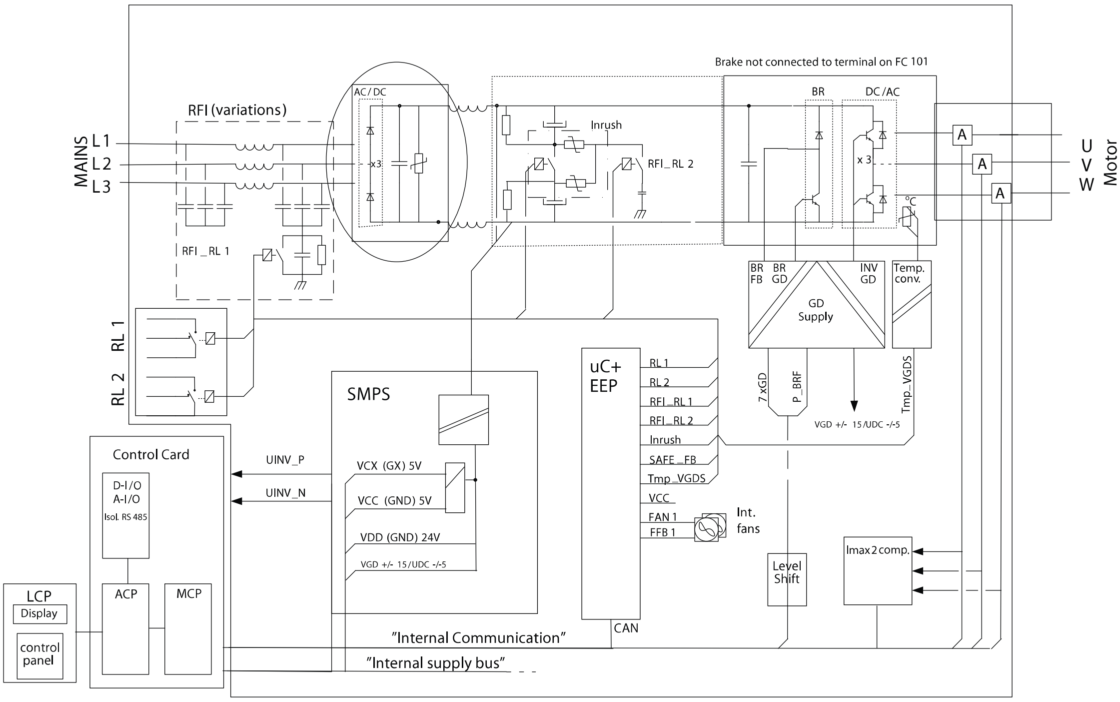

Illustration 3.3 Example of H6 Power and Control Section

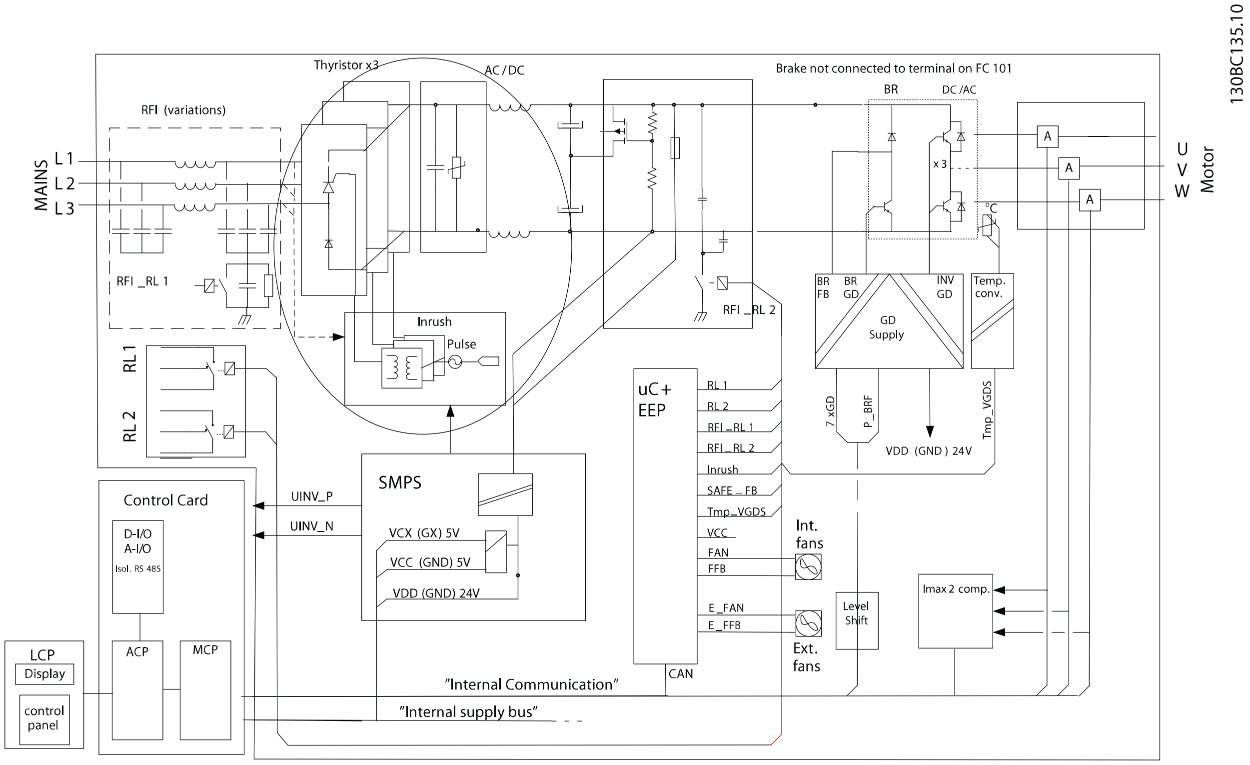

Illustration 3.4 Example of H7, H8, I7, I8 Power and Control Section

3.3.2 Intermediate Section

Following the rectifier section, voltage passes to the intermediate section. An LC filter circuit consisting of the DC bus inductor and the DC bus capacitor bank smooths the rectified voltage.

The DC bus inductor 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 capacitor bank assembly consists of up to six capacitors arranged in series/parallel configuration. A bleeder circuit maintains equal voltage drops across each capacitor. It also provides a current path for discharging the capacitors once power has been removed from the frequency converter.

Also located in the intermediate section is the 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.

In some units, RFI relay 2 can be opened to minimise voltage charge up.

If DC-link increases above a certain level specified in EE-prom for each unit, RFI relay 2 opens automatically.

130BC335.10

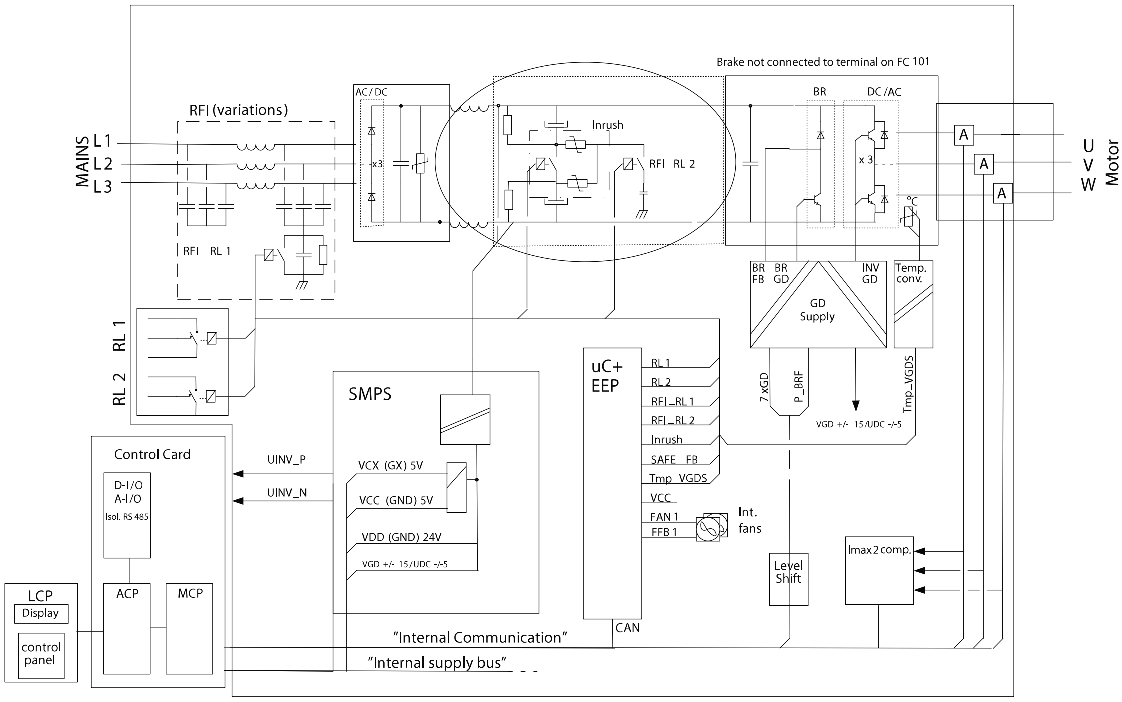

Illustration 3.5 Example of H6 Intermediate Section

130BC336.10

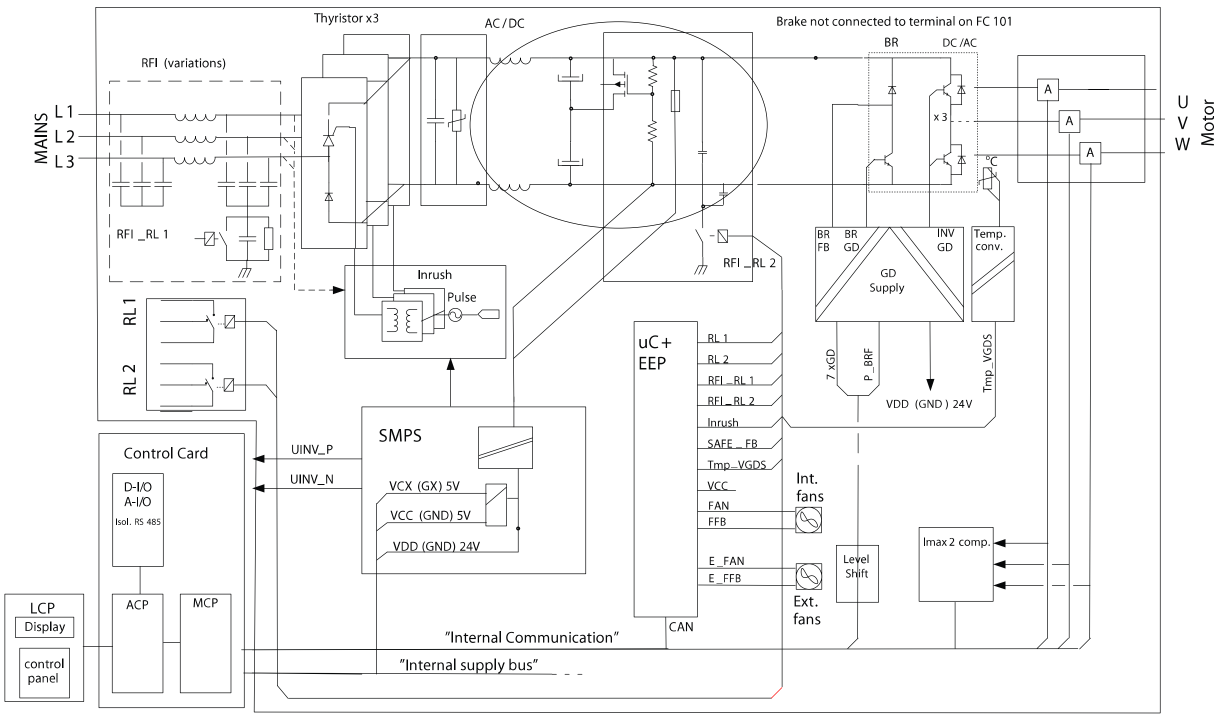

Illustration 3.6 Example of H7, H8, I7, I8 Intermediate Section

3

3.3.3 Inverter Section

In the inverter section (see *Illustration 3.8*), gate signals are delivered from the control card, through the power card to the gates of the IGBTs. The series connection of each set of IGBTs is delivered to the output, first passing through the current sensors.

Once a run command and speed reference are present, the IGBTs begin switching to create the output waveform, as shown in *Illustration 3.8*. Looking at the phase-to-phase voltage waveform with an oscilloscope shows that the Pulse Width Modulation (PWM) principal creates a series of pulses which vary in width. Basically, the pulses are narrower as zero crossing is approached and wider the farther from zero crossing. The pulse duration of applied DC voltage controls the width. Although the voltage waveform is a consistent amplitude, the inductance within the motor windings serve to average the voltage delivered and so. As the pulse width of the waveform varies, the average voltage seen by the motor varies as well. This then equates to the resultant current waveform which takes on the sine wave shape expected in an AC system. The pulse rate determines the waveform frequency waveform. By employing a sophisticated control scheme, the frequency converter can deliver a current waveform that nearly replicates a true AC sine wave.

This waveform, as generated by the Trane VVC^{plus} PWM principle at the control card, provides optimal performance and minimal losses in the motor.

Hall effect current sensors monitor the output current and deliver proportional signals to the power card where they are buffered and delivered to the control card. The control card logic uses these current signals to determine proper waveform compensations based on load conditions. They further serve to detect over current conditions, including ground faults and phase-to-phase shorts on the output.

During normal operation, the power card and control card are monitoring various functions within the frequency converter. The current sensors provide current feedback information. The DC bus voltage and mains voltage are monitored as well as the voltage delivered to the motor. A thermal sensor mounted inside the sixpack IGBT module provides heatsink temp feedback for the inverter. This applies to unit up to and including H6 and I6 frame sizes. For H7-H8 and I7-I8 frame sizes, the inverter consists of 3 dual IGBT modules and the thermal sensor is mounted separately on the heatsink.

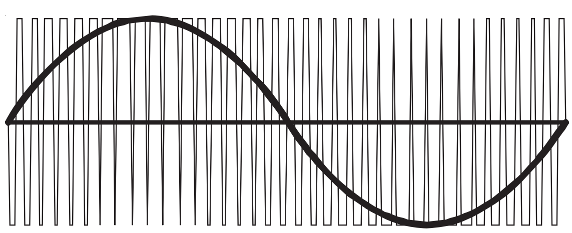

Illustration 3.7 Output Voltage and Current Waveforms

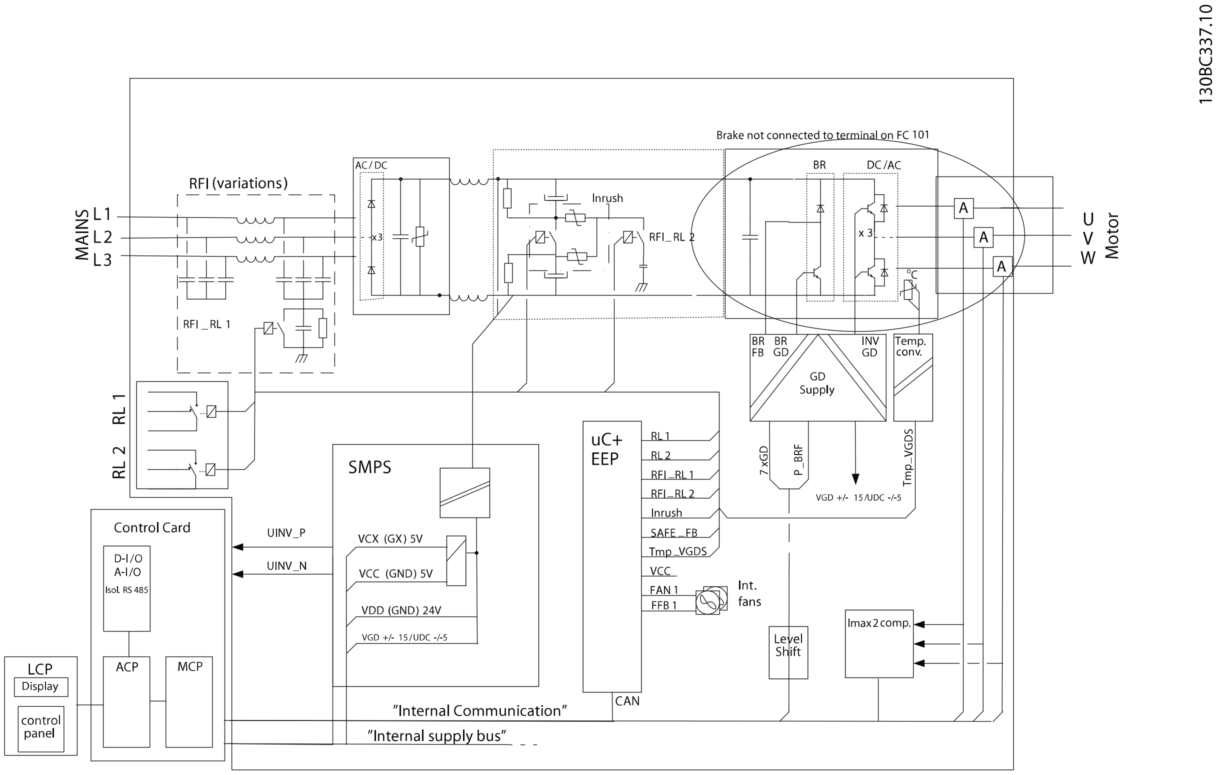

Illustration 3.8 Example of H6 Inverter Section

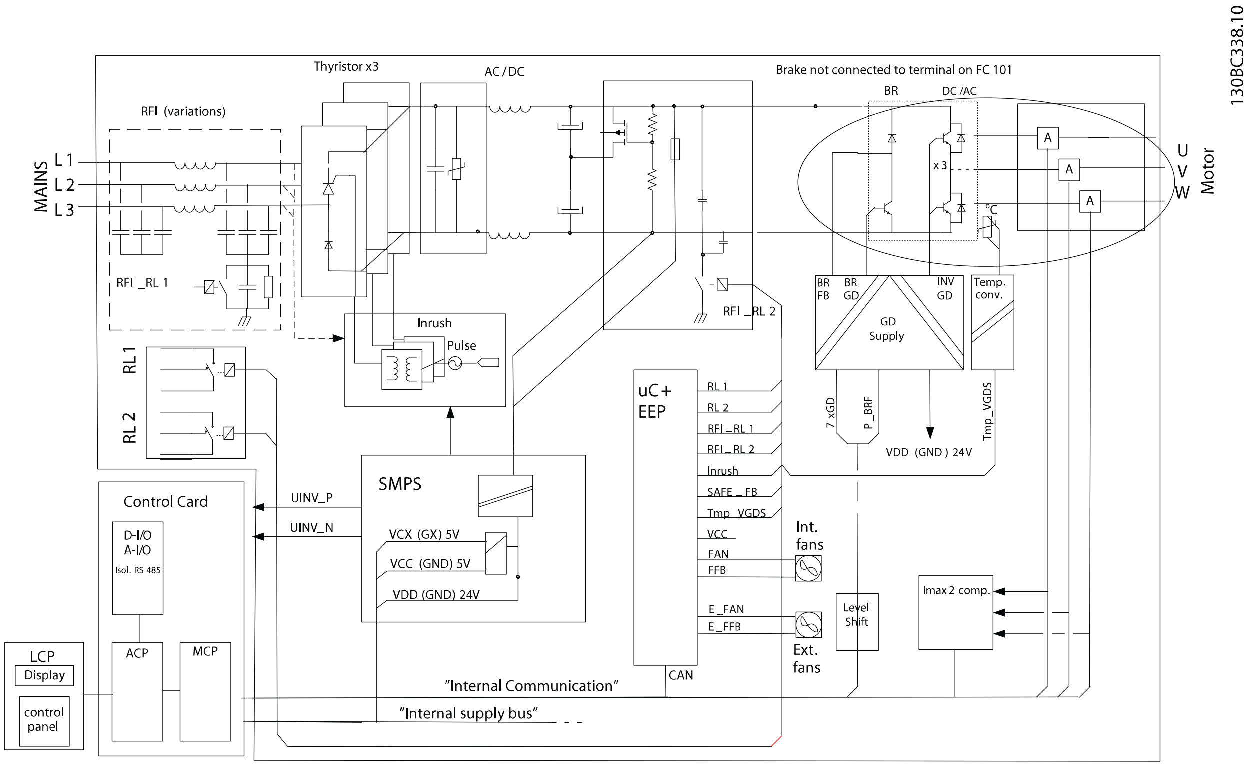

Illustration 3.9 Example of H7, H8, I7, I8 Inverter Section

3

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 max 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 max 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
FAN max 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 max 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 bus voltage before working on the unit. Some points in the frequency converter are referenced to the negative DC bus. They are at bus 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 .
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. When using proper troubleshooting procedures, make no assumptions.

CAUTION

Never assume that a motor is wired properly after a service of the frequency converter. There is a risk of overlooking for example,

- **loose connections**
- **improper programming**
- **added equipment**

It is best to develop a detailed approach, beginning with a physical inspection of the system. See *Table 4.1* for items to examine.

4.3 Fault Symptom Troubleshooting

This troubleshooting section is divided into sections based on the symptom being experienced. To start, *Table 4.1*, provides a visual inspection check list. Often, wrong installation or wiring of the frequency converter cause the problem. The check list provides guidance through various items to inspect during any frequency converter service process.

Next, symptoms are approached as the technician most commonly discovers them: reading an unrecognized frequency converter display, problems with motor operation, or a warning or alarm displayed by the frequency converter. Remember, the frequency converter processor monitors inputs and outputs as well as internal frequency converter functions. Thus, an alarm or warning does not necessarily indicate a problem within the frequency converter itself.

Each incident has further descriptions on how to troubleshoot that particular symptom. When necessary, further referrals are made to other parts of the manual for more procedures. presents detailed discussions on areas of frequency converter and system troubleshooting that an experienced repair technician must understand for effective analysis.

Finally, a list of tests, is provided. Always 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 a repair to the frequency converter.

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 for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on input power side of frequency converter or output side to motor. Examine operation and condition of these items as possible causes for operational faults. Check function and installation of pressure sensors or encoders (etc.) used for feedback to frequency converter.
Cable routing	Avoid routing motor wiring, AC line wiring, and signal wiring in parallel. If parallel routing is unavoidable, try to maintain a separation of 150–200 mm (6-8 inches) between the cables or separate them with a grounded conductive partition. Avoid routing cables through free air.
Control wiring	Check for broken or damaged wires and connections. Check the voltage source of the signals. Though not always necessary depending on the installation conditions, the use of shielded cable or a twisted pair is recommended. Ensure the shield is terminated correctly.
Frequency converter cooling	Check operational status of all cooling fans. Check door filters on NEMA 12 (IP54) units. Check for blockage or constrained air passages. Verify bottom gland plate is installed.
Frequency converter display	Warnings, alarms, frequency converter status, fault history and many other important items are available through the display on the local control panel of frequency converter.
Frequency converter interior	Frequency converter interior must be free of dirt, metal chips, moisture, and corrosion. Check for burnt or damaged power components or carbon deposits that were the result of a catastrophic component failure. Check for cracks or breaks in the housings of power semiconductors, or pieces of broken component housings loose inside the unit.
EMC considerations	Check for proper installation with regard to electromagnetic capability. Refer to the frequency converter instruction manual 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.
Grounding	The frequency converter requires a dedicated ground wire from its chassis to the building ground. It is also suggested that the motor be grounded to the frequency converter chassis as well. The use of conduit or mounting of the frequency converter to a metal surface is not considered a suitable ground. Check for good ground connections that are tight and free of oxidation.
Input power wiring	Check for loose connections. Check for proper fusing. Check for blown fuses.
Motor	Check nameplate ratings of motor. Ensure that motor ratings coincide with frequency converters. Ensure frequency converter's motor parameters (*1-20 Motor Power* to *1-25 Motor Nominal Speed*) are set according to motor ratings.
Output to motor wiring	Check for loose connections. Check for switching components in output circuit. Check for faulty contacts in switch gear.
Programming	Ensure frequency converter parameter settings are correct according to motor, application, and I/O configuration.
Proper clearance	These frequency converters require top and bottom clearance adequate to ensure proper air flow for cooling in accordance with the frequency converter size. frequency converters with exposed heat sinks out the back of the frequency converter must be mounted on a flat solid surface.
Vibration	Though somewhat subjective look for an unusual amount of vibration that the frequency converter may be subjected to. The frequency converter should be mounted solidly or the use of shock mounts employed.

Table 4.1 Visual Inspection

4.5 Fault Symptoms

4.5.1 No Display

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

130BP044.10

Illustration 4.1 LED Indicator Lights

Be certain, however, that the display is dark. Having a single character in the upper corner of the LCP or just a dot indicates that communications may have failed with the control card. This situation typically appears when a serial bus 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 *chapter 6.4.1 No Display Test (Display is Optional)* to carry out further trouble-shooting steps.

4.5.2 Intermittent Display

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

The first step is to rule out a problem in the control wiring. To do so, disconnect all control wiring by 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 shorts 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 (Line2) Flashing

This indicates that a local stop command has been given by pressing [Off/Reset]. The frequency converter cannot accept any further run command until the local stop is cleared. Press [Auto On] or [Hand On] to clear the local stop.

⚠CAUTION

The frequency converter may start immediately. If the frequency converter is being operated in local control, or remote control with a maintained run signal, the frequency converter starts immediately.

4.5.4 WRONG or WRONG LCP Displayed

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

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

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

Ensure that the unit is programmed correctly according to the reference signal being used, and that all reference limits are set correctly as well. Perform *chapter 6.4.7 Input Terminal Signal Tests* to check for faulty reference signals.

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

Check settings of all motor parameters, including all motor compensation settings (Slip Compensation, Load Compensation, etc.). For Closed Loop operation, check PID settings. Perform *chapter 6.4.7 Input Terminal Signal Tests* to check for faulty reference signals. Perform Output Phase Imbalance Test to check for loss of motor phase.

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

NOTICE

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

Check setting of all motor parameters, see *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test*.

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 open winding in motor or open connection to motor.

Perform *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test* to ensure that frequency converter is providing correct output (see *Motor Runs Rough* above).

Check motor for open windings. Check all motor wiring connections.

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

4.6 Warnings and Alarms

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

- **24-00 FM Function**
- **24-05 FM Preset Reference**
- **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 may, however, reduce the warning condition. For example, if the warning displayed were Torque Limit (Warning 12), the frequency converter would be reducing speed to compensate for the over-current condition. In some cases, if the condition is not corrected or worsens, an alarm condition is activated and the frequency converter output to the motor terminated. 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

No.	Description	Warning	Alarm	Trip Lock	Parameter Reference
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 *6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

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

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

Perform input terminal signal test.

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

Troubleshooting

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

WARNING/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 *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 if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

Check that the supply voltage matches the frequency converter voltage.

Perform input voltage test.

Perform soft charge circuit test.

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

Troubleshooting

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

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

Display the thermal drive 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 whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded

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

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

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

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

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

⚠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 *1-93 Thermistor Source* selects terminal 53 or 54.

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

⚠WARNING

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 phases to ground, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting

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

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

WARNING

Disconnect power before proceeding.

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

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

WARNING

Disconnect power before proceeding.

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

WARNING

Live Electrical Components!

Troubleshooting:

Check connections on the serial communication cable.

Increase *8-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify a proper installation based on EMC requirements.

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

Troubleshooting

Check for proper fan operation.

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

Check the sensors on the heatsink and control card.

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

WARNING

Disconnect power before proceeding.

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

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

WARNING

Disconnect power before proceeding.

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

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

WARNING

Disconnect power before proceeding.

Remove 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

No.	Text
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
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 allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

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

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the setting in *4-18 Current Limit*.

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

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

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

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

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

ALARM 58, AMA Internal fault
Contact your Trane supplier.

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

WARNING 60, External interlock
A digital input signal is indicating a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip. Clear the external fault condition. To resume normal operation, apply 24 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 initialised to default settings after a manual reset. To clear the alarm, reset the unit.

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

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

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

WARNING 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 *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 .
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, over current, or inverter time. Avoid this situation by sizing the frequency converter properly for the application. Also ensure that intermittent load conditions cause anticipated operation in torque limit or an occasional trip. However, specific parameters that are improperly set, can cause nuisance or unexplained occurrences. The following parameters are important in 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
- rated motor speed

It is important to set these parameters accurately. Enter the motor data required as listed on the motor nameplate. For effective and efficient load control, the frequency converter relies on this information for calculating the output waveform in response to the changing demands of the application.

1-29 Automatic Motor 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. 2 key parameter values set by this function are stator resistance and main reactance, *1-30 Stator Resistance (Rs)* and *1-35 Main Reactance (Xh)*. If unstable motor operation is experienced, 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. Consult the *Quick Guide* for more information on this function.

As stated, the AMA function must be set *1-30 Stator Resistance (Rs)* and *1-35 Main Reactance (Xh)*. The values for these parameters can either be supplied by the motor manufacturer, or contain factory default values.

NOTICE

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

5.1.1 Overvoltage Trips

Overvoltage trip occurs when the DC bus voltage reaches its DC bus alarm voltage high (see *chapter 1.8.1 Short Circuit and Over-current Trips*). Before tripping, the frequency converter displays a high voltage warning. Mostly, fast deceleration ramps with respect to load inertia causes an over voltage 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 bus. If the amount of returned voltage is too high, the frequency converter trips.

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 over voltage control function (*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 bus voltage at an acceptable level. One caution with over voltage 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 which increases magnetisation current to increase loss in motor and reduce DC-link voltage. If the DC-link voltage exceeds a certain voltage, the overvoltage control increases the frequency.

5

5.1.2 Mains Phase Loss Trips

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

When the input voltage becomes unbalanced or a phase disappears completely, the ripple voltage increases. This situation 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. Line disturbances can be caused by line notching, defective transformers, or 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.

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

Severe imbalance of supply voltage or phase loss can easily be detected with a voltmeter. View line disturbances through an oscilloscope. Conduct tests for

- input imbalance of supply voltage
- input waveform
- and output imbalance of supply voltage

as described in .

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. There are 2 basic commands that must be given to any frequency converter to obtain an output. Commands provided to the frequency converter to obtain an output:

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

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

- Digital inputs (18, 19, 27, 29)
- Analog outputs (42, 45)
- 10 V output
- Analog inputs (53, 54)
- Serial communication bus (68, 69)

The presence of a correct reading indicates that the microprocessor of the frequency converter has detected the desired signal. See *chapter 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. The circuitry providing the signal along with its associated wiring must then be checked.

5.1.4 Programming Problems

Difficulty with operation of the frequency converter can be a result of improper programming of the frequency converter parameters. 3 areas where programming errors can affect frequency converter and motor operation are

- motor settings
- references and limits
- and I/O configuration

See .

The frequency converter must be set up correctly for the motor(s) connected to it. Parameters must have data from the motor nameplate entered into the frequency converter. These data enables the frequency converter processor to match the frequency converter to power characteristics of the motor. The most common result of the inaccurate motor data is that the motor drawing higher than normal amounts of current must perform the task expected of it. In such cases, setting the correct values to these parameters and performing the Automatic Motor Adaptation (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. These parameters must be set 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. Utilising an I/O function involves a two-step process. The desired I/O terminal must be wired properly, and the corresponding parameter must be set accordingly. Control terminals are programmed in parameter groups *5-0* Digital I/O Mode* and *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 a number of ways. The motor or motor wiring can develop a phase-to-phase or phase-to-ground short resulting in an alarm indication. Checks must be made to determine whether the problem is in the motor wiring or the motor itself.

A motor with unbalanced, or unsymmetrical, 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.

Quite 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 output terminals. Perform *chapter 6.4.6 Output Imbalance of Motor Supply Voltage Test* procedure on all 3 phases with an analog voltmeter. 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 one or more output IGBTs are not switching on and off correctly. This problem can be a result of a defective IGBT or gate signal.

5.2 Internal Frequency Converter Problems

If an over temperature indication is displayed, determine whether this condition actually exists within the frequency converter or whether the thermal sensor is defective. If not, the temperature sensor must be checked.

5.2.1 Current Sensor Faults

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

The simplest method of determining whether a current sensor is defective is to disconnect the motor from the frequency converter. Then observe the current in the frequency converter display. With the motor disconnected, the current should be 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 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.

5.2.2 Signal and Power Wiring Considerations for Electromagnetic Compatibility

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

NOTICE

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

5.2.3 Effects of EMI

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

- Motor speed fluctuations
- Serial communication transmission errors

5

- 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 behaviour
- Radio and TV interference
- Telephone interference
- Computer network data loss
- Digital control system faults

5.2.4 Sources of EMI

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

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

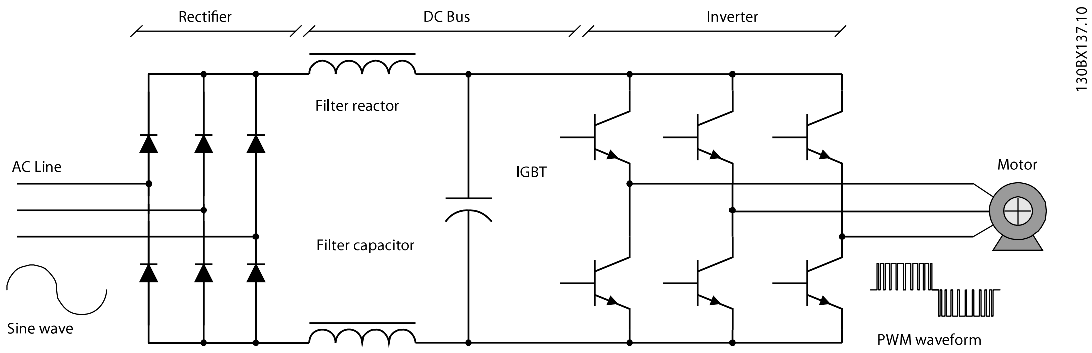

Illustration 5.1 Frequency Converter Functionality Diagram

5.2.5 EMI Propagation

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

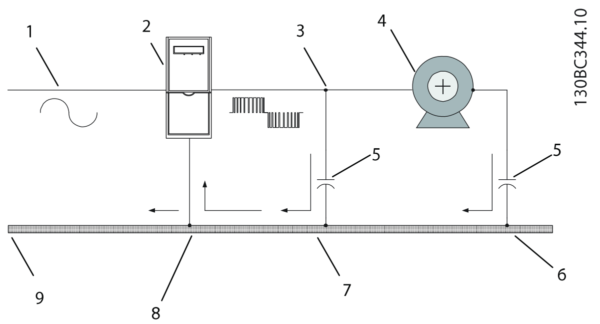

Illustration 5.2 Ground Currents

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

Table 5.1 Legend to *Illustration 5.2*

CAUTION

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

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

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

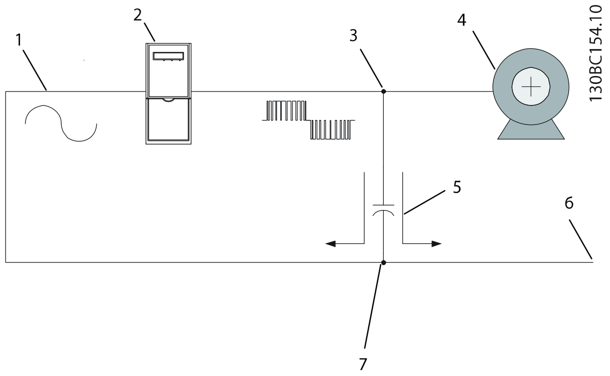

Illustration 5.3 Signal Conductor Currents

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

Table 5.2 Legend to *Illustration 5.3*

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 are 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 5.4*.

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.

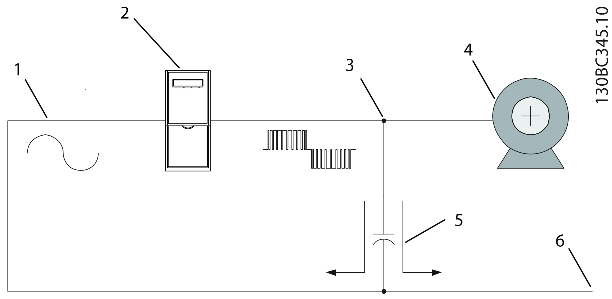

Illustration 5.4 Alternate Signal Conductor Currents

1	AC line
2	Frequency converter
3	Motor cable
4	Motor
5	Stray capacitance
6	AC line

Table 5.3 Legend to *Illustration 5.4*

NOTICE

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

5.2.6 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 travelling through the power network. The ground connection is ineffective if it has high impedance to high-frequency currents. Therefore1 it must be as short and direct as practical. 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

5

If parallel routing is unavoidable, try to maintain a separation of 200 mm (6–8 inches) between the cables or separate them with an 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 screened twisted-pair cables are available which are designed to minimise the effects of EMI. While unscreened twisted-pair cables are often adequate, screened twisted-pair cables provide another degree of protection. The signal cable screen must be terminated in a manner that is appropriate for the connected equipment. Avoid terminating the screen through a pigtail connection as it increases the high frequency impedance and spoils the effectiveness of the screen.

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 on 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, then 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 screened power cable is the most effective means to alleviate EMI problems. The cable screen 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 screening on the motor cable must be terminated at both ends.

If a screened 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 screened 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 one or more specific types of twisted-pair, screened 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 screened cable provides additional EMI protection, the screen 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 actually not defective.

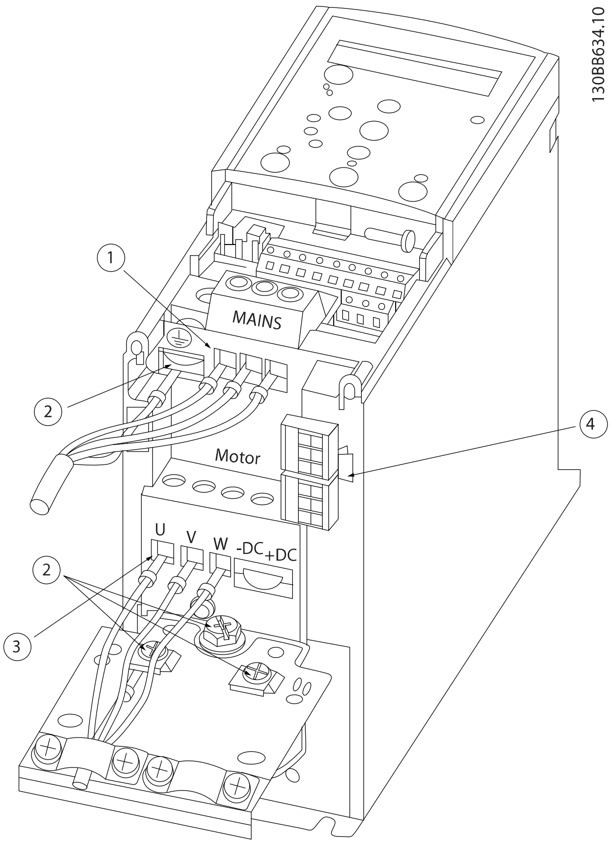

Illustration 6.1 H1-H5 Frame
IP20 200-240 V, 0.25-11 kW and IP20 380-480 V, 0.37-22 kW

1	Line
2	Ground
3	Motor
4	Relays

Table 6.1 Legend to *Illustration 6.1*

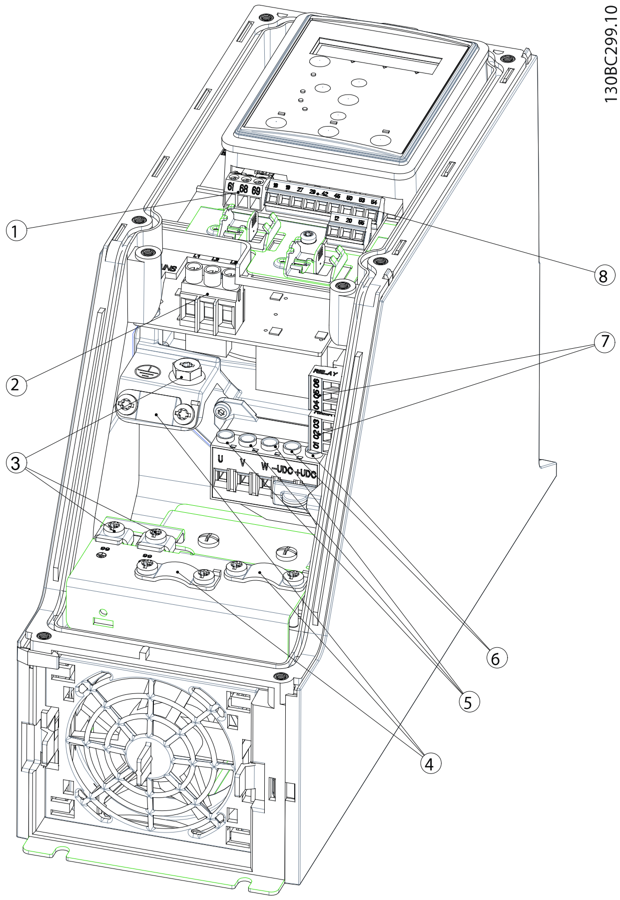

Illustration 6.2 I2 Frame
IP54 380-480 V, 0.75-4.0 kW

1	RS-485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Table 6.2 Legend to *Illustration 6.2*

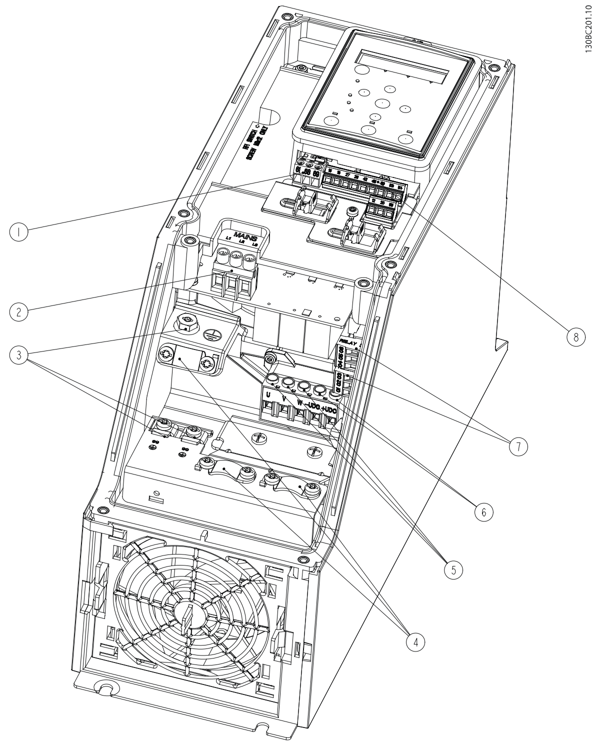

Illustration 6.3 I3 Frame
IP54 380-480 V, 5.5-7.5 kW

1	RS-485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Table 6.3 Legend to *Illustration 6.3*

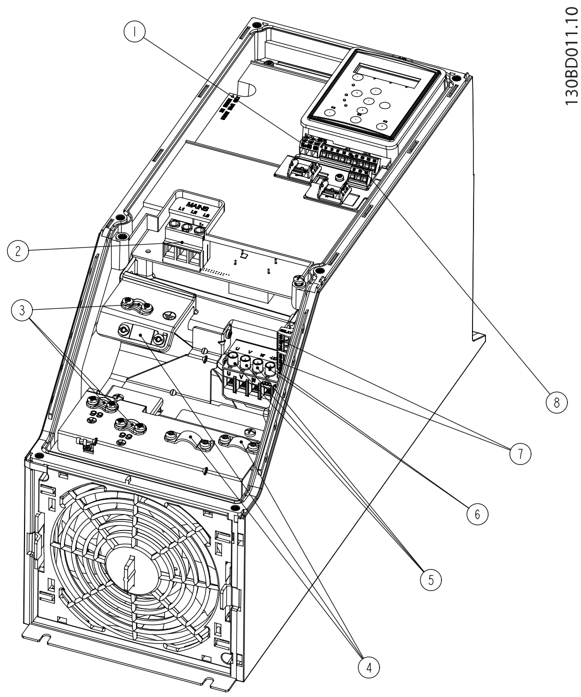

Illustration 6.4 I4 Frame
IP54 380-480 V, 0.75-4.0 kW

1	RS-485
2	Line in
3	Ground
4	Wire clamps
5	Motor
6	UDC
7	Relays
8	I/O

Table 6.4 Legend to *Illustration 6.4*

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 backups, UPS and DC-link connections to other frequency converters. Wait for the capacitors to fully discharge before performing any service or repair work. The amount of wait time is listed in the *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

All tests should be made with a meter capable of testing diodes. Use a digital volt/ohmmeter (VOM) set on the diode scale or an analog ohmmeter set on Rx100 scale. Before making any checks, disconnect all connections for:

- input
- motor
- brake resistor

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

WARNING

Disconnection of the input cable whilst the frequency converter is powered, could result in electrical shock, personal injury, and death.

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

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

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 startup, before applying power to frequency converter.

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 leads 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 intermediate circuit.

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.

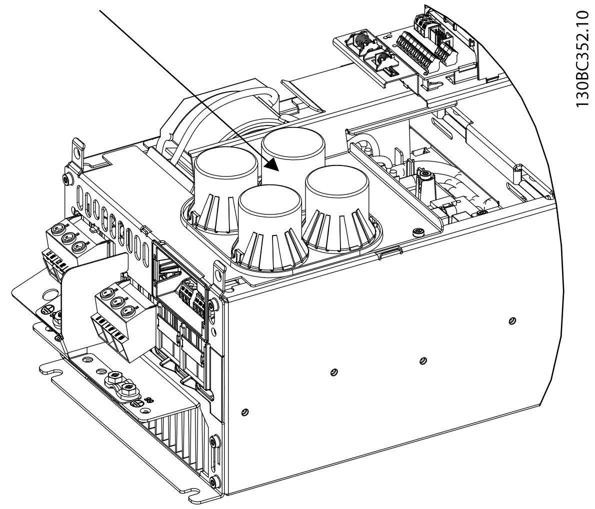

Illustration 6.5 UDC Terminals Location on H6 Frequency Converter

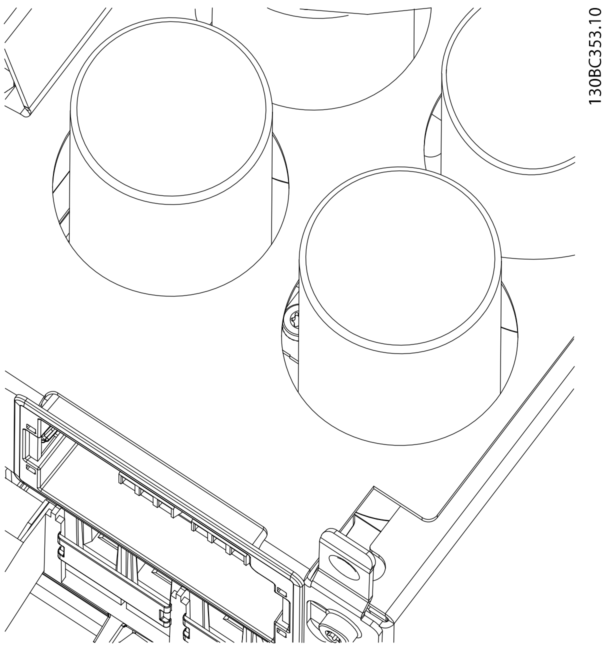

Illustration 6.6 Metal Cover over Terminals

6

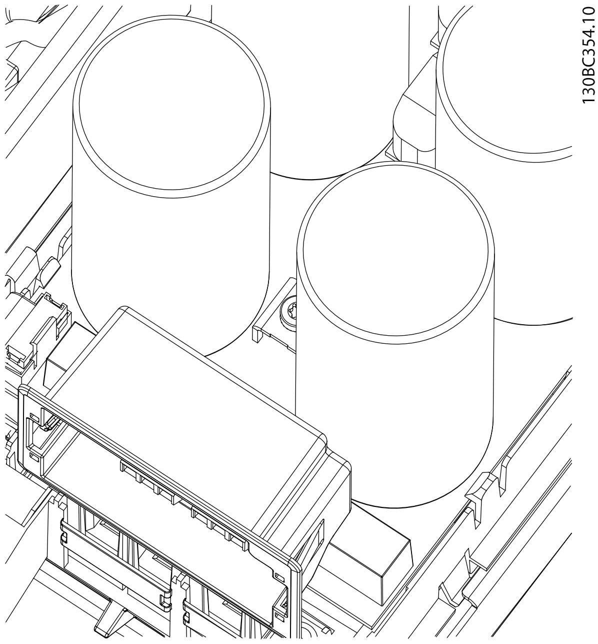

Illustration 6.7 The UDC Terminals on the Circuit Board

H7 and H8

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

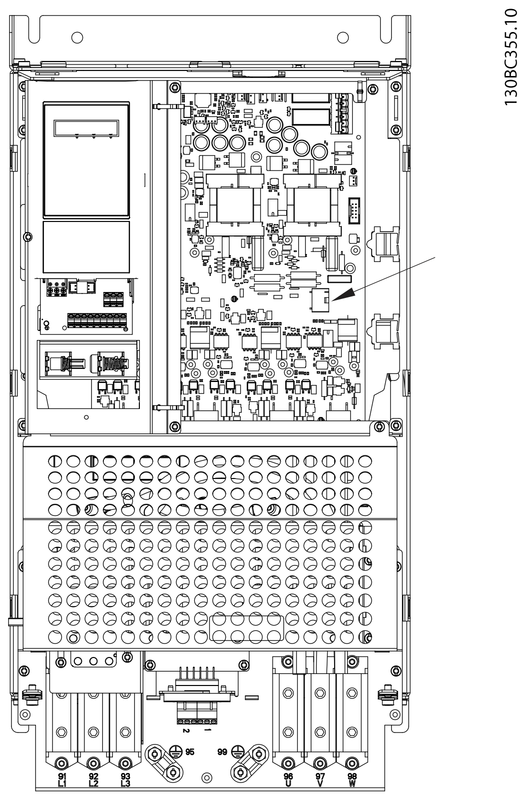

Illustration 6.8 Power Card

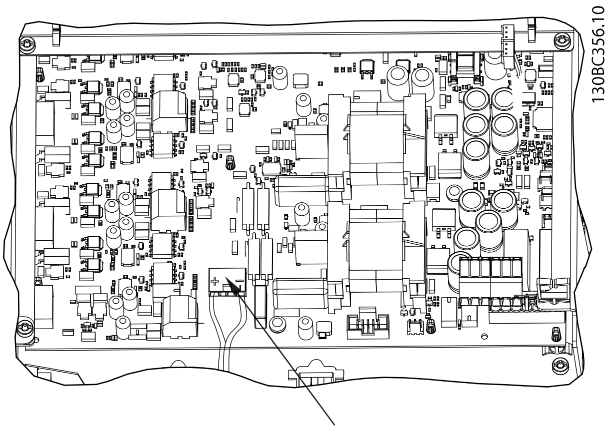

Illustration 6.9 +/- UDC Terminals

H9

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

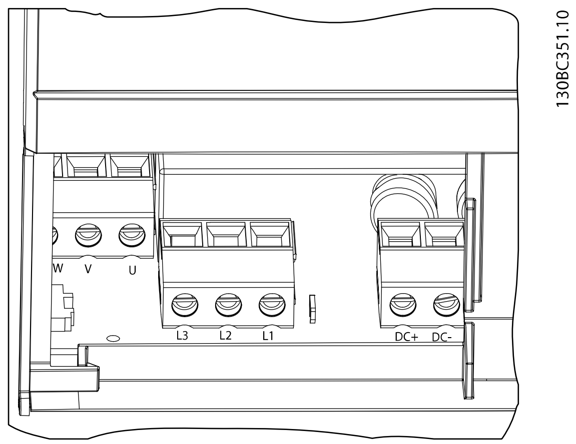

Illustration 6.10 UDC Terminals Location on H9 Frequency Converter

H10

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

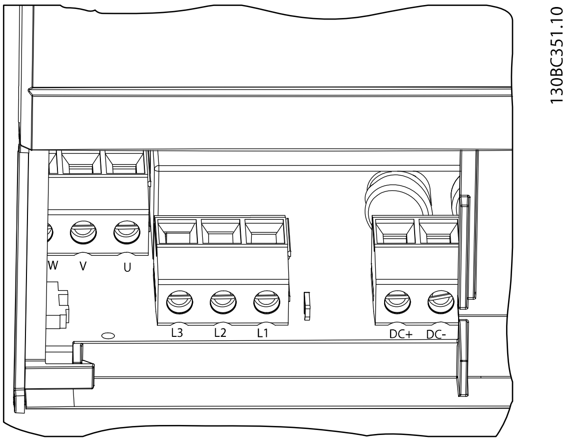

Illustration 6.11 UDC Terminals Location on H10 Frequency Converter

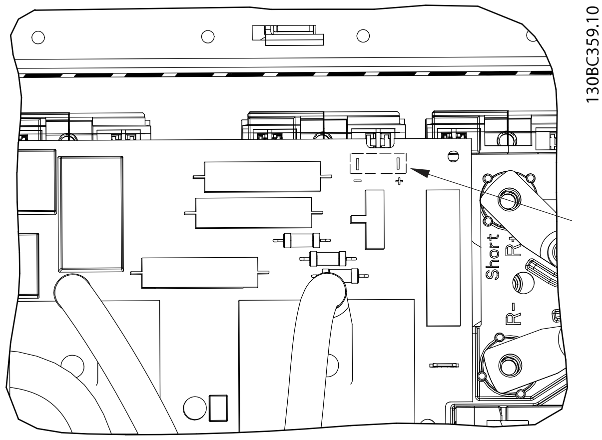

Illustration 6.14 +/- UDC Terminals on Current Sensor Board - Close-up View

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.

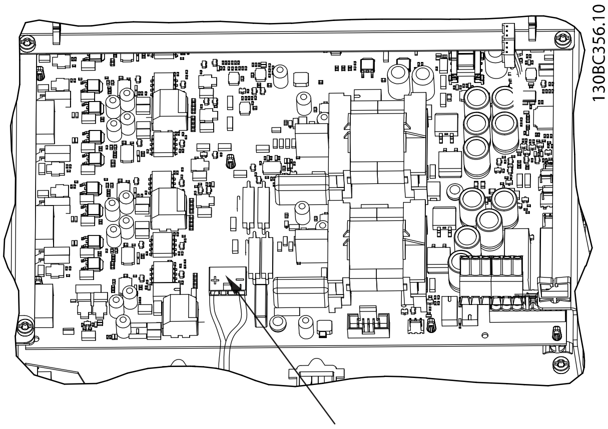

Illustration 6.12 +/- UDC Terminals on Power Card

Illustration 6.13 +/- UDC Terminals on Current Sensor Board

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 does not switch, and the output voltage drops on the fault terminal, UVW.

Preparation:

- Disconnect the motor from the frequency converter.
- Ensure 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, and 50 Hz/1500 RPM output depending on the instrument used.

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 regarding terminal 20. The meter must read 21-27 V DC.

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

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

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

Replace the LCP with a known good one. If the problem persists, replace the control card in accordance with the disassembly procedures.

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%. Should a greater current variation exist, 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 one current while the third 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.
4. Remove power to frequency converter.
5. Swap the phase that appears to be incorrect with one of other 2 phases.
6. Reapply power to the frequency converter and place it in run.
7. 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 SCR/diode modules. Phase loss caused by the mains supply can be easily detected. In addition, the SCR/diode modules control the rectifier section. If one of the SCR/diode modules becomes defective or the gate signal to the SCR lost, the frequency converter responds the same as loss of one 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*.

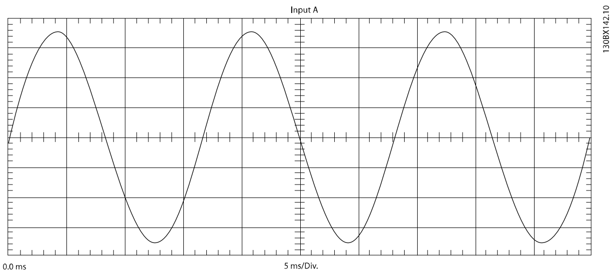

Illustration 6.15 Normal AC Input Voltage Waveform

The waveform shown in *Illustration 6.16* represents 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 SCR/diode modules.

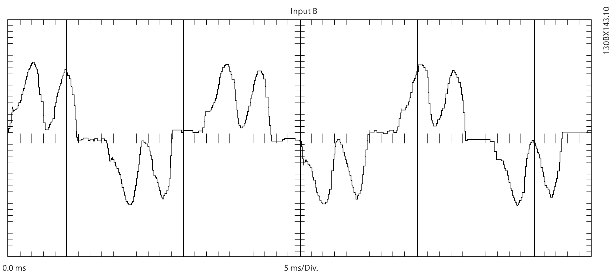

Illustration 6.16 AC Input Current Waveform with Diode Bridge

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

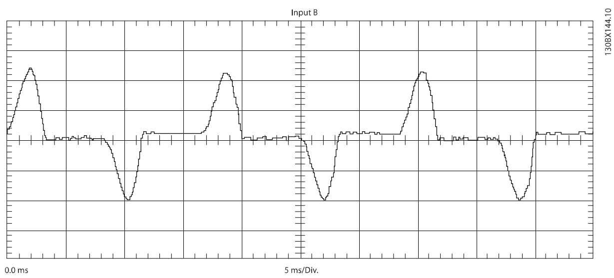

Illustration 6.17 Input Current Waveform with Phase Loss

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

6.4.6 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 is unbalanced as well as the voltage, the frequency converter is not gating the output 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.

The initial test can be made with the motor connected and running its load. If suspect readings are recorded, disconnect the motor cables to isolate the problem further.

1. Using a voltmeter, measure AC output voltage at frequency converter motor terminals 96 (U), 97 (V), and 98 (W). Measure phase-to-phase checking U to V, then U to W, and then V to W.

All 3 readings must be balanced within 8 V AC of each other. The actual value of the voltage depends on the speed at which the frequency converter is running. The volts/hertz ratio is relatively linear (except in VT mode) so at 60 Hz the voltage should be approximately equal to the mains voltage applied. At 30 Hz, it is about half of that, and so on, for any other speed selected. The exact voltage reading is less important than balance between phases.

2. Next, monitor 3 output phases at the motor terminals 96 (U), 97 (V), and 98 (W) with the clamp on the ammeter. An analog device is preferred. To achieve an accurate reading, run the frequency converter above 40 Hz as this is normally the frequency limitation of such meters.

The output current 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.

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

Since the current follows the voltage, it is necessary to differentiate between a load problem and a frequency converter problem. Should a voltage imbalance in the output be detected with the motor disconnected, it is necessary to test the gate drive circuits for proper firing. If output voltage is unbalanced, measure from ±UDC to the output phases U, V and W, to find out which IGBT is not firing correctly. To determine if there is a gate firing problem, replace the power card. This applies for frequency converters with separate IGBT modules. For frequency converters with IGBTs on the power card, the solution may already be found.

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

6.4.7 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 displayed, 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 no signal is present.

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

If the desired signal is not present in the display, the problem 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 *chapter 6.4.3 Basic Control Card Voltage Test* earlier in this section.

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

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

6.5 Initial Start Up Or After Repair Drive 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 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. Using an analog voltmeter or a DVM capable of measuring true RMS, 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 6.4.2 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. Using a clamp-on style ammeter, measure output current on each output phase. All currents must be balanced.

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.

7

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.

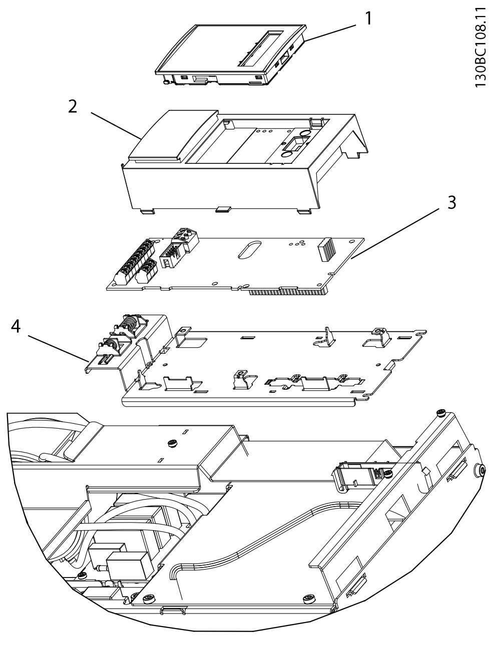

Illustration 7.1 Control Card and Control Card Mounting Plate

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

Table 7.1 Legend to *Illustration 7.1*

7.3.2 Heatsink Fan Assembly

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

Reinstall in the reverse order.

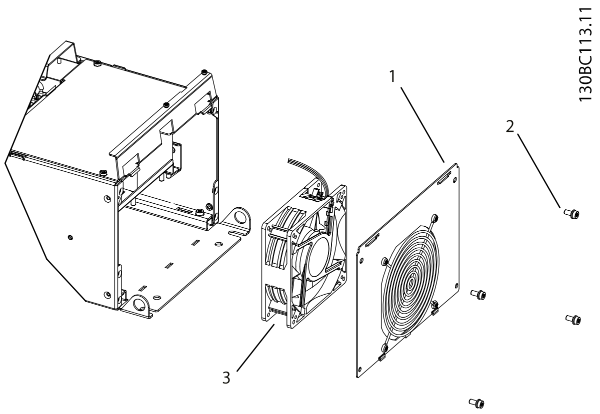

Illustration 7.2 Heatsink Fan Assembly

1	Fan cover plate
2	Screws
3	Fan assembly

Table 7.2 Legend to *Illustration 7.2*

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.

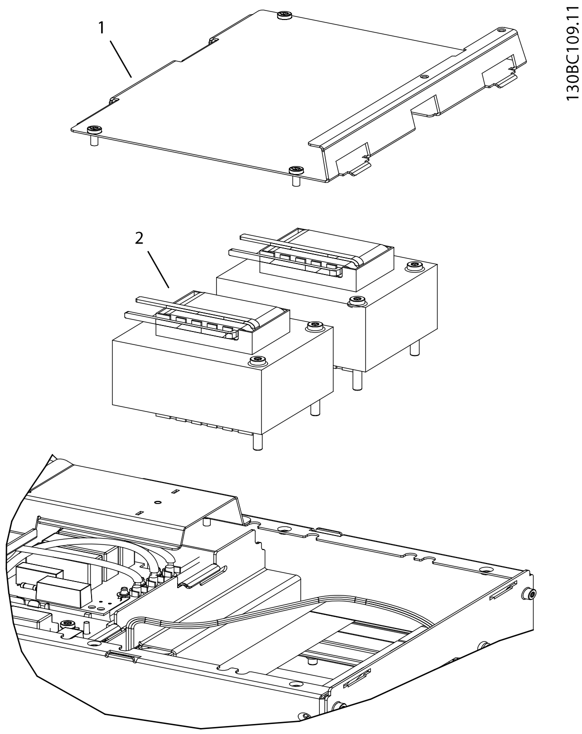

Illustration 7.3 DC Coil

1	DC coil cover
2	DC coils

Table 7.3 Legend to *Illustration 7.3*

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.

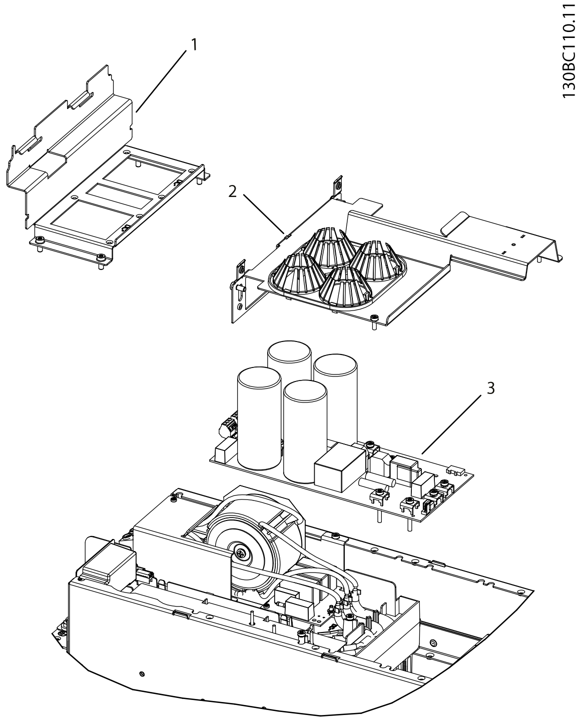

Illustration 7.4 DC Link Card

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

Table 7.4 Legend to *Illustration 7.4*

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.

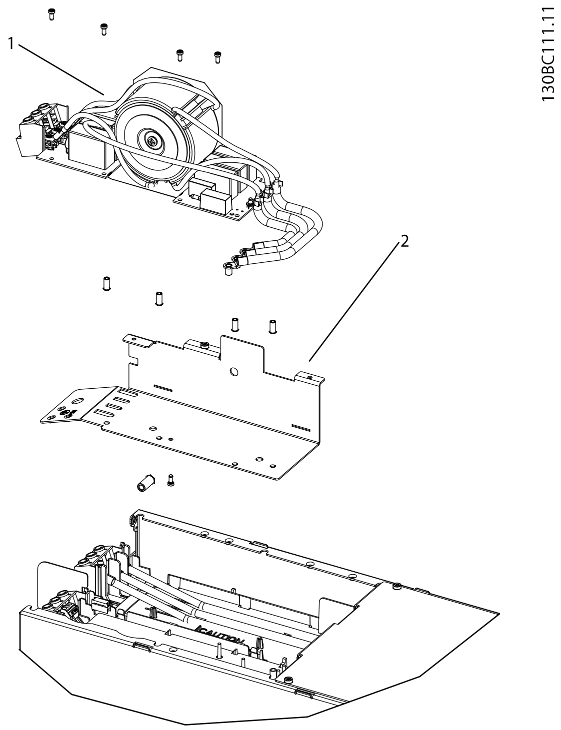

Illustration 7.5 RFI Filter

1	RFI filter
2	EMC shield

Table 7.5 Legend to *Illustration 7.5*

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.

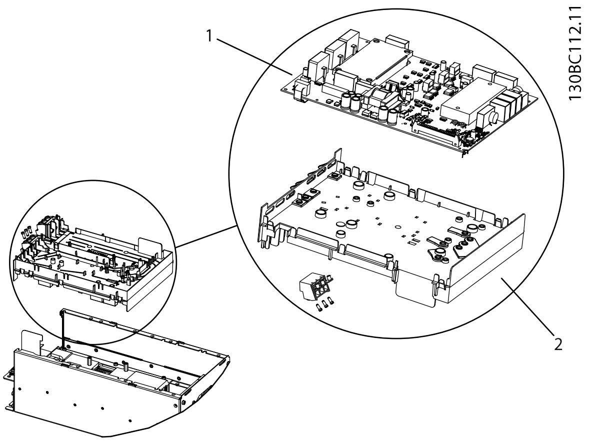

Illustration 7.6 Power Card

1	Power card
2	Power card mounting plate

Table 7.6 Legend to *Illustration 7.6*

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.

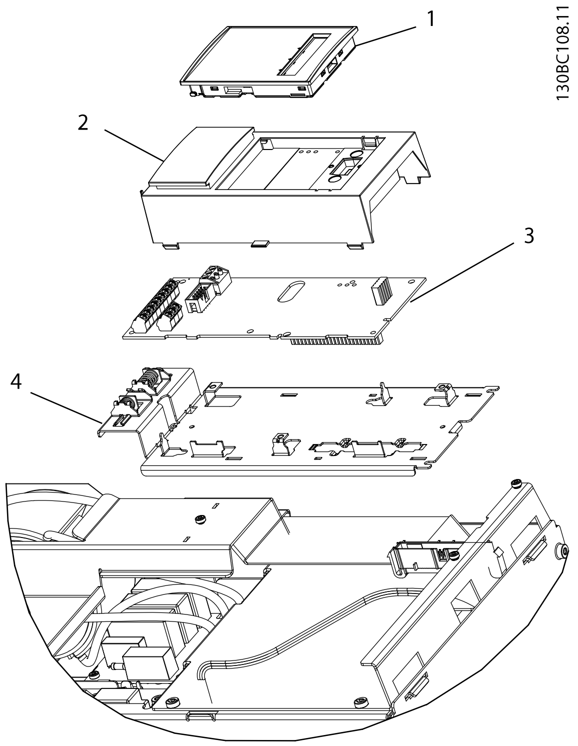

Illustration 7.7 Control Card and Control Card Mounting Plate

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

Table 7.7 Legend to *Illustration 7.7*

7

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.

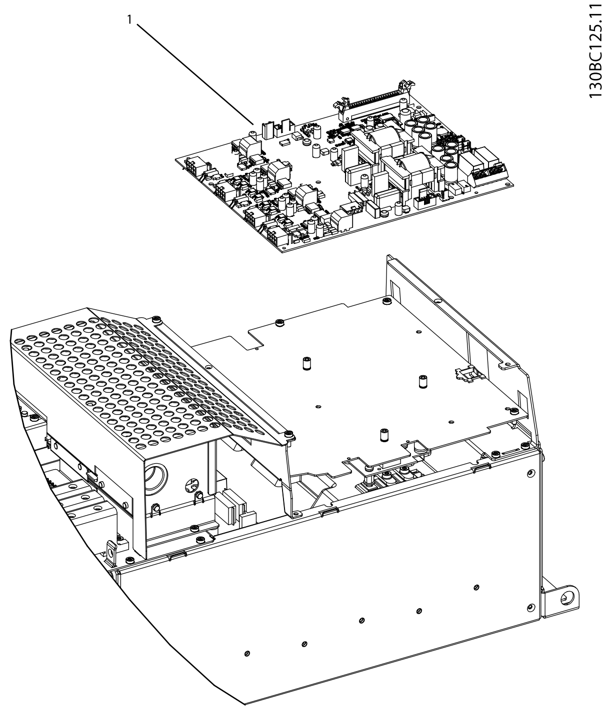

Illustration 7.8 Power Card

1	Power card

Table 7.8 Legend to *Illustration 7.8*

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.

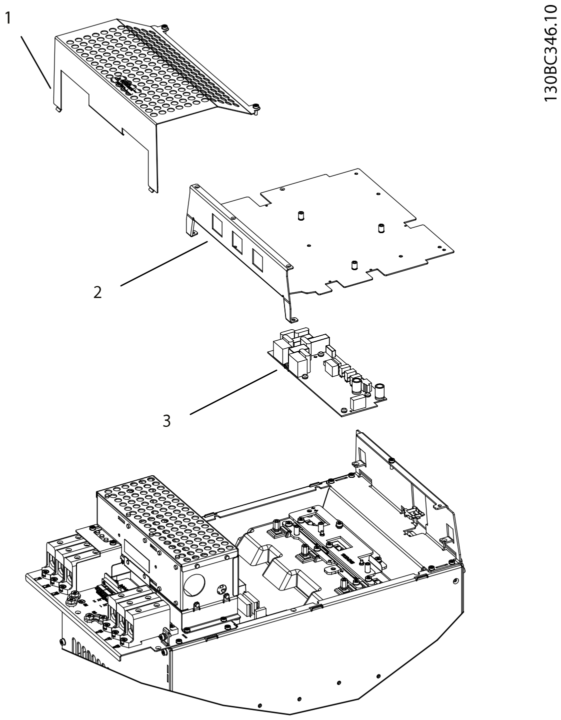

Illustration 7.9 Inrush Card

1	EMC shield
2	Power card mounting plate
3	Inrush card

Table 7.9 Legend to *Illustration 7.9*

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.

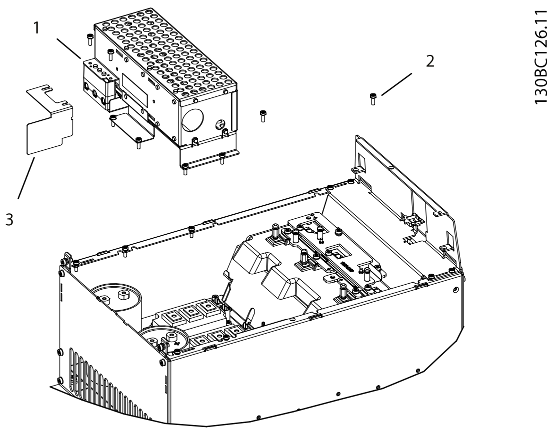

Illustration 7.10 RFI Filter

1	RFI filter
2	Screws
3	EMC shield

Table 7.10 Legend to *Illustration 7.10*

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.

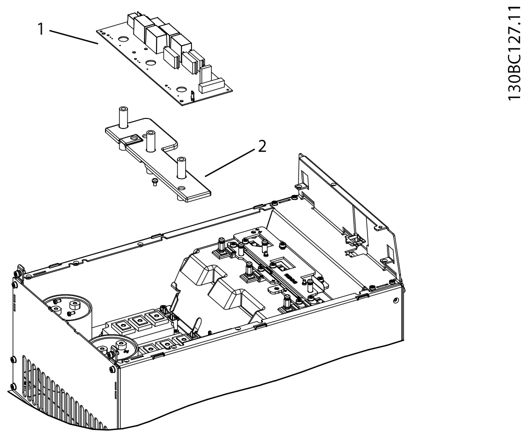

Illustration 7.11 Relay or Transducer Card

1	Relay transducer card
2	Relay card mounting plate

Table 7.11 Legend to *Illustration 7.11*

7

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 heatsink 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 heatsink.

Reinstall in the reverse order. Join the mounting snaps.

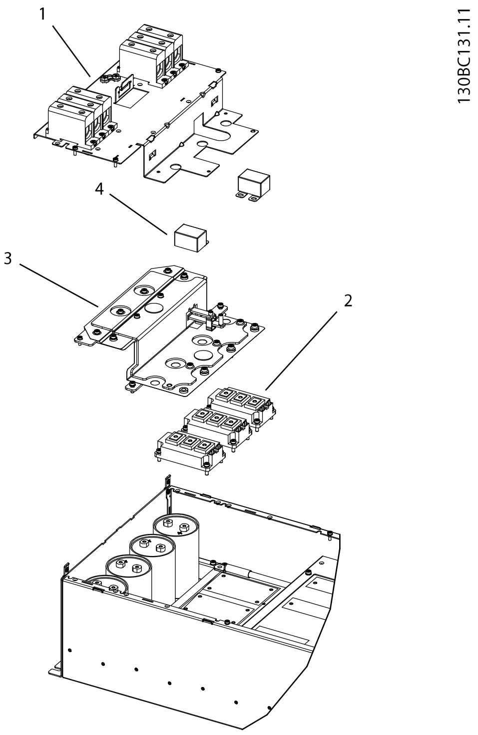

Illustration 7.12 IGBT

1	Cable mounting plate
2	IGBT
3	Bus bar
4	Capacitor

Table 7.12 Legend to *Illustration 7.12*

7.4.8 Heatsink 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.

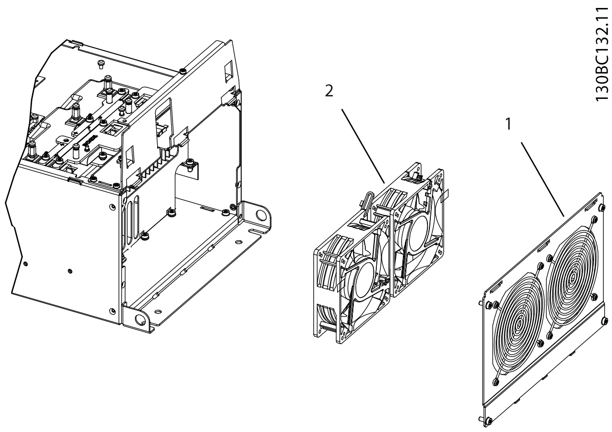

Illustration 7.13 Heatsink Fan Assembly

1	Fan cover
2	Fan assembly

Table 7.13 Legend to *Illustration 7.13*

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 heatsink.
3. Remove the heatsink.
4. Remove 4 screws (T20) from each of the 2 DC Coils.
5. Remove the coils.

Reinstall in the reverse order.

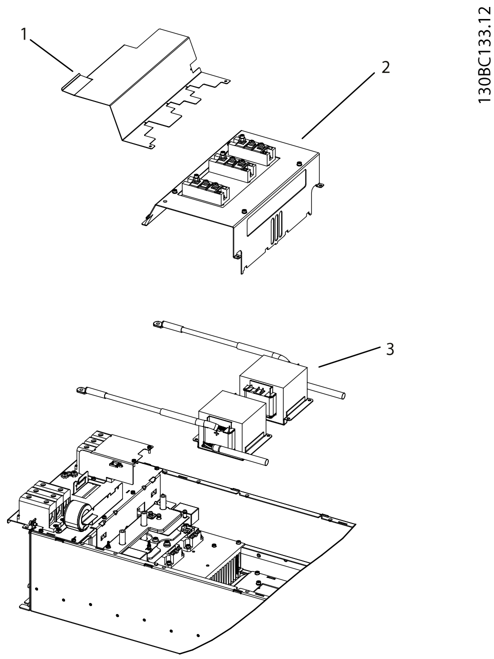

Illustration 7.14 DC Coil

1	DC coil cover plate
2	Heatsink
3	DC coil

Table 7.14 Legend to *Illustration 7.14*

7.4.10 Capacitor Bank

1. Remove the foil.
2. Remove the 6 screws on the bottom plate.
3. Remove the bottom 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.

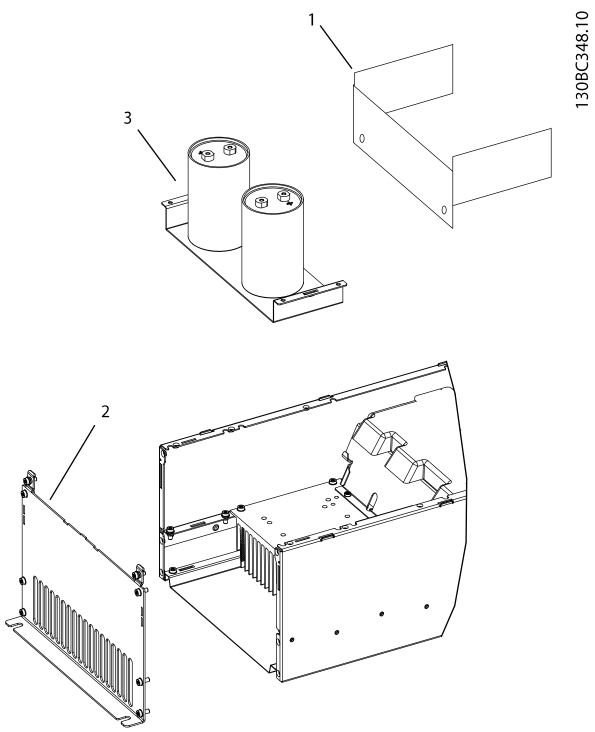

Illustration 7.15 Capacitor Bank

1	Foil
2	Bottom plate
3	Capacitor bank

Table 7.15 Legend to *Illustration 7.15*

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.

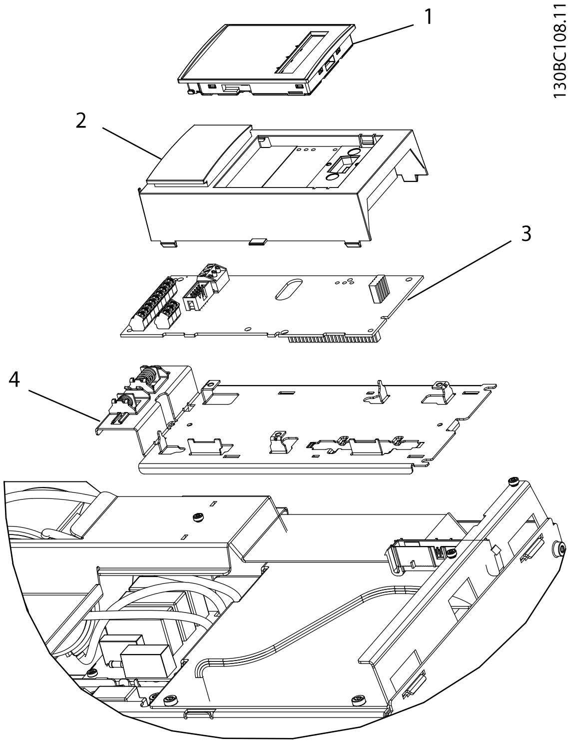

Illustration 7.16 Control Card and Control Card Mounting Plate

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

Table 7.16 Legend to *Illustration 7.7*

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.

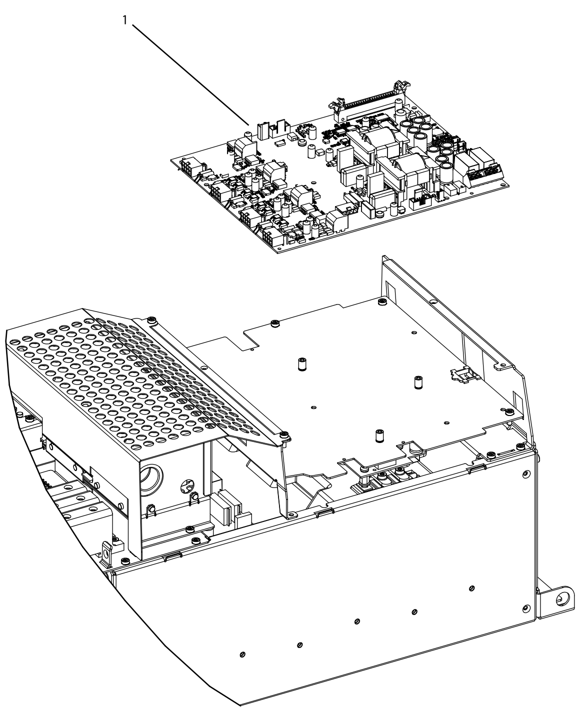

Illustration 7.17 Power Card

1	Power card

Table 7.17 Legend to *Illustration 7.17*

7

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.

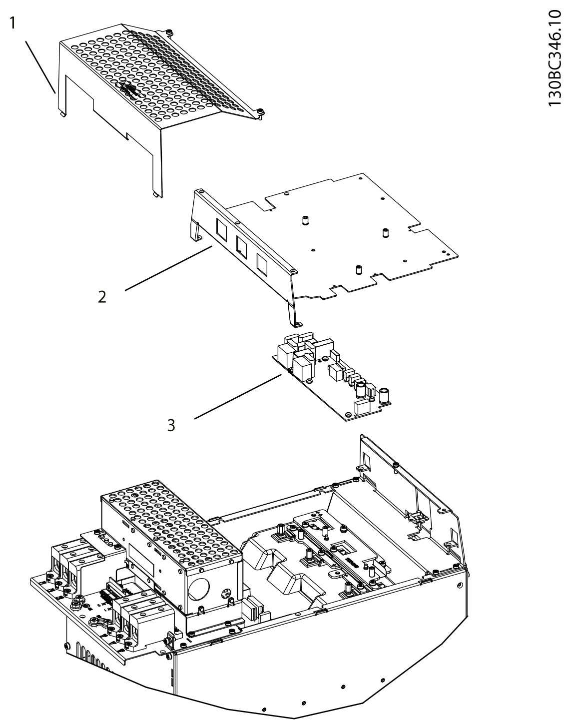

Illustration 7.18 Inrush Card

1	EMC shield
2	Power card mounting plate
3	Inrush card

Table 7.18 Legend to *Illustration 7.18*

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.

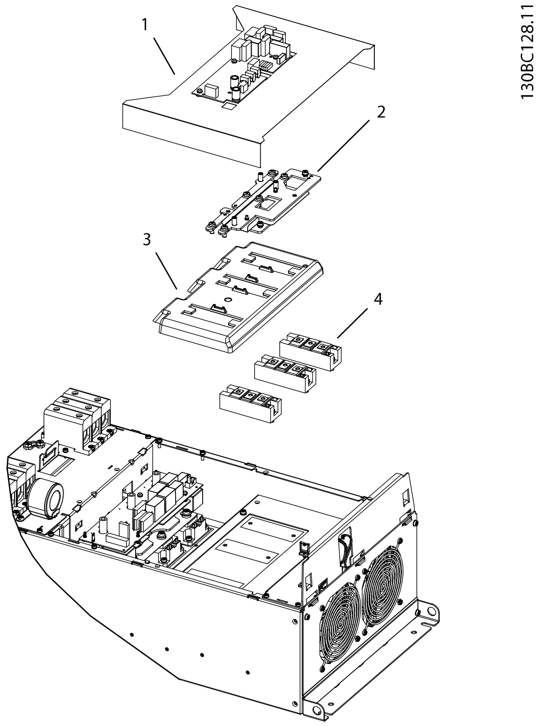

Illustration 7.19 Rectifier Modules

1	Foil
2	Bus bar
3	Plastic cover
4	Rectifier modules

Table 7.19 Legend to *Illustration 7.19*

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.

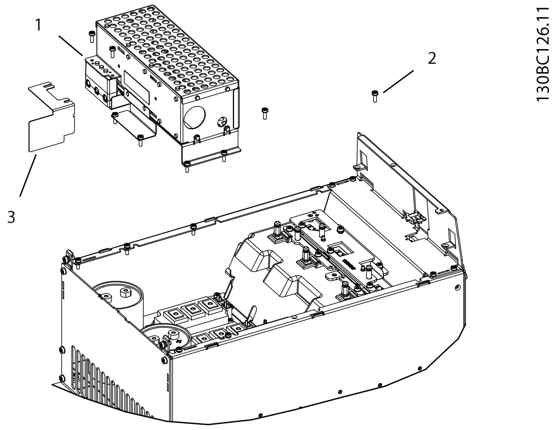

Illustration 7.20 RFI Filter

1	RFI filter
2	Screws
3	EMC shield

Table 7.20 Legend to *Illustration 7.20*

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.

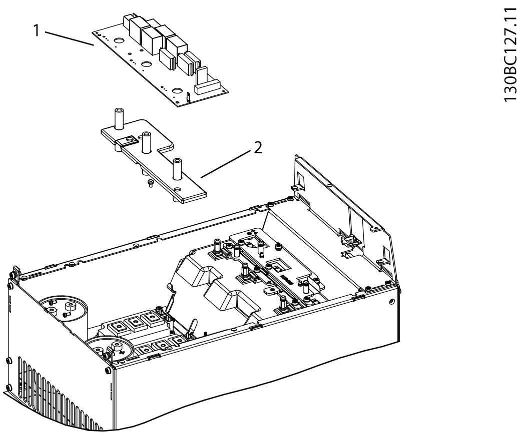

Illustration 7.21 Relay Transducer Card

1	Relay transducer card
2	Relay card mounting plate

Table 7.21 Legend to *Illustration 7.21*

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 heatsink.

Reinstall in the reverse order. Join the mounting snaps.

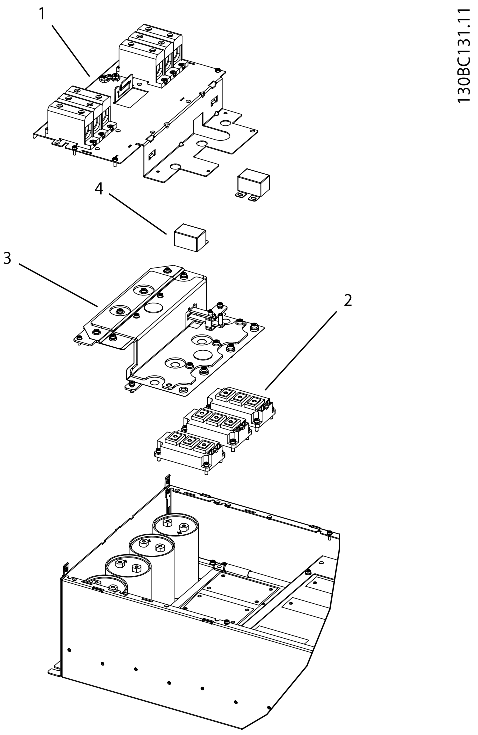

Illustration 7.22 IGBT

1	Cable mounting plate
2	IGBT
3	Bus bar
4	Capacitor

Table 7.22 Legend to *Illustration 7.22*

7.5.8 Heatsink 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.

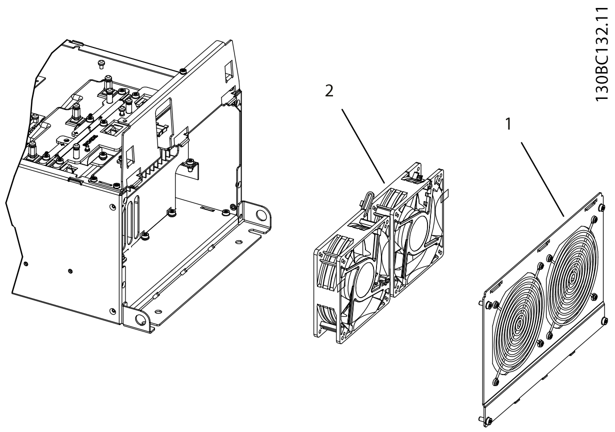

Illustration 7.23 Heatsink Fan Assembly

1	Fan cover
2	Fan assembly

Table 7.23 Legend to *Illustration 7.13*

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 heatsink.
3. Remove the heatsink.
4. Remove 4 screws (T20) from each of the 2 DC Coils.
5. Remove the coils.

Reinstall in the reverse order.

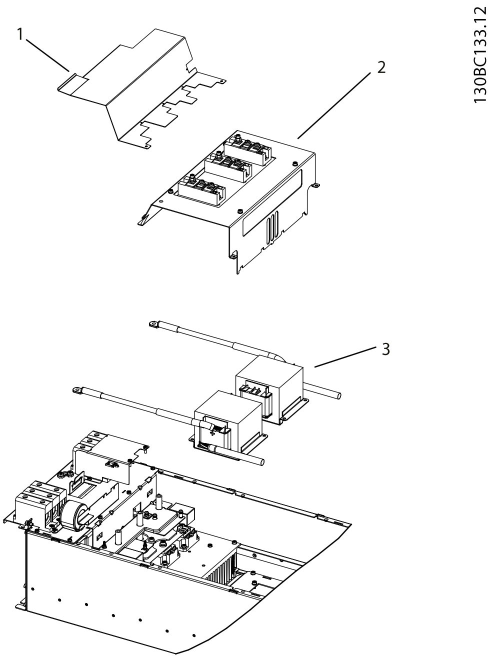

Illustration 7.24 DC Coil

1	DC coil cover plate
2	Heatsink
3	DC coil

Table 7.24 Legend to *Illustration 7.14*

7.5.10 Capacitor Bank

1. Remove the foil.
2. Remove the 4 screws from the bottom plate.
3. Remove the bottom 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.

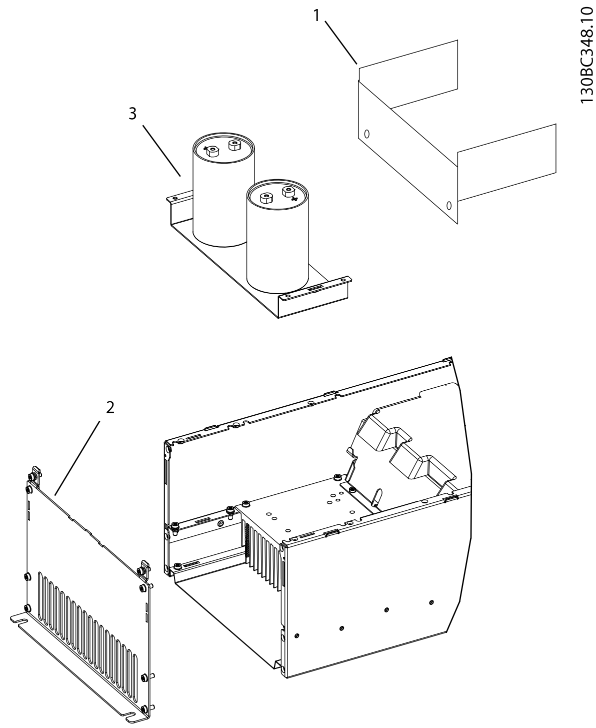

Illustration 7.25 Capacitor Bank

1	Foil
2	Bottom plate
3	Capacitor bank

Table 7.25 Legend to *Illustration 7.25*

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.

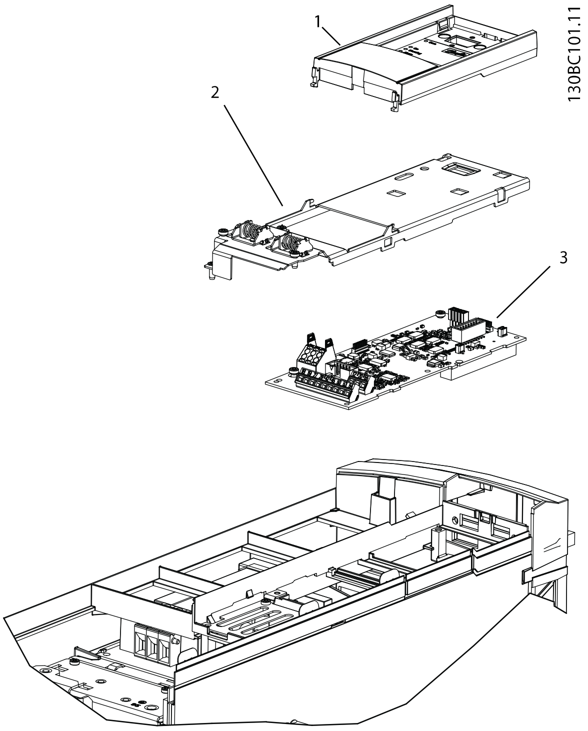

Illustration 7.26 Control Card and Control Card Mounting Plate

1	LCP
2	Control card mounting plate
3	Control card

Table 7.26 Legend to *Illustration 7.26*

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.

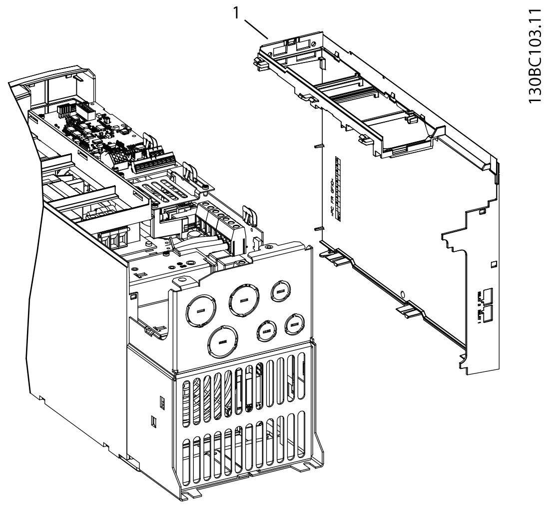

Illustration 7.27 Power Card Cover

1	Power card cover

Table 7.27 Legend to *Illustration 7.27*

7.6.3 Power Card

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

⚠CAUTION

The power card and the heatsink 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.

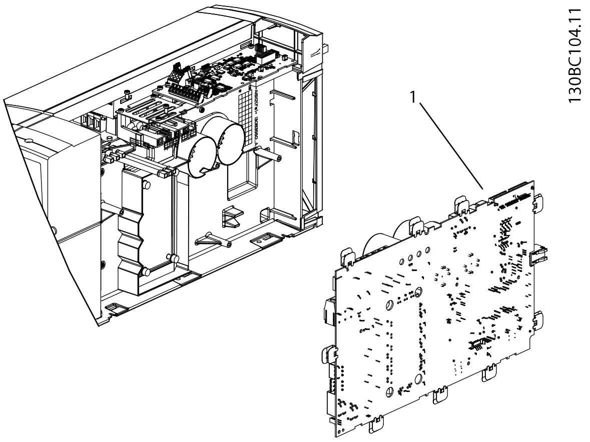

Illustration 7.28 Power Card

1	Power card

Table 7.28 Legend to *Illustration 7.28*

7.6.4 Heatsink 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 heatsink.
5. Lift out the DC coils.

Reinstall in the reverse order.

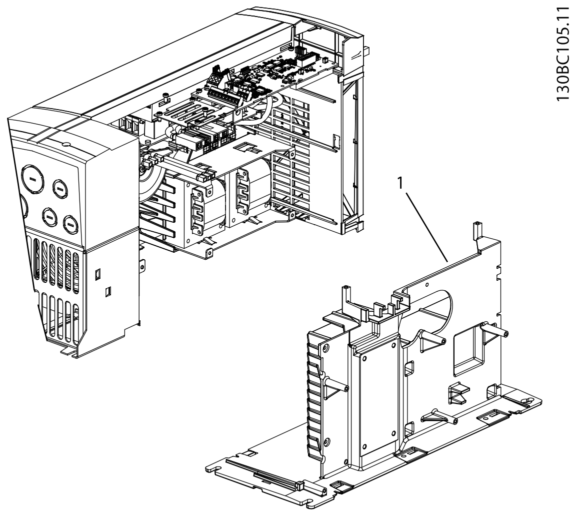

Illustration 7.29 Heatsink

1	Heatsink

Table 7.29 Legend to *Illustration 7.29*

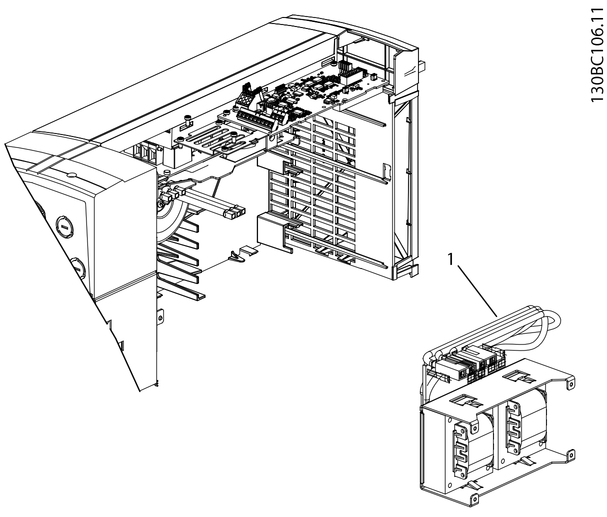

Illustration 7.30 DC Coil

1	DC coil

Table 7.30 Legend to *Illustration 7.30*

7.6.5 Heatsink 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.

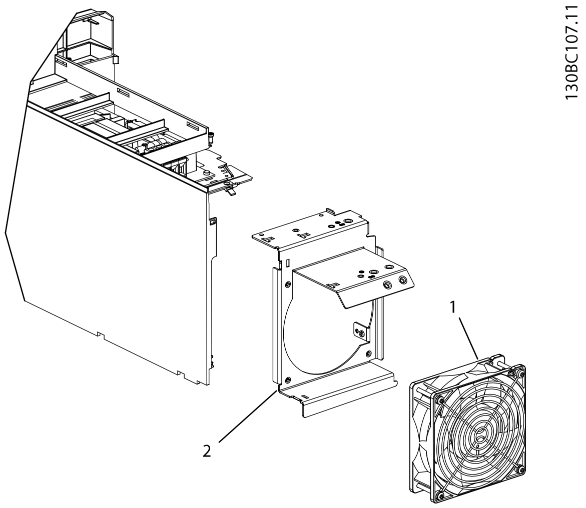

Illustration 7.31 Heatsink Fan Assembly

1	Heatsink fan
2	Fan mounting plate

Table 7.31 Legend to *Illustration 7.31*

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

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.

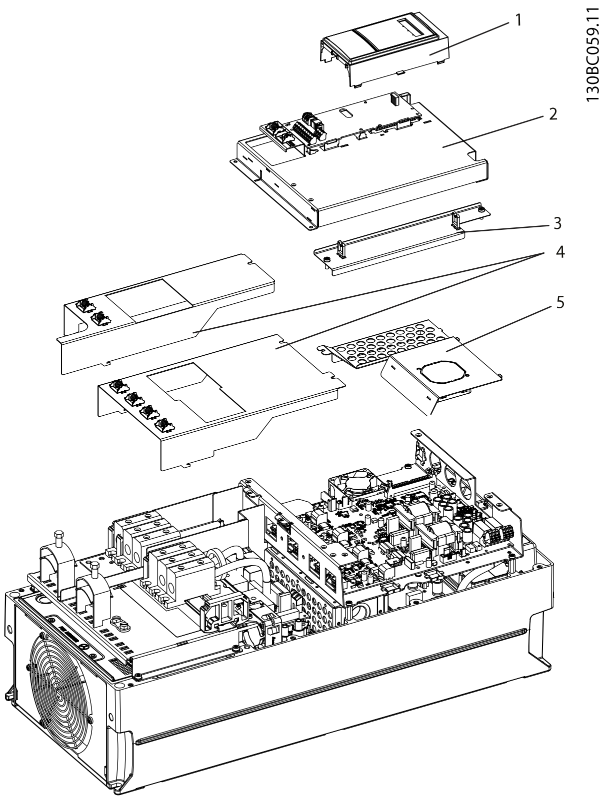

Illustration 8.1 Control Card and Control Card Mounting Plate

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

Table 8.1 Legend to *Illustration 8.1*

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.

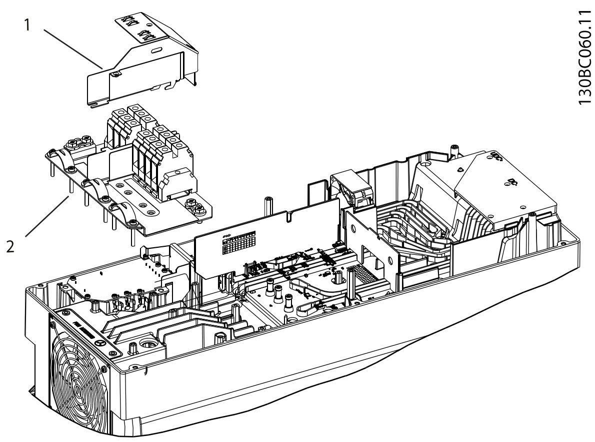

Illustration 8.2 Cable Mounting Plate

1	EMC shield
2	Cable mounting plate

Table 8.2 Legend to *Illustration 8.2*

8.2.3 Heatsink 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.

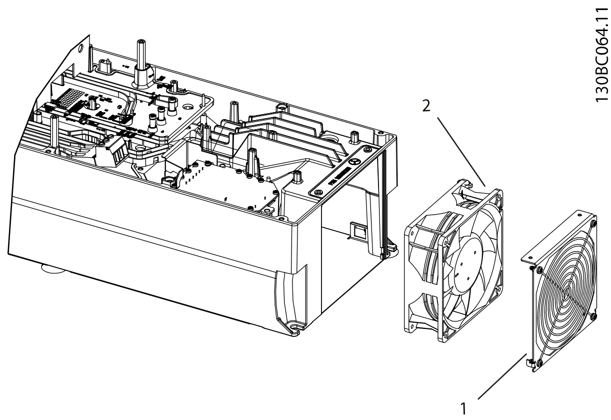

Illustration 8.3 Heatsink Fan Assembly

1	Fan cover
2	Fan assembly

Table 8.3 Legend to *Illustration 8.3*

8

8

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.

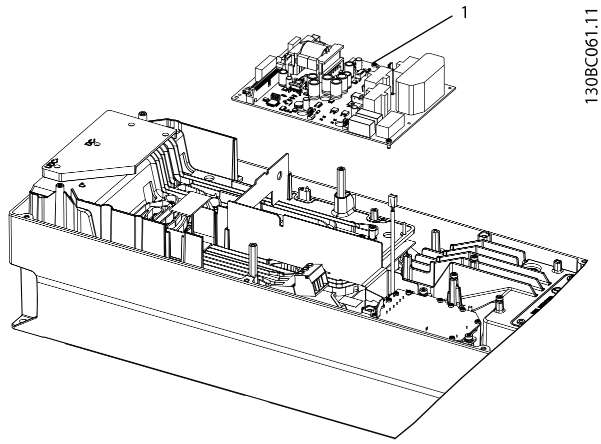

Illustration 8.4 SMPS Card

1	SMPS card

Table 8.4 Legend to *Illustration 8.4*

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.

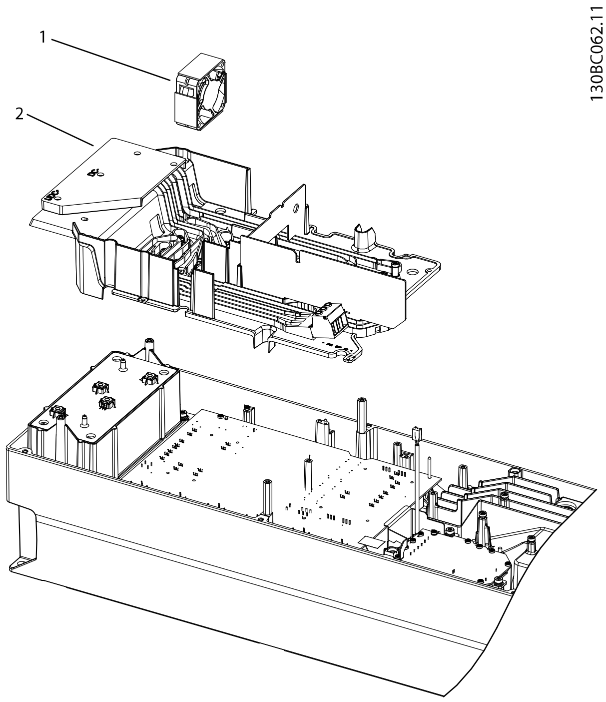

Illustration 8.5 Bus Bar Unit

1	Fan
2	Bus bar unit

Table 8.5 Legend to *Illustration 8.5*

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.

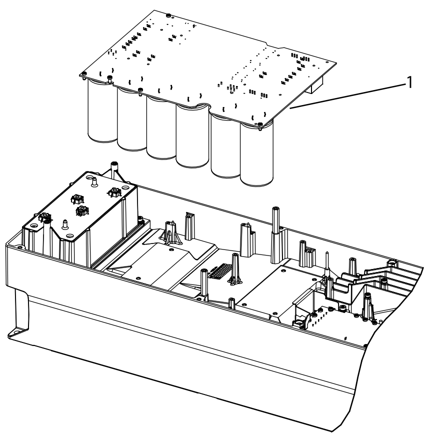

Illustration 8.6 Power Card

1	Power card

Table 8.6 Legend to *Illustration 8.6*

8.2.7 DC Coil

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

Reinstall in the reverse order.

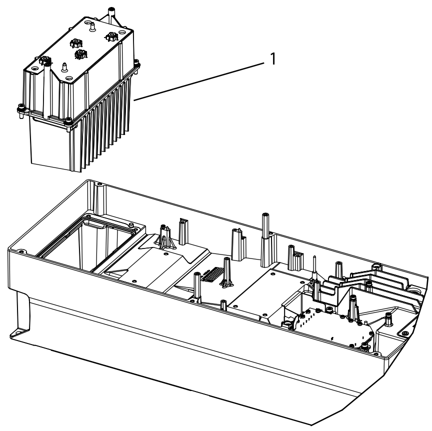

Illustration 8.7 DC Coil

1	DC coil

Table 8.7 Legend to *Illustration 8.7*

8

8.2.8 RFI Filter

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

Reinstall in the reverse order.

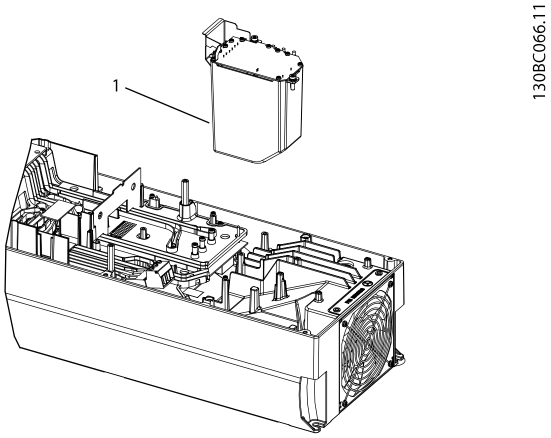

Illustration 8.8 RFI Filter

1	RFI filter

Table 8.8 Legend to *Illustration 8.8*

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.

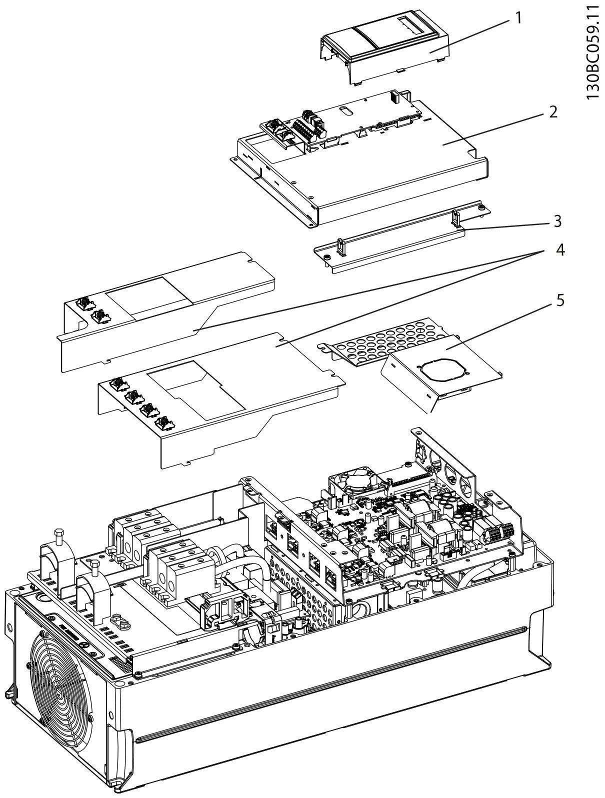

Illustration 8.9 Control Card Mounting Plate

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

Table 8.9 Legend to *Illustration 8.9*

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.

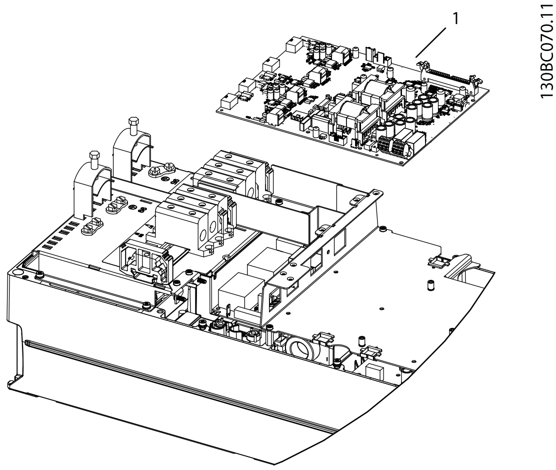

Illustration 8.10 Power Card

1	Power card

Table 8.10 Legend to *Illustration 8.10*

8

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.

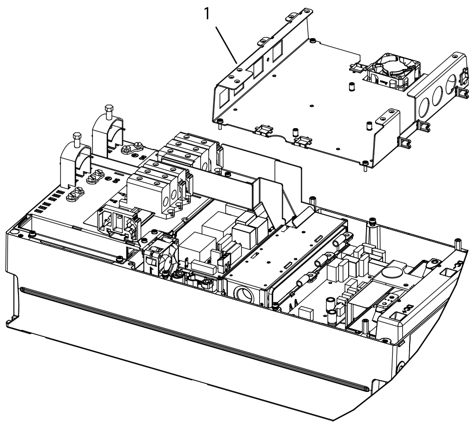

Illustration 8.11 Power Card Mounting Plate

1	Power card mounting plate

Table 8.11 Legend to *Illustration 8.11*

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.

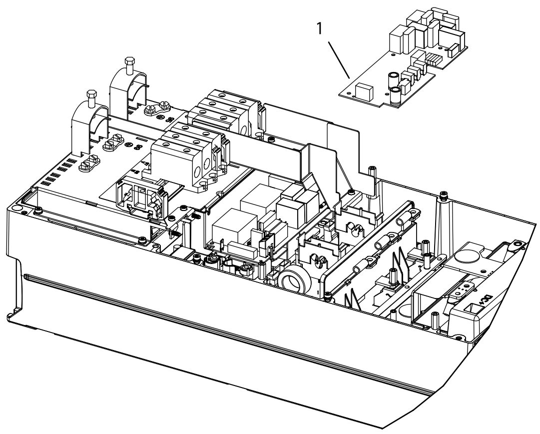

Illustration 8.12 Inrush Card

1	Inrush card

Table 8.12 Legend to *Illustration 8.12*

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.

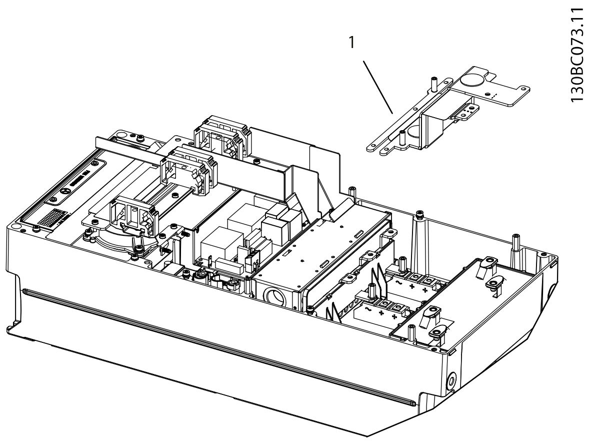

Illustration 8.13 Bus Bar

1	Bus bar

Table 8.13 Legend to *Illustration 8.13*

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.

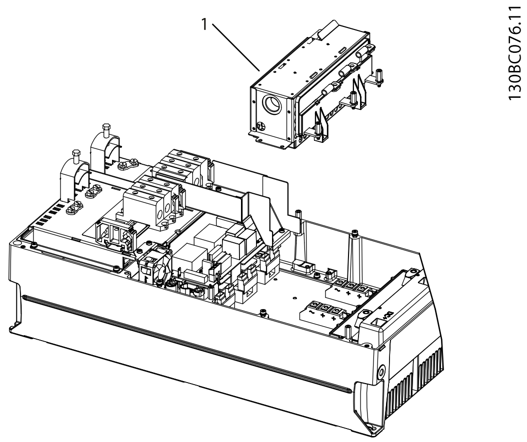

Illustration 8.14 RFI Filter

1	RFI filter

Table 8.14 Legend to *Illustration 8.14*

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.

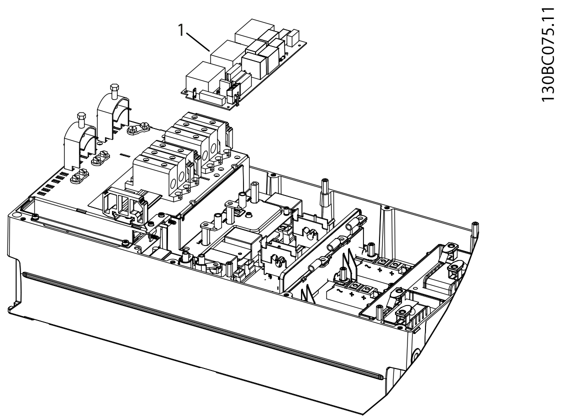

Illustration 8.15 Relay Transducer Card

1	Relay transducer card

Table 8.15 Legend to *Illustration 8.15*

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.

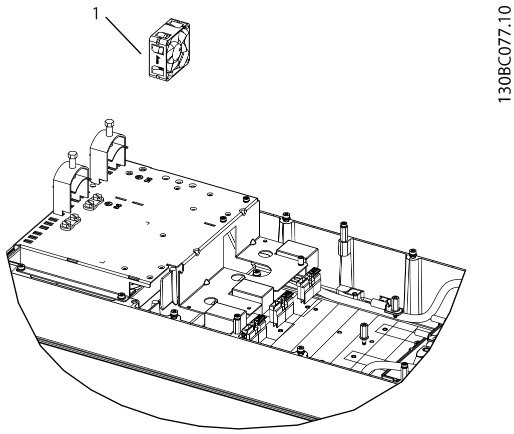

Illustration 8.16 Fan

1	Fan

Table 8.16 Legend to *Illustration 8.16*

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.

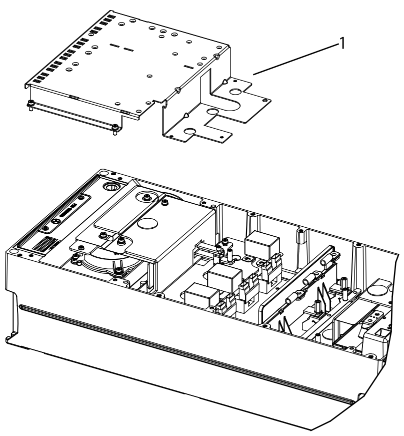

Illustration 8.17 Terminal Plate

1	Terminal plate

Table 8.17 Legend to *Illustration 8.17*

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.

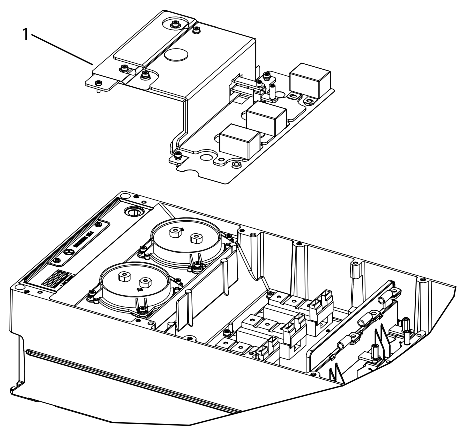

Illustration 8.18 DC Bus Bar Assembly

1	DC bus bar assembly

Table 8.18 Legend to *Illustration 8.18*

8

8.3.11 Heatsink Fan Assembly

1. Remove gate cables from IGBTs.
2. Remove 2 screws (T20) from the heatsink 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.

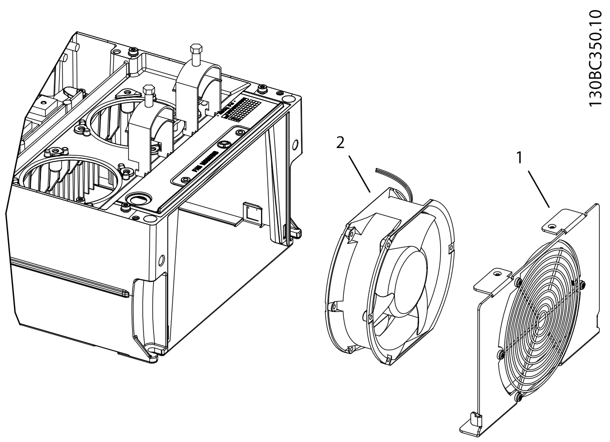

Illustration 8.19 Heatsink Fan Assembly

1	Fan cover plate
2	Fan assembly

Table 8.19 Legend to *Illustration 8.19*

8.3.12 Capacitor Bank

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

Reinstall in the reverse order.

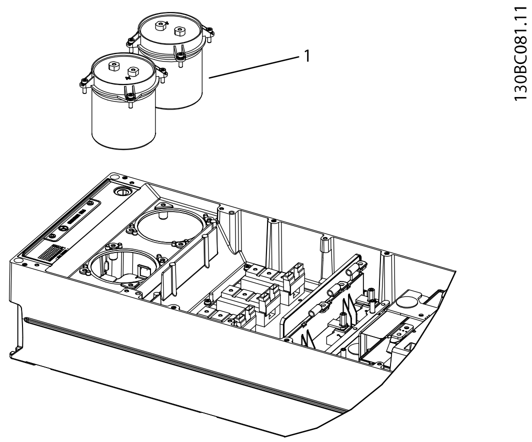

Illustration 8.20 Capacitors

1	Capacitors

Table 8.20 Legend to *Illustration 8.20*

8.3.13 DC Coil

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

Reinstall in the reverse order.

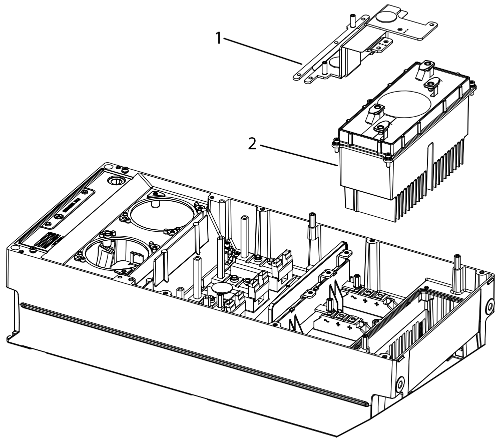

Illustration 8.21 DC Coil

1	Bus bar
2	DC coil

Table 8.21 Legend to *Illustration 8.21*

8.3.14 IGBT

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

CAUTION

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

2. Remove all IGBTs.

Reinstall in the reverse order.

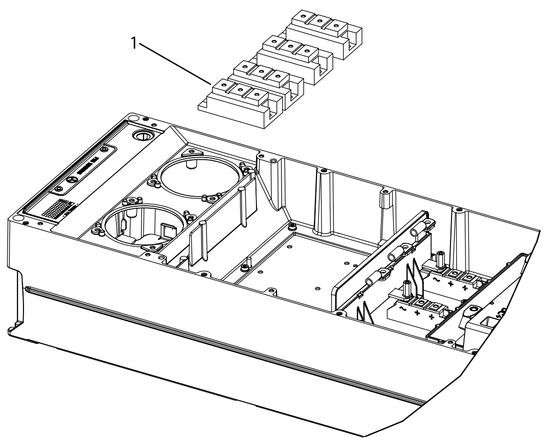

Illustration 8.22 IGBT

1	IGBT

Table 8.22 Legend to *Illustration 8.22*

8

8.3.15 Thyristor

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

CAUTION

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

2. Remove the thyristors.

Reinstall in the reverse order.

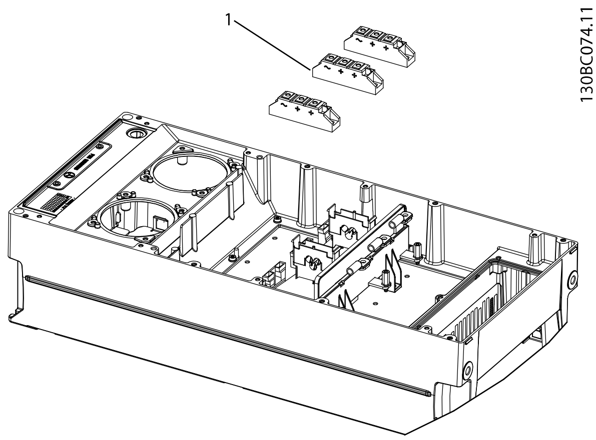

Illustration 8.23 Thyristor

1	Thyristor

Table 8.23 Legend to *Illustration 8.23*

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.

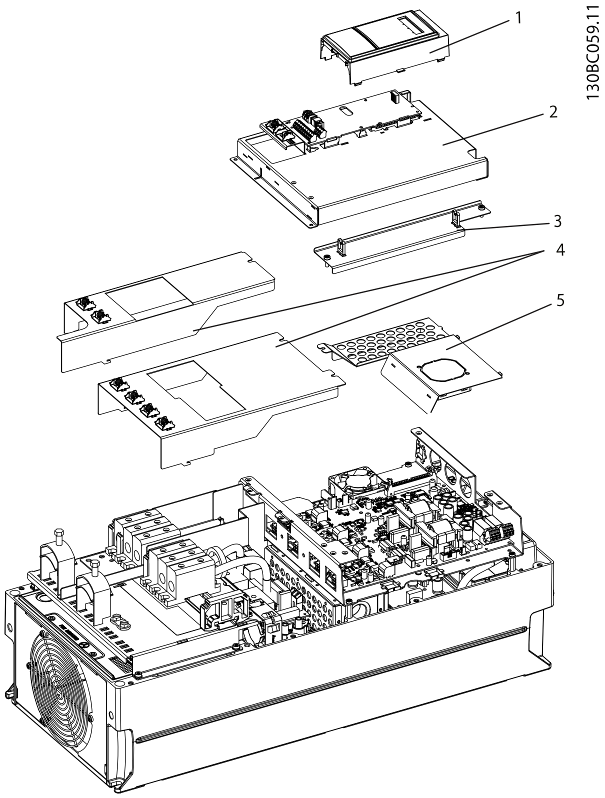

Illustration 8.24 Control Card Mounting Plate

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

Table 8.24 Legend to *Illustration 8.9*

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.

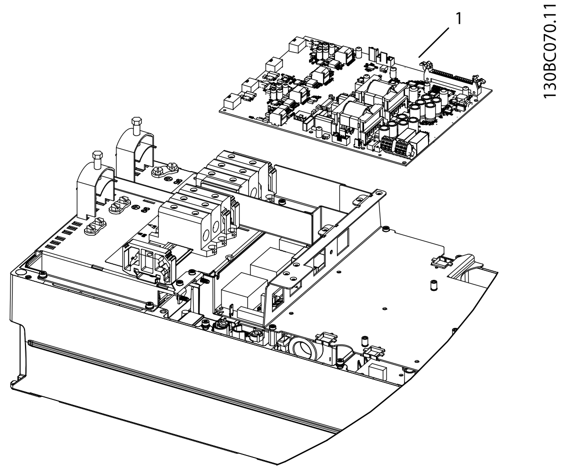

Illustration 8.25 Power Card

1	Power card

Table 8.25 Legend to *Illustration 8.10*

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.

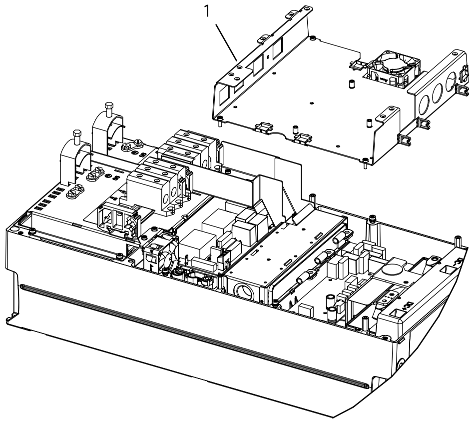

Illustration 8.26 Power Card Mounting Plate

1	Power card mounting plate

Table 8.26 Legend to *Illustration 8.11*

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.

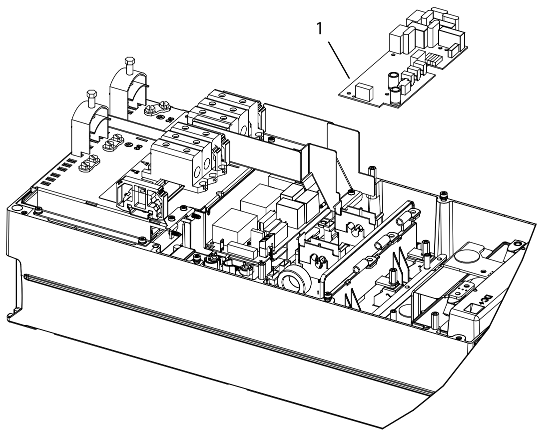

Illustration 8.27 Inrush Card

1	Inrush card

Table 8.27 Legend to *Illustration 8.12*

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.

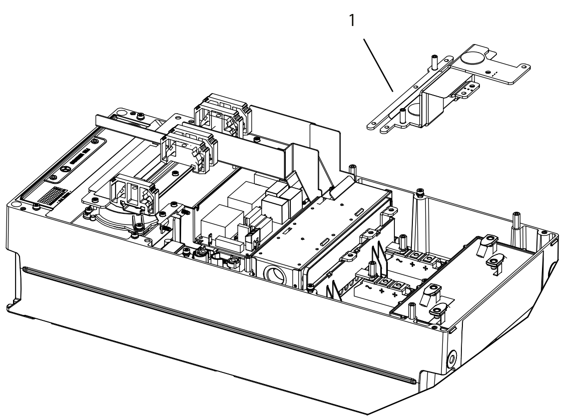

Illustration 8.28 Bus Bar

1	Bus bar

Table 8.28 Legend to

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.

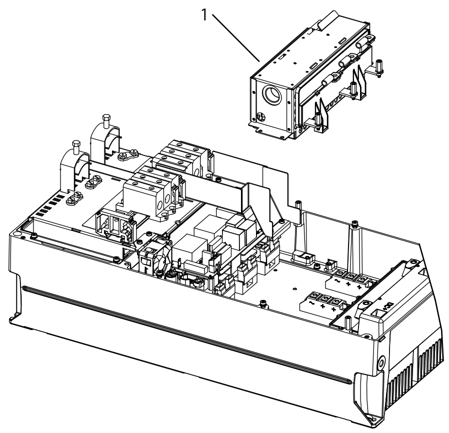

Illustration 8.29 RFI Filter

1	RFI filter

Table 8.29 Legend to *Illustration 8.14*

8

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.

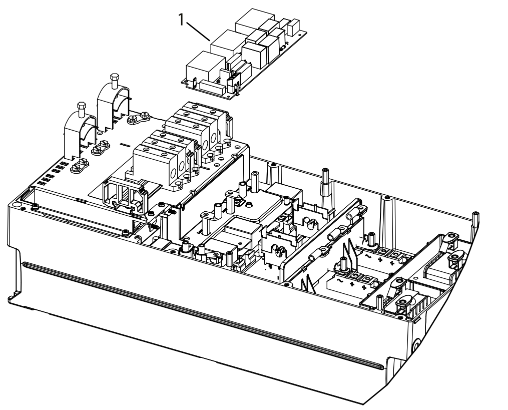

Illustration 8.30 Relay Transducer Card

1	Relay transducer card

Table 8.30 Legend to *Illustration 8.30*

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.

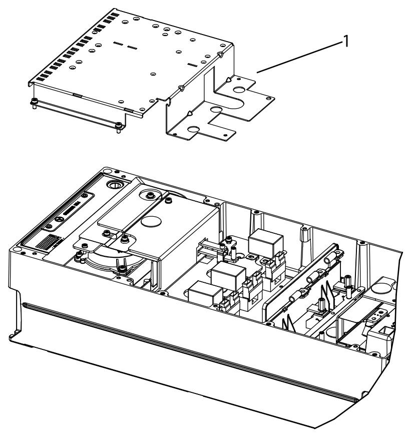

Illustration 8.31 Terminal Plate

1	Terminal plate

Table 8.31 Legend to *Illustration 8.31*

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.

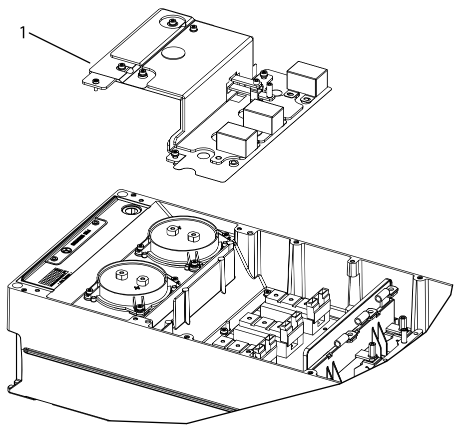

Illustration 8.32 DC Bus Bar Assembly

1	Bus bar assembly

Table 8.32 Legend to *Illustration 8.32*

8.4.10 Heatsink Fan Assembly

1. Remove 4 screws (T20) from the heatsink 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.

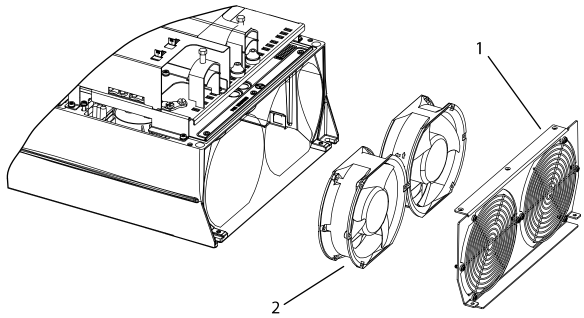

Illustration 8.33 Heatsink Fan Assembly

1	Fan cover plate
2	Heatsink fan

Table 8.33 Legend to *Illustration 8.33*

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.

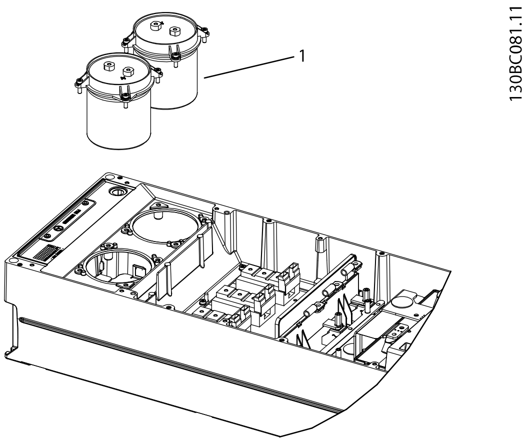

Illustration 8.34 Capacitors

1	Capacitors

Table 8.34 Legend to *Illustration 8.20*

8.4.12 DC Coil

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

Reinstall in the reverse order.

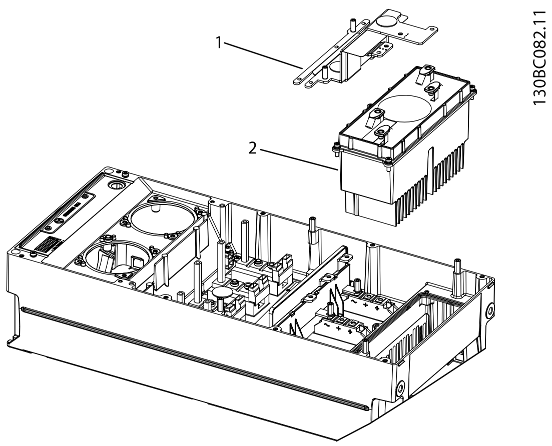

Illustration 8.35 DC Coil

1	Bus bar
2	DC coil

Table 8.35 Legend to *Illustration 8.21*

8.4.13 IGBT

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

⚠CAUTION

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

2. Remove all IGBTs.

Reinstall in the reverse order.

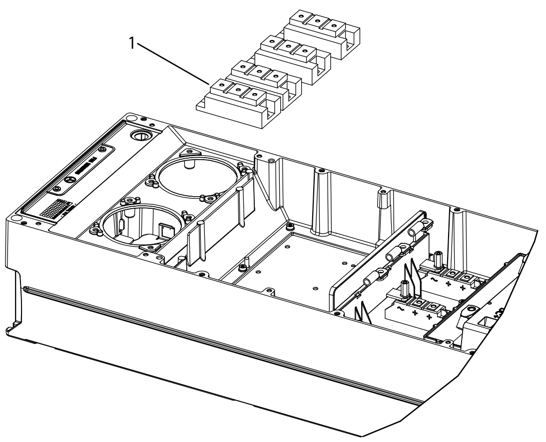

Illustration 8.36 IGBT

1	IGBT

Table 8.36 Legend to *Illustration 8.36*

8.4.14 Thyristor

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

⚠CAUTION

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

2. Remove the thyristors.

Reinstall in the reverse order.

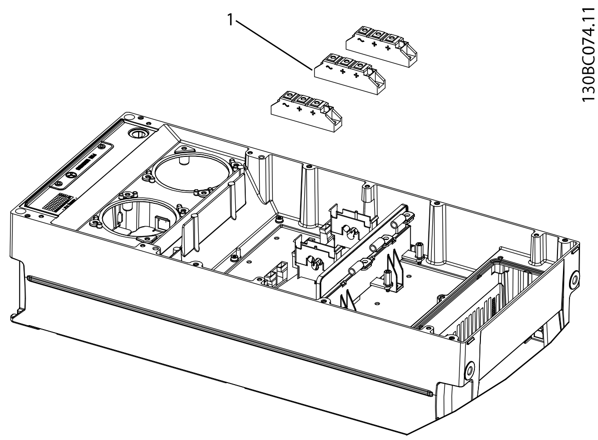

Illustration 8.37 Thyristor

1	Thyristor

Table 8.37 Legend to *Illustration 8.23*

9 Block Diagrams

9.1 Block Diagrams, Frame Sizes H and 9

9.1.1 H6 Frame Size

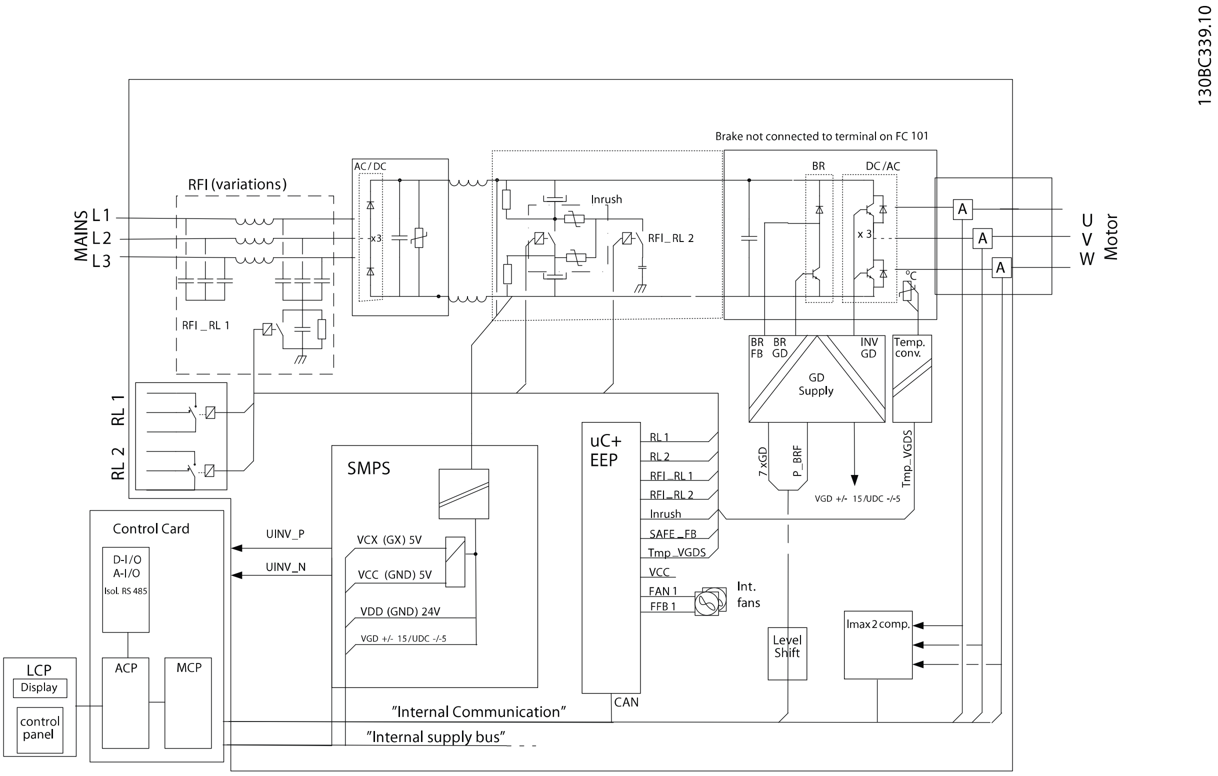

Illustration 9.1 H6 Frame Size

9.1.2 I6 Frame Size

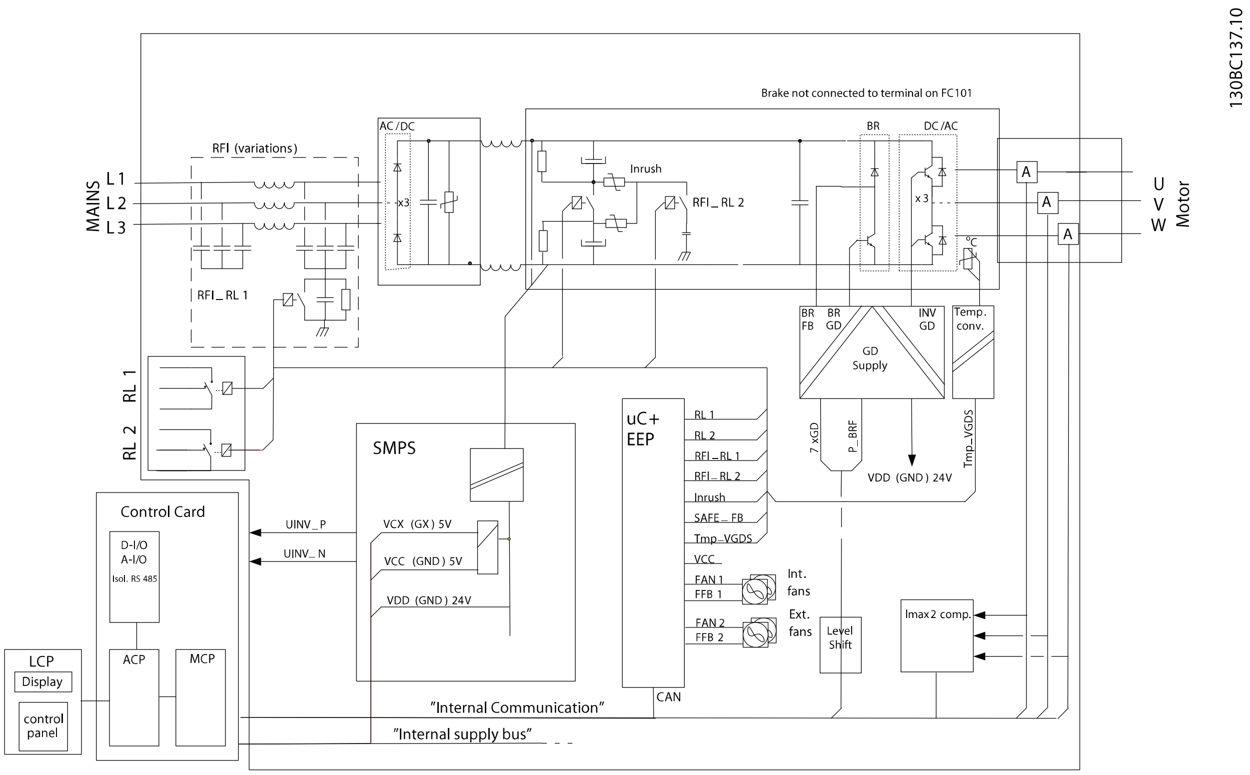

Illustration 9.2 I6 Frame Size

9

9.1.3 H7, H8, I7, I8 Frame Size

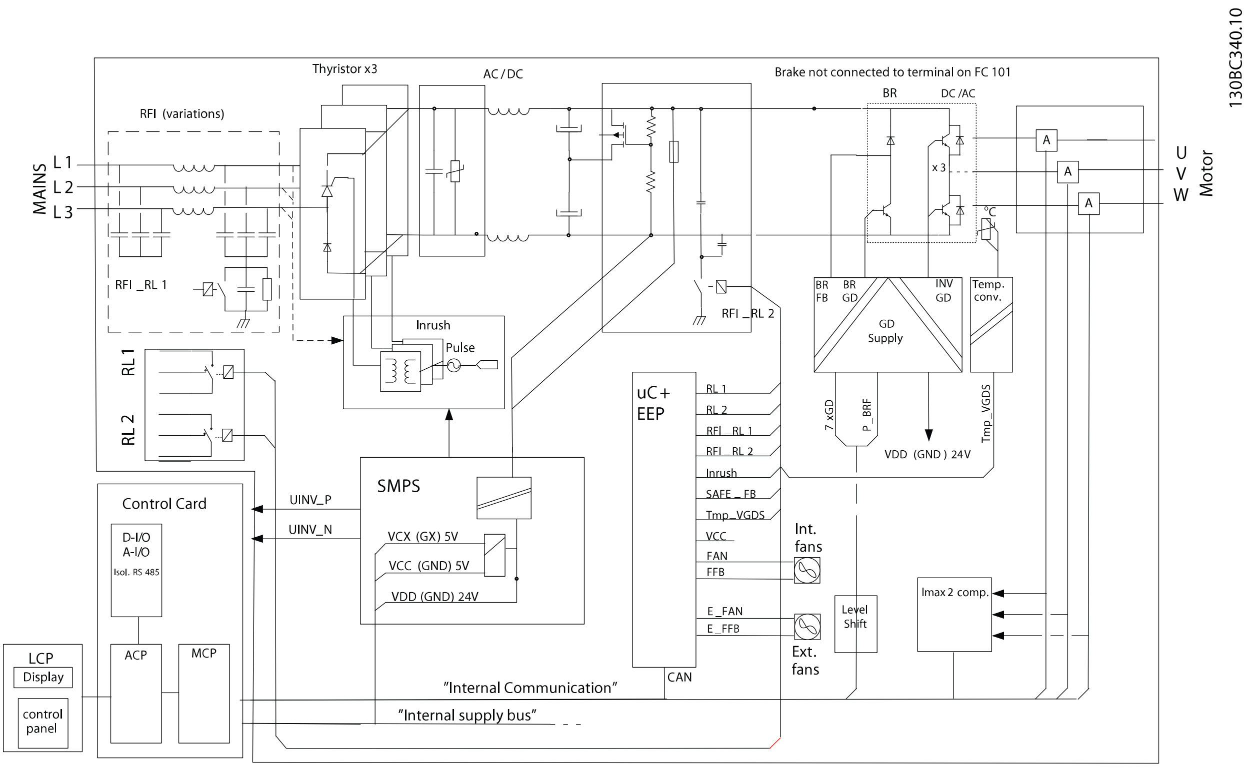

Illustration 9.3 H7, H8, I7, I8 Frame Size

9.1.4 H9 Frame Size

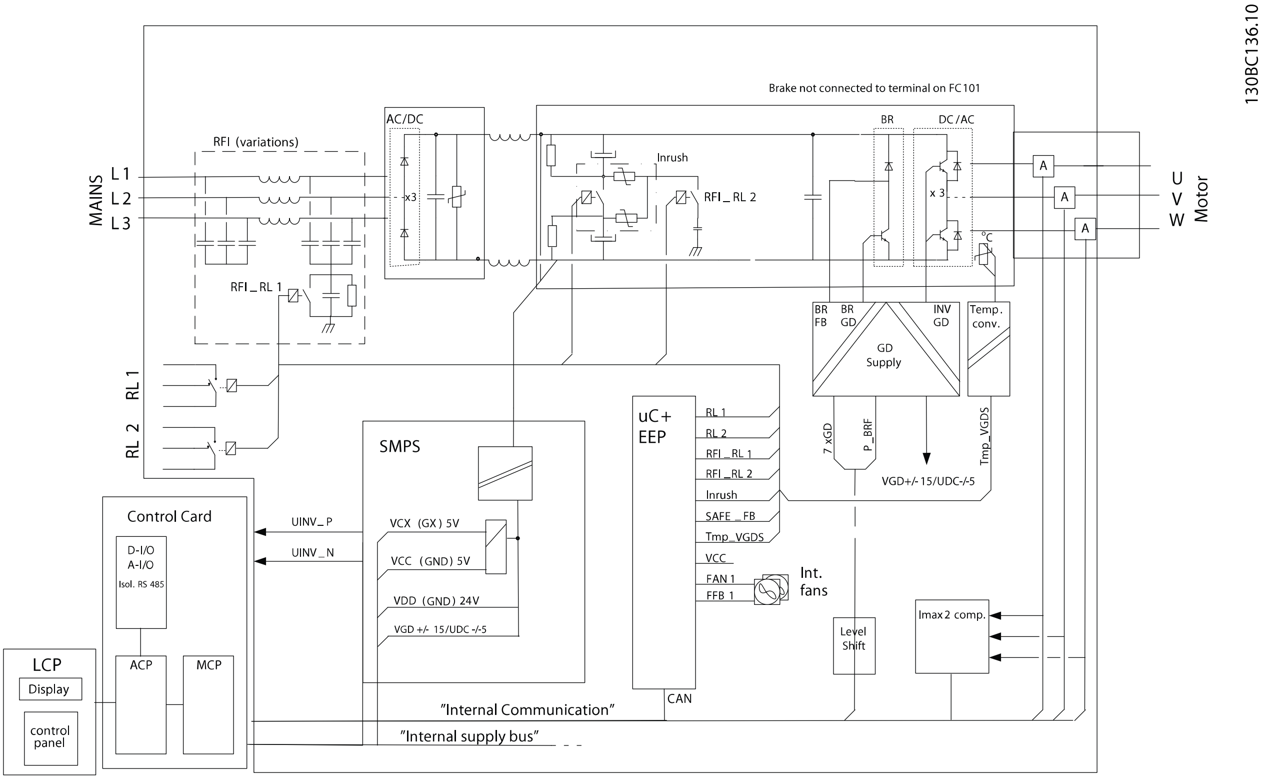

Illustration 9.4 H9 Frame Size

9

9.1.5 H10 Frame Size

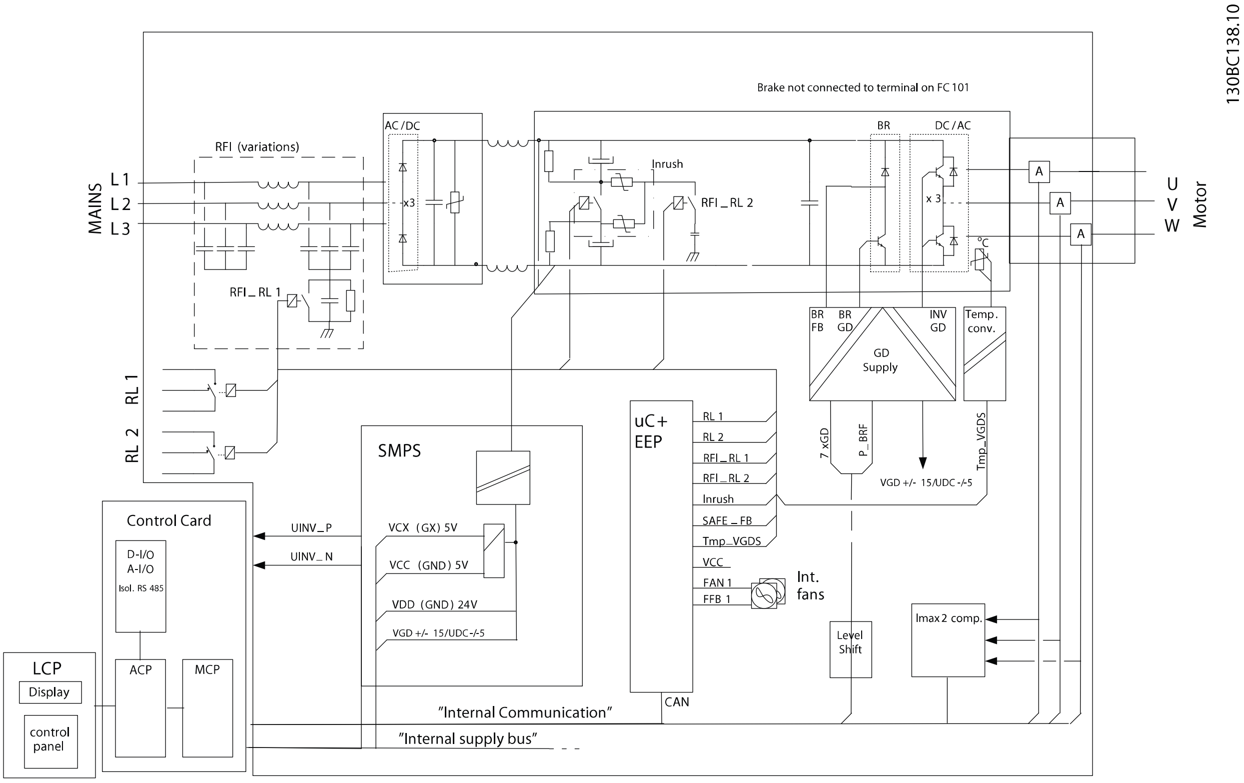

Illustration 9.5 H10 Frame Size

Index

Literature Order Number	BAS-SVM04A-EN
Date	November 2013
Supersedes	

www.trane.com

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

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

130R0538 MG18K102 *MG18K102* Rev. 2013-11-14